Construction Estimating Reference Book

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Estimating Basics

What is Construction Estimating?

Construction estimating is the process of identifying and providing an accurate projection of all costs associated with a specific construction process or project. These costs include the various materials, permits, labor, taxes, and administrative overhead associated with a project. Simple mathematical processes and logic are the building blocks that make up the complex estimates used by construction firms.

Why is Construction Estimating Needed?

The ultimate goal of any business, including those in the construction industry, is to be profitable. Profit is calculated by subtracting the costs of your services from the fee you charge your clients. The more accurate the projection, the easier it is for a construction company to know what to charge their clients.

Articles in the Estimating Basics Unit

The following articles and resources cover all the content required for the Estimating Basics unit.

Construction-specific Math

Estimating Math Concepts

The vast majority of construction estimating problems can be solved using basic addition, subtraction, multiplication, and division skills coupled with a knowledge of simple geometry functions, such as length, perimeter, area, and volume. Additionally, an understanding of a few simple trigonometric functions will be used. This chapter will review these basic concepts and mastering these concepts will enable you to perform most estimating calculations. The review will begin with the concept of length.

Length

The ability to add, subtract, multiply and divide length is the most fundamental estimating mathematical skill. It is used constantly when performing quantity takeoffs and estimates. The biggest challenge faced with length calculations is that dimensions on construction plans and drawings prepared using the English system of measurement are given in feet, inches, and fractions of an inch. It is common to see length measurements listed in the following format:

11'- 10 ¼"

This measurement would be read as eleven feet, ten and one quarter-of-an-inch. This is a convenient form of measurement for the trade craftsman in the field to use as it corresponds to the layout of most rulers and tape measures in the English system. It is, however, problematic for the construction estimator because he or she frequently needs to add, subtract, multiply, or divide by these fractional numbers. This problem is not as prevalent in the metric system. In the metric system, it is easy to convert 1.19 meters into 119 centimeters. Due to the straightforward nature of the metric system, complicated conversions are generally unnecessary. This chapter will primarily deal with the English system.

Figure 2-1 shows an example of rectangular shaped concrete footing for a small shed.

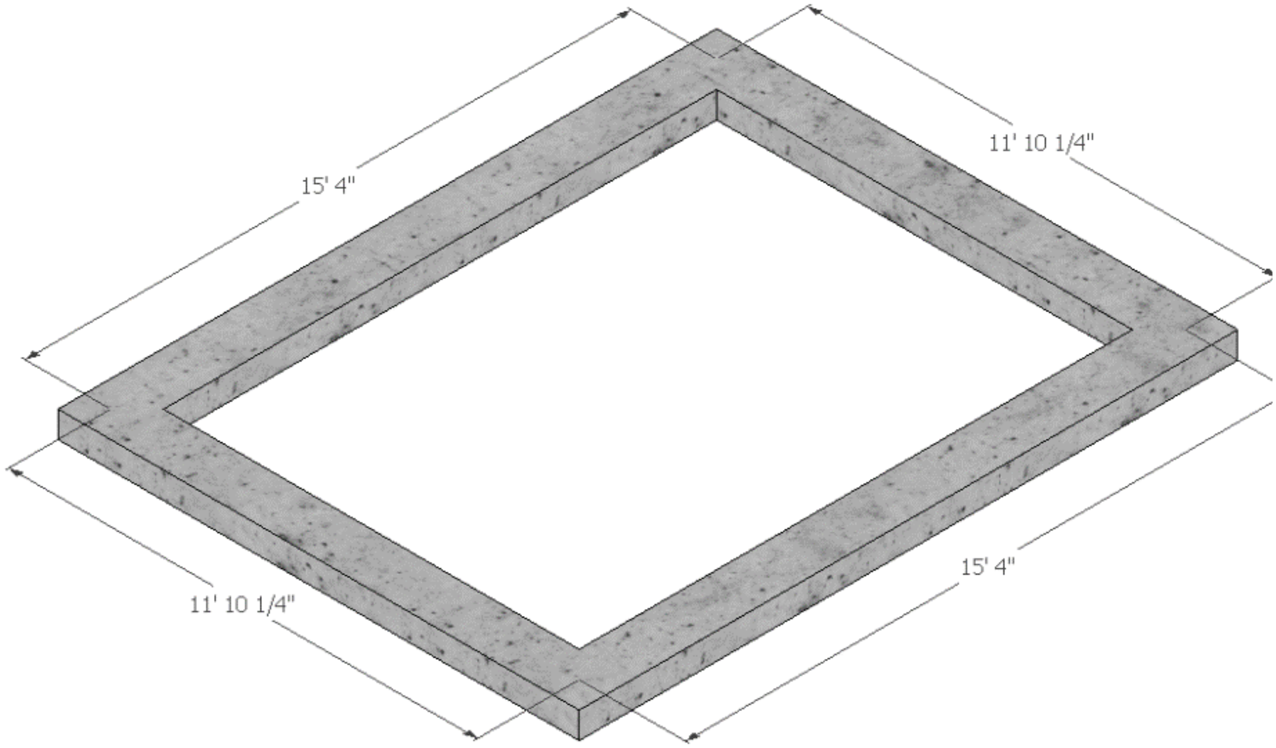

Figure 2-1 Small shed concrete footing.

The dimensions for the footing are given to the center of the footing, and the estimator would need to calculate the total length of the footings by adding up the dimensions of each of the sides.

The manual calculation would be as follows:

15'- 4"

11'- 10 ¼"

15'- 4"

+ 11'- 10 ¼"

To solve this equation, the estimator would first need to add the fractional inches.

¼" + ¼" = ½"

If the total of the fractions is greater than 1 inch, then the result would need to be converted to inches and fractions. Because the example is less than 1 inch, the 1/2 inch can be left in the fractional form. Next, the inches would be added together, and if the total is greater than 12 inches, it would need to be converted into feet and inches by dividing the total by 12.

4**" + 10" + 4" + 10" = 28" ÷ 12" = 2'- 4"**

The 2 feet from the inch column would be carried over to the feet column, and the total feet would be added together.

2' + 15' + 11' + 15' + 11' = 54'

The total calculation would read

54' - 4 ½"

Calculations like this are very accurate, but it can be time-consuming to perform. The estimator should not only strive for accuracy but also speed. One method of accelerating the process is to convert the fractional numbers into a decimal format. Modern calculators can do this quite easily. In addition, formulas can be written in Microsoft Excel to speed up the process; however, the estimator should strive to do basic fraction-to-decimal conversions in his or her head.

Fractions of an inch are converted to decimal form by dividing the numerator by the denominator. The one-quarter-inch fraction in the previous example can be converted to a decimal by dividing the 1 by the 4, as shown below.

1 ÷ 4 = 0.25

Any fraction could be converted to decimal form using this method, but accuracy closer than one-quarter-of-an-inch is not necessary. Memorizing the following three fractional conversions will be sufficient in most construction estimating circumstances:

¼" = 0.25"

½" = 0.5"

¾" = 0.75"

Converting inches to feet is done in similar fashion, except that the inch dimension is divided by 12. The following chart shows the inch conversions:

1" ÷ 12" = 0.083'

2" ÷ 12" = 0.167'

3" ÷ 12" = 0.250'

4" ÷ 12" = 0.333'

5" ÷ 12" = 0.417'

6" ÷ 12" = 0.500'

7" ÷ 12" = 0.583'

8" ÷ 12" = 0.667'

9" ÷ 12" = 0.750'

10" ÷ 12" = 0.833'

11" ÷ 12" = 0.917'

As is the case with fractions, memorizing a few of the inch conversions will be sufficient in most cases. The five conversions highlighted above should be memorized.

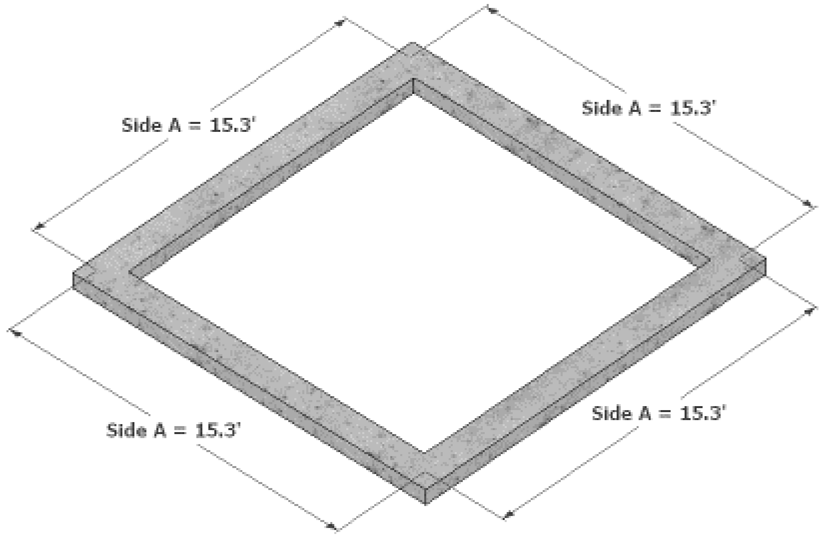

Figure 2-2 Perimeter of a square footing where each side is 15.3 feet' long

In practical reality, the estimator should be able to quickly perform a rough calculation for the length of the shed footings in his head by converting the fractional dimensions to decimal form and rounding close dimensions. Using this method, the estimator would convert the 15' 4" length to 15.3' and the 11' 10 ¼" would be rounded up to 12' leaving a simple calculation of

12.0' + 15.3' + 12.0' + 15.3' = 54.6'

In this example, the 54.6' length would be close enough to get an accurate estimate of the length of the footings and would result in about 1/5 of a cubic foot (one or two shovels full) of additional concrete for the footing.

Perimeter

The previous example with the concrete footings shows an important use of length calculations in determining the perimeter of various shapes. Calculating the perimeter of basic square or rectangular shapes could be done by adding up the length of each side, as was shown in the previous example; however, slightly more complex formulas would be more useful.

Perimeter of Squares and Rectangles

A square is a rectangle shape where all the sides are the same length. The perimeter of a square where the length of each side is 15.3' long, as shown in Figure 2-2, could be written as

15.3' + 15.3' + 15.3' + 15.3' = 61.2'

This would work, but as will be shown when creating formulas for the spreadsheet calculator, it can get unwieldy to use. A simpler formula would be to multiply the length of the single side by 4.

Length of Side A × 4

15.3' × 4 = 61.2'

The formula for a rectangle would be slightly more complex because it involves sides of two different lengths. Instead of using the previous example for the rectangular footing in Figure 2-3, the formula would be written as the Length of Side A × 2 + Length of Side B × 2.

15.3' × 2 + 12.0' × 2 = 54.6'

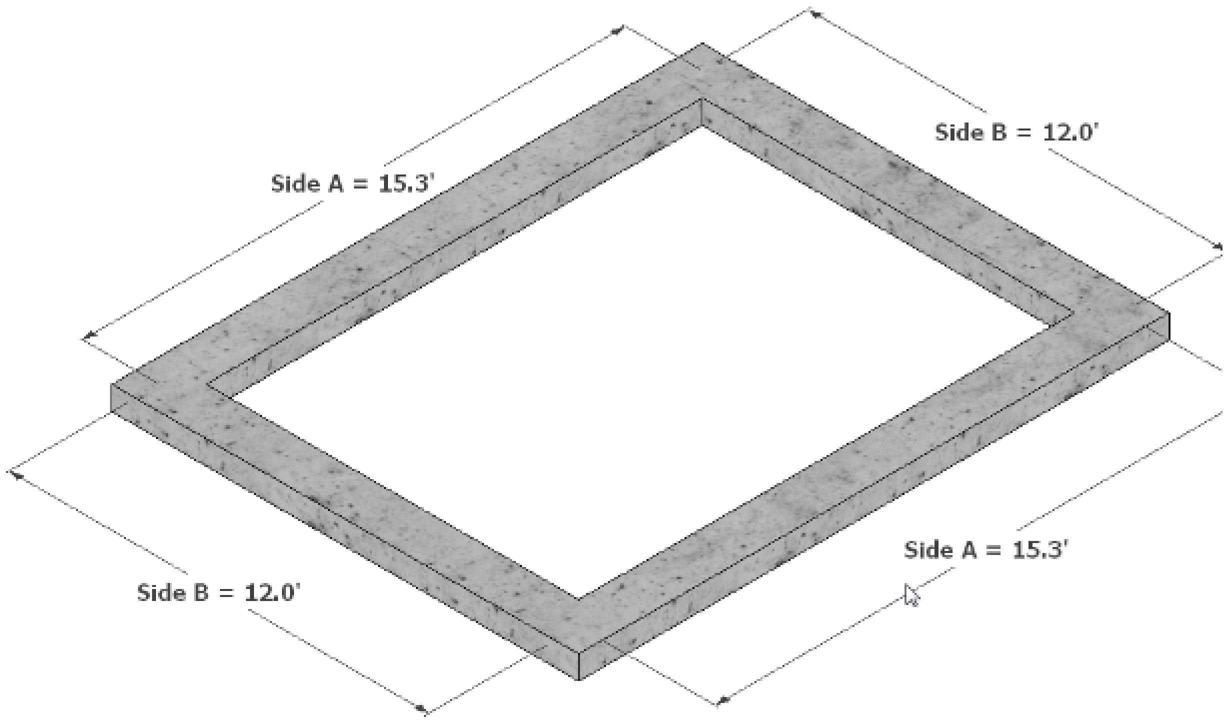

Figure 2-3 Perimeter of a rectangle footing with two side being 15.3 feet and two sides being 12.0 feet

Perimeter of Circles

The traditional formula for calculating the perimeter of a circle is

$$\text{Radius} \times 2 \times \prod$$

Radius is the distance from the center of a circle to its edge, and ∏ is the symbol for the Greek letter pi (pronounced pie) and represents the mathematical constant of 3.14159…, which is a ratio of a circle's diameter to its circumference. The diameter of a circle is the distance across the circle at its center point. Figure 2-4 shows a circle whose radius is 10' and corresponding diameter is 20'.

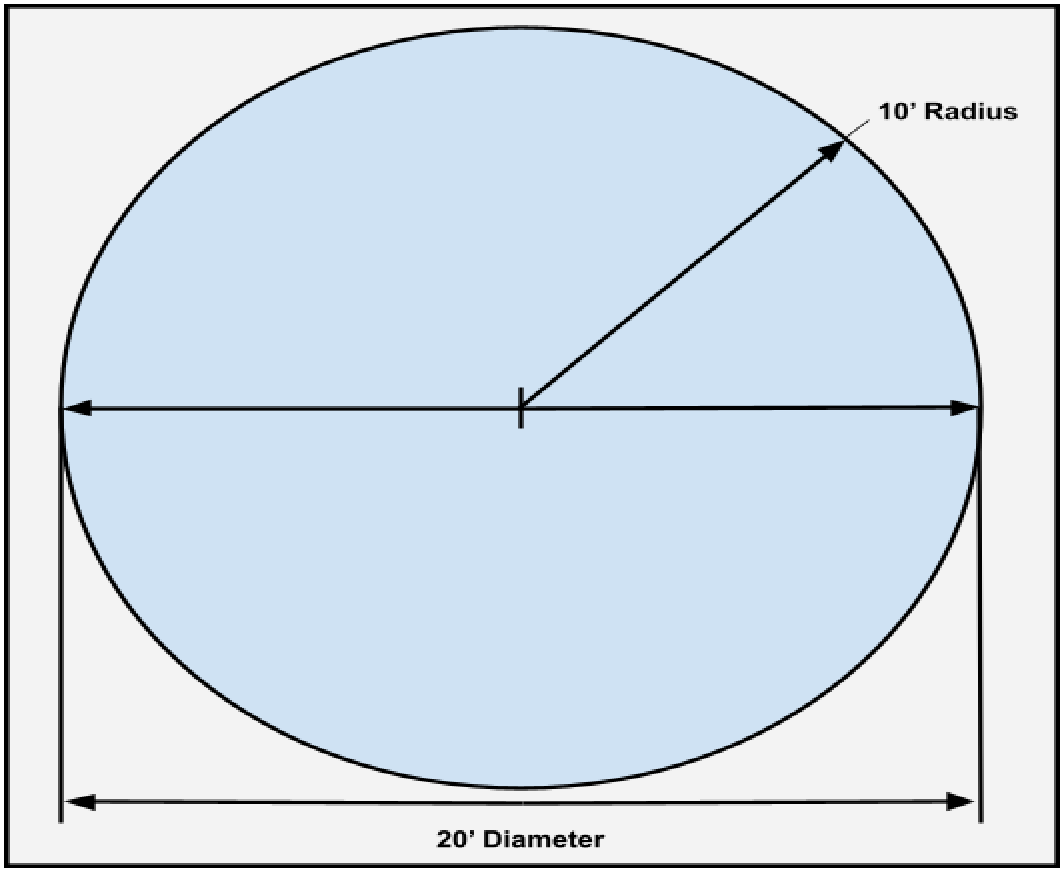

Figure 2-4 Circle with 10-foot radius and 20-foot diameter.

The formulas for calculating the perimeter of the circle in Figure 2-4 would then be

Radius × 2 × ∏

10' × 2 × 3.14159 = 62.83'

Or

Diameter × ∏

20' × 3.14159 = 62.83'

Both formulas will result in the correct answer.

Perimeter of Partial Circles

The estimator may need to calculate the perimeter distance of a partial circle, or what is called the arc length of the partial circle. A common way to do this is to take into account the angle of degree that the partial circle contains. A full circle is divided into 360 degrees. A partial circle would represent some fraction of the full circle. Figure 2-5 shows the same 20-foot diameter circle that is used in Figure 2-4. The full circle is 360°, and the partial circle arc length is 90°.

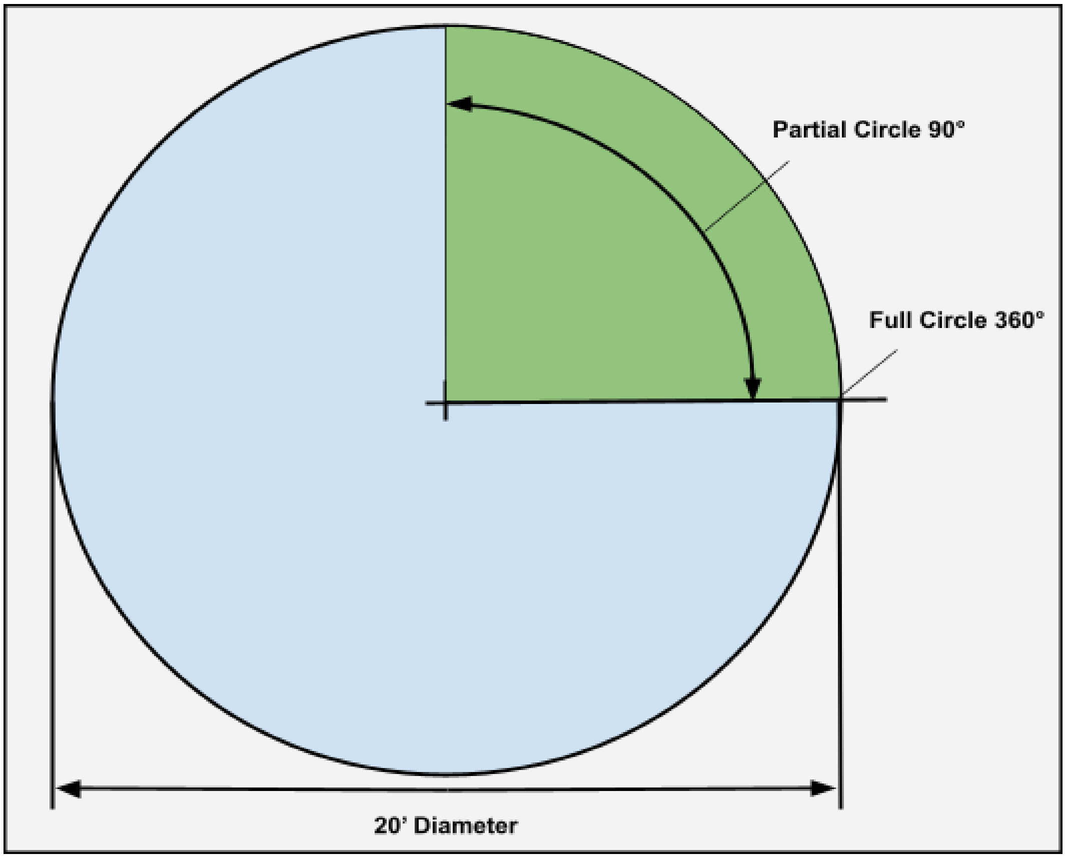

Figure 2-5 90° partial circle arc.

The arc length of the partial circle would be calculated by first determining the fractional part of the circle the arc represents. In this case, the 90° of the arc would be divided by the 360° of the full circle and the results reduced to a decimal equivalent.

$$\frac{90^\circ}{360^\circ} = \frac{1}{4}$$

$$\frac{1}{4} = 0.25$$

The length of the arc would then be calculated by the following formula:

Diameter × ∏ × 0.25

20' × 3.14159 × 0.25 = 15.71'

The arc length of other partial circles can be calculated in a similar fashion.

Perimeter of Triangles

Calculating the perimeter of a triangle depends upon the type of triangle. The three most common triangle shapes encountered in construction estimating are right triangles, equilateral triangles, and isometric triangles. All triangles are composed of three angles with the total of all three angles equaling 180 degrees. The difference in each type of triangle is how the angles come together to form the shape. Each triangle requires a slightly different method for determining the perimeter.

Perimeter of Right Triangles

Right triangles are triangles that have one 90° angle. The total of the other two angles equal 90°. Figure 2-11 shows several examples of right triangles: an isosceles triangle, a 30-60-90 triangle, and a general triangle. An isosceles triangle has two legs of the same length and two 45° angles. A 30-60-90 triangle has one 30° angle, one 60° angle, and one 90° angle. The two non-90° angles of a general triangle are a combination of angles other than 30°, 45°, and 60°. Each type of right triangle has some common elements: two legs, usually identified as Side A and Side B. The intersection of Sides A and B form the 90° angle. The side opposite the 90° angle is the hypotenuse.

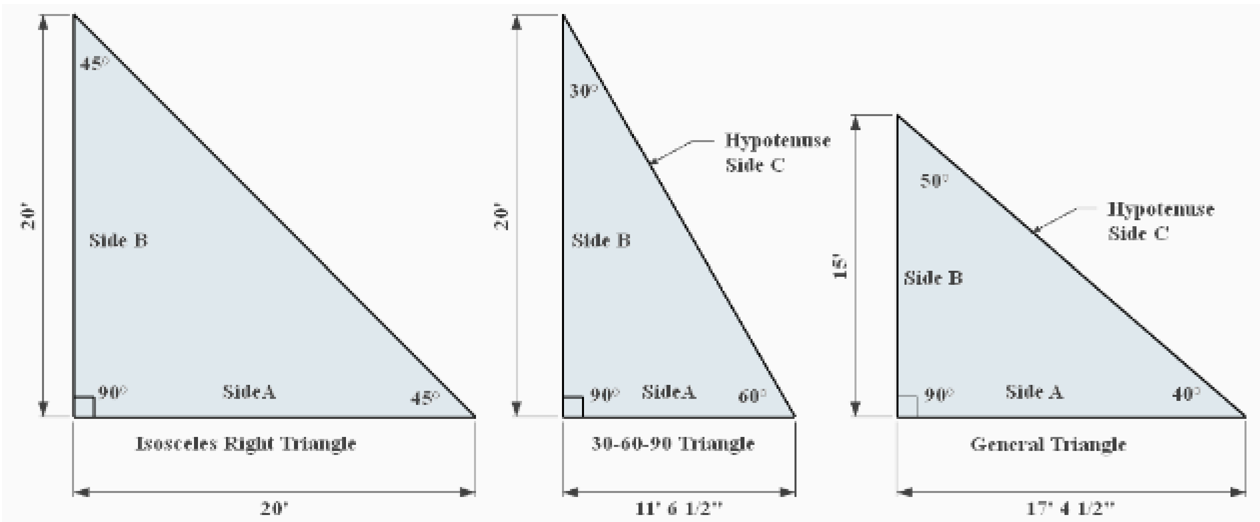

Figure 2-11 Three type of right triangles.

The length of the hypotenuse is determined by using the Pythagorean Theorem, which states that the square of the hypotenuse is equal to the square of the sum of the two sides. This is commonly referred to as

A2 + B2 = C2

Using the Pythagorean Theorem, the hypotenuse for the 30-60-90 triangle in Figure 2-11 could be solved by following the equation Side A^2 + Side B^2 = Side C^2.

$$11 \text{ ft.} - 6 \tfrac{1}{2} \text{ in.}^2 + 20 \text{ ft.}^2 = \text{Side } C^2$$

$$11.54 \text{ ft.}^2 + 20 \text{ ft.}^2 = C^2$$

$$133.17 + 400 = C^2$$

$$\sqrt{533.17\ ft.} = 23.09\ ft.$$

The perimeter of the same triangle would then be solved by following the equation Length Side A + Length Side B + Length Side C.

11.54' + 20' + 23.09' = 54.63'

A calculator would commonly be used to determine the square root of 533.17, but it also could be used to solve the entire 30-60-90 right triangle problem. Calculators are programmed to use mathematical order of operations when solving equations; an understanding of this concept is essential to solve construction estimating problems and writing formulas in Microsoft Excel.

Math Order of Operations

Most students are familiar with the phrase “Please Excuse My Dear Aunt Sally,” which is used to help remember the acronym PEMDAS, which represents the order in which mathematical operations in an equation are solved. The mathematical order is

1. Parenthesis
2. Exponents
3. Multiplication
4. Division
5. Addition
6. Subtraction

In the previous 30-60-90 triangle example, the first step to solving the equation would be to convert the 11'6 ½" to decimal form. The decimal equivalent of the ½" fraction is 0.5" (this fractional conversion should have been memorized), and when it is added to the 6-inch length, it equals 6.5 inches. Next, 6.5 inches will be converted to a decimal foot equivalent by dividing by 12 and adding the decimal inches to the 11 feet. Mathematically the equation would be

$$11 + 6.5 \div 12 = 11.54167$$

This equation works because the order of operations requires division before the addition, and the equation would be solved in the following order

Step 1: $6.5 \div 12 = 0.54167$

Step 2: $0.54167 + 11 = 11.54167$

Perimeter of Equilateral Triangles

Determining the perimeter of equilateral triangles is a little simpler because all three legs of an equilateral triangle are the same length, and each of the angles are the same at 60°. Figure 2-15 shows an equilateral triangle with a length on each side of 20 feet.

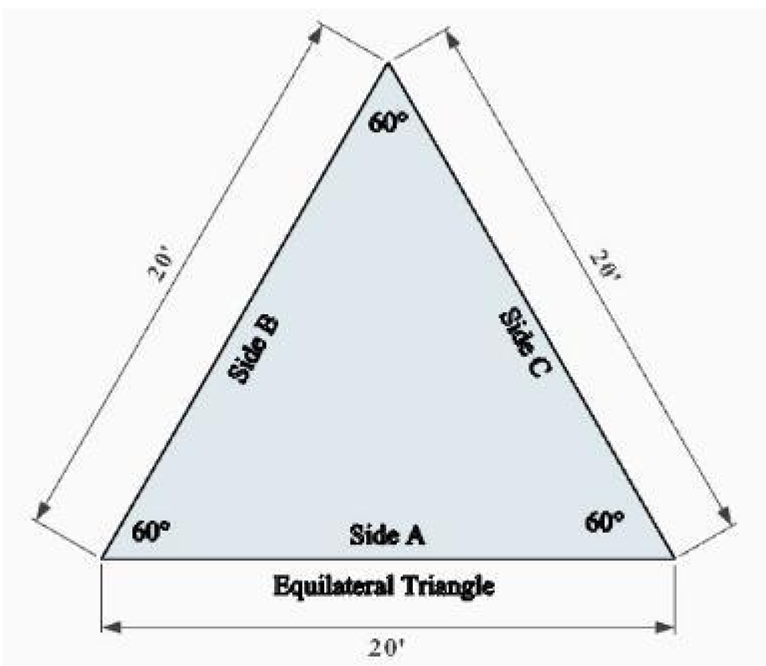

Figure 2-15 Equilateral Triangle

Calculating the perimeter of this triangle is as simple as adding up the three sides, as shown below.

Side A + Side B + Side C

$$20' + 20' + 20' = 60'$$

Calculating the Perimeter of Isometric Triangles

Isometric triangles have two sides that are the same length with two corresponding angles that are also the same. The third side is a different length, and the angle opposite the third side is not equal to either 45 or 60 degrees. Figure 2-16 shows an example of an isometric triangle in which the base is 20 feet long.

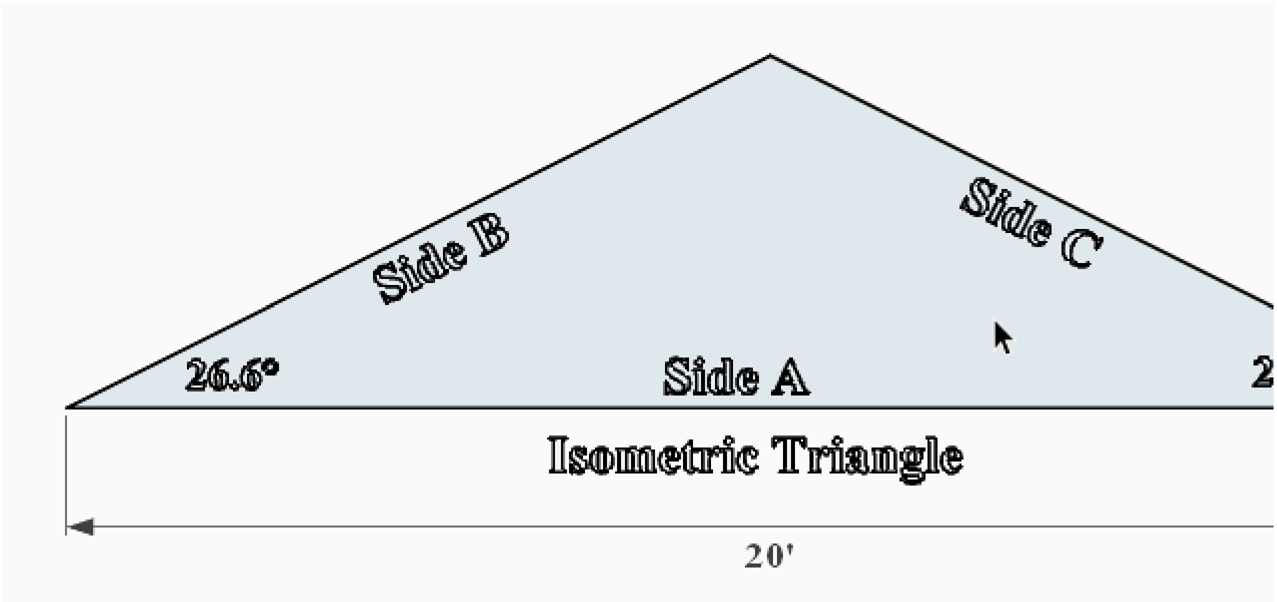

Figure 2-16 Isometric Triangle

In the example in Figure 2-16, the base is 20 feet long, and the two similar angles are 26.6°. Calculating the perimeter of this shape is a little more complex. The simplest method involves separating the isometric triangle into two similar right triangles and then using trigonometric functions to solve for the length of Side B or Side C. Figure 2-17 shows the previous isometric triangle broken into two similar right triangles. The length of the base of each triangle is 1/2 of the previous length of 20 feet or 10 feet.

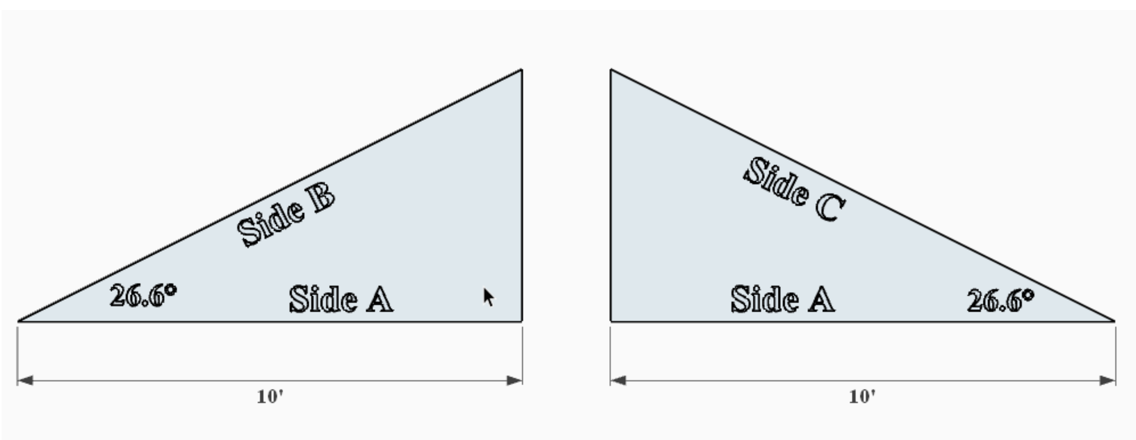

Figure 2-17 Isometric triangle broken into two similar right triangles.

Using Cosine to Solve for Hypotenuse Length

The length of either Side B or Side C can be determined by using one of several methods using simple trigonometric functions. The first function that could be used is the Cosine function. The formula for doing this would be written as

$$\frac{1}{\cos 26.6^\circ} \times 10'$$

The simplest method of determining the Cosine of 26.6° is to use the Cosine function of a calculator. This could be done on most standard handheld scientific calculators. To determine the Cosine of 26.6°, simply type the angle degrees of 26.6 into the calculator and press the Cos key. This will display the cosine value of 26.6°, which is .8941. Next, the results will be divided into one. To do this, press the reciprocal key on the calculator (1/x). This will display 1.18375. Finally, multiply this number by half of the length of Side A (half of Side A of the isometric triangle), which is 10 feet. The results will be 11.18375 feet, which is the length of both Side B and Side C of the isometric triangle (Figure 2-18).

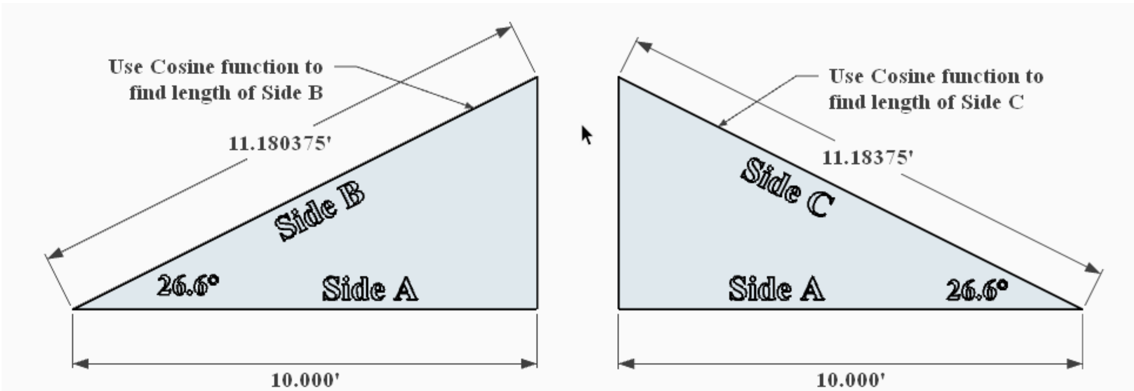

Figure 2-18 Using Cosine to find length of Sides B and C

The perimeter of this isometric triangle would be the sum of the three sides.

20' + 11.18375' + 11.18375' = 42.36750'

Using Tangent to Solve for Height

Another trigonometric function that could be used to solve the isometric triangle would be the tangent function. The tangent function can be used to solve the length of the side opposite the angle of a right triangle. The formula for doing this would be

$$\tan 26.6^\circ \times 10'$$

To determine the tangent of 26.6° using a calculator, enter 26.6 into the calculator and press the “tan” key. The calculator will return the tangent value of 0.500. Next, multiply this by the length of Side A of the triangle or 10 feet. The result will be 5 feet, which is the vertical height of the isometric triangle (Figure 2-20).

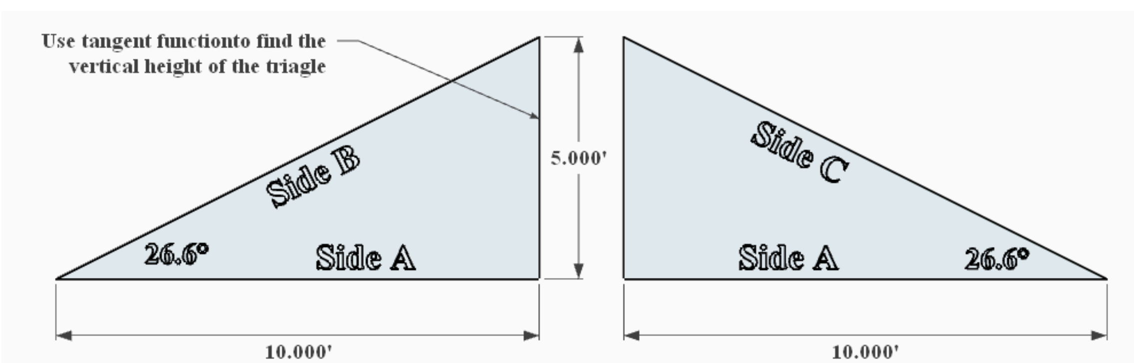

Figure 2-20 Use tangent function to find vertical height of the isometric triangle.

With the vertical height of the isometric triangle known, the Pythagorean Theorem can be used to solve for the length of the hypotenuse.

Using Slope to Find the Perimeter of a Triangle

Construction documents often use the term slope to identify the angles of a right triangle. The slope is a ratio of the vertical height of the triangle to the horizontal length of the triangle. The vertical length is usually called the rise and horizontal length is called the run. The slope is commonly identified in the documents using a slope symbol, which is shown as a triangle where the run is 12 inches and the rise a portion of that. Figure 2-21 shows an example of a shed roof. The roof slope is indicated by slope symbol with the run shown as 12 inches and the rise of 6 inches. This may be expressed as either 6:12 or 6/12.

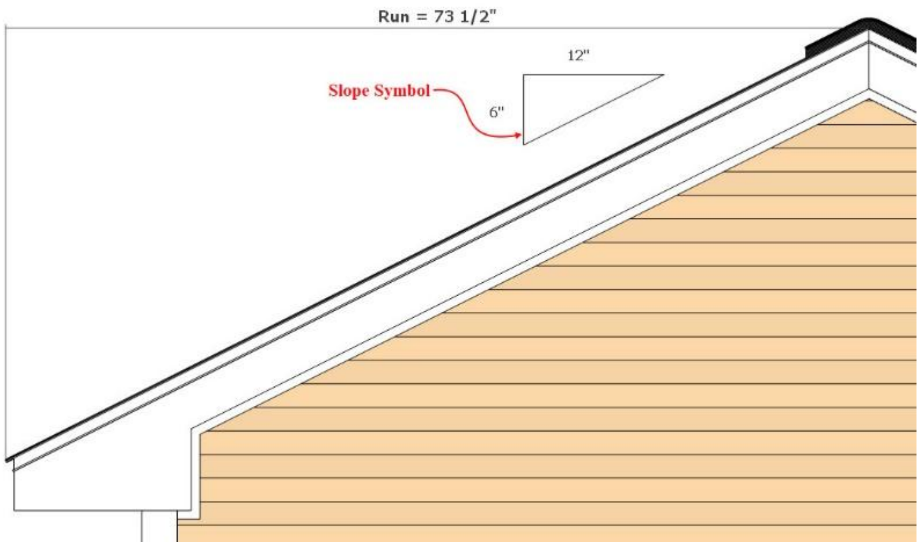

Image of a roof with a labeled slope of 6 over 12 and a total run of 73.5 inches

The slope ratio can be used to determine the length of any side of the triangle when the length of one side is also known. For example, the roof shown in Figure 12-21 has a run length of 73-1/2" the length of the rise can be determined by doing the following:

$$\frac{6}{12}'' \times 73\,\frac{1}{2}'' = 36\frac{3}{4}''$$

With the length of both the rise and run known, the Pythagorean Theorem can be used to calculate the length of the hypotenuse (slope length) by using the following equation:

$$\sqrt{Rise^2 + Run^2}$$

Or

$$\sqrt{73\frac{1}{2}^2 + 34\frac{3}{4}^2}$$

Or

$$\sqrt{73.5^2 + 34.75^2}$$

Or

$$\sqrt{5,402.24 + 1,207.56}$$

Or

$$\sqrt{6,609.81}$$

Or

81.3"

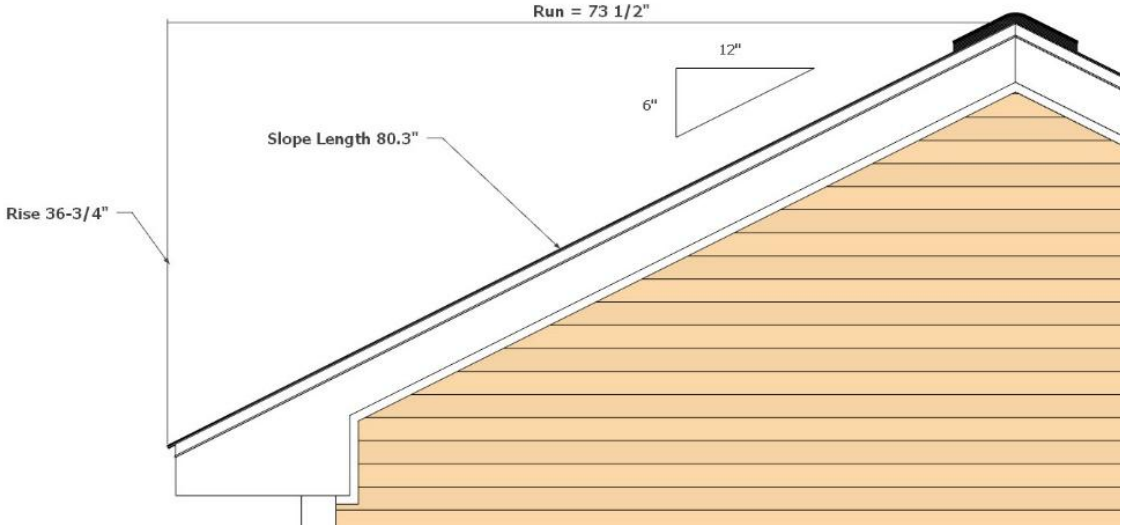

Figure 2-22 Three sides of the roof slope triangle.

Estimate Planning

Effective construction cost estimating is both a science and an art. The science of estimating involves the correct application of proper mathematical principles in calculating material and labor quantities, whereas, the art of estimating involves the subjective part of an estimate. Elements such as the productivity of the labor force can have a huge impact on construction cost. Even on projects that appear similar, many factors of the human equation can affect the productivity of a worker. The effective estimator will apply some measure of art to the scientifically calculated quantities.

Recommended steps to effectively plan an estimate include estimating systematically, estimating the same each time, following the construction sequence, and controlling your environment. The discussion will begin with estimating systemically.

Estimating Systematically

Estimating systematically means to establish some form of system when preparing the estimate. The system could consist of many parts. For example, one part of the system when doing a lineal feet of wall could include the physical way of completing the takeoff. The estimator could start at the top left corner of the document and complete the takeoff measuring all horizontal walls moving towards the right and bottom of the page, marking off each horizontal wall as it is counted. Next, the vertical walls could be counted using the same pattern. Another part of the system could be to use colored markers or pencils to mark off each element as it is counted, with a specific color representing a specific construction element.

An additional part of the system could include identifying each type of quantity that is to be calculated. For example, concrete footing could be calculated using a cubic yard quantity or a lineal foot quantity. Either one could be correct depending upon the need in the estimate. The key would be to determine which method is appropriate for which instance and to systematically apply the appropriate system in the correct instance. Another aspect of estimating systematically could include monitoring and updating the system as the need arises.

Estimate the Same Each Time

Estimating the same each time is closely related to estimating systematically but might include additional elements such as measuring to specific parts of the element. For example, when calculating lineal feet of wall, the length could be determined by measuring from the center line to the center line of walls. It could also be calculated by measuring to one side of the wall. Where there are corners or intersections, the corners could be counted a single time, or they could be double counted. Again, either way could be appropriate depending on the circumstances.

Following the Construction Sequence

It is generally recommended that estimates be prepared in the order of the construction sequence. This helps in the mental process of building the project in your mind. In addition, it provides the opportunity to identify challenges and obstacles that elements installed early in the construction process might cause for elements that are installed at a later time.

Control Your Environment

Estimating is a difficult mental process. It takes work and concentration to visualize in the mind the construction process. Failing to control the environment can lead to a break in concentration which can lead to errors or omissions in preparing the estimate. A few of the principles that go into controlling your environment could include laying out the room to your advantage, working without interference, and confining phone calls to outgoing calls.

Layout the Room to Your Advantage

The room where the estimate is made should be set up to aid in the estimating process. When working with paper plans, there should be a table sufficiently large to allow the plans to lay flat and easily turn the pages. Supplementary materials such as reference materials, catalogs, estimating tables, and price lists should be easily available without having to waste time searching for them.

Computers should be comfortable and convenient to use. Large monitors and multiple screens can be an asset, especially when graphic or computerized takeoff programs such as On Screen Takeoff or Bluebeam are used. Computer files should be structured and set up to aid in the estimating process and allow for easy access of information and materials.

Other aides such as pencils and markers should be easily accessible and easy to use.

Confine Phone Calls

Phone calls should be limited to those which pertain to the current estimate to not cause distractions.

Work Without Interference

Interruptions can cause significant wasted time and can result in mistakes that can cost thousands of dollars.

Figure 5-1 Control the estimating environment.

http://maxpixel.freegreatpicture.com/Architecture-Architectural-Drawing-Plans-Drawing-2284505

Steps in the Estimating Process

Important steps in the estimating process include making a job site visit, plan review, developing a mental visualization of the job, and contingency planning.

Job Site Visit

One important activity of planning the estimating process is to make a visit to the job site. Even if there are adequate plans and specifications, additional essential information can be obtained during a job site visit. Often that information cannot be determined in any other way. Items to include in a checklist of a job site visit should include the following:

Utilities

One of the first things to check on a job site visit is the public and private utility locations on the site. These services include electrical power, sewer and water, fuel gas, telephone, television, and computer internet.

Electrical Power Supply

Information about the location and condition of the electrical power supply is essential. Power may be supplied either overhead or underground. In addition to the permanent power supply for the finished project, temporary power will also need to be supplied during the construction process and some procedures made for the transition from temporary power to permanent power at a point in the process.

Questions such as where will the temporary power pole be set if needed? Who will supply and install it, the contractor or the power company? Where will the power meter be located and where will power enter the home?

Sewer and Water Supply

Construction projects also have needs for both temporary and permanent water supply. The source of the water and sewer should be determined. Will it be supplied using public utilities or do well and septic systems need to be installed? Where will the sewer and water enter the house?

Public utility water and sewer main lines typically are run on one side of the street or alley. If the supply lines are located on the opposite side of the street, plans will need to be made for either excavating the street or drilling under the street.

The depth of sewer and water lines will also need to be determined particularly if the structure includes a basement. Public sewer lines may not be deep enough to allow for basement bathroom fixtures without the additional installation of a separate sewage pump. The same is also likely true with septic systems as many public health utilities only allow for shallow septic systems installations.

Fuel Gas Supply

Many construction projects also have a requirement for fuel gas supply. The fuel gas may be either natural gas which is supplied through a network of underground supply lines, or propane which usually has a supply tank located on the site with underground lines running from the tank to the appliances. Natural gas supply lines may also be run on a single side of the street. The placement of the gas meter or propane tank will need to be determined, and the location where the gas will enter the structure will also need to be established.

Telephone, Television, and Computer

Utilities can also include other electrical and electronic transmission facilities such as telephones, television, and computer internet networks. Transmission supply for these utilities can also be located above or underground. Satellite systems and receivers may also need to be installed.

Job Site Logistics

Job site logistics include essentials such as the access to the job site, trash management, sanitation, and job site security.

Job Site Access

Provisions will need to be made for access of construction materials and equipment during the building process. There may need to be places for laydown and storage of supplies delivered to the job. The unloading, placement, and workspace of construction equipment also need to be considered.

Some building lots may be small, tight, or steeply sloped making it difficult to access all sides of the building. Concrete may need to be pumped and other special arrangements made.

Trash Management

Arrangement will need to be made on most construction projects for the removal of trash and construction waste. Determinations will need to be made such as who will be responsible for the removal of waste. Will individual subcontractors be required to remove their own waste, or will facilities be provided for the joint removal of all waste? Will a waste dumpster be provided on the jobsite and, if so, where will the dumpster be located? Some municipalities do not allow the placement of dumpsters on public streets. In addition, large roll-off dumpsters require a significant amount of space above the dumpster to allow it to be winched up onto the flatbed of the dump truck. Overhead utility lines can interfere with this which could limit the placement of the dumpster.

Figure 5-2 Trash disposal dumpster on a street. Some municipalities do not allow for placement of dumpsters on public streets.

Sanitation

Sanitation facilities such as portable toilets may be required on the job site. Determination will need to be made as to what the needs and requirements are. Placement of any portable toilet facilities will also need to be determined. As is the case with dumpsters, some municipalities may not allow for the placement of temporary sanitation facilities on public streets.

Figure 5-3 Portable toilet on the job site.

Site Conditions

Site conditions include elements of site use and planning such as soil conditions and type, site elevations, storm water requirements, zoning requirements, and deed and restrictive covenants.

Soil Conditions and Type

Visiting the site can provide valuable information about soil conditions at the site and whether further study is needed. The visit should be used to determine as much as possible about the soil conditions. What type of soil is it? Could it be gravel that will require shoring the excavation? There may be expansive clay conditions that would require additional excavation and fill before placing exterior concrete flatwork. Does the topsoil need to be stripped and can it be stored on site, or will it need to be hauled away? Is the topsoil suitable for landscape planting, or will additional topsoil need to be brought in?


Figure 5-4 The heavy rock and gravel content of this soil will require topsoil fill to be brought in.

Site Elevations

Site elevation considerations to take into account include the shape and contour of the building lot. Is it conducive to the style and shape of home to be built? What is the present grade of the lot, and will significant changes to the grade need to be made? What is the final grade of the lot? What is the drainage of the lot, and will there need to be accommodations for stormwater control?

Stormwater Requirements

The Environmental Protection Agency requires a Stormwater Pollution and Prevention Plan (SWPPP) to be submitted on building sites one acre or larger. The SWPPP plan requires the builder to control the drainage of all stormwater on the site and to prevent the silt from excavation from leaching off of the site. The SWPPP plan may require the installation of stormwater control features such as silt fences, drainage mats, and hay bales.

Zoning

Most municipalities have zoning requirements and restrictions. Zoning restrictions may limit the use, size, and type of possible construction within the zoned area. Zoning also usually requires specific setbacks for the front, rear, and sides of the property. It is important to determine if the structure fits within the zoning setback restrictions of the property.

Deed and Restrictive Covenants

In addition to zoning requirements, property may have specific deed and restrictive covenants attached to it. These may further specify the details of construction and can, at times, be very restrictive.

Plan Review

The second step in the estimate planning process includes a plan and specification review. The estimator should review the plans in detail and begin building the plans within their mind. Check the plans and the specific details of the plans and look for any discrepancies. Do the same with the specifications, and make sure that all the details are understood. See that the plans reflect all of the conditions found on the site visit.

How were the plans obtained? Were they supplied by the architect? Were they supplied by the customer, or were they purchased from a plan service? Each of these choices have different ramifications for the construction process. Make sure that all of the changes requested by the owner have been incorporated into the plans. Check to see if the plans meet the local building code. In addition, make sure that you are familiar with the building method used.

Mental Visualization of the Job

During the plan review process, begin the process of building the project in your mind. Focus on how the job will be built and what procedures will be used. What sequence will be followed during the construction process? Identify any nonstandard construction processes that the project will involve.

Use this time to develop questions for the architect and owner. Identify any code clarifications that might be needed and any special requirements for the project.

Contingency Planning

Contingency planning is making plans and preparations to account for unexpected or unforeseen circumstances. This is not the same as just adding amounts to the estimate in case something was forgotten and doesn’t take the place of careful and thoughtful estimating. However, careful and thoughtful planning does include considering possible unexpected outcomes and making contingencies for those outcomes if it seems like the situation warrants it. Some possible areas where contingency planning might be justified could include labor and subcontractors, weather, inflation, and the owner.

Labor and Subcontractors

Labor situations in construction can, on occasion, be volatile, especially during times of high economic growth which can fuel an increase in quantity and size of construction projects. This can lead to shortages of construction craft, subcontractor labor, and increases in wage cost. In addition, the schedule of a project may be slowed down as labor becomes available or needs to be trained.

Weather

The weather can have a significant effect on construction planning and costs. Building in cold climates may require arrangement for temporary heat in the building or for elements of the building to be tented and heated. In addition, workers generally require more time and energy when working in cold conditions. Hot weather can also have a significant effect on building. For example, roofers may not be able to install roofing shingles on a roof during the heat of the day because of damage that can occur from walking on the hot shingles. Rain or other weather factors can also significantly delay the project. These possibilities should be considered when undertaking and planning an estimate.

Caption

Inflation

The construction industry can be a very volatile business and is very sensitive to inflationary pressures, both positive and negative. From 2003 to 2005, residential inflation increased at a rate of 10% per year and the years 2007 until 2011 experienced a 17% deflation over the four-year period. New residential construction again returned to an inflationary cycle from 2013 to 2017 that averaged 6% per year (2). Planning for such volatile cycles can be challenging, especially on construction projects that can span multiple years. The current economic climate does need to be considered when planning an estimate. Questions to consider include whether lumber prices are rising or falling and if construction labor costs are rising or falling. If the situation warrants it, contingencies may need to be included in the estimate. Current inflation trends can easily be found from a number of sources, including government and private sources such as the National Association of Home Builders.

The Owner

A construction contractor once wrote:

> *"Working for nice people virtually eliminates bad debt, boosts crew morale, reduces callbacks, and improves referrals. You sleep better at night and have an easier time coming to work Monday mornings,*

and so do the people you work with…. What we can't do is make a chronically angry, resentful person happy with our work no matter how hard we try. We can't make an irrevocably untrusting soul feel comfortable letting us in his house. We can't (and shouldn't) adjust our prices sufficiently to satisfy a stubborn tightwad."

Journal of Light Construction, Paul Eldrenkamp, December 2001

All construction projects ultimately have an owner. If the owner is known at the time that the estimate is prepared, it would be appropriate to include in the contingency planning any additional costs that could be incurred as a result of working with a difficult owner. As the previous article mentions, some owners can be easy to deal with and others less so. There is a real cost involved in working with difficult owners. Part of contingency planning should include evaluating the requirements and temperament of the owner.

CITATIONS:

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How to Complete Materials Estimates

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Material Size, Unit, and Unit Cost Definitions

When estimating materials in the Estimating Workbook, Size, Units, Unit Cost, Quantity, and Waste must all be calculated and accounted for. It is vital to understand what each of these terms mean in the context of construction estimating.

Size	the number of units included in a package
Unit	the way the material is measured and sold by the supplier. Like a package
Unit Cost	How much a single unit of the material costs to purchase from a supplier
Quantity	The number of packages that must be purchased to successfully complete the project
Waste	The percentage of material that is anticipated to be unused or unusable due to error or unforeseen circumstances

Definitions for Size, Unit, Unit Cost, Quantity, and Waste

Soft Drink Example

You plan to host a party to watch a sporting event on television with friends. Seven people will be present, including yourself.

You will provide beverages to your guests, who all prefer the same soft drink. You anticipate that over the course of the event, each person will drink three soft drinks. You know from experience that some of your guests will not finish their drinks, and that some may drink more than three.

You go to the store, and find that the soft drink is only sold in packages of six cans for $3.50 per package. You decide to purchase four packages of soft drinks. If you were to use the construction estimating definitions of the terms above, they would fit this example as follows:

- Material - Preferred Soft Drink
- Size - 6
- Units - cans/pk
- Unit Cost - $3.50
- Quantity - 4

The Size is listed as 6 because the Unit is defined as cans/pk. If the Unit were defined as pack, the Size would be 1. This is problematic because you might not know how many cans are included in a pack, which is why the Unit is defined as cans/pk.

You intend for each of the seven attendees to drink three soft drinks. If you purchase four packages of six cans, you will have 24 total cans for the event. This is the minimum you must purchase to provide three cans to each attendee, and there should be three cans left over. This is why the Quantity is listed as 4.

Shoe Example

You need a new pair of shoes. You go to the store and find a pair that you like. It costs $65.00. If you were to use the construction estimating definitions of the terms above, they would fit this example as follows:

- Material - Shoes
- Size - 1
- Units - pair
- Unit Cost - $65.00
- Quantity - 1

In the above example, you have two feet, which require one pair of shoes. The Size is 1 because the Units define shoes as being sold in pairs. You cannot purchase shoes individually. Given your need and the Units at which shoes are sold, you require 1 unit, which is 1 pair. This is why the Quantity is listed as 1.

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How to Calculate Material Size in Excel

Size, Units, and Unit Cost are defined by the suppliers from which you purchase your construction materials. Because of this, the Estimating Workbook includes supplier and material databases that must be referenced when estimating materials for a construction project.

Formula Requirements for Calculating Size

- There must be a defined material.
- If there is no defined material, the cell should read 0.
- If there is a material, the formula should reference the database where that material is found.
- The formula should find an exact match.

Excel Functions Used to Calculate Size

- IF - IF will be used to fulfill the requirement that a material be defined.
- VLOOKUP - VLOOKUP will be used to reference a defined database and pull the required information into the cell.

Size Formula

Definitions

The formula used to calculate Size will use the following definitions:

- material_cell is the the cell in the row that states what the material is.
- “” means blank in Excel formulas.
- database_name is the name of the array that contains the material information from the supplier. It is pre-labeled in the Estimating Workbook.
- column_in_database is the column in the database that contains the information you are looking for; Size, in this case.

Formula Syntax

IF(material_cell=””,0,VLOOKUP(material_cell,database_name,column_in_database,FALSE))

Explanation

Reading the above formula in layman’s terms would be something like this.

IF(material_cell=””	If the material cell is blank.
,0	Display 0
,VLOOKUP	If the material cell is not blank, do a VLOOKUP function.
(material_cell	Look for the material named in the material cell
,database_name	In the database I have chosen.
,column_in_database	In the column of the database I have specified.
,FALSE))	The database must return an exact match.

SIZE Formula Breakdown and Explanation

Example

You are completing the Stair Framing Materials section of the Estimating Workbook.

- The Stringer Spacer row states in cell E372 that the material used for that part of the stairs will be 2” X 4” - 14’ Fir (STD &BTR).
- Cell F372 needs a formula entered that will meet the requirements for calculating Size.

F372 =IF(E372="",0,VLOOKUP(E372,FramMatDB,4,FALSE))

	A	B	C	D	E	F	G	H	I	J	K
71	SunRoc	0%		Sleepers	2" x 4" - RL Fir (STD & BTR)	1	Ft	$ 0.45	3		$ 1.35
72	SunRoc	0%		Stringer Spacer	2" X 4" - 14' Fir (STD & BTR)	14	Ft	$ 8.21	2		$ 16.42
73	SunRoc			Stringer Hangers							$ -
74	SunRoc	0%		Temporary Treads							$ -

Screenshot of the Framing tab, showing the Size formula in the function bar

- The formula will pull information from the Frame Material Database (FramMatDB) via a VLOOKUP function.

A1 Framing Lumber Database

	A	B	C	D	E	F	G	H
1	**Framing Lumber Database**							
2								
3							Suppliers	
4	DESCRIPTION	TYPE	CATEGORY	SIZE	UNITS	BMC(REX)	SunRoc	
16								
17	3-1/2" X 9-1/2" GLUE LAM BEAM	4 X 10	Glam	1	Ft	$ 15.50	$ 14.50	
18	3-1/2" X 13-1/2" GLUE LAM BEAM	6x14	Glam	2	Ft	$ 17.89	$ 17.45	
19								
20	1-1/4" x 9-1/2" Timberstrand	2x10	TmbStrnd	1	Ft	$ 1.75	$ 1.62	
21	1-1/4"X11-7/8 TimberStrand	2x12	TmbStrnd	1	Ft	$ 2.00	$ 1.94	
22								
23	Fink Truss, 2x4 up to 38'	2x4	Truss	1	SF	$ 3.16	$ 3.25	
24	Fink Truss, 2x4 40' to 50'	2x4	Truss	1	SF	$ 3.88	$ 3.98	
25	Fink Truss, 2x6 up to 38'	2x4	Truss	1	SF	$ 4.11	$ 3.99	
26	Fink Truss, 2x6 40' to 50'	2x4	Truss	1	SF	$ 4.56	$ 4.86	
27	Scissor Truss, 2x4 up to 38'	2x6	Truss	1	SF	$ 3.03	$ 3.83	
28	Scissor Truss, 2x4 40' to 50'	2x6	Truss	1	SF	$ 3.99	$ 4.80	
29	Gable Fill Truss 28'	2x6	Truss	1	EA	$ 250.00	$ 255.00	
30	Gable Fill Truss 32'	2x6	Truss	1	EA	$ 299.00	$ 316.00	
31	Gable Fill Truss 40'	2x6	Truss	1	EA	$ 400.00	$ 443.00	
32								
33	Simpson 22x7x4 Shear Wall	2x4	Swall	1	Ea	$ 635.00	$ 650.00	
34								

Screenshot of the Framing Material Database

- Size information is located in the fourth column of the Framing Material Database.
- FALSE is the last component of the formula because it must find an exact match of the material.

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How to Calculate Material Units in Excel

Size, Units, and Unit Cost are defined by the suppliers from which you purchase your construction materials. Because of this, the Estimating Workbook includes supplier and material databases that must be referenced when estimating materials for a construction project.

Formula Requirements for Calculating Units

- There must be a defined material.
- If there is no defined material, the cell should read 0.
- If there is a material, the formula should reference the database where that material is found.
- The formula should find an exact match.

Excel Functions Used to Calculate Units

- IF - IF will be used to fulfill the requirement that a material be defined.
- VLOOKUP - VLOOKUP will be used to reference a defined database and pull the required information into the cell.

Units Formula

Definitions

The formula used to calculate Units will use the following definitions:

- material_cell is the the cell in the row that states what the material is.
- "" means blank in Excel formulas.
- database_name is the name of the array that contains the material information from the supplier. It is pre-labeled in the Estimating Workbook.
- column_in_database is the column in the database that contains the information you are looking for; Units, in this case.

Formula Syntax

IF(material_cell="",0,VLOOKUP(material_cell,database_name,column_in_database,FALSE))

Explanation

Reading the above formula in layman's terms would be something like this.

IF(material_cell=""	If the material cell is blank.
,0	Display 0
,VLOOKUP	If the material cell is not blank, do a VLOOKUP function.
(material_cell	Look for the material named in the material cell
,database_name	In the database I have chosen.
,column_in_database	In the column of the database I have specified.
,FALSE))	The database must return an exact match.

Units Formula Breakdown and Explanation

Example

You are completing the Stair Framing Materials section of the Estimating Workbook.

- The Stringer Spacer row states in cell E372 that the material used for that part of the stairs will be 2” X 4” - 14’ Fir (STD &BTR).
- Cell G372 needs a formula entered that will meet the requirements for calculating Units.

G372 =IF(E372="",0,VLOOKUP(E372,FramMatDB,5,FALSE))

	A	B	C	D	E	F	G	H	I	J	K
372	SunRoc	0%		Stringer Spacer	2" X 4" - 14' Fir (STD & BTR)	14	Ft	$ 8.21	2		$ 16.42
373	SunRoc			Stringer Hangers							$ -
374	SunRoc	0%		Temporary Treads							$ -

Screenshot of the Framing tab, showing the Units formula in the function bar

- The formula will pull information from the Frame Material Database (FramMatDB) via a VLOOKUP function.

A1 Framing Lumber Database

	A	B	C	D	E	F	G	H
1	**Framing Lumber Database**							
2								
3							**Suppliers**	
4	**DESCRIPTION**	**TYPE**	**CATEGORY**	**SIZE**	**UNITS**	**BMC(REX)**	**SunRoc**	
16								
17	3-1/2" X 9-1/2" GLUE LAM BEAM	4 X 10	Glam	1	Ft	$ 15.50	$ 14.50	
18	3-1/2" X 13-1/2" GLUE LAM BEAM	6x14	Glam	2	Ft	$ 17.89	$ 17.45	
19								
20	1-1/4" x 9-1/2" Timberstrand	2x10	TmbStrnd	1	Ft	$ 1.75	$ 1.62	
21	1-1/4"X11-7/8 TimberStrand	2x12	TmbStrnd	1	Ft	$ 2.00	$ 1.94	
22								
23	Fink Truss, 2x4 up to 38'	2x4	Truss	1	SF	$ 3.16	$ 3.25	
24	Fink Truss, 2x4 40' to 50'	2x4	Truss	1	SF	$ 3.88	$ 3.98	
25	Fink Truss, 2x6 up to 38'	2x4	Truss	1	SF	$ 4.11	$ 3.99	
26	Fink Truss, 2x6 40' to 50'	2x4	Truss	1	SF	$ 4.56	$ 4.86	
27	Scissor Truss, 2x4 up to 38'	2x6	Truss	1	SF	$ 3.03	$ 3.83	
28	Scissor Truss, 2x4 40' to 50'	2x6	Truss	1	SF	$ 3.99	$ 4.80	
29	Gable Fill Truss 28'	2x6	Truss	1	EA	$ 250.00	$ 255.00	
30	Gable Fill Truss 32'	2x6	Truss	1	EA	$ 299.00	$ 316.00	
31	Gable Fill Truss 40'	2x6	Truss	1	EA	$ 400.00	$ 443.00	
32								
33	Simpson 22x7x4 Shear Wall	2x4	Swall	1	Ea	$ 635.00	$ 650.00	
34								

Screenshot of the Framing Material Database

- Units information is located in the fifth column of the Framing Material Database.
- FALSE is the last component of the formula because it must find an exact match of the material.

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How to Calculate Material Unit Cost in Excel

Size, Units, and Unit Cost are defined by the suppliers from which you purchase your construction materials. Because of this, the Estimating Workbook includes supplier and material databases that must be referenced when estimating materials for a construction project.

Formula Requirements for Calculating Unit Cost

- There must be a defined material.
- There must be a defined supplier
- If there is no defined material or defined supplier, the cell should read 0.
- If there is a material, the formula should reference the database where that material is found.
- If there is a supplier, the formula should reference the database where the supplier is found.
- The formula should find an exact match for the material.
- The supplier must be confirmed to supply the material.

Excel Functions Used to Calculate Size

- IF - IF will be used to fulfill the requirement that a material be defined.
- OR - OR will be used to fulfill the requirement that the supplier be defined.
- VLOOKUP - VLOOKUP will be used to reference a defined database and pull the required information into the cell.
- MATCH - MATCH will be used to ensure that the supplier supplies the defined material

Units Formula

Definitions

The formula used to calculate Units will use the following definitions:

- material_cell is the cell in the row that states what the material is.
- supplier_cell is the cell in the row that states who the supplier is.
- "" means blank in Excel formulas.
- material_database_name is the name of the array that contains the material information from the supplier. It is pre-labeled in the Estimating Workbook.
- supplier_list_name is the name of the array that contains the supplier information within the material database. It is pre-labeled in the Estimating Workbook.

Formula Syntax

IF(OR(material_cell="",supplier_cell="",0, VLOOKUP(material_cell,material_database_name, MATCH(supplier_cell,supplier_list_name,0),FALSE))

Explanation

Reading the above formula in layman's terms would be something like this.

IF(OR(material_cell="",supplier_cell=""	If the material cell or the supplier cell is blank
,0	Display 0
,VLOOKUP	If neither the material cell nor the supplier cell is blank, do a VLOOKUP function.
(material_cell	Look for the material named in the material cell.
,material_database_name	In the database I have chosen.
,MATCH(supplier_cell,supplier_database_name,	And pull the information from the column that matches the defined supplier in the named array for material suppliers in the database.
,FALSE))	The database column has to return an exact match.

Unit Cost Formula Breakdown and Explanation

Example

You are completing the Stair Framing Materials section of the Estimating Workbook.

- The Stringer Spacer row states in cell E372 that the material used for that part of the stairs will be 2” X 4” - 14’ Fir (STD &BTR).
- The Stringer Spacer row also states in cell A372 that the supplier of the material is SunRoc.
- Cell H372 needs a formula entered that will meet the requirements for calculating Unit Cost.

H372 fx =IF(OR(E372="",A372=""),0,VLOOKUP(E372,FramMatDB,MATCH(A372,FramSupplierList,0),FALSE))

	A	B	C	D	E	F	G	H	I	J	K
71	SunRoc	0%		Sleepers	2" x 4" - RL Fir (STD & BTR)	1	Ft	$ 0.45	3		$ 1.35
72	SunRoc	0%		Stringer Spacer	2" X 4" - 14' Fir (STD & BTR)	14	Ft	$ 8.21	2		$ 16.42
73	SunRoc			Stringer Hangers							$ -
74	SunRoc	0%		Temporary Treads							$ -

Screenshot of the Framing tab, showing the Unit Cost formula in the function bar

- The formula will pull information from the Frame Material Database (FramMatDB) via a VLOOKUP function.

A1 fx Framing Lumber Database

	A	B	C	D	E	F	G	H
1	**Framing Lumber Database**							
2								
3							**Suppliers**	
4	**DESCRIPTION**	**TYPE**	**CATEGORY**	**SIZE**	**UNITS**	**BMC(REX)**	**SunRoc**	
16								
17	3-1/2" X 9-1/2" GLUE LAM BEAM	4 X 10	Glam	1	Ft	$ 15.50	$ 14.50	
18	3-1/2" X 13-1/2" GLUE LAM BEAM	6x14	Glam	2	Ft	$ 17.89	$ 17.45	
19								
20	1-1/4" x 9-1/2" Timberstrand	2x10	TmbStrnd	1	Ft	$ 1.75	$ 1.62	
21	1-1/4"X11-7/8 TimberStrand	2x12	TmbStrnd	1	Ft	$ 2.00	$ 1.94	
22								
23	Fink Truss, 2x4 up to 38'	2x4	Truss	1	SF	$ 3.16	$ 3.25	
24	Fink Truss, 2x4 40' to 50'	2x4	Truss	1	SF	$ 3.88	$ 3.98	
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31	Gable Fill Truss 40'	2x6	Truss	1	EA	$ 400.00	$ 443.00	
32								
33	Simpson 22x7x4 Shear Wall	2x4	Swall	1	Ea	$ 635.00	$ 650.00	
34								

Screenshot of the Framing Material Database

- Unit Cost information is located in a named array of suppliers within the Framing Material Database.
- The MATCH function within the formula will use the supplier name in A372 of the Framing tab to identify which of the prices for the specified material to show in the Unit Cost cell.
- FALSE is the last component of the formula because it must find an exact match of the material.

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How to Complete Labor Estimates Using the NCE

Basic Cost Estimating Steps using the NCE

1. Identify the Construction Task to be estimated.
2. Identify the materials to be used in completing the construction task.
3. Calculate the amount of work to be completed for the task, measured by the units for the task (eg. Framing is measured in square feet).
4. Find the task in the NCE. Use the search function, if possible.
5. Estimate the total cost to complete the task based on the figures for material and labor for the task.

Estimating Example Using the NCE

A residential project needs a complete framing estimate. It is a two story residence with a concrete slab foundation. The takeoff shows that the first floor dimensions are 35’ x 41’, and the second floor dimensions are 32’ x 38’. Standard materials will be used, so it is appropriate to use the Carpentry Rule of Thumb section of the Residential division of the NCE (2018).

Step 01: Identify the Construction Task to be estimated

- Framing of two stories with a concrete slab foundation.
- Standard specifications for stud, joist, and rafter spacing (16” on center), riser count, backing, blocking and bracing.

Step 02: Identify the materials to be used in completing the construction task

- Framing Lumber: Conventional
- Subfloor: 5/8" OSB
- Rough Stairway: 15 Risers
- Rafters, Braces, Collar Beams, Ridge Boards: 2” x 8”
- Roof Sheathing: 7/16” OSB

Step 03: Calculate the amount of work to be completed for the task, measured by the units for the task

- Framing is measured in SF.
- The SF for each floor must be calculated to measure the total amount of work to be done.
    - First Floor = 35’ x 41’ = 1,435 SF
    - Second Floor = 32’ x 38’ = 1,216 SF

Step 04: Find the task in the NCE

Keyword Search: Framing

From 2018 NCE, p 33:

Task	Craft@Hrs	Unit	Material	Labor	Total
Total framing, first of two floors, concrete foundation	B1@.146	SF	2.45	4.88	7.33
Total framing, second floor of a two-story residence	B1@.191	SF	4.44	6.38	10.82

Step 05: Estimate the total cost to complete the task based on the figures for material and labor for the task

First Floor Total per SF	$7.33
First Floor SF	1,435 SF
First Floor Cost Calculation	1,435 SF x $7.33 = $10,518.55

Second Floor Total per SF	$10.82
Second Floor SF	1,216 SF
Second Floor Cost Calculation	$13,157.12
Total Estimated Cost to Frame	$23,675.67

2

Construction Estimating Tools

What Tools Does an Estimator Use?

There are multiple tools available to estimators that allow them to complete their work. Some of the most important include:

- Spreadsheet programs to plan, track, calculate and estimate costs (Excel)
- PDF readers for viewing digital construction plans (Adobe Reader)
- Takeoff software to pull accurate measurements from construction plans (Bluebeam)
- Just about any other tool that allows estimators to complete accurate estimates.

Excel
Bluebeam
Cost Data Manuals

Excel

Excel is a powerful spreadsheet tool used in construction estimating to track all of the research and calculations that go into completing an accurate estimate. It is required in the Construction Estimating course at BYU-Idaho. Similar programs like Google Sheets and Numbers on Mac OS are unacceptable alternatives.

How to Download Excel Through BYU-Idaho

Students and employees of BYU-Idaho can download and install Microsoft Office, including Excel, for free by following the instructions outlined in Downloading & Installing Microsoft Office for Free.

Guide for Learning to Use Excel

BUS 115, a Business Applications course offered through BYU-Idaho, offers a free resource to learn how to complete basic Excel functions and tasks. Use it as a reference as you complete your Construction Estimating coursework.

Excel in Practice

Bluebeam

What is Bluebeam Revu, and how will I use it?

- Bluebeam Revu is a digital tool commonly used in the construction industry for viewing, sharing, and annotating various document formats.
- The primary feature used in this course is the detailed marking and measuring tools that will allow you to complete building plan takeoffs.
- It is also possible to upload your National Construction Estimator 2018 pdf file into Revu for easy reading and marking during your estimating assignments.

Installation Requirements

Bluebeam Revu must be installed on a Windows computer. The software is no longer supported Mac.

Bluebeam Video Guides

The following video guides are available to help you learn to use Bluebeam.

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Download and Registration

(04:06 mins, "Download and Registration" Transcript)

Getting Started and Sheet Navigation

(14:34 mins, "Getting Started and Sheet Navigation" Transcript)

Creating Bookmarks

(07:24 mins, "Creating Bookmarks" Transcript)

Measurement Tools

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Cost Data Manuals

Construction is a vast industry that encompasses a myriad of project types from small remodel jobs to vast billion-dollar commercial and industrial projects. Some projects can span years and decades. Even the most seasoned construction estimator will be required to estimate materials, products, and assemblies they have not previously encountered, or that they need additional information on, to correctly estimate. Some primary sources for obtaining information about construction costs and processes are known as cost data manuals. These resources serve as invaluable databases of information and can be an invaluable tool for the construction estimator.

Cost Data Manual Publishers

These databases are provided by a number of different publishers and cover a wide range of material, processes, and procedures from basic construction processes to detailed specialty and trade work. Some cost data manuals are more universal in nature and serve as a primary source for finding information about the majority of processes and operations on a construction project. Others are more specific in nature and serve as resources for specific specialty trades and contractors. In addition, there are different resources that serve various segments of the industry, such as industrial, heavy highway, commercial, and residential construction. A brief review of some of the publishers and their products are as follows:

Craftsman Book Company

The Craftsman Book Company is a large publisher of construction-related books and products. They publish a line of cost data manuals, with their signature product known as the National Construction Estimator (NCE). This major reference serves as a resource for both the residential and commercial construction industry and is a general reference for all phases of construction work from basic processes to specialty trade work. It is published in both printed and electronic formats. The residential portion of the reference is organized in alphabetic order of materials and processes. The commercial portion is organized into divisions following the CSI MasterFormat classification system. This will be the primary cost data manual that will be used in this course.

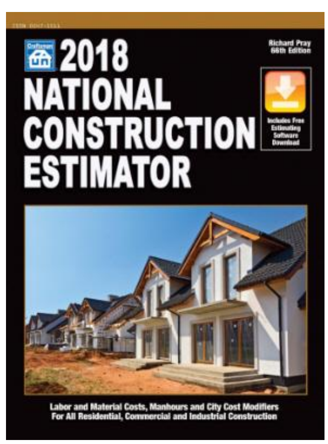

Figure 3.1: The National Construction Estimator manual

Much more about this resource will be covered later in this chapter.

In addition to the National Construction Estimator, the Craftsman Book Company publishes a wide range of cost data manuals and software that provide more specific and detailed cost information for subcontract and specialty trades. These include the following:

- National Building Cost Manual
- National Concrete & Masonry Estimator
- National Earthwork & Heavy Equipment Estimator
- National Electrical Estimator
- National Framing & Finish Carpentry Estimator
- National Home Improvement Estimator
- National Painting Cost Estimator
- National Plumbing & HVAC Estimator
- National Renovation & Insurance Repair Estimator
- National Repair & Remodeling Estimator

More specific information can be obtained from the Craftsman Book Company website.

RSMeans

The RSMeans company is also a large publisher of construction-related books and software. Their catalog of cost data manuals is likely the most extensive in the industry and includes their signature product known as the RSMeans Building Construction Costs data manual. This general reference source is intended primarily for the commercial construction industry. The text is organized similar to the MasterFormat style common in the commercial construction industry which is organized into 50 separate divisions. In addition to this flagship product, the RSMeans company publishes the following:

Figure 3-2: Building Construction Costs manual

- Assemblies Costs
- Commercial Renovation Costs
- Concrete & Masonry Costs
- Construction Cost Indexes
- Contractors Pricing Guides: Residential Repair & Remodeling Costs
- Electrical Change Order Costs
- Electrical Costs
- Facilities Costs
- Maintenance & Repair Costs
- Green Building Costs
- Heavy Construction Costs
- Interior Costs
- Labor Rates for the Construction Industry
- Light Commercial Costs
- Mechanical Costs
- Open Shop Building Construction Costs
- Plumbing Costs
- Residential Costs
- Site Work & Landscape Costs
- Square Foot Costs
- Yardsticks for Costing

More specific information can be found on the RSMeans website.

Saylor Publications

Saylor Publications offers a number of different cost data publications. The flagship publication is known as the Current Construction Costs, which is a cost data manual focused primarily for the commercial construction industry. The reference is organized into 16 major divisions, which follows the older CSI MasterFormat classification of 16 major divisions. This reference provides information in a unit cost format. Additional products from this publisher include the following:

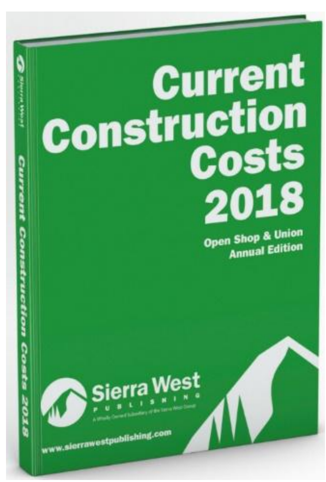

Figure 3-3: Current Construction Costs manual

- Current Construction Cost Manual
- Current Remodeling Repair Construction Cost Manual
- Current Construction Cost Residential
- Current Residential Remodeling Costs

More specific information can be found on the Sierra West Publishing website.

Frank R. Walker Company

The Frank R. Walker Company publishes a cost data manual known as Walker's Building Estimator's Reference Book. This reference has been in continuous publication since 1915. It is considered a standard reference source for commercial construction. It is organized in a manner following the CSI division format. The standard reference cost data manual can be purchased in an individual chapter format covering sub-specialties. More information can be found on the Frank R. Walker Company website.

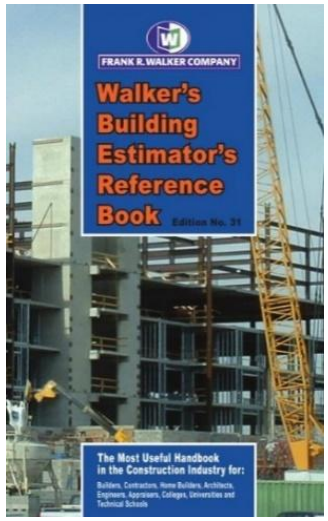

Figure 3-4: Walker's Building Estimator's Reference Book

Citations:

Craftsman Book Company. (2018). 2018 Craftsman Costbooks. Retrieved from https://www.craftsman-book.com/

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Advantages and Disadvantages of Using Cost Data Manuals

There are both advantages and disadvantages to using cost data manuals when preparing an estimate. Ultimately, it is the estimator's responsibility to determine the value of the data that is acquired from cost data manuals. Some of the advantages and disadvantages of using cost data manuals are as follows:

Advantages of Cost Data Manuals

Advantages of using cost data manuals include establishing costs for unfamiliar items, making a quick check of figures, standardizing costs, and helping to understand the necessary factors that go into a particular cost estimate.

Establishing Cost for Unfamiliar Items

Certainly, one of the most important benefits of using cost data manuals is being a resource for establishing costs of unfamiliar items. For example, the requirements for energy efficient and green building construction has significantly increased in recent years. One popular program known as Leadership in Energy & Environmental and Design (LEED) has specific requirements for design, materials, and processes that must be incorporated into the project in order for the project to meet the required LEED standard. The owner may specify a specific standard, such as a LEED Silver or LEED Gold, and the contractor is responsible to manage the construction process to meet the standards of an outside certifying agency. There is a construction cost associated with this process, and the estimator can reference cost data manuals such as the National Construction Estimator or the RSMeans Green Building Cost Data manual.

Quick Check of Figures

There are occasions when the construction estimator needs to make a quick check of the figures to help establish a benchmark or ballpark figure. In addition, there can be occasions when a mistake or error in the estimate can lead to significant miscalculation. A quick check of the figures can often point out that something could be amiss that requires further examination.

Standardizing Costs

There are occasions on construction projects when a client may question the veracity of the costs on the project. This can often stem from a lack of understanding of what a fair cost for the project is or a desire to understand that they are receiving value for their dollar. Referencing costs from cost data manuals can help to clear up any confusion or uncertainty of the value received.

Understanding Necessary Factors that Go into Establishing a Cost

When estimating items or systems that are unfamiliar, it is important to understand all of the elements that go into completing the system so all of the elements can be established and priced. For example, the RSMeans 2012 Green Building Cost Data manual shows the cost data for installing a stand-alone photovoltaic power system. 28 separate items are included in the system to be estimated including interrelated items such as deep cycle solar batteries, battery temperature computer probes, wooden vented battery enclosures, and lightning surge suppressors. When estimating unfamiliar items, the estimator should strive fully to understand all factors that go into the cost of the item.

Disadvantages of Using Cost Data Manuals

There can be disadvantages to using cost data manuals including the fact that published costs may not be your costs, actual job conditions may vary, material costs may vary, or it can provide a false sense of security.

Published Costs May Not Be Your Costs

Just because a cost is published in a cost data manual does not necessarily mean that it will be the actual cost for your project. There can be a wide range of valid causes for significant variation in price. This can be especially true when undertaking an unfamiliar process or procedure. Prices published in cost data manuals are for the industry in general and represent an industry standard. This would suggest that the prices published are for experienced crews who are familiar with this form of work. There is always a learning curve when undertaking new procedures and processes that can make it both more time consuming and costly. The estimator should make a realistic assessment of the capabilities of the crew that will actually complete the work.

Actual Job Conditions May Vary

Every construction project is different. Locations are different, circumstances are different, materials are different, and crews are different. For example, one project may be undertaken in the summer with few concerns about the weather and another may be undertaken in the winter with significant weather-related issues. Another may require distant travel requirements, increased regulation, or administration oversight. Most often, these special circumstances are not included in the price established in cost data manuals.

Figure 3-5: The estimator will need to account for the significant additional costs associated with installing the exterior masonry materials in the winter.

False Sense of Security

Relying too much on cost data manual information without making the effort to truly understand the real costs involved can lead to a false sense of security about the project. The use of cost data manuals does not overshadow the need to truly count all of the costs involved in the situation.

Understanding the realistic use of cost data manuals, the authors of the National Construction Estimator state that "[these cost figures are] as accurate as possible considering that the estimators who wrote the book don't know your subcontractors or materials suppliers, haven't seen the plans or specifications, don't know what building code applies or where the job is, had to project material costs at least six months into the future, and had no record of how much work the crew that will be assigned to the job can handle.

You wouldn't bid a job under these conditions. And we don't claim all construction is done at these prices" (Pray, 2018, p. 5).

In spite of the concerns about possible cost inaccuracies with using cost data manuals, they can be a vital part of any construction estimator procedure.

NCE 2018 Layout

The 2018 edition of the National Construction Estimator will be used in this course as a vital resource. A new version comes out each year, but using the 2018 edition will allow the coursework to stay the same while still allowing you to learn vital estimating processes. The 2018 NCE will serve as the primary source for obtaining construction labor and subcontractor costs for the project assignments and tests. Information about the layout and use of the data manual will be addressed next.

Layout of the National Construction Estimator

The National Construction Estimator is divided into three major sections: the introduction section, the residential section, and the commercial section.

Introduction Section

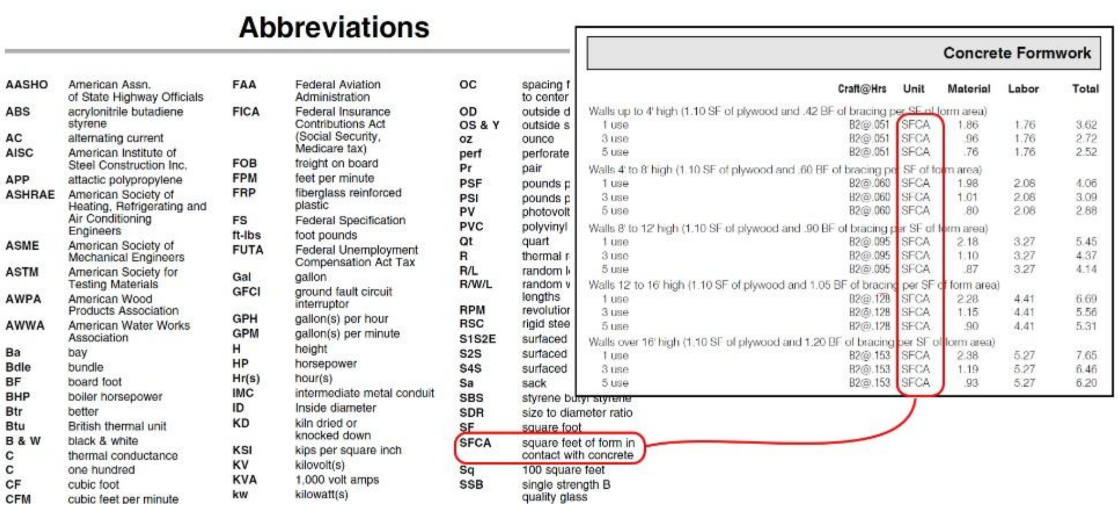
The introduction section is comprised of an introduction and explanation about using the National Construction Estimator and a number of other information sections including abbreviations and symbols, craft codes, hourly costs, crew compositions, residential division labor costs, adjusting labor costs, and area modification factors.

How to Use this Book Introduction

The first few pages of the National Construction Estimator are an explanation about using the resource, including information about pricing methods involving delivery, sales tax, waste and coverage, supervision expenses, payroll taxes, man-hours, labor productivity, equipment costs, subcontractor costs, and markup.

Abbreviations

The second subsection of the introduction section is a description of the abbreviations used in the database. Abbreviations are used throughout the text. When encountering an unusual or unknown abbreviation, the user should refer to the reference at the beginning of the book. NCE Figure 3-1 shows an example of the abbreviation subsection highlighting the abbreviation for square foot of contact area (SFCA) and the use of the abbreviation in the concrete formwork subsection.



Abbreviations

AASHO	American Assn. of State Highway Officials	FAA	Federal Aviation Administration	OC	spacing f to center
ABS	acrylonitrile butadiene styrene	FICA	Federal Insurance Contributions Act (Social Security, Medicare tax)	OD	outside d
AC	alternating current	FOB	freight on board	OS & Y	outside s
AISC	American Institute of Steel Construction Inc.	FPM	feet per minute	oz	ounce
APP	attactic polypropylene	FRP	fiberglass reinforced plastic	perf	perforate
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers	FS	Federal Specification	Pr	pair
ASME	American Society of Mechanical Engineers	ft-lbs	foot pounds	PSF	pounds p
ASTM	American Society for Testing Materials	FUTA	Federal Unemployment Compensation Act Tax	PSI	pounds p
AWPA	American Wood Products Association	Gal	gallon	PV	photovolt
AWWA	American Water Works Association	GFCI	ground fault circuit interruptor	PVC	polyvinyl
Ba	bay	GPH	gallon(s) per hour	Qt	quart
Bdle	bundle	GPM	gallon(s) per minute	R	thermal r
BF	board foot	H	height	R/L	random l
BHP	boiler horsepower	HP	horsepower	R/W/L	random w lengths
Btr	better	Hr(s)	hour(s)	RPM	revolutior
Btu	British thermal unit	IMC	intermediate metal conduit	RSC	rigid stee
B & W	black & white	ID	Inside diameter	S1S2E	surfaced
C	thermal conductance	KD	kiln dried or knocked down	S2S	surfaced
C	one hundred	KSI	kips per square inch	S4S	surfaced
CF	cubic foot	KV	kilovolt(s)	Sa	sack
CFM	cubic feet per minute	KVA	1,000 volt amps	SBS	styrene butyl styrene
		kw	kilowatt(s)	SDR	size to diameter ratio
				SF	square foot
				SFCA	square feet of form in contact with concrete
				Sq	100 square feet
				SSB	single strength B quality glass

Concrete Formwork

	Craft@Hrs	Unit	Material	Labor	Total
Walls up to 4' high (1.10 SF of plywood and .42 BF of bracing per SF of form area)					
1 use	B2@.051	SFCA	1.86	1.76	3.62
3 use	B2@.051	SFCA	.96	1.76	2.72
5 use	B2@.051	SFCA	.76	1.76	2.52
Walls 4' to 8' high (1.10 SF of plywood and .60 BF of bracing per SF of form area)					
1 use	B2@.060	SFCA	1.98	2.08	4.06
3 use	B2@.060	SFCA	1.01	2.08	3.09
5 use	B2@.060	SFCA	.80	2.08	2.88
Walls 8' to 12' high (1.10 SF of plywood and .90 BF of bracing per SF of form area)					
1 use	B2@.095	SFCA	2.18	3.27	5.45
3 use	B2@.095	SFCA	1.10	3.27	4.37
5 use	B2@.095	SFCA	.87	3.27	4.14
Walls 12' to 16' high (1.10 SF of plywood and 1.05 BF of bracing per SF of form area)					
1 use	B2@.128	SFCA	2.28	4.41	6.69
3 use	B2@.128	SFCA	1.15	4.41	5.56
5 use	B2@.128	SFCA	.90	4.41	5.31
Walls over 16' high (1.10 SF of plywood and 1.20 BF of bracing per SF of form area)					
1 use	B2@.153	SFCA	2.38	5.27	7.65
3 use	B2@.153	SFCA	1.19	5.27	6.46
5 use	B2@.153	SFCA	.93	5.27	6.20

NCE Figure 3-1: Abbreviation subsection of the NCE showing abbreviation for Square Foot of Contact Area and the abbreviation use in the Concrete Formwork subsection.

Craft Codes

The third subsection of the introduction contains information about craft codes, hourly costs, and crew compositions. The section is divided into two divisions, a residential division and a commercial division. NCE Figure 3-2 shows an example of the residential division costs with the information about Crew B1 highlighted. The cost for crew B1 is shown as $33.34 per hour, and the crew is comprised of two individuals: one laborer and one carpenter.

Residential Division

Craft Code	Cost Per Manhour	Crew Composition	Craft Code	Cost Per Manhour	Crew Composition
B1	$33.44	1 laborer and 1 carpenter	BR	$35.45	1 lather
B2	$34.60	1 laborer, 2 carpenters	BS	$32.78	1 marble setter
B3	$32.27	2 laborers, 1 carpenter	CF	$35.03	1 cement mason
B4	$36.96	1 laborer 1 operating engineer 1 reinforcing iron worker	CT	$34.83	1 mosaic & terrazzo worker
			D1	$35.92	1 drywall installer 1 drywall taper
B5	$36.57	1 laborer, 1 carpenter 1 cement mason 1 operating engineer 1 reinforcing iron worker	DI	$35.95	1 drywall installer
			DT	$35.89	1 drywall taper
			HC	$29.01	1 plasterer helper
B6	$32.48	1 laborer, 1 cement mason	OE	$42.13	1 operating engineer
B7	$30.32	1 laborer, 1 truck driver	P1	$36.39	1 laborer, 1 plumber

NCE Figure 3-2: Sample of the residential division craft codes, hourly costs, and crew compositions.

Each construction process covered in the NCE contains a column labeled Craft@Hrs. The letters and numbers in this column show the estimates for who will do the work (the craft code), an @ symbol meaning at, and how long the work will take (given in man-hours). For example, NCE Figure 3-3 shows an example of the Carpentry, Detailed Breakdown section for installing TJI floor joists. The Craft@Hrs column along with the labor costs are highlighted.

Carpentry, Detailed Breakdown

Floor joist wood, TJI truss type Suitable for residential use, 50 PSF floor load design. Costs shown are per square foot (SF) of floor area, based on joists at 16" OC, for a job with 1,000 SF of floor area. Figure 1.22 SF of floor area for each LF of joist. Add the cost of beams, supports and blocking. For scheduling purposes, estimate that a two-man crew can install 900 to 950 SF of joists in an 8-hour day.

	Craft@Hrs	Unit	Material	Labor	Total
9-1/2" TJI/15	B1@.017	SF	2.34	.57	2.91
11-7/8" TJI/15	B1@.017	SF	2.57	.57	3.14
14" TJI/35	B1@.018	SF	3.72	.60	4.32
16" TJI/35	B1@.018	SF	4.08	.60	4.68

NCE Figure 3-3: Floor joist wood, TJI subsection of the NCE.

This means that Crew B1 can install 9 ½" TJI/15 floor joists at a rate of .017 hours per square foot of floor area or 17 hours per 1,000 square feet of floor area.

The labor cost for installing the floor joists is listed at $0.57 per square foot. That means that 1,000 square feet would cost

$$\$1,000\, SF \times \frac{\$0.57}{SF} = \$570.00$$

Crew B1 has a cost per man-hour listed as $33.44. Calculated another way, if the 17 man-hours determined to complete the job were multiplied by the $33.44 cost per man-hour, the total would be

$$17\, Manhrs \times \frac{\$33.44}{Manhrs} = \$568.48$$

Residential Labor Cost Division

The residential labor division shows how the labor costs are determined for individual craft trades. NCE Figure 3-4 shows an example of the residential labor division labor costs with the cost for a building laborer and carpenter highlighted.

Residential Division

Craft	1 Base wage per hour	2 Taxable fringe benefits (@5.50% of base wage)	3 Insurance and employer taxes (%)	4 Insurance and employer taxes ($)	5 Non-taxable fringe benefits (@4.86% of base wage)	6 Total hourly cost used in this book
Bricklayer	$27.34	$1.50	25.30%	$7.30	$1.33	$37.47
Bricklayer's Helper	20.26	1.11	25.30	5.41	0.98	27.76
Building Laborer	20.67	1.14	32.66	7.12	1.00	29.93
Carpenter	25.72	1.41	31.56	8.56	1.25	36.94
Cement Mason	26.00	1.43	23.12	6.34	1.26	35.03
Drywall installer	26.60	1.46	23.53	6.60	1.29	35.95

NCE Figure 3-4: Residential labor division cost breakdown.

The base hour wage for a laborer, listed at $20.67 an hour with taxable fringe benefits, insurance and employer taxes, and non-taxable fringe benefits added on the total comes to $29.93 per hour. The carpenter wages are listed the same way with a total of $36.94 per hour. The rate for crew B1 with one laborer and one carpenter is calculated by adding the wages of each crew member together and dividing by the number of crew members as follows:

$$\frac{(\$29.93\ +\ \$36.94)}{2} = \$33.44$$

Area Modification Factors

An important factor that determines the construction cost is the area of the country where the job is located. Costs vary significantly by area and region. The area modification factors provide information about adjustments that should be made for both labor and material based upon the area that the job is located. NCE Figure 3-5 shows an example of area modification factors for Idaho and Kansas.

Location	Zip	Mat.	Lab.	Equip.	Total Wtd. Avg.
Idaho Average		**0**	**-19**	**0**	**-9%**
Boise	837	1	-12	0	-5%
Coeur d'Alene	838	0	-21	0	-10%
Idaho Falls	834	-1	-19	0	-9%
Lewiston	835	0	-24	0	-11%
Meridian	836	0	-19	0	-9%
Pocatello	832	-1	-20	0	-10%
Sun Valley	833	0	-18	0	-8%

Location	Zip	Mat.	Lab.	Equip.	Total Wtd. Avg.
Hutchinson	675	-3	-9	-1	-6%
Independence	673	-3	39	-1	16%
Kansas City	660-662	0	10	0	5%
Liberal	679	-2	24	-1	10%
Salina	674	-3	-11	-1	-7%
Topeka	664-666	-3	2	-1	-1%
Wichita	670-672	-2	-6	-1	-4%

NCE Figure 3-5: Area modification factor for Idaho Falls, Idaho and Independence, Kansas.

The labor rates for Idaho Falls show that they are 19% below the national average, while the labor rates for Independence show that they are 39% above the national average. Given those rates, it could be expected that the rate for Crew B1 in Idaho Falls would be around 81% of $33.44 or $27.09 per hour, while the rate for Independence would be 139% of $33.44 or $46.48.

While area modification factors are very important when determining estimate costs for actual projects, the national average will be used for determining cost for the project assignments in this course.

NCE 2018 Residential Construction Costs Section

The residential section is the first cost section of the National Construction Estimator. This section is organized alphabetically and starts with “Adhesives” and ends with “Windows” on page 297. The carpentry division of this section utilizes four separate methods of preparing estimates: Carpentry, rule of thumb; Carpentry, assemblies; Carpentry, piecework rates; and Carpentry, detailed breakdown methods. NCE Figure 3-6 shows the Table of Contents for the NCE. The residential section is highlighted, and the four types of estimates for the carpentry framing category are emphasized.

Contents

A complete index begins on page 640

 ISBN 978-1-57218-334-6 1st printing October 2017 for the year 2018

NCE Figure 3-6: Table of Contents for the NCE with the residential section highlighted.

Carpentry Rule of Thumb

A rule of thumb is a principle with broad application that is not intended to be strictly accurate or reliable for every situation. Rule of thumb prices in the carpentry section are general guidelines for pricing construction framing cost. They are typically estimated as cost per square foot of floor in the living area. NCE Figure 3-7 shows an example of the rule of thumb costs for framing on single story conventional crawl-space foundations.

Framing a single story residence, conventional crawl-space foundation					
Sills, pier blocks, floor beams (145 BF per 1,000 SF)	B1@.018	SF	.10	.60	.70
Floor joists, doublers, blocking, bridging (1,480 BF per 1,000 SF)	B1@.028	SF	1.01	.94	1.95
Subflooring, 5/8" OSB (1,150 SF per 1,000 SF)	B1@.011	SF	.72	.37	1.09
Layout, studs, sole plates, top plates, header and end joists, backing, blocking, bracing and framing for openings (2,250 BF per 1,000 SF)	B1@.093	SF	1.54	3.11	4.65
Ceiling joists, header and end joists, backing, blocking and bracing (1,060 BF per 1,000 SF)	B1@.045	SF	.73	1.50	2.23
Rafters, braces, collar beams, ridge boards, 2" x 8" rafters 16" OC, (1,340 BF per 1000 SF)	B1@.032	SF	.92	1.07	1.99
Roof sheathing, 7/16" OSB (1,150 SF per 1,000 SF)	B1@.010	SF	.53	.33	.86
Total framing, single story, conventional foundation	B1@.237	SF	5.55	7.92	13.47
Add for plywood sheathing	—	%	8.55	—	—

NCE Figure 3-7: Rule of thumb costs for a single-story residence on a conventional crawl-space foundation.

The costs for framing the floor joists using this method would be calculated at $1.95 per square foot of living area. A building with 1000 square feet of living area could expect to cost $1,950.00 for the project. Framing the entire residence would cost $13.47 per square foot or $13,470.00 for the job.

Carpentry Assemblies

The second subset of the carpentry section is the assemblies subsection. The costs in the assemblies subsection are established by creating a group, or assembly, of the individual components for the particular items being estimated. Figure 3-6 shows an example of a typical floor framing assembly with the four major floor assembly elements highlighted in color; this includes the rim joist, floor joist, floor sheathing, and floor blocking.

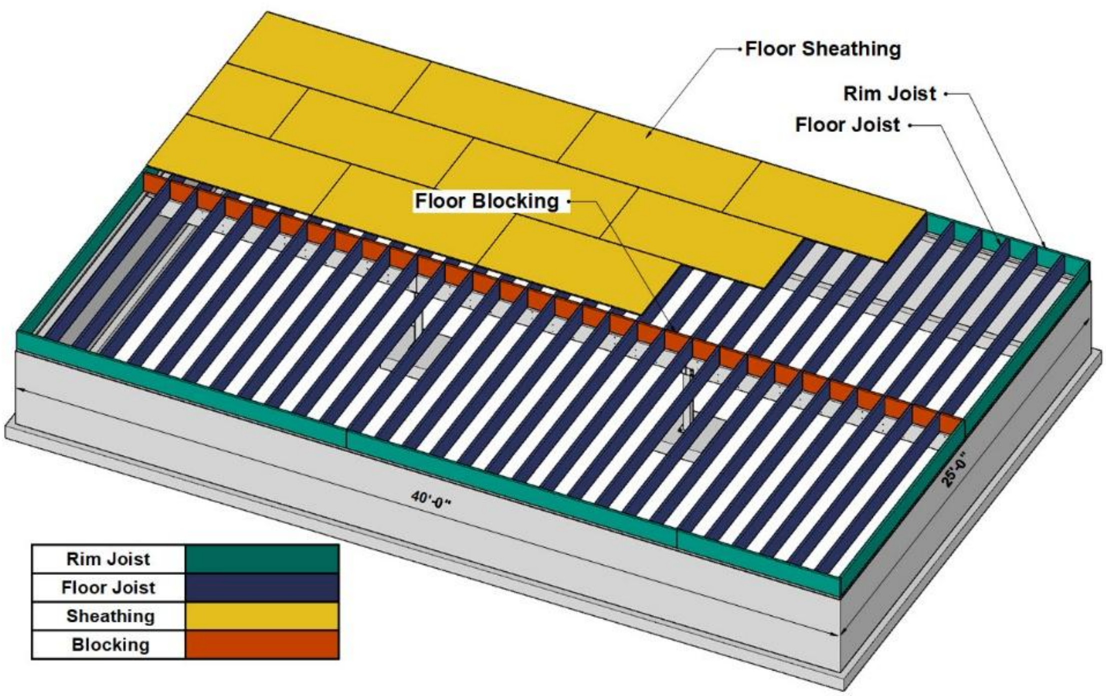


Figure 3-6: Typical floor framing assembly.

NCE Figure 3-8 shows an example of the Carpentry, Assemblies subsection of the National Construction Estimator. Floor joists, subflooring (sheathing), blocking, nails, and box or band joists (rim joist) are included in the description. In addition, the NCE includes 6 ¼" thick R19 insulation, which would not normally be considered part of a framing assembly. The price established for this method is $4.53 per square foot or $4,530.00 for a 1,000 square foot floor.

Floor Assemblies Costs for wood framed floor joists with subflooring and R-19 insulation. These costs include the floor joists, subflooring as described, blocking, nails and 6-1/4" thick R-1.9 fiberglass insulation between the floor joists. Figures include box or band joists and typical double joists. No beams included. Planked subflooring is based on 1.24 BF per square foot of floor. Costs shown are per square foot of area covered and include normal waste. Deduct for openings over 25 SF.

Carpentry, Assemblies

	Craft@Hrs	Unit	Material	Labor	Total
Floor joists 16" OC, R-19 insulation and OSB subflooring					
7/16" OSB subfloor					
2" x 6" joists	B1@.040	SF	2.10	1.34	3.44
2" x 12" joists	B1@.044	SF	3.01	[illegible]	[illegible]
3/4" OSB subfloor					
2" x 6" joists	B1@.042	SF	2.34	1.40	3.74
2" x 8" joists	B1@.043	SF	2.63	1.44	4.07
2" x 10" joists	B1@.045	SF	3.03	1.50	4.53
2" x 12" joists	B1@.046	SF	3.58	1.54	5.12

NCE Figure 3-8: Floor assemblies section.

The insulation could be removed from the calculation by looking up the cost from the insulation subsection of the National Construction Estimator. This is shown in NCE Figure 3-9, which highlights the square foot cost for installing 6 ¼" R19 insulation at 16 inches on center at $0.94 per square foot.

Insulation

	Craft@Hrs	Unit	Material	Labor	Total
Insulation See also Building Paper and Polyethylene Film. Coverage allows for studs and joists.					
Fiberglass insulation, wall and ceiling application, coverage allows for framing					
Kraft-faced, 16" OC framing members					
3-1/2" (R-11)	BC@.007	SF	.38	.26	.64
3-1/2" (R-13)	BC@.007	SF	.46	.26	.72
3-1/2" (R-15)	BC@.007	SF	.57	.26	.83
6-1/4" (R-19)	BC@.008	SF	.64	.30	.94
5-1/2" (R-21)	BC@.008	SF	.83	.30	1.13
9-1/2" (R-30)	BC@.008	SF	.93	.30	1.23
9-1/2" (R-30C) Cathedral ceiling	BC@.010	SF	.65	.37	1.02
12" (R-38)	BC@.009	SF	1.11	.33	1.44

NCE Figure 3-9: Insulation subsection of the NCE. The insulation could be removed from the floor framing assemblies by subtracting the cost.

Subtracting the $0.94 square foot cost from the $4.53 cost listed in the floor assemblies subsection would result in a price of $3.59 per square foot. The floor framing cost without the insulation would be $3,590.00 for 1,000 square foot of floor framing.

Piecework Rate

The third subset of the carpentry section is the piecework rate subsection. The costs in the piecework subsection are established by pricing per square foot of floor area. This is a specialty area of estimating that is focused primarily towards production home building by subcontractors who work for production building companies. These companies build large tracts of hundreds—even thousands—of homes in a single development. The work is repetitive, and the general subcontractor supplies all of the material for the project. The subcontractor who would use this pricing method supplies only the crew who would perform the framing labor in a production situation. NCE Figure 3-10 shows the introduction to the piecework rate subsection, which describes the details of this pricing method.

Piecework, Rough Carpentry Rough carpentry on residential tracts is usually done by framing subcontractors who bid at piecework rates (such as per square foot of floor). The figures below list typical piecework rates for repetitive framing work and assume all materials are supplied to the framing subcontractor. No figures appear in the Craft@Hrs column because the work is done for a fixed price per square foot and the labor productivity can be expected to vary widely.

NCE Figure 3-10: Rough carpentry piecework rate description.

NCE Figure 3-11 shows the floor and ceiling joists price category for the piecework rate subsection with the installation of 2' × 10" floor or ceiling joist spaced at 16" O/C highlighted. The price is established per square foot of area of floor joist. There are no craft hours or material costs associated with this pricing method.

Floor joists or ceiling joists Piecework rates
Lay out, cut and install floor or ceiling joists, including rim joists, doubled joists, straps, joist hangers, blocking at 8' OC and ceiling backing for drywall. Based on larger jobs with simple joist layouts set 16" OC and pre-cut blocking supplied by the general contractor. Add the cost of floor beams, if required. Costs per square foot of horizontal joist area. More complex jobs with shorter runs may cost 50% more.

2" x 8" ceiling or floor joists	—	SF	—	.21	.21
2" x 10" ceiling or floor joists	—	SF	—	.24	.24
2" x 12" ceiling or floor joists	—	SF	—	.26	.26
2" x 14" ceiling or floor joists	—	SF	—	.30	.30
Add for 12" OC spacing	—	SF	—	.09	.09
Deduct for 20" OC spacing	—	SF	—	–.03	–.03
Deduct for 24" OC spacing	—	SF	—	–.06	–.06

NCE Figure 3-11: Floor or ceiling joists piecework rate subsection of the NCE.

Detailed Breakdown

The majority of prices in the residential section of the NCE are established using the detailed breakdown method of pricing. This method prices each component of construction individually.
When estimating the prices for common construction tasks, the price for each individual component will need to be added into the total cost. NCE Figure 3-12 shows an example of the floor joist category of this subsection with the cost for 2" × 10" floor joist spaced 16" O/C highlighted. Also, highlighted is the description explaining that this pricing methods includes floor joist, box or band joists (rim joists), and double joist.

Floor joists Per SF of area covered. Figures in parentheses indicate board feet per square foot of floor including box or band joist, typical double joists, and 6% waste. No beams, blocking or bridging included. Deduct for openings over 25 SF. Costs shown are based on a job with 1,000 SF of area covered. For scheduling purposes, estimate that a two-man crew can complete 750 SF of area per 8-hour day for 12" center to center framing; 925 SF for 16" OC; 1,100 SF for 20" OC; or 1,250 SF for 24" OC.

2" x 6" Std & Btr					
2" x 6" floor joists, per MBF	—	MBF	668.00	—	668.00
12" centers (1.28 BF per SF)	B1@.021	SF	.86	.70	1.56
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20" centers (1.17 BF per SF)	B1@.015	SF	.76	.50	1.26
24" centers (1.03 BF per SF)	B1@.013	SF	.67	.43	1.10
2" x 10" Std & Btr					
2" x 10" floor joists, per MBF	—	MBF	672.00	—	672.00
12" centers (2.14 BF per SF)	B1@.025	SF	1.44	.84	2.28
16" centers (1.71 BF per SF)	B1@.020	SF	1.15	.67	1.82
20" centers (1.48 BF per SF)	B1@.016	SF	.99	.54	1.53
24" centers (1.30 BF per SF)	B1@.014	SF	.87	.47	1.34

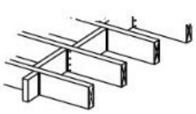
NCE Figure 3-12: Floor joist category of the detailed breakdown subset of the residential subsection of the NCE.

The cost of the floor joist framing would be calculated by multiplying the $1.82 cost per square foot. Using the example of 1,000 square feet, the cost for floor joist framing would be

$$\frac{\$1.82}{SF} \times 1,000\,SF = \$1,820.00$$

The description also explains that no beams, blocking, or bridging are included. This would extend to the floor sheathing. These items would need to be added as a separate cost. NCE Figure 3-13 shows the bridging or blocking category of the detailed breakdown subsection from the NCE. The blocking is priced per piece based upon the spacing of the floor joists.

Bridging or blocking Installed between 2" x 6" thru 2" x 12" joists. Costs shown are per each set of cross bridges or per each block for solid bridging, and include normal waste. The spacing between the bridging or blocking, sometimes called a "bay," depends on job requirements. Labor costs assume bridging is cut to size on site.



1" x 4" cross					
Joist bridging, per MBF	—	MBF	1,610.00	—	1,610.00
Joists on 12" centers	B1@.034	Ea	.80	1.14	1.94
Joists on 16" centers	[illegible]	Ea	1.10	1.14	2.24
[illegible] blocking, per MBF		MBF	[illegible]	–	[illegible]
Joists on 12" centers	B1@.042	Ea	.95	1.40	2.35
Joists on 16" centers	B1@.042	Ea	1.27	1.40	2.67
Joists on 20" centers	B1@.042	Ea	1.58	1.40	2.98
Joists on 24" centers	B1@.042	Ea	1.90	1.40	3.30
2" x 10" solid, Std & Btr					
2" x 10" blocking, per MBF	—	MBF	672.00	—	672.00
Joists on 12" centers	B1@.057	Ea	1.23	1.91	3.14
Joists on 16" centers	B1@.057	Ea	1.64	1.91	3.55
Joists on 20" centers	B1@.057	Ea	2.05	1.91	3.96
Joists on 24" centers	B1@.057	Ea	2.46	1.91	4.37

NCE Figure 3-13: Bridging or blocking category of the detail breakdown subset of the residential subsection of the NCE.

In order to add this cost to the floor framing, the estimator would need to know the actual dimensions of the floor that is to be framed so that the number of pieces of blocking could be calculated. Figure 3-5 shows an example of a 1,000 square framed floor system that is 25 feet wide and 40 feet long. The number of pieces of blocking would be calculated by dividing the 40-foot length of the floor by the floor joist spacing of 16 inches. This would result in 30 pieces of blocking.

$$40\ ft. \div \frac{16\ in.}{ft.} = 30\, pieces$$

Priced at $3.55 each would result in a total cost for blocking at

$$30\, pieces \times \frac{\$3.55}{Piece} = \$106.50$$

The floor sheathing would need to be added to the floor framing costs. NCE Figure 3-14 shows an example of the subflooring (floor sheathing) category of the residential framing section.

Subflooring					
Board sheathing, 1" x 6" #3 & Btr (1.18 BF per SF)					
Board sheathing, per MBF	—	MBF	2,580.00	—	2,580.00
With 12% shrinkage, 5% waste & nails	B1@.020	SF	3.05	.67	3.72
Add for diagonal patterns	B1@.001	SF	.30	.03	.33
OSB sheathing, Material costs shown include 5% for waste & fasteners					
3/8"	B1@.011	SF	.54	.37	.91
7/16"	B1@.011	SF	.48	.37	.85
1/2"	B1@.012	SF	.64	.40	1.04
5/8"	B1@.012	SF	.66	.40	1.06
3/4"	B1@.014	SF	.73	.47	1.20
7/8"	B1@.014	SF	1.50	.47	1.97
1"	B1@.015	SF	2.17	.50	2.67

NCE Figure 3-14: Subflooring subsection of the NCE.

The cost of $1.20 per square foot would be multiplied by the 1,000 square foot size of the floor framing. This would result in the following subflooring cost:

$$\frac{\$1.20}{SF}\ 1,000\ SF = \$1,200.00$$

The detailed breakdown cost of the three floor framing elements would result in a total detail breakdown floor framing cost of

Floor Framing = $1,820.00

Floor Blocking = $106.50

Floor Sheathing = $1,200.00

Total Cost = $3,126.50

This procedure of determining the detailed breakdown cost of each individual component of the construction process, and adding the costs together will be frequently followed when establishing construction cost for each project in this class.

Using the NCE in Class

A number of strategies can assist in making the use of cost data manuals more effective. Two important strategies are to utilize the information in the headings and instructions and modify the numbers to suit your needs.

Utilize the Information in the Header Section

Information in the header section of each category provides important information about the cost data presented in the section. For example, NCE Figure 3-12 shows the header of the floor joists section and explains all of the elements that the subsection prices, but it also gives hints into other items that will need to be added to the estimates, such as blocking and subflooring. In addition, the header section gives information that only openings in the floor over 25 square feet should be subtracted from the estimated quantity.

Modify Figure to Suit Your Needs

When using cost data manuals on actual projects, the estimator should modify the numbers to suit the needs of the project. For example, many sections of the NCE provide details about the cost of materials used in the manual. NCE Figure 3-16 shows details of the plates category in the detailed breakdown subsection of the residential section of the National Construction Estimator. The cost for 2"× 4" wall plates is shown as priced at $652.00 per MBF (Thousand Board Feet). Information is also given that a single 2"× 4" contains 0.73 board feet per lineal foot and that the material cost includes 10% for waste and nails. Shown mathematically, this would be calculated as the following:

$$\frac{\$652.00}{1000\ BF} = \$0.652\ BF$$

$$\$0.652\ BF \times \frac{0.73\ BF}{LF} = \$0.476\ LF$$

$$\$0.476 + 10$$

Plates (Wall plates) Std & Btr, untreated. For pressure treated plates, see also Sill Plates in this section. Figures in parentheses indicate board feet per LF. Costs shown include 10% for waste and nails

2" x 3" wall plates, per MBF	—	MBF	722.00	—	722.00
2" x 4" wall plates, per MBF	—	MBF	652.00	—	652.00
2" x 6" wall plates, per MBF	—	MBF	668.00	—	668.00
2" x 8" wall plates, per MBF	—	MBF	648.00	—	648.00
2" x 3" (.55 BF per LF)	B1@.010	LF	.44	.33	.77
2" x 4" (.73 BF per LF)	B1@.012	LF	.52	.40	.92
2" x 6" (1.10 BF per LF)	B1@.018	LF	.81	.60	1.41
2" x 8" (1.40 BF per LF)	B1@.020	LF	1.00	.67	1.67

NCE Figure 3-16: Plate category of the carpentry detailed breakdown subsection of the residential section of the NCE.

A single 8-foot 2"× 4" priced at $0.47 per lineal foot (priced without the 10% for waste and nails) would cost $3.74 each. If the price for that 2"× 4" were reduced to $3.00 each, the material lineal foot price would be $0.375 per lineal foot, not including the 10% waste and nails. If those two factors were added, then the material price per lineal foot would be

$$\$0.375 + \$0.0375 = \$0.4125\ LF$$

This price could be substituted when calculating the actual costs on a project.

Using the NCE Cost Data Manual in Class

The National Construction Estimator will be used in this class in a way that is significantly different than could be used in calculating real project costs. In most situations in this course, the national average for cost will be used. Most material cost will be taken from databases that are included as part of the estimating template supplied to the students in class. To simplify and standardize labor costs in this class, national average labor costs from the NCE will be used when determining labor cost. In addition, subcontractor costs for the class assignments will be the national average labor and material costs from the current edition of the National Construction Estimator.

3

General Estimating Guides and Aids

The guides in this section are generic overviews of how each Construction Phase tab of the Estimating Workbook is organizied. If there are specific considerations for a subsection of one of the tabs, these guides will provide basic instructions for navigating and completing them.

For more detailed instructions of how to complete your assignments, see the Assignment Walkthroughs section.

Estimating Math Cheat Sheat

Imperial Notation

' = feet

“ = inches

Fractional Notation for Lengths (example) 10’-11 ¼”

Common Decimal Conversions for the Imperial System

1" = 0.083'
2" = 0.167'
3" = 0.250'
4" = 0.333'
5" = 0.417’
6" = 0.500'
7" = 0.583'
8" = 0.667'
9" = 0.750'
10" = 0.833'
11" = 0.917'

Order of Operations

1. Parenthesis
2. Exponents
3. Multiplication
4. Division
5. Addition
6. Subtraction

Helpful Equations

$2\pi r$ = perimeter of a circle

$2\pi r$ (degree of angle ÷ 360) = length of an arc

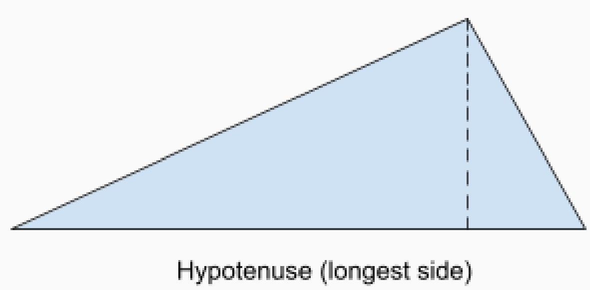
a2 + b2 = c2 (pythagorean theorem)

a x b ÷ 2 = area of a right triangle

$\pi r2$ = area of a circle

Area of Other Triangles

Create a line in the triangle from the angle opposite the longest side (hypotenuse) to the hypotenuse so that it forms two right triangles. Then use the equation to find the area of each right triangle and add them together.



Leave Feedback

Basic Takeoff Guide

A basic takeoff refers to measurements for different areas of a construction blueprint plan. These measurements will be “taken off” the blueprint using computer programs such as Bluebeam or On Screen Takeoff. With these rough dimensions, you can start to estimate quantities of material and labor required to complete the project.

Hint: You may want to use the Spreadsheet Calculator you created previously to help with these calculations.

Table of Contents

Determine the Sequence and Units of Measure for the Basic Takeoff

The first step is to decide the order in which you will measure elements of the plans, and the units you will use to measure them.

Step 01: Determine the Sequence for Completing the Basic Takeoff

Use the following sequence for basic takeoffs:

1. Square Footage of Floor Area
2. Square Footage of Flat Area Covered by Roof
3. Lineal feet of Footings
4. Lineal Feet of Foundation
5. Lineal Feet of Interior Wall
6. Lineal Feet of Exterior Wall
7. Lineal Feet of Common Wall
8. Lineal Feet of Garage Wall
9. Lineal Feet of Roof Edge
10. Lineal Feet of Roof Ridge Line
11. Door Schedule
12. Window Schedule

Step 02: Identify the Units of Measure for Structure Components

The units of measurement for the basic takeoff are found in the sequence above. It is vital to recognize these units because they will be used to estimate both material quantity and labor.

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Floor Area Section

Step 01: Measure the Main Floor Area

Calculate the space based on the exterior wall dimensions, not interior wall dimensions.

- If the exterior walls of the floor area you are measuring do not form a simple rectangle, break them into simple geometric shapes which can then be measured in square feet and added together to get a total square footage.

Example

- Figure 5-27 Shows a graphic of the first floor with the main floor area highlighted in light tan and the garage area in gray.
- Notice that Figure 5-27's dimensions from the takeoff in Bluebeam use the outside of the exterior walls.
- Because the main floor area is a simple rectangle, the square footage will be calculated using a single equation. **36' x 32' = 1,152 ft2.**

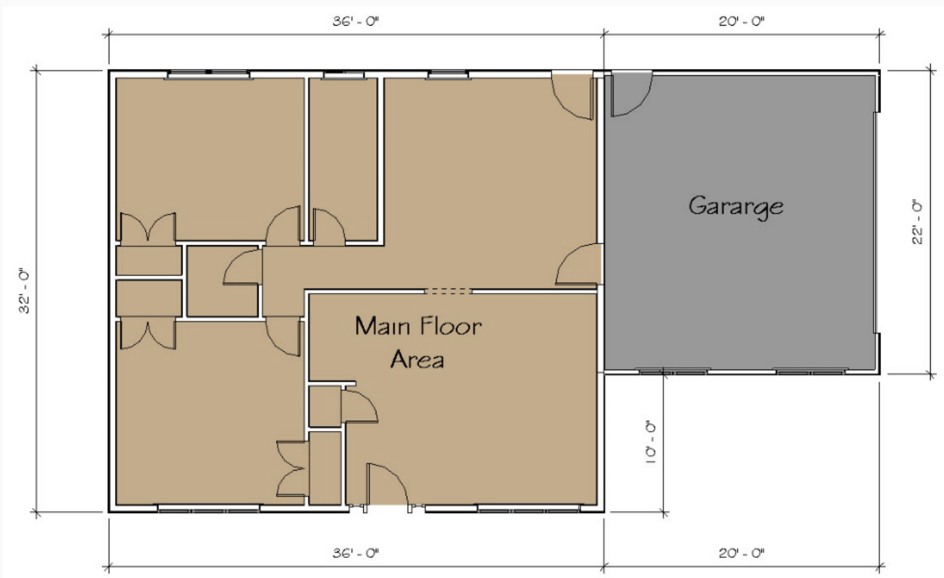

Figure 5-27 Graphic representation of the main floor and garage area of the building.

Step 02: Measure the Garage Floor Area

1. Calculate the space based on the exterior wall dimensions, not interior wall dimensions.
    - This process is basically the same as that for calculating the main floor area.
    - Based on the takeoffs in Figure 5-27 above, the area of the garage flooring is **440 ft^2**.

Step 03: Measure the Basement Floor Area

Calculate the basement based on the INTERIOR wall dimensions.

- This calculation includes the area of any storage area under a porch and any doorways formed in the concrete of the basement.

Example

- Figure 5-28 Shows a graphic of the basement plans for a structure.
- Notice that this figure's dimensions from the takeoff in Bluebeam use the inside of the basement walls.
- This figure shows a basement area, a porch area, and dimensions for the doorway.
- The formula for calculating the total area of this figure is as follows:
    - Basement Area + Porch Area + Doorway Area = Total Area
    - (34'-8" x 30'-8") + (9'-8" x 5'-7") + (3'-2" x 8") = Total Area
    - 1063.11 ft2 + 53.97 ft2 + 2.11 ft^2 = 1119.19 ft^2
    - The total area of the basement is **1119.19 ft^2**.

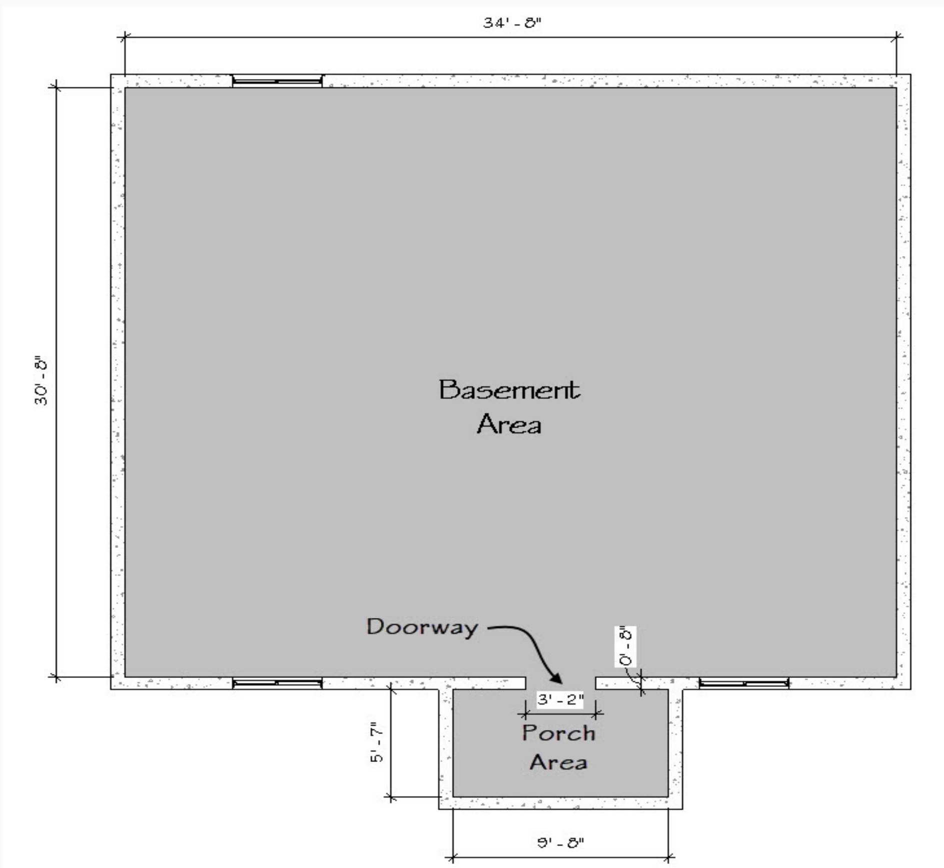

Figure 5-28 The basement floor area square footage is comprised of three separate floor areas.

Step 04: Enter the Floor Area into the Estimating Worksheet

Take the numbers you calculated for the various floor areas of the plans and enter them in the appropriate cells of the BasicInfo tab in the Estimating Worksheet.

Example

The numbers calculated from the graphics in Figure 5-27 and Figure 5-28 will be entered in the BasicInfo tab, as shown in Figure 5-30.

	A	B	C
1	**Basic Takeoff Information**		
2	**Item**	**Unit**	**Total**
3	**Floor Area**		
4	Main Floor Area	SF	**1152**
5	Basement Floor Area	SF	**1119.19**
6	Garage Floor Area	SF	**440**

Figure 5-30 Floor area subsection of the basic takeoff completed.

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Footings Section

The next basic takeoff to be completed will be the footing section. There are two distinct styles of footing; exterior wall footings and the interior grade footing.

Step 01: Measure the Exterior Wall Footings

Calculate the width, height, and length of the exterior wall footings. This is more complicated than it seems.

- Exterior wall footings are usually built to a specific standard.
- Residential buildings likely have standardized exterior footings that are16” wide and 8” deep (Figure 5-33).
- Because these footings have the added dimension of width, they must be calculated to account for overlap between any corners. Failing to do so will result in inaccurate footing estimates because the square area of each corner will have the lineal feet measurement counted twice.

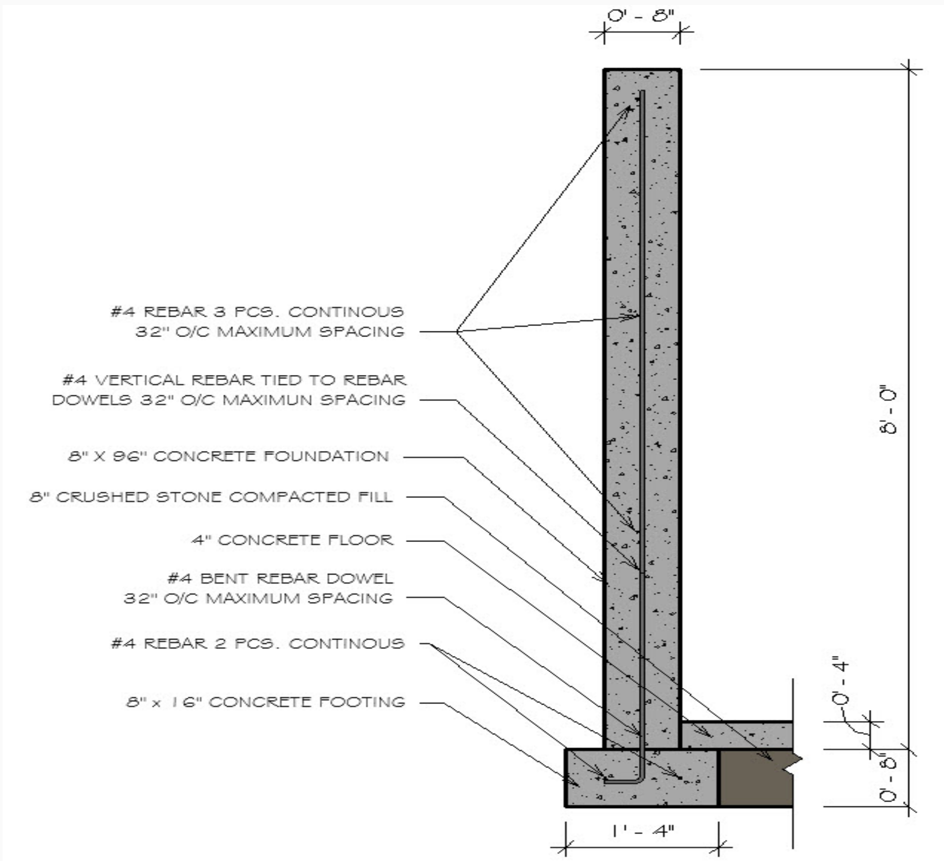

Figure 5-33 Footing and foundation wall section detailing the construction specifics.

Methods for Calculating Footings

This guide will offer two different methods for calculating the length of concrete footings. Examples for each method will be demonstrated using Figure 5-34.

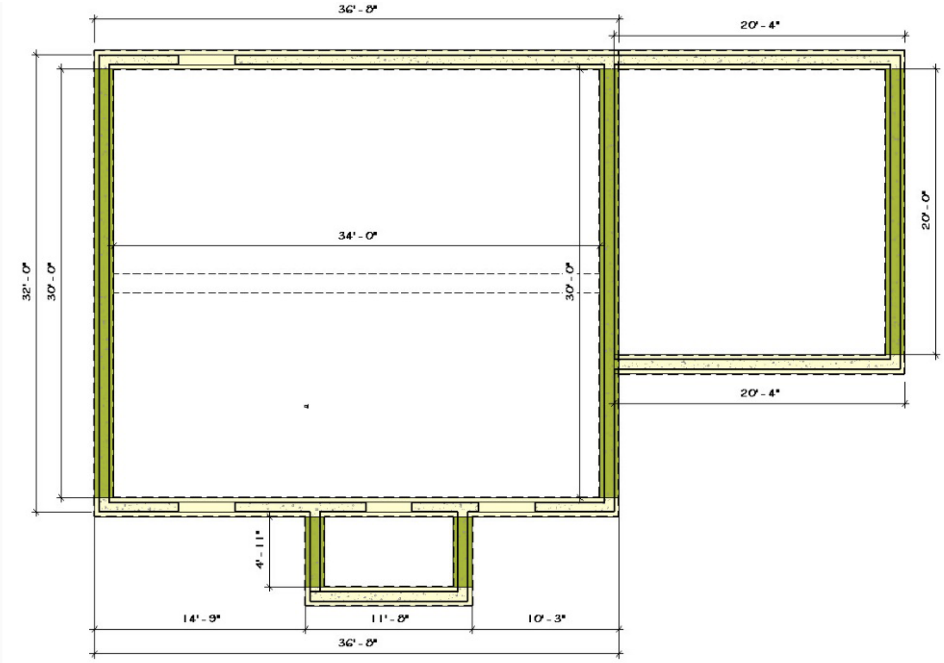

Figure 5-34

Method 01: Averaging the exterior and interior dimensions.

1. Measure both the exterior dimensions and interior dimensions of the footings.
2. Add both dimensions together and divide in half to find the average length. This is the estimated length of the footing.

(Exterior Dimension + Interior Dimension) ÷ 2 = Average Lineal Feet

Examples

- The leftmost footing in Figure 5-34 has an exterior length of 32' and an interior length of 30'.

(Exterior Dimension + Interior Dimension) ÷ 2 = Average Lineal Feet

(32' + 30') ÷ 2 = Average Lineal Feet

62' ÷ 2 = **31 Lineal Feet**

- The topmost footing in Figure 5-34 has an exterior length of 36'8" and an interior length of 34'.

(36'-8" + 34') ÷ 2 = Average Lineal Feet

70'-8" ÷ 2 = **35'-4" Lineal Feet**

- The total lineal feet for these two footings would be **66'-4"** using this method.

Method 02: Break the footings into individual pieces using Bluebeam and measure their length.

1. Break the footings into individual pieces that are placed on the page horizontally and vertically.
2. Calculate the horizontal footing by measuring to the outside of the footing the vertical footings by measuring to the inside of the footings.

Examples

- Notice that Figure 5-34 shows a dimensioned plan view of the footings.
- The horizontal footings on the page are dimensioned to the outside of the wall and are highlighted in yellow.
- The vertical footings on the page are dimensioned to the inside of the wall and are highlighted in green.
- The horizontal garage footings are measured to the basement foundation.

The leftmost vertical footing has a length of **30’** highlighted in green.

The topmost horizontal footing has a length of **36’-8”** highlighted in yellow.

- The total lineal feet for these two footings would be **66’-8”**.

Notice how the total lineal feet for these two footings are slightly different between the two methods. In general, using Method 01 might be easier if you do not have the ability to highlight and measure areas in the plans. Method 02 is a bit more accurate and should be used if possible.

Total Calculations for Figure 5-34: Using Option 02 and the Spreadsheet Calculator you made previously, the total lineal feet of the exterior footings is 215.50 LF, as illustrated in the graphic below.

Clear		
Lineal Feet		
Feet	Inches	Decimal
36	8	36.67
20	4	20.33
20	4	20.33
36	8	36.67
11	8	11.67
		0.00
30	0	30.00
4	11	4.92
4	11	4.92
30	0	30.00
20	0	20.00
		0.00
Total Feet	215.50 LF	
Total Yards	71.83 LY	

Total footing calculations for Figure 5-34

Step 02: Measure the Interior Wall Footings

Calculate the width, height, and length of the interior wall footings.

- Use the same method used to calculate the exterior wall footings.
- Interior and exterior wall footings are separated in a basic takeoff because they may have the same dimensions, but different requirements for reinforcement with rebar. Because of this, the cost of materials and labor per lineal foot is different for each type of footing.
- Figure 5-32 shows the difference in reinforcement for interior versus exterior wall footings.

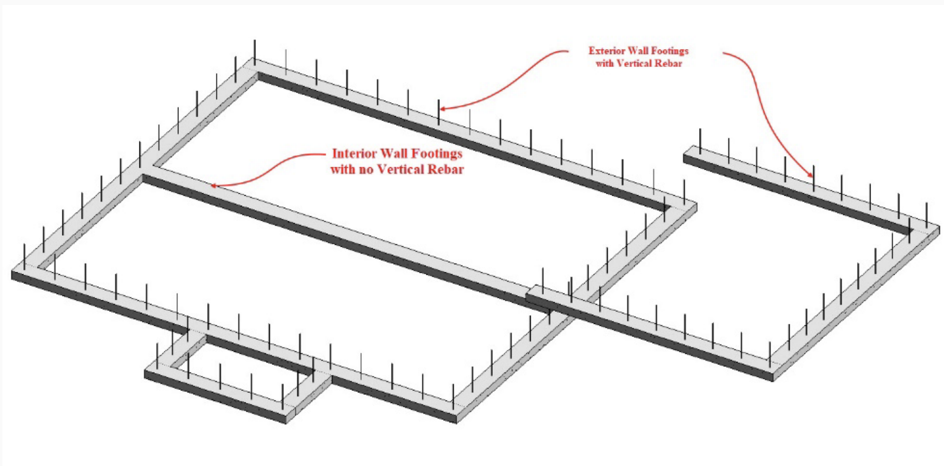

Figure 5-32 Exterior Wall footings with vertical rebar and Interior Grade footings without.

Step 03: Enter the Total Exterior and Interior Wall Footing Dimensions

The total widths, heights, and lengths of exterior and interior wall footings should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

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Foundations Section

The next basic takeoff to be completed will be the foundation section. There are two distinct styles of foundation; main foundation and the garage foundation. Each of these styles have different requirements for dimensions, as illustrated in Figure 5-31.

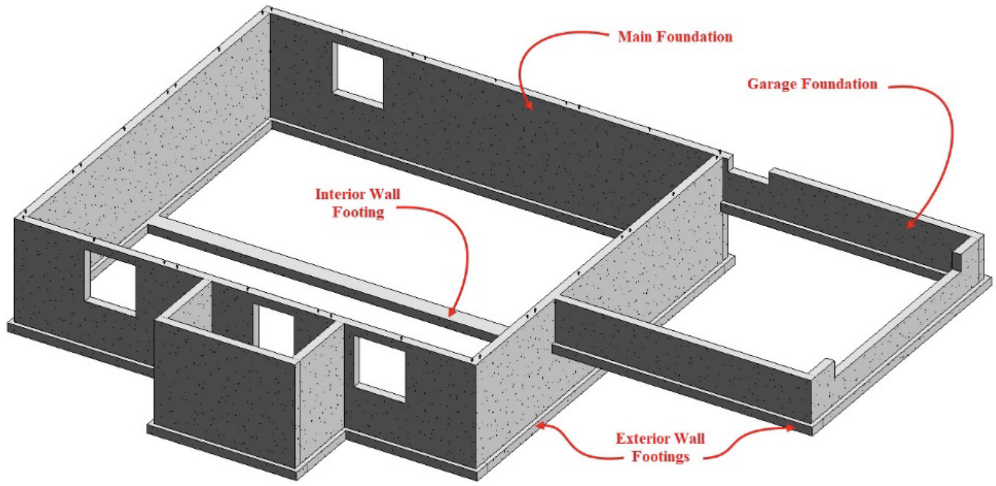

Figure 5-31 Three dimension footing and foundation view showing different footing and foundation styles.

Step 01: Measure the Main Foundation

Calculate the thickness, height, and length of the main foundation.

- This process carries the same complications as calculating exterior footings.
- Use Method 02 from the Strategies for Calculating Footings section above.

Example

- Figure 5-36 is a graphic of the foundation from the same structure used as an example for calculating footings.
- The foundations which are placed horizontally on the page are dimensioned to the outside of the walls and are highlighted in dark blue.
- The foundations placed vertically on the page are dimensioned to the inside of the wall and are highlighted in light blue

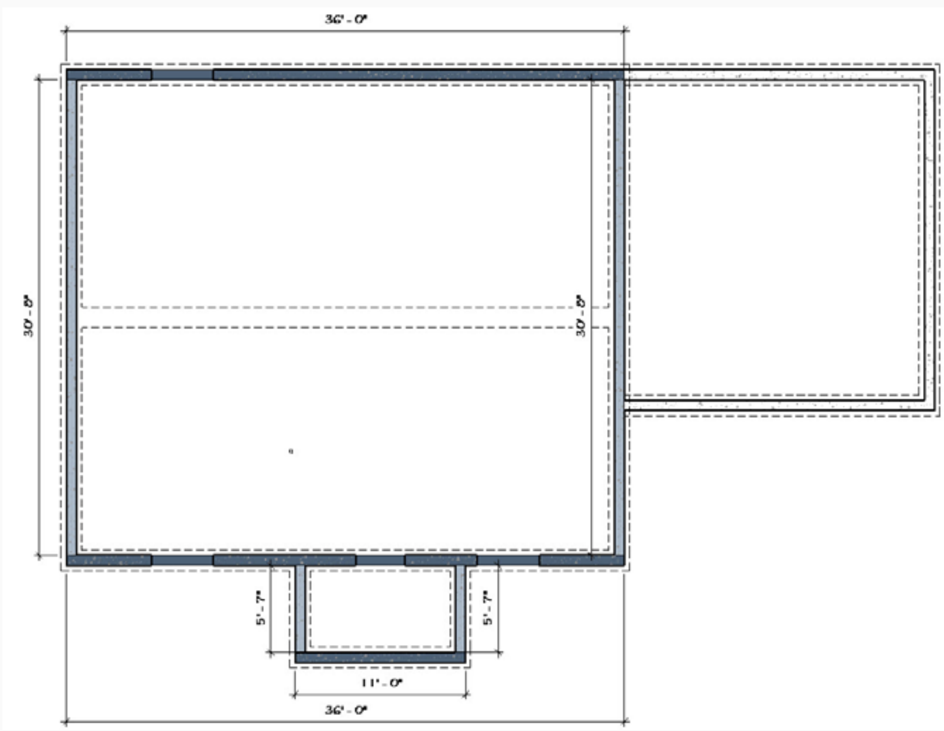

Figure 5-36 Graphic showing the lineal footage of foundation floor plan.

- Using the lengths provided by the highlights, the following numbers can be added up to calculate a total of 155.50 LF of Main Foundation.

Clear		
Lineal Feet		
Feet	Inches	Decimal
36	0	36.00
36	0	36.00
11	0	11.00
		0.00
30	8	30.67
5	7	5.58
5	7	5.58
30	8	30.67
Total Feet	155.50 LF	
Total Yards	51.83 LY	

Total foundation lengths for Figure 5-36

Step 02: Measure the Shallow or Garage Foundation

Calculate the thickness, height, and length of the garage foundation.

- This process is similar to that used to calculate the main foundation length.
- Because the two different types of foundation have different dimension requirements, they must be calculated separately. Failure to do so will result in inaccurate estimates for material and labor.

Step 03: Enter the Total Main and Shallow or Garage Foundation Lengths

The total thicknesses, heights, and lengths of main and garage foundations should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

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Basement & Pony Walls Section

The basement and pony wall takeoffs will be completed in similar fashion as the footing and foundation takeoffs.

Step 01: Identify the Different Wall Types Used in the Basement

Look at the construction plans and identify the types of walls used in the basement. Some criteria for identifying wall types includes:

- Is the wall load bearing, meaning it supports the structure above it, such as a floor or roof? These types of walls have a double top plate and are framed using 2x4's spaced 16 inches on center.
- Is the wall framed to provide a place to install insulation? These types of walls are framed using a single top plate with a stud spacing of 24 inches on center.

There are two types of basement walls that must be measured and estimated separately. They include Basement Bearing Walls and Basement Insulation Walls.

Basement Bearing Walls

- These are framed in the basement or on the foundation to support the floor system.
- Walls to frame out the various basement rooms are included in this category.
- Pony walls (shorter walls that sit on top of the foundation to complete the basement wall structure) are also included in this category.

Basement Insultation Walls

- These are walls framed around the inside of the foundation to provide a structure for installing insulation and wall finishes.

Figure 5-39 Shows the basement walls of the project used as an example in this guide.

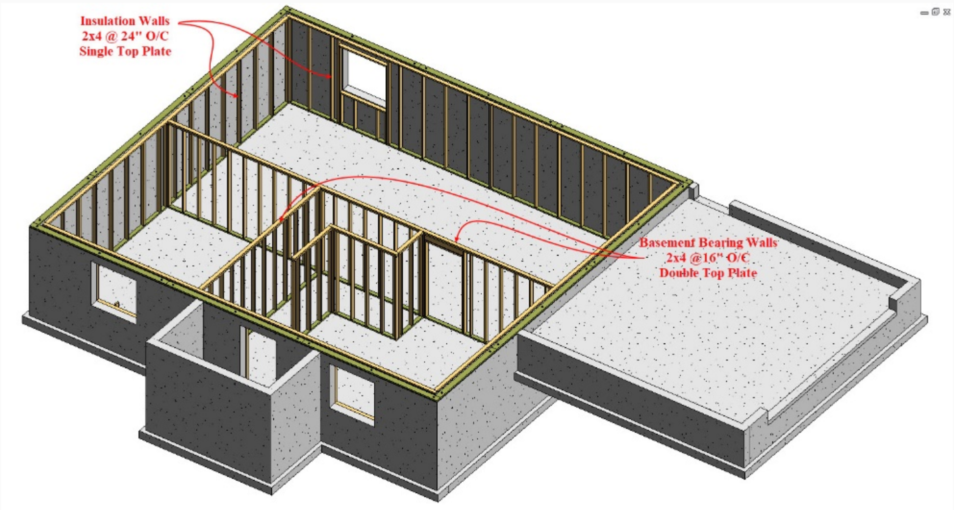

Figure 5-39 Basement bearing walls and insulation walls.

The actual construction of each wall type can best be determined by referencing building sections or wall section detail drawings. Most often notes and annotations will detail the wall construction similar to what was previously shown when calculating the footing and foundation walls. Figure 5-40 Shows and expanded section view of the footing and foundation wall section shown in Figure 5-33. The view shows the addition of the basement insulation wall.

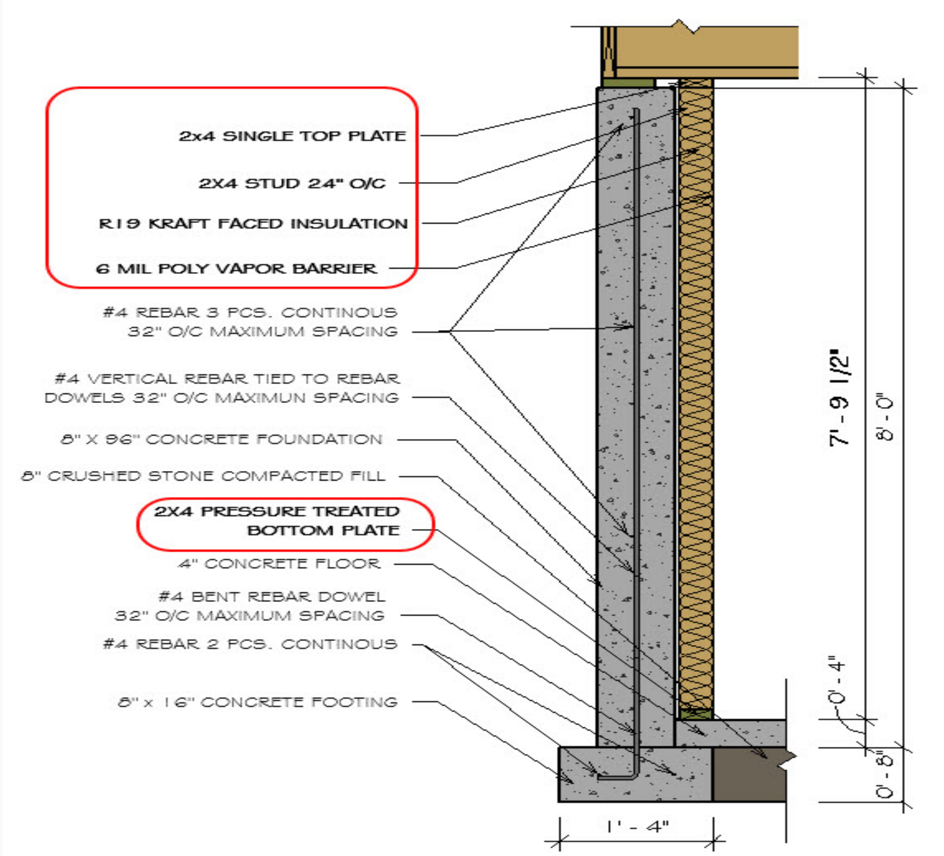

Figure 5-40 Wall section showing basement insulation wall.

Step 02: Measure the Height and Length of the Various Basement Walls

Calculate the height and length of the Basement Walls.

- This process carries the same complications as calculating exterior footings.
- Use Method 02 from the Strategies for Calculating Footings section above.

Example

- Figure 5-41 is a graphic of the basement walls from the same structure used as an example for calculating footings and foundations.
- The Insulation Walls are highlighted in pink, and the Bearing Walls are highlighted in blue.
- Notice that the various walls include blocks so that the corners where two walls join are not counted twice.

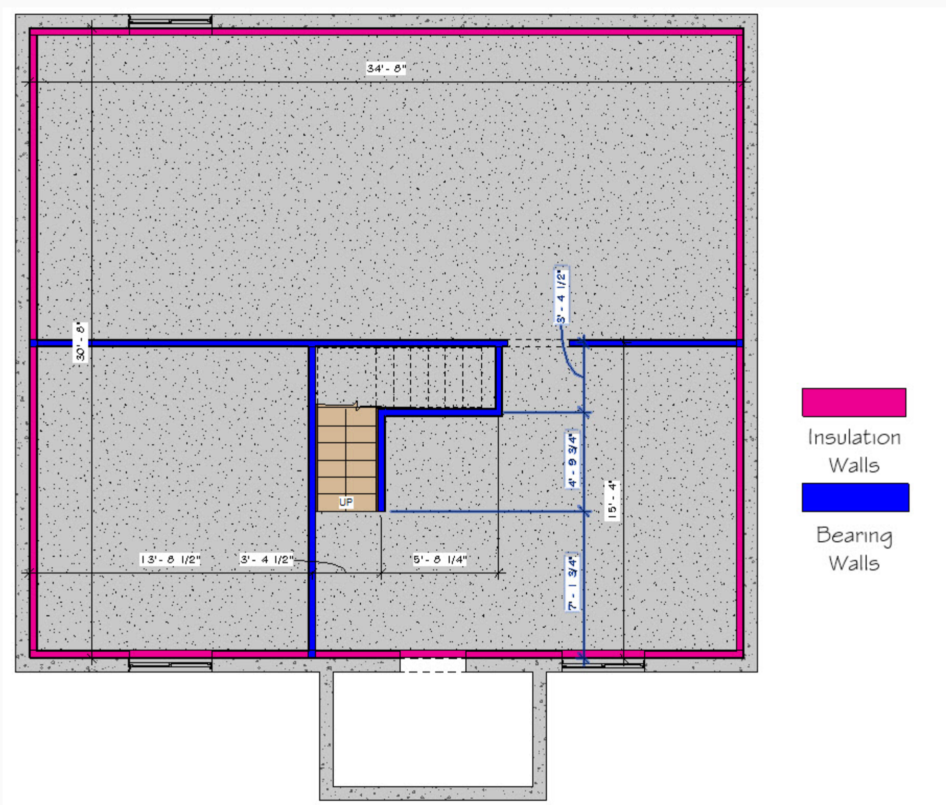

Figure 5-41 Basement bearing and insulation walls.

- Using the lengths provided by the highlights of the Bearing Walls, the following numbers can be added up to calculate a total of 63.75 LF of Basement Bearing Walls.

Lineal Feet		
Feet	Inches	Decimal
34	8	34.67
5	8	5.67
		0.00
15	2	15.17
4	10	4.83
3	5	3.42
Total Feet	63.75 LF	
Total Yards	21.25 LY	

Figure 5-42 Bearing wall lengths

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Exterior Walls Section

The Exterior Walls Subsection of the Basic Takeoff is comprised of walls with different material types.

Step 01: Identify the Different Wall Types Used in the Exterior Structure

There are three types of walls in the Exterior Walls category that must be estimated separately.

2x6 Exterior Walls

- These walls are built on the floor structure and could be framed as a single wall.
- These walls are sheathed with OSB sheathing.

2x4 Garage Walls

- These walls are built on the garage foundation.
- These walls are built using 2x4's as opposed to 2x6's.
- The studs are longer than other exterior wall types because they go all of the way to the foundation instead of resting on the floor system.
- The bottom plates of these walls are pressure treated material.

2x6 Common Walls

- These walls are built on the floor structure and could be framed as a single wall.
- These walls are covered with dry wall on both sides.
- These walls act as a shared barrier between 2x6 Exterior Walls and 2x4 Garage Walls
- Because of the difference in materials used (OSB versus drywall) Common Walls are estimated separately from Exterior Walls.

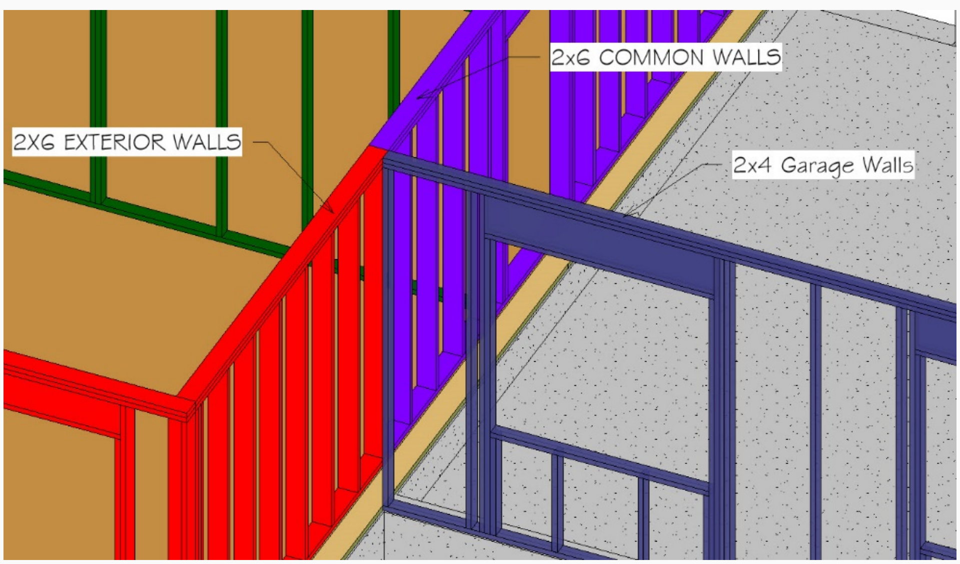

Figure 5-43 Exterior corner showing the intersection of three exterior wall types.

Step 02: Measure the Height and Length of the Various Exterior Walls

The heights and total lengths of the exterior walls should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

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Interior Walls Section

The Interior Walls subsection of the basic takeoff is comprised of walls that use different materials in their construction.

Step 01: Identify the Different Wall Types in the Interior of the Structure

There are three types of walls in the Interior Walls category that must be estimated separately.

2x4 Interior Walls

- These walls are found inside the exterior walls and are built on the floor structure of 2x4 studs.

2x6 Interior Walls

- These walls are found inside the exterior walls and are built on the floor structure of 2x6 studs.

2x4 Tall Interior Walls

- These walls are found inside the exterior walls and are built on the floor structure of 2x4 studs.
- These walls are taller than the height of the exterior walls and are typically found with vaulted ceilings.

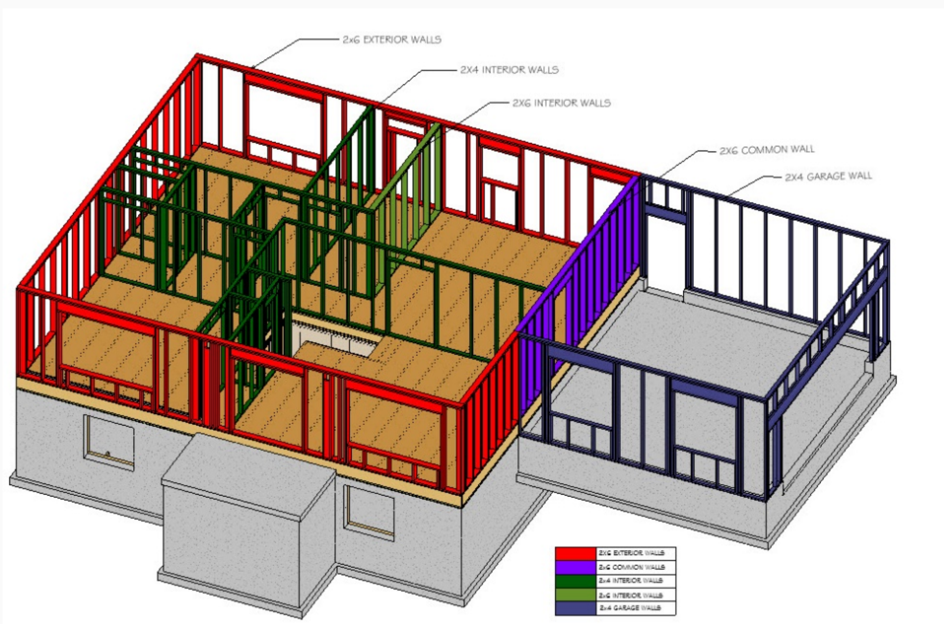

Figure 5-44 Color coded graphics of the main floor walls.

Step 02: Measure the Height and Length of the Various Interior Walls

The total lengths of main and garage foundations should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

Step 03: Enter the Measurements of the Various Walls into the Worksheet

The total lengths and heights of 2x6 Exterior Walls, 2x4 Garage Walls, and 2x6 Common Walls should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

	A	B	C
29	Basement & Pony Walls		
30	2x4 Basement Bearing Wall Length	FT	63.75
31	2x4 Basement Bearing Wall Height	FT	7.8
32	2x4 Basement Bearing Wall Area	SF	497.25
33			
34	2x4 Basement Insulation Wall Length	FT	129.2
35	2x4 Basement Insulation Wall Height	FT	7.8
36	2x4 Basement Insulation Wall Area	SF	1007.76
37			
38	Exterior Walls		
39	2x6 Exterior Walls Length	FT	114
40	2x6 Exterior Walls Height	FT	8
41	2x6 Exterior Walls Area	SF	912
42			
43	2x4 Garage Wall Length	FT	62
44	2x4 Garage Wall Height	FT	9
45	2x4 Garage Wall Area	SF	558
46			
47	2x6 Common Wall Length	FT	21.75
48	2x6 Common Wall Height	FT	8
49	2x6 Common Wall Area	SF	174
50	Interior Walls		
51	2x4 Interior Wall Length	FT	114.6
52	2x4 Interior Wall Height	FT	8
53	2x4 Interior Wall Area	SF	916.8
54			
55	2x6 Interior Wall Length	FT	12.25
56	2x6 Interior Walls Height	FT	8
57	2x6 Interior wall Area	SF	98
58			
59	2x4 Tall Interior Wall Length	FT	
60	2x4 Tall Interior Wall Height	FT	
61	2x4 Tall Interior Wall Area	SF	0
62			
63	Total SF Interior Walls		1014.8

Figure 5-45 Completed wall basic takeoffs.

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Roofs Section

The roof subsection of the basic takeoffs is comprised of three quantities which are, square footage of flat roof area, lineal feet of roof ridge, and lineal feet of roof edge.

Step 01: Identify and Measure the Flat Roof Dimensions

Identify the flat roof dimensions.

- The footprint of the roof is used to calculate the roof dimensions, not the actual area of each sloped side of the roof.
- This number includes all of the roof area, including overhangs.
- Be careful to identify any sections of roof that are covered by the overhangs of other roof sections. They still must be accounted for when calculating the total flat roof area.

Example

- Figure 5-46 Shows a dimensioned roof plan.
    - Notice that the roof plan does not show a small area of the garage roof that is under the main roof. This roof area is equal to the distance of the roof overhang multiplied by half of the roof width. This is highlighted by the area outlined in red.

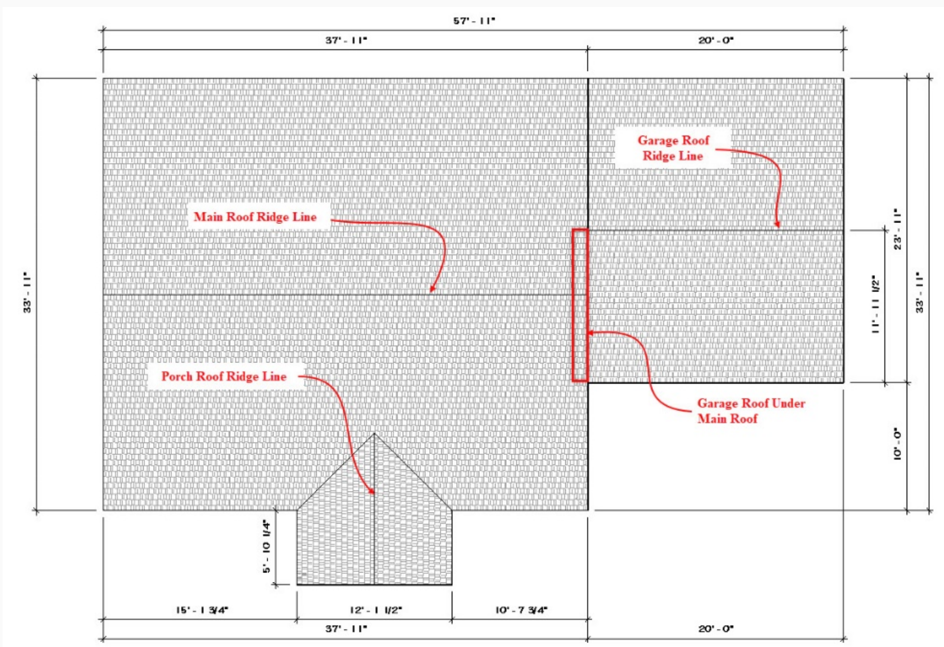

Figure 5-46 Roof plan showing flat roof dimensions.

Step 02: Segment the Flat Roof Area and Calculate the Dimensions

Figure 5-46 above is already segmented into multiple areas that can be entered into the Spreadsheet Calculator and added up to find the total flat roof area. (Figure 5-47)

Clear	Rectangle Area and Volume								
	Width		Length		Depth				
Area	Feet	Inches	Feet	Inches	Feet	Inches	Perimeter	Total Area	Total Volume
Area 1	33	11	35	11			139.67	1218.17	0.00
Area 2	20		23	11			87.83	478.33	0.00
Area 3	5	10.25	12	1.5			35.96	70.98	0.00
Area 4	1		11	11.5			25.92	11.96	0.00
Area 5							0.00	0.00	0.00
						Total Feet	289.38 FT	1779.45 SF	0.00 CF
						Total Yards	96.46 YDS	197.72 SY	0.00 CY

Figure 5-47 Dimensions of roof area input into the spreadsheet calculator.

The total flat roof area of the structure in Figure 5-46 is **1,779.45 SF**.

Step 03: Estimate the Lineal Footage of the Roof Ridge Line

The roof plan in Figure 5-46 Can also be used to determine the lineal footage of roof ridge line.

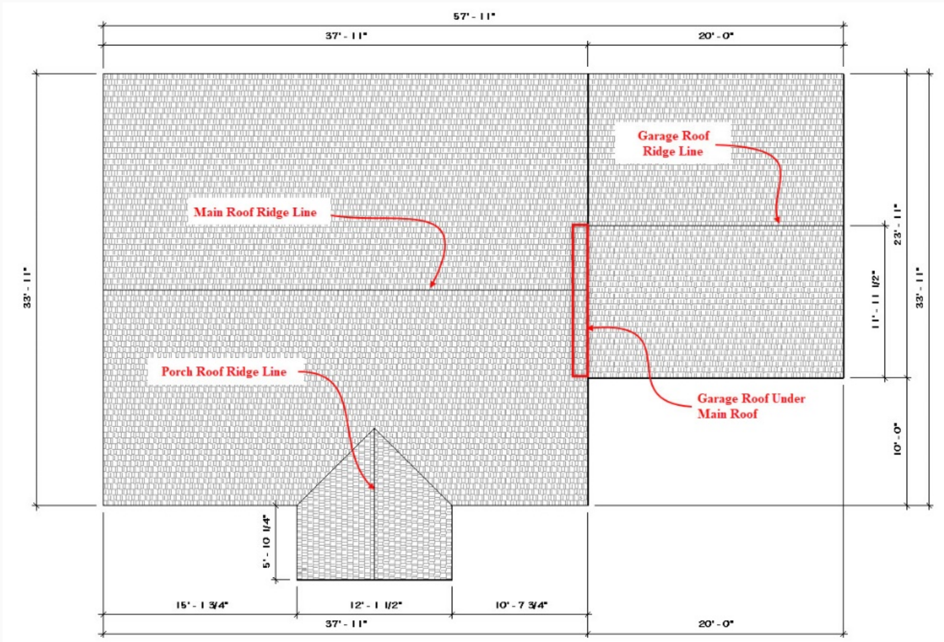

Figure 5-46 Roof plan showing flat roof dimensions.

- Three ridge lines are shown: the main roof ridgeline, the garage roof ridgeline, and the front porch ridgeline.
- The length of both the main roof and garage ridge lines can be determined from the dimensions.
  - To determine the length of the front porch ridgeline, add the 5'-10 ¼" roof edge distance to the roof run to find the total length.
  - In this case, the span of the roof is 12'-1 ½" and the run would be half of that distance, or 6'-0 ¾". The total length of the front porch ridgeline would be:

5'-10 ¼" + 6'- 0 ¾" = 11'- 11"

Figure 5-48 Shows the lineal footage of roof ridge line entered into the spreadsheet calculator.

Clear		
Lineal Feet		
Feet	Inches	Decimal
37	11	37.92
20		20.00
11	11	11.92
Total Feet	69.83 LF	
Total Yards	23.28 LY	

Figure 5-48 Lineal feet of roof ridge entered into the spreadsheet calculator.

Step 04: Estimate the Lineal Footage of the Roof Edge

The lineal footage of roof edge is a little more complicated than the other two roof basic takeoffs.

- This takeoff follows the edge of the roof around the building, and includes both the horizontal roof edges and sloped roof edges.

Example

Figure 5-49 Shows the East Side elevation of the example structure used in this walkthrough and highlights the roof edges in red.

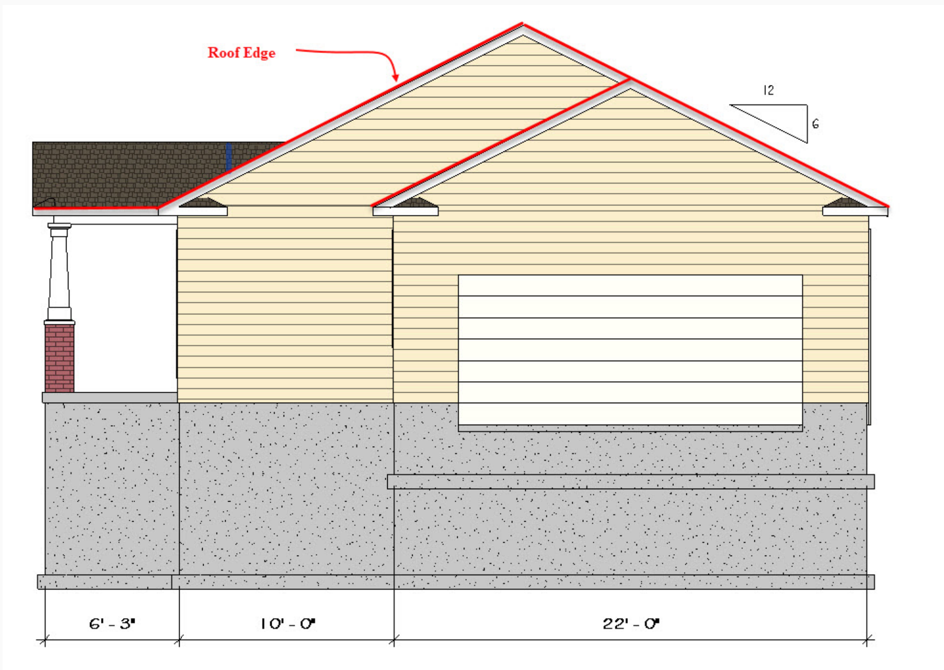

Figure 5-49 East elevation view showing roof edge.

Calculate Horizontal Roof Edges

- The single horizontal roof can be determined from the 6’-3’ dimension.

Calculate the Sloped Roof Edges

First, identify the Roof Slope.

- The roof slope in Figure 5-49 is shown as 6:12.
- The slope length of the roof is a triangle that is half of the roof span.

Next, identify and measure the each Roof Span.

- The smaller garage span is measured at 22'-0".
- The larger house span is determined by calculating the garage and the addition width of the house. This gives the roof ridge of the house a span of 32'-0".

Next, calculate the Run of each roof edge.

- The Run of a roof is the length of a horizontal line that would form a right triangle with a vertical line from the highest point of a roof edge and the roof slope.
- An easy way to calculate the Run of a roof is to divided the Span in half.
- The run of the smaller garage Span in Figure 5-49 can be calculated as follows:

22’- 0” ÷ 2 = 11’-0” Run

- The larger house Span is determined by calculating the garage and the additional width of the house. This gives the roof ridge of the house a span of 32'-0". The run can be calculated as follows:

32’- 0” ÷ 2 = 16’- 0” Run

Next, calculate the Rise of each roof edge.

- The run and the roof slope ratio can be used to calculate the vertical roof rise.
- Multiply the run by the slope ratio, which is given in Figure 5-49.
- The garage roof rise can be calculated by the following:

6/12 Ratio x 11’-0” Run

Or

½ x 11’- 0” = 5’- 6” Rise

- The main house roof rise can be calculated by the following:

6/12 Ratio x 16’- 0” Run

or

½ x 16’- 0” – 8’- 0” Rise

The run and rise of each section can be put into the spreadsheet calculator and used to calculate the slope length. This is shown in Figure 5-50.

Clear	Right Triangle Area and Volume									
	Run		Rise		Depth		Hyp	Perimeter	Total Area	Total Volume
Area	Feet	Inches	Feet	Inches	Feet	Inches				
Area 1	16	0	8	0			17.89	41.89	64.00	0.00
Area 2	16	0	8	0			17.89	41.89	64.00	0.00
Area 3	11	0	5	6			12.30	28.80	30.25	0.00
Area 4							0.00	0.00	0.00	0.00
Area 5							0.00	0.00	0.00	0.00
							Total Feet	112.58 FT	158.25 SF	0.00 CF
							Total Yards	37.53 YDS	17.58 SY	0.00 CY

Figure 5-50 Spreadsheet calculator used to determine roof slope length.

Calculate the total roof edge using the Run and Rise dimensions.

- Entering the Run and Rise dimensions into the spreadsheet calculator should calculate the Hypotenuse of each triangle.
- These Hypotenuse lenths will be the roof edge lengths.

Example

- The total roof edge on the side of the house shown in Figure 5-49 would be equal to the sloped roof edges of the house multiplied by two, and **one** garage sloped roof edge.
- Also add the horizontal run of the side of the front porch.
- The three sloped lengths are added the horizontal length to calculated the total length of the roof edge on this side of the house. The total would be as follows:

17.89′ + 17.89′ + 12.3′ + 6.25′ = 54.33′

- This total would be added to the totals for the other side of the roof to find the total length of roof edge. In the case of the example, this would be 186.00 LF.

Clear		
Lineal Feet		
Feet	Inches	Decimal
54	33	56.75
57	11	57.92
11	11	11.92
59	5	59.42
Total Feet	186.00 LF	
Total Yards	62.00 LY	

Figure 5-51 Lineal feet roof edge totals.

Step 05: Enter the Roof Takeoffs into the Worksheet

The square footage of the flat roof area and the total lineal footage of the roof ridge line and roof edge should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

For example, the inputs for the Roofs basic takeoff for the example structure is shown in Figure 5-52.

64	**Roofs**		
65	SF Flat Roof Area	SF	**1847.5**
66	Lineal Feet Roof Ridge Line	FT	**69.9**
67	Lineal Feet Roof Edge	FT	**186**

Figure 5-52 Roofs basic takeoffs.

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Windows and Doors Section

The majority of information to complete both the window and door takeoffs can be obtained from the door and window schedules.

Step 01: Copy the Information from the Door and Window Schedules into the BasicInfo Tab

Copy the information into the appropriate section in the Basic takeoffs.

- Figures 5-53 and 5-55 show the window schedule and the door schedule, respectively, for the structure used as an example throughout this walkthrough.

Type Mark	Count	Rough Opening Width	Rough Opening Height	Type	Manufacturer	Model
A	3	4' - 0"	4' - 0"	Vinyl Sliding w Buck	Amsco	Traditional Series
B	1	3' - 0"	5' - 0"	Double Window Unit	Amsco	Traditional Series
C	1	3' - 0"	1' - 0"	Vinyl Sliding	Amsco	Traditional Series
D	1	3' - 0"	3' - 0"	Vinyl Dbl Hung Window	Amsco	Traditional Series
E	2	2' - 6"	5' - 0"	Double Window Unit	Amsco	Traditional Series
F	2	2' - 6"	5' - 0"	Triple Window Unit	Amsco	Traditional Series

Figure 5-53 Example window schedule

<Door Schedule>

A	B	C	D	E	F	G	H	I	J	K
Function	Level	Door Number	Family and Type	Door Ty	Door Size	Manufacturer	Trim P	Width	Height	Area
Exterior	First Floor	0-0	Overhead-Sectional: 16' x 7'	100	16' x 7'			16' - 0"	7' - 0"	112.0 SF
Exterior	First Floor	1-1	Single-Raised Panel with Sidelights: 36"	A	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	First Floor	1-2	Gladiator Ext 6 Panel: 36" x 80"	B	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	First Floor	1-3	Gladiator Ext Glass: 36" x 80"	C	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	Foundation	1-4	Gladiator Ext 6 Panel: 36" x 80"	B	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Interior	Basement	0-1	Door-Opening: 36" x 80"	G	36" x 80"	None	0	0' - 0"	0' - 0"	0.0 SF
Interior	First Floor	1-5	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-6	Bostonian: 28" x 80"	D	28" x 80"	Jeld-Wen	3	2' - 4"	6' - 8"	15.6 SF
Interior	First Floor	1-7	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-8	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-9	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-10	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-11	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-12	Bostonian: 28" x 80"	D	28" x 80"	Jeld-Wen	3	2' - 4"	6' - 8"	15.6 SF
Interior	First Floor	1-13	Bostonian Cased Opening: 42" x 80"	F	42" x 80"	None	5	3' - 6"	6' - 9 1/4"	23.7 SF

Figure 5-55 Example door schedule

- The information entered into the basic takeoffs is shown in Figures 5-54 and 5-56.

68	**Basement Windows**						
69	**Description**	**Type Mark**	**Number of Windows**	**Width**	**Height**	**Perimeter**	**Area**
70	Vinyl Sliding w Buck	A	3	4	4	48	48
71						0	0
72	Total		3			48	48
73	**Main Floor Windows**						
74	**Description**	**Type Mark**	**Number of Windows**	**Width**	**Height**	**Perimeter**	**Area**
75	Double Window Unit	B	1	3	5	16	15
76	Vinyl Sliding	C	1	3	1	8	3
77	Vinyl Dbl Hung Window	D	1	3	3	12	9
78	Double Window Unit	E	2	2.5	5	30	25
79	Triple Window Unit	FT	2	2.5	5	30	25
80	Total		7			96	77

Figure 5-54 Window basic takeoffs

Exterior Doors					
Description	Door Number	Width	Height	Perimeter	Area
Overhead-Sectional: 16' x 7'	0-0	16.00	7.00	30	112
Single-Raised Panel with Sidelights: 36"	1-1	3.00	6.67	16.34	20.01
Gladiator Ext 6 Panel: 36" x 80"	1-2	3.00	6.67	16.34	20.01
Gladiator Ext Glass: 36" x 80"	1-3	3.00	6.67	16.34	20.01
Gladiator Ext 6 Panel: 36" x 80"	1-4	3.00	6.67	16.34	20.01
Total				95.36	192.04
Interior Doors					
Description	Door Number	Width	Height	Perimeter	Area
Door-Opening: 36" x 80"	0-1	3.00	6.67	16.34	20.01
Bostonian Double Bifold: 48" x 80"	1-5	4.00	6.67	17.34	26.68
Bostonian: 28" x 80"	1-6	2.33	6.67	15.67	15.5411
Bostonian: 30" x 80"	1-7	2.50	6.67	15.84	16.675
Bostonian Double Bifold: 48" x 80"	1-8	4.00	6.67	17.34	26.68
Bostonian Double Bifold: 48" x 80"	1-9	4.00	6.67	17.34	26.68
Bostonian: 30" x 80"	1-10	2.50	6.67	15.84	16.675
Bostonian: 30" x 80"	1-11	2.50	6.67	15.84	16.675
Bostonian: 28" x 80"	1-12	2.33	6.67	15.67	15.5411
Bostonian Cased Opening: 42" x 80"	1-13	3.60	6.67	16.94	24.012
				0	0
				0	0
				0	0
Total				164.16	205.1692

Figure 5-56 Door basic takeoff

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Preconstruction Estimating Guide

What Happens in the Preconstruction Phase?

The preconstruction phase of a project is where all of the documentation for fees, building plans, and funding is planned and processed. The end result will be to identify and estimate all the cost items associated with this phase.

Table of Contents

Architectural and Engineering Cost Estimate

Line items in this section of the Worksheet:

- Architect Fees
- Plan Fees
- Soil Testing
- Survey

If not mentioned in the Scope of Work, the cost of these items will be pre-populated in the workbook. Architectural fees are not required because you will be purchasing a plan from a plan service.

These costs are typically project-dependent. Check the Preconstruction Analysis or contact the Project Manager.

Survey Estimating Process

1. Identify lot type.
2. Reference the National Construction Estimator, Industrial and Commercial Division Contents, 01 General Requirements, Surveys.
3. The total cost next to the correct lot is the figure to enter in the estimate.

The lot type will be pre-populated in the workbook. The page to reference in the 2018 NCE will also be included in the workbook as a note.

Building Permit Cost Estimate

Most fees for the various building permits depend on the valuation of the finished building. To estimate these futures, you first need to compute the square footage of the building and value it per square foot. This will allow you to determine the fees based on the local government's permit cost tables.

Use the Basic Info numbers to populate the header of this section of the workbook.

How Permit and City Fees are Estimated

These figures are found through public information on the jobsite's governing body's website (eg. rexburg.org/city-fees).

This section will be pre-populated in the workbook.

See Building Permits in the preconstruction Section of the Reference Book for an explanation of the various fees associated with these cost items.

Construction Loan Cost Estimate

Line items in this section of the Worksheet:

- Origination Fee
- Interest Reserve
- Appraisal Fee
- Inspection Fee
- Title Insurance

Most fees for the construction loan will either be fixed cost items or calculated from the loan amount, term, interest rate, etc. To estimate these figures, you first need to set the terms of the loan. If available, reference the preconstruction Analysis document, or visit the website of the company's bank to see the latest loan interest rates (eg. beehive.org/rates).

See Construction Loans in the Preconstruction Section of the Reference Book for an explanation of the various fees associated with this cost item.

Real Estate Cost Estimate

Line items in this section of the Worksheet:

- Lot Price
- Real Estate Commission
- Inspection Fee
- Title Insurance
- Legal Fees

It is a common practice to purchase a building lot and sell it to the owner at a markup, minus real estate commission. Find the lot price to estimate real estate fees.

The commission and markup will be pre-populated in the workbook. See Real Estate in the preconstruction Section of the Reference Book for an explanation of the various fees associated with this cost item.

Temporary Utilities Cost Estimate

Line items in this section of the Worksheet:

- Temporary Power
- Electricity
- Gas
- Water

The cost items, details, and units will be provided by the Project Manager and pre-populated in the workbook. Most of these items are estimated using rates from the National Construction Estimator.

See Temporary Utilities in the preconstruction Section of the Reference Book for an explanation of the various cost items that fall under this category.

Job Site Facilities Cost Estimate

Line items in this section of the Worksheet:

- Field Office
- Field Office Setup
- Field Office Pickup
- Electrical Hookup
- Field Office Delivery
- Storage Facilities
- Sanitary Facilities

The cost items, details, and units will be provided by the Project Manager and pre-populated in the workbook. Most of these items are estimated using rates from the National Construction Estimator.

See Job Site Facilities in the preconstruction Section of the Reference Book for an explanation of the various cost items that fall under this category.

Bonds and Insurance Cost Estimate

Line items in this section of the Worksheet:

- Bonds
- Insurance

There are multiple types of bonds and builder's insurances. They are typically calculated as a percentage of the bid total.

See Bonds and Insurance in the preconstruction Section of the Reference Book for an explanation of the various cost items that fall under this category.

Job Site Supervision Cost Estimate

Line items in this section of the Worksheet:

- Supervision

The cost depends on the yearly wage of the employee supervisors, the duration of the project, and the time those supervisors will spend on the job. Ensure the employee database is current to calculate the most accurate estimate possible.

Sitework Estimating Guide

What Does Sitework Include?

Sitework, from the estimator's perspective, includes estimating items that are typically completed before excavation, including demolition, tree and brush removal, and site layout.

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The following categories must be estimated when completing the Sitework tab of the Worksheet:

Demolition Cost Estimate

Line items in this section of the Worksheet:

- Demolition
- Disposal

Estimating Process

Demolition and disposal fees vary by project. Some projects take place on already-developed parcels of land with existing buildings. On projects like this, the cost of demolishing and removing any structures or components on the jobsite must be included in the estimate. See Demolition in the Reference Book for an explanation of the various costs associated with this item.

Site Layout Materials Cost Estimate

Line items in this section of the Worksheet:

- Batter Boards
- Layout Stakes
- Batter Board Stakes
- String
- Tie Wire
- Paint
- Nails

Step 01: Check the Template for the Various Materials Databases

- The materials column should be set up with a Data Validation List that will allow you to select the appropriate material from the materials databases that have been provided.
- The Size and Units columns should be set up with an If function and a Vlookup function that will automatically put in the proper information when you select a material. If the material column is blank then the size and unit columns should also be blank.
- The Unit Cost section should be set up with an, If, Vlookup, and Match function so that the proper price is provided when the material and the supplier is selected.

Step 02: Estimate Corner and Straight Batter Boards

Determine the quantities needed of both corner and straight batter boards. Use the information, procedures, and rules outlined in the Site Layout section of the Reference Book to determine the quantity of corner and straight batter boards and batter material that you will need to purchase.

- There is no single right answer and many possible solutions to the problem. You should strive to be as efficient as possible, using as few batter boards as possible, while still making sure all exterior foundation corners are located.
- Write an Excel formula that will automatically calculate the lineal feet of batter boards that you will need based upon the quantities that you input in the header section.
- Write an Excel formula that will automatically calculate the number of batter board stakes that you will need based upon the quantities that you input in the header section.

Step 03: Estimate Other Materials

Determine the quantities needed for other materials for this portion of the estimate based on your takeoffs from the plans and the information provided in the textbook. Manually enter other materials and quantities. These items typically include:

- Layout Stakes
- String
- Tie Wire
- Paint (Marking)
- 8d Duplex Head Box Nails
- 16d Duplex Head Common Nails

See Site Layout in the Reference Book for an explanation of the various costs associated with this item.

Site Layout Labor Cost Estimate

Line items in this section of the Worksheet:

- Wages

Estimating Process

Site layout labor costs are determined by using the price from the residential section of the National Construction Estimator (NCE). Use the price for “Layout, Foundation layout, medium to large residence unless otherwise directed by the Project Manager. The Man-hours are determined by multiplying the Craft -hours by the quantity.

See Site Layout in the Reference Book for an explanation of the various costs associated with this item.

Excavation Cost Estimate

Line items in this section of the Worksheet:

- Tree and Brush Removal
- Clear and Grub
- Topsoil Strip, Haul, and Store
- Foundation Excavation
- Sewer and Water Connection
- Electrical and Gas Supply Trenching
- Grading

Step 01: Estimate Tree and Brush Removal

- Use the costs from the “Excavation with Heavy Equipment, Tree and Brush Removal” subsection of the Residential Section of the NCE for determining the cost of clearing and grubbing.

Step 02: Estimate Topsoil

- Read the soil test results to determine the depth of the topsoil on the jobsite.
- Check the (site plans?) for any other specifications or requests from the owner regarding excavation.
- Determine the quantity of soil that will need to be removed and stored and the cost of doing this.
- Identify any excavation equipment owned by the builder. The use of company-owned equipment will be added to the estimate in the Tools & Equipment portion of the worksheet later in the process.
  - If the excavation requires the use of equipment not owned by the builder, use the cost for “Excavation with Heavy Equipment “in the Residential Section of the NCE. Use the cost for a Bulldozer 65 HP unit.

Step 03: Estimate Foundation Excavation

- The main foundation excavation will extend 2 feet outside of the perimeter of the building unless otherwise specified by the Project Manager. Determine the quantity of soil to be removed. The foundation excavation will have straight sides.
- Use the cost for “Excavation with Heavy Equipment “in the Residential Section of the NCE. Use the cost for “Backhoe, operator and one laborer, ¾ CY bucket”. Use the “Average Soil” category.
- Garage footings are typically trench excavated.
  - Use the cost for “Trenching and backfill with Heavy Equipment” from the Residential Section of the NCE.
  - Use the cost for “24” wide bucket, 24” wide trench. Depths 3’ to 5’. Use the “Medium soil” option.
  - Use the total for labor and equipment.

Step 04: Estimate Foundation Backfill

- The foundation will need to be backfilled to the current level of the soil. In addition the soil around the foundation will need to be built up around the foundation and sloped out so that water will drain away.
- All of the soil (excluding top soil) that was excavated from the foundation will be used to backfill and build up around the foundation
- Use the cost for “Excavation with Heavy Equipment “in the Residential Section of the NCE. Use the cost for “Bulldozer 65 HP unit”.

Step 05: Estimate Sewer Connection

- Use the “Sewer Connections, Subcontract” subsection of the Residential Section of the NCE to determine the sewer connection costs.
- Determine the sewer trench width from the Scope of Work.
- The contractor is responsible for supplying a bed of sand 6” above and below the sewer line.
  - Use the Trenching and Backfill with Heavy Equipment subsection of the Residential section of the NCE.
  - Use the ¾ CY Wheel loader option.
  - The cost entered into the Sewer Connection subsection is for the equipment and labor cost of installing the sand bedding. The material cost for the sand will be added to the other utility trench bedding sand and priced in the Fill Materials subsection below.

Step 06: Estimate Water Connection

- Use the “Water Meter” subsection of the General Requirements section in the Commercial Section of the NCE to determine the cost of installing the water service.
- Determine the water line trench width from the Scope of Work.
- The contractor is responsible for supplying a bed of sand 6” above and below the water supply line.
  - Use the Trenching and Backfill with Heavy Equipment subsection of the Residential section of the NCE.
  - Use the ¾ CY Wheel loader option.
  - The cost entered into the Water Connection subsection is for the equipment and labor cost of installing the sand bedding. The material cost for the sand will be added to the other utility trench bedding sand and priced in the Fill Materials subsection below.

Step 07: Estimate Electrical Supply

- The utility company will supply up to 100 LF of electrical service supply line.
- The contractor is responsible for excavation and backfill of an electrical supply trench 1’ wide and 3’ deep extending from the supply transformer to the building exterior. Assume that the electrical trench will be excavated before the foundation is backfilled.
- Use the “Trenching and Backfill with Heavy Equipment” subsection of the Residential section of the NCE. Use the medium soil option.
- Use the “Soil, previously excavated” option for calculating backfill.
- Use the 60 HP front end loader.
- The soil will be compacted in 8” lifts using a jumping jack.
- The contractor is responsible for supplying a bed of sand 6” above and below the electrical supply line.
  - Use the Trenching and Backfill with Heavy Equipment subsection of the Residential section of the NCE.
  - Use the ¾ CY Wheel loader option.
  - The cost entered into the Electrical Supply Trenching subsection is for the equipment and labor cost of installing the sand bedding. The material cost for the sand will be added to the other utility trench bedding sand and priced in the Fill Materials subsection below

Step 08: Estimate Gas Supply

- The utility company will install the gas line from the street to the meter.
- The contractor is responsible for excavation and backfill of a gas line supply trench 1’ wide and 3’ deep extending from the street to the location where the meter entered the structure. Assume that the gas line trench will be excavated before the foundation is backfilled. Use the medium soil option.
- Use the “Soil, previously excavated option for calculating backfill.
- The soil will be compacted in 8” layers (lifts) using a jumping jack.
- The contractor is responsible for supplying a bed of sand 6” above and below the gas supply line.
  - Use the Trenching and Backfill with Heavy Equipment subsection of the Residential section of the NCE.
  - Use the ¾ CY Wheel loader option.
  - The cost entered into the Gas Supply Trenching subsection is for the equipment and labor cost of installing the sand bedding. The material cost for the sand will be added to the other utility trench bedding sand and priced in the Fill Materials subsection below

Step 09: Estimate Rough Grading

- The top soil that was stripped from the lot will be used for the rough grading unless otherwise specified by the Project Manager.
- Use the cost for “Excavation with Heavy Equipment “in the Residential Section of the NCE. Use the cost for “Bulldozer 65 HP unit” and the “Spread dumped soil” option.

See Excavation in the Reference Book for an explanation of the various costs associated with this item.

Erosion and Sediment Control Materials Cost Estimate

Line items in this section of the Worksheet:

- Silt Fence

Estimating Process

Erosion and sediment control costs are determined by using the prices from the Concrete Database.

See Erosion and Sediment Control in the Reference Book for an explanation of the various costs associated with this item.

Erosion and Sediment Control Materials Cost Estimate

Line items in this section of the Worksheet:

- Wages

Estimating Process

Erosion and sediment control labor costs are determined by using the price from the residential section of the National Construction Estimator (NCE). The labor cost is for installation of the silt fence, and is measured by the actual lineal footage of fence installed.

See Erosion and Sediment Control in the Reference Book for an explanation of the various costs associated with this item.

Fill Materials Cost Estimate

Line items in this section of the Worksheet:

- Fill Sand

Estimating Process

The fill sand quantity for all utility trenches will be combined together to determine the total amount of fill sand needed for the project.

See Fill Materials in the Reference Book for an explanation of the various costs associated with this item.

Well and Septic System Cost Estimate

Line items in this section of the Worksheet:

- Well
- Septic Tank

Estimating Process

Unless specified by the Project Manager, projects will be connected to a public utility system and there is no need for a well or septic system.

Concrete Estimating Guide

What Does Concrete Estimating Include?

Concrete estimating includes concrete footings, foundations, floors, sidewalks, driveways, patios, stairs, and miscellaneous concrete items.

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Footing Material Cost Estimate

Line items in this section of the Worksheet:

- Concrete
- Forms
- Rebar
- Stakes
- Spreaders
- Bracing
- Form Release
- Tie Wire
- Nails

Estimating Process

Concrete Footing Materials Header Section

- Use information from project plans and specifications to assist in entering the appropriate information in the blanks in the header section
- Some information was already determined when you did your basic takeoffs. Write a formula that will automatically place the information in the correct cell when it is entered on the basic take-off sheet.

Footing Material

- Footing concrete quantity should be automatically calculated using the information from the header section. The amount of concrete needed should be calculated to the nearest ¼ of a yard including a waste factor.
- The quantity of footing forms should be automatically calculated from the information given in the header section and should include the waste factor (Use Random Length Form Material).
- The quantity of horizontal rebar should be automatically calculated from the information given in the header section and should include the waste factor.
- The number of footing dowels should be automatically calculated from the information in the header section.
- Stakes, spreaders, bracing should be automatically calculated from information given in the header section.
- Tie wire and form oil should allow for manual input of material quantities

See Concrete Footings in the Reference Book for an explanation of the various costs associated with this item.

Footing Labor Cost Estimate

Line items in this section of the Worksheet:

- Wages

Estimating Process

- Use the cost for “Board Forming and Stripping” from the Residential Section of the NCE for determining forming cost.
- Use the cost for “Concrete Reinforcing Steel” from the Residential Section of the NCE to determining reinforcing costs
- Use the cost for “Column Footings” from the Residential Section of the NCE to determine the concrete placing cost.

Foundation Material Cost Estimate

Line items in this section of the Worksheet:

- Concrete
- Rebar
- Bolts
- Insulation
- Earthquake Straps
- Dampproofing
- Parging
- Window Bucks

Estimating Process

- The Foundation Concrete row should allow you to select a type of concrete from a data validation list and automatically fill in the size, units, and unit cost columns. The quantity of concrete should be determined by summing up the total cubic yards of concrete including a waste factor and rounded to the nearest ¼ yard.
  The foundation reinforcing quantity should be determined by automatically calculating it from the information in the header section.
- The foundation form material cost should be determined by using the "Plywood Forming" Material cost from the Residential Section of the NCE. Assume that the forms will be used 5 times
- The labor cost for the foundation earthquake straps should be determined by using the "Hold Downs (HD) subsection of the "Framing Connectors" subsection of the Residential section of the NCE. Use the HD10A option.

See Concrete Foundations in the Reference Book for an explanation of the various costs associated with this item.

Foundation Labor Cost Estimate

Line items in this section of the Worksheet:

- Wages

Estimating Process

- Use the “Plywood Forming” cost from the Residential Section of the NCE for determining the foundation forming cost.
- Use the “Concrete Reinforcing Steel” cost from the Residential Section of the NCE. For determining the cost for installing the reinforcing steel in the foundation.
- Use the “Concrete Walls” section from the Residential Section of the NCE for determining the concrete placement costs.
- Use the “8” thick walls, 4’ to 8’ high pumped option”.
- Use the Residential Section of the NCE for determining the anchor bolt placement cost.
- Dampproofing should be installed below grade on the foundation that encloses the living area. Use the Dampproofing, asphalt emulsion, Brush On” in the Thermal and Moisture Protection Section of the Commercial Section of the NCE.
- Pargeting is done on all foundation areas that are above grade and exposed to view. Use the “Pargeting, 2 coats, ½” thick” option in the Masonry Section of the Commercial Section of the NCE. For determining the pargeting cost.

Concrete Floor Cost Estimate

Line items in this section of the Worksheet:

- Concrete
- Forms
- Vapor Barriers
- Rebar
- Reinforcing Mesh
- Fill Material
- Stakes
- Concrete Cure

Estimating Process

Concrete floor quantities can be manually calculated and input or you may choose to automate the subsections.

See Concrete Floors in the Reference Book for an explanation of the various costs associated with this item.

Concrete Floor Labor Cost Estimate

Line items in this section of the Worksheet:

- Wages

Estimating Process

Use the “Slab, Walks, and Driveways subsection of the Residential Section of the NCE for determining concrete floor labor.

Sidewalk and Driveway Material Cost Estimate

Line items in this section of the Worksheet:

- Concrete
- Forms
- Rebar
- Reinforcing Mesh
- Fill Material
- Stakes
- Concrete Cure

Estimating Process

Concrete sidewalk and driveway quantities can be manually calculated and input or you may choose to automate the subsections.

Sidewalk and Driveway Labor Cost Estimate

Line items in this section of the Worksheet:

- Wages

Estimating Process

Use the “Slab, Walks, and Driveways subsection of the Residential Section of the NCE for determining concrete floor labor.

Concrete Steps Material Cost Estimate

Line items in this section of the Worksheet:

- Concrete
- Forms
- Reinforcing
- Bracing

Estimating Process

Concrete steps can be manually calculated and input or you may choose to automate the subsections.

To form the front porch, you will need enough 2”x8” material to form around the porch edge and the entry step.

Concrete Steps Labor Cost Estimate

Line items in this section of the Worksheet:

- Wages

Estimating Process

Use the prices “Steps on grade” from the Residential Section of the NCE.

Foundation Finish Estimate

Line items in this section of the Worksheet:

- Window Wells

Estimating Process

Ensure the materials databases are updated and correct. Then select the number of window wells needed.

Foundation Finish Labor Cost Estimate

Line items in this section of the Worksheet:

- Wages

Estimating Process

Use “Window Wells” from the Residential Section for finding the installation cost of window wells. Use the 4048-54 Option.

Leave Feedback

Framing Estimating Guide

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Basement & Pony Wall Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Ensure that the Wall Length (Feet) and Wall Height (Feet) cells for both Bearing Walls and Insulation Walls have pulled correct information from the BasicInfo tab.

Specifications and information for plates, studs, corners, windows and doors, Windows and Wall Sheathing should be present in the appropriate cells. If it is not present, use Bluebeam to study the plans and enter the missing values.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- Any Top Plates and Bottom Plates items will use the WallPlates user defined function to calculate quantity.
- Any Stud items will use the StudCount user defined function to calculate quantity.
- All other items will use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate.

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Floor Framing Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Ensure that the Square Foot Floor Area cell has correctly pulled information from the BasicInfo tab.

If the quantities for various girders, joists, etc. are not present, use Bluebeam to study the plans and input the missing values.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- All items should use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Exterior Wall Framing Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Ensure that the Wall Length (FT) and Wall Height (FT) cells for Exterior Walls, Garage Walls, and Common Walls have correctly pulled information from the BasicInfo tab.

If the quantities for the line items in the header are not present, use Bluebeam to study the plans and input the missing values.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- Any Top Plates and Bottom Plates items will use the WallPlates user defined function to calculate quantity.
- Any Stud items will use the StudCount user defined function to calculate quantity.
- All other items will use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate.

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Interior Wall Framing Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Ensure that the Wall Length (FT) and Wall Height (FT) cells for 2x4 Interior Walls, 2x6 Interior Walls, 2x4 Tall Interior Walls, and Interior Rake Walls have correctly pulled information from the BasicInfo tab.

If the quantities for the line items in the header are not present, use Bluebeam to study the plans and input the missing values.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- Any Top Plates and Bottom Plates items will use the WallPlates user defined function to calculate quantity.
- Any Stud items will use the StudCount user defined function to calculate quantity.
- All other items will use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate.

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Door & Window Headers Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Review the Window and Door Schedules (or the BasicInfo tab) to identify and count the number of doors and windows that fit each category in the header. Enter the correct values.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Specialty Framing Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Stair Framing Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Use Bluebeam to study the plans and enter any missing values in the cells that define the specifications for any stairs in the project.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Truss Roof Framing Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Use Bluebeam to study the plans and enter any missing values in the cells related to the Truss Roof Framing Materials.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Stick Roof Framing Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Use Bluebeam to study the plans and enter any missing values in the cells that define the specifications for any overbuild roof area in the project.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Stick Roof Soffit, Fascia, & Gable Wall Framing Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

Use Bluebeam to study the plans and enter any missing values in the cells for LF Roof Edge, Soffit Width (In), and SF Gable Walls.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Exterior Finishes Estimating Guide

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Roofing Materials Section

Refer to All About Roofing Materials for any questions regarding construction materials and processes related to this section

Header Information

Ensure that the SF of Flat Roof Area, LF Roof Edge, and LF Ridgeline cells have pulled correct information from the BasicInfo tab.

Starter Course

Starter Course refers to the area of every roof plane where a starter strip is laid down to begin finishing that section of Roof.

1. Open the plans in Bluebeam. Both the Roof Plans and the Elevation Views will be useful for calculating the Starter Course in LF.
2. Use the measuring tool to do takeoffs of every roof edge that will have a starter strip on it.
    - One easy way to identify roof edges that will require starter strip is to look for horizontal edges that do not border a gable.
    - Roof Overbuilds are typically perpendicular to the main roof and come to a point as they run up the main roof, forming a triangle. There will typically still be a horizontal edge in these features. That plan of the roof simply gets wider as it comes to ridge of the overbuild.
3. Add the LF of the edges together and enter that number in the LF Starter Course cell of the Roof Materials Section Header.
    - This number will also be the exact quantity of Starter Course material needed for the project, not accounting for waste.

Roof Slope (In per Ft)

Slope is the ratio of Rise/Run. In construction, it is measured in inches per foot, and typically is represented by a single number (eg. a Roof Slope of 8 indicates that for every 1' of horizontal run, the roof rises 8").

1. Open the plans in Bluebeam. The Elevation Views should have an inverted right triangle present at the roof slopes. This triangle will give values for rise and run.
2. Enter the value given for rise in the Roof Slope cell of the Roofing Materials Section Header.

SF of Sloped Roof Area

This cell contains a formula that should automatically calculate the SF of Sloped Roof Area, once the other header cells are completed.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- All items will use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate.

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Windows Section

Refer to All Window Materials for any questions regarding construction materials and processes related to this section

Header Information

Check the Window Schedule for the project to count the number of windows of each SF designation, then enter them in the appropriate cells of the header.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Exterior Doors Section

Refer to All Exterior Door Materials for any questions regarding construction materials and processes related to this section

Header Information

Check the Door Schedule for the project to count the number of doors of each width designation, then enter them in the appropriate cells of the header.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Vinyl Siding Section

Refer to All About Exterior Siding Materials for any questions regarding construction materials and processes related to this section

Header Information

Square Footage of House Wrap	Calculated by determining the length of the exterior walls covered by the house wrap including the area of the gable ends, and multiplying by the width of the roll of house wrap (typically 9'). Then add the SF of the gable walls, which will also be covered in wall wrap. Add all the measurements together and input that value in the spreadsheet.
Square Footage of Siding	Calculated by completing a takeoff of the area of all walls that are covered in vinyl siding in the plans in Bluebeam. Add all the measurements together and input that value in the spreadsheet.
LF Starter Strip	Calculated by identifying the starting points for every exterior surface covered in vinyl siding, and completing a takeoff of the LF of those starting points in Bluebeam. Add all the measurements together and input that value in the spreadsheet.
LF J Channel	Calculated by completing a takeoff of the perimeter of any window and exterior door openings in Bluebeam. Note that the bottom length of door openings will most likely not include J channel, so do not include it in your total. Add all the measurements together and input that value in the spreadsheet.
LF Utility (Underseal) Trim	Calculated by completing a takeoff of the lengths of the top of the exterior walls and the top of the gable walls in Bluebeam. Add all the measurements together and input that value in the spreadsheet.
LF Outside Corners	Calculated by completing a takeoff of the length of any outside corners where vinyl siding will meet. Add all the measurements together and inpt that value in the spreadsheet.
LF Inside Corners	Calculated by completing a takeoff of the length of any inside corners where vinyl siding will meet. Add all the measurements together and input that value in the spreadsheet.
LF Window Trim	Calculated by completing a takeoff of the perimeter of any window openings that the plans indicate will include trim in Bluebeam. Add all the measurements together and input that value in the spreadsheet.
LF Soffit	Calculated by completing a takeoff of the perimeter of the roof. Add all the measurements together and inpt that value in the spreadsheet.
Soffit Width (FT)	Calculated by completing a takeoff of the profile view of an area of soffit. Pay attention to the unit indicated for this measuement.
SF Porch Soffit Area	Calculated by completing a takeoff of the under area of the porch that is inside of the support beams in Bluebeam. Input this

	value in the spreadsheet.
SF Soffit	Automatically calculated when LF Soffit and Soffit Width (FT) are input in the appropriate cells.

A breakdown of how to calculate each item in the Viny Siding Material Header

Wall Siding Area Table

1. Navigate to the Vinyl Siding Materials section of the ExtFin tab.
2. Scroll to the right of that section to find the Wall Siding Area table.
3. Input the SF values of each of the following walls in the table:
    - Front Gable
    - Left Elevation Wall
    - Left Gable
    - Back Wall
    - Right Elevation Wall
    - Right Gable

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- All items will use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Interior Finishes Estimating Guide

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Insulation Section

Refer to All About Insulation Material for any questions regarding construction materials and processes related to this section

Header Information

Most of the information in this head can be pulled from the BasicInfo tab, or other places in the Estimating Workbook where it has been calculated previously. If a value is not present, enter formulae to reference those values, or use Bluebeam to study the plans and enter the missing values.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- All items should use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate.

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Drywall Section

Refer to All About Drywall for any questions regarding construction materials and processes related to this section

Header Information

SF Standard Drywall

Pull this information from the BasicInfo tab, using a formula to account for interior walls with both sides covered in drywall, the area of exterior walls, and the area of the common walls.

SF Water Resistant Drywall

Building plans do not always show which sections of walls will require water resistant drywall, or green board. If this is the case, look at the floor plans in Bluebeam and identify any wall sections that will come in contact with water. Bathrooms that include a shower or tub commonly use water resistant drywall. Use Bluebeam to measure and calculate the SF of any wall portions in the floor plans that will be built with water resistant drywall.

SF Fire Resistant Drywall

Fire resistant drywall will normally be found on common walls between the main building and the garage. Use Bluebeam to measure and calculate the SF of any wall portions in the floor plans that will be built with fire resistant drywall.

LF Outside Corners

Outside corners of interior walls require the installation of corner beads to strengthen those corners. Door frames with doors installed do not require corner beads, as they are reinforced with the door frame itself.

1. Identify and count all outside corners that will require a corner bead.
2. Use Bluebeam to measure the height of all wall sections that will require corner beads.
3. Calculate the LF of corner bead required by multiplying the various wall heights by the number of corner beads those heights require.
4. Input the total LF of required corner bead in the LF Outside Corners cell of the Drywall Materials Header.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in [How to Complete Material Estimates]:

- All items should use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Window Trim Section

Refer to All About Window Trim for any questions regarding construction materials and processes related to this section

Header Information

If the quantities for the line items in the header are not present, use Bluebeam to study the plans and input the missing values.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- All items should use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate.

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Interior Door Section

Refer to All About Interior Door Materials for any questions regarding construction materials and processes related to this section

Header Information

If the quantities for the line items in the header are not present, use Bluebeam to study the plans and input the missing values.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- All items should use LFQuantity and SFQuantity user defined functions to calculate quantity as is appropriate.

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Interior Trim Section

Refer to All About the Framing Phase for any questions regarding construction materials and processes related to this section

Header Information

LF Interior Walls

This information should be precalculated with a formula that will pull information from other parts of the workbook. If it does not, either write a formula to calculate this value, or use Bluebeam to complete a takeoff.

LF Interior Walls W/O Baseboard

Some walls will not require finishes like baseboards. Examples include wall sections with built-in cabinets, vanities, or appliances, stairways, and bathroom fixtures like tubs.

1. View the overhead floor plans and elevation floor plans in Bluebeam to identify any wall sections that will not include baseboard trim.
2. Use Bluebeam to complete a takeoff measurement of all wall sections without baseboard trim.
3. Add all the measurements together to estimate the total LF of wall sections without baseboard trim.
4. Enter this measurement in the Interior Trim Material Header for LF Interior Walls W/O Baseboard.

Note: Toilets are not typically built into the wall, so baseboard trim is likely to be installed behind it.

LF Door Openings

Door openings typically include a door frame and door casing that does not require the use of baseboard molding. Because of this, the LF of all door openings must be subtracted from the total LF of interior walls to accurately estimate the quantity of baseboard molding required.

1. View the overhead floor plans and elevation floor plans in Bluebeam to identify any door openings that include an actual door.
2. Use Bluebeam to complete a takeoff measurement of the width of all door openings that include a door.
3. Add all the measurements together to estimate the total LF of door openings.
4. Enter this measurement in the Interior Trim Material Header for LF Door Openings.

Note: Some building plans include archways without doors. These are typically trimmed with baseboard, so do not include any of these openings in your door opening count.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in [How to Complete Material Estimates](#):

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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All Other Sections

Refer to the resources found under Interior Finishes Phase for any questions regarding construction materials and processes related to this section

Header Information

Use Bluebeam to study the plans and enter any missing values in the cells that define the specifications for any stairs in the project.

Materials Subsection

Line items in this subsection that require extra consideration outside of the process described in How to Complete Material Estimates:

- n/a

Labor Subsection

This is the same process used for estimating labor costs for any other construction task using the NCE.

1. Ensure that the materials that correspond to each job description are present in the line items in the Materials Subsection.
2. Use the NCE to look up the CraftHrs, Unit, and Labor for the specific job and material.
3. Reference any relevant information in the Header and Material Subsection to calculate the quantity of Labor required for the job.
4. Ensure the Total cell has calculated the total cost for completing the job.

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Subcontractor Estimating Guide

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Basic Process for Completing the Subs Tab

There are multiple steps that go into completing the Subcontractor Phase of a construction project. Essentially, you will scope the work that you are subbing out, use the NCE to estimate the rough cost of materials and labor for completing the subcontract work, then comparing and leveling bids from various subcontractors to arrange the best possible prices for the various work to be completed.

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Define the Line Items and Materials for Each Subcontract

The line items and materials will usually be predetermined in the Estimating Workbook. If they are not, you should refer to the Building Plans, Scope of Work documents, or contact the Project Manager to identify the line items and materials to be used for subcontracting jobs.

One important part of this step is completing takeoffs in Bluebeam for items that are measured in LF and SF. For example, when estimating ceramic tile, you will need the SF of flooring that will have tile installed to really estimate the scope of the job.

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Identify Allowances for Subcontractor Jobs and Line Items

Refer to the Specification Sheets in the Building Plans to find any allowances specified for various cost items that fall under subcontractor jobs.

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Interpret the Bids

Look at all the bids for a specific Subcontractor job.

- This is not always as clear as it would appear. Sometimes a subcontractor can do multiple line items outside the scope of one specific subcontractor job. For example, a mechanical company could do items from both the electrical subcontractor job and the HVAC subcontractor job.

Identify any scope gaps found in the bids. Are there items outlined in the Specification Sheets and the Estimating Workbook that are not included in a bid?

Do the bids include Alternates, which can be added to bid for a specified price?

Identify any quality gaps between bids. Are some bids providing pricing on items that do not meet the specifications for the project?

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Level the Bids

After reviewing all the bids, your job is now to choose the best and least expensive subcontractor to do the specified work. Bid leveling is a great way to make the best decisions on which bids to accept.

Step 01: Add the Bids for a Job into the Bid Leveling Spreadsheet

Bid leveling consists of checking the line items of each subcontractor bid and comparing them to ensure each bid includes the same work. If you find that a bid is missing certain required line items for the job, you should contact them to ask for the cost of adding those items.

Example: The following image shows three bids for an HVAC job input into a bid leveling spreadsheet.

Bid Leveling Spreadsheet

TIME/DATE OF PRINTING: 4/13/23 13:11

Job Type:	BIDDERS		
COMPANY NAME:	**Hot Stuff**	**Cool Cucumber**	**Steve**
CONTACT:	Jim	Kayla	Steve
PHONE NUMBER:	555-5555	123-4567	888-8888
Job Requirements from Specifications			
50 MBH Furnace System	$ 3,750.00	$ 4,000.00	$ 3,500.00
8 ducts, 3 air returns Typ System	$ 3,850.00	$ 3,500.00	
1 additional Duct	$ 350.00	$ 450.00	
2 Bath Vent Kit	$ 125.00		$ 100.00
BOND RATE (REQUIRED BIDS OVER $25,000)			
BOND COST			
SUBTOTAL	$ 8,075.00	$ 7,950.00	$ 3,600.00
RANK	3	2	1
TOTAL BID=	**$ 8,075.00**	**$ 7,950.00**	**$ 3,600.00**

Notice that Steve is the lowest bidder, but his bid does not include pricing for any duct work. Cool Cucumber is the next lowest bidder, but does not include pricing for the bath vent kits. Hot Stuff is the highest bidder, but includes pricing for all required line items for the job.

Step 02: Request or Estimate any Missing Line Items

Contact the subcontractor rep for any bids that are missing line items. If they are willing to do that work, they will give you pricing for it. Add the additional pricing to their bid. If they do not provide additional pricing, you can also add the pricing for that line item from another bid to help you rank the bids more accurately.

Example: You contacted Kayla at Cool Cucumber to request pricing for two bath vent kits. She gives you the pricing of $150 ($75 each). You also contacted Steve to ask about pricing for the duct work, but he says that he does not do that kind of work. Instead of adding the pricing from one of the two other bids for Steve's missing line items, you leave it blank. Because Steve is not willing to do the work required you do not choose his bid.

COMPANY NAME:	Hot Stuff	Cool Cucumber	Steve
CONTACT:	Jim	Kayla	Steve
PHONE NUMBER:	555-5555	123-4567	888-8888
Job Requirements from Specifications			
50 MBH Furnace System	$ 3,750.00	$ 4,000.00	$ 3,500.00
8 ducts, 3 air returns Typ System	$ 3,850.00	$ 3,500.00	
1 additional Duct	$ 350.00	$ 450.00	
2 Bath Vent Kit	$ 125.00	$ 150.00	$ 100.00
BOND RATE (REQUIRED BIDS OVER $25,000)			
BOND COST			
SUBTOTAL	$ 8,075.00	$ 8,100.00	$ 3,600.00
RANK	2	3	1
TOTAL BID=	**$ 8,075.00**	**$ 8,100.00**	**$ 3,600.00**

Now that levelling has been completed, Hot Stuff is the actual lowest bid that will complete all of the required work.

Step 03: Decide on a Bid to Accept

Accept the bid that offers the best overall pricing. There may be circumstances that require you to choose a slightly higher bid, such as preferred subcontractors, personal experience, etc. In general, though, you want to maximize your profit by choosing the most economical bid for subcontractor work.

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Leave Feedback

Tools & Equipment Estimating Guide

This document provides explanations and examples for how to account for the acquisition of tools and equipment, and how calculate the use cost of tools and equipment in specific construction projects.

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Tools

Purchasing Tools

Unless the uniform capitalization rules apply, amounts spent for tools used in your business are deductible expenses if the tools have a life expectancy of less than 1 year or their cost is minor. (IRS Publication 535).

Annual Tool/Wage Ratio is a number used to define how much is spent on tools compared to how much is spent on labor. Because the number is expressed as a percentage, it can then be used as a guideline to estimate the tool cost for an individual project. It is calculated as the Annual Tool Cost divided by the Annual Payroll.

Project Cost of Tools is calculated as Total Project Labor Cost times Annual Tool/Wage Ratio.

Process for Estimating Tools

1. Record all tool purchases.
2. Calculate the Annual Tool/Wage Ratio
    - Annual Tool Cost ($) / Annual Payroll ($)
3. Calculate Project Cost of Tools
    - Total Project Labor Cost x Annual Tool/Wage Ratio

Example

Total Annual Payroll (wages)	$175,000
Annual Tool Purchases (Value)	$5,000
Total Labor Cost for Project	$35,000
Annual Tool/Wage Ratio	5,000 / 175,000 = .0285 = 2.85%
Project Cost of Tools	$35,000 x .0285 = $997.00

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Supplies

What are Supplies?

Supplies are items not listed in quantity takeoff, but used in the completion of a project. They may include:

- Cleaning supplies
- First aid supplies
- Safety supplies
    - Barriers
    - Flags

Annual Supply/Wage Ratio is a number used to define how much is spent on supplies compared to how much is spent on labor. Because the number is expressed as a percentage, it can then be used as a guideline to estimate the supply cost for an individual project. It is calculated as the Annual Supply Cost divided by the Annual Payroll.

Project Cost of Supplies is calculated as Total Project Labor Cost times Annual Supply/Wage Ratio.

Process for Estimating Supplies

1. Record all supply usage.
2. Calculate the Annual Supply/Wage Ratio
   - Annual Supply Cost / Annual Payroll
3. Calculate Project Cost of Supplies
   - Total Project Labor Cost x Annual Supply/Wage Ratio

Example

Total Annual Payroll (wages)	$175,000
Annual Supply Purchases (Value)	$3,200
Total Labor Cost for Project	$35,000
Annual Supply/Wage Ratio	3,200 / 175,000 = .0183 = 1.83%
Project Cost of Supplies	$35,000 x .0183 = $640.50

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Equipment

What is Equipment?

Equipment includes light and heavy construction vehicles, special equipment, etc.

- Work Truck
- Backhoe
- Compactor
- Scissor Lift

How is Equipment Acquired for Use in Construction Projects?

There are three options for accessing equipment for construction work.

- Renting
- Leasing
- Ownership

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Equipment Rental and Leasing

Equipment Rental

In this scenario, the equipment is owned by a rental company, and the construction company pays them for the temporary use of the equipment.

Rented Time Periods are the units by which the use of the equipment is measured. The rental company will provide rates that the construction company must pay per rented time period.

Examples of Rented Time Periods include:

- Hourly
- Half Day
- Day
- Week
- Month

Equipment Leasing

In this scenario, the equipment is owned by a manufacturer or dealership, and the construction company pays them for the long-term use of the equipment as if they were the owner for a defined period of time. The only meaningful difference between renting and leasing is that leasing is used for time periods beyond one year.

Advantages of Leasing

- The company pays no capital equipment expenses
- The equipment cost is expensed rather than depreciated
- The company Increases its bonding capacity
- The company always uses newer, more current equipment

Disadvantages of Leasing

- The company makes monthly lease payments for a specified contract period
- Lease payments are more expensive than loan payments
- Upon completion of the leasing period, the company does not own the equipment

How Rental Equipment Costs are Estimated

Cost per Rented Time Period is how much the rental company charges per Rented Time Period.

Length of Time Needed is the length of time the construction company plans to use the rented equipment, expressed in Rented Time Period units.

Example

A construction company requires a backhoe for 6 hours of work. They do not own a backhoe, so they must rent or lease one. The scope of work does not merit leasing, so they choose to rent the equipment from a rental company.

The rental company provides the following cost schedule per rented time period for backhoes:

- $50.00 per hour
- $150.00 per half day
- $275.00 per full day

The job scope calls for 6 hours of backhoe usage. Based on the rental company's cost schedule, which option is the most economical for the construction company?

- Rent per Hour = $300.00 ($50.00 per hour x 6 hours)
- Rent per Half Day = $300.00 (1 half day is insufficient for the job scope, so rounding up to the nearest half day unit yields ($150.00 x 2 half days)
- Rent per Day = $275.00 ($275.00 x 1 day)

Renting the backhoe for a full day is the most economical choice for the construction company.

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Purchasing and Owning Equipment

In this scenario, the equipment is purchased and owned by the construction company, often with a loan from a bank or other financial institution.

Equipment Costs

There are two categories of costs associated with purchasing and owning equipment, ownership costs and operating costs.

Ownership Costs

These costs are incurred by the equipment owner regardless of whether the equipment is actually used.

- Interest
- Depreciation
- Repairs
- Insurance, Taxes, Storage

Operating Costs

- Wear Items (eg. tires)
- Fuel
- Lubrication

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Calculating Interest Costs

There are multiple ways to calculate interest costs. Each of the following methods have specific applications, and not all are exact figures.

Approximate Overall Interest Cost

One easy way to approximately calculate interest costs uses the following components and formula:

- Purchase Price of Equipment (not loan amount)
- Interest Rate
- Life of Loan

$$\text{Purchase Price X Interest Rate X Life of Loan} \div 2$$

Example

A construction company purchases a skidsteer for $40,000. Before deciding how much of the purchase price will be covered by the company's cash, and how much will be covered by a loan, they apply the above formula to get a rough idea of how much interest they will be paying.

- Purchase Price = $40,000.00
- Interest Rate = 10% (or .10)
- Life of Loan = 5 years

$$40{,}000 \times .10 \times 5 \div 2$$

or

$$4{,}000 \times 5 \div 2$$

or

$$20{,}000 \div 2$$

or

$$10{,}000$$

In this example, the approximate interest cost for purchasing a $40,000 skidsteer will be $10,000.

Yearly Interest Cost

Calculating the annual interest cost of equipment purchases uses the following components and formula:

- Total Interest Cost (over the life of the loan)
- Life of Loan

$$\text{Total Interest Cost} \div \text{Life of Loan}$$

Example

A construction company purchases a work skidsteer for $40,000. The approximate total interest cost is $10,000. To estimate the cost of interest for the skidsteer for a specific fiscal year, they apply the above formula.

- Total Interest Cost = $10,000.00
- Life of Loan = 5 years

10,000 ÷ 5

or

2,000

In this example, the approximate yearly interest cost of the skidsteer is $2,000.

Monthly Interest Cost

Calculating the monthly interest cost of equipment purchases uses the following components and formula:

- Yearly Interest Cost

Yearly Interest Cost ÷ 12

Example

A construction company purchases a work skidsteer for $40,000. The approximate yearly interest cost is $2,000. To estimate the cost of interest for the skidsteer for a single month of ownership, they apply the above formula.

- Yearly Interest Cost = $2,000.00

2,000 ÷ 12

or

166.67

In this example, the approximate monthly interest cost of the skidsteer is $166.67.

Hourly Interest Cost

Calculating the hourly interest cost of equipment purchases requires you to calculate monthly work hours. Monthly work hours is calculated as follows:

- Number hours per year 2080
- 75% usage factor (the number of total monthly work hours the equipment is used) = 1560 hours per year
- 1560 ÷ 12 months = 130 hrs/month

Calculating the hourly interest cost of equipment purchases uses the following components and formula:

- Monthly Interest Cost
- Monthly Work Hours

Monthly Interest Cost ÷ Monthly Work Hours

Example

A construction company purchases a skidsteer for $40,000. The approximate monthly interest cost is $166.67. To estimate the cost of interest for the skidsteer per hour of use, they apply the above formula.

- Monthly Interest Cost = $166.67
- Monthly Work Hours = 130 hours

166.67 ÷ 130

or

1.28

In this example, the approximate hourly interest cost of the skidsteer is $1.28.

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Calculating Depreciation

Depreciation is the reduced value of a piece of equipment over the time of ownership. Used equipment can be purchased more cheaply than new equipment due to depreciation.

Yearly Depreciation Calculation

Estimating the depreciation of equipment uses the following components and formula:

- Purchase Price
- Scrap Value
- Number of Years of Useful Life

(Purchase Price - Scrap Value) ÷ Number of Years of Useful Life

Example

A construction company purchases a skidsteer for $40,000. The scrap value is estimated at $10,000. Its useful life is listed at 5 years. To estimate the yearly depreciation of the skidsteer, they apply the above formula.

- Purchase Price = $40,000
- Scrap Value = $10,000
- Number of Years of Useful Life = 5 years

(40,000 - 10,000) ÷ 5

or

30,000 ÷ 5

or

6,000

In this example, the approximate yearly depreciation of the skidsteer is $6,000.

Monthly Depreciation Calculation

Estimating the depreciation of equipment uses the following components and formula:

- Yearly Depreciation

Yearly Depreciation ÷ 12

Example

A construction company purchases a skidsteer for $40,000. The yearly depreciation is estimated to be $6,000. To estimate the monthly depreciation of the skidsteer, they apply the above formula.

- Yearly Depreciation = $6,000

6,000 ÷ 12

or

500

In this example, the approximate monthly depreciation of the skidsteer is $500.

Hourly Depreciation Calculation

Estimating the hourly depreciation of equipment requires you to calculate monthly work hours. Monthly work hours is calculated as follows:

- Number hours per year 2080
- 75% usage factor (the number of total monthly work hours the equipment is used) = 1560 hours per year
- 1560 ÷ 12 months = 130 hrs/month

Estimating the depreciation of equipment uses the following components and formula:

- Monthly Depreciation
- Monthly Work Hours

Monthly Depreciation ÷ Monthly Work Hours

Example

A construction company purchases a skidsteer for $40,000. The monthly depreciation is estimated to be $500. To estimate the hourly depreciation of the skidsteer, they apply the above formula.

- Monthly Depreciation = $500
- Monthly Work Hours = 130 hours

500 ÷ 130

or

3.85

In this example, the approximate hourly depreciation of the skidsteer is $3.85.

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Calculating Taxes, Insurance, and Storage

Taxes, insurance, and storage are all cost items related to owning equipment. Calculating how these cost items factor into individual project estimating requires a simple formula.

Annual Cost Items ÷ Number of Hours of Usage

Yearly Taxes, Insurance and Storage

Calculating the yearly tax, insurance, and storage cost of equipment requires following components and formula:

- Yearly Tax
- Yearly Insurance
- Yearly Storage

Yearly Tax + Yearly Insurance + Yearly Storage

Example

A construction company owns a skidsteer. The cost items for taxes, insurance, and storage or listed below. To calculate the annual cost items, they apply the above formula.

- Yearly Taxes on the Skidsteer = $350
- Yearly Insurance for the Skidsteer = $2,000
- Monthly Storage for the Skidsteer = $100

350 + 2,000 + (100 x 12)

or

350 + 2,000 + 1,200

or

3,550

In this example, the yearly cost items of the skidsteer total $3,550.

Monthly Taxes, Insurance and Storage

Calculating the monthly tax, insurance, and storage cost of equipment requires following components and formula:

- Yearly Tax
- Yearly Insurance
- Yearly Storage

Yearly Tax + Yearly Insurance + Yearly Storage ÷ 12

Example

A construction company owns a skidsteer. The cost items for taxes, insurance, and storage or listed below. To calculate the monthly cost items, they apply the above formula.

- Yearly Taxes on the Skidsteer = $350
- Yearly Insurance for the Skidsteer = $2,000
- Monthly Storage for the Skidsteer = $100

350 + 2,000 + (100 x 12) ÷ 12

or

350 + 2,000 + 1,200 ÷ 12

or

3,550 ÷ 12

In this example, the monthly cost items of the skidsteer total $295.83.

Hourly Taxes, Insurance and Storage

Calculating the hourly tax, insurance, and storage cost of equipment requires following components and formula:

- Monthly Cost Items
- Monthly Work Hours

Monthly Cost Items ÷ Monthly Work Hours

Example

A construction company owns a skidsteer. The cost items for taxes, insurance, and storage or listed below. To calculate the monthly cost items, they apply the above formula.

- Monthly Cost Items = $295.83
- Monthly Work Hours = 130 hrs

295.83 ÷ 130

or

2.28

In this example, the hourly cost items of the skidsteer total $2.28.

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Estimating Operating Costs

Unlike ownership costs, which the equipment owner accrues whether they use the equipment or not, operating costs are expressed in hours of usage. Calculating the hourly operating costs of equipment requires following components and formula:

- The Cost of the Wear Item
- The Life of the Wear Item (in hours)

Cost ÷ Life in Hours

Tire Cost Example

A construction company owns a skidsteer. New tires for the skidsteer cost $3,000 (installed), and they are rated for 4,000 hours of use.

- The Cost of Tires = $3,000
- Life of the Tires = 4,000 hrs

3,000 ÷ 4,000

or

.75

In this example, the hourly operating cost of tires for the skidsteer $.75.

Fuel Cost Example

A construction company owns a skidsteer, which is rated at using 6 gallons of fuel per hour of operation. The cost of fuel is $3.00. In this specific example, you can adjust the cost and life of fuel so that both are expressed in hours.

- The Cost of Fuel = $3.00 per gallon x 6 gallons per hour = $18.00
- Life of the Fuel = 1 hrs

18 ÷ 1

or

18

In this example, the hourly operating cost of fuel for the skidsteer is $18.

Lubrication Cost Example

A construction company owns a skidsteer. The service manual calls for lubrication every 150 hours of operation. The cost of labor for lubrication is $60. The lubricant is $2.50 per quart, and the skidsteer requires 4 quarts.

- The Cost of Fuel = $60 (labor) + 4 x $2.50 (lubricant) = $70.00
- Life of the Lubricant = 150 hrs

70 ÷ 150

or

.47

In this example, the hourly operating cost of lubrication for the skidsteer is $.47.

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Calculating Equipment Costs for Individual Projects

To calculate the cost of equipment for an individual project requires the following components and formula:

- Total Hourly Ownership Costs
- Total Hourly Operating Costs
- Total Hours of the Project

(Hourly Ownership Cost + Hourly Operating Cost) x Total Equipment Operating Hours

Example

A construction company has a project that requires the use of a skidsteer, which the company owns. This is all the information the estimator has related to the equipment and the project:

Ownership Costs	*Hourly Interest Cost*	$1.28
	Hourly Depreciation Cost	$3.85
	Hourly Tax, Insurance, & Storage	$2.28
Operation Costs	*Hourly Wear Items Cost*	$0.75
	Hourly Fuel Cost	$18.00
	Hourly Maintenance Cost	$0.47
Project Hours	*Hours Using Equipment*	75 hrs

Skidsteer Cost Breakdown

(1.28 + 3.85 + 2.28 + .75 + 18 + .47) ÷ 75

or

26.63 ÷ 75

or

1,997.25

In this example, the estimate for the use of the skidsteer on this project is $1,997.25.

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Leave Feedback

Overhead, Profit, and Sales Tax Estimating Guide

Overhead expenses must be taken into account when keeping the books for a business as well as when estimating profit.

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Overhead

What is Overhead?

Overhead are cost items that cannot readily be charged to any one project, but represent the cost of operating a construction company. They are incurred regardless of any specific project. There are two types of overhead items, Overhead Expense Items and Job Overhead Items.

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Estimating Overhead Costs

Some of the overhead costs of operating a business are one-time expenses that do not recur, or only recur once annually. Other expenses are incurred monthly. Regardless of how frequently the individual overhead items occur, they must be accounted for at monthly, semi-annual, and annual levels.

One-time or Single Overhead Costs

1. Overhead costs that are incurred only once or infrequently will be recorded in the month of the line item in which the expense occurs.
2. All expenses will then be added up to a 6 Month Total for each line item.
3. The 6 Month Total will be calculated as a Monthly Average (divide by 6)
4. The monthly average for each line item will be multiplied by 12 to calculate a Yearly Estimate.

Example

A computer monitor in the main office of a construction company breaks in February, and must be replaced. The replacement cost $289.50.

	January	February	March	April	May	June	6 Month Total	Monthly Average	Yearly Estimate
Computers	$0	$289.50	$0	$0	$0	$0	$289.50	$48.25	$579.00

Overhead Line Item for Computers Category

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Recurring Overhead Costs

Examples of recurring overhead costs include wages and salaries, health insurance, and vehicle costs.

1. Overhead costs that recur monthly will be recorded in the month of the line item in which the expense occurs.
2. All expenses will then be added up to a 6 Month Total for each line item.
3. The 6 Month Total will be calculated as a Monthly Average (divide by 6)
4. The monthly average for each line item will be multiplied by 12 to calculate a Yearly Estimate.

Example

Officer salaries of a construction company total $16,425.00 monthly.

	January	February	March	April	May	June	6 Month Total
Officer Salaries	$16,425.00	$16,425.00	$16,425.00	$16,425.00	$16,425.00	$16,425.00	$98,550.00

Overhead Line Item for the Officer Salaries Category

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Yearly Gross Income

As a construction company schedules and plans their projects in advance, they hopefully have a rough idea of what their estimated yearly income from all of their projects will be. This figure is the Estimated Yearly Gross Income

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Yearly Gross Overhead

1. Complete the Yearly Estimate for all line items in the Overhead Expenses tab.
2. Calculate the Estimated Yearly Gross Overhead by adding all the line item yearly estimates together.

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Yearly Gross Wages

1. Ensure the Wage tab of the Estimating Workbook is completed for each employee.
2. Calculate the Estimated Yearly Gross Wages by adding the Total Net Annual Payroll Amount for each employee listed in the Wage tab together.

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Overhead as a Percentage of Income

1. Estimate both Yearly Gross Income and Yearly Gross Overhead.
2. Calculate Overhead as a Percentage of Income by dividing Yearly Gross Overhead by Yearly Gross Income.

Example

A construction company has estimated the following values for their yearly overhead.

Estimated Yearly Gross Income	$2,586,000.00
Estimated Yearly Gross Overhead	$465,385.73
Estimated Yearly Gross Wages	$356,891.19

Overhead as a Percentage of Income	18%

Yearly Overhead Estimate

Overhead as a Percentage of Income would be calculated as follows:

$$465{,}385.73 \div 2{,}586{,}000 = 0.17996$$

In this example, Overhead as a Percentage of Income is 18%

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Which Line Items Do I Add Overhead To?

Construction firms must account for their administrative costs of doing business. Because their business is construction, it is appropriate to add in an overhead charge to line items in the estimate that require the use of company overhead resources.

The following considerations should be taken into account when choosing which items to add the overhead up-charge to. Note that there is no clear answer to any of these questions, and that some of the choices on line item overhead will vary from project to project in order to win bids over competitors.

- Should the company add overhead over their costs for labor items?
- Should the company add overhead over their costs for material?
- If a line item represents a cost that does not require the work of company employees (eg. Building Permits, Insurance, etc.) should they add overhead on top of the fees?
- Subcontractors require bid leveling and jobsite supervision by a company employee. Should overhead be added on the cost of hiring subcontractors to account for that work?

Recommended Guidelines for Overhead

- No overhead for costs and fees for the project that do not require the labor of company employees (eg. Architecture, Jobsite Facilities, etc.)
- No overhead for materials. Instead, make up overhead costs on the labor costs.
- Charge overhead for all labor costs.
- Charge overhead for all subcontractor costs because a company employee will bid level and will be onsite to supervise the work.
- Charge overhead for all allowance items because company employees will be buying the material and installing it.

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Profit

Profit is the balance of money paid to the construction company after all other expenses are paid. The amount of profit is variable depending upon factors, including:

- Type of work
- Market conditions
- Demand

How Much Profit Should I Add?

In general, for residential projects in decent market conditions and stable demand, 10% profit is a good starting number to use in estimating your final figures on a project estimate.

> *Construction is a business in which you are supposed to make a fair, reasonable profit.*
>
> *Frank Degostino*

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Which Line Items Do I Add Profit To?

Construction firms may choose to add a profit percentage to every line item in every phase of construction. Some may choose to offer certain materials or services at cost (ie. no profit) in order to make their estimate and resulting bid for the project more competitive.

The following considerations should be taken into account when choosing which items to add the profit up-charge to. Note that there is no clear answer to any of these questions, and that some of the choices on line item profit will vary from project to project in order to win bids over competitiors.

- Should the company add profit over their costs for labor items?
- Should the company add profit over their costs for material?
- If a line item represents a cost that does not require the work of company employees (eg. Building Permits, Insurance, etc.) should they add profit on top of the fees?
- Subcontractors require jobsite supervision by a company employee. Should profit be added on the cost of hiring subcontractors to account for that employee supervision?

Recommended Guidelines for Profit

- No profit for costs and fees for the project that do not require the labor of company employees (eg. Architecture, Jobsite Facilities, etc.)
- No profit for materials. Instead, make up profit on the labor costs.
- Charge profit for all labor costs.
- Charge profit for all subcontractor costs because a company employee will be onsite to supervise the work.
- Charge profit for all allowance items because company employees will be buying the material and installing it.

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Sales Tax

Sales tax rate is determined by the local and state governments where the project is being completed. It is a cost that must be accounted for, and whether it is covered by the client or the construction company is a decision that must be made when completing a project estimate.

Which Line Items Do I Add Sales Tax To?

Sales tax must be paid. It is the law.

Guidelines for Adding Sales Tax to Line Items

- Add sales tax to all materials, fees, and allowances.
- Do not add sales to to labor items.
- Add sales tax for special line items with especially large tax loads (eg. Real Estate Fees)

Remember, sales tax must be accounted for and paid by someone. If it is not included in line items as outlined above, the client will not pay them. In this scenario the construction company will pay sales tax, which will cut into profit.

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Total Cost Adjustment Guide

Review of Cost Adjustments Using Overhead, Profit, and Sales Tax

The difficult part in accounting for overhead, profit, and sales tax is that the estimator and construction company may choose whether or not to apply those adjustments to individual line items. The following section includes basic principles from the Overhead, Profit, and Sales Tax Estimating Guide.

Basic Principles for Adjusting Costs for Overhead, Profit, and Sales Tax

Recommended Guidelines for Overhead

- No overhead for costs and fees for the project that do not require the labor of company employees (eg. Architecture, Jobsite Facilities, etc.)
- No overhead for materials. Instead, make up overhead costs on the labor costs.
- Charge overhead for all labor costs.
- Charge overhead for all subcontractor costs because a company employee will bid level and will be onsite to supervise the work.
- Charge overhead for all allowance items because company employees will be buying the material and installing it.

Recommended Guidelines for Profit

- No profit for costs and fees for the project that do not require the labor of company employees (eg. Architecture, Jobsite Facilities, etc.)
- No profit for materials.
- Charge profit for all labor costs.
- Charge profit for all subcontractor costs because a company employee will be onsite to supervise the work.
- Charge profit for all allowance items because company employees will be buying the material and installing it.

Guidelines for Adding Sales Tax to Line Items

Sales tax must be paid. It is the law.

- Add sales tax to all materials, fees, and allowances.
- Do not add sales to to labor items.
- Add sales tax for special line items with especially large tax loads (eg. Real Estate Fees)

Remember, sales tax must be accounted for and paid by someone. If it is not included in line items as outlined above, the client will not pay them. In this scenario the construction company will pay sales tax, which will cut into profit.

Determine the Project Total After Cost Adjustments

Once adjusted costs are applied to each line item using the guidelines above, the total project cost can be caculated. Keep in mind that this may not be the final figure used for the final estimate.

Scenarios Where Changing the Project Estimate Total May Be Appropriate

- The client's budget is lower than the project estimate total
- High competition among construction companies may require forgoing profit on some line items in order to win a project bid.
- Any other number of reasons where the project estimate does not fall in line with the client's budget.

How Can the Project Total be Adjusted?

Strategies for adjusting the project total can result in small or large changes, depending on how they are executed.

Small Adjustments

Select specific line items to which overhead and profit have been added, and remove one or both of those adjustments from the line item.

Example

The base costs of the Concrete Phase of a project have been estimated. Following the guidelines for overhead, profit, and sales tax, the adjusted cost for Concrete Work is as follows:

Phase III										
Phase III Concrete Work										
CODE	DESCRIPTION	CATEGORY	BASE COST	OVERHEAD		PROFIT		SALES TAX		TOTAL COST
	FOOTING MATERIAL	Material	$ 1,800.00		$ -		$ -	x	$ 108.00	$ 1,908.00
	FOOTING LABOR	Labor	$ 1,000.00	x	$ 132.60	x	$ 100.00		$ -	$ 1,232.60
	FOUNDATION MATERIAL	Material	$ 2,200.00		$ -		$ -	x	$ 132.00	$ 2,332.00
	FOUNDATION LABOR	Labor	$ 1,900.00	x	$ 251.94	x	$ 190.00		$ -	$ 2,341.94
	INTERIOR FLATWORK MATERIALS	Material	$ -		$ -		$ -	x	$ -	$ -
	INTERIOR FLATWORK LABOR	Labor	$ -	x	$ -	x	$ -		$ -	$ -
	EXTERIOR FLATWORK MATERIALS'	Material	$ 3,500.00		$ -		$ -	x	$ 210.00	$ 3,710.00
	EXTERIOR FLATWORK LABOR	Labor	$ 1,200.00	x	$ 159.12	x	$ 120.00		$ -	$ 1,479.12
	CONCRETE STAIRS MATERIAL	Material	$ 250.00		$ -		$ -	x	$ 15.00	$ 265.00
	CONCRETE STAIRS LABOR	Labor	$ 275.00	x	$ 36.47	x	$ 27.50		$ -	$ 338.97
	FOUNDATION FINISH	Material	$ -		$ -		$ -	x	$ -	$ -
	FOUNDATION FINISH LABOR	Labor	$ -	x	$ -	x	$ -		$ -	$ -
					$ -		$ -		$ -	$ -
	SUBTOTALS FOR PHASE III	$ -	$ 12,125.00	$ -	$ 580.13	$ -	$ 437.50	$ -	$ 465.00	$ 13,607.63

Example Concrete Work Estimate with Recommended Adjusted Costs

The total adjusted cost as configured is $13,607.63. If the Project Manager or Owner insisted this figure was out of budget, and it should be closer to $13,500, adjustments must be made to reach that target.

Exterior Flatwork Labor has an adjusted total of $1,479.12.

EXTERIOR FLATWORK LABOR	Labor	$ 1,200.00	x	$ 159.12	x	$ 120.00	$ -	$ 1,479.12

Exterior Flatwork Labor with Recommended Cost Adjustments

In order to get the cost for this phase to come in under the budget of $13,500, you could omit profit from Exterior Flatwork Labor (a single line item). Doing so would adjust the line item down to $1,359.12, and the Concrete work total to $12,487.63.

EXTERIOR FLATWORK LABOR	Labor	$ 1,200.00	x	$ 159.12		$ -	$ -	$ 1,359.12

Exterior Flatwork Labor without Profit Cost Adjustment

Larger Adjustments

Strategies for larger adjustments may include, but are not limited to, the following:

- Remove overhead or profit from an entire phase of construction.
- Adjust the profit % for the entire project.

Ultimately, decisions on how adjustments to a project estimate are made do not lie with the estimator, but understanding how to do it will allow the estimator to give valuable insights to those decisionmakers.

4

Assignment Walkthroughs

Walkthroughs are available for the following assignments.

Small Cottage Preconstruction Walkthrough
Small Cottage Framing Walkthrough
Small Cottage Concrete Walkthrough
Small Cottage Exterior Finishes
Small Cottage Interior Finishes
Small Cottage Subcontractors Walkthrough
Small Cottage Tools & Equip, Overhead, & Summary Walkthrough

Estimating Basics Assignment Walkthroughs

Walkthroughs are available for the following Estimating Basics assignments.

Spreadsheet Calculator Walkthrough
Wage Rate Calculation Walkthrough
Cost Data Manuals Walkthrough

Spreadsheet Calculator Walkthrough

Spreadsheets are computer programs that are arranged in a grid format of columns and rows, similar to traditional accounting paper. This tutorial will teach basic concepts of using Excel by creating a spreadsheet calculator that can be very useful when preparing quantity takeoffs and construction estimates.

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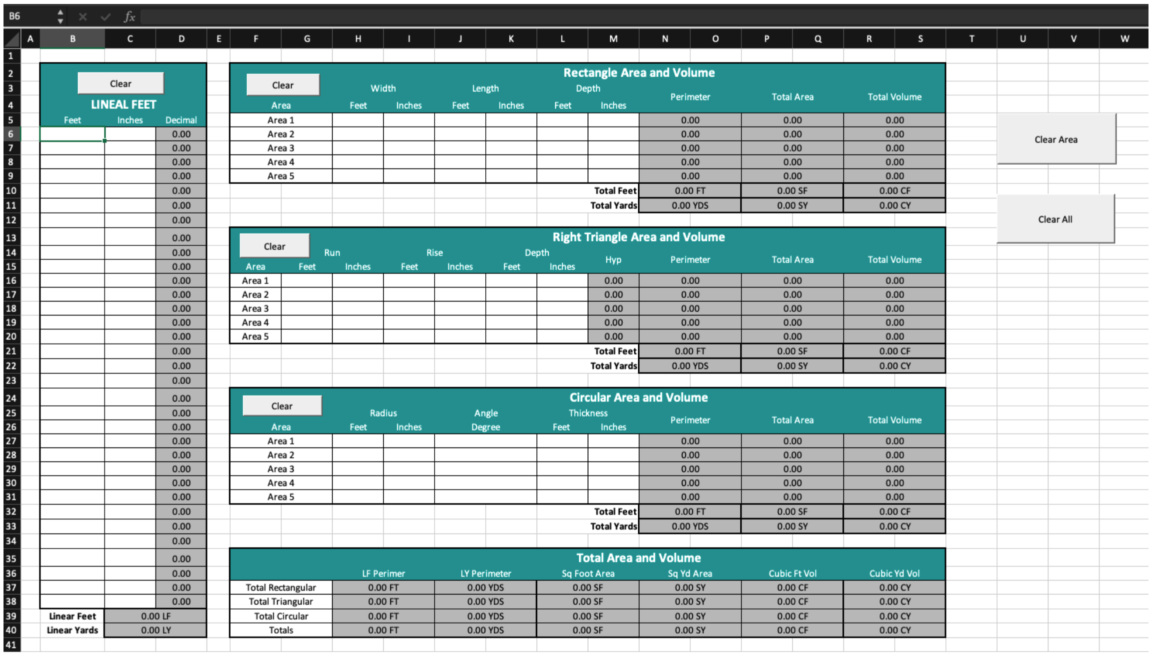
Assignment Overview

Create a spreadsheet that matches the appearance of the example and functionality outlined in the assignment scope below.



Complete Calculator Appearance Example

Spreadsheet Calculator Assignment Scope

Your completed spreadsheet calculator should include of the following specifications and functionality.

All Sections

- Match the format of the example image as closely as possible. This includes row and column numbers and sizes, color, borders, and text.
- Format the cells to display numbers to 2 decimal places.
- Include custom format displays for all Total cells to indicate the unit of measurement (LF, LY, SF, SY, CF, CY) for the calculation of those cells.
- Create and name one group of user input cells for each section. This is necessary to record a macro and make a functional Clear button.
- Create a button formatted with a macro to clear the content for each individual section.
- Create a single button formatted with a macro to clear the content of the three Area and Volume sections.
- Create a single button formatted with a macro to clear the content of all sections of the spreadsheet.

Lineal Feet Calculator Functionality

- Convert inputs from inches and feet to decimal feet in each row.
- Sum the total lineal feet and total lineal yards at the bottom of the section.

Rectangle Area and Volume Functionality

- Convert the feet/inch inputs for length, width, and depth to decimal feet, then calculate the perimeter, area, and volume for each row.
- Sum the total of all perimeters, areas, and volumes that are inputted into the cells.

Right Triangle Area and Volume Functionality

- Convert the feet/inch inputs for rise, run, and depth to decimal feet, then calculate the hypotenuse, perimeter, area, and volume for each row.
- Sum the total of all perimeters, areas, and volumes that are inputted into the cells.

Circular Area and Volume Functionality

- Convert the feet/inch inputs for radius and thickness to decimal feet, then calculate the perimeter, area, and volume for each row.
- Sum the total of all perimeters, areas, and volumes that are inputted into the cells.

Totals Section Functionality

- Calculate the total rectangular perimeter, area, and volume in both feet and yards.
- Calculate the total triangular perimeter, area, and volume in both feet and yards.
- Calculate the total circular perimeter, area, and volume in both feet and yards.
- Calculate the sum total or all perimeters, areas, and volumes in both feet and yards.

Walkthrough Videos

How to Create Macros in Excel (4:50 mins)

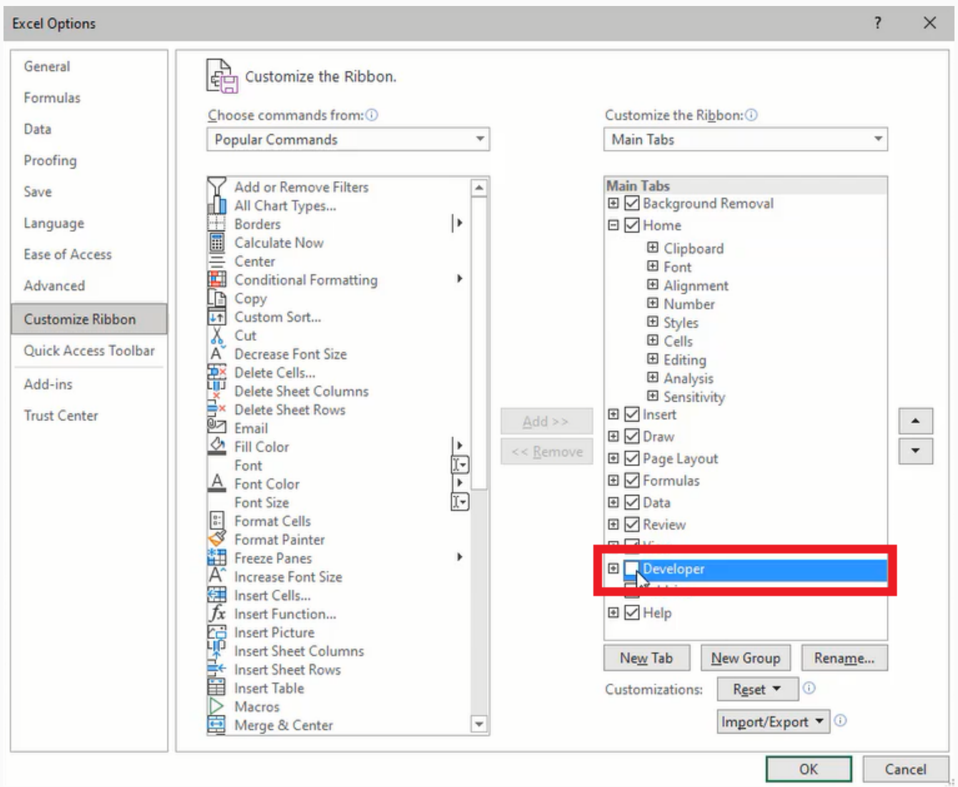
Spreadsheet Calculator Frequent Questions (20:33 mins)

Enable the Developer Tool Bar

How to Enable the Developer Tool Bar

This assignment will require you to set up macros in your spreadsheet. To enable macros, you must enable the Developer Toolbar.

1. Go to the File tab in the top-left corner of Excel.
2. Press the Options button to open the menu.
3. Select Customize Ribbon.
4. Press the checkbox for Developer in the list on the right to enable the toolbar.
5. Press OK.



Customize Ribbon menu and checkboxes

Lineal Foot Calculator

The first part of the spreadsheet that will be created is a lineal foot calculator. The length of each segment is entered in feet and inches. This is converted to decimal feet, and the individual sections are totaled and displayed in total lineal feet and total lineal yards. The calculator will also have a clear button which will allow the input to be easily cleared out and different input entered in the calculator (Figure 2-22). This can be very useful in estimating, like helping you calculate how many lineal feet of a particular wall style are in a project.

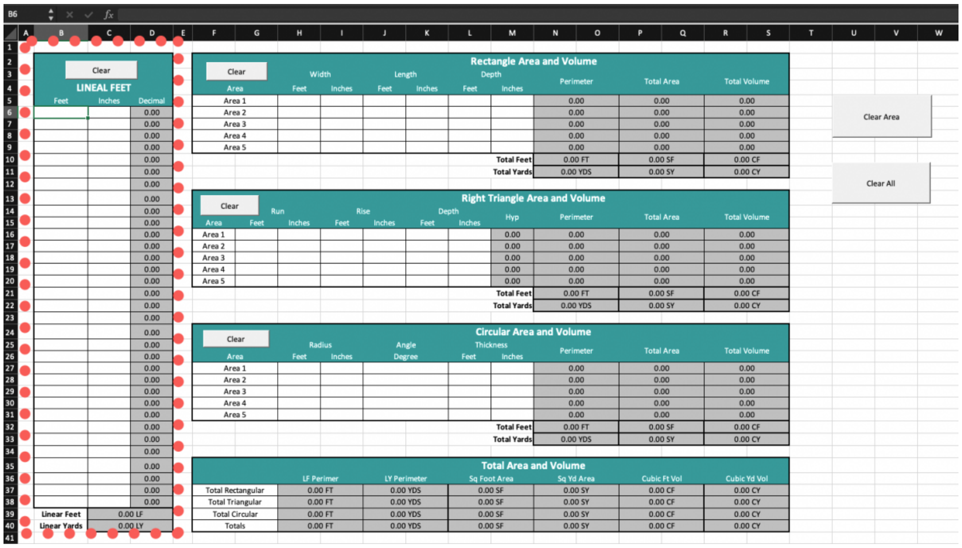


Figure 2-22 Lineal feet calculator outlined in the calculator spreadsheet

Step 01: Set Column Widths

1. Select Column A and adjust it a little narrower so that it doesn't take as much space on the page.
    - Zoom in to the line between column A and B. As the cursor is placed on the dividing line, the cursor changes shape, as is shown in Figure 2-23.
    - With the cursor a different shape, click the left mouse button and drag the border line to change the width of the column to approximately two pixels wide.

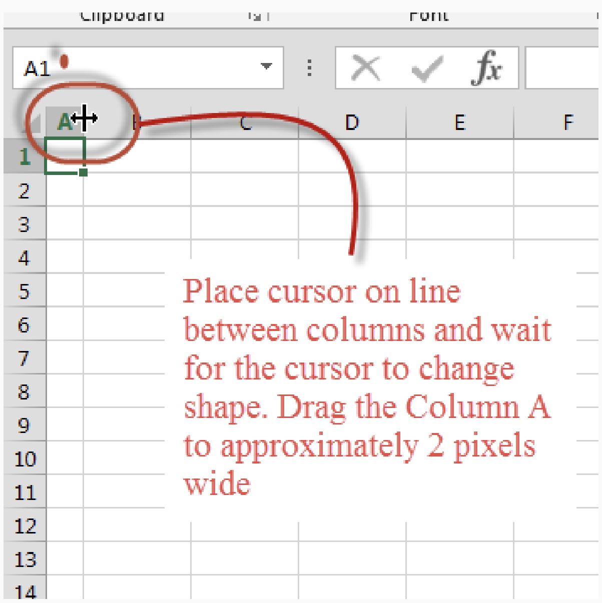


Figure 2-23 Make Column A smaller

Step 02: Creating Borders around Lineal Foot Calculator

1. Create a border around the cells that will be used for the calculator.
   - Place the mouse cursor in Cell B6 and drag down and to the right while holding the left mouse button pressed until all the cell between B6 and D38 are highlighted.
   - With those cells highlighted, click Home → Font → Borders → All Borders from the Ribbon. The group of cells should display with thin borders between each cell (Figure 2-24).

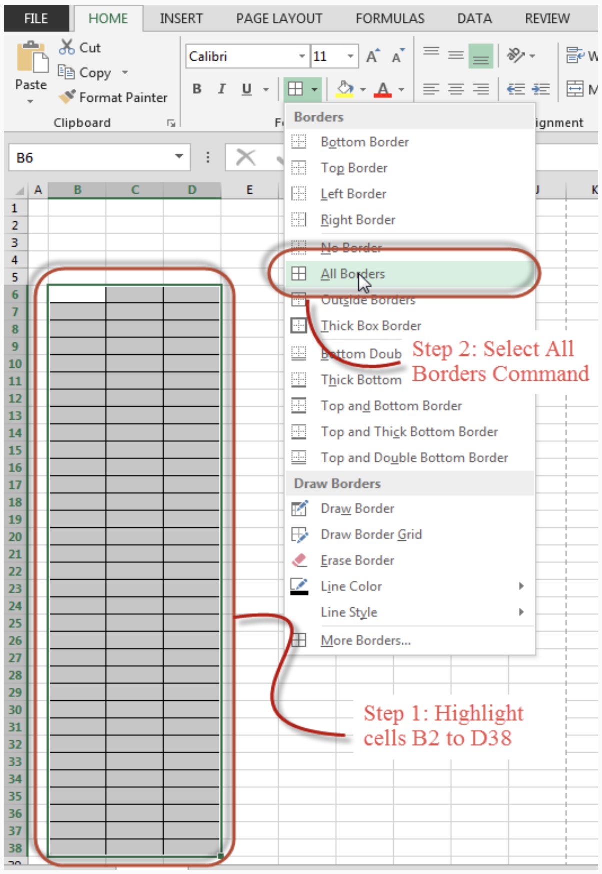


Figure 2-24 Create borders around the calculator area.

2. Place a thick border around the B6 to D38 group of cells and the group of cells between B2 and D5.
   - Select the group of cells between B6 and D38 and select Home → Font → Borders → Thick Box Border from the Ribbon.
   - Select Cells B2 to B5 and repeat the procedure by selecting Home → Font → Borders → Thick Box Border from the Ribbon. The cells should display with a thick border around them (Figure 2-25).

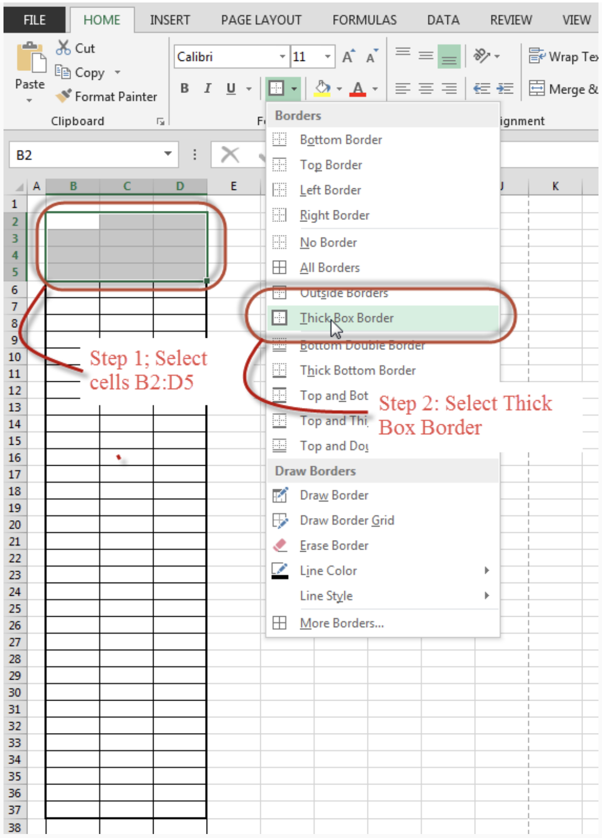


Figure 2-25 Create thick borders around the calculator area

Step 03: Merging Cells, Adding Fill Colors, Adding Titles

The next step will be to merge several cells in the header of the Lineal Foot Calculator to form larger single cells. A fill color will then be added to the header. Finally, text will be added for titles to the calculator.

1. Select cells B2 to D3, written as B2:D3. With cells B2:D3 highlighted, select Home → Alignment → Merge & Center → Merge & Center from the Ribbon. The six cells will combine into a single large cell (Figure 2-26).

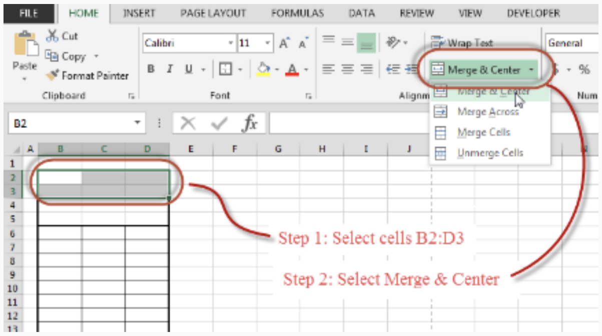


Figure 2-26 Merge cells to create one large cell.

2. Select cells B4:D4. With cells B4:D4 highlighted, select Home → Alignment → Merge & Center → Merge & Center from the ribbon. The three cells should be merged into a single cell (Figure 2-27).

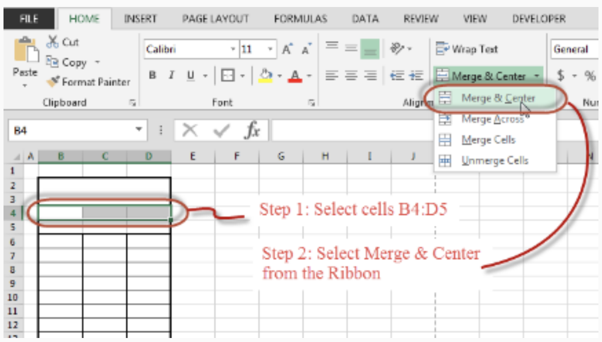


Figure 2-27 Merge cells to create a second large cell

3. Highlight cells B2:D5 and select Home → Font → Theme Color from the ribbon.
   - Choose a color of your choice from the color palette for the title header section (Figure 2-28).

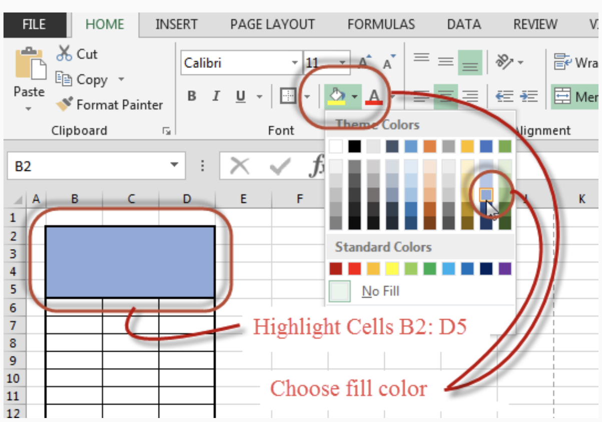


Figure 2-28 Fill in title header section with color

4. Click in the group of merged cells B4:D4 and type the text “Lineal Feet”.
    - The font and display of the text can be modified using any of the standard Microsoft Office text commands available on the Home → Font tab of the Ribbon.
    - Modify the font and color to display a font style of your choosing (Figure 2-29).

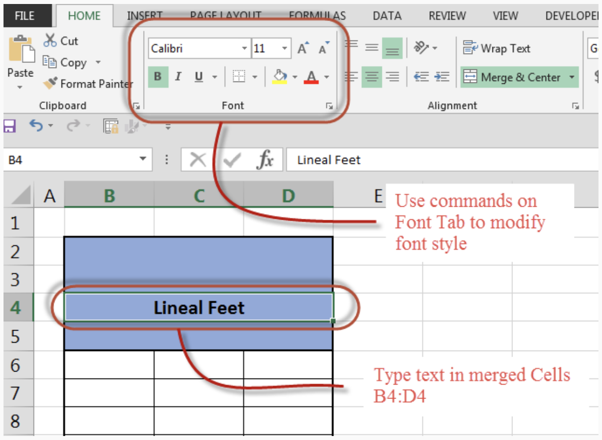


Figure 2-29 Add section title

5. Add Feet, Inches, and Decimal column titles to the calculator header and modify font style to suit your design (Figure 2-30).

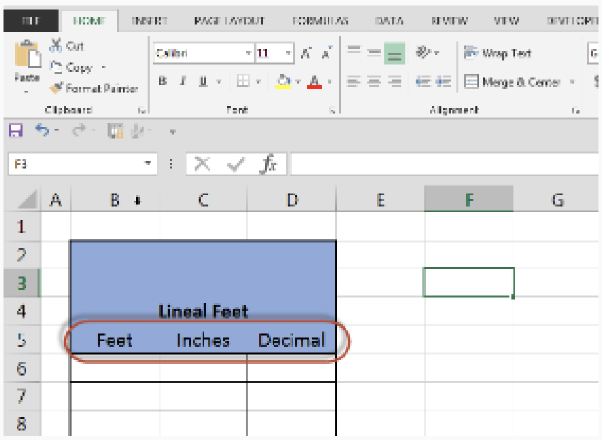


Figure 2-30 Add column header

Step 04: Writing the Function to Convert Feet and Inches to a Decimal in Excel

Feet and inch measurements are used very often in the construction process. One of the features of the calculator is that the dimensions can be input in feet and inches and the calculator will convert those numbers into a decimal format. The basic formula for making that conversion is to add the feet component to the inch component and divide by twelve inches per foot. Mathematically the equation to convert one foot six inches into the decimal equivalent of 1.5 feet is described in the following sequence of formulas.

$$1\ foot + \frac{6\ inches}{12\ inches} = 1.5\ feet$$

$$1\ foot + \frac{6\ \cancel{inches}}{12\ \cancel{inches}} = 1.5\ feet$$

$$1\ foot + \frac{6}{12} = 1.5\ feet$$

$$1\ foot + 0.5 = 1.5\ feet$$

Imperial to decimal conversion example

The formula for doing this in Excel is very similar. The added advantage that Excel has is that the input is not limited to numbers only. Excel will also accept the address of a cell as the input for a formula. For example, if the input in cell B6 was 1, and the input in cell C6 was 6, the formula to total the decimal equivalent could be written in cell D6 as =B6+C6/12 (Figure 2-31).

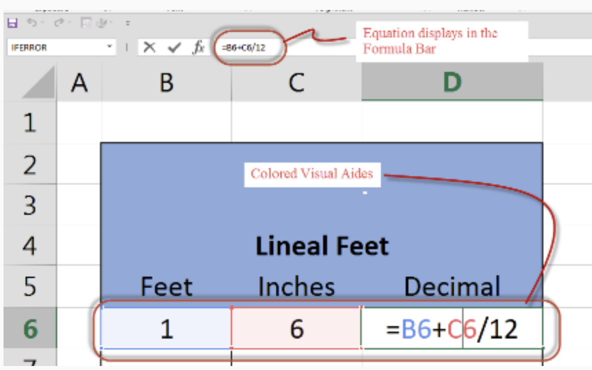


Figure 2-31 Formula to add together information from two cells

1. Select cell D6 and enter =B6+C6/12.
2. Press enter. It should now total the input from B6 and C6, converting them into a single decimal number.

Step 05: Copying the Formula into other Cells

Once a formula has been written it can be copied into other cells and used to automate the calculations.

1. Click in cell D6. A highlighted border will display around cell D6 to signify that it is the active cell.
    - A small green box will display in the bottom right-hand corner of the cell. This small green box is the fill handle, and can be used to copy the formula into other cells in the column.
2. Move the mouse cursor over the fill handle and wait until the cursor shape changes from a fat cross shape to a thin cross shape (Figure 2- 32).

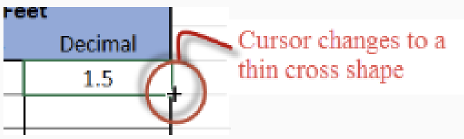


Figure 2-32 Cursor changes to copy to other cells.

3. Click the left mouse button and drag down to copy the formula all the way to cell D38 (Figure 2-33).

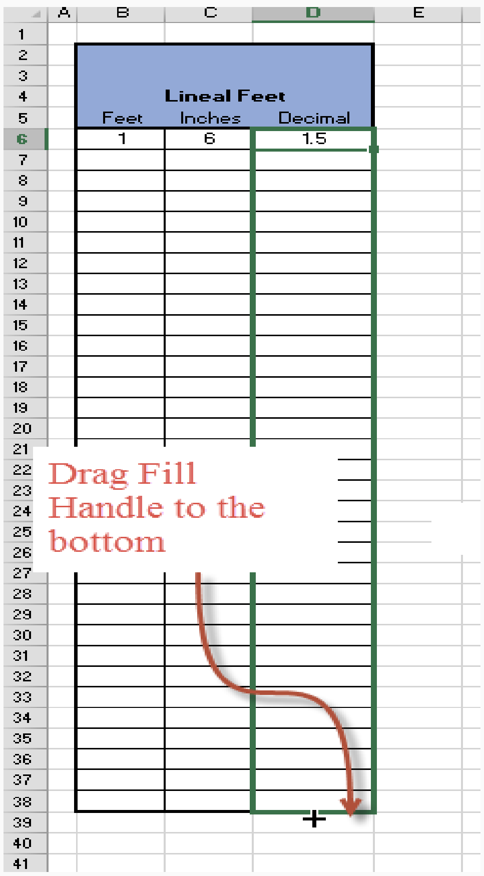


Figure 2-33 Drag to copy formula to all cells

4. Double click in any of the cells to check whether the formula has been copied correctly.
    - Not only has the formula been copied into the cell, but the cells the formula references have updated to match the correct row numbers for each row (Figure 2-34).

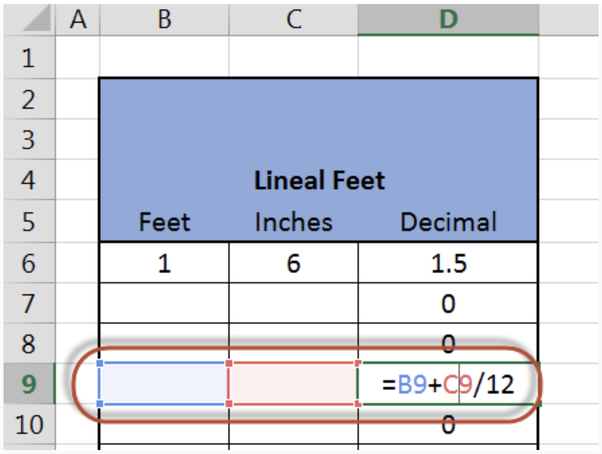


Figure 2-34 Relative reference updates the formula to reflect the correct cells.

5. Shade cells D6 through D38 light gray.
    - This is a standard that is often used to provide a visual reference to cells that have a formula in them. That way you can prevent overwriting the formula with manual inputs (Figure 2-35).

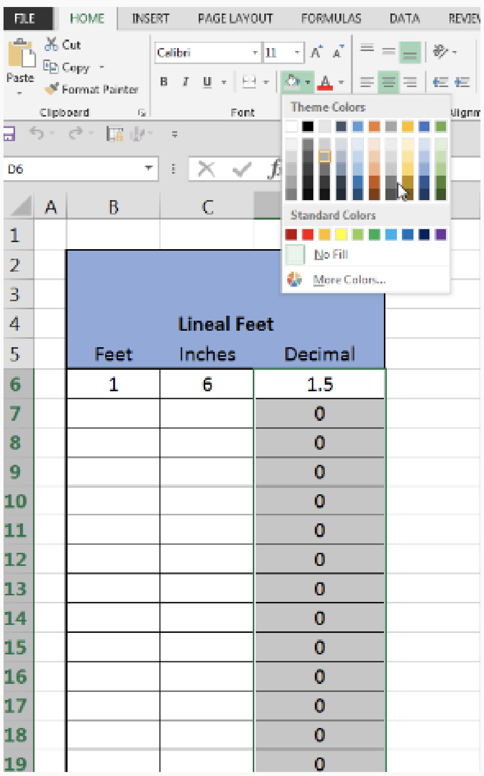


Figure 2-35 Visually indicating cells with a formula

Step 06: Adding Column Totals

Next, add the formulas for totaling the inputs from the calculator as both lineal feet and lineal yards.

1. Click and drag so that both cell C39 and D39 are highlighted.
2. Merge cells C39 and D39 using Home → Alignment → Merge & Center → Merge & Center from the Ribbon (Figure 2-36).
    - These cells will be merged together so that there is a bigger cell to display the totals.

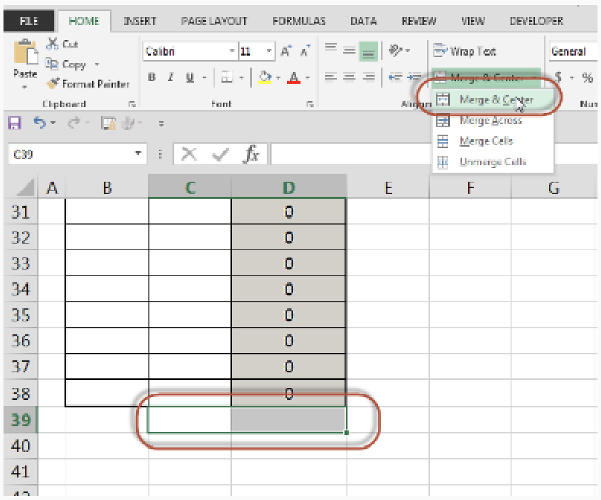


Figure 2-36 Merge cells to create larger total display

3. Repeat the merging for cells C40 and D40.
4. Select the newly created large cell at C39.
5. Add a thick border around them via Home → Font → Borders → Thick Box Borders from the Ribbon (Figure 2-37).

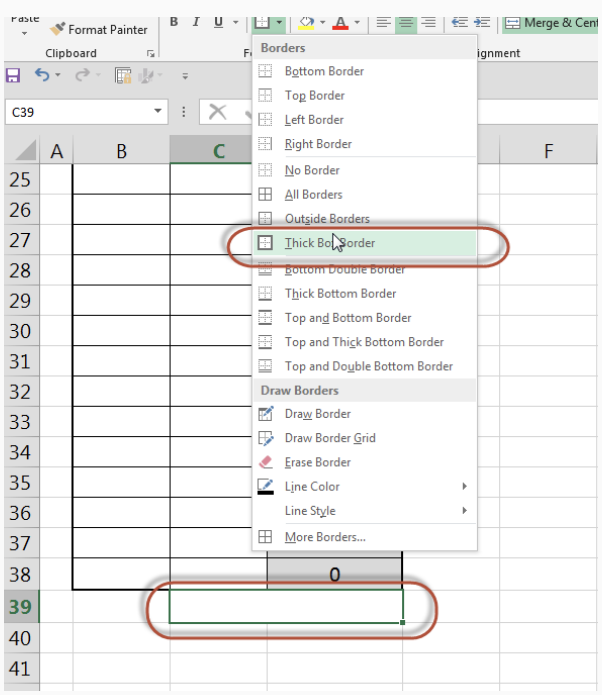


Figure 2-37 Create thick border around total cell.

6. Repeat for the large cell at C40.
7. Label cell B39 as “Lineal Feet”
8. Label cell B40 as “Lineal Yards.
9. Click and drag over cells B39 and B40, and align the text to the right.

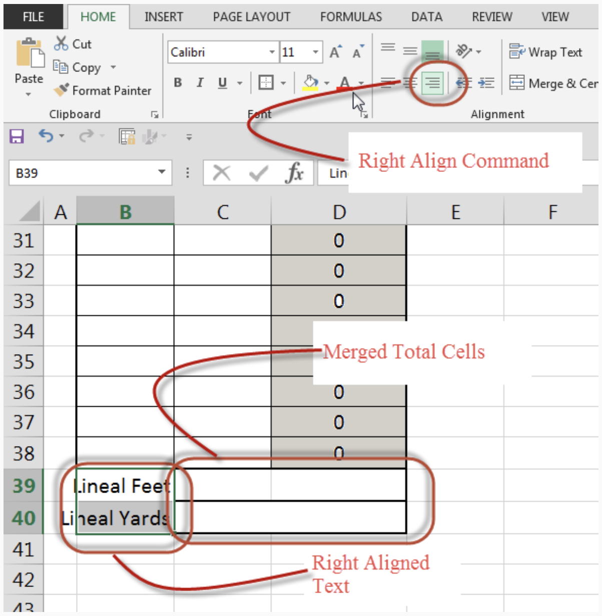


Figure 2-38 Labels for total cells

10. Add the formula for totalling the column figures as lineal feet in cell C39. Type =SUM(D6:D38) and hit enter.
    - The SUM formula adds up the numbers for a specified range of cells.
    - In Excel formulas, ranges, conditions, arguments, subordinate functions, etc. are entered between parentheses.
    - Note that this is not the only way to enter a formula in C39 that will total up the numbers from D6 to D38. For example, you can use the Insert Function button in the cell editing field, then choose your desired function (Figure 2-41).

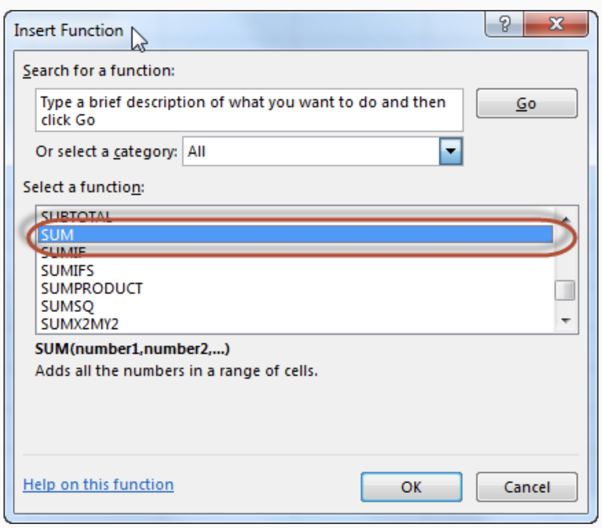


Figure 2-41 The Insert Function dialog box

- While multiple methods will work, directly entering the function by typing it is the most efficient (Figure 2-44).

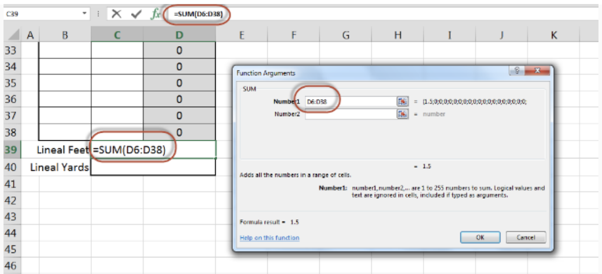


Figure 2-44 Excel syntax to add all cells from D6 to D38

11. Add the formula for totalling the column figures as lineal yards in cell C40.
    - 3 feet is equal to 1 yard, so to convert a number expressed in feet, you only need to divide it by 3.
    - There are several ways to enter a formula that will take the total number of decimal feet in cells D6 to D38 and convert it to a single number of decimal yards.
    - One option is to repeat the formula of =SUM(D6:D38) and add /3 after it. This will calculate the total number of lineal feet, and divide it by 3, resulting in the number of lineal yards. =SUM(D6:D38)/3.
    - The simpler way to write the formula is to reference cell C39, which already totals the numbers from D6 to D38, and divide it by 3. This formula would be =C39/3 (Figure 2-49).

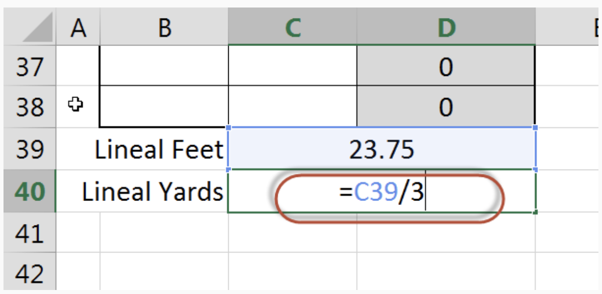


Figure 2-49 Converting Lineal Feet to Lineal Yards

Step 07: Modify the Display Characteristics

Using the formula to convert lineal feet to lineal yards may result in an answer that is multiple decimal places long. In this situation, numbers that are displayed to two decimal places will provide a sufficient level of accuracy.

Set the Decimal Places

1. Select the range of cells you want to adjust the decimal places for, in this case, D6 through D38.
2. Change the type of data by selecting the drop-down arrow in the Home → Number format drop-down menu.
    - This drop-down contains several data formats, including text, numbers, percentages, currency, etc.
    - The correct type of data for these cells in the calculator is a number. (Figure 2-50).

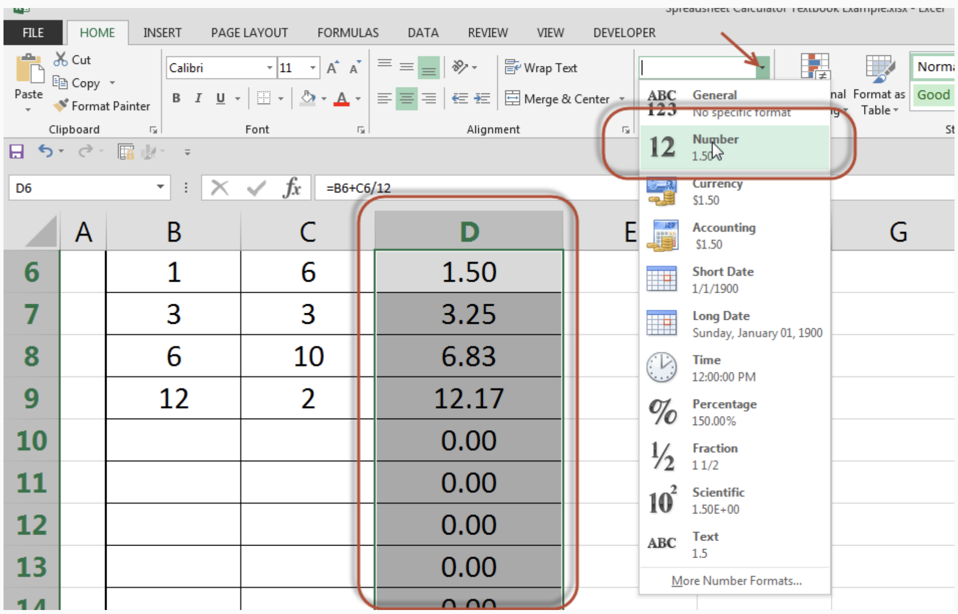


Figure 2-50 Change the display format to Number

- Changing the data type also changes the display to show two decimal places. This is because the default setting in Excel is to display numbers to two decimal places. This can, however, be changed if needed.

3. Change the Feet column to zero decimal places, and inches to two decimal places.
    - Highlight the desired cells and click the Increase Decimal, or Decrease Decimal buttons (Figure 2-51).

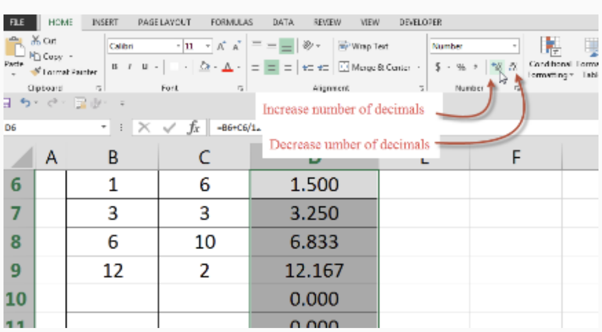


Figure 2-51 Buttons can be used to increase or decrease number of decimals to display.

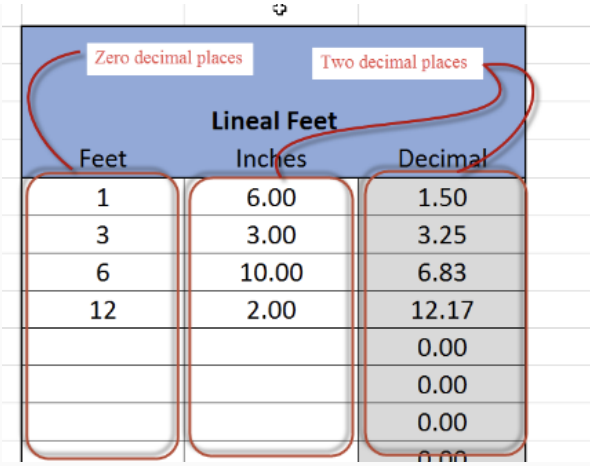


Figure 2-52 Change Feet column to zero decimal places and Inches and Decimal columns to two decimal places.

Creating a Custom Format Display

1. Display numbers in the total Lineal Feet cell as LF (Lineal Feet) and numbers in the total Lineal Yards cell as LY (Lineal Yards).
   - Select the Lineal Feet cell, C39.
   - Right-click in the cell and select Format Cells (Figure 2-53).

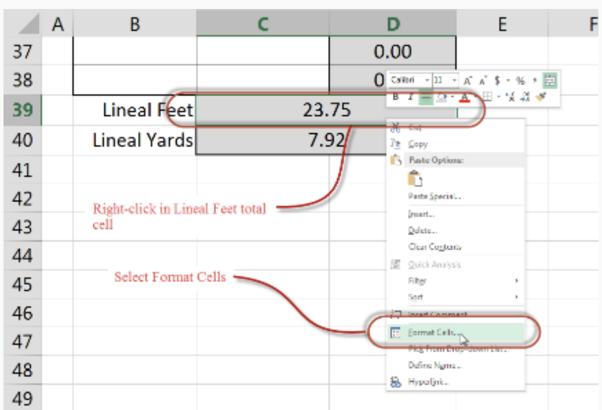


Figure 2-53 Right-click in Lineal Feet total cell and select Format Cells.

   - Select the Number tab from the Format Cells dialog box, and change the category from Number to Custom (Figure 2- 54).

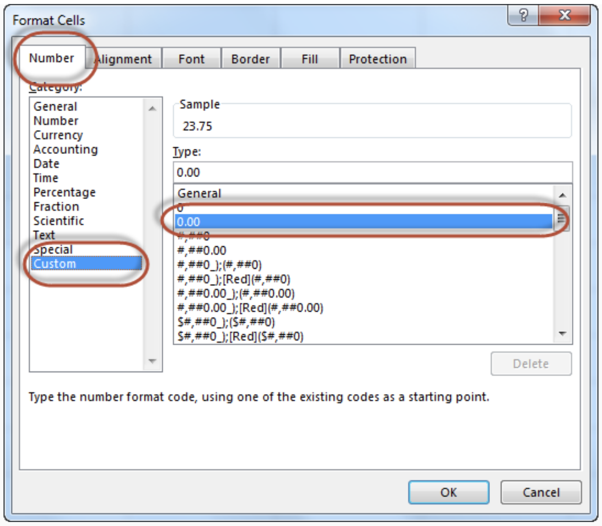


Figure 2-54 Change the category from Number to Custom

- Make sure that 0.00 is the active format and is showing in the Type: box.
- Click in the Type: box and place the cursor directly behind the last zero in the 0.00 number sequence (Figure 2-55).

Figure 2-55 Place the cursor behind the last zero in the Type box

- Enter a quotation mark, space, and LF, followed by another quotation mark directly behind 0.00 in the Type: box. It should display 0.00” LF” (Figure 2-56).

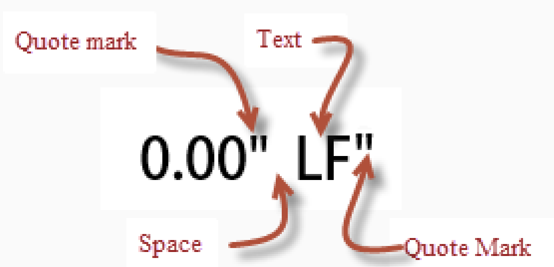


Figure 2-56 Display showing how to include text

- Check the formatting in the Sample box to ensure it displays correctly (Figure 2-57).

Figure 2-57 Sample box shows what the formatting will look like.

- Click OK to save the formatting changes.
- Repeat this procedure for Lineal Yards total cell with the exception that the text should say “LY”.

Step 08: Create Macros to Clear Data

At this point the calculator is functional. In practice, however, to clear out old inputs for a different set of numbers would require the user to select the numbers in the Feet and Inches columns manually and press the delete key. This can be time-consuming and runs the risk of accidentally selecting cells with formulas in them and deleting the formulas.

To streamline the process of deleting old data, create a macro. A macro is a set of commands that you can program and assign to a button (eg. click a single button to delete the contents of a named group of cells).

Creating a Group of Named Cells

1. Select a range of cells; B6 to C38 in this case.
2. Click the Name Box to the left of the function input field, and type LF_Select (Figure 2-59).

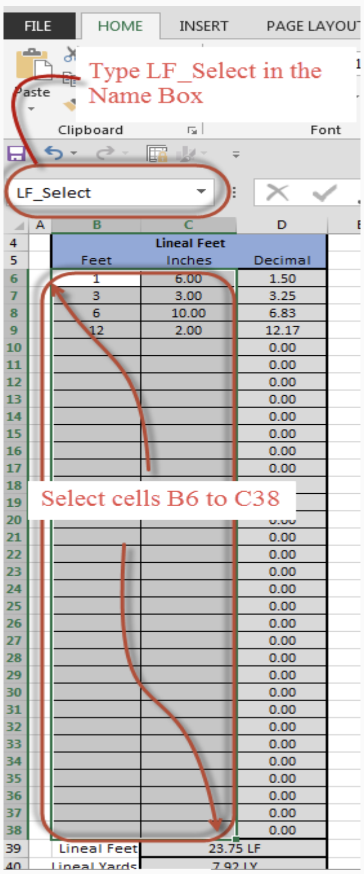


Figure 2-59 Naming a group of cells

3. Press enter. This range of cells is now named LF_Select in the spreadsheet.

There are some rules that must be adhered to when naming cells, or groups of cells. The rules are as follows:

- Each cell, or group of cells must have a unique name which cannot be shared with other cells or Excel macros.
- The name can only be one word long and cannot have any spaces in the name.
- Special characters cannot be used in naming cells or groups of cells.

Automating Clearing Calculator Inputs

This group of named cells can now be selected in a mouse click. The content of those cells can then be deleted by single pressing of the Delete key. This is still a two step process, however, and it can be further refined to a single step.

1. Save the file in a macro-enabled format with an xlsm file extension.
   - Select File → Save As from the Ribbon.
   - Choose a desired location to save your file.
   - Give the file a name and select Excel Macro-Enable Workbook (*xlsm) from the list of options in the Save As type box.
   - Click the Save button to save the changes.
2. Disable all macros with notifications.
3. Select Developer → Code → Macro Security from the Ribbon. In the Trust Center → Macro Settings dialog box that displays, select the Disable all macros with notifications option (Figure 2-63).

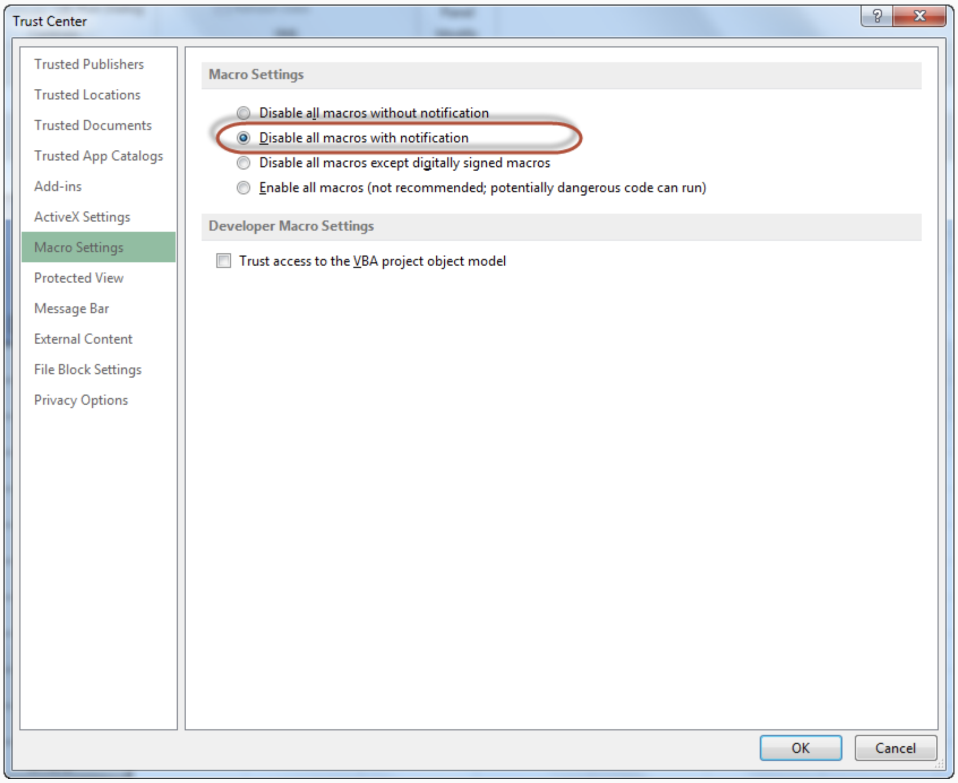


Figure 2-63 Using Macro Settings to adjust the security settings.

- Macros can be used to break the security of your files, which is why the default is to block them. The step above simply allows you to bypass the safeguard for macros you record in your spreadsheet.

3. Record the LF_Clear macro
   - Select Developer → Code → Record Macro from the Ribbon.
   - Type in the macro name LF_Clear in the Macro Name cell (Remember, the same name rules apply for naming macros as for naming cells).
   - Click Ok to start recording (Figure 2-64).

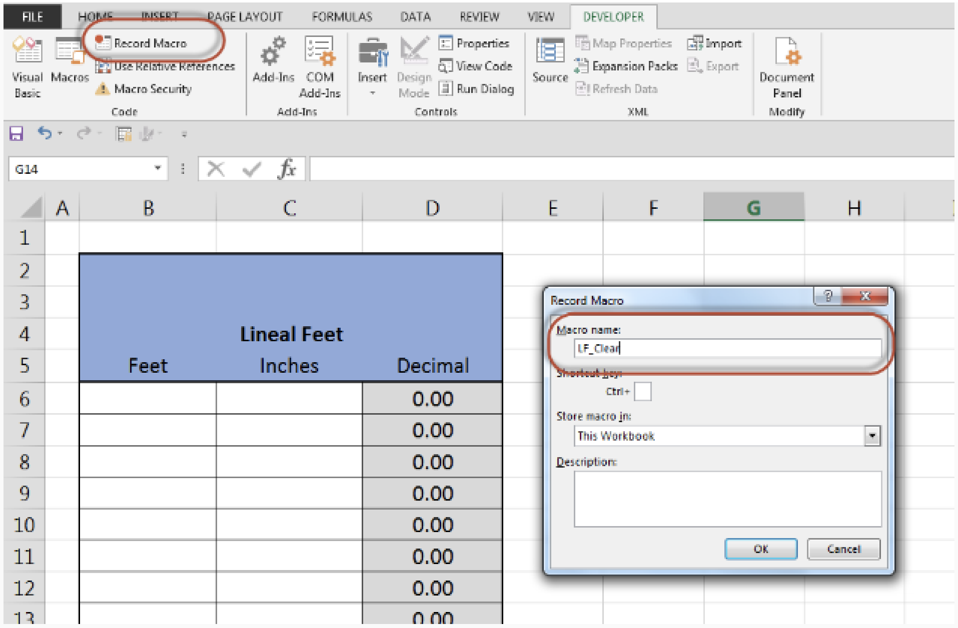


Figure 2-64 Select Record Macro and give the macro a name and click OK to start recording the macro.

- Select LF_Select from the drop-down menu in the Name Box (Figure 2-65).

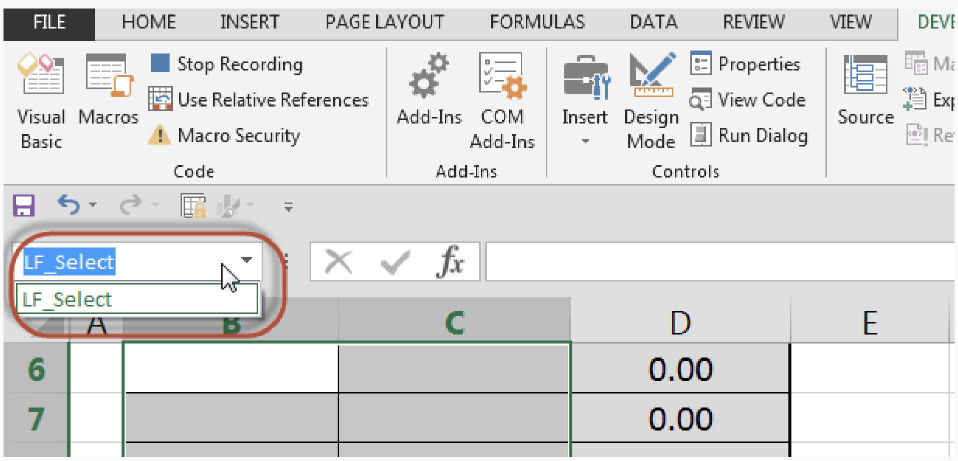


Figure 2-65 Select LF_Select from the drop-down menu

- Press the Delete key on the keyboard.
- Click in the first cell in the named group (B6) so that the calculator is ready to use again.
- Click Developer → Code → Stop Recording in the Ribbon (Figure 2-66).

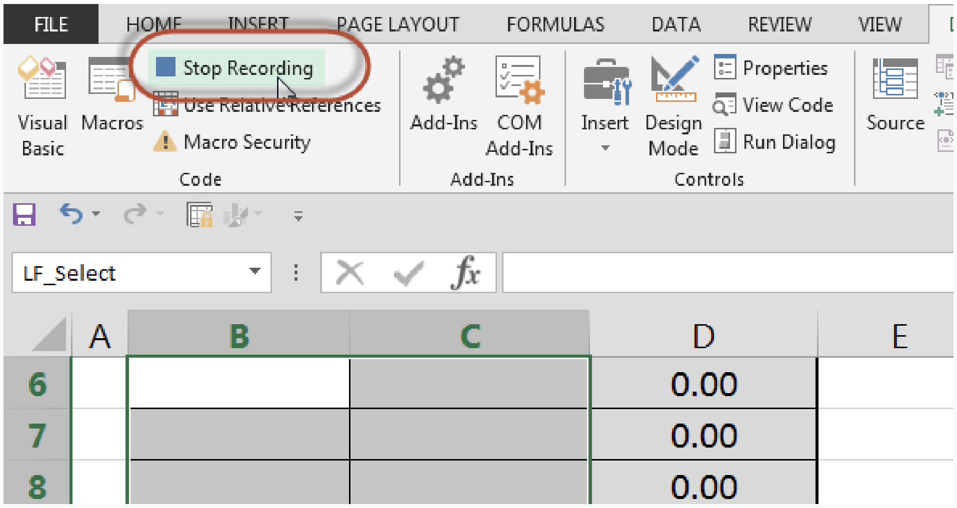


Figure 2-66 Stop macro recording

- Test the macro by selecting Developer → Code → Macro from the Ribbon, then selecting the LF_Clear macro from the list. Click the Run button. The screen should flash briefly and the content of the cells clear (Figure 2-67).

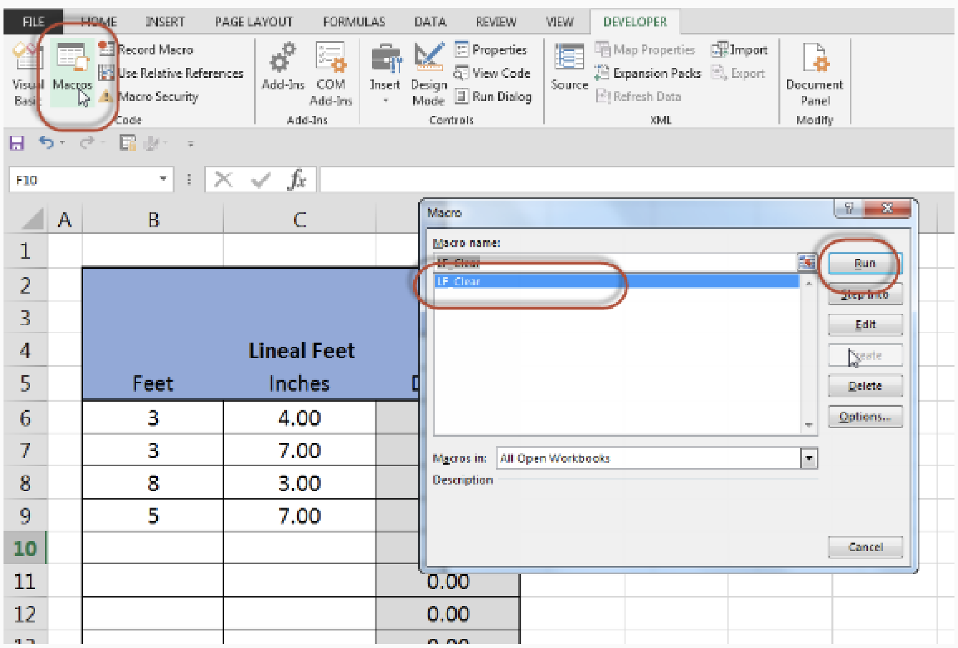


Figure 2-67 Test the macro by running it.

4. Create a Clear Button.
    - Select Developer → Controls → Insert → Form Controls → Button (Form Control) from the Ribbon (Figure 2-68).

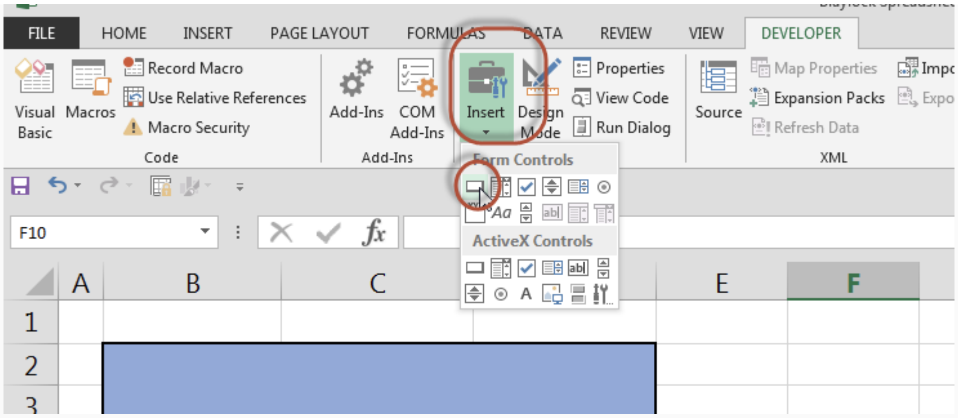


Figure 2-68 Creating the Clear button for the calculator

- After clicking the Button icon, move the cursor over the screen and left-click. This brings up the Assign Macro dialog box. Select the LF_Clear macro and click the Ok button (Figure 2-69).

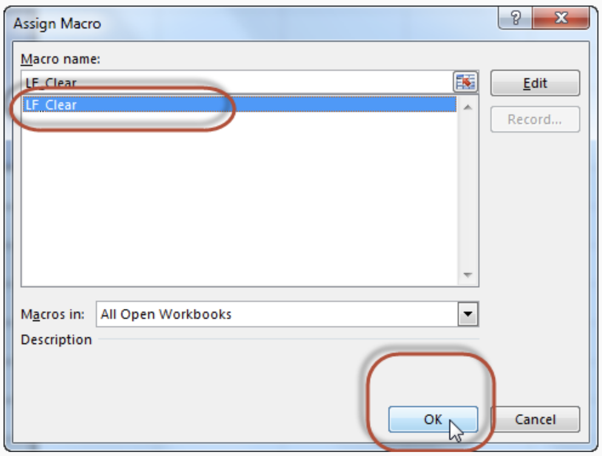


Figure 2-69 Assign the macro to the button

- Click and drag the button to the desired place on the screen.
- Right-click on the button and select Edit Text (Figure 2-71).

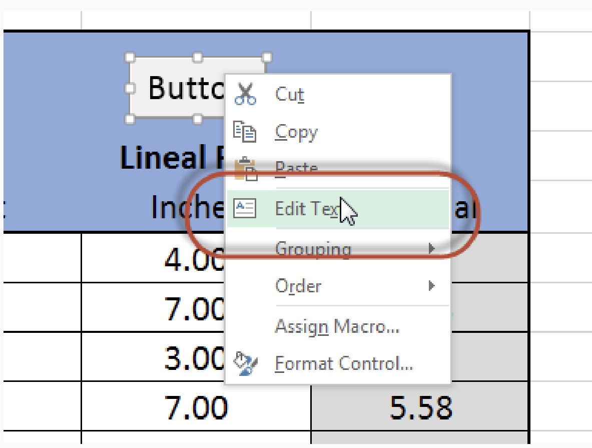


Figure 2-71 Edit the text of the button

- Change the text of the button to display “Clear”.
- Click somewhere other than the button to exit editing mode.
- Test the Clear button by clicking it. The screen should flash briefly, and the contents of the calculator clear (Figure 2-72).

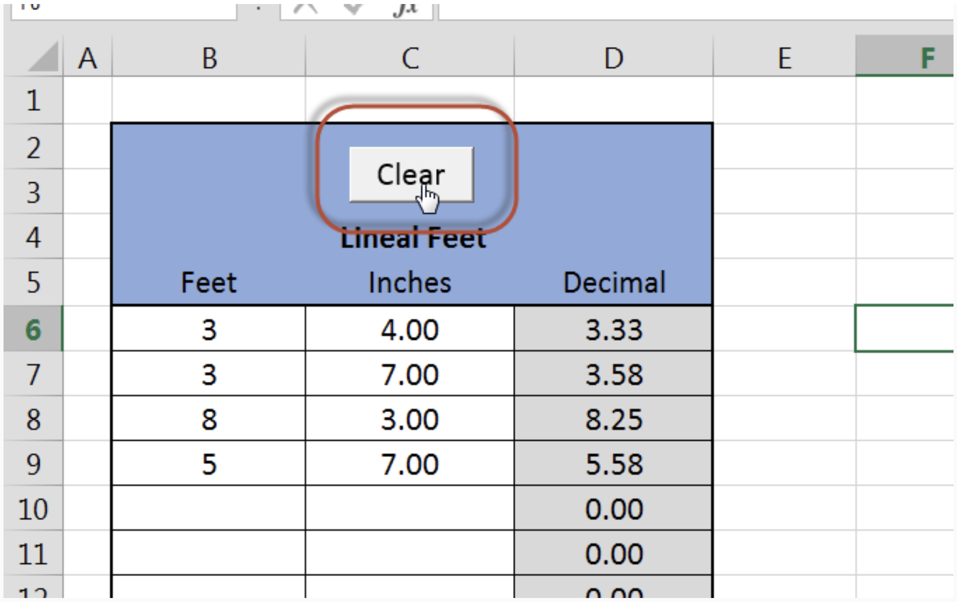


Figure 2-72 Test the Clear button

Area and Volume Calculators Formatting

The Lineal Feet portion of the spreadsheet calculator should now be fully functional. The area and volume portions of the calculators are completed in a similar fashion.

How to Format the Area and Volume Calculators

The first step in completing the remainder of the calculator is to format the Excel spreadsheet to display the rectangular area and volume, triangle area and volume, circular area and volume, totals, sections of the calculator. Figure 2-73 shows what the formatting of the finished calculator looks like and can be used as a pattern in preparing your calculator.

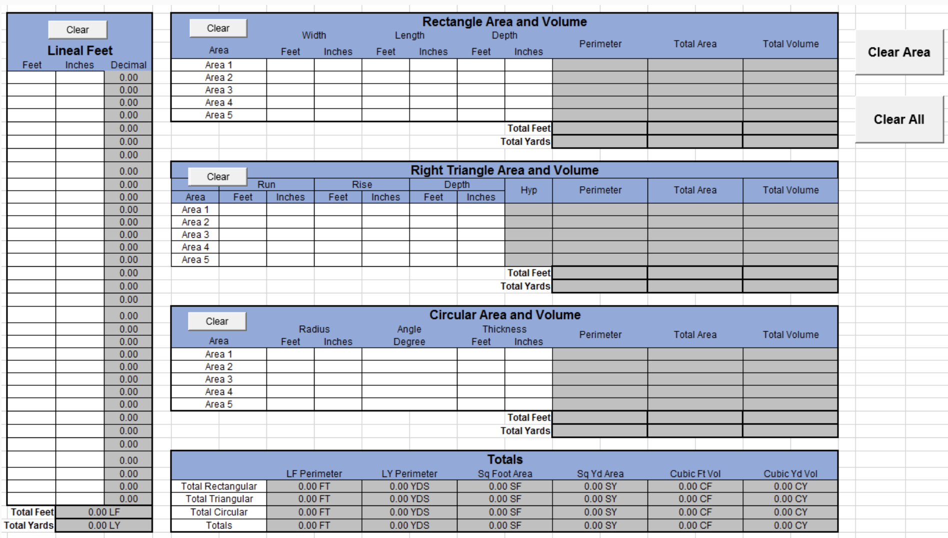
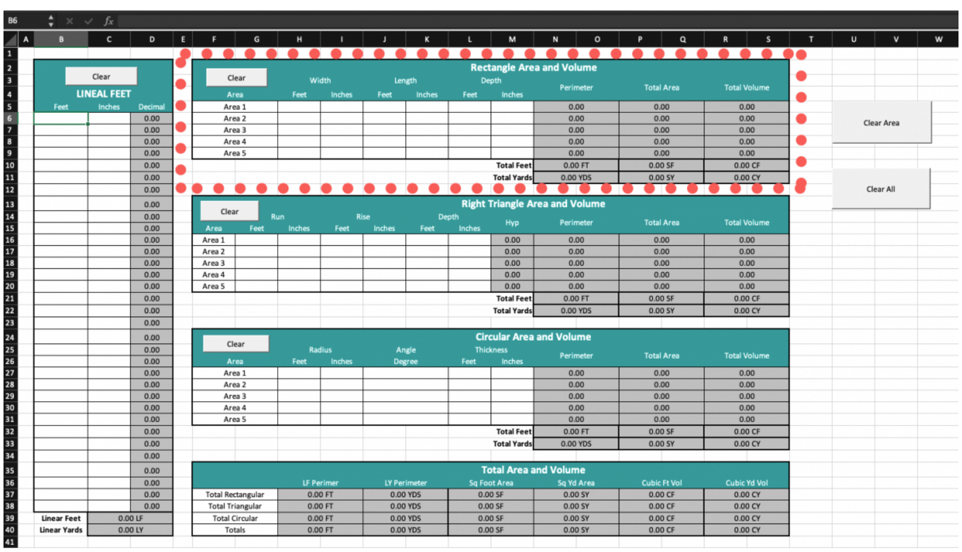


Figure 2-73 The completed blank formatted spreadsheet calculator.

Rectangle Area and Volume Calculator



Rectangle Area and Volume Calculator outlined

Step 01: Enter Formulas in the Rectangle Area and Volume Calculator

Remember that the formulas for perimeter, area, and volume all require specific measurements from the shape for which you calculate those figures. The basic steps for creating these formulas are as follows:

1. Reference the measurement for each length of the shape as a single decimal.
    - In Excel syntax, this would be ="feet" + "inches" /12.
    - These measurements will be expressed this way in the larger formulas for calculating perimeter, area, and volume.
2. Enter the formula for the specific calculation you want to make.
3. Click and drag the formula to all of the cells in that column.
    - This allows you to measure multiple shapes without having reset the calculator.
4. Enter the formula to calculate the sum of all totals in the calculator for both Total Feet and Total Yards.

Perimeter Formula Example

1. Perimeter of a rectangle is expressed as 2 x Side 1 + 2 x Side 2.
2. The formula in the spreadsheet calculator would be a little more complicated because the input would need to be converted to decimal form. In addition, there are issues with math order of operations, and so some parentheses will need to be added to the Excel equation.
3. Consider the first row for the Rectangle Area and Volume calculator.
    - The perimeter formula will be entered in the merged cell at N5.
    - When the calculator is functional, it will take manually entered numbers from the width and length cells and calculate the perimeter.
    - The formula for the perimeter of a rectangle in the first row of the Rectangle Area and Volume calculator would be written as follows (Figure 2-75).

$$= \overbrace{(H5 + I5 / 12) * 2}^{\text{Length}} + \overbrace{(J5 + K5 / 12) * 2}^{\text{Width}}$$

Figure 2-75 Excel formula for rectangle perimeter

- The black parentheses in each half of the equation represent the measurements of length and width converted to decimal feet. Without the parentheses, the calculator would multiply 12 * 2 first because the math order of operations requires multiplication before division. The inches would then be divided by the calculated 24 instead of the proper 12. Figure 2-76 shows the correct formula written in the calculator.

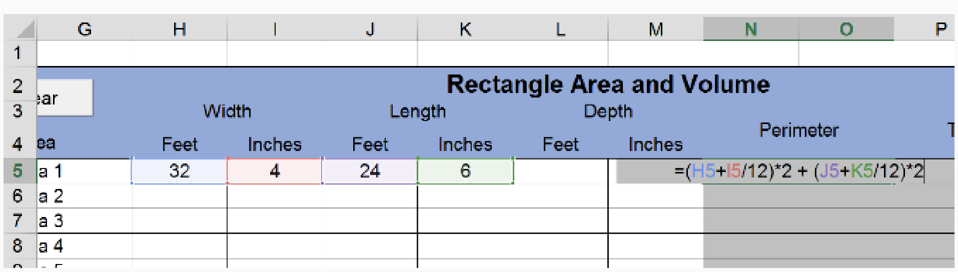


Figure 2-76 Completed Rectangular Area and Volume perimeter equation.

4. The correct formula can then be dragged down to fill the remainder of the calculator.

Area Formula Example

1. Area of a rectangle is expressed as Side 1 x Side 2.
2. The formula in the spreadsheet calculator would be a little more complicated because the input would need to be converted to decimal form.
3. Consider the first row for the Rectangle Area and Volume calculator.
    - The area formula will be entered in the merged cell at P5.
    - When the calculator is functional, it will take manually entered numbers from the width and length cells and calculate the area.
    - The formula for the area of a rectangle in the first row of the Rectangle Area and Volume calculator would be written as follows (Figure 2-77).

$$= \overbrace{(H5 + I5/12)}^{\text{Length}} * \overbrace{(J5 + K5/12)}^{\text{Width}}$$

Figure 2-77 Excel formula for rectangular area

	H	I	J	K	L	M	N	O	P	Q
1										
2	Rectangle Area and Volume									
3	Width		Length		Depth		Perimeter		Total Area	
4	Feet	Inches	Feet	Inches	Feet	Inches				
5	32	4	24	6			113.67		=(H5+I5/12)*(J5+K5/12)	
6							0.00			
7							0.00			
8							0.00			
9							0.00			
10						Total Feet				
11						Total Yards				

Figure 2-78 Completed Rectangular Area and Volume area equation.

- As with the perimeter formula, length and width are expressed within parentheses so each measurement will be converted to decimal feet.

4. The correct formula can be dragged down to fill the remainder of the calculator.

Volume Formula Example

1. Volume of a rectangular shape is expressed as Length x Width x Depth.
2. The formula in the spreadsheet calculator would be a little more complicated because the input would need to be converted to decimal form.
3. Consider the first row for the Rectangle Area and Volume calculator.
    - The volume formula will be entered in the merged cell at R5.
    - When the calculator is functional, it will take manually entered numbers from the width, length, and depth cells and calculate the volume.
    - The formula for the volume of a rectangular shape in the first row of the Rectangle Area and Volume calculator would be written as =(H5+I5/12)*(J5+K5/12)*(L5+M5/12).
4. The correct formula can be dragged down to fill the remainder of the calculator.

Step 03: Complete the Rectangle Area and Volume Totals

The final portion of the Rectangle Area and Volume calculator is to complete the totals of the perimeter, area and volume portions of the calculator.

- The Total Feet value of each column is determined by using the SUM function, similar to what was previously learned when completing the Lineal Feet portion of the calculator.
- The Total Yards value for the perimeter is determined by dividing the Total Feet value by three, as was previously done with the Lineal Feet portion of the calculator.
- The totals for the area and volume portions are done in similar fashion.
    - Remember that there are nine square feet in a square yard and 27 cubic feet in a cubic yard.
    - Figure 2-80 shows the perimeter totals for rectangle area and volume calculations. Use the numbers from this example to check the accuracy of your formulas.

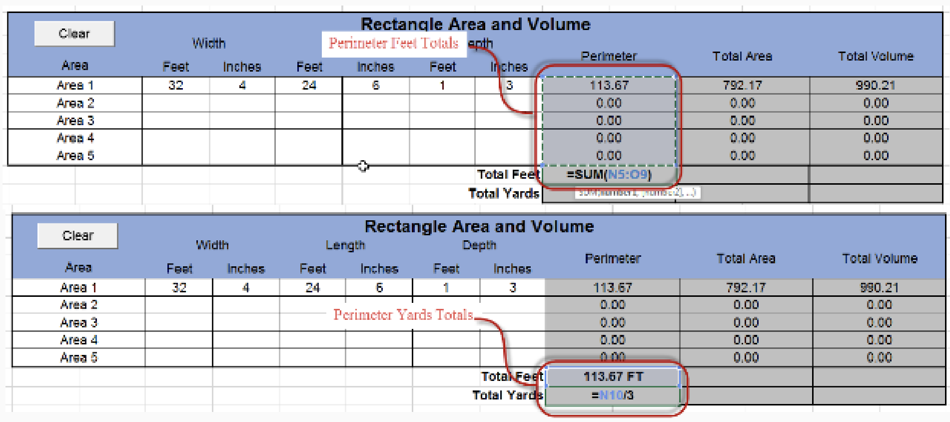


Figure 2-80 Perimeter total feet and total yard functions.

- Custom formats should also be used to identify the correct unit of the total such as FT, YDS, SF, SY, CF, and CY.
- In addition, the custom format should display the total to two decimal places, as was done with the Lineal Feet portion of the calculator.

Step 04: Complete the Rectangle Clear Macro

The final element to complete with the Rectangle Area and Volume section of the calculator is to create a clear button and a macro to clear this portion of the calculator.

- This is done by following a similar process that was used for the Lineal Feet portion of the calculator. The cells to be cleared will first need to be selected and given a custom name, such as Rect_Select (Figure 2-81).

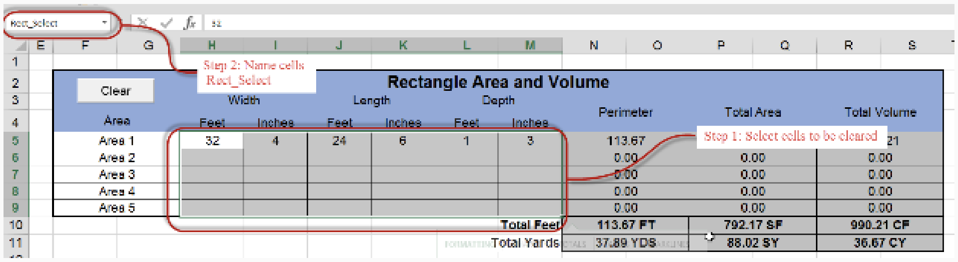


Figure 2-81 Selecting area to assign a custom name

- Next, a macro is recorded, named Rect_Clear, that selects the Rect_Select named group of cells and deletes the content of the cells.
- Finally, the clear button is assigned to that macro by right clicking on the button and selecting Assign Macro from the context menu (Figure 2-82).

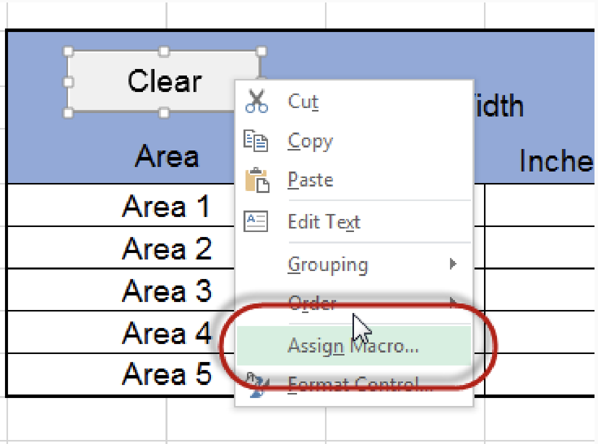
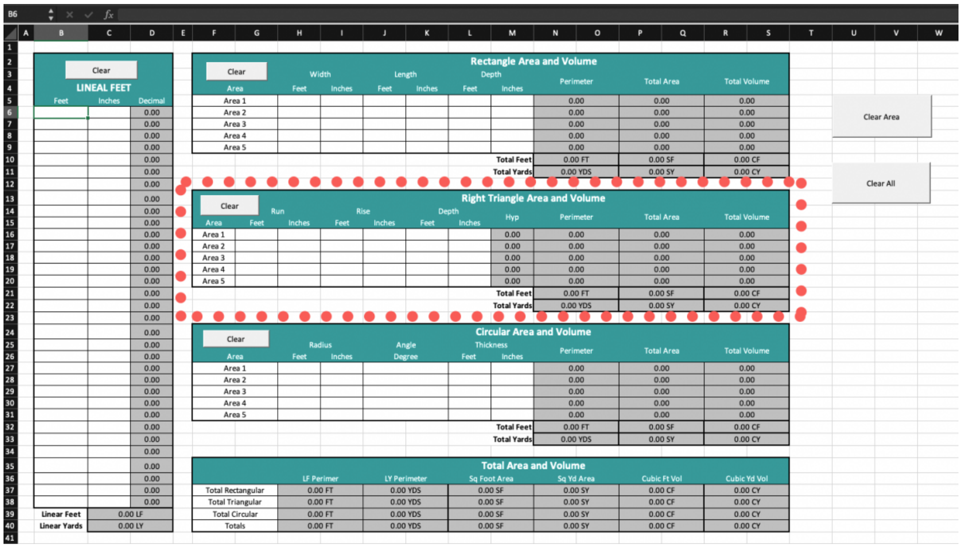


Figure 2-82 Assign a macro to the button

Right Triangle Area and Volume Calculator



Right Triangle Area and Volume Calculator outlined

Step 01: Enter Formulas in the Right Triangle Area and Volume Calculator

Right Triangle Area and Volume Formulas

In construction, the sides of a triangle are named run, rise, and hypotenuse, respectively. The programming for the Right Triangle Area and Volume calculator will have manual entries for rise, run, and depth in feet and inches. A formula to calculate the hypotenuse of the triangle is added because that measurement is required to calculate perimeter.

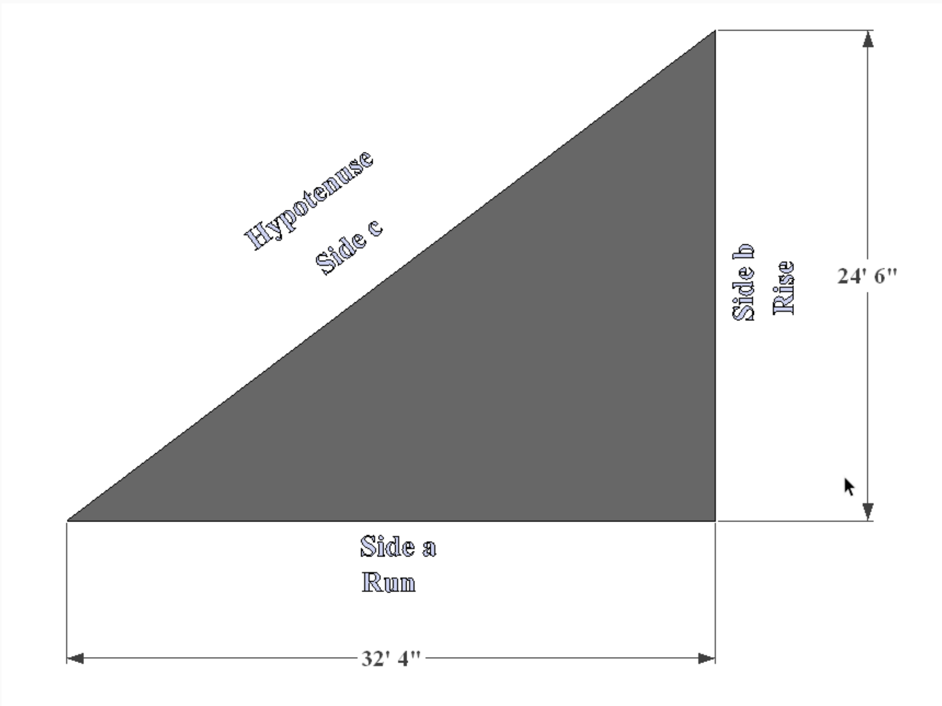


Figure 2-83 A right triangle using construction terms for the sides

- The mathematical formula for finding the hypotenuse of a right triangle is known as Pythagorean's Theorem, which states that the sum of the legs squared is equal to the hypotenuse squared.
- Written mathematically the formula for calculating the hypotenuse of a right triangle is a2 + b2 = c2
  - a = Run
  - b = Rise
  - c = Hypotenuse
- The SQRT (square root) function will be used for your hypotenuse formula in the calculator.
  - As in previous examples, the lengths for rise, run, and depth will be expressed using the formula for converting feet and inches to decimal feet.
  - Excel uses ^ to express exponents. ^2 = squared, ^3 = cubed, etc.

Hypotenuse Formula Example

1. Hypotenuse of a right triangle is expressed as Run squared + Rise squared = Hypotenuse squared.
   1. This means you will need to find the square root of whatever c2 equals in order to find the hypotenuse.

2. The formula in the spreadsheet calculator would be a little more complicated because the input would need to be converted to decimal form.
3. Consider the first row for the Right Triangle Area and Volume calculator.
    1. The hypotenuse formula will be entered in the cell at M16.
    2. When the calculator is functional, it will take manually entered numbers from the run and the rise to calculate the hypotenuse.
    3. The formula to find the hypotenuse of a triangle in the first row of the Right Triangle Area and Volume calculator would be written as follows (Figure 2-84).

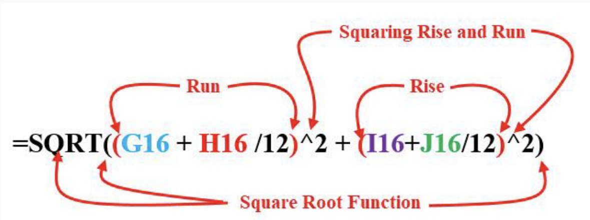


Figure 2-84 Excel formula for the slope of a triangle

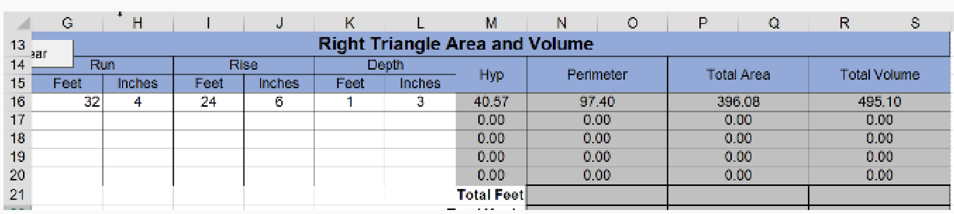
4. The correct formula can be dragged down to fill the remainder of the calculator.

Formulas for Calculating Right Triangle Perimeter, Area, and Volume

Previous instructions in this document outline the procedure for formatting, entering formulas, and creating macros. You have likely noticed that the instructions have become less detailed as they have progressed. The last steps will be completed on your own with minimal guidance from this walkthrough.

- Perimeter = Run + Rise + Hypotenuse
- Area = (Run x Rise) / 2
    - Remember order of operations when writing the syntax for this formula in Excel.
- Volume = Area x Depth

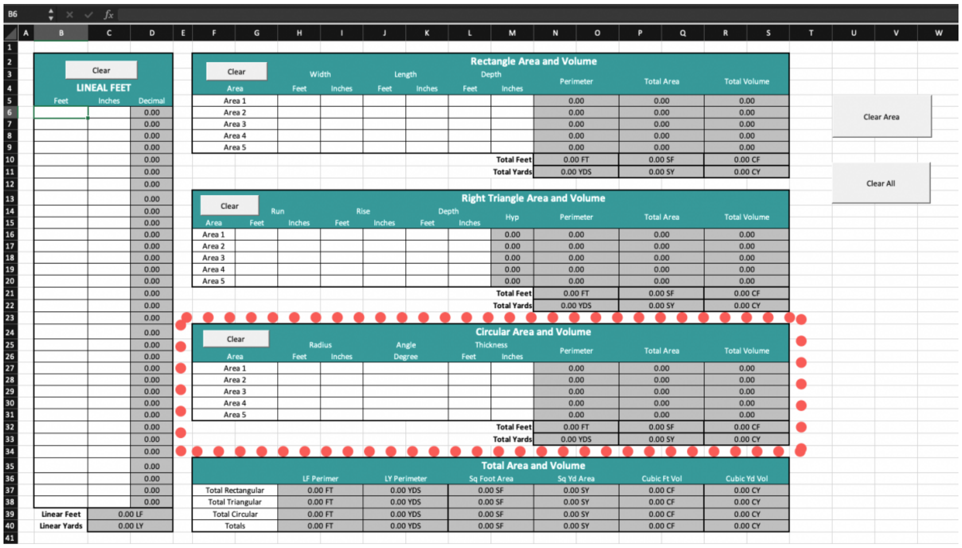
Use the manual entries in Figure 2-91 to check the accuracy of your formulas for hypotenuse, perimter, area, and volume.



	G	H	I	J	K	L	M	N	O	P	Q	R	S
13	ear	Right Triangle Area and Volume											
14	Run		Rise		Depth		Hyp	Perimeter		Total Area		Total Volume	
15	Feet	Inches	Feet	Inches	Feet	Inches							
16	32	4	24	6	1	3	40.57	97.40		396.08		495.10	
17							0.00	0.00		0.00		0.00	
18							0.00	0.00		0.00		0.00	
19							0.00	0.00		0.00		0.00	
20							0.00	0.00		0.00		0.00	
21							Total Feet						

Figure 2-91 Right Triangle Area and Volume calculated volume total.

Circular Area and Volume Calculator

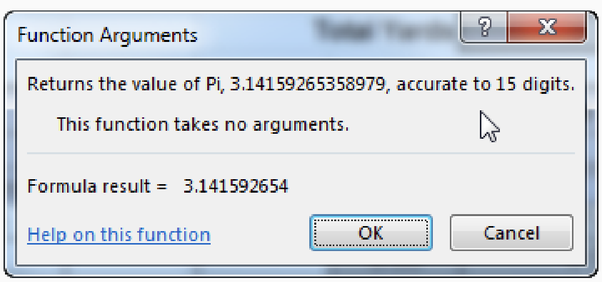


Circular Area and Volume Calculator outlined

Step 01: Enter Formulas in the Circular Area and Volume Calculator

Use previous instructions and the following information to complete the Circular Area and Volume Calculator.

- In a circle, the radius is the length from the center of the circle to any point at the edge.
- A circle contains 360 degrees.
    - If you enter anything less than 360 in the degree column, you are indicating that the shape is not a complete circle. You still need this number, though, because some shapes in a construction project will only be partial circles (arches).
- The thickness column refers to the height of a column, not the radius of a sphere. You will use this number when calculating the volume of a circular area.
- Circle Perimeter = 2 x π x Radius (2πr)
- Because your calculator must also calculate the perimeter of an arch, you must add a reference to the Angle column. This will be expressed as (“angle degrees” / 360).
- Circle Area = πr2
- Because your calculator must also calculate the area of an arch, you must add a reference to the Angle column. This will be expressed as (“angle degrees” / 360).
- Pi, or π, is entered in Excel using the PI function. It is entered as PI().
- When you enter PI() in a formula, you may receive the following dialog box. Click Ok and continue.



Function Arguments dialogue box

Example Formulas for Circular Perimeter and Area Using Excel Syntax

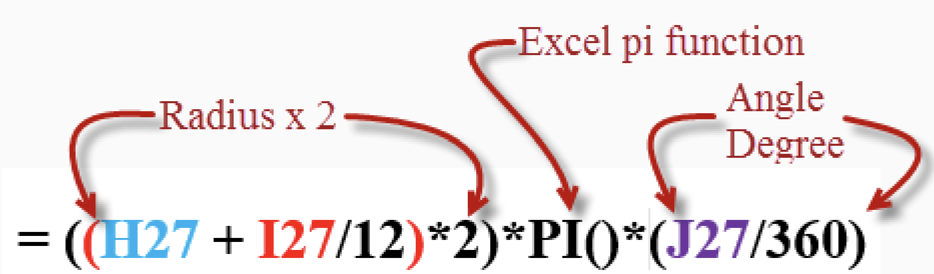


Figure 2-93 Excel formula for the circular perimeter

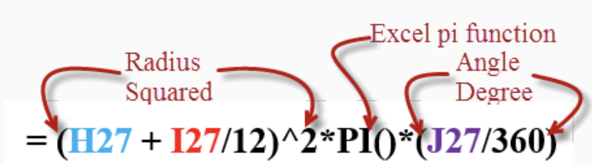
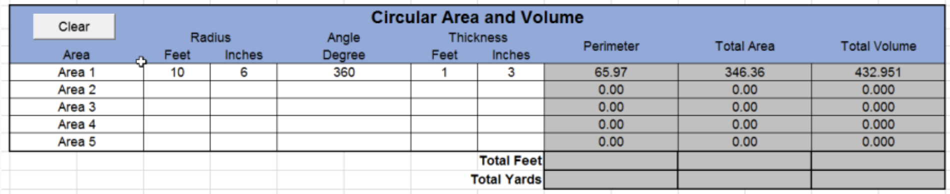


Figure 2-96 Excel formula for the circular area

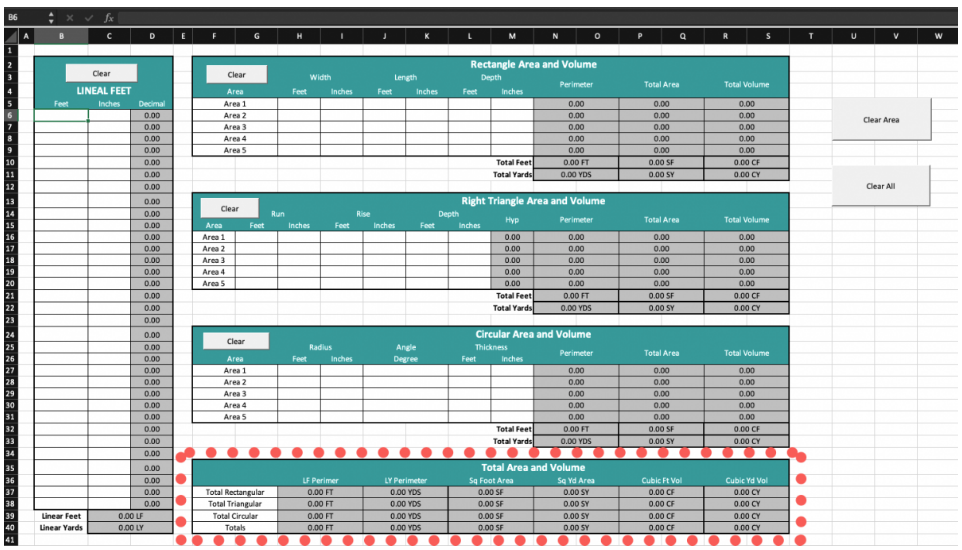


Clear	Radius		Angle	Thickness		Perimeter	Total Area	Total Volume
Area	Feet	Inches	Degree	Feet	Inches			
Area 1	10	6	360	1	3	65.97	346.36	432.951
Area 2						0.00	0.00	0.000
Area 3						0.00	0.00	0.000
Area 4						0.00	0.00	0.000
Area 5						0.00	0.00	0.000
					Total Feet			
					Total Yards			

Figure 2-100 Completed volume calculation to check your own formula accuracy.

Don't forget to drag down the formulas for the whole columns, enter formulas for total feet and total yards, and create a clear button for this calculator.

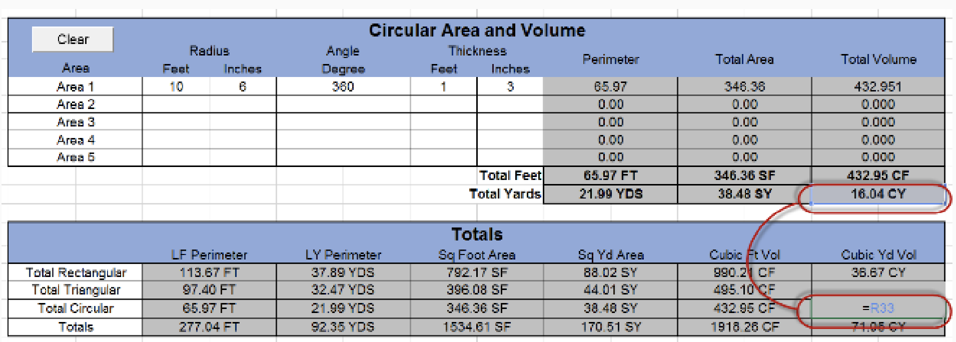
Totals Area of the Calculator



Total Area of the Spreadsheet Calculator outlined

How to Complete the Totals Section

The Totals portion of the calculator is completed by bringing the individual totals for each calculator section. For example, Figure 2-101 shows how the Total Yards conversion of the circular total cubic yard volume is brought forward by making the cell equal to the individual cell in that portion of the calculator.

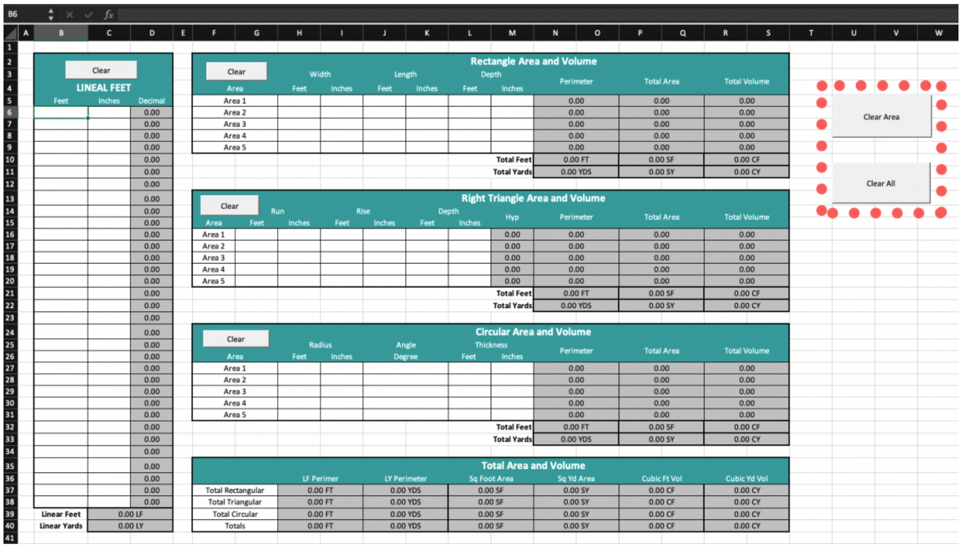


Clear	Radius		Angle	Thickness		Perimeter	Total Area	Total Volume
Area	Feet	Inches	Degree	Feet	Inches			
Area 1	10	6	360	1	3	65.97	346.36	432.951
Area 2						0.00	0.00	0.000
Area 3						0.00	0.00	0.000
Area 4						0.00	0.00	0.000
Area 5						0.00	0.00	0.000
					Total Feet	65.97 FT	346.36 SF	432.95 CF
					Total Yards	21.99 YDS	38.48 SY	16.04 CY

Totals	LF Perimeter	LY Perimeter	Sq Foot Area	Sq Yd Area	Cubic Ft Vol	Cubic Yd Vol
Total Rectangular	113.67 FT	37.89 YDS	792.17 SF	88.02 SY	990.21 CF	36.67 CY
Total Triangular	97.40 FT	32.47 YDS	396.08 SF	44.01 SY	495.10 CF	
Total Circular	65.97 FT	21.99 YDS	346.36 SF	38.48 SY	432.95 CF	=R33
Totals	277.04 FT	92.35 YDS	1534.61 SF	170.51 SY	1918.26 CF	71.05 CY

Figure 2-101 Transferring information from one cell to another to get totals

Clear Area and Clear All Macros



Clear Area and Clear All buttons outlined

How to Create the Clear Area and Clear All Buttons

The clear area and clear all macros are done in similar fashion to the other clear macros that have been created. The trick to completing these two macros is to create custom selection areas by using the Ctrl button on the keyboard when making your selections. Figure 2-102 shows the steps for creating a custom selection area for the Clear_Area macro. This macro clears out the area inputs for the rectangle, right triangle, and circular areas. The Clear All button and corresponding macro are used to clear out the entire calculator, including the lineal feet portion.

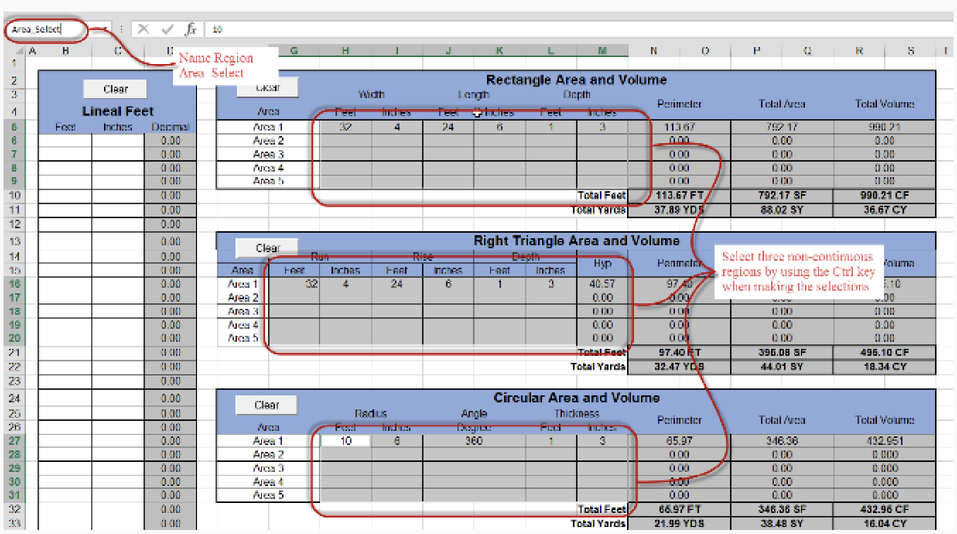


Figure 2-102 Using CTRL + selection areas to create a Clear All button

Previous Citation(s)

Rey, S. (n.d.). *Construction Estimating Quick Guides and Walkthroughs*. BYU-I Books. https://books.byui.edu/-JxEq

Wage Rate Calculation Walkthrough

What is Wage Rate?

In order to more accurately estimate the labor costs of a construction project, the estimator should calculate the total cost to the construction company per hour to employ each worker in a crew. This number is the wage rate, and is more than just the hourly wage workers are paid per hour.

Wage Rate Formula

$$\frac{Taxable\ Wages + Non\text{-}taxable\ Wages + Employer\ Tax\ and\ Insurance\ Contributions}{Total\ Billable\ Hours}$$

Formula for calculating Wage Rate

Table of Contents

Important!

Some of the numbers provided for various figues (eg. Employer Contribution Rates) may not match the figures for your assignment. This is done intentionally to demonstrate how the calculations are made, but to not do the work for you.

Wage Rate Calculation Scope of Work

Your completed spreadsheet should meet all of the following critera.

Taxable Wages Section

Complete the calculations for each of the following figures (displayed in orange):

- Overtime Wage Rate
- Number Regular Hour Per Year
- Number Overtime Hours Per Year
- Yearly Regular Wage ($)
- Overtime Wages Per Year ($)
- Total Taxable Wages Per Year ($)

	Taxable Wages					
Hourly Wage Rate	$ 10.00	$ 28.00	$ 20.00	$ 12.00	$ 8.50	$ 13.00
Number Regular Hours Worked Per Week	40.00	40.00	40.00	40.00	20.00	20.00
Bonus Wages Per Year (Christmas bonus) ($)	$ 500.00	$ 1,000.00	$ 500.00		$ 300.00	$ 300.00
Allowance Wages Per Year (Truck allowance) ($)	$ 3,000.00	$ 3,000.00	$ -	$ -	$ -	$ -
Cash Equivalents Per Year ($)	$ -	$ -	$ -	$ -	$ -	$ -
Number Weeks Overtime Per Year	12	12	12	12	0	0
Average Number Overtime Hours Per Week	10	10	10	10	0	0
Overtime Wage Rate	$ 15.00					
Number Regular Hour Per Year	2080					
Number Overtime Hours Per Year	120					
Yearly Regular Wage ($)	$ 20,800.00					
Overtime Wages Per Year ($)	$ 1,800.00					
Total Taxable Wages Per Year ($)	$ 26,100.00					

Taxable Wages section of the Wage Calculator Spreadsheet

Non-taxable Wages Section

Complete the calculations for each of the following figures (displayed in orange):

- Yearly Employer Health Insurance Premium
- Yearly Employee Health Insurance Premium
- Employer 401(k) Yearly Matching Contribution ($)
- Employee 401(k) Yearly Contribution ($)
- Total Employer Non-Taxable Contribution Per Year
- Total Employee Non-Taxable Withholding Per Year

	Non Taxable Wages					
Health Insurance Plan Type	Family	Family	Couple	Single	None	None
401(k) Employee Contribution Percentage	6.00%	6.00%	4.00%	0.00%	0.00%	0.00%
401(k) Employer Matching Contribution Rate	75.00%	75.00%	75.00%	75.00%	0.00%	0.00%
Yearly Employer Health Insurance Premium	$ 5,700.00					
Yearly Employee Health Insurance Premium	$ 5,700.00					
Employer 401(k) Yearly Matching Contribution ($)	$ 1,174.50					
Employee 401(k) Yearly Contribution ($)	$ 1,566.00					
Total Employer Non-Taxable Contribution Per Year	$ 6,874.50					
Total Employee Non Taxable Withholding Per Year	$ 7,266.00					

Non-taxable Wages section of the Wage Calculator Spreadsheet

Employer Tax & Insurance Contributions Section

Complete the calculations for each of the following figures (displayed in orange):

- Total Employer FICA Contribution Per Year
- Total Unemployment Premium Per Year (FUTA)
- Total Unemployment Premium Per Year (SUTA)
- Total Worker's Compensation Premiums Per Year ($)
- Total Liability Premiums Per Year ($)
- Total Net Annual Payroll Amount ($)

Employer Tax & Insurance Contributions						
Worker's Compensation Rate (%)	10.04%	1.19%	14.31%	14.31%	14.31%	0.19%
Liability Premium Rate (%)	3.90%	2.47%	3.90%	3.90%	3.90%	0.00%
Total Employer FICA Contribution Per Year	$ 1,440.80					
Total Unemployment Premium Per Year (FUTA)	$ 42.00					
Total Unemployment Premium Per Year (SUTA)	$ 261.00					
Total Worker's Compensation Premiums Per Year ($)	$ 2,751.46					
Total Liability Premiums Per Year ($)	$ 1,017.90					
Total Net Annual Payroll Amount ($)	$ 38,487.66					

Employer Tax & Insurance Contributions section of the Wage Calculator Spreadsheet

Billable Hours Section

Complete the calculations for each of the following figures (displayed in orange):

- Total Number Hours Paid Per Year
- Total Non-Billable Hours Per Year
- Total Billable Hours Per Year
- Average Hourly Wage Rate

Billable Hours						
Number Paid Holidays	6	6	6	6	0	0
Number Paid Vacation Days	10	10	5	5	0	0
Number Paid Sick Leave Days	4	4	4	4	0	0
Total Number Hours Paid Per Year	2200					
Total Non-Billable Hours Per Year	160					
Total Billable Hours Per Year	2040					
Average Hourly Wage Rate	$ 18.87					

Billable Hours section of the Wage Calculator Spreadsheet

Wage Rate Calculation Video Walkthroughs

Wage Calculator Assignment Walkthrough (Part 1), 23:28 mins

Wage Calculator Assignment Walkthrough (Part 2), 43:01 mins

Taxable Wages Calculation

Taxable Wages are all payments and taxable benefits provided to employees. It is calculated using the following steps:

Step 01: Calculate the **total regular wages** per year by multiplying the hourly wage by the total number of regular hours.

Example: John Doe is a full-time employee with an hourly rate of $10.

Hourly Wage Rate	$ 10.00
Number Regular Hours Worked Per Week	40.0
Bonus Wages Per Year (Christmas bonus) ($)	$ 500.00
Allowance Wages Per Year (Truck allowance) ($)	$ 3,000.00
Cash Equivalents Per Year ($)	0
Number Weeks Overtime Per Year	12
Average Number Overtime Hours Per Week	10

John Doe's Taxable Wages information from the Wage Calculator Spreadsheet

- Hourly Rate = $10
- Regular Hours = 2,080 hrs

Total Regular Wages = $20,800.00 ($10 x 2,080 hrs)

Step 02: Calculate the overtime rate (1.5 x regular hourly wage).

Example: John Doe is a full-time employee with an hourly rate of $10.

- Hourly Rate = $10
- Overtime Rate = 1.5 x Hourly Rate

Overtime Rate = $15 per hour

Step 03: Calculate the total number of overtime hours per year.

Example: John Doe is a full-time employee with an hourly rate of $10.

- Overtime Weeks = 12 wks/yr
- Overtime Average Hours = 10 hrs/wk

Overtime Hours per Year = 120 hrs

Step 04: Multiply the overtime rate by the total number of overtime hours, then add it to the total regular wages.

Example: John Doe is a full-time employee with an hourly rate of $10.

- Overtime Rate = $15
- Overtime Hours = 120 hrs
- Total Overtime Wages = $1,800 ($15 x 120 hrs)

Total Wages = $22,600.00 ($20,800 + $1,800)

Step 05: Add the value of any bonuses, allowances, and cash equivalents.

Example: John Doe is a full-time employee with an hourly rate of $10.

- Bonus: Christmas = $500.00 yr
- Allowance: Truck = $3,000.00 yr
- Total Bonus & Allowance = $3,500.00 ($500.00 + $3,00.00)

Total Taxable Wages = $26,100.00 ($22,600.00 + $3,500.00)

Note that the following items will be pre-populated in any estimation worksheet that includes labor: Worker Hourly Wage, Regular Weekly Hours, Bonuses, Allowances, Overtime Weeks, and Overtime Average Hours.

Non-Taxable Wages Calculation

Non-taxable Wages are benefits paid to employees that are not subject to payroll tax. They include Health Insurance Premiums from both the employee and employer and Retirement Plan Contributions from both the employee and the employer.

For the purposes of construction estimating, both employee and employer contributions to these benefits is taken into account when calculating Total Non-taxable Wages. To calculate this figure, follow these steps:

Step 01: Calculate the Yearly Employer Health Insurance Premium.

Example: John Doe is a full-time employee who has the family health insurance plan.

Overtime Rate	1.5	FICA Rate	7.65%	SUTA Rate	1.000%
Number Weeks per Year	52	FICA Contrib. Yearly Limit	$128,700.00	SUTA Yearly Limit	$38,200.00
Employer Portion Health Insurance	1/2	FUTA Rate	6.00%	Vorker Comp. Prem. Adj.	1.05
Employee Portion Health Insurance	1/2	FUTA Yearly Limit	$ 7,000.00		
Workers Compensation Rates		**Monthly Health Insurance Premiums**		**Liability Insurance Rates**	
Carpentry-Interior Trim (543700)	5.86%	Family	$ 800.00	General Contactor's	2.47%
Contractor-Supervisor (560600)	1.26%	Couple	$ 600.00	Carpenters	3.90%
Carpentry-Dwellings-3 Stories (565100)	10.39%	Single	$ 400.00		
Carpentry-Detached 1 or 2 (564500)	15.73%				
Clerical Office Employee (881000)	0.25%				
		Employee Wages			

Information from the Header of the Wage Calculator Spreadsheet

Health Insurance Plan Type	Family
401(k) Employee Contribution Percentage	3%
401(k) Employer Matching Contribution Rate	80%

John Doe's Non-taxable Wages information from the Wage Calculator Spreadsheet

- Family Plan Premium (monthly) = $800.00
- Family Plan Premium (annual) = $9,600.00 (12 x $800.00)
- Employer Contribution Percentage = 70%
  - This figure comes from the InsuranceDB tab, and does not match the number used in your own assignment.

Yearly Employer Health Insurance Premium = $6,720.00 ($9,600.00 x .7)

Step 02: Calculate the Yearly Employee Health Insurance Premium.

Example: John Doe is a full-time employee who has the family health insurance plan.

- Family Plan Premium (monthly) = $800.00
- Family Plan Premium (annual) = $9,600.00 (12 x $800.00)
- Employee Contribution Percentage = 30%

Yearly Employer Health Insurance Premium = $2,880.00 ($9,600.00 x .3)

Step 03: Calculate the Employer 401(k) Yearly Matching Contribution.

Example: John Doe's employer matches 80% of his 401(k) contributions.

- Employee 401(k) Yearly Contribution = $783.00
- Employer 401(k) Matching Contribution Rate = 80%

Employer 401(k) Yearly Matching Contribution = $626.40

Step 04: Calculate the Employee 401(k) Yearly Contribution.

Example: John Doe is a full-time employee with a yearly taxable wages total of $26,100.00. John Doe contributes 3% of his taxable wages to a 401(k) retirement account.

- John Doe Taxable Wages = $26,100.00
- John Doe 401(k) Contribution Percentage = 3%

Employee 401(k) Yearly Contribution = $783.00 ($26,100 x .03)

Step 05: Calculate the Total Employer Non-taxable Contribution Per Year.

Example: John Doe is a full-time employee.

- Yearly Employer Health Insurance Premium = $6,720.00
- Employer 401(k) Yearly Matching Contribution = $626.40

Total Employer Non-taxable Wages per Year = $7,346.40 ($6,720.00 + $626.40)

Step 06: Calculate the Total Employee Non-taxable Withholding Per Year.

Example: John Doe is a full-time employee.

- Yearly Employer Health Insurance Premium = $2,880.00
- Employee 401(k) Yearly Contribution = $783.00

Total Employee Non-taxable Withholding per Year = $3,663.00 ($2,880.00 + $783.00)

Note that the following items will be pre-populated in any estimation worksheet that includes labor: Health Insurance Plan, 401(k) Employee Contribution Rate, and 401(k) Employer Matching Rate.

Employer Tax Calculation

Step 01: Look up the current year FICA Earnings Limit on the Social Security Administration's website (ssa.gov).

Example: John Doe is a full-time employee.

Overtime Rate	1.5	FICA Rate	7.65%	SUTA Rate	1.000%
Number Weeks per Year	52	FICA Contrib. Yearly Limit	$128,700.00	SUTA Yearly Limit	$38,200.00
Employer Portion Health Insurance	1/2	FUTA Rate	6.00%	Worker Comp. Prem. Adj.	1.05
Employee Portion Health Insurance	1/2	FUTA Yearly Limit	$ 7,000.00		
Workers Compensation Rates		**Monthly Health Insurance Premiums**		**Liability Insurance Rates**	
Carpentry-Interior Trim (543700)	5.86%	Family	$ 800.00	General Contactor's	2.47%
Contractor-Supervisor (560600)	1.26%	Couple	$ 600.00	Carpenters	3.90%
Carpentry-Dwellings-3 Stories (565100)	10.39%	Single	$ 400.00		
Carpentry-Detached 1 or 2 (564500)	15.73%				
Clerical Office Employee (881000)	0.25%				
		Employee Wages			

Information from the Header of the Wage Calculator Spreadsheet

Worker's Compensation Rate (%)	10.04%
Liability Premium Rate (%)	3.90%

John Doe's Employer Tax & Insurance Contributions information from the Wage Calculator Spreadsheet

- John's 2018 Total Taxable Wages = $26,100.00
- 2018 FICA Earnings Limit = $128,400.00

John's wages are below the limit, so all of his taxable wages will be subject to FICA taxes.

Step 02: Calculate the Wages Subject to FICA Contributions, which are equal to total taxable wages - yearly employee health insurance premium - yearly employee 401(k) contribution.

Example: John Doe is a full-time employee.

- Total Taxable Wages = $26,100.00
- Yearly Employee Health Insurance Premium = $2,880.00
- Yearly Employee 401(k) Contribution = $783.00

Wages Subject to FICA Contributions = $22,437.00 ($26,100.00 - $2,880.00 - $783.00)

Step 03: Calculate Total FICA Contribution (15.3%).

Example: John Doe is a full-time employee.

- Wages Subject to FICA Contributions = $22,437.00

Total FICA Contributions = $3,432.86 ($22,437.00 x .153)

Step 04: Calculate Employer FICA Contribution (50% of total contribution).

Example: John Doe is a full-time employee.

- Total FICA Contributions = $3,432.86

Employer FICA Contributions = $1,716.43 ($3,432.86 x .5)

Employer Insurance Contributions Calculation

By law, employers are required by law to carry Federal Unemployment Insurance (FUTA), State Unemployment Insurance (SUTA), and Workers' Compensation Insurance. Employers should also carry Liability Insurance to shield them from claims for bodily injury, property damage, or loss that may arise as a result of failing to use reasonable care in conducting business.

The cost of these insurance premiums contribute to the cost of labor, and should be accounted for when completing a construction estimate. They are calculated as follows:

Step 01: Look up the current year FUTA Tax Rate on the Internal Revenue Service's website (irs.gov).

Example: John Doe is a full-time employee.

Overtime Rate	1.5	FICA Rate	7.65%	SUTA Rate	1.000%
Number Weeks per Year	52	FICA Contrib. Yearly Limit	$128,700.00	SUTA Yearly Limit	$38,200.00
Employer Portion Health Insurance	1/2	FUTA Rate	6.00%	Worker Comp. Prem. Adj.	1.05
Employee Portion Health Insurance	1/2	FUTA Yearly Limit	$ 7,000.00		
Workers Compensation Rates		**Monthly Health Insurance Premiums**		**Liability Insurance Rates**	
Carpentry-Interior Trim (543700)	5.86%	Family	$ 800.00	General Contactor's	2.47%
Contractor-Supervisor (560600)	1.26%	Couple	$ 600.00	Carpenters	3.90%
Carpentry-Dwellings-3 Stories (565100)	10.39%	Single	$ 400.00		
Carpentry-Detached 1 or 2 (564500)	15.73%				
Clerical Office Employee (881000)	0.25%				
		Employee Wages			

Information from the Header of the Wage Calculator Spreadsheet

- John's 2018 Total Taxable Wages = $26,100.00
- 2018 FUTA Tax Rate = 6.00% on the first $7,000.00 of wages

John's wages are over $7,000.00, so the FUTA Premium will be calculated for $7,000.00.

Step 02: Calculate the Total FUTA Premium.

Example: John Doe is a full-time employee.

- John's 2018 Total Taxable Wages = $26,100.00
- 2018 FUTA Tax Rate = 6.00%

Total FUTA Premium = $420.00 ($7,000 x .06)

Step 03: Look up the current year SUTA Tax Rate on the Idaho Department of Labor's website (labor.idaho.gov).

Example: John Doe is a full-time employee.

- John's 2018 Total Taxable Wages = $26,100.00
- 2018 SUTA Tax Rate = 1.00% on the first $38,200.00 of wages

John's wages are below $38,200.00, so the SUTA Premium will be calculated based on his total taxable wages.

Step 04: Calculate the Total SUTA Premium.

> **Example:** John Doe is a full-time employee.
>
> - John's 2018 Total Taxable Wages = $26,100.00
> - 2018 SUTA Tax Rate = 1.00%
>
> **Total SUTA Premium = $261.00 ($26,100 x .01)**

Step 05: Identify the Workers' Compensation Rate for each employee, and the Workers' Compensation Premium Adjustment (Mod Factor). These will both be available in any estimating worksheet for labor.

> **Example:** John Doe is a full-time employee.
>
> - **John's Workers' Compensation Rate = 10.04%**
> - **Employer's Mod Factor = 1.05%**

Step 06: Calculate the Workers' Compensation Premium before Mod Factor.

> **Example:** John Doe is a full-time employee.
>
> - John's 2018 Total Taxable Wages = $26,100.00
> - John's Workers' Compensation Rate = 10.04%
>
> **Workers' Compensation Premium (before Mod Factor) = $2,620.44 ($26,100 x .1004)**

Step 07: Calculate the Workers' Compensation Premium after Mod Factor.

> **Example:** John Doe is a full-time employee.
>
> - Workers' Compensation Premium (before Mod Factor) = $2,620.44
> - Mod Factor = 1.05%
>
> **Workers' Compensation Premium = $2,751.46 ($26,100 x 1.05)**

Step 08: Identify the Liability Premium Rate for each employee. These will be available in any estimating worksheet for labor.

> **Example:** John Doe is a full-time employee.
>
> - **Liability Premium Rate = 3.9%**

Step 09: Calculate the Liability Premium.

> **Example:** John Doe is a full-time employee.
>
> - John's 2018 Total Taxable Wages = $26,100.00
> - Liability Rate = 3.9%

Liability Premium = $1,017.9 ($26,100 x .039)

Note that the following items will be pre-populated in any estimation worksheet that includes labor: Workers' Compensation Rate (each employee), Workers' Compensation Premium Adjustment, Federal and State Unemployment Tax Rates and Limits, and Liability Insurance Rate .

Total Net Annual Payroll Calculation

Total Net Annual Payroll is the annual cost of an employee to the employer. It includes all wages, taxes, benefits, and insurance premiums paid by the employer. This is the number that will be used to eventually calculate the average hourly wage rate to use when estimating the labor cost of a construction project. It is calculated as follows:

Step 01: Calculate the Total Net Annual Payroll.

Example: John Doe is a full-time employee. The following totals from 2018 represent all employer-paid costs for John's employment.

Total Taxable Wages	$26,100.00
Total Employer Non-taxable Contribution	$7,346.40
Total Employer FICA Contribution	$1,716.43
Total FUTA Premium	$420.00
Total SUTA Premium	$261.00
Total Workers' Compensation Premium	$2,751.46
Total Liability Premium	$1,107.90

Total Net Annual Payroll = $39,703.19 (sum of all employer costs for John's employment)

Billable Hours Calculation

Billable Hours is the number of hours that can be attributed to work on projects for each employee over a year. In construction estimating. It is different from the number of hours paid each year. Billable Hours is calculated using the following steps:

Step 01: Calculate the Total Hours Paid per year.

Example: John Doe is a full-time employee.

Number Paid Holidays	6
Number Paid Vacation Days	10
Number Paid Sick Leave Days	4

John Does PTO and Sick Leave information from the Wage Calculator Spreadsheet

- Regular Hours per Year = 2,080
- Overtime Hours per Year = 120

Total Hours Paid = 2,200 hrs (2,080 + 120)

Step 02: Calculate the Total Non-billable Hours per year.

Example: John Doe is a full-time employee.

- Paid holidays = 6 days/yr x 8 hrs/day = 48 hr/yr
- Paid vacations = 10 days/yr x 8 hr/days = 80 hr/yr
- Paid sick leave = 4 days/yr x 8 hr/day = 32 hrs/yr

Total Non-billable Hours = 160 hrs (48 + 80 + 32)

Step 03: Calculate the Total Billable Hours per year.

Example: John Doe is a full-time employee.

- Total Hours Paid = 2,200 hrs
- Total Non-billable Hours = 160 hrs

Total Billable Hours = 2,040 hrs (2,200 - 160)

Average Hourly Wage Rate Calculation

As stated at the beginning of the Quick Guide, Average Hourly Wage Rate uses the following formula:

$$\frac{Taxable\ Wages + Non\text{-}taxable\ Wages + Employer\ Tax\ and\ Insurance\ Contributions}{Total\ Billable\ Hours}$$

Formula for calculating Wage Rate

Step 01: Calculate the Average Hourly Wage Rate.

Example: John Doe is a full-time employee.

- Taxable Wages = $26,100.00
- Non-taxable Wages = $7,346.40
- Employer Tax and Insurance Contributions = $6,256.79
- Total Billable Hours = 2,040 hrs

Average Hourly Wage Rate = $19.46

Previous Citation(s)

Rey, S. (n.d.). *Construction Estimating Quick Guides and Walkthroughs*. BYU-I Books. https://books.byui.edu/-JxEq

Cost Data Manuals Walkthrough

What are Cost Data Manuals?

Estimating is an art that is honed through experience. A starting point is necessary when building your experience base. Cost data manuals are published resources that act as databases of information to help give estimators a starting point for estimating everything from material and labor costs to adjustments by project region.

You will use the 2018 Edition of the National Construction Estimator.

Table of Contents

Cost Data Manuals Assignment Scope of Work

- Know how to navigate the NCE and find information necessary for estimating tasks.
- Study and understand the meaning of the abbreviations used in the NCE.
- Study and understand the definitions of some key terms as they are used in the NCE.
- Be able to complete the steps for basic cost estimating using the NCE.
- Take a quiz over the content outlined above.

National Construction Estimator Video Walkthrough

NCE Walkthrough, 5:40 mins

Navigating the NCE

The manual has two sections, Residential and Industrial/Commercial. Use the correct section for the type of project you are estimating.

Use the table of contents (p. 2, 2018 NCE) to find information related to the construction task you are estimating.

If using the PDF version of the NCE, use the search function to find specific tasks you want to estimate. The method for doing so will depend on your computer and the program you are using to view the PDF. In general it is ctrl + f (PC) or command + f (Mac).

NCE Abbreviations

Abbreviations are vital knowledge to understanding how common construction materials, terms, and principles are referred to in the National Construction Estimator. See page 06 of the 2018 NCE for a list of abbreviations.

NCE Key Terms

Labor	The work completed by workers (eg. installing material or completing tasks).
Craft	The type of work being completed (eg. carpentry, plumbing, masonry, etc.).
Craft Code	A two character designator that indicates who is doing the work (eg. B6 = 1 laborer and 1 cement mason).
Base Wage Per Hour	The craftsman's hourly wage.
Total Hourly Cost	The cost per hour for an employer to pay an employee, including insurance and taxes.
Manhours per Unit	A number that represents the number of manhours required for a specific crew to complete one unit of the task (eg. Crew BL requires 1.10 manhours to complete concrete form excavation of 1 CY of light soil). It also appears as Craft@Hrs in the NCE.
Cost Per Manhour	The sum of hourly costs of all crew members divided by the number of crew members.
Area Modification	A list of locations and percentages by which to adjust the cost of materials, labor, and equipment from the costs listed in the NCE.
Unit	The measurement unit for labor. It depends on the construction task (eg. framing uses SF as the unit of measure).
Material	A number that represents the cost per unit of the material as specified in the cost manual.
Total	A number that represents the total cost of labor and materials per unit of work.

List of Key Terms and Definitions used in the NCE

Basic Cost Estimating Steps using the NCE

1. Identify the Construction Task to be estimated.
2. Identify the materials to be used in completing the construction task.
3. Calculate the amount of work to be completed for the task, measured by the units for the task (eg. Framing is measured in square feet).
4. Find the task in the NCE. Use the search function, if possible.
5. Estimate the total cost to complete the task based on the figures for material and labor for the task.

Estimating Example Using the NCE

A residential project needs a complete framing estimate. It is a two story residence with a concrete slab foundation. The takeoff shows that the first floor dimensions are 35' x 41', and the second floor dimensions are 32' x 38'. Standard materials will be used, so it is appropriate to use the Carpentry Rule of Thumb section of the Residential division of the NCE (2018).

Step 01: Identify the Construction Task to be estimated

- Framing of two stories with a concrete slab foundation.
- Standard specifications for stud, joist, and rafter spacing (16" on center), riser count, backing, blocking and bracing.

Step 02: Identify the materials to be used in completing the construction task

- Framing Lumber: Conventional
- Subfloor: 5/8" OSB
- Rough Stairway: 15 Risers
- Rafters, Braces, Collar Beams, Ridge Boards: 2" x 8"
- Roof Sheathing: 7/16" OSB

Step 03: Calculate the amount of work to be completed for the task, measured by the units for the task

- Framing is measured in SF.
- The SF for each floor must be calculated to measure the total amount of work to be done.
  - First Floor = 35' x 41' = 1,435 SF
  - Second Floor = 32' x 38' = 1,216 SF

Step 04: Find the task in the NCE

Keyword Search: Framing

From 2018 NCE, p 33:

Task	Craft@Hrs	Unit	Material	Labor	Total
Total framing, first of two floors, concrete foundation	B1@.146	SF	2.45	4.88	7.33
Total framing, second floor of a two-story residence	B1@.191	SF	4.44	6.38	10.82

Step 05: Estimate the total cost to complete the task based on the figures for material and labor for the task

First Floor Total per SF	$7.33
First Floor SF	1,435 SF
First Floor Cost Calculation	1,435 SF x $7.33 = $10,518.55

Second Floor Total per SF	$10.82
Second Floor SF	1,216 SF
Second Floor Cost Calculation	$13,157.12
Total Estimated Cost to Frame	$23,675.67

Previous Citation(s)

Rey, S. (n.d.). *Construction Estimating Quick Guides and Walkthroughs*. BYU-I Books. https://books.byui.edu/-JxEq

Construction Estimating Reference Book. https://books.byui.edu/-JkY

Ranch House Assignment Walkthroughs

Walkthroughs are availabe for the following Ranch House assignments:

- Customer Database Walkthrough
- Ranch House Basic Takeoff Walkthrough
- Ranch House Preconstruction Walkthrough
- Ranch House Sitework Walkthrough
- Ranch House Concrete Walkthrough
- Ranch House Framing Walkthrough
- Ranch House Exterior Finishes Walkthrough
- Ranch House Interior Finishes Walkthrough
- Ranch House Tools & Equipment Walkthrough
- Ranch House Subcontractor Walkthrough
- Ranch House Overhead Walkthrough
- Ranch House Summary Page Walkthrough

Customer Database Walkthrough

The Estimate Worksheet is a living document that is used by multiple people involved with the project being estimated. Not every tab in the worksheet may be relevant to each of those involved persons, so having a database to pull information from for tabs will save time over manually entering the information. For this purpose, you will create databases to use with data validation to create an easy way to ensure correct information is being used in the relevant sections of the Estimating Worksheet.

Table of Contents

Assignment Overview

Customer Database Scope of Work

Your complete assignment should meet the following criteria:

CustomerDB Tab of the Estimating Spreadsheet

- Enter your own name in the CustomerDB tab.
- Create a formula that will combine first and last names together.
- Apply special formatting for the Zip Code column.
- Apply special formatting for the Phone Number column.
- Create a custom named range for the Customer List
- Create a custom named range for the Customer Database.

Summary Tab of the Estimating Spreadsheet

Complete the calculations for each of the following figures (displayed in orange):

- Insert data validation into the Customer Name field to create a dropdown from the Customer List range.
- Create VLOOKUP formulas to populate customer data from the Customer Database range in the appropriate fields for the following:
  - Street Address
  - City
  - State
  - Zip Code
  - Phone Numbers (Home, Work, and Cell)
  - Lot#
  - Community

Walkthrough Videos

CustomerDB Tab Walkthrough, 19:48 mins

Format the CustomerDB Tab of the Estimating Spreadsheet

The first step is to enter some information in the CustomerDB tab and format specific cells for the type of information they contain.

Step 01: Enter Names and Contact Information for Yourself

1. Open the Estimating Worksheet and navigate to the CustomerDB tab.
2. Enter your own last and first names and other contact information in Row 3 of the CustomerDB tab of the Estimating Worksheet. Do NOT enter anything into the “Name” column yet.
3. Sample information has already been input for three other customers (Figure 5-6).

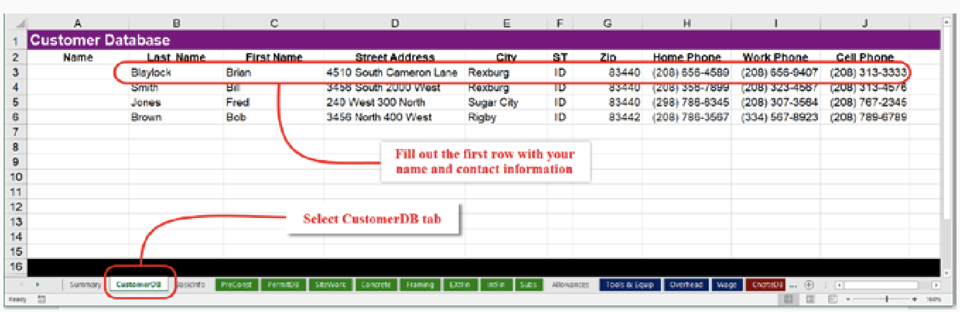
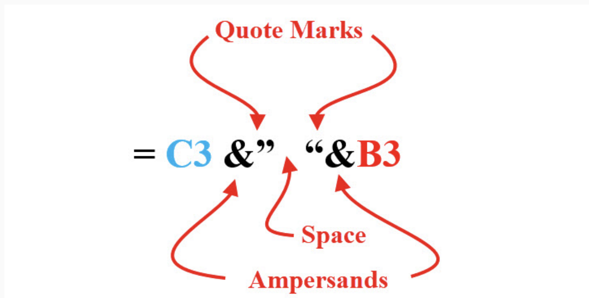


Figure 5-6 select the CustomerDB tab and enter your contact information as the first customer.

Step 02: Enter a Formula to Combine the First and Last Names Together

1. Go to Cell A3 of the CustomerDB tab.
2. Enter the following formula to combine the information in the “Last Name” and “First Name” columns in the “Name” column.
    - =C3 &” “&B3
    - This formula will simply pull the contents B3 and C3 and display them in the order you choose (Figure 5-7).



Function to correctly order last and first names

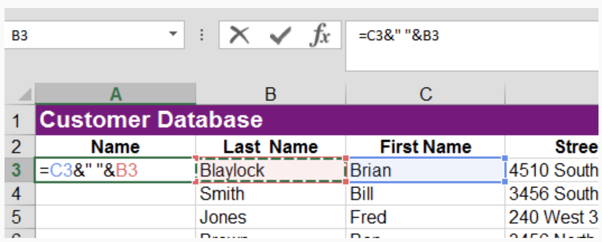


Figure 5-7 shows the formula written in Excel.

3. Complete the same formula in the other cells in Column A

Step 03: Format the Zip Code Column

1. Select the cells in the Zip Code column.
2. Right-click with the cells highlighted, then select the Format Cells option
3. Select Number → Special → Zip Code (Figure 5-8).

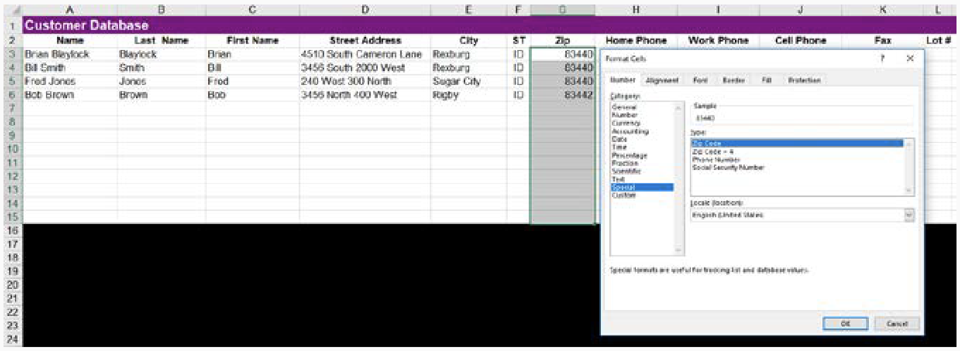


Figure 5-8 Format Zip Code

Step 04: Format the Phone Number Column

1. Select the cells in the Phone Number column.
2. Right-click with the cells highlighted, then select the Format Cells option
3. Select Number → Special → Phone Number (Figure 5-9).

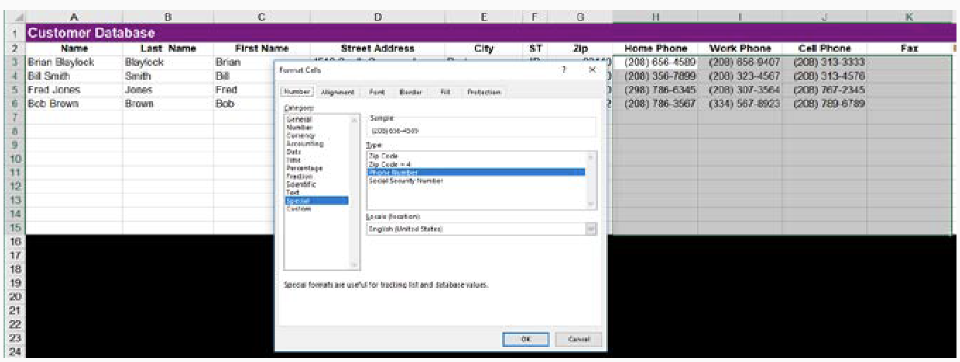


Figure 5-8 Format cells to display phone numbers

Create a Customer List Named Range and a Customer Database Named Range

The next step in setting up the customer database is to create a list of the customer names. This will be used to allow the use of drop-downs to select customers in the other tabs of the worksheet.

Step 01: Create a Customer List Named Range

1. Select the cells in column A from A3 to A16.
2. Click the Name Box to the left of the function input field, and type CustomerList (Figure 5-10). Save by pressing Enter.

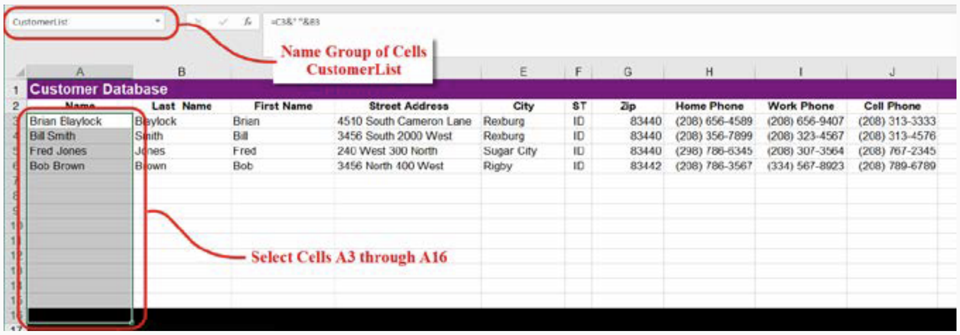


Figure 5-10 Name cells A3 to A16 CustomerList

Step 02: Create a Customer Database Named Range

1. Select the range of cells from A3 to K16.
2. Click the Name Box to the left of the function input field, and type CustomerDB (Figure 5-12). Save by pressing Enter.

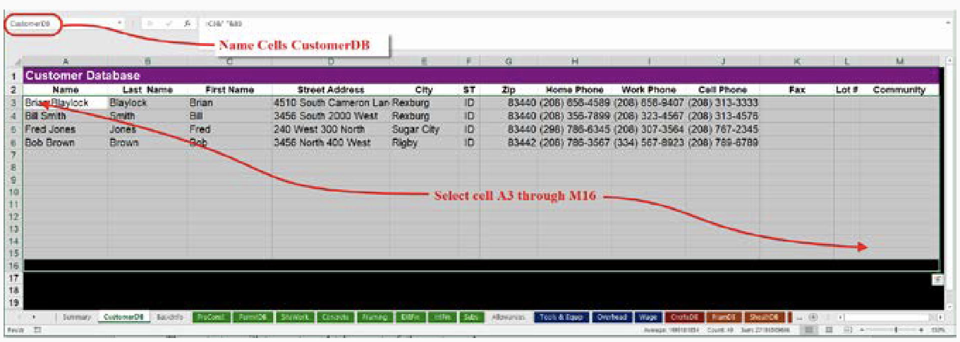


Figure 5-12 Create a group of named cells called CustomerDB

Use Data Validation to Create a Drop-Down Selection List

The named range titled CustomerList can be used with the Excel Data Validation command to create a custom drop-down selection list that can be placed in a cell, or group of cells. Data Validation will limit the data that can be placed in the cell to only data specifically upon the list. In this case, it will limit the data in a cell to a customer's name that is included in the CustomerList.

Step 01: Insert Data Validation into the Worksheet

1. Navigate to the Summary tab of the Estimating Worksheet.
2. Select the blank cell directly under the heading Customer Name.
3. Navigate to Data → Data Tools → Data Validation on the Ribbon (Figure 5-14).

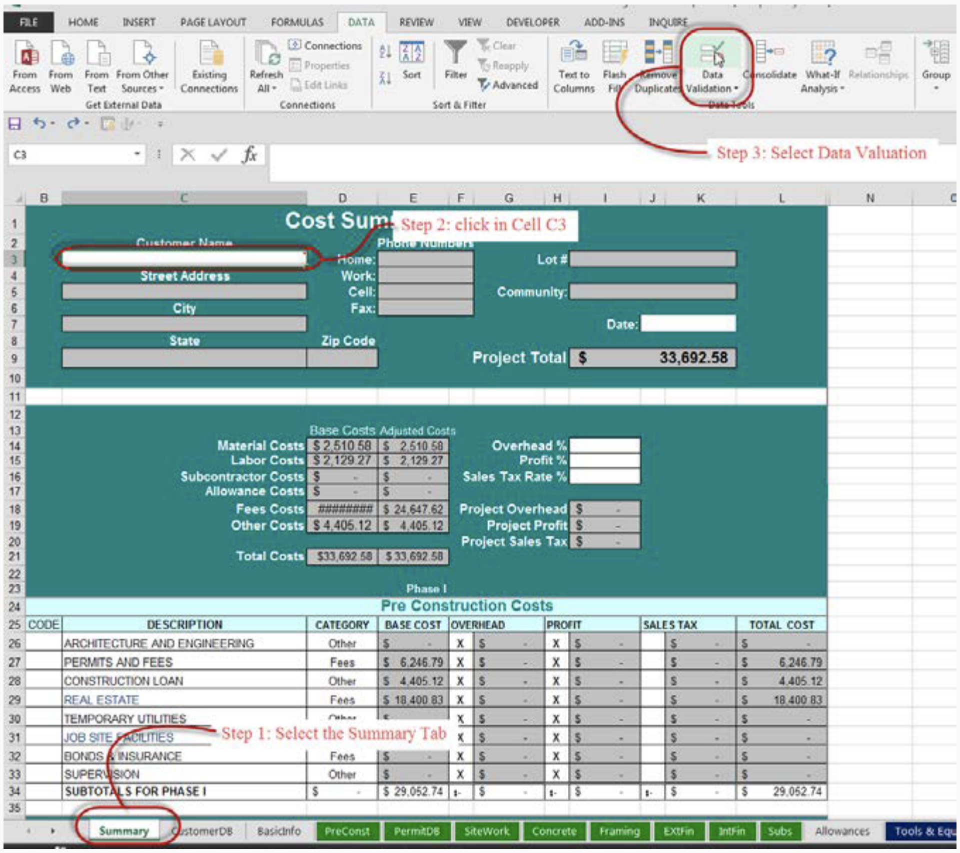


Figure 5-14 Creating a custom drop-down menu by using Data Validation

4. Click on the drop-down arrow in the input box directly underneath the Allow: parameter and change the value from Any value to List by selecting it from the menu (Figure 5-15).

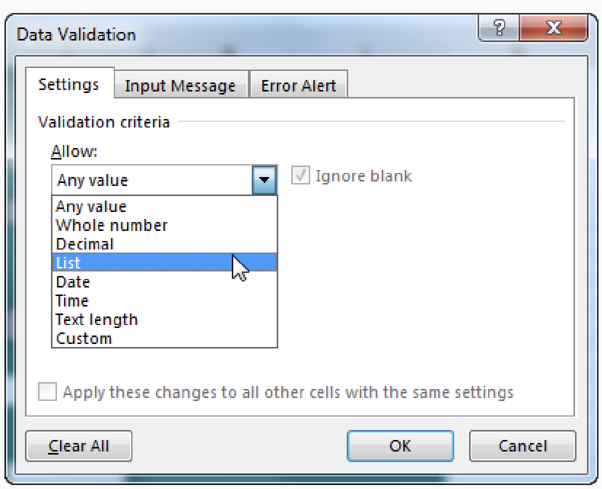


Figure 5-15 Choosing a list in Data Validation

5. Click in the empty box and press the F3 key on the keyboard. The F3 key is an Excel shortcut key to display the Paste Names dialog box.
6. Scroll down in the list of names until CustomerList is visible and click on the name to highlight it. Press Ok to paste the name in the Source input box (Figure 5-16).

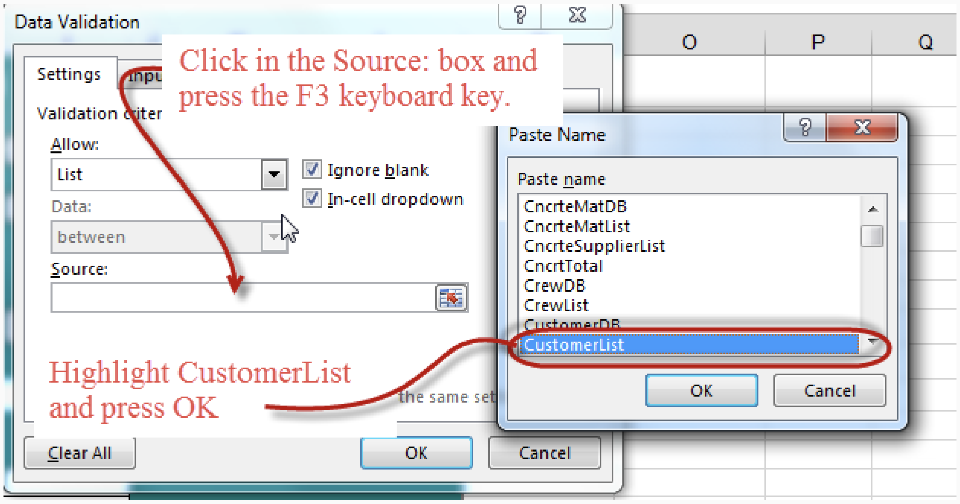


Figure 5-16 Choosing CustomerList as the Source for validation

7. The Source: value should read =CustomerList. Press OK to clear the Data Validation dialog box and return to the spreadsheet.
8. Click on the drop-down arrow that displays on the right side of cell C3. If the names from the CustomerDB tab are selectable in the drop-down, you have successfully completed this task.

Create Formulas to Input Customer Data

The next step will be to write Excel functions to automatically place the customer's information in the header of the summary sheet when a customer's name is selected from the drop-down list. The Excel VLOOKUP function will be used to do this.

Step 01: Identify the Destination Cells in the Summary Tab.

1. The destination cells for customer data are the empty cells in the header of the Summary tab. They include the following:
   - Street Address
   - City
   - State
   - Zip Code
   - Phone Numbers (Home, Work, and Cell)
   - Lot #
   - Community

Step 02: Enter a VLOOKUP Function in a Destination Cell.

1. Select the destination cell (eg. Street Address).
2. Click the small Insert Function icon located to the left of the formula bar.
3. Change the category from Most Recently Used to All. Scroll down the list of available function until VLOOKUP is found. Highlight the function and click OK (Figure 5-19).

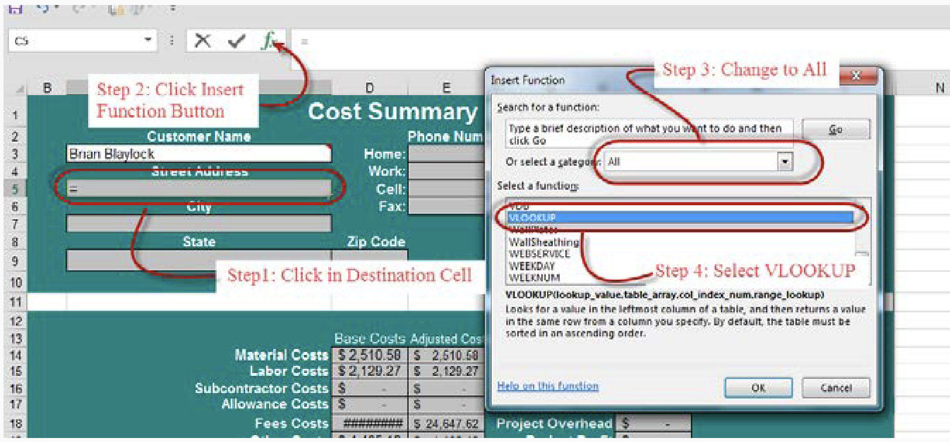


Figure 5-19 Insert VLOOKUP Function in Street Address Cell

4. Select the Lookup_value cell. This is the value you want to look up in the database. In this case, it is the name of the customer, which can be selected in the drop-down you created in C3. Therefore, the Lookup-value is C3 (Figure 5-20).

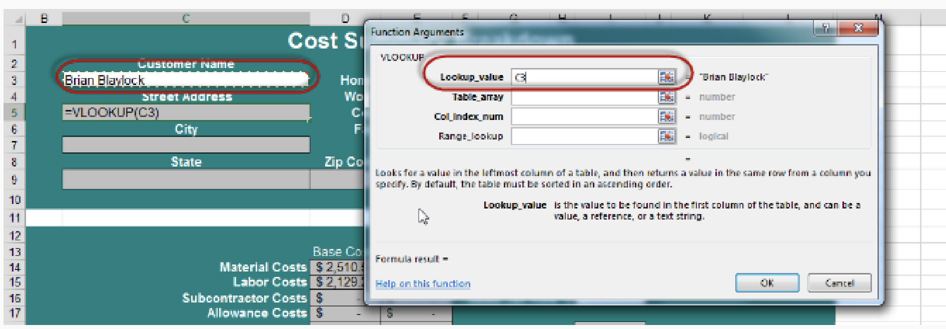


Figure 5-20 the Lookup_vlaue in the Function Arguments dialog box

5. The Table_array argument will be filled in next. This argument is for the database where the needed content is; in the case, the CustomerDB. The easiest way to do this is to click in the Table_array box and again use the F3 Function Key on the keyboard to bring up the Paste Names dialog box. Find the CustomerDB from the list and highlight it and select OK (Figure 5-21).

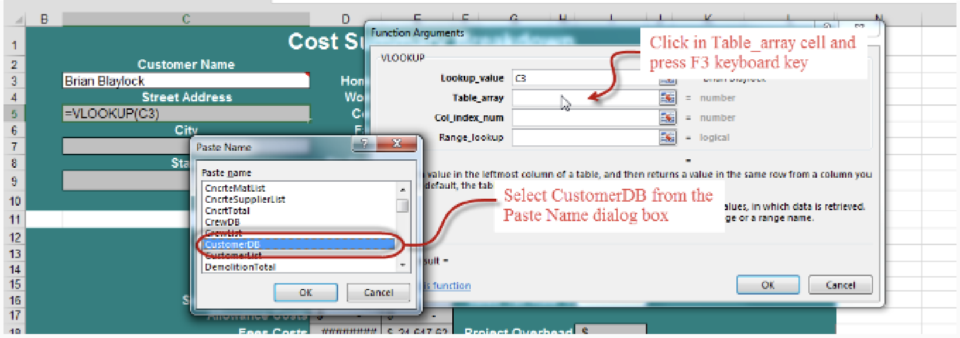


Figure 5-21 The Table_array in the Function Arguments dialog box

6. The third argument is the Col_index_num. This is the column number of the cell where the content is located; in this case, the Address is located in Column D, which is the fourth column of the CustomerDB (see Figure 5-18). Enter a 4 into the Col_index_num of the dialog box.
7. The fourth argument is the Range_lookup argument. This argument has two possible inputs, either True or False. Inputting True means that Excel will look for the closest match. Inputting False means that Excel will need to find an exact match.False is the correct answer for most uses in this spreadsheet. Click OK to finish entering the function in the cell (Figure 5-22).

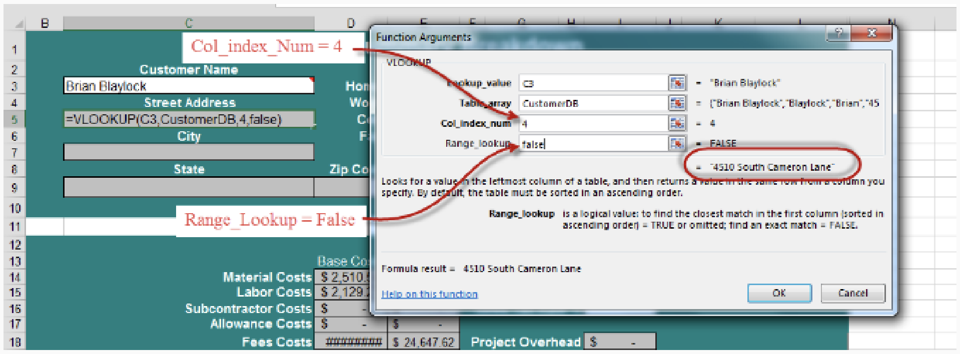


Figure 5-22 The Range_lookup in the Function Arguments dialog box with the correct preview

8. Check whether the VLOOKUP works by selecting a different customer from the drop-down in C3.
    - If your function is not working correctly, check the syntax by double-clicking the cell with the VLOOKUP. It should read as =VLOOKUP(C3,CustomerDB,4,FALSE).
9. Complete a similar VLOOKUP function for the other destination cells in the header of the Summary tab.

Previous Citation(s)

Rey, S. (n.d.). *Construction Estimating Quick Guides and Walkthroughs*. BYU-I Books. https://books.byui.edu/-JxEq

Ranch House Basic Takeoff Walkthrough

A basic takeoff refers to measurements for different areas of a construction blueprint plan. These measurements will be “taken off” the blueprint using computer programs such as Bluebeam or On Screen Takeoff. With these rough dimensions, you can start to estimate quantities of material and labor required to complete the project.

Hint: You may want to use the Spreadsheet Calculator you created previously to help with these calculations.

Table of Contents

Assignment Overview

Scope of Work

Use Bluebeam to take measurements and calculate estimates for a construction project from the project plans. The required estimates you will provide should include the following:

BasicInfo Tab

- Main Floor Area
- Basement Floor Area
- Garage Floor Area
- Exterior Wall Footing Length
- Garage\Patio Wall Footing Length
- Basement Foundation Length
- Shallow Foundation Length
- 2x4 Basement Bearing Wall Length
- 2x4 Basement Insulation Wall Length
- 2x6 Exterior Wall Length
- 2x4 Garage Wall Length
- 2x6 Common Wall Length
- 2x4 Interior Wall Length
- 2x6 Interior Wall Length
- Flat Roof Area
- Lineal Feet Roof Edge
- Lineal Feet Roof Ridge Line

Walkthrough Videos

Basic Takeoff Assignment Walkthrough, 19:34 mins

Determine the Sequence and Units of Measure for the Basic Takeoff

The first step is to decide the order in which you will measure elements of the plans, and the units you will use to measure them.

Step 01: Determine the Sequence for Completing the Basic Takeoff

Use the following sequence for basic takeoffs:

1. Square Footage of Floor Area
2. Square Footage of Flat Area Covered by Roof
3. Lineal feet of Footings
4. Lineal Feet of Foundation
5. Lineal Feet of Interior Wall
6. Lineal Feet of Exterior Wall
7. Lineal Feet of Common Wall
8. Lineal Feet of Garage Wall
9. Lineal Feet of Roof Edge
10. Lineal Feet of Roof Ridge Line
11. Door Schedule
12. Window Schedule

Step 02: Identify the Units of Measure for Structure Components

The units of measurement for the basic takeoff are found in the sequence above. It is vital to recognize these units because they will be used to estimate both material quantity and labor.

Estimate the Square Footage of the Floor Area from the Plans

Step 01: Measure the Main Floor Living Area

Calculate the space based on the exterior wall dimensions, not interior wall dimensions.

- If the exterior walls of the main floor area do not form a simple rectangle, break the main floor area into simple geometric shapes which can then be measured in square feet and added together to get a total square footage.

Example

- Figure 5-27 Shows a graphic of the first floor with the main floor area highlighted in light tan and the garage area in gray.
- Notice that Figure 5-27's dimensions from the takeoff in Bluebeam use the outside of the exterior walls.
- Because the main floor area is a simple rectangle, the square footage will be calculated using a single equation. **36' x 32' = 1,152 ft2.**

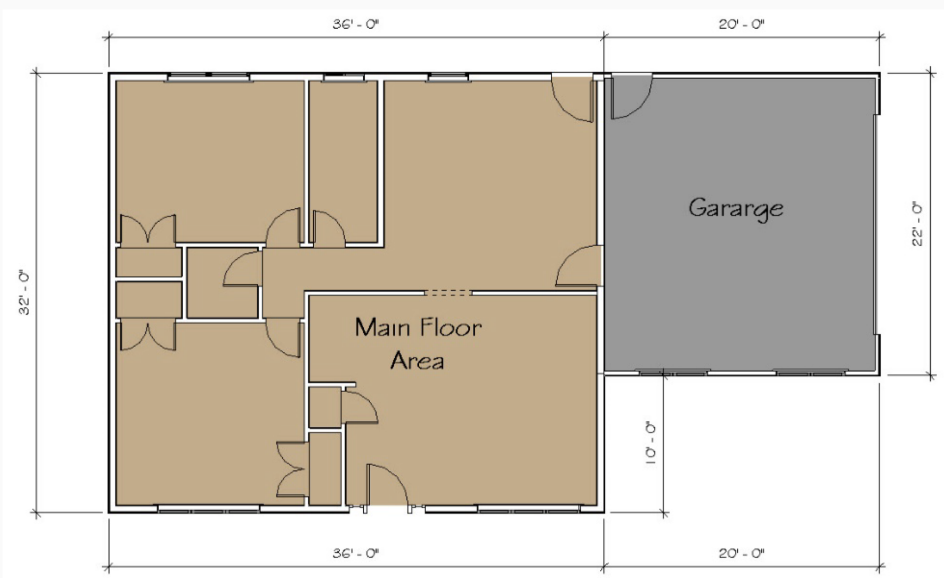


Figure 5-27 Graphic representation of the main floor and garage area of the building.

Step 02: Measure the Garage Floor Area

1. Calculate the space based on the exterior wall dimensions, not interior wall dimensions.
   - This process is basically the same as that for calculating the main floor area.
   - Based on the takeoffs in Figure 5-27 above, the area of the garage flooring is **440 ft^2**.

Step 03: Measure the Basement Floor Area

Calculate the basement based on the INTERIOR wall dimensions.

- This calculation includes the area of any storage area under a porch and any doorways formed in the concrete of the basement.

Example

- Figure 5-28 Shows a graphic of the basement plans for a structure.
- Notice that this figure's dimensions from the takeoff in Bluebeam use the inside of the basement walls.
- This figure shows a basement area, a porch area, and dimensions for the doorway.
- The formula for calculating the total area of this figure is as follows:
  - Basement Area + Porch Area + Doorway Area = Total Area
  - (34'-8" x 30'-8") + (9'-8" x 5'-7") + (3'-2" x 8") = Total Area
  - 1063.11 ft2 + 53.97 ft2 + 2.11 ft^2 = 1119.19 ft^2
  - The total area of the basement is **1119.19 ft^2**.

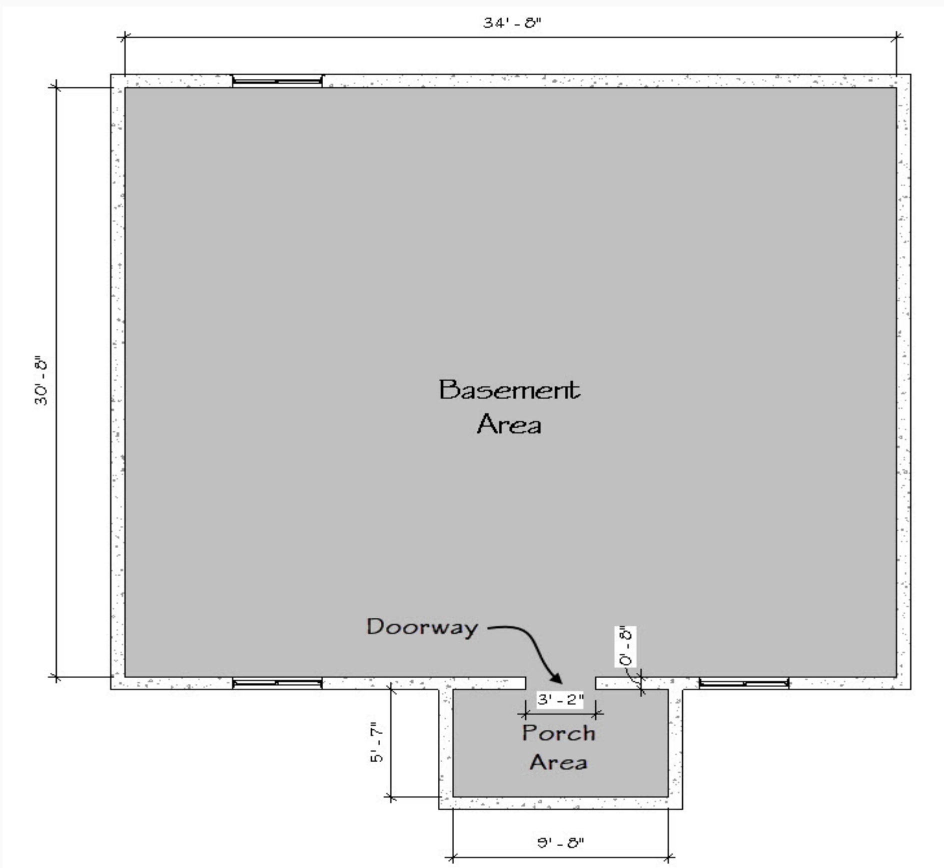


Figure 5-28 The basement floor area square footage is comprised of three separate floor areas.

Step 04: Enter the Floor Area into the Estimating Worksheet

Take the numbers you calculated for the various floor areas of the plans and enter them in the appropriate cells of the BasicInfo tab in the Estimating Worksheet.

Example

The numbers calculated from the graphics in Figure 5-27 and Figure 5-28 will be entered in the BasicInfo tab, as shown in Figure 5-30.

	A	B	C
1	**Basic Takeoff Information**		
2	**Item**	**Unit**	**Total**
3	**Floor Area**		
4	Main Floor Area	SF	**1152**
5	Basement Floor Area	SF	**1119.19**
6	Garage Floor Area	SF	**440**

Figure 5-30 Floor area subsection of the basic takeoff completed.

Estimate the Lineal Feet of the Footing from the Plans

The next basic takeoff to be completed will be the footing section. There are two distinct styles of footing; exterior wall footings and the interior grade footing.

Step 01: Measure the Exterior Wall Footings

Calculate the length of the exterior wall footings. This is more complicated than it seems.

- Exterior wall footings are usually built to a specific standard.
- For example, residential buildings likely have standardized exterior footings that are16” wide and 8” deep (Figure 5-33).
- Because these footings have the added dimension of width, they must be calculated to account for overlap between any corners. Failing to do so will result in inaccurate footing estimates because the square area of each corner will have the lineal feet measurement counted twice.

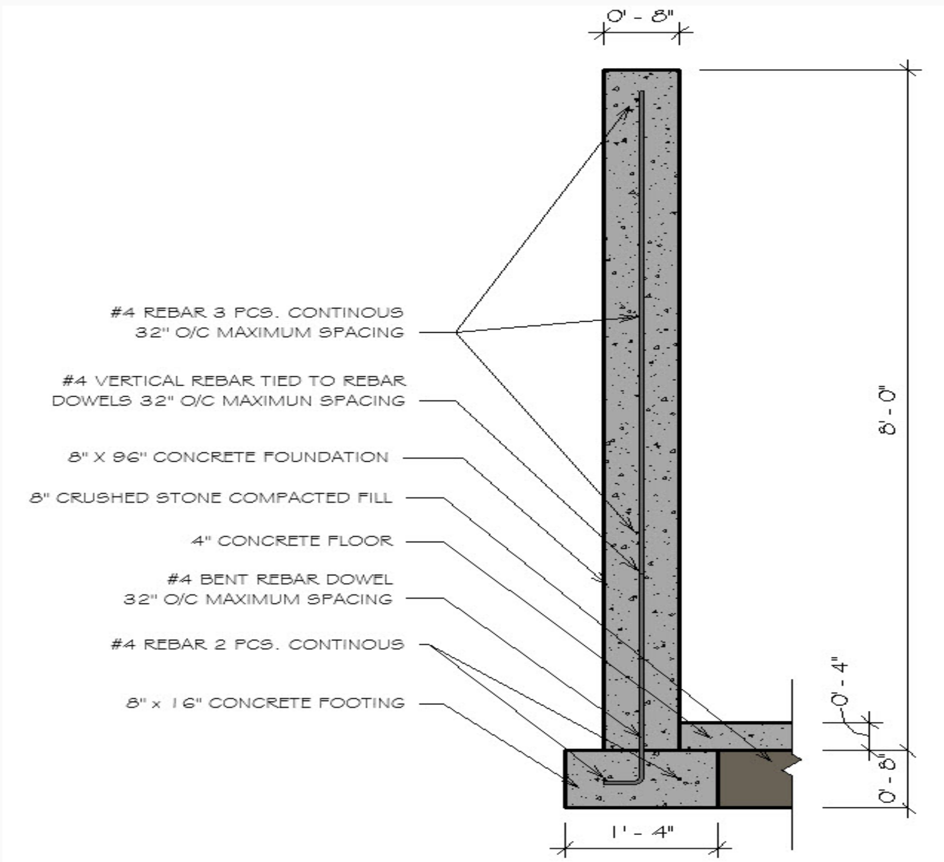


Figure 5-33 Footing and foundation wall section detailing the construction specifics.

Methods for Calculating Footings

This guide will offer two different methods for calculating the length of concrete footings. Examples for each method will be demonstrated using Figure 5-34.

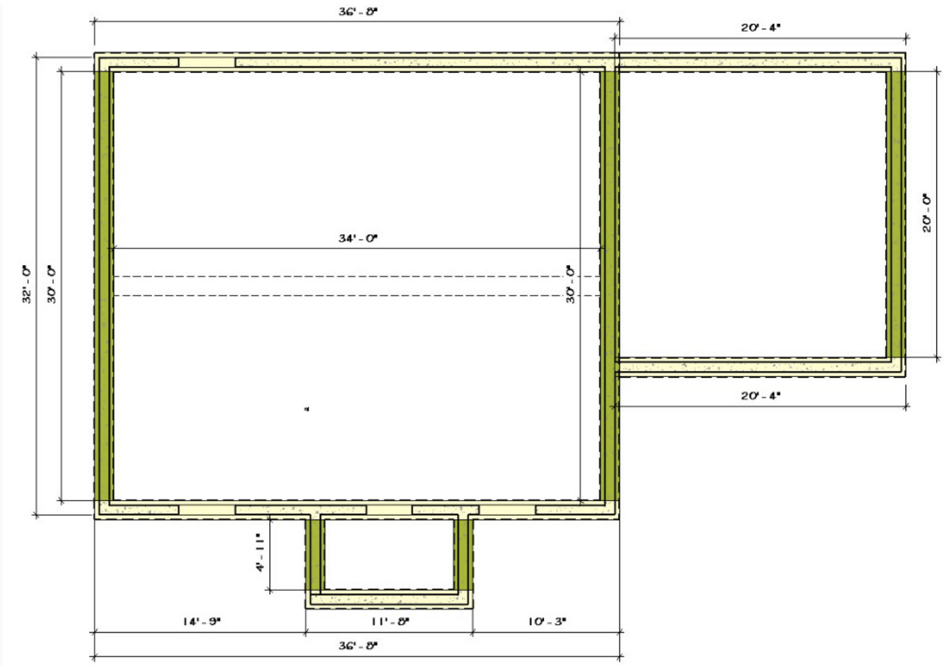


Figure 5-34

Method 01: Averaging the exterior and interior dimensions.

1. Measure both the exterior dimensions and interior dimensions of the footings.
2. Add both dimensions together and divide in half to find the average length. This is the estimated length of the footing.

(Exterior Dimension + Interior Dimension) ÷ 2 = Average Lineal Feet

Examples

- The leftmost footing in Figure 5-34 has an exterior length of 32' and an interior length of 30'.

(Exterior Dimension + Interior Dimension) ÷ 2 = Average Lineal Feet

(32' + 30') ÷ 2 = Average Lineal Feet

62' ÷ 2 = **31 Lineal Feet**

- The topmost footing in Figure 5-34 has an exterior length of 36'8" and an interior length of 34'.

(36'-8" + 34') ÷ 2 = Average Lineal Feet

70'-8" ÷ 2 = **35'-4" Lineal Feet**

- The total lineal feet for these two footings would be **66'-4"** using this method.

Method 02: Break the footings into individual pieces using Bluebeam and measure their length.

1. Break the footings into individual pieces that are placed on the page horizontally and vertically.
2. Calculate the horizontal footing by measuring to the outside of the footing the vertical footings by measuring to the inside of the footings.

Examples

- Notice that Figure 5-34 shows a dimensioned plan view of the footings.
- The horizontal footings on the page are dimensioned to the outside of the wall and are highlighted in yellow.
- The vertical footings on the page are dimensioned to the inside of the wall and are highlighted in green.
- The horizontal garage footings are measured to the basement foundation.

The leftmost vertical footing has a length of **30’** highlighted in green.

The topmost horizontal footing has a length of **36’-8”** highlighted in yellow.

- The total lineal feet for these two footings would be **66’-8”**.

Notice how the total lineal feet for these two footings are slightly different between the two methods. In general, using Method 01 might be easier if you do not have the ability to highlight and measure areas in the plans. Method 02 is a bit more accurate and should be used if possible.

Total Calculations for Figure 5-34: Using Option 02 and the Spreadsheet Calculator you made previously, the total lineal feet of the exterior footings is 215.50 LF, as illustrated in the graphic below.

Clear

Lineal Feet

Feet	Inches	Decimal
36	8	36.67
20	4	20.33
20	4	20.33
36	8	36.67
11	8	11.67
		0.00
30	0	30.00
4	11	4.92
4	11	4.92
30	0	30.00
20	0	20.00
		0.00
Total Feet	215.50 LF	
Total Yards	71.83 LY	

Total footing calculations for Figure 5-34

Step 02: Measure the Interior Wall Footings

Calculate the length of the interior wall footings.

- Use the same method used to calculate the exterior wall footings.
- Interior and exterior wall footings are separated in a basic takeoff because they may have the same dimensions, but different requirements for reinforcement with rebar. Because of this, the cost of materials and labor per lineal foot is different for each type of footing.
- Figure 5-32 shows the difference in reinforcement for interior versus exterior wall footings.

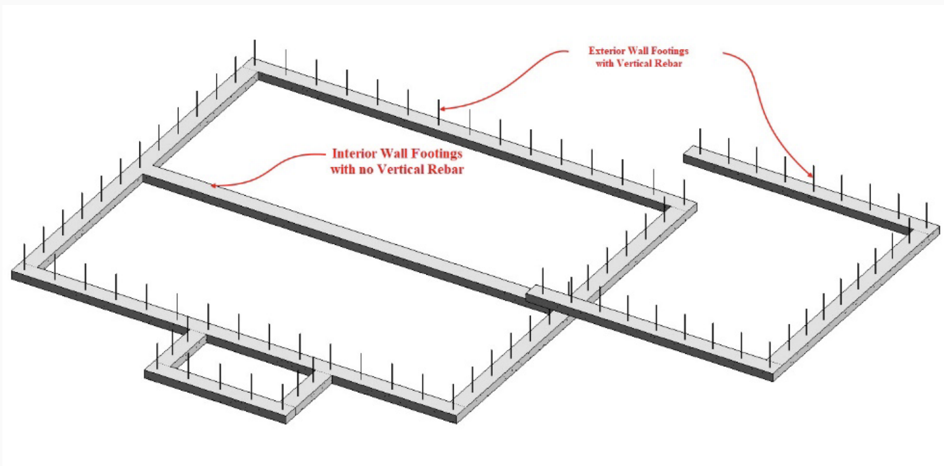


Figure 5-32 Exterior Wall footings with vertical rebar and Interior Grade footings without.

Step 03: Enter the Total Exterior and Interior Wall Footing Lengths

The total lengths of exterior and interior wall footings should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

Estimate the Lineal Feet of the Foundation from the Plans

The next basic takeoff to be completed will be the foundation section. There are two distinct styles of foundation; main foundation and the garage foundation. Each of these styles have different requirements for dimensions, as illustrated in Figure 5-31.

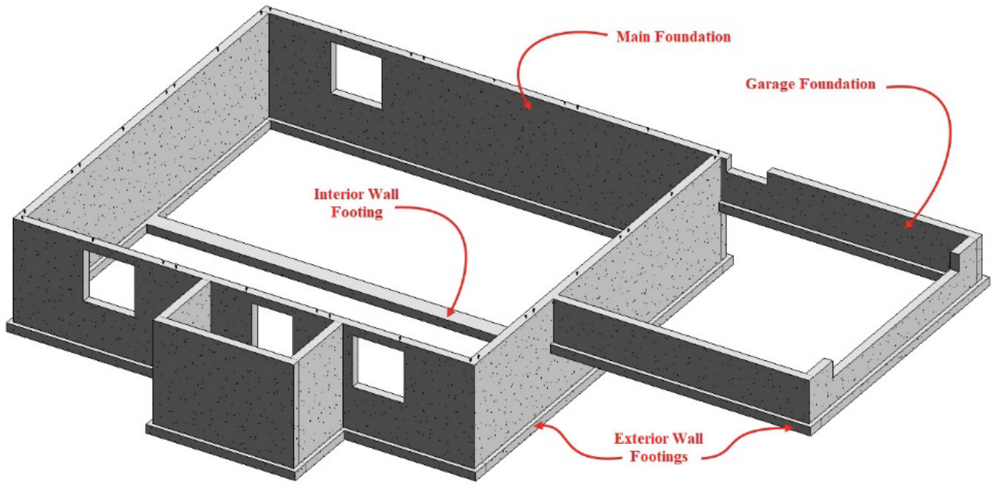


Figure 5-31 Three dimension footing and foundation view showing different footing and foundation styles.

Step 01: Measure the Main Foundation

Calculate the length of the main foundation.

- This process carries the same complications as calculating exterior footings.
- Use Method 02 from the Strategies for Calculating Footings section above.

Example

- Figure 5-36 is a graphic of the foundation from the same structure used as an example for calculating footings.
- The foundations which are placed horizontally on the page are dimensioned to the outside of the walls and are highlighted in dark blue.
- The foundations placed vertically on the page are dimensioned to the inside of the wall and are highlighted in light blue

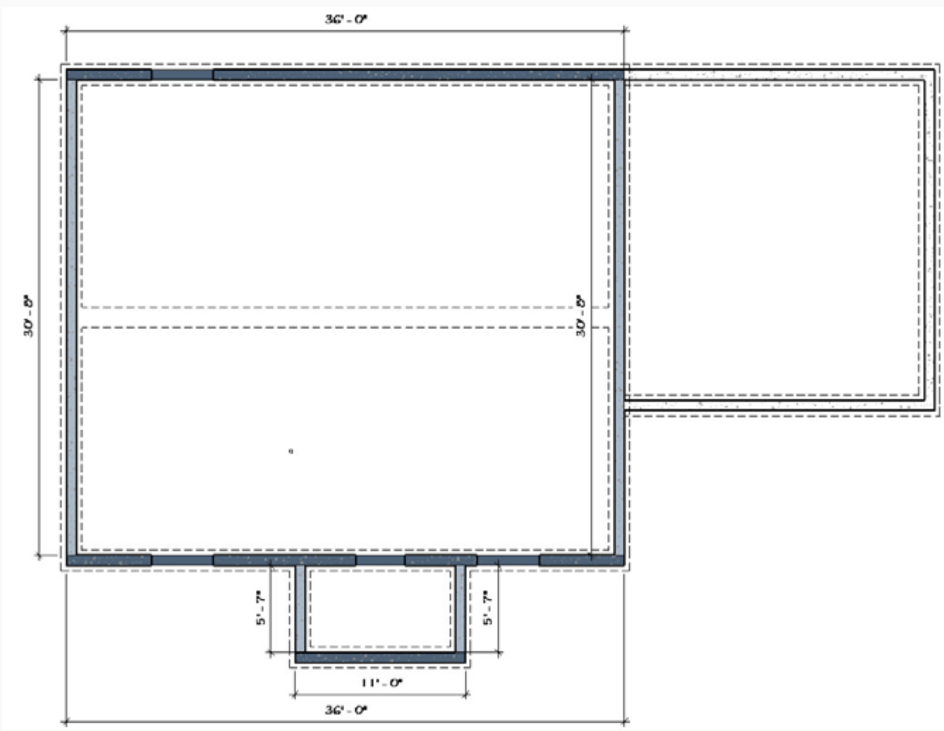


Figure 5-36 Graphic showing the lineal footage of foundation floor plan.

- Using the lengths provided by the highlights, the following numbers can be added up to calculate a total of 155.50 LF of Main Foundation.

Clear

Lineal Feet

Feet	Inches	Decimal
36	0	36.00
36	0	36.00
11	0	11.00
		0.00
30	8	30.67
5	7	5.58
5	7	5.58
30	8	30.67
Total Feet	155.50 LF	
Total Yards	51.83 LY	

Total foundation lengths for Figure 5-36

Step 02: Measure the Garage Foundation

Calculate the length of the garage foundation.

- This process is similar to that used to calculate the main foundation length.
- Because the two different types of foundation have different dimension requirements, they must be calculated separately. Failure to do so will result in inaccurate estimates for material and labor.

Step 03: Enter the Total Main and Garage Foundation Lengths

The total lengths of main and garage foundations should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

Estimate the Lineal Feet of the Various Walls from the Plans

The wall takeoffs will be completed in similar fashion as the footing and foundation takeoffs. There are a number of different wall type. There are also a number of different ways of classifying the walls. For purposes of this assignment, walls will be classified into three basic categories. These categories are Basement Walls, Exterior Walls, and Interior Walls. Each of these categories will include different kinds of walls that are estimated separately because they vary in the specifications and materials used to construct them.

Step 01: Identify the Different Wall Types Used in the Basement

Look at the construction plans and identify the types of walls used in the basement. Some criteria for identifying wall types includes:

- Is the wall load bearing, meaning it supports the structure above it, such as a floor or roof? These types of walls have a double top plate and are framed using 2x4's spaced 16 inches on center.
- Is the wall framed to provide a place to install insulation? These types of walls are framed using a single top plate with a stud spacing of 24 inches on center.

There are two types of basement walls that must be measured and estimated separately. They include Basement Bearing Walls and Basement Insulation Walls.

Basement Bearing Walls

- These are framed in the basement or on the foundation to support the floor system.
- Walls to frame out the various basement rooms are included in this category.
- Pony walls (shorter walls that sit on top of the foundation to complete the basement wall structure) are also included in this category.

Basement Insultation Walls

- These are walls framed around the inside of the foundation to provide a structure for installing insulation and wall finishes.

Figure 5-39 Shows the basement walls of the project used as an example in this guide.

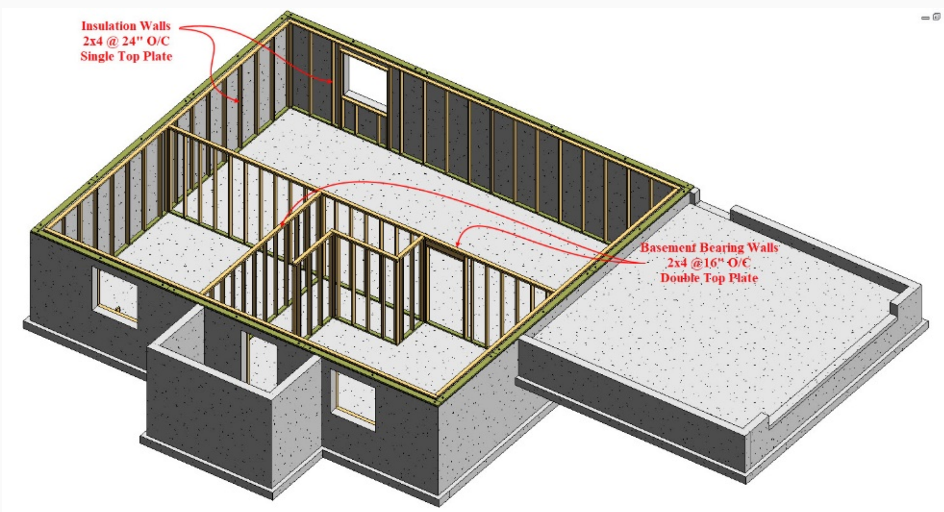


Figure 5-39 Basement bearing walls and insulation walls.

The actual construction of each wall type can best be determined by referencing building sections or wall section detail drawings. Most often notes and annotations will detail the wall construction similar to what was previously shown when calculating the footing and foundation walls. Figure 5-40 Shows and expanded section view of the footing and foundation wall section shown in Figure 5-33. The view shows the addition of the basement insulation wall.

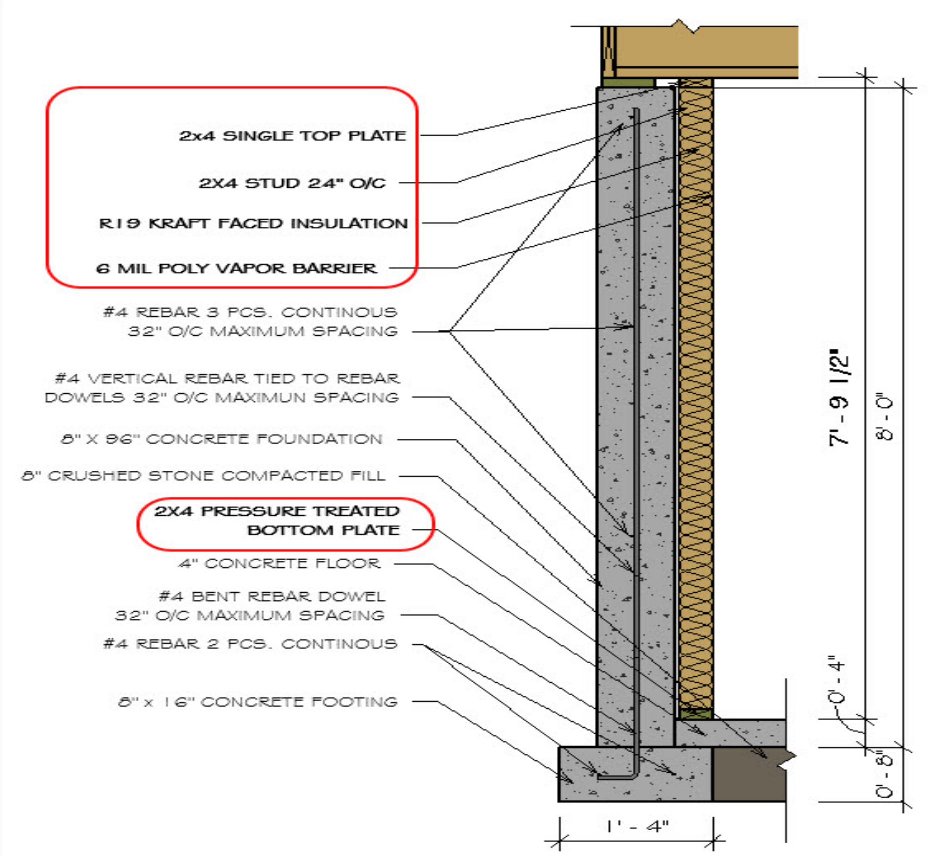


Figure 5-40 Wall section showing basement insulation wall.

Step 02: Measure the Height and Length of the Various Basement Walls

Calculate the height and length of the Basement Walls.

- This process carries the same complications as calculating exterior footings.
- Use Method 02 from the Strategies for Calculating Footings section above.

Example

- Figure 5-41 is a graphic of the basement walls from the same structure used as an example for calculating footings and foundations.
- The Insulation Walls are highlighted in pink, and the Bearing Walls are highlighted in blue.
- Notice that the various walls include blocks so that the corners where two walls join are not counted twice.

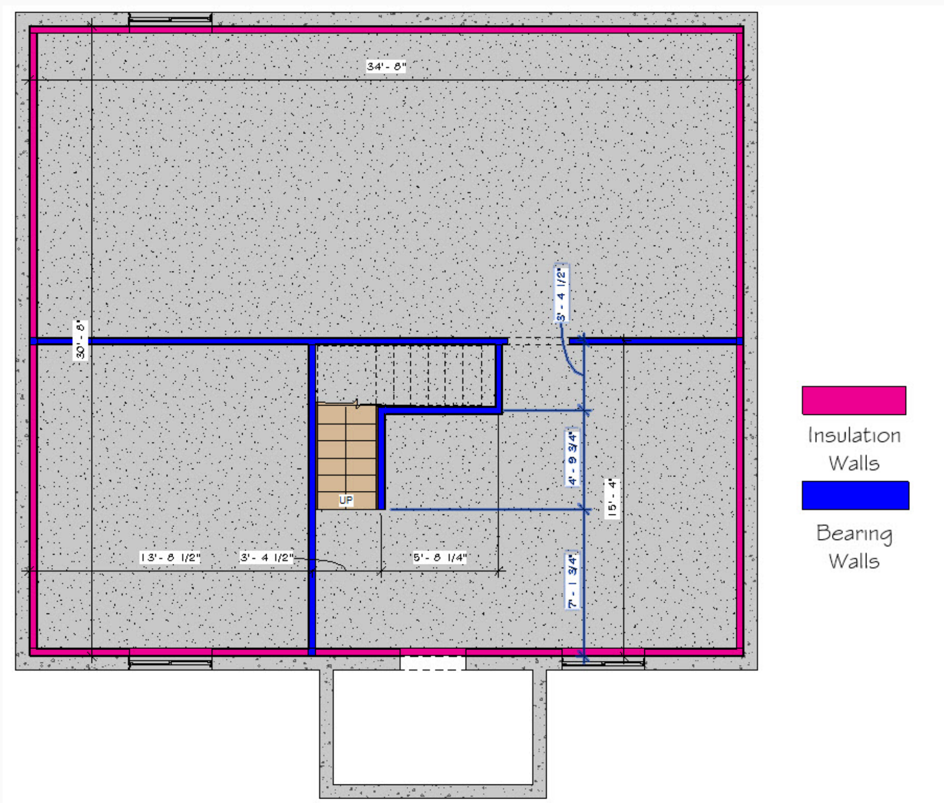


Figure 5-41 Basement bearing and insulation walls.

- Using the lengths provided by the highlights of the Bearing Walls, the following numbers can be added up to calculate a total of 63.75 LF of Basement Bearing Walls.

Clear		
Lineal Feet		
Feet	Inches	Decimal
34	8	34.67
5	8	5.67
		0.00
15	2	15.17
4	10	4.83
3	5	3.42
Total Feet	63.75 LF	
Total Yards	21.25 LY	

Figure 5-42 Bearing wall lengths

Step 03: Identify the Different Wall Types Used in the Exterior Structure

There are three types of walls in the Exterior Walls category that must be estimated separately.

2x6 Exterior Walls

- These walls are built on the floor structure and could be framed as a single wall.
- These walls are sheathed with OSB sheathing.

2x4 Garage Walls

- These walls are built on the garage foundation.
- These walls are built using 2x4's as opposed to 2x6's.
- The studs are longer than other exterior wall types because they go all of the way to the foundation instead of resting on the floor system.
- The bottom plates of these walls are pressure treated material.

2x6 Common Walls

- These walls are built on the floor structure and could be framed as a single wall.
- These walls are covered with dry wall on both sides.
- These walls act as a shared barrier between 2x6 Exterior Walls and 2x4 Garage Walls
- Because of the difference in materials used (OSB versus drywall) Common Walls are estimated separately from Exterior Walls.

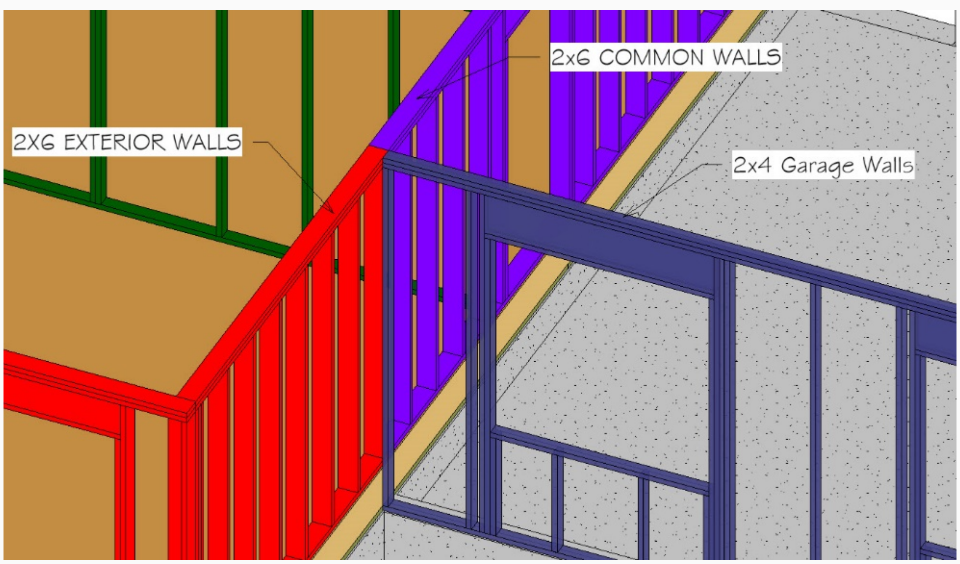


Figure 5-43 Exterior corner showing the intersection of three exterior wall types.

Step 04: Measure the Height and Length of the Various Exterior Walls

The heights and total lengths of the exterior walls should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

Step 05: Identify the Different Wall Types in the Interior of the Structure

There are three types of walls in the Interior Walls category that must be estimated separately.

2x4 Interior Walls

- These walls are found inside the exterior walls and are built on the floor structure of 2x4 studs.

2x6 Interior Walls

- These walls are found inside the exterior walls and are built on the floor structure of 2x6 studs.

2x4 Tall Interior Walls

- These walls are found inside the exterior walls and are built on the floor structure of 2x4 studs.
- These walls are taller than the height of the exterior walls and are typically found with vaulted ceilings.

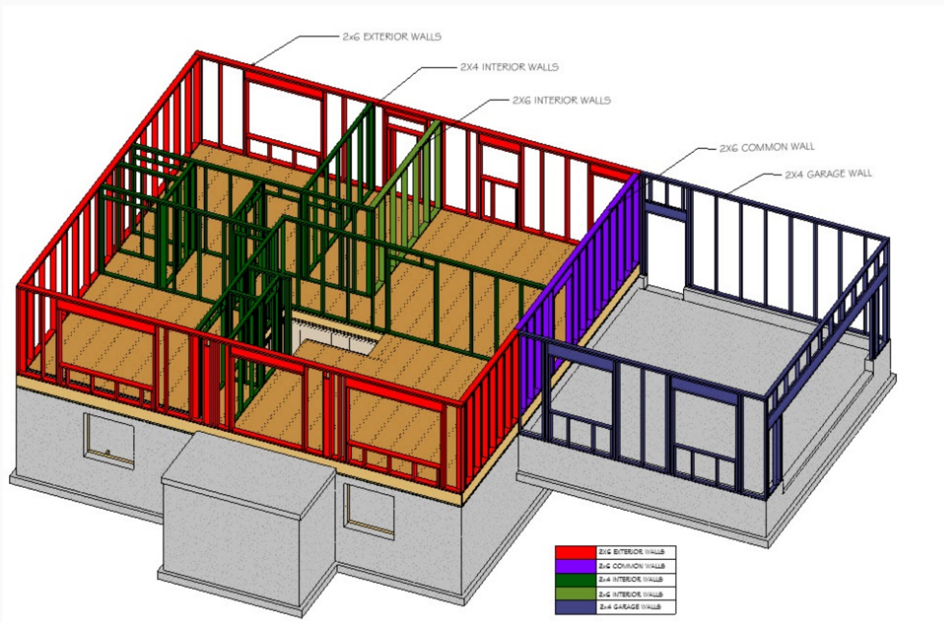


Figure 5-44 Color coded graphics of the main floor walls.

Step 06: Measure the Height and Length of the Various Interior Walls

The total lengths of main and garage foundations should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

Step 07: Enter the Measurements of the Various Walls into the Worksheet

The total lengths and heights of 2x6 Exterior Walls, 2x4 Garage Walls, and 2x6 Common Walls should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

	A	B	C
29	**Basement & Pony Walls**		
30	2x4 Basement Bearing Wall Length	FT	**63.75**
31	2x4 Basement Bearing Wall Height	FT	**7.8**
32	2x4 Basement Bearing Wall Area	SF	**497.25**
33			
34	2x4 Basement Insulation Wall Length	FT	**129.2**
35	2x4 Basement Insulation Wall Height	FT	**7.8**
36	2x4 Basement Insulation Wall Area	SF	**1007.76**
37			
38	**Exterior Walls**		
39	2x6 Exterior Walls Length	FT	**114**
40	2x6 Exterior Walls Height	FT	**8**
41	2x6 Exterior Walls Area	SF	**912**
42			
43	2x4 Garage Wall Length	FT	**62**
44	2x4 Garage Wall Height	FT	**9**
45	2x4 Garage Wall Area	SF	**558**
46			
47	2x6 Common Wall Length	FT	**21.75**
48	2x6 Common Wall Height	FT	**8**
49	2x6 Common Wall Area	SF	**174**
50	**Interior Walls**		
51	2x4 Interior Wall Length	FT	**114.6**
52	2x4 Interior Wall Height	FT	**8**
53	2x4 Interior Wall Area	SF	**916.8**
54			
55	2x6 Interior Wall Length	FT	**12.25**
56	2x6 Interior Walls Height	FT	**8**
57	2x6 Interior wall Area	SF	**98**
58			
59	2x4 Tall Interior Wall Length	FT	
60	2x4 Tall Interior Wall Height	FT	
61	2x4 Tall Interior Wall Area	SF	**0**
62			
63	Total SF Interior Walls		**1014.8**

Figure 5-45 Completed wall basic takeoffs.

Complete the Roof Takeoff

The roof subsection of the basic takeoffs is comprised of three quantities which are, square footage of flat roof area, lineal feet of roof ridge, and lineal feet of roof edge.

Step 01: Identify and Measure the Flat Roof Dimensions

Identify the flat roof dimensions.

- The footprint of the roof is used to calculate the roof dimensions, not the actual area of each sloped side of the roof.
- This number includes all of the roof area, including overhangs.
- Be careful to identify any sections of roof that are covered by the overhangs of other roof sections. They still must be accounted for when calculating the total flat roof area.

Example

- Figure 5-46 Shows a dimensioned roof plan.
  - Notice that the roof plan does not show a small area of the garage roof that is under the main roof. This roof area is equal to the distance of the roof overhang multiplied by half of the roof width. This is highlighted by the area outlined in red.

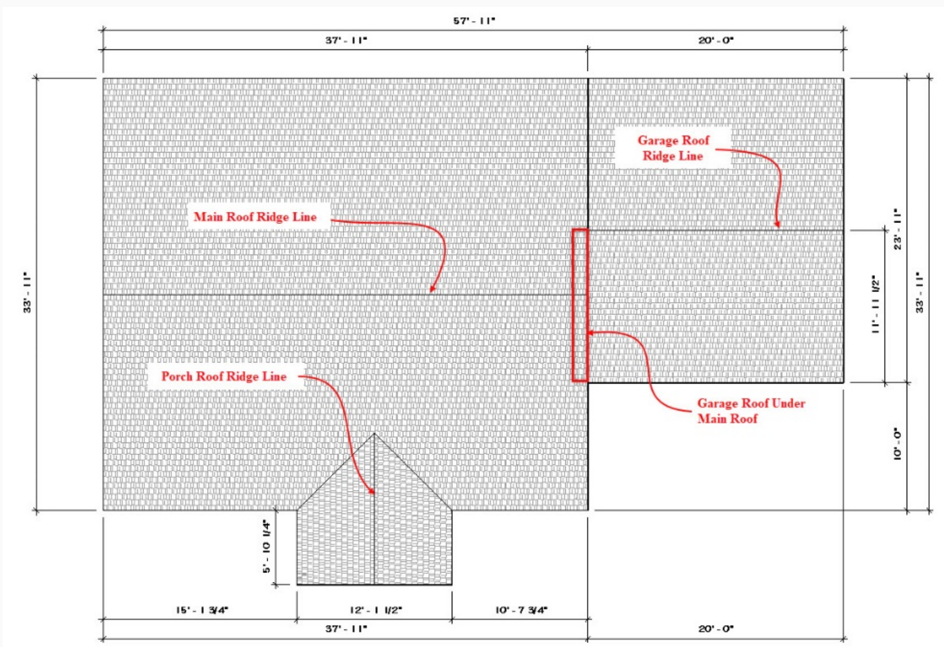


Figure 5-46 Roof plan showing flat roof dimensions.

Step 02: Segment the Flat Roof Area and Calculate the Dimensions

Figure 5-46 above is already segmented into multiple areas that can be entered into the Spreadsheet Calculator and added up to find the total flat roof area. (Figure 5-47)

Clear	Rectangle Area and Volume								
	Width		Length		Depth		Perimeter	Total Area	Total Volume
Area	Feet	Inches	Feet	Inches	Feet	Inches			
Area 1	33	11	35	11			139.67	1218.17	0.00
Area 2	20		23	11			87.83	478.33	0.00
Area 3	5	10.25	12	1.5			35.96	70.98	0.00
Area 4	1		11	11.5			25.92	11.96	0.00
Area 5							0.00	0.00	0.00
						Total Feet	289.38 FT	1779.45 SF	0.00 CF
						Total Yards	96.46 YDS	197.72 SY	0.00 CY

Figure 5-47 Dimensions of roof area input into the spreadsheet calculator.

The total flat roof area of the structure in Figure 5-46 is **1,779.45 SF**.

Step 03: Estimate the Lineal Footage of the Roof Ridge Line

The roof plan in Figure 5-46 Can also be used to determine the lineal footage of roof ridge line.

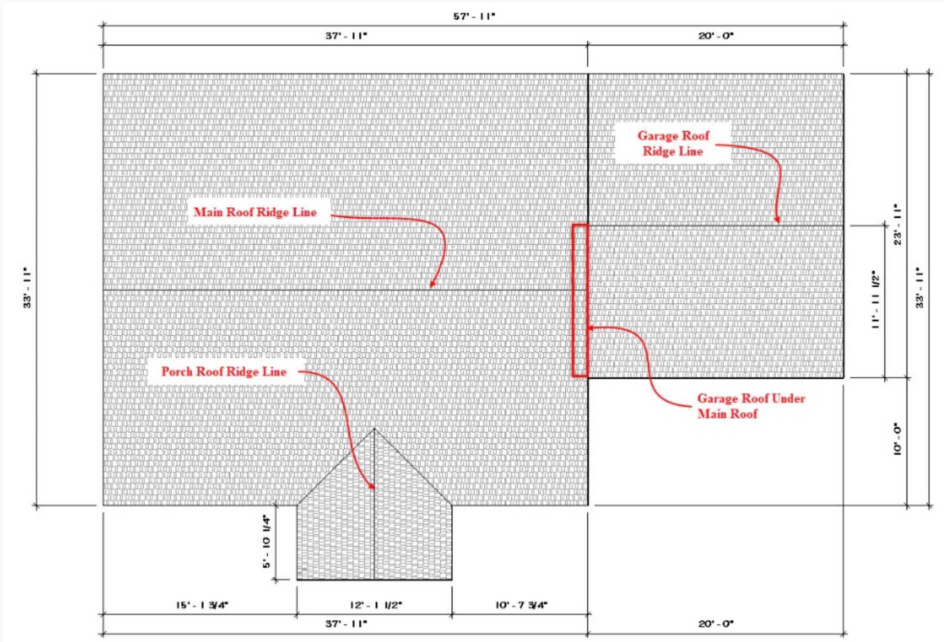


Figure 5-46 Roof plan showing flat roof dimensions.

- Three ridge lines are shown: the main roof ridgeline, the garage roof ridgeline, and the front porch ridgeline.
- The length of both the main roof and garage ridge lines can be determined from the dimensions.
  - To determine the length of the front porch ridgeline, add the 5’-10 ¼” roof edge distance to the roof run to find the total length.
  - In this case, the span of the roof is 12’-1 ½” and the run would be half of that distance, or 6’-0 ¾”. The total length of the front porch ridgeline would be:

5’-10 ¼” + 6’- 0 ¾” = 11’- 11”

Figure 5-48 Shows the lineal footage of roof ridge line entered into the spreadsheet calculator.

Clear		
Lineal Feet		
Feet	Inches	Decimal
37	11	37.92
20		20.00
11	11	11.92
Total Feet	69.83 LF	
Total Yards	23.28 LY	

Figure 5-48 Lineal feet of roof ridge entered into the spreadsheet calculator.

Step 04: Estimate the Lineal Footage of the Roof Edge

The lineal footage of roof edge is a little more complicated than the other two roof basic takeoffs.

- This takeoff follows the edge of the roof around the building, and includes both the horizontal roof edges and sloped roof edges.

Example

Figure 5-49 Shows the East Side elevation of the example structure used in this walkthrough and highlights the roof edges in red.

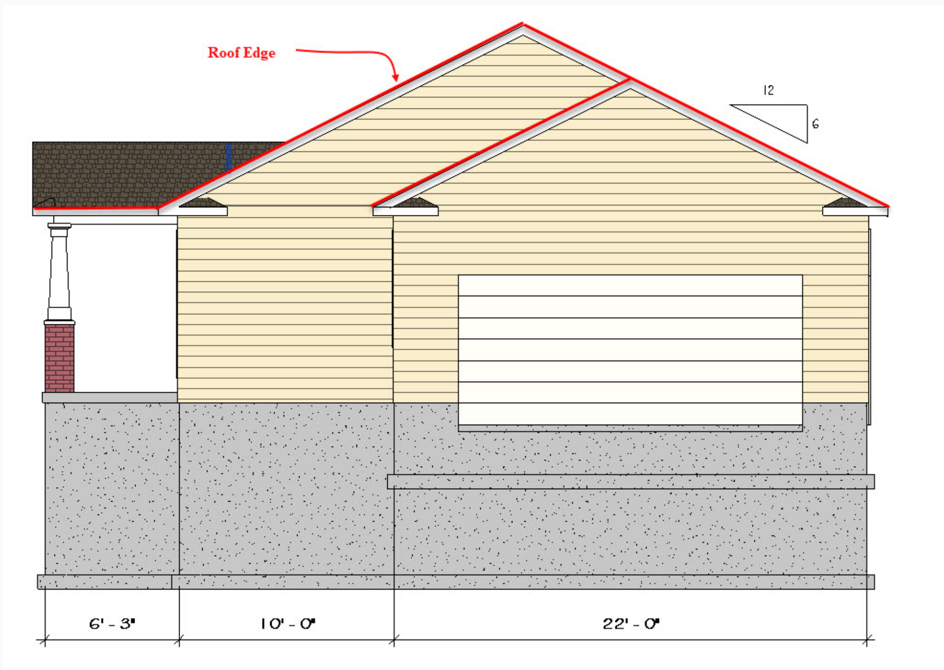


Figure 5-49 East elevation view showing roof edge.

Calculate Horizontal Roof Edges

- The single horizontal roof can be determined from the 6’-3’ dimension.

Calculate the Sloped Roof Edges

First, identify the Roof Slope.

- The roof slope in Figure 5-49 is shown as 6:12.
- The slope length of the roof is a triangle that is half of the roof span.

Next, identify and measure the each Roof Span.

- The smaller garage span is measured at 22'-0".
- The larger house span is determined by calculating the garage and the addition width of the house. This gives the roof ridge of the house a span of 32'-0".

Next, calculate the Run of each roof edge.

- The Run of a roof is the length of a horizontal line that would form a right triangle with a vertical line from the highest point of a roof edge and the roof slope.
- An easy way to calculate the Run of a roof is to divided the Span in half.
- The run of the smaller garage Span in Figure 5-49 can be calculated as follows:

22’- 0” ÷ 2 = 11’-0” Run

- The larger house Span is determined by calculating the garage and the additional width of the house. This gives the roof ridge of the house a span of 32'-0". The run can be calculated as follows:

32’- 0” ÷ 2 = 16’- 0” Run

Next, calculate the Rise of each roof edge.

- The run and the roof slope ratio can be used to calculate the vertical roof rise.
- Multiply the run by the slope ratio, which is given in Figure 5-49.
- The garage roof rise can be calculated by the following:

6/12 Ratio x 11’-0” Run

Or

½ x 11’- 0” = 5’- 6” Rise

- The main house roof rise can be calculated by the following:

6/12 Ratio x 16’- 0” Run

or

½ x 16’- 0” – 8’- 0” Rise

The run and rise of each section can be put into the spreadsheet calculator and used to calculate the slope length. This is shown in Figure 5-50.

Clear	Right Triangle Area and Volume									
	Run		Rise		Depth		Hyp	Perimeter	Total Area	Total Volume
Area	Feet	Inches	Feet	Inches	Feet	Inches				
Area 1	16	0	8	0			17.89	41.89	64.00	0.00
Area 2	16	0	8	0			17.89	41.89	64.00	0.00
Area 3	11	0	5	6			12.30	28.80	30.25	0.00
Area 4							0.00	0.00	0.00	0.00
Area 5							0.00	0.00	0.00	0.00
							Total Feet	112.58 FT	158.25 SF	0.00 CF
							Total Yards	37.53 YDS	17.58 SY	0.00 CY

Figure 5-50 Spreadsheet calculator used to determine roof slope length.

Calculate the total roof edge using the Run and Rise dimensions.

- Entering the Run and Rise dimensions into the spreadsheet calculator should calculate the Hypotenuse of each triangle.
- These Hypotenuse lenths will be the roof edge lengths.

Example

- The total roof edge on the side of the house shown in Figure 5-49 would be equal to the sloped roof edges of the house multiplied by two, and **one** garage sloped roof edge.
- Also add the horizontal run of the side of the front porch.
- The three sloped lengths are added the horizontal length to calculated the total length of the roof edge on this side of the house. The total would be as follows:

17.89′ + 17.89′ + 12.3′ + 6.25′ = 54.33′

- This total would be added to the totals for the other side of the roof to find the total length of roof edge. In the case of the example, this would be 186.00 LF.

Clear		
Lineal Feet		
Feet	Inches	Decimal
54	33	56.75
57	11	57.92
11	11	11.92
59	5	59.42
Total Feet	186.00 LF	
Total Yards	62.00 LY	

Figure 5-51 Lineal feet roof edge totals.

Step 05: Enter the Roof Takeoffs into the Worksheet

The square footage of the flat roof area and the total lineal footage of the roof ridge line and roof edge should be entered in the respective cells of the BasicInfo tab of the Estimating Worksheet.

For example, the inputs for the Roofs basic takeoff for the example structure is shown in Figure 5-52.

64	**Roofs**		
65	SF Flat Roof Area	SF	**1847.5**
66	Lineal Feet Roof Ridge Line	FT	**69.9**
67	Lineal Feet Roof Edge	FT	**186**

Figure 5-52 Roofs basic takeoffs.

Complete the Window and Door Basic Takeoffs

The majority of information to complete both the window and door takeoffs can be obtained from the door and window schedules.

Step 01: Copy the Information from the Door and Window Schedules into the BasicInfo Tab

Copy the information into the appropriate section in the Basic takeoffs.

- Figures 5-53 and 5-55 show the window schedule and the door schedule, respectively, for the structure used as an example throughout this walkthrough.

Type Mark	Count	Rough Opening Width	Rough Opening Height	Type	Manufacturer	Model
A	3	4' - 0"	4' - 0"	Vinyl Sliding w Buck	Amsco	Traditional Series
B	1	3' - 0"	5' - 0"	Double Window Unit	Amsco	Traditional Series
C	1	3' - 0"	1' - 0"	Vinyl Sliding	Amsco	Traditional Series
D	1	3' - 0"	3' - 0"	Vinyl Dbl Hung Window	Amsco	Traditional Series
E	2	2' - 6"	5' - 0"	Double Window Unit	Amsco	Traditional Series
F	2	2' - 6"	5' - 0"	Triple Window Unit	Amsco	Traditional Series

Figure 5-53 Example window schedule

<Door Schedule>

A	B	C	D	E	F	G	H	I	J	K
Function	Level	Door Number	Family and Type	Door Ty	Door Size	Manufacturer	Trim P	Width	Height	Area
Exterior	First Floor	0-0	Overhead-Sectional: 16' x 7'	100	16' x 7'			16' - 0"	7' - 0"	112.0 SF
Exterior	First Floor	1-1	Single-Raised Panel with Sidelights: 36"	A	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	First Floor	1-2	Gladiator Ext 6 Panel: 36" x 80"	B	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	First Floor	1-3	Gladiator Ext Glass: 36" x 80"	C	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	Foundation	1-4	Gladiator Ext 6 Panel: 36" x 80"	B	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Interior	Basement	0-1	Door-Opening: 36" x 80"	G	36" x 80"	None	0	0' - 0"	0' - 0"	0.0 SF
Interior	First Floor	1-5	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-6	Bostonian: 28" x 80"	D	28" x 80"	Jeld-Wen	3	2' - 4"	6' - 8"	15.6 SF
Interior	First Floor	1-7	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-8	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-9	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-10	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-11	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-12	Bostonian: 28" x 80"	D	28" x 80"	Jeld-Wen	3	2' - 4"	6' - 8"	15.6 SF
Interior	First Floor	1-13	Bostonian Cased Opening: 42" x 80"	F	42" x 80"	None	5	3' - 6"	6' - 9 1/4"	23.7 SF

Figure 5-55 Example door schedule

- The information entered into the basic takeoffs is shown in Figures 5-54 and 5-56.

68	Basement Windows						
69	Description	Type Mark	Number of Windows	Width	Height	Perimeter	Area
70	Vinyl Sliding w Buck	A	3	4	4	48	48
71						0	0
72		Total	3			48	48
73	Main Floor Windows						
74	Description	Type Mark	Number of Windows	Width	Height	Perimeter	Area
75	Double Window Unit	B	1	3	5	16	15
76	Vinyl Sliding	C	1	3	1	8	3
77	Vinyl Dbl Hung Window	D	1	3	3	12	9
78	Double Window Unit	E	2	2.5	5	30	25
79	Triple Window Unit	FT	2	2.5	5	30	25
80	Total		7			96	77

Figure 5-54 Window basic takeoffs

Exterior Doors					
Description	Door Number	Width	Height	Perimeter	Area
Overhead-Sectional: 16' x 7'	0-0	16.00	7.00	30	112
Single-Raised Panel with Sidelights: 36"	1-1	3.00	6.67	16.34	20.01
Gladiator Ext 6 Panel: 36" x 80"	1-2	3.00	6.67	16.34	20.01
Gladiator Ext Glass: 36" x 80"	1-3	3.00	6.67	16.34	20.01
Gladiator Ext 6 Panel: 36" x 80"	1-4	3.00	6.67	16.34	20.01
Total				95.36	192.04
Interior Doors					
Description	**Door Number**	**Width**	**Height**	**Perimeter**	**Area**
Door-Opening: 36" x 80"	0-1	3.00	6.67	16.34	20.01
Bostonian Double Bifold: 48" x 80"	1-5	4.00	6.67	17.34	26.68
Bostonian: 28" x 80"	1-6	2.33	6.67	15.67	15.5411
Bostonian: 30" x 80"	1-7	2.50	6.67	15.84	16.675
Bostonian Double Bifold: 48" x 80"	1-8	4.00	6.67	17.34	26.68
Bostonian Double Bifold: 48" x 80"	1-9	4.00	6.67	17.34	26.68
Bostonian: 30" x 80"	1-10	2.50	6.67	15.84	16.675
Bostonian: 30" x 80"	1-11	2.50	6.67	15.84	16.675
Bostonian: 28" x 80"	1-12	2.33	6.67	15.67	15.5411
Bostonian Cased Opening: 42" x 80"	1-13	3.60	6.67	16.94	24.012
				0	0
				0	0
				0	0
Total				164.16	205.1692

Figure 5-56 Door basic takeoff

Check Your Work and Submit the Basic Takeoff

- Save your Estimating Template with the Basic Info worksheets completed for the assigned project plans.
- Name your Estimating Template with your first and last name in the title followed by “Basic Takeoff Assignment”

Example: John Doe Basic Takeoff Assignment

- Submit your completed Estimating Template.

Previous Citation(s)

Rey, S. (n.d.). *Construction Estimating Quick Guides and Walkthroughs*. BYU-I Books. https://books.byui.edu/-JxEq

Ranch House Preconstruction Walkthrough

The Preconstruction phase of a construction project consists of obtaining plans, permits, a jobsite, and utilities for the jobsite.

Table of Contents

Assignment Overview

Preconstruction Estimate Scope of Work

Your complete assignment should meet the following criteria:

Basic Info Tab

- Correct the information from your Basic Takeoff submission using the file found in the Week 04 Module. You need to do this to ensure your numbers for the rest of the estimates for the project are accurate.

PreConst Tab

Architectural and Engineering Section

- Look up the Unit Cost for a survey in the NCE using the following designation: Residential Lot, Tract Work, 4 Corners. (See 2018 NCE p. 313)

Building Permit Header

- Ensure that the Building Permit header correctly references information from your corrected BasicInfo tab. It should pull correct SF and SF Valuation from the BasicInfo tab.
- Check the Building Permit Value Adjustment Percentage for the Idaho Falls area in the 2018 NCE. Enter the adjusted (100 - adjustment percentage) value in the Building Permit Value Adjustment Percentage.

Temporary Utilities Section

- Look up the Unit Cost for temporary power in the NCE. Use the criteria found in that line item of the PreConst tab of the estimating workbook. (See 2018 NCE p. 318)

Job Site Facilities Section

- Look up the Unit Cost for sanitary facilities in the NCE. Use the criteria found in that line item of the PreConst tab of the estimating workbook. (See 2018 NCE p. 318)

Walkthrough Video

Preconstruction Walkthrough Video, 4:32 mins

Ranch House Sitework Walkthrough

The Sitework phase of a construction project consists of the basic excavating, grading, and other prep work necessary prior to beginning the actual building of the structure.

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Assignment Overview

Sitework Estimate Scope of Work

Your complete assignment should meet the following criteria:

SiteWork Tab

Site Layout Labor Section

- Look up the Labor for foundation layout in the NCE. Use the criteria found in that line item of the Sitework tab of the estimating workbook. See the following sources for references on how to complete this task:
  - How to Complete Labor Estimates Using the NCE
  - 2018 NCE p. 189

Walkthrough Video

Sitework Estimating Walkthrough, 1:42 mins

This content is provided to you freely by BYU-I Books.

Access it online or download it at https://books.byui.edu/construction_estimat/ranch_house_sitework.

Leave Feedback

Ranch House Concrete Walkthrough

The Concrete phase of a construction project consists of all jobs that require concrete withing the structure.

Table of Contents

Assignment Overview

Concrete Estimate Scope of Work

Your complete assignment should meet the following criteria:

Concrete Tab

Footing Material Header

- Ensure that the information for Footing Length has been correctly transferred from the BasicInfo tab.

Footing Material Section

- Estimate the Size, Units, and Unit Cost for the Footing Concrete. See How to Complete Materials Estimates for reference in completing this task.

Footing Labor Section

- Estimate the Labor for Board Forming and Stripping. See the following sources for references on how to complete this task:
    - How to Complete Labor Estimates Using the NCE
    - 2018 NCE p. 88

Foundation Material Header

- Ensure that the information for Foundation Length has been correctly transferred from the BasicInfo tab.

Foundation Labor Section

- Estimate the Labor for Plywood Forming. See the following sources for references on how to complete this task:
    - How to Complete Labor Estimates Using the NCE
    - 2018 NCE p. 89

Concrete Floor Material Header

- Ensure that the information for Floor Area has been correctly transferred from the BasicInfo tab.

Concrete Floor Material Section

- Estimate the Size, Units, and Unit Cost for the Basement Floor Concrete. See How to Complete Materials Estimates for reference in completing this task.

Concrete Floor Labor Section

- Estimate the Labor for Slabs, Walks & Driveways. See the following sources for references on how to complete this task:
    - How to Complete Labor Estimates Using the NCE
    - 2018 NCE p. 94

Concrete Steps Section

- Estimate the Quantity for the Concrete Steps Concrete and Reinforcing. See How to Complete Materials Estimates for reference in completing this task.

Video Walkthroughs

Concrete Footing Material Estimate Walkthrough, 6:42 mins

Concrete Estimating Walkthrough 01, 7:18 mins

Concrete Estimating Walkthrough 02, 6:18 mins

Ranch House Framing Walkthrough

What Does the Framing Estimate Include?

Framing is a very material-intesive phase of the construction process. It provides the scaffolding for virtually every part of the structure.

Table of Contents

Basement and Pony Wall Floor Framing Labor Section

Step 01: Estimate the Labor for Installing Top and Bottom Plates

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

Step 02: Estimate the Labor for Installing the Wall Studs

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.Step 05: Determine Temporary Bracing Quanities

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Floor Framing Material Section

The next step is to estimate several items in the Floor Framing Material section of the Estimating Workbook. Watch the walkthrough video, then follow the proceeding steps.

Framing Walkthrough: Floor Framing Material and Supplier, 6:46 mins

Step 01: Look at the Framing Plans to Identify Cost Items

Open the Floor Framing Plans in Bluebeam and identify the following items:

- Floor Girders - refers to the material aligned perpindicular to the floor joists in the framing plan
- Mud Sill - runs the perimter of the floor framing plan
- Floor Joists - multiple lengths across the entire floor framing plan
- Joist Headers - refers to the material lining the stair opening in the framing plan

Step 02: Estimate the Quantity of Floor Girder Material

The Floor Girder refers to the material aligned perpindicular to the floor joists in the framing plan. There are multiple lengths, and the material is likely to be 2-1-3/4" x 9-1/2" Micro-Lam Beam.

1. Use Bluebeam to complete a takeoff measurement of the floor girders.
2. Add all the measurements together to estimate the total LF of the floor girders.
3. Enter this measurement in the Floor Framing Material Header for Floor Girders.

Step 03: Estimate the Quantities for Mud Sill, Sealer, and Rim Joists

The measurement for Mud Sill, Sill Sealer, and Rim Joists will all be the same.

1. Use Bluebeam to complete a takeoff measurement of the perimeter of the Mud Sill.
2. Enter this measurement in the Floor Framing Material Header for Sill Sealer, Mud Sill, and Rim Joist.

Step 04: Estimate the Quantity for Floor Joists

There are multiple lengths of floor joists in the plans.

1. Use Bluebeam to complete a takeoff measurement of all floor joists.
2. Add all the measurements together to estimate the total LF of the floor joists.
3. Enter this measurement in the Floor Framing Material Header for LF Floor Joists.

Step 05: Estimate the Quantity of the Joist Headers

The Joist Headers refer to the material surrounding the stair opening in the framing plan. There are three sides, and the material is likely to be 1-1/4" x 9-1/2" Timber.

1. Use Bluebeam to complete a takeoff measurement of the joist headers.
2. Add all the measurements together to estimate the total LF of the joist headers.
3. Enter this measurement in the Floor Framing Material Header for Joist Headers.

Step 06: Estimate the Floor Girder Material Cost

This task requires you to write functions that will correctly pull size, unit, and cost data from a material database.

1. Enter a function into the Size cell for the Floor Girder in the Floor Framing Material section that will pull the appropriate size data from the framing databse, given a material being entered in appropriate cell of the row. This should be done using both IF and VLOOKUP functions, and should return an exact match.
2. Enter a similar function into the Units cell for the Floor Girder, except to pull the unit data, given a material. This should be accomplished by changing the column the VLOOKUP function references.
3. Enter a function into the Unit Cost cell for the Floor Girder in the Floor Framing Material section that will pull the appropriate cost data from the framing database, given a material and a correctly matching supplier being entered in appropriate cells of the row. This should be done using IF, OR, VLOOKUP, and MATCH functions, and should return an exact match.

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Exterior Wall Framing Material Section

The next section to complete is Exterior Wall Framing Material.

Framing Walkthrough: Exterior Walls Section, 5:22 mins

Step 01: Estimate the Quantity of Top Plates

This step will require you to use the Function Builder tool to enter a custom User Defined Function that has been preloaded into the Estimating Workbook.

1. Use the Function Builder Tool to enter the WallPlates function.
2. Identify the correct cells the function should reference for Material, WallLength, NumberPlates, WasteFactor, and Size.

Step 02: Estimate the Quantity of Bottom Plates

This step will require you to use the Function Builder tool to enter a custom User Defined Function that has been preloaded into the Estimating Workbook.

1. Use the Function Builder Tool to enter the WallPlates function.
2. Identify the correct cells the function should reference for Material, WallLength, NumberPlates, WasteFactor, and Size.

Step 03: Estimate the Quantity of Wall Studs

This step will require you to use the Function Builder tool to enter a custom User Defined Function that has been preloaded into the Estimating Workbook.

1. Use the Function Builder Tool to enter the StudCount function.
2. Identify the correct cells the function should reference for Material, WallLength, StudSpacing, Corners, Door_Window, Big_Window, and WasteFactor.

Step 04: Estimate the Quantity of Wall Sheathing

This step will require you to use the Function Builder tool to enter a custom User Defined Function that has been preloaded into the Estimating Workbook.

1. Use the Function Builder Tool to enter the Wall_Sheathing function.
2. Identify the correct cells the function should reference for Material, WallLength, Wall_Sheathing_Height, Number_Sides,WasteFactor, and Sides.

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Exterior Wall Framing Labor

The next section to complete is Exterior Wall Framing Labor.

Step 01: Estimate the CraftHrs and Labor for Exterior Walls Labor

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost and CraftHrs for the specific labor item.

This process must be done for all line items in the Exterior Walls Labor subsection of the Exterior Wall Framing Labor section.

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Interior Wall Framing Material Section

The next section to complete is Interior Wall Framing Material.

Step 01: Estimate the Quantity of 2x4 Wall Studs

This step will require you to use the Function Builder tool to enter a custom User Defined Function that has been preloaded into the Estimating Workbook.

1. Use the Function Builder Tool to enter the StudCount function.
2. Identify the correct cells the function should reference for Material, WallLength, StudSpacing, Corners, Door_Window, Big_Window, and WasteFactor.

Step 02: Estimate the Quantity of 2x6 Wall Studs

This step will require you to use the Function Builder tool to enter a custom User Defined Function that has been preloaded into the Estimating Workbook.

1. Use the Function Builder Tool to enter the StudCount function.
2. Identify the correct cells the function should reference for Material, WallLength, StudSpacing, Corners, Door_Window, Big_Window, and WasteFactor.

Step 03: Estimate the Quantity of 2x4 12' Wall Studs

This step will require you to use the Function Builder tool to enter a custom User Defined Function that has been preloaded into the Estimating Workbook.

1. Use the Function Builder Tool to enter the StudCount function.
2. Identify the correct cells the function should reference for Material, WallLength, StudSpacing, Corners, Door_Window, Big_Window, and WasteFactor

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Interior Wall Framing Labor Section

The next section to complete is Interior Wall Framing Labor.

Step 01: Estimate the CraftHrs and Labor for Interior Wall Framing Labor

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost and CraftHrs for the specific labor item.

This process must be done for all line items in the Exterior Walls Labor subsection of the Exterior Wall Framing Labor section.

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Door & Window Headers Section

The next section to complete is Door & Window Headers.

[Framing Walkthrough: Doors, Windows, Shear Walls, and Stairs]

Step 01: View the Door and Window Sections of the BasicInfo Tab

These sections in the BasicInfo tab have information that must be input in the Framing tab. Find and view these sections in the BasicInfo tab as you complete the following steps.

Step 02: Enter the Number of Interior Doors

Interior doors use a 2x4 Flat construction for the headers. Reference the information in the BasicInfo tab to input the number of doors for each of the following sizes:

- Doors 3 ft or Less
- Doors Over 3 ft to 4 ft
- Doors Over 4 ft to 5 ft
- Doors Over 5 ft to 6 ft

Step 03: Enter the Number of Exterior Doors

Exterior doors use a 2 - 2x10 construction for the headers. Reference the information in the BasicInfo tab to input the number of doors for each of the following sizes:

- Doors 3 ft or Less
- Doors over 4 ft to 5 ft

Step 04: Enter the Number of Windows

Windows are exterior features, and use a 2 - 2x10 construction for the headers. Reference the information in the BasicInfo tab to input the number of windows for each of the following sizes:

- Windows over 2 ft to 3 ft
- Windows over 5 ft to 6 ft

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Specialty Framing Materials Section

The next section to complete is Specialty Framing Materials.

Step 01: Find and Input the Quantity of Shear Walls

Reference the Building Plans to find the quantity of shear walls. They may be referred to as Simpson Strong Walls. Because these are a specialty item that is purchased and installed as a complete unit, you only need to enter the quantity.

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Specialty Framing Labor Section

fsdadsf

Step 01: Input the Quantity of Shear Walls to Install

Because these are a specialty item that is purchased as a complete unit, the labor cost to install it is also preset. You only need to enter the quantity of shear walls being installed to estimate the labor.

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Stair Framing Materials Section

The next section to complete is Stair Framing Materials.

Step 01: Input the Total Rise of the Stairs from the Plans

Total Rise refers to the total height of the stairway, not the height of the individual steps. It extends from the concrete floor to the top of the stair landing.

1. Use Bluebeam to complete a takeoff measurement of the rise of the stairs.
2. Enter this measurement in the Stair Framing Materials Header for Total Rise in inches.

Step 02: Estimate the Stair Stringers Material Cost

This task requires you to write functions that will correctly pull size, unit, and cost data from a material database.

1. Enter a function into the Size cell for the Stair Stringers in the Stair Framing Materials section that will pull the appropriate size data from the framing database, given a material being entered in appropriate cell of the row. This should be done using both IF and VLOOKUP functions, and should return an exact match.
2. Enter a similar function into the Units cell for the Stair Stringers, except to pull the unit data, given a material. This should be accomplished by changing the column the VLOOKUP function references.
3. Enter a function into the Unit Cost cell for the Stair Stringers in the Stair Framing Materials section that will pull the appropriate cost data from the framing databse, given a material and a correctly matching supplier being entered in appropriate cells of the row. This should be done using IF, OR, VLOOKUP, and MATCH functions, and should return an exact match.

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Stair Framing Labor Section

The next section to complete is Stair Framing Labor.

Step 01: Estimate the Labor and Quantity for the Stairway Risers

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Risers are counted by units of 1, including the landing riser
3. Use the NCE to look up the labor cost for the specific labor item.

Step 02: Estimate the Labor and Quantity for the Stair Landing

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Landings are measured in SF, so the labor for installing them is counted in 1 SF increments. You will need to calculate the SF of the entire landing to accurately estimate the total labor cost.
3. Use the NCE to look up the labor cost for the specific labor item.

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Truss Roof Framing Material Section

The next section to complete is Truss Roof Framing Material.

Video Walkthrough: Roof Framing

Step 01: Identify the Standard Trusses and Scissor Trusses in the Plans

The roof framing will be comprised of Standard Trusses and Scissor Trusses. Look at the plans to identify the trusses.

Standard Trusses will have a "T" prefix. Examples include:

- T1
- T1GE
- T1STRG
- T2
- T3
- T3GE

Scissor Trusses will have an "S" prefix. Examples include:

- S1
- S1A
- S1B

Step 02: Estimate the SF of the Standard Truss Area

Trusses are measured in SF of the entire flat area they support. This does not refer to the area of the various planes of the finished roof, but the flat area to which the trusses are mounted.

1. Use Bluebeam to complete a takeoff measurement of all standard truss areas NOT in the garage area in the Roof Framing Plans.
2. Input the total area from the takeoff in the Standard Truss Area cell of the SF Flat Roof Area Including Overhangs row in the Truss Roof Framing Material header.

Step 03: Estimate the SF of the Scissor Truss Area

Trusses are measured in SF of the entire flat area they support. This does not refer to the area of the various planes of the finished roof, but the flat area to which the trusses are mounted.

1. Use Bluebeam to complete a takeoff measurement of all scissor truss areas in the Roof Framing Plans.
2. Input the total area from the takeoff in the Scissor Truss Area cell of the SF Flat Roof Area Including Overhangs row in the Truss Roof Framing Material header.

Step 04: Estimate the SF of the Garage Truss Area

Trusses are measured in SF of the entire flat area they support. This does not refer to the area of the various planes of the finished roof, but the flat area to which the trusses are mounted.

1. Use Bluebeam to complete a takeoff measurement of all standard truss areas found in the garage area in the Roof Framing Plans.
2. Input the total area from the takeoff in the Garage Truss Area cell of the SF Flat Roof Area Including Overhangs row in the Truss Roof Framing Material header.

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Truss Roof Framing Labor Section

The next section to complete is Truss Roof Framing Labor.

Step 01: Estimate the Labor Cost of Installing the Trusses and Roof Sheathing.

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. These items are measured in SF, so the labor for installing them is counted in 1 SF increments.
3. Use the NCE to look up the labor cost for the specific labor item.

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Stick Roof Framing Materials

The next section to complete is Stick Roof Framing Materials.

Step 01: Identify the Ridge Board in the Roof Framing Plans

The ridge boards are labeled in the Roof Framing Plans. Using a search feature in whichever program you are using to view plans will be helpful in identifying them.

Step 02: Estimate the Quantity of Ridge Board Material Required

Ridge boards are measured in LF.

1. Use Bluebeam to complete a takeoff measurement of all ridge board lengths found in the Roof Framing Plans.
2. Use the Function Builder Tool to enter the LFQuantity function in the Quantity cell of the Ridge Board row of the Stick Roof Framing Materials Section.
3. Identify the correct cells the function should reference for Material, Length, WasteFactor, and Size.

- There will not be a cell to reference for Length in the header. Instead, enter the lengths manually in the Length field of the Formula Builder (eg. 31+16.5+12.25).

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Stick Roof Soffit, Fascia, & Gable Wall Framing Materials Section

The next section to complete is Stick Roof Soffit, Fascia, & Gable Wall Framing Materials.

Step 01: Identify All of the Gables in the Building Plans

Gables are the end parts of a wall that encloses the area under a pitched roof. Look at the plans and identifall all gable areas. They may not all be triangles.

Step 02: Measure the Roof Edges of the Gables

Roof Edge is measured in LF.

1. Use Bluebeam to complete a takeoff measurement of all edges of the gables that border the roof.
2. Enter the sum of all the gable edges bordering the roof in the LF Roof Edge cell of the Stick Roof, Soffit, Fascia, & Gable Wall Framing Materials header.

Step 03: Identify the Soffit Width in the Plans

A soffit is the underside of a roof that extends from the sides of a structure to the edge of the roof. Identify the soffits in the building plans.

Step 04: Measure the Width of the Soffit in Inches

Soffit widths are measured in inches.

1. Use Bluebeam to do a takeoff to measure the width of the soffits from the structure.
2. Enter the width of the soffit in the Soffit Width (In) cell of the Stick Roof Soffit, Fascia, & Gable Wall Framing Materials header.

Step 05: Measure the Area of the Gable Walls

Gable walls are measured in SF.

1. Use Bluebeam to do a takeoff to measure the area of the gable walls in the plans. Do not forget any unconventionally shaped gable walls, like those found between the roof of a main structure and the roof of a garage.
2. Enter the SF of all gable walls in the SF Gable Walls cell of the Stick Roof Soffit, Fascia, & Gable Wall Framing Materials header.

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Previous Citation(s)

Rey, S. (n.d.). *Construction Estimating Quick Guides and Walkthroughs*. BYU-I Books. https://books.byui.edu/-JxEq

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Ranch House Exterior Finishes Walkthrough

Exterior finishes include every material that covers every exterior portion of the structure. This includes roofing, walls, doors, and windows.

Table of Contents

Roofing Materials Header

The first step is to complete the Roofing Materials Header.

Exterior Finishes: Roofing Materials Header, 4:35 mins

Step 01: Identify and Measure the Starter Course of the Roof

Starter Course refers to the area of every roof plane where a starter strip is laid down to begin finishing that section of roof.

1. Open the plans in Bluebeam. Both the Roof Plans and the Elevation Views will be useful for calculating the Starter Course in LF.
2. Use the measuring tool to do takeoffs of every roof edge that will have a starter strip on it.
    - One easy way to identify roof edges that will require starter strip is to look for horizontal edges that do not border a gable.
    - Roof Overbuilds are typically perpendicular to the main roof and come to a point as they run up the main roof, forming a triangle. There will typically still be a horizontal edge in these features. That plan of the roof simply gets wider as it comes to ridge of the overbuild.
3. Add the LF of the edges together and enter that number in the LF Starter Course cell of the Roof Materials Section Header.
    - This number will also be the exact quantity of Starter Course material needed for the project, not accounting for waste.

Step 02: Identify the Roof Slope in Inches per Foot

Slope is the ratio of Rise/Run. In construction, it is measured in inches per foot, and typically is represented by a single number (eg. a Roof Slope of 8 indicates that for every 1' of horizontal run, the roof rises 8").

1. Open the plans in Bluebeam. The Elevation Views should have an inverted right triangle present at the roof slopes. This triangle will give values for rise and run.
2. Enter the value given for rise in the Roof Slope cell of the Roofing Materials Section Header.

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Roofing Materials Section

The next step is to complete the Roofing Materials Section.

Exterior Finishes: Roofing Materials Section, 16:59 mins

Step 01: Write a Function to Pull the Size of Each of the Roofing Materials

This task requires you to write functions that will correctly pull size, unit, and cost data from a material database.

1. Enter a function into the Size cell for the Roofing Felt row in the Roofing Materials section. This function should pull the appropriate size data from the roofing databse, given a material being entered in appropriate cell of the row. This should be done using both IF and VLOOKUP functions, and should return an exact match.
2. Repeat the above step for the Size cell of all other items in the Roofing Materials section.

Note: If your function returns an n/a value, you are likely not referencing the correct database in the function.

Step 02: Write a Function to Pull the Units of Each of the Roofing Materials

1. Enter a similar function into the Units cell for the Roofing Felt, except to pull the unit data, given a material. This should be accomplished by changing the column the VLOOKUP function references.
2. Repeat the above step for the Units cell of all other items in the Roofing Materials section.

Note: If your function returns an n/a value, you are likely not referencing the correct database in the function.

Step 03: Write a Function to Pull the Unit Cost for Each of the Roofing Materials

1. Enter a function into the Unit Cost cell for the Roofing Felt row in the Roofing Materials section. This function should pull the appropriate cost data from the framing database, given a material and a correctly matching supplier being entered in appropriate cells of the row. This should be done using IF, OR, VLOOKUP, and MATCH functions, and should return an exact match.
2. Repeat the above step for the Unit Cost cell of all other items in the Roofing Materials section.

Note: If your function returns an n/a value, you are likely not referencing the correct database in the function.

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Roofing Labor Section

The next step is to complete the Roofing Labor section.

[Exterior Finishes: Roofing Labor Section](), 3:47 mins

Step 01: Estimate the Labor Cost for Roofing Labor

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.
3. Repeat this process for all labor items in the Roofing Labor section not already completed.

Note: Look at the materials header to see what weight of felt is being used. You can also reference the roofing plans.

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Window Materials Section

The next step is to complete the Window Materials section.

[Exterior Finishes: Window Materials Section], 3:00 mins

Step 01: Find the Windows in the BasicInfo Tab

The BasicInfo tab has already been populated with the Window Schedule. Locate the section of that tab that includes the window information.

Step 02: Enter the Quantity for Each Window Type in the ExtFin Tab

1. Take the information from the BasicInfo tab for each window type and input it in the appropriate Quantity cells in the Window Materials section of the ExtFin tab. There are two ways to do this.
    - You can simply identify each window type and quantity, and input the number in the Quantity cells.
    - You can also create an equation so that the Quantity cells pull information from the BasicInfo tab for each window type.

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Exterior Door Materials Section

The next step is to complete the Exterior Door Materials section.

[Exterior Finishes: Exterior Door Materials](), 0:59 mins

Step 01: Find the Doors in the BasicInfo Tab

The BasicInfo tab has already been populated with the Door Schedule. Locate the section of that tab that includes the exterior door information.

Step 02: Enter the Quantity for Each Exterior Door Type in the ExtFin Tab

1. Take the information from the BasicInfo tab for each exterior door type and input it in the appropriate Quantity cells in the Exterior Door Materials section of the ExtFin tab. There are two ways to do this.
    - You can simply identify each exterior door type and quantity, and input the number in the Quantity cells.
    - You can also create an equation so that the Quantity cells pull information from the BasicInfo tab for each exterior door type.

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Wall Siding Area Table

The next step is to complete the Wall Siding Area table.

Exterior Finishes: Wall Siding Area, 3:15 mins

Step 01: Identify the Exterior Finishes on the Walls of the Structure

1. View the plans in Bluebeam to identify which of the exterior walls are finished with vinyl siding. You should be able to identify the following:
    - Front Gable
    - Left Elevation Wall
    - Left Gable
    - Back Wall
    - Right Elevation Wall
    - Right Gable

Note: Be sure to identify any small exterior wall sections between roof elevations that are covered in vinyl siding.

Step 02: Measure the Area of any Vinyl Siding Walls in the Plans

1. Use Bluebeam to do a basic takeoff measurement of the SF of all walls that are covered in vinyl siding.

Step 03: Input the SF Values into the Wall Siding Area Table

1. Navigate to the Vinyl Siding Materials section of the ExtFin tab.
2. Scroll to the right of that section to find the Wall Siding Area table.
3. Input the SF values of each of the following walls in the table:
    - Front Gable
    - Left Elevation Wall
    - Left Gable
    - Back Wall
    - Right Elevation Wall
    - Right Gable

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Vinyl Siding Labor Section

The next step is to complete the Vinyl Siding Labor section.

Step 01: Estimate the Labor Cost for Missing Items in the Vinyl Siding Labor Section

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.
3. Repeat this process for all labor items in the Vinyl Siding Labor section not already completed.

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Previous Citation(s)

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Ranch House Interior Finishes Walkthrough

Interior Finishes includes all the finishing touches that make the construction project appear complete inside.

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Insulation Labor Section

The first step is to complete the Insulation Labor section.

[Interior Finishes: Insulation Labor](), 8:08 mins

Step 01: Identify the Specs of Type 1 and Type 2 Wall Insulation

Wall insulation includes many different attributes that must be identified in order to accurately estimate the labor to install it. These attributes include the following:

- Depth x Width x Height - Insulation comes in multiple sizes.
- R Value - Insulation has a rating system by which its ability to insulate against the elements is graded. This value will use the prefix, "R", followed by a number (eg. R19)..
- Facing - Insulation has multiple types of facings that cover the insulation material. Some insulation does not have a facing.

You can find the required specs of the insulation materials in the Insulation Material section of the IntFin tab.

Step 02: Estimate the Labor Cost of Installing Type 1 Wall Insulation

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

Note: Sometimes the NCE does not provided a labor cost for the exact material that you will be using in a construction project. In this case, you may choose to make a judgement call based on the known attributes of the material you will be using. In the case of insulation, you may choose to estimate using a material with the same thickness, but a different facing or R value than what is described in the Insulation Materials section.

Step 03: Estimate the Labor Cost of Installing Type 2 Wall Insulation

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

Note: Sometimes the NCE does not provided a labor cost for the exact material that you will be using in a construction project. In this case, you may choose to make a judgement call based on the known attributes of the material you will be using. In the case of insulation, you may choose to estimate using a material with the same thickness, but a different facing or R value than what is described in the Insulation Materials section.

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Drywall Materials Header

The next step is to complete the Drywall Materials header.

[Interior Finishes: Drywall Materials Section], 10:29 mins

Step 01:Identify the Walls that Requires Water Resistant Drywall

Building plans do not always show which sections of walls will require water resistant drywall, or green board. If this is the case, look at the floor plans in Bluebeam and identify any wall sections that will come in contact with water.

Bathrooms that include a shower or tub commonly use water resistant drywall.

Step 02: Measure the Length of Walls that will be Built with Water Resistant Drywall

1. Use Bluebeam to measure any wall lengths in the floor plans that will be built with water resistant drywall.

Step 03: Estimate the Quantity of Water Resistant Drywall Required in SF

1. Use Bluebeam to measure the height of any walls that will be built with water resistant drywall.
2. Multiply the length of the water resistant drywall walls by the wall height to get the SF of water resistant drywall required for the project.
3. Input the SF quantity of water resistant drywall into the SF Water Resistant Drywall cell of the Drywall Materials Header in the IntFin tab of the Estimating Workbook.

Note: The Estimating Workbook is configured to calculate the total SF of standard drywall required based on the basic takeoff done previously. When you input a value for the water resistant drywall it is also subtracted from the standard drywall quantity.

Step 04: Count the Number of Outside Corners that Require Corner Bead

Outside corners of interior walls require the installation of corner beads to strengthen those corners. Door frames with doors installed do not require corner beads, as they are reinforced with the door frame itself.

1. Identify and count all outside corners that will require a corner bead.

Step 05: Estimate the LF of Corner Bead Required for the Project

1. Use Bluebeam to measure the height of all wall sections that will require corner beads.
2. Calculate the LF of corner bead required by multiplying the various wall heights by the number of corner beads those heights require.
3. Input the total LF of required corner bead in the LF Outside Corners cell of the Drywall Materials Header.

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Drywall Materials Section

The next step is to complete the Drywall Materials section.

Interior Finishes: Drywall Materials, 7:22 mins

Step 01: Calculate the Size, Units, and Unit Cost of Ceiling GWB

This task requires you to write functions that will correctly pull size, unit, and cost data from a material database.

1. Enter a function into the Size cell for the Ceiling GWB row in the Floor Framing Material section that will pull the appropriate size data from the drywall databse, given a material being entered in appropriate cell of the row. This should be done using both IF and VLOOKUP functions, and should return an exact match.
2. Enter a similar function into the Units cell for the Celing GWB row, except to pull the unit data, given a material. This should be accomplished by changing the column the VLOOKUP function references.
3. Enter a function into the Unit Cost cell for the Celing GWB row in the Floor Framing Material section that will pull the appropriate cost data from the drywall database, given a material and a correctly matching supplier being entered in appropriate cells of the row. This should be done using IF, OR, VLOOKUP, and MATCH functions, and should return an exact match.

Step 02: Calculate the Size, Units, and Unit Cost of Standard GWB

This task requires you to write functions that will correctly pull size, unit, and cost data from a material database.

1. Enter a function into the Size cell for the Standard GWB row in the Floor Framing Material section that will pull the appropriate size data from the drywall databse, given a material being entered in appropriate cell of the row. This should be done using both IF and VLOOKUP functions, and should return an exact match.
2. Enter a similar function into the Units cell for the Standard GWB row, except to pull the unit data, given a material. This should be accomplished by changing the column the VLOOKUP function references.
3. Enter a function into the Unit Cost cell for the Standard GWB row in the Floor Framing Material section that will pull the appropriate cost data from the framing database, given a material and a correctly matching supplier being entered in appropriate cells of the row. This should be done using IF, OR, VLOOKUP, and MATCH functions, and should return an exact match.

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Drywall Labor Section

The next step is to complete the Drywall Labor section.

Step 01: Calculate the Labor Cost of the Drywall Labor Section

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

This process must be done for all incomplete line items in the Drywall Labor section.

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Window Trim Labor Section

The next step is to complete the Window Trim Labor section.

Step 01: Calculate the Labor Cost of Items in the Window Trim Labor Section

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

This process must be done for all incomplete line items in the Window Trim Labor section.

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Interior Door Labor Section

The next step is to complete the Interior Door Labor section.

Interior Finishes: Interior Door Labor, 0:31 mins

Step 01: Calculate Labor Costs for Items in the Interior Door Labor Section

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

This process must be done for all incomplete line items in the Interior Door Labor section.

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Interior Trim Material Header

The next step is to complete the Interior Trim Material header.

Interior Finishes: Interior Trim Material Header, 8:28 mins

Step 01: Identify any Walls in the Plans that Do Not Include Baseboard Trim

Some walls will not require finishes like baseboards. Examples include wall sections with built-in cabinets, vanities, or appliances, stairways, and bathroom fixtures like tubs.

1. View the overhead floor plans and elevation floor plans in Bluebeam to identify any wall sections that will not include baseboard trim.

Note: Toilets are not typically built into the wall, so baseboard trim is likely to be installed behind it.

Step 02: Measure the Lengths of all Walls without Baseboard Trim

1. Use Bluebeam to complete a takeoff measurement of all wall sections without baseboard trim.
2. Add all the measurements together to estimate the total LF of wall sections without baseboard trim.
3. Enter this measurement in the Interior Trim Material Header for LF Interior Walls W/O Baseboard.

Note: Your input for this cell will reduce the value of LF Baseboard also found in the header. This is due to a simple function that subtracts the LF of walls withouth baseboard and door openings from the total LF of interior walls.

Step 03: Identify all Door Openings in the Plans that Include a Door

Door openings typically include a door frame and door casing that does not require the use of baseboard molding. Because of this, the LF of all door openings must be subtracted from the total LF of interior walls to accurately estimate the quantity of baseboard molding required.

1. View the overhead floor plans and elevation floor plans in Bluebeam to identify any door openings that include an actual door.

Note: Some building plans include archways without doors. These are typically trimmed with baseboard, so do not include any of these openings in your door opening count.

Step 04: Measure and Total the LF of all Door Openings with Doors

1. Use Bluebeam to complete a takeoff measurement of the width of all door openings that include a door.
2. Add all the measurements together to estimate the total LF of door openings.
3. Enter this measurement in the Interior Trim Material Header for LF Door Openings.

Note: Your input for this cell will reduce the value of LF Baseboard also found in the header. This is due to a simple function that subtracts the LF of walls withouth baseboard and door openings from the total LF of interior walls.

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Closet Shelving Labor Section

The next step is to complete the Closet Shelving Labor section.

Step 01: Calculate the Labor Cost of the Items in the Closet Shelving Labor Section

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

This process must be done for all incomplete line items in the Closet Shelving Labor section.

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Stair Finish Materials Section

The next step is to complete the Stair Finish Materials section.

Interior Finishes: Stair Finish Materials, 3:49 mins

Step 01: Measure the Length of the Staircase

Stairways can be measured in multiple ways. The rise, run, number of risers, and depth of treads all contribute to the value required to measure the length of the staircase.

1. Open the plans in Bluebeam and measure the length of the skirt board found in the Stair Section Detail. Be sure to measure between the furthest horizontal edges of the skirt board.
    - You can also use the Pythagorean Theorum to calculate the hypotenuse of a right triangle formed by the total rise and total run of the stairs.

Step 02: Determine How Many Skirt Boards are Required for the Stairs

Skirt boards are installed on both sides of a staircase. The size of the skirt board material available from the supplier will affect the quantity required. If the length of the stairs is less than the size of the skirt board material, then two skirt boards are required; one for each side of the staircase.

1. Enter the quantity of skirt boards required in the appropriate cell of the Skirt Board row.

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Stair Finish Labor Section

The next step is to complete the Stair Finish Labor section.

Step 01: Calculate the Labor Cost of Items in the Stair Finish Labor Section

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

This process must be done for all incomplete line items in the Stair Finish Labor section.

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Finish Accessories Labor Section

The next step is to complete the Finish Accessories Labor section.

Step 01: Calculate the Labor Cost of Items in the Finish Accessories Labor Section

This is the same process used for estimating labor for any other construction task using the NCE.

1. Ensure that the Quantity for both the specific materials and labor item in the Estimating Workbook is accurate.
2. Use the NCE to look up the labor cost for the specific labor item.

This process must be done for all incomplete line items in the Finish Accessories Labor section.

Previous Citation(s)

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JxEq

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Ranch House Tools & Equipment Walkthrough

What does the Tools & Equipment Estimate Include?

Tools and equipment are vital assets required for a construction company to complete their work. The cost to acquire, operate, and maintain tools and equipment must be accounted for when completing an estimate for a project bid.

What to Enter in the Tools & Equip Tab

The company accountant has given you the following numbers to enter in the Tools & Equip tab of the Estimating Workbook based on a forecast completed earlier.

In the Total Tools column (B), add the following values for each month:

Month	Amount
January	250
February	$350
March	$450
April	$850
May	$700
June	$350
July	$350
August	$350
September	$450
October	$280
November	$350
December	$350

Table of Monthly Tool Figures to Enter

Ranch House Subcontractor Walkthrough

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Ranch House Subs Tab Scope of Work

This assignment will require you to use Bid Levelling to find the best combination of subcontractor bids for these subcontracts:

- Plumbing
- Electrical
- HVAC

The steps for completing the above work are as follows:

1. Defining the line items for each subcontract.
2. Using the NCE to estimate the material and labor costs for the subcontractor items. This will give you a good idea of whether the submitted bids are fair or not.
3. Identifying any allowances for subcontractor line items.
4. Interpretting and levelling the bids.
5. Completing the line items in the Ranch House Estimating Workbook.

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Define the Line Items and Materials for Each Subcontract

1. Look at the Subs tab of the Ranch House Estimating Workbook. The cells highlighted in yellow will help you determing the material and labor line items to be handled by subcontractors.
2. Check the line items against the Specification Sheets in the Ranch House Plans. Note any discrepencies and move onto the next step.

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Estimate the Labor and Material Cost of Subcontractor Items

You do not want to be taken advantage of by unknowingly accepting a bid that is grossly overpriced. If you do not have enough experience in the construction industry or in your area to have rough idea of what subcontracting jobs should cost, you should strongly consider using a cost data manual to estimate them. The basic process for doing so is as follows:

1. Identify the subsection of the NCE that corresponds to the subcontractor work being estimated
2. Find the closest approximation to the material/line item you are estimating.
    - Example: The exact cabinet size for which you are estimating install labor is not in the NCE list, but one that is very close to external dimensions and features is listed. Use that item to estimate labor. It is an estimate, afterall.
3. Identify the Craft Hrs, Size, Units, Unit Cost, and Quantity, and input those values in the Estimating Workbook.
    - Some of these values might not be present in the NCE. In that case, review your other documents to see if you can find the information. Building plans are helpful for identifying specs and quantities of many subcontractor items like cabinets and appliances.

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Identify Allowances for Subcontractor Jobs and Line Items

Refer to the Specification Sheets in the Building Plans to find any allowances specified for various cost items that fall under subcontractor jobs.

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Interpret the Bids

1. Look at all the bids for a specific Subcontractor job.
    - This is not always as clear as it would appear. Sometimes a subcontractor can do multiple line items outside the scope of one specific subcontractor job. For example, a mechanical company could do items from both the electrical subcontractor job and the HVAC subcontractor job.

Comparing Subcontractor Bids Walkthrough Video, 5:27 mins

2. Identify any scope gaps found in the bids. Are there items outlined in the Specification Sheets and the Estimating Workbook that are not included in a bid?

Identifying Scope Gapes in Subcontractor Bids Walkthrough Video, 2:48 mins

3. Do the bids include Alternates, which can be added to bid for a specified price?
4. Identify any quality gaps between bids. Are some bids providing pricing on items that do not meet the specifications for the project?

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Level the Bids

After reviewing all the bids, your job is now to choose the best and least expensive subcontractors to do the specified work. Bid leveling is a great way to make the best decisions on which bids to accept.

Use a Bid Leveling Spreadsheet to get all the bid information in one place, look for scope gaps, then choose the best bid that fulfills all of the job requirements. This will allow you to get the best overall subcontractor pricing.

Bid Leveling, Applying Alternates, and Requesting More Information, 5:40 mins

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Ranch House Overhead Walkthrough

A construction company's product is completed construction projects, but the cost to run the business side of the company must also be accounted for. the cost of advertising, office staff and equipment, etc. (ie. costs that are not directly related to a construction project) are some of these cost categories that fall under overhead. Overhead is the costs required to operate a business.

What to Enter in the Overhead Tab

The company accountant has given you the following numbers to enter in the Overhead tab of the Estimating Workbook based on a forecast completed earlier.

	January	February	March	April	May	June
Advertising	$500	$250	$200	$100	$100	$100
Office Personnel	Leave Alone					
Computers	$2000	$100	$0	$0	$0	$0
Dues and Subscriptions	$50	$50	$50	$50	$50	$50
Electricity for Office	$150	$150	$150	$150	$150	$150
Heat for Office (Gas)	$120	$100	$80	$60	$30	$20
General Insurance	$1450	$1450	$1450	$1450	$1450	$1450
Health Insurance	$4150	$4150	$4150	$4150	$4150	$4150
Meals and Entertainment	$300	$300	$300	$300	$300	$300
Office Supplies	$250	$250	$250	$250	$250	$250
Officer Salaries	$4000	$4000	$4000	$4000	$4000	$4000
Postage	$25	$25	$25	$25	$25	$25
Professional Fees	$1590	$100	0	0	0	0
Rental Expenses	$500	$500	$500	$500	$500	$500
Telephone	$250	$250	$250	$250	$250	$250

Tools and Equipment	Leave Alone					
Travel	$150	$150	$150	$150	$150	$150
Vehicles	$550	$550	$550	$550	$550	$550

IMPORTANT: Enter Estimated Yearly Gross Income

Enter $1,600,000 in the cell for Estimated Yearly Gross Income. Failure to do so prevent you from calculating the correct percentage for Overhead as a Percentage of Income.

Ranch House Summary Page Walkthrough

Once the Tools & Equpment and Overhead tabs of your Ranch House Estimate are complete, you can begin working on the Summary page.

The purpose of this assignment is to review the totals of the Ranch House Estimate in each of Construction Phase tabs. Additionally, you must complete the following tasks for successful completion of the Summary Tab:

- Ensure that the Overhead, Profit, and Sales Tax percentages are entered correctly.
- Determine which items in each phase will include adjustments to the base cost calculated in their tabs.

Enter Overhead, Profit, & Sales Tax %

The first step is quite simple for this assignment.

Overhead, Profit, & Sales Tax %

Please note the following points, then enter the correct numbers in the Summary tab of the Ranch House Estimating Workbook.

- Overhead % is calculated as estimated yearly overhead divided by estimated yearly gross Income. You can find this figure in the Overhead tab.
- This construction company completes its initial estimate with a 12% profit.
- Idaho sales tax is 6%.

Example: A construction company always completes initial estimates with a 10% profit. Their estimated yearly overhead and estimated yearly gross income are $132,600 and $1,000,000 respectively.

$$\frac{\$132600}{\$1000000} = .1326 = 13.26\%$$

The resulting figures in the Cost Summary Header would be as follows:

Overhead %	13.26%
Profit %	10%
Sales Tax Rate %	6%

Example Cost Summary Header from the Summary tab

Enter the Following in Your Ranch House Estimating Workbook

- Overhead % = Your calculated number from the Overhead tab, assuming $1,600,000 of estimated yearly gross income.
- Profit % = 12%
- Sales Tax % = 6%

Accounting for Overhead, Profit, and Sales Tax

The next step for completing the Summary tab of the Ranch House Estimating Workbook requires you to select which items will include adjustments for overhead, profit, and sales tax. Use the following guidelines to do so.

How to Calculate Overhead, Profit, and Sales Tax in the Estimating Workbook

The Summary tab includes a total of each subsection of each construction phase. Within those tables are columns for Overhead, Profit, and Sales Tax.

To add adjustments to a line item for Overhead, Profit, and/or Sales Tax, add an "x" into the the provided space in the column for each respective adjustment. The calculation will be completed and added to the total cost for the line item.

Example

In the following example, notice that the columns for Overhead, Profit, and Sales Tax that include an "x" include a calculation based on the respective percentages in the Summary tab heading, and that a total is for each line item is calculated.

			Pre Cons
CODE	DESCRIPTION	CATEGORY	BASE COS
	ARCHITECTURE AND ENGINEERING	Other	$ 1,500
	PERMITS AND FEES	Fees	$ 800
	CONSTRUCTION LOAN	Other	$ 200
	REAL ESTATE	Fees	$ 38,000
	TEMPORARY UTILITIES	Other	$ 1,200
	JOB SITE FACILITIES	Other	$ 150
	BONDS & INSURANCE	Fees	$ 125
	SUPERVISION	Other	$ 5,800
	SUBTOTALS FOR PHASE I	$ -	$ 47,775

Pre-Construction Cost Totals with Adjustments

Recommended Guidelines for Adjusting Costs for Overhead, Profit, and Sales Tax

Recommended Guidelines for Overhead

- No overhead for costs and fees for the project that do not require the labor of company employees (eg. Architecture, Jobsite Facilities, etc.)
- No overhead for materials. Instead, make up overhead costs on the labor costs.
- Charge overhead for all labor costs.
- Charge overhead for all subcontractor costs because a company employee will bid level and will be onsite to supervise the work.
- Charge overhead for all allowance items because company employees will be buying the material and installing it.

Recommended Guidelines for Profit

- No profit for costs and fees for the project that do not require the labor of company employees (eg. Architecture, Jobsite Facilities, etc.)
- No profit for materials.
- Charge profit for all labor costs.
- Charge profit for all subcontractor costs because a company employee will be onsite to supervise the work.
- Charge profit for all allowance items because company employees will be buying the material and installing it.

Guidelines for Adding Sales Tax to Line Items

Sales tax must be paid. It is the law.

- Add sales tax to all materials, fees, and allowances.
- Do not add sales to to labor items.
- Add sales tax for special line items with especially large tax loads (eg. Real Estate Fees)

Remember, sales tax must be accounted for and paid by someone. If it is not included in line items as outlined above, the client will not pay them. In this scenario the construction company will pay sales tax, which will cut into profit.

Example

Cost Category	Overhead	Profit	Sales Tax
Allowance	X	X	X
Fees (Require Employee Supervision)	X	X	X
Fees (No Employee Supervision)			X
Labor	X	X	
Materials			X
Other (Require Employee Supervision)	X	X	X
Other (No Employee Supervision)			X
Subs	X	X	

Which items to add Overhead, Profit, and Sales Tax to according to the guidelines.

Small Cottage Assignment Walkthroughs

Walkthroughs are available for the following Small Cottage assignments.

Small Cottage Basic Takeoff Walkthrough

Table of Contents

Scope of Work

This assignment is similar to the basic takeoff you completed for the Ranch House project. You will use Bluebeam and the provided plans to complete the required sections of the BasicInfo tab in the workbook.

You will be required to complete the window section of this project. See the plans for the necessary information to do so.

Video Walkthrough

Small Cottage Basic Takeoff Lab Walkthrough

Helpful Resources

- Basic Takeoff Guide (includes how to complete flat roof area and window schedule calculations)

Small Cottage Sitework Walkthrough

This document includes resources that will aid you in completing this phase of the Small Cottage project estimate.

Table of Contents

Scope of Work

- The Small Cottage Sitework estimate includes various material and labor estimates. Rely on the principles you have learned for completing each of these kinds of estimates.

Lab Walkthrough Videos

Sitework Video 01

Sitework Video 02

Other Helpful Resources

- How to Complete Material Estimates
- How to Complete Labor Estimates Using the NCE
- Sitework Estimating Guide
- Sitework Construction Processes

Small Cottage Preconstruction Walkthrough

This document includes resources that will aid you in completing this phase of the Small Cottage project estimate.

Table of Contents

Scope of Work

Your complete assignment should meet the following criteria:

Basic Info Tab

- Correct the information from your Basic Takeoff submission. You need to do this to ensure your numbers for the rest of the estimates for the project are accurate.

PreConst Tab

Architectural and Engineering Section

- Look up the Unit Cost for a survey in the NCE using the following designation: Residential Lot, Tract Work, 4 Corners. (See 2018 NCE p. 313)

Building Permit Header

- Ensure that the Building Permit header correctly references information from your corrected BasicInfo tab. It should pull correct SF and SF Valuation from the BasicInfo tab.
- Check the Building Permit Value Adjustment Percentage for the Idaho Falls area in the 2018 NCE. Enter the adjusted (100 - adjustment percentage) value in the Building Permit Value Adjustment Percentage.

Temporary Utilities Section

- Look up the Unit Cost for temporary power in the NCE. Use the criteria found in that line item of the PreConst tab of the estimating workbook. (See 2018 NCE p. 318)

Job Site Facilities Section

- Look up the Unit Cost for sanitary facilities in the NCE. Use the criteria found in that line item of the PreConst tab of the estimating workbook. (See 2018 NCE p. 318)

Lab Walkthrough Videos

Other Helpful Resources

- [Preconstruction Estimating Guide]
- [Preconstruction Cost Items]

Small Cottage Framing Walkthrough

Table of Contents

Scope of Work

- The Small Cottage Framing estimate includes various material and labor estimates. Rely on the principles you have learned for completing each of these kinds of estimates.
- See the Other Helpful Resources listed below for a refresher on how to complete various estimates.

Video Walkthrough

Small Cottage Framing Lab Walkthrough, Pt. 1

Small Cottage Framing Lab Walkthrough, Pt. 2

Other Helpful Resources

- How to Complete Material Estimates
- How to Complete Labor Estimates Using the NCE
- Concrete Estimating Guide
- Concrete Construction Processes and Materials

Small Cottage Concrete Walkthrough

This document includes resources that will aid you in completing this phase of the Small Cottage project estimate.

Table of Contents

Scope of Work

- The Small Cottage Concrete estimate includes various material and labor estimates. Rely on the principles you have learned for completing each of these kinds of estimates.
- See the Other Helpful Resources listed below for a refresher on how to complete various estimates.

Lab Walkthrough Videos

Other Helpful Resources

- How to Complete Material Estimates
- How to Complete Labor Estimates Using the NCE
- Concrete Estimating Guide
- Concrete Construction Processes and Materials

Small Cottage Exterior Finishes

Table of Contents

Scope of Work

- The Small Cottage Exterior Finishes estimate includes various material and labor estimates. Rely on the principles you have learned for completing each of these kinds of estimates.
- See the Other Helpful Resources listed below for a refresher on how to complete various estimates.

Video Walkthrough

Other Helpful Resources

- How to Complete Material Estimates
- How to Complete Labor Estimates Using the NCE
- Concrete Estimating Guide
- Concrete Construction Processes and Materials

Small Cottage Interior Finishes

Table of Contents

Scope of Work

- The Small Cottage Interior Finishes estimate includes various material and labor estimates. Rely on the principles you have learned for completing each of these kinds of estimates.
- See the Other Helpful Resources listed below for a refresher on how to complete various estimates.

Video Walkthroughs

Small Cottage Drywall Lab Walkthrough

Small Cottage Interior Finishes Lab Walkthrough

Other Helpful Resources

- How to Complete Material Estimates
- How to Complete Labor Estimates Using the NCE
- Concrete Estimating Guide
- Concrete Construction Processes and Materials

Small Cottage Subcontractors Walkthrough

Table of Contents

Scope of Work

The Small Cottage Subcontractors estimate will be very similar to the one completed for the Ranch House project.

Video Walkthrough

Other Helpful Resources

- Subcontractors Estimating Guide

Small Cottage Tools & Equip, Overhead, & Summary Walkthrough

Once the Subs tab of your Small Cottage Estimate is complete, you can begin working on the Summary tab. Please note that Tools & Equip tab and Overhead tab have been completed for you.

The purpose of this assignment is to review the totals of the Small Cottage Estimate in each of Construction Phase tabs. Additionally, you must complete the following tasks for successful completion of the Summary Tab:

- Complete the Tools & Equip tab.
- Complete the Overhead tab.
- Ensure that the Overhead, Profit, and Sales Tax percentages are entered correctly.
- Determine which items in each phase will include adjustments to the base cost calculated in their tabs.

Complete the Tools & Equipment Tab

Calculate the Interests Costs of All Listed Equipment.

For the purposes of this assignment, use the following formulas to calculate Montly, Yearly, and Total interest costs, respectively.

Total Interest Cost

$$Total\ Interest\ Cost\ =\ \frac{Purchase\ Price\ \times\ Interest\ Rate\ \times\ Loan\ Term}{2}$$

Example

A skid steer was purchased for $40,000. The construction company secured a $30,000 loan at 5% interest over a 3 year term. The total interest cost would be calculated as follows:

$$\frac{\$40000\ \times\ .05\ \times\ 3}{2}\ =\ \$3000$$

Yearly Interest Cost

$$Yearly\ Interest\ Cost\ =\ \frac{Total\ Interest\ Cost}{Loan\ Term}$$

Example

The yearly interest cost for the skid steer would be calculated as follows:

$$\frac{\$3000}{3}\ =\ \$1000$$

Monthly Interest Cost

$$Montly\ Interest\ Cost\ =\ \frac{Yearly\ Interest\ Cost}{12}$$

Example

The monthly interest cost for the skid steer would be calculated as follows:

$$\frac{\$1000}{12}\ =\ \$83.33$$

Calculate the Depreciation of All Listed Equipment.

For the purposes of this assignment, use the following formulas to calculate Montly, Yearly, and Total depreciation costs, respectively.

Total Depreciation Cost

$$Total\ Depreciation\ Cost\ =\ Purchase\ Price\ -\ Scrap\ Value$$

Example

A skid steer was purchased for $40,000. The scrap value of the skid steer after its service life of 6 years is $7000. The total depreciation cost would be calculated as follows:

$$\$40000\ -\ \$7000\ =\ \$33000$$

Yearly Depreciation Cost

$$Yearly\ Depreciation\ Cost\ =\ \frac{Purchase\ Price\ -\ Scrap\ Value}{Service\ Life}$$

Example

The yearly depreciation cost for the skid steer would be calculated as follows:

$$\frac{\$40000\ -\ \$7000}{6}\ =\ \$5500$$

Monthly Depreciation Cost

$$Montly\ Depreciation\ Cost\ =\ \frac{Yearly\ Depreciation\ Cost}{12}$$

Example

The monthly depreciation cost for the skid steer would be calculated as follows:

$$\frac{\$5500}{12}\ =\ \$458.33$$

Calculate the Monthly Taxes of All Listed Equipment.

For the purposes of this assignment, use the following formulas to calculate Montly taxes.

Monthly Taxes

$$Monthly\,Taxes\;=\;\frac{Yearly\,Taxes}{12}$$

Example

A skid steer has yearly tax costs of $800. The monthly tax cost would be calculated as follows:

$$\frac{\$800}{12}\;=\;\$66.67$$

Calculate the Total Monthly and Yearly Costs of All Listed Equipment.

Total Monthly Costs

Add the monthly interest, depreciation, and tax costs of each piece of equipment to calculate the total monthly cost.

Total Yearly Costs

Add the yearly interest, depreciation, and tax costs of each piece of equipment to calculate the total yearly cost.

What to Enter in the Tools Table

The company accountant has given you the following numbers to enter in the Tools & Equip tab of the Estimating Workbook based on a forecast completed earlier.

In the Total Tools column (B), add the following values for each month:

Month	Amount
January	$700
February	$250
March	$350
April	$300
May	$425
June	$150

July	$600
August	$300
September	$450
October	$175
November	$300
December	$400

Table of Monthly Tool Figures to Enter

Complete the Overhead Tab

What to Enter in the Overhead Table

The company accountant has given you the following numbers to enter in the Overhead tab of the Estimating Workbook based on a forecast completed earlier.

	January	February	March	April	May	June
Advertising	$500	$250	$200	$250	$200	$250
Office Personnel	Leave Alone					
Computers	$1850	$225	$0	$0	$0	$0
Dues and Subscriptions	$50	$50	$50	$50	$50	$50
Electricity for Office	$150	$150	$150	$150	$150	$150
Heat for Office (Gas)	$120	$100	$80	$60	$30	$20
General Insurance	$1450	$1450	$1450	$1450	$1450	$1450
Health Insurance	Leave Alone					
Meals and Entertainment	$400	$400	$400	$400	$400	$400
Office Supplies	$175	$175	$175	$175	$175	$175
Officer Salaries	Leave Alone					
Postage	$25	$25	$25	$25	$25	$25
Professional Fees	$1590	$100	0	0	0	0
Rental Expenses	$650	$650	$650	$650	$650	$650

Telephone	$250	$250	$250	$250	$250	$250
Tools and Equipment	Leave Alone					
Travel	$200	$200	$200	$200	$200	$200
Vehicles	$550	$550	$550	$550	$550	$550

Enter the Estimated Yearly Gross Overhead, Gross Wages, and Calculate Overhead as a Percentage of Income

Base your calculation on an estimated yearly gross income of $2,000,000.

Yearly Gross Overhead

This is calculated as the sum of all yearly estimates for each overhead line item. See your Ranch House Estimate as an example.

Yearly Gross Wages

This is calculated as the sum of the Total Net Annual Payroll Amount for each employee from the Wage tab of your estimating workbook. See your Ranch House Estimate as an example.

Overhead as a Percentage of Income

Calculate this figure by dividing your Estimate Yearly Gross Overhead by your Estimated Yearly Gross Income ($2,000,000).

Enter Overhead, Profit, & Sales Tax %

Navigate to the Summary tab of your Small Cottage Estimating Workbook.

Overhead, Profit, & Sales Tax %

Please note the following points, then enter the correct numbers in the Summary tab of the Small Cottage Estimating Workbook.

- Enter the number you calculated on the Overhead tab for Overhead as a Percentage of Income.
- Your construction company has asked you to complete the Small Cottage estimate based on a 10% profit figure.
- Idaho sales tax is 6%.

Accounting for Overhead, Profit, and Sales Tax

The next step for completing the Summary tab of the Small Cottage Estimating Workbook requires you to select which items will include adjustments for overhead, profit, and sales tax. Use the following guidelines to do so.

Recommended Guidelines for Adjusting Costs for Overhead, Profit, and Sales Tax

Recommended Guidelines for Overhead

- No overhead for costs and fees for the project that do not require the labor of company employees (eg. Architecture, Jobsite Facilities, etc.)
- No overhead for materials. Instead, make up overhead costs on the labor costs.
- Charge overhead for all labor costs.
- Charge overhead for all subcontractor costs because a company employee will bid level and will be onsite to supervise the work.
- Charge overhead for all allowance items because company employees will be buying the material and installing it.

Recommended Guidelines for Profit

- No profit for costs and fees for the project that do not require the labor of company employees (eg. Architecture, Jobsite Facilities, etc.)
- No profit for materials.
- Charge profit for all labor costs.
- Charge profit for all subcontractor costs because a company employee will be onsite to supervise the work.
- Charge profit for all allowance items because company employees will be buying the material and installing it.

Guidelines for Adding Sales Tax to Line Items

Sales tax must be paid. It is the law.

- Add sales tax to all materials, fees, and allowances.
- Do not add sales to to labor items.
- Add sales tax for special line items with especially large tax loads (eg. Real Estate Fees)

Remember, sales tax must be accounted for and paid by someone. If it is not included in line items as outlined above, the client will not pay them. In this scenario the construction company will pay sales tax, which will cut into profit.

How to Calculate Overhead, Profit, and Sales Tax in the Estimating Workbook

The Summary tab includes a total of each subsection of each construction phase. Within those tables are columns for Overhead, Profit, and Sales Tax.

To add adjustments to a line item for Overhead, Profit, and/or Sales Tax, add an "x" into the the provided space in the column for each respective adjustment. The calculation will be completed and added to the total cost for the line item.

Example

In the following example, notice that the columns for Overhead, Profit, and Sales Tax that include an "x" include a calculation based on the respective percentages in the Summary tab heading, and that a total is for each line item is calculated.

			Pre Cons
CODE	DESCRIPTION	CATEGORY	BASE COS
	ARCHITECTURE AND ENGINEERING	Other	$ 1,500
	PERMITS AND FEES	Fees	$ 800
	CONSTRUCTION LOAN	Other	$ 200
	REAL ESTATE	Fees	$ 38,000
	TEMPORARY UTILITIES	Other	$ 1,200
	JOB SITE FACILITIES	Other	$ 150
	BONDS & INSURANCE	Fees	$ 125
	SUPERVISION	Other	$ 5,800
	SUBTOTALS FOR PHASE I	$ -	$ 47,775

Pre-Construction Cost Totals with Adjustments

5

Construction Materials and Process Index

Factors that Affect Construction Costs

The United States Census Bureau reported that the average cost of a home in the United States in January of 2018 was $385,000 with the median home cost being $326,400. They also reported that for the year 1975, the average and median home cost in the United States was $42,600 and $39,300 respectively. The preceding numbers represent a national average; however, housing cost can vary widely across the country or even within very limited areas. Prices can range from less than $100,000 to millions of dollars for houses of comparable size, quality, and amenities. Factors that contribute to residential construction costs include location, quality of materials and finishes, and special features included in the home.

Location

Many factors contribute to the overall cost of a house, but one of the most important contributing factors is the location of the house. The selling price of all real estate is subject to the variables of the marketplace and values both rise and fall on an ongoing basis. While it is possible in some instances to move a house, in most circumstances it is an impractical and costly option. Quality of life issues such as school choice, commute times, safety issues, crime rate, neighborhood quality, employment opportunities, leisure, and recreational activities are directly tied to the location of the property. Other variables such as local building codes and regulations can affect building costs. For example, one municipality may require high impact and building fees, while a neighboring municipality may not. Specific locations may also require stricter and costlier building standards such as the requirement to install high impact resistant windows in buildings along coastlines in hurricane prone areas. Location can also play a role in construction costs associated with the quality of materials, finishes, and special features. Homes built in affluent locations tend to also have higher quality materials, finishes, and upscale special features.

Quality of Materials and Finishes

Material and finishes can have a significant impact upon the cost of building a home. For example, using an expensive exterior finish material, such as brick veneer, could cost somewhere between 9 and 15 dollars per square foot of wall area. Using a less expensive exterior finish, such as vinyl siding, could cost somewhere between 4 and 8 dollars per square foot of wall area. A small home with outside dimensions of 36 feet wide by 32 feet deep would have 136 lineal feet of exterior wall that is 9 feet tall (Figure 1-5).

$$36\ ft. + 32\ ft. + 35\ ft.\ 32\ ft. =\ 135\ ft.$$

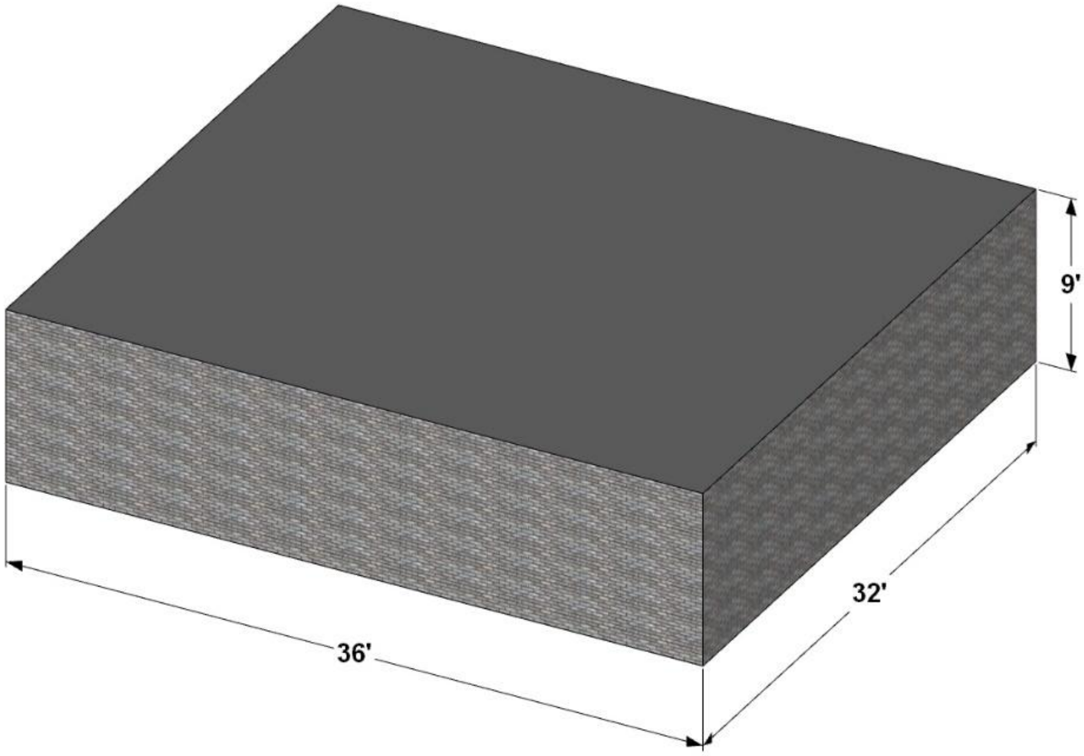


Figure 1-5: Small rectangular building 36 feet wide by 32 feet deep with 136 lineal feet of exterior wall.

A simplistic example without any windows or doors would have 1,224 square feet of wall area. Overall cost for brick priced at fifteen dollars per square foot would result in an exterior finish cost of $18,360 for the project, while the less expensive vinyl at 4 dollars a square foot would result in an overall cost of $4,896 for the project, a difference of $13,464. This same logic could be applied to any number of materials and finishes, such as roofing and flooring materials. In fact, it would be expected that high-end finishes would be used throughout high-end projects, thus, the overall cost increases not just for a single item, but through the entire project.

Figure 1-6: Brick exterior adds considerably to the cost of this house.

Special Features

Special features included with the construction of a house can add significantly to its cost. This can include items such as fireplaces, jetted tubs, kitchen cabinets, mechanical and electrical systems, and bathroom accessories and finishes. Many builders leave special features out of the initial building design but offer them as specific upgrades or amenities that can be added to the house.

Figure 1-7 High end kitchen cabinets and appliances add significantly to the cost of the house.

While it is important to pay attention to the expense of items when preparing a cost estimate, there are many other financial factors that go into establishing the value of the house that are outside of traditional “stick and brick” building components. A report authored yearly by the National Association of Home Builders (NAHB) designates what these other financial factors are.

NAHB Single Family House Cost Report

The NAHB is a trade organization consisting of builders and other partners associated with the residential construction industry. Each year, the NAHB surveys its members and releases a “Cost of Constructing a Home” report. The survey asks its members to estimate their costs for building an average home sized at 2,800 square feet on a quarter acre lot with three or four bedrooms and two bathrooms. The 2016 study determined the average selling price for a home that met those specifications was equal to $427,892. The breakdown of these costs into major subtotals is as follows:

Finished Lot (including financing)	$91,996	21.5 %
Construction Costs (material and labor)	$237,760	55.6 %
Financing Cost	$7,636	1.8 %
Overhead and General Expenses	$21,835	5.1 %

Marketing Cost	$5,314	1.2 %
Sales Commission	$17,448	4.1 %
Profit	$45,902	10.7 %
Total Sales Price	$427,892	100 %

The important element of this information is not the specific dollar amount for each subcategory, as that amount changes on a yearly basis and can rise or fall based upon market conditions. The share of price percentage for each subcategory can also change, however, it is important to understand the significance of the percentage of the total sales price that each subcategory identifies. For example, construction costs are listed at $237,760 or 55.6 percent of the total overall costs. It may be tempting to reason that when the material and labor cost estimate for a home is finished, the estimate is complete. While the material and labor costs are a significant portion of the overall budget, they really only represent a little over half of the total cost. Estimating work in this course will include determining all construction costs, not just material and labor.

The Real Cost of Labor and How to Calculate Wage Rate

A generally accepted axiom in the construction industry is that of the three major cost categories of a construction estimate, the material, the labor, and the overhead, estimating labor represents the greatest risk to the contractor. This is often true because there can be many potential influences that are outside of a contractor's control that can affect worker performance. Because of the added risk, the estimator should take additional care when preparing a labor cost estimate and seek to anticipate and evaluate any potential issues that may arise and develop contingencies for dealing with those potential issues.

On the surface, the formula and calculations for determining labor costs are quite simple, however, buried within that simplicity can be a myriad of other issues which can make the challenge significant. In its simplest terms, calculating labor cost is a matter of establishing two variables. The first is a basic unit or quantity that represents the particular material or process being estimated and determines the quantity of time that it will take for the material installation or construction process. This is known as the production rate. The second is allotting a financial cost to the material installation or construction process. This is known as the wage rate. The basic formula for estimating labor is to multiply the production rate by the wage rate.

$$Production\ Rate\ \times\ Wage\ Rate\ =\ Labor\ Cost$$

The remaining balance of this chapter will explore the numerous elements that must be taken into consideration when calculating labor cost beginning with the production rate.

Production Rate

The steps to calculate your production rate are to 1) determine the basic unit of labor, 2) determine the crew, 3) determine the productivity factor, and then 4) calculate the work hours.

Determine the Basic Unit of Labor

The first element in estimating the production rate is to determine a basic unit of labor. This is the measurement that will be used to quantify the process to be estimated. A wide variety of measurements could be possible, with some more appropriate than others for a given situation. For example, two possible methods of estimating concrete footings could be cubic yard or lineal footage. Either could be appropriate depending upon the circumstances. Footings for residential construction are often similar sizes such as 16 inches wide by 8 inches tall or 18 inches wide by 9 inches tall. These footings typically are formed using 2 × 8 or 2 × 10 material on each side and have two pieces of continuous horizontal rebar. Vertical rebar is also placed at standard distances (Figure 4-1).


Figure 4-1: Typical residential footing of standard size and construction.

In this case, it may be desirable to estimate the footing at lineal foot cost as material and labor would be similar for most installations.

Footing for commercial construction, such as those shown in Figure 4-2, can vary widely by size, material, and function. These footings have multiple variations in size and profiles with multiple arrangements of rebar, and it may be more appropriate to estimate these footings by cubic yard quantity.


Figure 4-2: Commercial footings with a variation in size and construction.

Determining the Crew

Several important factors should be taken into consideration when determining the crew that will perform a specific task. Considerations would include the specific set of skills needed to perform the operation, the optimum number of members in the crew, and the job description for each crew member.

Skills Needed to Perform the Operation

Specialized skill sets are needed to perform most construction operations, and optimal crew configuration would include individuals with the desired skill sets. Information, such as that contained in cost data manuals, can assist in determining crew configurations. NCE Figure 4-1 shows an example from the crew database in the National Construction Estimator with examples of job descriptions, number of crew members, and average crew cost per hour.

Residential Division

Craft Code	Cost Per Manhour	Crew Composition
B1	$33.44	1 laborer and 1 carpenter
B2	$34.60	1 laborer, 2 carpenters
B3	$32.27	2 laborers, 1 carpenter
B4	$36.96	1 laborer 1 operating engineer 1 reinforcing iron worker
B5	$36.57	1 laborer, 1 carpenter 1 cement mason 1 operating engineer 1 reinforcing iron worker
B6	$32.48	1 laborer, 1 cement mason
B7	$30.32	1 laborer, 1 truck driver
B8	$36.03	1 laborer 1 operating engineer
B9	$32.62	1 bricklayer 1 bricklayer's helper
BB	$37.47	1 bricklayer
BC	$36.94	1 carpenter
BE	$40.04	1 electrician
BF	$33.79	1 floor layer
BG	$35.68	1 glazier
BH	$27.76	1 bricklayer's helper
BL	$29.93	1 laborer
BR	$35.45	1 lather
BS	$32.78	1 marble setter
CF	$35.03	1 cement mason
CT	$34.83	1 mosaic & terrazzo worker
D1	$35.92	1 drywall installer 1 drywall taper
DI	$35.95	1 drywall installer
DT	$35.89	1 drywall taper
HC	$29.01	1 plasterer helper
OE	$42.13	1 operating engineer
P1	$36.39	1 laborer, 1 plumber
PM	$42.85	1 plumber
PP	$33.82	1 painter, 1 laborer
PR	$36.99	1 plasterer
PT	$37.70	1 painter
R1	$35.60	1 roofer, 1 laborer
RI	$38.83	1 reinforcing iron worker
RR	$41.27	1 roofer
SW	$41.59	1 sheet metal worker
T1	$32.55	1 tile layer, 1 laborer
TL	$35.17	1 tile layer
TR	$30.71	1 truck driver

NCE Figure 4-1: National Construction Estimator residential crew information.

Determining the Productivity Factor

Another element in determining the production rate is the crew productivity factor. The productivity rates of a crew can vary dramatically between crews and even within the same crew in different circumstances. Productivity of workers that is less than ideal will require an increase in the number of hours that the work requires, and a productivity factor greater than the norm will mean a decrease in the labor hours. Some of the variables that contribute to the productivity factor of crews include the availability of workers, climate conditions, working conditions, and other factors.

Availability of Workers

The construction industry is sensitive to economic factors and goes through cycles of high prosperity and times that are less so. These up and down cycles also have an effect on worker productivity. For example, in times of high economic prosperity, there tends to be shortages of workers in the industry as companies compete for high-skilled labor. During these times, high wages also draw more workers into the industry, however, these workers tend to have less training and fewer skills. As a result, they work slower, demonstrating lower levels of productivity. The opposite is true in times of less economic prosperity. Workers compete for fewer jobs, and those with less training and more marginal skills tend to drop out of the industry as unemployment rates rise. Typically, the workers left in the industry are those with higher levels of training and skills and tend to have higher productivity rates.

Climate Conditions

Construction work is often outside and can be subject to effects of the weather. Cold temperature, rain, and snow can have a big impact on many construction procedures and projects. For example, concrete setting is subject to temperature. The colder the temperature, the slower the hardening process. Ambient air temperatures below 40 degrees can significantly slow down or stop the hydration process. Concrete that is allowed to freeze before it reaches a strength of 500 psi will be irreparably damaged and will never achieve sufficient strength. Additional time and protection measures will need to be accounted for when placing concrete in cold conditions.

The opposite is also true of hot or windy conditions. Hot, dry, or windy conditions can evaporate the water from the concrete mix before it has time to complete the hydration process.

Working Conditions

Working conditions, such as number of workers on the job, working space, high rise construction, material on hand, and traveling to the job can also affect construction productivity.

Number of Workers on the Job

Too few or too many workers can have an adverse effect on construction productivity. Too few workers can lead to overtasked workers and a loss of productivity. Workers, at times, can put in long periods of work hours, but continued overwork will lead to a host of problems as workers are overworked. This includes not only a general loss of productivity, but also a loss of quality in their work. Overworked employees also have more injuries and other health care costs and take shortcuts that can lead to accidents or injury.

Too many workers on a job can have a negative effect that leads to many of the same problems. It can lead to inefficiencies as workers get in each other's way, or the work of one individual conflicts with the work of others. This is often known in the industry as the crowding, or stacking, of trades. In addition, too many workers can lead to safety violations and injuries.

Figure 4-3: Too many workers on a job site can lead to worker inefficiency.
Public Domain https://media.defense.gov/2013/Apr/30/2000054296/-1/-1/0/130420-F-RJ363-043.JPG

Working Space

Lack of sufficient working space where the worker is confined can lead to inefficiency.

High Rise Construction

High rise construction can also lead to worker inefficiency. Typically, there are limited means to access a building's higher levels while under construction. High rise projects can have hundreds or thousands of workers on a job with limited access to the higher floors. In addition, there are time issues with getting material to the higher floors as material placement conflicts for the limited resources.

Figure 4-4: Inefficiencies can occur with high rise construction getting workers and material to the proper floors. CC0: https://pxhere.com/en/photo/453618

Materials on Hand

Delivery delays or disorganized project scheduling can lead to worker inefficiency as they wait on materials. The opposite can also be true. Material that is on the job site before it is needed can become an obstacle to work around.

Traveling to the Job

Projects at remote locations or that are far from the source of worker supply may also cause inefficiencies as workers need time to travel to the job site. The contractor often may be required to pay for travel time, either one way or both ways, as the workers travel to the job site. This factor will need to be included as labor costs are determined.

Other Factors

Other factors can contribute to worker inefficacy. Studies have shown that on average, workers accomplish only 30 to 50 minutes of work per hour. Factors that contribute to this include worker breaks such as coffee breaks, bathroom breaks, water breaks, or lunch breaks that start early or stop late. Other factors such as worker conversation, discussions about the “big game” or the “big date” last night can contribute to less than a full time period of work.

Figure 4-5: Coffee or other breaks can lead to worker inefficiency.

Daily startup and cleanup activities also contribute to worker inefficiencies, as workers get tools and materials on hand, get organized to start the day, and then get tools cleaned up and put away at the completion of their shift. Effective job organization can lead to a decrease in inefficiencies.

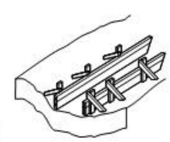
Calculating the Total Work Hours

The formula for calculating total work hours should include a productivity factor as part of the equation. This basic formula would be

$$\frac{Quantity\,Takeoff \times Production\ Rate}{Productivity\,Factor} = Work\ Hours$$

NCE Figure 4-2 shows an example of the cost associated with board forming and stripping concrete footings. The Craft@hrs information shows that Crew B2 can form footings at a rate of 0.115 hours per SF. The introduction identifies the actual unit as square foot of contact area (SFCA), and it explains that when forms are required on both sides, the surface area of each side will need to be included.

	Craft@Hrs	Unit	Material	Labor	Total
Board forming and stripping For wall footings, grade beams, column footings, site curbs and steps. Includes 5% waste. Per SF of contact area. When forms are required on both sides of the concrete, include the contact surface for each side.					
2" thick forms and bracing, using 2.85 BF of form lumber per SF. Includes nails, ties, and form oil					
Using 2" lumber, per MBF	—	MBF	660.00	—	660.00
Using nails, ties and form oil, per SF	—	SF	.22	—	.22
1 use	B2@.115	SF	2.18	3.96	6.14



NCE Figure 4-2: NCE cost for board forming and stripping concrete footings.

Figure 4-6 shows an example of a typical 8x16 residential concrete footing. The forms are on both sides and are eight inches tall. The square foot of contact area for one side of the footing would be determined by converting the area of one lineal of footing form to a decimal form with the following calculation:

$$\frac{8\,in.}{12\,in.} \times 1\,ft. = 0.667\,SFCA$$

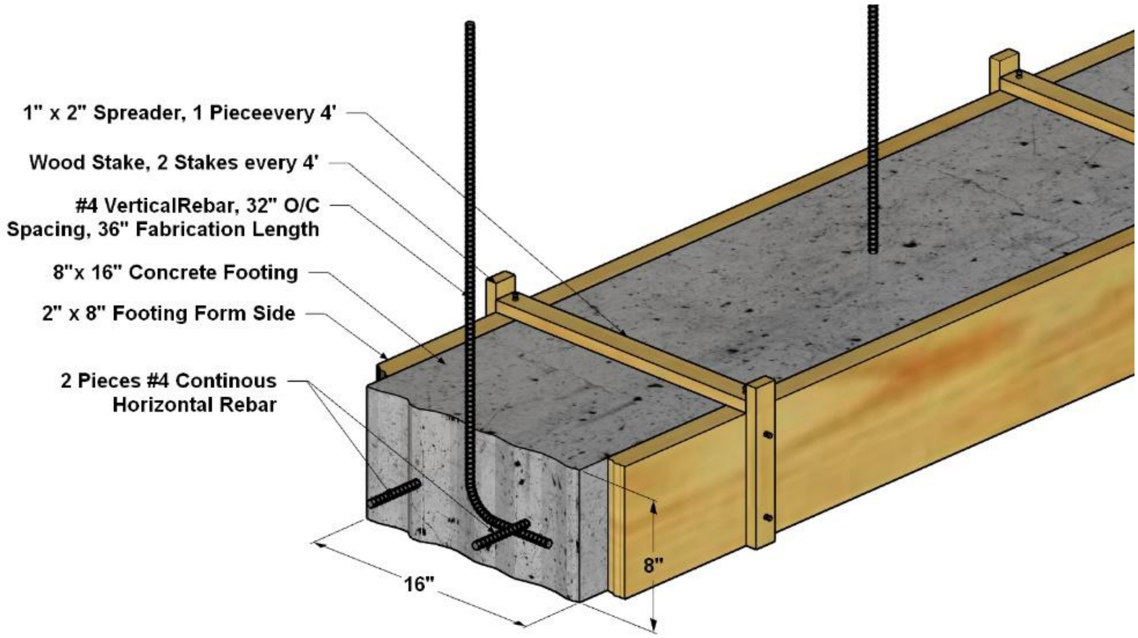


Figure 4-6: Typical residential concrete footing.

The quantity would be doubled to account for the forms on both sides and would result in the following quantity:

$$0.667\,\frac{SFCA}{Side}\ \times\ 2\,Sides\ =\ 1.334\,SFCA$$

Using an example of 100 lineal feet of footings, the total square feet of contact area would be

$$100\,LF\ \times\ 1.334\frac{SFCA}{LF}\ =\ 133.4\,SFCA$$

Crew B2 can install the footings at a rate of 0.115 hour per SFCA. The number of hours required to install the 100 lineal feet of footings would be

$$0.115\frac{Manhrs}{SFCA}\ \times\ 133.4\,SFCA\ =\ 15.34\,Manhrs$$

This would be the ideal number of man-hours needed to complete the project. If a productivity factor of 80% were included to account for a factor, the actual number of man-hours would be

$$\frac{15.34\,Manhrs}{.80}\ =\ 19.18\,Manhrs$$

NCE Figure 4-1 shows that crew B2 has three crew members, one laborer, and two carpenters. This means that it would take crew B2 6.39 hours to complete the footing formwork as shown by the following calculation:

$$\frac{19.18\,Manhrs}{3\,Men}\ =\ 6.39\,Hrs$$

Calculating production using these methods can be invaluable, however, the most accurate method of estimating labor is taken from historical data based upon crews' past performance in a similar situation and should be a focus of the construction estimator's efforts.

The second half of the equation in determining construction labor costs is to determine the employee wage rates. While cost data manuals can be helpful in establishing wage rates, much more accurate figures can be obtained when actual employee wage rates are known. This is more complex than simply applying an employee's hourly pay rate to the equation. True employee wage costs are an aggregate of many factors, and each of those factors need to be taken into consideration when determining total employee wage costs. Another name for total employee wage cost is known as burdened labor costs.

Burdened Labor Costs

Burdened labor costs are typically separated into three main cost categories. These categories are employee wages, fringe benefits, and employer wage taxes. The combination of fringe benefits together with employer wage taxes is often known as "labor burden," and the term "burdened labor cost" is defined as the employee wages plus the labor burden. All three of the elements must be included together if true total employee cost is to be known.

Total burdened labor costs are all of the expenditures that an employer has as a result of using employees. This is much different than employee take-home pay, which is the amount that the employee has left over when all deductions and payroll taxes are subtracted from their gross pay. Figure 4-7 shows a graphical representation of this concept with the employee's take-home pay on the left end of the scale and the total employer burdened labor costs on the right end of the scale, with the employee's hourly pay rate between. In the example, the employee is paid at a rate of $10.00 per hour. His take-home pay might be around $7.00 or less an hour, and the total cost to his employer might be around $18.96 per hour. The $7.00 employee take-home pay amount is just an estimate because the actual amount would vary based upon a number of factors outside of the employer's control. The three categories of cost, employee wages, fringe benefits, and employer payroll taxes are important for the construction estimator to understand.

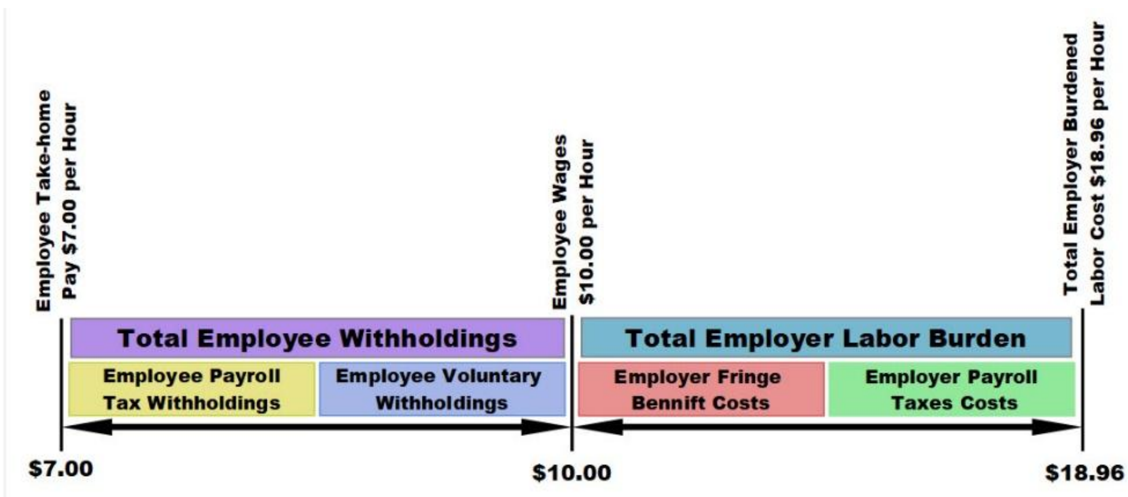


Figure 4-7: Graphical representation of difference between take home pay and total employer labor burden cost.

Employee Wages

The Fair Labor Standards Act (FLSA) requires that most employees in the United States be paid at least the federal minimum wage for all hours worked and overtime pay at time and a half the regular rate of pay for all hours worked over 40 hours in a workweek. The FLSA provides an exemption from both the minimum wage and overtime requirements for employees employed as bona fide executive, administrative, professional, and outside sales employees. These are known as salaried or exempt employees.

Salaried Employees

There are specific requirements mandated by law for employees to be classified as a salaried or exempt employees. The United States Department of Labor sets the following standards for workers to be classified as exempt or salaried employees:

“To qualify for exemption, employees generally must be paid at not less than $455* per week on a salary basis. These salary requirements do not apply to outside sales employees, teachers, and employees practicing law or medicine. Exempt computer employees may be paid at least $455* on a salary basis or on an hourly basis at a rate not less than $27.63 an hour.

Being paid on a ‘salary basis’ means an employee regularly receives a predetermined amount of compensation each pay period on a weekly, or less frequent, basis. The predetermined amount cannot be reduced because of variations in the quality or quantity of the employee’s work. Subject to exceptions listed below, an exempt employee must receive the full salary for any week in which the employee performs any work, regardless of the number of days or hours worked. Exempt employees do not need to be paid for any workweek in which they perform no work. If the employer makes deductions from an employee’s predetermined salary, i.e., because of the operating requirements of the business, that employee is not paid on a ‘salary basis.’ If the employee is ready, willing and able to work, deductions may not be made for time when work is not available.”

https://www.dol.gov/whd/overtime/fs17g_salary.htm

In the construction industry, salaried employees are usually management employees such as executives, project managers, project engineers, and superintendents. Salary employees can be paid on a weekly, biweekly, monthly, or other basis. Figure 4-8 shows an example of a salaried employee’s pay, which is based upon a monthly wage.

Salaried employee monthly wage. (Not paid by the hour)

$$\textbf{Monthly Wage}\ \frac{\$4,500.00}{\text{month}} \times \frac{12\ \text{month}}{\text{yr.}} = \frac{\$54,000.00}{\text{yr.}}$$

Figure 4-8: Yearly wage cost for a salaried employee.

Hourly Employees

Most craft and trade employees are classified as hourly employees, and their compensation is determined by several factors, including the wage rate of regular and overtime hours and the number of hours worked.

Regular Wages

Regular wages represent the amount that an employee is compensated for working 40 hours or less per week. The monetary amount of regular wages paid to employees is subject to a wide range of variables including specific market and economic conditions. The specific rate can be determined by negotiations or other factors that are outside of the contractor’s control such as union wages or what is known as “Davis-Bacon” wages.

Negotiated Wages

Negotiated wages are determined by negotiation between the employer and the employee and can be subject to wide variables. Both the employer and employee have freedom to determine what the rate will be. Highly desirable potential employees or those whose skills are in high demand can usually command higher wage rates than those who are less desirable or in less demand.

Union Wages

Union wages are determined by negotiations between the representing union and the contractors. The wages set for union employees are based upon their job classification and skill level, such as apprentice, journeyman, and master. Union wages are typically higher than negotiated. In addition, unions are typically responsible for training their employees.

Davis-Bacon Wages

Davis-Bacon wages are also known as “prevailing wages.” There is a wage standard set by the federal government on government funded projects. The Department of Labor researches labor cost in specific locations and publishes those rates for the locations. The prevailing wage is usually defined as a per-hour wage. In addition to the per-hour wage, a cash equivalent value of benefits is also specified that adds to the cost of the wage. For example, a Davis-Bacon hourly wage could be set at $30.00 per hour. In addition to the hourly wage, a supplementary $8.00 per hour fringe benefit wage could be added, making the effective wage rate $38.00 per hour.

Pay periods for hourly employees can be weekly, biweekly, monthly, or other. However, regardless of the pay period, the wages are calculated on a 40-hour workweek basis. This is typically based upon a five day, eight hours per day, 40-hour workweek schedule, but other schedules could also apply. Estimating the cost for regular wages is based upon the 40-hour workweek and a 52-week year, which equals 2,080 hours per year. Figure 4-9 shows the yearly regular wage costs for a non-exempt employee who earns $10.00 per hour and works full time at 40 hours per week.

$$\text{Hourly wage rate} = \frac{\$10.00}{\text{hour}}$$

$$\text{Weekly wage } \frac{\$10.00}{\text{hr.}} \times \frac{40\text{ hrs.}}{\text{wk.}} = \frac{\$400.00}{\text{wk.}}$$

$$\text{Yearly Wage } \frac{\$400.00}{\text{wk.}} \times \frac{52\text{ wks.}}{\text{yr.}} = \frac{\$20{,}800.00}{\text{yr.}}$$

Note: using monthly calculations will yield incorrect result because there are 4 extra weeks per year

$$\textbf{Example: } \frac{\textbf{4 wks.}}{\textbf{month}} \times \frac{\textbf{12 months}}{\textbf{yr.}} = \frac{\textbf{48 wks.}}{\textbf{yr.}}$$

Figure 4-9: Yearly regular wage costs for non-exempt employees.

Wages for work that total 40 hours or less per week are classified as regular wages, and wages for work that exceed over 40 hours in a given week are classified as overtime wages.

Overtime Wages

Overtime wages are paid for non-exempt employees whenever they work for more than 40 hours per week. Overtime wages are calculated using 1 ½ times the employee’s regular wage. This is commonly known as time and a half. Figure 4-10 shows the overtime calculations for the employee in Figure 4-9 who worked 12 weeks of overtime in the preceding year and averaged 10 hours of overtime in each of those 12 weeks.

$$\text{Overtime wage rate } \frac{\$10.00}{\text{hr.}} \times 1\frac{1}{2} \text{ times} = \frac{\$15.00}{\text{hr.}}$$

$$\text{Number weeks' overtime per year} = 12$$

$$\text{Average number overtime hours per week} = 10$$

$$\text{Overtime hours'year } \frac{10 \text{ hrs}}{\text{wk.}} \times \frac{12 \text{ wks}}{\text{yr.}} = \frac{120 \text{ hrs}}{\text{yr.}}$$

$$\text{Overtime pay } \frac{\$15.00}{\text{yr.}} \times \frac{120 \text{ hrs.}}{\text{yr.}} = \frac{\$1{,}800.00}{\text{yr.}}$$

$$\text{Total yearly wages} = \text{regular wage} + \text{overtime wages}$$

$$\textbf{Yearly wages: } \frac{\$20,800.00}{\textbf{yr.}} + \frac{\$1,800.00}{\textbf{yr.}} = \frac{\$22,600.00}{\textbf{yr.}}$$

Figure 4-10: Overtime Calculations.

Other Wages

Other wages include taxable employment compensation outside of regular and overtime wages. Some examples of other wages include bonuses, allowances, and cash equivalents.

Bonuses: Bonuses are cash payment to employees outside of regular employment compensation. Examples of bonuses could include a bonus for exceeding a production goal or a Christmas bonus. They can be paid on a one-time basis or more often as the company policy specifies.

Allowances: Allowances are cash payments given to an employee to cover the costs of some expenses. For example, a construction superintendent who is required to use their own vehicle to visit different job sites may be paid a monthly allowance for the use of their vehicle. Allowances are different from mileage reimbursements in which the mileage is recorded and the employee is reimbursed at a set rate (usually established by the IRS). Reimbursements are not considered a form of taxable wages, whereas allowances are. This means that they are subject to federal tax withholding requirements.

Cash Equivalents: Cash equivalents are payments that are made to the employee in lieu of a fringe benefit that is due. This type of wage can be used on federally funded construction projects where contractors are required to pay the "prevailing wage," which includes both a per-hour wage and an additional fringe benefit requirement. With these types of project wages, the contractor can choose to establish an appropriate benefit program such as health insurance, retirement programs, or 401K benefits, or they may choose to pay the employee the cash equivalent of the benefit. These payments are considered income and subject to tax withholding requirements. Figure 4-11 shows an example of other wage calculations for an employee who receives a $500.00 per year Christmas bonus and a $250.00 per month truck allowance.

Christmas bonus = $500.00

$$\text{Truck allowance } \frac{\$250.00}{\text{month}} \times \frac{12 \text{ month}}{\text{yr.}} = \frac{\$3{,}000.00}{\text{yr.}}$$

Total bonuses, cash equivalents, & allowances = $3,500.00

Figure 4-11: Bonus and truck allowance costs for an employee.

Total Taxable Wage

The total taxable wage of an employee is the sum of the employee's regular wage, overtime wage, bonuses, allowances, and cash equivalents. Figure 4-12 shows the total taxable wages for an employee who is paid $10.00 per hour, works 120 additional hours per year overtime, receives a $500.00 Christmas bonus, and $250.00 per month truck allowance. This employee's total taxable wages would be $26,100 per year.

Total taxable wages:

Regular wages:	**$20,800.00 yr.**
Overtime wages:	**$1,800.00 yr.**
Bonuses:	**$500.00 yr.**
Allowances:	**$3,000.00 yr.**
Cash equivalents:	**$0.00 yr.**
Total:	**$26,100.00 yr.**

Figure 4-12: Total taxable wage of an employee.

Fringe Benefits

Fringe benefits are compensation items that are provided to employees as a result of their employment. Fringe benefits can be defined as either a taxable or non-taxable fringe benefit. The distinction between taxable and non-taxable is set by the law and defined by the Internal Revenue Service. Fringe benefits are considered taxable unless they are specifically defined as non-taxable under the law.

Taxable Fringe Benefits

One example of taxable fringe benefits could include holidays, vacations, or sick leave. It is considered a taxable fringe benefit because employees are paid for days that they do not work and that pay is subject to taxes.

Holidays

Paid holidays are time off that employees are given from work to celebrate specific national or local holidays for which they are paid their regular wage.

Vacations

Paid vacations are time given off to employees for which they are paid while vacationing. Company rules often establish vacation policies, such as employees accrue a number of days' vacation per year based upon their years of employment. For example, a company may have a policy that requires employees to work for one year before they qualify for paid vacation days. After a year, they may qualify for a minimum number of vacation days per year, such as five per year. Each additional two years of employment qualifies the employee for an additional paid vacation day per year up to the company maximum of 10 days' vacation per year.

Sick Leave

Sick leave is also paid time off given to employees when they are sick. Companies may have ridged standards for what qualifies as sick leave, or they may have more relaxed policies that provide more employee discretion when taking sick days.

Employees are paid for holidays, vacations, and sick leave on a 40-hour per week basis. Overtime usually cannot be collected at the same time as receiving pay for these times off. The cost to employers for providing these benefits to their employees should be recouped throughout the year by adjusting costs to clients by using the concept of billable hours.

Billable and Non-Billable Hours

Employee pay for holidays, vacations, and sick leave is typically not billable to a specific job. The cost should be accrued throughout the year by billing the cost as part of the labor burden. This is done by first calculating the number of hours that an employee may have during the year in accrued paid holidays, vacations, and sick leave. Figure 4-13 shows an example of an employee that has 6 days of paid holidays per year, 10 days of paid vacation, and 4 days of paid sick leave. Each of these days are calculated based upon an eight-hour day and shows a total of 160 hours for which the employee is paid. The 160 hours are known as non-billable hours.

Paid holidays, vacations, and sick leave:

$$\text{Paid holidays } \frac{6 \text{ days}}{\text{yr.}} \times \frac{8 \text{ hrs.}}{\text{day}} = \frac{48 \text{ hrs.}}{\text{yr.}}$$

$$\text{Paid vacations } \frac{10 \text{ days}}{\text{yr.}} \times \frac{8 \text{ hrs.}}{\text{day}} = \frac{80 \text{ hrs.}}{\text{yr.}}$$

$$\text{Paid sick leave } \frac{4 \text{ days}}{\text{yr.}} \times \frac{8 \text{ hrs.}}{\text{day}} = \frac{32 \text{ hrs.}}{\text{yr.}}$$

$$\textbf{Total nonbillable hrs.} \frac{48 \text{ hrs.}}{\text{yr.}} + \frac{80 \text{ hrs.}}{\text{yr.}} + \frac{32 \text{ hrs.}}{\text{yr.}} = \frac{160 \text{ hrs.}}{\text{yr.}}$$

Figure 4-13: The number of non-billable hours per year is the total hours of all paid holidays, paid vacations, and sick leave.

The total number of hours that the employee is paid for in the year is a total of the regular work hours, overtime hours, holiday hours, vacation hours, and sick leave hours. The employer can only bill for the time that the employee is on the job. The time that the employee spends on holidays, vacations, and sick leave are non-billable hours. Figure 4-14 shows the number of hours that an employer can bill for if the employee had a total of 160 non-billable hours in the year based upon the accrued holidays, vacations, and sick leave.

This employee has potential regular hours of 2,080 hours per year based upon the regular 40 hours per workweek and 52 weeks per year.

$$40\frac{Hrs.}{Wk.} \times 52\frac{Wks.}{Yr.} = 2,080\frac{Hrs.}{Yr.}$$

In addition, the employee works an average of 10 hours per week for 12 weeks per year for a total of 120 overtime hours per year.

$$10\frac{Hrs.}{Wk.} \times 12\frac{Wks.}{Yr.} = 120\frac{Hrs.}{Yr.}$$

Some of the 40 hours per week pay that the employee is paid are given as paid holidays, vacations, and sick leave. The hours that the employee is paid for which he does not work are non-billable hours.

Total hours paid per year:

$$\text{Regular hours } \frac{52 \text{ wks.}}{\text{yr}} \times \frac{40 \text{ hrs.}}{\text{wk.}} = \frac{2080 \text{ hrs.}}{\text{yr.}}$$

$$\text{Overtime hours } \frac{12 \text{ wks}}{\text{yr}} \times \frac{10 \text{ hrs.}}{\text{wk.}} = \frac{120 \text{ hrs.}}{\text{yr.}}$$

Total hours paid per year = 2080 hrs. + 120 hrs. = 2200 hrs.
Total billable hours per year = 2200 hrs. – 160 hrs. = 2040 hrs.

Figure 4-14: Employee total billable hours are calculated by subtracting the non-billable hours from the total hours worked.

Non-Taxable Fringe Benefits

A second form of fringe benefits for employees is known as non-taxable fringe benefits. These are wages and benefits that are paid to employees that are not subject to payroll taxes. The description of a non-taxable benefit is defined by the following from the IRS:

"In most cases, the excluded benefits aren't subject to federal income tax withholding, social security, Medicare, federal unemployment (FUTA) tax, or Railroad Retirement Tax Act."

(RRTA) taxes and aren't reported on Form W-2.

https://books.byui.edu/-FFVx

A wide range of fringe benefits can qualify under certain conditions as non-taxable. However, the most common non-taxable wages and benefits offered are insurance and retirement benefits.

Insurance Benefits

Employers often offer some combination of health, dental, life, and disability insurance benefits to their employees. The cost for these insurance benefits can be paid entirely by the employer or the employee and shared between the employer and employee. The money expended for qualifying insurance payments by either the employer or the employees are not subject to income tax withholding, social security, Medicare, or federal unemployment taxes and are considered exempt expenses. Figure 4-15 shows an example of the calculated yearly health insurance cost to the employer if the total monthly cost for the insurance package was $950.00 per month and the employer and employee split the cost of the insurance premiums by each paying half.

Monthly health insurance premiums = $950.00

Employer pays ½ = $475.00
Employee pas ½ = $475.00

Yearly employer health insurance premiums:

$$\frac{\$475,00}{\text{month}} \times \frac{12 \text{ months}}{\text{yr.}} = \frac{\$5,700.00}{\text{yr.}}$$

Figure 4-15: The calculated yearly insurance cost to the employer.

Retirement Benefits

Employers frequently offer retirement benefits to their employees. Examples of retirement benefits include union pensions, traditional pension plans, profit sharing plans, and 401(k) plans. The cost of these benefits may be paid entirely by the employer, shared between the employer and employee, or paid entirely by the employee. Regardless of who pays the cost, these benefits are also exempt from payroll taxes. Figure 4-16 shows the calculated yearly cost to the employer who contributes matching funds to an employee's 401(k) plan. The employee deposits 6% of his total taxable wages including regular wages, overtime wages, bonuses, allowances, and cash equivalents into a 401(k) retirement account. The example below is based upon a total taxable wage of $26,100 per year; the employee deposits 0.06 x $26,100.00 = $1,566.00 into their 401(k) account. The employer matches 75% of the employee's contribution or 0.75 x $1,566.00 = $1,174.50 into the employee's 401(k) account.

Employees total yearly wages = $22,600.00 yr.
Employees total yearly bonuses and allowances = $3,500.00 yr.
Total taxable wages: $22,600.00 yr. + $3,500.00 yr. = $26,100.00 yr.

Employee 401(k) contributions: 6% of total taxable wages.
Employee 401(k) contributions: 0.06 x $26,100.00 = $1,566.00 yr.

Employer contribution: 75% of the employee contribution rate = 4.5% of wages.
Employer 401(k) yearly matching contribution =0.045 x $26,100 = $1,174.50 yr.

Figure 4-16: 401(k) retirement contribution calculations.

Total Non-Taxable Fringe Benefits

Both the employer and the employee in Figures 4-15 and 4-16 made payments to the employee's health insurance and 401(k) retirement account. Their total non-taxable contributions are the sum of their yearly insurance premiums and retirement account deposits. This is shown in Figure 4-17.

Total employer non-taxable contribution per year = Insurance premium total + 401(k) matching contribution = $5,700.00 + $1,174.50 = $6,874.50

Total employee non-taxable withholding per year = Insurance premium + employee 401(k) yearly deposit =$5,700 + $1,566.00 = $7,266.00

Figure 4-17: Totals for both the employer and employee non-taxable contributions per year.

Payroll Taxes

A wide range of federal and state withholdings and taxes are assessed based upon payroll amounts. These payroll taxes can be charged to the employee, employer, or to both. Payroll taxes can contribute significantly to employment costs and need to be carefully determined based upon the specific situation. Payroll taxes include social security taxes, Medicare taxes, state and federal unemployment taxes, worker compensation insurance, and liability insurance.

Social Security and Medicare Taxes

The Federal Insurance Contributions Act (FICA) needs each employee to pay social security and Medicare taxes. The amount that is required for social security is 12.4% of an employee's wages, and the amount for Medicare taxes is 2.90% of wages. This totals a combined FICA contribution of 15.3%. This percentage has remained stable for many years. The federal government also establishes an earnings limit by which FICA contributions no longer have to be made. The limit usually goes up each year and is based upon average national wages. In 2018, the FICA earnings limit was $128,700.00. The law requires that the employees pay half or 7.65% of the FICA contribution and that an employer pay the other 7.65%. Self-employed individuals, such as independent contractors, must make contributions to social security and Medicare taxes through the Self-Employed Contributions Act of 1954. In the case of self-employed individuals, however, they are required to make the entire 15.3% contribution.

When determining labor cost, an estimator will only need to account for the 7.65% half of the employer FICA contributions. FICA tax is calculated in the following manner:

If an employee earns more in a year than the $128,700 earnings limit, their FICA contribution is equal to the maximum contribution, which is

$$\frac{\$128,700.00}{Yr.} \times 7.65$$

If an employee earns less in a year than the contribution limit of $128,700, the entire amount of their wages is subject to social security contributions. This earning limit does include all total taxable wages including regular wages, overtime wages, bonuses, allowances, and cash equivalents. The exception to this are contributions made by the employee for non-taxable fringe benefits such as insurance and retirement. Figure 4-18 shows an example of the FICA contributions that are due from an employee who has total taxable wages of $26,100.00 per year and has made the previously discussed $5,700.00 health insurance payments and 401(K) retirement withholdings.

Total yearly wages = $22,600
Total bonuses, allowances, and cash equivalents = $3,500.00 yr.

Total taxable wages per year = $22,600 + $3,500 = $26,100 yr.

Yearly employee health insurance premium = $5,700.00 yr.
Yearly employee 401(k) contribution = $1,566.00 yr.

Wages subject to FICA contributions = Total taxable wages – employee health insurance – employee 401(k) yearly contributions

Wages subject to FICA: $26,100.00 - $5,700.00 – $1566.00 = $18,834.00 yr.

Total employer FICA contribution = .0765 x $18,834.00 = $1,440.80 yr.

Figure 4-18: FICA contributions that are due from the employer.

Unemployment Insurance

By law, employers are required to pay federal unemployment tax (FUTA) and state unemployment tax (SUTA). For 2018, federal law required the payment of 6.0 % on the first $7,000.00 of wages that an employee earns. Most states have a state unemployment tax program, and if the employer meets the qualifications of their state requirements, the federal unemployment tax obligation is reduced by 5.4%, which means the employer pays 0.6% of the first $7,000.00 of wages. State unemployment tax requirements vary from state to state. For example, in the state of Idaho, the standard 2018 SUTA contribution was 1.0 % on the first $38,200 of total wages earned, including regular wages, overtime wages, bonuses, allowances, and cash equivalents. There can be a wide variation in rates due to the variations in an employer's claims history. Employers with a history of frequent layoffs and high unemployment claims will be given a higher claims rate than those with a lower claims history. The actual rate assigned must be obtained from the state agency that administers the state unemployment requirements in that state. New employers with no claims history will be assigned an experience rate based upon that state's requirements. In Idaho, new employers are assigned a rate of 1.0% until a claims history can be determined.

The FUTA tax is 0.6% for the first $7,000.00 in wages. Since the employee earned more than $7,000.00, the employer is required to pay 0.6% of $7,000.00 or $42.00. When calculating the SUTA Tax, the total compensation for the employee was $26,100 for the year, and since that is below the $37,800 minimum amount, all of the employee's wages are subject to SUTA tax. This employer has been assigned a rate by the state of 1.0%. The SUTA tax liability is

$$0.01 \times \frac{\$26,100.00}{Yr.} = \frac{\$261.00}{Yr.}$$

Both the SUTA and FUTA calculations are shown in Figure 4-19.

Total taxable wages = $26,100.00 yr.

Total unemployment premium (FUTA) = .006 x $7,000.00 = $42.00 yr.

Total unemployment premium (SUTA) = .01 x $26,100 = $261.00 yr.

Total unemployment, FUTA + SUTA: $42.00 yr. + $261.00 yr. = $303.00 yr.

Figure 4-19: The SUTA and FUTA calculations.

Workers' Compensation Insurance

By law, all employers are required to carry workers' compensation insurance for their employees. This insurance helps pay the medical expenses and some lost wages for employees who are injured in the course of their employment. It may also pay benefits to survivors of employees who are killed in the course of their employment. The entire cost of workers' compensation insurance is paid by the employer and is based upon the type of work performed by the employee and the company's accident history. Employees are classified according to categories established by the National Council of Compensation Insurance (NCCI). Some categories of employment are considered more hazardous than others, and employees in more hazardous categories of employment are assigned a higher worker compensation premium rate. In addition, different states have different premium rates. In Idaho, roofing work (5551) is considered a high-risk category and is assigned a rate of $18.49 for every $100.00 or 18.49% of wages paid. Carpentry-NOC (5403) is assigned a rate of $10.04 per $100.00 of wages paid or 10.04%.

The premium rate for workers' compensation insurance may be modified due to the experience history of the employer. Employers with a history of frequent accidents or costly claims are assigned a higher rate than employers with a lower history of accidents and claims. This is known as an experience modifier and can have a dramatic effect on the workers' compensation claims. Figure 4-20 shows the workers' compensation premium payment for the employee in Figure 4-12. The employee is classified as Carpentry-NOC and is assigned a premium rate of 10.04%. In addition, the company has been given an experience modifier rating of 1.05%. Workers' compensation insurance is based upon the total employee compensation including regular wages, overtime wages, bonuses, allowances, and cash equivalent payments. The employee's total compensation for the year was $26,100.00, which is multiplied by 10.04% and equals $2,620.44. This sum is multiplied by the experience modifier of 1.05 for a total premium payment of $2,751.46 per year.

Total taxable wages = $26,100.00

Premium rate: Carpentry-NOC = 10.04%

Experience modifier = 1.05

Premium payment = $26,100.00 x 0.1004 = $2,620.44 Yr.

Premium adjustment for experience modifier = $2,620.44 x 1.05 = $2,751.46 Yr.

Workers' compensation premium = $2,751.46 Yr.

Figure 4-20: The workers compensation premium payment for the employee.

Liability Insurance

Liability insurance protects the company and employees from claims such as bodily injury, property damage, or loss that may arise as a result of failure to use reasonable care in conducting business operations. The premiums for general liability insurance vary by state and the contractor's record of claims. The premiums for general liability are based upon payroll cost for each class of trade employed. For example, the premium payments for a concrete finisher may be 5% of the payroll, and a carpenter may be 3.9% of the payroll. The liability insurance premium for the employee in Figure 4-12 is based upon their total compensation of $26,100.00 and a 3.9% premium rate. This results in a yearly liability insurance premium payment of $1,017.90 for that employee. This is shown in Figure 4-21.

Total taxable wages = $26,100.00

Premium rate, carpentry = 3.9%

Liability premium = $26,100 x 0.039 = $1,017.90/yr.

Figure 4-21: Yearly liability insurance premium payment.

Total Burdened Labor Cost

The total annual labor cost is determined by summing the wages paid to the employee and adding the cost of the individual burden items. Figure 4-22 shows the total annual labor cost for the employee in Figure 4-12.

Total taxable wages	=$26,100.00 Yr.
Employer health insurance premium	= $5,700.00 Yr.
Employer 401(k) matching contribution	= $1,174.50 Yr.
Employer FICA contribution	= $1,440.80 Yr.
Unemployment premium (FUTA)	= $42.00 Yr.
Unemployment premium (SUTA)	=$261.00 Yr.
Workers' compensation premium	=$2,751.46 Yr.
Liability insurance premium	=$1,017.90 Yr.
Total burdened labor cost	=$38,487.66 Yr.

Figure 4-22: The total burdened labor cost for the employee.

The average hourly wage for this employee is calculated by dividing the total yearly employer cost by the number of billable hours. It was determined in Figure 4-6 that the employee had accrued 2,040 billable hours. Figure 4-15 shows the calculations for determining the average hour wage rate for this employee.

Total burden labor cost: $38,487.66 yr.

Total billable hours per year: 2040 yr.

$$\text{Average hourly wage rate: } \frac{\$38,487.66}{2040\text{ Hrs.}} = \frac{\$18.87}{\text{Hr.}}$$

Figure 4-23: The calculations for determining the average hour wage rate for this employee.

The labor burden markup percentage is calculated by dividing the total net annual payroll by the annual cost of the billable wages. The employee in Figure 4-3 had a total net annual payroll of $39,368.81 and a total employee compensation, including bonuses, allowances, and cash equivalents of $26,100.00. The money that is paid for holidays, sick leave, and vacations needs to be subtracted from the total employee compensation and the total yearly compensation needs to be divided by that amount. This is shown in Figure 4-24.

Total net annual payroll: $38,487.66 yr.

Total taxable wages: $26,100.00 yr.

Employee vacation, sick leave, and holiday pay (non-billable pay): 160 x $10.00 = $1,600.00 yr.

Total employee compensation – non-billable pay: $26,100.00 - $1,600.00 = $24,500 yr.

Burden markup = (38,487.66/24,500.00)-1 = 63.56%

Figure 4-24: The labor burden markup percentage is calculated.

Determining the Weighted Average Wage Rate

The weighted average wage rate is the average of the total burdened labor cost for each employee in the crew. This is calculated by adding up the burdened labor cost for each crew member and dividing by the number of members in the crew. Figure 4-25 shows an example of this calculation for a crew of three.

Weighted Average Wage Rate

Employee	Position	Total Burdened Labor Rate
John Jackson	Foremen	$27.50
Sam Jones	Carpenter	$20.25
Larry Level	Laborer	$18.87
	Total Wages	$66.62

$$\textbf{Weighted Average Wage Rate: } \frac{\$66.62}{3} = \$22.21$$

Figure 4-25: Weighted average wage rate for a crew of three.

Calculating Total Burdened Labor Costs

The first section of this chapter explained that the formula for calculating the total labor costs is Production Rate x Wage Rate = Labor Cost.

The production rate for 100 lineal feet of footings was previously calculated by multiplying the length of the footings by the square footage of contact area for each lineal foot of footing. Next, the production rate of 0.115 hours per square foot of contact area is multiplied by the total square footage of contact area to determine the number of man-hours needed to form the footing. Finally, the total hours are divided by the productivity of 0.80 for a total calculation of 19.18 hours (Figure 4-26).

Total Manhours for 100 Lineal Feet Footing Forms

Footing Length x Square Foot Contact Area per Foot

$$100\ \text{LF} \times 1.334\ \frac{\text{SFCA}}{\text{LF}} = 133.4\ \text{SFCA}$$

Man-hours per Square Foot x Square Foot Contact Area

$$0.115\ \frac{\text{ManHrs}}{\text{SFCA}} \times 133.4\ \text{SFCA} = 15.34\ \text{Manhrs}$$

Total Man-hours Divided by Productivity Factor

$$\frac{15.34\ \text{ManHrs}}{.80} = 19.18\ \text{ManHrs}$$

Figure 4-26: Man-hour calculations for 100 lineal feet footing.

The total burdened labor cost is determined by multiplying the production rate by the weighted average wage rate.

$$\frac{\$22.21}{Manhr.} \times 19.18\ Manhrs = \$425.99$$

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Preconstruction Cost Items

This section will cover estimating the costs that are usually incurred either before a construction project begins or early in the building process. Expenses include building plan costs, engineering and development costs, building lot costs, building permits, plan check fees, and hookup and impact fees.

Building Plan Costs

Many building projects do not have a building plan cost associated with them because in the traditional building model, the owner contracts separately with an architect or engineer to design the project. In this case, the expenses for the design and engineering of the project is the responsibility of the owner and not the contractor, and it doesn't need to be included in the estimate. There are times, however, when the contractor will have design and engineering expenses. An example of this would be if the contractor were to undertake a spec building project, such as building a house with the anticipation of selling the home either during the construction process or shortly after it is completed. In this case, there will be design and plan costs which will need to be included in the estimate.

On larger buildings, an architect is usually hired to design the project. The architect usually charges a fee based upon a percentage of the building cost estimate. The percentage that is charged can change with the size and complexity of the project. A typical fee percentage could be anywhere from a low of three percent to a high of ten percent or above.

Figure 6-5 Spec home for sale.

Usually, the greater the cost of the project, the lower the percentage of the fee. For example, a project that was valued at $3,000,000 might have an architect fee valued at five percent of the cost of the project. In this case the amount to be included in the estimate would be:

$$\$3,000,000 \times 5\% = \$150,000$$

On a smaller project such as a home valued at $200,000, the percentage might be 10 percent or higher. In this case, the cost of the plan to be included in the estimate would be

$$\$200,000 \times 10\% = \$20,000$$

In either case, additional engineering such as the design of the mechanical or electrical systems of the building are considered part of the design expenses and are included in the architect's fee.

Because of the high cost of using an architect, many smaller buildings including most homes are built without the aid of an architect. In this case, the plans are likely purchased from a plan service.

Plan service companies usually have thousands of different home plans covering many different styles and sizes. Some even provide a service where the plan can be customized for the individual owner. The cost of purchasing the plans depends upon a number of factors, including the size and complexity of the building and the number of copies of the plans that are needed. In most instances, purchasing a set of plans gives the buyer the right to build the building one time, but some companies offer volume discounts where the same building can be built a number of times and the cost for the plans each time it is built is reduced. Figure 6-6 shows a sample of a small house plan from a plan service and the associated costs for purchasing the plan to build the house a single time.

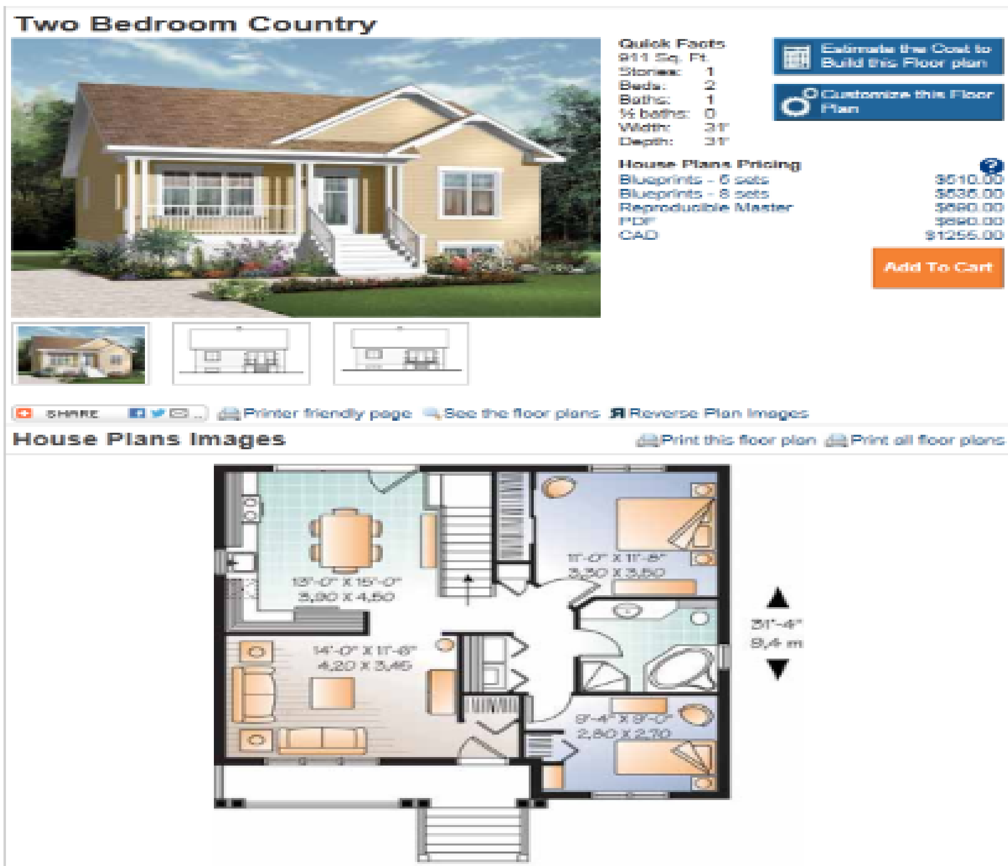


Figure 6-6 Home plan available for purchase.

http://www.builderhouseplans.com/house-plans/bhp/hwbdo63438.html

Engineering and Development Costs

The process of changing an undeveloped piece of real estate into an approved building lot can be some of the most complex and expensive expenditures associated with any construction project. A wide range of engineering and development costs may be encountered, including soil tests, installing roads, sewers, and other public utilities, making zoning changes, subdivision development, and recording fees. The development and engineering of building a subdivision is a specialty subgroup within the construction industry, and a detailed explanation of these costs is outside the scope of this text; however, a brief explanation of some of these costs will be given below.

Soil Testing

It is often desirable to conduct soil tests before beginning a building project to determine the nature of the soil and rock below the surface of the ground. This is done to determine if there are any hidden issues, such as high ground water levels, sinkholes, or unstable soil. A soil test is done by using a drill to take core samples, which are then analyzed to determine things, such as the nature and bearing capacity of the soil. In addition, if fill material is brought in to raise the ground level, other soil tests such as a compaction test will need to be performed.

Underground and Above-Ground Utilities

Most projects require the installation of a combination of both underground and above-ground utilities on the building site before construction can begin (Figure 6-7). The number of required utilities both underground and above-ground can be very extensive.

Figure 6-7 Storm sewer installation.

Roads

Roads will need to be built before any building process can begin. Many times, the developer is required to install streets, sidewalks, curbs, and gutters that will be deeded to the municipality (Figure 6-8). On other occasions, private roads will need to be built. In either case, the cost of designing, engineering and installing the road will need to be included as part of the development costs.

Figure 6-8 Curb and gutter installed prior to installing roadway.

Zoning

Zoning is a form of land use planning that controls the type of development that can occur in a specified zone. In practice, geographic regions within a municipality are separated into zone categories that specify the nature of the development that can occur within that zone. For example, zones may specify that buildings with similar usages be grouped together or separated from each other, such as the practice of separating single family homes from industrial facilities (Figure 6-9). There are times in the land development process that it is desirable for the developer to seek either a zoning change or a conditional use permit. This can be one of the most time consuming and expensive processes in the construction process. The time and costs involved can vary dramatically between municipalities and projects and should be carefully planned and estimated before attempting to undertake the process.

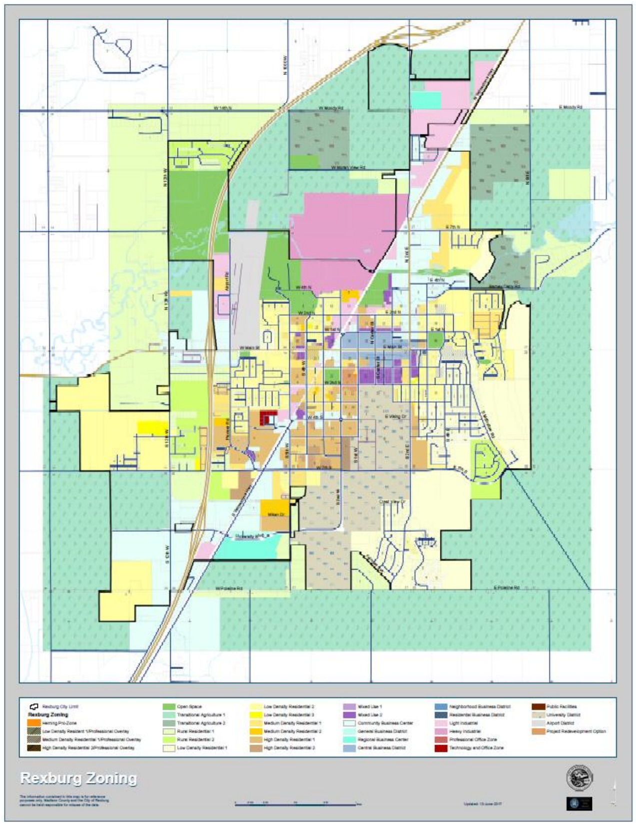


Figure 6-9 Rexburg, Idaho, zoning map example.

Purchased Building Lot

A builder may not have the time, the resources, or the desire to go through the delay and the expense of the development process and may choose to purchase a build-ready lot from a developer instead. In this situation, the developer undergoes the time and expense involved in the engineering and development process and passes those costs along to the buyer as part of the selling price of the lot (Figures 6-10 and 6-11).

In addition to the lot, there are usually additional expenses associated with the buying and selling of real estate. These additional costs include items such as title insurance and recording fees.

Title Insurance

The purpose of title insurance is to ensure that the buyer of real estate has a clear, unencumbered, and protected title to the property. It is a two-part process. First, the title professional will perform a search of public records, often going back many years, to ensure that that there are not any clerical errors, mistakes, unknown heirs, liens, or fraud involved with the property title, and that the seller really owns the property and is free to sell it. They will work to resolve any of these issues before the title is transferred. It is estimated that one-third of all title searches in the United States reveal unresolved concerns that must be cleared up before the title can be transferred. Second, the title company will work with an insurance vendor to underwrite an insurance policy to protect the buyer's interest should any future undiscovered issues be made known.

The cost of title insurance has two separate elements: the cost for doing the research and correcting any issues that arise, and a separate cost for the insurance policy to protect against any future problems. The cost can vary widely based upon the specifics of the policy, location, and individual title company. An online rate calculator can be useful in estimating title insurance costs.

Recording Fee

Another cost that is associated with purchasing property is a recording fee. This is a fee charged by the municipality to record the property sale on the public records and update the title records. There is usually a minimum charge associated with the recording of the first page and a charge for each additional page. For example, the recording fee for Madison County, Idaho, is $10.00 for the first page and $3.00 for each additional page.

Estimate Example 6-4 shows the summary of the building lot costs based upon the following figures:

- $30,000 purchase price for the completed ready-to-build lot.
- $352.00 title insurance costs calculated using an online rate calculator.
- $37.00 title recording fee for recording a ten-page title record, based on $10.00 for the first page and $3.00 for each additional page.

Building Lot						Cost Code		
Supplier	Item Description	Details	Size	Units	Unit Cost	Quantity	Override	Total
		Building Lot Cost						
	Lot Purchase Price	Building Lot 500 S Cameron Lane	1	Ea	$30,000.00	1		$ 30,000.00
	Lot Title Insurance	First American Title Insurance Policy	1	Ea	$ 352.00	1		$ 352.00
	Lot Recording Fee	10 Page Recording Fee	1	Ea	$ 37.00	1		$ 37.00
								$ -
				Total Building Lot	$			30,389.00

Estimate Example 6-4 shows the total building lot cost based upon a $30,000 lot purchase price, $352 title insurance policy, and a ten-page recording fee cost.

Building Permits

Most jurisdictions require the issuance of a building permit before the construction process is started. The cost for purchasing a building permit is usually based upon a percentage of the value of the improvements to the property. There is often a sliding scale where the actual percentage charged decreases as the value of the improvements increases. Table 6-2 shows the building permit fees for the city of Rexburg, Idaho, in 2018. Improvements valued at $500 or less are charged a base fee of $23.50. Improvements valued at $50,000 to $100, 000 are valued at 0.007 or .7%. Using this chart, a new home that was valued at $85,000 would have a permit cost of .007 × $85,000 = $595.00.

Per Construction Value of $ 0-500 Base	23.5000
Per Construction Value of $ 501-2,000	0.03050
Per Construction Value of $ 2,001-25,000	0.01402
Per Construction Value of $ 25,001-50,000	0.01008
Per Construction Value of $ 50,000-100,000	0.00700
Per Construction Value of $100,001-500,000	0.00560

Per Construction Value of $500,000-1,000,000	0.00475
Per Construction Value over $1,000,000	0.00365

Table 6-2 Rexburg, Idaho, 2018 building permit cost

Many building departments establish the value of the improvements based upon a square footage valuation. Typically, different types of construction and different building areas have a different square footage evaluation. For example, the National Construction Estimator lists the square footage costs for a typical residence in the third quarter of 2017 as $121.69 per square foot of the living area. It also explains that the cost of a finished basement would be 30% of the cost of the main floor, or 30% x $121.69 = $36.51 per square foot. In addition, the square footage cost outlined in the National Construction Estimator includes a 450 square foot garage and explains that the price can be adjusted for a larger or smaller garage by using 50% of the living area cost (NCE Figure 6-1).

To adjust the price for a smaller 440 square foot garage, the size of the garage would be subtracted from the 450 square foot standard.

$$450\ Ft^2\ -\ 440\ Ft^2\ =\ 10\ Ft^2$$

The square foot price of the garage would be determined by dividing the $121.69 square foot cost in half.

$$\frac{\$121.69}{Sf}\ \div\ 2\ =\ \frac{\$60.85}{Sf}$$

The amount that would be subtracted from the house price would be

$$10\ Ft^2\ \times\ \frac{\$60.85}{Ft^2}\ =\ \$608.50$$

Construction Economics Division

Construction Cost Index for New Single Family Homes

Period	% of 1967 Cost	$ per SF of Floor	Period	% of 1967 Cost	$ per SF of Floor	Period	% of 1967 Cost	$ per SF of Floor
2000			2006			2012		
1st quarter	516.8	72.30	1st quarter	641.63	89.77	1st quarter	762.28	106.66
2nd quarter	520.4	72.80	2nd quarter	641.73	89.79	2nd quarter	767.30	107.37
3rd quarter	524.2	73.33	3rd quarter	644.78	89.87	3rd quarter	770.24	107.82
4th quarter	525.7	73.55	4th quarter	655.91	91.77	4th quarter	773.50	108.23
2001			2007			2013		
2nd quarter	[illegible]	80.93	2nd quarter	[illegible]	[illegible]	2nd quarter	838.41	[illegible]
3rd quarter	587.05	82.10	3rd quarter	732.20	102.45	3rd quarter	837.71	117.98
4th quarter	611.14	85.51	4th quarter	735.44	102.90	4th quarter	840.98	118.44
2005			2011			2017		
1st quarter	608.70	85.17	1st quarter	744.17	104.12	1st quarter	848.72	119.53
2nd quarter	616.87	86.31	2nd quarter	751.04	104.94	2nd quarter	859.81	121.09
3rd quarter	621.21	87.18	3rd quarter	755.55	105.91	3rd quarter	863.94	121.69
4th quarter	631.35	88.34	4th quarter	757.83	106.66	4th quarter		

The figures under the column "$ per SF of Floor" show construction costs for building a good quality home in a suburban area under competitive conditions in each calendar quarter since 2000. This home is described below under the section "Residential Rule of Thumb." These costs include the builder's overhead and profit and a 450 square foot garage but no basement. The cost of a finished basement per square foot will be approximately 30% of the square foot cost of living area. If the garage area is more than 450 square feet, use 50% of the living area cost to adjust for the larger or smaller garage. To find the total construction cost of the home, multiply the living area (excluding the garage) by the cost in the column "$ per SF of Floor."

Deduct for rural areas	5.0%
Add for 1,800 SF house (better quality)	4.0
Add for 2,000 SF house (better quality)	3.0
Deduct for over 2,400 SF house	3.0
Add for split level house	3.0
Add for 3-story house	10.0
Add for masonry construction	9.0

Construction costs are higher in some cities and lower in others. Square foot costs listed in the table above are national averages. To modify these costs to your job site, apply the appropriate area modification factor from pages 12 through 15 of this manual. But note that area modifications on pages 12 through 15 are based on recent construction and may not apply to work that was completed many years ago.

NCE Figure 6-1 National Construction Estimator single family home costs for third quarter 2017 (p. 307).

The square foot cost should be adjusted for the area that the house will be built in. The area modification factor for Idaho Falls, Idaho, will be used for adjusting the square foot cost. NCE Figure 6-2 shows the area modification factors for Idaho with Idaho Falls highlighted showing a minus nine percent average.

Excel Figure 6-1 shows the calculations for a house with 1,152 square feet of living area, a 1,120 square foot finished basement, and a 440 square foot garage built in Rexburg, Idaho. The Building Permit Adjustment Percentage of 91% will be used to reflect the Idaho Falls area average.

Location	Zip	Mat.	Lab.	Equip.	Total Wtd. Avg.
Idaho Average		**0**	**-19**	**0**	**-9%**
Boise	837	1	-12	0	-5%
Coeur d'Alene	838	0	-21	0	-10%
Idaho Falls	834	-1	-19	0	-9%
Lewiston	835	0	-24	0	-11%
Meridian	836	0	-19	0	-9%
Pocatello	832	-1	-20	0	-10%
Sun Valley	833	0	-18	0	-8%

NCE Figure 6-2 NCE area modification factors for Idaho.

Building Permit

	SF	SF Valuation	Total
Main Floor	1152	$ 121.69	$140,186.88
Second Floor	0		$ -
Basement	1120	$ 36.51	$40,887.84
Garage	440	$ 60.85	$ (608.45)
Total Building Value	$		180,466.27
Building Permit Value Adjustment Percentage	91%		
Plan Check Fee Percentage	10%		
Adjusted Building Vale	$	164,224.31	

Excel Figure 6-1 Building valuation calculations.

Plan Check Fee

Another element of the building permit that needs to be calculated is the plan check fee. This is a fee charged for reviewing the building plans to assure that the planned structure is designed according to the applicable building codes. The plan check fee is usually calculated as a percentage of the building permit fee. The master fee list for the City of Rexburg, Idaho, identifies a plan check fee as 10% of the building permit fee.

Other Permit Fees

Frequently, there are also other types of building permits that are required such as electrical permits, mechanical permits, and plumbing permits. Each of these also requires additional permit fees. Figure 6-12 shows the master fee list for the city of Rexburg, Idaho, and lists fees associated with electrical, mechanical, and plumbing permits. The first is the electrical plan check fee of 10% of the electrical permit cost. The second is an inspection fee of $130.00 for a residential electrical inspection, based on the cost for a residence between 0 and 1,500 square feet. The third is a fee of $65.00 for the installation and inspection of a temporary residential electrical service.

BLDELPCK	Building Inspection	Electrical Permit	Plan Check Fee Percent of Electrical Permit	20170302	10%
BLDELSF1	Building Inspection	Electrical Permit	Single Family Residential Inspection from 0000 sf to 1500 sf	20110720	$130.00
BLDELSF2	Building Inspection	Electrical Permit	Single Family Residential Inspection from 1501 sf to 2500 sf	20110720	$195.00
BLDELTMP	Building Inspection	Electrical Permit	Residential Temporary Service	20110720	$65.00
	Building	Electrical	Inspections not included in permit fee per hour & one hour		
BLDMEPCK	Building Inspection	Mechanical Permit	Plan Check Fee Percent of Mechanical Permit	20170302	10%
BLDMEPX2	Building Inspection	Mechanical Permit	Failure to acquire a Permit before construction	previous	double all fees
BLDMESF1	Building Inspection	Mechanical Permit	Single Family Residential Inspection 0000-1500 sf	20110720	$130.00
BLDMEPCK	Building Inspection	Mechanical Permit	Plan Check Fee Percent of Mechanical Permit	20170302	10%
BLDMEPX2	Building Inspection	Mechanical Permit	Failure to acquire a Permit before construction	previous	double all fees
BLDMESF1	Building Inspection	Mechanical Permit	Single Family Residential Inspection 0000-1500 sf	20110720	$130.00

Figure 6-12 Electrical and mechanical permit fee structure for Rexburg, Idaho.

https://books.byui.edu/-nBvH

The mechanical and plumbing permits are also priced based upon the square footage of the residence. The price for homes in the 0 sq. ft. to 1,500 sq. ft. range is also $130 each for both the mechanical and plumbing permits. In addition, a plan check fee of 10% of the cost of the permit fee is accessed for both.

Impact, Connection, and Capacity Fees

In addition to building permit fees, municipalities also charge other fees as a result of construction. For example, part of the cost of operating and maintaining both a public and private utility structure is often recovered by levies and fees on the users of the utilities. The fees can include impact fees, capacity fees, and connection fees.

Impact Fees

In June of 2000, the announcement that Ricks Junior College would transition into a four-year university named BYU-Idaho had significant impact on the city of Rexburg, Idaho. The following decade and a half saw a significant increase in the student population, faculty, and support staff for the university. Building activity in Rexburg increased ten-fold the following year and has continued to increase in the years after, as numerous houses, apartments, businesses, and roads were built (Figure 6-13). The growth put significant strain on the city's public works structure and in September 2003, the city imposed an impact fee to help in expanding its public works infrastructure. The initial impact fee was set at $972.29 for a single-family home, $903.03 per unit in a single student apartment, $432.38 per married student apartment and $130.28 for commercial buildings. The fees have continued to increase as the impact of the university's expansion has been realized. Impact fees for the city of Rexburg include fees for parks, police, fire, and streets.

Capacity Fees

In addition to impact fees, Rexburg assesses capacity fees for the additional water and sewer capacity that they are required to provide as the city's population continues to grow. Originally called hook-up or connection fees, the fees associated with connecting to the city water and sewer structure are called capacity fees.

Connection Fees

Often, utilities services are also provided by private utility companies. This would commonly include landline telephone service, internet connection service, electrical power service, and natural gas supply. In some places, the water and sewer are also supplied by private companies. Many of these private companies charge connection fees for their services. Figure 6-13 shows a view of the Rexburg city web page describing the impact and capacity fees required by the city.

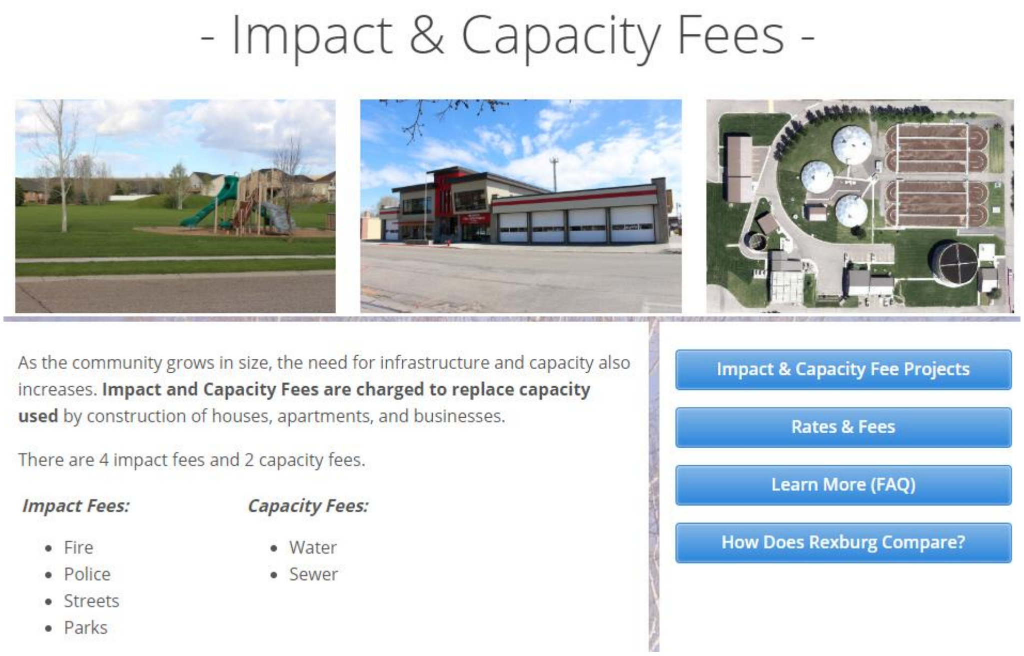


Figure 6-13 Rexburg city impact and capacity fee explanation.

The impact and capacity fees for the city of Rexburg can also be determined from the same city fee website as the building permit fees.

Construction Loans

Construction loans are short term loans that provide financing to cover the cost of building a project. When the project is completed and sold, the buyer acquires long term financing and the construction loan is retired.

Loan to Value Ratio

Oftentimes, a lender is unwilling to provide a loan that will cover the entire cost of the project. They want the borrower to have a stake in the project. The percentage of the total building costs that the lender is willing to finance is known as the loan-to-value ratio and is expressed as a percentage. In Estimate Example 6-6 above, the Adjusted Building Value is listed at $164,224.31. If a loan-to-value ratio was given by the lender of 90%, then the lender would be willing to finance 90% of the Adjusted Building Value.

$$\$164{,}224.31 \times 90\% = \$147{,}801.88$$

This would be the maximum amount that the mortgage company would be willing to finance for the loan. There are a number of costs that are associated with construction loans and each of these needs to be accounted for in the estimating process. Some of these potential costs include the loan origination fee and the interest reserve amount.

Building Permit

	SF	SF Valuatior	Total
Main Floor	1152	$ 121.69	$ 140,186.88
Second Floor	0		$ -
Basement	1120	$ 36.51	$40,887.84
Garage	440	$ 60.85	$ (608.45)
Total Building Value	$		180,466.27
Building Permit Value Adjustment Percentage	91%		
Plan Check Fee Percentage	10%		
Adjusted Building Vale	$	164,224.31	

Supplier	Item Description	Details	Size	Units	Unit Cost	Quantity	Override	Total
	Building Permit	Rexburg Single Family Dwelling	1	Ea	$ 0.00560	164224.31		$ 919.66
	Plan Check Fee	Percent of Building Permit	1	Ea	$ 91.97	1		$ 91.97
	Electrical Permit	Rexburg Single Family 0 to 1,500 SF	1	Ea	$ 130.00	1		$ 130.00
	Electrical Plan Check	Percent of Electrical Permit Fee	1	Ea	$ 13.00	1		$ 13.00
	Electrical Temp Service	Rexburg Temporary Service Fee	1	Ea	$ 65.00	1		$ 65.00
	Mechanical Permit	Rexburg Single Family 0 to 1,500 SF	1	Ea	$ 130.00	1		$ 130.00
	Mechanical Plan Check	Percent of Mechanical Permit Fee	1	Ea	$ 13.00	1		$ 13.00
	Plumbing Permit	Rexburg Single Family 0 to 1,500 SF	1	Ea	$ 130.00	1		$ 130.00
	Plumbing Plan Check	Percent of Plumbing Permit Fee	1	Ea	$ 13.00	1		$ 13.00
	City Capacity Fee-Water	Single Family Dwelling Fee	1	Ea	$1,700.00	1		$ 1,700.00
	City Capacity Fee-Sewer	Single Family Dwelling Fee	1	Ea	$1,745.00	1		$ 1,745.00
	City Impact Fee-Parks	Single Family Dwelling Fee	1	Ea	$1,020.00	1		$ 1,020.00
	City Impact Fee-Police	Single Family Dwelling Fee	1	Ea	$ 150.00	1		$ 150.00
	City Impact Fee-Fire	Single Family Dwelling Fee	1	Ea	$ 280.00	1		$ 280.00
	City Impact Fee-Streets	Single Family Dwelling Fee	1	Ea	$1,160.00	1		$ 1,160.00
	Telephone Connection	Not Required						$ -
					Total Building Permit	$		7,560.62

Estimate Example 6-4 Shows the elements of the building permit costs for a 1152 square foot building with a finished basement and a 440 square foot garage in Rexburg, Idaho.

Loan Origination Fee

A loan origination fee is a fee that is charged by a bank or other lender for writing a loan. The fee is charged up front and is usually priced as a percentage of the loan amount. Loan origination fees can vary widely between different lenders, types of loans, and circumstances. Commonly, loan origination fees cost 1/2% to 2% of the loan amount.

Once the origination fee percentage is provided by the lender, the cost of the fee can be estimated by multiplying the percentage by the loan amount. Using a loan amount of $147,801.88 from the previous example and a loan origination fee percentage of 1%, the loan origination fee would be calculated at

$147,801.88 x 1% = $1,478.02

Interest Reserve

A construction loan is structured differently than a conventional loan. With a conventional loan, the entire loan amount is distributed when the loan is issued, and the borrower begins making monthly or other periodic payments over a given period (fifteen or thirty years) to repay the loan amount and the interest that will accrue during the loan repayment period.

A construction loan is different in that it is a short-term loan and is issued for periods such as one or two years. Typically, it is expected that the construction loan principal and any accrued interest will be paid back by the sale of the property or refinancing with a long-term real estate mortgage and the ending of the loan.

Second, a construction loan is different in that the borrower often does not make monthly payments, neither interest nor principal, during the time that the loan is outstanding. This is because the borrower typically already has a mortgage or rent payment that must be made on their existing housing, and it would be difficult to make double mortgage payments. Nevertheless, interest does accrue during the loan period, but the periodic interest payments are paid out of the loan proceeds and then added to the loan amount. This is called the interest reserve.

Simple Interest Calculation

The interest amount on a loan, or what is known a simple interest, is calculated using the following formula:

Amount of Money Borrowed x Time in Years x Interest Rate

If $147,801.88 were borrowed for six months at an interest rate of 5%, then the total interest amount on the loan would be calculated using a formula of

$$\$147,801.88 \times \frac{6}{12} \times 5$$

* 6/12 is used because the money is borrowed for 6 months or ½ year.

Construction Loan Interest Calculations

Because the proceeds of construction loans are distributed over a period of time as the construction of the project progresses, the dollar amount that is due for the interest reserve also changes over time. In the typical construction cycle, the construction project starts out slowly as the builder acquires the necessary permits, mobilizes on the job site, and begins excavation. During these early phases of the project, the financial needs are relatively small, and only a small portion of the total amount of the construction loan is needed to pay these bills. Interest is paid on only the money that is actually dispersed from the loan account, so the amount needed to cover the interest reserve is small. As the construction cycle continues, the process accelerates as concrete is poured, the building is framed, and rough mechanical and electrical systems are installed. During this middle portion of the building cycle, the majority of the construction proceeds are distributed, and the amount needed to cover the interest reserve also increases. Finally, in the later portions of the construction cycle, the monetary requirements decrease as detail and punch list items are completed and the building is finished out.

Using the previous example of a loan amount of approximately $186,000 and given a construction time of six months, a month-by-month draw schedule might look something like the following:

- Month 1 = $5,000
- Month 2 = $12,000
- Month 3 = $33,000
- Month 4 = $50,000
- Month 5 = $37,000
- Month 6 = $10,802

Total = $147,802

The actual interest on the construction loan would be based upon the total amount of money that has been withdrawn at any given time

The actual interest costs would need to be calculated on a month by month basis using the total dollars of money borrowed up to that point. Using the draw schedule shown above, the actual interest cost for the first month would be

- Month 1 $5,000 × 1/12 × 5% = $20.83

The interest cost for the second month would be a based upon the total withdraws for both months one and two and would be

- Month 1, $5,000 + Month 2, $12,000 = $17,000

The actual interest cost for the second month would then be

- $17,000 × 1/12 × 5% = $70.83

The actual interest for the project the project would then be calculated as follows:

Month 1 = $5,000 × 1/12 × 5% = $20.83

Month 2 = $17,000 × 1/12 × 5% = $70.83

Month 3 = $50,000 × 1/12 × 5% = $208.33

Month 4 = $100,000 × 1/12 × 5% = $416.67

Month 5 = $137,000 × 1/12 × 5% = $570.83

Month 6 = $148,802 × 1/12 × 5% = $615.84

Total Interest = $1,903.34

In the early stages of estimating a project, it is difficult to get an accurate month-by-month cost breakdown of the project costs, and in reality, the actual disbursement of the loan funds may differ from any planned timetable. This will affect the total cost of the interest reserve amount. In order to account for this, it is common practice for estimators to assume that at any given time a total 50 percent of the loan funds will be dispersed to use that amount when calculating the interest reserve amount. Using this method, the interest reserve for the $147,802 construction loan would be calculated using the following formula:

50% of the Amount of Money Borrowed × Time in Years × Interest Rate

This would result in the following calculation:

$$(50\% \times \$147,802) \times \frac{6}{12} \times 5$$

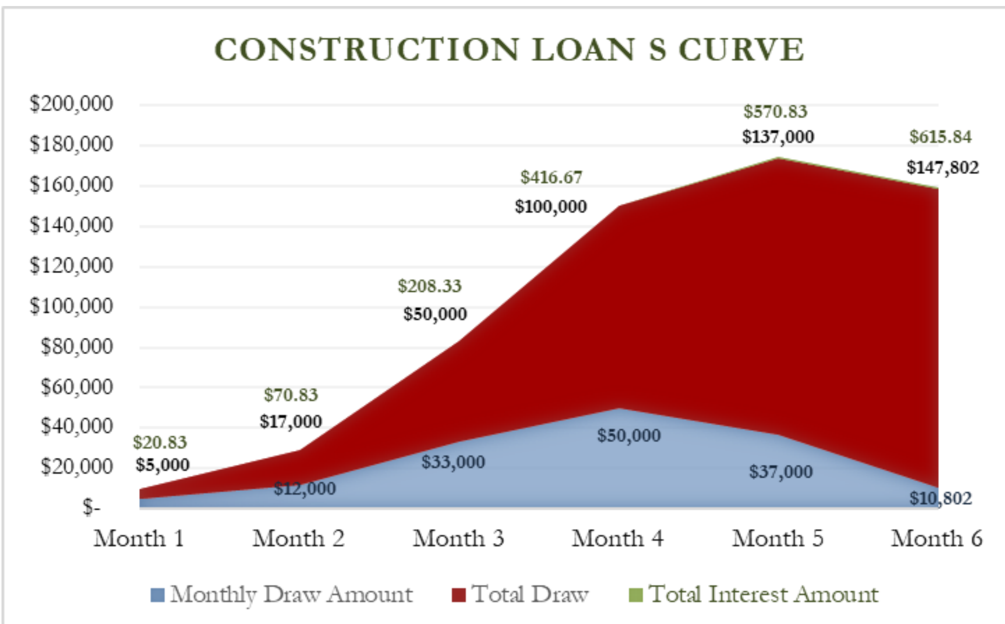


Chart 1 Chart showing the construction loan S curve.

The $1,847.53 amount of this calculation is 55 dollars less than the $1,903.34 that was estimated using a month-to-month formula in the example. Again, the month-to-month total could change based upon the actual disbursement schedule. Some estimators feel that the 50% figure is too low and use a higher percentage such as 55% or 60% of loan amount when calculating.

$$(55\% \times \$147,802.88) \times \frac{6}{12} \times 5$$

Estimate Example 6-5 shows the construction loan cost for an $147,801.88 construction loan for six months at a 5% interest rate. The loan origination fee is set at 1%, and the interest reserve percentage is set at 55%.

Construction Loan

Cost Code

Loan Term (Months)	6
Interest Rate	5.00%
Loan To Value Ratio %	90.00%
Loan Origination Fee %	1.00%
Interest Reserve Percentage	55.00%
Total Adjusted Building Value	$ 164,224.31
Loan Amount	$ 147,801.88

Supplier	Item Description	Details	Size	Units	Unit Cost	Quantity	Override	Total
	Origination Fee	Origination Fee	1	Ea	$ 147,801.88	0.01		$ 1,478.02
	Interest Reserve	Construction Loan	1	Ea	$ 2,032.28	1		$ 2,032.28
	Appraisal Fee	**Not Required**						$ -
	Inspection Fee	**Not Required**						$ -
	Title insurance	**Not Required**						$ -
								$ -
					Total Construction Loan	$		3,510.29

Estimate Example 6-6 Shows the elements of the construction loan costs for a $147,801.88 loan amount for six months at 5% interest and a 55% interest reserve percentage.

Additional information about construction loans can be obtained at HGExperts.com.

Real Estate Commission and Fees

The costs and fees associated with either the development of raw land into a buildable lot or the purchase of a build-ready lot has already been discussed. These costs will need to be included in the estimate. In addition, the sale of the finished structure on the lot is a separate real estate transaction and there may be other real estate, attorney, or legal fees related to that sale. Some of these costs and fees are paid by the buyer and some are paid by the seller, which, in this case, is the construction company. These costs will also need to be included in the estimate.

Attorney Fees

The requirement to have an attorney involved in a real estate transaction varies from state to state and sometimes even between different counties in a particular state. A discussion of these costs is outside of the scope of this text other than to note that it is the responsibility of the estimator to be aware of the costs of the specific legal requirements of a real estate transaction and to include any relevant costs in the estimate. A brief explanation of each state's specific requirements can be found at Escrowhelp.com.

Real Estate Commission

If a construction project is undertaken at the request of a specific owner, then a real estate commission usually will not be needed as part of the estimate; however, there are times when it is desirable for a builder to undertake a building project with the anticipation of selling the home during the construction process or after it is completed. This is known as building on speculation or what is called a spec home. Often, the builder contracts with a real estate agent to list and sell the spec home. In addition, some builders' volume of production is such that they can justify the expense of having an in-house real estate department which is responsible to market and sell their homes. In most cases, the expense of having a real estate agent sell a home is paid for by charging a real estate commission based upon the sale price of the house.

Real estate commissions are usually set as a percentage of the selling price of the house. Percentage rates are negotiable, but normal industry standards are usually set around six percent. In a real estate transaction where there is both a buying and a selling real estate agent, they would split the commission with each getting three percent. Each agent would then split their commission with their real estate broker as each gets one and a half percent as a final commission.

Imagine a situation where a builder contracts with a real estate agent or a situation where a company has its own in-house real estate transaction. For that agent to have exclusive rights to list all of the builders' homes, it might be necessary to negotiate a lower real estate commission percentage with the expectation that the lower rate would be compensated by a higher expected volume of sales. However, it would still be expected that an agent outside of this arrangement who brought a potential buyer to the table would expect to receive the normal three percent commission rate.

Establishing the Sales Price

The final sale price of any residential structure is highly variable and is based upon several factors including but not limited to the

- Hard costs of construction, including all labor and material costs.
- Construction company overhead requirements.
- Anticipate profit percentage.
- Total lot cost.
- Real estate commission.

Estimate Example 6-7 Real Estate

Real Estate

Cost Code

Real Estate Commission %	6.00%
Company Overhead %	8.00%
Company Profit %	10.00%
Total Lot Costs	$ 30,389.00
Total Adjusted Building Value	$ 164,224.31
Sales Price	$ 241,320.50

Supplier	Item Description	Details	Size	Units	Unit Cost	Quantity	Override	Total
		Real Estate Commission Cost						
	Real Estate Commission	6% Real Estate Commission	1	Ea	$ 14,479.23	1		$ 14,479.23
	Appraisal Fee	**Not Required**						$ -
	Title insurance	**Not Required**						$ -
	Legal Fees	**Not Required**						$ -
					Total Real Estate	$		14,479.23

Estimate Example 6-7 shows the real estate commission for a house with a selling price of $241,320.50

CITATIONS:

City of Rexburg. (2018). City Fees Directory. Retrieved May 8, 2018, from http://rexburg.org/pages/fee_list.php

Designer 390. (n.d.). Two Bedroom Traditional HWBDO63438 Traditional from BuilderHousePlans.com. Retrieved May 8, 2018, from https://books.byui.edu/-NJwo do63438.html

Pray, R. (2018). National construction estimator 2018 (66th ed.). Carlsbad, CA: Craftsman Book Company.

Basic Takeoff Detailed Process

Completing the Basic Takeoffs

In virtually any estimate, there will be some takeoffs that will be used multiple times when calculating quantities of specific materials. The estimator should establish what those takeoffs are at the very beginning of the estimating process, record the sums, and then use those totals each time they are needed. For example, if the estimator has calculated the total lineal footage of a specific wall type, then the total could be used in determining a wide range of specific materials quantities such as lineal footage of plate material, number of studs in the wall, square footage of insulation, drywall, quantities of paint and more. This section will go over the process for completing the basic takeoffs for the Arts and Crafts house. The process will begin floor area takeoffs.

Floor Area

The square footage of floor area for major portions of the structure are one of the first takeoffs that will need to be calculated. Most real estate transactions identify structures by the square footage of the living space and many of the needed costs of building, such as permits and financing, are calculated using those quantities. These quantities can also be used to calculate material quantities such as floor sheathing and concrete. Examples of these are the square footage of the living area of each floor such as the first floor, the second floor, and the basement. Other floor areas that need to be determined include non-living space such as the garage and porches.

Main Floor Living Area

Determining the size of the living area is one of the most fundamental quantities to calculate. The space is traditionally calculated to the outside the exterior walls and, as such, can generally be a fairly simple calculation that can be broken down into simple shapes. Figure 5-6 shows a graphic of the first floor with the main floor area highlighted in light tan and the garage area in gray.

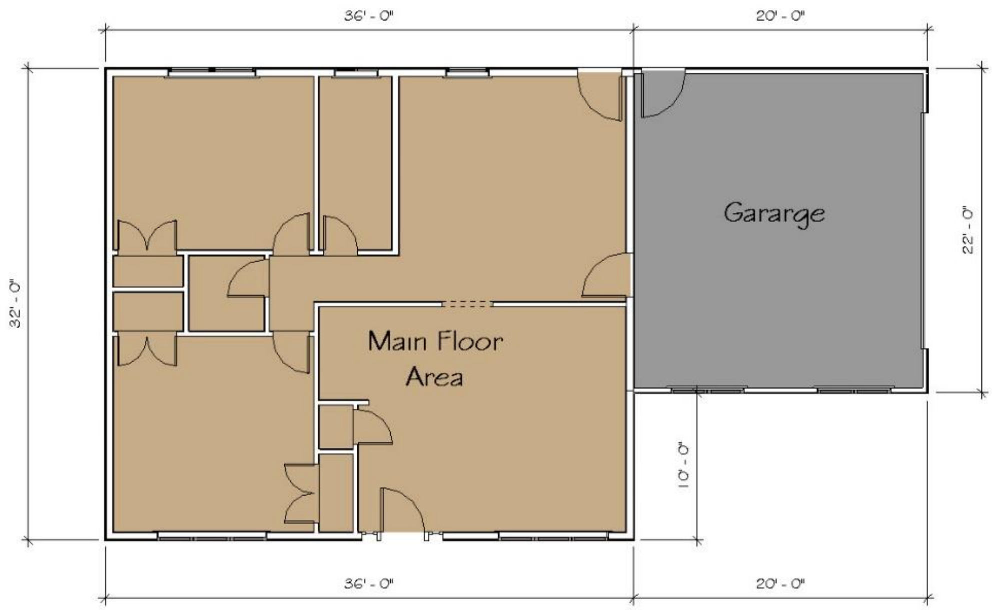


Figure 5-6 Graphic representation of the main floor and garage area of the building.

The area in this example is a simple rectangle and can be calculated by multiplying the thirty-six feet length of the rectangle by the thirty-two feet width using the following formula:

$$Length \times Width = SF\ Area$$

Or

$$36 \times 32 = 1,152\ ft^2$$

Garage Floor Area

The garage floor area can be calculated in the same fashion. In this case, the area will also be calculated to the exterior of the walls in order to gain an accurate measurement for the area in calculating the building permit. Another approach that would be useful with the garage floor area would be to calculate the area of the concrete floor. In this case, however, only the area to the exterior walls will be calculated as a simple rectangle of 22 feet by 20 feet using the following formula:

$$Length \times Width = Area\ ft.^2$$

Or

$$20' \times 22' = 440\ ft.^2$$

Basement Floor Area

The basement floor area will be calculated to the interior of the basement walls. This will also include the storage room under the front porch as is shown in Figure 5-7. Three rectangles will be calculated to determine the area. The large main floor rectangle is 34 feet 8 inches long and 35 feet 8 inches wide. The second rectangle under the front porch is 9 feet 8 inches long by 5 feet 7 inches wide. The third rectangle is the small doorway between the two and is 3 feet 2 inches long by 8 inches wide. The following formula will be used to calculate the area:

$$Basement\ Area + Porch\ Area + Doorway\ Area = Total\ Area$$

Or

$$(34'\text{-}8'' \times 30'\text{-}8'') + (9'\text{-}8'' \times 5'\text{-}7'') + (3'\text{-}2'' \times 8'') = Total\ Area$$

Or

$$1063.11\ ft.^2 + 53.97\ ft.^2 + 2.11\ ft.^2 = 1119.19\ ft.^2$$

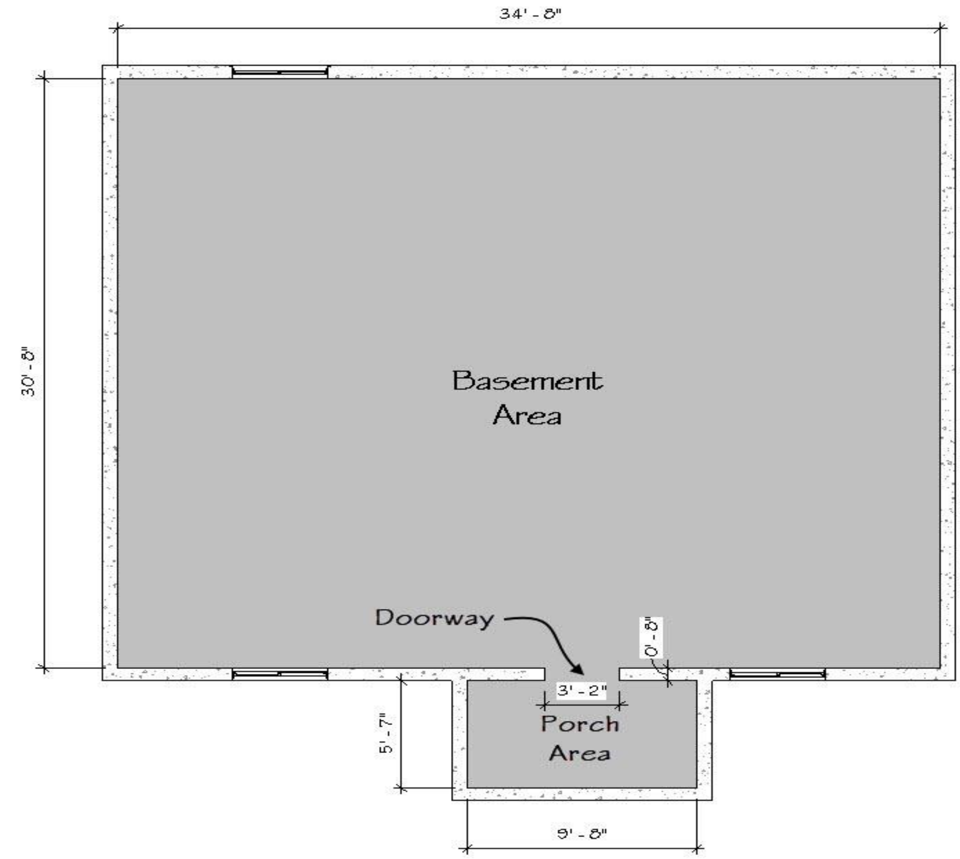


Figure 5-7 The basement floor area square footage is comprised of three separate floor areas.

Completing the Footings and Foundation Takeoffs

The next basic takeoffs to be completed will be the footing and foundation sections. Both sections show two distinct styles of footing and foundation. The two footing styles are the exterior wall footings and the interior grade footing. The two foundation styles are the main foundation and the garage foundation. This is shown in Figure 5-8.

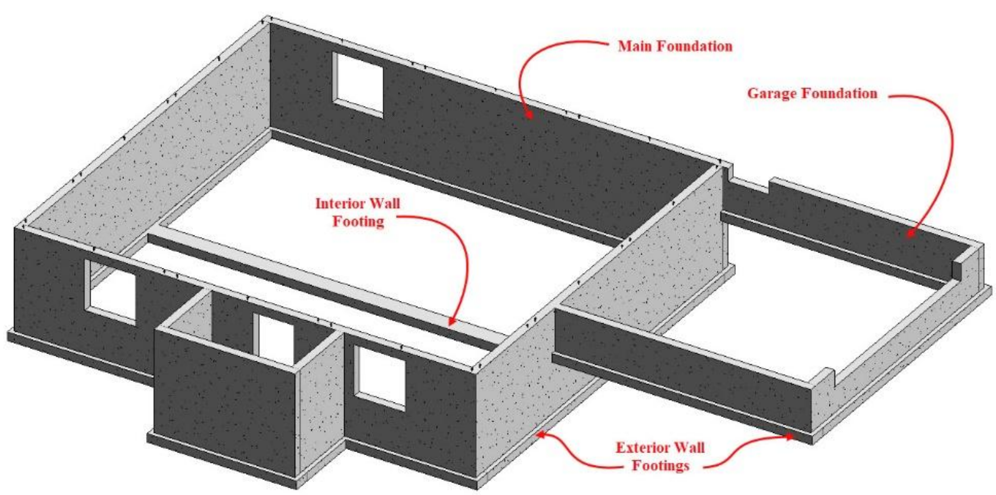


Figure 5-8 Three-dimensional footing and foundation view showing different footing and foundation styles.

Footing Takeoffs

The footings below both the main foundation and garage foundation are classified as exterior wall footings even though they support different foundation types. This is because both footings are identical in size, shape, and construction. The footings are 16 inches wide and 8 inches deep. Each footing also has two pieces of continuous horizontal rebar and vertical rebar dowel spaced at 32 inches on-center. The interior wall footing is also 16 inches wide by 8 inches deep and also has two pieces of continuous horizontal rebar, however, these footings do not have any vertical rebar dowel and, as such, are defined as a different style. This is shown in Figure 5-9.

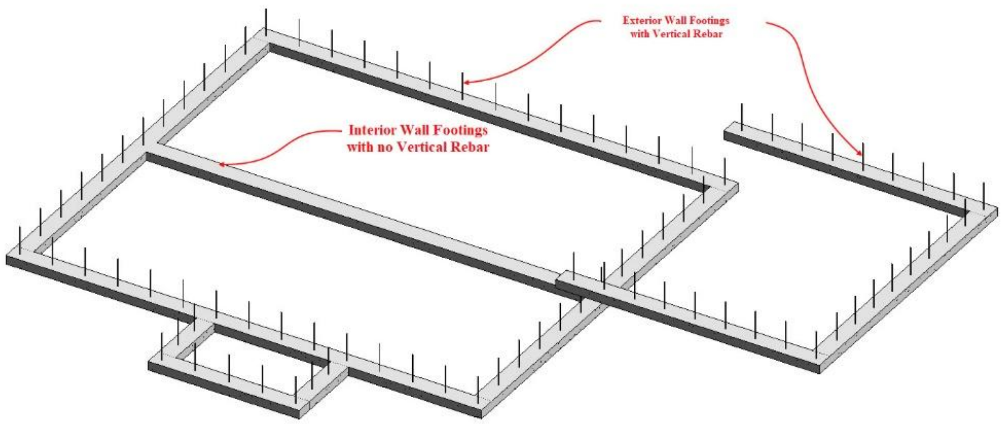


Figure 5-9 Exterior wall footings with vertical rebar and Interior grade footings without.

The particulars of footing and foundation size and construction information can usually be determined from section view drawings such as full building sections or more detailed wall sections. Figure 5-10 shows an example of a detailed footing and foundation wall section. The detail shows both dimensions and annotations listing the footing and foundation sizes and annotations describing the location, size, and spacing of the reinforcing rebar.

The length of the footings and foundations should be calculated in such a manner that corners are only counted once. If the measurements are calculated using only the exterior dimensions of the footing or foundation, the corners will be double counted resulting in excess concrete. If the measurements are calculated using only the interior dimensions, the corner will not be counted resulting in a shortage of concrete. One of several strategies could be employed to properly count the length of the footing or foundation.

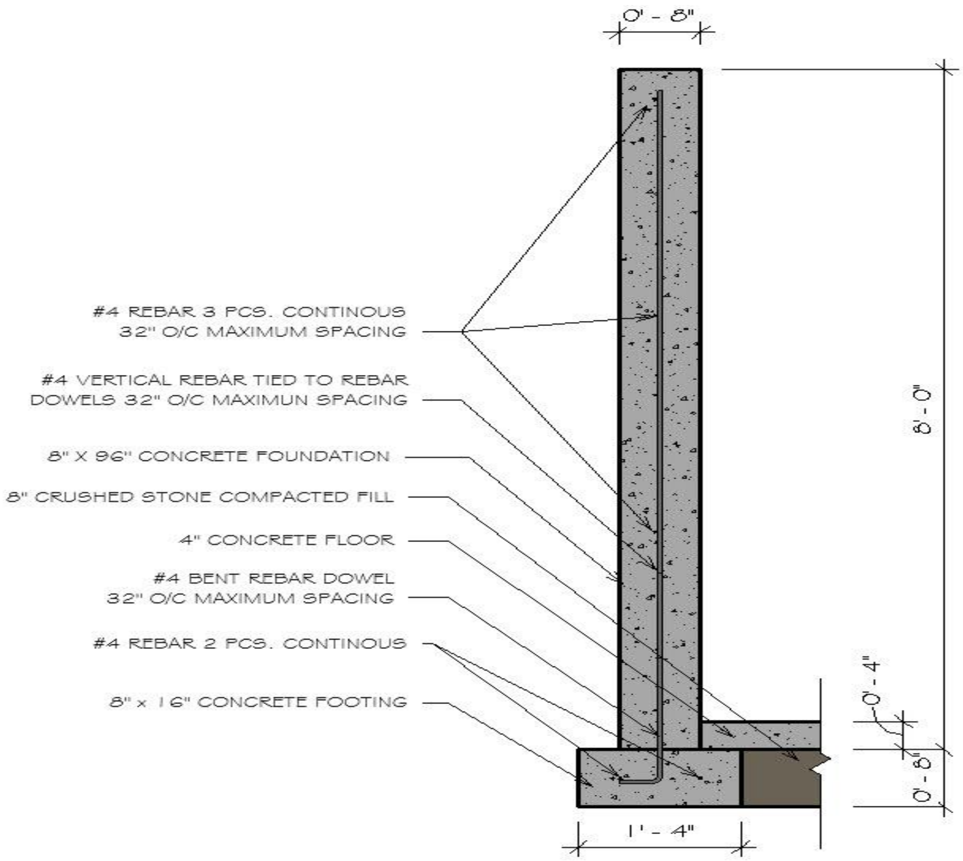


Figure 5-10 Footing and foundation wall section detailing the construction specifics.

Three possible approaches would be, (1) measure both the exterior dimensions and interior dimensions of the footings. Add both dimensions together and divide in half to find the average length. (2) Calculate the total length by measuring from the center of the footing. (3) Break the footings into footings that are placed on the page horizontally and vertically. Calculate the horizontal footing by measuring to the outside of the footing and the vertical footings by measuring to the inside of the footings. This is the approach that will be used in the following example.

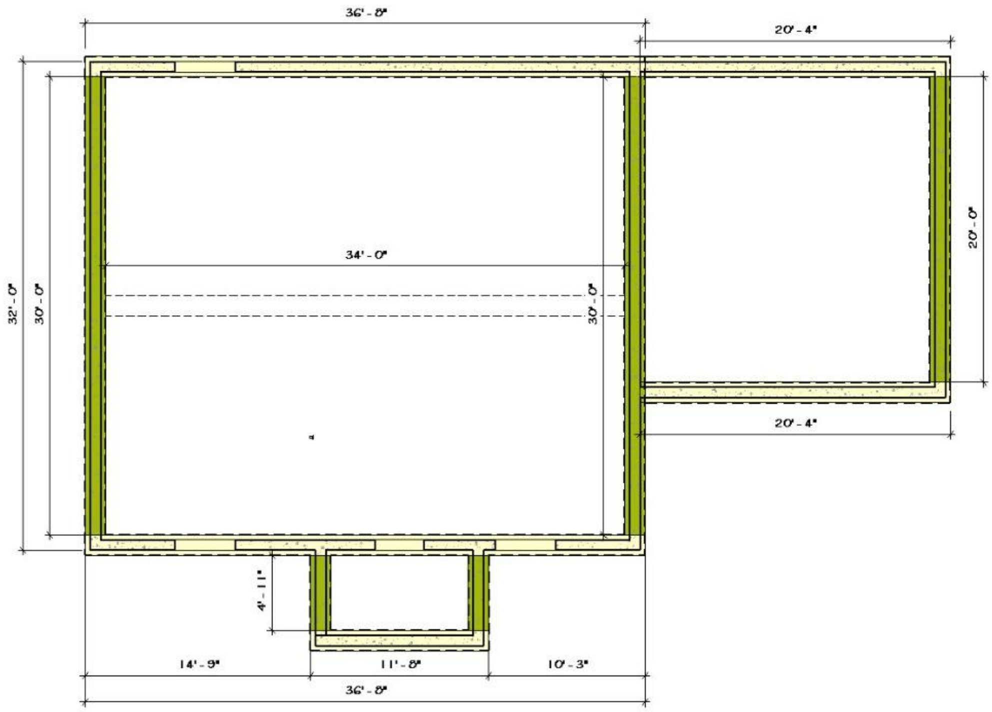


Figure 5-11 Calculating lineal feet of footings.

Figure 5-11 shows a dimensioned plan view of the footings. The footings which are placed horizontally on the page are dimensioned to the outside of the wall and are highlighted in yellow. The footings placed vertically on the page are dimensioned to the inside of the wall and are highlighted in green. The horizontal garage footings are measured to the basement foundation.

Foundation Takeoffs

The foundation takeoffs would be completed in similar fashion. The horizontal foundation elements would be dimensioned to the exterior of the wall and the vertical foundation elements would be dimensioned to the inside of the wall. The three-dimensional footing and foundation graphic shown in Figure 5-8 shows two separate foundation types: a main foundation and a garage foundation. These two types have different dimensions and reinforcing requirements and, as such, are treated as separate takeoffs. Figure 5-12 shows a dimensioned plan view of the foundation. The foundations which are placed horizontally on the page are dimensioned to the outside of the walls and are highlighted in dark blue. The foundations placed vertically on the page are dimensioned to the inside of the wall and are highlighted in light blue as shown in Figure 5-12. The garage foundation is a separate takeoff and is not highlighted in this graphic.

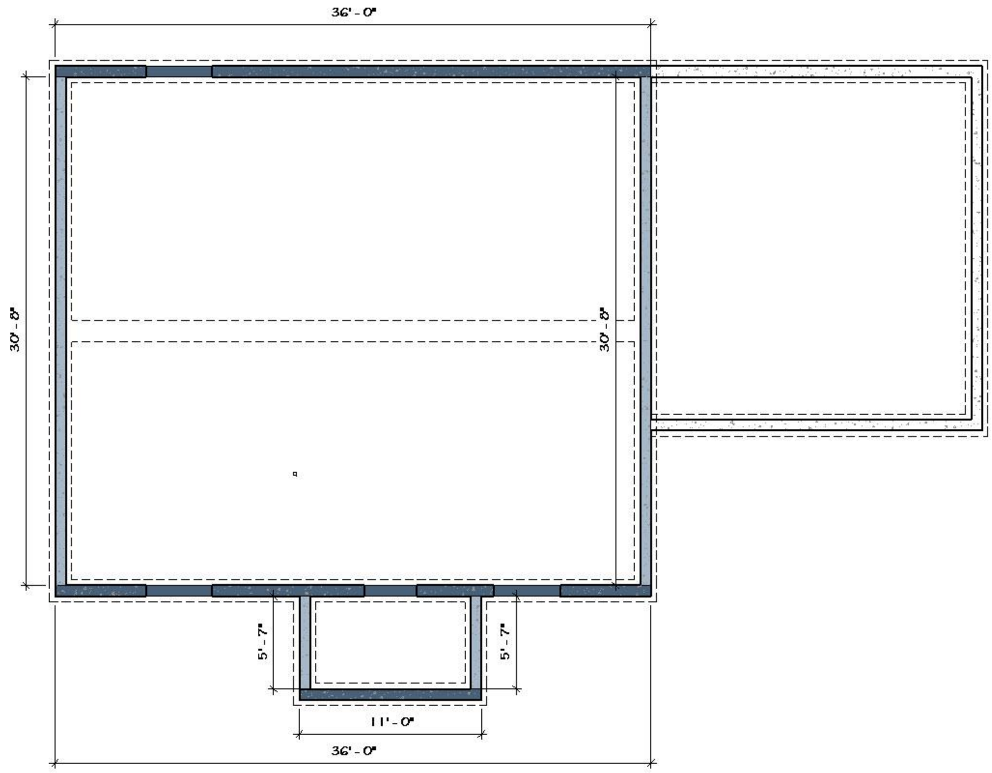


Figure 5-12 Graphic showing the lineal footage of a foundation floor plan.

Completing the Wall Takeoffs

The wall takeoffs will be completed in similar fashion as the footing and foundation takeoffs. There are a number of different wall types for both exterior and interior walls. There are also a number of different ways of classifying the walls. For the purpose of this exercise, walls will be classified primarily by their framing structure such as stud size, including width, length, and spacing. The plate layout includes the number of top and bottom plates. The wall sheathing that is installed during the framing phase. In most cases, wall finishes will not be taken into account in classifying different wall types. For example, exterior walls may have a brick or stone veneer finish, they may have a wood, or vinyl siding, or the exterior finish may be a combination of several finish types. If the structure of the framing is the same, the walls will be classified as the same type. The wall takeoffs will be divided into three broad categories of takeoffs. Each category will be estimated separately during the framing portion of the estimate. The three categories are basement and pony walls, exterior walls, and interior walls.

Basement and Pony Wall Takeoffs

The basement and pony walls are walls that are framed in the basement or on the foundation to support the floor system. In addition, they are also walls framed around the inside of the foundation to provide a structure for installing insulation and wall finishes. In addition, walls to frame out the various basement rooms are included. Figure 5-13 shows the walls in the basement. In this example, there are two wall types basement bearing walls that are used to support the floor. These walls have a double top plate and are framed using 2 × 4’s spaced 16 inches on-center. The other wall type is an insulation wall. These walls are framed to provide a place to install insulation. They are framed using a single top plate with a stud spacing of 24 inches on-center.

Figure 5-13 Basement bearing walls and insulation walls.

The actual construction of each wall type can best be determined by referencing building sections or wall section detail drawings. Most often, notes and annotations will detail the wall construction similar to what was previously shown when calculating the footing and foundation walls. Figure 5-14 shows an expanded section view of the footing and foundation wall section shown in Figure 5-10. The view shows the addition of the basement insulation wall. Bolded annotations in this graphic specifically detail the construction of this wall type. Of particular importance in this instance is the size of the studs, the size, type and number of the plates, and the stud spacing.

The corners of wood framed walls should also be counted only a single time as was done for the footing and foundation walls to avoid any overlap. At this early stage of the estimating process, the quantities calculated should be as precise as possible and contain only the raw numbers. Other factors such as waste factors or contingencies can be added later in the estimating process.

Figure 5-15 shows a floor plan view of the basement walls with the insulation walls highlighted in pink and the bearing walls highlighted in blue along with dimensions needed for calculating the lineal footage of both wall types.

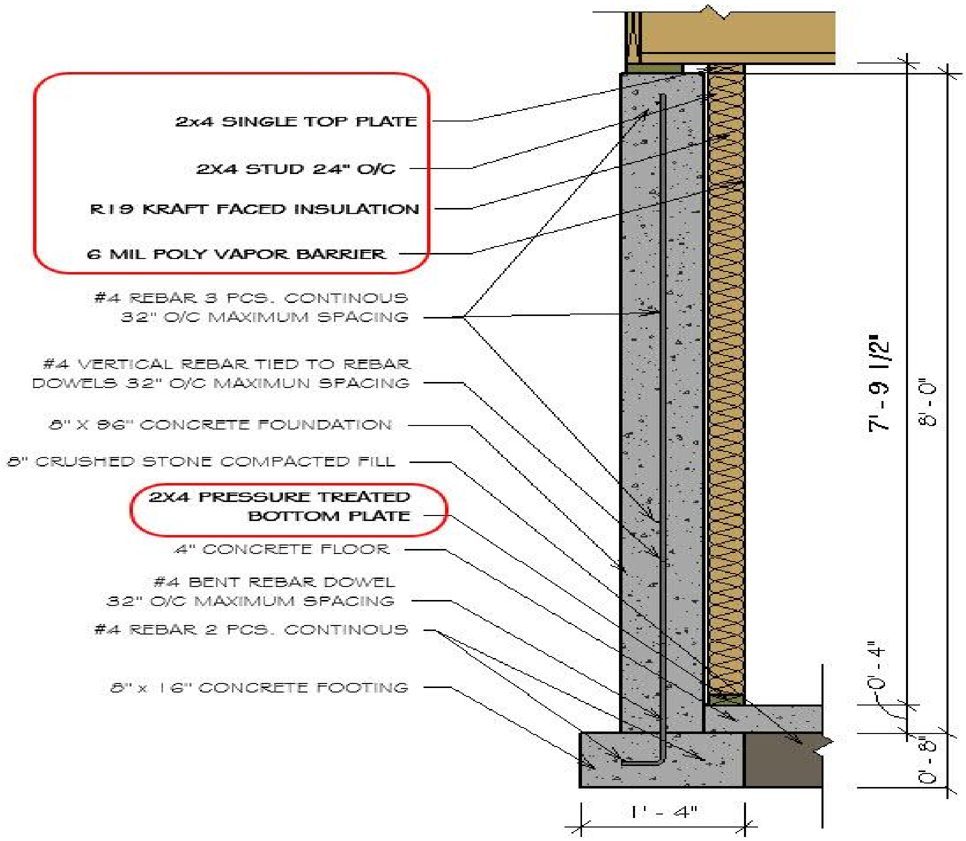


Figure 5-14 Wall section showing a basement insulation wall.

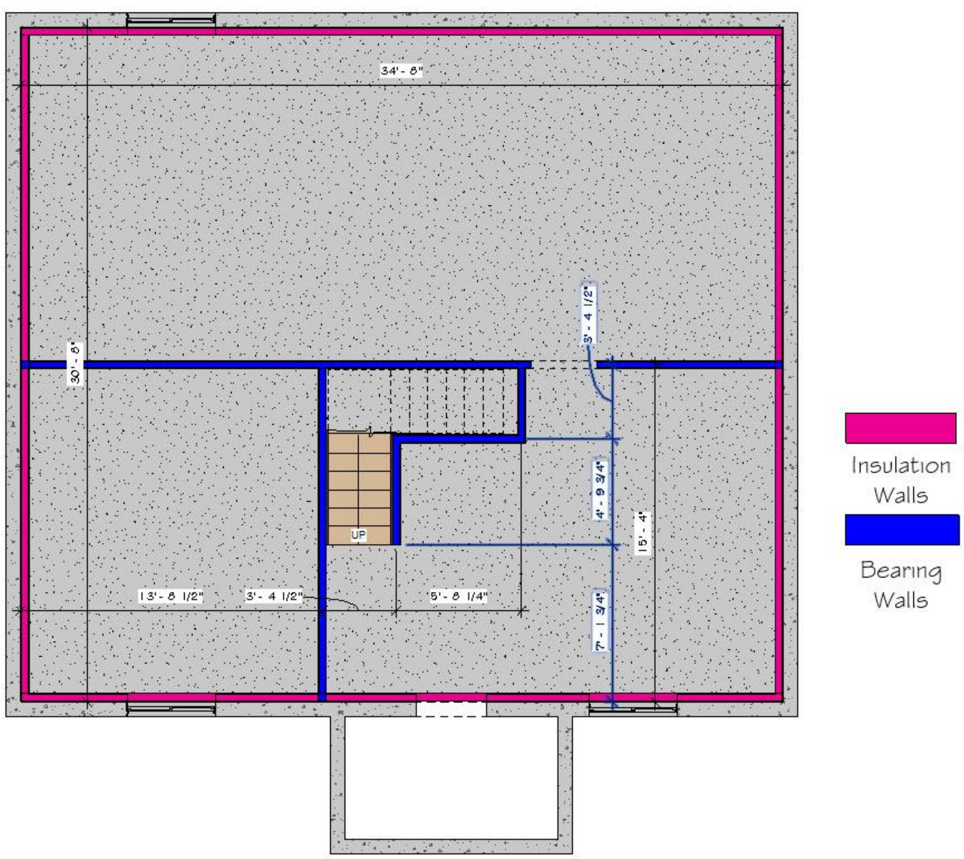


Figure 5-15 Basement bearing and insulation walls.

Determining the actual wall length to enter often takes a little bit of interpretation of the drawings. The outside dimensions of the walls are measured from the exterior of the building, or, in this case, the inside of the basement foundation. The interior measurements are dimensioned to the center of the wall. This conforms to standard construction methods where the carpenter lays out the wall to the center and then marks the offset from the center to the exterior of one side when installing the walls. Because of this wall placement, will be dimensioned in the drawings in fractions of an inch. The fractions can usually be ignored and either truncated or rounded up to the next whole number during the takeoffs. Figure 5-42 shows the bearing walls entered into the spreadsheet calculator with the horizontal walls entered first and the vertical walls second. Doors and openings less than 16 feet are ignored in completing the takeoff. The door in the center bearing walls just to the right of the stairway is ignored in this case and the wall calculated the entire length as shown.

The insulation walls would be determined in similar fashion.

Exterior and Interior Wall Takeoffs

Three wall types are included in the exterior wall category in the basic takeoffs. The three wall types are 2 × 6 exterior walls, 2 × 6 common walls, and 2 × 4 garage walls. Figure 5-16 shows a close-up view of the front corner of the building where the three exterior wall types intersect. The 2 × 6 exterior walls, and the 2 × 6 common walls are built on the floor structure and, technically, would be framed as a single wall, however, for the purpose of calculating the basic takeoffs, they will be separated into the two types because they are constructed differently. The exterior wall is sheathed with OSB sheathing and the common wall is covered with drywall on both sides. The 2 × 4 garage walls are displayed in blue and are built on the foundation walls. These walls have a different construction in that studs are 2 × 4's as opposed to 2 × 6's in the other types. The studs are also longer because they go all of the way to the foundation instead of resting on the floor system. In addition, the bottom plate is pressure treated material.

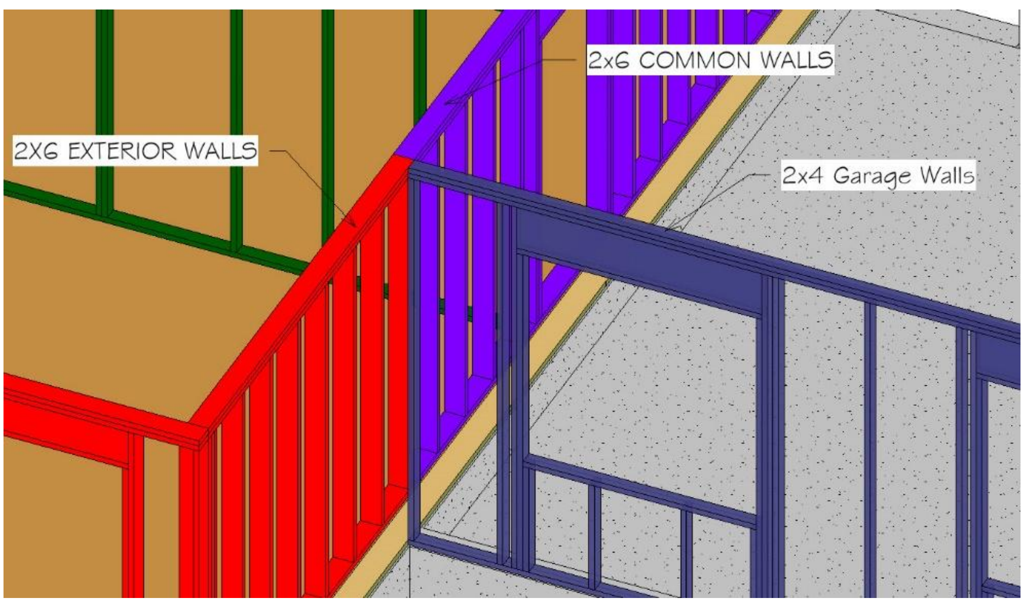


Figure 5-16 Exterior corner showing the intersection of three exterior wall types.

Figure 5-17 shows a color-coded graphic of all of the main floor walls, including the exterior walls and interior walls. Calculating the total length of these wall types is done in a manner similar to what has been previously done. Each wall type is identified using the floor plans and section drawings taking care to not double count the corners.

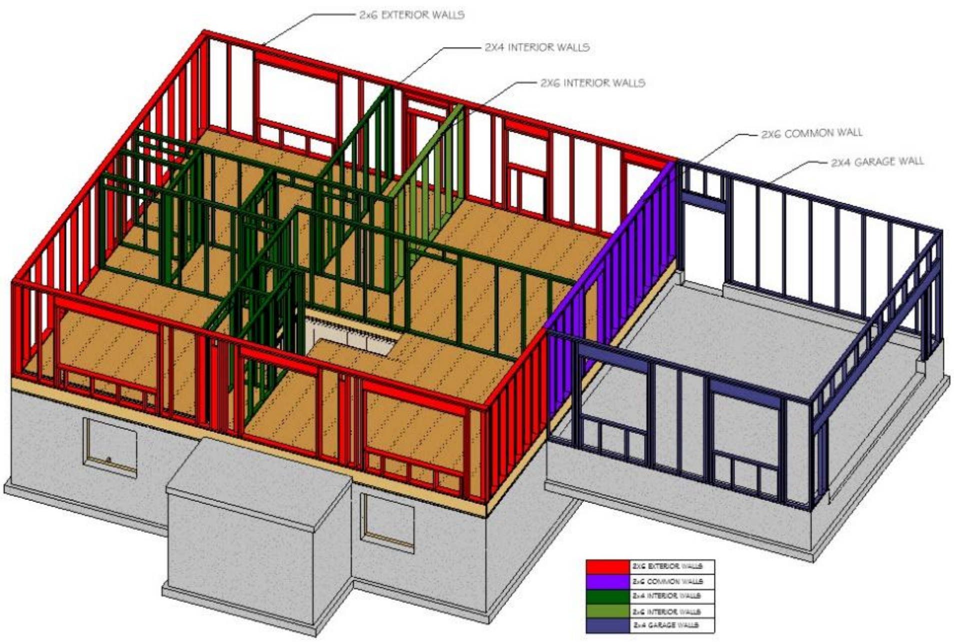


Figure 5-17 Color-coded graphic of the main floor walls.

Completing the Roof Takeoffs

The roof subsection of the basic takeoffs is comprised of three quantities which are, square footage of flat roof area, lineal feet of roof ridge, and lineal feet of roof edge.

Square Footage of Flat Roof Area

The square footage of the flat roof area is calculated as if it were a flat roof. This number includes all of the roof area including overhangs. This number can be used later in the estimating process to calculate the sloped roof area. Figure 5-18 shows a dimensioned roof plan. The roof plan does not show a small area of the garage roof that is under the main roof. This roof area is equal to the distance of the roof overhang multiplied by half of the roof width. This is highlighted by the area outlined in red.

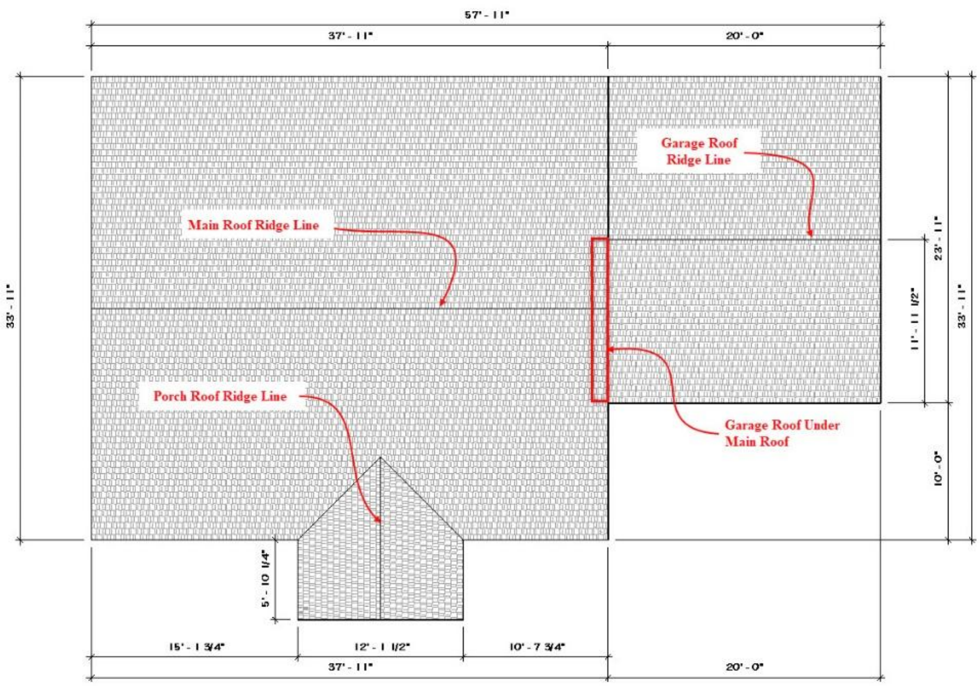


Figure 5-18 Roof plan showing flat roof dimensions.

Lineal Footage of Roof Ridge Line

The roof plan in Figure 5-18 can also be used to determine the lineal footage of the roof ridge line. Three ridge lines are shown; the main roof ridgeline, the garage roof ridgeline, and the front porch ridgeline. The length of both the main roof and garage ridge lines can be determined from the dimensions. To determine the length of the front porch ridgeline, add the 5'-10 ¼" roof edge distance to the roof run to find the total length. In this case, the span of the roof is 12'-1 ½" and the run would be half of that distance, or 6'-0 ¾". The total length of the front porch ridgeline would be

$$5'\text{-}10\ \frac{1}{4}''\ +\ 6'\text{-}0\ \frac{3}{4}''\ =\ 11'\text{-}11''$$

Lineal Footage of Roof Edge

The lineal footage of roof edge is a little more complicated than the other two roof basic takeoffs. This takeoff follows the edge of the roof around the building. It includes both the horizontal roof edges and sloped roof edges. Figure 5-19 shows the east side elevation of the house and highlights in red the roof edges.

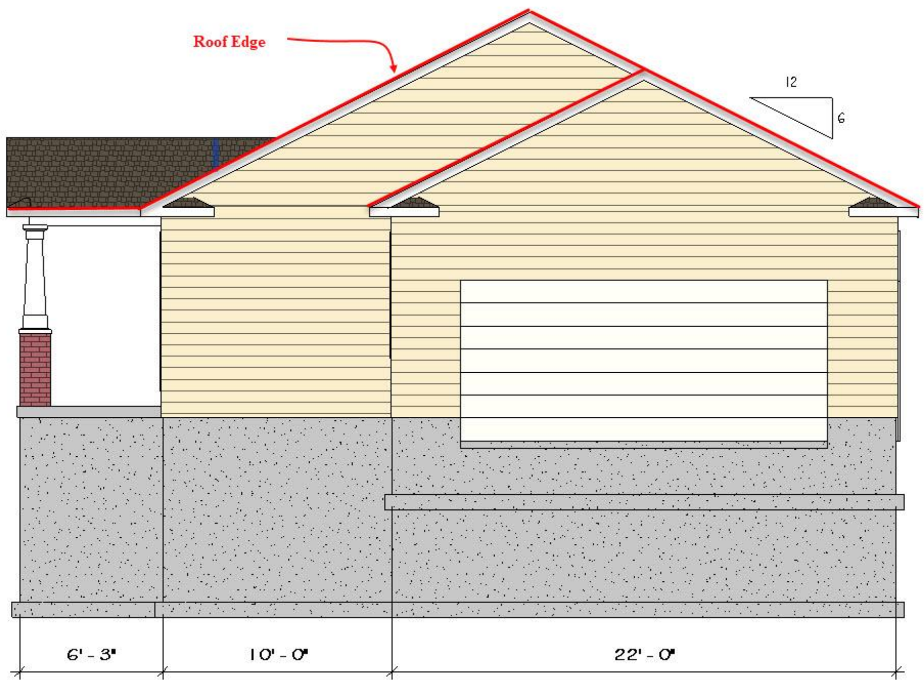


Figure 5-19 East elevation view showing roof edge.

This view shows both horizontal roof edges and sloped roof edges. The single horizontal roof can be determined from the 6'-3' dimension. The sloped roof edges will need to be calculated. The roof slope is shown as 6:12. The slope length of the roof is a triangle that is half of the roof span. Half of the roof span is commonly called the roof run. Two spans are given. The smaller garage span of 22 feet is listed. The house span is determined by calculating the garage and the additional width of the house and is 32 feet. Half of each span, or the run, would be as follows:

$$22'\text{-}0'' \div 2 = 11'\text{-}0''\ Run$$

$$32'\text{-}0'' \div 2 = 16'\text{-}0''\ Run$$

The total roof edge on this side of the house would be equal to the sloped roof edges of the house multiplied by two and one garage sloped roof edge. In addition, the horizontal run of the side of the front porch would be added. The run and the roof slope ratio can be used to calculate the vertical roof rise by multiplying the run by the slope ratio. The garage roof rise can be calculated by doing the following:

$$\frac{6}{12}\ Ratio \times 11'\text{-}0''\ Run$$

Or

$$\frac{1}{2} \times 11'\text{-}0'' = 5'\text{-}6''\ Rise$$

The main house roof rise can be calculated by doing the following:

$$\frac{6}{12}\ Ratio \times 16'\text{-}0''\ Run$$

Or

$$\frac{1}{2} \times 16'\text{-}0'' - 8'\text{-}0''\ Rise$$

The three sloped lengths are added to the horizontal length to calculate the total length of the roof edge on this side of the house. The total would be as follows:

$$17.89' + 17.89' + 12.3' + 6.25' = 54.33'$$

This total would be added to the totals for the other side of the roof to find the total length of roof edge.

Completing the Window and Door Basic Takeoffs

The majority of information to complete both the window and door takeoffs can be obtained from the door and window schedules. Copy the information into the appropriate section in the basic takeoffs. Figure 5-20 shows an example of the window schedule and the information entered into the basic takeoffs is shown in Figure 5-21.

Type Mark	Count	Rough Opening		Type	Manufacturer	Model
		Width	Height			
A	3	4' - 0"	4' - 0"	Vinyl Sliding w Buck	Amsco	Traditional Series
B	1	3' - 0"	5' - 0"	Double Window Unit	Amsco	Traditional Series
C	1	3' - 0"	1' - 0"	Vinyl Sliding	Amsco	Traditional Series
D	1	3' - 0"	3' - 0"	Vinyl Dbl Hung Window	Amsco	Traditional Series
E	2	2' - 6"	5' - 0"	Double Window Unit	Amsco	Traditional Series
F	2	2' - 6"	5' - 0"	Triple Window Unit	Amsco	Traditional Series

Figure 5-20 Window schedule.

The door schedule will be completed in a fashion similar to the window schedule. Figure 5-21 shows an example of the door schedule.

<Door Schedule>

A	B	C	D	E	F	G	H	I	J	K
Function	Level	Door Number	Family and Type	Door Ty	Door Size	Manufacturer	Trim P	Width	Height	Area
Exterior	First Floor	0-0	Overhead-Sectional: 16' x 7'	100	16' x 7'			16' - 0"	7' - 0"	112.0 SF
Exterior	First Floor	1-1	Single-Raised Panel with Sidelights: 36"	A	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	First Floor	1-2	Gladiator Ext 6 Panel: 36" x 80"	B	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	First Floor	1-3	Gladiator Ext Glass: 36" x 80"	C	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Exterior	Foundation	1-4	Gladiator Ext 6 Panel: 36" x 80"	B	36" x 80"	Jeld-Wen	2	3' - 0"	6' - 8"	20.0 SF
Interior	Basement	0-1	Door-Opening: 36" x 80"	G	36" x 80"	None	0	0' - 0"	0' - 0"	0.0 SF
Interior	First Floor	1-5	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-6	Bostonian: 28" x 80"	D	28" x 80"	Jeld-Wen	3	2' - 4"	6' - 8"	15.6 SF
Interior	First Floor	1-7	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-8	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-9	Bostonian Double Bifold: 48" x 80"	E	48" x 80"	Jeld-Wen	5	4' - 0"	6' - 8"	26.7 SF
Interior	First Floor	1-10	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-11	Bostonian: 30" x 80"	D	30" x 80"	Jeld-Wen	3	2' - 6"	6' - 8"	16.7 SF
Interior	First Floor	1-12	Bostonian: 28" x 80"	D	28" x 80"	Jeld-Wen	3	2' - 4"	6' - 8"	15.6 SF
Interior	First Floor	1-13	Bostonian Cased Opening: 42" x 80"	F	42" x 80"	None	5	3' - 6"	6' - 9 1/4"	23.7 SF

Figure 5-21 Door Basic Takeoffs.

Sitework Construction Processes

This chapter will cover items that are estimated in the sitework phase of construction, including demolition, tree and brush removal, site layout material and labor, excavation, erosion and sediment control. The discussion will begin with estimating items that are typically completed before excavation, including demolition, tree and brush removal, and site layout.

Demolition

There are many occasions in the construction process where demolition must take place before new construction can begin. Sometimes new buildings are built in a location where there are existing structures and the entire old structure must be torn down and the debris hauled away. On other occasions remodeling takes place of existing buildings, and the demolition must be of a selective nature where some parts are removed and others are left intact. In each case, the demolition process must be part of the estimate, and there are many factors to consider including the type of demolition process, the disposal of the waste, and the hazardous materials.

Type of Demolition Process

The type of demolition process used is based upon factors such as the structure type and the amount to be demolished, such as the entire building or just selective parts.

Whole Building Demolition

Whole building demolition is used when the entire building is to be razed to the ground, the waste removed, and a new structure built in its place. The actual demolition process depends largely on the building type. Large concrete and masonry buildings are often removed by imploding the entire structure. This is a very specialized field that requires the expertise of a specialist with high explosives. Buildings may be demolished by using more conventional means, such as using a trackhoe or other heavy equipment in the demolition process (Figure 7-1).

Figure 7-1 Track hoe demolishing steel and concrete block dormitory in preparation for new construction.

There are usually several different elements of a demolition estimate. The first is the demolition of the structure itself. Whether the building is destroyed using explosives or conventional means, the estimates are usually based upon the type of structure; whether it is steel, concrete, masonry, or wood; and the size of the structure. Common methods calculate quantities based upon the volume of the standing structure or the square footage of the floor area for each floor. These are straightforward calculations based upon the size of the structure. The total volume is usually priced per cubic foot and might have costs somewhere between 25 and 40 cents per cubic foot.

The demolition of the foundation, footings, and concrete floors usually would be in addition to the main structure and might be priced per square foot or lineal foot, depending upon the specific element and its construction. The type and amount of steel reinforcing in the concrete might also add significantly to the cost.

Finally, the disposal of the rubble will need to be accounted for. This can be a significant cost to the demolition process. Factors that can go into the disposal cost include dump disposal fees, the distance that it will need to be hauled, and the presence of hazardous waste.

Disposal Fees

Waste disposal fees at the dump, also known as tipping charges, can vary greatly from location to location. They could be as low as $30.00 per ton to over $120.00 per ton. The local dump or trash disposal company will need to be checked for the actual costs.

The waste on site can be managed in a number of ways, depending upon the volume that needs handling. It may be possible to have a smaller three cubic yard trash bin placed at the site that is emptied weekly by a waste disposal company. This would usually be handled with a monthly fee. Higher volumes up to 40 cubic yards can be handled with a roll off dumpster (Figure 7-2). This is a large container that is left at the site, and when it is filled, the disposal company retrieves the container, hauls it to the waste disposal site to be emptied, and returns it to the job if needed. The cost for this service is usually priced in two parts. The first is a hauling cost per load or trip costs for the company to pick up the full container, empty it, and return it if needed. This is usually a fixed cost, such as $250 per trip. The second is the disposal fee charged by the local dump, which is also priced per ton. The price can vary greatly depending upon the local fee structure. In addition, the weight of the load can vary greatly depending upon the material being disposed of.

Figure 7-2 Roll off dumpster.

Another element that can increase demolition costs is the possibility of hazardous waste. The two most common concerns for the building contractor are asbestos and lead. Both materials were commonly used in a wide variety of building materials in the past, and it is not uncommon to find a site contaminated by one, or both, of these materials. The removal and cleanup of the hazards can be a significant cost that will involve several features. The first is conducting a survey to determine the possibility and quantity of the contaminants. This will include taking samples and having the samples tested for contaminants. Next, a removal plan will need to be prepared. Then, the hazardous waste will need to be removed and properly disposed of by trained asbestos removal or lead abatement specialists. All of this can be a very costly undertaking.

Site Layout

Site layout is the process of locating the building on the site and marking out areas in preparation for excavating the footings and foundation. A site plan is usually included in the set of working drawings that shows the building's location on the site. Important considerations when locating the building on the site include observing setbacks and easements, which are established by the applicable zoning ordinances and building codes. Typically, a zoning ordinance will include required setbacks or distances that the structure must be positioned away from the building lot boundaries. Zoning ordinances can include front, side, and back building setbacks, and the construction must not be placed in such a way as it encroaches upon these setbacks.

Property lines are usually determined by survey stakes that are placed when the building lot is platted. Once the survey stakes are located, the measurements are made and temporary stakes are placed to mark the location of important reference points (Figure 7-3).

Figure 7-3 Stakes mark important reference points.

A common method of establishing corners and other points in the building location is to use batter boards. Batter boards are small structures that are built outside of the boundaries of the building and consist of placing stakes into the ground with lengths of framing lumber between the stakes. They are typically placed outside the corner and intersection locations of the building's perimeter. The corners of the building are marked with the batter boards and string is placed between them. The intersection of the string is marked as the corners of the building. After the corners and intersection are located using the string stretched between the batter boards, the corners are transferred to the ground using a plumb bob attached to a string. Stakes are then placed in the ground at the corner points (Figure 7-4). Measurements are made from the stakes, and the outside of the excavation is determined and marked on the ground using aerosol marking paints (Figure 7-5).

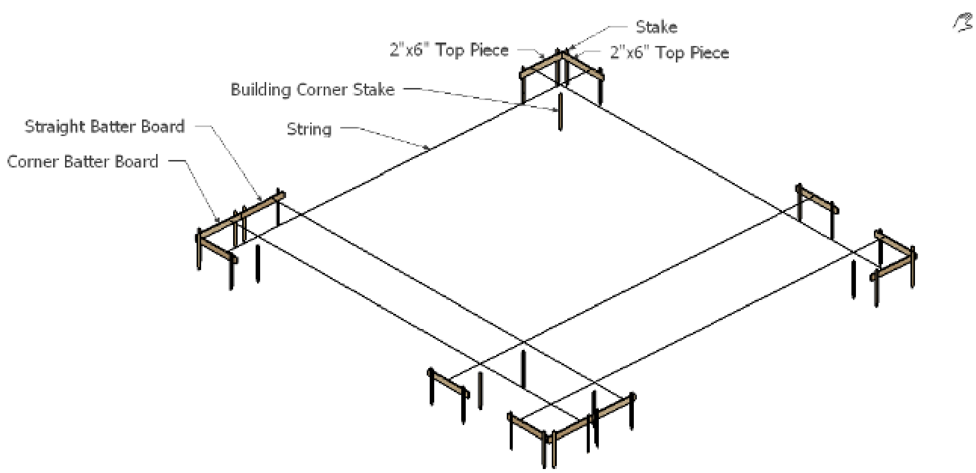


Figure 7-4 Building layout using batter boards, stakes, and string.

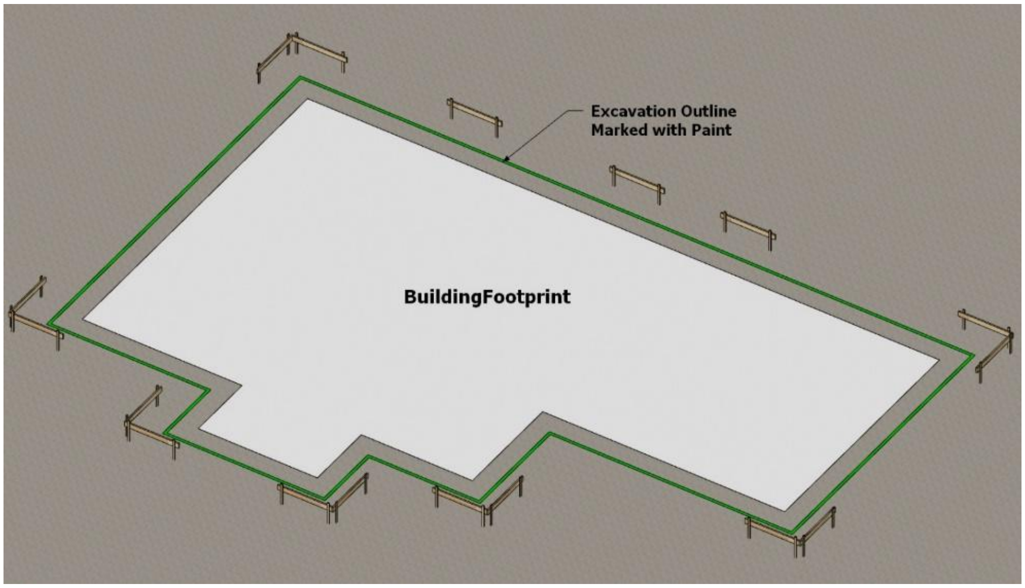


Figure 7-5 Using marking paint to layout excavation.

It is not practical to automate the quantity input of all materials in this subsection as some things such as the quantity of layout stakes or nails are bulk consumable items, or items where the relative cost is small in relation to the time and effort that it would require to count the quantity of each item. Still, these items must be placed in the estimate to make sure that they are accounted for in the overall construction cost and purchased so that they will be available on the job site when needed. For items such as this, quantities placed in the estimate are based more upon experience of past usage and rules of thumb.

As was previously taught, batter boards are small temporary frames that are constructed, set up, and leveled on the building site. From the batter boards, strings are stretched to represent the edges and corners of the building that is being constructed. Corner batter boards are L shaped and are made of a 2"× 6" top board and four stakes as shown in Figure 7-6. Straight batter boards (Figure 7-7) are also used to mark out other building projections. Straight batter boards are made of a single top 2"× 6" with two stakes.

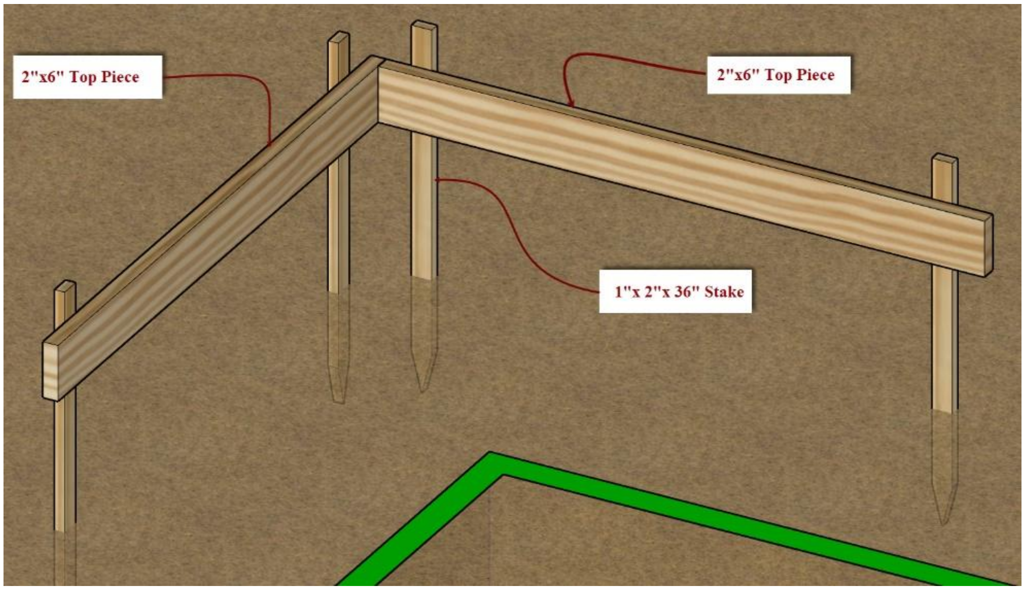


Figure 7-6 Corner batter board.

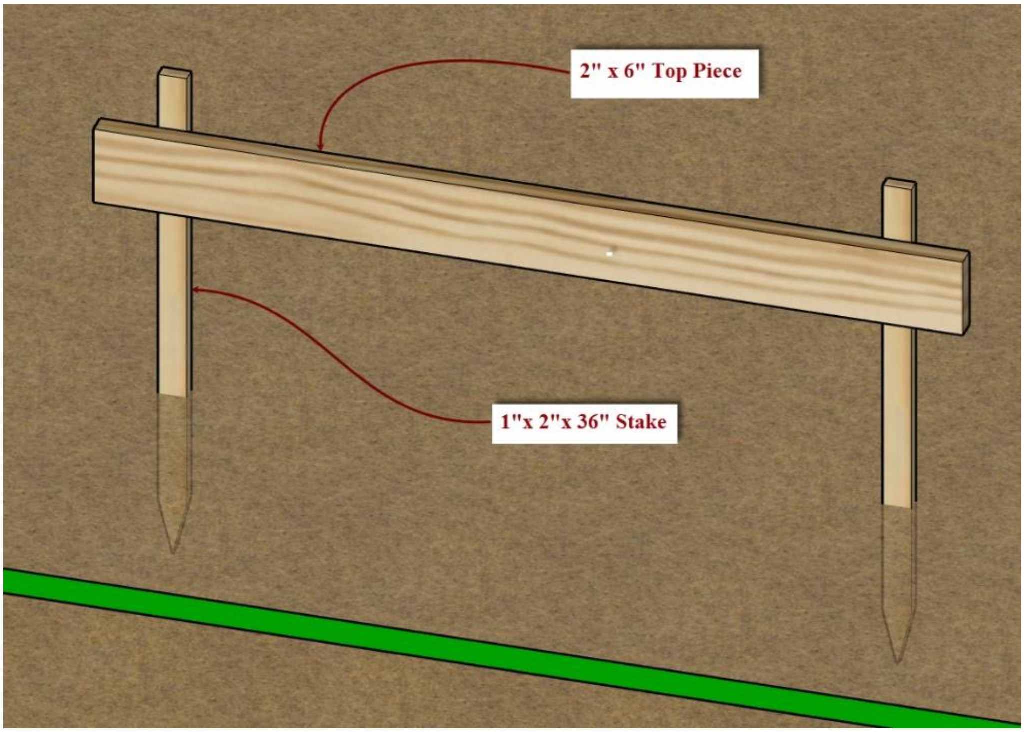


Figure 7-7 Straight batter board.

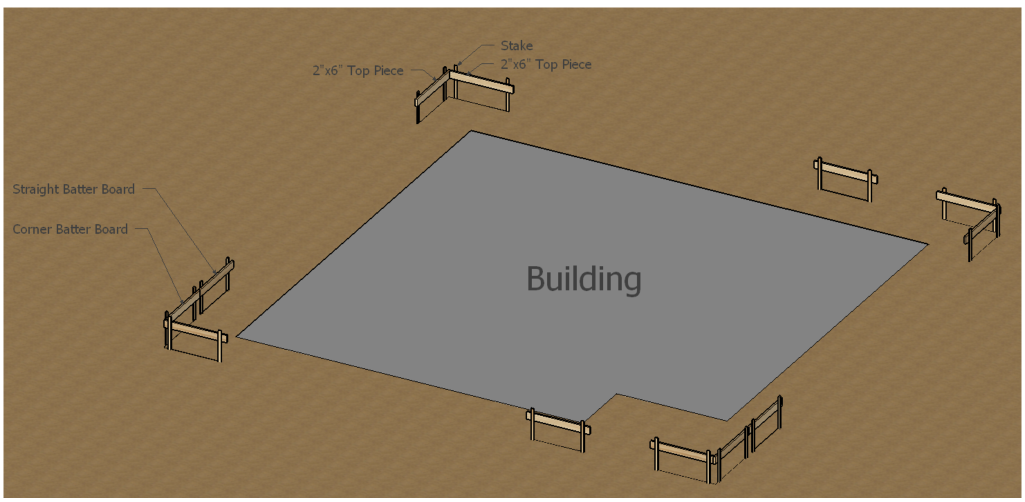


Figure 7-8 Possible arrangement of L-shaped and straight batter boards used to lay out a building.

Using the combination of L shaped and straight batter boards, several different configurations are possible to lay out this building. One configuration may or may not be better than any other, but the construction estimator should understand some possible layouts so that sufficient material is purchased for the batter boards on the project. Figure 7-9 shows a possible sample building layout for a small house.

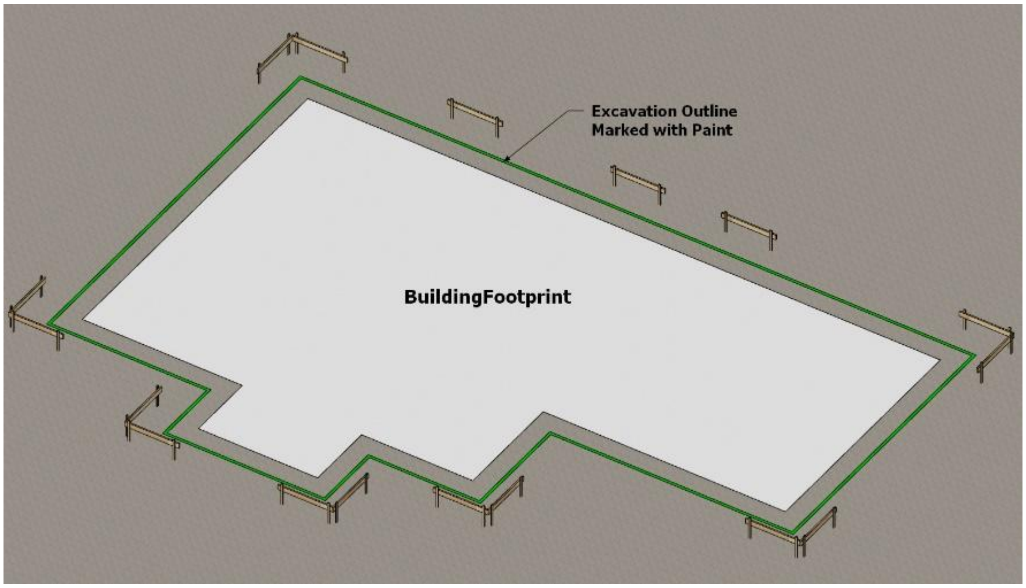


Figure 7-9 Building batter board layout.

In Figure 7-9, there are six corner batter boards and three straight batter boards. In this example, no batter boards are combined.

The minimum length of the side for a corner batter board is five feet because the batter board must extend out past any excavation onto undisturbed soil, and the excavation for the foundation must be a minimum of two feet past the building line. If the batter board length for the building in Figure 7-9 were five feet long on each side, the estimate for batter board and stake material would be:

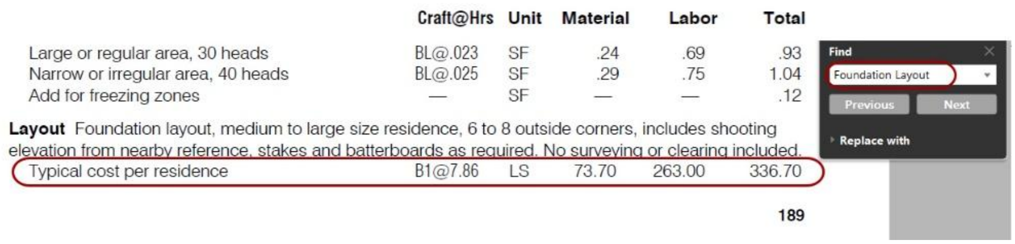
Corner Batter Boards	6 corners × 2 pieces × 5 ft. = 60 ft.
Straight Batter Boards	3 straight × 1 piece × 5 ft. = 15 ft. Total Batter Board Material = 75 ft.
Batter Board Stakes	6 corners × 4 stakes = 24 stakes 3 straight × 2 stakes = 6 stakes 30 Stakes at 24 stakes/bundle = 1.5 bundles

Adding a Waste Factor

A waste factor is a percentage of material over the actual calculated raw quantity of material needed to cover some unforeseen usage, such as material that is too warped or damaged to be used or was perhaps cut the wrong size by mistake. The actual percentage to be used as the waste factor for any given material is a judgment call based upon past experience and historical records.

Site Layout Labor

The site layout labor can be completed using data from the National Construction Estimator (NCE). Using the search function, the keyword “Foundation Layout” is searched, which brings up several possibilities. Clicking on the link brings up a page in the cost book. We will use “Layout,” “Foundation Layout,” and “Medium to Large Residence” as an example.



	Craft@Hrs	Unit	Material	Labor	Total
Large or regular area, 30 heads	BL@.023	SF	.24	.69	.93
Narrow or irregular area, 40 heads	BL@.025	SF	.29	.75	1.04
Add for freezing zones	—	SF	—	—	.12

Layout Foundation layout, medium to large size residence, 6 to 8 outside corners, includes shooting elevation from nearby reference, stakes and batterboards as required. No surveying or clearing included.

Typical cost per residence	B1@7.86	LS	73.70	263.00	336.70

189

NCE Figure 7-1 Factors that contribute to cost for a site layout

The NCE identifies five relevant factors in determining the cost for site layout which are

- Craft@Hrs B1@7.86
- Unit LS
- Material 73.70
- Labor 263.20
- Total 336.70

Craft@Hrs identifies both the crew and the number of man-hours needed to complete the project. This means that crew B1, which has one laborer and one carpenter, will need 7.86 man-hours to complete the layout of this building. This means that it will take the two men 3.93 work hours or approximately half a day to complete the building layout.

The unit identified is LS, which stands for lump sum, and is another way of saying a single price for the entire job. Identified by the NCE, the material cost for laying out the building is $73.20. That and the labor cost of $263.00 can be used in preparing the site layout labor cost estimate.

Excavation

The excavation activities include clearing the site, removing topsoil, footing and foundation excavation, installing utilities to the structure, and rough site grading.

Clear and Grub

Clear and grub includes tree and brush removal and other activities to clear the site in preparation for excavation. The removal of brush and trees from a building lot is often needed before excavation can begin. These costs can vary greatly depending upon the type of work that is required. The estimate for this work generally falls into one of several categories. The first is tree and brush removal, or what is commonly known as clear and grub. This consists of removing the vegetation from the lot so that construction can begin. The cost for clear and grub is usually based upon a price per acre, with the price variation based upon the type of material that needs to be removed. Typically, estimators distinguish between light brush, heavy brush, and wooded lots. Lots covered in either light or heavy brush would typically be scraped with a bulldozer or backhoe blade. Usually, the cost is estimated on a square foot basis. The NCE prices clearing and grub for a lot on an acre basis. In some cases, the square footage to be cleared would need to be converted to an acre unit of measurement.

Tree removal can vary depending upon the size and quantity of trees that need to be removed. One or two trees are priced on an individual basis with the price being determined by the diameter of the trees being removed. The cost of removing the tree stump is an additional cost and will need to be calculated separately. Clearing the trees from heavily wooded lots is usually calculated on an acre basis using tree harvesting equipment. The individual elements of excavation include clearing the site in preparation for the excavation.


Figure 7-10 Sagebrush on a portion of the site cleared prior to excavation.

Figure 7-11 shows an area for tree removal and clear and grub. A single ten-inch tree and stump will need to be removed and an area around the excavation cleared of brush prior to excavation. The edges of the area are a little untidy with inconsistent dimensions. However, an average area could be calculated. This would be done by first finding the average length of each side. The back horizontal dimension is 92'-6 ½", and the front horizontal dimension is 87'-7". To calculate the average length, add the two dimensions together and divide by two as shown in the following example:

(92' 6 ½" + 87'-6") ÷ 2

Or

(92.54' + 87.5') ÷ 2

Or

180.04 ÷ 2 = 90.02'

The left side vertical dimension is 93'- ½", and the right side vertical dimension is 82'- 0". To calculate the average length, add the two dimensions together and divide by two as shown in the following example:

(93'- ½" + 82'-0") ÷ 2

Or

(93.04' + 82') ÷ 2

Or

175.04' ÷ 2 = 87.52'

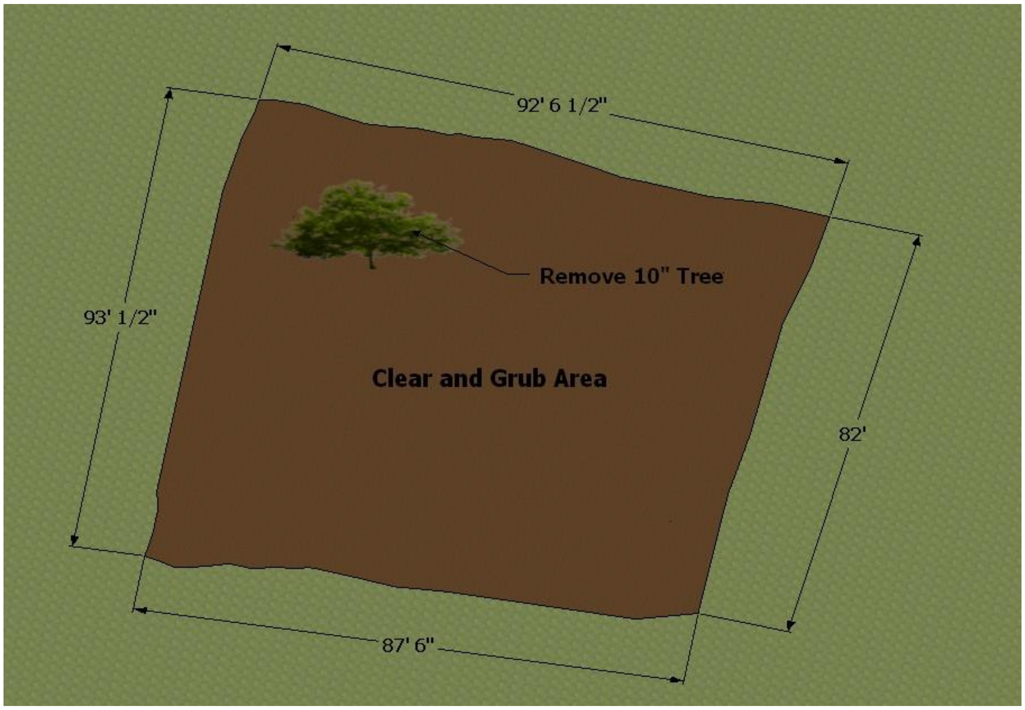


Figure 7-11 Tree removal and clear and grub prior to excavation.

The clear and grub area would then be calculated by the following:

$$90.02' \times 87.52' = 7878.55\ \text{ft}^2$$

The square footage could then be converted to an acre measurement by dividing the total by 43,560, which is the amount of square footage in an acre.

$$7878.55\ \text{ft}^2 \div 43{,}560\ \text{acres/ft}^2 = 0.18\ \text{acres}$$

NCE Figure 7-2 shows a sample page from the NCE for both clearing and grubbing the site and removal of trees and stumps.

	Craft@Hrs	Unit	Material	Labor	Total
Tree and brush removal, labor only (clear and grub, one operator and one laborer)					
Light brush	B8@34.8	Acre	—	1,250.00	1,250.00
Heavy brush	B8@45.2	Acre	—	1,630.00	1,630.00
Wooded	B8@48.7	Acre	—	1,750.00	1,750.00
Tree removal, cutting trees, removing branches, cutting into short lengths with chain saws and axes, by tree diameter, labor only					
8" to 12" (5 manhours per tree)	BL@5.00	Ea	—	150.00	150.00
13" to 18" (7 manhours per tree)	BL@7.00	Ea	—	210.00	210.00
19" to 24" (11 manhours per tree)	BL@11.0	Ea	—	329.00	329.00
25" to 36" (14 manhours per tree)	BL@14.0	Ea	—	419.00	419.00
Tree stump removal, using a small backhoe, by tree diameter, operator only					
6" to 10" (1.6 manhours per stump)	0E@1.60	Ea	—	67.40	67.40
11" to 14" (2.1 manhours per stump)	0E@2.10	Ea	—	88.50	88.50
15" to 18" (2.6 manhours per stump)	0E@2.60	Ea	—	110.00	110.00
19" to 24" (3.1 manhours per stump)	0E@3.10	Ea	—	131.00	131.00

NCE Figure 7-2 Sample page showing costs from the NCE for tree removal and clearing the lot.

Topsoil

After the site has been clear, the next step is to remove the topsoil prior to footing and foundation excavation. The topsoil is the upper layer of soil. It is usually composed of minerals, organic matter, water, and air. It is the soil that supports most plant life. It is common practice to remove the soil prior to excavation and save it for later use when grading and landscaping (Figure 7-12). If the topsoil is not removed and stored separately, it will most likely be contaminated by mixing it with rocks and other excavated material. The layer of topsoil is most likely a few inches to a few feet thick. The cost for stripping the topsoil is usually calculated by determining the area that needs to be cleared by the depth of excavation. The quantity is usually priced per cubic yard.

Figure 7-12 Stripped topsoil piled up and stored on job site.

Figure 7-13 shows an area for topsoil removal. The dimensions for the removal are 68'- 4" x 50'- 3" at an 8" depth. The eight-inch depth will need to be converted to a foot quantity by dividing by 12. The calculations for determining the quantity of topsoil are as follows:

$$68'\text{-}4'' \times 50'\text{-}3'' \times \frac{8''}{12''}$$

Or

68.33' × 50.25' × 0.66' = 2289.17 ft^3

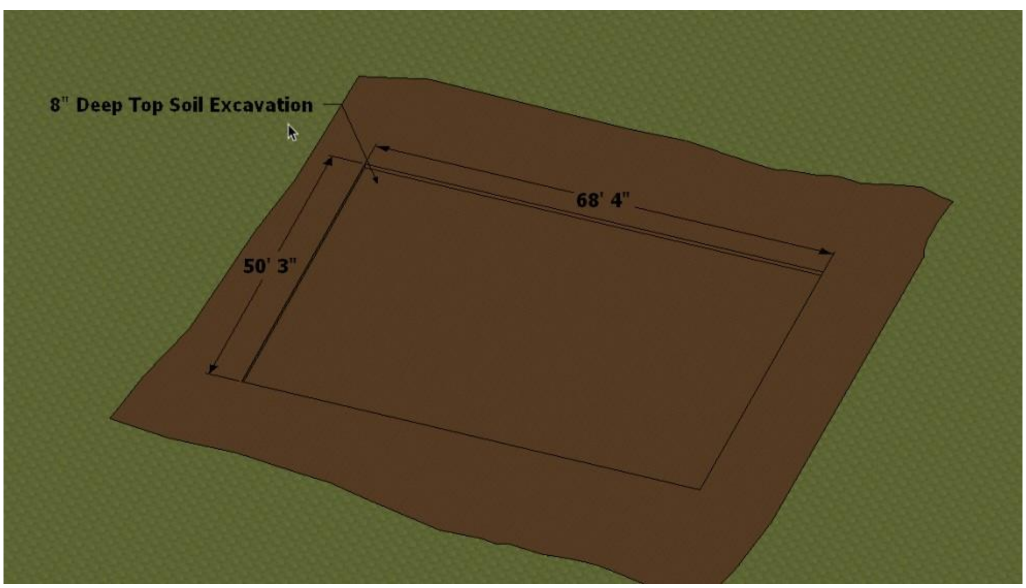


Figure 7-13 Topsoil removal.

The cubic foot quantity will need to be converted to a cubic yard quantity by dividing the total by 27. The calculation is as follows:

$$2,789.17\ ft^3 \div 27\ \frac{ft^3}{yd^3} = 103.30\ yd^3$$

One other element that may need to be taken into consideration is if the excavated topsoil needs to be hauled away. The price for hauling the soil is usually priced per cubic yard with the cost increasing as the length of the haul gets longer.

NCE Figure 7-3 shows a sample page from the NCE for stripping topsoil using a 65 HP bulldozer. The topsoil removal cost is priced per cubic yard. In addition, the price for hauling away the topsoil is shown, which is also priced per cubic yard. The cost per cubic yard for hauling away the topsoil varies depending upon the size of the truck used and the distance of the haul. In this example, the topsoil will be stored onsite for later use in backfill and grading.

Bulldozer, 65 HP unit					
Backfill (36 CY per hour)	0E@.027	CY	—	1.14	1.14
Clearing brush (900 SF per hour)	0E@.001	SF	—	.04	.04
Add for thick brush	—	%	—	300.0	—
Spread dumped soil (42 CY per hour)	0E@.024	CY	—	1.01	1.01
Strip topsoil (17 CY per hour)	0E@.059	CY	—	2.49	2.49
Bulldozer, 90 HP unit					
Backfill (40 CY per hour)	0E@.025	CY		1.05	1.05
4 mile haul (4 CY per hour)	B7@.500	CY	—	15.20	15.20
5 mile haul (3 CY per hour)	B7@.666	CY	—	20.20	20.20
4 CY truck					
Short haul (11 CY per hour)	B7@.182	CY	—	5.52	5.52
2-3 mile haul (7 CY per hour)	B7@.286	CY	—	8.67	8.67
4 mile haul (5.5 CY per hour)	B7@.364	CY	—	11.00	11.00
5 mile haul (4.5 CY per hour)	B7@.444	CY	—	13.50	13.50
5 CY truck					

NCE Figure 7-3 Cost for stripping and hauling topsoil.

Foundation Excavation

Three possible elements of the foundation excavation are the excavating for the footing and foundation, trenching for shallow footings and foundations, and backfilling the excavation once the foundation is placed.

Several factors need to be taken into consideration when determining the quantity of soil removed for the footing and foundation excavation. The four factors are the footprint of the building, the excavation outside of the footprint of the building, the depth of the excavation, and the topsoil already removed.

Footprint of the Building

The shape of the building determines the size, shape, and depth of excavation that is needed. Larger, more complex buildings will require bigger excavations.

Excavation Outside the Footprint of the Foundation

Most foundation excavations extend past the boundaries of the foundation because space is needed for the workers to form and strip the foundation formwork. Typically, foundation excavations extend a minimum of two feet outside of the formwork (Figure 7-14).

Depth of Excavation

The depth of the foundation and footing excavation is determined by a number of factors, the first being the type of construction. In some areas, basements are a common element in residential construction, and in some areas, they are not. One of the factors that is often considered when determining to include a basement is the frost depth for the area. In areas of colder climates, the ground frequently freezes in the winter and the building's footings need to be deeper than the depth of the frost. In addition, different portions of the excavation can be at different depths to account for full/partial basements or garages. Figure 7-15 shows an excavation for a basement at half depth with four feet tall foundation walls and a shallow excavation for the garage footings. Two distinct piles of soil are also shown where the topsoil and regular soil are kept separate for later backfilling.

Figure 7-14 Excavation outside of the formwork.

Topsoil Already Removed

The topsoil where the excavation is to take place is removed as a first step in excavating for the footings and foundation. The topsoil is removed and either stored onsite or hauled away. In either case, the quantity of topsoil will not need to be included in the footing and foundation excavation quantity.

Figure 7-15 Multi-depth foundation excavation.

Foundation excavations are usually calculated using a cubic yard measurement by taking into account the factors of the footprint of the building, excavation outside of the building footprint, depth of excavation, and the depth of topsoil already removed.

Trenching for Shallow Foundations

Some foundation excavation is accomplished by trenching. Trenching could be combined with more traditional bulk excavation for excavating shallow garage footings, such as in Figure 7-16. Trench excavation can be used for shallow foundation construction such as slab on grade or post tensioned concrete slab foundations. Figure 7-17 shows a post tensioned concrete slab where the slab is thickened at the edges by digging a shallow trench around the exterior of the building.

Figure 7-16 Combination deep and trench foundation.

Figure 7-17 Shallow post tensioned foundation.

A sample foundation excavation is shown in Figure 7-18. The excavation will have two different depths—a shallow excavation where the garage is located and a deeper excavation for the basement area of the house. In addition, a broad area of topsoil will be removed before the foundation excavation.

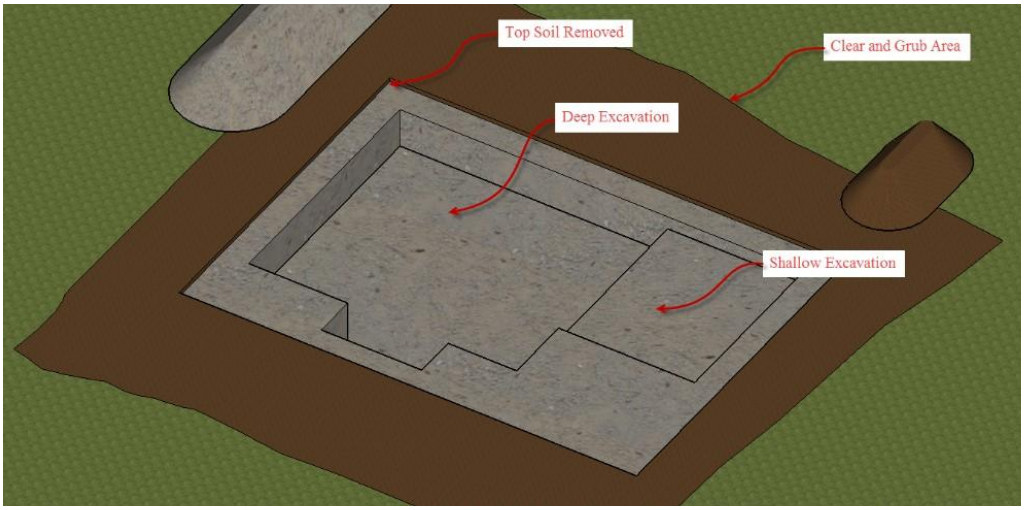


Figure 7-18 A sample foundation excavation.

The first step in calculating the foundation excavation is to determine the building footprint and the area outside of the building footprint. Figure 7-19 shows the excavation with the outline of the main building footprint and the garage footprint superimposed in the excavation. It is assumed that the excavation outside of the footprint will extend two feet outside of the building footprint.

Determining the Area of Excavation

The square footage of the main building depth is determined by calculating the area of two rectangles consisting of the main building, including the front porch area, and the area excavated outside of the building footprint. Figure 7-20 shows the total excavation dimensions.

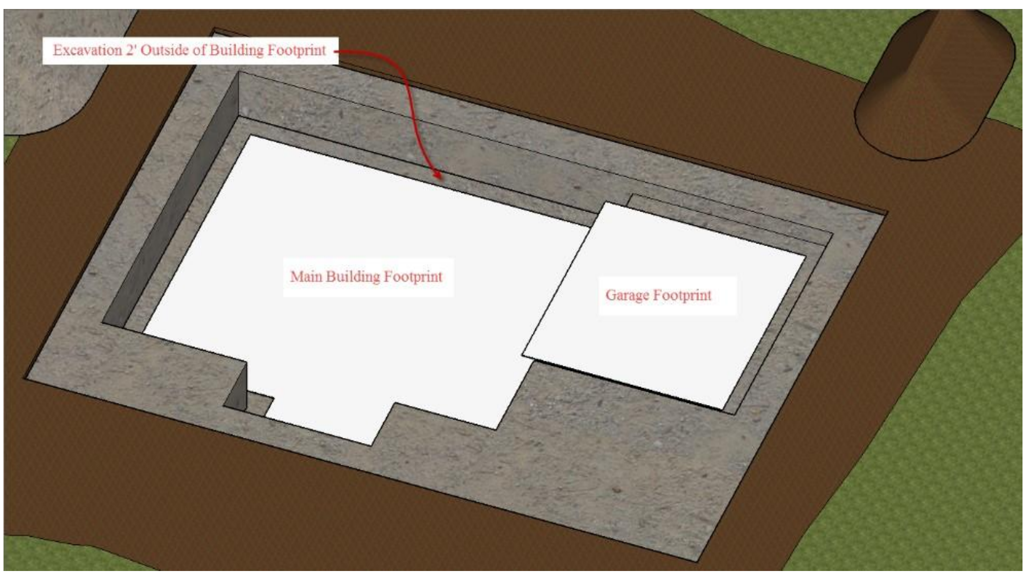


Figure 7-19 Building footprint superimposed over the excavation.

The calculation for the main building depth area is

(36'-0" × 40'-0") + (6'-3"× 15'-0")

Or

36.0' × 40.0' = 1,440 ft^2

$$6.25' \times 15.0' = 93.75 \text{ ft}^2$$

$$1{,}440 \text{ ft}^2 + 93.75 \text{ ft}^2 = 1{,}533.75 \text{ ft.}^2$$

The calculation for the garage excavation area is

$$20'\text{-}4'' \times 26'\text{-}0''$$

Or

$$20.33' \times 26.0' = 528.67 \text{ ft}^2$$

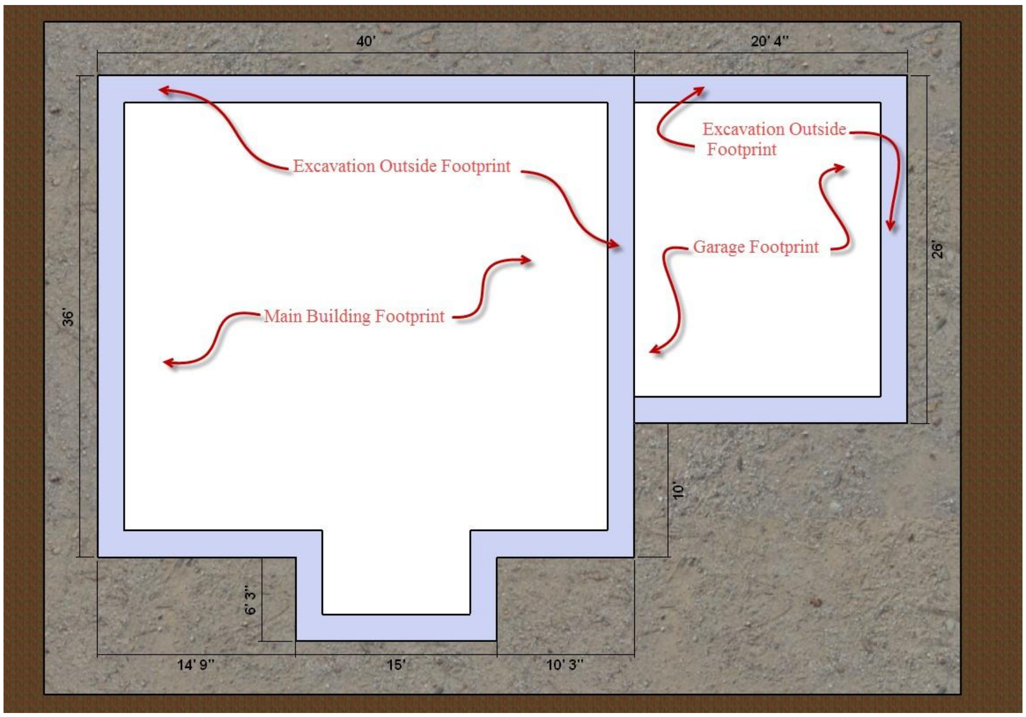


Figure 7-20 Total excavation dimensions.

Determining the Depth of Excavation

The depth of excavation is determined by the amount of topsoil removed and the depth of the excavation required. Figure 7-21 shows the excavation depth of six feet eight inches from the original ground level. Eight inches of topsoil are removed first and then the main foundation is excavated to a level of six feet. The garage foundation will be excavated to a level of two feet below the topsoil excavation depth.

The calculations for determining main building excavation quantity is

$$1{,}533.75 \text{ ft}^2 \times 6' = 9{,}202.50 \text{ ft}^3$$

The calculations for determining the garage excavation is

$$528.67 \text{ ft}^2 \times 2' = 1{,}057.34 \text{ ft}^3$$

The total of the two areas added together and converted to cubic yards is

$$(9,202.550\ ft^3\ +\ 1,057.34\ ft^3)\ \div\ 27\frac{ft^3}{yd^3}\ =\ 400.00\ yd^3$$

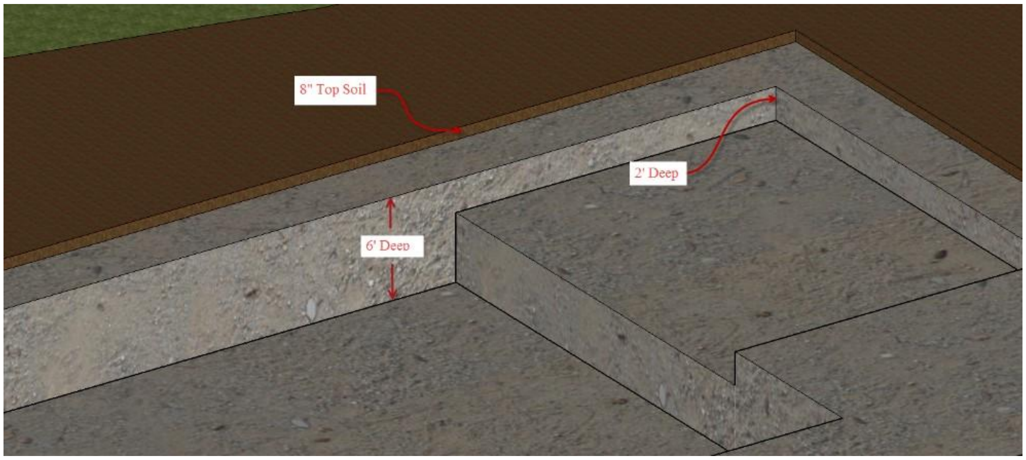


Figure 7-21 Dimensions for the depth of excavation.

Backfilling Around Foundation

Once the foundation has been placed, the soil that was removed will need to be backfilled around the foundation to bring the level of soil back up to the grade level. One method of calculating the foundation backfill quantity is to subtract the amount of soil removed for the foundation excavation and then subtract the volume of the amount excavated. In some cases, additional soil is backfilled above the original level soil against the foundation and sloped away from the foundation to allow water to flow away from the building. Another advantage of this is that the excess soil removed from the foundation excavation will not need to be hauled away. Figure 7-22 shows a foundation that has been backfilled above the original grade and sloped away from the building. Topsoil will need to be placed above the fill material.


Figure 7-22 Foundation backfilled above the original grade and sloped away to allow water to drain away from the foundation.

When the backfilled soil is placed, it will also need to be compacted to prevent it from settling after the building is completed. This is usually accomplished by replacing the soil in layers, called lifts, and then compacting each layer. The compacting could be done using machine mounted equipment or portable “jumping jack” type compactors.

Figure 7-23 shows the excavation with the footing and foundation completed, ready for backfilling. The area of excavation outside of the foundation will be backfilled up to the level of the existing soil. In addition, the inside of the garage will also be filled to a level for the garage floor. The backfill in this area will need to be compacted as it is being filled in order to avoid any settling of the dirt once the house is complete.

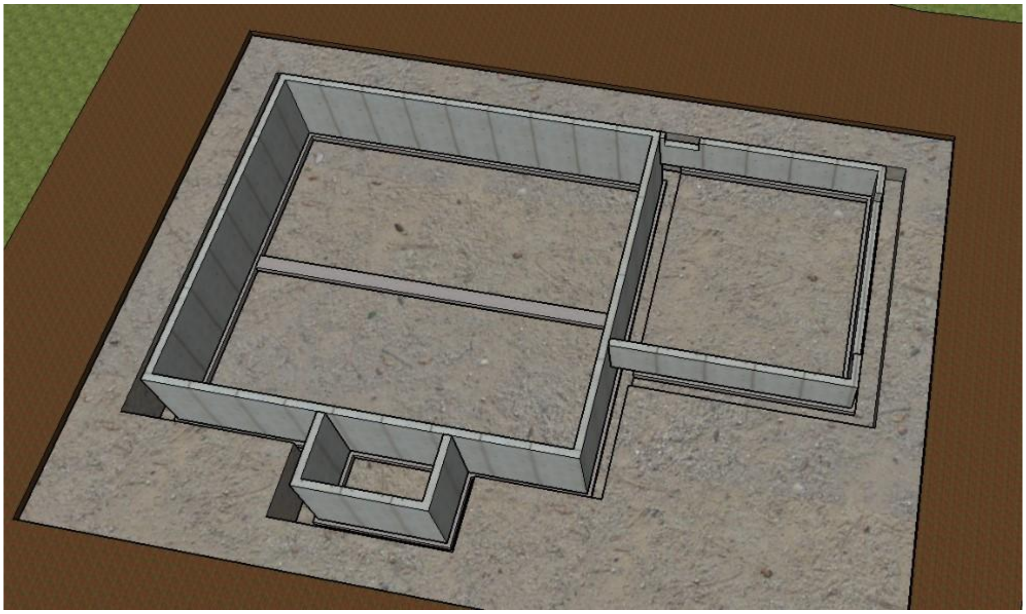


Figure 7-23 Excavation with foundation complete ready for backfilling.

Figure 7-24 shows the backfill complete up to the level of the existing soil. Calculating this quantity of backfill will require determining the area of the complex shape around the excavation and multiplying the area by the depth of the excavation. As there are several different area shapes with differing depths, this could be somewhat of a complex calculation. One quick method that could be used to get a rough number is to subtract the volume the structure occupies with the volume of soil removed from the excavation. Using this method of backfilling, there will be excess soil that will need to be hauled off the job site, which will entail an additional cost.

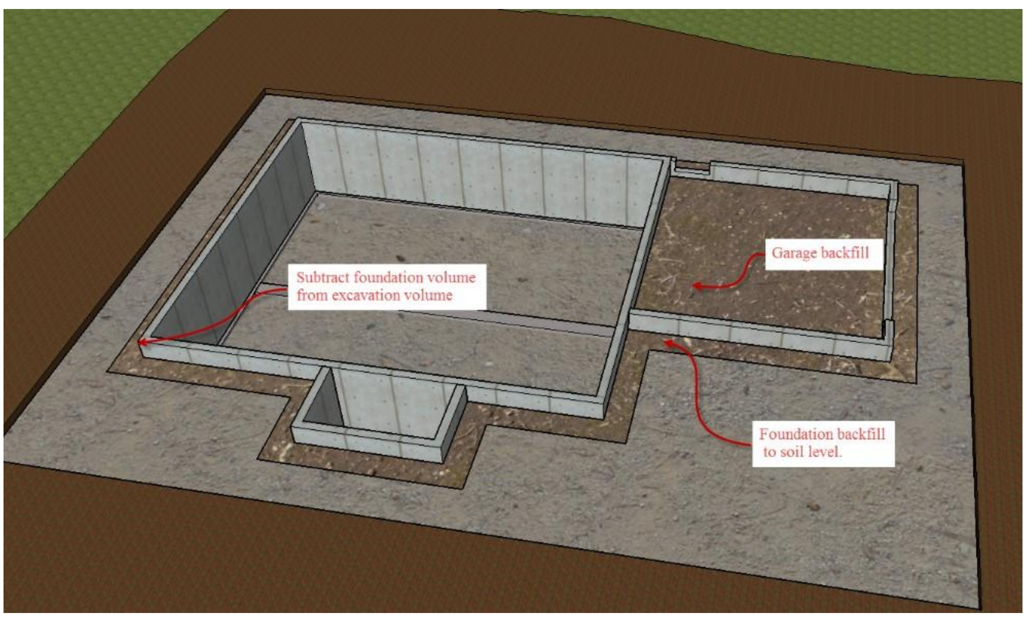


Figure 7-24 Foundation backfill to existing soil level.

Figure 7-25 shows another method of backfilling, which is to build up the soil level around the foundation and grade it so that it slopes away from the building. This has several advantages in that the foundation excavation will not need to be as deep, requiring less initial excavation, and all of the soil excavated can be utilized on the job site and will not need to be hauled away. In addition, a slope will be created that will allow water to naturally drain away from the building, helping to keep the foundation dry.

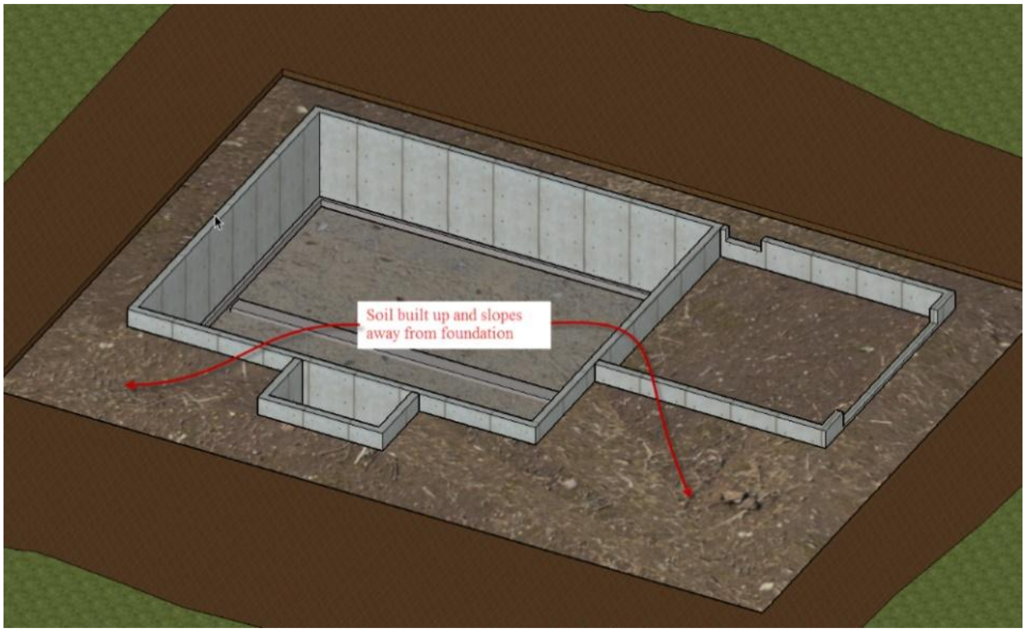


Figure 7-25 Soil built up to slope away from the foundation.

NCE Figure 7-4 shows a sample page from the NCE for excavation with heavy equipment. The foundation excavation could be priced using a backhoe with the ¾ CY bucket in average soils.

	Craft@Hrs	Unit	Material	Labor	Total
Excavation with Heavy Equipment These figures assume a crew of one operator unless noted otherwise. Only labor costs are included here. See equipment rental costs at the end of this section. Use the productivity rates listed here to determine the number of hours or days that the equipment will be needed. For larger jobs and commercial work, see excavation costs under Site Work in the Commercial and Industrial division of this book.					
Excavation rule of thumb for small jobs	—	CY	—	2.85	2.85
Backhoe, operator and one laborer, 3/4 CY bucket					
Light soil (13.2 CY per hour)	B8@.152	CY	—	5.48	5.48
Average soil (12.5 CY per hour)	B8@.160	CY	—	5.76	5.76
Heavy soil (10.3 CY per hour)	B8@.194	CY	—	6.99	6.99
Sand (16 CY per hour)	B8@.125	CY	—	4.50	4.50
Add when using 1/2 CY bucket	—	%	—	25.0	—
Bulldozer, 65 HP unit					
Backfill (36 CY per hour)	0E@.027	CY	—	1.14	1.14
Clearing brush (900 SF per hour)	0E@.001	SF	—	.04	.04
Add for thick brush	—	%	—	300.0	—
Spread dumped soil (42 CY per hour)	0E@.024	CY	—	1.01	1.01

NCE Figure 7-4 Cost for excavation and backfill.

Estimating Utility Excavation and Installation

Estimating the installation of building utilities can be a complex process that involves many participants and gathering information from a wide variety of sources. Often this involves connections with a number of different public and private utilities, each with its own requirements and regulation. It is expected that the estimator will become familiar with the specific procedures that each utility requires. This is often referred to as “doing due diligence.”

Common utility installations could include the water and sewer service, electrical service, natural gas or propane supply, and communications infrastructure. Water, sewer, and gas infrastructure has traditionally been supplied with underground installation and electricity and communication via overhead transmission lines. Some construction may require traditional overhead installation, but most modern infrastructure is delivered underground and will require some form of trenching.

Utility Trench Size

The width and depth of the trench requirements can vary greatly by the local conditions and utility requirements. Most installations would involve a minimal depth requirement for health and safety reasons, but other factors can also come into play. For example, the depth of the sewer line would be determined by the depth of the public sewer or private septic tank. Some sewer line installations are deep enough that they would allow the sewer line to be excavated below the bottom of basement footing and would allow the natural drainage of the building sewer. Other installations could be shallower, which would require basement installations to use a sewage pump to move the effulgent up to a level above the utility sewer level to provide for the natural drainage of the line. This would mean a shallower excavation.

The depth of the water line excavation could change based upon local requirements. Water lines need to be installed below the frost depth, which could vary from location to location. Other utilities such as electricity, gas, and communication have minimum and maximum depth requirements. In the case of electricity, gas, and communication lines, it is common to allow lines that are run in conduit to be placed at a shallower depth than direct burial type of lines.

Several factors also must be taken into account when determining the width of a utility trench. Laborers need sufficient workspace to safely install the utility. Often, the deeper the trench, the wider it will need to be for work to be performed in a safe manner. Deeper trenches often also require either a slope-sided excavation or shoring to prevent the sides of the trench from collapsing onto the workers.

In some instances, several utilities can be installed in the same trench, but there are usually requirements for the lines to be separated by specific distances, which can require a wider excavation. For example, water and sewer lines can be allowed in the same trench, however, there may specific requirements to do so, such as requiring the water and sewer lines to be a minimum of one foot apart horizontally and the sewer line to be located a minimum of one foot below the water line. On occasion, electricity, gas, and communication lines can be allowed in the same trench, however, there would be specific separation requirements requiring additional trench width. Electricity, gas, and communication are usually not allowed to be located in the same trench as water and sewer lines.

The length of the excavation is determined by the distance between the utility connection and where it enters the structure. In some cases, a developed lot would have connections run to the property and the connections could be made by simply tying into the systems. In other cases, the utility connection will need to extend into the street and may require tearing up and replacing a portion of the street.

Fill Sand

Underground utility lines need to be supported continually along their length. For example, sewer lines need to be installed on a support bed that consistently slopes. They also need to be installed on the required grade to allow the sewage to flow by gravity away from the structure. Unnecessary depressions and bumps in the excavation can hinder the flow of the system and cause future problems. It is common to install utility lines on engineered fill material, such as sand, to allow the consistent grading of the line bed. In addition, sand can be used to surround the utility line to protect it from damage by rocks and other debris that could come into contact with the line as it is backfilled. The sand bed provides other advantages, including providing an indicator of the location of the utility should a need arise in the future to excavate the utility.

Requirements for bedding sand vary from circumstance to circumstance. Sand bedding may be required for direct burial lines such as electrical, gas, and communication lines, but it may be omitted in lines that are run in conduit.

Sand that is placed below the utility line is called bedding sand, and sand that is placed above the utility line is shading sand. Additional sand is often needed to make up the space between the bedding sand and the shading sand to the thickness of the utility line. For example, if the requirements were for a four-inch layer of bedding sand and a six-inch layer of shading sand in a trench that contained a four-inch diameter sewer line, the sand requirement would be a total sand depth of 14 inches.

4" Bedding Sand + 4" Pipe Thickness + 6" Shading Sand = 14" Total Sand Depth

Figure 7-26 shows an example of a main sewer line that has been installed in a bed of sand.


Figure 7-26 Main sewer line installed in a sand bed.

Estimating Sewer Connection

The sewer connection is the cost associated with the excavation and installation of the sewer line from the public utility to the house. The cost would include the excavation of the trench, the installation of the sewer pipe and cleanouts, and the backfilling of the trench.

Figure 7-27 shows a PVC pipe sewer line installed in a trench. The soil in the bottom of the trench is fairly free of large rocks or other debris and has been graded to a consistent slope, and sand has not been placed in the bed.


Figure 7-27 PVC sewer pipe and cleanout installed in a trench.

Sewer Line Cost

NCE Figure 7-5 shows the NCE cost for sewer line installation. Installation is priced as a lump sum subcontract cost based on the type of sewer pipe installed. Different costs are also shown if the line is run to the street in the front of the structure or to an alley in the back. The lump sum price includes up to 40 feet of installation with an additional charge per lineal foot over the 40-foot standard.

Sewer Connections, Subcontract Including typical excavation and backfill.					
4" vitrified clay pipeline, house to property line					
Long runs	—	LF	—	—	25.30
Short runs	—	LF	—	—	26.80
6" vitrified clay pipeline					
Long runs	—	LF	—	—	28.20
Short runs	—	LF	—	—	33.10
Street work	—	LF	—	—	67.30
4" PVC sewer pipe, city installed, property line to main line					
Up to 40 feet (connect in street)	—	LS	—	—	2,200.00
Up to 40 feet (connect in alley)	—	LS	—	—	1,590.00
Each foot over 40 feet	—	LF	—	—	49.50
6" PVC sewer pipe, city installed, property line to main line					
Up to 40 feet (connect in street)	—	LS	—	—	3,530.00

NCE Figure 7-5 NCE subcontract sewer line installation cost.

Figure 7-28 shows a four-inch PVC sewer line run to the front of the house. The excavation will run for a distance of 34 feet. This falls within the allotted 40 feet base run price estimate, so the lump sum rate of $2,200.00 will apply.

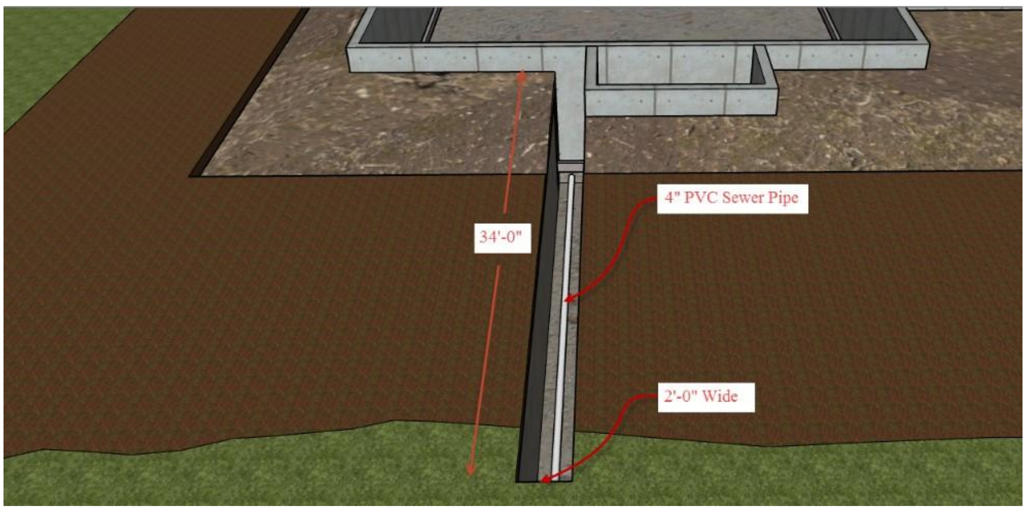


Figure 7-28 2’-0” x 34’-0” sewer trench with 4” PVC sewer pipe.

Estimating Sand Fill

In this estimate example, the contractor will provide a bulk supply of sand material to be used as bedding for the sewer pipe and the rest of the utility lines (Figure 7-29). The approximate amount of sand needed for the project will need to be calculated. The quantity of sand for the sewer line is determined by the length of the trench, the width of the trench, and the depth of the sand. The sand will be placed 6" above and 6" below the pipe. With a 4" diameter sewer pipe, the total sand depth is 16" (Figure 7-30).

The calculations for determining the quantity of fill sand is as follows:

$$24" \times 16" \times 34'$$

Or

$$2' \times 1.33' \times 34'$$

Or

$$2' \times 1.33' \times 34' = 90.44\, ft^3 \div 27 \frac{ft^3}{yd^3} = 3.35\, yd^3$$

Figure 7-29 Sand bedding material provided by contractor for installation of utilities.

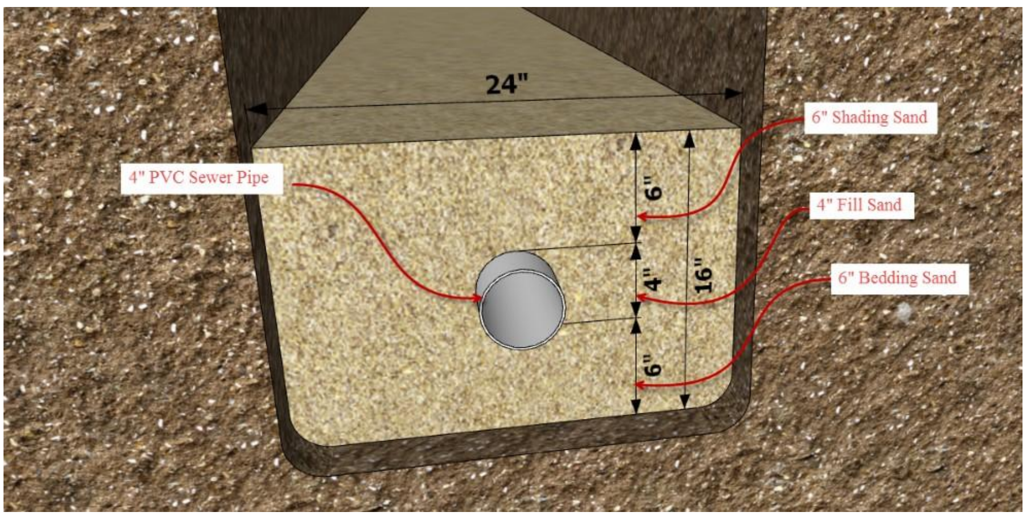


Figure 7-30 24” x 16” of sand around the sewer pipe.

The water connection is the cost associated with the cost of excavation and installation of the water line from the public utility to the house. The installation is handled on a subcontractor basis. The cost includes the excavation of the trench, the installation of the water line, water meter, and backflow preventer. Code requires that the water line is installed at least twelve inches away from and twelve inches above the sewer line. It also requires it to be below the frost line. Figure 7-32 shows a trench excavation and water meter box in preparation for the installation of a water line.

Figure 7-31 shows a separate 34-foot trench excavation in the front of the house for the water line. The trench will be 12 inches wide.

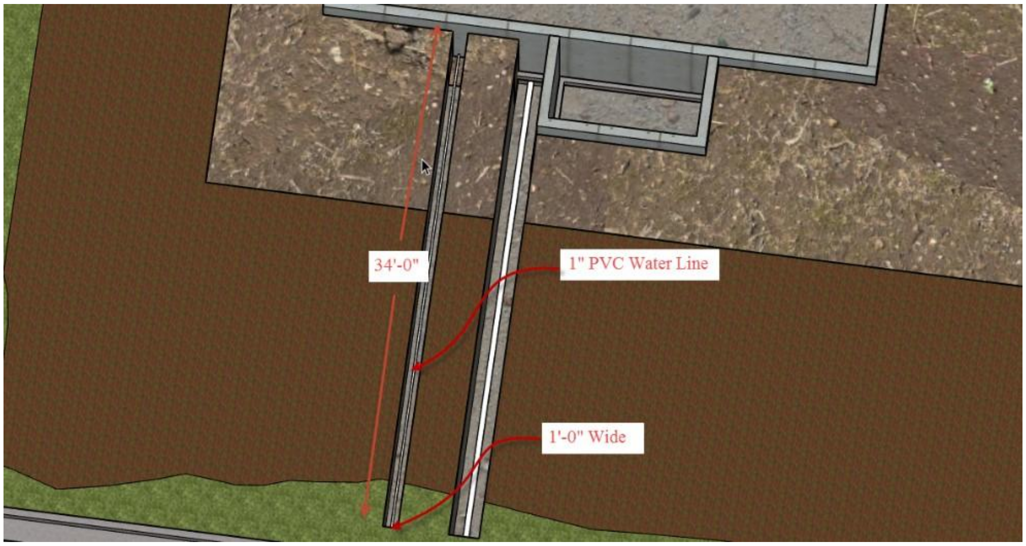


Figure 7-31 One foot by thirty-four foot water line excavation.

The one-inch water line will be installed on a bed of sand six inches above and below (Figure 7-32).

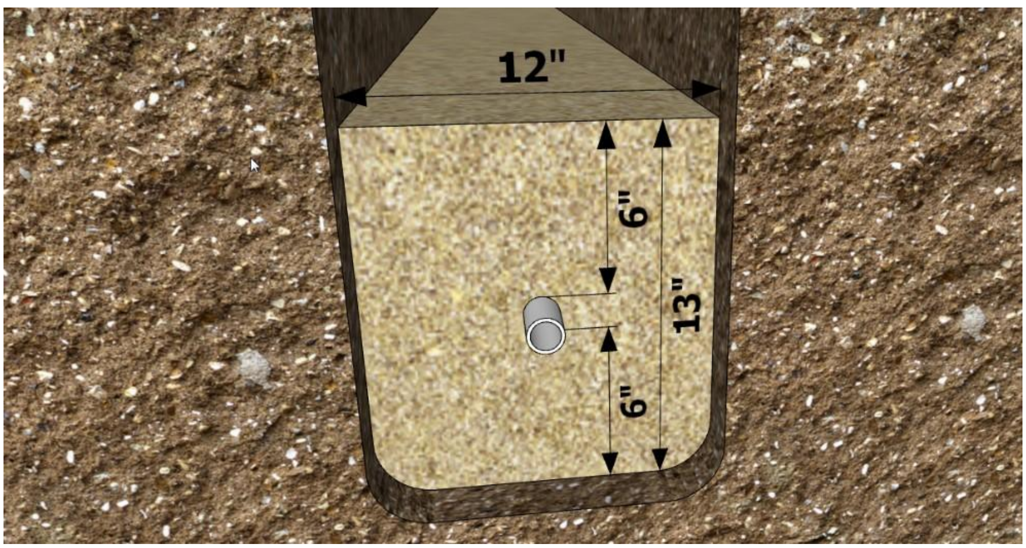


Figure 7-32 Water line in sand bed.

NCE Figure 7-6 shows the water meter installation costs from the NCE. The description of the cost explains that this is a lump sum cost for the excavation and installation of the water service, including the parts and materials needed. Cost would be less if building on a build-ready lot where the main utility services were already installed and the contractor simply needed to hook up to the existing system. The cost for the installation of the backflow preventer, which will prevent any contaminated water from entering the city's portable water system, is also priced as an additional cost.

Water Meters Check with the local water district for actual charges. These costs are typical for work done by city or county crews and include excavation and pipe to 40' from the main, meter, vault, re-compaction and repairs to the street. These costs do not include capacity fees or other charges which are often levied on connection to new construction. The capacity fee per living unit is typically $5,000. For commercial buildings, figure 20 fixture units equal one living unit. (Bathtubs, showers and sinks are 2 fixture units, water closets are 4, clothes washers are 3 and lavatories are 1.) The cost for discontinuing service will usually be about the same as the cost for starting new service, but no capacity fee will be charged. Add the backflow device and capacity fee, if required.

1" service, 3/4" meter	—	LS	—	—	3,090.00
1" service, 1" meter	—	LS	—	—	3,180.00
Add for 1" service per LF over 40'	—	LF	—	—	73.60
2" service, 1-1/2" meter	—	LS	—	—	3,560.00
2" se[illegible]	[illegible]	LS	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	—	—	[illegible]
2" meter (double line)	—	LS	—	—	1,280.00
Backflow preventer with single check valve. Includes pressure vacuum breaker (PVB), two ball valves, one air inlet and one check valve					
1" pipe	—	LS	—	—	307.00
2" pipe	—	LS	—	—	603.00

NCE Figure 7-6 Cost for excavation and installation of the water meter and water service.

Estimating the Electrical Supply

The electrical installation in most situations is provided by the electrical utility. Electricity was traditionally supplied to the residence by above ground utility poles and an overhead electrical service line. This may still be the case in many circumstances, particularly if the building is a long existing development. However, most modern installations are supplied by an underground service. Most electrical power is delivered along high voltage power lines and must be stepped down to the standard 100 to 120 volt, 60 hertz standard that is common in the United States before being delivered to the customer. A transformer is commonly located on, or close to, the property to provide the change in electrical voltage. The transformer can be a utility pole mounted system or a ground mounted system. As a rule, the electrical utility is responsible for the installation and maintenance of the electrical service across the owner's property, from the utility's supply equipment to the individual electrical meter.

Figure 7-33 shows an example of an underground electrical service installation. The contractor is responsible for excavating a trench from the transformer to the electrical meter base panel. A small framed power wall has been installed to attach the meter base. After the trench is dug, the power wall framed, the meter base, and conduit put in place, the power company's service crew installs the main power line from the transformer to the meter base

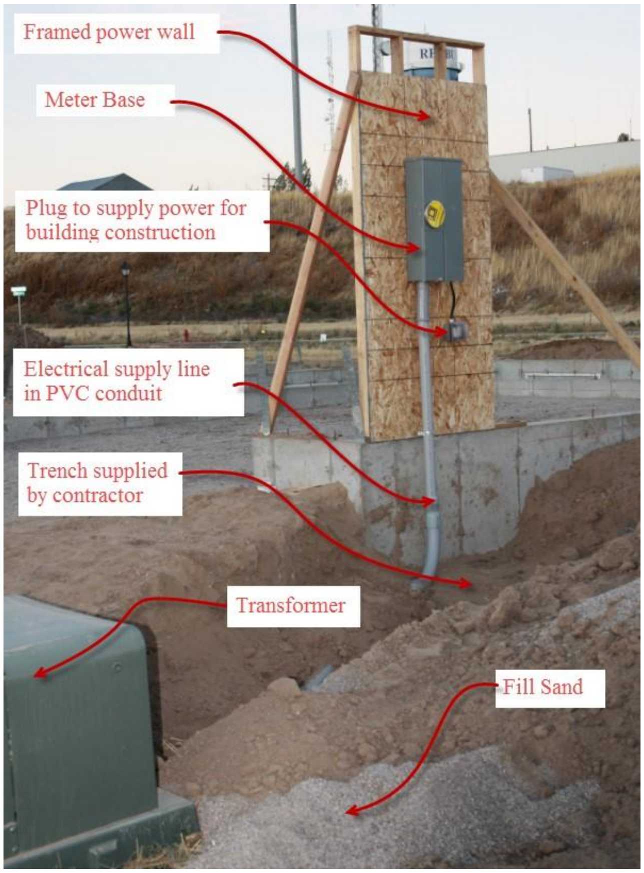


Figure 7-33 Underground electrical service to framed power wall.

Once all of this has been completed and an inspection made by the local building official, the trench will be backfilled, compacted, and the meter will be set by the power company. This will provide power for the building of the house and will ultimately become the power supply for the finished structure.

Figure 7-34 shows the underground electrical supply installation from a previously installed transformer to the meter base location on the back of the garage wall. The power line will be installed in a two-inch diameter PVC electrical conduit buried in a 12-inch-wide by 30-inch-deep trench that is 41 feet long. The electrical supply estimate in this section will include installing the electrical supply lines and excavating, backfilling, and compacting the trench. In addition, the contractor will supply a quantity of sand fill for backfilling around the supply conduit.

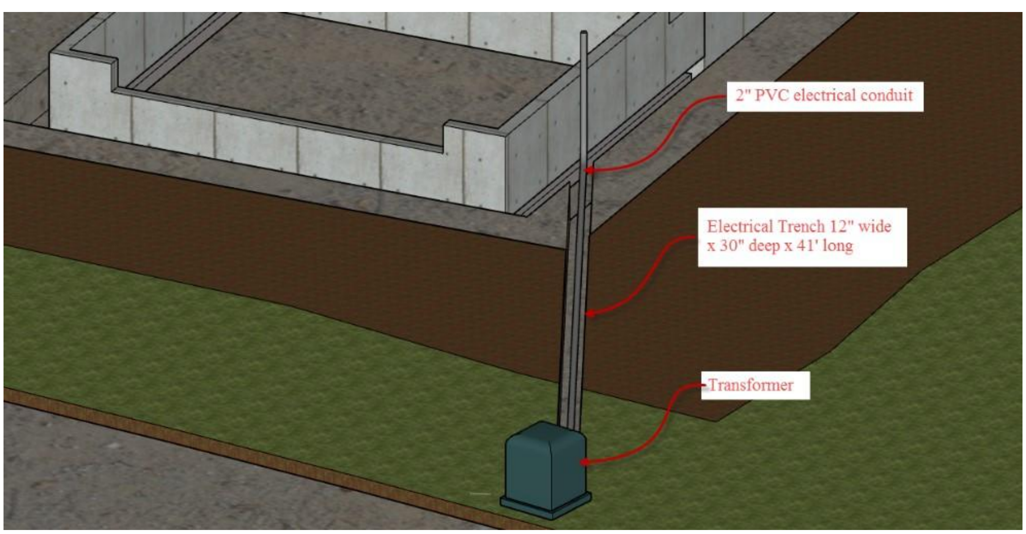


Figure 7-34 Electrical supply.

Estimating Electrical Supply Installation

The cost for estimating the installation of the electrical supply lines by the power utility will need to be obtained from the company. Sometimes this can be done by using an online installation cost estimator provided by the power company, such as the one provided on Rocky Mountain Power's website.

To begin using the estimator, click the Line Extension Estimator → Get Started buttons. Select the state from the drop-down list and put the distance of the installation of 41 feet that was calculated from the plans and press the Next button (Figure 7-35).

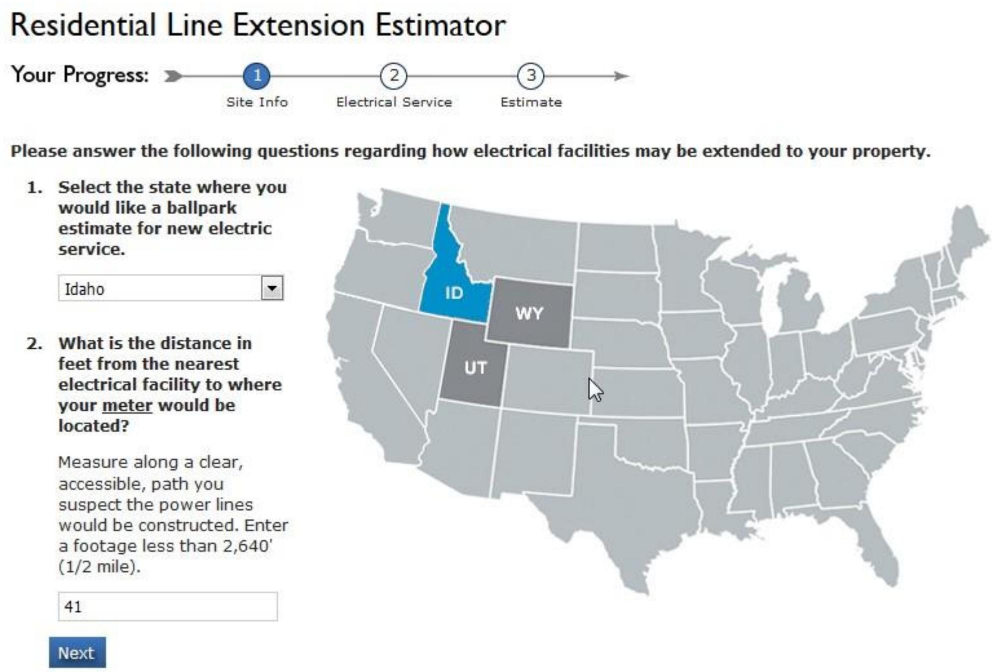


Figure 7-35 Select state and distance for electrical line installation.

The next screen has seven different options for installing the power line. In this case, the transformer has been installed on the site and the power will be run underground from the transformer to the meter base in a contractor supplied trench and conduit. Pick the Short Underground from Underground option and click the Next button (Figure 7-36).

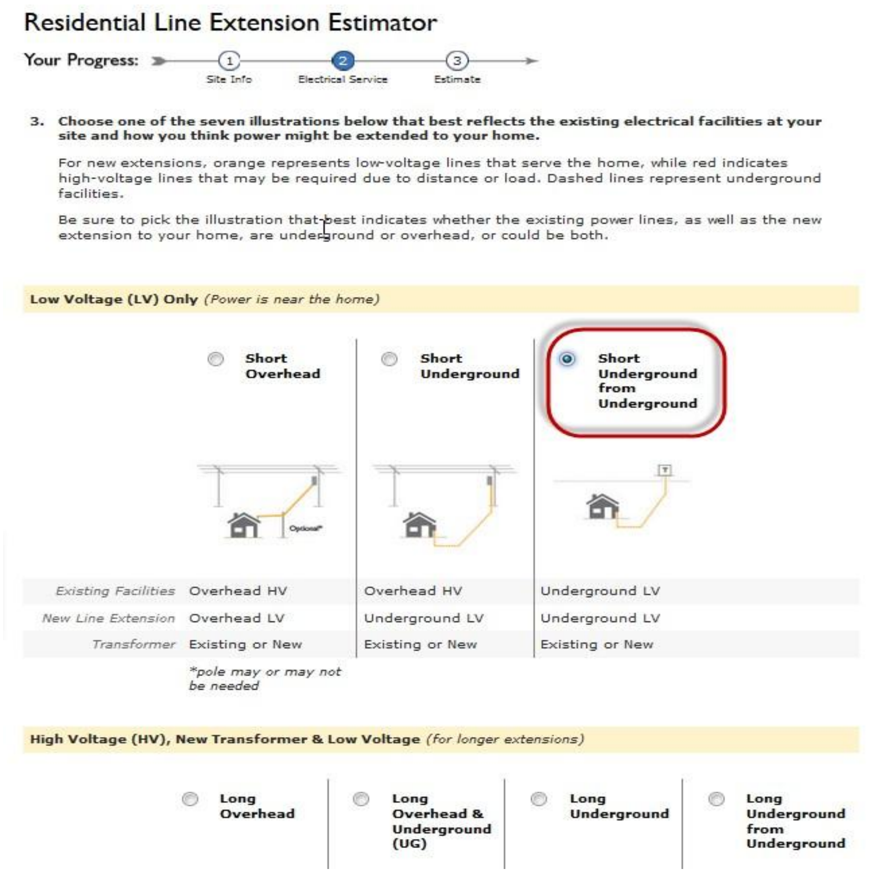


Figure 7-36 Select Short Underground from Underground option.

Click the Yes radio button to indicate that the ground level transformer is already installed and then click the Get a Ballpark Estimate button to get the cost estimate (Figure 7-37).

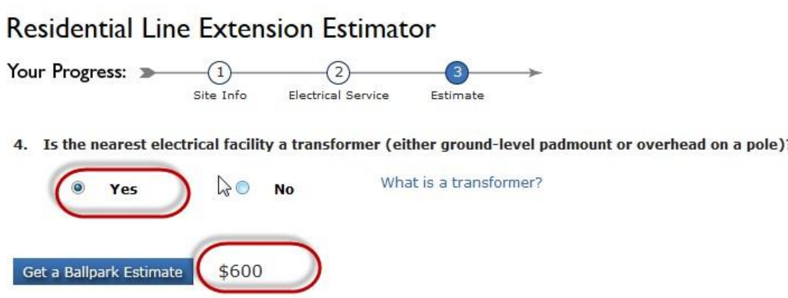


Figure 7-37 Ballpark estimate.

The price estimate of $600 is what can be put into the estimating template as the electrical supply installation cost.

Estimating Electrical Trench Excavation

The contractor is responsible for the trench excavation for the power supply line trench. The depth of the trench is determined by the type of installation and the power company requirements. The power company has provided the diagram shown in Figure 7-38 for the electrical trench excavation.

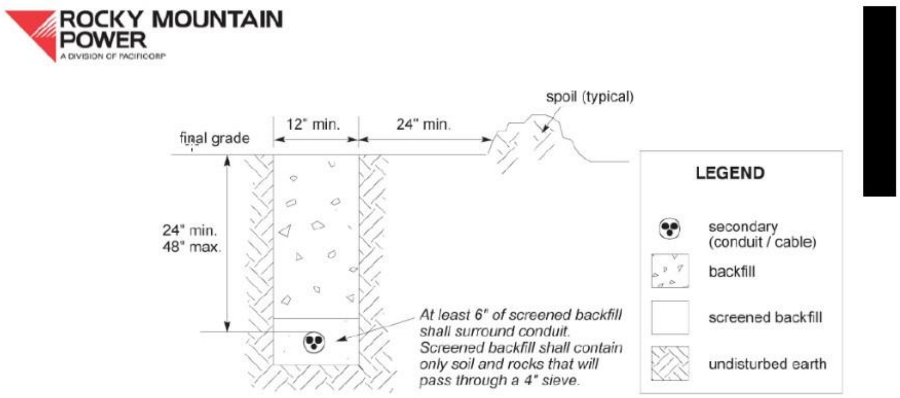


Figure 2.3.5 – Secondary Trench

Figure 7-38 Electrical trench details.

The length of the excavation is determined by finding the length from the transformer to the meter base. Trench excavation is priced in the NCE as a lineal foot cost based upon the width of the trench and the type of soil. The electrical supply example in Figure 6-84 identifies the trench as being 12 inches wide x 30-inch-deep x 41 feet long. The excavation cost of $2.04 per lineal foot for medium soil from the NCE will be used for this estimate (Figure 6-89). The cost is calculated as follows:

41' x $2.04 per LF = $83.64

Estimating Trench Backfill, Compaction, and Sand Fill

Trench backfill and compaction are priced in the NCE as a cubic yard cost. The quantity of soil to be backfilled and compacted is determined by the following:

12" × 30" × 41'

Or

1' x 2.5' x 41' = 102.5 ft^3

Or

$$102.5\ ft^3\ \div\ 27\frac{ft^3}{yd^3}\ =\ 3.80\ yd^3$$

The NCE estimates the price of backfill using a front-end loader 60 hp as $2.32 per cubic yard (Figure 6-89). The cost for backfill would be

$2.19 x 3.80 yd^3 = $8.32

The NCE estimates the price of compaction using a “jumping jack” type compactor as $3.95 per cubic yard (Figure 6-89). The cost for compaction would be

$4.10 x 3.80 yd^3 = $15.58

Estimating Sand Fill

The power company has specific requirements for the type of backfill that is required around the conduit or power cable. In order to avoid the possibility that the soil on site doesn’t meet the requirements, sand will be provided by the contractor. Four inches of bedding sand, six inches of cover sand, and two inches of sand for the diameter of the pipe for a total depth of 12 inches will be used. The calculations for determining the quantity of fill sand would be as follows:

12" x 12" x 41'

Or

1' x 1' x 41' = 41 ft^3

Or

$$41\ ft^3\ \div\ 27\frac{ft^3}{yd^3}\ =\ 1.52\ yd^3$$

The NCE prices the equipment and labor for installation for the sand bedding at $1.42 per cubic yard. The calculation would be

1.52 yd^3 x $1.29 = $1.97

NCE Figure 7-7 shows the trenching, backfill, and sand fill cost for the electrical trench.

	Craft@Hrs	Unit	Material	Labor	Equipment	Total
Trenching and Backfill with Heavy Equipment These costs and productivity are based on utility line trenches and continuous footings where the spoil is piled adjacent to the trench. Linear feet (LF) and cubic yards (CY) per hour shown are based on a crew of two. Reduce productivity by 10% to 25% when spoil is loaded in trucks. Shoring, dewatering or unusual conditions are not included.						
Wheel loader 55 HP, with integral backhoe						
12" wide bucket, for 12" wide trench. Depths 3' to 5'						
Light soil (60 LF per hour)	B8@.033	LF	—	1.19	.69	1.88
Medium soil (55 LF per hour)	B8@.036	LF	—	1.30	.75	2.05
Heavy or wet soil (35 LF per hour)	B8@.057	LF	—	2.05	1.18	3.23
18" wide bucket, for 18" wide trench. Depths 3' to 5'						
Light soil (55 LF per hour)	B8@.036	LF	—	1.30	.75	2.05
Medium soil (50 LF per hour)	B8@.040	LF	—	1.44	.83	2.27
Heavy or wet soil (30 LF per hour)	B8@.067	LF	—	2.41	1.39	3.80
24" wide bucket, for 24" wide trench. Depths 3' to 5'						
Light soil (50 LF per hour)	B8@.040	LF	—	1.44	.83	2.27
Medium soil (45 LF per hour)	B8@.044	LF	—	1.59	.91	2.50
Heavy or wet soil (25 LF per hour)	B8@.080	LF	—	2.88	1.66	4.54
Backfill trenches from loose material piled adjacent to trench. No compaction included.						
Soil, previously excavated						
Front-end loader 60 HP (50 CY per hour)	B8@.040	CY	—	1.44	.75	2.19
D-3 crawler dozer (25 CY per hour)	B8@.080	CY	—	2.88	2.02	4.90
3/4 CY crawler loader (33 CY per hour)	B8@.061	CY	—	2.20	1.28	3.48
D-7 crawler dozer (130 CY per hour)	B8@.015	CY	—	.54	.83	1.37
Sand or gravel bedding						
3/4 CY wheel loader (80 CY per hour)	B8@.025	CY	—	.90	.39	1.29
Compaction of soil in trenches in 8" layers						
Pneumatic tampers (40 CY per hour)	BL@.050	CY	—	1.50	1.19	2.69
Vibrating rammers, gasoline powered "Jumping Jack" (20 CY per hour)	BL@.100	CY	—	2.99	1.11	4.10

NCE Figure 7-7 Costs for trenching and backfill.

Estimating the Gas Supply

Residential construction is often able to take advantage of either natural gas or propane for use in heating and cooking. The installation cost will be different for the two types of fuel. Propane is usually supplied by a storage tank that is placed upon the property. The storage tank could be rented or purchased. A line is run underground from the storage tank to the building to supply the gas appliances. Costs to install propane would include the tank, excavation, and supply lines from the tank to the building.

Natural gas is usually run from underground utility lines that are installed by the gas company. The gas is supplied to the property under high pressure to a gas meter that reduces the pressure and measures the amount of gas used, so the gas utility can bill the customer. The site work phase cost for natural gas would include excavation of a trench for the installation of the gas supply, sand bedding for the gas line, backfill, and compaction of the trench.

Figure 7-39 shows the rough installation for a natural gas supply meter. The contractor is responsible for excavating a trench and providing bedding sand for the gas utility line. In some installations, the customer is responsible for proving a conduit for the gas line. Other installations may not require a conduit but could require sand bedding and shading. The contractor also installs the interior gas supply piping and tests it for leaks before the gas meter is installed.

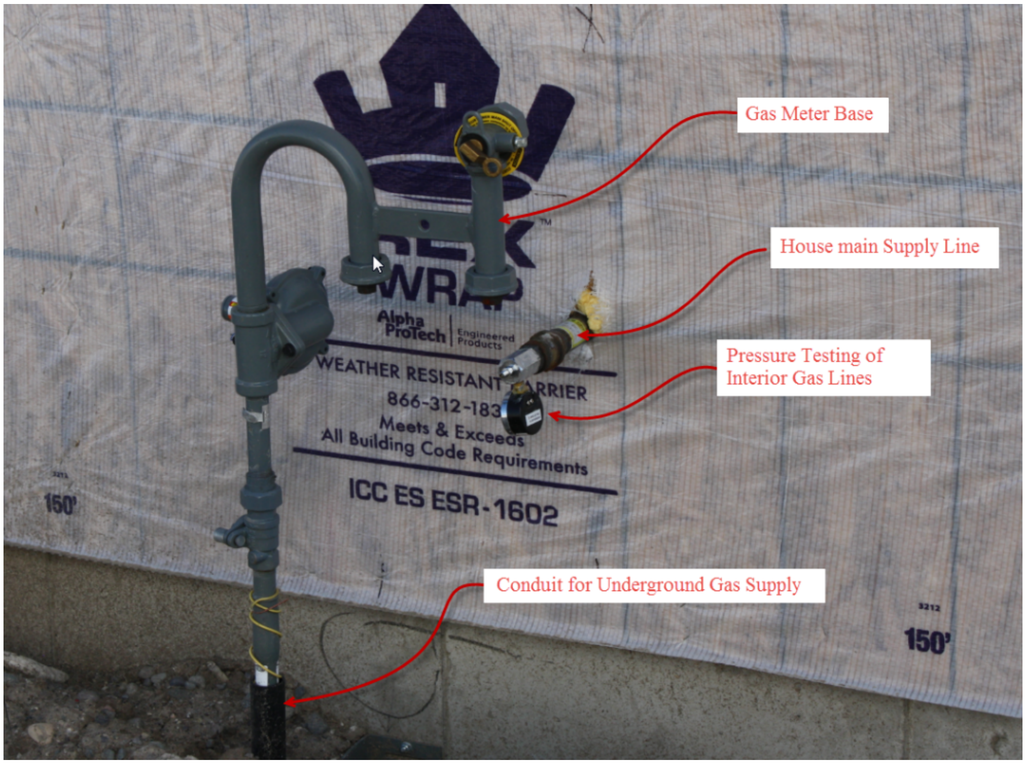


Figure 7-39 Natural gas meter base installation.

Once all of the infrastructure is in place, tested, and inspected, the gas utility will install the meter to supply the gas to the house.

Estimating Gas Supply Trenching

Figure 7-40 shows an example of the gas supply trench that is 12 inches wide, 30 inches deep, and 40 feet long. The excavation cost of $2.05 per lineal foot for medium soil from the NCE will be used for this estimate, the same as was used for the electrical trench (NCE Figure 7-7). The cost is calculated as follows:

40' x $2.05 per LF = $82.00

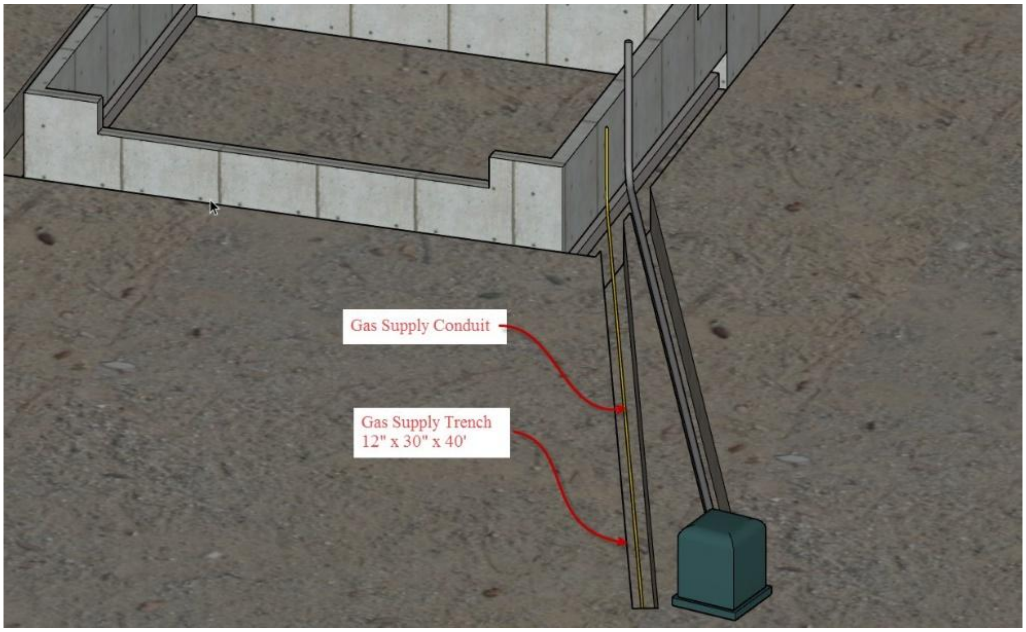


Figure 7-40 Gas supply trench.

Estimating Trench Backfill, Compaction, and Sand Fill

Trench backfill and compaction are priced in the NCE as a cubic yard cost. The quantity of soil to be backfilled and compacted is determined by the following:

12" × 30" × 40'

Or

1' x 2.5' x 40' = 100 ft^3

Or

$$100\ ft^3\ \div\ 27\frac{ft^3}{yd^3}\ =\ 3.70\ yd^3$$

The NCE estimates the price of backfill using a front-end loader 60 hp as $2.19 per cubic yard (NCE Figure 7-7). The cost for backfill would be

$2.19 x 3.70 yd^3 = $8.10

The NCE estimates the price of compaction using a “jumping jack” type compactor as $4.10 per cubic yard (Figure 6-89). The cost for compaction would be

$4.10 x 3.70 yd^3 = $14.62

Estimating Sand Fill

The gas company has specific requirements for the type of backfill that is required around the gas line. To avoid the possibility that the soil on site does not meet the requirements, the contractor will provide the sand. Four inches of bedding sand, six inches cover sand, and two inches of sand for the diameter of the pipe for a total depth of 12 inches will be used. The calculations for determining the quantity of fill sand would be as follows:

12" x 12" x 40'

Or

$$1' \times 1' \times 40' = 40\ ft^3$$

Or

$$40\ ft^3 \div 27\frac{ft^3}{yd^3} = 1.48\ yd^3$$

The NCE prices the equipment and labor for installation for the sand bedding at $1.42 per cubic yard. The calculation would be

$$1.48\ yd^3 \times \$1.29 = \$1.91$$

Rough Grading Estimate

The rough grading cost includes the cost for spreading the previously excavated topsoil over the backfilled soil excavation. Figure 7-41 shows an example where the topsoil has been graded over the backfill.

Figure 7-41 Topsoil graded over the site.

The topsoil that was removed prior to foundation excavation and stored on the site will be used for the rough grading.

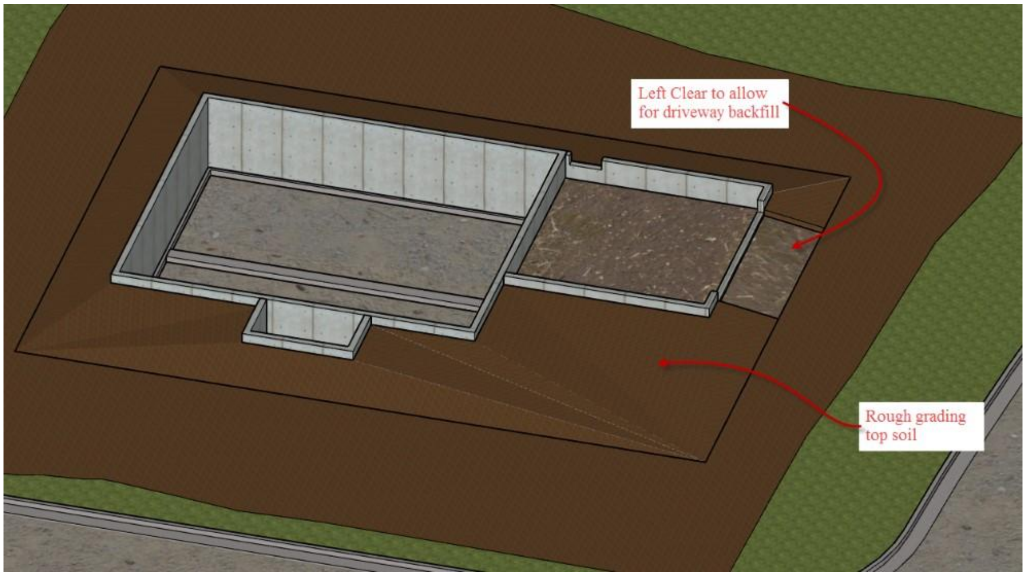


Figure 7-42 Rough grading topsoil.

There will not be any topsoil fill underneath the driveway area as that will have compacted engineered fill material for supporting the driveway. NCE Figure 7-8 shows the NCE cost to spread the topsoil using a 65 hp dozer and places the cost at $1.01 per cubic yard.

Excavation with Heavy Equipment These figures assume a crew of one operator unless noted otherwise. Only labor costs are included here. See equipment rental costs at the end of this section. Use the productivity rates listed here to determine the number of hours or days that the equipment will be needed. For larger jobs and commercial work, see excavation costs under Site Work in the Commercial and Industrial division of this book.

Excavation rule of thumb for small jobs	—	CY	—	2.85	2.85
Backhoe, operator and one laborer, 3/4 CY bucket					
Light soil (13.2 CY per hour)	B8@.152	CY	—	5.48	5.48
Backfill (36 CY per hour)	0E@.027	CY	—	1.14	1.14
Clearing brush (900 SF per hour)	0E@.001	SF	—	.04	.04
Add for thick brush	—	%	—	300.0	—
Spread dumped soil (42 CY per hour)	0E@.024	CY	—	1.01	1.01
Strip topsoil (17 CY per hour)	0E@.059	CY	—	2.49	2.49

NCE Figure 7-8 Cost for spreading topsoil.

Using the quantity of 103.3 cubic yards that was previously calculated to strip the topsoil before foundation excavation, the cost for rough grading would be

$$103.3 \text{ yd}^3 \times \$1.01 = \$104.33$$

Estimating Erosion and Sediment Control

Stormwater runoff from construction sites can be a significant source of water pollution. When soil is excavated and plant material removed in any of the previously discussed excavation activities, the water that runs across the bare soil picks up silts and other pollutants, which then makes its way into streams and other waterways. The Environmental Protection Agency has regulations that oversee the management of stormwater pollution on construction sites. Excavation activities that impact one acre or larger sites are required to submit a stormwater pollution and prevention plan, commonly referred to as a SWPPP's plan, before excavation activities can begin. The purpose of the SWPPP's plan is to outline the methods that will be used on a construction site to control the silt and other pollutants from stormwater runoff.

Some examples of elements in a stormwater plan would be erecting a silt fence, using straw bales in drainage ditches, and covering the ground with erosion control mats.

Silt Fences

Silt fences are fences made of some form of semi-porous geotextile fabric. Stakes are attached to the fabric at regular intervals. The fence is placed on the downside of a sloped lot, and the bottom of the fence is buried in a shallow trench approximately six inches deep. The semi-porous nature of the fence allows water to flow through the fence while trapping the silt particles behind the fence. Figure 7-43 shows an example of a silt fence.

Figure 7-43 A silt fence.

Silt fence material is commonly purchased in rolls such as 100 feet long and three feet high. Installation costs are estimated as a lineal foot cost and would include shallow trench excavation and installing the fence. Figure 7-44 shows the installation of 136 feet of silt fence along the rear and side of the property.

Figure 7-44 Silt fence installation.

NCE Figure 7-9 shows the installation price of the silt fence in the NCE.

	Craft@Hrs	Unit	Material	Labor	Total
Silt fence, black 6 mil poly with stakes 8' OC, staked and buried 9" deep					
3' high, 100 LF roll	BL@.030	LF	.33	.90	1.23

NCE Figure 7-9 Cost for installation of silt fence.

CITATIONS:

Craftsman Book Company. (n.d.). 2018 Craftsman Costbooks. Retrieved from https://www.craftsman-book.com/

Richard Pray Craftsman Book Company, 2018 National Construction Estimator, 66 Edition.

Concrete Construction Processes and Materials

This chapter will cover items that are estimated in the concrete phase of construction. This will include concrete footings, foundations, floors, sidewalks, driveways, patios, stairs, and miscellaneous concrete items. The discussion will begin with footings.

Concrete Footings

Estimating concrete footings begins with estimating the formwork needed for the footings. There are a number of ways that concrete footings can be formed. Each has advantages and disadvantages. The three most common are trench footings, 2"× 10" formed footings, and 2"× 4" formed footings.

Trench Footings

The most basic method of forming concrete footings is to dig a trench in the soil, place the reinforcing steel, and fill the trench with concrete. This method is usually the least expensive option for forming footings because separate form material does not have to be purchased. However, there are several disadvantages to this method. The first is that not all soils are suitable for trench footings. Soil that has a high clay content and holds its shape works well for forming trench footings. Sandy or gravelly soils, however, are not because of the difficulty in getting these soils to hold their shape after the trench is dug. The soil tends to slough off into the footings, making it difficult to pour and finish the concrete. Another drawback is the difficulty in getting level because there are no flat footing sides to screed the concrete off. With this method, metal rebar stakes are placed in the center of the trench at regular intervals, and the top of the stakes are set to the finished elevation using a transit or laser level (Figure 8-1). The top of the concrete is poured to the top of the grade stakes, which are used as a reference when floating to the top of the surface.

Figure 8-1: Trench footings

Another disadvantage to this method of forming is that it is more difficult to accurately estimate the amount of concrete that will be used because of the inconsistencies in the footing depth and shape. Commonly, a larger waste factor would be used when estimating trench footings.

Estimating trench footings is typically an excavation problem. The quantity to be excavated in cubic yards can be calculated by multiplying the length, depth, and thickness. Alternatively, it may be calculated as a lineal footage of trenching.

2"× 4" Footing Forms

A second method of forming footings is to use 2"× 4" or 2"× 6" framing lumber to form the top of the footings and then to either backfill the open portion at the bottom of the footing, or excavate a few inches of soil at the base of the footings (Figure 8-2). The advantage of this method is that the footings can be formed more precisely, and the form tops can be used to screed the concrete, which results in a more level footing. The disadvantage is the time that is required to build the forms and the cost of the form material, although the cost of the form material is considerably less than purchasing material to form the footings at full depth.

There can be considerable hand labor involved, either backfilling around the footing forms or hand excavating the base of the footings.

Estimating 2"× 4" footings requires calculating both the quantity of form material to be purchased and the quantity of soil to be either hand excavated or backfilled. The quantity of form side material is calculated by multiplying the length of the footings by the number of form sides (typically two). For a project with 216 lineal feet of footing, there would be approximately 432 lineal feet of forms to purchase and 216 lineal feet to excavate.

Figure 8-2 Footing formed using 2"× 6" lumber. Dirt will need to be backfilled around the bottom of the footings before the concrete can be poured.

2"× 10" Footing Forms

The third method of forming footings is to use 2"× 8", 2"× 10", or 2"× 12" framing lumber to form the footings. This is the most common method used. The wider lumber allows the footings to be formed full width with very little backfill or hand excavation required (Figure 8-3).

Estimating 2"× 10" requires calculating the quantity of form material to be purchased. The quantity of form material is calculated by multiplying the length of the footing by the number of form sides (typically two). For a project with 216 lineal feet of footing, there would be approximately 432 lineal feet of forms to purchase.

Figure 8-3 2 × 10 inch concrete forms.

Number of Form Uses

Another aspect of the purchase of footing formwork material that needs to be part of the equation is the number of form uses. Framing lumber for form material is expensive and contractors try to reuse material when possible (Figure 8-4). Still, each time footings are formed, some of the material that was used is destroyed and cannot be reused in future formwork. This is typically accounted for by adding a number of form variables to the equation. A typical example is that a set of forms could be used in five separate footings before the material is too damaged to be used any further. With this example, the estimate for footing material for any single project would be one-fifth of the total amount needed for the project. The expectation is that the other four-fifths would be brought from old projects and reused. Using the previous estimated quantity of 432 lineal feet of formwork, only one-fifth or 87 lineal feet would be included in the estimate for that project.

Figure 8-4 Concrete form material salvaged and prepared for use on another job.

Stakes and Spreaders

Footings formed by either the 2"× 4" or the 2"× 10" method require stakes and spreaders. The stakes are used to anchor the forms to the ground and hold them in place, and spreaders are used to keep the forms from spreading apart from the pressure of the concrete. Stakes can be made of either wood or metal. Metal stakes are typically reused time and time again and only a small amount is included in the estimate to cover the stakes that are lost or unusable after the project. Wooden stakes are typically destroyed with a project and are considered disposable. New stakes are usually purchased with each project. The number of stakes needed is dependent upon the type and size of the footing, but a common example would be to use two stakes for every four lineal feet of footing. This would place one stake on each side of the formwork every four feet. In the previous example, using 150 lineal feet of footings, the number of stakes needed would be

$$\frac{216\ feet}{4\ feet} \times 2\ stakes = 108\ stakes$$

Wooden stakes are usually sold in bundles of 24 stakes, so three bundles would be insufficient and four bundles would need to be purchased.

Spreaders are used to keep the forms a consistent distance apart (Figure 8-5). They are usually made from some type of framing lumber, such as 1" × 2" × 8' furring strips. They are usually placed approximately every four feet of footings. The quantity of spreader material is calculated by multiplying the number of spreaders by the length of each spreader and dividing by the length of the spreader material. Each spreader is usually the width of the footing plus an additional three inches to account for the thickness of the form material. Footings that are 18 inches wide would require spreaders that are a minimum of 21 inches long. Using the above example of 150 lineal feet of footings, 38 spreaders would be needed.

$$\frac{216\ feet}{4\ feet} = 54\ feet$$

Each spreader would need to be at least 21 inches long. If they were cut out of 1" × 2" × 8' spreader material, one board would yield four spreaders, which would require the purchase of ten boards.

$$\frac{54\ Pieces}{4\ Pieces\ per\ Board} = 13.5\ rounded\ to\ 14\ boards$$

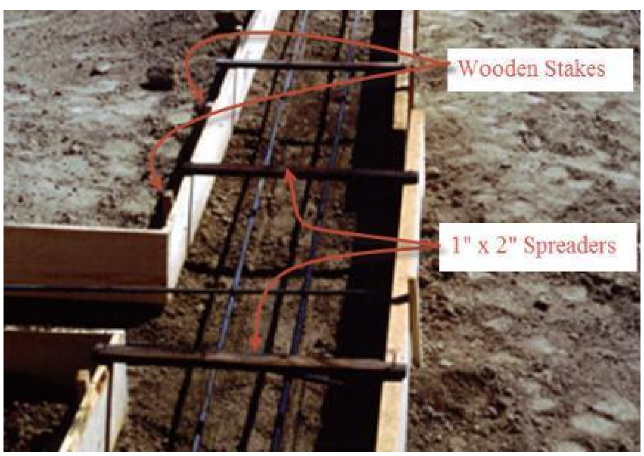


Figure 8-5 Wood stakes and spreaders.

Footing Reinforcing

Steel rebar is often placed in concrete to strengthen it. The combination of steel and concrete together make a better structure than either alone. This is because they have complimentary characteristics. Concrete is very good under compression and can carry large compressive loads, however, it is relatively weak under tension. To compensate for this weakness, steel is embedded in the concrete because steel has a high tensile strength.

Steel rebar used in construction is usually deformed rebar. This means that the rebar has been made with ribs and depressions on its surface (Figure 8-6). The deformations help the concrete to mechanically bond to the rebar surface and prevent slippage under heavy loads. Still, under very heavy loads, such as earthquakes, the rebar can pull out of the concrete. The individual pieces of rebar are tied together, or there are bends and hooks in the rebar to tie it to each other to increase bonding capacity.

Figure 8-6 Steel Rebar styles.

Steel rebar comes in many different types and styles. The most common type is black rebar, however, it is also available in epoxy coated, zinc coated, and stainless steel for special applications. Different strength grades of rebar are also available such as grade 40 with a minimum yield strength of 40,000 pounds per square inch or grade 60 with a minimum yield strength of 60,000 pounds per square inch. Rebar is sized by diameter in units of one eighth of an inch and given designations such as #4 bar, which refers to rebar four eighths or one half of an inch in diameter. Standard rebar sizes in the United States range from #2 bar (1/4") to #18 (2-1/4'). Rebar is also sold in standard lengths of 20 feet (most common size), 30 feet, 40 feet, and 60 feet.

In residential construction, rebar is often purchased in 20 foot lengths. Once on site, the individual pieces of rebar are cut and bent to meet the needs of the project using portable rebar forming equipment shown in Figure 8-7.

On some projects, both straight 20-foot length and prefabricated shapes may be purchased (Figure 8-8).

Figure 8-8 Both straight and preformed rebar delivered to the job site.

Two types of steel reinforcing are commonly embedded in concrete footings: horizontal rebar and vertical rebar.

Horizontal Rebar

Horizontal rebar is placed in the footings in one or more continuous bands that are made up of individual pieces of rebar that have been bent and tied together to mirror the path of the footings. The individual rebar pieces are overlapped before they are tied together with a code minimum overlap requirement of 24 bar diameters. This means that a #4 rebar, which has a diameter of one half an inch, would require a minimum of 12 inches of overlap where two bars are tied together. Figure 8-9 shows an example of two rows of #4 horizontal rebar bent to match the shape of the footing. Individual pieces of rebar are lapped a minimum of 12 inches and tied together.

Estimating horizontal rebar is done by multiplying the lineal feet of footing by the number of pieces of rebar. In the previous example of 150 lineal feet of footing, there would be roughly 300 lineal feet of rebar. However, additional rebar will be needed to compensate for the lapping requirement. Because #4 rebar requires a minimum of 12 inches of lapping, each 20-foot piece of rebar will yield only 19 feet of usable rebar. The formula for calculating rebar under these circumstances would be as follows:

$$\frac{216\ LF\ \times\ 2\ Pieces}{19\ LF} = 22.7\ pieces$$

This would be rounded up to a total of 23 pieces of rebar to meet the horizontal rebar requirement.

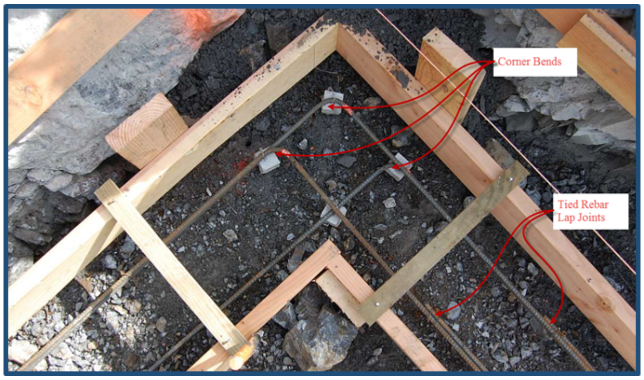


Figure 8-9 Horizontal rebar following the path of the footing.

Vertical Rebar

Vertical rebar is usually required in concrete footings that support concrete or masonry walls. The vertical rebar connects the footing and foundation together. Usually, the code minimum requirement is one #4 for rebar spaced a maximum of 48" on-center, but local requirements may require a closer spacing or larger rebar. The vertical rebar has a hook bent on the end that anchors it into the concrete. The vertical rebar is most often placed in the footings after the concrete has been placed, but while it is still pliable (Figure 8-10). It may be placed in the footings prior to the placement of the concrete and braced and tied into place as shown in Figure 8-11. In both cases, the rebar and concrete needs to stand undisturbed until the concrete is allowed to harden.


Figure 8-10 Installing vertical rebar in freshly placed concrete footings.


Figure 8-11 Vertical rebar placed in footing prior to concrete placement.

The fabricated length of vertical rebar is determined by three factors: the hook length, the embed length, and the exposure length. Standard engineering design sets the hook length at 12 times the rebar diameter. This would mean a six-inch hook length for a standard #4 bar. The embed length is determined by the thickness of the footing and the amount of rebar embedded in the footing. Code requires the rebar to have a minimum of three inches of concrete cover between the rebar and the bottom of the footing. The maximum embed depth for an eight-inch-thick concrete footing would be five inches, but the distance could be as small as three inches. The IRC requires the footing reinforcing to extend a minimum of 14 inches into the stem wall that the footing supports. A minimum length for the vertical rebar in an eight-inch-deep by sixteen-inch-wide footing using #4 rebar would be calculated as follows:

Hook Length = 6"

Maximum Embed Depth = 5"

Minimum Exposure Length = 14"

6" + 5" + 14" = 25"

This would be the minimum length for the vertical footing rebar, however, it is often made longer. One consideration for determining the length would be to size the rebar so that a standard 20-foot length would be cut into equal segments without significant leftover waste. It is not uncommon in a residential setting for the vertical rebar in the footings to have a minimum of 25-inch exposure to accommodate the vertical rebar in the foundation wall. Figure 8-12 shows an example of an 8"× 16" footing with two pieces of horizontal rebar and vertical rebar spaced at 32 inches on-center. The exposure length of the vertical rebar is 25 inches with a five-inch embed distance and a six-inch hook length.

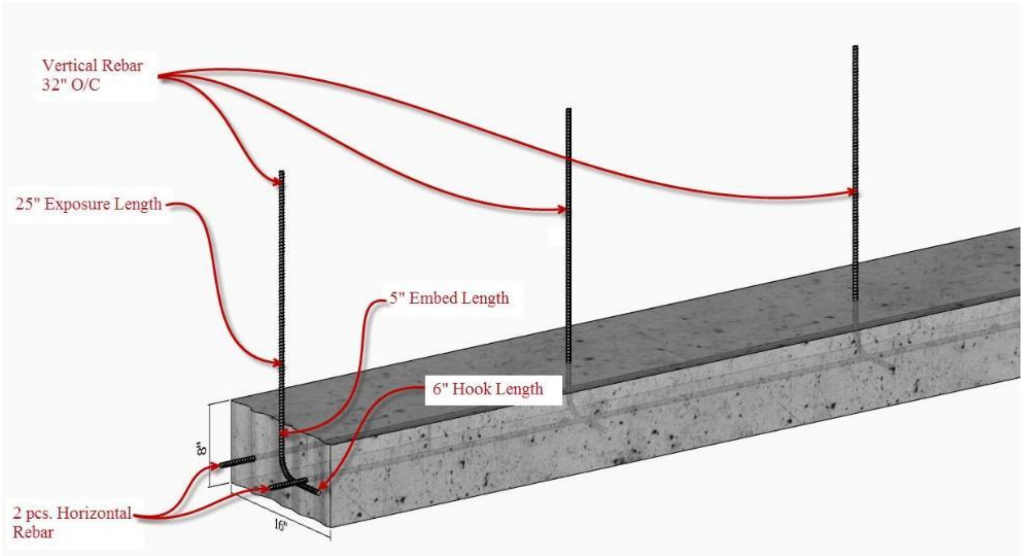


Figure 8-12 Footing with two pieces of horizontal rebar and vertical rebar 32" O/C.

The length calculations for the vertical rebar length would be as follows:

Hook Length = 6"

Embed Depth = 5"

Exposure Length = 25"

6" + 5" + 25" = 36"

If a 20-foot length were to be cut into 36-inch segments, each 20-foot piece would yield

20 ft. ÷ 3 ft. = 6.67 pieces

Each 20-foot length would yield six pieces with some waste. Determining the number of pieces of vertical rebar is calculated by dividing the length of the footing by the vertical rebar spacing and adding an additional piece of rebar for each footing corner and intersection. In the previous example of 150 feet of footing with a rebar spacing of 32 inches and eight corners and intersections, the number of horizontal rebar would be as follows:

216 ft. ÷ 2 ft. − 8 in.= 81 pcs.

81 pcs.+8 pcs.= 89 pcs

89 pcs. ÷ 6 pcs. = 14.8 rounded to 15 pcs. of rebar

Footing without Vertical Rebar

Some footings do not have vertical rebar even if there is horizontal rebar. Typically, these types of footings are used to support load bearing walls that are not made of masonry or concrete such as interior wood framed bearing walls. One example of load bearing footings is shown in Figure 8-13. These interior grade footings are formed and poured at the same time as the exterior wall footings. They have horizontal rebar in them, but the vertical rebar has been omitted. Later, backfill will be placed to the level off the top of the footings and a concrete floor will be poured in the basement. Wood framed walls will also be built on the concrete to support the first floor framing. Figure 8-14 shows interior grade footings in a crawl space construction. In this example, wood framed load bearing pony walls will be built directly on the footing to support the first floor framing.

Figure 8-13 Interior grade footings for basement construction.

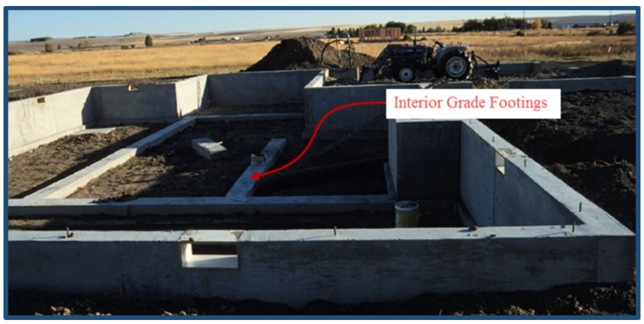


Figure 8-14 Interior grade footings for crawl space construction.

Figure 8-15 shows another type of interior footing called a thickened slab footing. This type is used when a concrete floor is poured. Soil is excavated where the footing is located. Horizontal rebar is placed in the excavation, and the footing and floor are poured as a single monolithic pour.

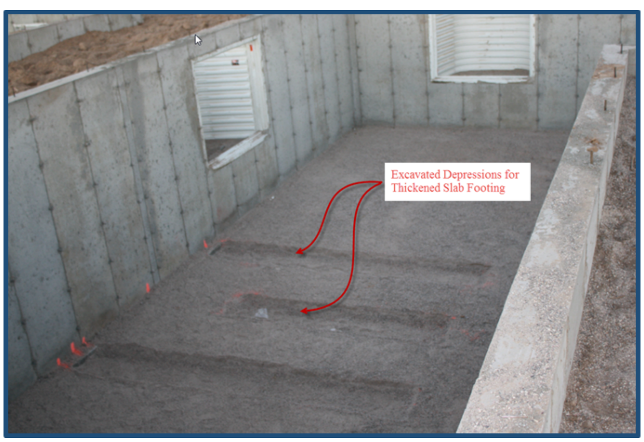


Figure 8-15 Excavated depressions for thickened slab footings.

Most concrete for residential construction projects is delivered to the job site in ready-mix concrete trucks. Several factors need to be taken into consideration when estimating the concrete including the quantity of concrete needed, the design mix of the concrete, the concrete placing method, and any curing requirements.

Calculating the Quantity of Footing Concrete

Concrete is calculated as a cubic foot quantity that is then converted into a cubic yard quantity when ordering from the ready-mix company. The footing dimensions determined when completing the basic takeoffs can be used to calculate the quantity of concrete in the footings. For example, the dimensions of the exterior wall footing given in the basic takeoffs are listed as 16 inches wide, 8 inches thick, and 216 feet long. The calculations for determining the quantity of concrete would be done by first converting the inch dimensions to feet and then multiplying the feet amounts and converting the total to cubic yards.

16" × 8" × 216' = Total Cubic Feet

or

1.33' × .67' × 216' = 192 ft^3

or

$$192\ ft^3 \div 27 \frac{ft^3}{yd^3} = 7.11\ yd^3$$

The minimum quantity of concrete that can be ordered at most ready-mix companies is one quarter of a cubic yard. Quantities of concrete calculated should be rounded up to the next cubic yard when estimating. The total quantity of concrete ordered for this footing would be equal to 7.25 cubic yards.

Delivering concrete can be costly, and ready-mix companies like to deliver full trucks of concrete whenever possible. Concrete ready-mix trucks range in size from smaller eight cubic yard rear discharge trucks (Figure 8-16) to larger eleven cubic yard front discharge trucks (Figure 8-17). Ready-mix companies typically charge an extra fee for delivery of loads that are less than the capacity of the truck. This is known as a short-load fee. Short-load fees can add 15 to 20 dollars for each cubic yard short of a full load.

Figure 8-16 Rear load concrete ready-mix truck.

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Figure 8-17 Front load concrete ready-mix truck.

By Paul [CC BY-SA 2.0 (https://creativecommons.org/licenses/by-sa/2.0)], via Wikimedia Commons

Concrete Design Mix

Concrete is primarily a mix of coarse aggregate, fine aggregate, and Portland cement, also known as gravel, sand, and cement. The exact portions of each element in the mix is one of the factors that determines the characteristics of the concrete, including its strength and durability. In addition, other chemicals or substances known as admixtures can be added to the mix to change or enhance the properties of the concrete. Batch plants (Figure 8-18) have specific recipes for these elements and can greatly affect the cost of the concrete. A discussion of these admixtures is beyond the scope of this text.

Figure 8-18 Concrete batch plant.

The strength of the concrete is one of the most important factors when using concrete. Concrete strength is defined by the pounds per square inch (psi) that it can support. Concrete footing strength requirements can vary from around 2,500 psi to 5,000 psi or more depending on the needs of the specific project. The strength of the concrete for a given project usually can be found in the plans or specification. There may be specific location strength requirements required by the building code or structural engineer. Concrete with higher strength requirements typically have more cement in the mix, which increases the cost of the mix. An old-fashioned method of specifying concrete strength is to identify it by the bag mix. A bag mix is the number of standard 94 lb. bags of cement in the mix per cubic yard of concrete. Bag mixes usually range from a somewhat weak 4-bag mix, which would be comparable to around a 2000 psi concrete to a 7-bag mix, which would equate to around a 5,000 psi concrete.

Concrete Placing Method

The method of placing the concrete in the footings can vary greatly and add significantly to the cost of the concrete. The concrete can be placed by direct chute, in which case the truck will need sufficient access to the job site to be able to reach all of the footings with the concrete chute (Figure 8-19). If the concrete cannot be delivered via the chute, it may need to be pumped or delivered with a crane and a bucket. Each of these options add to the cost of placing the concrete. In addition, ready-mix companies usually provide a specific time period for the unloading of the concrete truck and lengths of time greater than the allowance may result in an overcharge.


Figure 8-19 Placing concrete using a ready-mix truck chute.

Concrete Curing

Concrete turns from its plastic state to a solid state in a chemical process known as hydration. During the hydration process, the water in the concrete forms chemical bonds with the compounds in the cement in the form of hydrates. The hydration process begins rapidly after the concrete is mixed and water is added. As the concrete continues to set, the hydration process begins to slow down but continues for some time depending upon a number of factors. The strength of specific concrete is tested by taking samples in the form of cylinders from the concrete ready-mix truck and allowing them to cure for a specific period of time. The cured cylinders are then broken and the specific psi at which the cylinder shattered is noted. Common cure times in the construction industry for curing and testing cylinders are seven days and 28 days.

The hydration process can be impacted by a number of factors including the design mix, the water in the mix, and the curing temperature. The specific design mix of the concrete determines what the concrete's anticipated strength should be. The water in the concrete mix can affect the ultimate strength that the concrete should obtain. Too much water in the initial mix can weaken the concrete, but the reverse is also true, if the water in the mix is allowed to evaporate before it has time to combine with the cement compounds, the mix will be weaker. Once the concrete is placed, steps can be taken to slow the evaporation of the water into the atmosphere or seepage into the ground to allow sufficient time for most of the water in the concrete to hydrate with the cement. Temperature can also have an effect upon the concrete hydration process. Hot temperatures can accelerate the process but can also increase the rate of evaporation. The reverse is also true. Cold temperatures slow down the hydration process. If the water in the concrete is allowed to freeze before the concrete has reached a strength of 500 psi, the hydration process will be irreplaceably impacted and the strength of the concrete permanently impacted.

Curing is the process of using some artificial means to maintain ambient conditions so that the concrete may develop its designed strength. It may involve providing some form of barrier to slow the evaporation of water such as leaving the formwork in place for an extended period of time, covering the concrete with plastic sheathing, or applying a curing compound to the concrete surface.

Curing may also involve tenting around the concrete, providing artificial heat to keep the concrete warm, or covering recently poured concrete with thermal blankets (Figure 8-20) to allow it to retain the heat that is generated during the hydration process. Any curing needs must be accounted for when preparing an estimate.

Figure 8-20 Blankets are used to cover concrete footing to allow them to cure properly in cold weather.

Footing Material Costs

This section will focus on the concrete footing material. The emphasis will be on creating an assembly's estimate from the various elements that are part of forming, placing, and stripping concrete footings. Creating assemblies is a powerful way of estimating that can greatly speed up and simplify the estimating process. With a properly structured takeoff assembly, a few simple inputs or basic takeoffs will be inputted, and a basic unit of cost, such as price per lineal foot, will be developed.

Completing the Footing Material Header Section

Figure 8-21 shows an example of the footings and formwork that will be estimated. Two types of footings are identified: the exterior wall footings and the interior grade footings. In order to create your assembly, you will need to know the following variables.

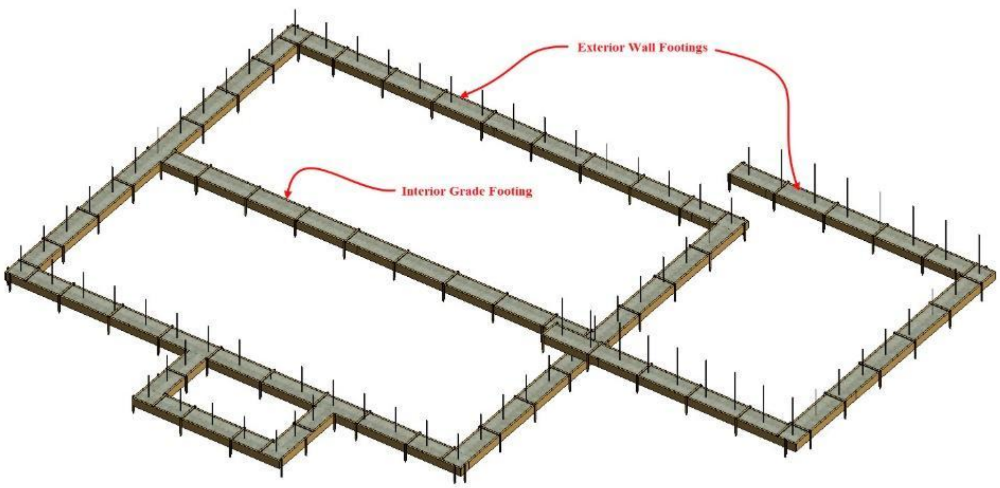


Figure 8-21 Graphic showing concrete footing formwork.

Number of Footing This Size.This variable is used to determine how many footings of a particular size and makeup there are. Most often, the input would be one for continuous strip footings even if there are several instances of the same footing type in a project.With strip footings, the important measurement is the length. The most likely instance when the variable would be higher is when it is used to identify a number of spot footings, each of which are the same size as the other. In Figure 8-22, the input has been set at one for both the exterior wall and grade beam footings.

Number of Horizontal Rebar. This variable is used to determine how many pieces of horizontal rebar there are in the footing assembly. Typical residential footings have two pieces of #4 rebar placed horizontally in the bottom of the footings, as shown in Figure 8-23; however, this number could easily be changed depending on the specific code and engineering requirements of the project.

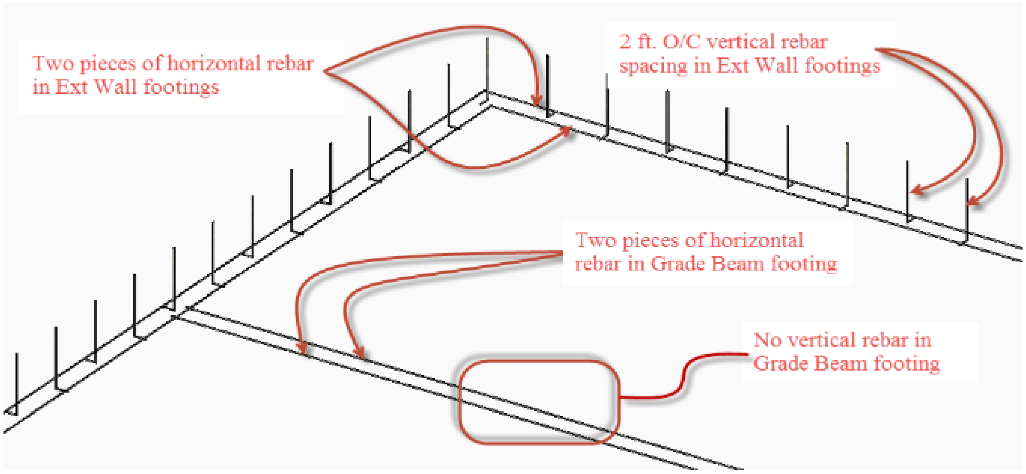


Figure 8-22 Two pieces of horizontal rebar in each footing type. 2 ft. O/C spacing for vertical rebar in exterior wall footings and no vertical rebar in grade beam footing.

Vertical Rebar Spacing. The vertical rebar spacing variable is used to determine the spacing for vertical rebar or dowels in the footings that will tie to the vertical rebar in the foundation. The spacing is determined by the engineering requirements of the project or the building code. Not all footings require vertical rebar. Only those footings that will have concrete foundation walls on them will need vertical rebar to tie the footing and foundation together. For our example, the vertical rebar spacing has been set to 2'-8" for the exterior wall footings and to zero for the grade beam footings because there is no vertical rebar in that footing.

Rebar Lap Length. The rebar lap is the code required distance that two pieces of rebar must lap each other when they are being tied together. The code requirement is that rebar must lap by 24 bar diameters. A #4 rebar, such as is in this project, is one-half-inch in diameter, and therefore, the lap length requirement is 24 × 1/2" or 12 inches, which is equal to one foot.

Vertical Rebar Length. The vertical rebar length is the length of the piece that vertical rebar is cut to before it is bent to make the footing dowels. This will include the exposed length of the rebar, the distance that is embedded into the footing, and the length of the hook. Figure 8-16 shows an example of the vertical rebar length for the footings in the example. The exposure length is 25", the embedded length is 5", and the hook length is 6", for a total length of 36". Thus the standard 20-foot length of rebar can be cut into six 36" inch pieces with some waste.

Number of Corners or Intersections. Whenever there is vertical rebar, there is usually a piece of vertical rebar in the corner of each footing or at the intersection of two footings. This variable is a count of how many corners or intersections there are that have a piece of vertical rebar in them and will add another vertical rebar to the count. A judgement call may be necessary in determining this number. Figure 8-25 shows the vertical rebar in the footings.

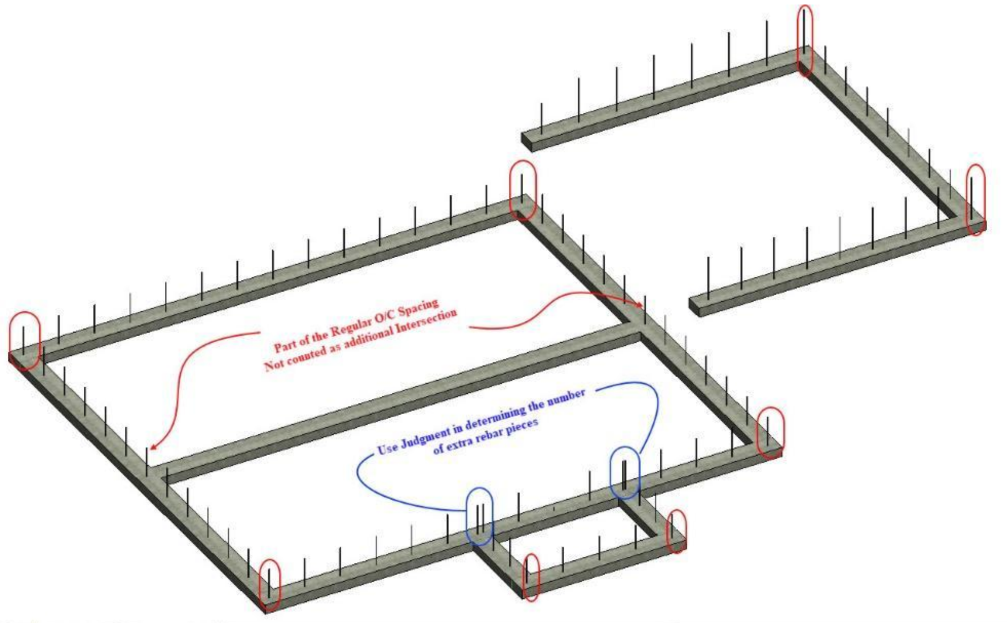


Figure 8-24 A judgement will need to be made in this instance. The intersection between the main foundation and interior grade foundation (marked in red) would not likely need extra rebar. The intersection at the porch footing intersection (marked in blue) could, or could not, require extra rebar and the amount added is based upon judgement. The rebar circled in red would most likely need additional rebar.

Because the interior grade footing has no vertical rebar, the intersection between the interior grade footing would not be counted as an intersection where an extra rebar would be placed and would not have rebar there unless, as is the case in this instance, the rebar at the intersection falls close to the normal on-center spacing layout. The intersection between the main footing and the front porch may or may not require additional rebar. The choice would be made depending upon whether or not the on-center spacing is close to the normal on-center spacing. In this instance, the number eight is placed in the header section for this variable, based upon the number that is highlighted in red in Figure 8-25.

Number of Form Sides. This variable counts the number of sides for each form. This is used in determining the amount of form material to purchase. This number is generally two for standard strip footings but can be different. For example, a spot footing would have four sides to it, and a trench footing would have zero sides.

Form Brace Spacing. This variable determines the interval that is needed for stakes or other form bracing. Four feet is generally used for standard strip footings, but the number could be higher when the bracing needs are greater and could be lower with some types of footing forms. For example, trench footings usually have no need for bracing.

Number of Form Uses. It is common construction practice to use concrete form lumber more than one time. The forms are usually disassembled and moved to the next job. However, each time a set of forms are used, there is a certain amount of waste and new forms will need to be bought. In this example, it will be assumed that each piece of form material can be used at least five times. So for each new job, only one-fifth of the form material will be purchased for use on this job. The rest of the material will be brought from other jobs.

Once you know all of these variables, you can calculate how much of each material will be used per lineal foot of footing.

Misc. Footing Material

Miscellaneous footing materials can include bracing, form release, tie wire, and nails. Some quantities can be calculated, and some are estimated based upon past experience.

Bracing. Not all footing formwork needs bracing. Often, forms are braced by shoveling dirt up against the forms. Footings that are taller or have significant pressure may require additional bracing.

Form Release. Form release is a chemical agent that is applied to concrete formwork to aid in removing the forms after the concrete has hardened. It is typically applied as a liquid or powder to the formwork as it is installed. Calculating the amount of form release is done by determining the square footage of formwork area that is in contact with the concrete. This is typically called square footage of contact area or SFCA. Most form release manufacturers will provide product data including the recommended coverage rate in square foot per gallons. Some products have different coverage rates for different form material. For example, steel forms would require less form release material than porous plywood forms. To calculate the quantity of form release, simply divide the SFCA by the coverage rate per gallon for that product on the formwork material.

Tie Wire. Concrete tie wire is used to tie reinforcing together to form the rebar grid work together. It is commonly sold in 3-/12 pound rolls or in bundles of preformed looped pieces. One roll of wire would be sufficient for a project of this size.

Nails. Formwork is usually installed using duplex headed nails. These nails are manufactured with a double head. The nails are hammered in tight to the first head to hold the formwork tight together, however, the second head is left exposed so that hammer claws or a pry bar can be used to remove the nails when disassembling the forms. Nails are sized by a unit known as a penny, which is abbreviated with the letter d. Formwork nails are usually 8d, 12d, and 16d size, which equates to 2-1/2", 3-1/4", and 3-1/2" respectively. These nails are usually purchased by the 50 lb. box, which is many more than will be used on a single residential project. Only a portion of the box will be used with the quantity in pounds estimated for this single project at five pounds of both 8d and 16d nails.

The form release material located on the concrete database is entered into the materials column along with the size, units, and unit cost. The quantity is calculated by dividing the SFCA of the total footings from the header section by 300, which is the application rate per gallon for the form release.

Footing Labor

The concrete footing labor can be estimated using the residential section of the National Construction Estimator. There are three main costs involved in pricing footing labor: board forming and stripping, install reinforcing, and placing concrete.

Board Forming and Stripping

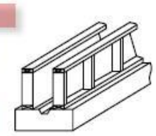
The first footing labor quantity to be estimated will be board forming and stripping. This is a labor cost for both forming and stripping the footings after the concrete is poured. NCE Figure 8-1 shows a screenshot of the board forming and stripping section of the NCE.

The overview clarifies that this section would be appropriate for estimating a number of concrete items including both wall and grade beam footings. It also defines the unit of measurement as per square foot of contact area and explains that for estimating footings “when the forms are required on both sides of the concrete.” That is the case in this example; the square footage of contact area for both sides of the footings should be used.

The square footage of contact area information is calculated by multiplying the length of the footings by the footing height and the number of form sides.

Concrete Formwork

	Craft@Hrs	Unit	Material	Labor	Total
Board forming and stripping For wall footings, grade beams, column footings, site curbs and steps. Includes 5% waste. Per SF of contact area. When forms are required on both sides of the concrete, include the contact surface for each side.					
2" thick forms and bracing, using 2.85 BF of form lumber per SF. Includes nails, ties, and form oil					
Using 2" lumber, per MBF	—	MBF	660.00	—	660.00
Using nails, ties and form oil, per SF	—	SF	.22	—	.22
1 use	B2@.115	SF	2.18	3.96	6.14
3 use	B2@.115	SF	1.05	3.96	5.01
5 use	B2@.115	SF	.82	3.96	4.78
Add for keyway beveled on two edges, one use. No stripping included					
2" x 4"	B2@.027	LF	.46	.93	1.39
2" x 6"	B2@.027	LF	.70	.93	1.63



NCE Figure 8-1 Board forming and stripping section of the NCE.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.88.

The price for board forming and stripping identifies the prices based upon number of uses, however, this only has application with the material cost, and the material cost has already been calculated with the footing forms cost.

Install Reinforcing

NCE Figure 8-2 shows a screenshot of the NCE Concrete Reinforcing Steel section. The costs are priced both by the pound and lineal foot.

Concrete Reinforcing Steel Steel reinforcing bars (rebar), ASTM A615 Grade 60. Material costs are for deformed steel reinforcing rebars, including 10% lap allowance, cutting and bending. These costs also include detailed shop drawings and delivery to jobsite with identity tags per shop drawings. Add for epoxy or galvanized coating of rebars, chairs, splicing, spiral caissons and round column reinforcing, if required, from the sections following the data below. Costs per pound (Lb) and per linear foot (LF) including tie wire and tying.

	Craft@Hrs	Unit	Material	Labor	Total
Reinforcing steel placed and tied in footings and grade beams					
1/4" diameter, #2 rebar	RI@.015	Lb	1.13	.58	1.71
1/4" diameter, #2 rebar (.17 Lb per LF)	RI@.003	LF	.19	.12	.31
3/8" diameter, #3 rebar	RI@.011	Lb	.72	.43	1.15
3/8" diameter, #3 rebar (.38 Lb per LF)	RI@.004	LF	.28	.16	.44
1/2" diameter, #4 rebar	RI@.010	Lb	.70	.39	1.09
1/2" diameter, #4 rebar (.67 Lb per LF)	RI@.007	LF	.47	.27	.74
5/8" diameter, #5 rebar	RI@.009	Lb	.62	.35	.97

NCE Figure 8-2 Concrete Reinforcing Steel section of the NCE.

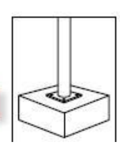
2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.89.

The lineal footage of footing rebar is calculated by multiplying the total lineal footage rebar purchased by multiplying the number of 20-foot lengths of rebar for both the horizontal and vertical rebar in the exterior wall footing.

Placing Concrete

The concrete footing labor is determined by using the Column Footings subsection of the NCE (NCE Figure 8-3).

	Craft@Hrs	Unit	Material	Labor	Total
Column Footings Concrete material and placing only. Material costs are for 3,000 PSI, 5.7 sack mix, with 1-1/2" aggregate with 5% waste included. Labor cost is for placing concrete in an existing form. Add for excavation, board forming and steel reinforcing.					
Using concrete (before waste allowance)	—	CY	118.00	—	118.00
Typical cost per CY	B1@.875	CY	124.00	29.30	153.30



NCE Figure 8-3 Cost for footing labor.

The price is established per cubic yard.

You can complete both the interior grade footing materials and labor portions of an estimate using information from the basic takeoffs and details in the plans and specification.

Concrete Foundations

Estimating concrete foundations begins with estimating the foundation formwork. Foundation formwork can be erected using a number of different methods. Forms can be built out of plywood and other framing lumber, or they can be set up using pre-manufactured foundation forms. In addition to the forms themselves, other concrete form material will need to be estimated including snap ties, clamps, walers, strong backs, bracing, and form release. Other elements that will become part of the finished foundation will need to be estimated as well including steel rebar, door and window bucks, block outs, and the concrete itself.

Foundation Formwork

One method of forming concrete foundations is with plywood forms. The material may simply be sheets of plywood, or it may be special plyform material that has a hard, impregnated phenolic resin coating. Typically, the form material is drilled with a pattern of holes that are used for the placement of snap ties to hold the foundation forms together (Figure 8-34).

Figure 8-34 Phenolic resin coated plyform material with predrilled snap tie holes.

Figure 8-35 shows the formwork in a large commercial project for a concrete foundation that is over 16 feet tall. The formwork shows multi-levels of plyform material with many horizontal levels of walers, some held in place by the snap tie clamps and others held in place by the vertical strong backs. The entire assembly is braced and straightened by long 2"× 10" diagonal braces.

Figure 8-35 Foundation formwork for a large commercial building.

The foundation formwork for a more typical residential structure is shown in Figure 8-36. The smaller foundation requires fewer horizontal levels of walers, no strong backs, and smaller and fewer diagonal braces. The forms also use the less costly plywood rather than the coated plyform material.


Figure 8-36 Typical residential foundation formwork using plywood forms.

Foundations can be formed using a commercial form system. These types of forms are typically easier to set up and take down than those that are made of plywood or plyform material. They are also usually more rigid and require less in the way of bracing material (Figure 8-37). Most often, a specialty concrete subcontractor would utilize this type of formwork because a full set of forms for even a small residential project is costly to purchase.

Figure 8-37 Commercial formwork system.

Snap Ties

Snap ties are the mechanical fasteners that are used to temporarily hold formwork together while the concrete is being placed. They are also used to hold the form material a consistent distance apart resulting in a concrete wall of a specific thickness. Snap ties are engineered so that a portion of each tie remains inside of the concrete wall after it is completed and cured and the remaining portion, which extends outside of the concrete, is snapped (broken) off and disposed of. Different styles of formwork require different types of snap ties.

Wire Type with Plastic Cone Snap Ties

Figures 8-38 to 8-41 show examples of a typical wire type of snap tie with a plastic cone that is commonly used in plywood and plyform foundation formwork construction.

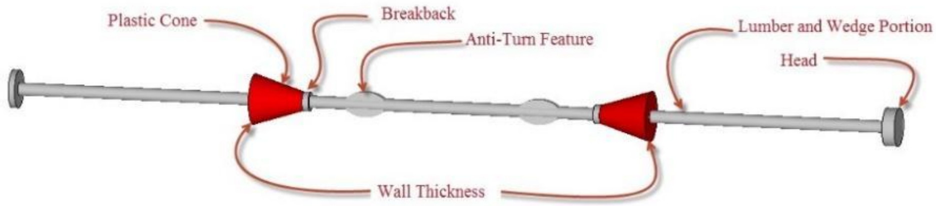


Figure 8-38 Typical plastic cone snap tie.

Figure 8-39 Plyform formwork construction using wire type plastic cone snap ties.


Figure 8-40 Wire type plastic cone ties prior to snapping off exposed portion.


Figure 8-41 Holes left over after snapping off ties.

Flat Type Snap Ties

Flat type snap ties are commonly used in manufactured form systems. Figures 8-42 to 8-45 show examples of flat type snap ties and their usage in formwork. Typically, the forms and snap ties are held together using some form of wedges and pins.

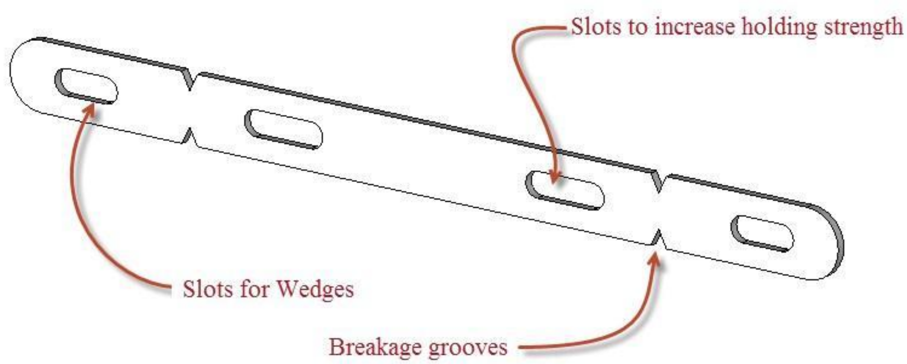


Figure 8-42 Flat type snap type.

Figure 8-43 Manufactured form system.

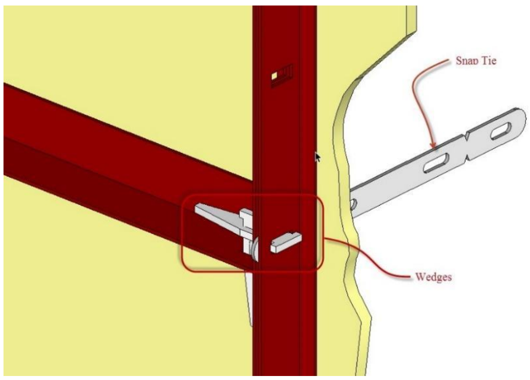


Figure 8-44 Wedges and snap ties in a manufactured form system.

Figure 8-45 Partially removed formwork showing snap tie exposure.

Snap Tie Clamps and Wedges

The majority of concrete foundation formwork materials can be salvaged and reused many times before it becomes worn out. Snap tie clamps or wedges are used to hold the formwork together. They clamp on each side of the formwork and hold the form sides tight to the snap tie. This allows the forms to be spaced a specific distance apart and helps prevent the forms from bowing due to the outward pressure of the concrete as it is placed. Often, the snap tie clamps also attach to the walers or strongbacks to provide additional bracing and allow the forms to be straightened. Snap tie clamps are reusable items and are salvaged, cleaned up, and reused many times. Generally, two snap tie clamps are needed for each snap tie used in the formwork as both sides of the forms are clamped. Although the clamps are reused, it is often appropriate to add an amount to the estimate for each snap tie. They often have to be rented, or if already owned, they need periodic replacement.

Figure 8-46 shows clamps attached to concrete formwork and the walers. Several styles of snap tie clamps are used in concrete forming. The types used are often dependent upon the form material style. Figure 8-47 shows Jahn style clamps ready for reuse.

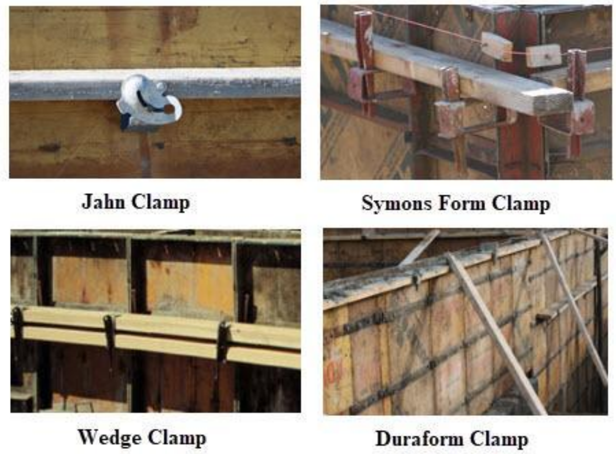


Figure 8-46 Snap tie clamp types.


Figure 8-47 Jahn style clamps ready for reuse.

Walers

Walers are the horizontal members that are used to straighten and brace the foundation forms and keep them from bulging. The quantity of walers used depends upon the formwork system type and the height of the forms. They are reusable items, but a percentage should be included in the estimate to account for usage and wear of form walers. Figure 8-48 shows several types of form systems with the walers.


Figure 8-48 Several form systems with walers.

Strongbacks and Bracing

Strongbacks are vertical bracing members that are used to strengthen and stiffen the forms. The need for strongbacks depends entirely on the type of forming system and the height of the forms. Often, in a residential setting, strongbacks are not used at all. Bracing is the use of diagonal members to straighten and brace the forms. Turnbuckles are frequently attached to either end of the brace that can be used to micro adjust and straighten the forms (Figure 8-49).


Figure 8-49 Tall commercial forms require extensive bracing including strongbacks.

Foundation Reinforcing

Steel reinforcing is often placed in concrete foundation. The size, layout, and quantity of the steel is determined by the engineering needs of the foundation. In a residential setting, the steel reinforcing requirements are often determined by the building code and are specified in the plans and specification. The reinforcing needs may be such that it will need to be designed by an engineer. The rebar in foundations is often placed in a grid formation of both vertical and horizontal rebar, which can also include multiple grids of horizontal and vertical rebar. Figure 8-50 shows a residential foundation with a grid of vertical and horizontal rebar.


Figure 8-50 Rebar grid in residential foundation.

Figure 8-51 shows a commercial building foundation with a double grid of closely spaced horizontal and vertical rebar.

Figure 8-51 Multiple rebar grids in commercial foundation.

Figure 8-52 shows an example of the concrete foundation section that specifies a maximum rebar spacing of 32" O/C spacing.

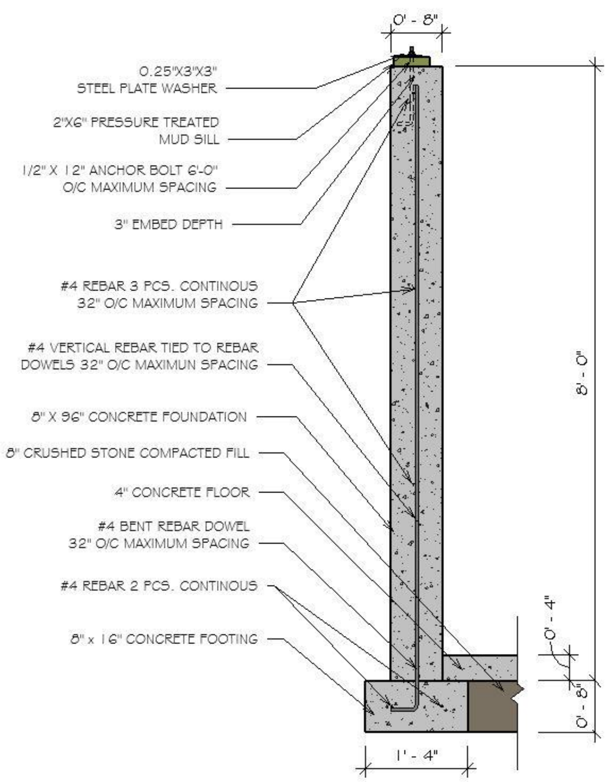


Figure 8-52 Foundation wall section that details maximum O/C rebar spacing.

Figure 8-53 shows a three dimensional graphic of the foundation with three rows of horizontal rebar and 80" lengths of vertical rebar tied to the vertical footing rebar.

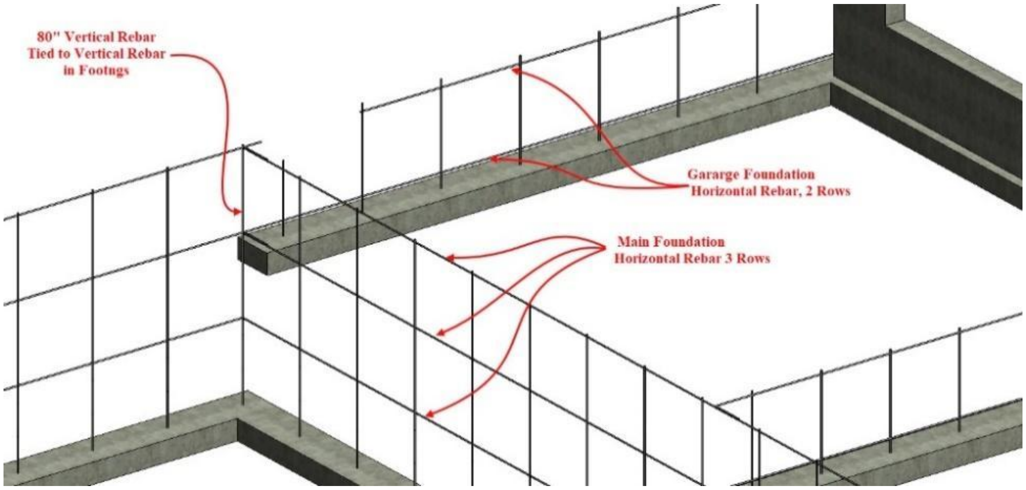


Figure 8-53 Vertical and horizontal rebar in main and garage foundation.

Foundation Horizontal Rebar

There are often multiple rows of horizontal rebar in a foundation. The placement of these may be specified by the on-center spacing requirements outlined by the building code, or there may be specific engineering requirements for the placement of the rebar and the maximum or minimum amount of concrete coverage. For example, two addendums to the Rexburg building code make modifications to the International Residential Code and state the following:

"Section R404.14. Delete: Entire section. Insert: All concrete or masonry foundation walls constructed at a height equal to or lower than 4' shall be constructed with a minimum of #4 rebar spaced at 24" o.c. horizontally and #4 rebar spaced at 48" o.c. vertically. The vertical bars shall have a minimum bend of 6" with the bends rotated in each alternately in each direction."

These codes determine both quantity, size, and placement of rebar requirements in both the footing and foundation.

The horizontal rebar quantity would be calculated by determining the number of rows required and multiplying this by the length of the foundation wall. Considerations will also need to be made to account for the lapping requirements when tying the rebar together and an appropriate waste factor.

Foundation Vertical Rebar

The vertical rebar in the foundation is usually placed as an extension to the vertical rebar placed in the footings. Each vertical footing rebar would have an additional piece of vertical rebar tied to it to extend the rebar grid to the top of the foundation. The length of each foundation vertical piece is determined by the exposure amount of the rebar in the footings, the height of the foundation, the rebar lapping requirements, and the amount of rebar coverage at the top of the foundation. Figure 8-23 shows a graphic of the footing, including vertical rebar where the exposure amount is 25". Figure 8-52 shows a graphic of the foundation including vertical rebar. The foundation height is eight feet and the maximum embed distance at the top is identified as three inches. The formula for determining the length of the vertical rebar in the foundation would be as follows:

Foundation Height – Footing Exposure Amount – Maximum Embed Distance + Rebar Lap Length

or

8'-0" – 25" – 3' + 12"

or

96" – 25" – 3" + 12" = 76"

or

6.67 ft.

The length of a normal 20-foot piece of rebar would be divided by the 6.67-foot length of each piece and would be as follows:

20'-0" ÷ 6.67' = 3 Pieces

This would be rounded down to three even pieces and would yield

20 ft ÷ 3 = 6.67 ft.

The total number of 20-foot pieces of rebar that would need to be purchased could be determined by multiplying the 6.67-foot length by the number of vertical pieces.

Very often in construction when the foundation is only a few feet tall, as is shown in Figure 8-54, the vertical rebar in the footings is extended to the top of the foundation and the vertical rebar requirements for the foundation are calculated as part of the footing rebar requirements and no additional rebar is added for the foundation.


Figure 8-54 Vertical rebar in this short foundation installed as the footing vertical rebar and no additional rebar is added for the foundation.

Anchor Bolts

Anchor bolts are used to attach the structure to the foundation. They are embedded in the foundation concrete while it is still in a plastic state. Specific anchor bolt size, embed distance, spacing, and plate washer requirements are specified by the building code and are usually detailed in the plans and specification. The foundation wall section, shown in Figure 8-52, shows the foundation anchor bolts and specifies a maximum spacing of 6'-0" on-center. In addition to the on-center spacing requirements, there is a requirement for an anchor bolt at each end of the mud sill and at each corner (Figures 8-55 and 8-56).


Figure 8-55 Anchor bolts.


Figure 8-56 Anchor bolts with square plate washers.

Earthquake Straps

Earthquake straps or hold-downs are hardware connections that attach the walls more firmly to the foundation. In houses located in earthquake prone zones, such as those specified by the IRC as zones D, E, and F, additional attachments will need to be provided. The earthquake straps help resist the lateral and sliding loads that are placed on the structure in an earthquake (8-57).


Figure 8-57 Earthquake straps placed in concrete foundation.

One common type of earthquake strap is placed at the building corners and at the edges of doors and windows. The strap anchors are embedded in the foundation concrete. The straps extend above the foundation to the wall framing, and they are attached by nailing to the studs in the walls above. When nailing the straps to the wall framing, it is required that all nail holes in the strap be filled. Usually two studs are needed in the wall framing to meet the nailing requirements. Very often, the straps are placed in locations where there are already double studs such as corners or the edges of windows and doors (Figure 8-58).


Figure 8-58 Earthquake straps attached to wall framing.

Foundation Dampproofing and Waterproofing

Although the terms dampproofing and waterproofing appear to be similar, there is a distinct difference between the two.

Foundation Dampproofing

Dampproofing is intended to keep soil moisture out of a building, while waterproofing is intended to keep out both moisture and liquid water. The IRC section 406.1 requires that “foundation walls that retain earth and enclose interior spaces and floors below grade shall be dampproofed from the top of the footing to the finished grade.” A number of materials can be used for dampproofing, including bituminous coating (tar), acrylic modified cement, and surface bonding cement. The coating can be applied by a paint roller, brushing, or spraying. Dampproofing is usually estimated as a square footage cost by determining the square footage of area to be covered and the coverage rate of the dampproofing material (Figure 8-59).

Figure 8-59 Foundation dampproofing is required for all enclosed living spaces.

Foundation Waterproofing

Foundation waterproofing is a more rigorous process than dampproofing. The process is intended to create an impermeable barrier for the liquid water in situations such as high groundwater.

Waterproofing is required by the IBC “in areas where high water tables or other severe soil-water conditions are known to exist” (R402.2). Waterproofing is a more intensive process that usually requires some form of membrane coating. The IBC specifies that “the membrane shall consist of 2-ply hot mopped felts, 55-pound roll roofing, 6 mil polyvinyl chloride, 6 mil polyethylene or 40 mil polymer-modified asphalt” (R402.2).

Many waterproofing systems are proprietary products that require the application be installed by a certified applicator in order to warrant the product. The waterproofing system usually consists of more than just a water resistive barrier but could also contain other elements such as drainage mats and pipes. Waterproofing materials can include cementitious products, liquid membranes, sheet membranes, built-up systems, and bentonite. Estimating waterproofing will usually require pricing with a subcontractor.

Estimating Dampproofing and Waterproofing

Dampproofing and waterproofing is usually estimated based upon a square foot cost or a cost per square (100 SF). The calculations are based upon the length of the area to be dampproofed or waterproofed and the height of the treatment. Usually, the area of the windows or other openings are subtracted from the total area.

Foundation Insulation

Foundation insulation is very often installed in order to increase the energy efficiency of the structure. There are a number of methods for installing the insulation. One method that is used on basement and crawlspace construction is to install wood framed walls inside of the foundation and attach the insulation material to the wood framing. This type of insulation would be installed later in the construction process and is not typically estimated during the concrete phase of the estimate. Figure 8-60 shows wood-framed basement insulation walls on the concrete foundation walls, which have insulation installed in the completed framing.

Figure 8-60 Insulation installed in basement wood-framed walls. This type of insulation will not be estimated during the concrete phase.

Rigid sheet insulation is often installed to insulate concrete foundations. The insulation can be installed either to the interior or the exterior of the foundation. It is most often placed on the interior when the foundation is buried in the earth and supporting a concrete slab floor. This helps to separate the heated interior space from the cold, damp earth. The insulation can be installed along the foundation walls and also under the floor slab. Figure 8-61 shows workmen installing rigid polystyrene foam along the inside of concrete foundation walls.

Figure 8-61 Workers installing polystyrene foam insulation inside of foundation walls.

Rigid foam insulation can be installed on the exterior of the foundation walls. If the insulation extends past the finished grade and is exposed, it will need to have some type of protective surface installed over it, such as metal or cement parging.

Foundation Parging

Parging or pargeting, as it is sometimes called, is a thin cementitious mortar that is troweled on concrete or masonry walls to cover and smooth the imperfections in the surface such as snap tie holes, concrete form seams, and voids. Parging also adds a measure of protection and waterproofing to the walls. Parging can be purchased in premixed powders that are mixed with water to make a cementitious paste. The parging can be mixed from scratch with fine sand, often called silica sand, and cement powder. Liquid adhesives, or acrylic admixtures, can be added into the mix to improve adhesion and strength. The parging is usually troweled onto the walls and smoothed out with a rubber float. The parging is usually only installed on the foundation above grade on exposed areas. Commonly, a foundation will have dampproofing or waterproofing below the grade and have a parging coat on the foundation above the grade. Parging is usually estimated by determining the square footage of the parging area and pricing per square footage. Openings such as doors and windows are usually subtracted from the square footage of parging area.

Figure 8-62 Cement foundation parging.

Foundation Material Costs

This section will focus on preparing the concrete foundation material estimate. The emphasis will be on creating an assembly estimate from the various elements that are part of forming, placing, and stripping concrete foundations.

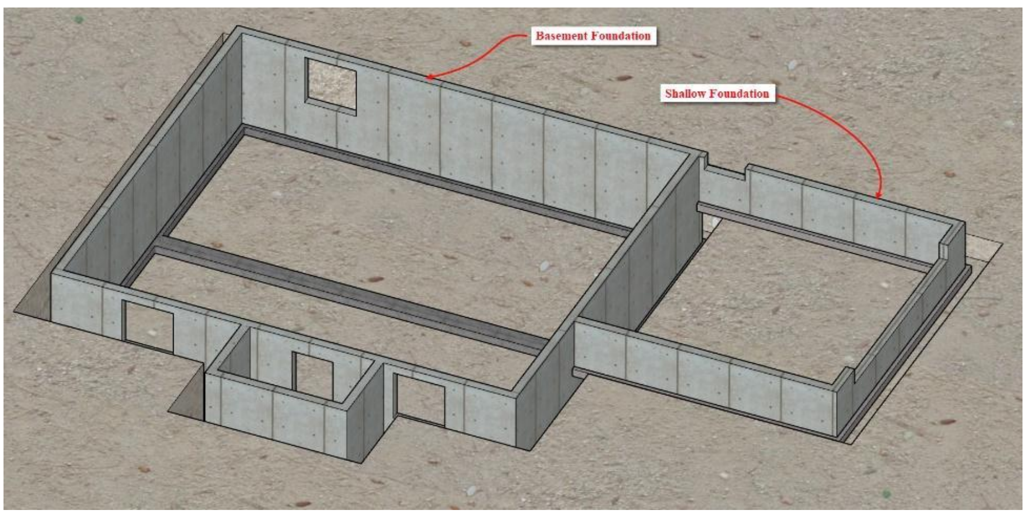


Figure 8-63 Completed foundation.

An explanation for each of the necessary variables to create your assembly is as follows:

SF Foundation Blockouts. This variable is used to input the square footage of openings such as doors and windows that are created in the foundation at the time the concrete is placed. The blockouts can be made of wood or metal materials and prevent the area from being filled with concrete during the pour. The square footage of the blockouts will be subtracted from the square footage of foundation area and will subtract a quantity of concrete from the cubic yards concrete total. Figure 8-64 shows a metal window blockout in a concrete foundation, and Figure 8-65 shows a blockout in the garage foundation for the installation of the garage door.


Figure 8-64 Metal window foundation blockout.


Figure 8-65 Garage door blockout in foundation.

Vertical Rebar Spacing.This variable accounts for the spacing of the vertical rebar that is installed in the foundation. Usually the spacing is the same as the vertical rebar spacing in the footings, which in this case is 32" or 2'-8".

Vertical Rebar Length. This variable accounts for the length of the vertical rebar that is tied to the vertical rebar in the footings. Figure 8-81 shows the vertical rebar in the foundation, which was calculated at 80" or 6'-8".

Number of Horizontal Rebar.This variable accounts for the number of rows of continuous horizontal rebar that is installed in the foundation. This number was previously calculated at three.

Rebar Lap Length.This variable accounts for the code required 24 bar diameter lapping length when the rebar sections are tied together. The rebar that is installed in #4 rebar and the lapping length would be calculated at 4/8"× 24 = 12". This is converted to a 1-foot measurement and entered into the header.

Foundation Bolt Spacing.This variable accounts for the spacing of the foundation anchor bolts that are installed in the top of the concrete foundation. The code required 6'-0" on-center spacing will be input into the header section.

Foundation Mudsill Material Length.This variable accounts for the length of the mudsill material that will be bolted to the foundation. The number will be used to calculate the extra mudsill bolts that are required on each mudsill end.

Number of Corners and Intersections.This variable adds an additional foundation anchor bolt in the corners and intersection of the foundation where additional bolts are required.

Foundation Dampproofing Height. The foundation dampproofing height is the distance that the dampproofing material extends from the top of the footings to the finished grade. In this case, the top one foot of the foundation is exposed, so the dampproofing height is entered at 7'-0".

Rigid Insulation. This variable is the amount of rigid insulation that will be used. If the concrete foundation does not have any rigid insulation installed, then a zero is inputted. If it has rigid insulation on either the inside or outside of the foundation, then a one is inputted. A two is inputted if insulation is installed on both the inside and outside of the foundation.

Rigid Insulation Height. If the foundation has insulation installed, this variable allows for the height of the insulation.

Foundation Parging Height. This variable allows for the height of the cement parging. This is usually the height from the top of the foundation to the finished grade.

Other Information. Other information such as number of vertical rebar, SF foundation area, square feet of contact area, and cubic yards of concrete is calculated from the variables above and your building plans.

With these variables, you can calculate the quantities of foundation materials.

Foundation Concrete Quantity Formula

The formula for calculating the foundation concrete is to multiply the cubic yards concrete by the waste factor, and the total is divided by the size of the material, which in this case is one cubic yard. The total should be rounded up to the nearest quarter of a cubic yard. This is because concrete is usually purchased in 1/4 cubic yard increments (Excel Figure 8-29).

Horizontal Reinforcing Quantity Formula

The basic formula for calculating horizontal reinforcing material is performed by multiplying the foundation length by the number of horizontal rebar and the waste factor. The total is divided by the rebar size minus the rebar lap length.

Vertical Reinforcing Quantity Formula

The formula for calculating the vertical reinforcing quantity is performed by multiplying the number of vertical rebar by the vertical rebar length and the waste factor. The total is divided by the rebar size.

Foundation Bolt Quantity Formula

The foundation bolt quantity is calculated with the following formula:

((Foundation Length ÷ Foundation Bolt Spacing) + Number of Corners and Intersections + (Foundation Length ÷ Foundation Mudsill Material Length)) × Waste Factor

Foundation Rigid Insulation Quantity Formula

The foundation rigid insulation quantity is calculated with the following formula:

((Rigid Insulation × Rigid Insulation Height × Foundation Length) ÷ (Area of One Sheet of Rigid Insulation)) × Waste Factor

Remember, rigid insulation in the formula above is the amount of insulation installed. If there is insulation on one side, this variable will be a 1. If there is insulation on both the inside and the outside, this variable will be a 2.

Shallow Foundation Wall Costs

This will be completed in a fashion similar to what was done with the basement foundation walls.

Complete the shallow foundation materials estimate using information from the basic takeoffs and details in the plans and specification. Apply the same principles and formulas learned in previous portions of the estimate to estimate the shallow foundation wall.

Completing the Miscellaneous Foundation Material Costs

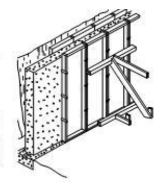
The miscellaneous foundation material costs section will include material for both the basement and shallow foundations. The items estimated include plywood forming material cost, earthquake straps, foundation dampproofing, foundation parging, and window bucks (Figure 8-44).

Foundation Form Material Costs

In this instance, the material cost for forming the foundation will be taken from the residential section of the NCE. NCE Figure 8-4 shows a screenshot of this section.

Plywood forming For foundation walls, building walls and retaining walls, using 3/4" plyform with 10% waste and 2" bracing with 20% waste. All material costs include nails, ties, clamps, form oil and stripping. Costs shown are per SF of contact area. When forms are required on both sides of the concrete, include the contact surface area for each side.

Using 3/4" plyform, per MSF	—	MSF	1,240.00	—	1,240.00
Using 2" bracing, per MBF	—	MBF	660.00	—	660.00
Using nails, ties, clamps & form oil, per SF	—	SFCA	.22	—	.22



3 use	B2@.051	SFCA	[illegible]	1.76	2.72
5 use	B2@.051	SFCA	.76	1.76	2.52
Walls 4' to 8' high (1.10 SF of plywood and .60 BF of bracing per SF of form area)					
1 use	B2@.060	SFCA	1.98	2.08	4.06
3 use	B2@.060	SFCA	1.01	2.08	3.09
5 use	B2@.060	SFCA	.80	2.08	2.88

NCE Figure 8-4 Plywood forming subsection from the NCE.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.88.

The information in the description explains that the costs described are for forming walls with plyform material and includes all material cost for forms, bracing, snap ties, clamps, etc. The unit of measurement identified is the square footage of the contact area and explains that both sides of the forms should be used. The material costs are based on the number of times that the forms will be used or reused. For this example, five uses will be selected. The size is 1. The unit is SFCA, and the material cost is identified as $0.80 per SFCA.

SF Foundation Area	624.00	248.00	872.00
Square Feet Contact Area	1248.00	496.00	1,744.00
Cubic Yards Concrete	13.67	5.52	19.19

Supplier	Wst	Item Description	Materials	Size	Units	Unit Cost	Quantity	Override	Total
			Basement Foundation Foundation Materials						
Walter(Rex	5%	Foundation Concrete	3000 psi Concrete	1	yd	99	14.5		$ 1,435.50
BMC(REX)		Rigid Insulation	1"x4'X8' EXTRUDED POLY INSULATIO						
			Misc. Foundation Material						
		Found. Form Mat. Cost	Walls 4' to 8' High, 5 Uses	1	SFCA	$ 0.80	=H81		$ 1,395.20

Excel Figure 8-45 Foundation form material information input and tied to the SFCA quantity in the header section.

Foundation Earthquake Anchors

Figure 8-66 is a graphic of the foundation with earthquake straps installed. They are usually installed at the corners of the foundation and at the side of large openings, such as would be required for a garage door.

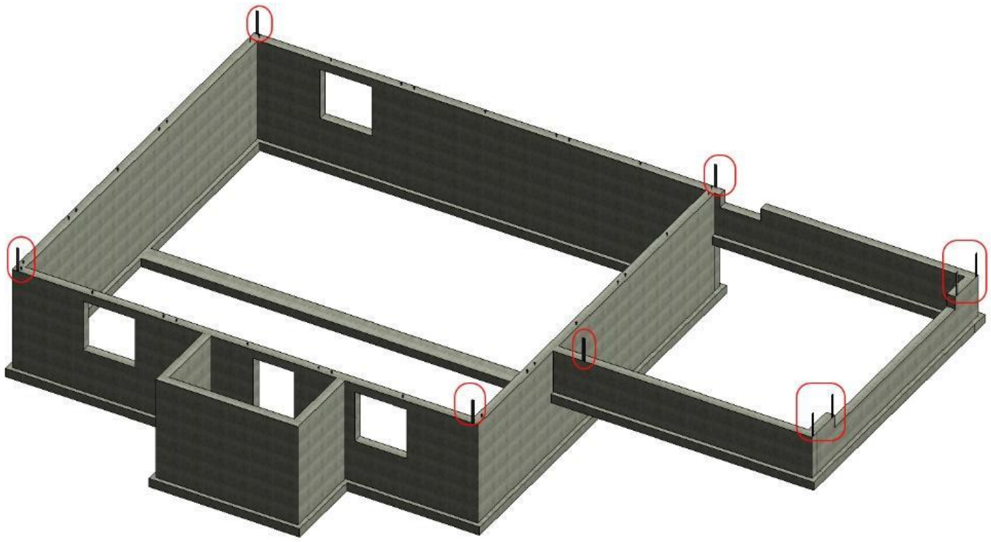


Figure 8-66 Earthquake anchors installed in the foundation.

Foundation earthquake straps are a count and list items taken from the plans. Their location would usually be specified on a foundation plan. They may be detailed on the plans by either a symbol or a text note. If the connector is identified using an annotation symbol, there will be an annotation legend on the plans showing what each symbol means (Figure 8-67).

FRAMING CONNECTORS	
SYMBOL	TYPE
1	SIMPSON STHD10 12 GAUGE, STRAP TIE HOLDOWN
2	SIMPSON LUS24, 2"X4" U-TYPE JOIST HANGER
3	SIMPSON LUS26, 2"X6" U-TYPE JOIST HANGER
4	SIMPSON LUS210, 2"X10" U-TYPE JOIST HANGER
5	SIMPSON HUS210-2, 4"X10 U-TYPE JOIST HANGER
6	SIMPSON H2.5 HURRICANE ANCHOR
7	SIMPSON ST2215 2"X16" STRAP TIE
8	SIMPSON ST6224 2"X24" STRAP TIE

Figure 8-67 Framing Connector Legend

Figure 8-68 is a foundation detail showing two earthquake straps. One is identified with a text note and the other by using an annotation symbol. Normal drafting convention would use one or the other, not both.

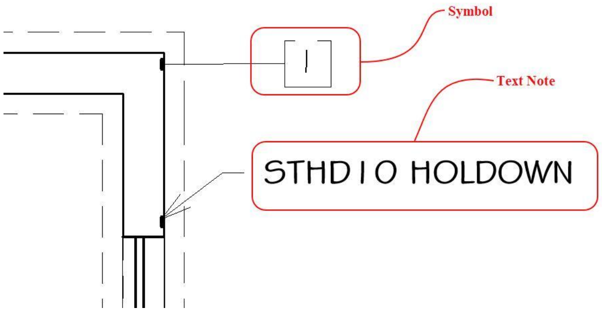


Figure 8-68 Earthquake strap details on the foundation plan. One strap is identified with an annotation symbol and the other with a text note. Typically, the drafter would use one or the other method, not both.

Foundation Dampproofing

Foundation dampproofing will be installed on the foundation walls that enclose the living area of the basement. Dampproofing starts just below the finished grade and extends down to the top of the footings. The distance the foundation extends above grade can vary greatly, however, the minimum distance that the foundation extends above grade is six inches. The actual distance depends greatly upon the actual terrain and building conditions. For this example, we will assume that the foundation extends 12 inches above the grade, and the dampproofing will start two inches below the grade or 14 inches below the top of the foundation. Dampproofing will not be installed on the garage portion of the foundation that does not enclose living space.

The area dampproofing covers is the length of the enclosed foundation multiplied by the height. Windows and other openings will be subtracted from the total. Figure 8-69 shows the foundation dampproofing that is 82 inches high. The length is the total length around the foundation.

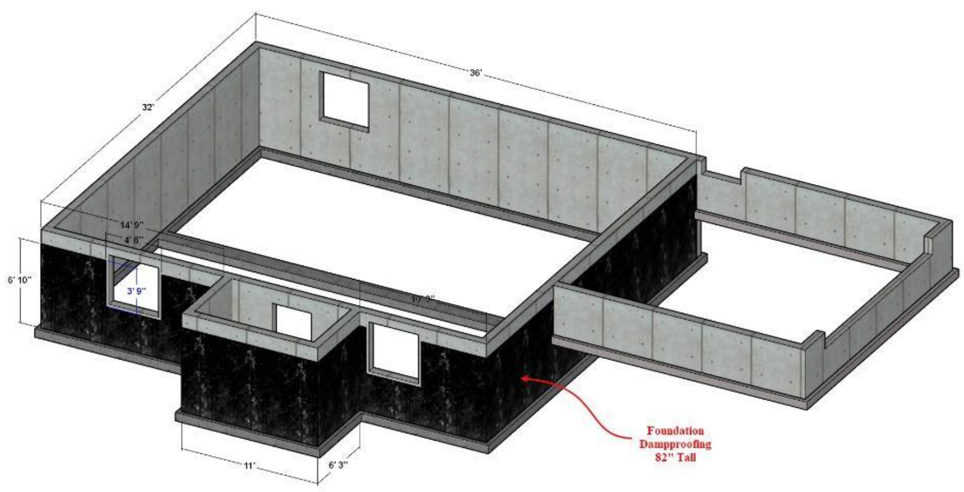


Figure 8-69 Foundation dampproofing 82 inches high.

The foundation dampproofing length would be

36'+ 32'+ 10'-3" + 6'-3" + 11'+6'-3" + 14'-9" + 32'= 148'-6"

The foundation dampproofing area would be

148'-6" × 6'-10" = 1,074.75 ft^2

The dampproofing is typically held back about three inches from the edge of the windows. This area would be 3'-9" × 4'-6". The calculated area would be multiplied by the number of windows, which is three.

3'-9" × 4'-6" × 3 windows = 50.625 ft^2

This is subtracted from the total as follows:

$$1{,}074.75\ ft^2 - 50.625\ ft^2 = 1{,}024.125\ ft^2$$

Foundation parging is commonly done on the foundation area that is exposed above the grade and exposed to view. As was previously determined, the dampproofing is just below the finished grade. The parging will cover the area from the top of the dampproofing to the top of the foundation, or 14 inches. The length of the parging will be the length of the foundation that has parging. This will also include the area of the parged garage foundation (8-70).

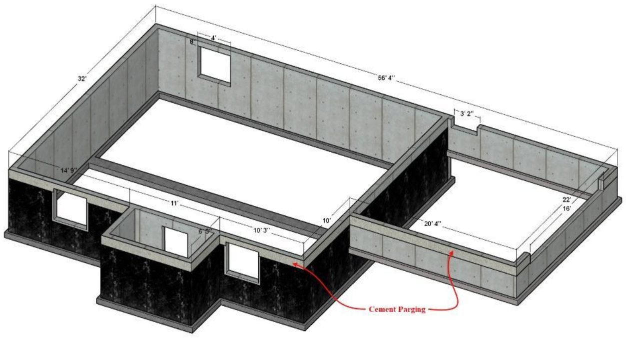


Figure 8-70 Cement parging on main foundation and garage foundation.

The foundation dampproofing parging length will be

$$36'\text{-}4" + 22' + 20\text{-}'4" + 10' + 10\text{-}'3" + 6'\text{-}3" + 11'\text{-}0" + 6'\text{-}3" + 14'\text{-}9" + 32' = 189'\text{-}2"\ ft^2$$

The area of the window and door openings will be subtracted from the total area.

$$\text{Garage door opening } 1'\text{-}2" \times 16' = 18.67\ ft^2$$

$$\text{Garage entry door opening } 1' \times 3'\text{-}2" = 3.17\ ft^2$$

$$\text{Window openings } 6" \times 4' \times 3 \text{ windows} = 6\ ft^2$$

$$18.67\ ft^2 + 3.17\ ft^2 + 6\ ft^2 = 27.85\ ft^2$$

This is subtracted from the total.

$$189'\text{-}2"\ ft^2 - 27.85\ ft^2 = 161.32\ ft^2$$

Steel Window Bucks

The steel window bucks are a count-and-list item. If it was determined when completing the basic takeoffs that there were three basement windows 4'-0" × 4'-0", three window bucks at that size would be included in the estimate (Excel Figure 8-49)

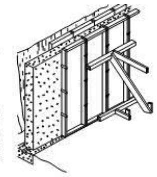
Programing the Concrete Foundation Labor Costs

The concrete foundation labor costs will be estimated using the National Construction Estimator. The labor cost will be a combined cost for both the basement and shallow foundations..

Plywood Forming

The labor cost for plywood forming will be taken from the residential section of the National Construction Estimator. NCE Figure 8-5 shows a screenshot of the plywood forming subsection.

Plywood forming For foundation walls, building walls and retaining walls, using 3/4" plyform with 10% waste and 2" bracing with 20% waste. All material costs include nails, ties, clamps, form oil and stripping. Costs shown are per SF of contact area. When forms are required on both sides of the concrete, include the contact surface area for each side.



Using 3/4" plyform, per MSF	—	MSF	1,240.00	—	1,240.00
Using 2" bracing, per MBF	—	MBF	660.00	—	660.00
Using nails, ties, clamps & form oil, per SF	—	SFCA	.22	—	.22

3 use	B2@.051	SFCA	[illegible]	1.76	2.72
5 use	B2@.051	SFCA	.76	1.76	2.52
Walls 4' to 8' high (1.10 SF of plywood and .60 BF of bracing per SF of form area)					
1 use	B2@.060	SFCA	1.98	2.08	4.06
3 use	B2@.060	SFCA	1.01	2.08	3.09
5 use	B2@.060	SFCA	.80	2.08	2.88

NCE Figure 8-5 Plywood forming section.

The labor costs for plywood forming is priced per square foot of contact area.

Concrete Reinforcing Steel

NCE Figure 8-6 shows a screenshot of the NCE concrete reinforcing steel section. The costs are priced both by the pound and lineal foot. The price per lineal foot will be used.

Concrete Reinforcing Steel Steel reinforcing bars (rebar), ASTM A615 Grade 60. Material costs are for deformed steel reinforcing rebars, including 10% lap allowance, cutting and bending. These costs also include detailed shop drawings and delivery to jobsite with identity tags per shop drawings. Add for epoxy or galvanized coating of rebars, chairs, splicing, spiral caissons and round column reinforcing, if required, from the sections following the data below. Costs per pound (Lb) and per linear foot (LF) including tie wire and tying.

	Craft@Hrs	Unit	Material	Labor	Total
Reinforcing steel placed and tied in footings and grade beams					
1/4" diameter, #2 rebar	RI@.015	Lb	1.13	.58	1.71
1/4" diameter, #2 rebar (.17 Lb per LF)	RI@.003	LF	.19	.12	.31
3/8" diameter, #3 rebar	RI@.011	Lb	.72	.43	1.15
3/8" diameter, #3 rebar (.38 Lb per LF)	RI@.004	LF	.28	.16	.44
1/2" diameter, #4 rebar	RI@.010	Lb	.70	.39	1.09
1/2" diameter, #4 rebar (.67 Lb per LF)	RI@.007	LF	.47	.27	.74
5/8" diameter, #5 rebar	RI@.009	Lb	.62	.35	.97

NCE Figure 8-6 Concrete reinforcing steel section.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.89.

The lineal footage of footing rebar is calculated by multiplying the total lineal footage rebar purchased by multiplying the number of 20-foot lengths of rebar for the horizontal and vertical rebar in both the basement and shallow foundations.

Placing Concrete Walls

NCE Figure 8-7 shows a screenshot of the Concrete Walls subsection of the residential section of the NCE, which will be used to price the labor costs associated with placing concrete walls for the foundation.

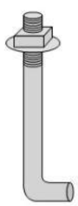
Concrete Walls Cast-in-place concrete walls for buildings or retaining walls. Material costs for concrete placed direct from chute are based on 2,000 PSI, 5.0 sack mix, with 1" aggregate, including 5% waste. Pump mix costs include an additional $15.00 per CY for the pump. Labor costs are for placing only. Add the cost of excavation, formwork, steel reinforcing, finishes and curing. Square foot costs are based on SF of wall measured on one face only. Costs do not include engineering, design or foundations. For expanded coverage of concrete and formwork, see the *National Concrete & Masonry Estimator* at http://CraftsmanSiteLicense.com

Using concrete (before 5% waste allowance)	—	CY	115.00	—	115.00
4" thick walls (1.23 CY per CSF)					
To 4' high, direct from chute	B1@.0[illegible]	SF	1.49	.43	1.92
12' to 16' high, pumped	B3@.027	[illegible]	2.53	.87	3.40
16' high, pumped	B3@.030	SF	2.53	.97	3.50
8" thick walls (2.47 CY per CSF)					
To 4' high, direct from chute	B1@.026	SF	2.98	.87	3.85
4' to 8' high, pumped	B3@.030	SF	3.37	.97	4.34
8' to 12' high, pumped	B3@.033	SF	3.37	1.06	4.43

NCE Figure 8-7 Concrete walls section.

The introduction provides information about methods used to price the labor cost, including information that the labor unit is per square foot of wall area measured from one face only.

NCE Figure 8-8 shows a screenshot of the Foundation Bolts subsection of the residential section of the NCE, which will be used to price the installation of the anchor bolts labor costs of the foundation.



Foundation Bolts Galvanized, with nut and washer attached. Costs per bolt or bag.

1/2" x 6", pack of 1	B1@.107	Ea	1.69	3.58	5.27
1/2" x 6", pack of 25	B1@5.35	Ea	28.00	179.00	207.00
1/2" x 8", pack of 1	B1@.107	Ea	2.00	3.58	5.58
1/2" x 8", pack of 25	B1@5.35	Ea	35.10	179.00	214.10
1/2" x 10", pack of 1	B1@.107	Ea	2.31	3.58	5.89
1/2" x 10", pack of 25	B1@5.35	Ea	41.30	179.00	220.30
1/2" x 12", pack of 1	B1@.107	Ea	2.84	3.58	6.42
1/2" x 12", pack of 25	B1@5.35	Ea	50.40	179.00	229.40
1/2" x 18", pack of 1	B1@.107	Ea	4.00	3.58	7.58
1/2" x 18", pack of 25	B1@5.35	Ea	71.50	179.00	250.50
5/8" x 8", pack of 1	B1@.107	Ea	3.93	3.58	7.51
5/8" x 8", pack of 10	B1@2.68	Ea	30.40	89.60	120.00
5/8" x 10", pack of 1	B1@.107	Ea	4.40	3.58	7.98
5/8" x 10", pack of 10	B1@2.68	Ea	32.90	89.60	122.50

NCE Figure 8-8 Foundation bolt section.

Foundation bolts are priced both per each and pack of 25.

NCE Figure 8-9 shows a screenshot of the extruded polystyrene insulation panel portion of the insulation subsection of the residential section of the NCE, which will be used to calculate the insulation cost.

Extruded polystyrene insulation panel, Dow Blue Board, water resistant. By thermal resistance value, (R-). Density of 1.6 lbs. per CF. Gray Board density is 1.3 lbs. per CF.

3/4" x 2' x 8', tongue & groove, R-3.8	BC@.011	SF	1.17	.41	1.58
1" x 2' x 8', R-5.0	BC@.011	SF	.74	.41	1.15
1" x 2' x 8', tongue & groove, R-5.0	BC@.011	SF	.49	.41	.90
1" x 4' x 8', R-5.0	BC@.011	SF	.77	.41	1.18
1" x 4' x 8', tongue & groove, R-5.0	BC@.011	SF	.72	.41	1.13
1-1/2" x 2' x 8', R-7.5	BC@.015	SF	1.29	.55	1.84
1-1/2" x 2' x 8', tongue & groove, R-7.5	BC@.015	SF	1.23	.55	1.78

NCE Figure 8-9 A screenshot of the extruded polystyrene insulation panel portion of the insulation subsection.

Foundation insulation is priced per square foot. The quantity of rigid insulation will be zero if there is no insulation on the project.

Earthquake Anchors

NCE Figure 8-10 shows a screenshot of the hold downs portion of the Framing Connectors subsection of the residential section of the NCE, which will be used to calculate the earthquake strap cost.

Framing Connectors

	Craft@Hrs	Unit	Material	Labor	Total
4" header (HH4)	[illegible]	Ea	[illegible]	[illegible]	[illegible]
6" header (HH6)	BC@.046	Ea	14.30	1.70	16.00
Hold downs (HD), including typical nuts, bolts and washers for studs. Add for foundation bolts					
HD2A	BC@.310	Ea	7.62	11.50	19.12
HD5A	BC@.310	Ea	20.00	11.50	31.50
HD8A	BC@.420	Ea	25.50	15.50	41.00
HD10A	BC@.500	Ea	27.50	18.50	46.00
HD20A	BC@.500	Ea	53.50	18.50	72.00

NCE Figure 8-10 Earthquake anchor labor costs.

The earthquake anchors are priced per each.

NCE Figure 8-11 shows a screenshot of the Dampproofing subsection of the Thermal and Moisture Protection section of the commercial section of the NCE, which will be used to calculate the dampproofing cost.

07 Thermal and Moisture Protection

	Craft@Hrs	Unit	Material	Labor	Total
Dampproofing					
Asphalt wall primer, per coat, gallon covers 250 SF	CL@.010	SF	.03	.41	.44
Asphalt emulsion, wall, per coat, gallon covers 33 SF, brush on	CL@.013	SF	.21	.53	.74

NCE Figure 8-11 Dampproofing cost from the commercial section of the NCE.

The dampproofing is priced per square foot.

NCE Figure 8-12 shows a screenshot of the Parging (pargeting), Waterproofing and Dampproofing subsection of the masonry section of the commercial section of the NCE, which will be used to calculate the dampproofing cost.

Parging (Pargeting), Waterproofing and Dampproofing					
Parging, 2 coats, 1/2" thick	M3@.070	SF	.28	3.46	3.74
Parging, 2 coats, waterproof, 3/4" thick	M3@.085	SF	.40	4.20	4.60

NCE Figure 8-12 Foundation parging labor costs.

The parging is priced per square foot. Estimate example 8-4 shows the completed foundation labor costs.

Concrete Flatwork

Two primary classifications of concrete flatwork are cast on earth flatwork and suspended flatwork. Cast on earth flatwork is directly supported upon the earth and includes garage floors, basement floors, slab on grade floors, sidewalks, driveways, patios, and equipment slabs. Suspended concrete flatwork consists of structural slabs used in concrete multi-story construction. In residential construction, suspended concrete slabs are occasionally used in situations where an exterior porch is built on top of a basement foundation room such as a storage room.

Cast on Earth Flatwork

Cast on earth flatwork is generally composed of several separate and distinct layers. Even the most basic concrete flatwork cast directly on the native soil has two layers: the concrete slab and the supporting native soil. Figure 8-71 shows an example of a concrete floor cast directly upon the earth.

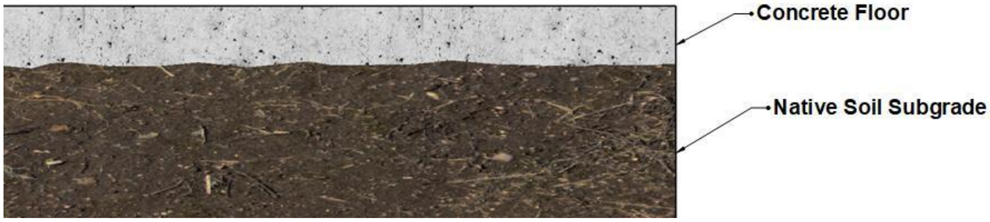


Figure 8-71 Concrete floor cast directly upon native soil.

The supporting native soil is an important part of a concrete flatwork system. If the native soil is sufficiently compacted and stable, the slab can hold up well, but in many cases, native subgrade soil does not provide an ideal base for the concrete. Many concrete floor systems can be improved by the addition of a subbase material. Desirable subbase material is a layer on top of the subgrade that is composed of compacted granular fill material that can be trimmed and graded easily. Some examples of desirable subbase material include gravel, crushed stone, and road base.

Gravel

Gravel is composed of small rocks that are naturally formed by weathering and erosion. The rock typically has a rounded smooth shape. Gravel is graded, so the batch is uniform size, which is achieved by sending the rock through a specific screen grid size. Common sizes of gravel would be 1-inch, 3/4-inch, or 3/8-inch gravel. The small 3/8 or smaller is sometimes called pea gravel (Figure 8-72).


Figure 8-72 Gravel.

Crushed Stone

Crushed stone is a granular gravel-like material that is formed by crushing larger rocks into smaller pieces. Crushed stone is sized and graded similarly to gravel but has sharper more angular edges as a result of the crushing the larger rocks into smaller sizes. Crushed stone is graded and sized similar to gravel (Figure 8-73).


Figure 8-73 Crushed stone.

Road Base

Road base is comprised of gravel or crushed stone with the addition of fines such as sand and a clay binder material. Road base can be moistened and compacted to provide a stable base that holds its shape for the concrete layer. Road base can be called other things such as road mix, pit run, bank gravel, and crusher run, depending upon how the material is processed.

Figure 8-74 Road base is a mixture of gravel, fines, and binder material.

Figure 8-75 shows an example of a concrete floor on a subbase of compacted road base material.

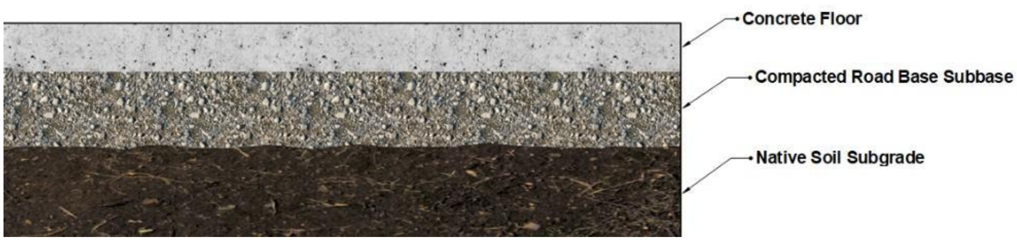


Figure 8-75 Concrete floor on compacted road base subbase.

Figure 8-76 shows a garage floor that has a layer graded subbase installed and smoothed ready for the concrete layer.

Figure 8-76 Garage floor with compacted road base subbase installed ready for concrete.

Figure 8-77 shows an example of a basement floor that has a subbase of compacted road base installed and graded ready for the concrete floor. This floor also has portions excavated for a thickened slab that will be used as a support for load bearing walls installed on the top of the floor. The compact road base material is able to hold its shape for the thickened slab footing depressions.

Figure 8-77 Basement floor with compacted road base subbase. Portions have been excavated for a thickened slab footing.

More complex cast on earth floor systems can have additional layers, such as vapor barriers, insulation, and reinforcing. Concrete floors wick moisture out of the soil, which can increase the relative humidity in a building making the space feel cold and damp. Often a vapor barrier is placed on the soil or subbase before placing the concrete. Vapor barriers are commonly made of polyethylene plastic, which is sold in different thicknesses measured in mils. Common vapor barriers would have a thickness of four or six mils. The vapor barrier can significantly reduce moisture migration into the building from the concrete floor.

In addition, rigid foam insulation can be installed to increase the energy efficiency of the structure and slow down the transfer of heat. Rigid foam insulation appropriate for under slab installation is extruded polystyrene foam, as opposed to expanded polystyrene, which shouldn't be used in an under slab installation. Common brands of extruded polystyrene include pink colored foam from Owens Corning and blue colored dow styrofoam (Figure 8-76).

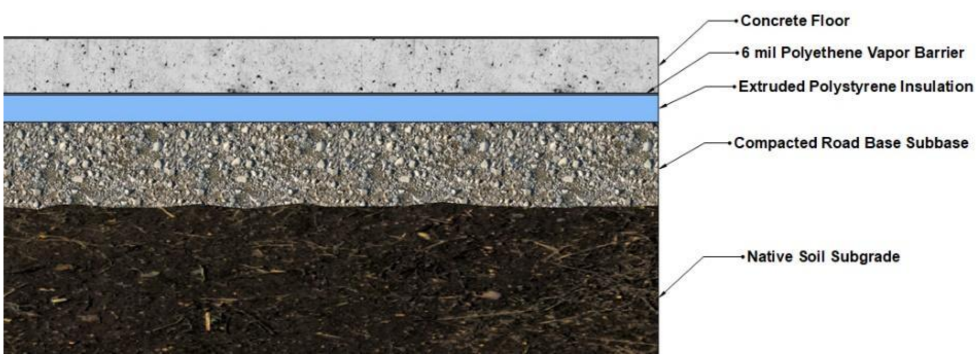


Figure 8-78 A multi-layer cast on earth concrete floor system.

Additional elements of a cast of earth floor system include formwork, reinforcing, isolation materials, and concrete.

Concrete Flatwork Formwork

The formwork for concrete flatwork in residential construction is often made of two-by-four or two-by-six material. Some flatwork types such as basement and garage floors that are inside of foundation walls require little formwork. Other flatwork such as sidewalks and driveways can require more extensive formwork.


Figure 8-79 Forms required at the opening of the garage door.

Sidewalks and driveways typically require formwork on each side and ends.


Figure 8-80 Driveway formwork.

Formwork for curved shaped forms require material that can be bent and formed. It can be one by material or even thinner bender board. Figure 8-81 shows an example of the formwork for a curved sidewalk.


Figure 8-81 Curved sidewalk formwork.

Formwork often also requires the use of forms to screed and level the concrete in addition to the forms that define the exterior shape. The screed forms are staked in the center of the form and carefully leveled and straightened. The concrete is placed and raked as smooth and level as possible. A straightedge is pulled across the screed board forms to further level and smooth the slab. After the concrete has had a chance to set slightly, the screed form boards are removed, and concrete is shoveled into the gaps and leveled again.

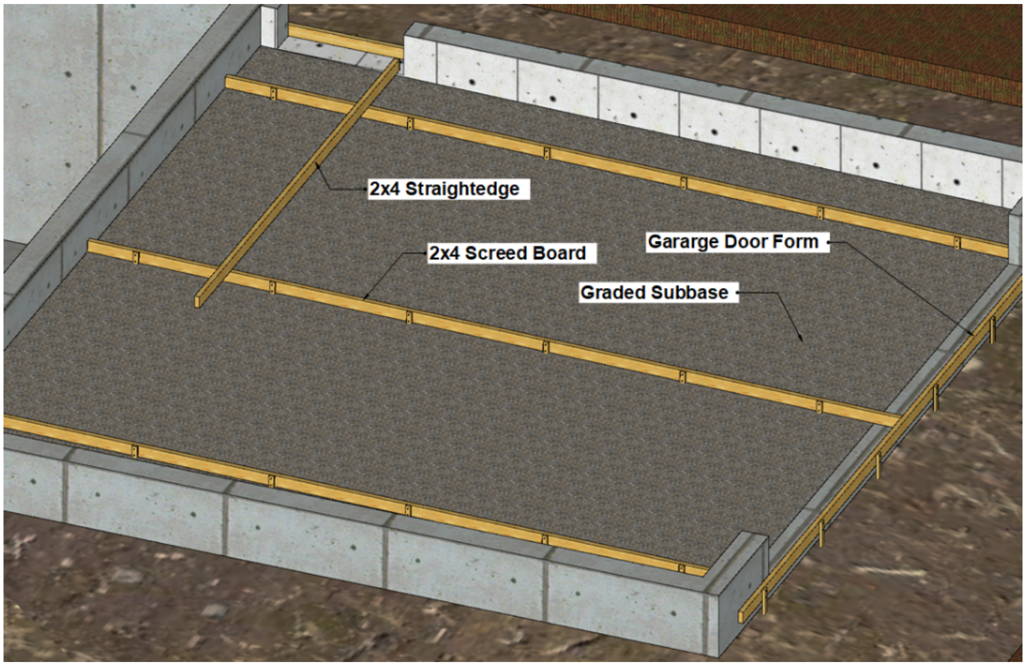


Figure 8-82 Garage floor with screed boards installed.

Concrete Flatwork Reinforcing

Reinforcing can be installed in concrete flatwork to strengthen the slab. Two types of reinforcing that can be installed are steel rebar and welded wire mesh. Rebar is often installed in a grid pattern with lengths of rebar running each way. Figure 8-83 shows an example of a sidewalk slab with an 18-inch grid of number four rebar.


Figure 8-83 Concrete flatwork with an 18-inch grid of #4 rebar.

Another type of flatwork reinforcing is welded wire mesh, which is also known as welded wire fabric (WWF). Welded wire fabric is purchased in rolls or sheets of wire mesh formed into a grid pattern, which is specified by combining the grid spacing in inches and the wire cross sectional area in hundredths of square inches. Common sizes specification would include 6 × 6 -W1.4/W1.4 or 4 × 4 W4.0 × W4.0. Figure 8-84 shows an example of a sidewalk with welded wire fabric installed prior to placing the concrete.

Figure 8-84 Welded wire fabric installed in concrete slab.

Isolation Materials

At times, it is desirable to isolate or separate two concrete slabs from each other. One reason for this is to prevent cracks in one slab from telegraphing to the other. To isolate the slabs from each other, material is placed between the two slabs to separate them. This is commonly known as expansion material or an expansion joint. Some common expansion materials include asphalt impregnated fibrous material, rubber, wood, and other synthetic materials. It is typically sold in widths suitable for concrete flatwork and lengths or rolls. Figure 8-85 shows an example of asphalt impregnated fibrous isolation material installed between an existing concrete slab and a new concrete slab.

Figure 8-85 Expansion material between existing concrete and new concrete.

Flatwork Concrete

Concrete used for flatwork construction should be strong and durable. The concrete should be ordered with a compressive strength between 3,500 and 5,000 psi. The procedure used when placing and finishing the concrete is also important and can dramatically impact the final strength. Concrete that is less stiff and more fluid is easier to place and finish, however, adding water to the concrete to improve the workability can affect the concrete strength as the water/cement ratio in the mix is an important factor in determining the ultimate strength of the concrete.

Testing Concrete Strength

A test that is used to sample the water/cement ratio in a concrete mix is known as a slump test. This is done by filling a 12-inch cone full of fresh concrete directly from the ready-mix truck. The concrete in the cone is consolidated and air gaps removed by agitating it with a metal rod. The concrete is smoothed off level with the top of the cone and the cone carefully lifted off the pile of concrete. The amount that the concrete slumps down from the top of the cone determines the concrete slump and indicates the consistency of the concrete. Flatwork concrete should be placed at a slump consistency between one inch and four inches (Figure 8-86).


Figure 8-86 Concrete slump test.

Additional water can be added to the concrete mix by the ready mix truck. However, adding too much water at the site will irrevocably impact the concrete strength. Because it is easier to place and work concrete, workers often have additional water added on the site. Adding one gallon of water per cubic yard can increase the slump by as much as one inch and lower the compressive strength by as much as 200 psi.

Calculating Concrete Quantity

Concrete for flatwork is calculated by the cubic yard as measured by the thickness, width, and length of the slab. A waste factor is also usually included in the calculation. The amount of waste factor is dependent upon the grading of the subgrade or subbase. Carefully leveled and graded subbase will allow for a smaller waste factor such as five percent. Inaccurately graded subgrades may require a waste factor of 10 percent or more. The final quantity will need to be rounded up to the next quarter yard increment.

Concrete Curing

Another factor that can impact the strength of concrete flatwork is the curing process that it goes through. The hydration process is affected by the temperature of the concrete and the time that the water has to combine with the cement before it evaporates. One method of curing the concrete is to apply a liquid curing compound to the surface for the slab. Concrete cure is a commercial product that is typically applied to the slab with a pump type sprayer. Concrete curing is calculated by determining the number of square feet that a gallon of cure will cover.


Figure 8-87 Spraying concrete curing compound.

Calculating Concrete Floor, Sidewalk and Driveways Material Costs

CalculatingConcrete Floor Costs

To calculate the cost of the concrete floor, you will need to know the variables for the floor thickness, floor area, thickened slab cross sectional area, thickened slab length, lineal feet of rebar, reinforcing mesh, lineal feet of forms, lineal feet of expansion material, vapor barrier, concrete curing, and fill material depth.

Floor Thickness

The floor thickness for the basement floor can be determined from sectional views of the foundation. Figure 8-88 shows a sectional view of the foundation including the basement floor, vapor barrier, and the floor fill material. The floor thickness is identified as four inches, the vapor barrier is identified as a six mil polyethylene barrier, and the fill material as eight inches of compacted fill.

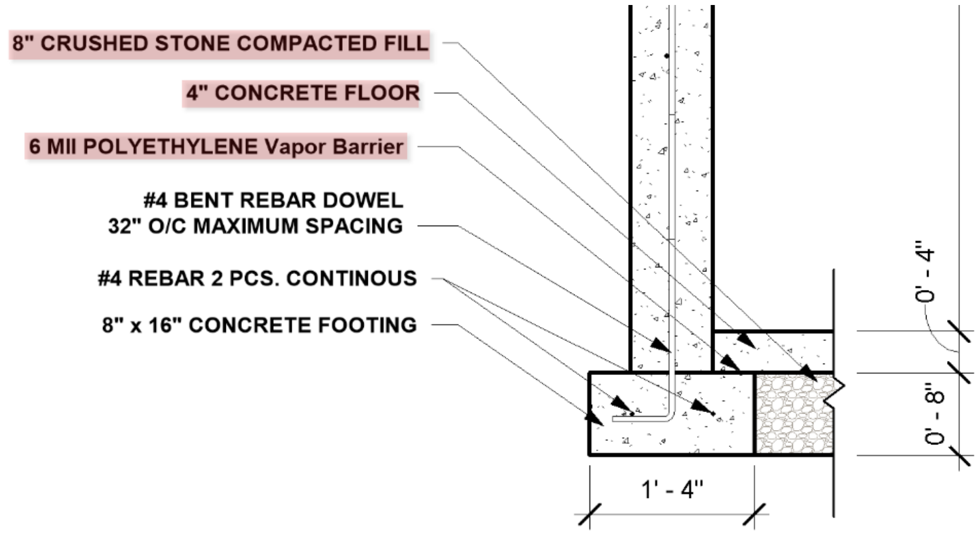


Figure 8-88 Concrete foundation section showing concrete floor construction.

Floor Area

For this example, we will use the basic takeoffs of a basement floor area that is 1,120 square feet and a garage floor area of 440 square feet, as is shown in Excel Figure 8-58.

Basic Takeoff Information		
Item	**Unit**	**Total**
Floor Area		
Main Floor Area	SF	**1152**
Basement Floor Area	SF	**1120**
Garage Floor Area	SF	**440**

Excel Figure 8-58 Basic takeoff showing basement and garage floor area.

Thickened Slab Cross Sectional Area and Length

Thickened slab cross sectional area and length are for inputting information about thickened slab footing under the concrete floor. In this situation, the thickened slab and floor are placed in one monolithic pour. Figure 8-89 shows a basement floor with thickened slab areas excavated.

Figure 8-89 Basement ready for concrete floor showing thickened slab excavations.

Thickened slabs are often shaped like a trapezoid, as is shown in Figure 8-90. The cross sectional area is calculated by finding the average horizontal width and multiplying by the footing height.

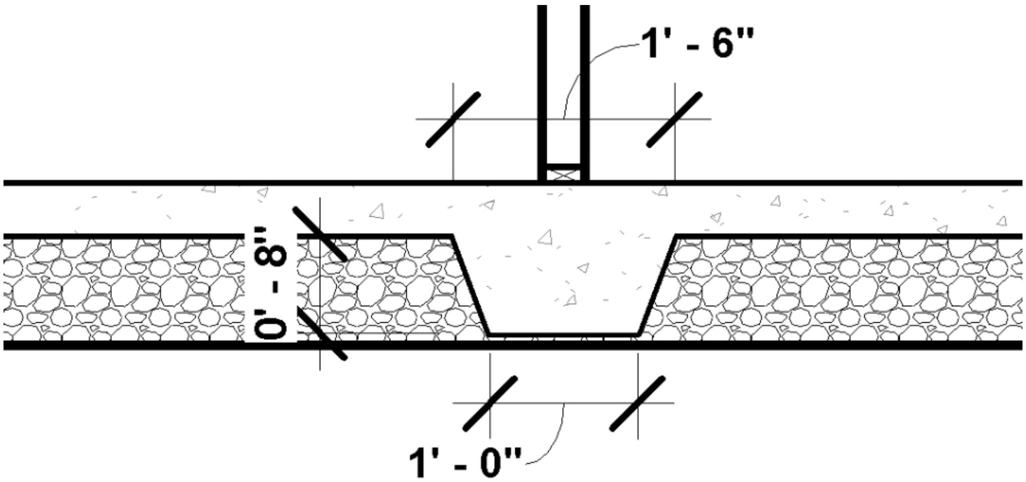


Figure 8-90 Cross section view of a thickened slab footing.

The calculation to determine the average width is determined by adding the width of the footing at the top to the width of the bottom and dividing the sum in half.

Average Width = (1'-6" + 1'-0") ÷ 2 = 1'-3"

Cross Sectional Area: 1'-3" x 0'-8" = 0.833 ft^2

The length of the thickened slab footing is determined as 14' – 5" by the floor plan view of the basement, as is shown in Figure 8-91.

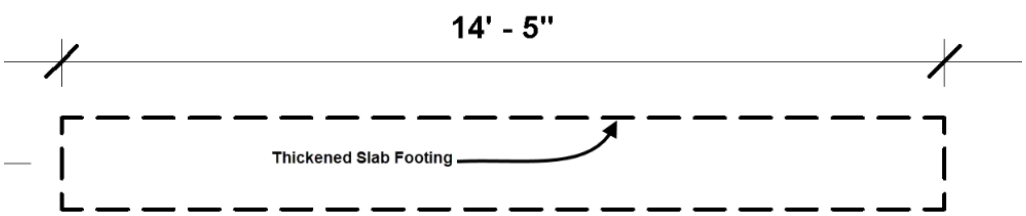


Figure 8-91 Thickened slab footing length.

In this instance, the footing is not a thickened slab area, and the footing supporting the basement load bearing wall is an interior grade footing and was previously calculated, as is shown in Estimate Example 8-1.

Rebar and Reinforcing Mesh

The information about lineal feet of rebar for the floor is inputted into the header section. This is done by making a manual calculation. For example, Figure 8-92 shows a section view of a front porch that has a rebar grid spaced six inches on-center. The length of the rebar going each direction will need to be determined from a plan view. The number of pieces in each direction will need to be determined. The total of all of the pieces determine the total lineal footage.

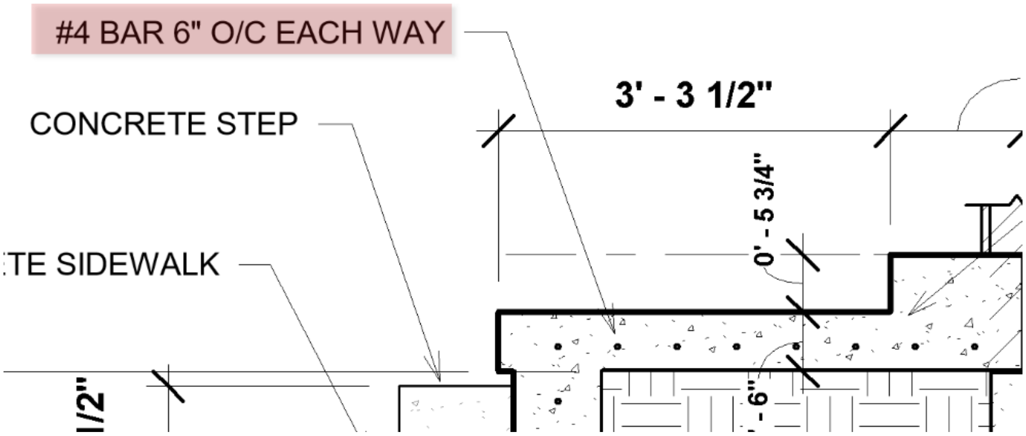


Figure 8-92 Front porch showing a six-inch rebar grid.

Some slabs do not include reinforcing mesh. The requirements to install reinforcing mesh are usually shown using symbolic representations or annotations in detailed section views, as is shown for the patio in Figure 8-93. The adjacent floor in the garage does not have reinforcing mesh.

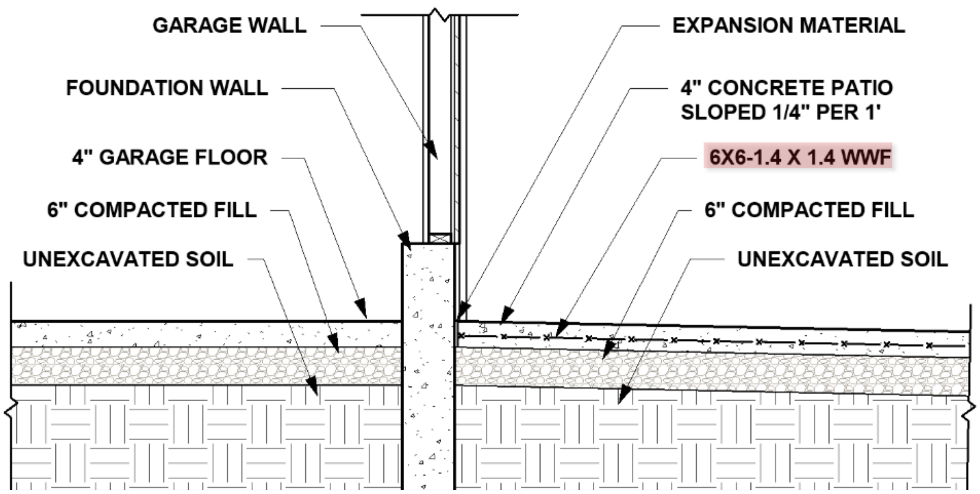


Figure 8-93 Detailed section view showing reinforcing mesh in a concrete patio.

The area of the patio is determined by the site plan view. Figure 8-94 shows an example site plan view. The area is calculated by multiplying the length and the width.

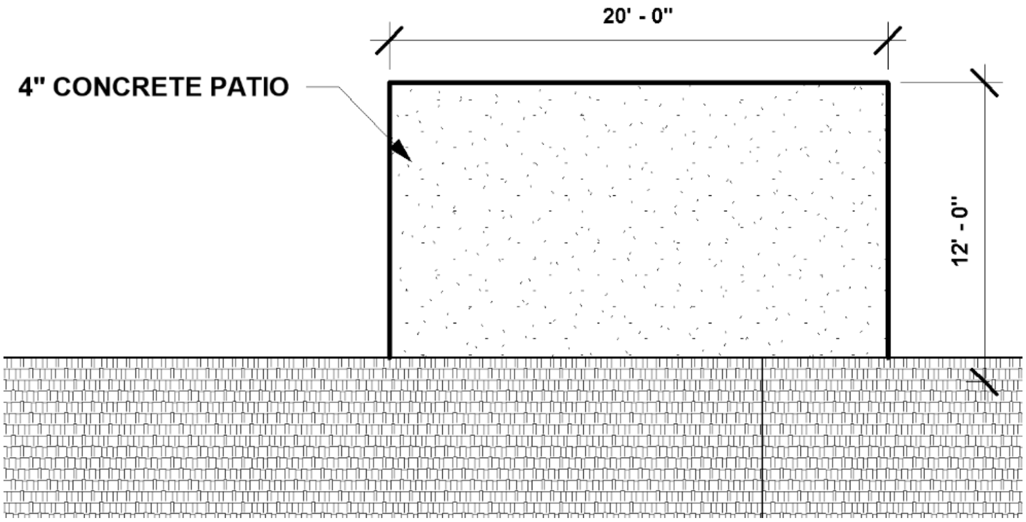


Figure 8-94 Partial site plan view showing the patio area.

Patio length × Patio width

$$20' \times 16' = 320 \text{ ft}^2$$

This would be the quantity used to calculate the reinforcing mesh quantity.

Lineal Feet Forms

The lineal feet of forms are determined by the need and what would be best coordinated with the concrete installers. Basement floors are often placed without the use of additional forms or screed boards. The garage floor would need forms across both door openings but could be placed easily without the use of other forms or screed boards. The concrete patio in Figure 8-94 would need forms around the outside of the slab that would be calculated as follows:

12 ft + 20 ft + 12 ft = 44 ft

LF Expansion Material

Expansion material would be used typically to isolate two separate concrete slabs from each other. Expansion material could be used on the patio in Figure 9-94 between the slab and the house. At a minimum, it would be needed between the patio and the adjoining concrete garage floor. In addition, expansion material would be placed between the front of the garage floor and the driveway.

Vapor Barriers

Some floors and slabs do not have a vapor barrier. If there is a vapor barrier, the quantity would be determined by the square foot of floor or slab area. Figure 8-88 shows a six mil vapor barrier underneath the basement floor slab.

Concrete Curing

Some concrete floors and slabs do not use concrete curing. If they do, the quantity is determined by the square foot of the floor or slab area.

Fill Depth Material

The fill depth input in the header section allows for input of the thickness of the floor or slab fill depth in inches. When fill is utilized, the depth of the fill is inputted and the square footage of the floor or slab area is used to calculate the cubic yards of fill material. All concrete floors or slabs will have fill material installed to a depth as shown in the section or detail views. When the depth of the fill is inputted, the square footage of floor area from the header section is used to calculate the cubic yards of fill material.

Estimating the Concrete Floors Labor Costs

Both the concrete floor, sidewalk, and driveway labor cost estimates can be completed using the Slabs, Walks, and Driveways subsection of the National Construction Estimator. NCE Figure 8-13 shows an example of this subsection. The cost is based upon the square footage of the concrete flatwork and includes the labor to form, place, and strip the slab. The labor for the four-inch-thick option is shown at $2.52 per square foot.

	Craft@Hrs	Unit	Material	Labor	Total
Column Footings Concrete material and placing only. Material costs are for 3,000 PSI, 5.7 sack mix, with 1-1/2" aggregate with 5% waste included. Labor cost is for placing concrete in an existing form. Add for excavation, board forming and steel reinforcing.					
Using concrete (before waste allowance)	—	CY	118.00	—	118.00
Typical cost per CY	B1@.875	CY	124.00	29.30	153.30
Slabs, Walks and Driveways Typical costs for reinforced concrete slabs-on-grade including fine grading, slab base, forms, vapor barrier, wire mesh, 3,000 PSI concrete, finishing and curing. For expanded coverage of concrete and formwork, see the *National Concrete & Masonry Estimator* at http://CraftsmanSiteLicense.com. For thickened edge slabs, add the area of the thickened edge. Use 500 square feet as a minimum.					
2" thick	B5@.067	SF	2.09	2.45	4.54
3" thick	B5@.068	SF	2.46	2.49	4.95
4" thick	B5@.069	SF	2.83	2.52	5.35
5" thick	B5@.070	SF	3.20	2.56	5.76
6" thick	B5@.071	SF	3.57	2.60	6.17

NCE Figure 8-13 Slabs, Walks, and Driveways subsection of the NCE.

Concrete Steps

Concrete steps are created by erecting formwork to hold and shape the unsolidified concrete, placing the concrete in the forms, and allowing it to set to a point that it will hold the desired shape but is still pliable. At that point, the forms are stripped away, and the final floating and troweling of the surface is done to provide for a consistent finished surface.

Concrete steps can be placed directly upon the earth, or they may be constructed in such a way that they are constructed as a self-supporting unit known as a suspended stairway. In either case, formwork will need to be fashioned before the stair concrete can be placed.

Casts on Earth Stairs

Casts on earth stairs are placed by placing the concrete directly upon the earth. With this type of construction, a base of solid compacted fill is required under the stairs to provide support and keep them from settling. Often, additional fill will be placed under the stairs to serve as a replacement for some of the concrete material when the steps are thick. Casts on earth concrete stairs may be placed between existing concrete walls on one or both sides, or they may be placed as a single monolithic unit.

Casts on Earth Stairs Between Existing Walls

Figure 8-95 shows an example of the formwork for concrete stairs formed between two existing walls.

Figure 8-95 concrete steps formed between two concrete pony walls.

Compacted fill was placed under the stairway and shaped to the desired slope. This stairway also has polystyrene foam insulation placed between the earth and the stairs as heating tubes will be cast into the concrete to keep the stairs free of snow and ice in the winter. The individual steps were formed by staking riser form material at each tread level. The concrete will be placed in the forms and allowed to harden to a point that the riser forms can be removed. The holes left by the metal stakes will be filled, and the workmen will finish the top and face of the stairs.

Casts on Earth Stairs with Open Ends

Stairs with open ends will also require end panels. Smaller stairs with two or three steps may be able to use a single piece of plywood at each end, or more extensive end formwork may be required. Figure 8-96 shows an example of the formwork for a small two-step concrete stair, such as would be used to walk up to the front porch of a house.

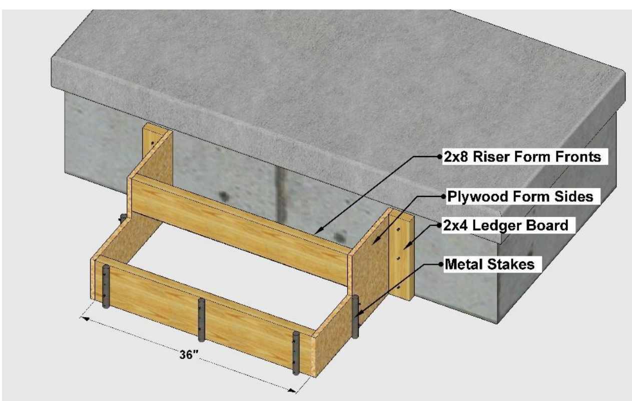


Figure 8-96 Set of small stair forms.

The small stairway will require six pieces of material, including two form sides, two riser form pieces, and two ledger boards. Although there are no dimensions other than the 36-inch width, the relative size of the pieces can be determined. Code requirements specify that the maximum riser height of 7-3/4" and a minimum run of 10" are likely less than 12". The height of the plywood form sides can be determined by multiplying the two 7-3/4" maximum riser heights to equal 15-1/2". The length of the plywood form sides would be determined by multiplying the two run lengths of 12" to equal 24". One piece of plywood 16"× 48" would make both plywood form sides. Two pieces of 2 × 8 framing lumber three feet long would make both of the riser form fronts. Two pieces of 2 × 4 framing lumber 16 inches long will make the ledger boards.

Larger stairs such as in Figure 9-97 will require more extensive formwork.

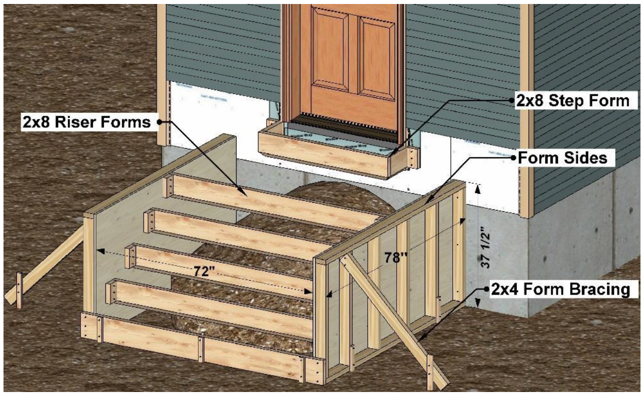


Figure 8-97 Large set of stair forms.

This larger set of forms will require more extensive formwork material. The dimensions of the stairs are 72 inches wide and 78 inches long and 37-1/2" tall. To construct the form sides, the following will be needed:

2 pcs 3/4" × 4' × 8' plywood

4 Pcs 2×4 × 78" plates

12 pcs 2×4 × 36" studs

2 pcs 2×4 × 54" form bracing

The form risers are approximately 72 inches long. The front riser form is a little longer, and the 2 × 8 step form is a little shorter, but they could be averaged at 72 inches. Ten six-inch blocks are also needed to support the riser forms, but the assumption can be made to use scraps from the form side studs. The totals would be as follows:

6 pcs 2×8 × 72" riser forms

Porch and Landings

Often, a building will have a front porch or landing that will need to be formed and placed at the same time as a stairway. The large set of stairs previously shown in Figure 8-97 was formed and placed as one monolithic pour separate from the building foundation. Often, the porch will have a foundation underneath it that will require a concrete porch on the top of it. The foundation may be a shallow foundation that will be backfilled and the porch placed on top of the fill. See Figure 8-98.


Figure 8-98 Porch foundation has been backfilled and the concrete porch will be placed directly on the backfill.

The foundation for this kind of porch will be backfilled, and the formwork will consist of two-by-four ledger boards that are attached to the foundation wall. Attached to the ledger material, two-by-ten form material will be used for the porch edge. In the case of a small step, such as in Figure 8-99, two-by-six or two-by-eight material would be used to form the step.

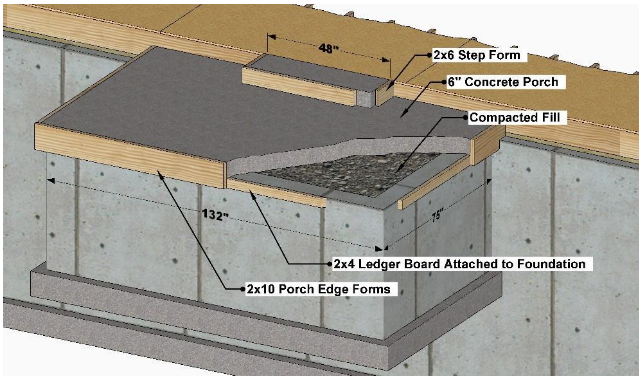


Figure 8-99 Shallow foundation front porch. The foundation is backfilled and forms are set for pouring the porch and step.

Figure 8-100 also shows where a porch such as this has been placed and the porch edge formwork stripped. The ledger board is still attached to the foundation.


Figure 8-100 Porch concrete has been placed and the form edge boards stripped. The ledger board is still attached to the concrete foundation.

Other times, the foundation will be the full depth of the basement with the expectation that a suspended concrete porch slab will be placed upon the top and room created underneath the porch will serve as a basement storage room such as is shown in Figure 8-99.


Figure 8-101 The porch foundation has been poured to the full depth of the basement. The concrete porch slab will serve as a cap for the basement storage room underneath the porch.

The suspended porch slab shown in Figure 8-101 will require additional reinforcing to support it. The rebar extending from the foundation walls will be bent over and placed in the porch slab and be incorporated into the reinforcing rebar mat in the concrete cap. The same porch edge forms, ledger strip, and step edge forms will be used as the porch for the backfilled foundation. However, a temporary floor and extensive temporary support bracing will need to be installed before placing this style of concrete porch (Figure 8-102).

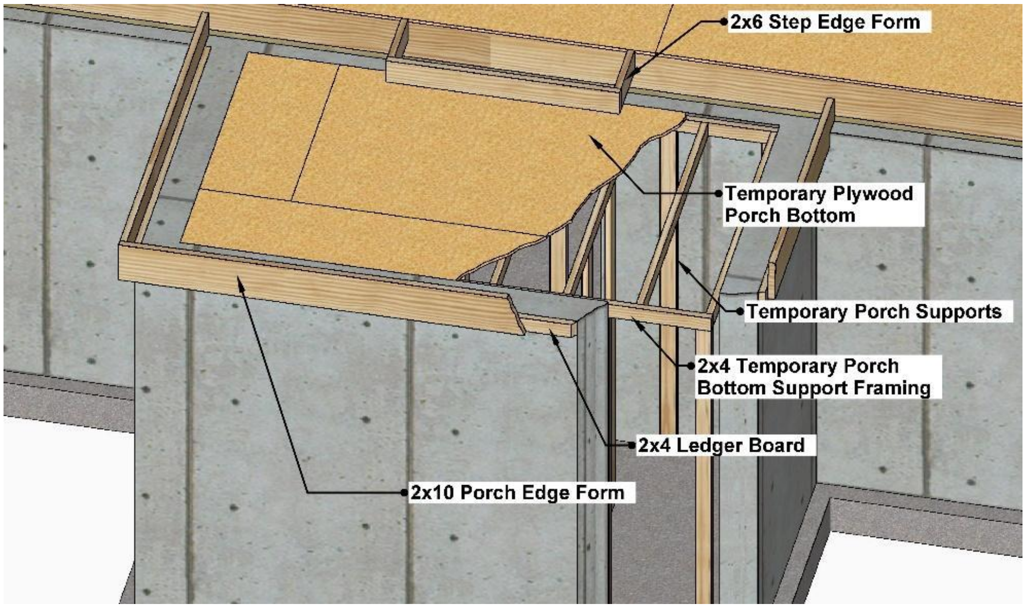


Figure 8-102 Suspended porch over basement foundation will require extensive temporary support bracing.

Estimating the Concrete Steps Costs

To estimate the cost of concrete steps, you will need to know variables for square feet of sectional stair area, stair width, landing area in square feet, and landing area thickness.

Figure 8-103 shows a colored section view of a front porch stair with two stair types: a small two tread front sidewalk step and a front porch with a single step to the front door that is poured with the porch as a monolithic concrete pour.

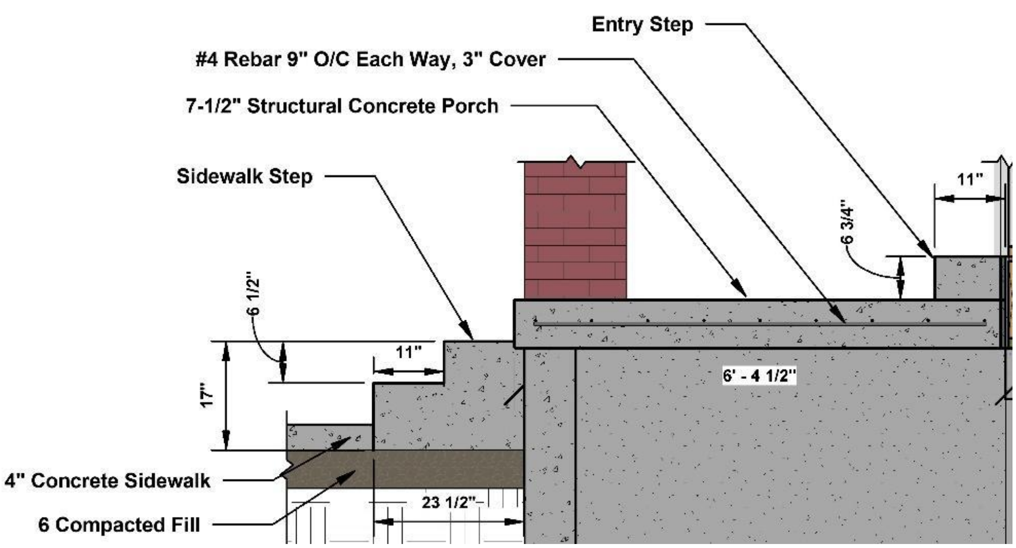


Figure 8-103 Section view of a front porch and sidewalk step.

Figure 8-104 shows the same porch and stairs from a plan view perspective.

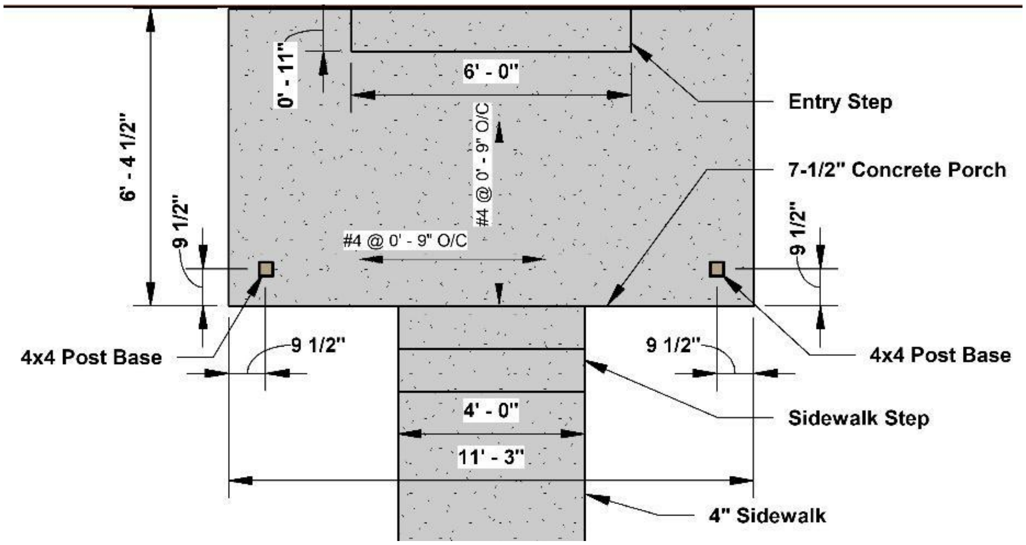


Figure 8-104 Colored plan view of front porch and stairs.

Determining the Sidewalk Step Variables

The sidewalk step has two variables, SF Sectional Stair Area and Stair Width.

SF Sectional Stair Area

The SF of sectional stair is found by determining the area of the sectional area of the stairway. For example, Figure 8-105 shows the details of the concrete sidewalk step shown in Figures 8-103 and 8-104.

The end view of the small stairs has dimensions of 23½ inches deep and 17 inches tall. Each step has a rise of 6½ inches and a run of 11 inches. The bottom step extends four inches below the riser height to account for the sidewalk depth. The overall width has an extra 1½ inches added to account for the distance the stair extends underneath the porch overhang. The sectional area could be determined using several methods. One method would be to calculate the rectangular area of the bottom step and add the rectangular area of the top step. The small notch in the top of the stairs can be ignored.

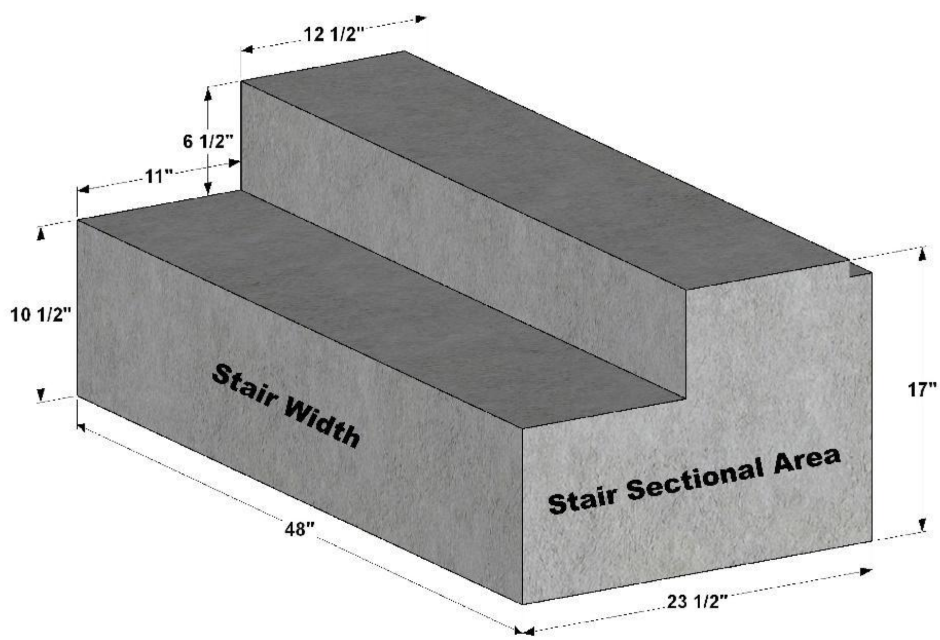


Figure 8-105 End view of a small stairway to calculate the SF of Sectional Stair Area.

Stair Width

Figure 8-105 shows the width of the stairway as 48 inches wide. Multiplying the stair sectional area by the stair width will give you the needed volume of concrete, which in this case is 0.34 cubic yards.

Determining the Front Porch Variables

The front porch includes an entry step, landing, and reinforcing. The entry step and landing will be placed in a single monolithic pour, and the inputs will be a little more extensive. Figure 8-106 shows a three dimensional view of the front porch landing and entry step.

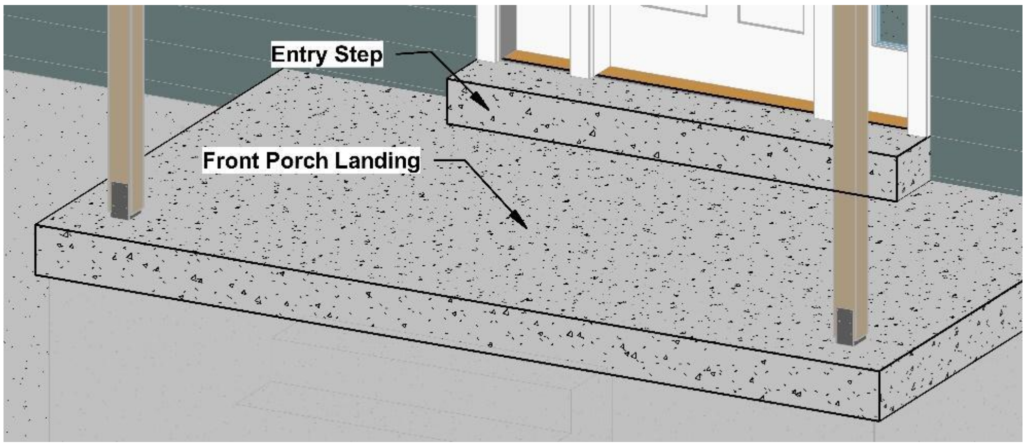


Figure 8-106 Front porch showing porch landing and entry step.

SF Sectional Stair Area

The SF section stair area (Figure 8-103) shows a section view of the front porch. The SF sectional area is the area of the end of the entry step. The dimensions shown are 6¾ inches high by 11 inches wide. Multiplying the height by the width will return the sectional area as follows:

$$Sectional\ Area: \frac{6\frac{3}{4}'' \times 11''}{12} = 0.52\ ft^2$$

Stair Width

The stair width is shown on Figure 8-104 as 6 feet or 72 inches.

Landing Area (Square Feet)

The landing area is determined by multiplying the width of the landing by the length of the landing. Figure 8-104 shows the dimensions of the landing as 6 feet, 4½ inches wide by 11 feet, 3 inches long. Multiplying the width by the length results in the landing area as follows:

$$Landing\ Area\ (SF): 6\ ft\ 4\tfrac{1}{2} in \times 11\ ft\ 3\ in = 71.72\ ft^2$$

Landing Area Thickness (IN)

The landing thickness is shown in both Figure 8-103 and 8-104 as 7½ inches. Using these variables and the formulas for volume, you will find that a concrete quantity of 1.78 cubic yards is needed for the front porch.

Concrete Steps — Cost Code

	Sidewalk Step	Front Porch	Garage Step	Step	Step	Total
SF Sectional Stair Area	2.28	0.52				
Stair Width (IN)	48	72				120
Landing Area (Square Feet)		71.72				71.72
Landing Area Thickness (Inches)		7.5				
LF Reinforcing						
Concrete (Yds.)	0.34	1.78				2.11

Excel Figure 8-63

LF Reinforcing

The front porch is a structural concrete slab installed over a basement storage room. A grid of reinforcing rebar will be placed in the porch slab to strengthen it. The rebar grid can be identified in the plans by using several methods. For example, an annotation symbol as shown in Figure 8-106 can be used to specify the reinforcing. The annotation specifies a grid of number four rebar spaced at nine inches on-center, both horizontally and vertically. The annotation in the section drawing shown in Figure 8-104 also identifies a rebar grid of number four rebar spaced nine inches on-center. This annotation also specifies a three-inch rebar cover space. Figure 8-108 shows a view of the front porch with the rebar grid exposed.

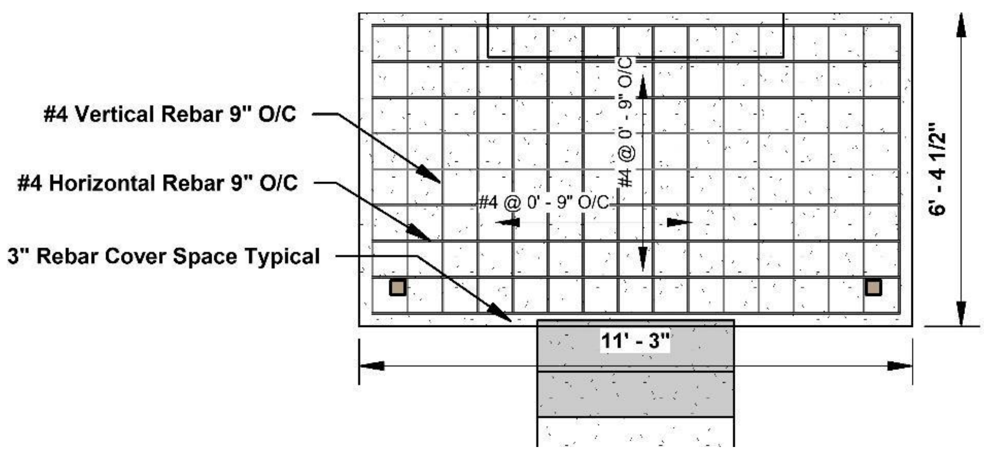


Figure 8-108 Exposed rebar view of the front porch.

The quantity of rebar is calculated by determining the number of horizontal rebar and its length and the number of vertical rebar and its length. The number of horizontal rebar is determined by dividing the porch width by the rebar spacing rounding up to the next whole number.

$$Number\ Horizontal\ Rebar:\ 6\ ft\ 4\tfrac{1}{2}\ in\ \div\ 9\ in\ =\ 8.5$$

The 8.5 is rounded up to nine. The length of the horizontal rebar is calculated by subtracting the cover distance of three inches on each end from the overall porch length as follows::

$$Horizontal\ Rebar\ Length:\ 11\ ft\ 3\ in\ -\ (2\ \times\ 3\ in)\ =\ 10\ ft\ 9\ in$$

The quantity of vertical rebar is calculated in a similar manner.

$$Number\ Vertical\ Rebar:\ 11\ ft\ 3\ in\ \div\ 9\ in\ =\ 15$$

In this case, the product is a whole number of 15, however, because of the whole number, an additional rebar will need to be added as a starting rebar for a total of 16. The length of the vertical rebar is calculated by subtracting the cover distance of three inches on each edge by the overall porch width as follows:

$$Vertical\ Rebar\ Length:\ 6\ ft\ 4\tfrac{1}{2}\ in\ -\ (2\ \times\ 3\ in)\ =\ 5\ ft\ 10\tfrac{1}{2}\ in$$

The total lineal feet of rebar is calculated as

$$Total\ Lineal\ Feet\ Rebar:\ (9\,pcs.\ \times 10\ ft\ 9\ in)\ +\ (16\,pcs.\ 5\ ft\ 10\tfrac{1}{2}\ in)$$

or

$$Total\ Lineal\ Feet\ Rebar:\ 96\ ft\ 9\ in\ +\ 94\ ft\ =\ 190\ ft\ 9\ in$$

Determining the Garage Step Variables

The final concrete step to estimate on this project is the garage steps. Figure 8-109 shows a section view of this step with the overall dimensions.

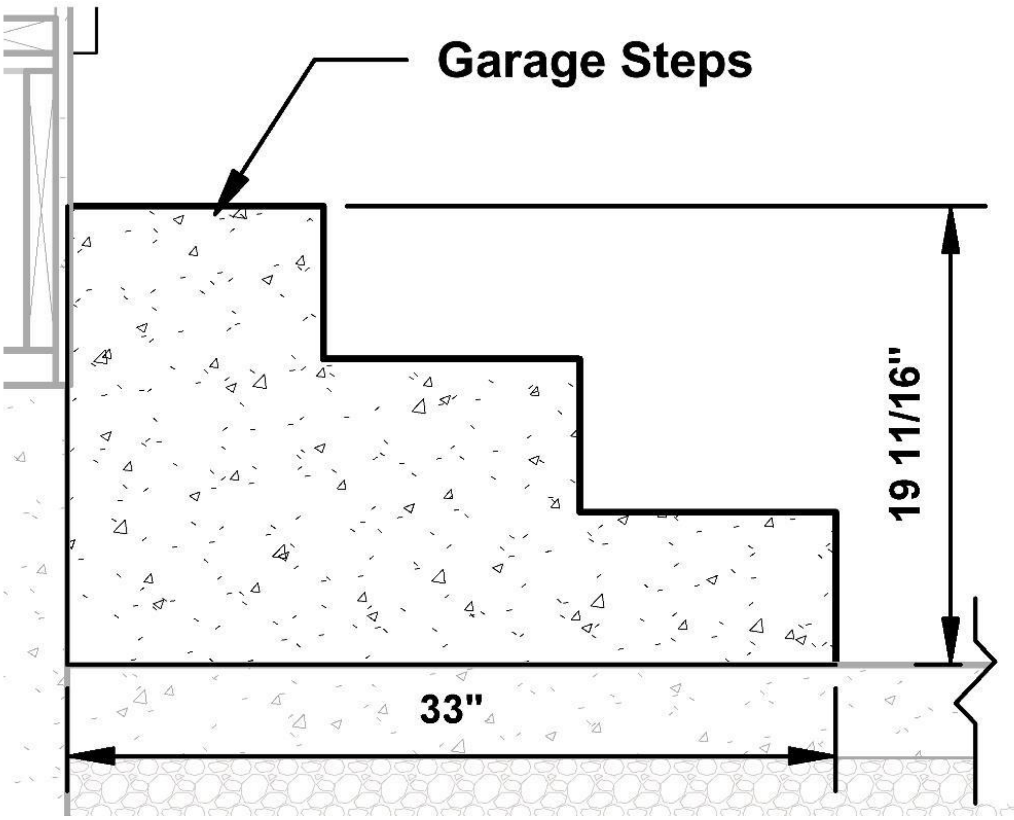


Figure 8-109 Section view of garage steps.

The individual riser height and tread length is not given but can be calculated easily by dividing the total rise by the number of risers and the total run by the number of treads.

$$Riser\ Height:\ 19\tfrac{11}{16}\ in\ \div\ 3\ =\ 6\tfrac{9}{16}\ in$$

$$Tread\ Length:\ 33\ in\ \div\ 3\ =\ 11\ in$$

The square footage of sectional area can be calculated by multiplying the steps overall length by the steps overall height and subtracting the area of one tread and riser multiplied by three. Figure 8-110 shows the calculations and calculated SF sectional stair area of 3.00 square feet.

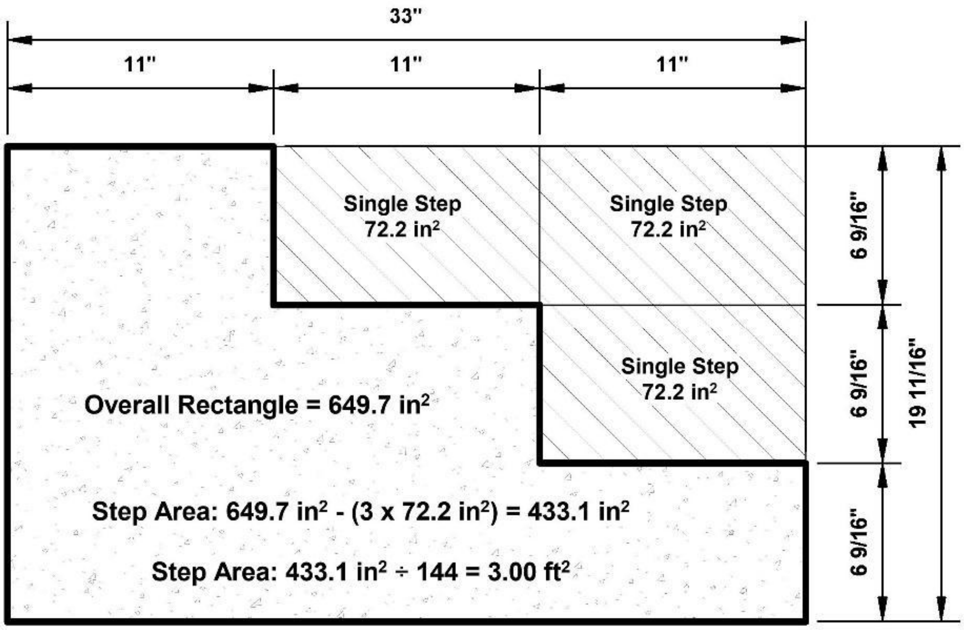


Figure 8-110 SF sectional stair area calculations.

The stair width of 40 inches can be determined from the plan view as is shown in Figure 8-111.

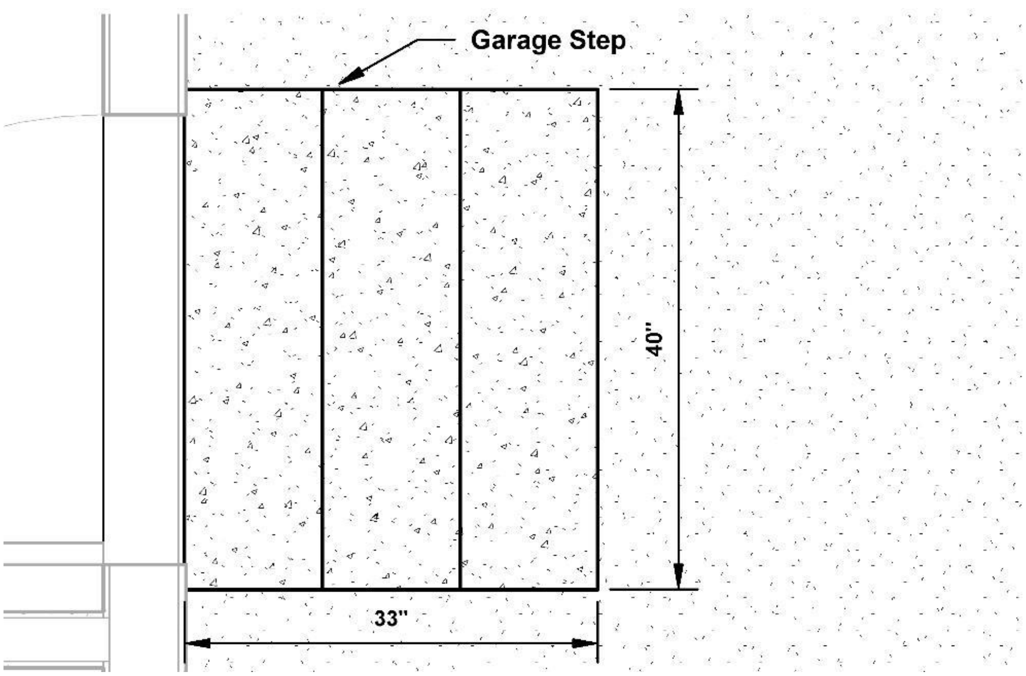


Figure 8-111 Plan view of garage steps.

Completing the Concrete Steps Material Costs

The concrete material subsection allows for inputs of concrete, reinforcing, step form sides, step riser forms, porch edge forms, porch, porch bottom forms, and form bracing. The material quantities calculated are totaled for all of the concrete stairs in the project.

Concrete

This is a total of the concrete needed in all of the steps on your project.

Reinforcing

The correct reinforcing material is multiplied by the waste factor and rounded up to the next full piece.

Step Form Sides

Both the sidewalk step and the garage step will require form sides. Three quarter inch plywood form material will be used to form the sides of the steps. One method of calculating the amount of plywood for the step side forms is to sketch it out as is shown in Figure 8-112. This shows that approximately one half of a sheet of plywood will be needed to form both the sidewalk step and the garage step sides. Even though plywood can be purchased only in full size sheets, it is likely that at least some of the form sides could be made from scraps on the project.

Step riser forms will be used on all three of the steps. Two-by-eight material will be used to form the stair risers. Two pieces four feet long will be used for the sidewalk steps; three pieces 40 inches long will be needed for the garage steps; one piece eight feet long will be used to form the entry step on the front porch. The totals would be as follows:

2 pcs. 2 in. × 8 in. × 48 in. = 96 in.

3 pcs. 2 in. × 8 in. × 40 in. = 120 in.

1 pcs. 2 in. × 8 in. × 96 in. = 96 in.

Total = 312 in. or 26 ft.

Porch Edge Forms

The porch edge forms will be constructed out of 2 × 10 material. Enough material will need to be purchased to form the three exposed edges of the porch. Figure 8-104 shows a plan view of the porch with two porch ends at 6 feet, 4½ inches and one porch front at 11 feet, 3 inches. Each porch edge should be made out of a single piece of lumber, and each piece should be rounded up to the nearest two-foot increment, which will result in the following:

2 pcs. 2 in. × 10 in. × 8 ft. = 16 ft.

1 pcs. 2 in. × 10 in. × 12 ft. = 12 ft.

Total = 16 ft. + 12 ft. = 38 ft.

Porch Bottom Forms

The porch in this project is a slab that is suspended over a storage room in the basement. This will require the porch bottom to be formed so that the porch can be placed. The bottom will be formed out of plywood that will be supported by a framework of bracing. After the porch is placed and had a chance to cure sufficiently, the porch formwork will be taken down leaving only a suspended concrete slab. Figure 8-102 shows an example of the porch bottom plywood form work that will be required. Figure 8-112 shows the layout for the pieces of plywood.

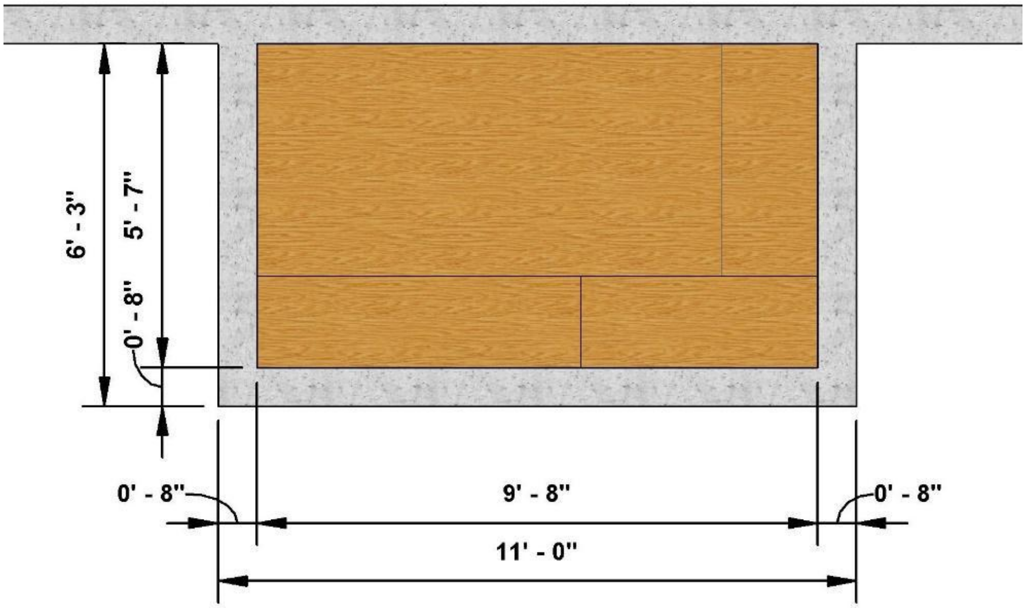


Figure 8-112 Porch bottom plywood formwork.

The dimensions of the inside of the porch bottom are five foot seven by nine foot eight. Multiplying the dimensions would result in the following calculation:

$$5 \text{ ft } 7 \text{ in x } 9 \text{ ft } 8 \text{ in} = 53.97 \text{ ft}^2$$

A standard four foot by eight-foot sheet of plywood is equal to 32 square feet. It will take close to two sheets of plywood for the porch form bottom.

Form Bracing

The porch bottom forms will require extensive bracing to support it while the concrete cures. A framed floor will be installed below the plywood to support it with two-by-four floor joists every two feet on-center. The floor joist will be supported by temporary framed walls every two feet. The 5 foot, 7 inch width of this porch will require at least four framed walls two feet on-center. Material for the porch bottom bracing will be as follows:

Porch Bottom Joists: 6 pcs. 2" × 4" × 5'-7" = 33'-6"

2 pcs. 2" × 4" × 9'-8" = 19'-4"

Temporary Walls Plates: 8 pcs. 2" × 4" × 9'-8" = 77'-4"

Temporary Wall Studs: 24 pcs. 2" × 4" × 8' = 192'

Total 322'-2"

Although all 322 feet will be used for the temporary form bracing, most of it will be able to be salvaged and reused in other parts of the projects. An estimate of five form uses will be used to calculate the bracing material similar to what was done when estimating footing formwork. The total will be divided by five to calculate the amount to purchase for the project.

322 ft. ÷ 5 = 64'-6"

Figure 8-113 shows a cutaway view of the porch formwork's temporary bracing.

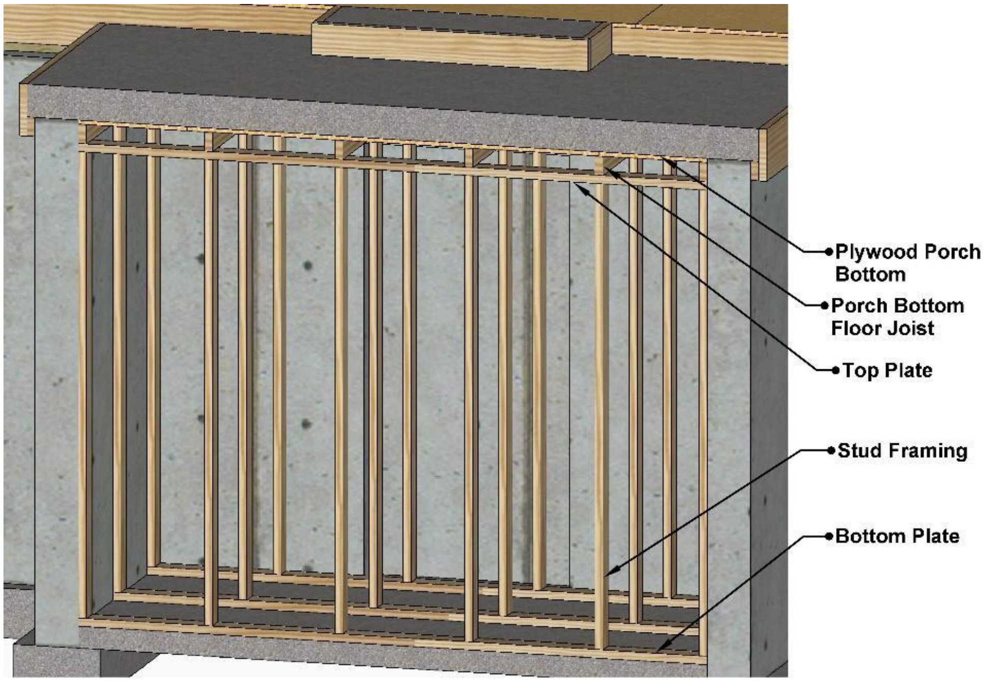


Figure 8-113 Cutaway view of front porch temporary bracing

Completing The Concrete Step Labor Costs

The concrete step labor costs will be estimated using the steps-on-grade subsection of the residential section of the National Construction Estimator. NCE Figure 8-14 shows a screenshot of the National Construction Estimator.

Concrete Finishing

	Craft@Hrs	Unit	Material	Labor	Total
Curbs and gutters Small quantities. Material costs are for 2,000 PSI, 5.0 sack mix with 1" aggregate. No waste included. Labor cost is for placing and finishing concrete only. Add for excavation, wood forming, steel reinforcing.					
Per CY of concrete	B6@1.61	CY	115.00	52.30	167.30
Steps-on-grade Costs include layout, fabrication, and placing forms, setting and tying steel reinforcing, installation of steel nosing, placing 2,000 PSI concrete directly from the chute of a ready-mix truck, finishing, stripping forms, and curing. Costs assume excavation, back filling, and compacting have been completed. For scheduling purposes, estimate that a crew of 3 can set forms, place steel, and pour 4 to 5 CY of concrete cast-in-place steps in an 8 hour day. See also Cast-in-place Concrete Steps-on-Grade in the Industrial Section 3. Costs shown are for concrete steps with a 6" rise height and 12" tread depth supported by a 6" thick monolithic slab.					
Total cost of steps per CY of concrete	B1@5.43	CY	341.00	182.00	523.00

NCE Figure 8-14 Steps-on-grade subsection of the NCE.

The concrete steps are priced per cubic yard of concrete. The 2.48 total cubic yards of concrete in the header section will be used to estimate the quantity of concrete for a total cost of

$$2.48 \text{ yd.}^3 \times \$182.00 = \$451.36$$

Foundation Finish

Estimate Example 8-6 Concrete Steps

Concrete Steps — Cost Code

	Sidewalk Step	Front Porch	Garage Step	Step	Step	Total
SF Sectional Stair Area	2.28	0.52	3.00			
Stair Width (IN)	48	72	40			
Landing Area (Square Feet)		71.72				
Landing Area Thickness (Inches)		7.5				
LF Reinforcing		190.75				190.75
Concrete (Yds.)	0.34	1.78	0.37			2.48

Supplier	Wst	Item Description	Materials	Size	Units	Unit Cost	Quantity	Override	Total
			Concrete Step Materials						
Walter(Rex	5%	Concrete	3500 psi Concrete	1	yd	$ 101.50	2.75		$ 279.13
BMC(REX)	5%	Reinforcing	1/2" X 20' GRADE 40 REBAR	20	ft	$ 5.54	11		$ 60.94
BMC(REX)		Step Form Sides	3/4" - 4' X 8' CDX PLYWOOD	32	sqft	$ 30.49	0.5		$ 15.25
BMC(REX)		Step Riser Forms	2" x 8" - RL Fir (STD & BTR)	1	Ft	$ 0.76	26		$ 19.76
BMC(REX)		Porch Edge Forms	2" x 10" - RL Fir (STD & BTR)	1	Ft	$ 1.11	38		$ 42.18
BMC(REX)		Porch Bottom Form	3/4" - 4' X 8' CDX PLYWOOD	32	sqft	$ 30.49	2		$ 60.98
BMC(REX)		Form Bracing	2" x 4" - RL Fir (STD & BTR)	1	Ft	$ 0.49	65		$ 31.85
							$		510.08

Concrete Steps Labor — Cost Code

Crew	Men	Days	Man-hours	Job Description	CraftHrs	Unit	Labor	Quantity	Override	Total
B1	2	0.8	13.47	Steps on Grade	5.43	CY	$ 182.00	2.48		$ 451.36
	Total	0.8	13.47				Total Concrete Steps Labor	$		451.36
							Total Concrete Floor Material and Labor	$		961.44

Estimate Example 8-6 Concrete Steps

A foundation finish costs section can be included in your estimate for miscellaneous concrete items needed to complete the project.

The building code requires that all basement rooms with habitual space have a separate form of egress in the case of an emergency such as a fire. Basement rooms such as bedrooms, family rooms, recreation rooms, dens, exercise rooms, media rooms, and offices would typically be defined as habitual rooms. Often the defined form of egress for these rooms is a window. There are also specific requirements for size and location of windows that are defined as egress windows. The code requirements for an egress window are as follows:

- The bottom of the egress window opening can't exceed 44" from the finished floor.
- The minimum opening area of the egress window is 5.7 square feet.
- The minimum egress window opening height is 24" high.
- The minimum egress window opening is 20" wide.

https://books.byui.edu/-xBbk

In addition to the window egress requirements, there are egress requirements for a window well when the bottom of the window is below the finished grade. The requirements for an egress window well are as follows:

- Egress window wells are required where the bottom of the egress window is below ground level.
- The egress well must not interfere with the egress window fully opening.
- The distance from the egress window to the back of the egress well must be at least 36".
- The minimum area of the egress well must be 9 square feet (width × projection).

Egress window wells that are deeper than 44 inches also have specific requirements that are as follows:

- Egress ladders and/or steps are required on window wells deeper than 44" and must be permanently attached.
- An egress ladder or step may encroach into a well up to 6".
- Steps and/or distance between rungs of the ladder can't exceed 18".
- The rungs of an egress ladder must be 12" wide or greater and must project a minimum of 3" away from the back wall but can't exceed 6" from the back of the wall.

If the egress window is to have a cover, the cover must be able to be operated by the average person without the aid of tools.

There are many options available for meeting the window well requirements for basement windows including galvanized or painted steel window wells, polyethylene plastic window wells, and site made window wells. Window well construction may be simply utilitarian in construction, or it may be more decorative and have molded in features, such as escape ladders and imitation brick or stone façade. Often, egress window wells are constructed of snap together pieces that allow window wells of varying depths to be installed using standard size pieces.

Figure 8-114 shows an example of several painted steel window wells that have been installed on a basement foundation window before the foundation had been backfilled.

Figure 8-114 Painted steel window wells installed on foundation walls before backfilling the foundation.

Figure 8-115 shows a steel window well with an imitation stone façade. The window well also has an attached escape ladder.

Figure 8-115 Steel window well with faux stone faced and escape ladder.

Completing the Foundation Finish Costs

The foundation finish costs will be completed by simply counting and listing the window wells. Figure 8-116 shows a basement plan view and identifies three basement windows identified by type mark A.

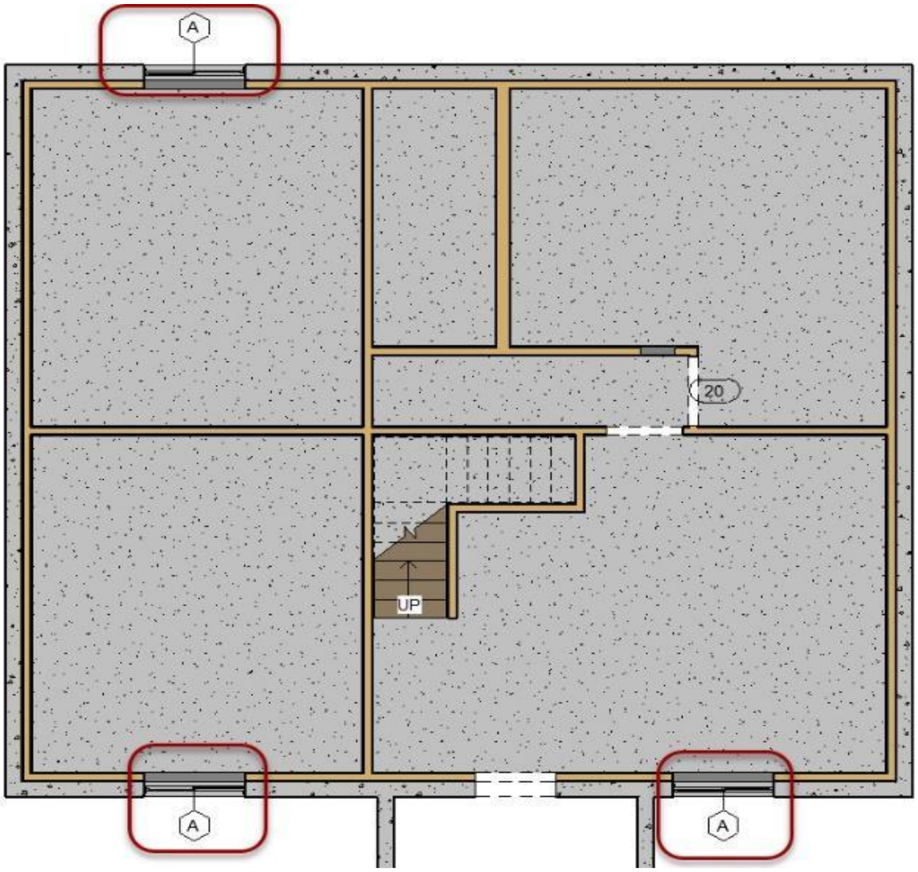


Figure 8-116 Basement floor plan with basement windows highlighted.

Each of these windows is listed in the window schedule as a 4’0” x 4’0” window. The “Window Well 52" W x 36" P x 46" H” is placed into the materials section of the estimating template from the hardware database and the count of three is manually entered into the spreadsheet.

NCE Figure 8-17 shows the window well subsection of the National Construction Estimator with the window wells closest to the actual window well highlighted. The crew, labor hours, unit, and unit labor cost of $50.20 is placed in the estimating template and the total of three manually entered into the quantity cell of the estimating template. Estimate Example 8-7 shows the completed foundation finish subsection of the NCE.

Foundation Finish Material — Supplier: Walter(Rex) — Cost Code:

Supplier	Wst	Item Description	Materials	Size	Units	Unit Cost	Quantity	Override	Total
BMC(REX)		Window Well	Window Well 52" W x 36" P x 46" H	52	Ea	280.32	3.00		$ 840.96
						Total Foundation Finish Material	$		840.96

Foundation Finish Labor — Cost Code:

Crew	Men	Days	Man-hours	Job Description	CraftHrs	Unit	Labor	Quantity	Override	Total
B1	2	0.3	4.50	Install Window Walls	1.5	Ea	$ 50.20	3.00		$ 150.60
	Total	0.3	4.50				Total Foundation Finish Labor	$		150.60
							Total Foundation Finish Material and Labor	$		991.56

Estimate Example 8-7 Completed foundation finish subsection

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Framing Construction Processes and Materials

This chapter will cover items estimated in the framing phase of construction, including wall framing, floor framing, door framing, window header framing, specialty framing, stair framing, and roof framing. The discussion will begin with wall framing.

Wall Framing

Typical residential wall framing construction usually includes several distinct wall framing types. We will discuss three general subphases: basement and pony walls, exterior walls, and interior walls. Each discrete wall type may share some common framing elements with other wall types such as the same size and type of wall studs; however, distinctive wall types will also have framing elements that are different, which make it desirable to estimate the wall type separately.

In the typical construction sequence, load bearing basement and pony walls, which support the floor system, are constructed first. Next, the floor system is framed. Then, the exterior and interior walls are built. Normally the construction sequence is followed in preparing an estimate, however, for the sake of brevity and because estimating all wall framing types will use a similar process, estimating the walls will be covered before floor framing is discussed. The three-wall estimating subphases, basement and pony walls, exterior walls, and interior walls, will be covered separately.

Basement and Pony Walls

Basement and pony walls are commonly used in construction where there is a foundation that is below grade and a wood framed floor built on top of the foundation. The basement and pony walls provide intermediate support for the floor system when distance is more than the floor system can bridge in a single span.

Pony Walls

Pony walls are short walls that extend from footing or foundation stem walls to the floor joists. In addition, a short wall that doesn't extend to the ceiling, such as could be built around a stairwell opening, could also be classified as a pony wall. Pony walls could be identified by other names such as a cripple wall, stem wall, or half wall. Figures 9-1 to 9-4 show some examples of pony walls in wood framed construction.

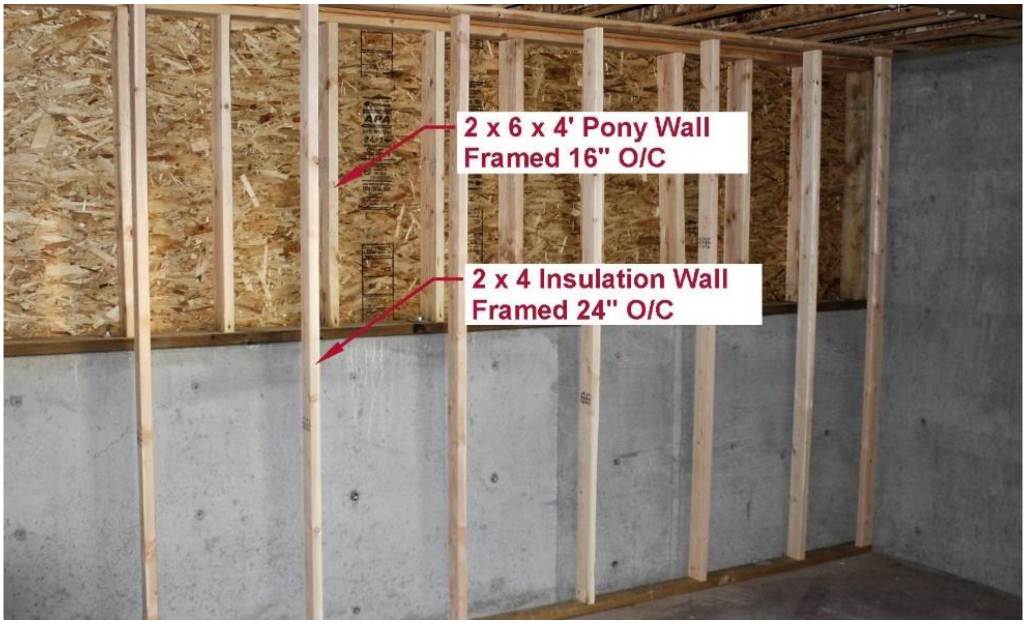


Figure 9-1 Basement foundation pony wall and insulation wall construction.


Figure 9-3 Pony wall supporting floor system in crawl space construction. Two-by-four construction with redwood bottom plate and double top plate.

Figure 9-4 Pony wall around stair opening. Two-by-four construction with bottom plate and double top plate.

Pony walls typically have top and bottom plates and a stud spacing, such as 16 or 24 inches on-center, similar to what is common in wall framing. If the base of the pony wall rests upon a concrete surface, the plate will need to be of pressure treated lumber or other rot resistant material. There may be either single or double top plates, depending upon the needs of the pony wall. When estimating the material to be used for the studs in pony walls, the typical stud material purchased for the project would be cut into shorter lengths for the studs. For example, if a wall required 20 studs and each stud was to be cut to a 30-inch length, a typical 92 5/8-inch wall stud could be cut into three pony wall studs of 30 inches each and seven studs would need to be purchased. However, if the pony wall studs were 32 inches long, ten 92 5/8-inch studs would need to be purchased because each stud could be cut into only two pony wall studs.

Basement Walls

The construction of basement walls can vary depending upon the use of the wall. Walls that are used to support the floor system and that rest upon a concrete surface will typically have pressure treated bottom plate material and a double top plate. The wall could be either 2 × 4 or 2 × 6 construction, depending upon the load supported by the wall. Basement walls that are load bearing will also require load bearing headers. Headers will be discussed in a later section. Other types of basement walls are also common. Secondary wood framed walls are often installed inside of the concrete foundation walls to provide space for insulation, electrical wiring, and provide convenient attachment for drywall material. If this secondary wall type rests upon a concrete surface, a pressure treated bottom plate will need to be provided. The top plate of these secondary walls, however, may be either a single top plate or double top plate, and the stud spacing may be either 16 or 24 inches on-center. Other basement walls used to separate the space into individual rooms may also have unique construction. Figure 9-5 shows some examples of three types of basement wall construction. The wall in the forefront is a load bearing wall with 16 inch on-center spacing, double top plates, and a load bearing door header. The wall behind also has 16 inch on-center spacing and a double top plate but utilizes a non-load bearing header. The wall along the foundation has a single top plate and 24 inch on-center spacing.

Figure 9-5 Examples of three types of basement wall construction.

Figure 9-6 also shows examples of basement wall construction further along in the construction process. The construction is similar with several load bearing walls using double top plates, 16 inch on-center spacing and load bearing headers. In the background, walls framed around the foundation with single top plates and 24 inch on-center spacing can be seen. The insulation and vapor barrier have been installed.

Figure 9-6 Example of basement wall construction.

Exterior Walls Subphase

Several exterior type walls are included in the exterior walls subphase. Two common exterior type walls are exterior walls and garage walls. Exterior walls will be covered first.

Exterior Walls

Exterior walls are commonly created using 2 × 6 construction to allow for additional space for insulation. The stud spacing can be either 16 or 24 inches on-center. Typically, a single bottom plate is used and double top plates. The bottom plate is placed upon the floor system, so treated lumber is usually not needed. The walls are commonly sheathed using 1/2 or 7/16-inch OSB sheathing. Doors and windows are installed in exterior walls, which requires additional framing including load bearing headers, jack, king, and cripple studs and sills.

In many instances, exterior walls are also load bearing, so headers need to be structural and supported on jack studs.

Figure 9-7 shows an example of typical exterior wall framing. The wall is framed with 2 × 6 studs spaced 16 inches on-center. There is a single bottom plate and double top plates. The window framing is supported by a single trimmer and king stud assembly on each side. A single 2 × 10 header is installed to carry to roof load over the window; however, 2 × 6 head sills are installed on each side of the header to provide attachment for the cripple studs and drywall. Cripple studs fill in the wall below the rough window sill, and because the wall is framed over eight feet tall, cripple studs are also installed between the top of the header assembly and the double top plate to carry the load down to the 2 × 10 header. The view also shows a 2 × 4 intersection partition assembly where a single 2 × 6 wall stud is turned flat to provide support for the partition wall and backing for the drywall to be installed. In addition, 2 × 6 horizontal blocking is used to provide backing for the horizontal seam in the 1/2-inch OSB sheathing.

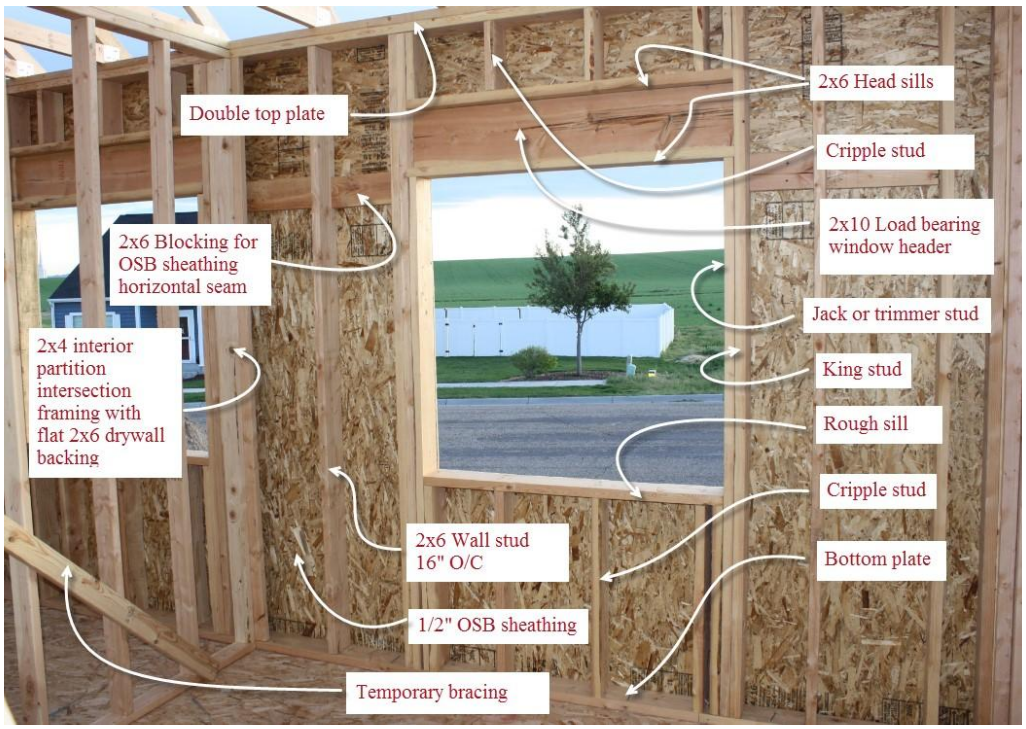


Figure 9-7 Exterior wall framing features.

Garage Walls

Garage walls are also exterior type walls but often utilize a different construction method and materials. Garage walls are often constructed directly on the garage foundation and have a bottom plate of a pressure treated material. In addition, because the walls are built on the foundation and not the floor framing, they are taller than other exterior walls. They are also often constructed out of 2 × 4 material instead of 2 × 6 material. Figure 9-8 shows a garage wall and where it meets with a common wall.

Figure 9-8 A garage wall built upon the foundation and transition to a common wall.

Common Walls

The common wall is the wall that is shared between the garage and the house. Technically, it could be considered an interior wall as both sides are commonly covered in drywall the same as interior walls, but it also has insulation, and the garage side could be considered exterior as it is usually not heated, which is one of the reasons for placing it in the exterior wall subphase. It usually does not have sheathing such as an exterior wall. Common walls are usually 2 × 6 construction to allow for the installation of sufficient depth of insulation (Figure 9-9).

Figure 9-9 Common walls meet the garage walls.

Interior Wall Subphase

A number of wall types are estimated in the interior wall subphase including 2 × 4 interior partition walls, common walls, plumbing walls, and rake walls.

2 × 4 Interior Walls

Interior partition walls are usually 2 × 4 construction. The stud spacing can be either 16 or 24 inches on-center with a single bottom plate. Either a single or double top plate can be used. Headers over interior non-load bearing walls are commonly a single flat 2 × 4 with cripple studs filling into the top plate (Figure 9-10).

Figure 9-10 Two-by-four interior partition walls.

2 × 6 Plumbing Walls

2 × 6 plumbing walls are usually installed as part of the bathroom. Most residential construction is required to have at least one 3-inch diameter plumbing vent pipe. Often, a 2 × 6 stud wall is installed to allow access for the plumbing vent pipe and appropriate fittings (Figure 9-11).

Figure 9-11 Plumbing vent pipe in a 2 × 6 framed wall.

Tall Walls

Tall walls are framed walls that are taller than the normal wall height. They could be either an exterior or interior wall and be either 2 × 4 or 2 × 6 construction, depending upon the needs. Examples of tall walls in exterior construction could be walls that are framed around fireplace chimneys or for two-story entrances or rooms. Interior tall walls could be walls that separate two rooms that share a tall ceiling, such as those structures that have cathedral ceilings in them.

Rake Walls

Rake walls are angled walls that are commonly built upon standard walls, either interior or exterior. Figure 9-12 shows an example of a rake wall built on top of an interior partition wall. The wall is built as a straight pony wall with a single top and bottom plate. Sloped ceiling joists are attached to the rake wall, and the wall is tied into the trusses with blocking between the trusses and ceiling joists.

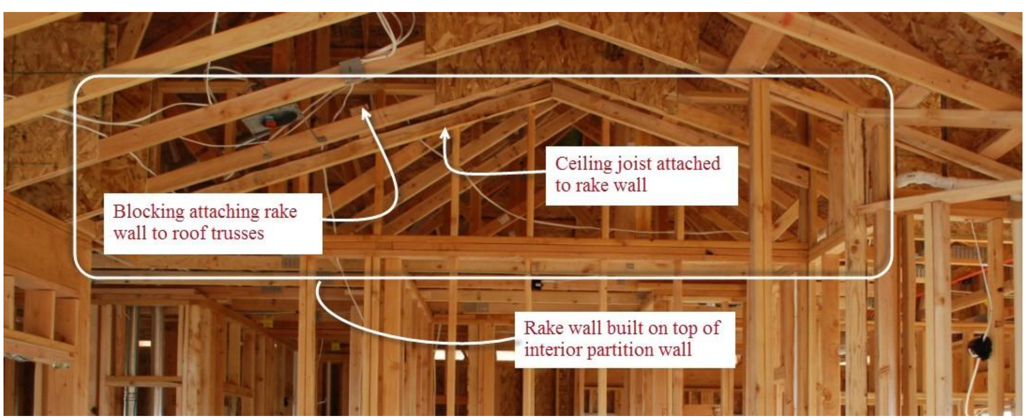


Figure 9-12 Rake wall example.

Figure 9-13 shows another example of a rake wall. In this case, the rake wall is created by filling in between the chords of the W truss in the roof. There is also a plant shelf built on top of the interior partition walls that steps back to the rake wall. The sloped ceiling is framed on the rake wall by attaching a ceiling joist to the W truss chord members.

Figure 9-13 Rake wall built by attaching to the W truss chord members. The rake wall steps back to allow for a plant shelf on top of the partition walls.

Exterior Walls Framing Material

Despite the variations in wall framing styles, most framed walls will be estimated using similar formulas. The difference in each wall type will be accounted for by making changes in the header section of the estimating template. Excel Figure 9-1 shows the header section for the exterior wall subphase of the framing. It will be used as an example for completing each of the three different wall framing subphases.

Figure 9-14 shows a representation of the main floor wall framing for the Arts and Crafts sample house. The various exterior and interior walls are displayed using the following color code:

- Exterior Walls = Red
- Interior Walls = Green
- Common Wall = Violet
- Garage Walls = Blue

Exterior Wall Framing Material

The exterior wall length and wall height parameters of 114 lineal feet and eight feet, respectively, will be the measurements that we use as an example in this chapter. The walls are constructed with two top plates and a single bottom plate and a stud spacing of 16 inches on-center. The number of corners, partitions, and hold downs are determined from the floor plan. The corners, partitions, and hold downs are numbered in red circles on the representation in Figure 9-14. The determining factor in including a particular intersection with a particular wall style is where the extra studs are located. In actual construction, the right-front exterior wall and the common wall would be built as a single wall, and intersections 1 and 12 could be considered as part of the common wall or part of the garage walls but, in this case, will be counted as part of the exterior walls. Two studs will be added to the estimate for each corner or intersection. Figure 9-15 shows a close-up view of intersections 6, 7, and 8. Intersection 6 falls on the location of a regular on-center stud spacing where ladder blocking is used to create the intersection. Intersections 7 and 8 are created by turning a single 2 × 6 stud sideways to provide anchoring for the intersecting wall and backing for the drywall.

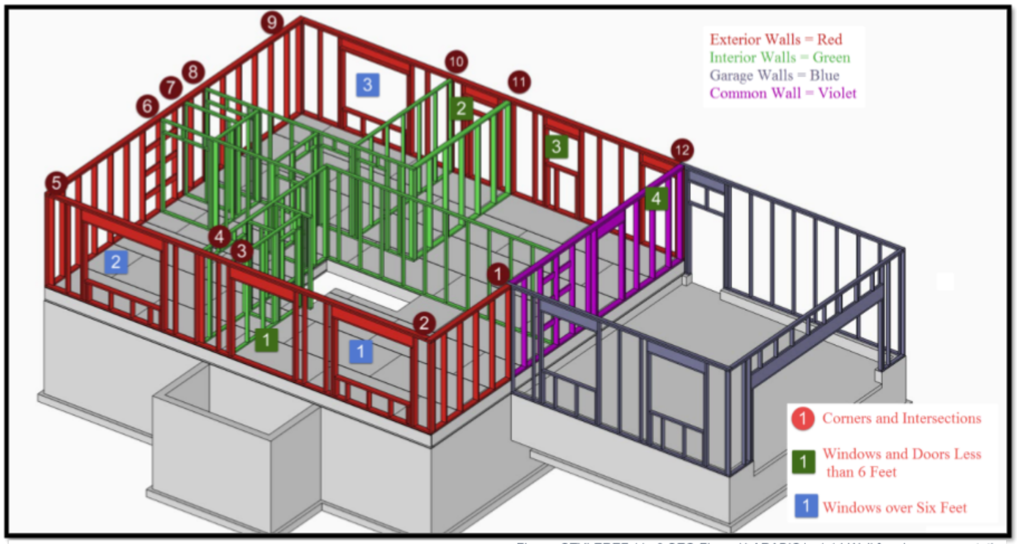


Figure STYLEREF 1 \s 9 SEQ Figure * ARABIC \s 1 14 Wall framing representation

Figure 9-14 Corners, partitions, and hold downs labeled with numbered red circles

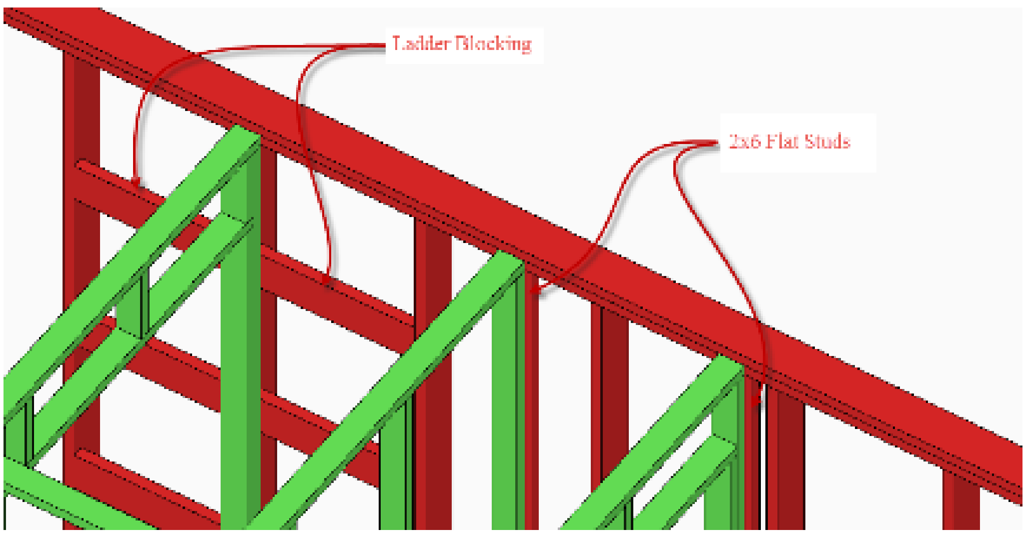


Figure 9-15 Wall intersection construction.

Windows and Doors Less Than Six Feet

Framed openings for windows and doors require trimmer studs on each end to support the header. The estimating template calculates two additional wall studs for each framed window and door opening that is less than six feet in width. King studs are also used in conjunction with each trimmer stud, however, extra studs are usually not added to the estimate because the two king studs can be accounted for by the normal on-center studs that are left out of the opening. The location of window openings in the on-center stud layout may make additional studs needed in specific circumstances, but adding two additional studs for smaller window and door openings is sufficient.

Windows Six Feet or Greater

Building code generally requires double trimmer studs supporting headers for openings that are six feet wide or greater. In accordance with the requirement, six additional studs will be added to the estimate for window openings that are six feet or wider. The extra studs are only added to windows, not door openings, because even though the double stud requirement also exists for doors, several studs in the standard on-center layout will be left out of the wider door opening that can be used for trimmer studs. On the other hand, windows have the window sill and cripple stud requirements that will need the additional studs.

Wall Sheathing

When you are determining the different wall assemblies, be sure that you know if there is sheathing on both sides or only one side of the wall. You only will be accounting for OSB, plywood or foam sheathing when doing exterior walls. Drywall will be accounted for when we estimate the interior walls.

Wall Sheathing Height

You will need to know the height of the wall sheathing. The exterior walls are installed on the floor system, but the wall sheathing is installed from the top of the wall to the top of the foundation, and the total wall sheathing height would be totaled as follows:

- Wall Height = 8' 1-1/8"
- Mudsill = 1-1/2"
- Floor Joists 11-7/8"
- Floor Sheathing = 3/4"
- Total Height = 9' 3-1/4" or 9.3

Wall Plates

The amount of plates that you will need in order to frame your walls can be determined by the following formula:

Wall Length × Number of Plates (either top or bottom) × (1 + Waste Factor) / Size

Wall Plates = Wall Length × NumberPlates × (1+ WasteFactor) / Size

Floor Framing

Elements of a typical floor framing assembly in residential construction could include floor beams or girders, girder support posts, mudsill, floor joists, rim joists, opening headers, bridging and blocking, joist hanger, and floor sheathing. The discussion will begin with floor beams and girders.

Floor Beams and Girders

All floor joist systems have a limited design span which restricts the distance that the floor joist can span without intermittent support. Most often, residential construction is designed with this in mind, and bearing walls are strategically placed to support the floor system within the limits of the design span; however, there are occasions where the desire for a more open style of design prevents the placing of wall supports within the limits of the floor system design span. In this case, the installation of intermittent floor beams or girders are needed. The terms girder or beams could be used to signify the same thing. Generally speaking, a girder is considered a larger, heavier beam that supports other beams; but in practical usage, the terms are often used interchangeably. There are many different materials that can be used in residential construction as beams or girders. The list of possible girder or beam material includes traditional materials such as solid beams or built-up beams; engineered material, such as laminated veneer lumber (LVL), laminated strand lumber (LSL), glulam lumber, or parallel strand lumber; and steel beams, such as I beams, W beams, or flitch beams.

Traditional Beams and Girders

Traditionally wooden beams have been made of solid lumber, but solid wood beams are seldom used any longer because of the difficulty in finding sufficient stock of large trees to mill the beams, the time it takes to adequately dry the lumber, and the overall high cost. There are some cases in residential construction where traditional post and beam construction is used, but those are more of a specialty type of construction than is common. In many instances where traditional wooden beams are used, the beams are salvaged from older buildings and are used as more of an architectural feature, rather than a true structural element as shown in Figure 9-18 where hand-hewn salvaged beams were used.


Figure 9-18 Hand-hewn salvaged beams used as architectural elements in construction.

Photo Courtesy of Ronald Kinville.

Another traditional method of creating beams and girders is to create a built-up beam by assembling multiple layers of dimensional framing lumber together. The layers could be nailed or bolted together. Figure 9-22 shows a floor support beam consisting of lengths of framing lumber, which are cut so that the seams end over a support post and the layers overlap so that the seams do not line up.

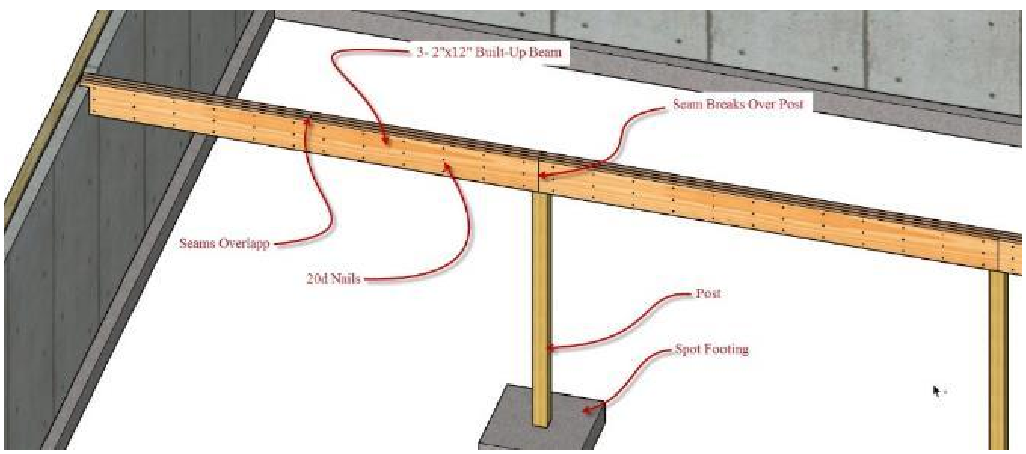


Figure 9-19 Built-up floor support beam constructed of three layers of 2" × 12" framing lumber nailed together.

Engineered Beams and Girders

Most contemporary beams are constructed using engineered material. Some possible types of engineered beams include: glulam, parallel lam, laminated veneer lumber (LVL), and laminated strand lumber (LSL). Some types of engineered beams such as LVLs and LSLs are frequently joined together to form built-up beams, such as can be done with framing lumber. One major advantage of engineered lumber is that it is eco-friendlier than traditional types of beams because they are usually manufactured from smaller second and third growth forests and plantations while engineered lumber tends to be stronger and able to span greater distances than traditional solid or built-up beams.

Glulam Beams

Glulam beams are made from smaller pieces of dimensional lumber that are laminated and glued together. The individual pieces are usually stacked and glued together horizontally in layers as shown in Figure 9-20.

Figure 9-20 Glulam beam

Glulam beams have the advantage of being able to be manufactured in a wide number of sizes and shapes. Curved architectural shapes can be created, as well as beams designed for outdoor and weather resistant applications (Figure 9-21).

Figure 9-21 Glulam beam supporting floor system and LVL garage door header.

Parallel strand lumber (PSL) is a type of engineered lumber where long pencil diameter strands of lumber are chopped from the timber and bundled and compressed into shapes for beams and columns (Figure 9-22).

Figure 9-22 Parallel strand lumber beam.

Laminated strand lumber, which is often abbreviated as LVL lumber, is manufactured by bonding thin veneers of wood with waterproof glue to form thick billets of lumber. The billets are then sawed into the desired size. The grain in the veneers of wood mostly runs parallel to each other, as opposed to plywood where the grain of each layer alternates direction. LVL lumber is most often manufactured in thicknesses similar to dimensional lumber and can be combined together to make thicker dimensions as done with traditional built-up beams. LVL lumber has the advantage of being stronger and able to carry bigger loads than traditional built-up beams (Figure 9-23).

Figure 9-23 Built-up LVL beam supporting floor.

Laminated Strand Lumber

Laminated strand lumber (LSL) is an engineered lumber that is manufactured by bonding together large chopped flakes of wood material. It looks similar to oriented strand lumber (OSL), but the wood fibers are larger. Typically, LSL lumber has a length-to-thickness ratio of the fibers of 150 to one, while OSL lumber has a length-to-thickness ratio of 75 to one. The fibers are combined with glue and pressed into a mat of the appropriate thickness and sawed to size. LSL lumber is not as strong as LVL lumber and LSL rim joist. While in appropriate circumstances they can be used as beams, and they are most often used in applications, such as floor headers and rim joists (Figure 9-24).

Figure 9-24 LSL rim joist.

Steel Beams and Girders

Steel beams can be used as structural components in residential construction, especially when spanning longer distances and carrying larger loads. In addition, steel can be laminated with structural wood elements to form a flitch beam.

I Beams

Standard steel I beam shapes include both W beams and S beams. The horizontal elements of the beam are known as the flanges and the vertical portion the web. Beams are manufactured in standard shapes and sizes. W beams, which are also known as wide-flange beams, typically have wider flange shapes. In addition, the flanges are essentially parallel to each other, while S beams (standard beams) have narrower flanges and angled web shapes as shown in Figure 9-25. The American standard for specifying steel beams is to designate the height in inches followed by the weight in pounds per lineal foot. A W 12 × 40 beam is a wide flange beam that is nominally 12 inches tall and has a weight of 40 pounds per lineal foot. The W12 beams range in size from a W12 × 14 beam, which is 11.91 inches tall, 3.97 inches wide, and it has a weight of 14 pounds per lineal foot, to W12 × 136, which has a height of 13.91 inches, a width of 12.4 inches, and a weight of 136 pounds per lineal foot.

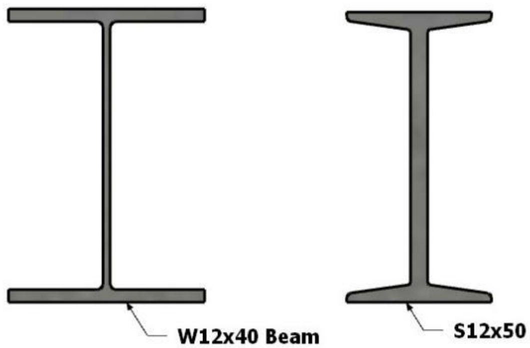


Figure 9-25 Wide flange and standard steel shapes.

Steel is commonly used in residential construction in combination with wood for carrying greater loads. Figure 9-26 shows an example of an apartment building framing that uses a combination of wood and steel construction.

Figure 9-26 Wood and steel framing construction.

Flitch Beams

Another way of utilizing steel for beams in residential construction is to use flitch beams. A flitch beam is constructed of one or more layers of steel plate sandwiched between structural wood framing lumber. The assembly is commonly bolted together. The combination of steel and wood sandwiched together forms a stronger beam than wood alone and is much lighter than steel. Flitch beams are seldom used any longer as modern engineered lumber such as glulam and LVL beams are comparable in strength to flitch beams and require much less fabrication cost (Figure 9-52).

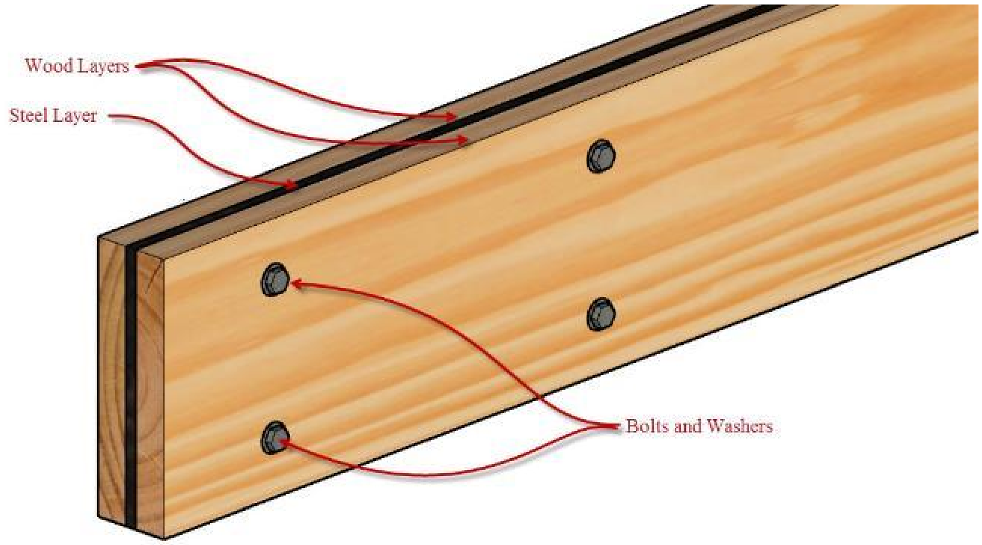


Figure 9-27 Steel and wood flitch beam.

Posts are used to support beams and girders. Posts can be made of a number of different types of materials including solid wood, engineered wood, and structural steel. Posts also require some method of attachment to both the beam and the supporting base structure.

Solid Wood Posts

Solid wood posts are often used in residential construction. They come in standard sizes and lengths, such as 4 × 4, 6 × 6, and 4 × 6. Standard lengths would be from eight feet to 20 feet long (Figure 9-53).

Figure 9-28 Solid wood post supporting porch structure.

Figure 9-29 shows a hand-hewn solid wood post supporting traditional hand-hewn solid wood beams.

Figure 9-29 Hand-hewn wood post supporting traditional hand-hewn wood beams.

Photo Courtesy of Ronald Kinville.

Engineered Wood Posts

Wooden posts can be made of engineered wood products, such as LVL, LSL, and PSL lumber (Figure 9-30).

Figure 9-30 Parallel strand lumber post.

Steel Posts

Both wood and steel beams can be supported by steel posts, but steel beams cannot be supported by wood posts. Steel beams are required by code to be supported by steel posts. Steel posts can be fabricated from a number of standard steel shapes including wide flange shapes, square tubing, and round tubing. Figure 9-31 shows wide flange beams supported by a wide flange column.

Figure 9-31 Wide flange beams supported by a wide flange column.

Figure 9-32 shows multiple steel W beams supported by a single square tubular steel post.

Figure 9-32 Steel beams supported by 8 × 8 square steel post.

Steel posts for wooden beams are commonly fabricated with steel base plates and steel top plates. The top plate can be flat or fabricated in a U saddle shape. Square steel posts are specified by the size of the post and the thickness of the steel. For example, a 4 × 4 × 3/16 steel post is a 4-inch square with walls that are 3/16 inches thick. Round steel posts are specified by the diameter of the post and the wall thickness such as 4 OD × 3/16. Figure 9-33 shows an example of floor beams supported by steel posts.

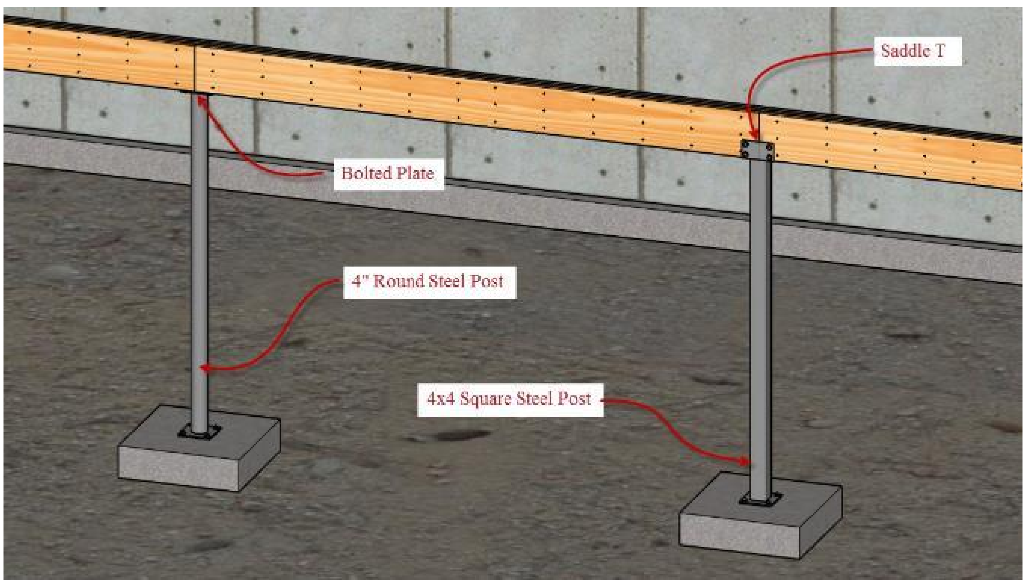


Figure 9-33 Several types of steel posts supporting wooden beams.

Post and Beam Anchors

Posts need to be anchored to both the base and the beams. Many different styles of prefabricated post and beam connectors are available. Some posts are anchored by bolts inset in the concrete. Code also requires a minimum 1-inch standoff from a concrete base. Figure 9-34 shows an example of a post base that is anchored by a bolt cast in the concrete. The base is bolted down. A 1 inch steel spacer is placed in the bottom, and the sides are folded up and nailed to the post; anchors are cast directly in the concrete, and the top of the post is also attached to the beam using a bracket as shown in Figure 9-35.


Figure 9-34 Post base anchored by a bolt cast in concrete


Figure 9-35 4 × 4 square wood post attached to LVL beam with bracket.

Examples of different types of anchors are pictured in Figure 9-36.

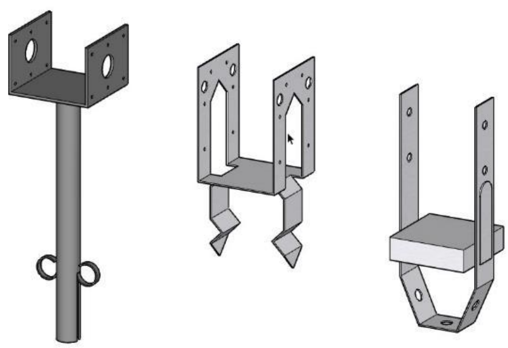


Figure 9-36 Styles of post base brackets that are set in concrete.

Mudsill

The mudsill is the framing element that attaches the floor or the wall to the foundation. Typically, the mudsill is firmly anchored to the foundation using bolts bedded into the concrete or other commercial dedicated mudsill anchors. Because the mudsill is in direct contact with the concrete of the foundation, a rot resistant material is used. Traditionally, that material was redwood, cedar, cypress or other naturally rot resistant wood. The material most often used today is pressure treated lumber. This is lumber that has been placed in pressurized vats along with liquid chemical preservatives. The pressure forces the chemicals into the pores of the wood, increasing its resistance to rot-causing insects and microorganisms.

The mudsill is attached by drilling holes that line up with the preinstalled concrete anchor bolts, slipping the sill over the embedded bolts, and placing washers and nuts on the bolts. In addition, mudsills, which are installed in prominent earthquake zones, are required to have large plate washers placed between the bolt and nut. The building code requires the placement of anchor bolts a maximum of six feet on-center, with the distance decreasing to four feet in structures that are over two stories in height. In addition, each mudsill piece must have a minimum of two bolts installed in it, anchoring it to the foundation. The bolts must be placed a minimum of seven bolts' diameters (3-1/2" for 1/2" diameter bolts) and no farther than 12 inches from the end of each plate section. Figure 9-37 shows an example of a 2 × 6 pressure-treated mudsill bolted to a foundation using plate washers.

Estimating mudsill is calculating the length of the perimeter of the wood floor system. In addition, walls like garage walls that are attached directly to the foundation are drilled and bolted to the foundation.

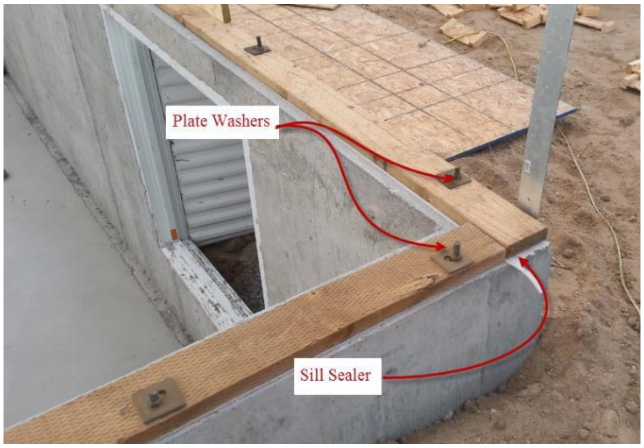


Figure 9-37 Mudsill bolted to foundation with plate washers.

Mudsill Sealer

The mudsill sealer is a gasket that is placed between the rough concrete foundation and the mudsill. The purpose of the sill sealer is to fill in the small gaps and crevices. This helps with both air and insect penetration. Most commonly, a commercial foam sill sealer material is used. The material comes in rolls of standard length, such as 50', and it is cut at the site and installed over the foundation anchor bolts between the foundation and the mudsill. Sill sealer is also used between the foundation and bottom plate of walls that are directly bolted to the foundations, such as garage walls. Estimating sill seal is a simple matter of determining the length of the mudsill and how many full rolls of sill sealer material will need to be purchased.

Floor Joists

The main structural element of a wood framed floor system is the floor joists. Traditionally floor joists have been constructed out of dimensional lumber such as 2 × 8, 2 × 10, and 2 × 12. Solid dimensional lumber wood floor joist can be used still, however, the practice has declined dramatically in recent years due to the ready availability, higher strength, and lower cost of engineered floor systems such as wooden I joist and floor truss systems.

Solid Wood Dimensional Floor Joists

While the use of solid wood dimensional lumber floor joists has declined in recent years, it is still a viable option for framing floor systems. Solid wood floor joists have typically been limited to the wider dimensions of the material such as 2 × 8's, 2 × 10's, and 2 × 12's. Standard lengths of dimensional lumber are in two-foot increments from eight feet long to 20 feet long. Often, this is not sufficient to cover a floor in a single span. Commonly, what is done in this situation is to join the two joists of a span in the center by lapping and nailing them together. The building code has specific requirements that the joint must lap at least three inches and cannot lap more than 12 inches. Figure 9-38 shows an example of a solid wood floor system that has been lapped and joined over the center load bearing span.

Figure 9-38 Solid wood floor joist lapped and nailed in the center.

Engineered Wooden I Joists

Engineered wooden I Joists have several advantages over solid wood joists. They are lighter and stronger and can span greater distances than traditional joists. They are also straighter and stiffer and contribute to floors that have fewer squeaks. They can be manufactured out of smaller second growth and plantation grown forests. The one downside of engineered I joists is that they rapidly fail in the case of a fire, which can lead to premature building failure.

I joists consist of two main elements: flanges and a web. The web is sandwiched between the flanges that form an I shape. The flanges are typically made of either solid, finger jointed lumber, or LVL lumber. The web can be manufactured from plywood, LVL lumber, or oriented strand board. They are manufactured in standard sizes from 9½ inches tall to 24 inches tall, and in lengths up to 80', although lengths of 40' to 42' are more common. The web thickness is commonly around 3/8 inches thick, but it can be thicker. The flanges range in size from 1⅜ inches thick to 1½ inches thick and 1¾ inches to 3½ inches wide (Figure 9-39). I joist with wide webs and thicker, wider flanges can span great distances.

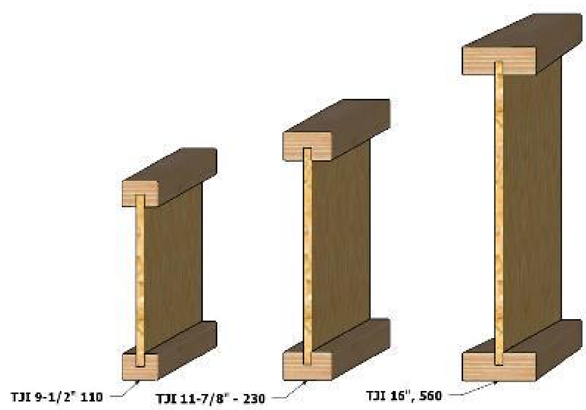


Figure 9-39 Examples of three standard I joist sizes.

The size, layout, and spacing for engineered floor joists are usually designed by the supplier using specific computer software. They are typically purchased in full span lengths and are not lapped over bearing walls. Figure 9-40 shows an example of a typical engineered floor joist layout.


Figure 9-40 Typical engineered I joist floor layout.

Floor Trusses

A third option for floor layout is an engineered floor truss system. Floor trusses have several advantages over both solid wood joists and engineered I joists. They can span longer distances than conventional floor joists. In addition, they can be engineered with chases and open space for the installation of electrical and HVAC ductwork inside the floor system. Floor truss systems are designed and engineered by the truss manufacture. Figure 9-41 shows an example of a floor truss system installed.


Figure 9-41 Floor truss system installed.

Rim Joists

Rim joists are used to cap the end of floor joists. They hold the joist the required distance apart. They also serve as the starting and ending joist of a floor system and the box in the entire floor system. Traditional solid wood dimensional floor joists typically use lengths of the same material as the floor joists. Engineered wood I joists typically use engineered LSL rim board material. Figure 9-42 shows an example of LSL rim joist installed and ready for floor joists. The quantity of rim joist material is calculated by determining the length of the rim of the floor system.


Figure 9-42 LSL rim board installed ready for the floor joists.

Framing Floor Openings

Many floor systems have openings in them which require framing. Some openings are supported by load bearing walls, post, or beams and others are framed and supported by the floor structure. Often, the openings require strengthening the floor structure by adding additional floor framing members. Floor members that run parallel to the main floor joists are known as trimmers and floor members that run perpendicular to the main floor joist are known as headers. If the floor opening is supported only by the floor structure, the code allows for framing the opening using single trimmers and single headers if the opening is less than 48 inches. This is shown in Figure 9-43.

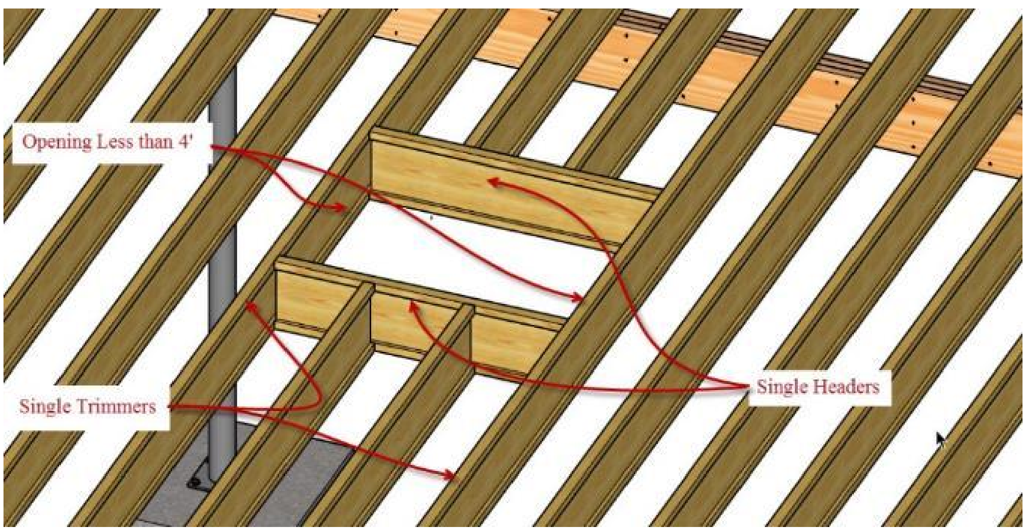


Figure 9-43 Single trimmers and single headers in a floor opening less than 48" wide.

Floor openings supported only by the floor structure that are greater than 48 inches are required by code to be framed with double trimmers and double headers (Figure 9-44).

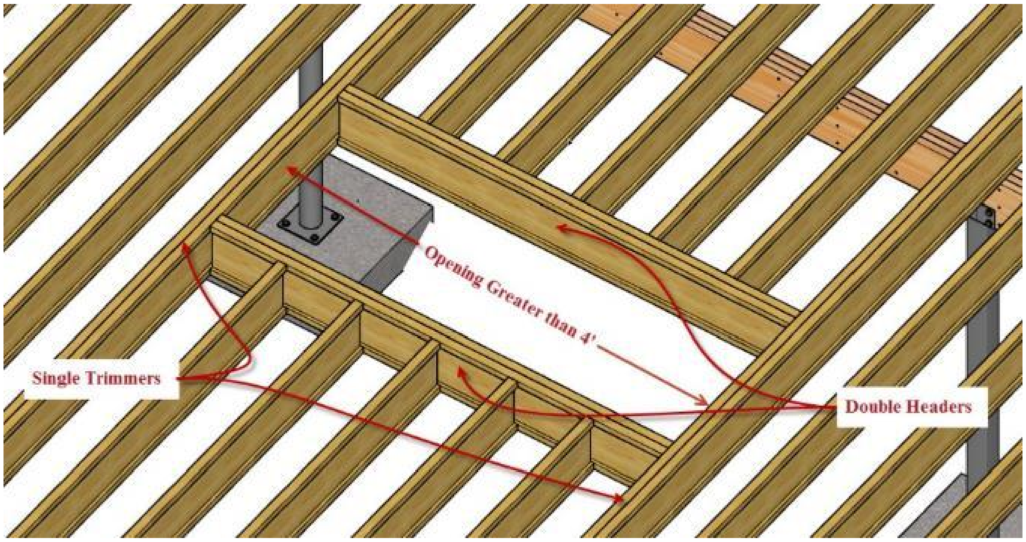


Figure 9-44 Double trimmer and headers are required on openings larger than 48".

Floor systems supported by bearing walls can use single headers and trimmers around the opening as long as there is at least 1 ½ inches of bearing for the wall supported floor joists. Figure 9-45 shows a stairway opening that has been framed with a single LSL header around all four sides. The headers are supported underneath with load bearing walls.


Figure 9-45 Framed stairway opening.

Bridging and Blocking

Code requires that the ends of floor joists be supported from rotation by solid blocking or by being attached to a solid band joist. The standard LSL rim joist qualifies as the end support in typical situations. Intermediate blocking or bridging is also required in situations where the nominal depth to thickness ratio of the floor joist exceeds a six-to-one ratio. This means that any standard 2 × 12 floor joist or smaller does not require intermediate blocking. Floor joists that exceed the 2 × 12 depth-to-thickness ratio require blocking placed at eight-foot intervals. There is an exception to the normal blocking and bridging rule in areas of high earthquake probability that require solid blocking at the intermediate supports. Figure 9-46 shows an example of intermediate blocking on an engineered I joist floor using short I joist blocks. Estimating blocking is a matter of calculating the lineal footage of the blocking.

Figure 9-46 Intermediate I joist blocking.

Joist Hangers

The ends of floor joists that are not supported by a bearing surface of at least 1½ inches are required to be supported by joist hangers that are appropriate for the flooring material. Figure 9-47 shows an example of engineered I joists attached to a LVL beam. Figure 9-48 shows special top mounted joist hangers that are used for engineered I joists. The web on the I joist is not thick enough to support standard nails on joist hangers and requires the top mounted variety. In addition, a double joist hanger is also shown, which is required when double joists need to be supported. The web of the engineered I joists has been strengthened by filling in the web with OSB sheet material.


Figure 9-47 Nail-on joist hanger supporting I joist on an LVL beam.

Figure 9-48 Top mounted single and double joist hangers.

Floor Sheathing

Plywood or OSB subflooring is used over the floor joists to form the subflooring. Traditionally a two-layer flooring has been used: a base layer of 5/8 inches to 3/4-inch plywood followed by a layer of particle board sheeting. Most commonly today the subfloor is constructed of a single layer of tongue and groove plywood or OSB sheeting. Figure 9-49 shows an example of a stack of OSB tongue and groove subfloor.


Figure 9-49 Tongue and groove OSB floor sheathing.

The subflooring is laid perpendicular to the major direction of the floor joists. The floor is usually covered from the exterior of the rim joist to the exterior of the rim joists. Standard sheets of subfloor come in 4' × 8'. Figure 9-50 shows an example of the first couple of rows of OSB subflooring laid down. Estimating subflooring is done by calculating the area to be covered by the size of each sheet, which is commonly 32 square feet.


Figure 9-50 OSB subflooring.

Frequently the subflooring is glued down with construction adhesive. The adhesive is supplied in tubes of either 10 or 28 ounces and is applied with a caulking gun. It is estimated that one tube of 28-ounce adhesive can cover 88 lineal feet of joist using a standard 1/4-inch diameter bead of construction adhesive (Figure 9-51). This means that each ounce can cover 3.14 lineal feet of joist. The spacing of the floor joists determines the amount of adhesive needed. Spacing floor joists at 16 inches O/C means that each sheet will need seven beads of adhesive multiplied by the four-foot sheet width or 28 lineal feet of adhesive. One tube of adhesive is needed for every three sheets. Spacing the sheathing at 19.2 inches reduces the amount by four feet, meaning one tube will be needed for every three and a half sheets. Increasing the spacing to 24 inches on-center means that each tube will cover over four sheets.


Figure 9-51 Construction adhesive used on floor joists.

Estimating Floor Framing

The first step in completing a floor framing estimate will be to determine the framing members of your floor. . This will be discussed first. Second, the quantity of material for the floor framing will be calculated. Third, the labor cost for the floor framing will be determined.

Determining the Floor Framing Material

The following are the variables that you will need to know regarding your framing members and methods.

Square Foot of Floor Area

We will use the example of a floor with an area of 1,152 square feet. This will be used to calculate the area of floor sheathing.

Floor Girder

The floor girder is determined by calculating the length of any girders that are supporting the floor. Built-up girders such as one constructed of two pieces of 1¾ inches × 11⅞ inches. Microlam lumber will need to account for both pieces. For example, if the built-up girder spanned 10', then 20' of material would need to be purchased. In addition, it is customary to only sell material in two-foot increments, so if the total were less or more than full two-foot increments, the total would need to be rounded up to the next two-foot length.

Girder Support Post

This is the quantity of girder support posts that are needed. This is a simple count of the posts. The height of the posts would be accounted for in the length of the purchased material.

Sill Sealer

The sill sealer length is determined by calculating the length of the sill sealer underneath the mudsill plates on the foundation. In addition, sill sealer will be used underneath the garage walls built upon the foundation. Figure 9-52 shows the sill sealer installed on the foundation wall underneath the mudsill and the garage walls. The total distance is added together.

36' + 32' + 36' + 32' + 0'-5-1/2" + 10'-9 + 3' + 3' + 20'-4" = 173'-6 ½"

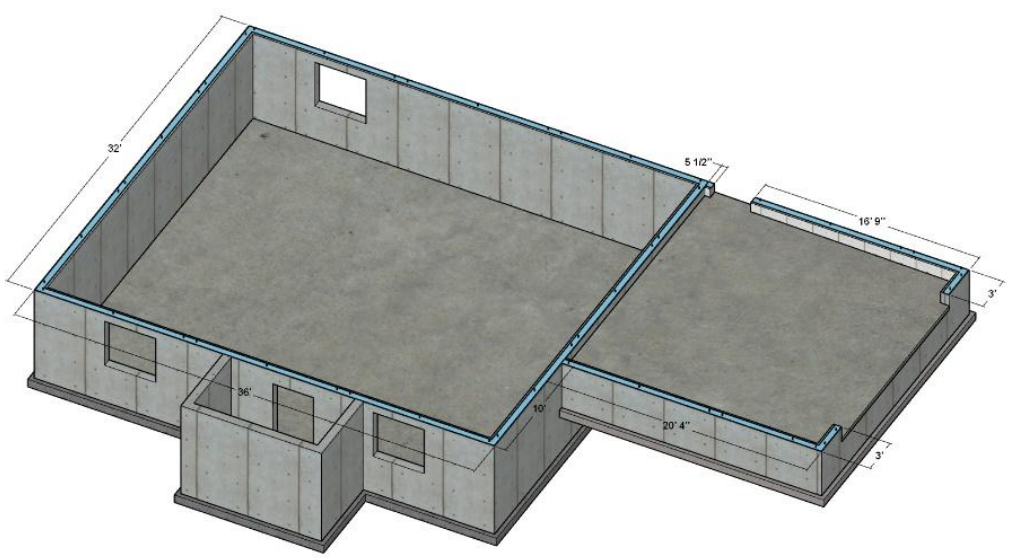


Figure 9-52 Sill sealer on foundation walls.

Mudsill

The mudsill length is determined by calculating the length of the mudsill underneath the rim joists. Figure 9-53 shows a representation of the mudsill. It extends around the four sides of the floor. The floor dimensions are 36 feet wide by 32 feet deep. The dimensions for the mudsill are

2 sides × 36 feet long = 72 feet

2 sides × 32 feet long = 64 feet

Total = 136 feet

Rim Joist

The rim joist in our example is constructed out of 1¼ inches × 11⅞ inches of LSL rim joist material. In the example shown above, the length of the rim joist is the same as is for the mudsill. This amount of 136 feet as was previously calculated for the mudsill will be used for the rim joist.

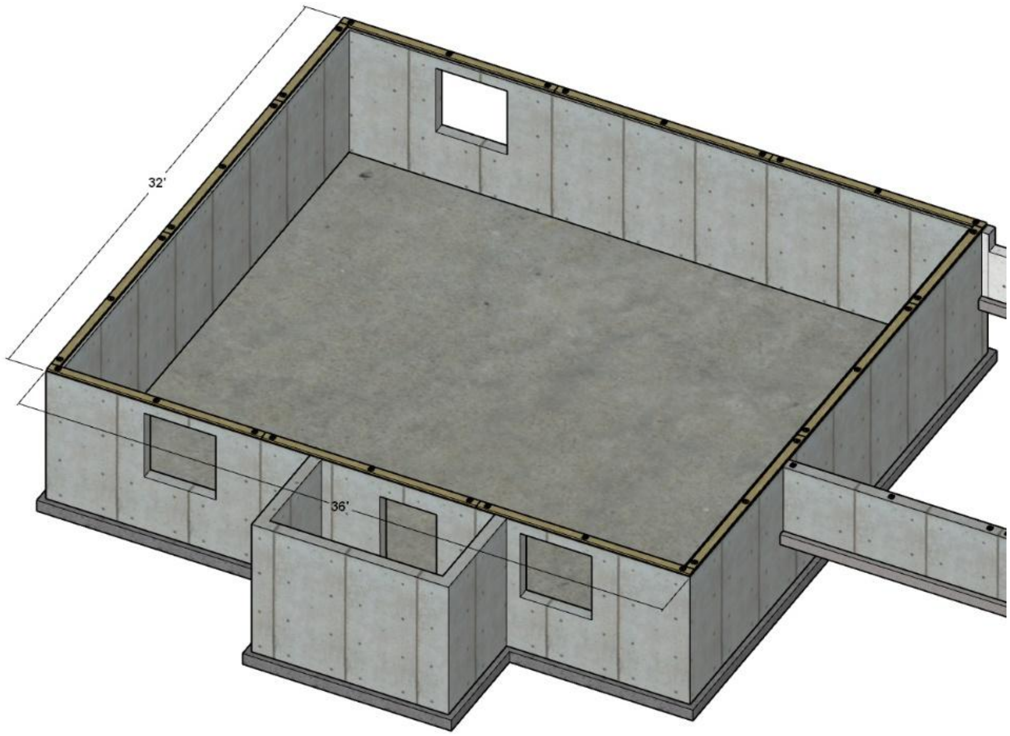


Figure 9-53 Foundation mudsill.

Floor Joist

The quantity of floor joist is determined by calculating the individual length of each joist and adding them together. In practice, joists of specific lengths and specific joist sizes are determined and multiplied by the number of joists that are that length. The table that follows shows an example of calculating the quantity of floor joists. The totals would be calculated as follows:

9 Floor Joist × 31' 8-1/2" = 285' 4-1/2"

5 Floor Joists × 15' 10-3/4" = 79' 5-3/4"

4 Floor Joist × 12' 6-3/4" = 50' 3"

8 Floor Joists × 31' 8-1/2" = 253' 8"

1 Floor Joist 7' 7-1/4" = 7' 7-1/4"

Total = 676' 4-1/2"

The total of 676' 4½ inches would be rounded up to 677 feet.

Joist Headers

Joist headers represent the floor joist headers that are needed to frame any openings in the floor. Figure 9-54 shows the area around the framed stair opening highlighted in red. Most of the opening will be framed with 1¼ inches LSL rim joist material. All the floor headers in this instance sit upon load bearing basement walls or are less than the four feet required for double header and trimmers, so it will not be necessary to double up any of the trimmers or headers around the floor opening.

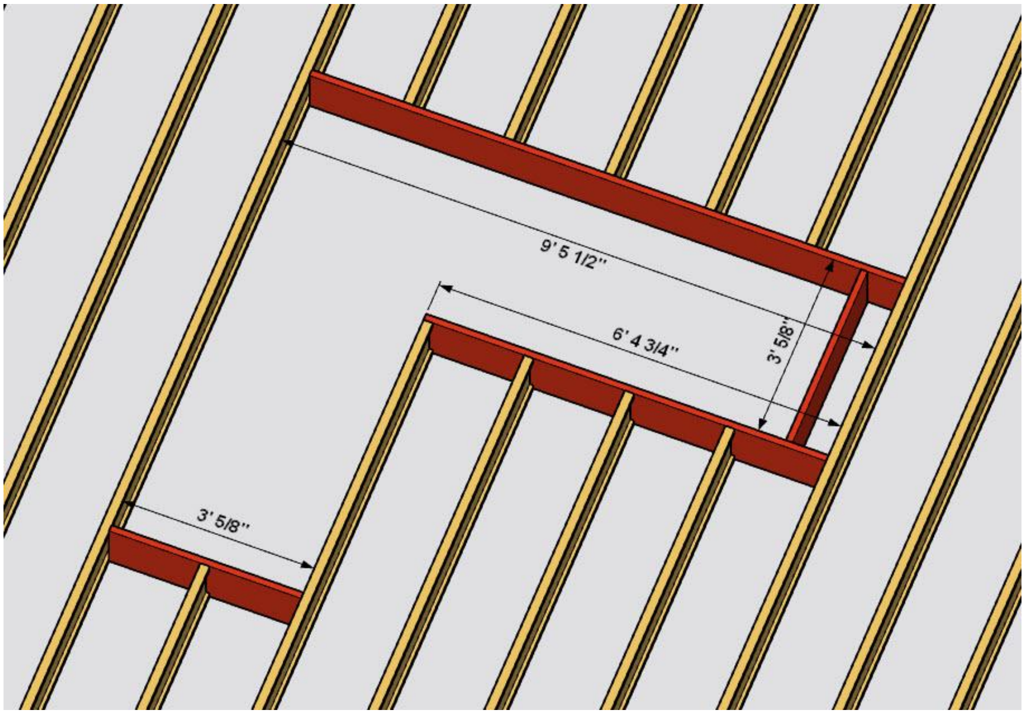


Figure 9-54 Stair opening headers.

The total of floor opening headers would be as follows:

$$9'5\frac{1}{2}'' + 3'\frac{5}{8}'' + 6'4\frac{3}{4}'' + 3'\frac{5}{8}'' = 21'11\frac{1}{2}''$$

The total would be rounded up to 22 feet.

Bridging and Blocking

Figure 9-54 shows a single row of blocking along the center of the load bearing basement wall. In the example shown, there is a stairwell header along a part of the bearing wall that will serve as the blocking along that portion of the wall. One method of determining the lineal footage of blocking is to count the spaces in the floor joist and multiply the number by the length of each joist blocking.

The floor joists in this instance are spaced at 19.2 inches on-center. Each engineered I joist is 1¾ inches wide. Each block will need to be equal to

19.2" -1.75" = 17.45"

There are 16 individual sections of blocking, so the total lineal footage of blocking is equal to

17.45 in × 16 pcs. = 23.27 ft.

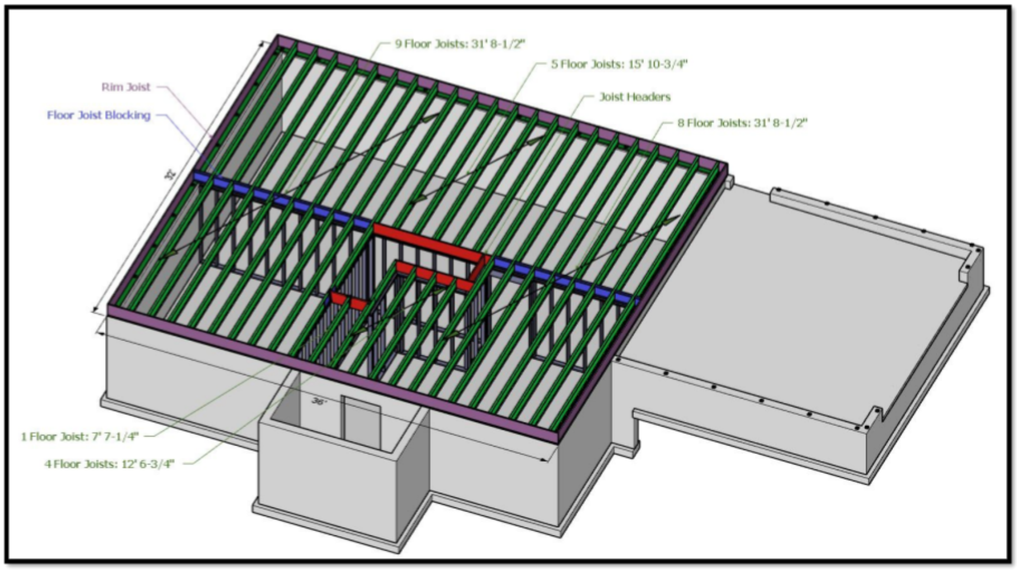


*Figure STYLEREF 1 \s 9 SEQ Figure * ARABIC \s 1 55 Floor framing elements.*

Figure 9-55 Stair opening headers

Completing the Floor Framing Material Quantities

The formulas for quantity are all very similar. If you are calculating lineal feet, you simply multiply the needed lineal feet that you have determined by the waste factor and then divide by the length of the framing member. For example, if you determined that there were 500 feet of rim joist on your project and you wanted a 5% waste factor, then you would multiply 500 by 1.05, which is 525 lineal feet. If your rim joists were each 20 feet long, you would then divide 525 by 20, which is 26.25. Since you are buying complete joists, you would round up and buy 27 rim joists.

Hangers

Hangers are needed when there are floor system elements that are not supported on load bearing surfaces. The joist hangers are usually just a counted item with no formula associated with them. Most of the floor joists and headers in the example are placed upon bearing surfaces and no hangers are required. The exception is the small header at the end of the stairwell. Hangers are needed to support the header on each end of the floor joist, and the single floor joist attached to the header. This will require two types of hangers: a 1¼ inches wide hanger to support the LSL rim board header and a 1¾ inches hanger to support the 1¾ inches wide I joist. Three-quarter-inch thick OSB filler strips will be needed on the web of the floor joist supporting the LSL header. This is shown in Figure 9-56.

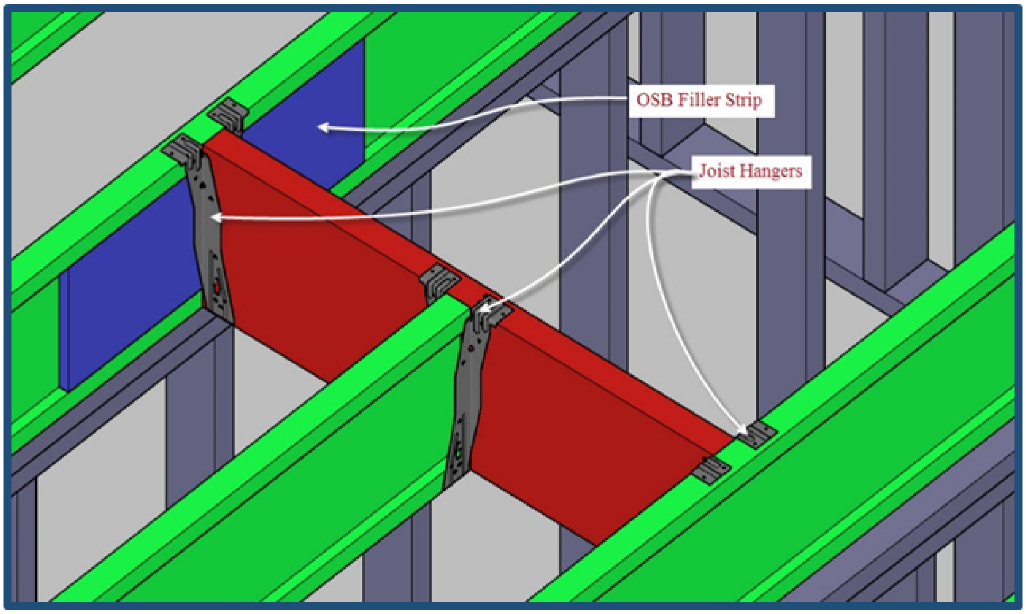


Figure 9-56 Joist hanger installation.

Floor Sheathing

The floor sheathing quantity will be determined by calculating the area of the floor to be covered and dividing by the square footage of coverage per sheet, which is 32 square feet per sheet for common four-foot × eight-foot sheets.

Adhesive

The quantity of construction adhesive is determined by the square footage of the floor area and the spacing of the floor joists. As previously discussed, one ounce of construction adhesive can cover approximately 3.14 lineal feet of floor joist. The floor joist spacing will tell you how many joists you need per square foot of area.

The LF joist per SF floor area will be used in a formula to calculate the quantity of floor adhesive. The number determined will need to be increased by a small amount because double beads of floor adhesive will be needed on each floor joist at eight-foot intervals where the sheets are butted together. The value determined will be increased by 0.125.

The formula is as follows:

$$(\text{LF Joist per SF Floor Area} + .125) \times \text{Square Foot Floor Area} \times (1 + \text{Waste Factor}) / 3.14 / \text{Size}$$

Nails

Nails used for framing are usually bought in bulk and the surplus carried forward to new jobs. In this case, the nail quantities will be estimated as two boxes of 16 penny and eight penny framing nails for our example project.

Door and Window Header Framing

Most residential construction requires some form of framing support over door and window openings. The support often comes in the form of headers. Many different types of headers and header material are possible based upon the specific needs of the project.

Traditional Header Styles

Traditionally, headers were most often constructed of two pieces of dimensional framing lumber nailed together. At times, a piece of 1/2-inch-thick sheet stock was placed in between the dimensional lumber pieces to serve as a spacer to make the thickness of the header match the 3½ inch thickness of 2 × 4 framed walls. This style of header is still used with 3½-inch-thick walls. There can be a variation in the width of the header. For example, headers spanning short distances can use two pieces of 2 × 4 lumber, while headers spanning greater distances can be built with up to four 2 × 12 pieces of dimensional lumber. Non-load bearing walls can use a single piece of flat 2 × 4 for the header. Figure 9-57 shows an example of three traditional header styles.

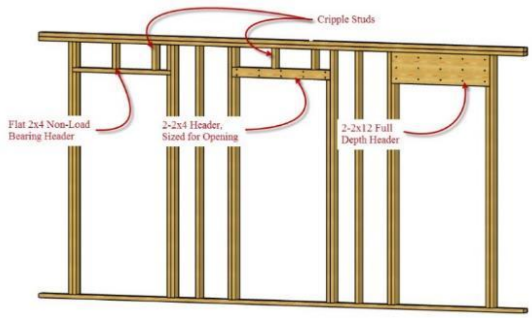


Figure 9-57 Three header styles.

Figure 9-58 shows a view of the construction of traditional three-layer header construction using two pieces of 2 × 12-inch dimensional lumber and a single layer of 1/2-inch OSB spacer.

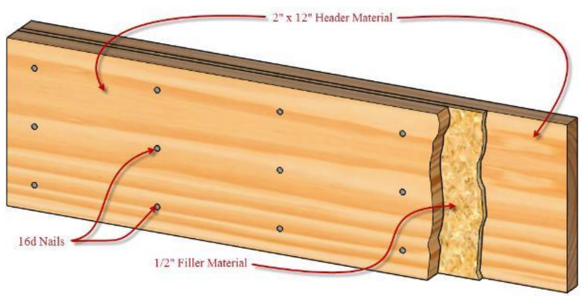


Figure 9-58 Traditional header construction.

Single Piece Headers

Efforts to improve both energy efficiency and material usage in framing construction has resulted in changes in the style of header construction that have become common. Many headers installed now only have a single structural framing element as a header. These headers usually require an additional top sill to bring the width to match that of the existing wall. The advantage of this type of header is not only a savings of cost for framing material, but it allows for space for installing insulation to assist in the energy efficiency of the structure. Figure 9-59 shows an example of a single two-by-ten-inch header installed in a two-by-six-inch framed wall. This header style allows for the installation of four inches in insulation to improve the energy efficiency of the house.

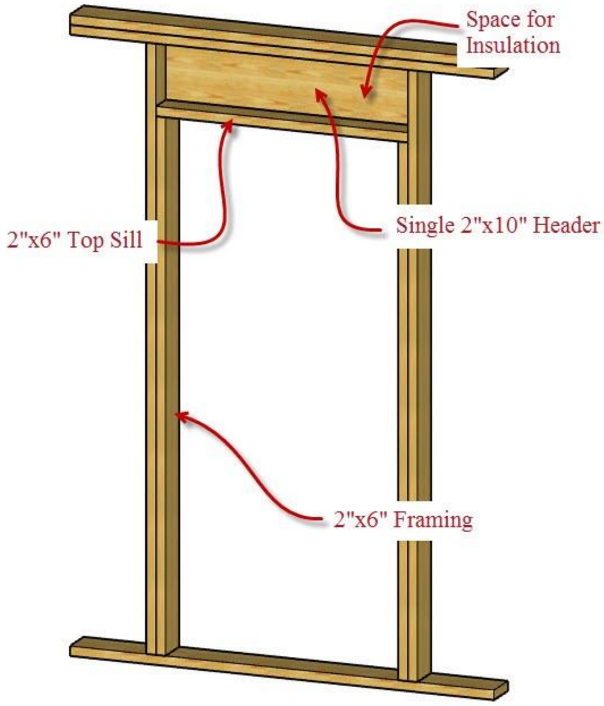


Figure 9-59 Single header installed above door opening.

Figure 9-60 shows a single solid lumber two-by-ten-inch header.


Figure 9-60 Single solid lumber header.

Box Beam Headers

Code also allows for the installation of box beam headers. A box beam header is a framed box with plywood on one or both sides. Code requires a minimum of 15/32-inch structural sheathing on one or both sides. The interior of the header must also have cripples with a spacing that equals the stud spacing of the wall. The interior of the header may also contain insulation to aid in energy efficiency (Figure 9-61).

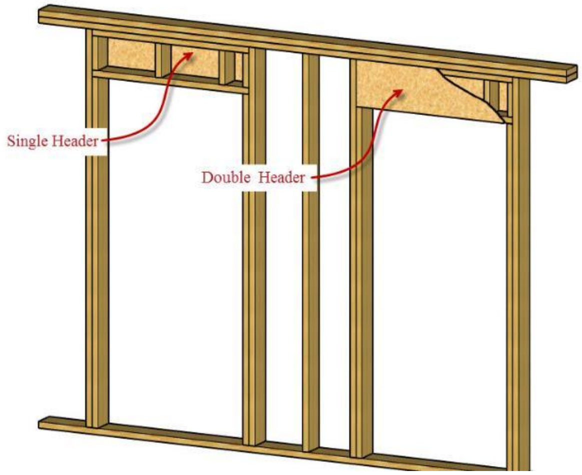


Figure 9-61 Single and double box beam headers.

Engineered Lumber Headers

Headers could be made from glulam, LVL, LSL, and PSL lumber. The engineered lumber such as LVL and LSL can be built up in multiple layers as is common with dimensional lumber to build stronger headers. Figure 9-62 shows an example of two windows with single header construction. The header above the window on the left is solid dimensional lumber, and the one on the right is laminated veneer lumber.


Figure 9-62 Two single headers. The one on the left is constructed of solid dimensional lumber the one on the left is laminated veneer lumber.

Figure 9-63 shows an example of a long double LVL micro lam header over a garage door.

Figure 9-63 Long double LVL header over a garage door.

Estimating the Door and Window Headers

You will need to add the cost of door and window headers to your estimate. In order to do this, you will need to know the type of headers that you will be using. Once you have determined this, it is simply a matter of determining how much of each header type you will need and the cost of the types of headers you will be using.

Specialty Framing Subsection

The special framing subsection is for estimating the cost of specific framing items not covered in other subsections. These are often count and list items, which can vary widely depending upon the specific job requirements.

Specialty Framing Materials

Several items that are placed in this section for the example project include the front porch posts, LVL beams and framing connectors. Figure 9-68 shows the front porch framing. The finished porch will have decorative stone and wood posts that cover the 4 × 4 wood posts that are the support for the roof. The posts also support a LVL beam that wraps around three sides of the porch to support the roof trusses and other roof soffit and fascia framing.

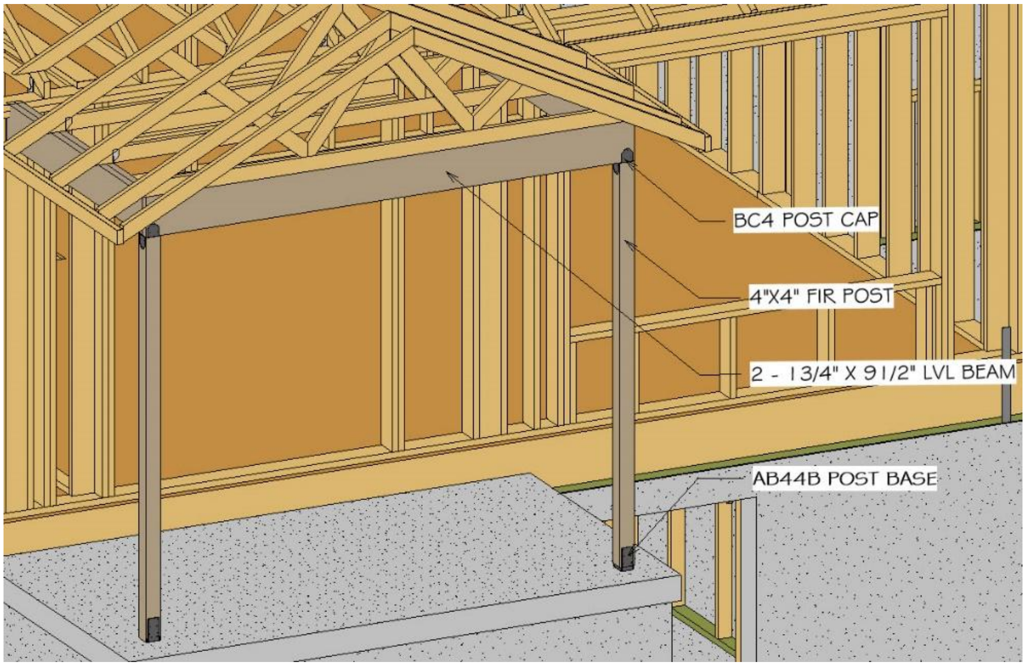


Figure 9-68 Front porch post and beam framing.

The dimensions of the front porch are determined from the plans, sections, and details as shown in Figure 9-69.

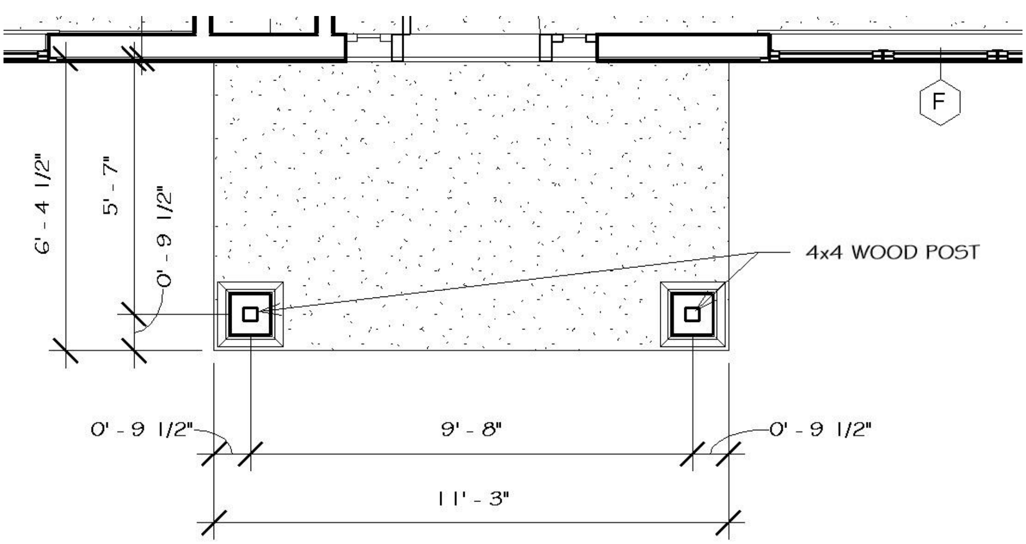


Figure 9-69 View of front porch details.

Porch Posts

The height of the posts can be determined from an elevation view at a little under eight feet. This will be rounded up to the full eight-foot increment and two eight-foot 4 × 4 posts will be used in the estimate .

LVL Porch Beams

The center to center placement of the posts is at 9' 8". The LVL beam at the top will need to extend at least to the outside of the post or an additional 3½ inches for a total of 9 feet, 11 inches, which will be rounded up to the next two-foot increment of 12 feet. The LVL beams on the side of the porch will need to extend to the outside edge of the post. In addition, the beams will need to extend inside of the wall framing to be supported with at least one trimmer stud. This would add an additional three inches to the length for a total of 5' 10", which would be rounded up to the next two-foot increment of six feet. Added together, the total length would be

$$6\text{ ft} + 12\text{ ft} + 6\text{ ft} = 24\text{ ft}$$

The 1¾ inches of LVL material is doubled up to form the 3½-inch wide beams, so the 24-foot total would be doubled resulting in a total purchase of 48 feet. This will be used in the estimate .

Porch Hardware

Each post will be anchored to the concrete porch and to the top LVL with a post cap. These will be included in the estimate .

Stair Framing

Often, the structure for stairways is constructed during the framing process. Some of the finished parts of a stairway are installed during the framing process, but it's possible that they do not get installed. The discussion will begin with a review of standard stair construction terms and methodology.

Stair Framing Terms

Figure 9-70 shows the essential parts of stair framing including total run, total rise, unit run, unit rise, tread, riser, length of the stairwell, and headroom.

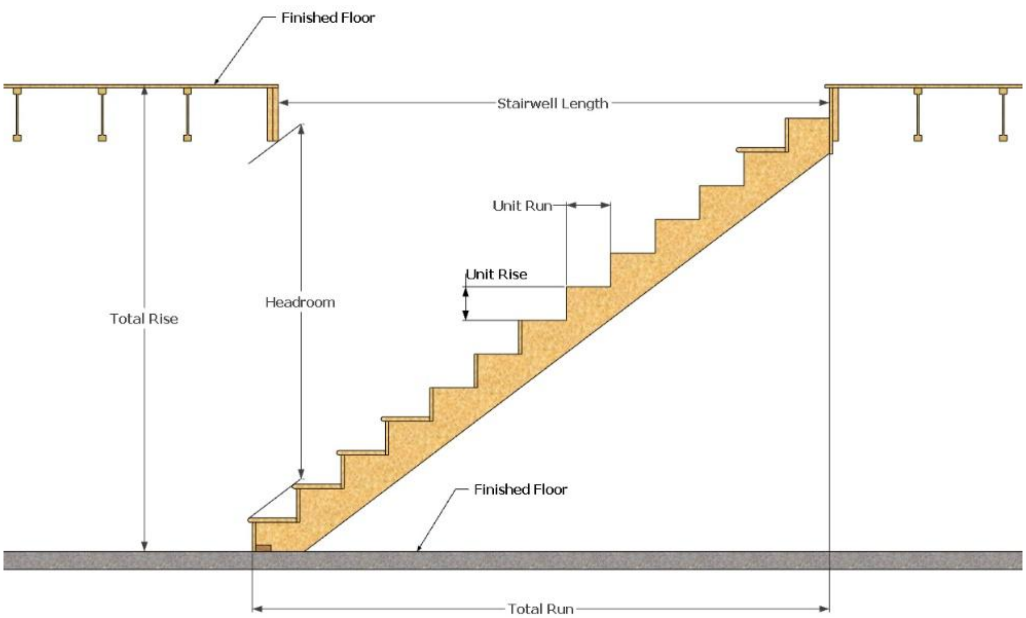


Figure 9-70 Stair terms.

It is not uncommon for residential house plans to provide only minimal information about stair framing. The construction estimator would be required to determine the necessary elements of the stairway to be estimated. This will require an understanding of minimum stair building code requirements.

Unit Rise

The unit rise is the vertical distance that the stair will rise for each step. The building code requires that residential stairways have a maximum unit rise of seven and three quarters of an inch. In commercial construction, the maximum rise is seven inches. The actual unit rise is determined by dividing the total rise by the number of risers.

Total Rise

The rise is the total height of the stairway calculated from finished floor to finished floor. One common example would be for stairs from the first floor to the basement of a residence. An example of typical construction is shown in Figure 9-71. The foundation height is eight feet and the basement floor thickness is four inches. The wood floor system consists of a 1½-inch mudsill, 11⅞-inch rim joist, and three quarters of an inch OSB subfloor. The calculation for the finished floor to finished floor height would be

(96" – 4") + 1-1/2" + 11-7/8" + 3/4" = 106-1/8"

Calculating Unit Rise

To calculate the unit rise, first divide the total rise by the maximum desired unit rise.

106-1/8" ÷ 7-3/4" = 13.69

Since there cannot be a fraction of a riser, the 13.69 is rounded up to the next whole number or 14 inches.

106-1/8" ÷ 14 = 7.58"

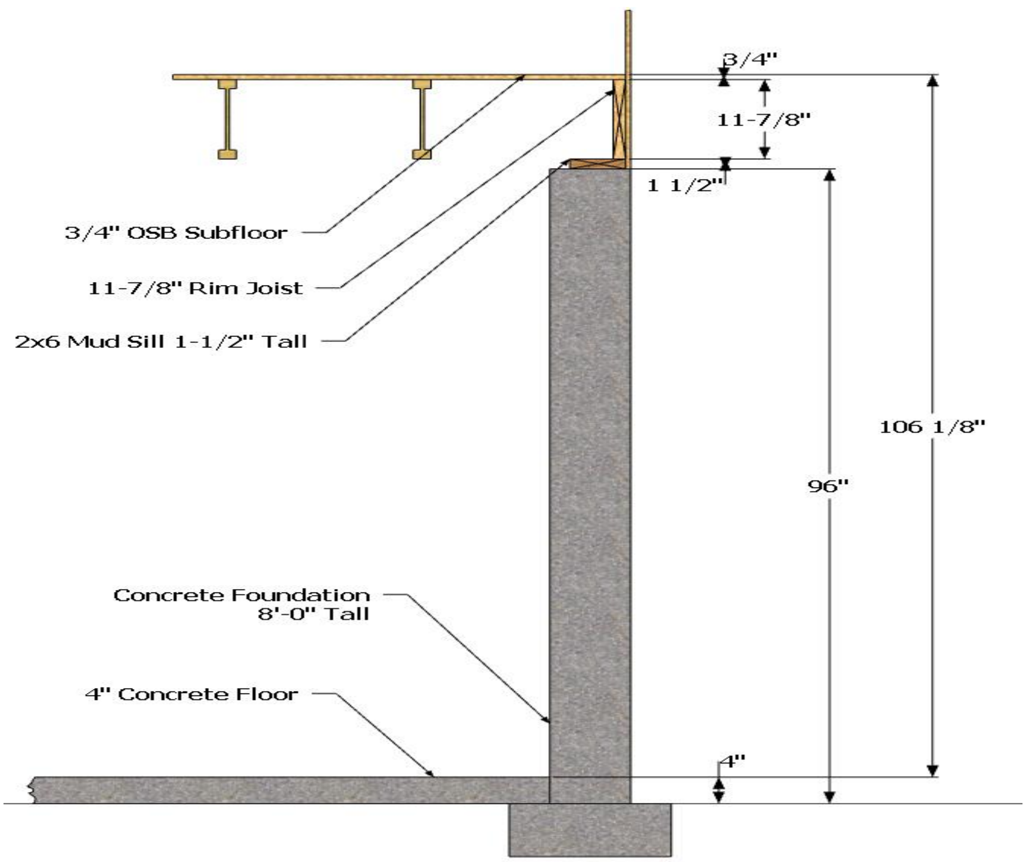


Figure 9-71 Finished floor to finished floor height calculation for basement stairs.

Unit Run

The unit run is the horizontal length of each step. The building code requires that residential stairways have a minimum run length of 10 inches. In commercial construction, the minimum run length is 11 inches.

Total Run

The total run is determined by multiplying the unit run by the number of treads. The example shown in Figure 9-69 shows 13 ten-inch-wide treads. This would result in a total unit run of

13 treads × 10 inches = 130 inches

or

130 inches ÷ 12 inches/ foot = 10' -10"

The combination of the unit rise and unit run work together to make a stairway more or less comfortable to use. Generally, as a rule, as the unit rise increases, the unit run decreases within the limits of the maximum unit rise and minimum unit run required by the building code.

A common formula that is used in determining the ratio of the unit rise to the unit run is to multiply the unit rise by two and add it to the one-unit run. The three together should equal 25 inches with a variance of plus or minus one inch. For example, if a stairway had a unit rise of 7½ inches and a unit run of 10 inches, the formula would be as follows:

$$(7\tfrac{1}{2}\ inches\ \times\ 2)\ +\ 10\,inches\ =\ 25\,inches$$

This would be well within the required 25 inches plus or minus one inch.

In the example from Figure 9-69, the unit rise was calculated at 7.58 inches. To determine an idyllic unit run, subtract the total of two multiplied by the unit rise by 25 inches as follows:

25 inches – (2 × 7.58") = 9.84"

However, this would be below the minimum run requirements of 10 inches. A run of 10 inches would work, and the total together would equal 26.16 inches, which would be in the plus or minus one-inch range.

Stairwell Length

It is possible to have a stairwell length that is shorter than the total run. If this is the case, another variable also must be taken into account, which is the minimum headroom height.

Headroom

The code requires that the minimum headroom distance is 6'8" or 80 inches. The length is a vertical distance measured along the slope of the front of the treads to the floor or ceiling above.

Stair Framing Elements

Stair framing usually requires several elements that could be broken into the stair's components and the landing.

Stair Component

The stair component comprises the stair stringers, sleepers, stringer spacers, stringer hanger, and temporary treads (Figure 9-72).

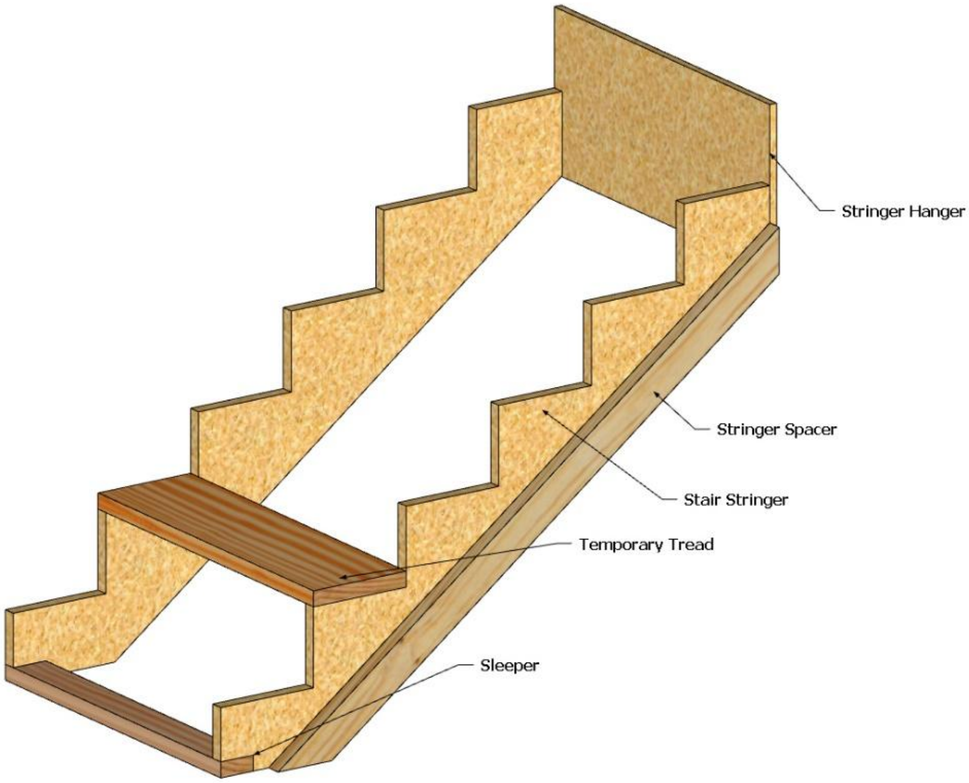


Figure 9-72 Framing components of a stairway.

Stair Stringers


Figure 9-2 Pony wall from concrete foundation to floor framing. Two-by-six construction with pressure treated bottom plate and double top plates.

Stair stringers are the support elements of the stairway. Stringers can be called stair jacks or stair carriage. Traditionally, stringers were constructed of 2 × 12-inch framing lumber. This can be the case, but they are more often made from engineered lumber such as laminated strand lumber (LSL) or laminated veneer lumber (LVL). These can be purchased in widths from 9½ inches to 14 inches and have a thickness of 1¾ inches. A stair run will have a minimum of two stringers, but it could have three or more depending upon the width of the stairway and the needed strength.

The length of the stringer is determined by calculating the slope length of a triangle formed from the total run and total rise of the stair (Figure 9-73).

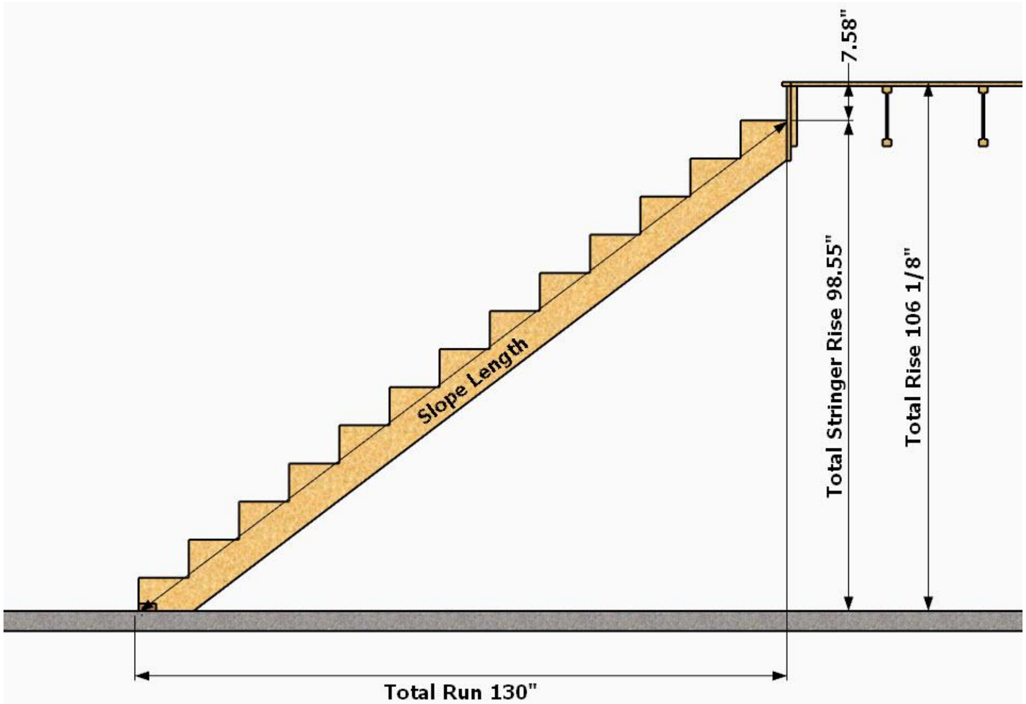


Figure 9-73 Stair stringer slope length.

The previously determined total rise of 106 1/8 inches and total run of 130 inches will be used. In this case, the stringer ends one-unit rise or 7.58 inches below the finished floor, so that will be subtracted from the total rise for a total stringer rise of 98.55 inches. The slope length will be calculated by using Pythagorean's theorem. The decimal lengths inputted into the formula are as follows:

$$130\text{ in}^2 + 98.55\text{ in}^2 = C^2$$

or

$$\sqrt{16,900 + 9,712.10}$$

or

$$\sqrt{20,157.81}$$

or

163.13 inches

This would be rounded up to 164 inches or 13½'. Framing lumber is usually sold in increments of two feet, and the total will be rounded up to a purchase length of 14'. This would be multiplied by the number of stringers.

Sleeper

The sleeper is a length of framing lumber that is inserted at the bottom of the stairway. Its purpose is to provide a means of solid attachment of the stringers to the floor. If the bottom of the stair is resting upon concrete, the sleeper will need to be of pressure treated lumber or other rot resistant material. The sleeper will also need to be firmly anchored to the floor and may require anchor bolts into a concrete floor. The length material needed is the same as the width of the stairway (Figure 9-74).

Stringer Spacer

The stringer spacer is usually a length of 2 × 4 material attached to the bottom of the stringer. The purpose is to hold the stringer a distance away from the stud wall framing. This is so that drywall can be slipped down past the top of the stringer and attached to the wall studs, so it will not have to be cut around the stair shaped stringer. The length of the stringer's spacer board is usually the same length as the stringer (Figure 9-74).

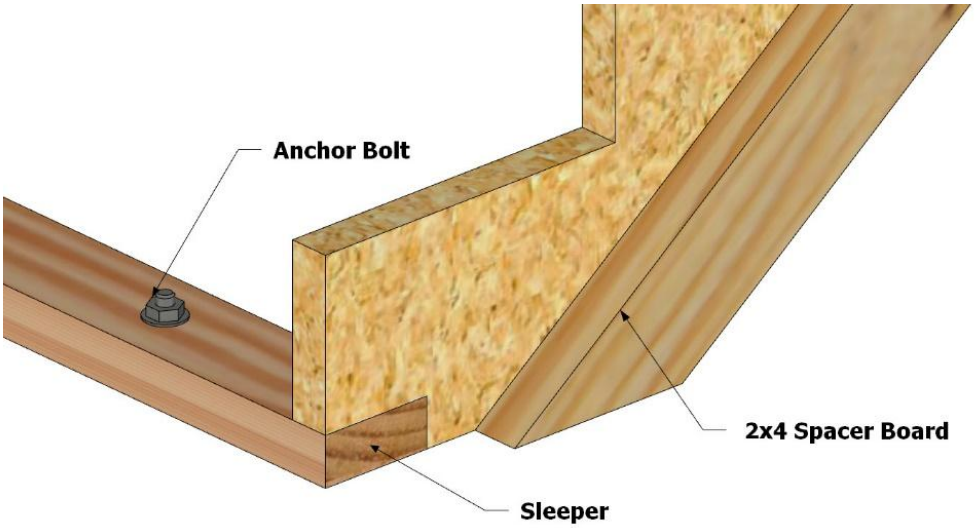


Figure 9-74 Sleeper anchored to the floor.

Stringer Hanger

The purpose of the stringer hanger is to support the top of the stairway as it rests against the floor system. Several methods could be used including a hanger board and hanger hardware. A hanger board is a piece of OSB that is attached to the top of the stringer and also attached to the floor system. The hanger board becomes, in essence, the riser for that stair, so to keep the stair run consistent the thickness of the hanger board (usually 3/4") is cut off of the stair tread length. This is shown in Figure 9-75.

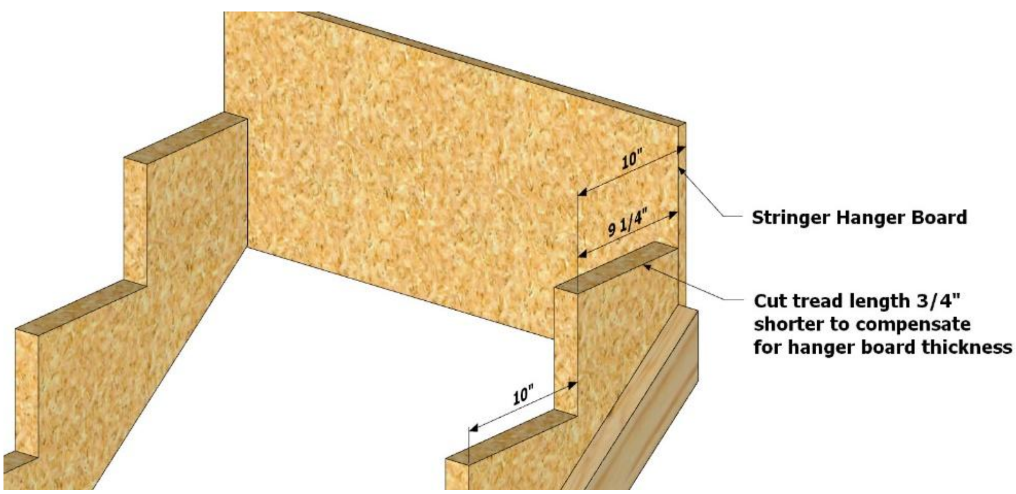


Figure 9-75 Stringer hanger board.

Another method of attaching the top of the stringer is to use framing anchors to attach it to the floor framing as is shown in Figure 9-76. In this case, stringer hangers are count and list items.

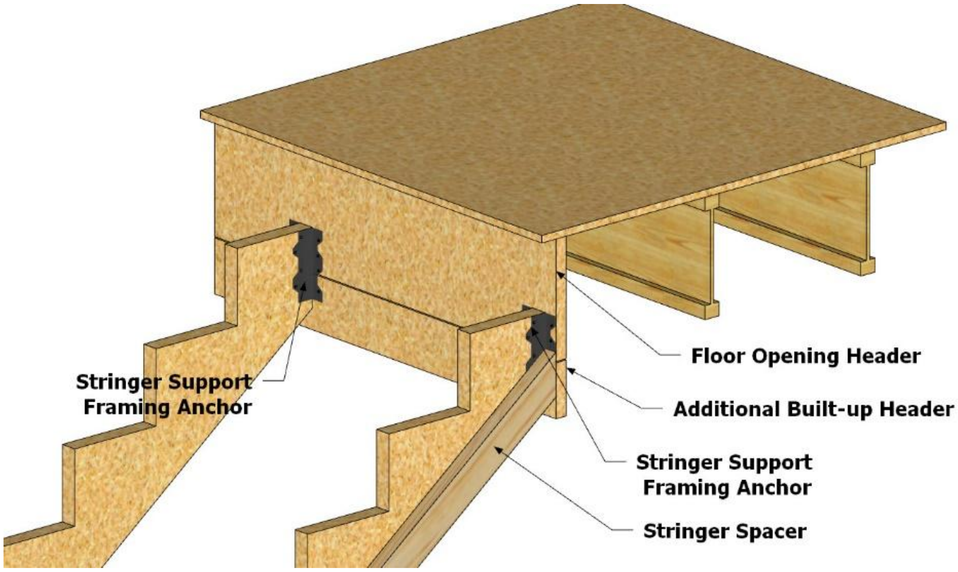


Figure 9-76 Stringer support framing anchor.

Temporary Treads

If the stairway is to be used during the construction project, temporary treads will need to be installed. Often, if the finished treads are such that they will not be exposed and have a covering, such as carpet, the finished treads will be installed during the framing phase, but it will be priced later during the interior phase of construction. If temporary treads are installed, they will need to be priced at this time. Current safety regulations prohibit the former practice of installing a single 2 × 4 or 2 × 6 to be used as a temporary tread. The temporary treads need to be of the same width as the finished treads. This means that they will likely need to be constructed of 2 × 10 or 2 × 12 material. This material can be costly and should be added to the estimate. Calculating the quantity is done by determining the width of each tread and multiplying that by the number of treads to establish a lineal footage of material needed (Figure 9-77).

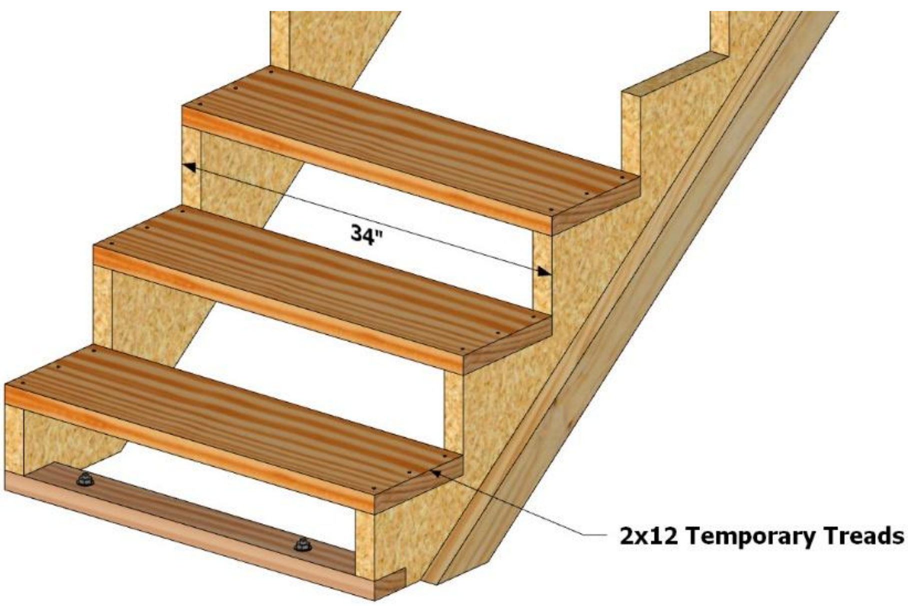


Figure 9-77 Temporary treads.

Stair Landings

Stair landings are used when it is desirable to provide for a change of direction in the stairs. They do take up valuable floor space, but they also allow for stairs to fit into some spaces they otherwise would not. In addition, building codes require that landings be installed at every 12 feet of vertical rise in a stairway. Landings are usually framed like small floors with joists and subfloor, and they are often supported by surrounding walls. Figure 9-78 shows a stair landing framed with 2 × 10 floor joists.

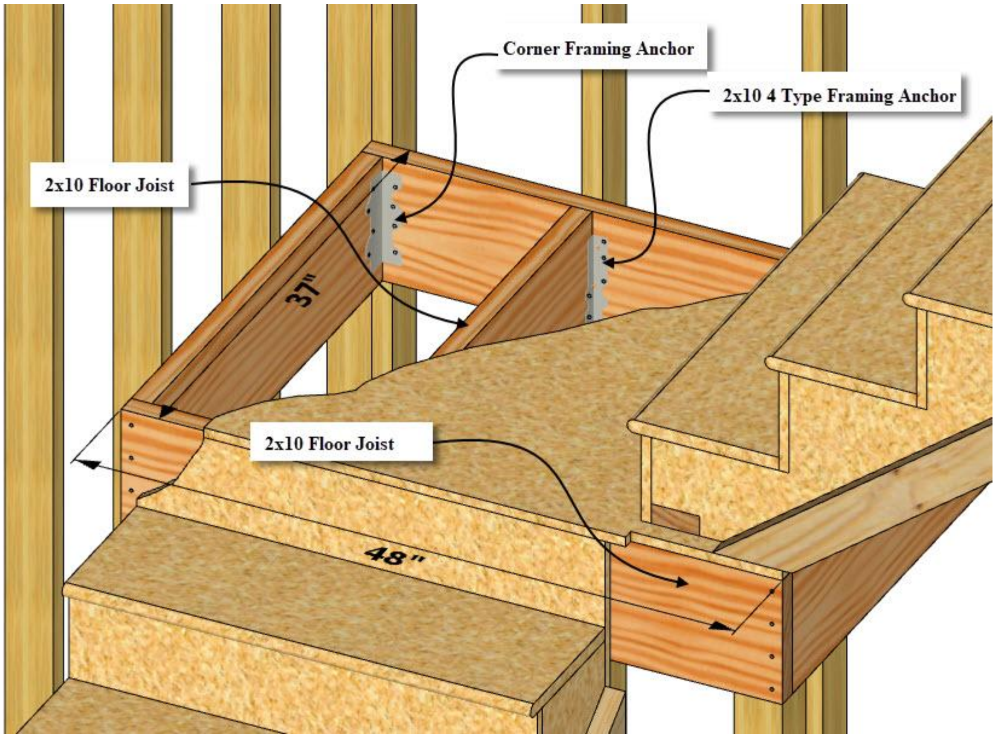


Figure 9-78 Stair landing.

The landing is sized at 37 inches by 48 inches. There are three joists 34 inches long and two rim joists 48 inches long. In addition, four corner framing anchors and four 2 × 10 joist hangers installed. The floor is covered with 3/4-inch OSB sheathing.

Closed Sides

An additional consideration when estimating stair framing is the number of closed sides. Stairways can be constructed so that all of the sides of the stairway are enclosed by walls as shown in Figure 9-79.

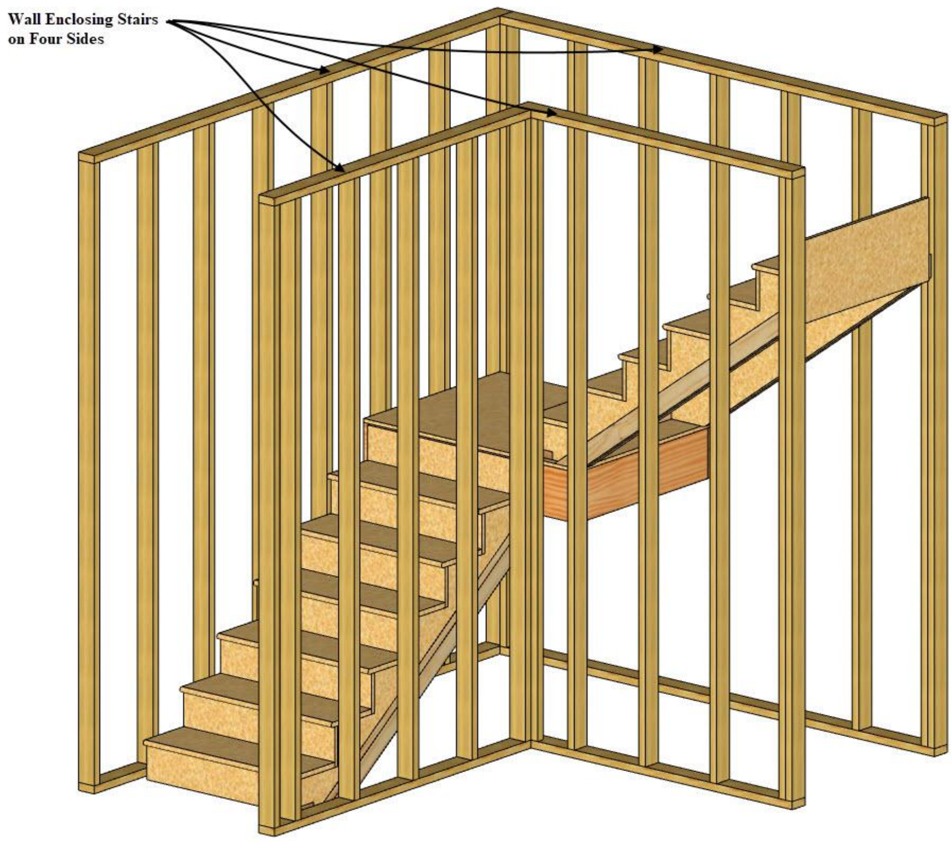


Figure 9-79 Walls enclose stairway on all four sides.

Stairways can be constructed so that no sides are enclosed by walls, or so that any combination of closed and enclosed such as the example in Figure 9-80 which shows the stairway with three enclosed walls and one open side.

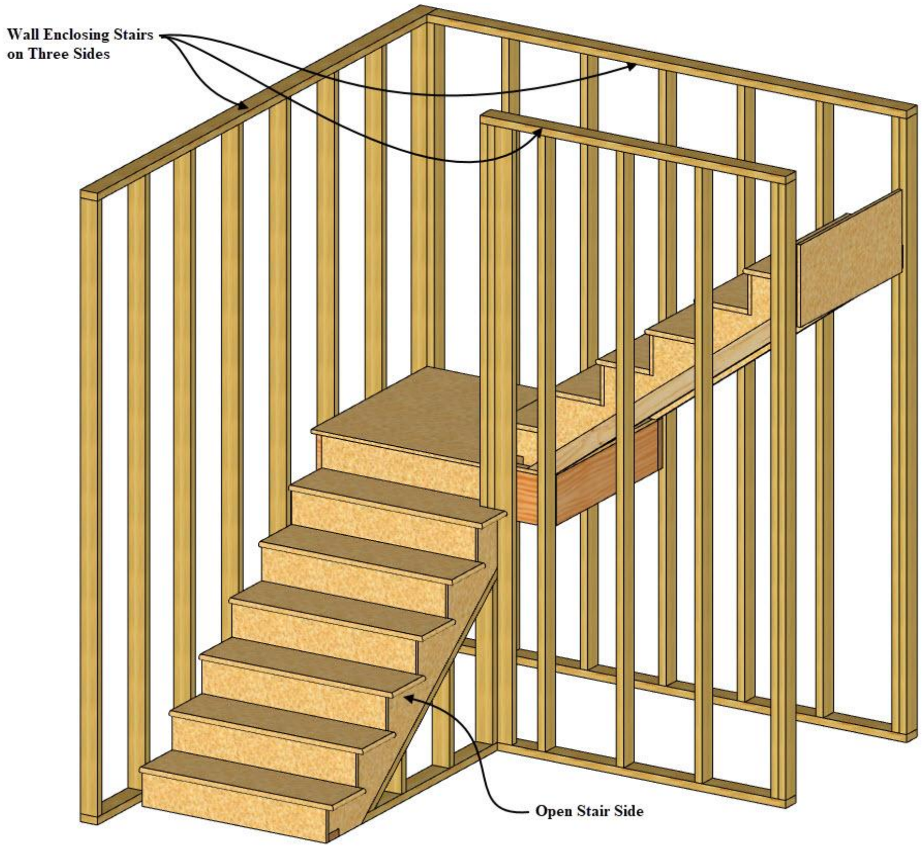


Figure 9-80 Stairway with one open side.

Stair Material

Figure 9-81 shows the view of the floor plan that details the stairway. In this instance, the stairway is L-shaped with a landing halfway along the stairway. Residential house plans may provide more detail than this about the stair construction, or they may not. Using the information from this view and finished floor to finished floor height, the stair construction can be determined.

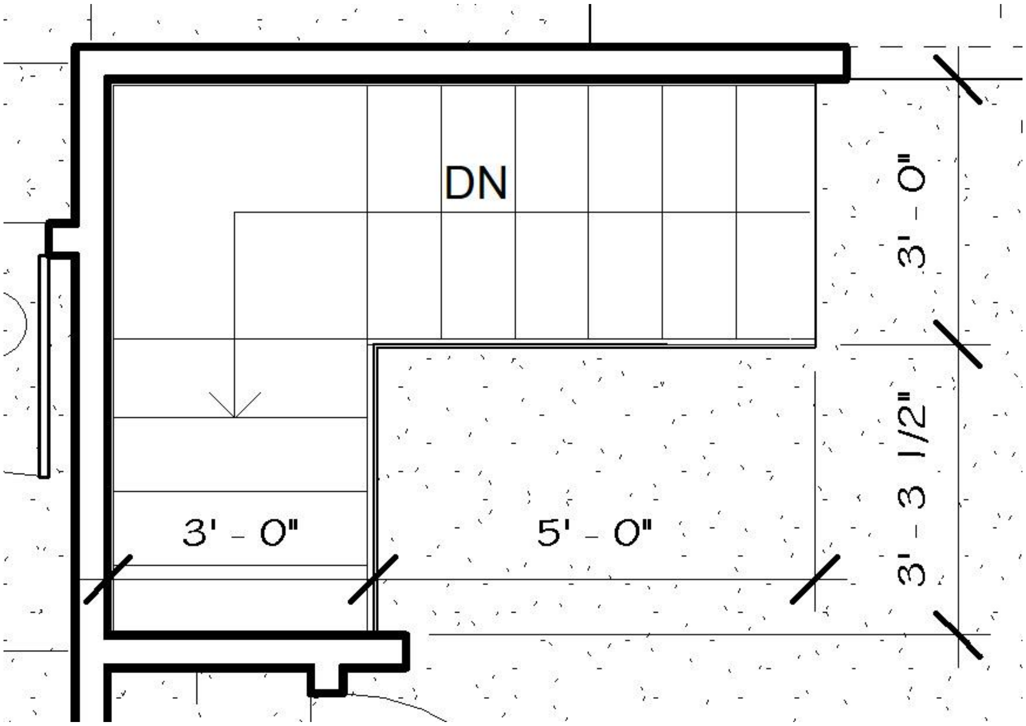


Figure 9-81 Residence floor plan showing stairway details.

The view shows six treads from floor level down to the landing level. Four more treads are shown from the landing down to the base of the stairway, however, there are two additional treads covered by the floor and wall above it.

Stringer Hanger

The stringer hanger utilized in this instance will be three quarters of an inch thick OSB material. Each stringer hanger will need to be as long as the width of the stairway, which, in this case, is three feet. The width of the stringer spacer will need to be at least as wide as the height of two risers. The riser height was previously calculated at 7.58 inches and doubled would be 15.6 inches. This will be rounded up to an even increment of 16 inches. One stringer hanger will be needed for each stair, so two will be needed for the project. Even though it is not usual to purchase a portion of a sheet, smaller scraps left over from making the OSB risers could be utilized.

Temporary Treads

Temporary treads will not be used on this project because the finished OSB treads will be installed at the time the stairway is framed. The OSB tread quantity will be calculated later during the interior finish phase.

Stair Landing Materials

The stair landing material will be manually calculated using methods that have already been discussed.

Landing Joists

Figure 9-78 shows the stair landing which is 48 inches long and 36 inches wide. It is constructed of 2 × 10 inch material spaced 16 inches on-center. In addition, there are two rim pieces 48 inches long. The total would be as follows:

4 PCS × 4 ft. + 2 PCS 4 ft. =

or

16 ft. + 8 ft. = 24 ft.

Landing Subfloor

The landing subfloor will be three quarters of an inch OSB material. The finished size including overhangs for the tread nosing at the landing is approximately 38 inches wide by 48 inches long. This equals approximately one half of a sheet.

Framing Anchors

Figure 9-77 shows the stair landing and a couple of the framing anchors. The end of each 2 × 10 floor joist is supported by a 2 × 10 "U" type joist hanger for a total of four for the job. Each corner of the landing is also reinforced with a corner framing anchor. There will be four on the job.

Roof Framing

There are many styles of residential roofs; however, most are primarily built using one of two systems: the traditional roof framing system, which is also known as rafter framing or stick roof framing, and the other main roof framing system, which is also known as truss roof framing. Traditionally, almost all framing was done using rafter framing, however, the majority of contemporary house framing utilizes truss roof framing. Some roofs are also framed using a hybrid of both systems such as truss framing for the majority of roof elements, but many of the details and small particulars are still stick framed. An effective construction estimator will need an understanding of both systems. Regardless of the system used, a basic understanding of basic roofing terms and principles is important.

Common Roof Framing Terms and Principles

Important roof framing terms to understand include total span, total run, total rise, unit rise, unit run, slope, line length, and pitch. Figure 9-82 shows an example of the basic roof framing terms.

Total Span

The total span is the distance of the roof from the outside of the bearing wall to the outside of the other bearing wall. Most often, this is the width of the building, but the span could also be from an outside bearing wall to an interior bearing surface.

Total Run

The total run is usually one half of the total span, however, there are some roof styles in which the run is longer on one side of the roof than the other.

Total Rise

Total rise is the distance of vertical rise of the roof. The amount of rise is determined by the distance of the run and the steepness of the roof. Steeper roofs will have a greater vertical rise than ones that are shallower.

Slope Length

The slope length, also known as the line length, is the angled distance of the roof edge. It is determined by finding the length of the hypotenuse of the triangle that is formed by the total rise and the total run.

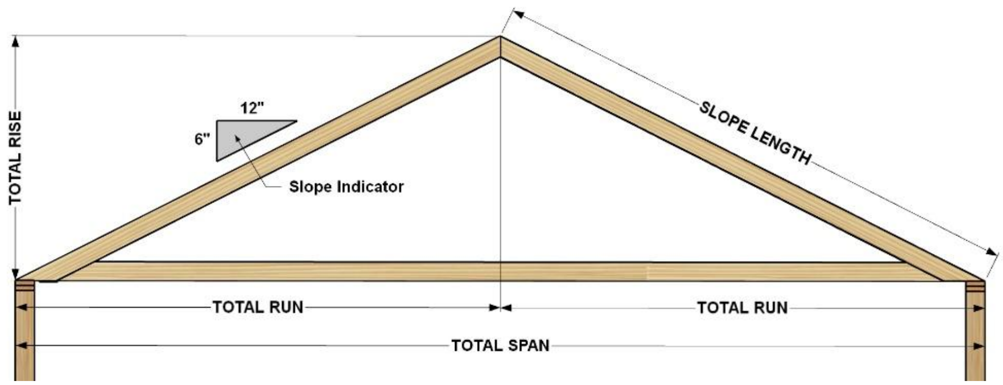


Figure 9-82 Basic roof framing terms.

Unit Run

Unit run is a fixed unit of measurement that is always 12 inches in the English measurement system. Any measurement in the horizontal direction is always expressed as the run.

Unit Rise

Unit rise is the vertical distance of rise of the roof for every unit run or 12 inches of the total run. Typically, it is expressed in inches.

Slope

Slope is the ratio of unit rise to the unit run. It would be expressed in terms such as 6:12 slope or a 6/12 slope, which means that the vertical rise of the roof is 6 inches for every 12 inches of horizontal run. The higher the slope the steeper the roof is. A roof slope of 12:12 would represent a roof with a 45-degree angle of slope. It is possible with very steep roofs to have a slope greater than 12 inches, such as a 16:12 slope.

Pitch

Pitch is the ratio of the unit rise of the roof over the unit span. According to a US government document written in 1993, pitch constitutes the following:

> *"Pitch is the ratio of unit of rise to the unit of span. It describes the slope of a roof. Pitch is expressed as a fraction, such as 1/4 or 1/2 pitch. The term pitch is gradually being replaced by the term cut. Cut is the angle that the roof surface makes with a horizontal plane. This angle is usually expressed as a fraction in which the numerator equals the unit of rise, and the denominator equals the unit of run (12 inches), such as 6/12 or 8/12. This can be expressed in inches per foot."*
>
> *https://www.constructionknowledge.net/*

The term cut is also usually no longer used and has been replaced by the term slope. In contemporary usage, the term pitch is still common, however, the terms slope and pitch are used interchangeably to mean the ratio of the rise of the roof over the run of the roof.

Calculating the Rafter Roof Slope Length

With the total run and the roof slope known, both the total rise and the roof sloped length can be calculated (Figure 9-83).

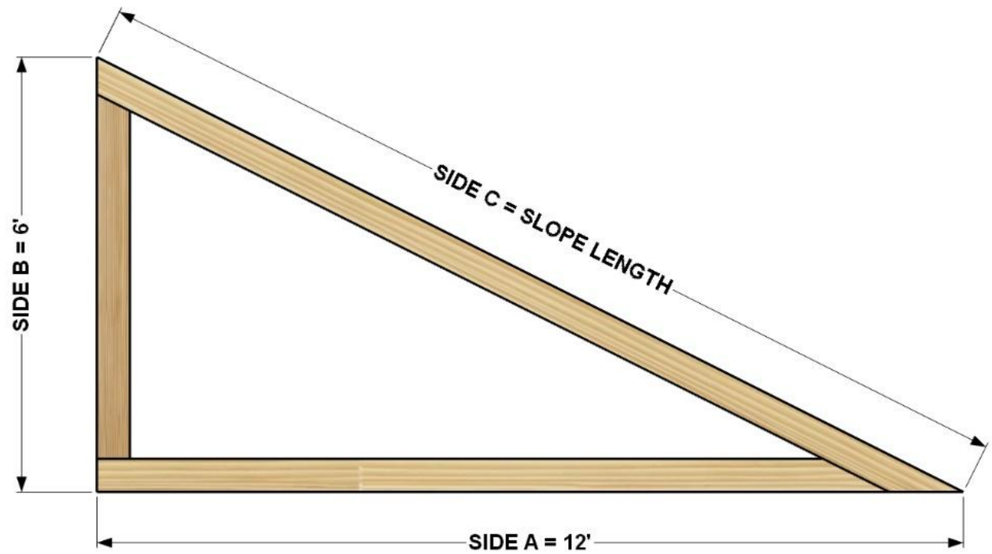


Figure 9-83 Calculating the slope length.

Calculating the Total Rise

The total run and the roof slope can be used to calculate the total rise of the roof. For example, if the total run of a roof were 12 feet and the roof slope was given as 6:12, then the following formula could be used to calculated the total rise:

Total Rise: Total Run × Roof Slope

$$Total\ Rise:\ 12\ ft\ \times\ \frac{6\ in}{12\ in}\ =\ 6\ ft$$

Calculating the Roof Slope Length

With the total run and rise known, the roof slope length can be calculated using the Pythagorean theorem of A2 + B2 = C2. The roof slope length would be as follows:

$A^2 + B^2 = C^2$

or

$12\ ft^2 + 6\ ft^2 = C^2$

or

$144\ ft^2 + 36\ ft^2 = 180\ ft^2$

or

$$\sqrt{180\ ft}$$

or

13.42 ft.

Total Run and Rise Including Overhangs

The total run, rise, and slope length calculated so far are for a simple triangle. Most roof framing also includes a roof overhang. The roof overhang should be included in the roof calculations. Figure 8-84 shows a roof with a more realistic layout including the roof overhang.

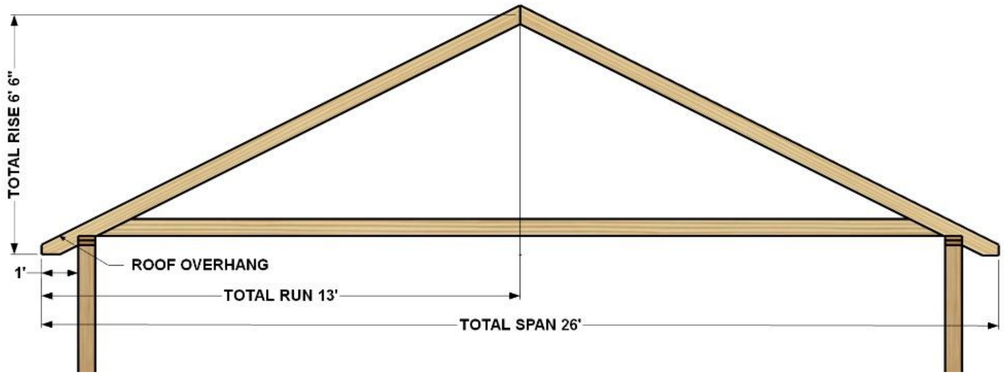


Figure 9-84 Roof framing including overhang.

Figure 9-84 also shows that the rise is measured to the center of the rafter. When calculating the total run, total rise, and sloped length, the dimensions are calculated using a triangle that is formed from the center of rafter as is shown in Figure 9-85. This is also known as the line length.

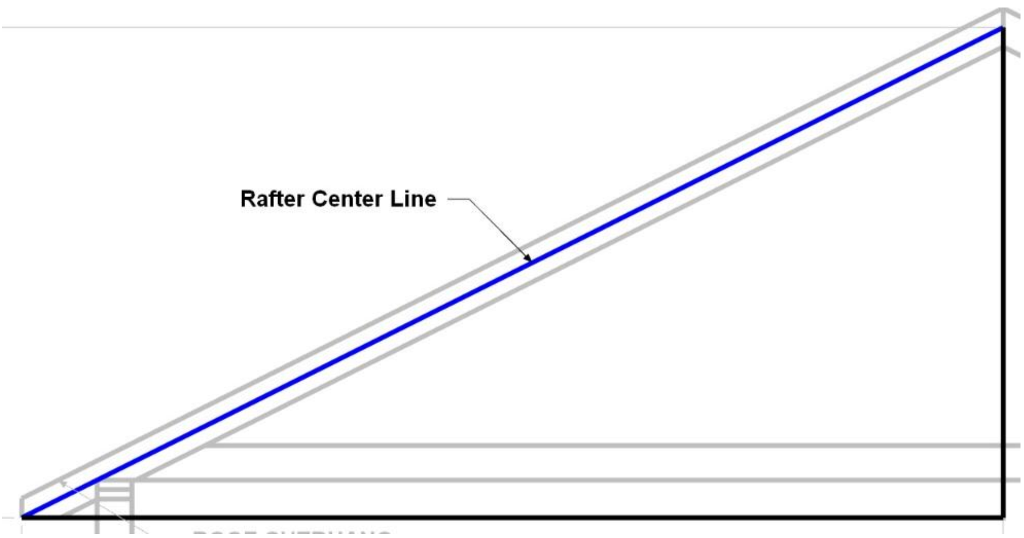


Figure 9-85 Rafter center line.

The dimensions shown in Figure 9-84 are used to calculate the actual slope roof length as follows:

Total Run = 13'0"

Total Rise = 6'6"

13 ft. 0 in^2 + 6 ft. 6 in^2 = Slope Length^2

$$169'\,0'' + 42'\,3'' = \sqrt{211'\,3''}$$

14.53'

Rafter Length Charts

Traditionally, carpenters used a rafter length chart to calculate the length of roofing members. For convenience, rafter charts are printed on framing squares that can be used to lay out roofing members. The scale for laying out rafter lengths includes a multiplication factor aligned with each slope. For example, the number aligned with the 6 on the blade of the square is 13.42 (Figure 9-86).

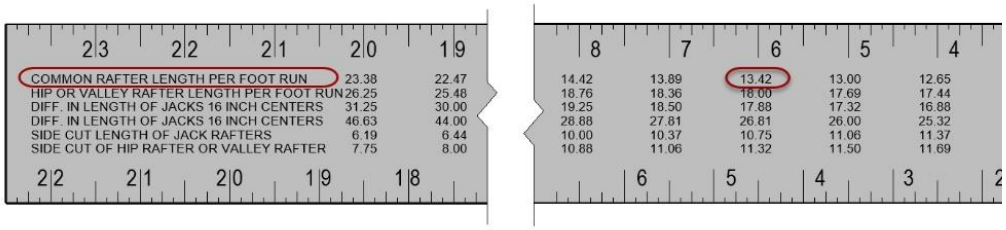


Figure 9-86 Framing square showing the length factor for a 6:12 roof slope.

This represents the length of slope in inches for every one foot of horizontal run. In use, the total run in feet is multiplied by the slope factor to obtain the total sloped length in inches. The total inches are divided by 12 to obtain the slope length in feet. The previous example had a roof with a 13' total run. Multiplying that length by the slope factor of 13.42 will result in the following:

$$13\ ft \times 12.42\frac{in}{ft} = 174.46\ in$$

$$\frac{174.46\ in}{12\frac{in}{ft}} = 14.53\ ft$$

Common length factors for the different roof slopes are shown in Table 8-1.

Common Rafter Length Factors	
Roof Slope	**Length Factor**
2:12	12.16
3:12	12.37
4:12	12.65
5:12	13.00
6:12	13.42
7:12	13.89
8:12	14.42

Table 9-1 Rafter length multiplication factor

Rafter Framing Terms

Framed rafter roofs are formed of several components including common rafters, ridge boards, hip rafters, valley rafters, hip and valley jack rafters, and cripple jack rafters. Figure 9-87 shows an example of the various roof framing components.

Figure 9-87 Rafter framed roof components.

CCA-By-ArmchairBuilder.com: https://www.flickr.com/photos/armchairbuilder/7345565380/in/photostream/

Common Rafters

Common rafters span from the ridge board to the wall. They are the type most often used in rafter framing and become the basis point for all other roof framing elements. The top of the common rafter is cut plumb and ties into the ridge board. The bottom of the rafter has a bird's mouth cut that rests upon the top of the exterior wall, and the rafter tails extend out past the walls and form the roof overhang.

Ridge Boards

Ridge board forms the peak of the roof and ties the top of the rafters together. Because the top of the rafter is a vertical plumb cut, ridge board needs to be wider than the rafter material. The width of the ridge board is dependent upon the slope of the roof. The steeper the roof, the wider the ridge board needs to be (Figure 9-88).

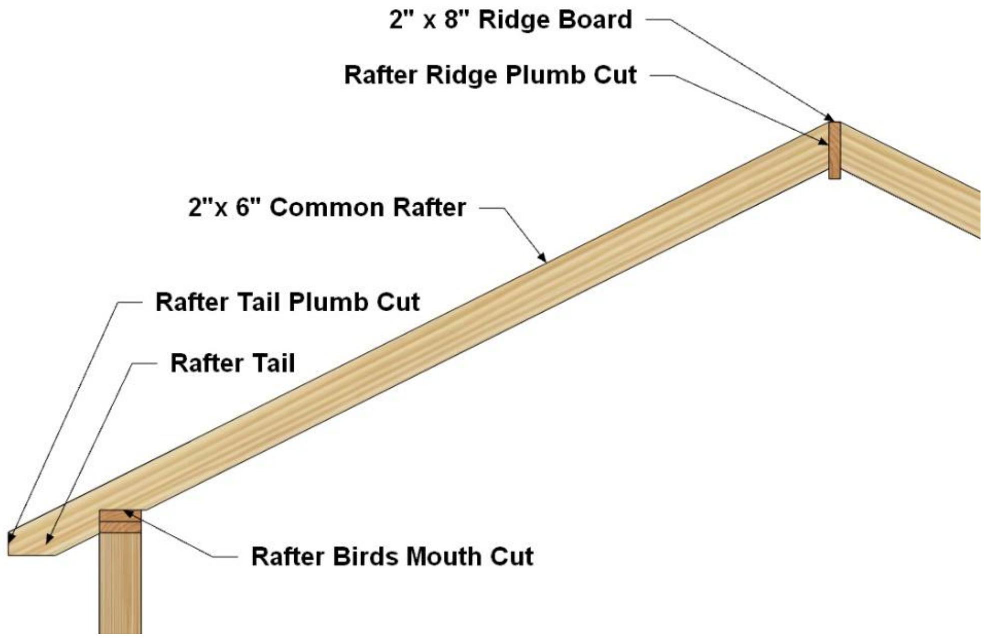


Figure 9-88 Common rafter and ridge board.

Hip Rafter and Valley

The hip rafter forms the intersection of two roof sections. They are formed at 45-degree angles to the wall plates and cross the corner of two walls. They form a ridge in the roof. The jack rafters that tie into the hip rafter are also cut with a plumb cut. The hip rafter is wider than the rafters that tie into it.

The valley rafters also form two intersections of the roof planes; however, they meet in a valley of the roof instead of a ridge. Like the ridge board and hip rafter, valley rafters are wider than the intersecting rafters.

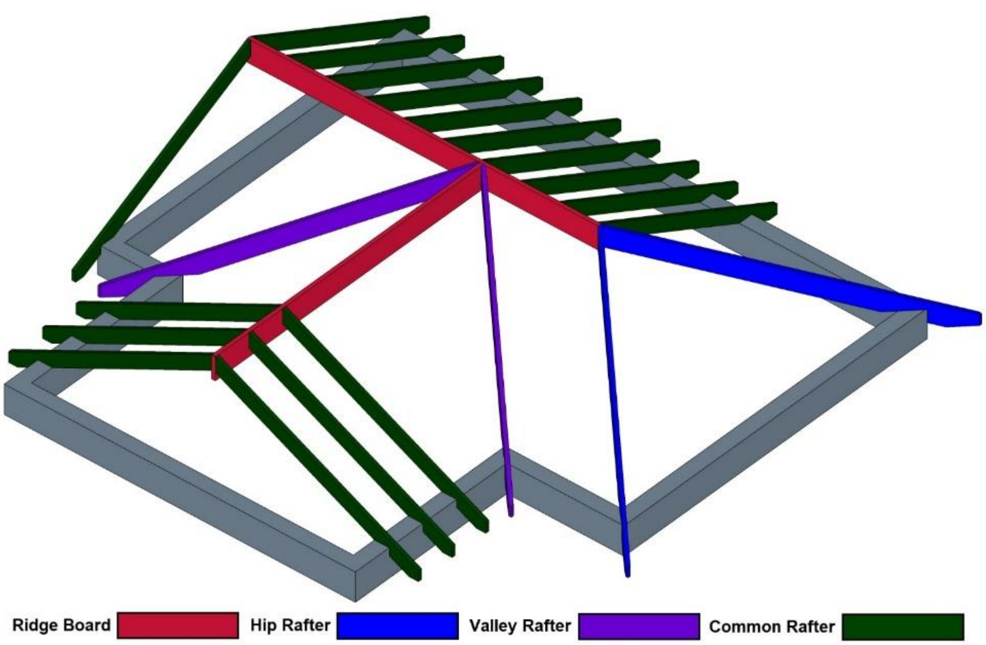


Figure 9-89 Roof framing with common rafters, ridge boards, hip, and valley rafters

The length and layout of hip and valley rafters are identical and determined by the following formula:

$$\text{Run Length}^2 + \text{Common Rafter Length}^2 = \text{Hip Rafter Length}^2$$

Using the roof example in Figure 9-84 with a total run length of 13' and a common rafter length of 14.53', the length of a hip or valley rafter would be calculated as follows:

$$13\ ft^2 + 14.53\ ft^2 = \text{Hip Rafter Length}^2$$

or

$$169\ ft^2 + 211.12\ ft^2 = 380.12\ ft^2$$

or

$$\sqrt{380.12\ ft^2}$$

or

19.50 ft.2

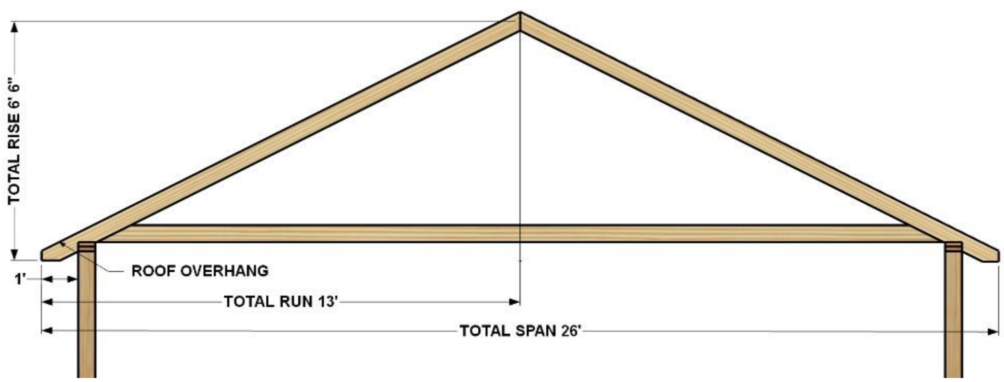


Figure 9-84 Roof framing including overhang.

Slope factor charts can be used to calculate the length of hip and valley rafters. Figure 9-90 shows a graphic of a framing square with the slope factor for hip and valley rafters highlighted.

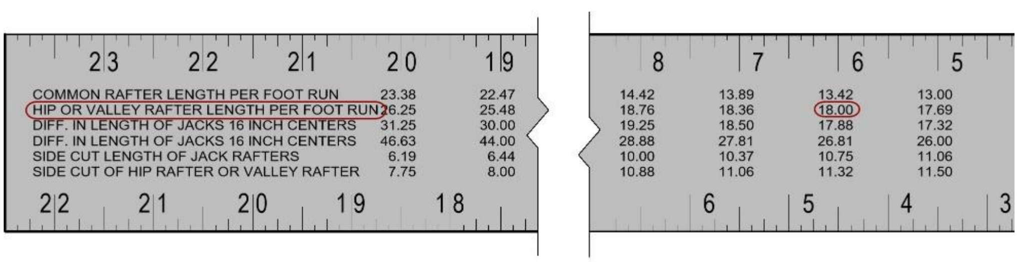


Figure 9-90 Framing square showing hip and valley length factor for 6:12 slope roof.

Using the length factor for the previous roof with a 13-foot total run would result in the following calculations:

$$13\ ft \times 18\frac{in}{ft} = 234\ in$$

$$\frac{234\ in}{12\frac{in}{ft}} = 19.50\ ft$$

Common lengths for hip and valley rafters are shown in Table 2.

Hip and Valley Length Factors	
Roof Slope	**Length Factor**

2:12	17.09
3:12	17.23
4:12	17.44
5:12	17.69
6:12	18.00
7:12	18.36
8:12	18.86

Table 9-2 Hip and valley rafter multiplication factor.

Jack Rafters

Jack rafters are cut shorter than common rafters and at least one end lands upon a hip or valley rafter. Three types of jack rafters are hip jack rafters, valley jack rafters, and cripple jack rafters. Hip jack rafters have a birds' mouth cut at the bottom similar to a common rafter, but the top of the hip jack rafter has a compound angled cut to tie into a hip rafter. Valley jack rafters have an angled cut at the top similar to a common rafter, but the bottom of the valley jack rafter has a compound angle cut to tie into a valley rafter. Cripple jack rafters have compound angle cuts at both the top and the bottom of the rafter and tie into a hip rafter at the top and a valley rafter at the bottom.

Each jack rafter on the side of a roof is cut at a different length than the adjacent rafter, and the jack rafters get longer or shorter as they move up or down the slope of the roof. The change in length between each rafter is a consistent amount based upon the slope of the roof and the spacing of the rafters. Framing squares also have tables on them that identify the amount that each jack rafter changes based upon the roof slope and spacing factors. Figure 9-91 shows a graphic of a framing square with the rafter differences in length highlighted.

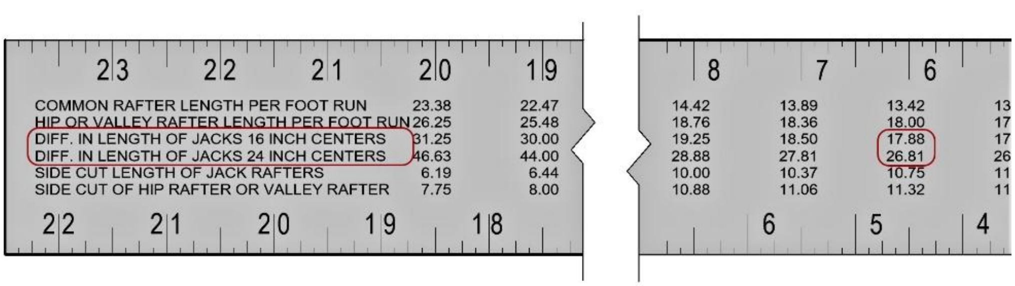


Figure 9-91 Difference in length of jack rafters.

The table shows that for a rafter with a 6:12 slope, each jack rafter would vary in length by 17.88 inches if the rafters were spaced at 16-inch centers and 26.81 inches if the rafters were spaced at 24-inch centers. Figure 9-92 shows a rafter framed roof with the three types of jack rafters highlighted.

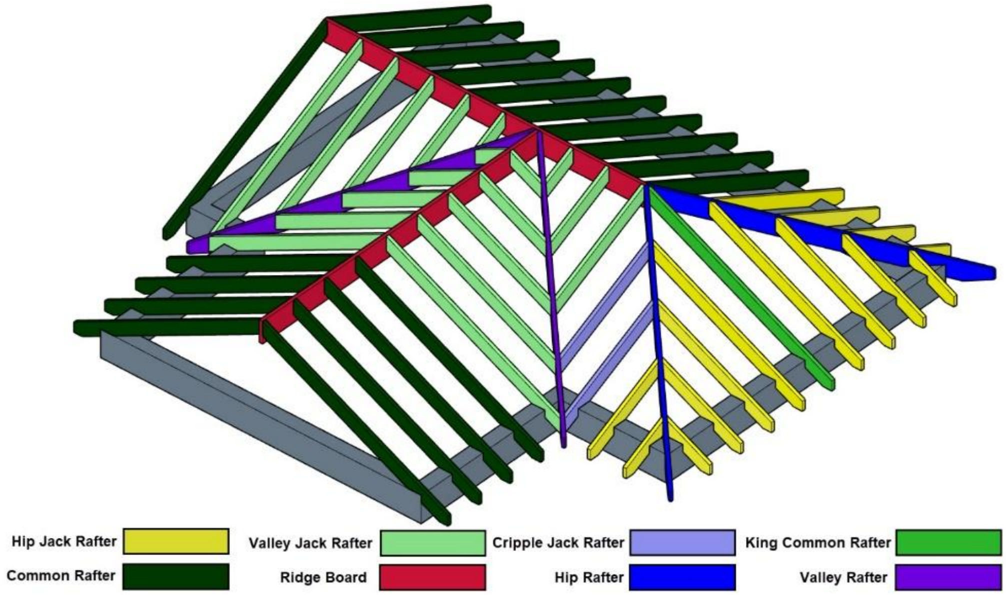


Figure 9-92 Jack rafter framing.

Other Exterior Rafter Framing Components

Other components used in rafter framing include sub-fascia, barge rafters, lookouts, and gable end framing. Each of these are important components used in the completion of the exterior roof elements.

Sub-Fascia

Sub-fascia is a horizontal framing member that attaches to the rafter tails that are used to attach the finished fascia material. Sub-fascia is sometimes called false fascia or rough fascia. The sub-fascia is often constructed of 2 × 4 material, but 2 × 6 or wider material is also commonly used depending upon the style of the roof. Calculating the quantity of sub-fascia material is a matter of calculating the horizontal length of the roof edge. On hip style roofs, this would include all of the roof edges, however, the angled edged members of gable roof ends are usually calculated as barge rafters.

Barge Rafters

Barge rafters are the angled edge members of a gable end roof that forms the overhang of the roof on the ends. Barge rafters are also called fly rafters or rake rafters. They are similar to common rafters with the exception that they do not have a birds' mouth cut at the bottom to sit on the bearing wall. Usually they are made using 2 × 4 material, but 2 × 6 and wider material is sometimes used. Barge rafters are typically the same length as the common rafters. Calculating barge rafters is usually a matter of calculating the number of barge rafters by their length. They are supported in the roof structure by the gable end lookouts and the gable end framing.

Gable End Lookouts

Gable end lookouts are framing members that extend from the common rafters to the barge rafters and support the barge rafters, which form the overhang of the roof on the gable ends. The lookouts can be either long or short depending upon the style. Shorter gable end overhangs of 12 inches or less often use lookouts that attach to the end rafter and the lookout as shown in Figure 9-93.

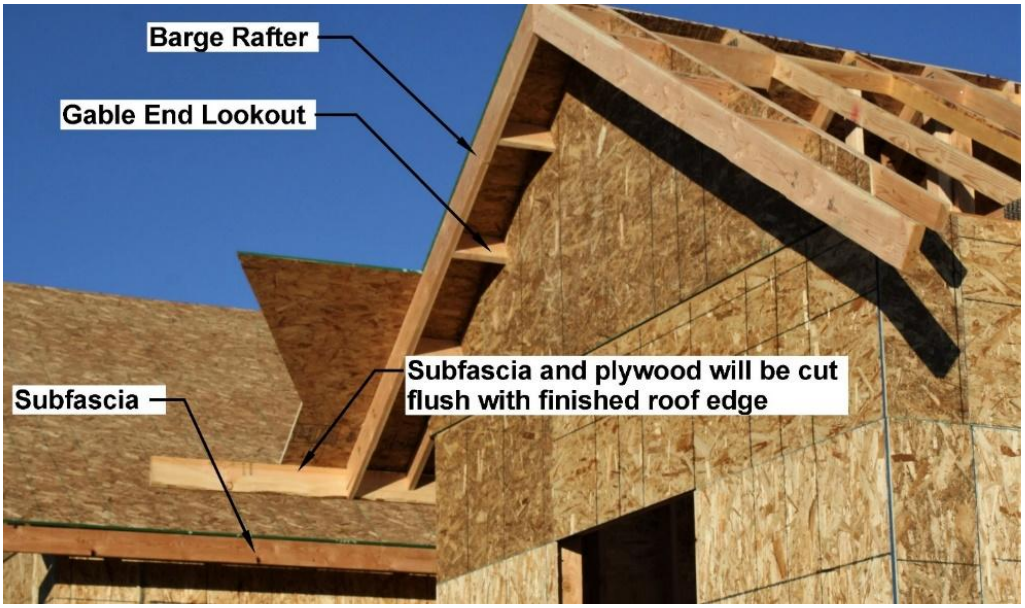


Figure 9-93 Gable end framing showing barge rafters, short lookouts, and sub-fascia.

Some lookouts extend back into the roof framing and attach to a common rafter. They rest upon and cantilever past the gable end framing to support the barge rafters. This is typically the case for roofs with longer gable end overhangs as shown in Figure 9-94.

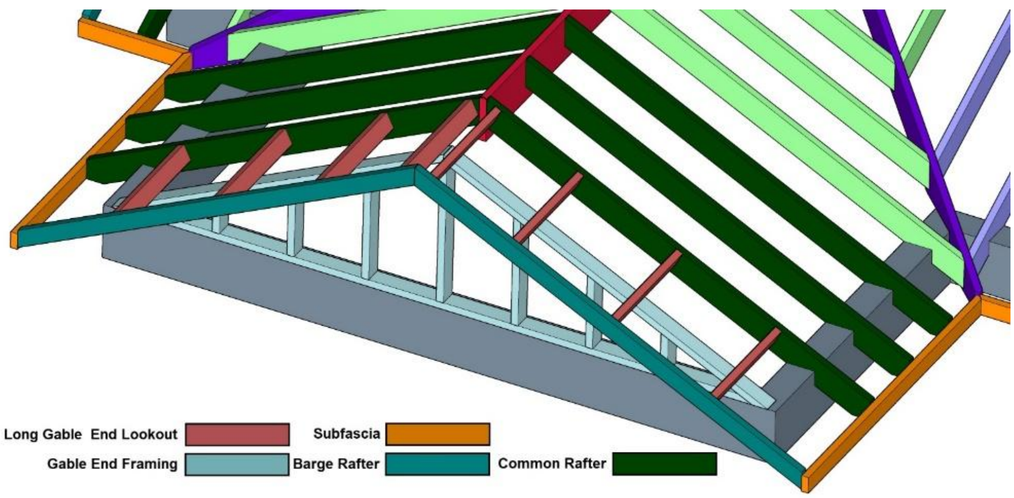


Figure 9-94 Gable end framing with long gable end lookouts.

Calculating gable end lookouts is a matter of determining the length of the lookouts and multiplying by the number of lookouts. The length of the lookouts can be calculated by first determining if the lookouts are long or short. If the lookouts are short, their length is equal to the overhang distance. If they are long, the lengths are determined by adding the overhang distance to the rafter spacing. For example, if the rafters were spaced 16 inches on-center and the overhang distance were 12 inches, the total length of each lookout would be

$$16 \text{ in} + 12 \text{ in} = 28 \text{ in}$$

The number of lookouts is determined by the sloped roof length (Figure 9-85) and the lookout spacing. For example, if the sloped roof length were determined to be 14.53 feet (Figure 9-85) and the spacing were 24 inches (2') on-center, the number of gable end lookouts would be

$$14.53 \text{ ft} \div 2 \text{ ft} = 7.265$$

This would be rounded up to eight gable end lookouts on each roof slope. The total lookout quantity would be

8 × 28 in = 224 in

or

$$\frac{224\,in}{12\frac{in}{ft}} = 18\ ft\ 8\ in$$

Gable End Framing

Gable end framing is the studs that are installed to fill in the angled portion of the wall created by the gable roof. Several methods can be used to fill in the gable end framing. The example Figure 9-94 shows a small rake wall framed in the gable end. This would be common in installation where the gable end lookouts cantilever over the rake wall, and it is used to support the cantilevered lookouts. Calculating this type of framing would include determining the length of the bottom plate, two angled top plates, and the individual studs cut at an angle at the top. Each stud would vary in length a consistent distance based upon the roof slope and the stud spacing. For example, the gable end framing shown in Figure 9-95 has a total run of 12' and a total rise of 6', and a slope angle length of 13'5". The king stud is 6' long and each adjacent stud is eight inches shorter than the preceding stud.

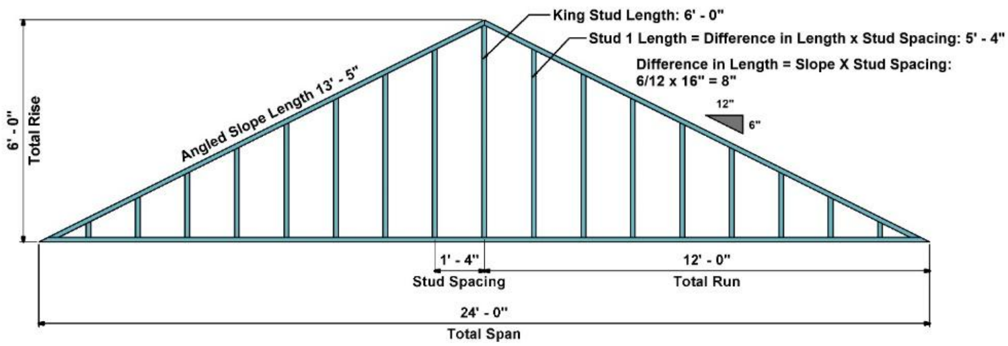


Figure 9-95 Gable end rake wall showing framing.

The gable end framing would include the following:

Bottom Plate: 1 pcs. 2×4 × 24' 0"

Angled Top Plate: 2 pcs. 2×4 × 13' 5"

King Stud: 1 pcs. 6' 0"

Stud 1: 2 pcs. 5' 4"

Stud 2: 2 pcs. × 5' 0"

Stud 3: 2 pcs. × 4' 8"

Stud 3: 2 pcs × 4' 0"

Stud 4: 2 pcs. × 3' 4"

Stud 5: 2 pcs. × 2' 8"

Stud 6: 2 pcs. × 2' 0"

Stud 7: 2 pcs. × 1' 4"

Stud 8: 2 pcs. × 0' 8"

Total Length = 104' – 10"

A simpler method of calculating this gable end wall framing would be to visualize the gable end as a rectangle with a width equal to the total run and the height equal to the total rise with each stud equal in length to the king stud. The king stud would be counted once, and the angled cut studs counted as one king stud (Figure 9-96). The calculations for this would be

Bottom Plate: 2 pcs. 2×4 × 12' 0"

Angled Top Plate: 2 pcs. 2×4 × 13' 5"

King Stud: 9 pcs. 6' 0"

Total Length = 104' – 10"

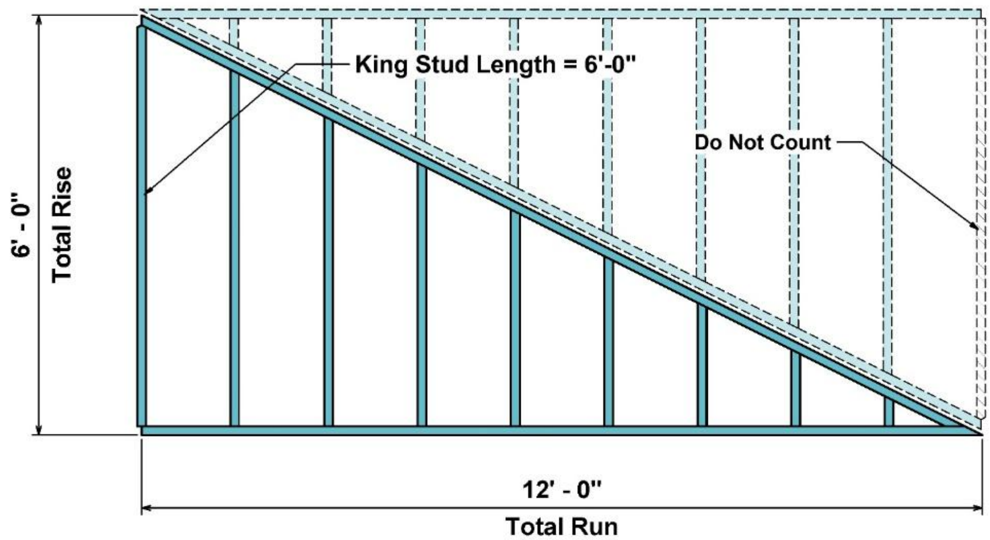


Figure 9-96 Rectangle estimate of gable end wall framing.

Another method would be similar to the example shown in Figure 9-97. This example uses short lookouts attached to common rafters at the gable end. Vertical 2 × 4's are notched into the gable end rafters and attached to the top plate of the wall. The calculation for this wall type would be similar to the previously calculated gable end framing with the exception that the top and bottom plate are eliminated.

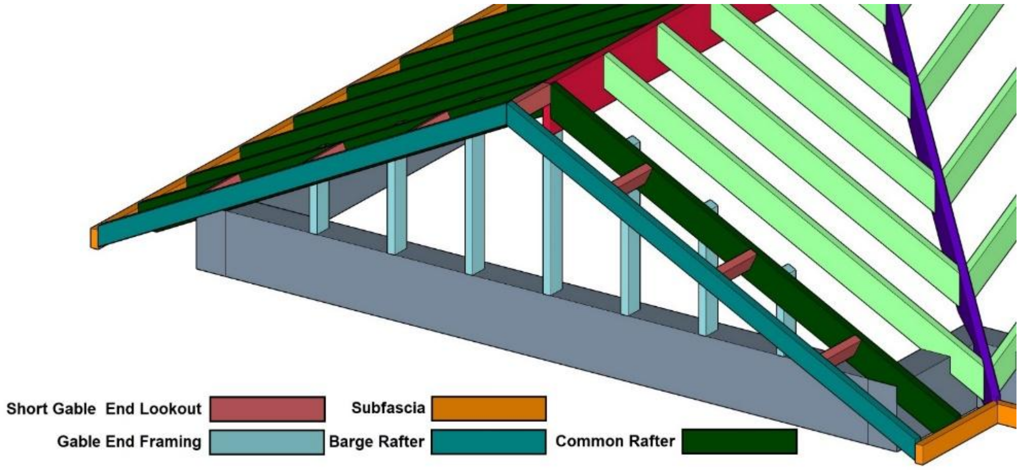


Figure 9-97 Gable end framing notched into the common rafters at the end and attached to the top plate of the wall.

Interior Rafter Framing Components

Interior rafter framing components include ceiling joists, collar ties, rafter bracing, and ridge beams. Rafter framed roofs require one of these elements to make the roof structurally sound. In addition, they serve other functions such as providing support for the ceiling material.

Roof framing has to support two types of loads: live loads and dead loads. Live loads are the result of non-stationary forces, such as is caused by wind and snow. Building code requires roofs to be built to withstand the typical maximum live loads that a roof in a geographic area is subjected to. Dead loads are the result of stationary forces such as the weight of the roof framing and roofing material. Without the additional framing elements such as ceiling joists, rafter bracing, collar ties, or ridge beams, the downward live, and dead load forces can cause the building walls to bulge outward as is shown in Figure 9-98.

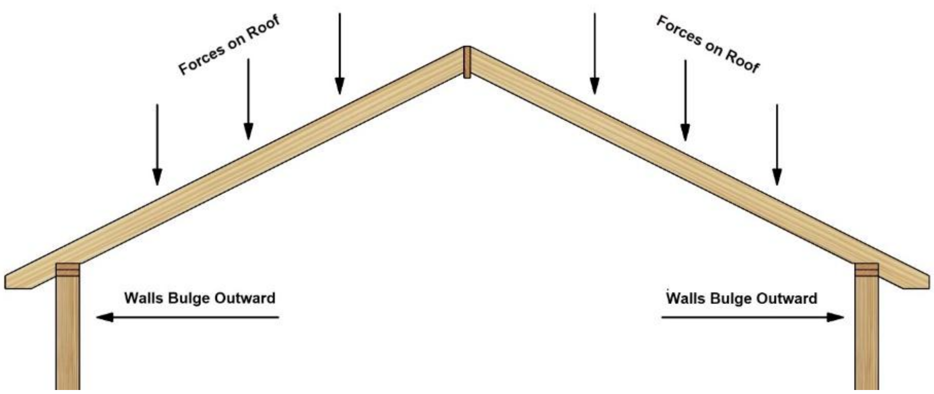


Figure 9-98 Live and dead load forces on a roof can cause the walls to bulge outward without additional elements to tie the roof structure together.

Ceiling Joists

The most common method of tying the roof framing together is with the use of ceiling joist. In addition to providing a structure for attaching the ceiling finish such as the ceiling drywall, the ceiling joist ties the roof structure together. The ceiling in narrower rooms can be made from a single piece of material, however, it is also common for ceiling joist to be attached together over a load bearing interior wall (Figure 9-99).

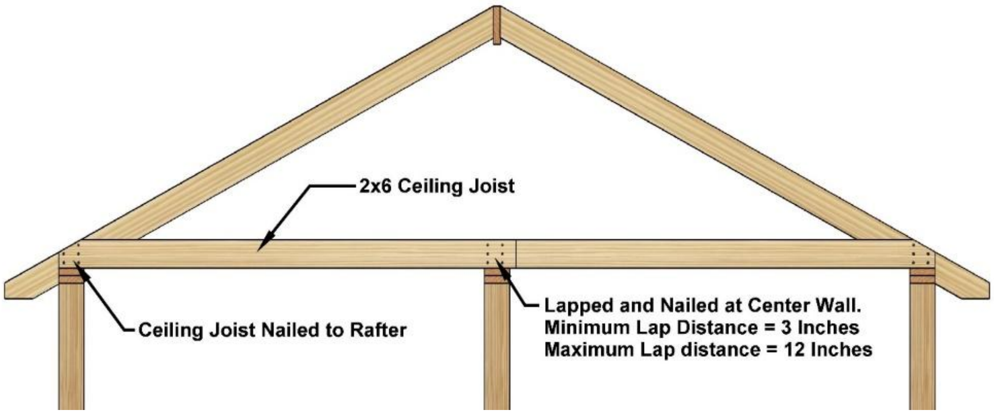


Figure 9-99 Ceiling joist nailed to rafters and lapped and nailed at center intersection.

In situations where two ceiling joists meet, the building code requires that either the joists lap each other or a fastening plate tie each joist together. Where the ceiling joists lap, the code mandates a minimum lap distance of three inches and a maximum lapping distance of 12 inches.

Estimating ceiling joist is a matter of determining the length of the joists and the number of joists needed. The length of joist material is equal to the span of the roof plus any additional length needed to meet the code mandated lapping requirements. The number of ceiling joists is determined by the rafter spacing, usually 16 or 24 inches on-center as each rafter should be tied together with a ceiling joist.

Rafter Bracing

Rafter bracing can be used to support and brace the roof to diminish the size of rafter material required by the building code. Factors that contribute to the material size include the live and dead load requirements, the type of lumber used, and the span of the roof.

Live load requirements are usually based upon the local weather conditions. Areas that receive a heavy snow load in the winter have a larger requirement for live load than those that receive little or no snow. The specific requirements for a geographic area would be specified by the local building department.

Dead load requirements are usually determined by the weight of the framing and roofing material. For example, a traditional slate or concrete tile roof weighs considerably more than one roofed with asphalt shingles and would have a higher dead load requirement.

Figure 9-100 shows a view of two rafter span tables based upon a 24 on-center spacing with different live load requirements. The first table shows a span table based upon a live load condition of 20 pounds per square foot, and the second shows the span table based upon a live load (ground snow load) condition of 50 pounds per square foot. In addition, each table has two options for dead load, one for 10 pounds per square foot, and one for 20 pounds per square foot.

TABLE R802.5.1(4)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground snow load=50 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	SS	6-8	10-	13-0	15-10	18-4	6-6	9-6	12-0	14-8	17-0
	Douglas fir-larch	#1	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Douglas fir-larch	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Douglas fir-larch	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0

Figure 9-100 Two rafter span tables from 2015 IRC.

https://books.byui.edu/-xZeu

Number two grade Douglas fir-larch framing material is highlighted, with the spans for 2 × 6 material emphasized in both tables. The first table shows a maximum spacing for the material at 10 pounds per square foot at 11'9". The second table shows a maximum spacing for the material at 20 pounds per square foot at 7'4", a difference of span of about 4½ feet for the same material.

The 2 × 6 material spaced at 24 inches on-center would not work in a situation with a roof span of 24'. The 12' run of the roof would be longer than the maximum span of 11'9" allowed for the minimum live and dead load requirements shown. The rafter spacing could be decreased from 24 inches on-center to 16 or 12 inches on-center to increase the span, or a wider rafter material like a 2 × 8 could be used. Another option would be to provide bracing for the rafter. The bracing could extend from the center of the rafters down to a load bearing wall in the center (Figure 9-101).

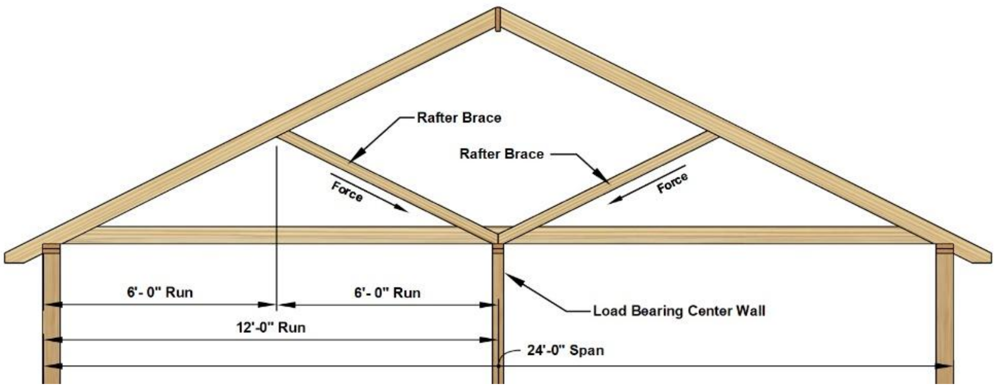


Figure 9-101 Rafter braces.

The braces cut the distance of the run to 6' (half its original distance), which would meet the span requirement of the 50 pound per square foot live load and 20 pounds per square foot dead load.

The length of the braces would be calculated by using the roof slope of 6/12 and the 6' run length of the braces. The rafter length multiplication factor from Table 9-1 shows a multiplication factor of 13.42 inches per lineal foot of horizontal run.

$$13.42\frac{in}{ft} \times 6\ ft = 80.52\,in$$

or

$$80.52\,in \div 12\frac{in}{ft} = 6.71\ ft$$

Two braces would be needed for each rafter pair.

Collar Ties

In circumstances where it is desirable to have a ceiling that is higher than the exterior walls, or situations where a vaulted ceiling is preferred, collar ties can be substituted for ceiling joist. A collar tie is a form of ceiling joist that ties the rafters together at a plane that is higher than the bottom of the attic space. The building code requires modifications to the allowable span for rafters when collar ties are used instead of ceiling joists. The modifications are based upon a ratio of the distance that the collar ties are above the plane at the bottom of the attic and the total rise of the roof. Figure 9-102 shows an example of an installation where the collar tied is raised 16 inches above the top plate of the supporting walls.

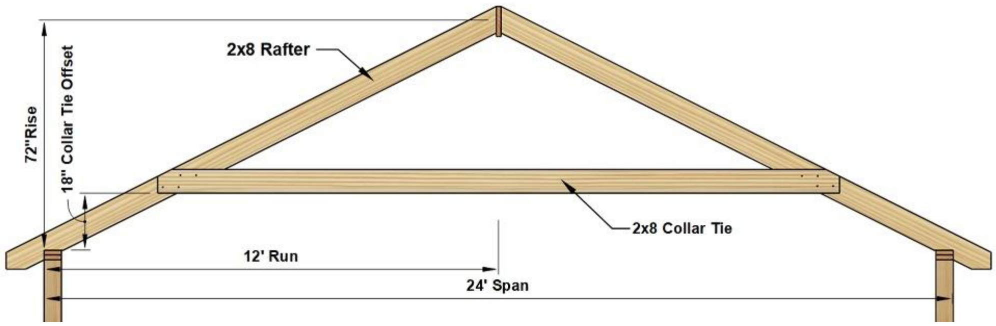


Figure 9-102 Roof framing with collar tie.

The total rise of the roof is approximately 72 inches high. The ratio is determined by dividing the distance above the top plate by the total rise.

$$\frac{18''}{72''} = 0.25$$

Table 9-3 shows the adjustment requirements for rafter size when collar ties are used.

Collar Tie Adjustment Table	
Collar Tie Height to Total Rise Ratio	**Rafter Span Adjustment Factor**
1/3	67%
1/4	76%
1/5	83%
1/6	90%
1/7.5 or less	100%

Table 9-3 Rafter span adjustment when using collar ties.

https://books.byui.edu/-WLYL

The ratio of 0.25 is equal to 1/4 (.25) and the adjustment factor of 76% will be used.

The maximum span allowed for the rafters will only be 76% of the maximum allowed by the code. Figure 9-103 shows an example from Table R802.5.1 (5) of the 2015 International Residential Building Code (IRC).

TABLE R802.5.1(1)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof live load=20 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans[a]									
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	SS	9-1	14-4	18-10	23-4	Note b	8-11	13-1	16-7	20-3	23-5
	Douglas fir-larch	#1	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas fir-larch	#2	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Douglas fir-larch	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

Figure 9-103 Rafter span table from the 2015 IRC.

https://codes.iccsafe.org/public/document/IRC2015/chapter-8-roof-ceiling-construction

Based upon a roof live load of 20 pounds per square foot and a dead load of 10 pounds per square foot, the maximum span allowed for #1 Douglas Fir/Larch lumber is 12'6" for a 2 × 6 rafter. Using this table shows that a 2 × 6 rafter would be sufficient for a building with a 24 foot span (12 foot run) if standard ceiling joist were used. However, using collar ties spaced up 18 inches above the top plate would require the allowable span to be reduced to 76 percent of the 13'6" maximum span. In this case, the span would be reduced to

12 ft 6 in x 0.76 = 9 ft 6 in

This would be insufficient for the project. The next largest size of 2 × 8 lumber has a maximum span of 15'10". Using the same formula, the maximum span in this situation would be

$$15\ ft\ 10\ in\ \times\ 0.76\ =\ 12\ ft\ 0\tfrac{13}{32}\ in$$

The 2 × 8 rafter material would meet the code requirement (Figure 9-104).

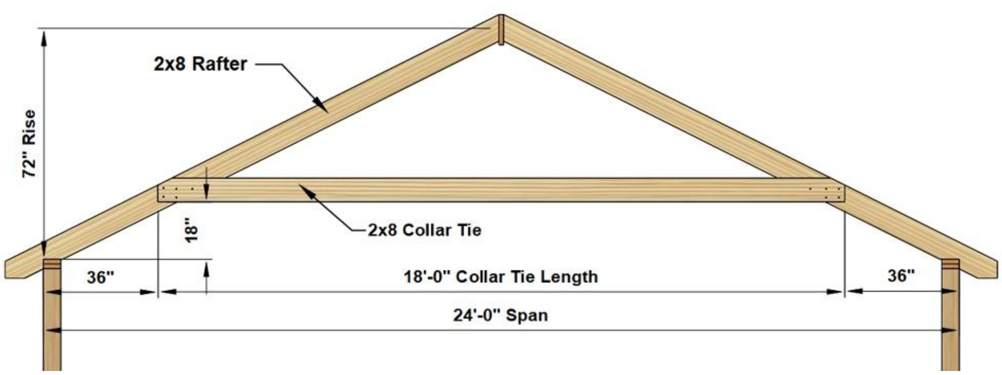


Figure 9-104 Collar tie.

The size of the collar tie will be determined by the building code. Figure 9-105 shows a portion of the 2015 IRC Table R802.4(1) for sizing ceiling joists with the #2 2 × 8 Douglas fir/larch lumber highlighted.

TABLE R802.4(1)—continued
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable attics without storage, live load = 10 psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	SS	10-5	16-4	21-7	Note a
	Douglas fir-larch	#1	10-0	15-9	20-1	24-6
	Douglas fir-larch	#2	9-10	14-10	18-9	22-11
	Douglas fir-larch	#3	7-8	11-2	14-2	17-4

Figure 9-105 Ceiling joist span table.

https://codes.iccsafe.org/public/document/IRC2015/chapter-8-roof-ceiling-construction

Based upon the live and dead load requirements for this situation, 2 × 6 Douglas fir-larch lumber can span a maximum distance of 18'9".

The length of the collar tie is determined by the roof slope and the collar tie offset distance. The roof is a 6/12 slope, and the distance above the top plate is equal to 18 inches.

First the roof slope and the distance above the top plate is used to determine the length that is subtracted from each side of the collar tie. The slope of 6/12 means that for every six inches of vertical rise of the roof, the horizontal run of the roof is 12 inches. The 18-inch distance of the collar tie above the top plate is divided by the six-inch vertical rise of the roof.

18 in Vertical Rise ÷ 6 in Slope Rise = 3

This number is multiplied by the 12-inch horizontal run.

3 x 12 in Horizontal Run = 36 in

This is the amount that is subtracted from each side of the roof span to calculate the length of the collar tie.

$$24\ ft\ Span\ -\ (2\ \times\ \frac{36\ in}{12\ in})$$

or

24 ft Span - (2 x 3 ft) = 18 ft

Estimating the number of collar ties is a matter of counting the number of rafter pairs. The number of collar ties would be equal to the number of rafter pairs as each rafter pair would be joined with a collar tie.

Collar ties are limited by the building code to a vertical rise of no more than 1/3 of the total rise of the roof. When a higher ceiling is desired on a rafter framed roof, a ridge beam will be needed.

Ridge Beams

Ridge beams are structural beams that are used in place of a ridge board to support the roof structure. They are structural beams that typically support half of the load of the roof. Ridge beams, like floor girders, can be constructed of a number of materials, including solid lumber, built-up framing lumber, or engineered materials such as glulam lumber, LVL lumber, or parallel strand lumber. The size of the beam is determined by the roof load, both live load and dead load, the span of the roof, the length of the beam, and the carrying capacity of the beam material. Ridge beams can be installed below the rafters to carry the load (Figure 9-106).

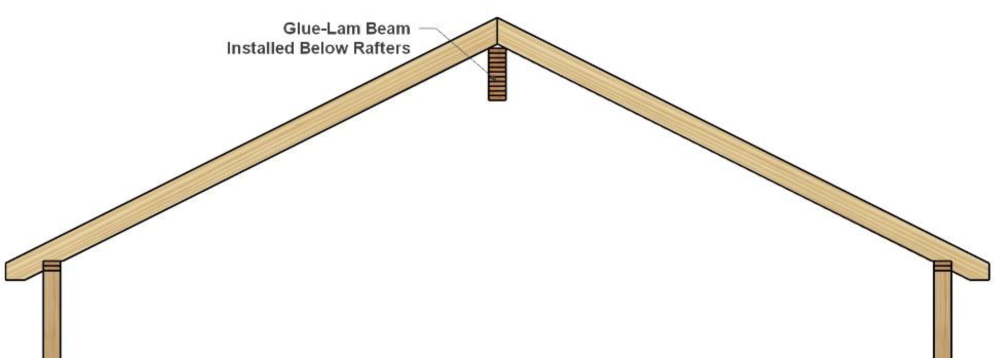


Figure 9-106 Glulam beam installed below rafters.

Glulam beams may be installed flush with the rafter and in this case hangers will be required to attach the rafters to the beam (Figure 9-107).

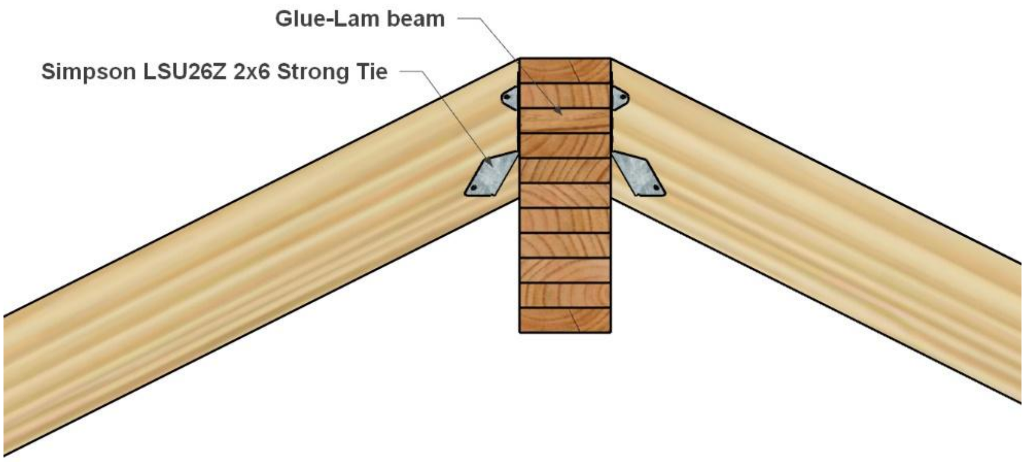
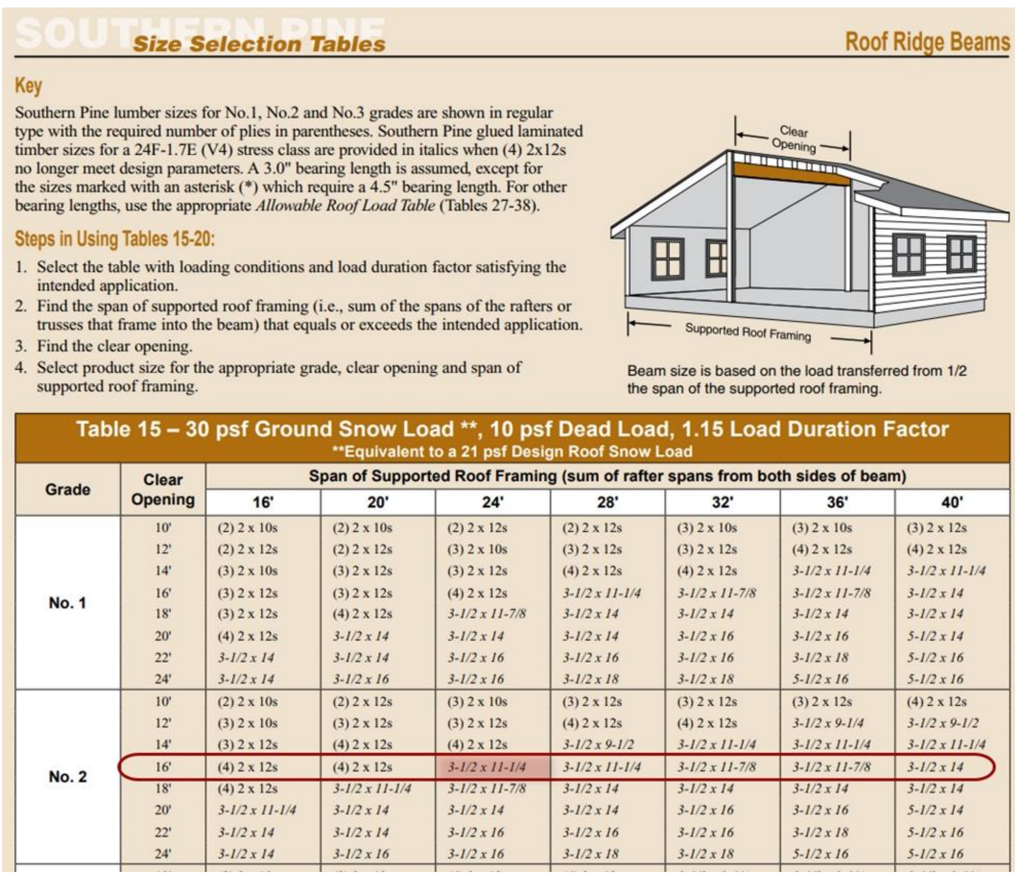


Figure 9-107 Rafters attached flush with beam top.

Span charts (Figure 9-108) can be used to determine the size of a required beam based upon the loads, beam length, and building width. Using the example of a building that is 24 feet wide and has a live load requirement of 30 pounds per square foot and a dead load requirement of 10 pounds per square foot, a single glulam beam constructed of number two Southern Pine lumber would need to be a minimum of 3½ inches wide and 11¼ inches tall to span a clear opening distance of 16'.



SOUTHERN PINE *Size Selection Tables*

Roof Ridge Beams

Key

Southern Pine lumber sizes for No.1, No.2 and No.3 grades are shown in regular type with the required number of plies in parentheses. Southern Pine glued laminated timber sizes for a 24F-1.7E (V4) stress class are provided in italics when (4) 2x12s no longer meet design parameters. A 3.0" bearing length is assumed, except for the sizes marked with an asterisk (*) which require a 4.5" bearing length. For other bearing lengths, use the appropriate *Allowable Roof Load Table* (Tables 27-38).

Steps in Using Tables 15-20:

1. Select the table with loading conditions and load duration factor satisfying the intended application.
2. Find the span of supported roof framing (i.e., sum of the spans of the rafters or trusses that frame into the beam) that equals or exceeds the intended application.
3. Find the clear opening.
4. Select product size for the appropriate grade, clear opening and span of supported roof framing.

Clear Opening

Supported Roof Framing

Beam size is based on the load transferred from 1/2 the span of the supported roof framing.

Table 15 – 30 psf Ground Snow Load **, 10 psf Dead Load, 1.15 Load Duration Factor
**Equivalent to a 21 psf Design Roof Snow Load

Grade	Clear Opening	Span of Supported Roof Framing (sum of rafter spans from both sides of beam)						
		16'	20'	24'	28'	32'	36'	40'
No. 1	10'	(2) 2 x 10s	(2) 2 x 10s	(2) 2 x 12s	(2) 2 x 12s	(3) 2 x 10s	(3) 2 x 10s	(3) 2 x 12s
	12'	(2) 2 x 12s	(2) 2 x 12s	(3) 2 x 10s	(3) 2 x 12s	(3) 2 x 12s	(4) 2 x 12s	(4) 2 x 12s
	14'	(3) 2 x 10s	(3) 2 x 12s	(3) 2 x 12s	(4) 2 x 12s	(4) 2 x 12s	*3-1/2 x 11-1/4*	*3-1/2 x 11-1/4*
	16'	(3) 2 x 12s	(3) 2 x 12s	(4) 2 x 12s	*3-1/2 x 11-1/4*	*3-1/2 x 11-7/8*	*3-1/2 x 11-7/8*	*3-1/2 x 14*
	18'	(3) 2 x 12s	(4) 2 x 12s	*3-1/2 x 11-7/8*	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 14*
	20'	(4) 2 x 12s	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 16*	*3-1/2 x 16*	*5-1/2 x 14*
	22'	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 16*	*3-1/2 x 16*	*3-1/2 x 16*	*3-1/2 x 18*	*5-1/2 x 16*
	24'	*3-1/2 x 14*	*3-1/2 x 16*	*3-1/2 x 16*	*3-1/2 x 18*	*3-1/2 x 18*	*5-1/2 x 16*	*5-1/2 x 16*
No. 2	10'	(2) 2 x 10s	(2) 2 x 12s	(3) 2 x 10s	(3) 2 x 12s	(3) 2 x 12s	(3) 2 x 12s	(4) 2 x 12s
	12'	(3) 2 x 10s	(3) 2 x 12s	(3) 2 x 12s	(4) 2 x 12s	(4) 2 x 12s	*3-1/2 x 9-1/4*	*3-1/2 x 9-1/2*
	14'	(3) 2 x 12s	(4) 2 x 12s	(4) 2 x 12s	*3-1/2 x 9-1/2*	*3-1/2 x 11-1/4*	*3-1/2 x 11-1/4*	*3-1/2 x 11-1/4*
	16'	(4) 2 x 12s	(4) 2 x 12s	*3-1/2 x 11-1/4*	*3-1/2 x 11-1/4*	*3-1/2 x 11-7/8*	*3-1/2 x 11-7/8*	*3-1/2 x 14*
	18'	(4) 2 x 12s	*3-1/2 x 11-1/4*	*3-1/2 x 11-7/8*	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 14*
	20'	*3-1/2 x 11-1/4*	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 16*	*3-1/2 x 16*	*5-1/2 x 14*
	22'	*3-1/2 x 14*	*3-1/2 x 14*	*3-1/2 x 16*	*3-1/2 x 16*	*3-1/2 x 16*	*3-1/2 x 18*	*5-1/2 x 16*
	24'	*3-1/2 x 14*	*3-1/2 x 16*	*3-1/2 x 16*	*3-1/2 x 18*	*3-1/2 x 18*	*5-1/2 x 16*	*5-1/2 x 16*

Figure 9-108 Span table for Southern Pine beams.

http://www.southernpine.com/app/uploads/SS_15-20L.pdf

Estimating ridge beams is usually a count and list process where the beam quantity, size, and cost are calculated individually.

Truss Roof Framing

Since the development of the metal-plate connector truss system in the 1950's, truss roof framing continues to increase in popularity, and it is estimated that currently 80 percent of new residential construction utilizes pre-manufactured roof truss systems. Truss roof framing has several distinct advantages of conventional stick framed roofs.

Truss roof components are assembled in manufacturing facilities using automated equipment. Their assembly requires less time and skill than cutting and assembling stick framed components on the job site. Manufactured trusses can be made using smaller and cheaper pieces of lumber, yet they are very strong and able to span larger distances than conventional framed roofs. This allows for more open design and eliminates interior load bearing walls. Less time is usually needed on the job site for the roof framing, which helps the contractor get the roof completed and the building weather in faster.

Disadvantages of truss roof framing can be the size of the truss members, which may require the assistance of large equipment and cranes on the job site. In addition, there may be longer lead times required for ordering trusses and having them delivered to the job.

The development of computer truss design software has also increased significantly the type and styles of trusses that are available and allows for almost unlimited possibilities for truss roof design.

Truss Styles

Dozens of basic truss styles and designs are available to meet specific project needs. General category types would include standard gable roof style trusses, modified interior ceiling trusses, specialty roof style trusses, and service trusses.

Standard Gable Style Roof Trusses

Standard gable style roof trusses include Fink, Howe, fan, king post, and queen post trusses as well as modified versions of each of these. Figures 9-109 and 9-110 show examples of standard and modified standard truss configurations.

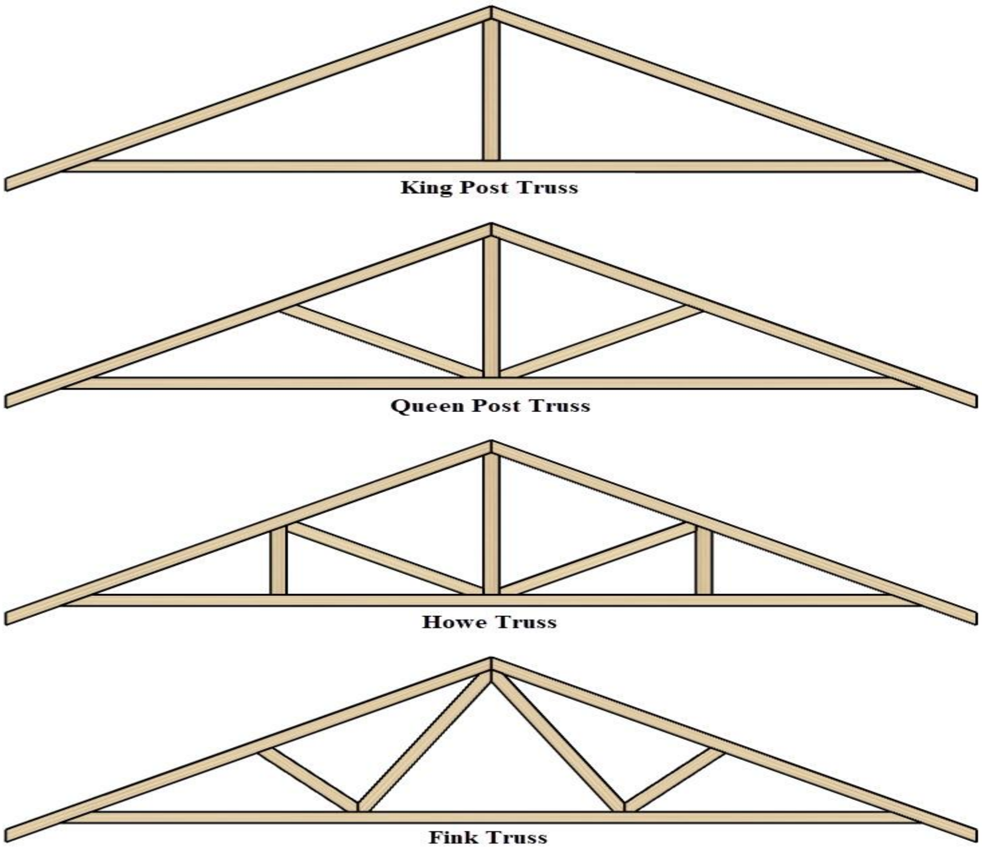


Figure 9-109 Standard gable style roof trusses.

Standard style trusses are also available in modified styles that provide additional structural support (Figure 9-110).

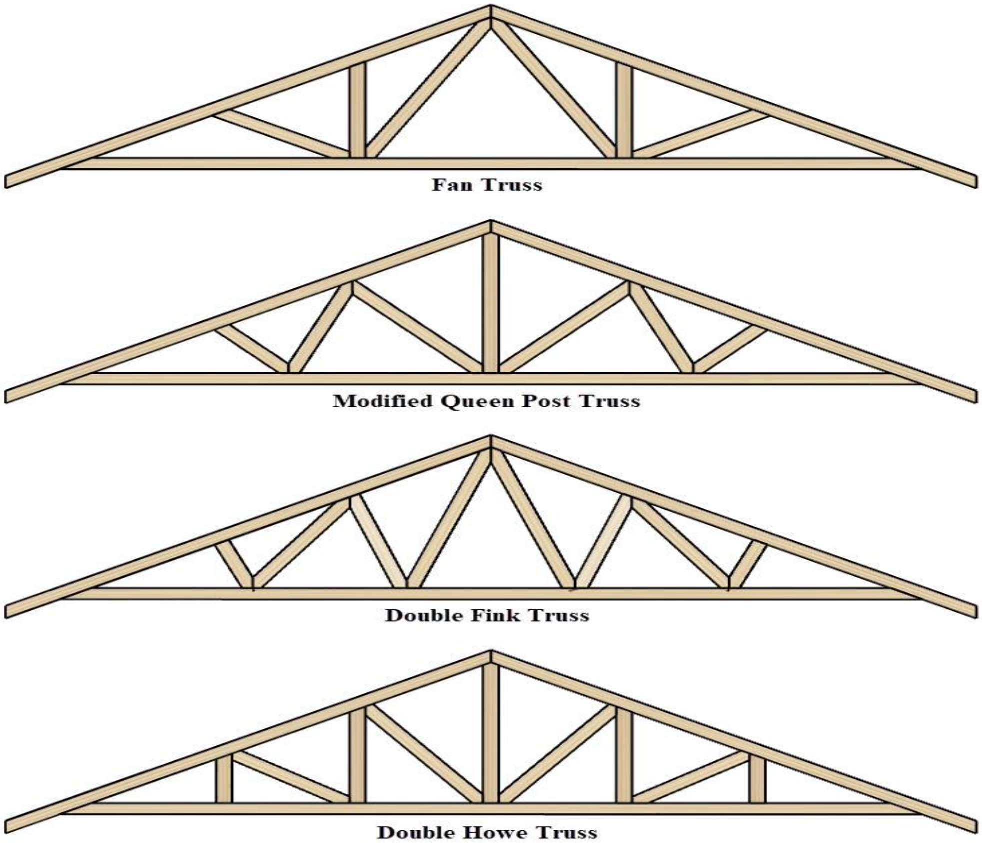


Figure 9-110 Standard and modified gable trusses.

Modified Interior Ceiling Type Truss Configurations

Trusses can be designed for interior ceiling configurations such as cathedral or sloped ceiling. These include scissor, cambered, cathedral, and studio type ceilings. Figure 9-111 shows some examples of these truss configurations.

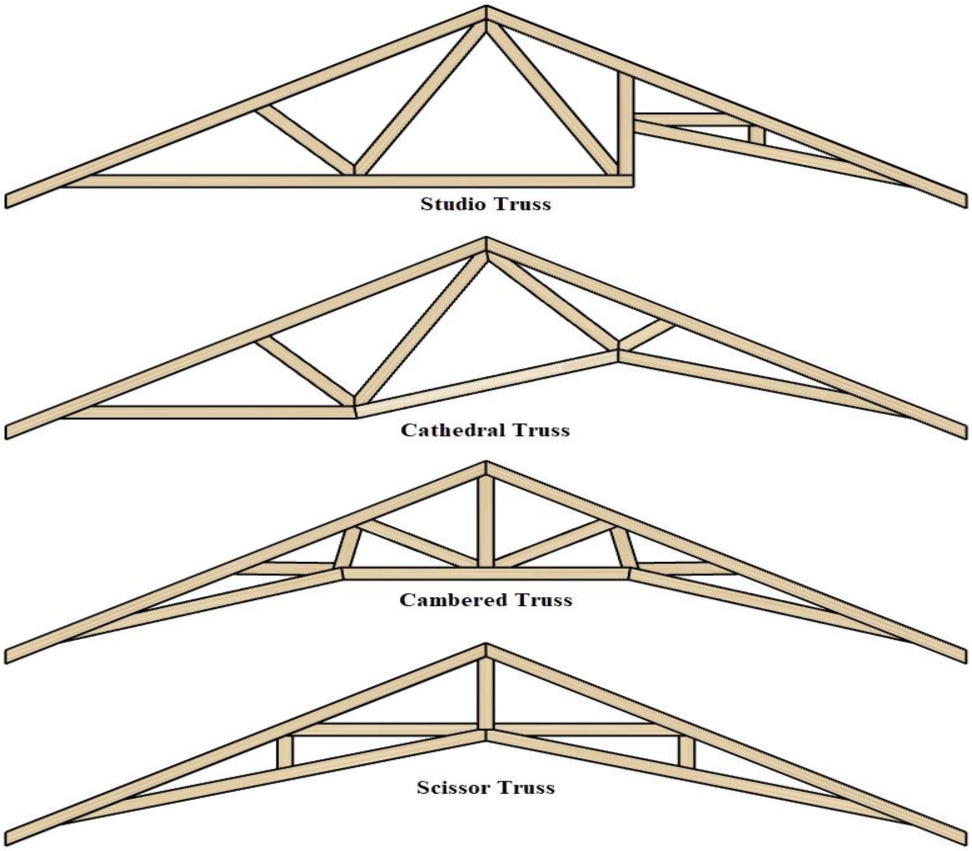


Figure 9-111 Modified ceiling truss configurations.

Specialty Truss Configurations

Specialty truss configurations are available in different shapes and styles. Some common specialty types include girder trusses, gable end trusses, hip trusses, mono pitch trusses, and jack trusses.

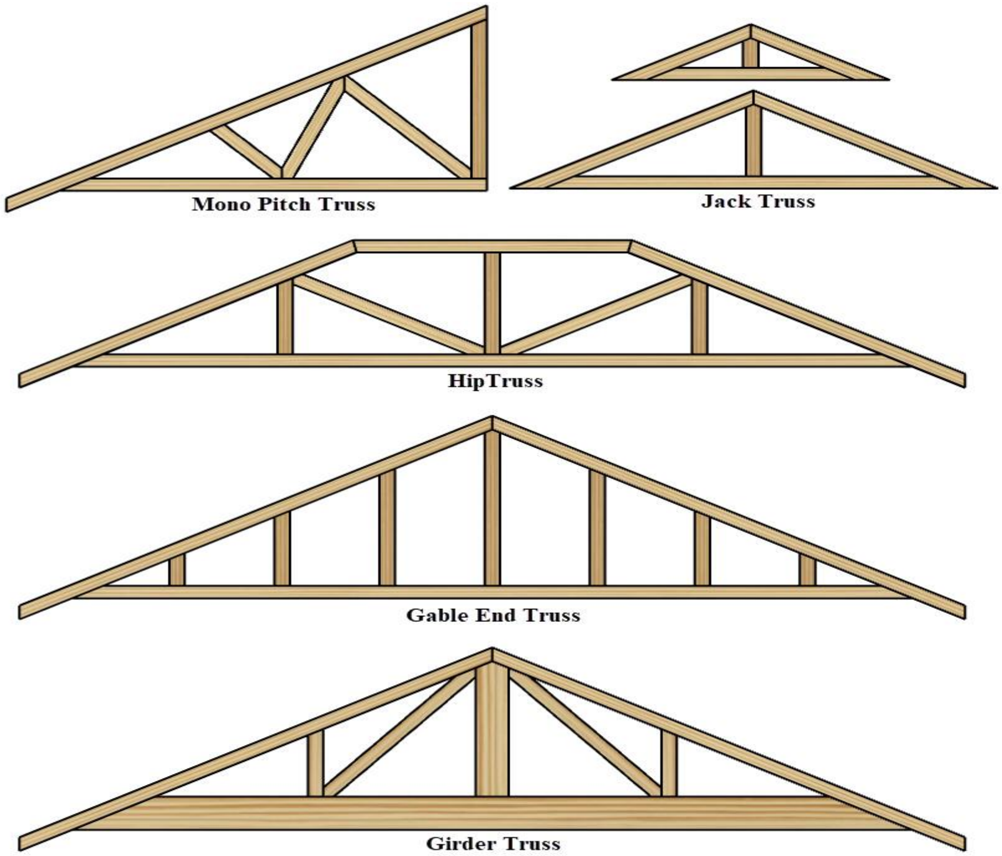


Figure 9-112 Specialty truss configurations.

Girder trusses are used to carry the load of other trusses. Examples of girder truss usage includes where trusses meet to form intersecting valleys. They have larger bottom plates and other heavier components to carry the load of the supporting trusses. Often multiple girder trusses are placed together to increase the carrying capacity.

Gable end trusses are used on the gable ends for attaching wall sheathing and exterior finishes. Gable end trusses, which have only vertical web members, are not considered load bearing trusses; the walls supporting the trusses require load bearing headers above all openings. Special gable end trusses can be manufactured with angled web members to make them load bearing. In addition, gable end trusses can be manufactured with top chord lowered down a distance so that gable end lookouts can cantilever over the top of the gable end truss to support the barge rafter.

Hip trusses are used in conjunction with other specialty trusses such as mono pitch trusses to construct hip style truss roofs. Jack trusses are used to complete a roof that forms intersecting gable roofs. Each truss in a package of jack trusses is consistently smaller in size to form the valley of the roof.

Truss Plans and Drawings

Truss designers use sophisticated computer software to design truss roof systems. The advancement in the ability of computer software and systems has contributed to the increasing popularity of truss roof systems and the ability to design and deliver more complex truss roof systems. Using the software, the designer is able to design the roof and test that it will be able to withstand the needed loads. The truss designer will prepare a number of drawings and details outlining the specific truss design and placement for each project. Figure 9-113 shows a truss plan with six truss configurations. It also shows the location and placement of each truss.

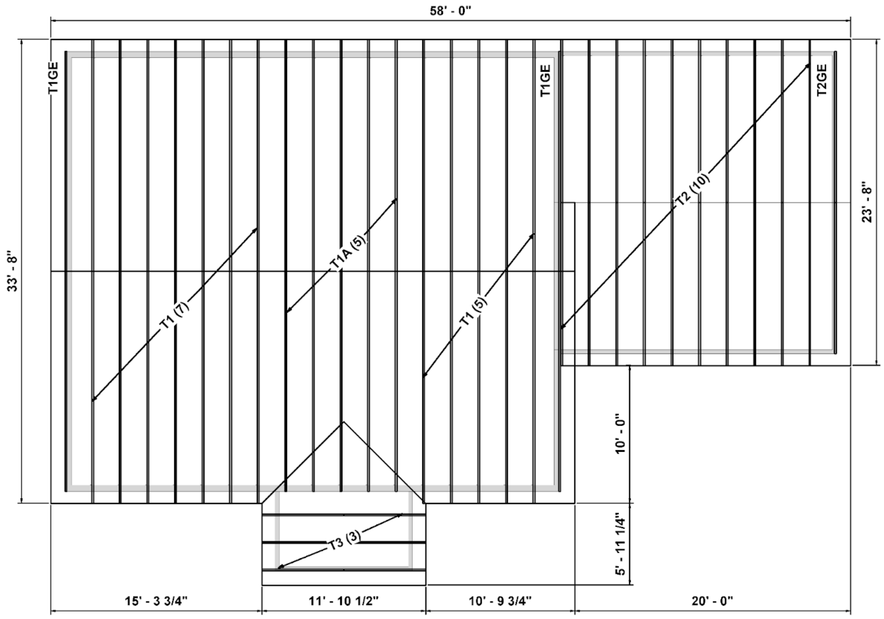


Figure 9-113 Truss plan with six truss configurations

Figure 9-114 shows the cover sheet of a truss plan. Information about the project is included on the sheet. Each truss for the project is identified both with a name and small graphic. Specific details about each truss size is also included.

Standard Truss and Supply LLC
2355 S. Yellowstone Hwy.
St. Anthony, ID 83445
(208) 624 8787

To:
Brigham Young
University
525 South Center Street
Rexburg, Idaho
83460-1030

Quotation
Job Number: B6110001
Page: 1
Date: 6/14/18

Project: Estimating Textbook Arts and Crafts House Model:
Block No:
Lot No:

Contact:	Site:	Office:
Name:	Brian Blaylock	Brian Blaylock
Phone:		
Fax:		

Tenative Delivery Date:

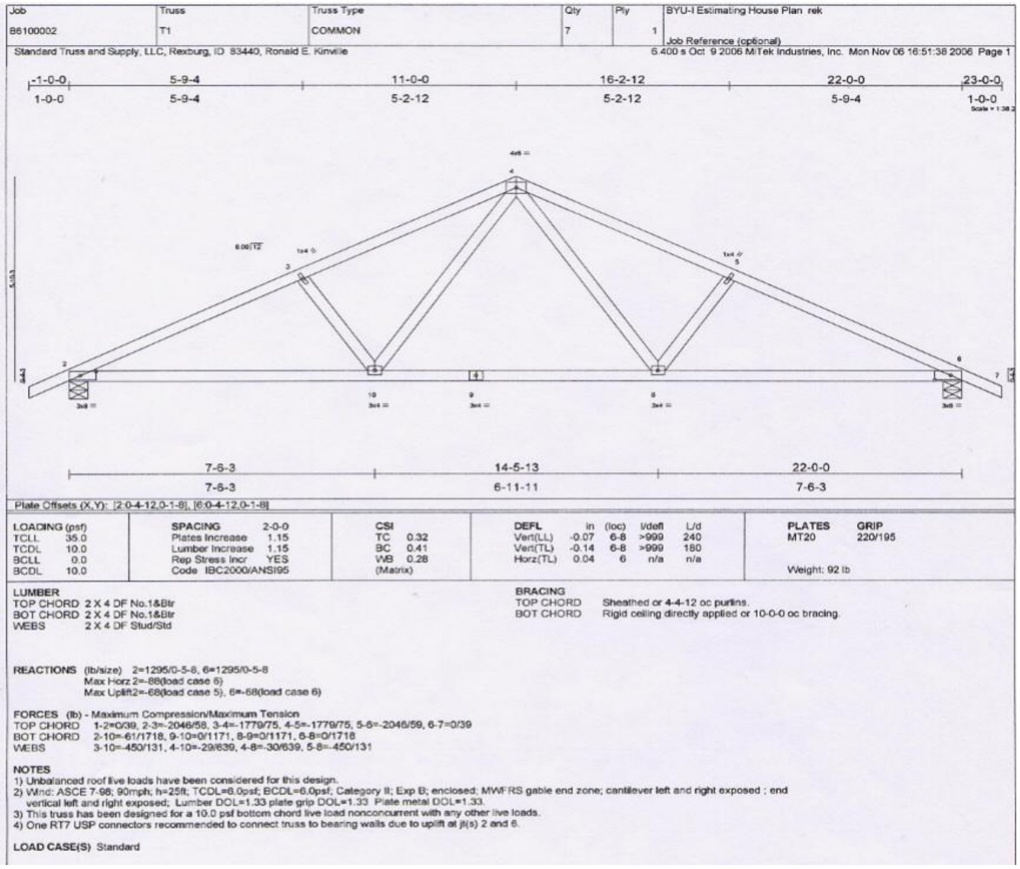
Deliver To:

Account No: 6569407
Designer: REK
Salesperson: Ron Kinville
Quote Number: B6100001
P.O. Nimber:

Profile:	Qty:	Pitch		Type ID:	Base Span	O/A Span	Overhang	
		Top	Bottom				Left	Right
	12	6	0	Fink T1	32.00	32.00	1.00	1.00
	5	6	0	Fink T1A	32.00	32.00	1.00	0.00
	10	6	0	Fink T2	22.00	22.00	1.00	1.00
	3	6	0	Fink T3	11.00	11.00	1.00	1.00
	2	5	0	Gable T1GE	32.00	32.00	0.00	0.00
	1	5	0	Gable T2GE	22.00	22.00	0.00	0.00

Figure 9-114 Cover sheet of a truss order shows specific details about the order.

Each truss configuration will also have a detail sheet that shows the specific construction details for each truss, including specific size and engineering information like the load carrying ability of the truss. An example of a Fink truss configuration is shown in Figure 9-115.



Job	Truss	Truss Type	Qty	Ply	BYU-I Estimating House Plan rek
B6100002	T1	COMMON	7	1	Job Reference (optional)

Standard Truss and Supply, LLC, Rexburg, ID 83440, Ronald E. Kinville — 6.400 s Oct 9 2006 MiTek Industries, Inc. Mon Nov 06 16:51:38 2006 Page 1

-1-0-0 | 5-9-4 | 11-0-0 | 16-2-12 | 22-0-0 | 23-0-0
1-0-0 | 5-9-4 | 5-2-12 | 5-2-12 | 5-9-4 | 1-0-0

7-6-3 | 14-5-13 | 22-0-0
7-6-3 | 6-11-11 | 7-6-3

Plate Offsets (X,Y): [2:0-4-12,0-1-8], [6:0-4-12,0-1-8]

LOADING (psf)	SPACING 2-0-0	CSI	DEFL in (loc) l/defl L/d	PLATES GRIP
TCLL 35.0	Plates Increase 1.15	TC 0.32	Vert(LL) -0.07 6-8 >999 240	MT20 220/195
TCDL 10.0	Lumber Increase 1.15	BC 0.41	Vert(TL) -0.14 6-8 >999 180	
BCLL 0.0	Rep Stress Incr YES	WB 0.28	Horz(TL) 0.04 6 n/a n/a	
BCDL 10.0	Code IBC2000/ANSI95	(Matrix)		Weight: 92 lb

LUMBER
TOP CHORD 2 X 4 DF No.1&Btr
BOT CHORD 2 X 4 DF No.1&Btr
WEBS 2 X 4 DF Stud/Std

BRACING
TOP CHORD Sheathed or 4-4-12 oc purlins.
BOT CHORD Rigid ceiling directly applied or 10-0-0 oc bracing.

REACTIONS (lb/size) 2=1295/0-5-8, 6=1295/0-5-8
Max Horz 2=-88(load case 6)
Max Uplift2=-68(load case 5), 6=-68(load case 6)

FORCES (lb) - Maximum Compression/Maximum Tension
TOP CHORD 1-2=0/39, 2-3=-2046/58, 3-4=-1779/75, 4-5=-1779/75, 5-6=-2046/59, 6-7=0/39
BOT CHORD 2-10=-61/1718, 9-10=0/1171, 8-9=0/1171, 6-8=0/1718
WEBS 3-10=-450/131, 4-10=-29/639, 4-8=-30/639, 5-8=-450/131

NOTES
1) Unbalanced roof live loads have been considered for this design.
2) Wind: ASCE 7-98; 90mph; h=25ft; TCDL=6.0psf; BCDL=6.0psf; Category II; Exp B; enclosed; MWFRS gable end zone; cantilever left and right exposed ; end vertical left and right exposed; Lumber DOL=1.33 plate grip DOL=1.33 Plate metal DOL=1.33.
3) This truss has been designed for a 10.0 psf bottom chord live load nonconcurrent with any other live loads.
4) One RT7 USP connectors recommended to connect truss to bearing walls due to uplift at jt(s) 2 and 6.

LOAD CASE(S) Standard

Figure 9-115 Individual detail sheet for a Fink truss configuration.

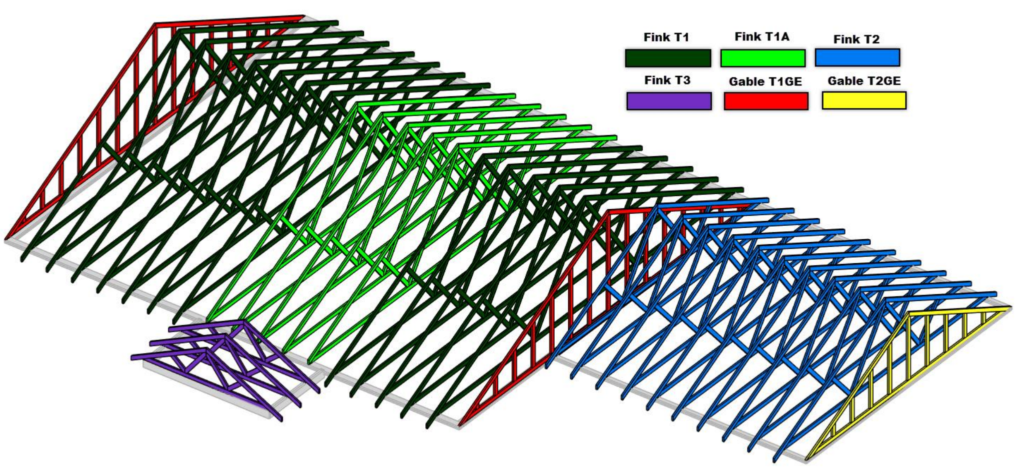


Figure 9-116 Fink truss configuration diagram

Roof Truss Overhang Framing Members

In addition to the individual truss members, truss roof framing typically requires additional onsite overhang framing members including sub-fascia, barge rafters, and gable end lookouts.

Sub-Fascia

The horizontal sub-fascia is installed at the base edge of the roof, similar to the installation with conventional framed roofing. When an overhang is desired along the horizontal roof edge, the truss members are usually fabricated so that the top chord of the truss extends past the building edge with a tail to form the horizontal roof edge. A sub-fascia piece is attached to truss tail. The sub-fascia members are commonly made from 2 × 4 material, but 2 × 6 and wider material can also be used.

Barge Rafters

If a roof overhang is wanted on the gable end of the building, barge rafters will need to be installed. The sizing and construction of barge rafters in truss roof construction is the same as with conventional stick framed roof construction. The layout of the rafter and the angle of the cuts are determined using mathematics, a framing square, or a rafter length multiplication factor based upon the slope and total run of the roof, as has been previously discussed. The barge rafters are typically supported by gable end lookouts, the same as is done with conventional stick roof framing.

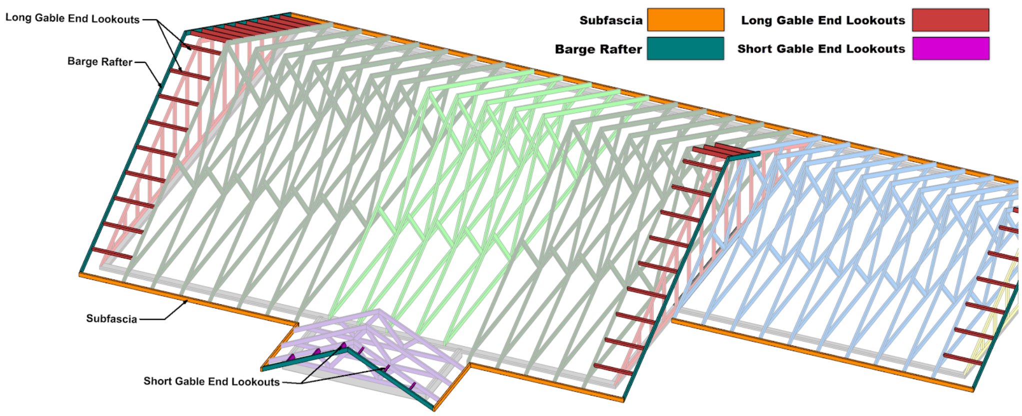


Figure 9-117 Barge rafter and gable diagram

Gable End Lookouts.

The gable end lookouts are horizontal roof members that extend from the trusses to the support for the barge rafters. Lookouts may be long or short depending upon the overhang of the gable end. Short gable end lookouts are attached directly to the gable end rafter in a fashion similar to conventional roof framing. Gable ends with longer overhang often use longer lookouts that are attached to the first truss inside of the gable end truss. The gable end truss is fabricated, with the top chord lowered down the width of the lookout material, and the lookouts rest upon and cantilever past the edge of the gable roof. The barge rafters are attached to the lookouts. Estimating gable end lookout is a matter of determining the length of the lookouts, either long or short, and multiplying by the number of lookouts.

Truss Roof Bracing

Truss roof framing requires bracing to strengthen and support the roof. A minimum amount of bracing typically requires three types of bracing, which includes top chord bracing, bottom chord bracing, and diagonal bracing (gable end bracing) (Figure 9-118).

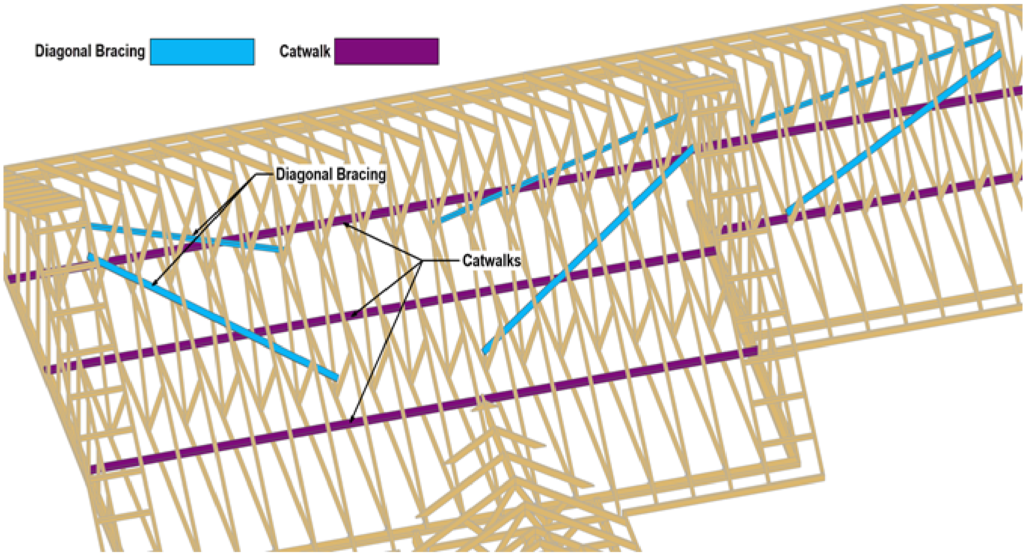


Figure 9-118 Truss roof bracing showing catwalks and diagonal bracing.

Top Chord Bracing

The solid roof sheathing made of either plywood or OSB often can satisfy the top chord sheathing requirement. When a roof does not have sheathing such as could be the case when sheet metal roofing is installed, horizontal bracing will need to be installed along the top chord of the trusses.

Bottom Chord Bracing

Bottom chord bracing is often provided by attaching a horizontal ribbon of framing material attached across the top of the bottom chord of the truss. This type of bracing is frequently called the “catwalk.” This can be made from 2 × 4 or 2 × 6 framing lumber.

When the length of the catwalk requires multiple pieces of lumber, the pieces are joined by lapping over each piece by at least the distance of one rafter spacing interval. Bottom chord bracing is usually spaced at 8' to 10' intervals across the roof width. Figure 9-118 shows roof truss construction with catwalks along the length of the main house and two catwalks along the length of the garage.

Diagonal Bracing

Diagonal or gable end bracing is attached at an angle from the gable end of the roof to a point inside of the roof. The diagonal bracing can attach to vertical truss chord members, or it can be attached at an angle across the web bracing of the trusses. The diagonal bracing can be installed at a single sloped angle or in an X fashion. The height and width of the trusses determine the length of the diagonal brace. Typically, a 12' to 16' length of lumber will suffice for each diagonal brace. Figure 9-117 shows a roof with six diagonal braces, each approximately 14' long. Figure 9-119 shows a truss roof installation with diagonal X bracing and a catwalk.

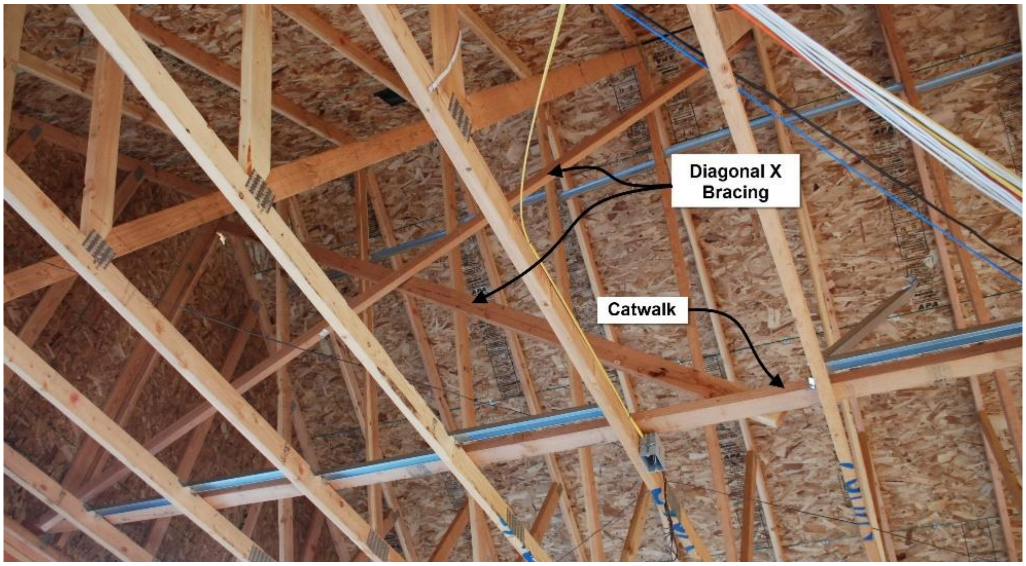


Figure 9-119 Diagonal X bracing and catwalks

Truss Roof Overbuild

On occasion, truss framing roof construction will require additional roof framing or roof overbuild framing. A specialty set of jack trusses can be made to fill in overbuild sections, however, contractors often elect to stick framing in the overbuild section rather than purchase additional small trusses. These trusses can be quite expensive for their size as they take time and effort to make multiple one-off truss instances of trusses. Figure 9-120 shows a truss roof with a couple of small roof overbuilds.


Figure 9-120 Truss roof with several small overbuild roofs.

Figure 9-121 shows an example of the stick framed portion of the front porch roof. The portion of the truss roof underneath the overbuild is covered with roof sheathing and the overbuild built on top of it.

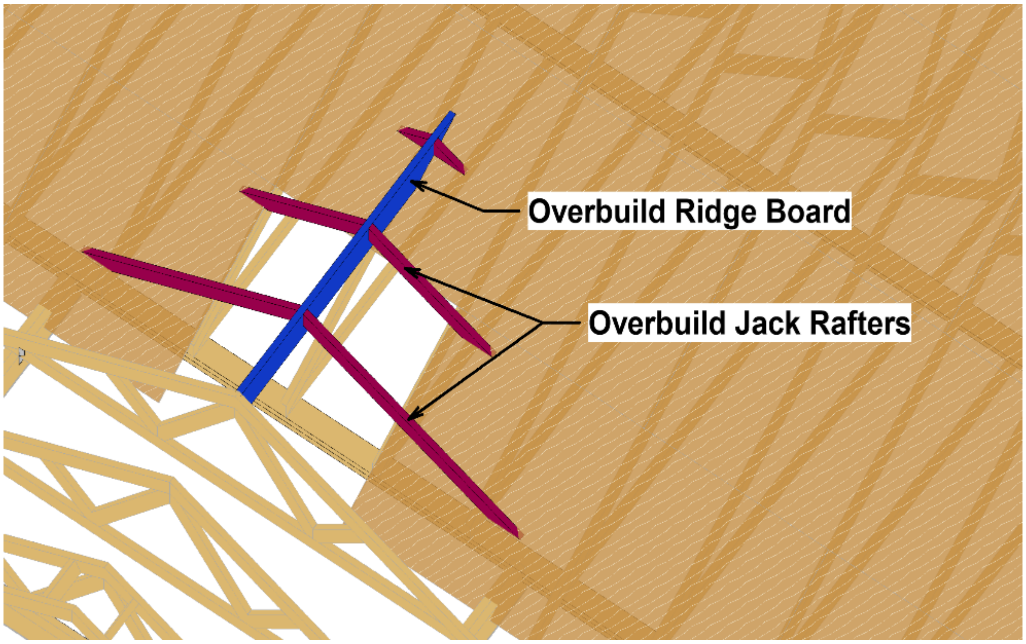


Figure 9-121 Front porch overbuild roof framing.

Seven individual pieces make up the overbuild framing. Six jack rafters and one ridge board. The truss plans in Figure 9-122 show the front porch section of the roof with a span of 11'10 ½" wide, which could be rounded up to 12' and a run of 6'. The ridge board would be equal to the 6' span, and the length of the longest rafter would be based upon the rise and run of the 6' span and 6 in slope.

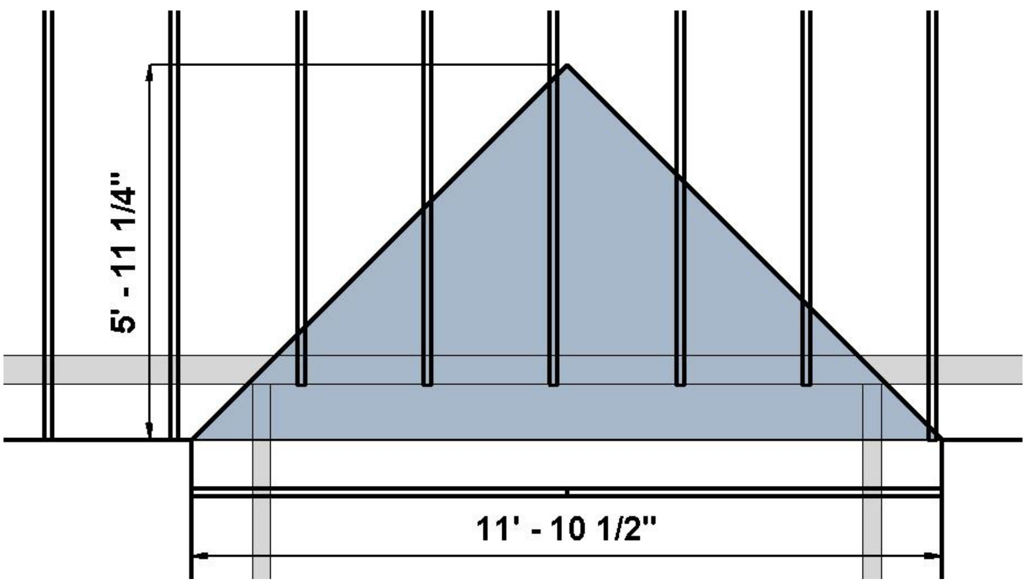


Figure 9-122 Front porch overbuild triangle.

The rise would be equal to 36 inches, and the rafter length could be calculated using the run and the slope factor of 13.42 from Table 9-2.

$$\text{Rafter Length} = 72 \text{ in.} \times 13.42 \div 12 = 80.64 \text{ in.}$$

The difference in length of rafter space 24 inches apart from Figure 9-91 is given as 26.81 inches. Each jack rafter would decrease in size by that amount for a total of

Jack Rafter 1: 2 pcs 80.64 in.

Jack Rafter 2: 2 pcs. 54 in.

Jack Rafter 3: 2 pcs. 27.16 in.

Framing Connectors

Each project will require different truss anchors, depending upon the truss style. Framing anchors are often identified on the plans using a framing connector legend that identifies framing connectors by type using a standard symbol with the connecter identified on the plan by the symbol. Figure 9-121 shows an example of a framing connector legend. Often, the connector legend will be a standard architectural detail identifying a number of common framing connectors, not all of which are used on that specific project. In addition, the framing connector may be identified by annotations or notes on the plans, such as is the case in Figure 9-123 that shows a small section of a roof framing plan that contains several structural framing tags and annotations. Framing connector 7 represents a Simpson ST22515 Strap tie; framing connector represents a Simpson H2.5 hurricane anchor. There is also an annotation explaining that a Simpson H2.5 framing connector is located on the end of each truss. The abbreviation "Typ." suggests that this is a common detail on each truss end. This annotation eliminates the need to tag every H2.5 framing connector, as this could make the drawing over-cluttered.

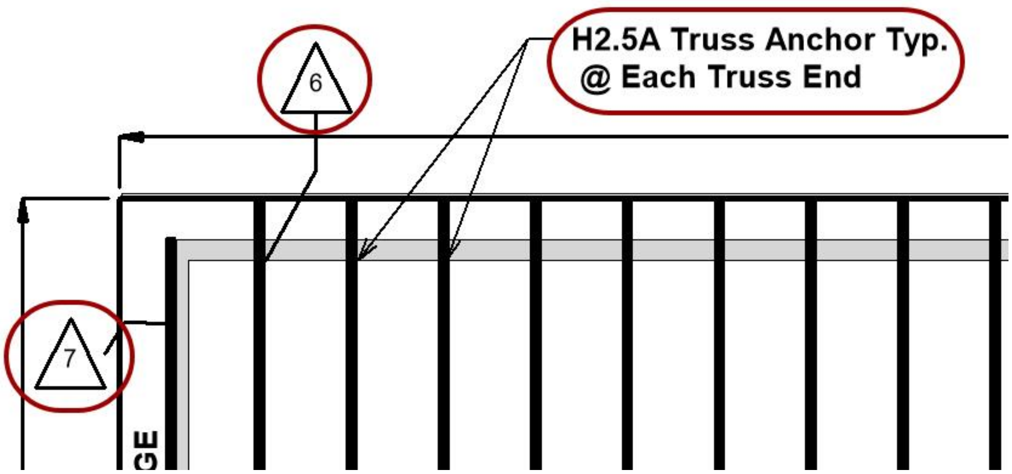


Figure 9-123 Section of roof framing plan showing framing connector symbols and annotations.

It is the construction estimating professional's responsibility to identify the framing connectors on the project from the plans and specifications and make an accurate count of the connectors required. Several types of metal truss anchors are usually required with truss roof installation. Common examples of required anchors include hurricane anchors, U type hangers, and strap anchors.

Hurricane Anchors

Hurricane anchors are the most common type of roof truss anchors that are required. A hurricane anchor attaches the roof truss to the top plates, studs, and the wall framing. There are multiple types of hurricane anchors that can be used; some are more applicable than others in a given situation. Figure 9-124 shows an example of two common types of truss anchors: H1 and H2 truss anchors. Hurricane anchors are typically required on each truss, as it is attached to the exterior supporting walls.

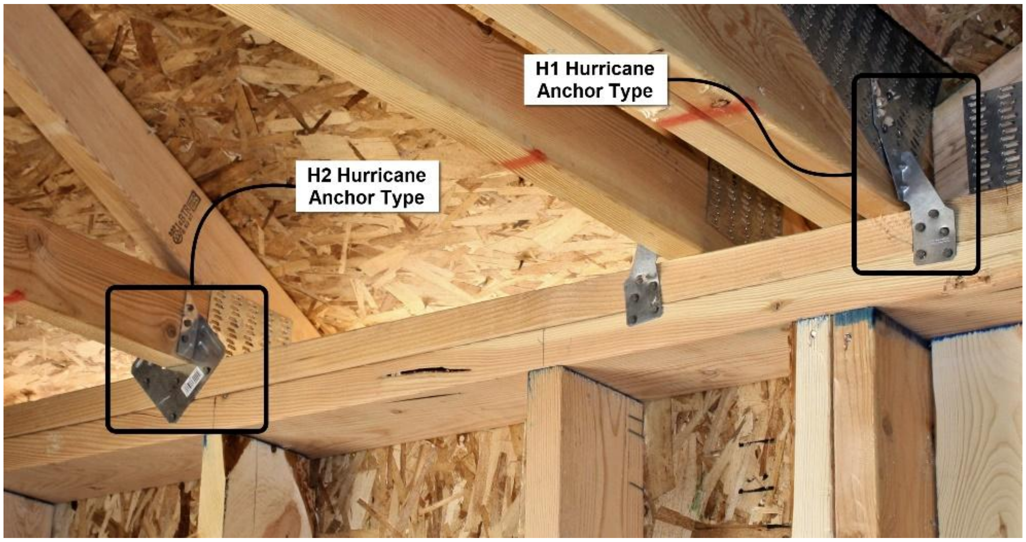


Figure 9-124 H1 and H2 style hurricane anchors.

U Type Hangers

U type anchors are typically required when one truss is supported by another truss, such as when a girder truss has trusses attached to it. Several types of U type hangers can be required, such as single U type hangers, double U type hangers, or angled hangers. Figure 9-125 shows an example of two types of U type hangers: a single 2 × 4 U type hanger and an angled U type hanger.

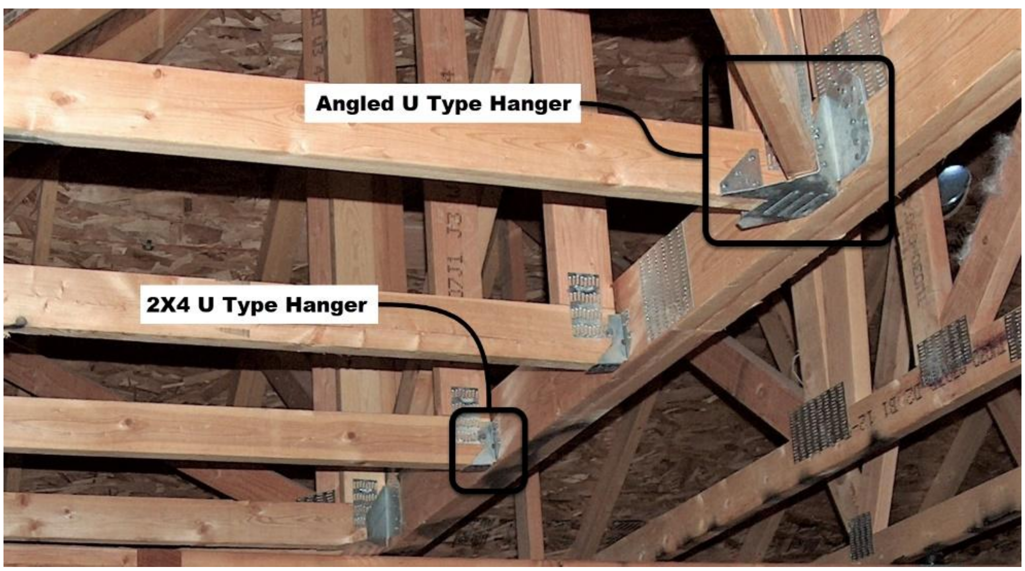


Figure 9-125 Two types of U type truss hangers.

Strap Tie Anchors

Strap tie anchors are used in high wind or earthquake areas to tie framing elements together such as floors and the walls or the roofs and the walls. Figure 9-126 shows an example of strap tie anchors placed between the exterior walls and the gable end trusses.

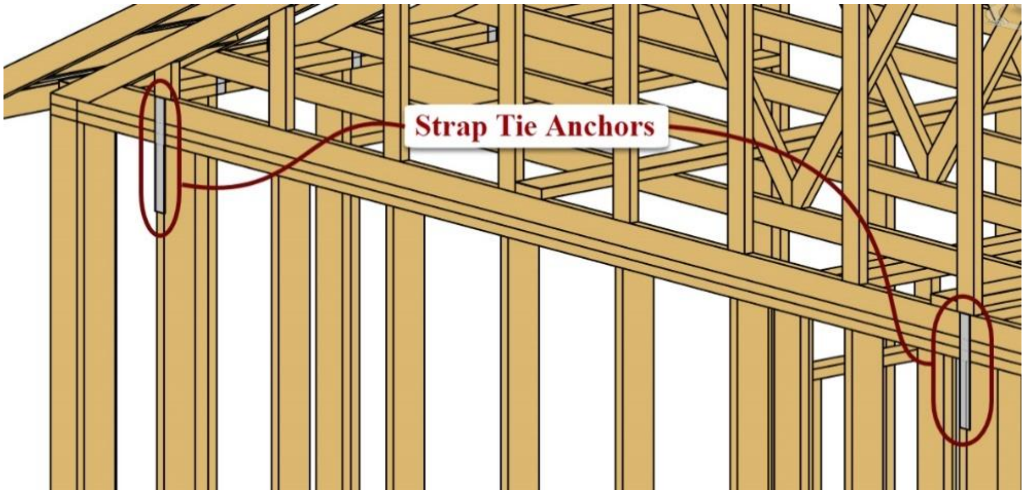


Figure 9-126 Strap tie anchors between the exterior wall and gable end truss.

Roof Sheathing

Roofs are commonly framed with plywood or OSB sheathing material. Thickness of 7/16 inch, 1/2 inch, or 5/8 inch are most often used. Thicker sheathing can be used on some roofs with heavier roof loads or wider truss spans. Figure 9-127 shows one half in OSB sheathing delivered to the job site in preparation for installation on the roof.


Figure 9-127 One half inch OSB sheathing at the job site ready for installation on the roof.

Roof sheathing typically calculated by the square footage of sloped roof area. The slope roof area can be determined by multiplying the square footage of flat roof area by the roof slope factor. Figure 9-128 shows a roof with the first layer of OSB sheathing installed. Figure 9-129 shows the roof sheathing completed.


Figure 9-128 Roof with the first layer of OSB sheathing installed.

Figure 9-129 Complete OSB sheathing on a roof.

Soffit Ledger

Soffit ledger boards are installed on the exterior wall level with the horizontal fascia. They are used to attach the exterior finish soffit material, particularly wood soffit finish. Soffit ledgers are also commonly used to support the Soffit J Channel when installing aluminum or vinyl soffit. Estimating soffit ledgers is a matter of counting the lineal foot of horizontal material. Figure 9-130 shows an example of a 2 × 4 soffit ledger.

Figure 9-130 Two-by-four soffit ledger installed along the exterior wall.

Soffit Lookouts

Soffit lookouts are also horizontal members installed to support the exterior finish soffit material. They are installed between the soffit ledger and rough fascia. They are usually spaced using standard framing on-center spacing. The length of the soffit lookout is determined by the width of the soffit. For example, a 12 inch soffit overhang would have lookouts calculated at 12 inches long. Soffit lookouts are estimated by calculating the number of soffit lookout pieces by the length of the soffit lookout. Figure 9-131 shows an example of soffit lookouts. Lookouts are often not installed with aluminum or vinyl soffit material.

Figure 9-131 Soffit lookouts.

Truss Roof Framing Examples

Truss roof framing can be very basic or very complex. Figures 9-132 through 9-144 show examples of various truss roof configurations, both simple and complex.


Figure 9-132 Truss roof framing package delivered to the job site.


Figure 9-133 Small jack trusses delivered to the job site.


Figure 9-134 Setting a small girder truss.


Figure 9-135 Setting roof trusses with a small crane.


Figure 9-136 Partially completed truss framed roof


Figure 9-137 Hip roof framing.


Figure 9-138 Complex girder truss.


Figure 9-139 Scissor truss roof framing


Figure 9-140 Cathedral ceiling trusses.


Figure 9-141 Small corner hip roof framing.


Figure 9-142 Half cathedral roof ceiling.


Figure 9-143 Girder truss and truss hangers


Figure 9-144 Room framed with attic trusses.

Estimating Truss Roof Framing

It is apparent from the truss installation examples in Figures 9-132 through 9-144 that there are endless numbers of variations in truss roof framing possibilities. For this reason, estimating the cost of truss roof framing presents some challenges. The truss construction details will need to be engineered before any price can be established, and the actual cost of the truss package will need to be provided by the truss manufacturer. The contractor should anticipate using the actual truss price from the manufacturer whenever possible.

In spite of the challenges of estimating the actual roof truss package, the estimator will often need to provide preliminary estimate numbers when preparing a construction cost estimate.

Estimating the Truss Material Cost

The NCE contains different prices for different basic truss types. The following is a guide to help you use the NCE to estimate truss material cost.

- Any standard style of trusses will be estimated using the Fink truss option. The price is estimated using a square foot cost based upon the square footage of the flat roof area, including roof overhangs.
- Any modified ceiling truss will be estimated using the scissor truss option. The price is estimated using a square foot cost based upon the square footage of the flat roof area, including overhangs.
- Any specialty type truss will be estimated using the specialty truss option. The trusses are estimated by the price per individual truss. These individual trusses are located within the square footage space of the standard and scissor truss areas. The specialty trusses are an addition to the square foot cost of the standard and scissor truss styles. In addition, the specific count of these specialty trusses is obtained using the following guidelines:
- Gable end and special gable end trusses are counted as one each.
- Trusses ganged together such as double girder trusses are counted as two trusses or more depending upon the number of trusses ganged together.
- Hip trusses, or girder hip trusses are counted as one each for each hip or hip girder truss.
- Groups of smaller trusses, such as those attached to a hip, or hip girder truss, are counted together as one specialty truss.
- Groups of smaller trusses such as a group of jack or valley trusses are counted as a single truss.

Completing the Truss Roof Framing Materials

Roof Sheathing

The quantity of roof sheathing is determined by using the square footage of sloped roof area. Information about the sheathing type can be found from the plans. Frequently, this information can be found on the detail section drawing, shown in Figure 9-145, which shows the roof sheathing as 1/2-inch OSB Sheathing.

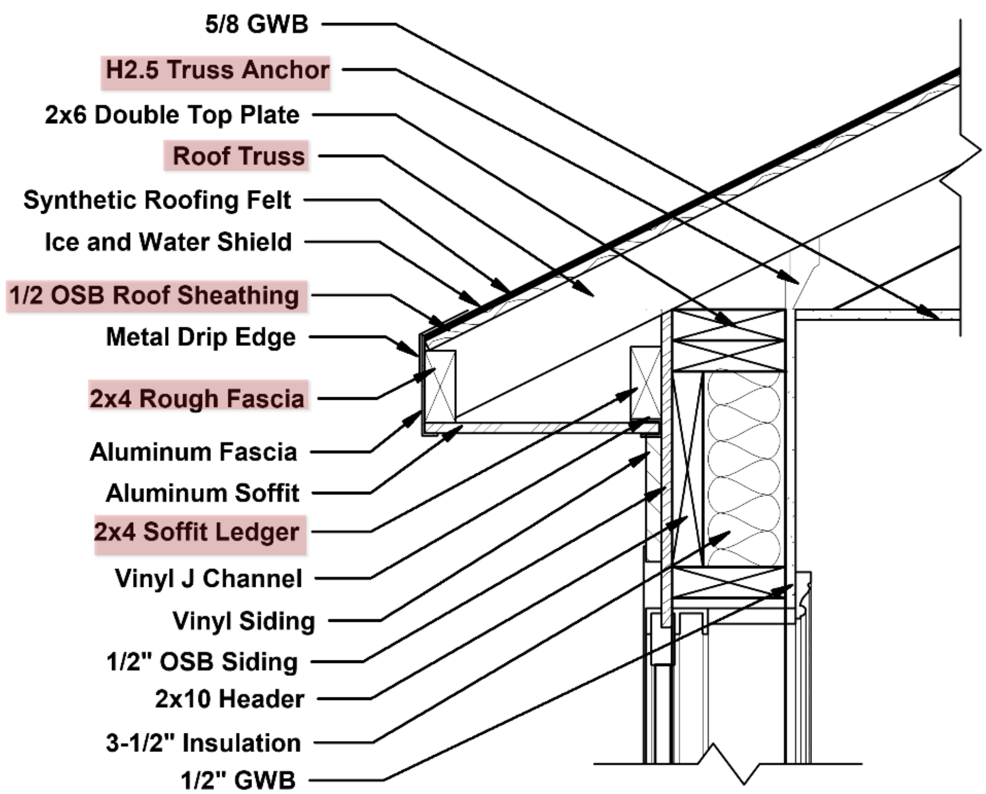


Figure 9-145 Detail wall section showing roof sheathing and rough fascia.

Fascia Board

The fascia board can be determined from the lineal feet of roof edge from the basic takeoffs. The type of fascia material can be determined from detail section drawings as shown in Figure 9-145. Figure 9-116 shows a view of the roof overhang components. The fascia board is a combination of barge rafter and sub-fascia.

Catwalk

The catwalk installation shown in Figure 9-117 shows a view with catwalk installation. Three pieces of 2 × 6 lengths of catwalk are installed along the bottom of the trusses for the main building, and two pieces of 2 × 6 catwalks are installed along the bottom of the garage trusses. The main building catwalks would be equal to three times the length of the building and the garage catwalks would be equal to two times the length of the garage. The total would be equal to

Main Building Width: 36 ft. × 3 pcs. = 108 ft.

Garage Width: 20 ft. × 2 pcs. = 40 ft.

Total: 108 ft. + 40 ft. = 148 ft.

Diagonal Bracing

Diagonal bracing is required on all truss gable ends. The diagonal bracing is typically made from 12' to 16' lengths of 2 × 4 material. Figure 9-117 shows six diagonal bracing pieces, each at 14' long.

Gable End Lookouts

Gable end lookouts include both long and short lookouts. Figure 9-116 shows a graphic of the roof overhang components, including the gable end lookouts. There are 41 long gable end lookouts that are shown in the project. Each long gable end lookout is equal to the length of one truss space and the roof overhang. Six short gable end lookouts are also shown on the front porch. The short overhang length is equal to the distance of the overhang or one foot. The total for gable end lookouts is equal to

Long Overhang: Truss Spacing 2 ft. + Overhang Distance 1 ft. = 3 ft.

Long overhang lookouts: 41 pcs. × 3 ft. = 123 ft.

Short Overhang: Overhang Distance = 1 ft.

Short Overhang Lookout: 6 pcs. × 1 ft. = 6 ft.

Total Gable End Lookouts: 123 ft. + 6 ft. = 129 ft.

Soffit Ledger

The 2 × 4 soffit ledgers will be installed on the wall parallel to the horizontal fascia boards as shown in Figure 9-143 to support the aluminum soffit J channel material. Estimating the quantity of soffit ledger is done by determining the horizontal length of fascia. Figure 9-116 shows the rough fascia board highlighted. The length can be calculated using the roof truss area graphic in Figure 9-141. The graphic shows the following horizontal roof lengths:

Back Edge: 58 ft.

Front Edge: 15 ft. 3-3/4 in. and 10 ft. 9-3/4 in.

Front Garage Edge: 20 ft.

Front Porch Edge: 2 pcs. 5 ft. 11-1/4 in.

The totals will be rounded up to the next half a foot.

Total Ledger: 58 ft. + 15 ft. 6 in. + 11 ft. + 20 ft. + 6 ft. + 6 ft. = 116 ft. 6 in.

Soffit Lookouts

There will be no soffit lookouts on this project as the soffit will be aluminum soffit material.

Nails

The building code requires that roof sheathing be fastened with nails placed at six-inch intervals along the edge and at 12-inch intervals along the framing supports in the middle of the panels. This calculates to approximately 60 nails per sheet of sheathing. The 8d Bostich framing nails are sold in a quantity of 2,000 nails per box. The 72 sheets of OSB on the roof multiplied by 60 nails per sheet equates to 4,320 eight penny nails (three boxes) for the roof sheathing installation.

The truss and truss framing will be installed using 16 penny framing nails. Estimate 25 nails for each truss and its associated rough fascia, catwalks, and diagonal bracing. There are 33 roof trusses for a total of 825 nails. The gable end lookouts will be installed using eight nails each. There are 48 pieces of ladder blocking for a total of 384 nails. The total nails for the installation will be 1,209. Sixteen penny framing nails are also sold in a box of 2000. One box will need to be purchased.

Completing the Truss Framing Anchor Materials

There are various different types of framing anchor materials that can be used. Figure 9-148 shows a copy of the roof framing plan with the framing connectors tagged and annotated. We will briefly discuss these materials.

2 × 6 U Type Hangers

The 2 × 6 U type hangers are typically used to support truss ends on a supporting load bearing girder truss as shown in Figure 9-139. This project has no girder trusses, and no 2 × 6 U type hangers will be used on this project.

2 × 4 U Type Hangers

The 2 × 4 U type hangers are typically used to support truss ends on a supporting load bearing girder truss as shown in Figure 9-123. This project has no girder trusses, and no 2 × 4 U type hangers will be used on this project.

Hurricane Anchors

The building code requires hurricane anchors to attach the end of the trusses as they are anchored to the exterior load bearing walls. One hurricane anchor is required at the end of each truss (Figure 9-122). There are 28 standard trusses in the project with a hurricane anchor on each end for a total of 56 anchors.

Strap Tie Anchors

The framing connector annotation symbol with a seven in the center represents a Simpson ST2215 strap tie (Figure 9-121). The annotations show six of these strap ties in the project, which is the quantity that will be used in the estimate.

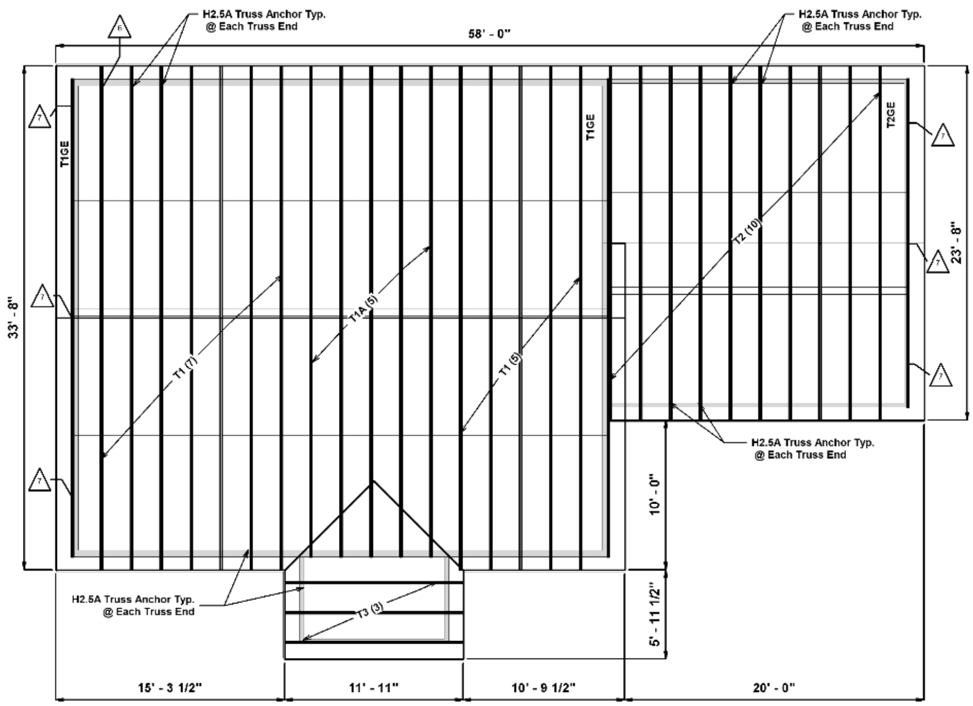


Figure 9-146 Truss plan with framing connector tagged and annotated.

Hanger Nails

Framing connectors usually require specific nails to meet the installation requirements. In addition, the requirement is typically for every nail hole to be filled. Information about the number of nail holes per fastener are usually readily available. The H2.5A hurricane anchors require six nails each for a total of

$$6 \text{ Nails} \times 56 \text{ Hanger} = 336 \text{ Nails}$$

The ST2215 strap ties require 20 nails each for a total of

$$20 \text{ Nails} \times 6 \text{ Strap Ties} = 120 \text{ Nails}$$

$$\text{Total nails: } 336 \text{ nails} + 120 \text{ nails} = 456 \text{ nails}$$

The price of these nails can be found in the NCE.

CITATIONS:

Automated Structures Inc. (n.d.). Truss FAQ. Retrieved from https://www.automatedtruss.com/truss-faq.html

Buza, J., BUCS (Ed.). (1993). Builder 2 & 3(Vol. 1) (United States, United States Navy, Professional Development and Technology Center). Naval Education and Training. Retrieved from https://www.constructionknowledge.net/public_domain_documents/Builder_and_2_vol_1_NAVEDTRA_14043_1993.pdf

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GLOSSARY OF ROOF TERMINOLOGY - Residential Reports. (n.d.). Retrieved from http://www.residentialreports.com.au/wp-content/uploads/2015/03/Glossary-of-Roof-Construction-Terminology.pdf

Gromicko, N., & Gromicko, B. (n.d.). Structural Design Basics of Residential Construction for the Home Inspector. Retrieved from https://www.nachi.org/structural-design-basics-residential-construction.htm

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Roof Trusses. (n.d.). Retrieved from https://www.sbcindustry.com/ education/topical-library/roof-trusses

The Benefits of Building With Roof Trusses. (2016, January 29). Retrieved from https://www.nisbetbrower.com/the-benefits-of-building-with-roof-trusses/

Exterior Finishes Construction Processes and Materials

The exterior finish phase of construction covers the materials and processes used to get the structure weathered in and water tight, including the architectural materials and processes that give each building its distinct characteristics. These materials and processes include the roofing system, moisture protection membranes, flashings, windows, exterior doors, and siding and trim. The discussion will begin with roofing systems.

Roofing Systems

The roofing system is usually the first exterior system installed on a structure after the framing is completed. This is done to protect the structure from rain, snow, and other harmful or dangerous conditions. Most dimensional and engineered framing material can withstand the effects of the elements for a short period of time while the structure is being completed; still, it is best to get some form of moisture protection on the structure as soon as possible to help limit any degradation that can occur from long exposure.

A roofing system typically consists of a number of different materials and layers including roofing felt, ice and water shield, drip edge, shingles, flashing, and nails. Each of these materials will be covered in detail. Figure 10-1 shows a delivery of roofing materials, including roofing felt, ice and water shield, and shingles.

Figure 10-1: Roofing material delivery.

Roofing felt is usually the first element placed upon the roof in a roofing system. Roofing felt is manufactured by saturating heavy felt with asphalt or coal tar material. The felt comes in 36-inch-wide rolls and is made in several thicknesses designated as 15 lb., 30 lb., and 60 lb. This is the weight of felt that is needed to cover 100 square feet of roof area or what is known as one square. Each 36-inch-wide roll of felt weighs approximately 60 pounds, with the length of the roll getting longer as the weight per pound decreases. A 60-lb. roll of felt is 36 feet long, which means it actually covers 108 square feet, but with the need for lapping each layer, it is usually calculated as covering 100 square feet, with the additional 8 square feet lost as a lap allowance. Correspondingly, a 30-lb. roll of felt is calculated to cover 200 square feet of roof, and a 15 lb. roll covers 400 square feet of roof. Commonly, both 15-lb. and 30-lb. felt are used as underlayment for asphalt roofing shingles; the heavier 60 lb. felt often has a mineral layer on it and is used as a rolled roofing cover in utility construction.

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 2: Roll roofing felt.

In more recent years, manufacturers have developed synthetic roofing felts. These are usually some form of plastic polymers that are manufactured for that purpose. Often, synthetic underlayment comes in rolls that are traditionally wider and longer than felt, so each roll covers more roof area and is faster to install. They also have the benefit of being stronger and more resilient in high wind areas. Also, some products can be left exposed on the roof before being covered with roofing shingles for a much longer period of time. They are typically more expensive than traditional felts, but they are becoming much more popular because of the other advantages. Estimating roofing felt is a matter of determining the square footage of the sloped roof area and the amount of coverage that each roll provides. A role of 15-lb. felt contains 423 square feet of felt, but when installing the felt, there is a minimum of 2-inch overlap on the edge and 4 inches on the ends. Most estimators assume that one role of 15-lb. felt will cover approximately 400 square feet. A role of 30-lb. felt covers approximately 200 square feet. Roofs that are cut up or have a lot of angles will need additional roofing felt. Synthetic felt is sized a little differently. Rolls are sized in rounded increments, and so the overlap quantity will need to be calculated and subtracted from the total. For example, a 1000-square-foot-role of synthetic felt would still have an overlap requirement. A lapping requirement of 4 inches limits the amount of coverage to 916 square feet.

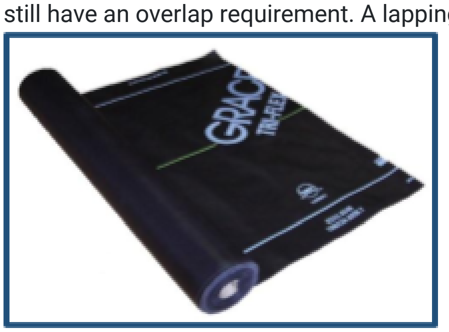

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 3: Synthetic roofing felt.

Ice and Water Shield

Ice and water shield is a self-sticking roofing membrane that is used to protect the structure due to ice dams. An ice dam is caused when the heat from the attic rises through the roof and melts the snow on the roof. The water runs to the end of the roof until it gets to the eaves, where the roof's edge is cold, which causes the water to freeze again and turn into ice along the edge. The ice can cause the shingle to lift up and to build up thick enough to form a negative slope on the roof. The water then is able to run back into the interior of the structure. The ice and water shield is usually wide enough that it extends several feet back into the roof past the overhang to seal the roof past any areas where leaks will form. The ice and water shield can be used to seal other vulnerable areas of the roof.

Ice and water shield usually comes in rolls three feet wide and in varying lengths, such as 75 feet. Estimating ice and water shield is usually a matter of calculating the total length divided by the length per roll. Figure 10-4 shows ice and water shield installed along the edge of a roof with roofing felt installed above the ice and water shield.

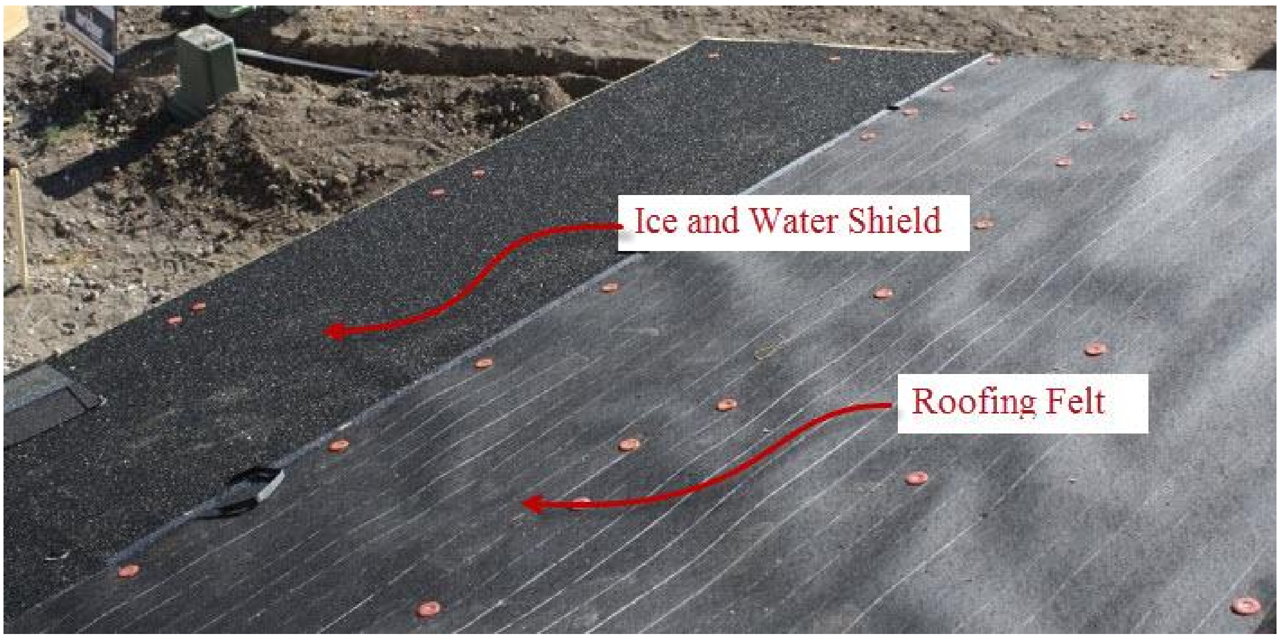

Figure 10-4: Ice and water shield and roofing felt on a roof.

Drip Edge

Drip edge is a metal flashing that is placed along the edge of the roof. It forms an overhang that allows the roofing material to extend past the edge of the roof. This forces the water that runs off the edge of the roof out away from the fascia. If the water is allowed to run down the fascia, it can make its way back into the structure and cause rot and other damage. Most professionals recommend installing the drip edge to the roof decking along the eaves of the roof and then installing the ice and water shield and roof felt over the drip edge. The drip edge is installed over the ice and water shield and roofing felt along the gable ends of the roof. Figures 10-5 through 10-7 show examples of drip edge installation.

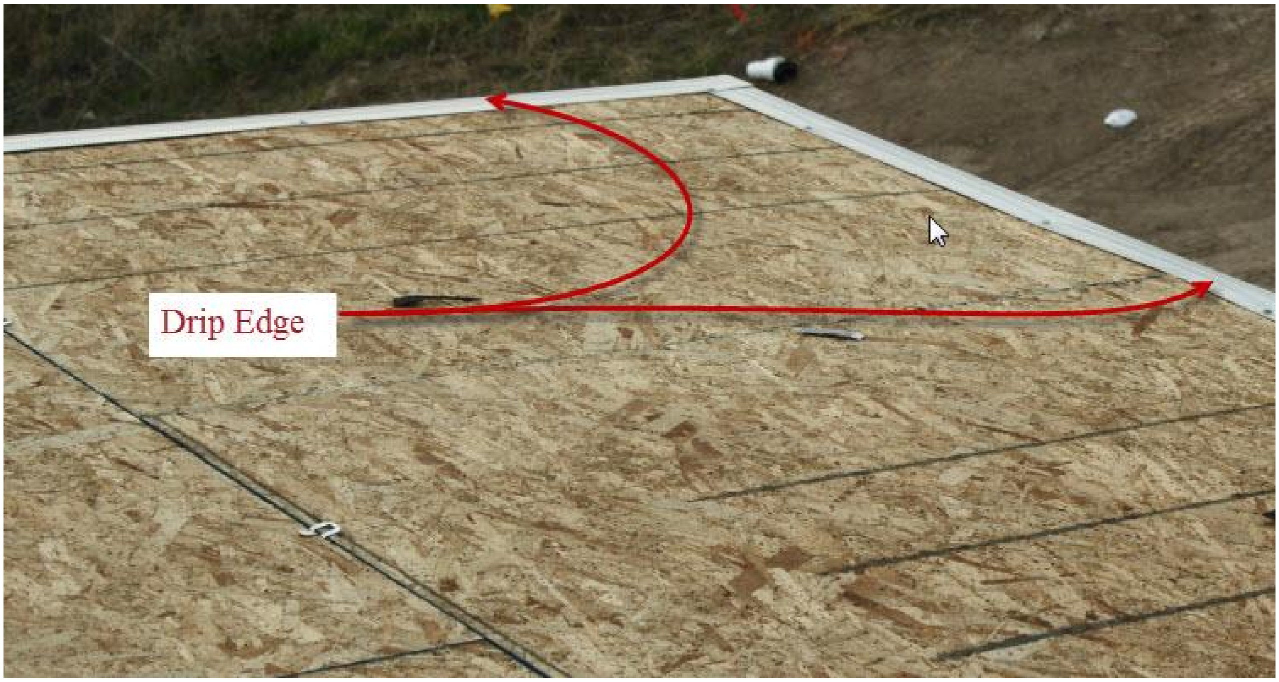

Figure 10-5: Drip edge installed over roof sheathing.

Figure 10-6: Drip edge along fascia.

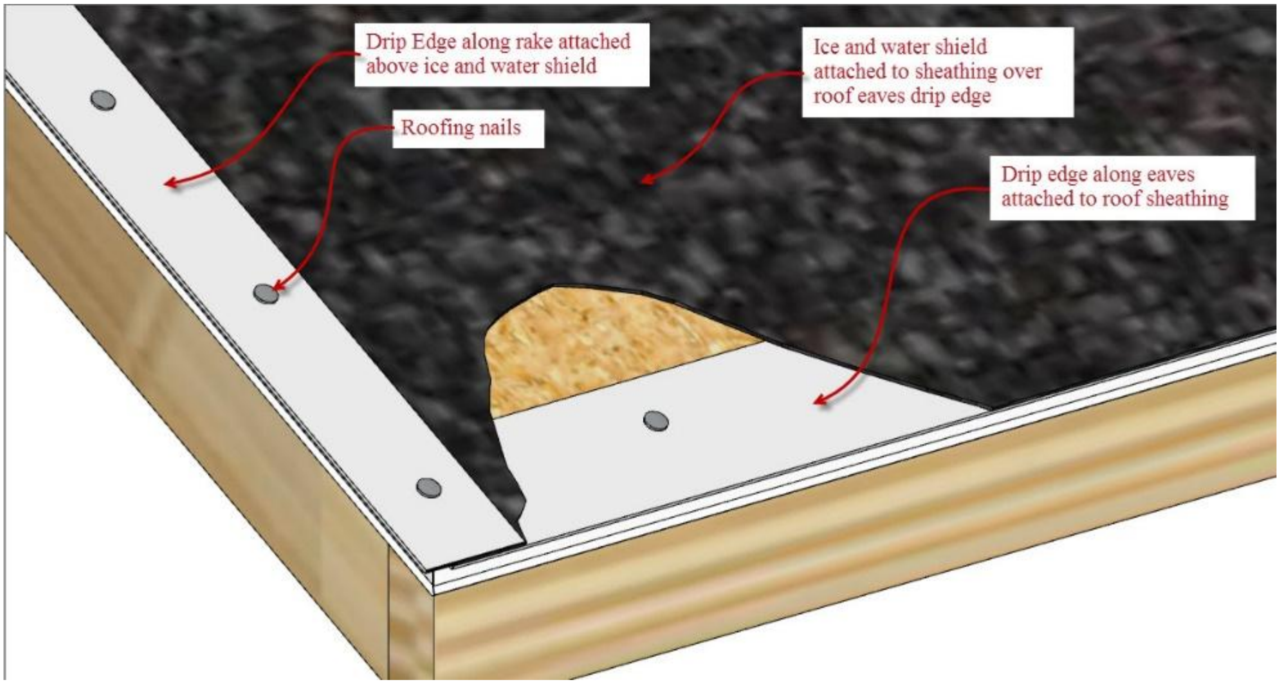

Figure 10-7: Drip edge installation.

Shingles

Asphalt shingles are the most popular type of residential roofing in North America. Asphalt shingles are popular because they are relatively inexpensive when compared to other roofing material types; they are easy to install, they come in a wide range of colors and styles, they are durable, and they have a good life span. They have been widely used as a roofing material since they were invented over 100 years ago. Originally, asphalt shingles were made by impregnating a mat of cotton felt with asphalt resins and coating the shingles with a layer of crushed slate to add protection and durability. Other organic material such as wool, wood pulp, and jute replaced cotton felt due to the high cost in the 1920’s. In the early 1960’s, fiberglass was introduced as material for the mat and is now commonly used in the majority of shingles produced. Fiberglass is more fire resistant than paper and other organic material, and it allows the shingles to be made using less asphalt resin.

Many types of granular surfaces are used to provide protection and color to the shingles. Common minerals include slate, quartz, vitrified brick, and ceramic granules. Many different styles of asphalt shingles have been manufactured over the years. Four major categories of shingles are common today: strip shingles, tab shingles, dimensional shingles, and luxury shingles.

Strip Shingles

Strip shingles are the original and most basic type of asphalt shingles. They are constructed of a single layer of asphalt impregnated mat. They have been manufactured in a variety of shapes including single tab, hexagon tab, and round tab, but the most common style of strip shingle is the three tab. Figure 10-8 shows an example of a three-tab shingle. The shingle is partially divided into three separate sections. They are typically thinner and lighter in weight than dimensional and luxury shingles and have a shorter life expectancy of 20 to 25 years. Three-tab shingles used to be the most popular style of shingle, but their use has declined in recent years and now are mostly installed by residential contractors building rental properties and economy priced homes. They are also used in replacement situations and for making starter strips and hip and ridge coverings. Figure 10-8 shows an example of a typical three-tab shingle installation.

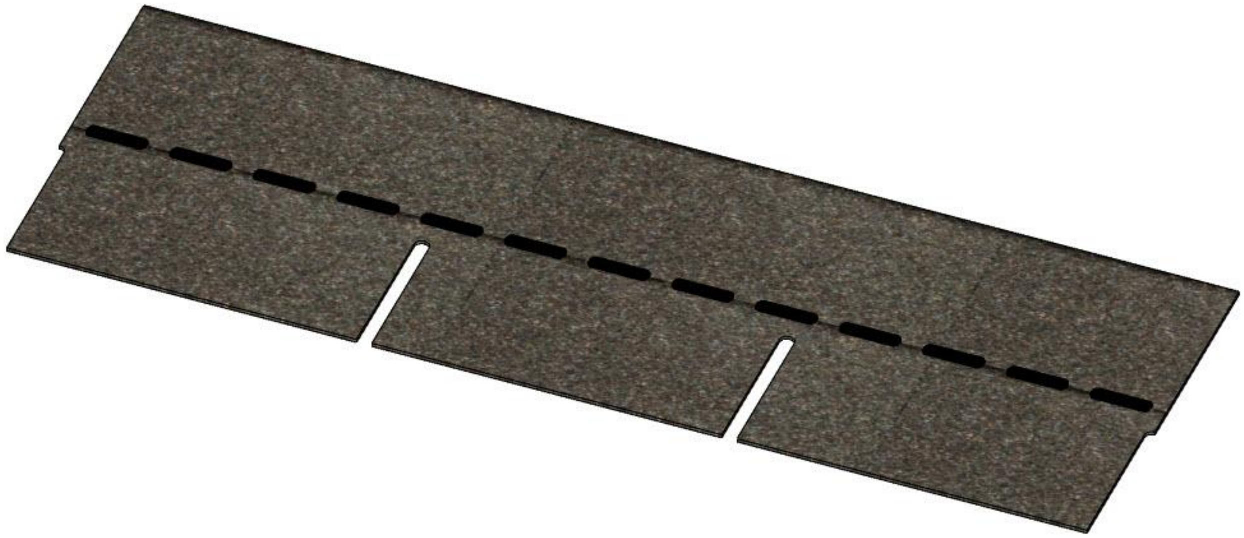

Figure 10-8: Single layer three-tab shingle with consistent tab spacing.

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Figure 10-9: Typical three-tab shingle installation.

Dimensional Shingles

Improvements in the manufacturing process and the desire from customers for a more elegant architectural look have led to the development of multi-layer dimensional shingles. Dimensional shingles are also called laminated shingles or architectural shingles. Typically, these types of shingles are two or three layers thick and weigh significantly more than three-tab strip shingles. The layout and pattern of the shingle is three dimensional with multiple thickness layers and varied tab layouts to give the roof more of a pattern of shade and dimension to resemble more traditional roofing materials such as wood shakes.

An additional advantage of dimensional shingles is that they create a roof covering that is more robust and can last longer than strip shingles. These types of shingles can have an expected life span of 30 to 40 years. The additional weight of this type of shingle also contributes to their ability to better withstand damage caused by wind. The additional benefits of these types of shingles have contributed to their significant increase in popularity and have made these types of shingles the most popular style of residential roofing and has helped to contribute to the decline in the use of strip style shingles. Figure 10-10 shows an example of the construction of one type of dimensional shingle. The tabs on the top layer in this example are cut at a slight angle and have varying widths and spacing. The bottom layer is recessed under the top tab layer and gives the shingle a three-dimensional look, as can be seen in Figure 10-11, which shows the effect of the light and shadow from dimensional shingles installed on a roof.

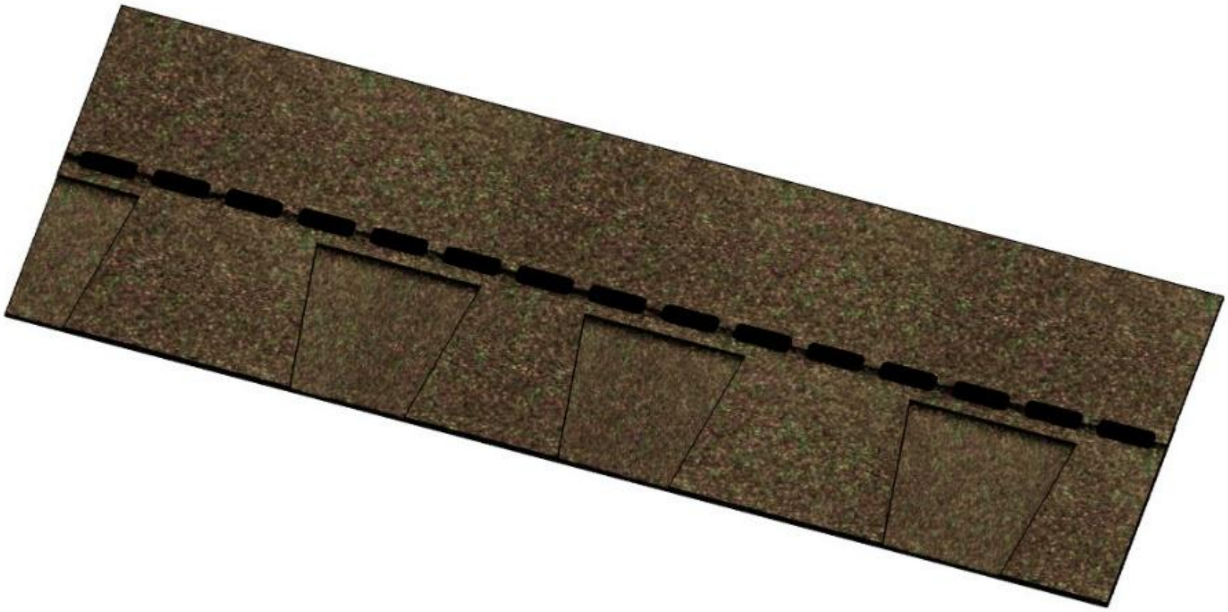


Figure 10-10: Two-layer dimensional style shingle with varied tab spacing.

2. 

Figure 10-11: Effect of light and shadow in dimensional shingles.

Luxury Shingles

Luxury shingles are also known as premium or designer shingles. These are asphalt shingles that are made to emulate the look of a traditional slate or wood shake roof. They are multi-layer shingles that have deeper profiles and greater variation in individual tab lengths, shapes, and colors. This style of shingles commands not only a premium price for materials but would also require additional installation labor.

Figure 10-12: Sample luxury shingle styles.

Installing asphalt shingles

Several factors need to be taken into consideration when installing asphalt shingles. These factors include the shape and size of the shingles, the exposure amount, the starter course, valleys flashing, and valley shingles, hip and ridge shingles, and flashing and roof vents. Each of these will be discussed in turn.

Shape, Size, and Exposure of the Shingles

While there can be a wide variation in shingle size, most asphalt shingles are two standard sizes: an English standard that is 12 inches wide by 36 inches long and a metric standard that is 337 millimeters wide (13-1/4 inches) and 1 meter (39-3/8 inches) long. Each size of shingle has a specific amount of the shingle that is left exposed to the elements, which is known as the exposure. Typically, English size shingles have a 5-inch exposure, while a metric standard shingle has a 5 5/8-inch exposure (Figure 10-13).

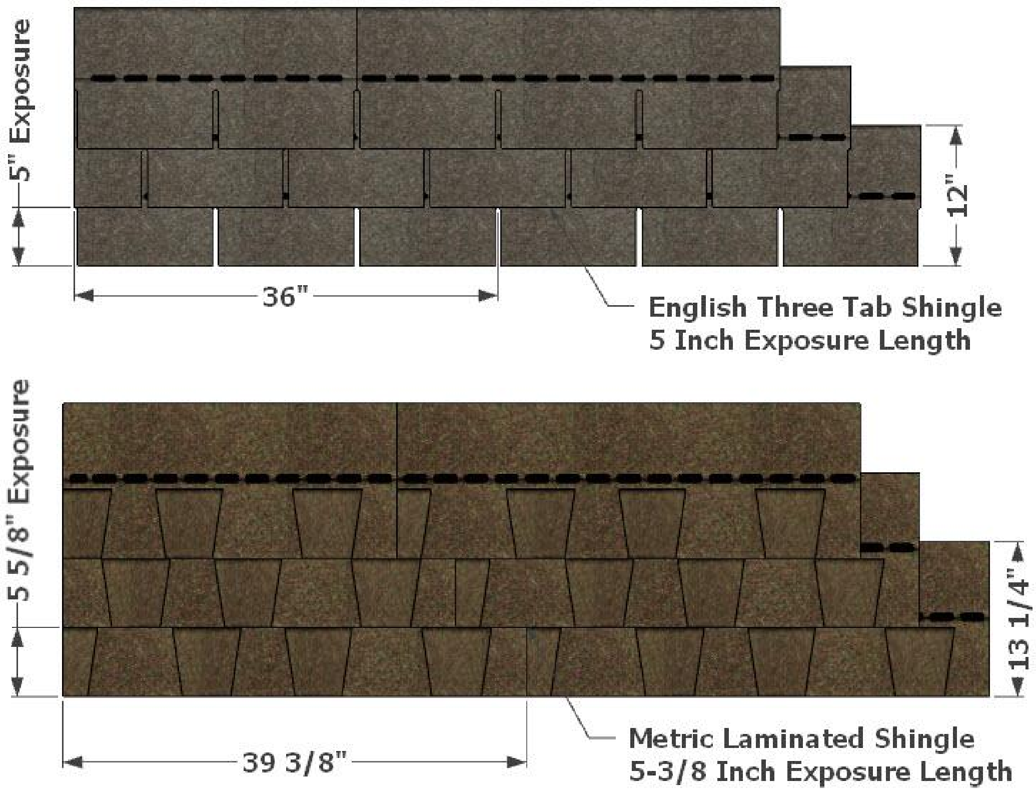


Figure 10-13: Shingle exposure.

Starter Course

The first horizontal row of shingles on a roof is the starter strip. This is the initial layer of shingles that is laid down that serves as the base for the roof shingles. Traditionally, the starter course was created by either turning the first row of three-tab shingles upside down on the edge of the roof. Another method was to cut half of the width of the three-tab shingle and use it as the starter course. Most shingle manufacturers produce a dedicated starter strip. Purchasing a premade starter strip usually saves money as it is commonly cheaper to purchase the premade item as opposed to creating one from standard shingles. In addition, it takes less labor to install a premade starter shingle than to cut and install one from a standard three-tab shingle. Several types of starter courses are manufactured. The first is made in a strip the size of a standard shingle. Each full shingle has a perforation down the center that allows it to be broken into two 6-1/2" × 38" pieces. The starter course has a strip of sealing adhesive that is placed close to the edge of the roof to keep the bottom edge of the shingles down in high wind. Figure 10-14 shows an example of a starter strip that will be split down the middle before installing.

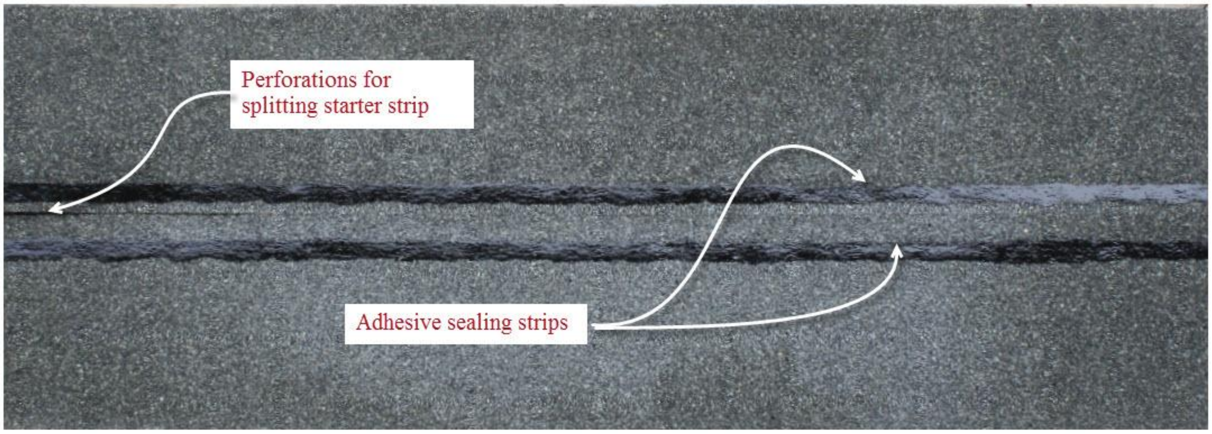
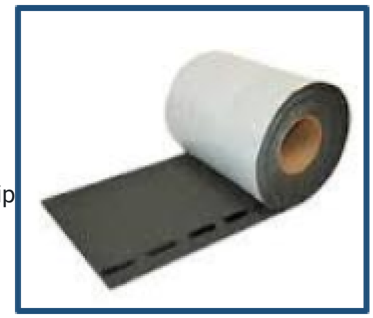


Figure 10-14: Starter strip 

A second type of starter strip is shown in Figure 10-15 that comes in roll form that is laid down as a continuous length.

Determine the amount of starter strip along the horizontal edge of the roof that is needed. Then, determine the lineal feet of the starter strip supplied in each bundle or roll and determine the number of bundles or rolls needed. For example, a bundle of starter strips may have 120 lineal feet, while a roll type might have 33 feet. Figure 10-16 shows an example of a starter strip attached along the end of the roof. The starter strip is nailed down along both the horizontal and gable roof edges.

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 15: Roll type starter strip*

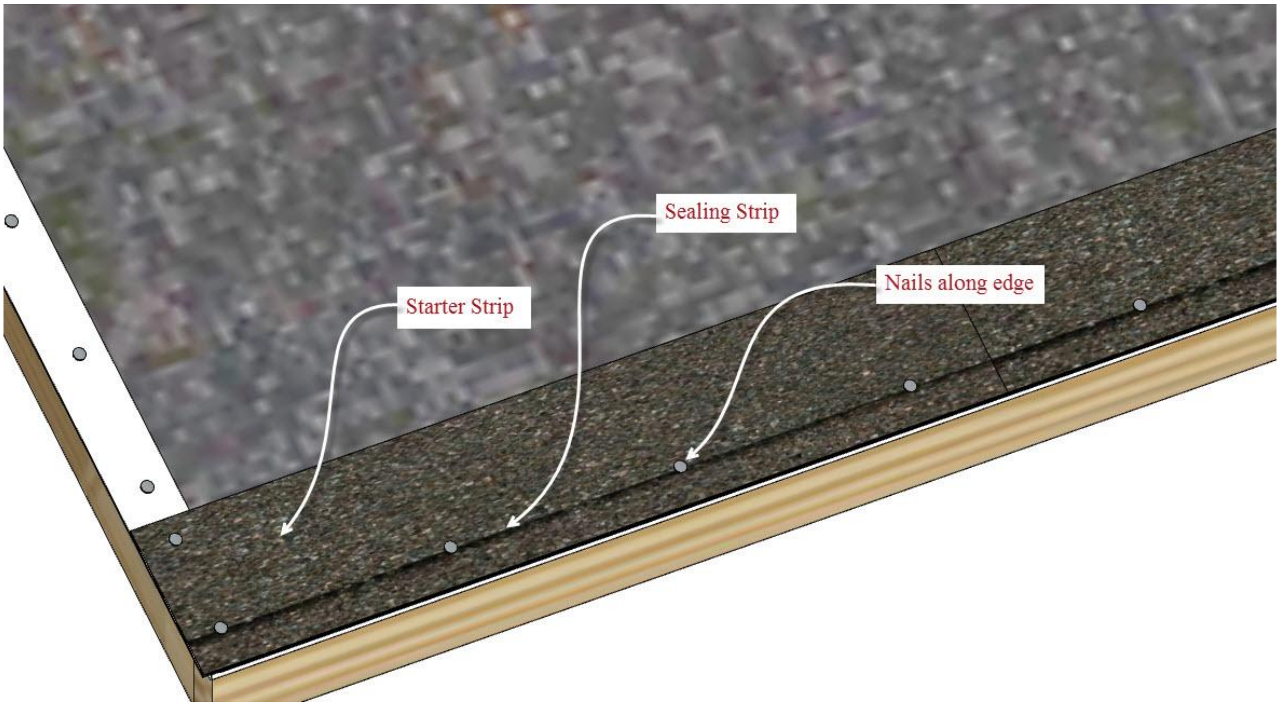


Figure 10-16: Starter strip along the roof edge.

Valley Flashing

Roof valleys require a layer of flashing protection in addition to the shingle layers. A number of different products can be successfully used as flashing, including sheet metal and membrane flashing.

Sheet Metal Flashing

Some form of sheet metal has been used as valley flashing for centuries. Sheet lead was one of the first metal flashing products but is not commonly used today due to the high cost and the toxicity of lead. Sheet copper is also another traditional flashing material that is still occasionally used. Because of the high cost of copper, its use as flashing is usually limited to high-end construction and historic restorations. More commonly used as metal flashing are galvanized steel or aluminum. The aluminum may be left with the silver tone mill finish, or it may be anodized, which imparts a very hard colored finish to the metal.

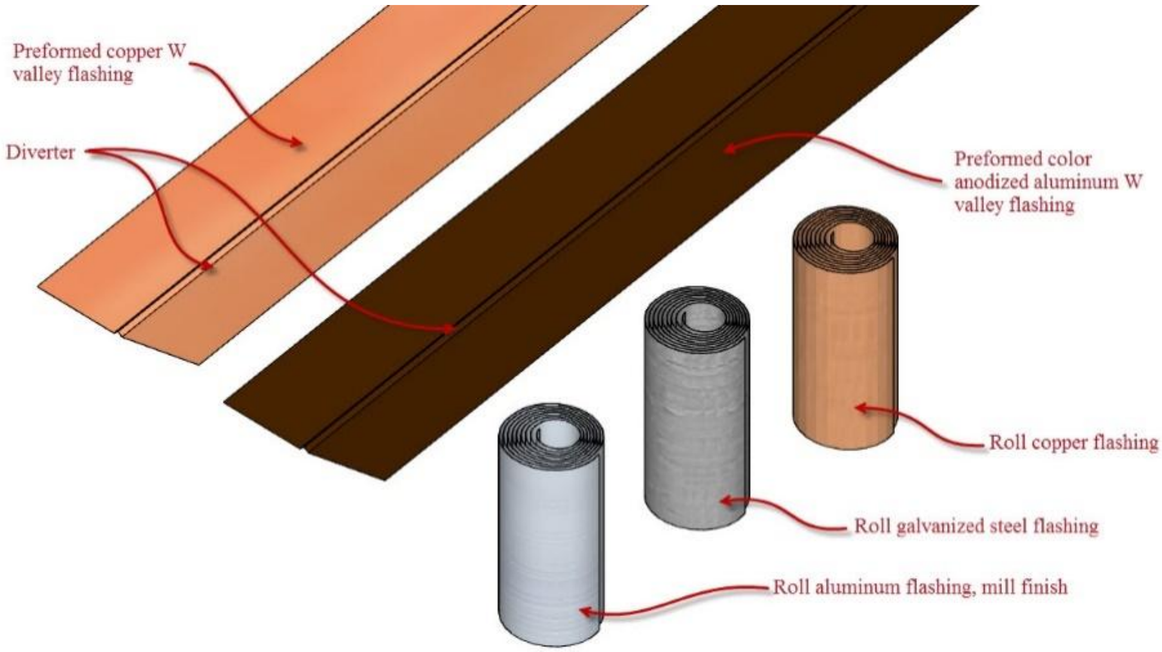


Figure 10-17: Preformed W and rolled metal flashing.

The metal flashing can be purchased in a roll of a specific width and length, such as 18 inches wide by 50 feet long. In addition, preformed metal flashing can be used. Preformed metal flashing is typically sold in sizes such as 20 inches wide by 10 feet long. Preformed metal flashing is also called W flashing because of the distinctive W shape that is formed when a small ridge known as a diverter is formed into the metal shape. This helps keep water running down the valley from migrating up the opposing side of the valley where it may get under the shingles lining that side of the valley. Figure 10-18 shows a high definition luxury shingle roof with a preformed brown anodized aluminum W flashing installed in the valleys. It is also important to note that many shingle manufacturers also require a membrane flashing underneath a metal flashing.

Figure 10-18: Luxury shingle roof with anodized aluminum W valley flashing.

Membrane Flashing

Membrane flashing is made of a pliable membrane. One type of membrane flashing is 90# rolled roofing. This is a heavy duty style of roofing felt that has a mineral layer like standard asphalt shingles. It usually comes in roll form, approximately 3 feet wide and 33 feet long that covers 100 square feet or one square. The rolled roofing is formed in the valley and nailed down along the edges. The nails are kept at least 12 inches away from the center of the valley.

A second type of membrane flashing is adhesive back ice and water shield. The ice and water shield is adhered to the center of the valley and shingled over. Estimating ice and water shield is the same as other membrane flashing by estimating the length of the flashing and dividing by the length of the roll. The installation of the ice and water shield is usually installed along the roof edges first, and the membrane valley flashing is installed over the top to facilitate the smooth flow of the water from the valley to the edge of the roof. Figure 10-19 shows a roof with ice and water shield installed along the roof edges and a valley flashing with the remainder of the roof covered with the synthetic roofing felt.

Figure 10-19: Ice and water shield valley flashing.

Shingling Valleys

There are three generally accepted methods of applying shingles in a valley. The three methods are the open, woven, and closed cut valleys.

Open Valleys

The open valley is the same as is shown in Figure 10-18. The shingles are installed so that they are cut back from the center of the valley, leaving the metal valley flashing exposed. This is often done in situations such as historic restorations and high end installations because it is significantly costlier than the other two valley shingling methods. The high cost is due to the additional cost of the metal valley flashing and the added labor to carefully cut each shingle along the valley edge to maintain proper open space in the valley. The open valley method has the additional advantage of allowing the water to move more rapidly off of the roof in the event of a storm, which can help to maintain the roof integrity.

Woven Valleys

Woven valleys are also considered a desirable method of installing roof valleys; however, their use is limited to three-tab style shingles because the additional thickness of laminated shingles and luxury shingles make them difficult to weave into the proper valley. In addition, woven valleys require the roofer to install two or more roof sides simultaneously because the valley must be woven course by individual course as the roofer moves up the roof. This can add to the complexity of installing the roofing, as the roofer has to work on multiple roof slopes concurrently and may have to install additional scaffolding or utilize safety equipment that allows the installer to move to the different roof slopes.

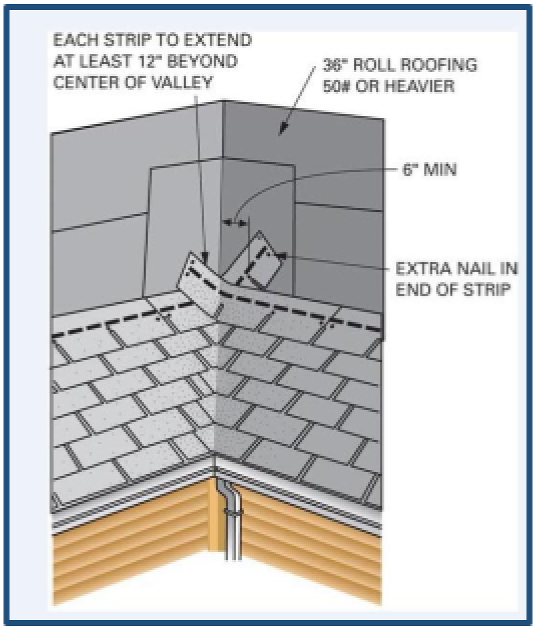


*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 20: Woven valley*

When installing a woven valley, the roofer installs a single course of shingles along the roof. When the valley is reached, the shingle is bent to form into the valley and allowed to extend at least one foot into the opposing roof slope and nailed off to keep the shingle bent into the valley. Next, the same course is laid on the opposing slope and also formed down into the valley and brought up at least 12 inches into the opposing roof slope and nailed down. Each course is formed up the roof weaving the valley shingles together as shown in Figure 10-20.

Closed Cut Valleys

Closed cut valleys are formed by installing a course of shingles on the roof. When the valley is reached, the shingle is formed into the valley and brought up at least 12 inches past the valley on the opposing side of the roof. The shingle is nailed down similar to the shingles in a woven valley. The shingles are continued course by course up the single roof edge with the end of each course extending into the opposing roof. Once the first side of the roof is installed to the peak, the second side is installed. At the valley, a straight line is chalked down the valley a few inches past the center of the valley, and the shingles of the second side are cut at an angle to match the angle of the valley. This is shown in Figure 10-21.

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 21: Closed cut valley.

Hip and Ridge

The intersection that forms the peak of the roof where two hip roof planes meet and the top intersection where top roof planes on gable style roofs need to be covered with a finished roofing material to keep the roof watertight. Several types of materials can be used, including metal hip, ridge cap flashing, and hip and ridge type shingles.

Metal Hip and Ridge Flashing

Metal hip and ridge flashing is used frequently on roofing material such as slate, wooden shingles, clay tile, and sheet metal roofing. It is not as common on asphalt shingles, but it is sometimes used to add architectural character and detail to high-end roofing installations as shown in Figure 10-22.

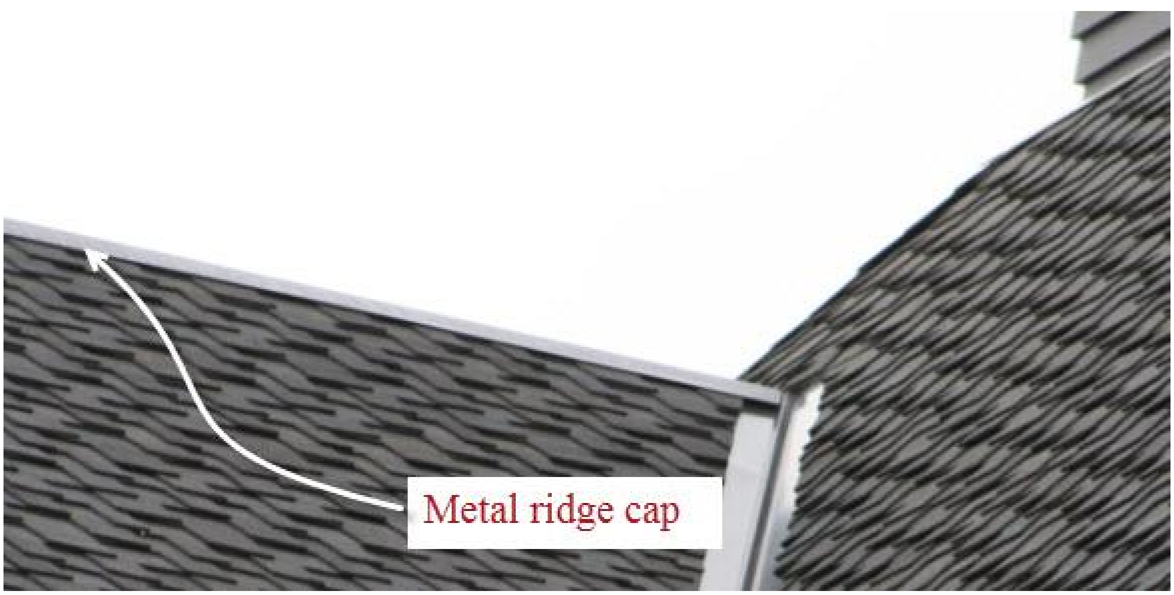


Figure 10-22: Metal ridge cap on luxury asphalt shingle installation.

Metal ridge cap flashing is available in a number of different profiles and materials including sheet copper, anodized aluminum, and galvanized or painted steel. It is also available in many sizes and profiles from basic utilitarian shapes to historic architectural profiles. Figure 10-23 shows some sample metal ridge cap flashing profiles.

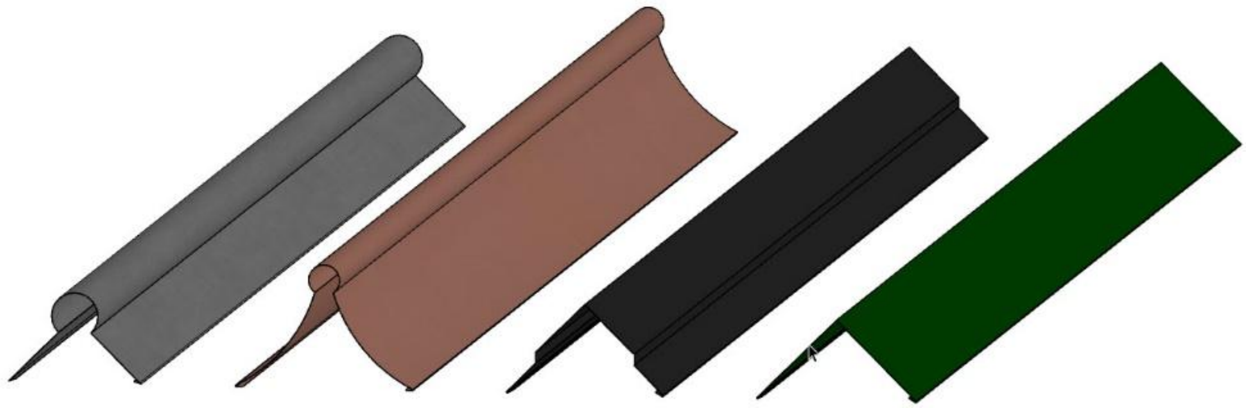


Figure 10-23: Sample metal ridge cap profiles.

Estimating metal ridge cap flashing is a matter of determining the length of ridge needed and dividing by the length of the premade ridge cap. Frequently, it is provided in lengths of around 10 feet.

Hip and Ridge Shingles

Asphalt hip and ridge caps are the most common type of ridge caps used on asphalt shingle roofs. They can be bought as a premade cap or made onsite from standard three-tab shingles.

Premade Hip and Ridge Shingles

Most manufacturers of asphalt shingles provide a pre-manufactured option for completing the hip and ridge portions of a roof. Pre-manufactured hip and ridge shingles are usually provided in a box or bundle with a bundle covering a specific amount of lineal feet of roof peak with the required exposure. Figure 10-24 shows an example of premade hip and ridge shingles.

Figure 10-24: Premade hip and ridge shingles.

Site Made Hip and Ridge Shingles

Traditionally, most hip and ridge shingles have been made on site using standard three-tab shingles. To make hip and ridge shingles, a standard three-tab shingle is cut into three separate sections at the individual tabs. This results in three pieces 12 inches wide for an English size shingle and 13 1/8 inch for a metric size shingle. The back part of the cut is tapered slightly back a few degrees so that it is hidden by the exposure of the shingle above it. This is shown in Figure 10-26.

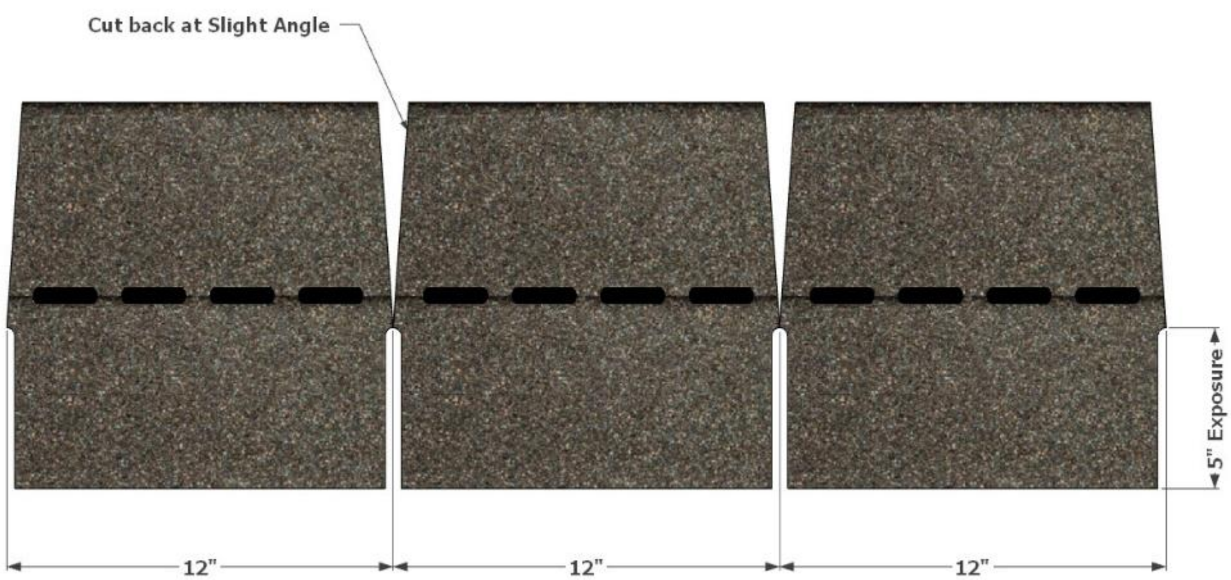


Figure 10-25: Job cut ridge cap.

The lineal feet of coverage that each bundle of three-tab shingles can cover depends upon the type of shingle. English sized shingles typically have 27 shingles in a bundle. Each shingle is cut into three, so one bundle can make 81 ridge shingles. Each shingle would have an exposure of 5 inches for a total of 33'9". A metric size bundle of shingles has 21 pieces of shingles, but each shingle has a 5 5/8" exposure, so one bundle can make 63 ridge shingles with an exposure of 5 5/8" for a total length of 29'6".

Estimating site-made hip and ridge shingles is a matter of determining how many lineal feet of hip and ridge need to be covered by the number of individual hip and ridge shingles and the number that each bundle can produce. Figure 10-26 shows an example of site made hip and ridge shingles installed.

Figure 10-26: Site made hip and ridge shingles installed.

Miscellaneous Roof Flashings

Valley flashing and metal ridge flashing may not be the only type of flashings needed on a roof installation. These types of flashing could include chimney flashing, wall flashing, step flashing, and mechanical equipment flashings.

Chimney Flashing

Fireplace chimneys can be problem places for completing the roofing on a structure. It is required that the chimneys extend past the slope of the roof by several feet, which often creates a potential place in the roof where water can pond or enter. This is true for both a traditional masonry fireplace chimney and more current wooden framed chimney chases that house prefabricated metal fireplace flues. The type and amount of flashing needed depends greatly upon the exact location of the chimney in relation to the roof and the potential for water to build up behind or around the chimney. In addition, chimneys that have a horizontal face perpendicular to the slope of the roof wider than 30 inches will need a cricket installed behind the chimney to facilitate the water running around the chimney and down the slope of the roof. Figures 10-27 and 10-28 show some potential chimney flashing methods using corrosion metal flashing material.

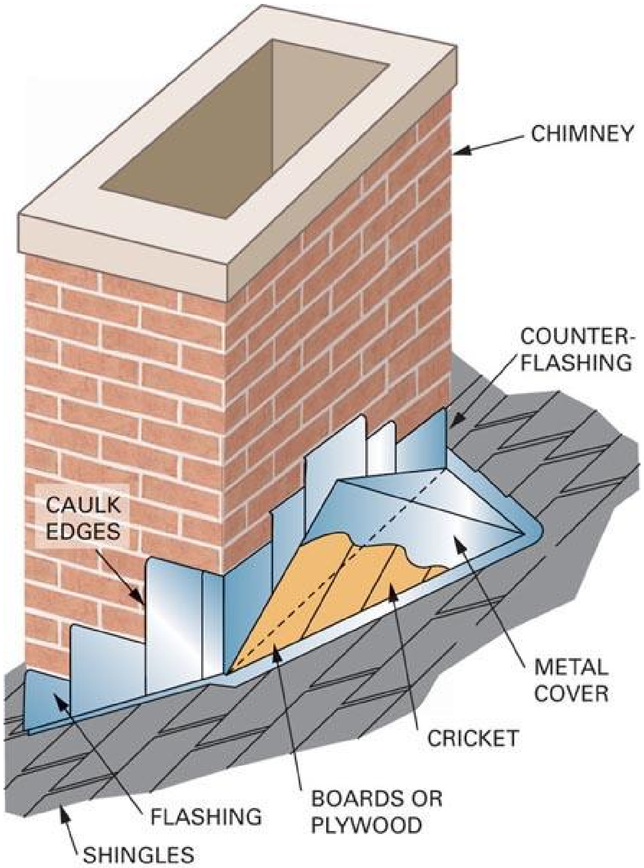


Figure 10-27: Chimney flashing with cricket.

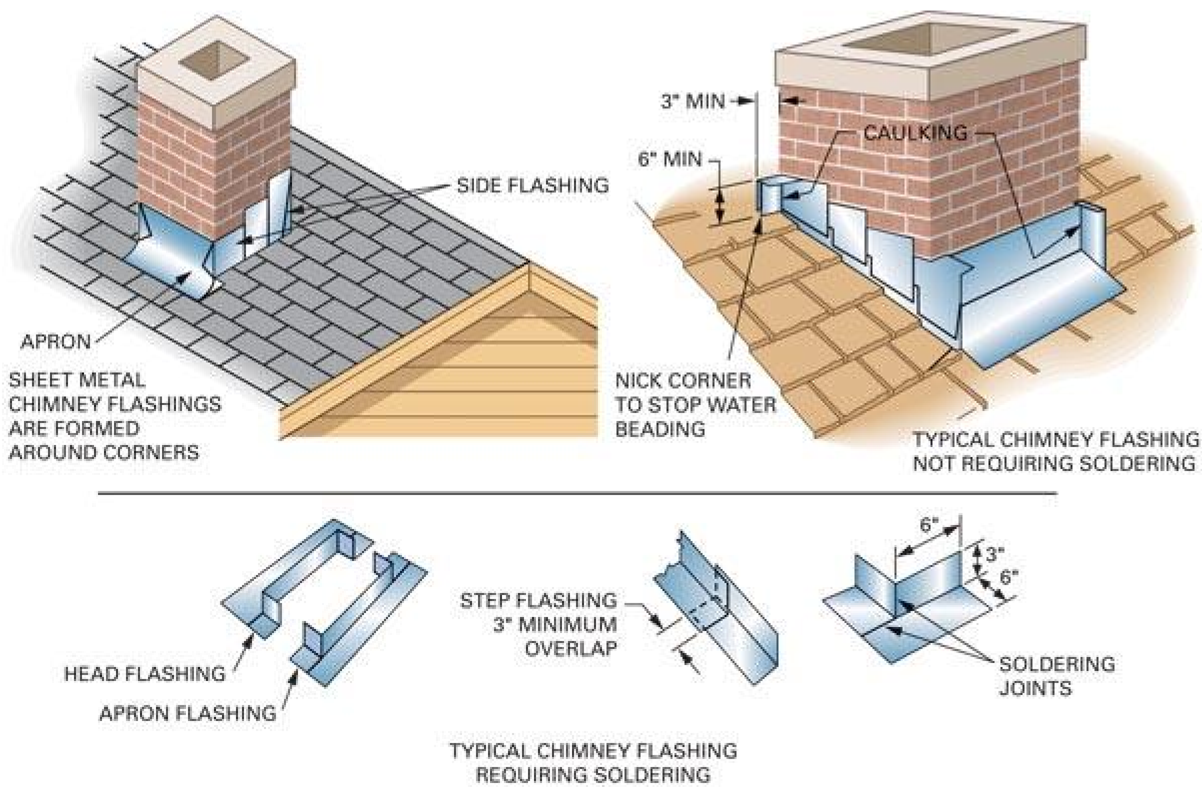


Figure 10-28: Chimney flashings.

Wall Flashing

Anytime the slope of a roof contacts a vertical wall, some form of metal flashing is usually needed. If the ridge of the slope is horizontal to the wall plane, then usually a simple bent flashing will be used. Figure 10-29 shows an example where a bent flashing is installed on the wall plane and bent into the slope of the roof between the layers of shingles. The bent wall flashing will later be covered by the house wrap membrane, so any water hitting the wall will run down the house wrap membrane and out to the surface of the roof shingles. Estimating bent wall flashing is simply a matter of determining the horizontal length of the roof top edge and deterring the manufactured length of the bent flashing to find the number of whole piece that will need to be purchased.

Figure 10-29: Bent wall flashing installed along the vertical wall plane.

On wall installations where the slope of the roof is parallel to the plane, step flashing is used to weatherproof the shingle installation. Step flashing is small L shaped pieces of metal. The horizontal portion of the L shape is placed between each course of shingles and the vertical portion of the L is nailed to the wall plane. Each piece of step flashing is used for only a single course and subsequent pieces' stair step up the wall as shown in Figure 10-30.

Figure 10-30: Step flashing.

Since one piece of step flashing is used with each course of shingles, once piece of step flashing is estimated for the length of shingle exposure along the sloped distance of the roof. For example, if English size shingles were used with an exposure distance of five inches, then one piece of step flashing would be needed of each five inches of sloped roof length. If metric size shingles were used, one piece of step flashing would cover 5 5/8 inches of the sloped roof length.

Mechanical Equipment Flashing

Several types of mechanical equipment are commonly needed to complete roofing installations. Examples of mechanical equipment flashing include plumbing vent flashings and chimney vent flashings.

Code requires plumbing drainage and waste lines to be vented to the atmosphere. Most often, venting is accomplished by extending plumbing vent lines through the roof plane. Where the plumbing lines exit, the roof usually requires some form of plumbing vent boot. Figure 10-31 shows an ABS plumbing vent extending through the roof structure with a flashing boot installed.

Figure 10-31: ABS pipe vent flashing boot.

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 32: Furnace vent flashing.

Many types of gas fire appliances such as furnaces and water heaters require vents that extend through the roof to remove toxic gases due to the combustion process. Often, these appliances are also vented through the roof using metal chimney ductwork. This ductwork usually requires a flashing boot where it extends through the roofing plane as shown in Figure 10-32.

Roof Vents

Proper ventilation of the attic space is an important element of the roofing system in any construction. The attic space should be vented to allow a flow of air in an effort to maintain a temperature that is close to the ambient temperature of the outside air. Not allowing the attic to vent properly can cause the attic space to overheat, which can cause issues and adversely affect the lifespan of the roofing system in both the winter and the summer.

In the winter as the temperature in the attic rises, it causes any snow accumulation on the roof to melt and turn into water. The water runs down the slope of the roof until it reaches the eaves which are not getting heat from the attic space. As the water hits the transition between the attic portion and the eave portion of the roof, it refreezes. As this cycle continues, the freezing water builds up along the roof eaves and forms an ice dam. The ice dam can damage the shingles and can even build up to the point that there is a negative slope on the roof edge, which allows water to flow back into the structure. Keeping the attic cool will help to minimize the freeze thaw cycle and keep the snow on the roof until the entire roof plane is closer to a consistent temperature, allowing the water from the melted snow to completely drain off of the roof edge.

In the summer, the heat in the attic space can build up and cause damage to the roof shingles as they become overheated. In addition, the overheated attic can contribute to a loss of energy efficiency as the warm heated air radiates back into the house in the evening, requiring additional air conditioning. The two primary methods of proving for attic ventilation is to install either multiple individual roof vents or a continuous vent along the ridge. Figure 10-33 shows an example on six individual vents close to the ridge on the back side of a roof. These particular types of vents are also known as turtle vents due the shape.

Figure 10-33: Turtle attic vents on the back side of a roof.

The second type of roof vent that is commonly used is a ridge vent. With a ridge vent, the roof sheathing is cut back one inch on each side of the peak of the roof, allowing a two-inch-wide gap at the roof peak. A commercial ridge vent material that is constructed of some type of porous or screen material is attached over the opening at the roof ridge. The ridge shingles are then placed over the ridge vent material in a manner that allows air to flow freely out of the ridge vent (Figure 10-34).

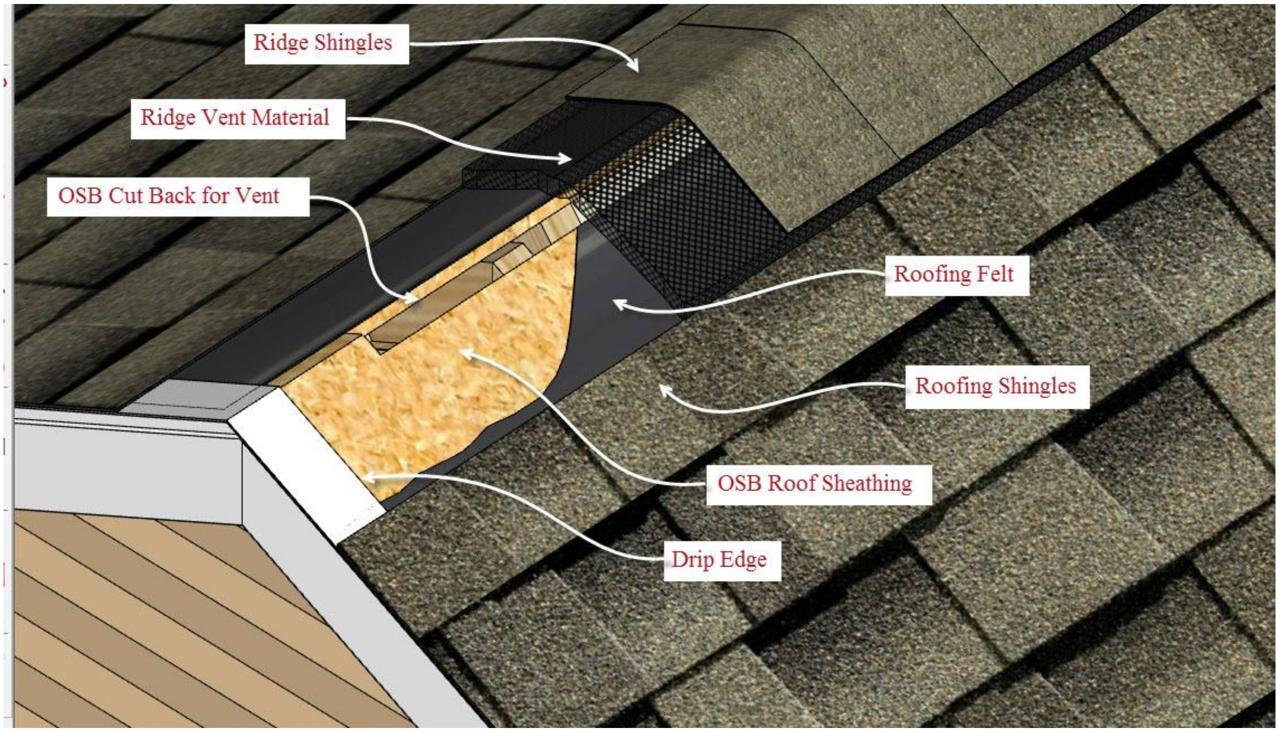


Figure 10-34: Continuous ridge vent.

Calculating ridge vents depends upon the type. Individual vents are simply a count and list item. Ridge vents are calculated by determining the length of the ridge, which has vents installed divided by the length of vent material in each roll.

Roofing Nails

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 35: Plastic cap nails.

Two types of nails are commonly used when installing roofing material. The first type is known as cap nails. These are roofing nails that have a large metal or plastic cap at the head to help provide increased surface area to hold down material, such as roofing felt or ice and water shield, as is shown in Figure 10-2. They are frequently manufactured from corrosion resistant material, such as stainless or galvanized steel, and they are typically hand driven. They are sold in boxes or tubs by the pound (Figure 10-35.)

The second type consists of large head roofing nails which are used to attach the asphalt roofing shingles. Typically, the minimum requirement for nailing shingles is for each shingle to have four nails per full size shingle placed, as shown in Figure 10-38. Shingles applied in locations where they are subject to high winds can require six nails per full size shingle. Both the four nail pattern and six nail patterns are shown in Figure 10-38.

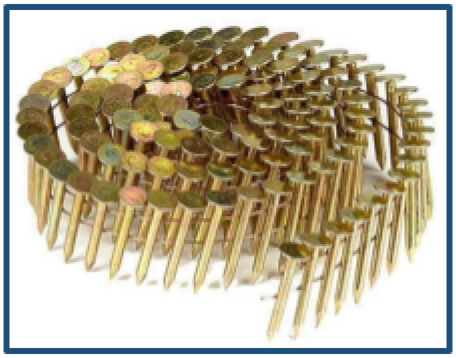


Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 36: Coil roofing nails.

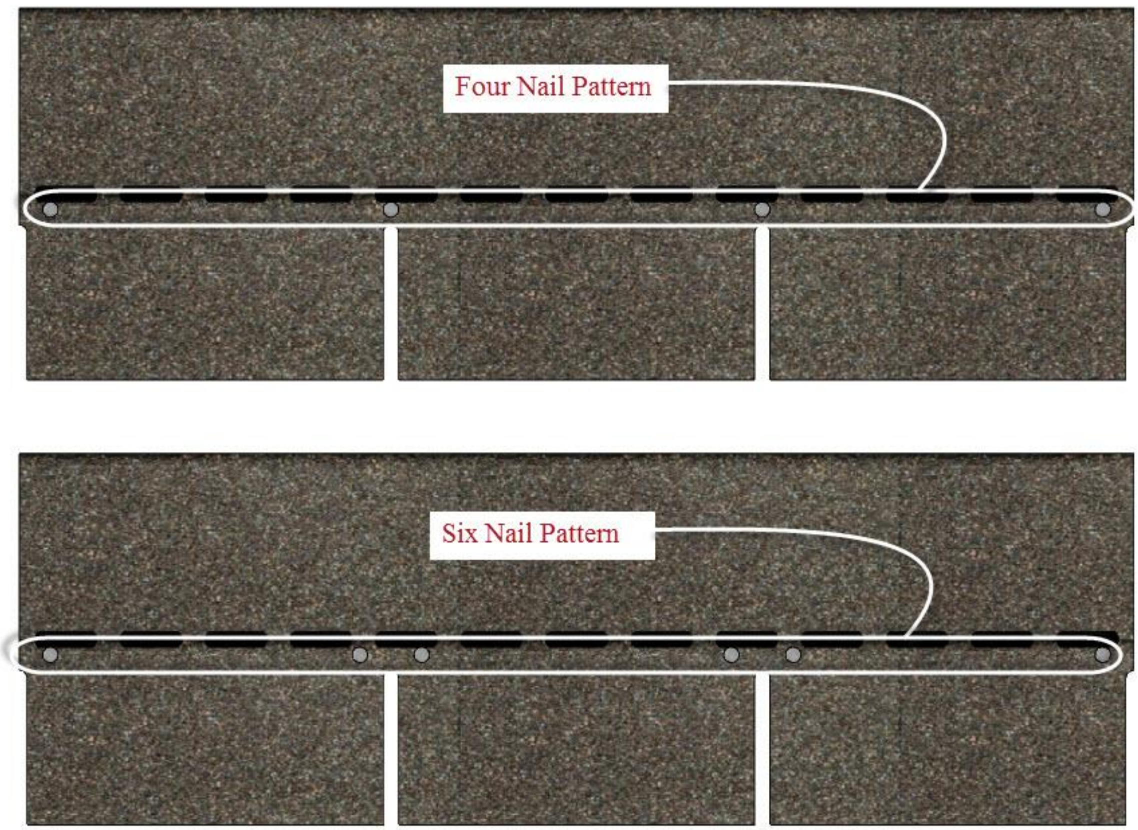


Figure 10-37: Four and six nail shingle nailing patterns.

A rough estimate of the nails can be determined by the amount of roofing material purchased. For example, it is recommended that roofing felt be nailed down at eight inch intervals along both edges and the middle. This results in approximately one and one-half nails per square foot of roof area. A roll of #30 roofing felt can cover approximately 200 square feet of roof, therefore, approximately 300 nails are needed per roll of 30 lb. felt. A roll of #15 felt would need 600 nails. Estimating nails for shingles would be similar, but it would depend upon the number of required nails per shingle. Each bundle of standard size shingles contains 27 shingles. Using a four nail pattern would require approximately 108 nails per bundle, and using a six nail pattern would require 162 nails per bundle. Metric sized shingles would require 88 or 132 nails per bundle, based upon a four or six nail per shingle nailing pattern. Most roofing nails would list the approximate number of nails per box or container and can be used to calculate the number of boxes or containers.

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All About Window Materials

This document gives a detailed overview of the types of window materials used in residential construction projects. Windows for residential construction are manufactured in almost an infinite variety of types, styles, shapes, and sizes, using a number of different materials. The construction estimator will need to become familiar with window types, frame materials, methods of construction, and installation.

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Window Types

One method of classifying a window is by its type of operation. Fixed windows include non-operating and operating windows, which include window types such as casement, double and single hung, and sliding.

Fixed Window

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 40 Arched top fixed window. CC by Andersen Corp-ND

Fixed windows cannot be opened to allow circulation of air, but are fixed in place. The primary purpose of these window types is to allow light to enter the space. They can be very large windows or picture windows, which allow large amounts of lights into a space or access to desirable views. They can be smaller windows where there is no need to allow for air circulation, but it is desirable to allow in light. Fixed windows can be square or rectangular but are also manufactured in an almost infinite variety of shapes and sizes. Fixed windows are often combined with operating windows in an installation.

Operating Window

Operating windows have a sash that can be moved in some way to allow the window to open. Typically, these window types are identified by the way they move. The most common operating window types include casement, sliding, single, and double hung windows.

Casement Windows

Casement windows operate by using a hinge action on either the right or left side of the window. Very often, these windows have a crank or other mechanism that operates the window and holds it open or closed at a specific angle. These windows are desirable because they allow almost the entire sash portion to open. Figure 10-41 shows a casement window type.

Sliding Windows

The sash in sliding windows also moves in a horizontal direction, but the sash slides horizontally in a track. These windows are economical because the sliding mechanism is not as complex as other window operating types. In addition, these windows can be made in larger sizes and still operate efficiently and smoothly. When open, one half of a sliding window covers the other half, so the maximum these window types can be opened at a time is half of the window size (Figure 10-42).

Double and Single Hung Windows

Double and single hung windows operate by allowing the sash to move in a vertical direction. A double hung window has two movable sashes. One is over the other, and each sash can move. The top sash slides down, and the bottom sash slides up. Still, the maximum opening size of the window will only be equal to half of the window size as one sash covers the other when open. The advantage of this type of window is that the top sash can be lowered, which makes the opening at the top of the room and allows warm air that has risen to naturally escape out of the window.

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 43 Double hung window. CC by Andersen Corp. - ND

With single hung windows, the bottom sash lifts up to cover the top sash. Both of these window types are also a little more complicated in their manufacture in that there is usually some type of lifting mechanism that holds or counterbalances the weight of the sash and keeps the window sash raised (Figure 10-43).

Combined Windows

Some installations use multiple individual window units, each in its own space, such as is shown in Figure 10-44, which has a wall of windows consisting of single hung and fixed window units.

Figure 10-44 Wall of individual windows units with each unit in its own space.

CC0 Gregory Butler, Pixabay-Photo 276551

Combination windows are windows that combine multiple windows together in a single unit. The combination unit could be multiple units all of the same type or combinations of several different types, such as is shown in Figure 10-45, which has a single arched top fixed window unit on top of a sliding unit.

Figure 10-45 Combination window unit.

Window Frame Materials

Modern windows are constructed of a number of different materials including wood, metal, vinyl, fiberglass, and composites.

Wood Window Frames

Wood was the first material that window frames were made from and is still used extensively today. Wood is an excellent material to manufacture. Wood is a beautiful material that is warm and inviting. It also is a very good insulator and helps to make these window types energy efficient. On the downside, wood is subject to decay from moisture and termites and must be regularly maintained. Many modern window manufactures combine wood interiors with a metal, fiberglass, or vinyl exterior to make them more durable. Wood windows also are usually costlier than some of the other alternatives.

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 47 Wood window.
CC by Andersen Corp. - ND

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 46 Vinyl window construction.
CC by Steve Anderson - ND

1.

Vinyl Windows

Vinyl window frames are made from polyvinyl chloride (PVC) with ultraviolet inhibitors to prevent degradation from sunlight. Vinyl has good moisture resistance and does not require painting. Traditionally, vinyl window frames were manufactured in white, but now, most manufacturers supply them in different colors. The vinyl extrusions can be filled with insulation to make them more energy efficient. They provide a good low maintenance value in a window product.

Fiberglass Windows

Fiberglass window elements are made by a process known as pultrusion. The fiberglass roving and veil are covered in a fiberglass resin and pulled through a shaped mold, which forms and hardens the fiberglass. Each resulting straight pultrusion is cut to length and formed into window components. Fiberglass windows are considered stronger and more durable than vinyl windows, which allows the windows to be constructed of smaller pieces, allowing more glass and light. Fiberglass windows are typically about 25 percent more than vinyl. Fiberglass is stable and impervious to moisture, water, mold, and rot. It is also very temperature stable. The exteriors can turn chalky white when exposed to sunlight, and keeping them covered with a sunlight resistant product is essential.

Composite Material Windows

Composite windows are the newest entry into the window market. They are made of a composite material that is a combination of wood plastic resin material. Manufacturers claim that they are stronger and more durable than vinyl. The composite material is stable and impervious to moisture, water, mold, and rot.

Aluminum Windows

Once one of the most common window materials, aluminum extrusions, have gone out of favor because aluminum is a high thermal conductor and has very low thermal efficiency. The windows are strong, lightweight, and durable, but now aluminum is paired with another material, such as wood, to be used for the exterior.

Window with Multiple Material Types

Several manufacturers make windows that are a combination of several material types. For example, there are windows where the interiors are made of warm wood, and the exteriors are either covered in or made from weather resistant material. Some combinations include wood windows where the exterior is covered in weather resistant vinyl or composite material. Another type is a window in which a wood interior is bonded to a weather resistant aluminum exterior. This results in windows that can be both beautiful and very weather resistant. These windows are typically more expensive than those made from a single material. Figure 10-48 shows several different combination window types from Andersen windows.

Figure 10-48 Three Andersen window cladding and combination window types.

Window Glazing

Traditionally, windows were made from a single layer of glass that was manufactured to a specific thickness. Glass that is 3/32 inches thick is commonly known as single strength glass. Glass that is 1/8-inch-thick is known as double strength glass. Other thickness such as 1/4 inch, 3/8 inch and 1/2 inch are also available. Single layers of glass are a very poor insulator and contribute significantly to the heat loss and gain in a building. In addition to the need for increased energy efficiency and safety, other architectural requirements have led to an increase in options available in window glazing material.

Energy Efficient Glazing

There are many options and techniques that can be used to increase the energy efficiency of window glazing including insulating glass units, gas filled glazing units, heat absorbing tints, low-emissivity (Low-E) coatings, reflective coatings, and spectrally selective coatings. Energy efficient windows can use one or more of these options to increase their energy efficiency.

Insulating Glass Units

Insulating glass units are window glass units made of two or more window units that are hermetically sealed together and used in the window in place of a single piece of glass. The sealed unit traps air within the unit. Non-moving air is a good insulator and does slow down the heat loss and gain through the unit. The elements of a sealed unit include double panes of glass, a spacer filled with a desiccant material, and sealant around the perimeter of the unit as shown in Figure 10-49.

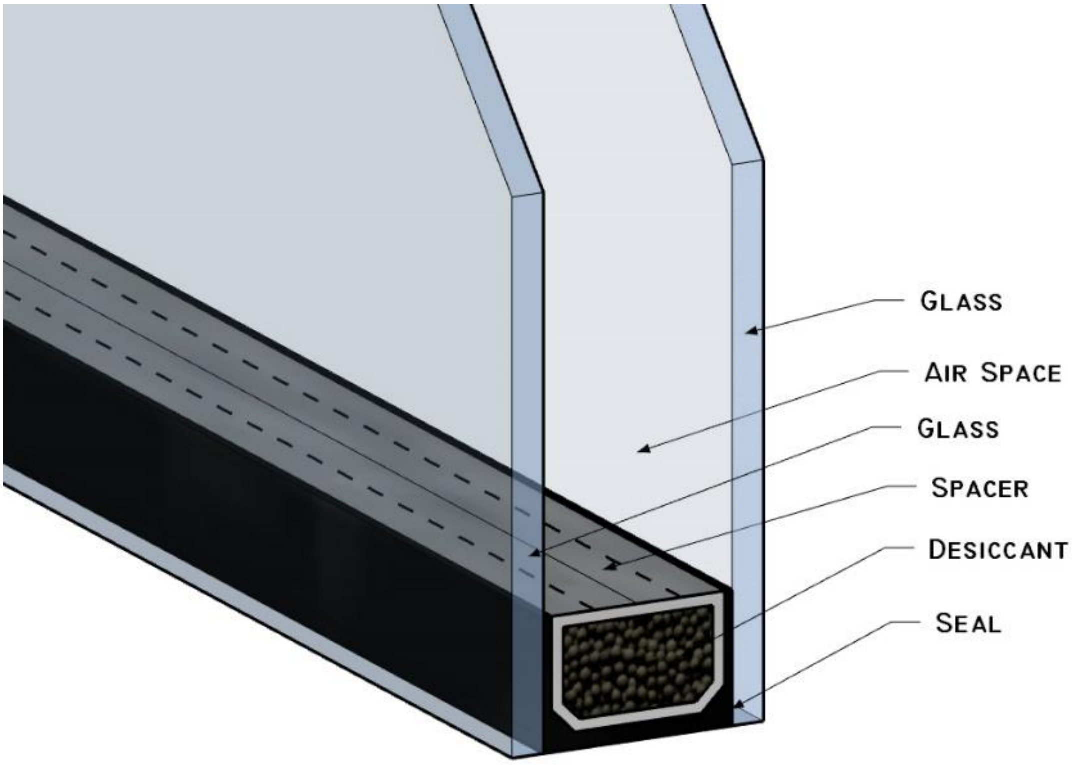

Figure 10-49 Seal glazing thermal unit construction.

Gas Filled Thermal Units

Gas filled thermal units are similar to regular sealed units, however, with gas filled units, the air inside of the unit has been replaced with an inert gas, such as argon or krypton. These gases are denser, and they slow the rate of thermal transfer.

Low-E Coatings

Low-E coatings or metal oxide coatings are microscopically thin metals that are applied to one or more of the surfaces of the glass. The Low-E coating lowers the U factor of the window. Low-E coatings can be designed to allow for low, moderate, or high thermal gain. However, Low-E coating can reduce the visible transmittance of the window.

Reflective Coatings

Reflective coatings are metallic mirror-like substances that are applied to the glass surface. They reflect back the solar radiation. They have a tendency to block more light than heat, but they are used in areas with high heat gain to help reduce air conditioning costs.

Spectrally Reflective Coatings

Spectrally, reflective coatings are Low-E coatings that are designed to block out specific wavelengths of light while allowing others to pass through. These coating types are often used to reflect the infrared heat wavelength while allowing the visible portion of the light to show through.

Safety Glazing

Safety glazing is required by the building code in many residential situations. For example, windows that meet all of the following requirements are required to have safety glazing:

- Window is greater than nine square feet in area.
- Bottom edge of the window is less than 18 inches above the floor.
- Exposed top edge of the window is greater than 36 inches above the floor.
- There are one or more walking surfaces within 24 inches of the window.

Safety glazing is usually one of three types: tempered glass, laminated glass, and wired glass.

Tempered Glass

Tempered glass is created through a process of heating the glass in a furnace to around 1,150 degrees Fahrenheit, after which the outer surface of the glass is cooled rapidly while the inside is left to cool slowly. This puts the outer edges of the glass in tension and makes the surface much stronger. The tension in the glass causes the glass to shatter into many small pieces if the glass is damaged. Safety glass is required by the building code to be etched or permanently marked, identifying the type of glass, the manufacture, the ANSI (American National Standard Institute) standard for safety glass and year, The Consumer Products Safety Commission standard for safety glass, and the Safety Glazing Council product approval number. The label and information can be in the form of a logo (Figure 10-50).

Laminated Glass

Laminated glass is manufactured by sandwiching a layer of polyvinyl butyral (PVB) or ethylene-vinyl acetate (EVA) between two or more layers of glass. The inner layer bonds the glass particles together in the case that the glass is shattered and prevents it from breaking into large dangerous pieces. Laminated glass can also help reduce the sound transmission through a glass window.

Wire Glass

Wire embedded glass can be used as safety glass. This was one of the first types of safety glass used, and windows with wire glass can still be seen in many buildings.

Polycarbonates

Polycarbonates are plastics, such as those sold under trade names such as Lexan® and Makrolon®, that can be used as safety glazing material.

Safety Glazing in Coastal Areas

The building code requires windows along coastal areas prone to hurricanes to be able to have high levels of impact due to wind. Depending on the specific location and the wind load requirements for that area, the impact resistance requirement can be quite substantial. The windows are required to pass what are known as a small missile test and a large missile test. In the most stringent areas, the large missile test requires the window to be able to resist the impact of a standard 8-foot 2 × 4 traveling at a rate of 80 feet per second (Figure 10-51)

Figure 10-51 Two-by-four cannon at the NAHB Housing Innovation Center used to test impact resistance of building materials for use in high wind-prone regions.

Architectural Requirements

There may be specific architectural design requirements for the glazing and windows of a building. These architectural requirements may be as small as requiring obscure glass in the widows of bathrooms and other privacy areas. Architectural glass could also include leaded or stained-glass windows and other decorative glass (Figure 10-52).

Figure 10-52 Decorative window glass used to create architectural detail.

All About Exterior Door Materials

Exterior doors are available in an almost unlimited variety of materials and styles. Regardless of the particular variety, materials, and styles, all exterior doors need to perform some essential functions, including an ability to be opened and closed easily while retaining the ability to securely keep out unwelcome intruders. They also need to be able to keep out elements of the weather including rain, snow, heat, and cold. They need to hold up under the constant deteriorating effects of the weather. In addition, many exterior doors are a primary area of focus for the home and can contribute to the beauty and street appeal of it. There are both advantages and disadvantages to each style and material, which can both contribute and detract from the door's ability to meet all of its functions.

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Door Construction Types

In spite of the almost unlimited number of door styles, most can be classified into one of three types: flush doors, panel doors, and sash doors. Each of these types will be covered.

Flush Construction Doors

Flush construction doors have a single smooth flat surface. The doors can be constructed of wood and wood veneers, metal, fiberglass, or composite materials.

Wooden Flush Doors

Wooden flush doors can be both hollow core and solid core. Hollow core wooden doors are primarily for interior use, and they do not hold up well under the demands of the weather. In addition, they are not very secure and can be forced. Solid flush core doors usually have a core of either solid wooden blocks or a composition material such as MDF (Medium Density Fiberboard). The faces of the doors are usually constructed of multilayer veneer plywood at least three layers thick. The face veneers can be paint grade material or high-quality veneers. Moldings can be applied to the faces of the doors to add interest and style to the door.

Metal Flush Doors

Metal flush doors are usually made from steel. They can be made entirely from steel or have a steel skin over other cores, such as wood. All steel doors are most used in commercial buildings. Steel doors in a residential setting are usually steel skin over other materials. Often, the door has a wood frame around the outside along with strategically placed wood blocks located where the hinges and locksets are installed. The rest of the door can be filled with high density foam insulation to aid in increasing energy efficiency.

Fiberglass Flush Doors

Fiberglass exterior flush doors have skins of fiberglass material and insulated interior cores. The edges of the door have a frame made of wood or composite materials. The fiberglass can be smooth or textured to look like wood. The doors can be stained to look like wood. Fiberglass holds up well to the demands of the weather and can make for attractive, stable doors.

Figure 10-54 shows the basic construction of a flat panel door. Materials and construction of the door varies by manufacturer.

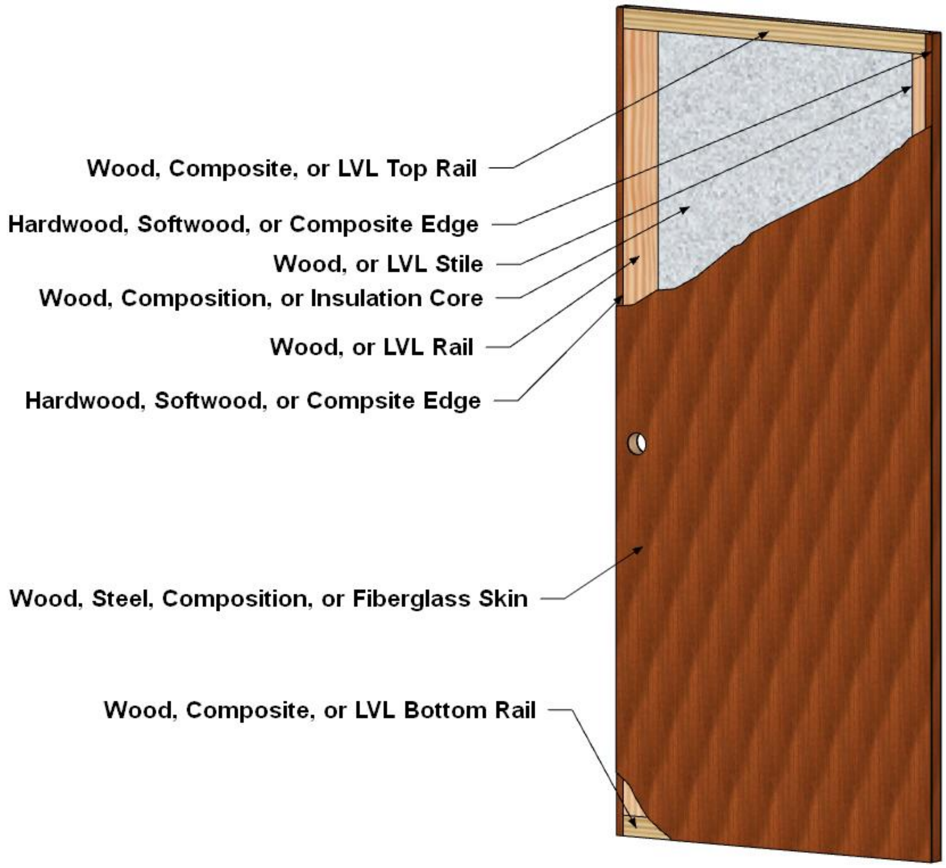

Figure 10-54 Flush door construction details.

Panel Doors

Panel construction doors can be made from wood, fiberglass, or steel. Wood panel doors can come in many different styles and construction methods. Fiberglass and steel panel doors are constructed in a similar fashion to flat panel doors, but they have embossed exteriors that resemble wood frame and panel doors.

Wood Panel Doors

Traditional wood panel doors are constructed of a number of individual wood pieces that are milled and joined together. Figure 10-55 shows an example of the typical construction of a panel door.

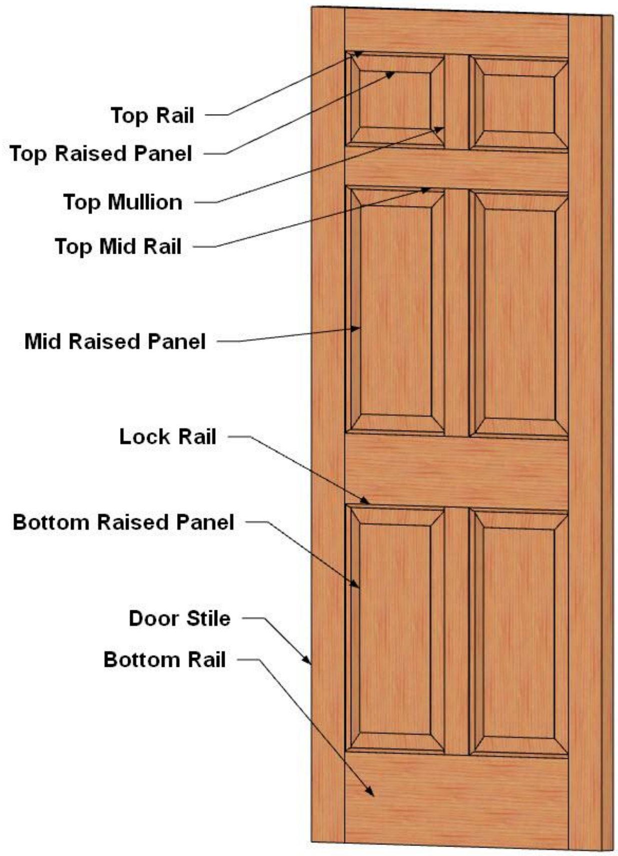

Figure 10-55 Six panel raised panel door.

Traditional wooden panel doors can be made in an almost limitless combination of styles, shapes, and sizes. Figure 10-56 shows an exploded view of a typical six panel door. The outside vertical members are called stiles. The horizontal members are known as rails. In addition, rails are named by their location: bottom, lock, mid, top, etc. The bottom rail is typically the widest rail in the door. The lock rail is usually centered at 38 inches above the base of the doors, which is the center location of the door lockset. Intermediate vertical pieces are known as mullions. Changing the shape and location of the various elements results in a different style of door. This is fairly easy to do. Some door manufactures will custom make doors to a client's specifications. In addition, many local mills and cabinet shops have the ability to make custom size and shape wood panel doors.

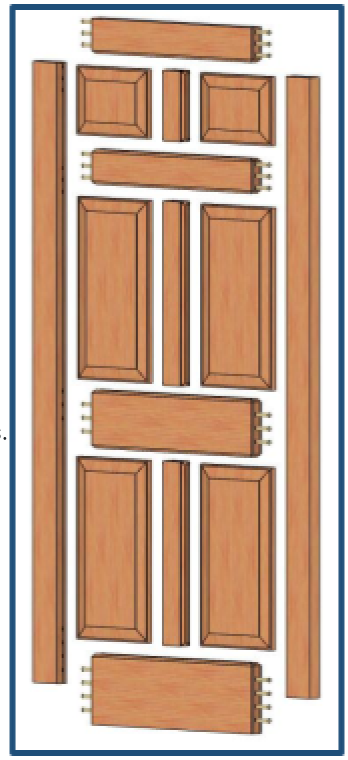

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 56 Exploded panel door construction.

Figure 10-57 shows a few possible raised panel style doors. Doors A and B have flat panels. Doors C and D have raised panels with an arch in the top rails and panels. Door C has an elliptical shaped arch, and door D has a center mullion with ogee shaped arches on each side. Door A has a squared edge joinery, and door B has square edge joinery that has a bead molding placed around the perimeter of the outside of the panels. Doors C and D have copper and stick edge joints.

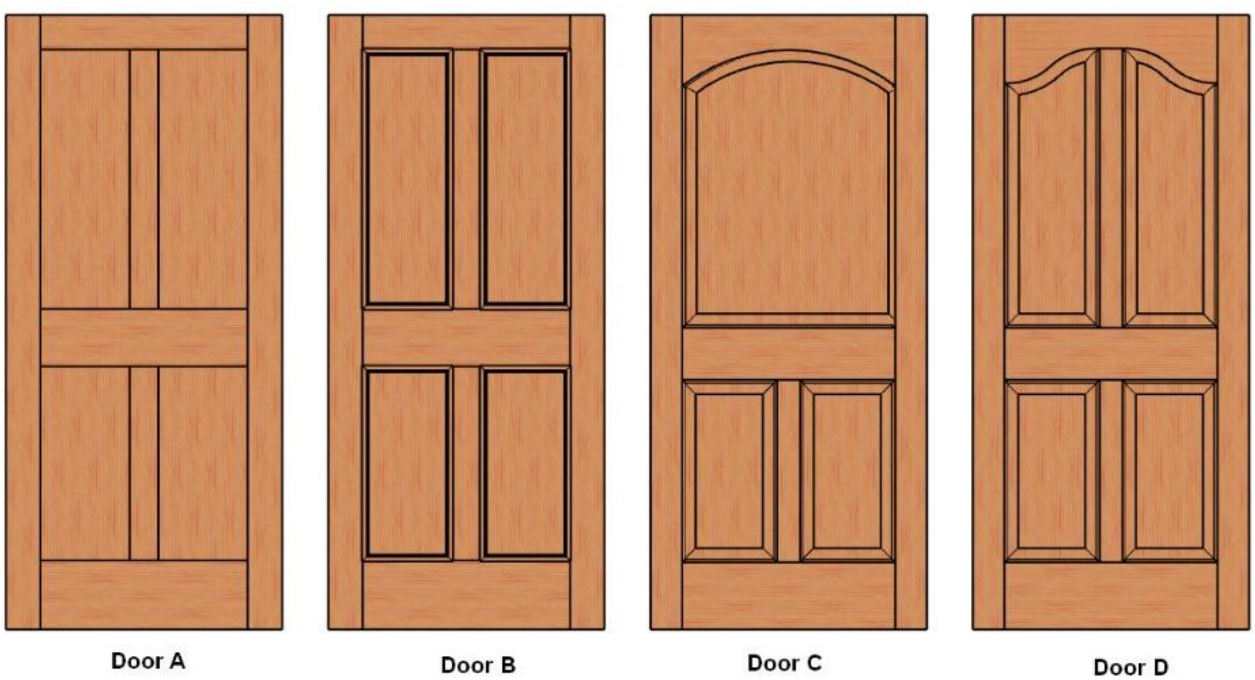

Figure 10-57 Four raised panel door styles.

Fiberglass and Steel Panel Constructed Doors

Figure 10-58 shows a sample fiberglass and steel panel door. They are constructed with a frame covered with a skin of fiberglass or steel attached to a frame made of LVL lumber, composite, or wood. Fiberglass and steel panel doors are available in a wide number of styles, but manufacturing techniques make it difficult to make true custom style doors. Fiberglass and steel panel doors hold up well to the rigors of weather.

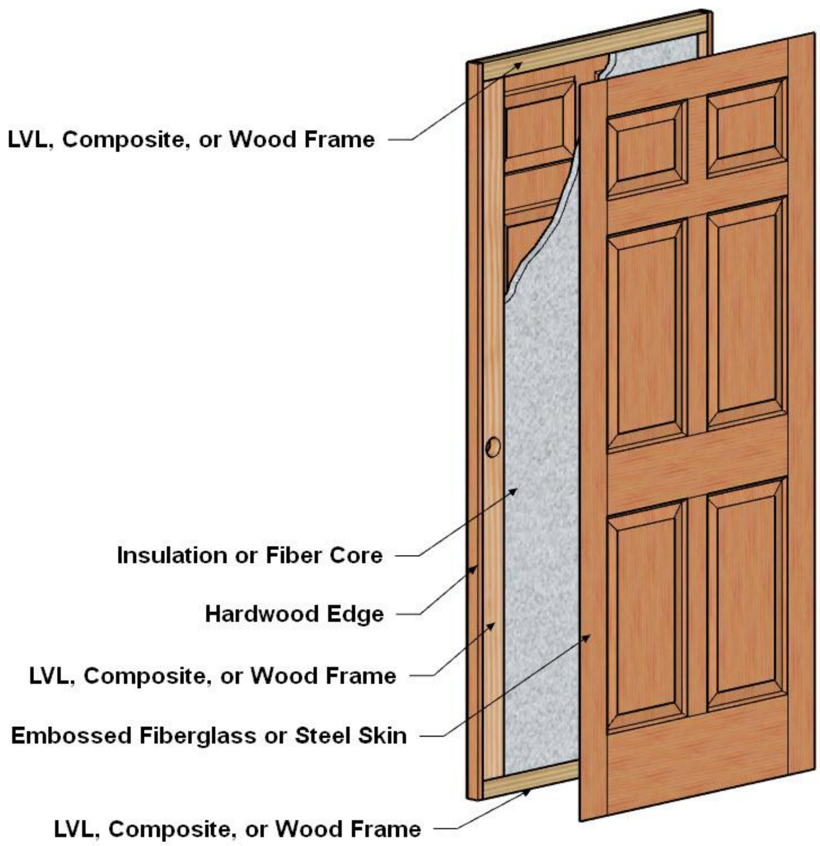

Figure 10-58 Sample frame and panel fiberglass or steel door.

Sash Doors

Sash doors have one or more glazing units in them. Building codes require that the glazing in doors be constructed of safety glass—usually tempered or laminated glass. In addition, to meet the needs of modern energy requirements, door glazing is usually constructed with insulated glass panels. A wide array of glazing is available from a small single panel to half lite and full lite doors. Figure 10-59 shows several examples of sash doors with one or more glazing panels.

Figure 10-59 Sash door examples.

The glazing in sash doors can be divided up into smaller windows called lites to provide architectural interest and mimic windows styles in older construction when glass was more economical to construct windows of multiple pieces of smaller glass. Modern manufacturing methods allow glazing to be made in large sizes. It is often desirable to make it appear as if the glazing was built up from many smaller lites to give the door a period look.

Door companies provide a number of different options. Four options are true divided lites, surface mounted grids, grids sealed in between the panes of glass, and a combination that utilizes both surface mounted grids and a matching grid in between the panes of glass. Figure 10-60 shows the four examples.

Figure 10-60 Door glazing divided into lites.

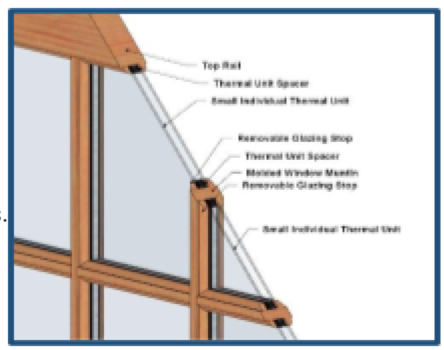

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 61 True divided lite detail.*

True Divided Lites

The glazing in doors with true divided lites is made of individual thermal units divided by wood millwork. This is similar to how window lites were traditionally made. However, traditional window lites were only single panes of glass. Modern true divided lites are made of individual thermal units with double or triple glazing sealed into individual units.

Surface Grid on Both Sides

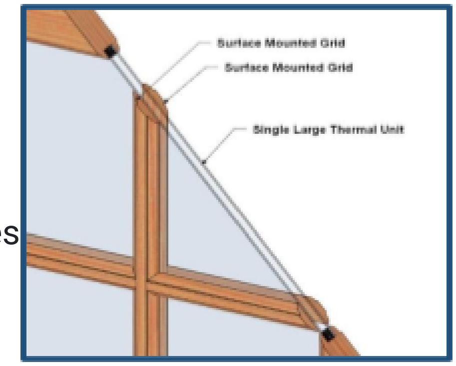

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 62 Surface mounted grids give the appearance of divided lites.*

The glazing on this type of sash door is usually a single large thermal unit. The look of a divided lite is provided either by adhering mutins directly to the exterior surface of the glazing or creating a removal grid work that is placed on top of one, or both sides, of the glass in the single thermal unit. This provides a traditional look while still using energy efficient single glazing units.

Grids Sealed Between Panes of Glass

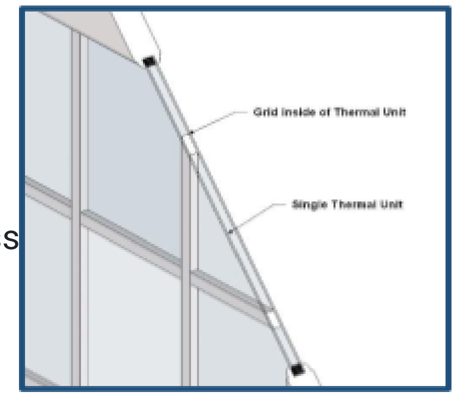

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 63 Grid inside thermal unit.*

Another option to provide the appearance of divided lite in sash doors is to install a grid between the layers of glass when the thermal unit is made. Usually, the grid is made from a vinyl or anodized aluminum material and cannot be changed unless the entire thermal unit is replaced. This provides an economical alternative to give the door a period look at a lesser cost than full divided lites. The color of the grid is also usually somewhat limited and cannot be changed in the future (Figure 10-63).

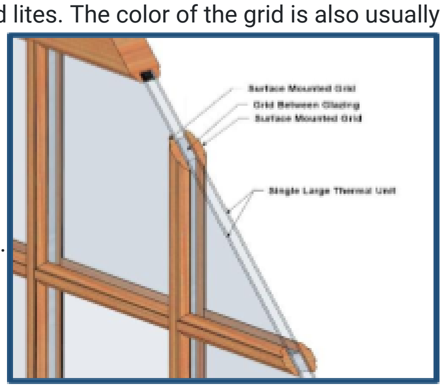

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 64 Combination grid units*

Combination Grids

The last option is to combine both surface mounted grids with a grid installed in between the glazing. This gives the look of full divided lites but allows for the increased energy efficiency of a single thermal unit. The exterior grids can be made of any material to match the exterior of the window. The inside grid is usually aluminum or vinyl.

Premium Style Glass Doors

Entry doors are also manufactured in a wide array of styles with premium glazing. This includes doors with stained glass, leaded glass, or etched glass. Modern doors have the glass sealed within a three-layer thermal unit. Layers of safety glass are placed on the outside with the decorative glass placed in the center (Figure 10-65).

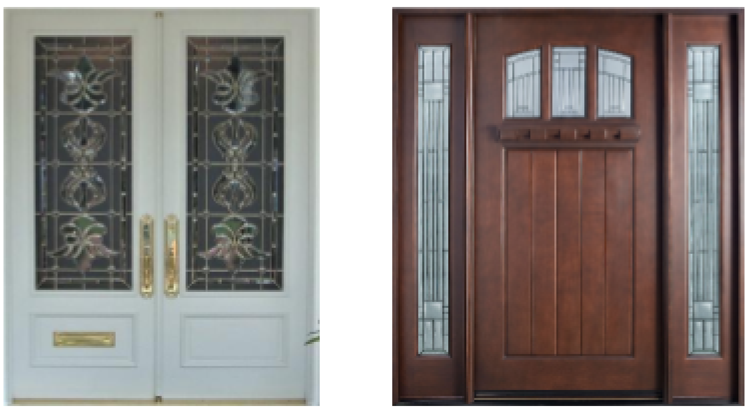

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 65 Premium art glass doors*

Combination Entry Units

Very often, exterior doors are combined with sidelights and transom windows and other decorative elements to give added architectural interest. Sidelights are narrow vertical units that are added to the sides of entry doors. Commonly, sidelights are placed on each side of the door, however, it is also possible to place a single sidelight on either the right or left side of the door. They are used to add emphasis to the entrance of a building. They can also be used to provide additional light in the entryway. Transom windows can be added to a combination door unit. A transom is a narrow horizontal unit that is placed above the door unit. Often, the transom window is the same width as the sidelights. Combination units can be purchased from manufacturers pre built and assembled, or they may be built up from individual parts and pieces that are assembled on the job. Installing built up units would require the estimator have a knowledge of all of the elements that go into the combination unit (Figure 10-66).

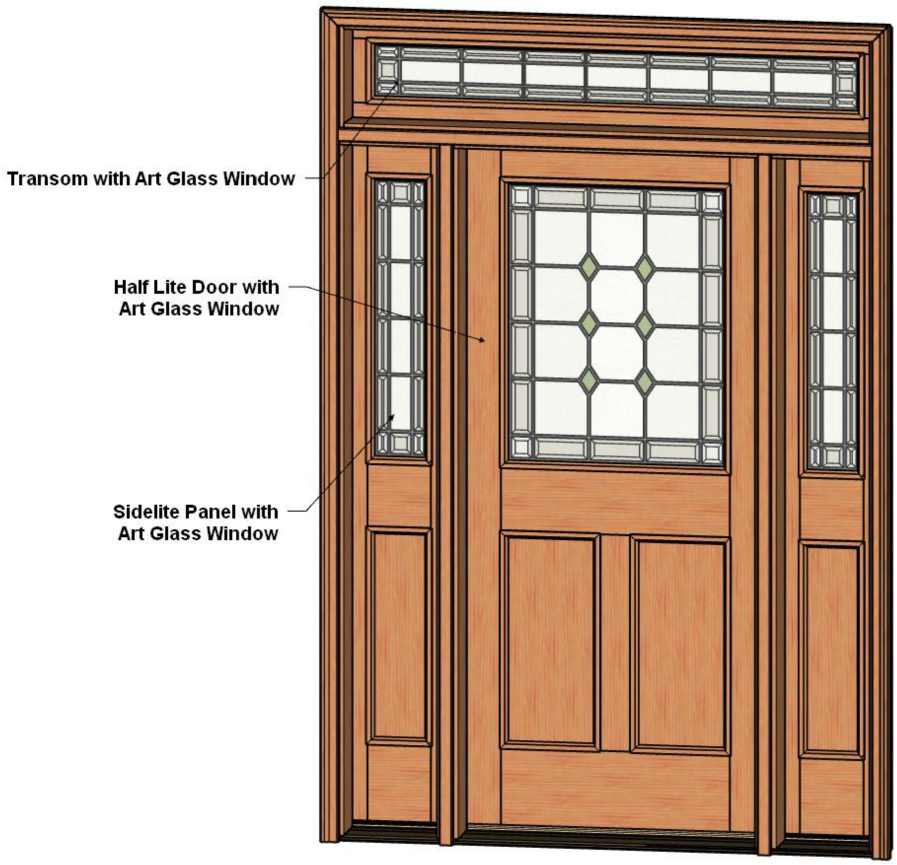

Figure 10-66 Combination entry door unit with two sidelights and a transom unit.

Patio Doors

Patio doors are often used to provide access to the outdoors from a room or to provide large amounts of light to the room. Patio doors usually have a frame made from any number of standard door materials including wood, aluminum, vinyl, fiberglass, and steel that encases a glass lite to form a single door panel. Patio doors have two or more of these panels, and at least one panel opens to allow access in one of three configurations: sliding, French, or center hinge.

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 68 Sliding patio door with one sliding unit and one fixed unit with narrow frame, single lite construction.

Sliding Patio Doors

Usually, only one panel on sliding patio doors moves by sliding along a track while the other is fixed in place. They are useful in situations where there may be a limited amount of space to open the doors. A number of frame options are usually available including narrow frames or wider frames meant to imitate more traditional doors. Sliding patio doors are also constructed with a wide range of glazing configuration including single lites, true divided lites, divided lites with surface grids, grids sealed between panes of glass, and combination grid units. Figure 10-67 shows a sliding glass door with wood and vinyl construction. Narrow frames allow for large single lite glazing in the door.

Figure 10-68 shows another example of sliding glass doors. This unit has three units. The two outside units are sliding, and the center unit is fixed. Wider stiles and rails give the doors a more traditional look. A custom arch shaped grid gives the doors high architectural interest.

French Doors

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 69 French patio doors with divided lites. CC-By Andersen Corp.-ND*

French doors are patio doors that are hinges on each side and open from the center outward. French doors open wider than other patio doors and can let in more fresh air and access. Typically, one panel on a French door is the main operating panel, and the second panel is secured by some form of sliding bolt. The strike plate for the lockset and deadbolt is attached to the edge of the stationary door. Typically, the operating panel closes against an astragal mounted to the secured unit. This configuration may degrade the energy efficiency of the door. French doors may be purchased in an inward opening configuration or an outward opening configuration. Figure 10-69 shows a pair of French doors with a divided lite configuration.

Center Hinged Patio Doors

At first glance, center hinged patio doors look similar to French style doors, however, the difference is that only one panel is hinged and operates. The hinges are attached to the fixed panel, and the door swings from the center. This is an advantage in some situations because the opening door can swing back against the fixed panel, saving some room in tight situations. Figure 10-70 shows a three panel center hinged patio door. The two panels on the left are fixed, and the left panel is operable.

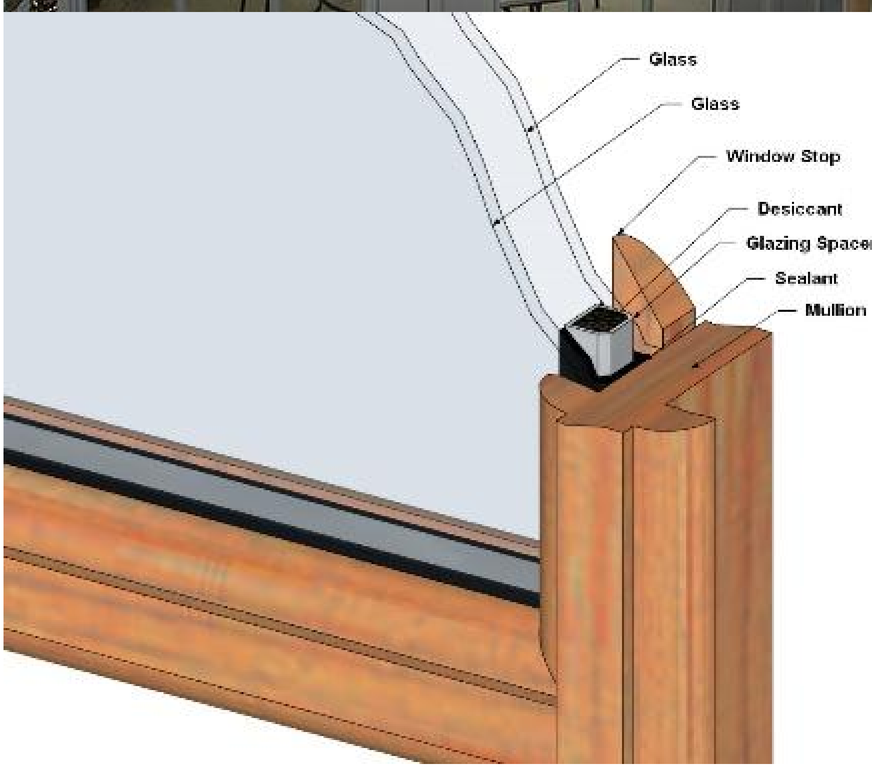

Figure 10-70 Three panel center hinge patio door.

Exterior Door Installation

Most exterior doors are delivered to the job site pre-hung on the jambs with hinges, weather stripping, threshold, and exterior casing installed. This has significantly simplified the installation of these doors and helped to increase the energy efficiency to exterior doors. Most major manufacturers supply their doors pre-assembled and pre-hung. If not, many building suppliers have the capability of assembling pre-hung doors for delivery to their customers. Figure 10-71 shows a view of a pre-hung door.

Figure 10-71 Pre-hung exterior door.

Figure 10-72 shows a close up view of the threshold portion of the pre-hung door and identifies the essential elements.

Figure 10-72 Close-up view of the threshold portion of a pre-hung exterior door.

Pre-hung Door Parts

Pre-hung exterior doors are usually supplied with the door slab, exterior door jamb set, threshold, weather stripping, and door sweep installed. Often, they are also supplied with the brick molding exterior casing attached. However, some suppliers do not supply the exterior brick molding, and it will need to be purchased separately. The estimator will need to determine the method used by the supplier.

Other items may also need to be purchased to complete the door installation including sill pan flashing, drip cap flashing, and self-adhered membrane flashing.

Sill Pan Flashing

The sill flashing can be a pre-manufactured plastic, vinyl, or metal pan. The pan is often purchased in three parts: two end pieces and a center piece that is assembled onsite. This allows the pan to be sized for different door sizes (Figure 10-73).

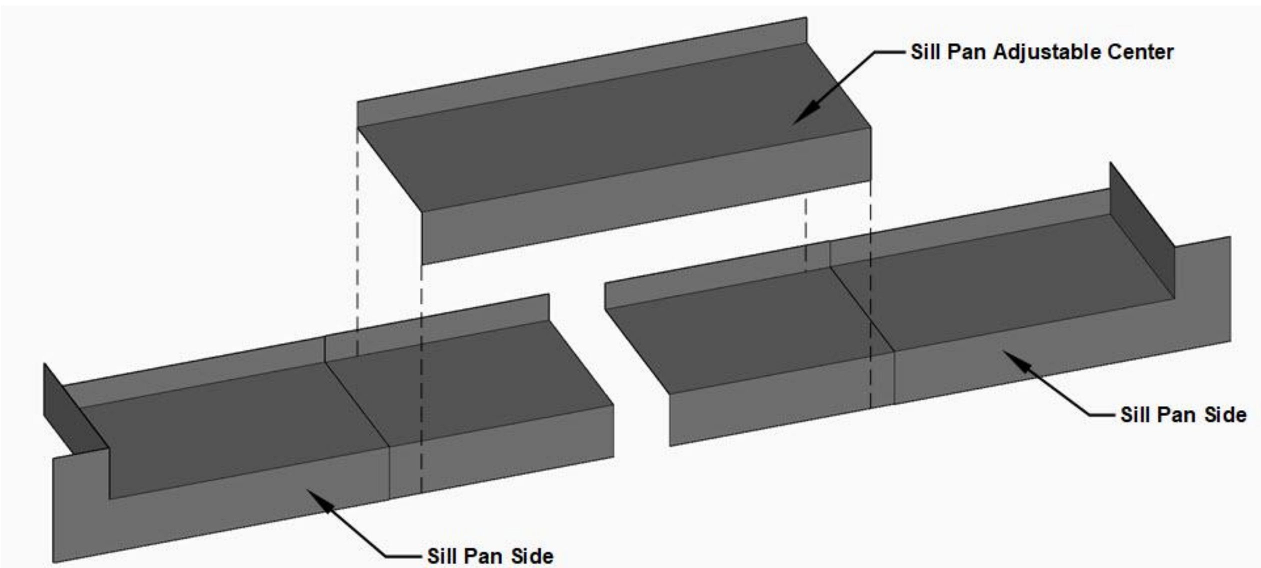

Figure 10-73 Prefabricated adjustable sill pan

A sill pan can be fabricated from self-adhered flashing tape. Four pieces of self-adhered flashing will be needed. The first piece is placed across the wall in front of the door at the base. Next, bow tie pieces are cut, bent, and placed in each corner. Third, a piece of flashing is placed along the front of the floor and bent down across the front of the door and walls (Figure 10-74).

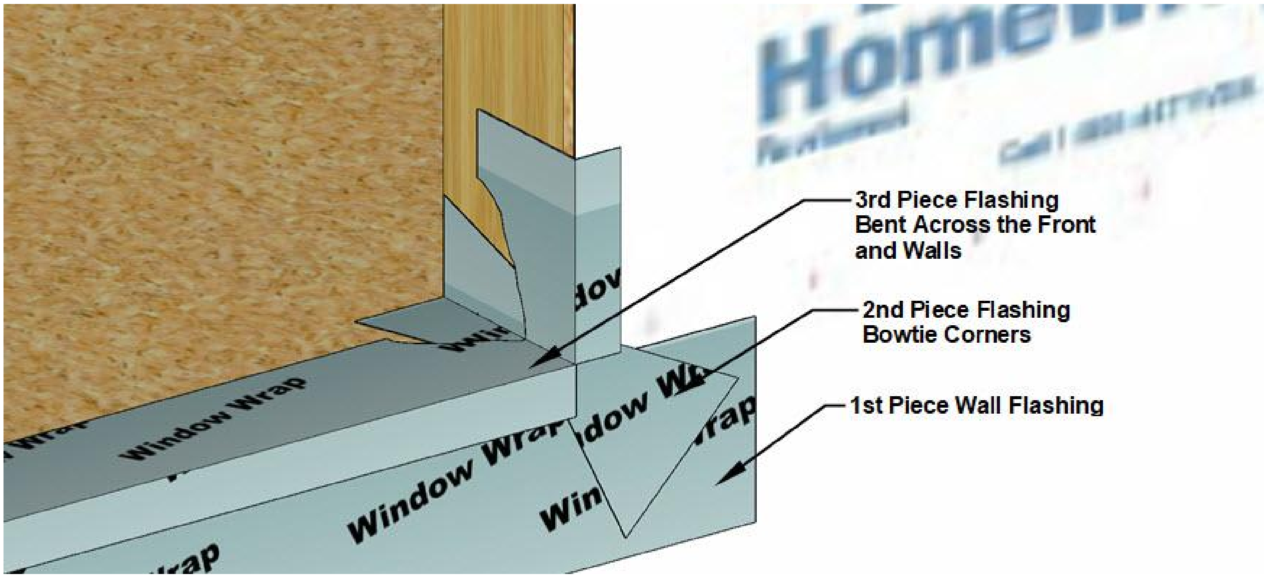

Figure 10-74 Door pan flashing constructed of four pieces of self-adhered flashing tape.

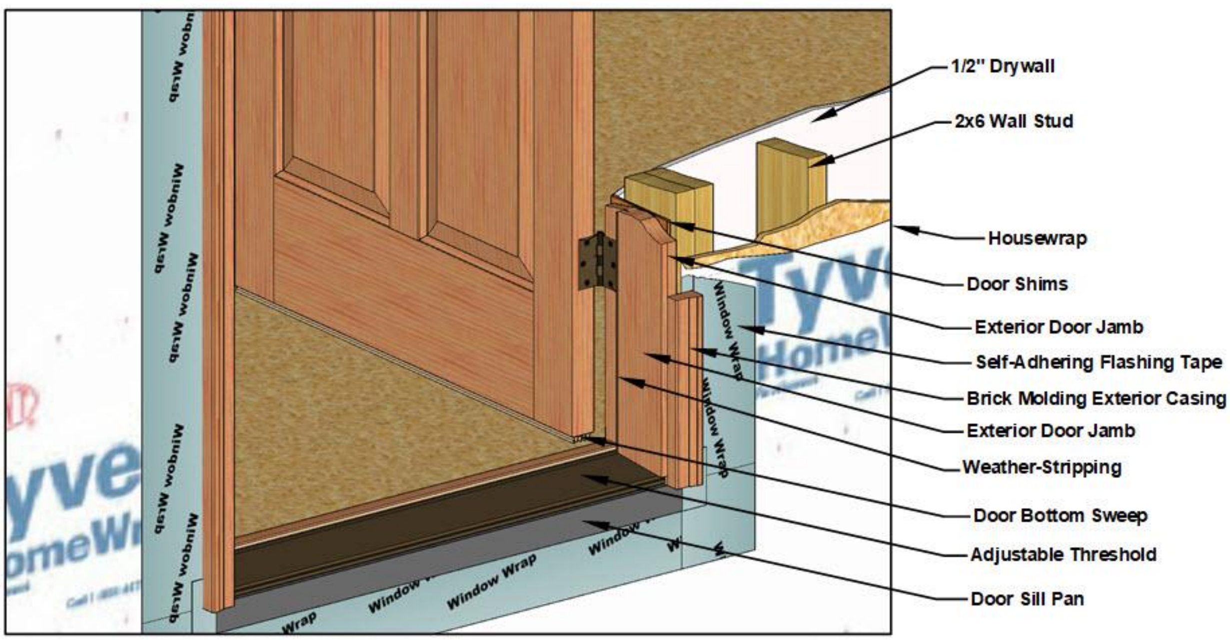

Figure 10-75 Exterior door installation flashing details.

Drip Cap Flashing

The top of the door should be flashed in a method that integrates the drainage plane of the exterior wall. A drip cap is placed on top of the brick molding exterior casing attached directly to the wall sheathing (Figure 10-76).

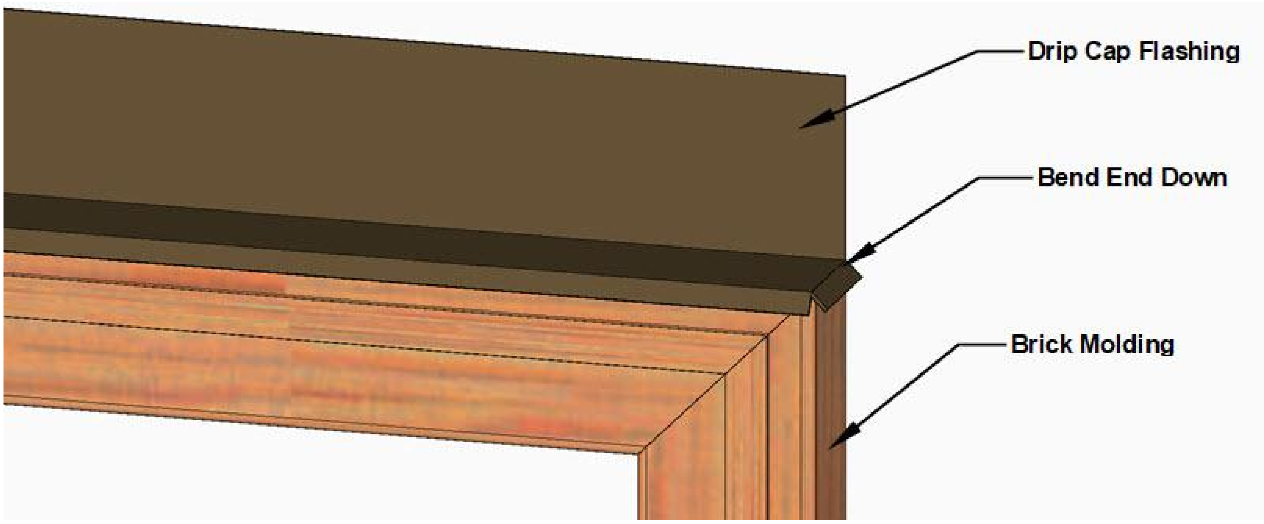

Figure 10-76 Drip Cap Flashing Detail.

Self-Adhered Flashing Tape

The top of the house wrap is cut back at a 45-degree angle, folded back, and temporarily taped out of the way. The side self-adhered flashing tape along the vertical sides of the door are placed over the edges of the drip cap, and the top layer of self-adhered flashing tape is placed across the top over top of the side flashing tape and drip cape. The flap of house wrap is folded back down and attached, and the angle cut is taped over to finish the installation. This will allow any water running down the wall to be channeled to the surface of the house wrap where it can drain away (Figure 10-77).

Figure 10-77 Exterior door top flashing details

Garage Doors

Garage doors are available in a wide range of materials and styles. Most contemporary residential garage doors are of the overhead sectional type. This means that the door consists of panels that open by sliding up on an overhead track. Figure 10-71 shows the typical construction of an overhead garage door constructed of five horizontal sections. The top section is glazing, and the bottom four are solid panels that allow the door to roll up on the track to open.

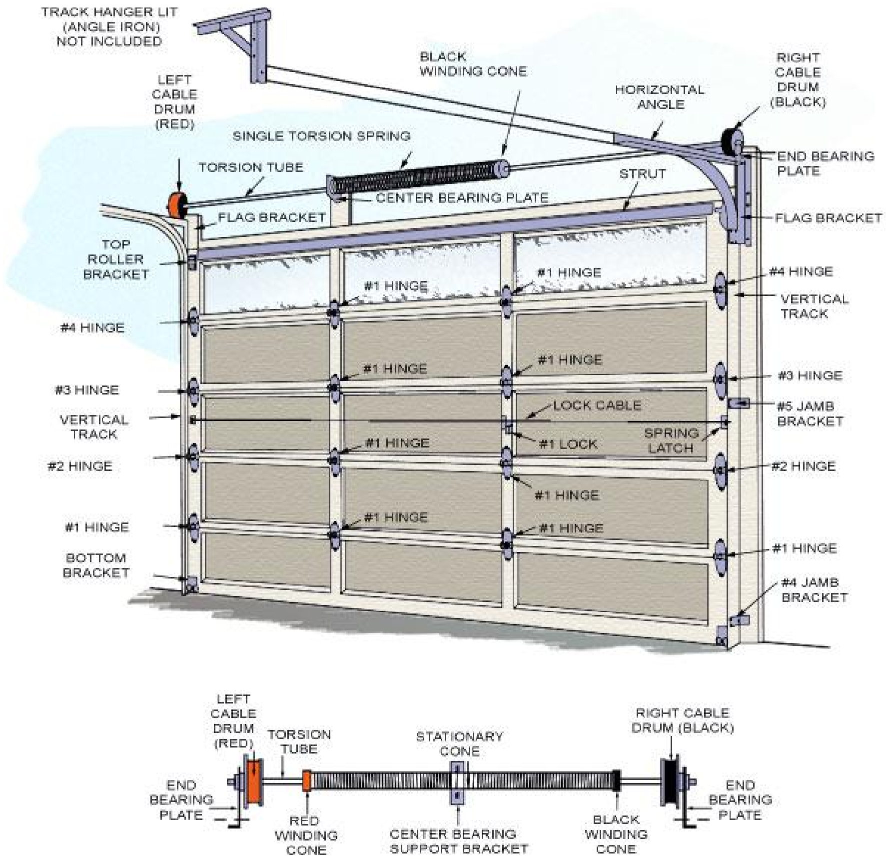

Figure 10-78 Typical overhead garage door construction.

By Doordoctor (Own work) [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], via Wikimedia Common

Common garage door materials include wood, aluminum, steel, fiberglass, and vinyl. They are made in many attractive styles. Some have insulated cores to assist in energy savings, and others are built to withstand high wind loads required in hurricane-prone areas. Figures 10-79 through 10-83 show some examples of garage doors.

Figure 10-79 Two double garage doors. They are wood grain with arched top windows.

Figure 10-80 Two single garage doors. Craftsman styles with divided lite windows.

Figure 10-81 Four garage doors. Three elliptical topped doors and one tall door.

Figure 10-82 Four farm style garage doors.

Figure 10-83 Two wood style garage doors.

Residential garage doors are usually manufactured in standard sizes of both single and double wide configurations. Standard sizes include single door widths of eight feet, nine feet, and ten feet. Double door widths come in standard sizes of 12 feet, 14 feet, 16 feet, and 18 feet. The standard residential garage door is seven feet tall, but eight feet is also common for taller vehicles. In addition to standard sizes, garage doors can be manufactured in a wide range of custom sizes.

Garage Door Installation

Manufactured garage doors are shipped with the materials and hardware needed to install the doors. The additional items estimated are framing lumber pieces used to anchor the door track and hardware to the building. In addition, some form of door jamb material will need to be installed. The actual jamb material will depend upon the installation. For example, Figures 10-79 and 10-81 show a garage door in a masonry installation, and one by wood material is installed as jambs against the door. Figures 10-80, 10-82, and 10-83 show wider material jamb with other wooden trim around them. Figure 10-84 shows the support framing for the garage door. Two by fours are installed on each side of the garage door that extends from the floor to the top plate of the wall. One two by four is also installed across the top. In the center of the door opening, a two by eight vertical center support is installed to anchor the door opening torsion spring. Two by six jamb material is installed around the inside of the opening for the door jambs.

Figure 10-84 Garage door support framing.

All About Exterior Siding Materials

A wide range of products are available for completing the exterior finish of a residential structure. Traditional materials include wood siding, which is available in a diverse array of products, horizontal and vertical panel siding, and wood shingle and shake siding. Masonry materials are another type of traditional exterior finish.

In addition to traditional exterior finish materials, numerous manufactured exterior finish products are also available for use for the exterior finish. These materials include hardboard or other manufactured wood or composite wood products, fiber cement products, steel, aluminum, and vinyl siding. There is also a wide range of manufactured masonry materials available including brick and stone veneers. Most manufactured exterior finish products are fabricated to simulate traditional wood and masonry products. Some of these products will be estimated in the exterior finish phase of the estimate and some in the subcontractor phase.

Another element of the exterior finish that is a vital part of the installation regardless of the material used is the installation of the water-resistive barrier (WRB) and the construction of the exterior drainage plane.

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Water-Resistive Barrier and Exterior Drainage Plane

The acronym WRB used in the construction industry stands for either the water-resistive barrier or weather-resistive barrier. While the two terms may appear to be interchangeable in use, they mean two different things. The function of the water-resistive barrier is to provide a barrier to bulk water intrusion into the interior wall assembly of the structure, which can lead to mold, rot, and a host of other problems. While a water-resistive barrier resists the penetration of bulk water, the material is somewhat porous, and shedding bulk water still allows the passage of water vapor. This is to provide an avenue for moisture that makes its way into the interior of the structure to evaporate out and allow the material to dry.

The function of the weather-resistive barrier is not only to limit the intrusion of bulk water penetration, but to limit the passage of water vapor. Other names for weather-resistive barrier include air barrier and vapor barrier. The installation of a weather-resistive barrier is more complex than that of a water-resistive barrier and usually requires the taping and sealing of all joints and penetrations in the barrier to prevent the free passage of air and water vapors. Weather-resistive barriers are most often used as a standard in more restrictive commercial construction, and the water-resistive barrier is used as the standard in residential construction.

Beginning with the release of the 2012 edition of the International Residential Code, the code mandated the installation of water-resistive barriers on residential construction. Section R703.1.1of the 2012 edition of states:

“The exterior wall envelope shall be designed and constructed in a manner that prevents the accumulation of water within the wall assembly by providing a water-resistant barrier behind the exterior veneer as required by Section R703.2 and a means of draining to the exterior water that enters into the assembly. Protection against condensation in the exterior wall assembly shall be provided in accordance with Section R702.2 of this code.”

Section R703.2 describes the minimum water-resistive barrier material as follows:

“One layer of No. 15 asphalt felt, free from holes and breaks and complying with ASTM D226 for Type 1 felt or other approved water-resistive barrier shall be applied over the studs or sheathing of all exterior walls. Such felt or material shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches. Where joints occur, felt shall be lapped not less than 6 inches. The felt or other approved material shall be continuous to the top of the walls and terminated at penetrations and building appendages in a manner to meet the requirements of the wall envelope as described in Section R703.1.”

Installing a functioning water-resistive barrier is an essential element in all contemporary residential construction projects. There are several approved materials for creating a water-resistive barrier.

Water-Resistive Barrier Materials

The standard specified in the IRC for water-resistive barriers is for No. 15 felt, but there are also several other approved alternatives including grade D building paper, plastic house wrap, liquid-applied WRB’s, rigid foam, and ZIP System sheathing.

Number 15 Felt

Traditionally, number 15 felt has been known as 15lb felt because it weighed 15 pounds per 100 square feet or square. Felt was traditionally made from cotton fiber, but modern felt uses other materials and is lighter in weight and is now called number 15. There are two ASTM standards for felt, and the ASTM D226 standard requires felt with a minimum of 11.5 to 12.5 pounds per square. Lower quality ASTM D4869 weighs 8.0 to 9.7 pounds per square and is not approved by code as a water-resistive barrier. Figure 10-86 shows an example of felt used as a WRB.

Figure 10-86 Felt water-resistive barrier.

Grade D Building Paper

Grade D building paper is a type of lightweight weather-resistive material. Kraft paper is saturated with tar to form a lightweight weather-resistant barrier. Code requires two layers of grade D building paper to meet the WRB requirements. It is often used for a second backing layer underneath stucco or other masonry materials as code does also require two WSB layers under these products. Figure 10-86 shows an example of a second layer of grade D building paper over plastic house wrap and underneath metal lathe in preparation for installing stucco.

Figure 10-87 Grade D building paper as a second layer of WRB in preparation for installing stucco.

Plastic House Wrap

There are many different brands and styles of plastic water-resistive barriers. Most are manufactured from a type of plastic called polyolefin. Several different manufacturing processes are involved in the main types being woven and non-woven, perforated and non-perforated. Each has its own desirable characteristics and cost point. They have become the most common form of water-resistive barrier. Popular brands include Tyvek, Typar, Weathermate, Weathermate Plus, Barricade, and R-Wrap. House wrap typically does a good job of shedding bulk water intrusion while still allowing water vapor to diffuse from the inside of the structure assembly.

House wrap typically comes in rolls nine feet wide, which allows for a single non-lapped layer in typical one-story exterior walls. Some plastic house wraps have a crinkled texture to aid in the draining of water. Figure 10-89 shows an example of a house wrap installation.

Figure 10-88 Plastic house wrap installation.

Liquid-Applied Water-Resistive Barriers

Liquid-applied water-resistive barrier is a material that is directly applied to the sheathing in liquid form. The material can be applied by spraying, rolling, or brushing. It is typically more expensive than some of the other alternatives but provides a very high-quality water-resistive barrier. Figure 10-90 shows a commercial building. The seams of the GlasRoc fiberglass siding have been taped in preparation for applying a liquid vapor barrier.

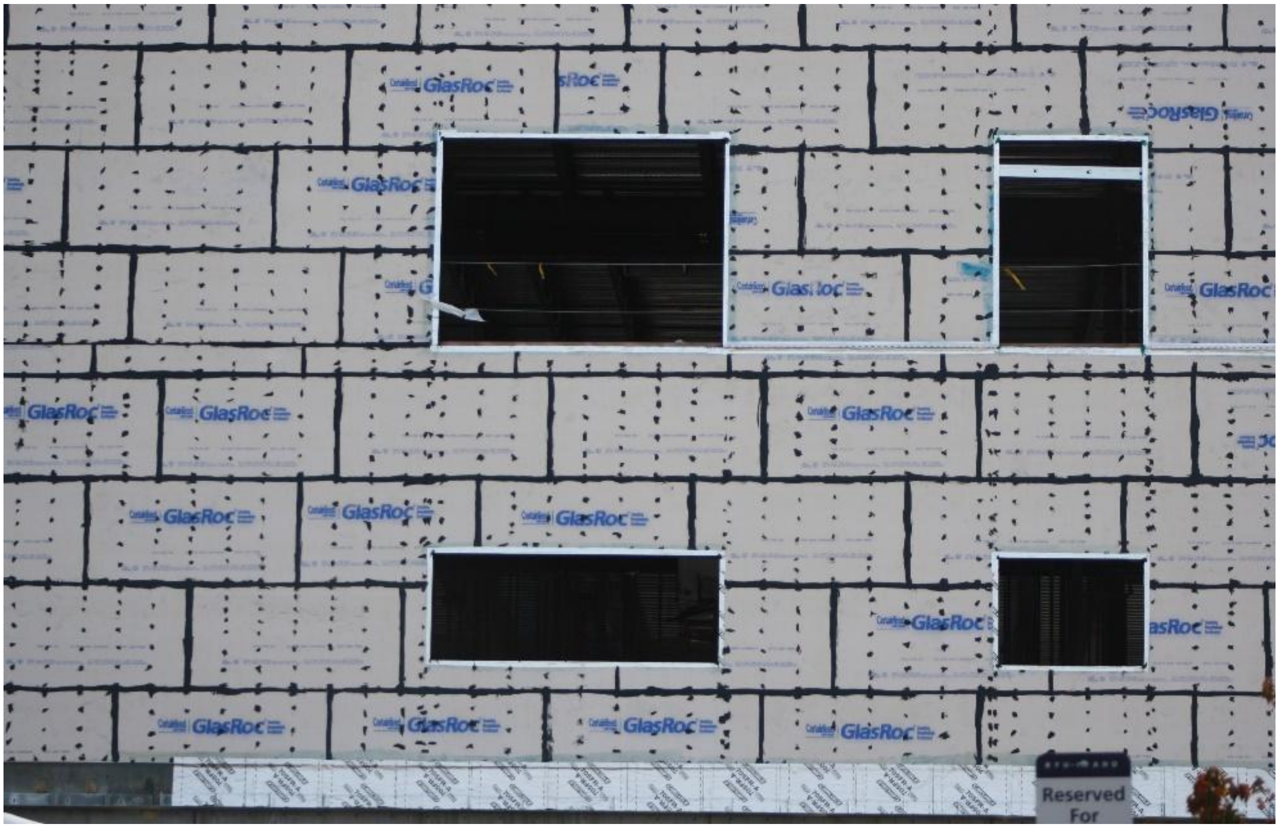

Figure 10-89 Seams and fasteners heads have been sealed in preparation for applying a liquid-applied water-resistive barrier material.

Figure 10-90 Dark blue liquid-applied water-resistive barrier applied over GlasRoc sheathing.

Courtesy of Nate Allen

Rigid Foam Water-Resistive Barrier

Rigid foam can be used as a water-resistive barrier. The foam must pass a stringent test for sun exposure and water penetration. In addition, specific details of installation must be observed including taping seams and details of window flashing and caulking. Not all brands of rigid foams have been approved for installation. Figure 10-91 shows an example of foam being applied over sheathing as a weather-resistive barrier.

Figure 10-91 Foam water-resistive barrier.

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ZIP System Water-Resistive Barrier

ZIP System water-resistive barrier is a commercial system composed of two parts: a plywood sheathing coated with a water-resistive material that resists the penetration of bulk water while still being vapor permeable and sealing tape that is applied to the joints to seal them and make them both water and vapor resistant. Figure 10-92 shows a model home with ZIP System sheathing being prepared for testing at the NAHB Housing Innovation Center. Tape still needs to be applied to the joints.

Figure 10-92 ZIP System sheathing applied to model home in preparation for testing.

Flashing Membranes

Flashing membranes are commonly used to seal around window and door openings to help keep out water and other moistures. They have been available since the 1990’s and are an outgrowth of the ice and water shield membranes used in roofing. Traditional techniques do not work well with many contemporary window and door installations. In addition, the development of some contemporary building products and methods of developing more energy efficient buildings initially resulted in other issues related to moisture intrusion and the inability of air tight structures to dry out when moisture would get into the structural assembly.

Flashing membranes are available in a variety of sizes from 4 inches to 18 inches wide. They are also available in a variety of materials, some of which are more suited for installation over different substrates and situations. Most flashing membranes are made from a rubberized asphalt core with a facing of either foil or reinforced polyethylene. The foil-faced flashing can be rated for a longer exposure in the sunlight before being covered. Many plastics faced foil can break down with extended exposure to sunlight. Manufacturers recommend that these be covered with 30 days of installation.

Most flashings are made from either modified bitumen or butyl rubber. Butyl is more expensive but adheres better in the cold and bonds better to a wider range of substrates. Some are manufactured to be very flexible, so it can be formed around sharp corners.

Care should be taken when installing flashing membranes. Most flashings adhere better in warmer temperatures. Installation at temperatures below 50 degrees can compromise the bond. Most flashing should be adhered by pressing with a roller rather than just hand pressure alone. Some materials such as masonry and OSB should be primed before applying flashing membranes. The flashing membrane should be installed on clean substrates before the WRB has a chance to collect dirt and grime. Flashing installation should not rely on the adhesive only. It should be installed in shingle fashion so that higher flashings drain into lower flashings. This keeps the water draining away from the building and integrated into the building's drainage plane.

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 93 Foil faced modified bitumen flashing membrane.

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House Wrap Tape

Manufacturers also use tape designed to seal the seams of water-resistant barriers. The tape is applied to both horizontal and vertical seams and cuts in the flashing. Care should be observed to install the tape on clean, dry surfaces. The tape should be pressed firmly in place with a J-Roller as it is installed. Figure 10-95 shows an example of a house wrap tape installation.

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 94 Tyvek Tape

Figure 10-95 House wrap tape applied to seams in house wrap installation.

Integrated Drainage Plane

The integrated drainage plane is how the water-resistive barrier, self-adhered window, door flashing, and other flashing material is integrated into a complete system. It prevents water from entering into the wall assembly and allows it to drain away from the structure.

One author has suggested that the standard for both water and weather-resistive barrier installation should be as follows:

"The WRB must be properly installed so as to maintain continuity of the barrier. This requires the WRB to be properly integrated with flashings, wall openings, and all adjacent enclosure assemblies, and to be sufficiently overlapped, correctly shingled, and properly sealed or taped at exposed laps (horizontal and/or vertical, depending on its intended purpose), as barrier discontinuities result in potential entry points for water (and air) to migrate into the building (1)."

Details in the installation of these materials and systems are important to creating a functioning, integrated drainage plane. Figure 10-96 shows an example of two window flashings. Flashing material has been installed around the material with little thought about how it will integrate with the WRB and the drainage plane of the building. The completed window will obviously be subjected to moisture as is evident by the beginning of rot and mold visible in the upper left-hand corner of the photograph. The window on the left has flashing that is fully integrated into the drainage plane and WRB. The flashing is tight and installed in shingle fashion to allow water to drain up and away to the surface. All joints and cuts have been taped and sealed.

Figure 10-96 Details of two window flashing installations. The window on the right has been installed with little regard to integrating it with the drainage plane of the building. The window on the left is properly flashed and integrated into the drainage plane.

Figure 10-97 shows examples of exterior door flashings. The door on the right is installed without any drip cap or flashing. Above the door is a flat two-story wall that will collect rainwater and other moisture that will run down the wall. Some of the excess water will find its way underneath the siding and into the door assembly as it hits the top of the door frame. The door on the left has a drip cap and flashing both above the door and on the sides. It is integrated with the WRB to bring the collected water to the surface where it can drain away. The slits in the WRB above the door will need to be taped to keep water from getting underneath the barrier.

Figure 10-97 Details of two door flashing. The door on the right has no drip cap and flashing and nothing to prevent water running down the wall from entering into the assembly. The door on the left has more complete flashing details.

Figure 10-98 shows an example of flashing details of the siding electrical mounting block. The box on the right is attached directly to the WRB surface. Any water running down the wall will make its way into the electrical outlet and interior wall assembly. The flashing on the left uses a small piece of flashing tape to channel water to the surface of the WRB and to drain away.

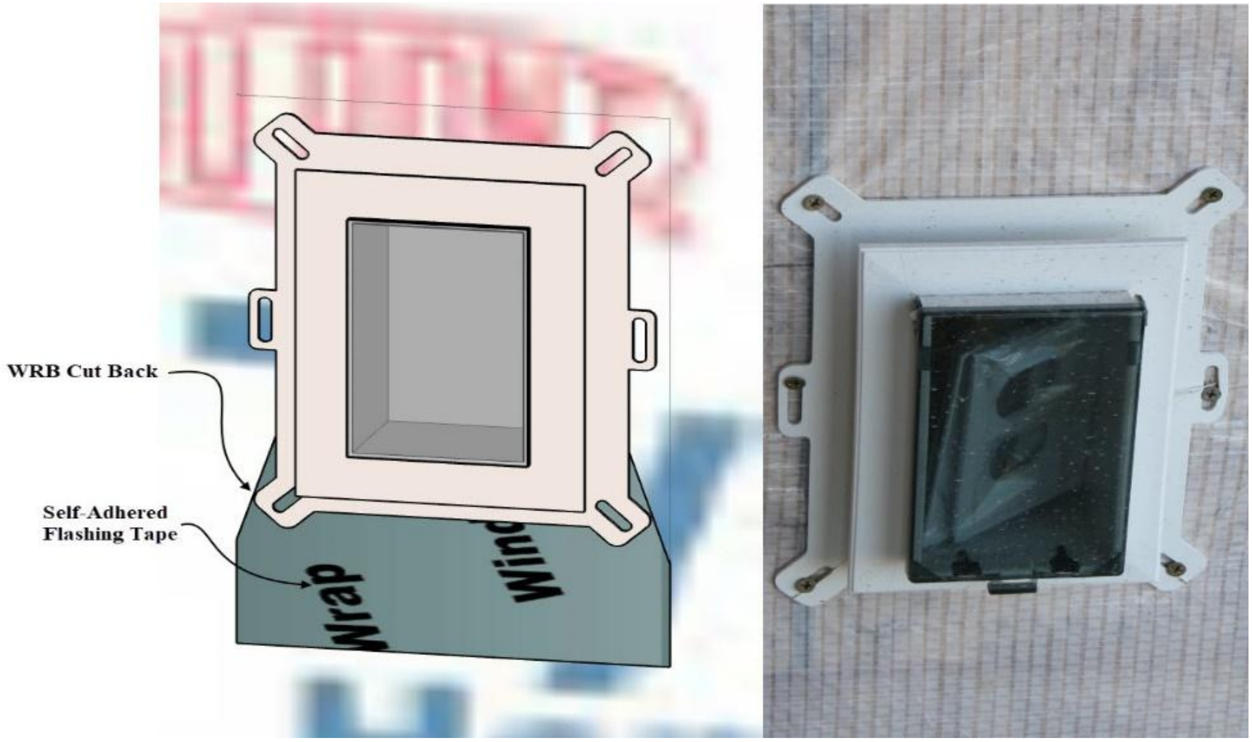


Figure 10-98 Electrical mounting block flashing detail.

Failure to develop a fully integrated drainage plane can result in significant damage to a structure. Figure 10-99 shows an example of a house. The building was built without a water-resistive barrier. A few years after construction, a deck was added to the build. The builder removed the vinyl siding and made no provisions for draining away the water. The snow built up on the surface and drained into the interior structure. This resulted in significant structural and cosmetic damage within the space of a few years. Extensive repair had to be undertaken.

Figure 10-99 Installation of deck without any WRB or integrated drainage plane resulted in significant structural and cosmetic damage to this structure.

Courtesy: Clark Blaylock

Steel, Aluminum, and Vinyl Siding

Exterior siding products made of steel, aluminum, and vinyl are some of the most common exterior wall finishes used. The material and installation cost of these products tends to be lower than wood, stucco, masonry, or other manufactured wood and masonry products. This is one of the reasons for their popularity. In addition to their lower cost, they have a proven track record of providing a long-lasting, durable exterior finish surface that requires little upkeep and maintenance. Most are manufactured to resemble traditional wood siding products and provide a good value for the cost-conscious consumer.

Steel, aluminum, and vinyl siding are very similar in their look and installation methods. Each of these products have their advantages and disadvantages.

Steel Siding Characteristics

Steel siding is made by extruding steel panels and coating them with a baked on enamel finish. It is available in a wide range of colors and textures that are manufactured to mimic wood siding products. It has the advantage of being the strongest and most durable of these siding products. It holds up well in areas where it is subject to high wind and possible damage to hail. The finish can get scratched, which can lead to rust and other damage. It is also the most expensive of the options to purchase and install. Usually, it requires some specialized equipment to cut and install. It requires little maintenance, and when maintenance is needed, it can be repainted to both improve appearance and increase longevity.

Aluminum Siding Characteristics

Aluminum siding is made by extruding metal panels and coating the panels with baked on enamel finish. It is very durable; it will not rot, rust, burn, or become subject to termite damage. However, it can be damaged by wind and hail. It is available in a wider range of colors and textures than steel siding. It can be repainted to maintain its look and increase longevity. The cost of aluminum siding is between the more expensive steel and less expensive vinyl siding.

Vinyl Siding Characteristics

Vinyl siding is the most popular of the siding products. It is manufactured in the widest range of colors and styles. It is also manufactured in different grades of quality and thickness, which also affects the look and longevity. Thinner and less expensive siding can have a life expectancy of 10 to 15 years, while thick and more expensive vinyl can last up to 40 years. It has good resistance to wind and hail and requires little upkeep, but it cannot be repainted to improve look and lifespan.

The most common length standards for steel, aluminum, and vinyl siding are 12 feet and 12 feet 6 inches, but they are available in longer lengths, such as 16 feet 8 inches, 20 feet, and 25 feet. Most are manufactured in several thicknesses with the thicker grades being considered a costlier premium grade. They are also available in several widths depending on the style from 7 inches to 12 inches wide.

Steel, Aluminum, and Vinyl Siding Styles

While styles and variations may not be available with some siding material, there is a wide range of available styles within each category of siding. The available styles can be subdivided into three major types: horizontal, vertical, and shingle style of siding. Within each of these types, there are also several different styles.

Horizontal Siding

Horizontal siding is manufactured to closely resemble traditional wood siding styles, which would include beveled clapboard siding and Dutch lap siding. Figure 10-100 shows examples of a number of horizontal siding profiles.

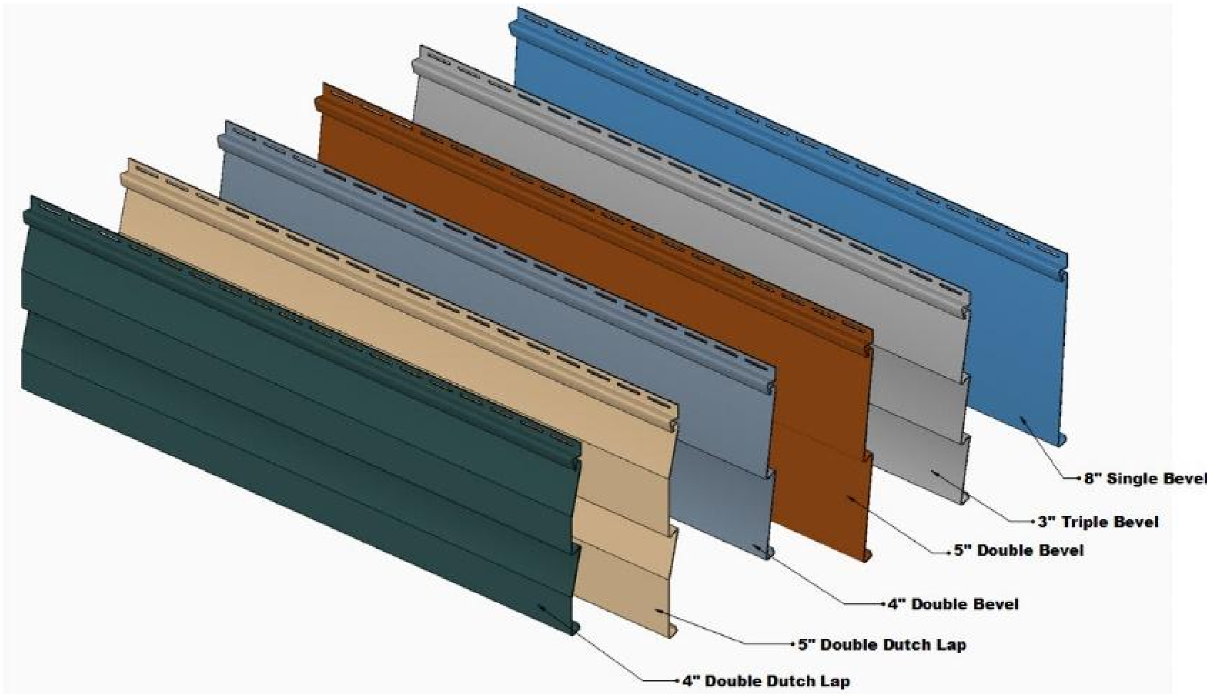


Figure 10-100 Horizontal siding profiles.

Vertical Siding

Vertical siding is also manufactured to resemble traditional wood vertical wood siding styles, including board and batten and drop channel siding (Figure 10-101).

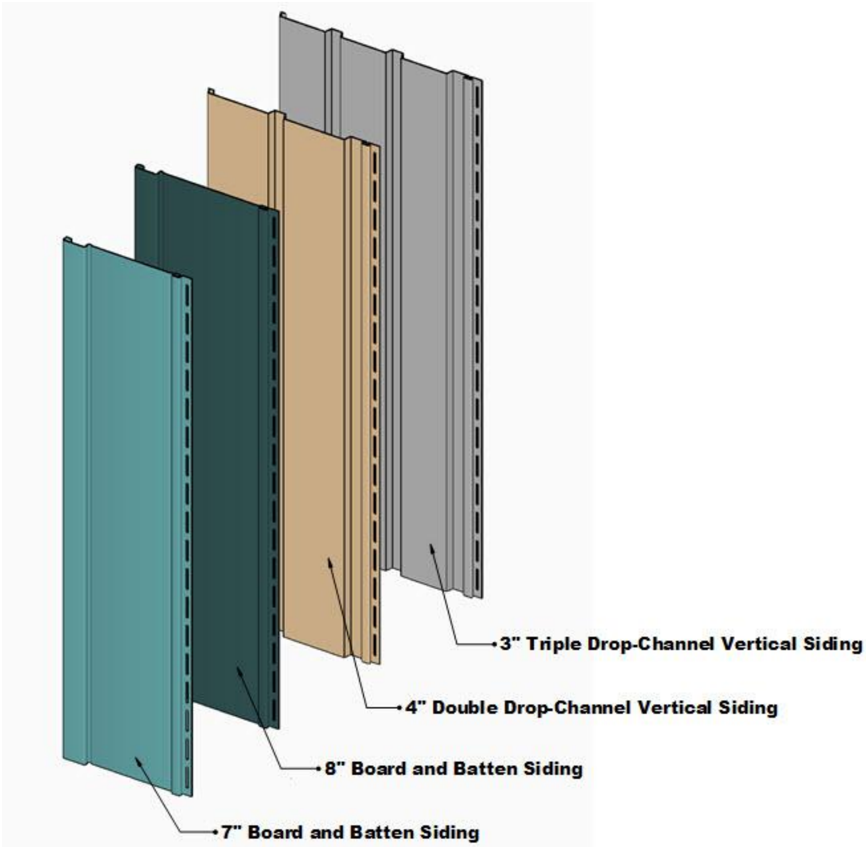


Figure 10-101 Vertical siding styles.

Shake and Shingle Siding

Shake and shingle siding is manufactured to resemble traditional wood shingle and shake siding. Traditional shingle siding is made to resemble sawn cedar shingle; whereas, shake siding is made to resemble hand split shake roofing shingles. In addition, shingle siding is also made to resemble sculptured Victorian style shingles, such as scalloped bottom shingles (Figure 10-102).

Figure 10-102 Shake shingle style siding.

Installing Siding

The technique for installing aluminum, steel, and vinyl siding is similar for all material. The soffit and fascia system is usually installed prior to the siding installation and will be covered in a later portion of this chapter. Horizontal siding is installed from the bottom of the wall working towards the top. Vertical siding can be installed from the left side working towards the right side or vice versa. Aluminum, steel, and vinyl products have a high coefficient of thermal expansion and expand when exposed to the heat of the summer sun and contract during the cold of winter. This expansion and contraction can be significant, and siding must be installed in a fashion that will allow it to expand and contract with the changes in the temperature. Several features are included in these products to accommodate this expansion and contraction. The first of these features is pre-punched nailing slots along the nailing hem. The siding is attached to the structure with either large headed galvanized or stainless roofing nails or staples. The fasteners are placed in the center of the slot and left with a small gap between the head of the nail or staple and the siding so that the siding can move freely back and forth as it expands and contracts without unsightly buckling (Figure 10-103).

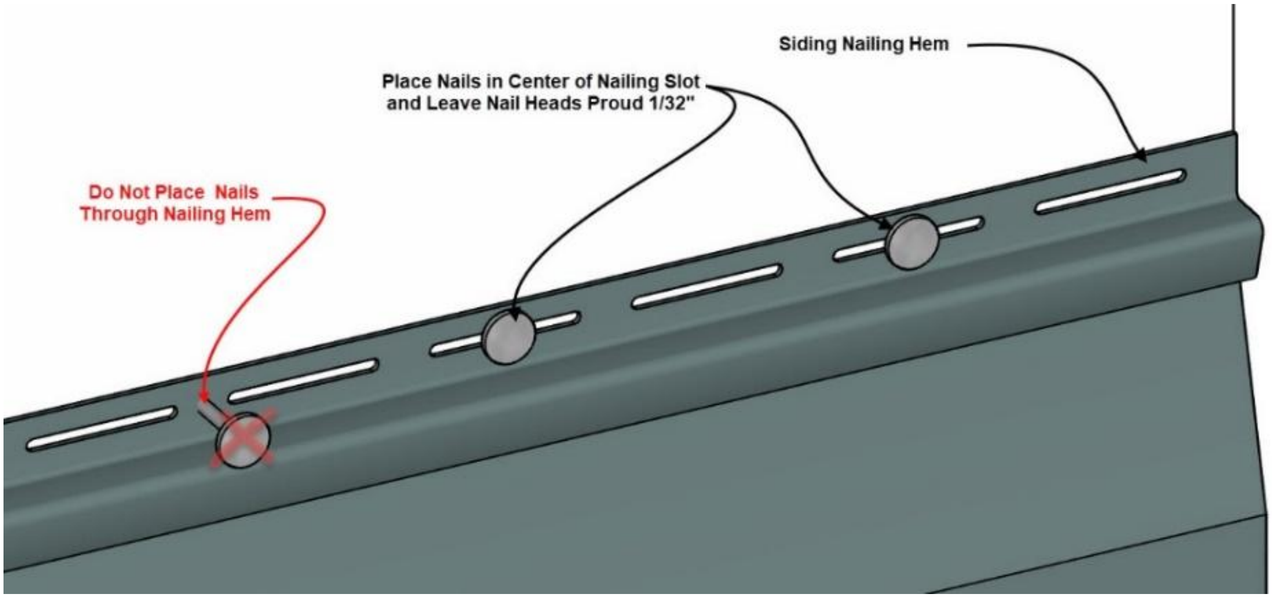


Figure 10-103 Siding nails are placed in the center of the slot in the nailing hem and stand proud of the surface 1/32".

Because it often becomes necessary to seam two or more pieces along a course, the nailing hem and locking channel of the siding is cut back a short distance, and the rest of the siding overlaps by at least one inch (Figure 10-104).

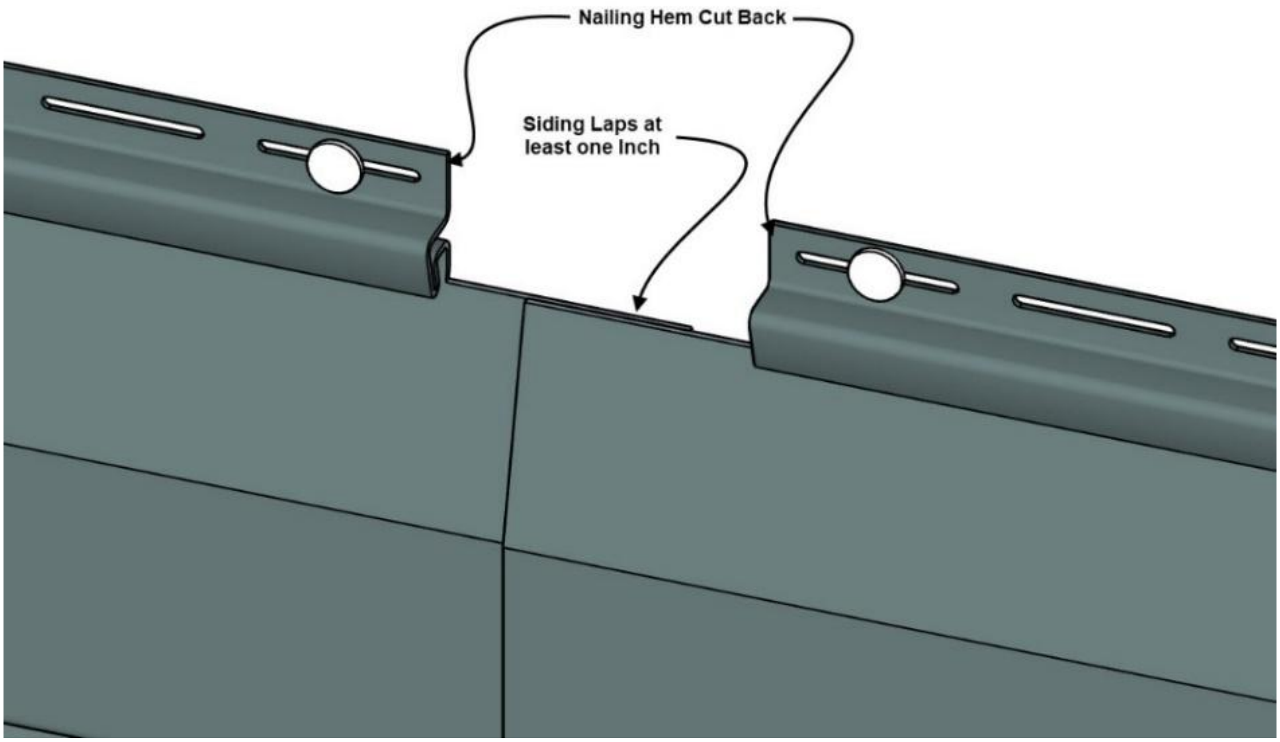


Figure 10-104 Siding lap joint details.

Trim and accessory pieces are used in the installation to finish cutting edges and anchor the siding. The trim pieces are also designed to allow the siding to expand and contract and provide a space allowing siding to move without buckling (figure 10-105).

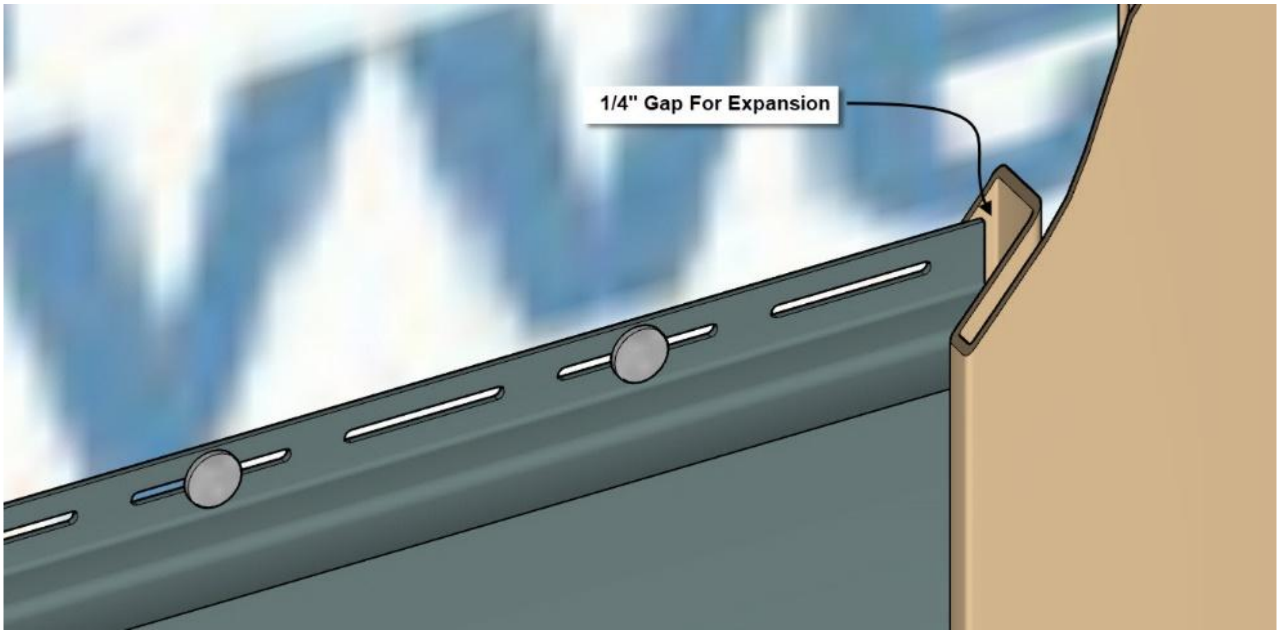


Figure 10-105 One quarter-inch gap is left for siding to expand.

The trim and accessory pieces are usually the first siding elements to be installed.

Siding Trim

Aluminum, steel, and vinyl siding requires specific trim and accessory items as part of their installation. Some of the standard trim pieces are starter strip, outside corner posts, J channel, utility trim, dual utility trim, round inside corner post, angled inside corner post, T channel, F channel, and other pieces. Figure 10-106 shows the profiles of these trim pieces. The application and use of each of these trim pieces will be discussed.

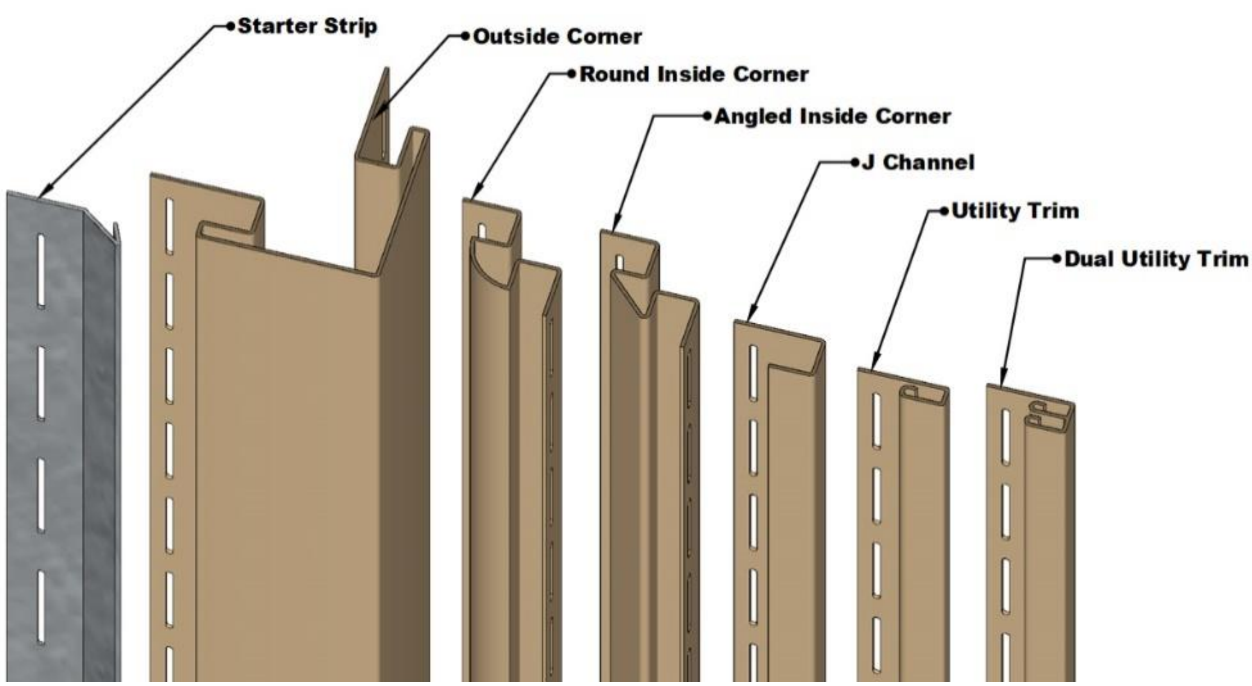


Figure 10-106 Siding trim profiles.

Outside Corner Post

The outside corner posts are usually the first siding pieces to be installed. They are marked and carefully plumbed as they are installed on each outside corner to insure a straight installation. The corner posts are installed to the base of the soffit and extend downward one quarter of an inch below the base of the wall. Nails are placed in the top of the highest slots on each side, and the post hangs from those nails. The rest of the nails are centered in the slots. Corner posts come in standard lengths of 10 feet, but other lengths up to 20 feet are available. Several widths and styles are also available from three inches wide up to seven inches wide (Figure 10-106).

Inside Corner Post

Inside corner posts are installed at the same time as the outside corner posts. The installation would also be the same including making sure the trim is installed true and straight. The length would be the same as the length of the outside corner posts (Figure 10-107).

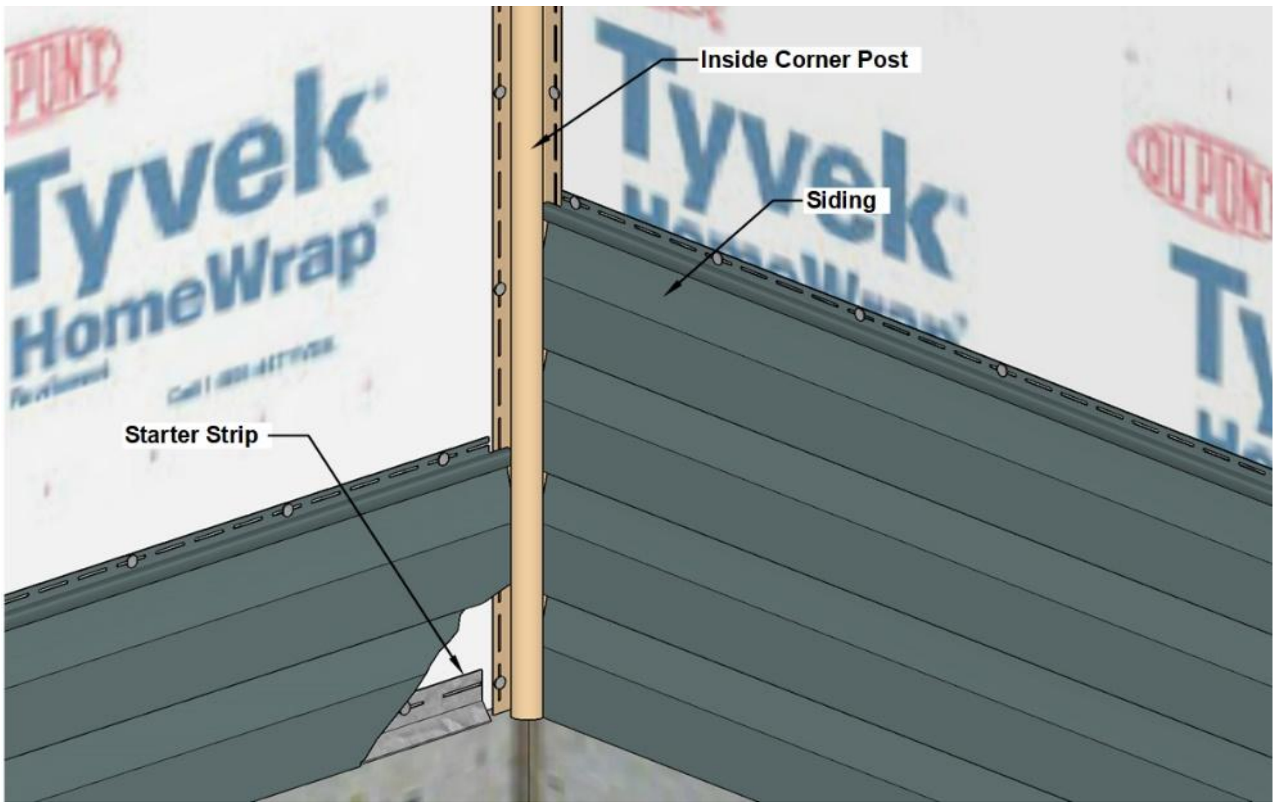


Figure 10-107 Inside corner post installation.

Starter Strip

Starter strip is a formed piece of metal or vinyl that is used at the base of a siding installation to provide a straight and level beginning for the installation and to attach the base of the siding to the structure. Starter strip is manufactured in aluminum, galvanized metal, and vinyl. It comes in lengths from 10 feet to 12½ feet. To install the starter strip, measure up from the bottom of the wall a distance equal to the width of the starter strip minus a small amount the siding that should overlap the foundation below, for example, a quarter of an inch. Mark and chalk a level line. The starter strip is attached with galvanized roofing nails or staples even with the level line. Hold the started strip back from the nailing hem of the corner posts and carefully line the top of each piece with the level line fastening with roofing nails or staples (Figure 10-108).

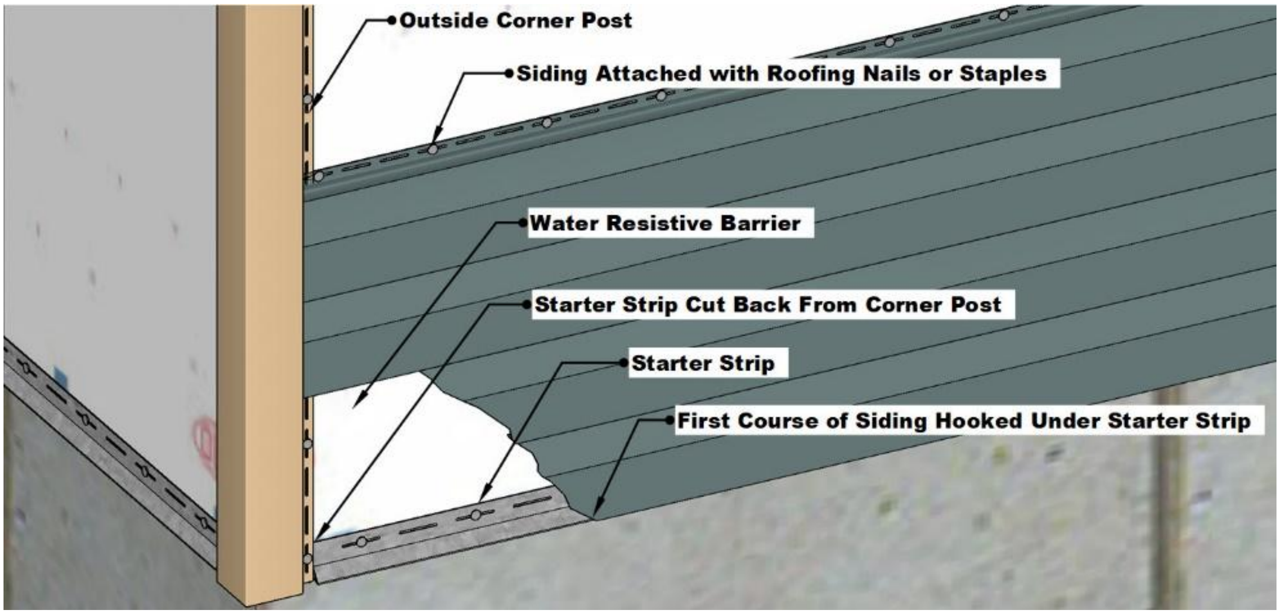


Figure 10-108 Corner post and starter strip installation.

J Channel

J channel can be used for multiple applications during the installation of the siding to trim and anchor the cut edges of the siding panels. Categories of applications include J channel at the top of wall installations, J channel door and window installation, J channel inside corner and vertical edge installation, and base and other horizontal installations.

J channel top of wall installation

It is used at the top of the installation where the wall siding meets the soffit material. This includes the soffit along the raked angle of gable ends, the edges where the siding meets the boxed gable ends, and the horizontal lengths of soffit. Figure 10-109 shows an example of these three wall top installations.

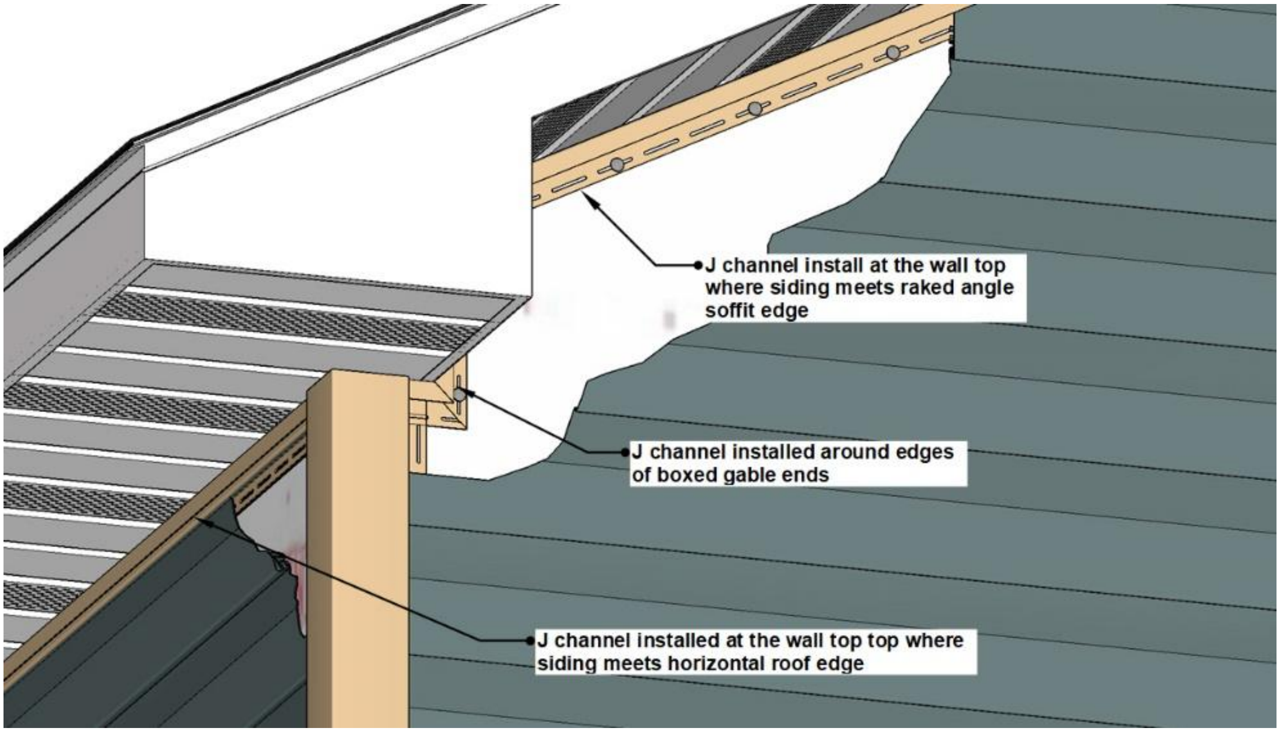


Figure 10-109 Wall top J channel installations.

J channel door and window installation

J channel is also used around window and door installations. Typically, the four edges of the windows have a J channel installed around them, and the top and both sides of the door exterior brick molding have a J channel installed. There may be some installations where the J channel is also installed at the bottom edge of the door when siding is below the door. Figure 10-110 shows the installation of the brick molding around the door exterior brick molding. When calculating the quantity of brick molding around the door brick molding, additional lengths of J channel should be estimated. The brick molding is typically several inches wide, and the J channel overlaps where horizontal and vertical J channel overlaps. The estimated length of the J channel at the top of the door should be the width of the door plus two times the brick molding width and two times the J channel width. The vertical brick molding should include the height of the door plus the brick molding and J channel width.

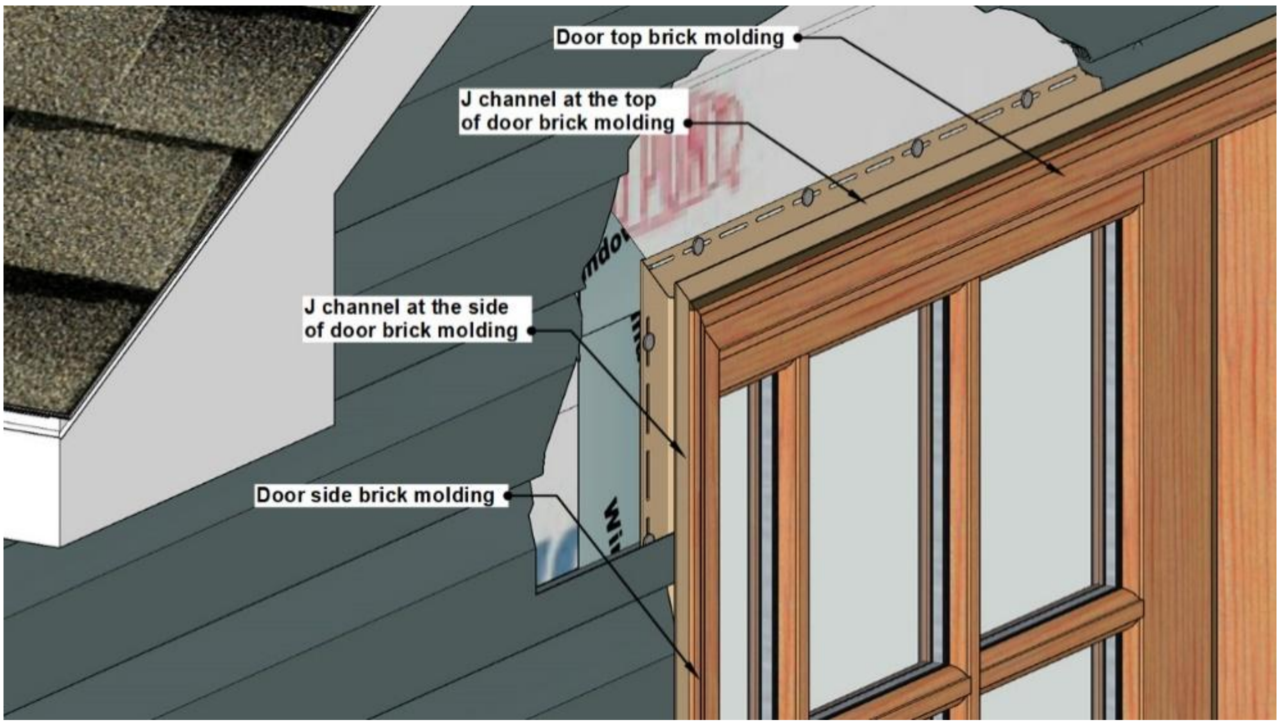


Figure 10-110 Installation of J channel around door exterior brick molding.

The installation of the J channel is typically around the four sides of the window. Double the width of the J channel should be added to each length of J channel calculated to account for corner overlap (Figure 10-111).

Figure 10-111 Widow J channel is installed around the four sides of the window opening.

J channel inside corner and vertical edge installation

In addition to standard inside corner post installation, which has been previously discussed, J channel can be used to install siding on inside corners and other vertical edge installations. There are two common methods for using J channel to create inside corners. The first is to use two pieces of J channel to form the corner. The second is to use one length of J channel plus one piece of 90 degree formed trim coil stock.

The two-piece J channel uses two pieces of vertical J channel installed in the corner, one on each side of the corner. The length of the J channel needed is double the length of the corner (Figure 10-112).

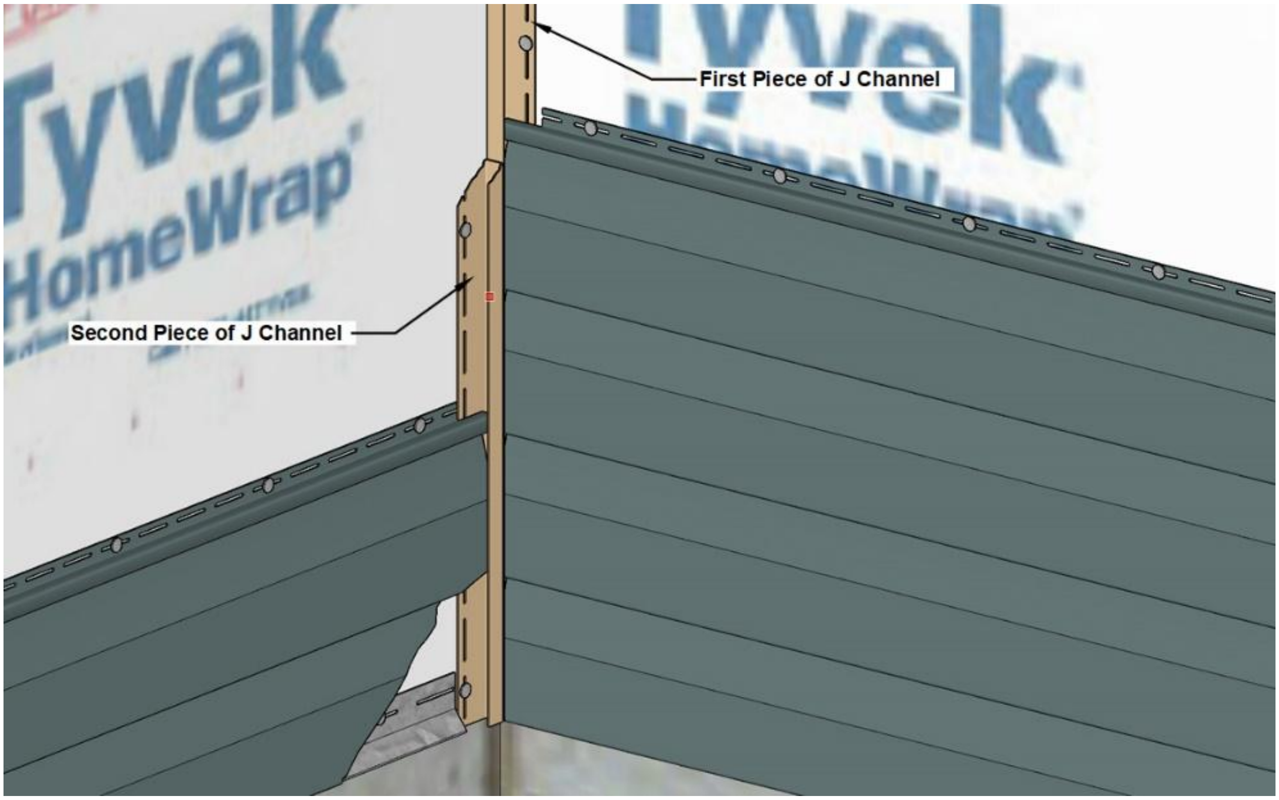


Figure 10-112 Two-piece J channel corner installation.

The second J channel corner installation is a four step process. First one piece of formed corner coil stock in the angle. Siding is installed on one wall first, then a piece of J channel is installed on the other wall tight against the face of the siding on the opposing walls. The siding on the second wall is then installed (Figure 10-113).

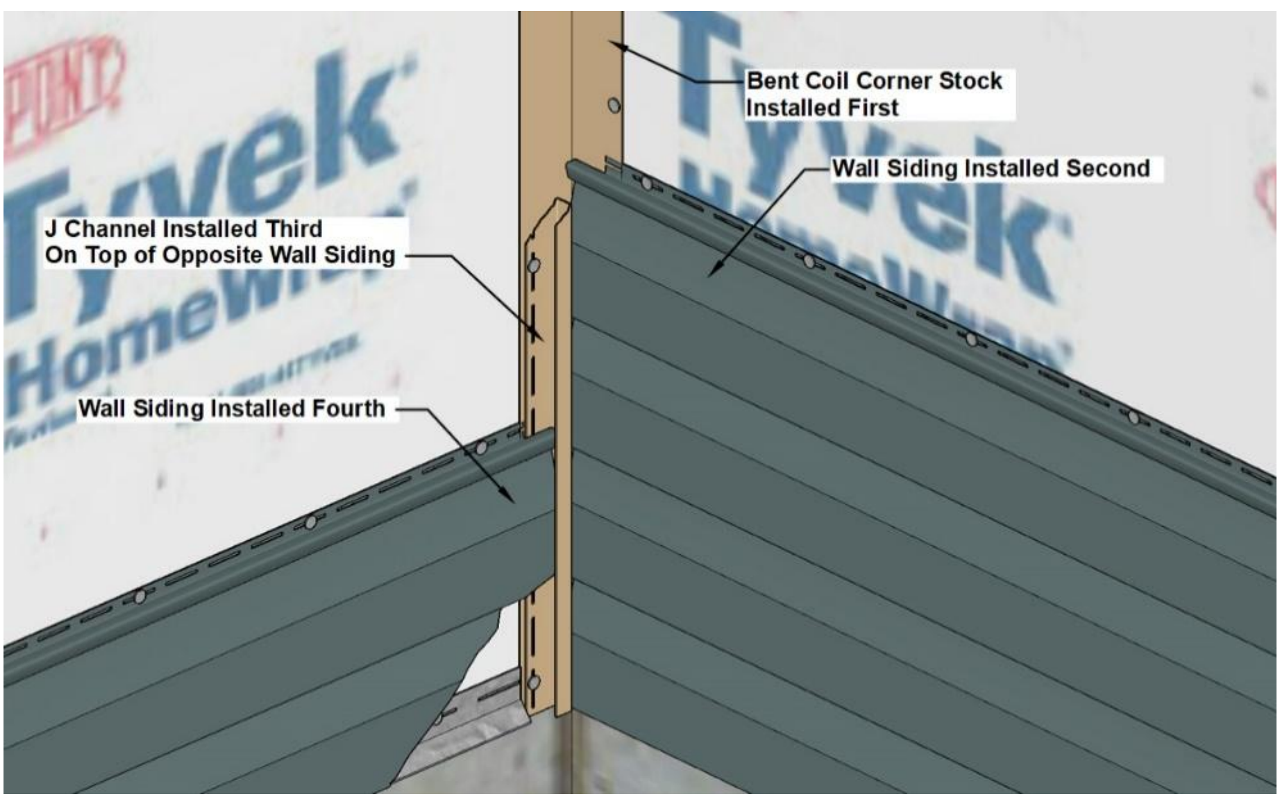


Figure 10-113 One J channel inside corner installation.

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 114 Vertical and other miscellaneous J channel installation.*

J channel can be used to trim other vertical edges when the siding meets another material such as stucco, brick, or synthetic masonry product. Figure 10-114 shows an example of a vertical J channel installed along an edge where stucco and rock will be installed. The same figure also shows some examples of other miscellaneous installations of J channel. The small roof protecting the gas meter and the penetration of the main gas line is also trimmed out with J channel.

Base and other horizontal installations

Most horizontal installations of siding begin with a starter strip, however, there are some applications where starter strip cannot be used. Often, J channel is substituted. For example, when brick or other masonry that is thicker than the siding is used as a wainscot at the base of the wall, the siding cannot hook underneath the starter strip without leaving an unsightly gap at the base. In addition, the base of the siding is often cut off so that the coursing of the siding remains even with full height siding installation that begins at the base of the wall with a starter strip. Figure 10-115 shows an example of siding installed on top of synthetic masonry wainscot.

Figure 10-115 J channel installed at the base of siding installed on top of a masonry wainscot.

Another application for installing J channel at the base of a siding installation is at the base of siding that is installed on a wall over an adjoining roof. For example, Figure 10-116 shows siding installed on a small wall above an adjoining garage roof. The rake angle of the garage roof requires the base of each siding course to be cut at an angle and the angled cut placed in J channel.

Another application for horizontal J channel is at the base of siding where the siding installation changes from horizontal to vertical style of siding. Figure 10-117 shows an example of this type of installation.

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 116 Installation of J channel along rake angle of the roof edge.*

The application of J channel in an installation can vary widely from project to project and can be subject to design requirements of the projects, such as for decorative trim items. In addition, the installation can be subject to installed preferences and techniques, some of which can be subject to use of utility or double utility trim on the projects.

*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 117 Installation of J channel at the base of a vertical siding installation where it transitions from horizontal siding*

Utility and Dual Utility Trim

Utility trim and dual utility trim are often used in conjunction with J channel during installation to anchor and finish edges, but it can also be used by themselves as pieces of installation trim to serve the same purpose. Figure 10-118 shows a comparison between standard J channel, utility trim, and dual utility trim profiles. The shapes of both are similar in that they have an overall J profile, however, utility trim is narrower, and the end of the J is bent to create a hook to catch a tab that is punched along the horizontal edge of the siding that has been cut. Dual utility trim is similar except that it has two hooked edges that allow for a more universal application.

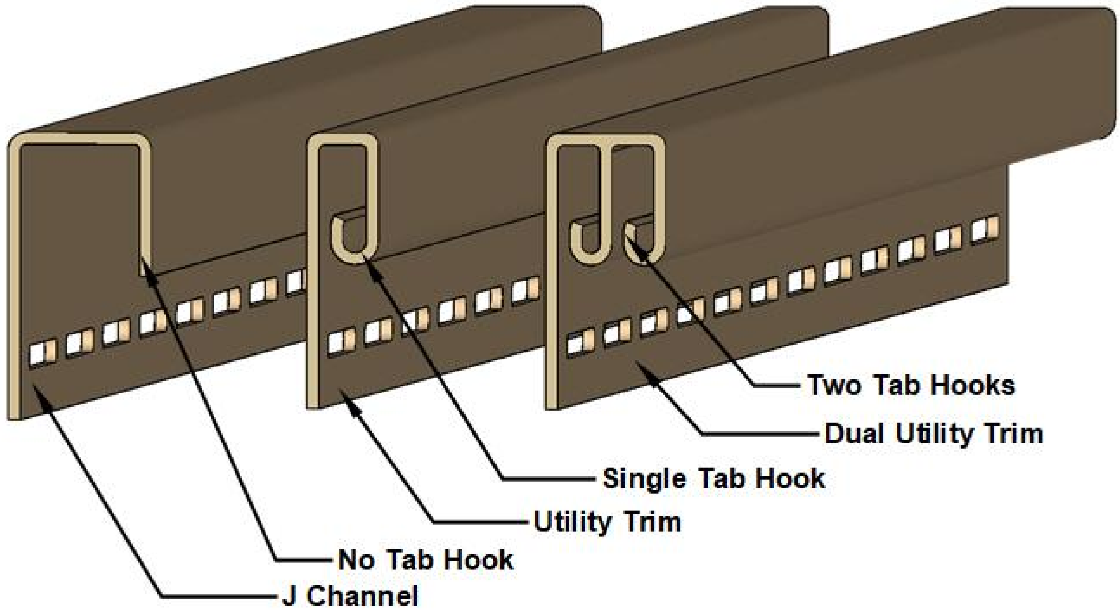


Figure 10-118 Comparison between J channel, utility trim, and dual utility trim profiles.

The installation of horizontal siding begins at the base, usually with a starter strip, and proceeds vertically up the wall in even increments based upon the designed course spacing of the siding. For example, 4-inch double bevel siding would have a calculated course spacing of 8 vertical inches of wall height. Correspondingly, 5-inch double bevel siding would have a course spacing of 10 inches. At the top of the installation, the wall siding meets the underside of the soffit overhang. The actual distance of the height of the wall siding installation can vary based upon variables such as the floor system thickness, designed wall height, roof slope, and roof overhang. The height of a siding installation with a standard 8-foot wall height can vary based upon the slope and overhang of the roof. Figure 10-119 shows an example of the effect of roof slope and overhang in the siding installation height. The roof on the left has a 4-inch slope and a 6-inch overhang with a siding height of 7 feet, 11 inches. The roof on the right has an 8-inch slope and a 24-inch overhang with a siding height of 6 feet, 9 inches.

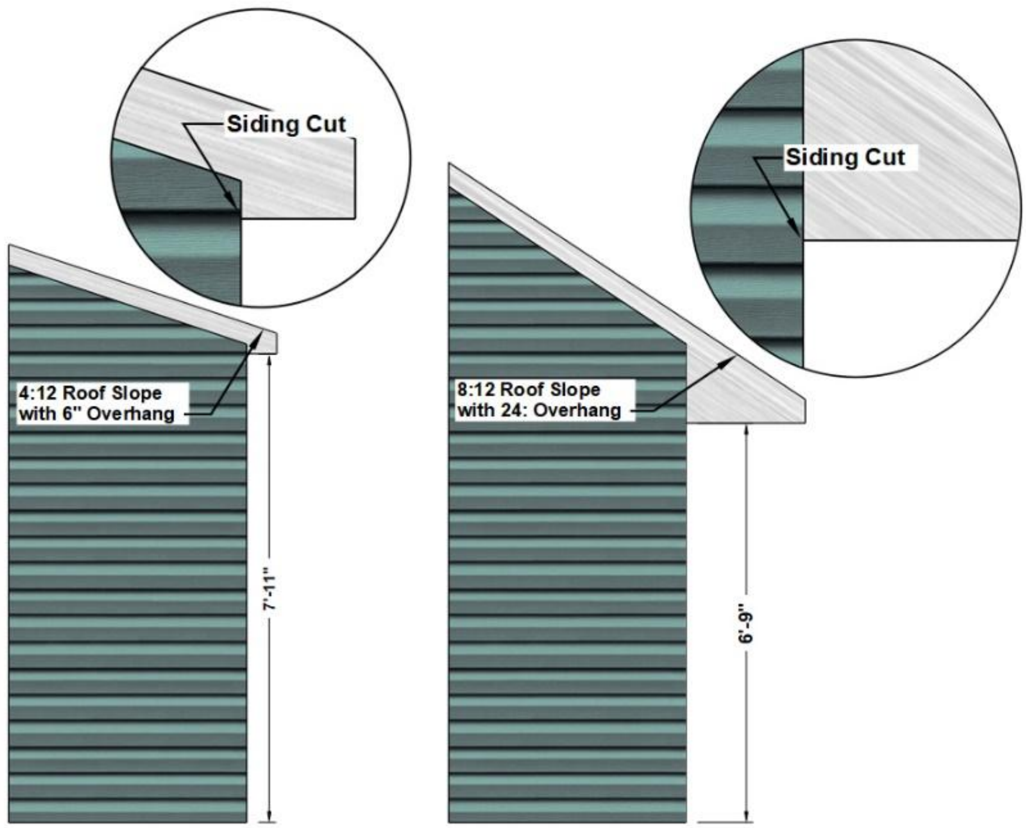


Figure 10-119 Roof slope and overhang changes the height of the siding installation.

The change in wall siding height also changes where the top of the siding will be cut to meet the underside of the roof soffit. The example on the left shows how the siding is cut near the top of the bevel, and the example on the right shows how the siding is cut in the center of the portion of the siding flat face. Utility trim or dual utility trim is used to finish and anchor the top of the cut siding. Figure 10-120 shows an example of cutting off the nailing hem at each of the locations described in the Figure 10-119 example.

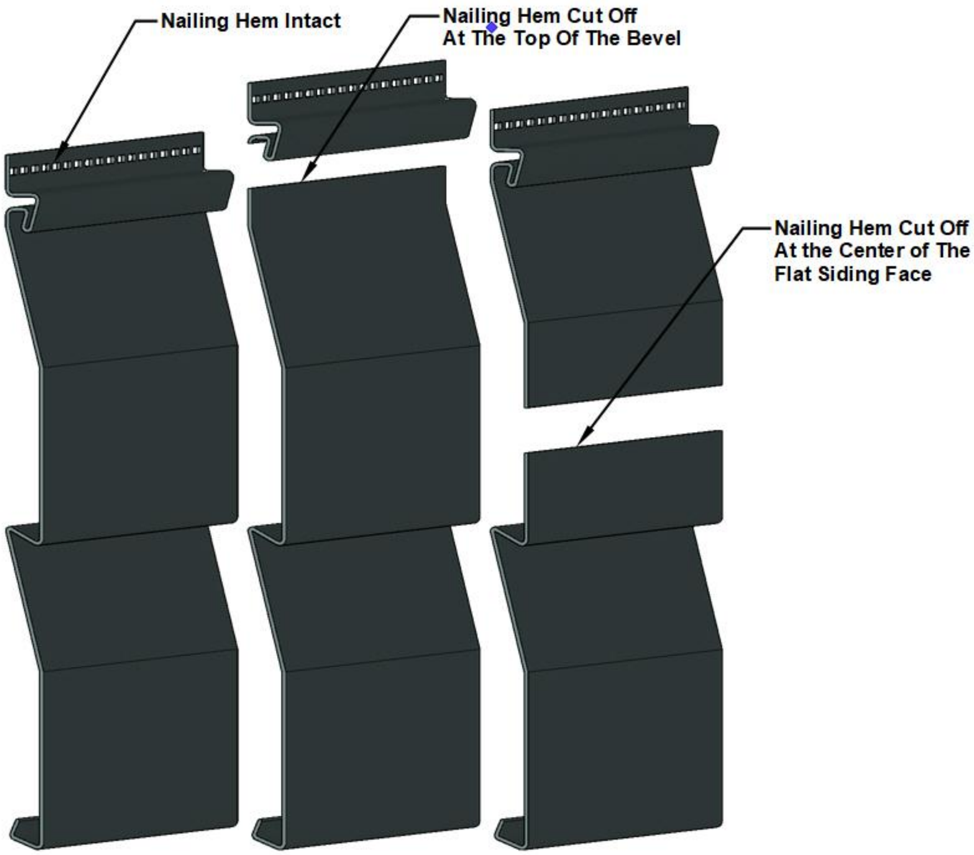


Figure 10-120 Nailing hem trimmed off of siding to be installed at the top of the wall.

A tool known as a snap-lock punch will be used to punch a row of tabs across the top of the siding edge. The punched tabs will be hooked into the J channel, which is what holds the cut siding piece in place without the nailing hem that has been removed (Figure 10-121).

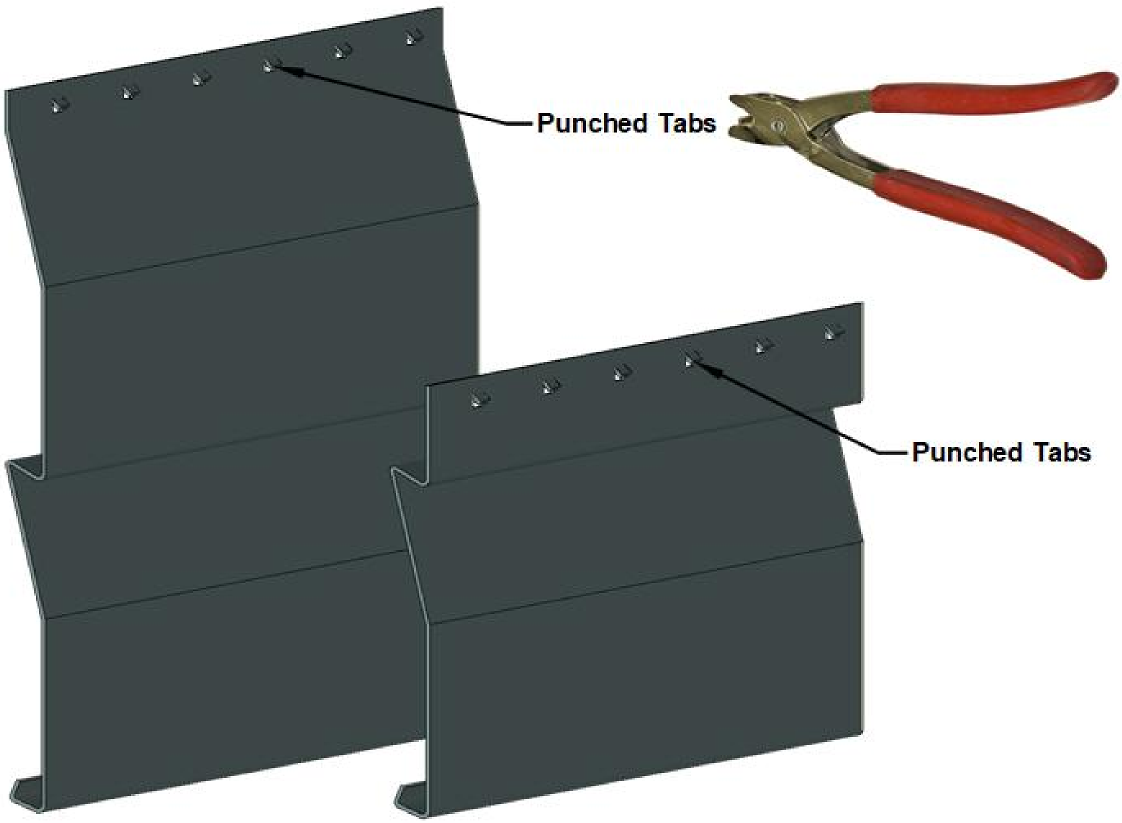


Figure 10-121 Snap-lock punch is used to punch locking tabs into cut siding edge.

J channel by itself cannot be used instead of utility trim to hold the cut siding in place because there is nothing to hold the locking tabs in place (Figure 10-122).

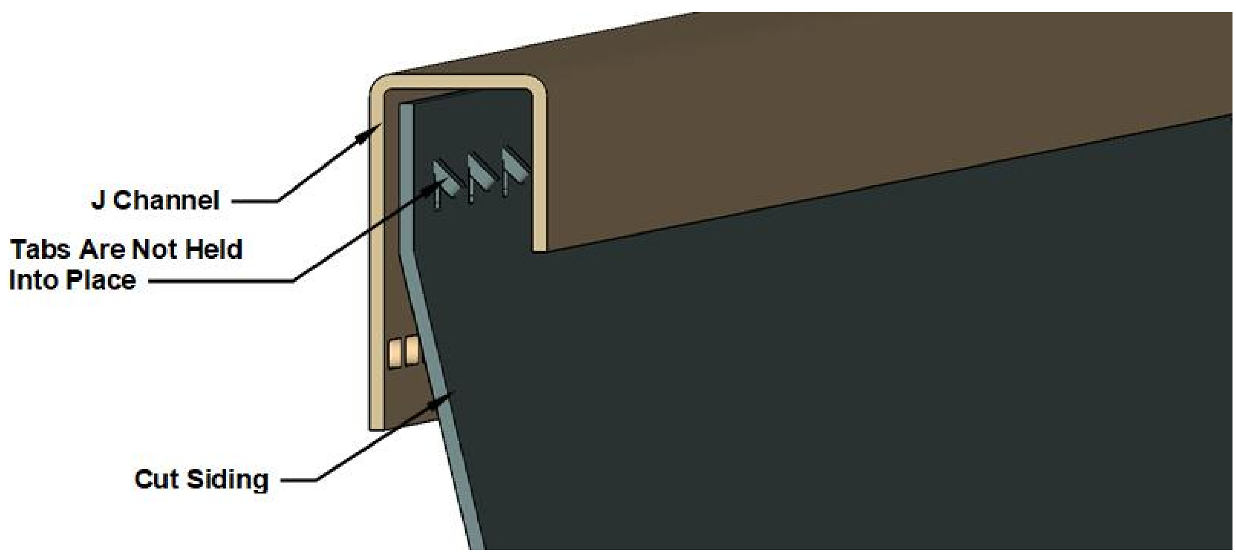


Figure 10-122 J channel alone cannot hold cut siding in place.

Either utility trim or dual utility trim is used inside of the J channel to hold the cut siding in place. Utility trim is used when the siding is cut at the top of the bevel. Dual utility trim can be used both for siding that is cut at the top of the bevel and siding that is cut on the flat face of the siding.

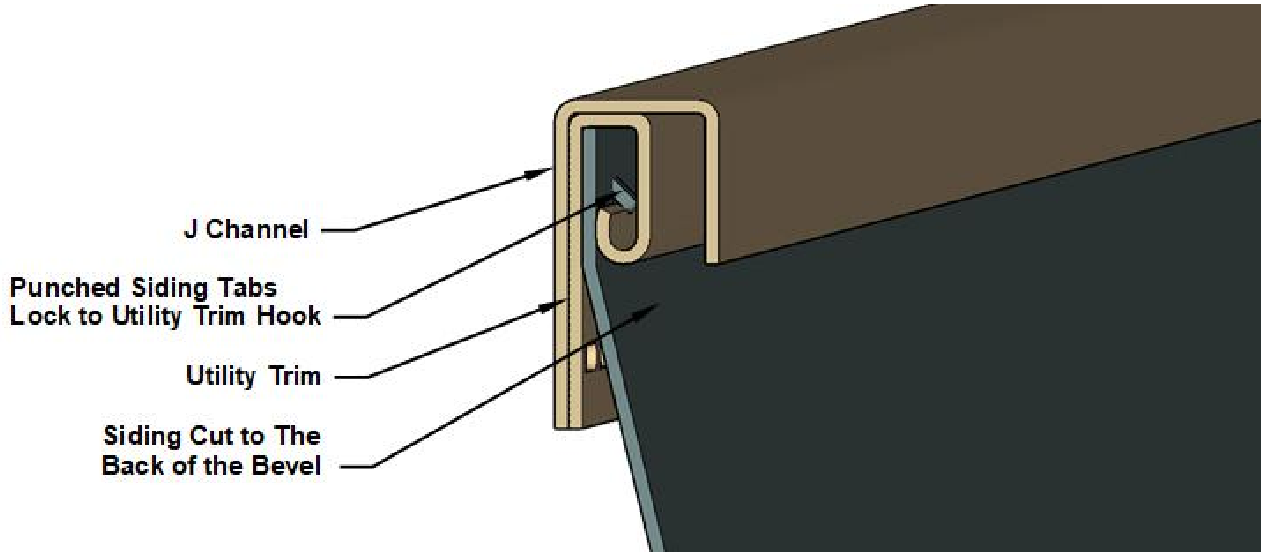


Figure 10-123 Utility trim inside of J channel to anchor cut siding in place.

Dual utility trim is also used inside of the J channel to hold the cut siding in place. Dual utility trim can be used both for siding that is cut to the back of the bevel or for siding that is cut into the siding face. The use of dual utility trim has a more universal application as it can be used wherever the installation requires the siding to be cut, but the cost is significantly higher than for utility trim (Figure 10-124).

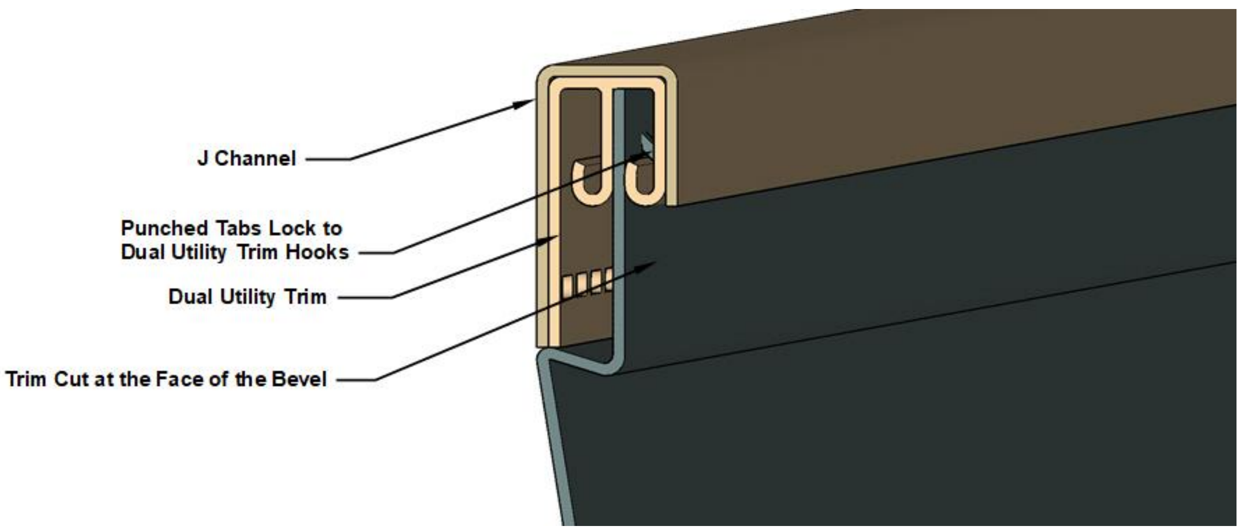


Figure 10-124 Dual utility trim used inside of J channel to anchor cut siding in place.

While J channel cannot be used in this application without the addition of utility or dual utility trim, both utility and dual utility trim can be used without J channel. This practice is very common in the industry, and the choice to include J channel or not is more of a design and installation preference than that of a practical necessity. Figure 10-125 shows utility trim installation with and without J channel.

Figure 10-125 This siding installation uses both J channel and utility trim at the top of the wall installation.

Utility trim and dual utility trim is also used to anchor the siding at the top and the bottom where it is cut around windows and doors. Figure 10-126 shows an example of a siding cut to fit around a window. The cut across the bottom of the window has a row of tabs punched along the edge. Utility trim will be installed under the window to anchor the piece of siding. The utility trim fits inside of the J channel at the bottom of the window. The siding at the top of the window would be cut and punched the same as the siding at the bottom of the window.

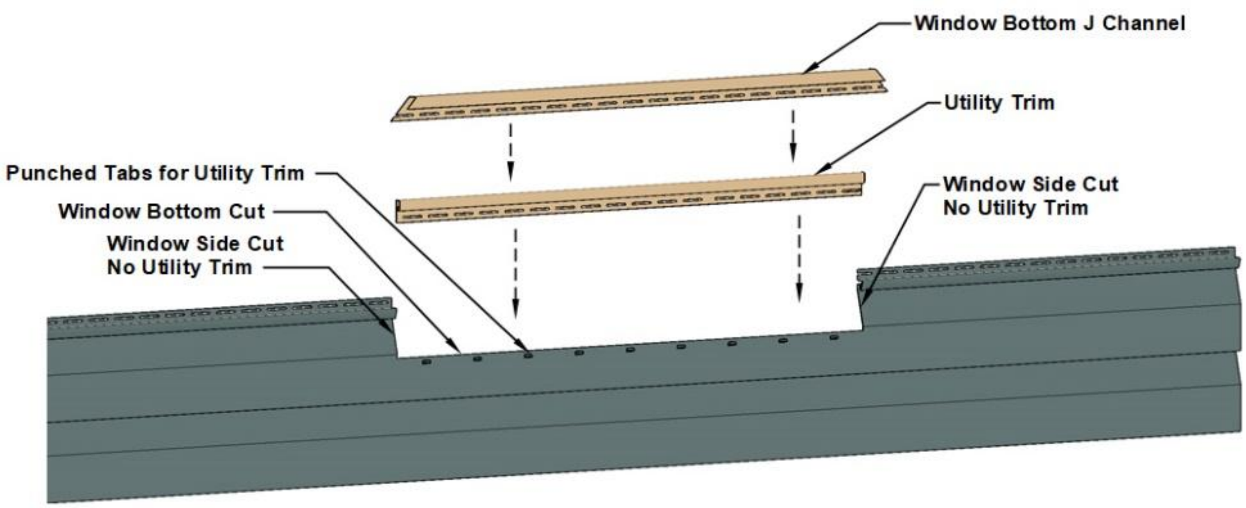


Figure 10-126 Siding notched to fit around a window. The siding is punched along the edge for installation in utility trim.

Because there can be some variation in the installation of siding and associated trim pieces, it is essential for the construction estimator to understand all of the elements that go into the installation and to then communicate effectively with the builder or installer to make sure everyone understands exactly how the siding will be installed. Figures 10-127 and 10-128 show exploded views of two walls of siding with the individual siding and trim pieces identified.

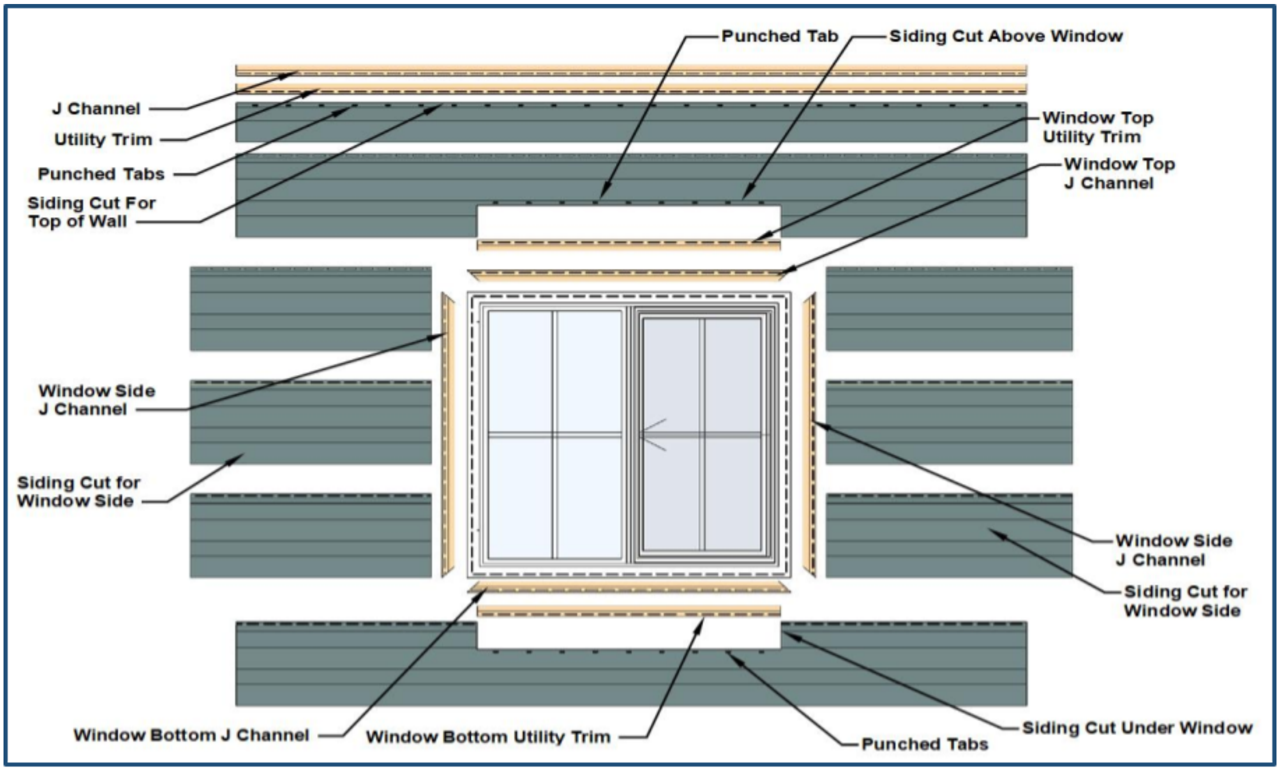


*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 127 Exploded view of siding installation around a window.*

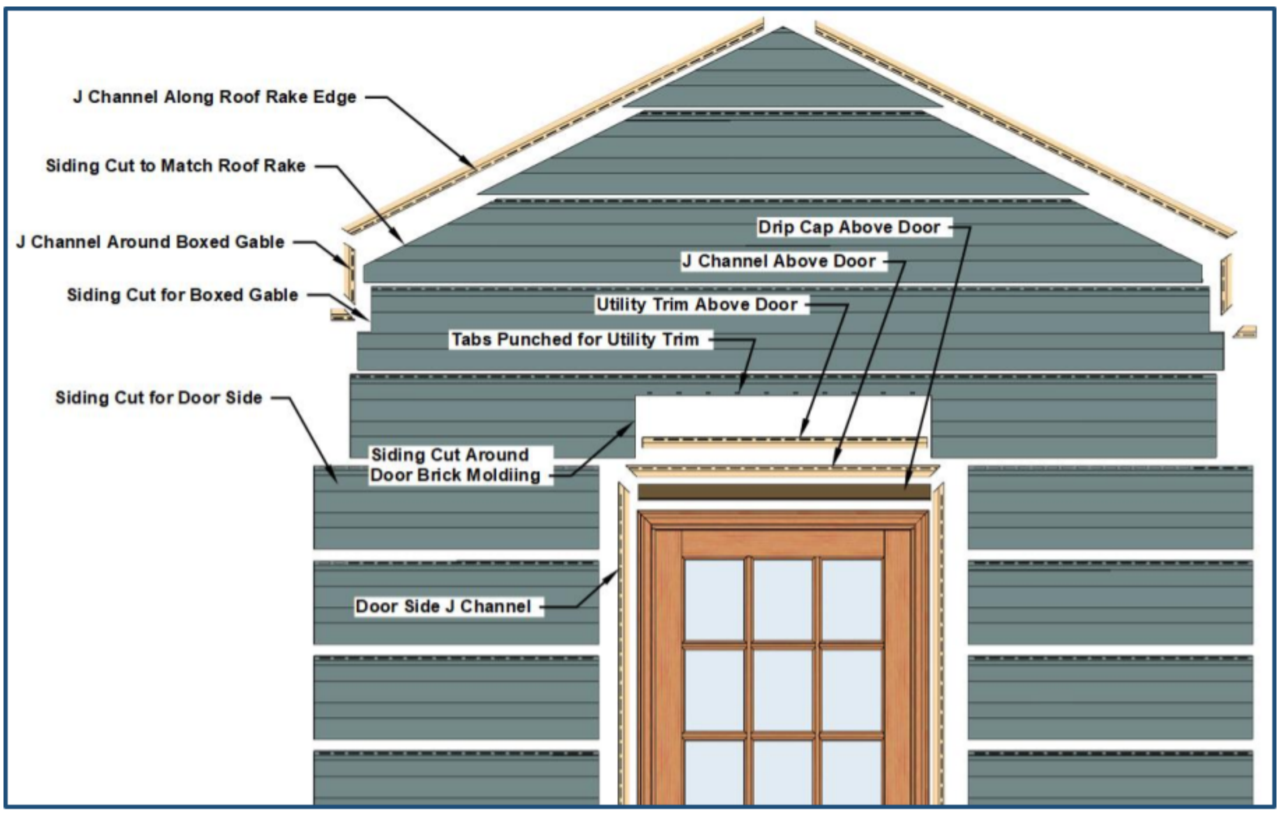


*Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 128 Exploded view of siding around door.*

Siding Decorative Trim

In addition to standard trim pieces, additional decorative trim pieces are available to add architectural style and interest to the project. These decorative pieces include window and door casings, wide lineal trim, soffit cove, and soffit crown.

Typically, these pieces are used instead of typical J channel molding. Figure 10-129 shows some examples of these.

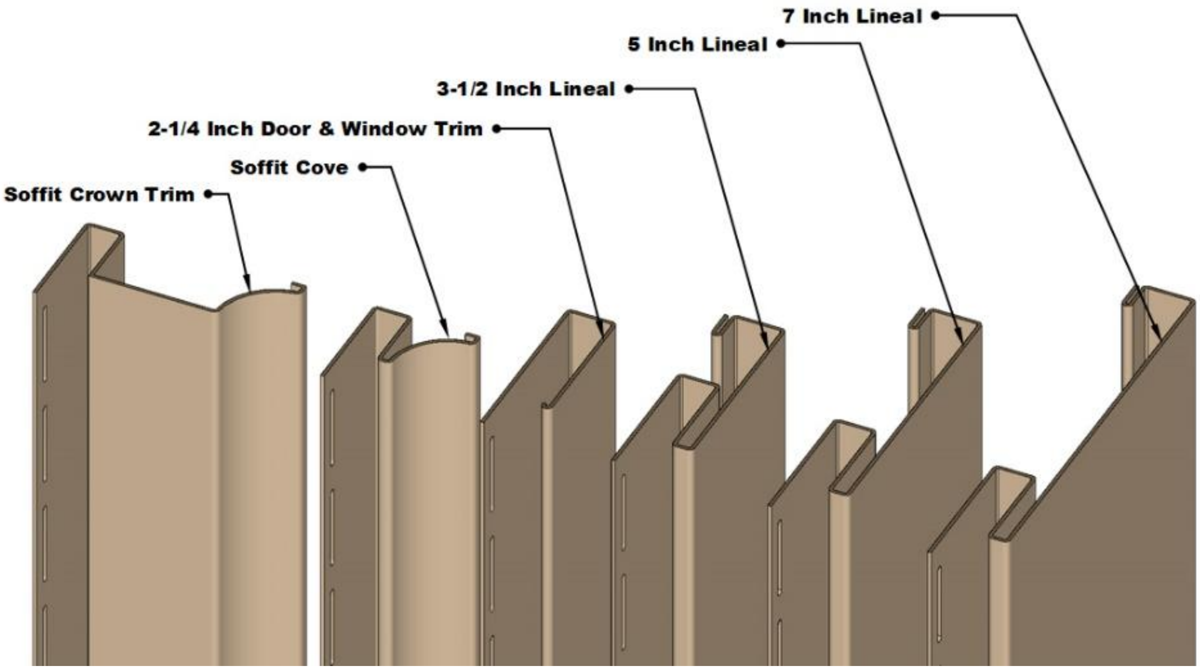


Figure 10-129 Decorative trim profiles.

Door and Window Casing

Door and window casing is trim that resembles J channel, but is wider. Typically, 2½ to 3½ inches wide. This is installed to mimic traditional wood window and door trim, which is typically this wide. It highlights the door and window elements of the exterior of the building. It is supplied in lengths like 12 feet, 6 inches long.

Lineal Trim

Lineal trim is designed to resemble traditional trim details such as frieze boards, band boards, and water boards at the wall base. Lineal trim has a pock for the siding edge like J channel, but the face is typically wider and is available in dimensions of 3½ inches wide, 5 inches wide, and 7 inches wide. On one side, the lineal is anchored with a finish trim, and the other is attached with a standard nailing hem. Lineal trim is available in lengths like 20 feet long.

Cove and Crown Trim

Cove and crown trim is used at the junction between the top of the wall and the soffit. Again, it is designed to mimic traditional siding details. Cove and crown trim is supplied in lengths like 12 feet, 6 inches long.

Figure 10-130 shows an example of a siding installation detailed with decorative trim pieces including a 7-inch water table at the base. 3½-inch crown trim at the top and 2¼-inch trim around the window and doors.

Figure 10-130 Siding installation with decorative trim details.

Siding Accessories

There are many other types of siding accessories that are also often part of the siding installation. Some may be essential to the project and others may be for decorative purposes only. These siding accessories include mounting blocks, vents and louvers, shutters, and other decorative elements.

Siding Mounting Blocks

Siding mounting blocks are used to finish the installation around items that penetrate through the siding or mount on the siding. These can include electrical outlets, switches, and light fixtures. Typically, mounting blocks have two parts. The first is a base piece that is firmly attached to the building framing on top of a water-resistive barrier. Where penetrations are made in the WRB, the penetration should be properly shingle flashed and integrated into the barrier. The second piece is a trim piece that snaps onto the base piece. It covers and trims the raw siding edges that are cut around the base piece. This is in essence an integrated J channel for the mounting. Figure 10-31 shows several examples of siding mounting blocks. The top photograph shows four mounting blocks. The top two mounting blocks are for light fixtures, and the bottom two mounting blocks serve as a mounting plate for the street address numbers. The photograph on the bottom left is for a dryer vent; the bottom middle photograph is for an electrical outlet; the bottom right photograph is for a hose bib.

Figure 10-131 Mounting block styles.

Vents and Louvers

Vent and louver trim accessories can serve as both functional and decorative trim items. Many times, vent trim is used as part of the attic ventilation system, or they could serve as simply decorative trim pieces. They are often constructed in a fashion similar to mounting blocks and have an integrated J channel. Other types may be installed that do not have an integrated J channel, and additional J channel will need to be purchased for the installation. Vents and louvers are available in a wide range of styles and sizes. Figure 10-132 shows several examples of vent and louver styles including square, split triangle, triangle, octagon, oval, and round shaped.

Figure 10-132 Six styles of attic vents.

Square: CC0, https://books.byui.edu/-diEL

Double Triangle CC0,

Triangle: CC0, By PaulBr7: https://pixabay.com/en/luxury-home-upscale-architecture-2409577/

Octagon: CC, By:David-D:https://www.flickr.com/photos/david_martin_foto/14299413363

Oval: Public Domain, By Architecture: Reg Summerhayes (1881–1976); this photograph: Hesperian. [Public domain], from Wikimedia Commons

Round: CC0, https://www.pexels.com/photo/architecture-building-business-buy-259098/

Shutters and Other Decorative Elements

Shutters and other decorative elements are used to add architectural interest to the project. These elements are available in an array of sizes and styles. Some suppliers will even make custom styles using a wide range of materials including wood, vinyl, aluminum, and steel. Figures 10-133 shows a house facade that utilizes shutters as a decorative element over both brick and siding.

Figure 10-133 Decorative shutters installed over both vinyl siding and brick.

Other decorative elements include items such as decorative door and window trim, brackets and corbels, gable end accents, column wraps and trim, sunbursts and fans, and door surrounds.

Figure 10-134 Decorative siding elements.

Site Fabricated Aluminum Trim Accessories

Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 135 Aluminum Trim Coil Stock

Most siding installations will include site fabricated trim accessories. These trim pieces are made from pre-remanufactured aluminum trim coil stock that is cut and bent on the job to meet site specific needs. Aluminum trim coil stock is typically purchased in rolls of 24 inches wide and 50 feet long. It can be purchased in a wide range of colors to either match or compliment the exterior siding material (Figure 10-135).

Some of the fabricated pieces include beam and column surrounds, L angle flashing, and door trim surrounds. The pieces are fabricated on site using a sheet metal siding brake. Siding brakes are available in sizes from 8 feet, 6 inches long to 14 feet, 6 inches long. Even though they are a larger piece of equipment, they are manufactured as lightweight as possible to make it more portable. Some models have support legs that fold down for transport. The roll of trim coil stock is placed in the machine and can be cut and bent using features of the equipment. Additional accessories can be purchased to create other, more complex shapes (Figure 10-136).

Figure 10-136 Sheet metal siding brake.

Figure 10-137 shows the roof support beams for an exterior porch that have been wrapped with a white trim coil facing.

Figure 10-137 Site fabricated trim coil beam wrap.

Figure 10-138 shows the L angle flashing between a brick ledger and the wall siding.

Figure 10-138 Site fabricated L angle flashing between brick ledge and wall siding.

Figure 10-139 shows an example of an exterior door where the jambs and brick molding have been wrapped with trim coil flashing.

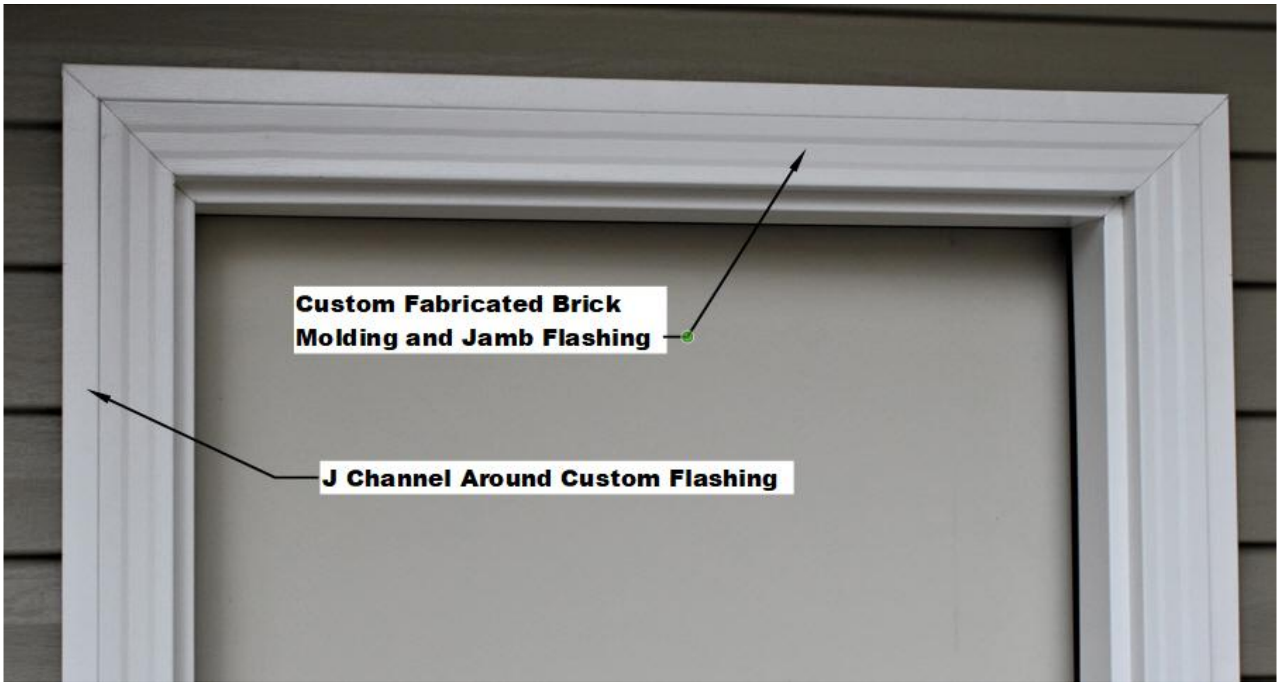


Figure 10-139 Site fabricated flashing around door jambs and brick molding.

Roof Cornice

The roof cornice in residential construction has two principle elements: the horizontal piece known as the Soffit and the vertical, or angled element, known as the fascia. In addition to the soffit and fascia, some cornice styles may have more, or fewer, elements. The roof cornice has two major functions, the first, and most important, is to extend the edge of the roof past the walls of the house to assist in keeping the water cascading off of the roof away from the walls of the house. The second is to provide architectural detail and interest to the structure. One of the primary elements that defines the architectural style of building is the shape of the cornice. There are a myriad of styles and sizes of cornices used in residential construction, however, they are typically categorized into three different types, a boxed cornice, and open cornice, and a closed cornice. Figure 10-140 shows an example of a traditional wood boxed cornice. A 2 × 4 sub fascia board is installed at the end of the rafter tails. A 2 × 4 soffit ledger board is installed along the wall. 2 × 4 soffit lookouts extend from the soffit ledger to the sub fascia. A 1 × 6 wood fascia board is installed on top of the sub fascia and a plywood soffit is attached to the sub fascia, soffit lookouts, and soffit ledger.

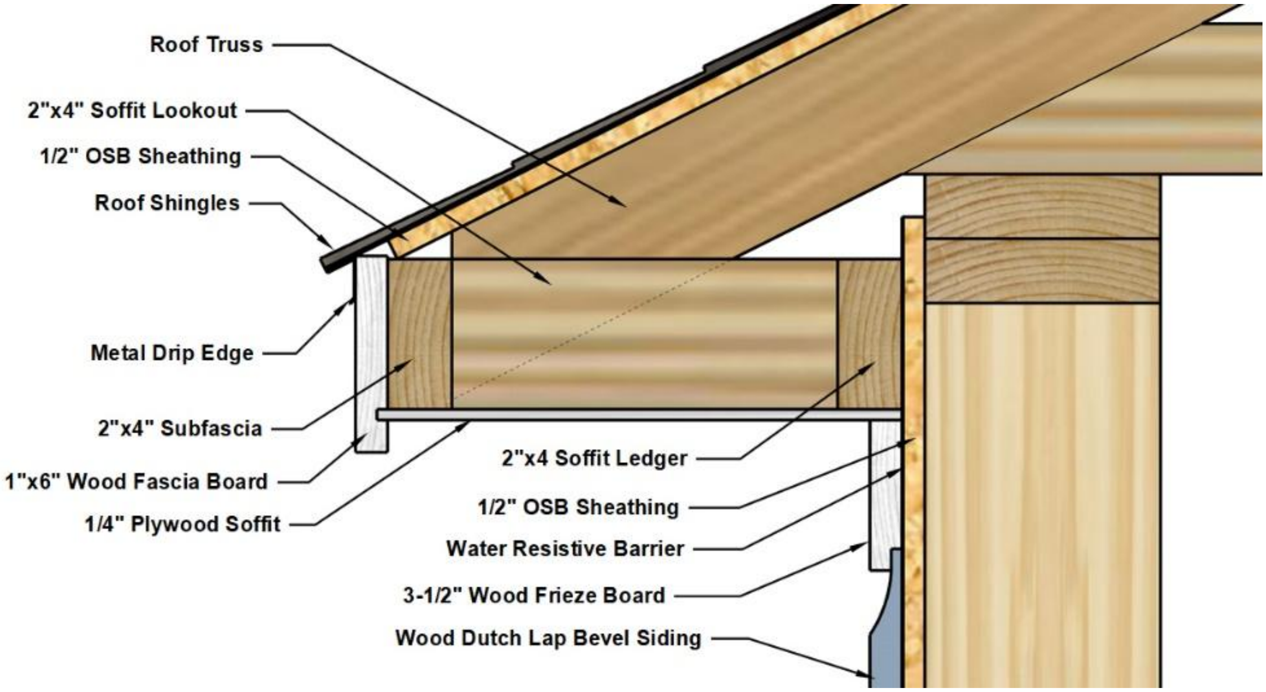


Figure 10-140 Traditional wood boxed cornice.

Figure 10-141 shows an example of a sloped roof soffit. The truss tails are cut perpendicular to the slope of the roof. The sub fascia is also installed at an angle with the fascia and soffit installed at the same angle.

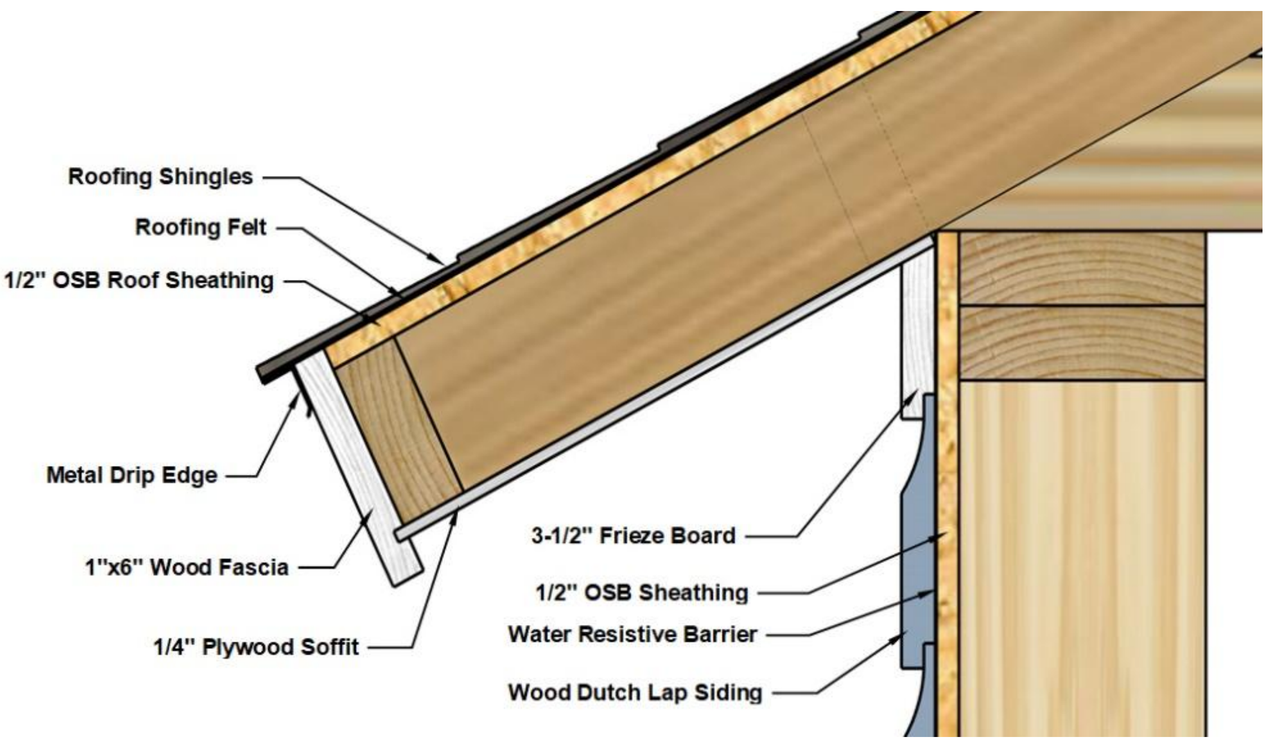


Figure 10-141 Slope roof cornice

Figure 10-141 shows an open cornice. The rafter tails have been sculptured to a pattern to add decorative detail to the installation. There is no sub fascia or fascia board. There is blocking, however, that has been installed between each rafter end.

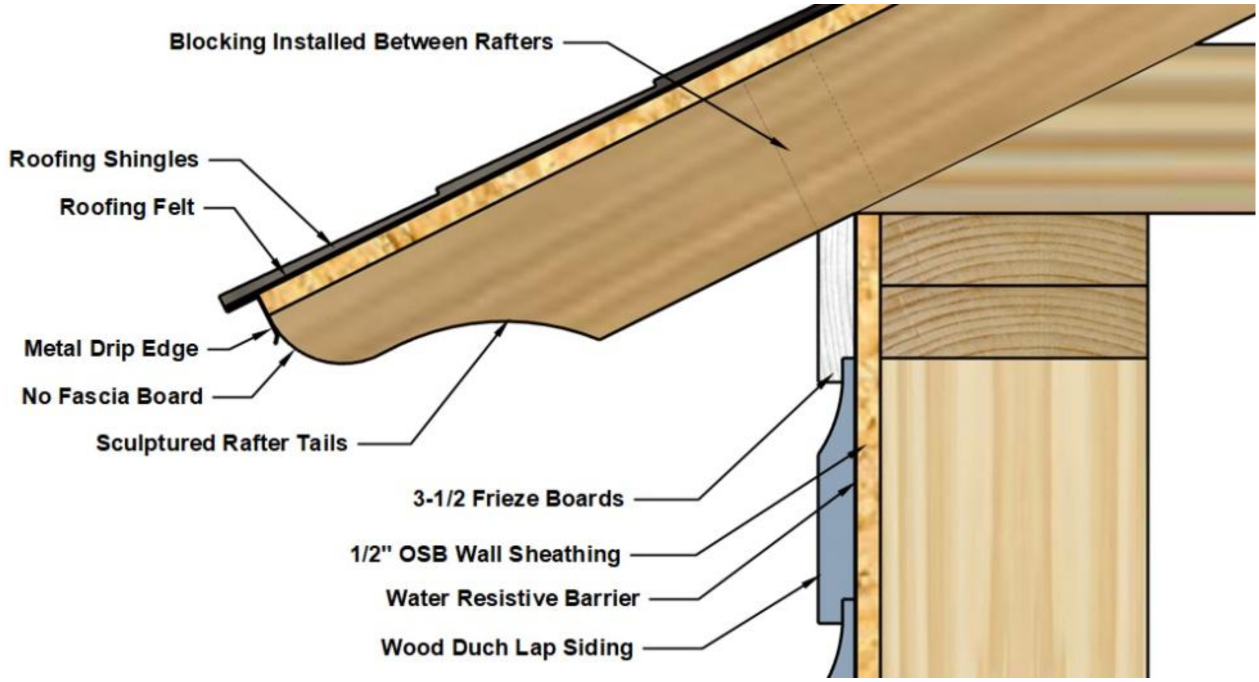


Figure 10-142 Open cornice with sculptured rafter tails.

Figure 10-143 shows an example of a closed cornice. There is no rafter overhang, and the cornice extends only a small amount over the edge of the roof. The edge of the rafters is covered with a wide frieze board. In addition, molding can be added to bring the edge of the roof out past the wall plane a few inches.

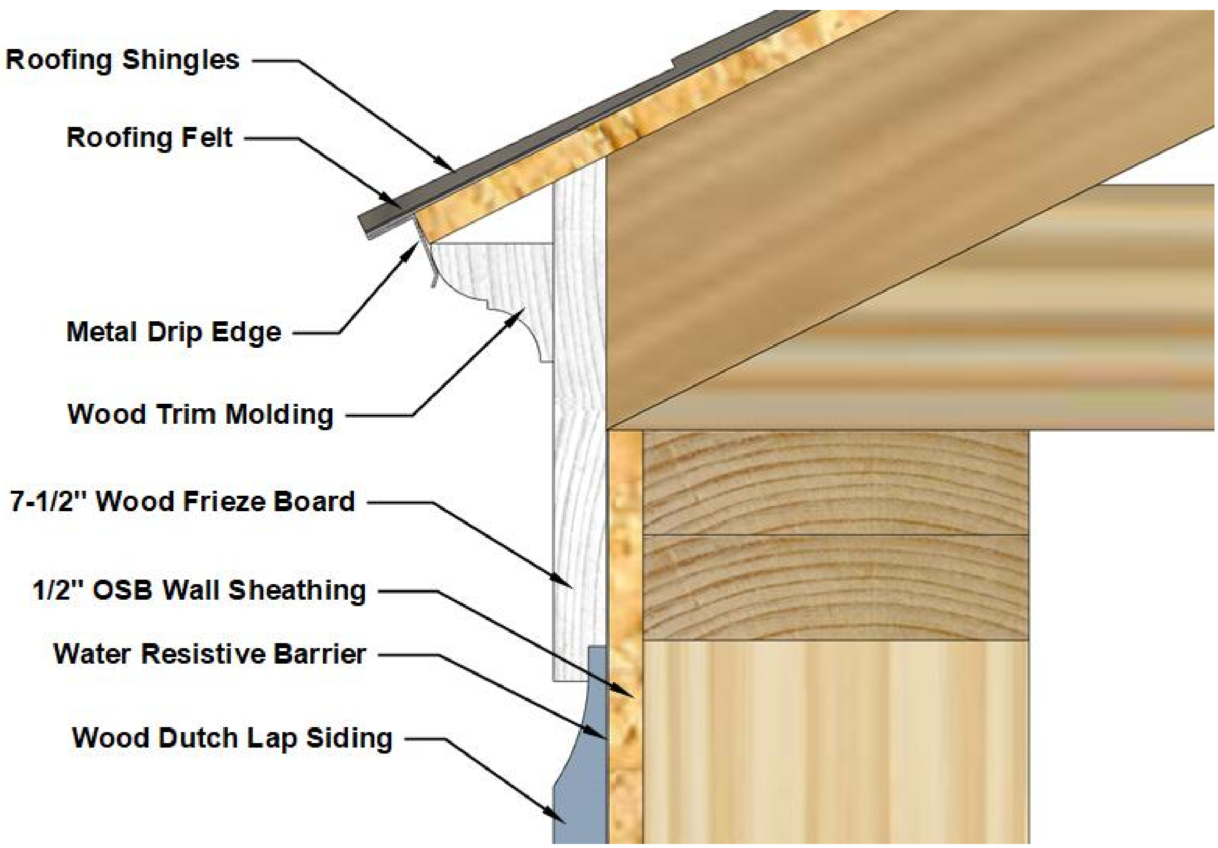


Figure 10-143 Closed cornice without any roof overhang.

Steel, Aluminum, and Vinyl Siding Cornice

Steel, aluminum, and vinyl siding soffits are a popular choice for cornice materials. In addition to being used in buildings with steel, aluminum, and vinyl siding, these materials are often used on buildings that have other siding materials such as wood, engineered wood, and fiber cement because of their ease of installation and maintenance free application. Often, the framing support for these materials is not as extensive as for wood fascia and soffit. The actual framing requirements depend upon the siding and trim accessories used. Boxed cornice soffits are typically constructed using separate fascia, soffit, and trim pieces.

Steel, Aluminum, and Vinyl Fascia

Fascia pieces are made from bent or formed L shaped pieces of steel, aluminum, or vinyl. They are manufactured in different standard widths from 4 inches wide to 12 inches wide. In addition, aluminum sheet stock is also commonly site fabricated into fascia material in either standard or custom widths. The L shaped material is commonly hemmed at the top and front edge to increase stiffness and strength. In addition, aluminum and vinyl fascia is often ribbed to add additional strength and stiffness. The fascia material is installed directly on top of the sub fascia with the bottom edge pressed up to the soffit and the top edge tucked under the drip edge. Figure 10-144 shows some examples of soffit materials.

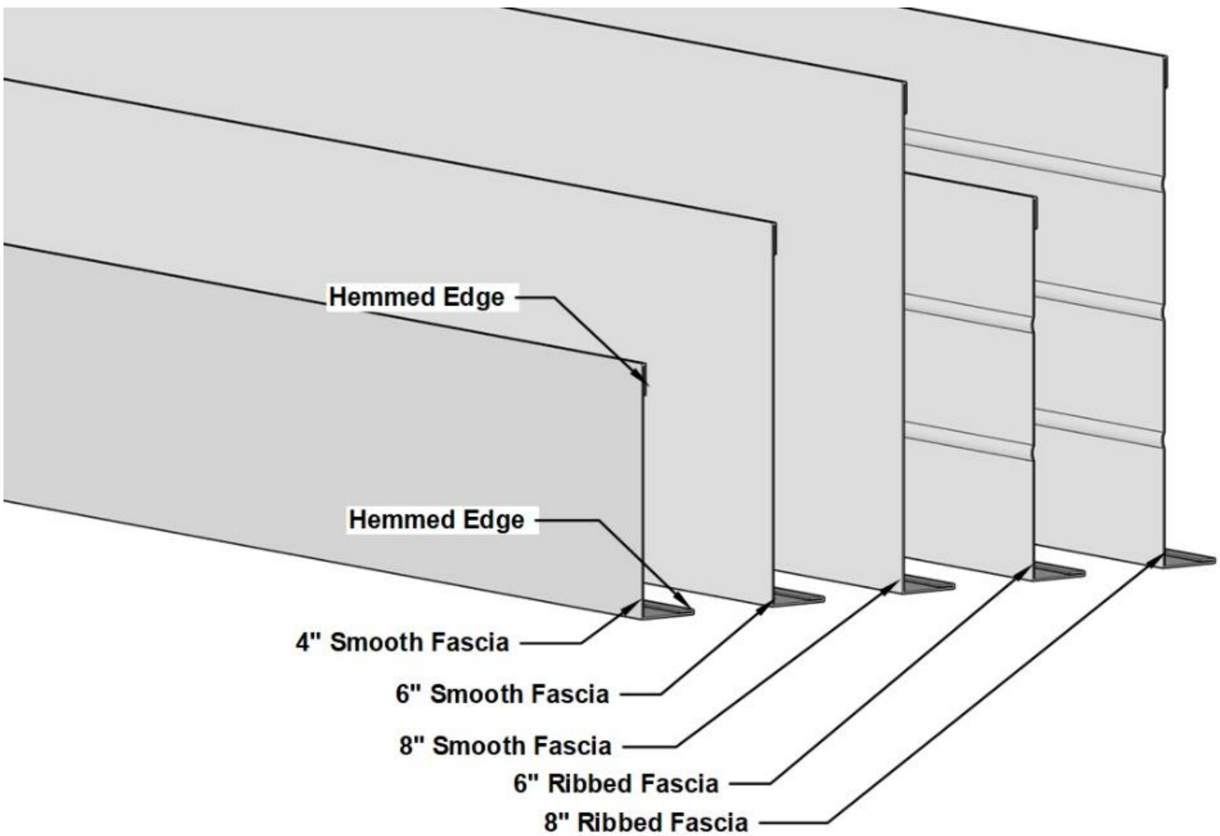


Figure 10-144 Examples of fascia.

Steel, Aluminum, and Vinyl Soffit

Soffit material is available commonly in either steel, aluminum, or vinyl. Several different widths and styles are available. The pattern is commonly formed to resemble grooved wood siding material. The patterns available would include 6-inch-wide single pattern,6-inch-wide double pattern, 5-inch-wide double pattern, 4-inch-wide triple pattern, and 4-inch-wide quad pattern. The total width of each piece of soffit would be multiples of each pattern repeated.

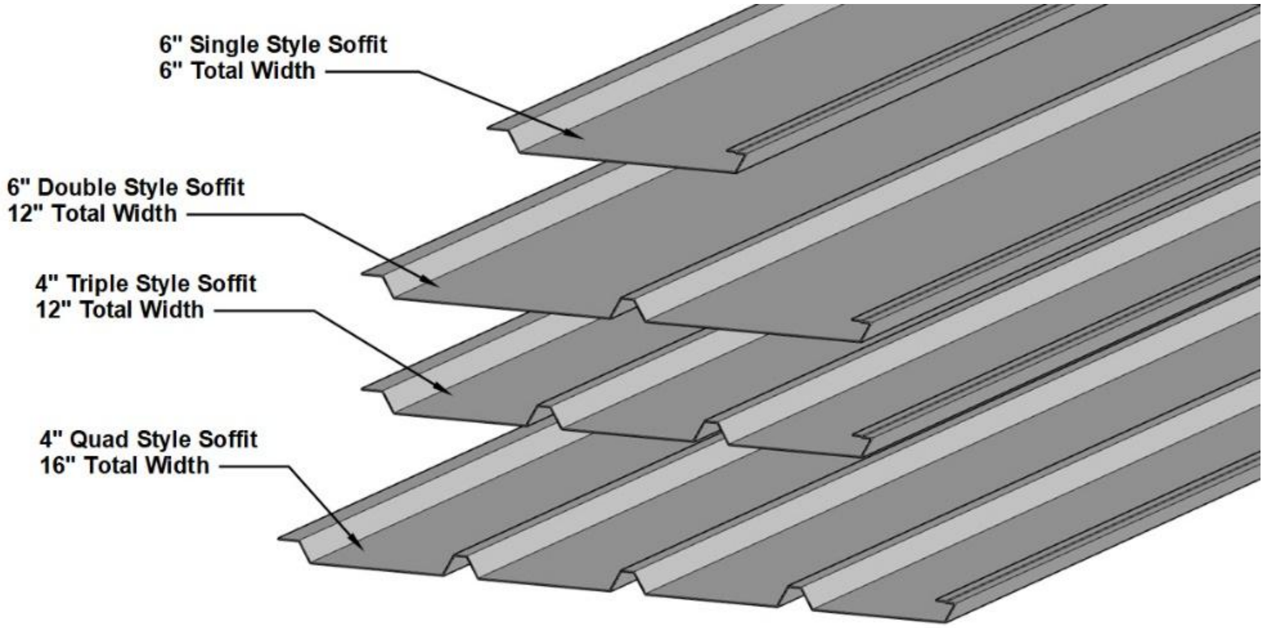


Figure 10-145 A few soffit styles.

In addition to the solid soffit styles shown in Figure 10-145, soffit material is also available vented to allow for attic ventilation. Soffit can be either fully vented where all of the faces have ventilation holes in them or partially vented with some of the faces vented and others not as shown in Figure 10-146.

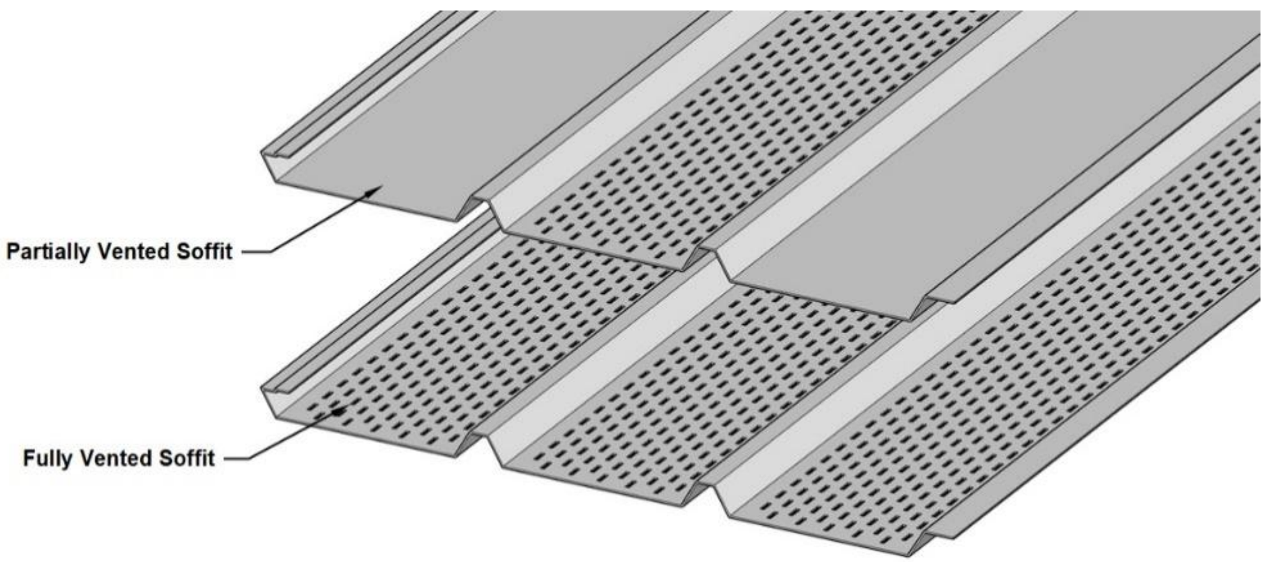


Figure 10-146 Fully and partially vented soffit material.

Cornice Trim

Most soffit installations will require additional trim included in the project. Some trim that could be required includes soffit J channel, soffit F channel, soffit H trim, and utility trim. Figure 10-147 shows some examples of these.

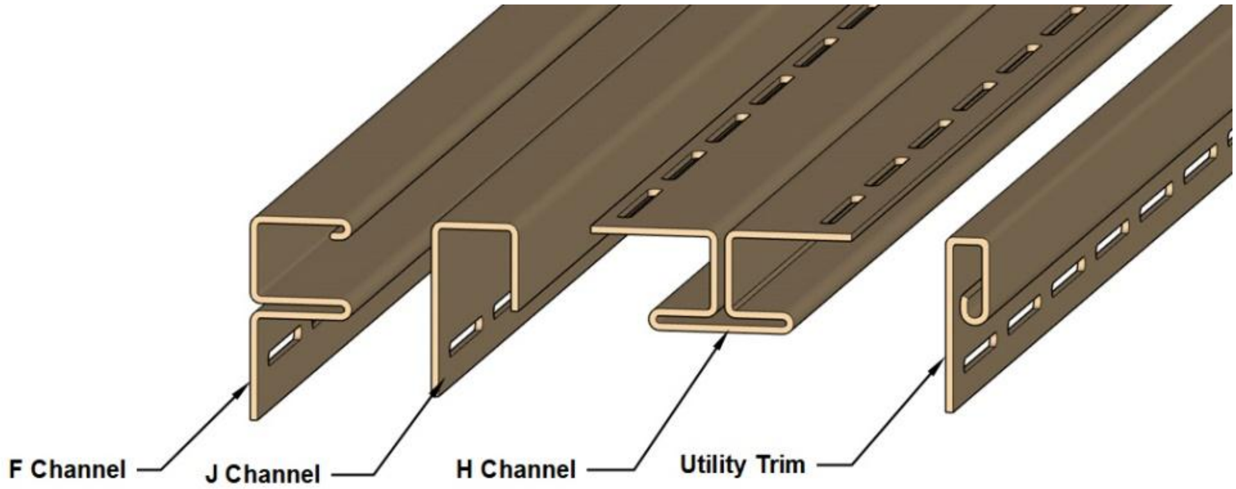


Figure 10-147 Examples of soffit trim profiles.

Figure 10-148 shows an example of a boxed cornice application that utilizes three siding elements: fascia, soffit, and F channel. The F channel is attached directly to the wall sheathing. One edge of the soffit is supported by the F channel, and the other is attached to the sub fascia. The fascia is tucked up under the drip edge, and the bottom is supported by attaching it to the sub fascia (Figure 10-148).

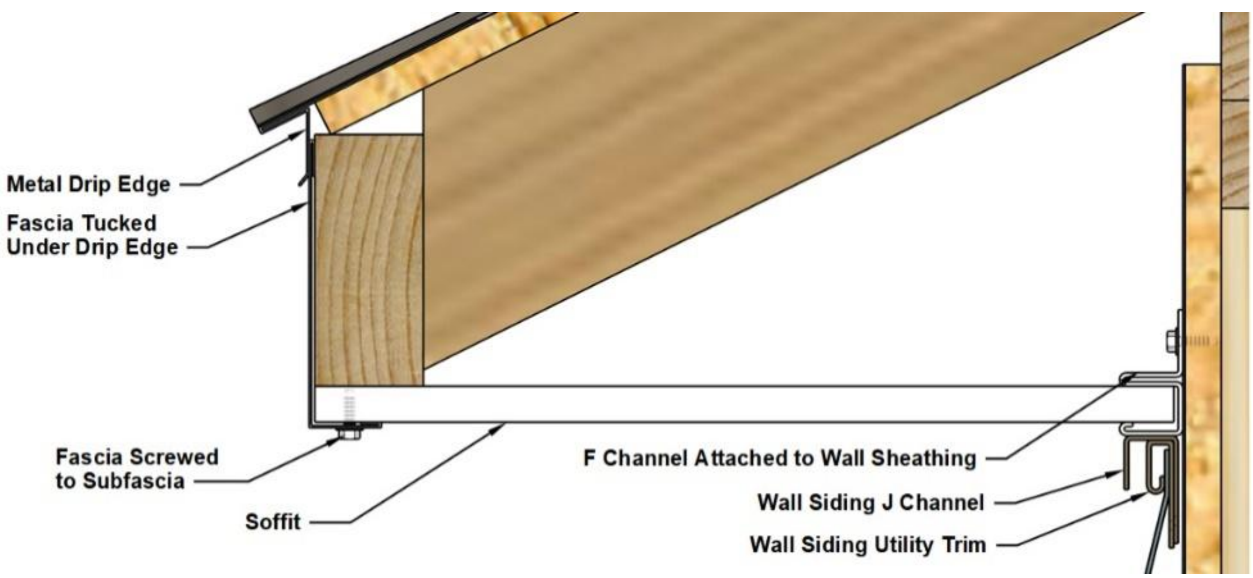


Figure 10-148 Boxed cornice installed with F Channel, soffit, and fascia.

Another common method of a boxed cornice installation uses fascia, soffit, and J channel. This installation requires the addition of a ledger strip to attach the J channel to as it is difficult to attach it directly to the wall sheathing.

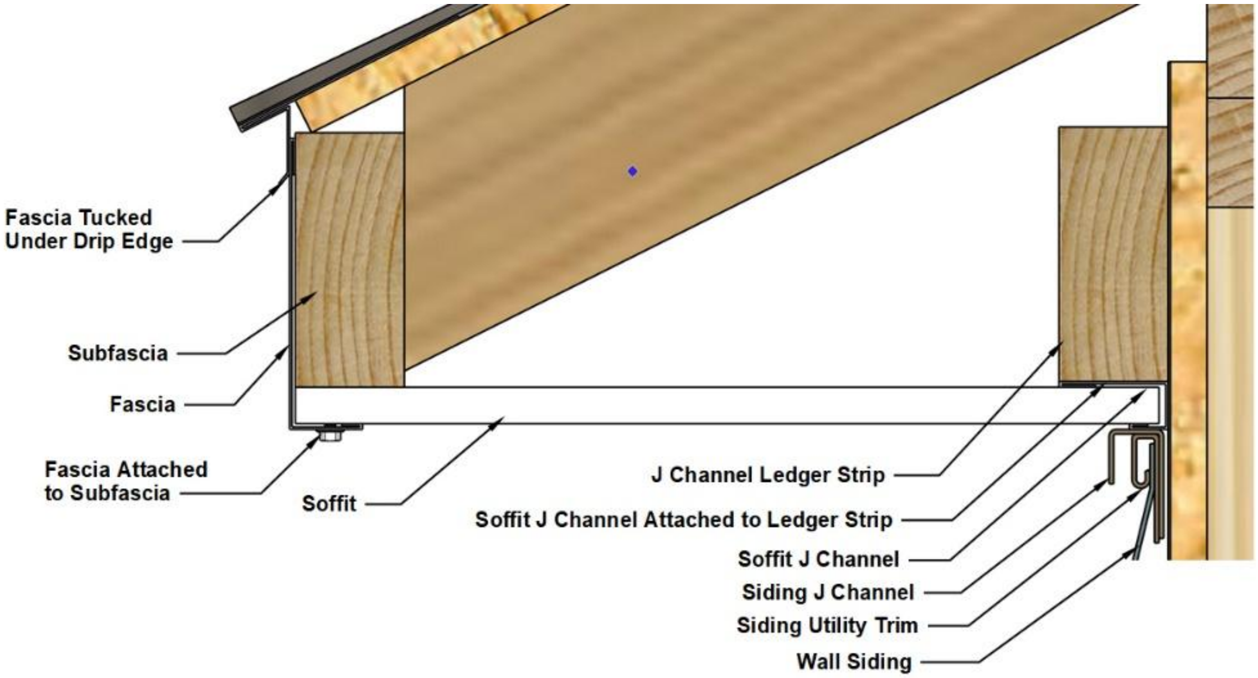


Figure 10-149 Boxed cornice installed with J channel, soffit, fascia, and ledger strip.

Figure 10-150 shows an example of an angled soffit installation. The soffit is sloped to match the roof slope, and the fascia is installed perpendicular to the soffit. The installation requires fascia, soffit, and J channel.

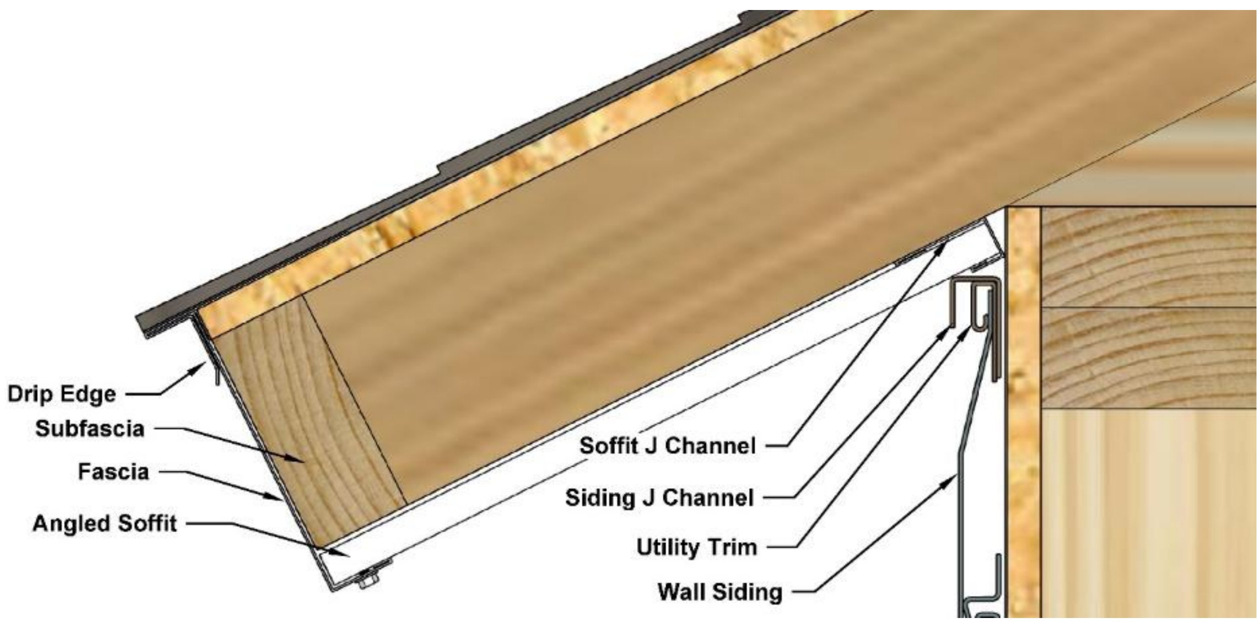


Figure 10-150 Angle soffit installation with soffit installed perpendicular to the soffit.

H Channel

H Channel is used to join pieces of siding or soffit material along the cut edge. For example, it is commonly used in forming the soffit where the walls meet at a corner. The soffit material is mitered at the corner where the two sides meet. H channel is placed between the two pieces. Another way of forming the corner is to have the sides meet at perpendicular angles with H channel between the pieces. Both types of soffit corners are shown in Figure 10-151.

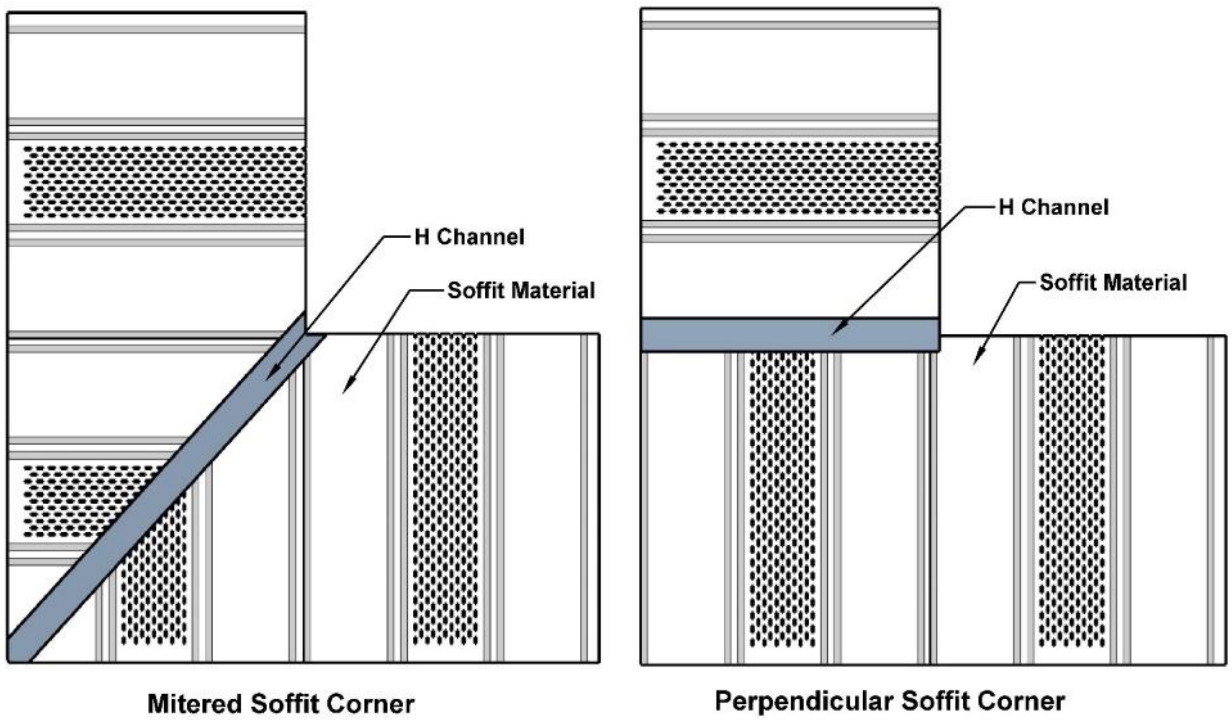


Figure 10-151 Soffit corners finished with H channel.

H channel can be formed from two pieces of J channel placed back to back. Figure 10-512 shows a perpendicular porch soffit with J channel placed back to back to form the H channel.

Figure 10-152 Perpendicular soffit with seam formed by back to back J channel.

H channel or back to back J channel can be used where the area to be covered by the soffit is longer than the soffit of siding material, and a seam is needed. Figure 10-153 shows an example of a porch soffit seam formed from back to back J channel.

Figure 10-153 Porch soffit seamed with double J channel

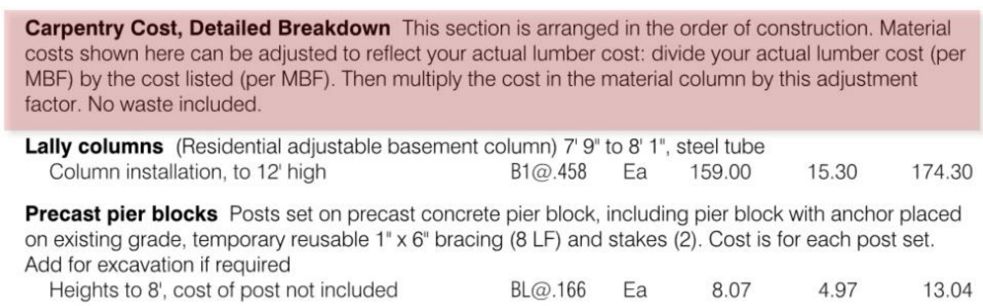
Figure 10-154 shows an example of vertical siding on a tall wall that has been seamed with H channel.

Figure 10-154 Vertical wall siding seamed with H channel.

Framing Labor Estimates

Exterior Wall Framing Labor

The wall framing labor costs will be estimated using the Detailed Breakdown section of the National Construction Estimator. The Detailed Breakdown section separates the wall framing into individual elements such as plates, studs, back and blocking, temporary bracing, and sheathing. Take care to make sure that it is the Detailed Breakdown section that is being used. The National Construction Estimator provides four different methods of preparing framing estimates: a Rule-of-thumb, an assembly, a piecework, and a detail breakdown method. The detailed breakdown provides a more detailed and comprehensive method of calculating labor costs. The Detailed Breakdown section of the National Construction Estimator is the final section in the residential framing portion of the manual. NCE Figure 9-1 shows a screenshot of the introductory paragraph of the Detailed Breakdown section. All detailed breakdown cost sections will follow the introduction.



Carpentry Cost, Detailed Breakdown This section is arranged in the order of construction. Material costs shown here can be adjusted to reflect your actual lumber cost: divide your actual lumber cost (per MBF) by the cost listed (per MBF). Then multiply the cost in the material column by this adjustment factor. No waste included.

Lally columns (Residential adjustable basement column) 7' 9" to 8' 1", steel tube

Column installation, to 12' high	B1@.458	Ea	159.00	15.30	174.30

Precast pier blocks Posts set on precast concrete pier block, including pier block with anchor placed on existing grade, temporary reusable 1" x 6" bracing (8 LF) and stakes (2). Cost is for each post set. Add for excavation if required

Heights to 8', cost of post not included	BL@.166	Ea	8.07	4.97	13.04

NCE Figure 9-1 Introduction to the Carpentry Cost, Detailed Breakdown section of the National Construction Estimator.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.39.

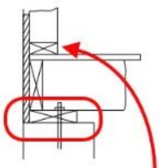
The quantities for estimating exterior wall framing labor will be taken from the basic takeoffs that you have already done.

Estimating Wall Plate Labor

The National Construction Estimator provides two different options for estimating wall plate labor, a sill plates subsection and a plates subsection. The introduction to each section provides a description and explanation of which section would be appropriate in a given situation. NCE Figure 9-2 shows a composite screenshot of both subsections.

Sill plates (At foundation) SYP #2 pressure treated lumber, drilled and installed with foundation bolts at 48" OC, no bolts, nuts or washers included. See also plates in this section. Figures in parentheses indicate board feet per LF of foundation, including 5% waste and wolmanized treatment.

Sill plates, per MBF	—	MBF	992.00	—	992.00
2" x 3" (.53 BF per LF)	B1@.020	LF	.44	.67	1.11
2" x 4" (.70 BF per LF)	B1@.023	LF	.77	.77	1.54
2" x 6" (1.05 BF per LF)	B1@.024	LF	.97	.80	1.77
2" x 8" (1.40 BF per LF)	B1@.031	LF	1.34	1.04	2.38



Plates (Wall plates) Std & Btr, untreated. For pressure treated plates, see also Sill Plates in this section. Figures in parentheses indicate board feet per LF. Costs shown include 10% for waste and nails

2" x 3" wall plates, per MBF	—	MBF	722.00	—	722.00
2" x 4" wall plates, per MBF	—	MBF	652.00	—	652.00
2" x 6" wall plates, per MBF	—	MBF	668.00	—	668.00
2" x 8" wall plates, per MBF	—	MBF	648.00	—	648.00
2" x 3" (.55 BF per LF)	B1@.010	LF	.44	.33	.77
2" x 4" (.73 BF per LF)	B1@.012	LF	.52	.40	.92
2" x 6" (1.10 BF per LF)	B1@.018	LF	.81	.60	1.41
2" x 8" (1.40 BF per LF)	B1@.020	LF	1.00	.67	1.67

NCE Figure 9-2 Composite view of Sill Plate and Plates section of the NCE.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.40.

The description of the sill plates section explains that it is to be used for sill plates that use pressure treated lumber and are drilled and attached to a foundation using anchor bolts. This subsection would be used on the garage wall plates where it is drilled for anchor bolts. The plates subsection uses untreated lumber and the sill plates that are set upon a floor. These types of plates are typically nailed to the subfloor, such as would be done for the exterior walls. There are occasions where a treated sill plate is used on a concrete floor, such as a basement floor. In this case, the plates subsection would be used even though treated lumber is used for the bottom plate. These types of plates are usually just nailed using powder actuated fasteners and not drill-to-fit anchor bolts.

The quantity of top plates would be estimated by multiplying the lineal feet of wall by the number of top plates. Typically, the quantity for labor is estimated from the data in the header section without an added waste factor because, as is shown in NCE Figure 9-2, the NCE accounts for a ten percent waste factor when pricing plate labor. Based on this, the labor cost for installing the top plates would be

114 Lineal Feet Wall × 2 Plates × .60 LF = $136.80

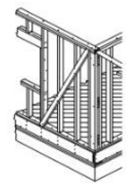
The labor costs for installing the bottom plate would be completed in a similar fashion and would be

114 Lineal Feet Wall × 1 Plate × .60 LF = $68.40

Estimating Wall Stud Labor

Figure 9-37 shows a screenshot of the studding section from the National Construction Estimator. The cost is priced per square footage of wall area on one side of the wall. Additional information is also provided in the introduction, explaining that openings less than 16 feet wide are not subtracted from the square footage of the wall. Additional cost is added for each corner or partition.

Studding Per square foot of wall area. Do not subtract for openings less than 16' wide. Figures in parentheses indicate typical board feet per SF of wall area, measured on one side, and include normal waste. Add for each corner and partition from below. Costs include studding, nails. Add for plates from the section above and also, door and window opening framing, backing, let-in bracing, fire blocking, and sheathing for shear walls from the sections that follow. Labor includes layout, plumb and align.



	Craft@Hrs	Unit	Material	Labor	Total
2" x 3", Std & Btr					
2" x 3" studs, 16" centers, per MBF	—	MBF	722.00	—	722.00
12" centers (.55 BF per SF)	B1@.024	SF	.40	.80	1.20
16" centers (.41 BF per SF)	B1@.018	SF	.30	.60	.90
20" centers (.33 BF per SF)	B1@.015	SF	.24	.50	.74
24" centers (.28 BF per SF)	B1@.012	SF	.20	.40	.60
Add for each corner or partition	B1@.083	Ea	9.37	2.78	12.15
2" x 4", Std & Btr					
2" x 4" studs, 16" centers, per MBF	—	MBF	652.00	—	652.00
12" centers (.73 BF per SF)	B1@.031	SF	.48	1.04	1.52
16" centers (.54 BF per SF)	B1@.023	SF	.35	.77	1.12
20" centers (.45 BF per SF)	B1@.020	SF	.29	.67	.96
24" centers (.37 BF per SF)	B1@.016	SF	.24	.54	.78
Add for each corner or partition	B1@.083	Ea	11.10	2.78	13.88
2" x 6", Std & Btr					
2" x 6" studs, 24" centers, per MBF	—	MBF	668.00	—	668.00
12" centers (1.10 BF per SF)	B1@.044	SF	.74	1.47	2.21
16" centers (.83 BF per SF)	B1@.033	SF	.55	1.10	1.65
20" centers (.67 BF per SF)	B1@.027	SF	.45	.90	1.35
24" centers (.55 BF per SF)	B1@.022	SF	.37	.74	1.11
Add for each corner or partition	B1@.083	Ea	15.90	2.78	18.68

NCE Figure 9-3 Studding section of NCE.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.43.

Based upon the labor cost for installing 2 × 6 studding on 16-inch centers, the cost for the studding labor would be

912 SF Wall Area × $1.10 per SF = $1,003.20

Additional cost would be added for each corner or intersection. The header shows 12 corners and partitions, and the labor cost would be

12 Corners and Partitions × $2.78 = $33.36

Estimating Wall Sheathing Labor

The wall sheathing area is calculated by multiplying the wall sheathing height by the wall length. The wall sheathing height typically includes the wall height and the height of the floor joist space, which includes the mudsill height, floor joist height, and floor sheathing thickness. Figure 9-38 shows a screenshot of the wall sheathing section of the NCE.

Sheathing, wall Per SF of wall surface, including 5% waste

BC plywood sheathing, plugged and touch sanded, interior grade					
1/4"	B1@.013	SF	.69	.43	1.12
3/8"	B1@.015	SF	.67	.50	1.17
1/2"	B1@.016	SF	.80	.54	1.34
5/8"	[illegible]	SF	[illegible]	[illegible]	1.49
3/4", 7-ply	B1@.020	SF	2.41	.67	[illegible]
OSB sheathing					
1/4"	B1@.013	SF	.32	.43	.75
3/8"	B1@.015	SF	.54	.50	1.04
7/16"	B1@.015	SF	.48	.50	.98
1/2"	B1@.016	SF	.64	.54	1.18
5/8"	B1@.018	SF	.66	.60	1.26
3/4"	B1@.018	SF	.73	.60	1.33

NCE Figure 9-4 Wall sheathing in the NCE.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.51.

The cost for wall sheathing is calculated by multiplying the following:

Wall Length × Wall Sheathing Height × Wall Sheathing × Labor Cost

114 LF × 9.3 FT × 1 × .50 = $530.10

Estimating Temporary Bracing Labor

The quantity of temporary bracing labor is determined by estimating one lineal foot of temporary bracing for each lineal foot of wall. The material costs were estimated using 50 percent of the wall length because the bracing material can be removed and reused, however, the total wall length will be used for estimating the labor costs. Excel Figure 9-5 shows the NCE temporary bracing section.

Temporary wood frame wall bracing, assumes salvage at 50% and 3 uses					
1" x 4" Std & Btr	B1@.006	LF	.17	.20	.37
1" x 6" Std & Btr	B1@.010	LF	.25	.33	.58
2" x 4" utility	B1@.012	LF	.11	.40	.51
2" x 6" utility	B1@.018	LF	.17	.60	.77

NCE Figure 9-5 NCE temporary wall bracing section.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.44.

The cost for temporary bracing labor would be

114 LF × .60 = $68.40

Estimating Backing and Nailers Labor

The quantity of backing and nailers labor is determined by estimating one lineal foot of labor for each lineal foot of wall. NCE Figure 9-6 shows the NCE backing and nailers section.

	Craft@Hrs	Unit	Material	Labor	Total
Backing and nailers Std & Btr, for wall finishes, "floating" backing for drywall ceilings, trim, z-bar, appliances and fixtures, etc. See also Bridging and Fireblocking in this section. Figures in parentheses show board feet per LF including 10% waste.					
1" x 4" (.37 BF per LF)	B1@.011	LF	.60	.37	.97
1" x 6" (.55 BF per LF)	B1@.017	LF	.96	.57	1.53
1" x 8" (.73 BF per LF)	B1@.022	LF	1.27	.74	2.01
1" x 10" (.92 BF per LF)	B1@.027	LF	1.53	.90	2.43
1" x 12" (1.10 BF per LF)	B1@.030	LF	2.42	1.00	3.42
2" x 4" (.73 BF per LF)	B1@.023	LF	.48	.77	1.25
2" x 6" (1.10 BF per LF)	B1@.034	LF	.74	1.14	1.88
2" x 8" (1.47 BF per LF)	B1@.045	LF	.95	1.50	2.45
2" x 10" (1.83 BF per LF)	B1@.057	LF	1.23	1.91	3.14
3" x 10" (2.76 BF per LF)	B1@.064	LF	2.11	2.14	4.25
1" x 8" Azec core	B1@.042	LF	2.98	1.40	4.38

NCE Figure 9-6 NCE Backing and nailers section.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.44.

The backing and nailer cost would be

114 LF × .77 = $87.78

Estimate Example 9-2 shows the exterior wall framing labor.

Floor Framing Labor

The floor framing labor will be estimated using the Detailed Breakdown section of the Residential section of the National Construction Estimator. The labor costs include installing floor girders, girder support posts, post base, post caps, floor joists, installing bridging and blocking, installing joist hangers, and installing subflooring.

Install Girder

There are no girder nor girder installation costs on this project.

Install Girder Support Post

There are no girder support installation costs on this project.

Install Post Base

There is no girder post base cost on this project.

Install Post Cap

There is no girder post cap cost on this project.

Install Floor Joists

The floor joist wood, TJI truss type subsection of the NCE will be used to estimate installing the floor joists. The cost is priced per square footage of floor area. The square foot floor area will be used to calculate the area for the floor joists. Figure 9-7 shows a screenshot of the TJI floor joist pricing from the National Construction Estimator.

	Craft@Hrs	Unit	Material	Labor	Total
Floor joist wood, TJI truss type Suitable for residential use, 50 PSF floor load design. Costs shown are per square foot (SF) of floor area, based on joists at 16" OC, for a job with 1,000 SF of floor area. Figure 1.22 SF of floor area for each LF of joist. Add the cost of beams, supports and blocking. For scheduling purposes, estimate that a two-man crew can install 900 to 950 SF of joists in an 8-hour day.					
9-1/2" TJI/15	B1@.017	SF	2.34	.57	2.91
11-7/8" TJI/15	B1@.017	SF	2.57	.57	3.14
14" TJI/35	B1@.018	SF	3.72	.60	4.32
16" TJI/35	B1@.018	SF	4.08	.60	4.68

NCE Figure 9-7 Floor joist framing labor.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.41.

Based upon the 1,152 square footage of floor area and the price for installing floor joists labor based upon a cost of 0.57 per square foot of floor area, the cost would be as follows:

1152 SF Floor Area × 0.57 SF = $656.64

Install Bridging and Blocking

The bridging or blocking subsection of the residential section of the NCE will be used to price the labor cost for installing bridging and blocking. The labor costs are priced based upon each piece of blocking installed and the spacing of the floor joists. Figure 9-10 shows a screenshot of the bridging and blocking pricing from the National Construction Estimator. Based upon 16 pieces of blocking entered into the header section and an installation cost of $1.91 per piece, the total cost for installation of bridging and blocking would be 17 Pieces × $1.90 = $30.56

Bridging or blocking Installed between 2" x 6" thru 2" x 12" joists. Costs shown are per each set of cross bridges or per each block for solid bridging, and include normal waste. The spacing between the bridging or blocking, sometimes called a "bay," depends on job requirements. Labor costs assume bridging is cut to size on site.

1" x 4" cross

	Craft@Hrs	Unit	Material	Labor	Total
2" x 12" solid, Std & Btr					
2" x 12" blocking, per MBF	—	MBF	742.00	—	742.00
Joists on 12" centers	B1@.057	Ea	1.63	1.91	3.54
Joists on 16" centers	B1@.057	Ea	2.18	1.91	4.09
Joists on 20" centers	B1@.057	Ea	2.72	1.91	4.63
Joists on 24" centers	B1@.057	Ea	3.27	1.91	5.18

NCE Figure 9-8 Screenshot of NCE bridging or blocking cost.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.41.

Installing Joist Hangers

The Framing Connectors section of the residential subsection of the National Construction Estimator will be used to price the installation cost for joist hangers. The top flange hangers 2 inches × 12 inches (LB212) will be used as it is the closest to the hangers used. The cost is priced per hanger (NCE Figure 9-9).

	Craft@Hrs	Unit	Material	Labor	Total
Top flange hangers (LB)					
2" x 6" (LB26)	BC@.046	Ea	3.49	1.70	5.19
2" x 8" (LB28)	BC@.046	Ea	3.17	1.70	4.87
2" x 10" (LB210)	BC@.046	Ea	9.67	1.70	11.37
2" x 12" (LB212)	BC@.046	Ea	8.54	1.70	10.24
2" x 14" (LB214)	BC@.052	Ea	8.37	1.92	10.29

Caption

Based upon the previously determined quantity of three, and an installation cost per hanger of $1.70, the total cost would be as follows:

3 Hangers × $1.70 = $5.10

Install Subflooring

The Subflooring section of the Residential subsection of the National Construction Estimator will be used to price the installation cost of the subflooring. The 3/4-inch OSB Sheathing cost will be used because it is the closest match to the 3/4-inch T&G subflooring installed in the project. The cost is based upon the square footage of the subfloor (NCE Figure 9-10). Based upon the calculated quantity of subflooring of 1,152 square feet and a labor cost of 0.47 per square foot the total would be

1,152 SF × 0.47 = $541.44

Subflooring	Craft@Hrs	Unit	Material	Labor	Total
Board sheathing, 1" x 6" #3 & Btr (1.18 BF per SF)					
Board sheathing, per MBF	—	MBF	2,580.00	—	2,580.00
3/4"	B1@.013	SF	.80	.43	1.23
OSB sheathing, Material costs shown include 5% for waste & fasteners					
3/8"	B1@.011	SF	.54	.37	.91
7/16"	B1@.011	SF	.48	.37	.85
1/2"	B1@.012	SF	.64	.40	1.04
5/8"	B1@.012	SF	.66	.40	1.06
3/4"	B1@.014	SF	.73	.47	1.20
7/8"	B1@.014	SF	1.50	.47	1.97
1"	B1@.015	SF	2.17	.50	2.67

NCE Figure 9-10 Screenshot of the subflooring in the NCE.

Window and Door Header

The labor cost will be taken from the detailed breakdown subsection of the Residential section of the National Construction Estimator. Modifications will be made to the estimating method used in the NCE (NCE Figure 9-11).

	Craft@Hrs	Unit	Material	Labor	Total
Door opening framing In wall studs, based on walls 8' in height. Costs shown are per each door opening and include header of appropriate size, double vertical studs each side of the opening less than 8' wide (triple vertical studs each side of openings 8' wide or wider), cripples, blocking, nails and normal waste. Width shown is size of finished opening. Figures in parentheses indicate header size					
2" x 4" wall studs, Std & Btr, opening size as shown					
2" x 4" wall studs, per MBF	—	MBF	652.00	—	652.00
4" x 4" and 4" x 6" headers, per MBF	—	MBF	916.00	—	916.00
4" x 8", 10", 12" and 14" headers, per MBF	—	MBF	974.00	—	974.00
To 3' wide (4" x 4" header)	B1@.830	Ea	20.00	27.80	47.80
Over 3' to 4' wide (4" x 6" header)	B1@1.11	Ea	24.60	37.10	61.70
Over 4' to 5' wide (4" x 6" header)	B1@1.39	Ea	27.10	46.50	73.60
Over 5' to 6' wide (4" x 8" header)	B1@1.66	Ea	33.80	55.50	89.30
Over 6' to 8' wide (4" x 10" header)	B1@1.94	Ea	53.00	64.90	117.90
Over 8' to 10' wide (4" x 12" header)	B1@1.94	Ea	67.00	64.90	131.90
Over 10' to 12' wide (4" x 14" header)	B1@2.22	Ea	83.30	74.20	157.50
Add per foot of height for 4" walls over 8' in height	—	LF	2.61	—	2.61
2" x 6" wall studs, Std & Btr, opening size as shown					
2" x 6" wall studs, per MBF	—	MBF	668.00	—	668.00
6" x 4" headers, per MBF	—	MBF	974.00	—	974.00
6" x 8", 10", 12" and 14" headers, per MBF	—	MBF	1,600.00	—	1,600.00
To 3' wide (6" x 4" header)	B1@1.11	Ea	33.40	37.10	70.50
Over 3' to 4' wide (6" x 6" header)	B1@1.39	Ea	42.30	46.50	88.80
Over 4' to 5' wide (6" x 6" header)	B1@1.66	Ea	47.80	55.50	103.30
Over 5' to 6' wide (6" x 8" header)	B1@1.94	Ea	62.80	64.90	127.70
Over 6' to 8' wide (6" x 10" header)	B1@2.22	Ea	99.80	74.20	174.00
Over 8' to 10' wide (6" x 12" header)	B1@2.22	Ea	134.00	74.20	208.20
Over 10' to 12' wide (6" x 14" header)	B1@2.50	Ea	173.00	83.60	256.60
Add per foot of height for 6" walls over 8' in height	—	LF	4.01	—	4.01

NCE Figure 9-11 Door opening framing subsection of the NCE.

This section identifies pricing for two different header styles. The first section is for headers in 2 × 4 walls and the second is for headers in 2 × 6 walls. The assumption is that headers in 2 × 4 walls are four inches wide and are constructed of two pieces of header bearing material and the headers in 2 × 6 walls are constructed of three pieces of header bearing material. Figure 9-67 shows an example of this.

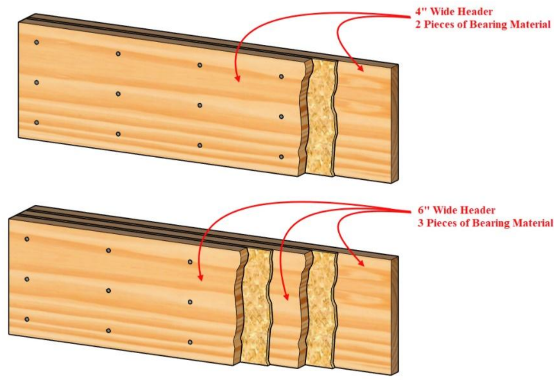


Figure 9-67 Examples of the two header styles in the NCE.

The NCE also prices different material for different header lengths. For example, headers in the “To 3' Wide (4" × 4" header)” category are made of two pieces of 2 × 4 inch framing lumber. Headers that span longer distances are made of wider pieces of framing lumber up to 2 × 12 inches. A careful interpretation of the labor costs for each header style reveals that the labor cost per lineal foot for each header style is essentially the same. For example, if the “To 3' Wide (4" × 4" header)” were used and the header length of three feet were used, the labor cost of $27.90 per each could be divided by the three foot length which would provide a cost of

$$\$27.80 \div 3\ ft = 9.27\ \frac{\$}{ft}$$

The same logic applied to the next header style of “Over 3' wide to 4' wide (4" × 6" header) shows a labor cost of $37.10 per each. If the labor cost were divided by the header length of four feet, the following would result:

$$\$37.10 \div 4\ ft = 12.37\ \frac{\$}{ft}$$

The labor cost per lineal foot does go down a little with the larger header sizes, but for the sake of brevity we will use the $9.27 cost for lineal foot for each four-inch wide header. The same logic applied to the six-inch wide headers would result in a cost per lineal foot of

$$\$37.10 \div 3\ ft = 12.37\ \frac{\$}{ft}$$

Window & Door Header Labor								Cost Code		
Crew	Men	Days	Man-hours	Job Description	CraftHrs	Unit	Labor	Quantity	Override	Total
				Install 4" Wide Door Headers	0.28	LF	$ 9.27	73.17		$ 678.26
				Install 6" Wide Door Headers	0.37	LF	$ 12.37	0.00		$ -
				Install 4" Wide Window Headers	0.33	LF		63.58		$ -
				Install 6" Wide window Headers	0.39	LF		0.00		$ -
	Total	0.0	0.00	Total Window and Door Header Labor				$		678.26
				Total Window and Door Header Cost				$		1,024.31

Excel Figure 9-48 Labor cost per lineal foot for door headers entered into the spreadsheet.

The same logic would be applied to the window header to obtain the cost per lineal foot. The only difference is that when establishing the cost per lineal foot, the minimum window width of two feet would be used.

Specialty Framing Labor

The National Construction Estimator will be used to price the labor costs for the specialty framing of the estimate.

Porch Posts Labor

The porch posts labor costs will be determined from the posts subsection of the detailed breakdown portion of the residential section. NCE Figure 9-12 shows an example of this subsection.

Posts S4S, green. Posts not in wall framing. Material costs include 10% waste. For scheduling purposes, estimate that a two-man crew can complete 100 to 125 LF per 8-hour day.

4" x 4", 4" x 6" posts, per MBF	—	MBF	916.00	—	916.00
4" x 8" to 4" x 12" posts, per MBF	—	MBF	974.00	—	974.00

	Craft@Hrs	Unit	Material	Labor	Total
4" x 4" per LF	B1@.110	LF	1.34	3.68	5.02
4" x 6" per LF	B1@.120	LF	2.02	4.01	6.03
4" x 8" per LF	B1@.140	LF	2.86	4.68	7.54
4" x 10" per LF	B1@.143	LF	3.57	4.78	8.35
4" x 12" per LF	B1@.145	LF	4.29	4.85	9.14
6" x 6" per LF	B1@.145	LF	5.29	4.85	10.14

NCE Figure 9-12 Post costs from the NCE.

The costs shown are priced per lineal foot and the quantity placed in the spreadsheet is for each eight-foot length of posts. The eight-foot length post will need to be converted to a lineal foot cost by multiplying the eight-foot size by the quantity of two for a total of 16'.

LVL Beam Labor

The LVL beam labor costs will be determined from the Beams subsection of the detailed breakdown portion of the residential section. NCE Figure 9-13 shows an example of this subsection.

Beams Std & Btr. Installed over wall openings and around floor, ceiling and roof openings or where a flush beam is called out in the plans, including 10% waste. Do not use these beams for door or window headers in framed walls, use door or window opening framing assemblies.

2" x 6" beams, per MBF	—	MBF	668.00	—	668.00
2" x 8" beams, per MBF	—	MBF	648.00	—	648.00

2" [illegible]	[illegible]	[illegible]	.74	[illegible]	[illegible]
2" x 8" (1.47 BF per LF)	B1@.037	LF	.95	1.24	2.19
2" x 10" (1.83 BF per LF)	B1@.046	LF	1.23	1.54	2.77
2" x 12" (2.20 BF per LF)	B1@.057	LF	1.63	1.91	3.54
4" x 6" (2.20 BF per LF)	B1@.057	LF	2.14	1.91	4.05
4" x 8" (2.93 BF per LF)	B1@.073	LF	2.85	2.44	5.29
4" x 10" (3.67 BF per LF)	B1@.094	LF	3.58	3.14	6.72
4" x 12" (4.40 BF per LF)	B1@.112	LF	4.29	3.75	8.04

NCE Figure 9-13 Beam cost from the NCE.

The price in the NCE is for 4 × 10-inch beams. The beams are constructed of two 1¾-inch LVL beams, so the 48' quantity in the materials section is divided in half for a labor quantity of 24' of LVL beams installed.

Post Base and Post Caps

The Framing Connectors section of the National Construction Estimator will be used to determine the cost of the porch post base and the porch post caps. NCE Figure 9-14 shows an example of the applicable post base subsection.

Post base (AB), adjustable, 16 gauge, galvanized					
4" x 4" (AB44B)	BC@.046	Ea	8.23	1.70	9.93
4" x 6" (AB46)	BC@.046	Ea	15.80	1.70	17.50
6" x 6" (AB66)	BC@.070	Ea	18.60	2.59	21.19
Add for rough lumber sizes	—	%	40.0	—	—

NCE Figure 9-14 Post base subsection.

NCE Figure 9-15 shows the applicable post cap subsection.

	Craft@Hrs	Unit	Material	Labor	Total
Post cap and base combination (BC), 18 gauge, galvanized					
4" x 4" (BC4)	BC@.037	Ea	3.86	1.37	5.23
4" x 6" (BC46)	BC@.037	Ea	10.90	1.37	12.27
6" x 6" (BC6)	BC@.054	Ea	12.60	1.99	14.59
8" x 8" (BC8)	BC@.054	Ea	41.20	1.99	43.19

NCE Figure 9-15 Post cap subsection.

Stair Framing Labor

The National Construction Estimator will be used to price the labor cost on framing the stairway landing. Four categories will be estimated.

Job-Built Stairway

NCE Figure 9-16 shows the job-built section of the National Construction Estimator. Different styles of stairs are priced as a unit of each. The description identifies this unit as per stair riser. The “L” of “U” shaped style with the OSB option will be used in this instance.

	Craft@Hrs	Unit	Material	Labor	Total
Job-built stairways 3 stringers cut from 2" x 12" Douglas fir material, treads and risers from 3/4" CDX plywood or OSB sheathing. Cost per 7-1/2" rise, 36" wide					
Using 2" Douglas fir, per MBF	—	MBF	771.00	—	771.00
Using 3/4" CDX plywood, per MSF	—	MSF	763.00	—	763.00
Using 3/4" OSB sheathing, per MSF	—	MSF	693.00	—	693.00
Using 1" x 6" white pine, per MBF	—	MBF	1,980.00	—	1,980.00
Straight run, 8'0" to 10'0" rise, plywood, per riser	B1@.530	Ea	13.60	17.70	31.30
Straight run, 8'0" to 10'0" rise, OSB, per riser	B1@.530	Ea	13.00	17.70	30.70
"L"- or "U"-shape, plywood, add for landings	B1@.625	Ea	15.20	20.90	36.10
"L"- or "U"-shape, per riser, OSB, add for landings	B1@.625	Ea	14.60	20.90	35.50
Semi-circular, repetitive work, plywood, per riser	B1@.795	Ea	15.20	26.60	41.80
Semi-circular, repetitive work, OSB, per riser	B1@.795	Ea	14.60	26.60	41.20
Landings, from 2" x 6" Douglas fir and 3/4" CDX plywood or 3/4" OSB, surfaced,					
per SF of landing surface, plywood	B1@.270	SF	3.10	9.03	12.13
per SF of landing surface, OSB	B1@.270	SF	2.98	9.03	12.01

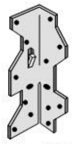
NCE Figure 9-16 Job-built stairways section of the NCE.

Stair Landings

Stair landings are priced per square foot of landing area. Previously, the landing was calculated at three feet wide by four feet long for a total of 12 square feet.

Landing Hangers

NCE Figure 9-17 shows a composite view of two subsections of the Framing Connectors section of the NCE. Two types of framing connectors are to be installed in the stair landing. Four 2 × 0 U-type joist hangers and four 9-inch L-type connectors.



Framing Connectors All bolted connectors include nuts, bolts, and washers as needed. Costs are based on bulk purchases. Add 20% for smaller quantities.					
Equivalent Simpson Strong-Tie Co. model numbers are shown in parentheses.					
Angle clips (A34 and A35), 18 gauge, galvanized, no nails included					
3" x 5" connector (A35 or A35F)	BC@.030	Ea	.48	1.11	1.59
3" x 4" connector (A34)	BC@.030	Ea	.43	1.11	1.54
Angle clips ("L") for general utility use, 16 gauge, galvanized, no nails included					
3" (L30)	BC@.027	Ea	.98	1.00	1.98
5" (L50)	BC@.027	Ea	1.77	1.00	2.77
7" (L70)	BC@.027	Ea	1.78	1.00	2.78
9" (L90)	BC@.027	Ea	2.20	1.00	3.20
Brick wall ties (BTR), 22 gauge, per 1,000					
"U"-type or formed seat type hangers ("U"). Standard duty, 16 gauge, galvanized					
2" x 4" (U24)	BC@.040	Ea	1.67	1.48	3.15
2" x 6" (U26)	BC@.046	Ea	1.80	1.70	3.50
2" x 10" (U210)	BC@.046	Ea	2.62	1.70	4.32
2" x 14" (U214)	BC@.052	Ea	6.26	1.92	8.18
3" x 4" (U34)	BC@.046	Ea	3.90	1.70	5.60
3" x 6" (U36)	BC@.046	Ea	3.55	1.70	5.25

NCE Figure 9-17 Composite view of the angle clips and U-type framing connectors in the NCE.

Estimating the Truss Framing Labor

The truss framing labor cost will be determined by using prices from the National Construction Estimator. NCE Figure 9-18 shows an example of the roof trusses subsection.

Carpentry, Detailed Breakdown

	Craft@Hrs	Unit	Material	Labor	Total
Roof trusses 24" OC, any slope from 3 in 12 to 12 in 12, total height not to exceed 12' high from bottom chord to highest point on truss. Prices for trusses over 12' high will be up to 100% higher. Square foot (SF) costs, where shown, are per square foot of area to be covered.					
Scissor truss					
2" x 4" top and bottom chords					
Up to 38' span	B1@.022	SF	3.09	.74	3.83
40' to 50' span	B1@.028	SF	3.86	.94	4.80
Fink truss "W" (conventional roof truss) 2" x 4" top and bottom chords					
Up to 38' span	B1@.017	SF	2.68	.57	3.25
40' to 50' span	B1@.022	SF	3.24	.74	3.98
2" x 6" top and bottom chords					
Up to 38' span	B1@.020	SF	3.32	.67	3.99
40' to 50' span	B1@.026	SF	3.99	.87	4.86
Truss with gable fill at 16"					
OC 28' span, 5 in 12	B1@.958	Ea	223.00	32.00	255.00
32' span, 5 in 12 slope	B1@1.26	Ea	274.00	42.10	316.10
40' span, 5 in 12 slope	B1@1.73	Ea	386.00	57.90	443.90

NCE Figure 9-18 National construction estimator roof truss subsection.

Just as is the case with the truss framing material section, there are three basic truss labor options, including scissor truss, Fink "W" (conventional roof truss), and truss with gable fill. The procedure for estimating the labor costs of truss installation will be as follows:

- Any standard style of trusses will be estimated using the Fink truss “W” (conventional roof truss) option. The price is estimated using a square foot cost based upon the square footage of the flat roof area, including roof overhangs.
- Any modified ceiling truss will be estimated using the “scissor truss” option. The price is estimated using a square foot cost based upon the square footage of the flat roof area, including overhangs.
- Any specialty type truss will be estimated using the “truss with gable infill” option. The trusses are estimated and priced per individual truss. These individual trusses are located within the square footage space of the standard and scissor truss areas. The specialty trusses are an addition to the square foot cost of the standard and scissor truss styles. In addition, the specific count of these specialty trusses is obtained using the following guidelines:
- Gable end and special gable end trusses are counted as one each.
- Trusses ganged together such as double girder trusses are counted as two trusses or more depending upon the number of trusses ganged together.
- Hip trusses, or girder hip trusses are counted as one each for each hip or hip girder truss.
- Groups of smaller trusses such as those attached to a hip, or hip girder truss, are counted together as one specialty truss.
- Groups of smaller trusses such as a group of jack or valley trusses are counted as a single truss.

Truss Roof Framing Labor

Truss roof framing labor includes estimating labor for truss installation, roof sheathing, fascia, soffit, and framing connectors. The labor cost for truss roof framing can be taken from the National Construction Estimator.

Truss Roof Framing Labor

The Roof Truss category in the Detailed Breakdown subsection of the Residential section of the National Construction Estimator was previously shown in NCE Figure 9-18. Truss installation labor was broken down into three truss types: the Fink truss “W” (conventional roof truss), the scissor truss, and the truss with gable infill. The individual truss areas for each truss type and the count of the specialty truss was placed in the header of the truss subsection. The same information will be used in estimating the truss labor cost. The craft hours, unit, and unit cost can be found in the National Construction Estimator.

Roof Sheathing Labor

NCE Figure 9-19 shows the “Sheathing, roof” subsection of the National Construction Estimator. The sheathing is priced per square foot of roof sheathing area.

Sheathing, roof Per SF of roof surface including 10% waste					
CDX plywood sheathing, rough					
1/2"	B1@.013	SF	.56	.43	.99
1/2", 4-ply	B1@.013	SF	.70	.43	1.13
3/4"	B1@.013	SF	.84	.43	1.27
OSB sheathing					
7/16"	B1@.013	SF	.50	.43	.93
1/2"	B1@.013	SF	.67	.43	1.10
5/8"	B1@.013	SF	.69	.43	1.12
3/4"	B1@.014	SF	.76	.47	1.23

NCE Figure 9-19 The roof sheathing subsection of the NCE.

Install Fascia Labor

NCE Figure 9-20 shows the fascia subsection of the National Construction Estimator. The “Hem-fir, S4S, dry, Std and Btr” 2 × 6 per LF option is highlighted. The 2 × 6 option is selected because it is the closest option to the 2 × 4 fascia installed in this project.

	Craft@Hrs	Unit	Material	Labor	Total
Fascia Material column includes 10% waste					
White Wood, #3 & Btr					
1" x 4", per MBF	—	MBF	2,180.00	—	2,180.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1" x 8", per LF	[illegible]	LF	1.74	[illegible]	[illegible]
Hem-fir, S4S, dry, Std and Btr					
2" x 6", per MBF	—	MBF	422.00	—	422.00
2" x 8", per MBF	—	MBF	553.00	—	553.00
2" x 10", per MBF	—	MBF	662.00	—	662.00
2" x 6", per LF	B1@.044	LF	.46	1.47	1.93
2" x 8", per LF	B1@.051	LF	.81	1.71	2.52
2" x 10", per LF	B1@.051	LF	1.21	1.71	2.92

NCE Figure 9-20 Fascia category of the National Construction Estimator.

The fascia is priced per lineal foot.

Install Gable End Soffits

The gable end soffit labor will be taken from the “Ceiling joists and soffits” category of the detailed breakdown subsection of the residential section of the National Construction Estimator. NCE Figure 9-21 shows the 24-inch centers option highlighted.

Ceiling joists and soffits Per SF of area covered. Figures in parentheses indicate board feet per square foot of ceiling including end joists, header joists, and 5% waste. No beams, bridging, blocking, or ledger strips included. Deduct for openings over 25 SF. Costs shown are based on a job with 1,000 SF of area covered. For scheduling purposes, estimate that a two-man crew can complete 650 SF of area per 8-hour day for 12" center to center framing; 800 SF for 16" OC; 950 SF for 20" OC; or 1,100 SF for 24" OC.

	Craft@Hrs	Unit	Material	Labor	Total
2" x 4", Std & Btr grade					
2" x 4" ceiling joists, per MBF	—	MBF	652.00	—	652.00
12" centers (.78 BF per SF)	B1@.026	SF	.51	.87	1.38
16" centers (.59 BF per SF)	B1@.020	SF	.38	.67	1.05
20" centers (.48 BF per SF)	B1@.016	SF	.31	.54	.85
24" centers (.42 BF per SF)	B1@.014	SF	.27	.47	.74

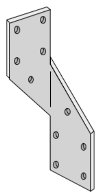
NCE Figure 9-21 Ceiling joist and Soffits category of the National Construction Estimator.

The soffits are priced per square foot of soffit area. The soffit area is the area of the overhang of the roof edge formed from the sub-fascia and barge rafters, shown in Figure 9-116. The combined length of the sub-fascia and barge rafters is equal to the lineal feet of roof edge calculated in the Basic Takeoffs. The width of the soffit can be taken from a building section detail, such as Figure 9-147, which shows the overhang as 12 inches. The square footage of soffit area will be equal to

$$186 \text{ ft} \times 1 \text{ ft} = 186 \text{ ft}^2$$

Estimating Truss Hanger, Hurricane Anchors, and Strap Ties

The truss hangers, hurricane anchors, and strap tie labor will be estimated using the “Framing Connector” category of the Residential section of the National Construction Estimator. The labor cost is priced individually for each item based upon quantities determined when calculating material cost. NCE Figure 9-22 shows an example of the hurricane and seismic ties option with the H2.5 tie highlighted. The labor cost is priced at $1.00 for each hurricane tie.



Framing Connectors

	Craft@Hrs	Unit	Material	Labor	Total
Hurricane and seismic ties (H)					
H1 tie	BC@.035	Ea	.87	1.29	2.16
H2 tie	BC@.027	Ea	1.31	1.00	2.31
H2.5 tie	BC@.027	Ea	.51	1.00	1.51
H3 tie	BC@.027	Ea	.65	1.00	1.65
H4 tie	BC@.027	Ea	.52	1.00	1.52
H5 tie	BC@.027	Ea	.58	1.00	1.58
H6 tie	BC@.045	Ea	3.96	1.66	5.62
H7 tie	BC@.055	Ea	9.53	2.03	11.56

NCE Figure 9-22 An example of the hurricane and seismic ties option.

If multiple sizes of the same framing anchor type are not needed, use the higher cost for all items of that type.

Exterior Finishes Materials Estimates

This document is a detailed breakdown of how to estimate the many different materials used in the Exterior Finishes Phase of construction projects

Table of Contents

Roofing Materials Header

The square footage of flat roof area, the lineal footage of roof edge, and the lineal footage of roof ridge line will be brought forward from the basic takeoffs in order to determine quantity. Below is more information that you will need to know to successfully estimate roof materials.

LF Starter Course

The starter course is placed along each horizontal roof edge as the starter course for the shingles. House Plan 10-1 shows a view of the roof plan from the building drawings. Each horizontal roof edge is calculated around the perimeter of the roof starting in the top left-hand corner and moving towards the right. Odd size dimensions can be rounded up or down to the nearest quarter foot.

58' + 21'+ 10' 8"+ 6'+ 6'+ 15'= 116'8"

LF Ice and Water Shield

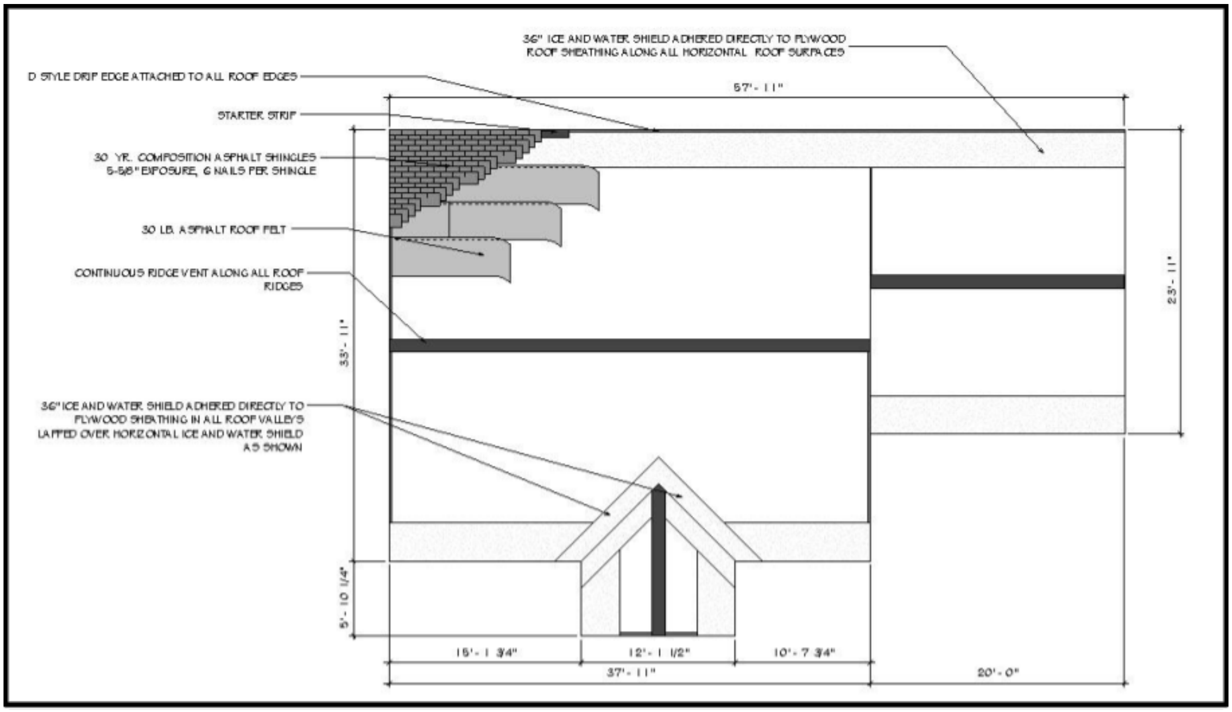
Ice and water shield will be installed both along the edges of the roof and in the valleys as valley flashing. This length of 116.67 feet from the header section will also be used for ice and water shield. In addition, the valley will have an ice and water shield.

The roof plan shows two valleys at the front of the roof where there is a front porch. The length of the valley can be determined by using the following Roof Valley Multiplier factor in the header section. To use this, multiply the run of the roof by the factor to determine the valley length. Roof plan shows the width of the front porch as 12'1½". The length of the run will be half of the porch roof width or 12'1½" / 2 = 6'¾". Entering the roof slope of 6" per foot will display a value of 1.5 as the value in the Roof Valley Multiplier cell. Multiplying the run length by the multiplier will result in the following:

6'¾" × 1.5 = 9'1-1/8"

The width of the valley flashing is usually added to the calculated valley length to account for the angle cuts and overlap on the valley flashing. The ice and water shield is three feet wide, therefore, the length of ice and water shield used for flashing in each valley will be

9' 1-1/8" + 3' = 12' 1-1/8"

3. 

Plan Figure STYLEREF 1 \s 10 SEQ Plan_Figure * ARABIC \s 1 1: Roof plan view of residential project.

There are two valleys on the roof, so this quantity will be multiplied by two, which would result in the following quantity rounded up to the nearest quarter foot:

$$2 \times 12' \text{ } 1\text{-}1/8" = 24' \text{ } 2 \text{ } ¼"$$

or

$$24.25'$$

The total for the ice and water shield would be

$$116.67' + 24.25' = 140.92'$$

or

$$141'$$

This quantity will be entered in the header section.

Roof Slope

The roof slopes at a ratio of six inches of vertical rise for every 12 inches of horizontal length.

Roofing Materials Section

Roofing Felt

Identify the correct roof felt material for your project. The roof plan identifies the roof felt as 30# felt for this project.

Rolls of traditional roofing 30 lb. felt is usually identified as containing two squares even though the roll actually contains 212 square feet, but it will only cover 200 square feet with the standard overlap. Rolls of 15 pound felt contain 425 square feet and will cover 400 square feet of roof area.

Synthetic roof felt is usually sold in rolls identified by the width and length, such as 4 feet wide by 250 feet long. Standard lapping width might be 3-6 inches. Synthetic felt with 1,000 square feet will only cover 937.5 square feet of roof area with a 3-inch lap distance, and 875 square feet with a 6-inch lap distance. In addition, the felt may or may not be placed on top of the ice and water shield, or the ice and water shield may be used as the first low of felt as shown in Figures 10-2 and 10-19.

Shingles

The correct shingle material for your project will need to be determined.

Starter Course

Identify the correct starter course material for your project.

Ridge Cap

A slightly modified version of the SFQuantity custom function will be used to calculate the quantity of ridge cap needed. The LF Ridgeline input in the header section will be used to determine the quantity of ridge cap shingles needed. The correct Ridge Cap material information is placed in the Materials, Size, Units, and Unit Cost cells using the materials userform. The basic SFQuantity custom function will be entered into the quantity cell as follows:

SFQuantity (E22, F11, B22, F22)

A slight modification of the function will be added to change the lineal foot input from the LF Ridgeline input in the header section. The modification is done by multiplying the LF of Ridgeline by the width of the ridgeline. The width of the ridge shingles is commonly one foot, so the length of the ridgeline will be multiplied by one foot. The modified formula is shown as follows:

SFQuantity (E22, F11* 1, B22, F22)

The modified formula entered into the spreadsheet is shown in Excel Figure 10-7.

	A	B	C	D	E	F	G	H	I	J	K
6					Roofing Materials				Cost Code		
7			Roof Slope Length Multiplier	1.12							
8			Roof Valley Multiplier	1.5							
9					SF of Flat Roof Area	1847.50					
10					LF Roof Edge	230.50					
11					LF Ridgeline	71.00					
12					LF Started Course	116.67					
13					LF Ice and Water Shield	141.00					
14					Roof Slope (In per Ft)	6					
15					SF of Sloped Roof Area	2065.57					
16											
17	Supplier	Wst	Item Description	Materials		Size	Units	Unit Cost	Quantity	Override	Total
18				Roofing Materials							
19	BMC(REX)	10%	Roofing Felt	30# ROOF FELT UNDERLAYMENT		200	SF	$ 21.93	10		$ 219.30
20	BMC(REX)	10%	Shingles	30 Year Timberline (arch) 1 - Bundle		33.3	SF	$ 28.50	69		$ 1,966.50
21	BMC(REX)	5%	Starter Course	Starter Course		100	LF	$ 28.26	2		$ 56.52
22	BMC(REX)	5%	Ridge Cap	Hip & Ridge Timberline		33.3	SF	=SFQuantity(E22,F11 * 1,B22,F22)			$ 44.25

Excel Figure 10-7 Modified ridge cap function entered into the spreadsheet.

Roofing Nails

Several types of roofing nails will be needed to install the roofing. The most common are cap nails for the roofing felt and roofing nails for the shingles. Cap nails are used to anchor the roofing felt to the sheathing. The cap nails are commonly spaced at six to eight inch intervals along both edges and the center of the felt. Based upon an eight inch spacing each cap nails are calculated to cover 0.67 square footage of felt per nail. Based upon a six inch spacing each nail will cover 0.5 square footage of felt per nail. The Materials, Size, Units, and Unit Cost for the correct nail will be entered into the spreadsheet using the Materials userform. The formula will be written to take into account a nail spacing of eight inches along each edge and in a single row across the middle and will use a 0.67 factor.

The written formula will be:

SF Sloped Roof Area * (1+ WasteFactor) / 0.67/ Size

Entered into the spreadsheet the formula would be:

= F15 * (1+B23) / 0.67 / F23

	A	B	C	D	E	F	G	H	I	J	K
6					Roofing Materials				Cost Code		
7	Roof Slope Length Multiplier			1.12							
8	Roof Valley Multiplier			1.5							
9					SF of Flat Roof Area	1847.50					
10					LF Roof Edge	230.50					
11					LF Ridgeline	71.00					
12					LF Started Course	116.67					
13					LF Ice and Water Shield	141.00					
14					Roof Slope (In per Ft)	6					
15					SF of Sloped Roof Area	2065.57					
16											
17	Supplier	Wst	Item Description		Materials	Size	Units	Unit Cost	Quantity	Override	Total
18					Roofing Materials						
19	BMC(REX)	10%	Roofing Felt		30# ROOF FELT UNDERLAYMENT	200	SF	$ 21.93	10		$ 219.30
20	BMC(REX)	10%	Shingles		30 Year Timberline (arch) 1 - Bundle	33.3	SF	$ 28.50	69		$ 1,966.50
21	BMC(REX)	5%	Starter Course		Starter Course	100	LF	$ 28.26	2		$ 56.52
22	BMC(REX)	5%	Ridge Cap		Hip & Ridge Timberline	33.3	SF	$ 14.75	3		$ 44.25
23	BMC(REX)		Nails		Cap Nails #12 x 1"	3000	Ea	=F15*(1+B23) /0.67/F23			$ 26.72

Excel Figure 10-8: Cap nails function entered into the spreadsheet.

Roofing nails will be calculated in a similar manner, using nails for a pneumatic roofing nailer. The nails are manufactured in individual coils and package in a box of 7,200 nails. Shingles are attached with either four or six nails per shingle. The quantity of nails can be calculated from the number of shingles purchased. Asphalt shingles are purchased in bundles of 27 shingles for standard size shingles and 21 for metric shingles.

The formula will be written as follows:

Bundles of Shingles * Shingles per Bundle * Nails Per Shingles * Waste Factor / Size

Entered into the spreadsheet the formula would be:

= I20 * 21 * 6 * (1 + B24) / F24

Excel Figure 10-9 shows the formula entered into the spreadsheet. The 10 percent waste factor will be included to account for the nails used to attach the starter strip and hip and ridge shingles. In this case, the quantity will not be rounded up as the leftover nails can be used on future jobs.

	A	B	C	D	E	F	G	H	I	J	K
6					Roofing Materials				Cost Code		
7			Roof Slope Length Multiplier	1.12							
8			Roof Valley Multiplier	1.5							
9					SF of Flat Roof Area	1847.50					
10					LF Roof Edge	230.50					
11					LF Ridgeline	71.00					
12					LF Started Course	116.67					
13					LF Ice and Water Shield	141.00					
14					Roof Slope (In per Ft)	6					
15					SF of Sloped Roof Area	2065.57					
16											
17	Supplier	Wst	Item Description		Materials	Size	Units	Unit Cost	Quantity	Override	Total
18					Roofing Materials						
19	BMC(REX)	10%	Roofing Felt		30# ROOF FELT UNDERLAYMENT	200	SF	$ 21.93	10		$ 219.30
20	BMC(REX)	10%	Shingles		30 Year Timberline (arch) 1 - Bundle	33.3	SF	$ 28.50	69		$ 1,966.50
21	BMC(REX)	5%	Starter Course		Starter Course	100	LF	$ 28.26	2		$ 56.52
22	BMC(REX)	5%	Ridge Cap		Hip & Ridge Timberline	33.3	SF	$ 14.75	3		$ 44.25
23	BMC(REX)		Nails		Cap Nails #12 x 1"	3000	Ea	$ 26.00	1.03		$ 26.72
24	BMC(REX)	10%	Nails		Coiled Roofing Nails (7200 per box)	7200	Ea	=I20* 21 * 6 *(1+B24) / F24			$ 69.57

Excel Figure 10-9: Roofing nail function entered into the spreadsheet.

Ice and Water Shield

The LFQuantity custom function will be used to calculate the quantity of ice and water shield that will be needed based upon the quantity entered into the header section. Entered into the spreadsheet the formula would be:

LFQuantity (E26, F13, B26, F26)

Excel Figure 10-10 shows the completed formula entered into the spreadsheet.

	A	B	C	D	E	F	G	H	I	J	K
6					Roofing Materials				Cost Code		
7			Roof Slope Length Multiplier	1.12							
8			Roof Valley Multiplier	1.5							
9					SF of Flat Roof Area	1847.50					
10					LF Roof Edge	230.50					
11					LF Ridgeline	71.00					
12					LF Started Course	116.67					
13					LF Ice and Water Shield	141.00					
14					Roof Slope (In per Ft)	6					
15					SF of Sloped Roof Area	2065.57					
16											
17	Supplier	Wst	Item Description		Materials	Size	Units	Unit Cost	Quantity	Override	Total
18					Roofing Materials						
19	BMC(REX)	10%	Roofing Felt		30# ROOF FELT UNDERLAYMENT	200	SF	$ 21.93	10		$ 219.30
20	BMC(REX)	10%	Shingles		30 Year Timberline (arch) 1 - Bundle	33.3	SF	$ 28.50	69		$ 1,966.50
21	BMC(REX)	5%	Starter Course		Starter Course	100	LF	$ 28.26	2		$ 56.52
22	BMC(REX)	5%	Ridge Cap		Hip & Ridge Timberline	33.3	SF	$ 14.75	3		$ 44.25
23	BMC(REX)		Nails		Cap Nails #12 x 1"	3000	Ea	$ 26.00	1.03		$ 26.72
24	BMC(REX)	10%	Nails		Coiled Roofing Nails (7200 per box)	7200	Ea	$ 52.38	1.33		$ 69.57
25					Roof Flashing						
26	BMC(REX)	5%	Ice & Water Shield		ICE SHIELD 3' X 54'	54	LF	=LFQuantity(E26,F13,B26,F26)			$ 210.00

Excel Figure 10-10: Ice and water shield formula entered into the spreadsheet.

Drip Edge

The correct drip edge material information is placed in the Materials, Size, Units, and Unit Cost cells using the materials userform. The basic LFQuantity custom function will be entered into the Quantity cell to calculate the amount of drip edge based upon the LF Roof Edge from the header section. The formula would be

LFQuantity (E27, F10, B27, F27)

Excel Figure 11-11 shows the completed formula entered into the spreadsheet.

	A	B	C	D	E	F	G	H	I	J	K
9					SF of Flat Roof Area	1847.50					
10					LF Roof Edge	230.50					
11					LF Ridgeline	71.00					
12					LF Started Course	116.67					
13					LF Ice and Water Shield	141.00					
14					Roof Slope (In per Ft)	6					
15					SF of Sloped Roof Area	2065.57					
16											
17	Supplier	Wst	Item Description		Materials	Size	Units	Unit Cost	Quantity	Override	Total
18					Roofing Materials						
19	BMC(REX)	10%	Roofing Felt		30# ROOF FELT UNDERLAYMENT	200	SF	$ 21.93	10		$ 219.30
20	BMC(REX)	10%	Shingles		30 Year Timberline (arch) 1 - Bundle	33.3	SF	$ 28.50	69		$ 1,966.50
21	BMC(REX)	5%	Starter Course		Starter Course	100	LF	$ 28.26	2		$ 56.52
22	BMC(REX)	5%	Ridge Cap		Hip & Ridge Timberline	33.3	SF	$ 14.75	3		$ 44.25
23	BMC(REX)		Nails		Cap Nails #12 x 1"	3000	Ea	$ 26.00	1.03		$ 26.72
24	BMC(REX)	10%	Nails		Coiled Roofing Nails (7200 per box)	7200	Ea	$ 52.38	1.33		$ 69.57
25					Roof Flashing						
26	BMC(REX)	5%	Ice & Water Shield		ICE SHIELD 3' X 54'	54	LF	$ 70.00	3		$ 210.00
27	BMC(REX)		Drip Edge		STYLE D DRIP EDGE	10	LF	=LFQuantity(E27,F10,B27,F27)			$ 99.12

Excel Figure 10-11: Drip edge formula entered into the spreadsheet.

Roof Vents

A continuous ridge vent material will be used along the top ridge of the roof. The LFQuantity custom function will be used to calculate the quantity needed, based upon the information placed in the header section. If individual turtle style vent is used, then the quantity needed would be a count and list item. The correct ridge vent material information is placed in the Materials, Size, Units, and Unit Cost cells using the materials userform. The formula would be:

LFQuantity (E28, F11, B28, F28)

Excel Figure 10-12 shows the completed formula entered into the spreadsheet.

	A	B	C	D	E	F	G	H	I	J	K
9					SF of Flat Roof Area	1847.50					
10					LF Roof Edge	230.50					
11					LF Ridgeline	71.00					
12					LF Started Course	116.67					
13					LF Ice and Water Shield	141.00					
14					Roof Slope (In per Ft)	6					
15					SF of Sloped Roof Area	2065.57					
16											
17	Supplier	Wst	Item Description		Materials	Size	Units	Unit Cost	Quantity	Override	Total
18					Roofing Materials						
19	BMC(REX)	10%	Roofing Felt		30# ROOF FELT UNDERLAYMENT	200	SF	$ 21.93	10		$ 219.30
20	BMC(REX)	10%	Shingles		30 Year Timberline (arch) 1 - Bundle	33.3	SF	$ 28.50	69		$ 1,966.50
21	BMC(REX)	5%	Starter Course		Starter Course	100	LF	$ 28.26	2		$ 56.52
22	BMC(REX)	5%	Ridge Cap		Hip & Ridge Timberline	33.3	SF	$ 14.75	3		$ 44.25
23	BMC(REX)		Nails		Cap Nails #12 x 1"	3000	Ea	$ 26.00	1.03		$ 26.72
24	BMC(REX)	10%	Nails		Coiled Roofing Nails (7200 per box)	7200	Ea	$ 52.38	1.33		$ 69.57
25					Roof Flashing						
26	BMC(REX)	5%	Ice & Water Shield		ICE SHIELD 3' X 54'	54	LF	$ 70.00	3		$ 210.00
27	BMC(REX)		Drip Edge		STYLE D DRIP EDGE	10	LF	$ 4.13	24		$ 99.12
28	BMC(REX)		Roof Vents		Ridge Vent	20	FT	=LFQuantity(E28,F11,B28,F28)			$ 158.92

Excel Figure 10-12: Roof vent formula entered into the spreadsheet.

Valley Flashing

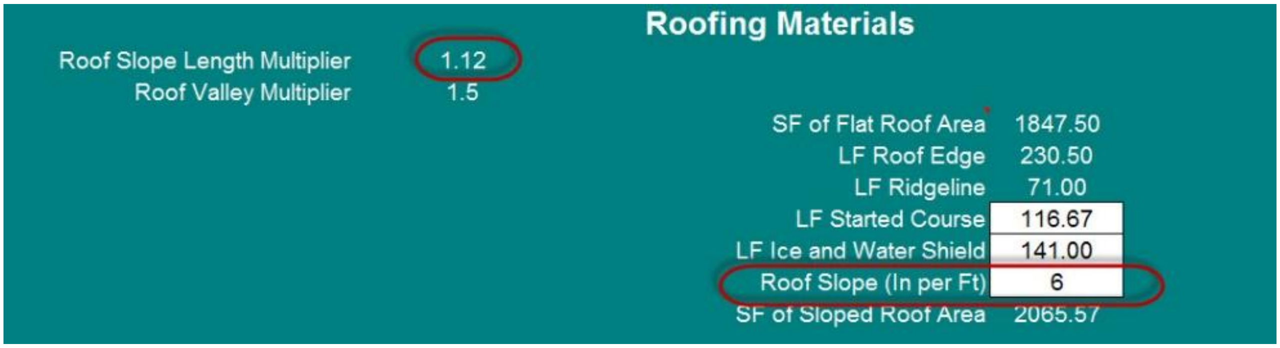
The valley flashing was calculated with the ice and water shield. No additional material will be needed, and the cells are left blank.

Chimney Flashing

There is no chimney on the project, and no chimney flashing will be needed. The cells are left blank.

Step Flashing

The step flashing quantity will be manually inputted. The total will be calculated by using the sloped roof length divided by the lap length of each flashing. Excel Figure 10-13 shows the Roof Slope Length Multiplier value, which is displayed in the header section of the roofing subsection. The multiplier is determined by the Roof Slope (In per ft.) variable. Changing the variable will change the multiplier. The six-twelve slope of the roof shows a slope length multiplier of 1.12.



Excel Figure 10-13: Roof slope multiplier.

The slope length of the roof is calculated by multiplying the run of the roof by the slope multiplier. Figure 10-38 shows the span of the garage roof as 24 feet. The run of the garage roof would be calculated as half of the length of the span or 12 feet.

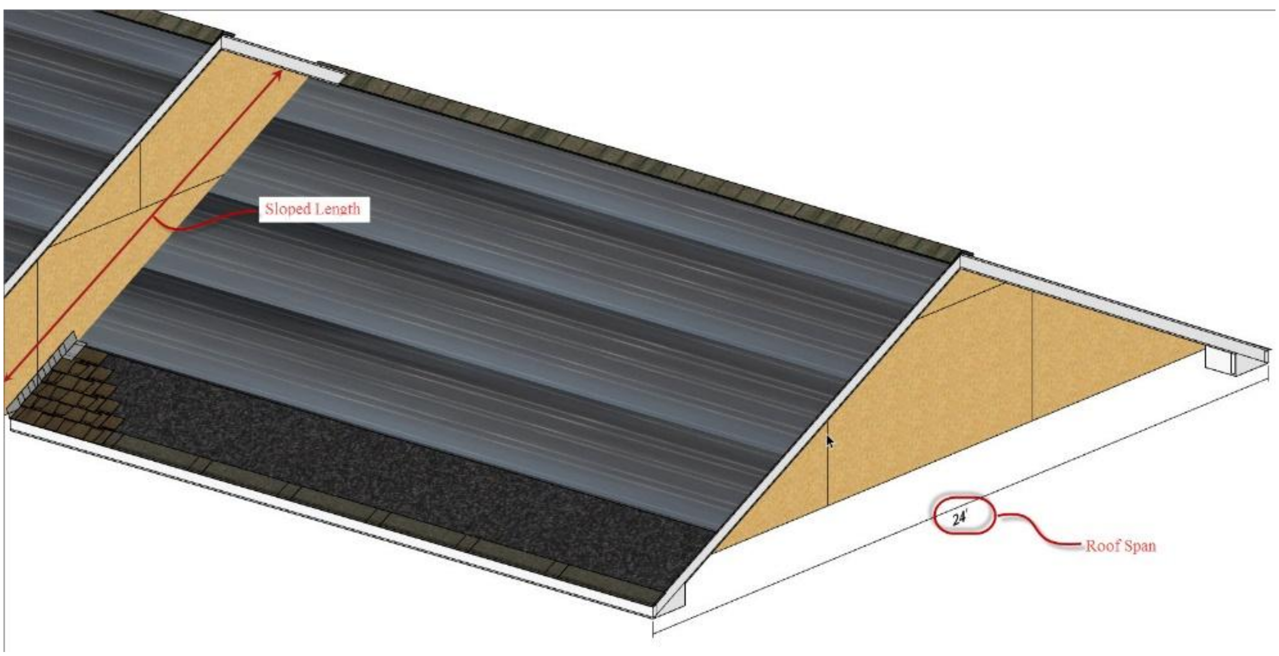


Figure 10-38: Roof slope length.

The sloped length would be as follows:

$$12 \text{ ft. x } 1.12 = 13.44 \text{ ft.}$$

Figure 10-39 shows the lap length for the step flashing based upon the 5 5/8 inches exposure length of a metric sized shingles. The step flashing will have the same exposure amount.

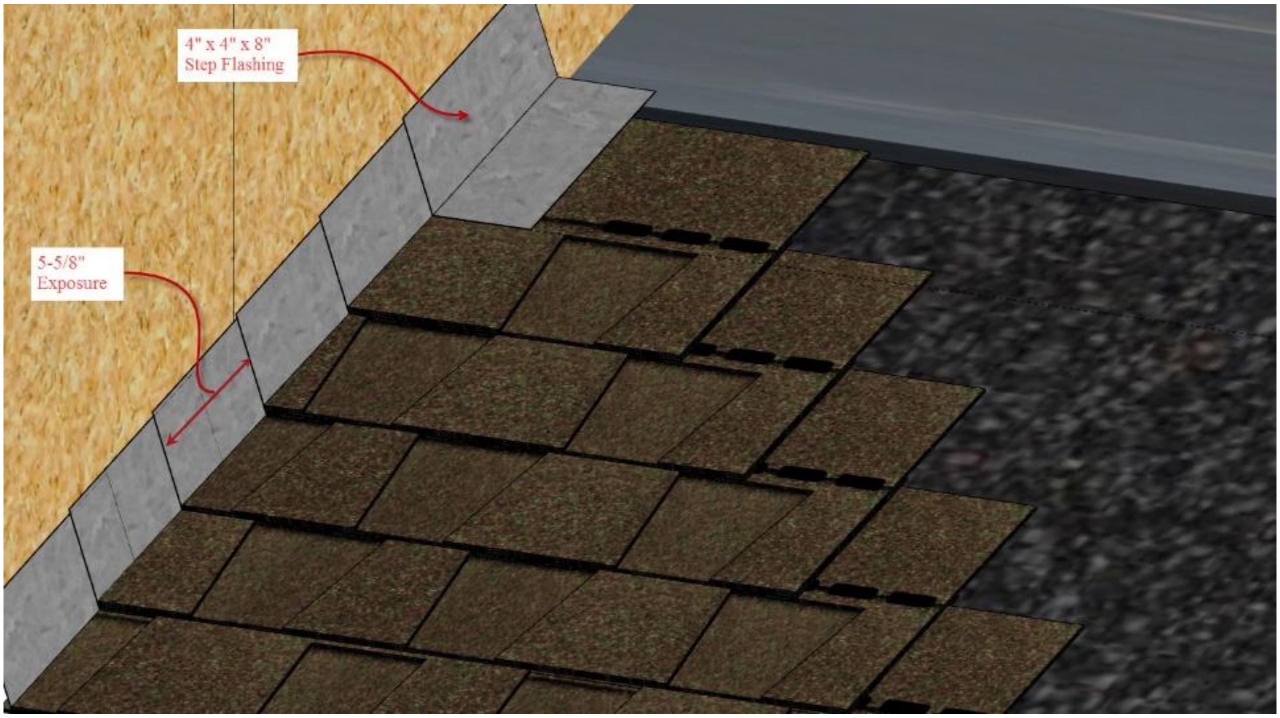


Figure 10-39: Step Flashing lap length.

Calculating the number of step flashing pieces is done by dividing the slope roof length of 13.44 feet by the exposure length of 5 5/8 inches. The 5 5/8 inches will also need to be converted to feet by dividing by 12. The equations for doing this is as follows:

Or

This number would be rounded up to 27 pieces and entered into the spreadsheet (Excel Figure 10-14).

25	Roof Flashing									
26	BMC(REX)	5%	Ice & Water Shield	ICE SHIELD 3' X 54'	54	LF	$ 70.00	3		$ 210.00
27	BMC(REX)		Drip Edge	STYLE D DRIP EDGE	10	LF	$ 4.13	24		$ 99.12
28	BMC(REX)		Roof Vents	Ridge Vent	20	FT	$ 39.73	4		$ 158.92
29	BMC(REX)		Valley Flashing							$ -
30	BMC(REX)		Chimney Flashing							$ -
31	BMC(REX)		Step Flashing	4" x 4' x 8" STEP FLASHING	1	Ea	$ 1.12	27		$ 30.24

Excel Figure 10-14: Step flashing quantity.

Plumbing Vent Flashing

The number and size of plumbing vents flashing needed for residential construction depends heavily upon the location and size of the fixtures and is subject to some fine-tuning by the plumber. The building code does require at least one outside vent, and each plumbing trap is required to be vented; however, there are a number of ways to accomplish the task. Each plumbing fixture could have its own individual outside vent, but this can be costly and can increase the chance of roof leaks as the number of roof penetrations increase. Figure 10-31 shows a single plumbing vent and Figure 10-33 shows four separate roof vents. Typically, vents for fixtures located close to each other, such as in a bathroom, are combined together so that there is a single roof penetration for the vent. Fixtures farther away may require their own roof vent. For example, in the sample plan the bathroom and kitchen are close together and could likely share a single vent, whereas, the laundry room is some distance away and may need its own roof vent. Based upon that assumption, two plumbing vent flashings will be estimated: flashing for a three-inch vent pipe and one for a two-inch vent pipe. These will be manually entered into the spreadsheet.

Vinyl Siding Materials Estimating (Detailed)

This document provides a detailed overview of the process for estimating materials in the Vinyl Siding Section of the ExtFin tab of the Estimating workbook.

Table of Contents

Vinyl Siding Estimating Overview

Often, residential house plans do not have extensive information about the specific details for installing vinyl siding, siding trim, and flashing. The construction estimator will need to understand the specifics about each project. Some information can be obtained from the plans, but other details may be left up to the siding installer or to some established company standard. For this activity, the following methods for installing vinyl siding will apply:

- The square footage of siding for rectangular walls will be calculated using the wall area with an added 10% waste factor.
- Windows, doors, and other openings less than 25 square feet in size will be ignored.
- Windows, doors, and other openings 25 square feet or greater will be subtracted from the total wall area.
- Gable ends and other triangular shaped areas will be calculated using a 30% waste factor.
- The intersection between the top of the wall and the soffit will be trimmed using vinyl J channel.
- J channel installed horizontally will include utility trim to anchor the siding in place.
- J channel installed at an angle will only use J channel without utility trim.
- The windows will be trimmed with a separate decorative three-inch-wide window J channel style of trim.
- J channel will be installed around the trim of all exterior doors.
- Utility trim will be installed along the horizontal top and bottom edges of each window inside of the three-inch-wide decorative trim. Utility trim will not be installed along the vertical edges of the windows.
- Utility trim will be installed along the horizontal top edge of each door inside of the J channel. Utility trim will not be installed along the vertical edges of the doors.

Square Footage of House Wrap

The house wrap is calculated by determining the length of the exterior walls covered by the house wrap including the area of the gable ends. The lengths of the exterior walls and the garage walls can be taken from the Basic Takeoffs. The house wrap covers the wall and the floor joist space down to the top of the foundation. For standard 8-foot-high exterior walls with a 12-inch-thick floor framing system this would typically be around 9 feet. House wrap is typically sold in standard rolls 9 feet wide, so 9 feet will be used to calculate the height of the area covered by the house wrap. Figure 10-155 shows the exterior walls portion of the basic takeoffs with the exterior wall and garage wall lengths highlighted.

Exterior Walls		
2x6 Exterior Walls Length	FT	**114**
2x6 Exterior Walls Height	FT	**8**
2x6 Exterior Walls Area	SF	**912**
2x4 Garage Wall Length	FT	**62**
2x4 Garage Wall Height	FT	**9**
2x4 Garage Wall Area	SF	**558**

Figure 10-155 Exterior walls section of the basic takeoffs.

Totaled together, the wall lengths would be

$$114 \text{ ft.} + 62 \text{ ft.} = 176 \text{ ft.}$$

The area of the exterior walls is multiplied by the 9-foot house wrap material size for a total square footage of exterior wall area of

$$176 \text{ ft. x } 9 \text{ ft.} = 1584 \text{ ft.2}$$

The square foot area of the gable ends is also added to the area. Figure 10-156 shows the garage gable end view. The width of the building is dimensioned at 32 feet. The roof run would be half of the building width calculated as

$$32 \text{ ft.} \div 2 = 16 \text{ ft.}$$

The roof has a 6:12 slope and the roof rise would be calculated as

$$6/12 \times 16 \text{ ft.} = 8 \text{ ft.}$$

The square footage of the gable end area is calculated as the area of a triangle.

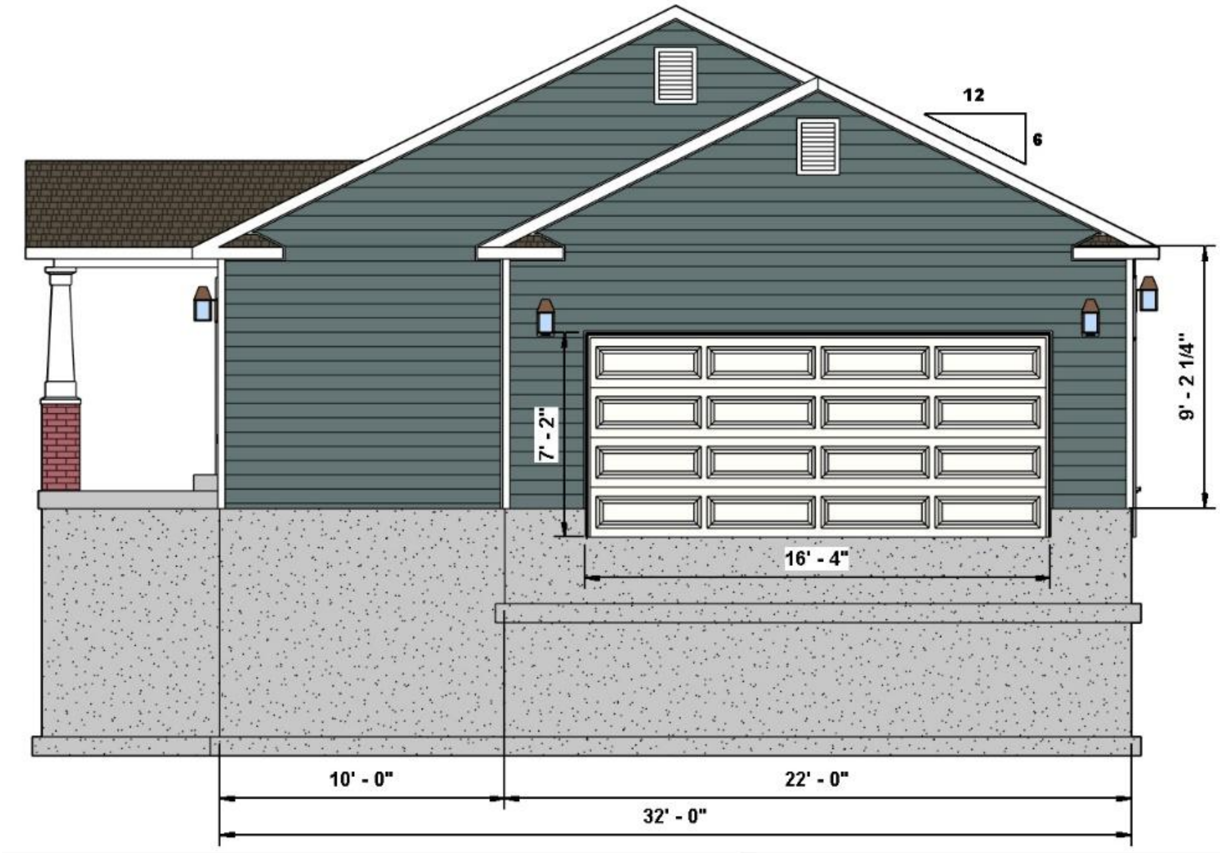


Figure 10-156 Right elevation view showing gable ends.

There are two gable ends shown in this view, however, they are nested within each other and can be estimated as one large gable end as the piece cut from the large gable will fit the smaller gable. The gable end on the other side of the project is also the same size. The total square foot area of house wrap would be calculated as

Wall Area: 1,584 ft.2 + Right End Gable: + 128 ft.2 + Left End Gable: 128 ft.2 = 1,840 ft.2

The area of doors, windows, and other openings are not subtracted from the total as the house wrap is installed over the openings and the house wrap cut out as waste. The total of 1840 square feet is placed in the header section of the estimating template.

Square Footage of Siding

The square footage of siding is calculated by totaling the individual areas of siding. A small wall siding area calculator is provided with the estimating template (Figure 10-157).

Wall Siding Area			
Wall	SF	Waste Factor	Total
			0

Figure 10-157 Wall siding area calculator.

The right elevation view shown in Figure 10-156 can be used to calculate the square footage of siding on that side of the project by calculating the individual areas.

Total Right Side House Area: 202.13 ft.2 + 91.88 ft.2 = 294 ft.2

The area of the garage door is calculated as follows:

16 ft. 4 in. × 7 ft. 2 in. = 117.06 ft.2

This is greater than 25 square feet, so the garage door area is subtracted from the wall area total, and this amount is entered into the wall siding area calculator with a 10 percent waste factor.

294 ft.2 – 117.06 ft.2 = 176.94 ft.2

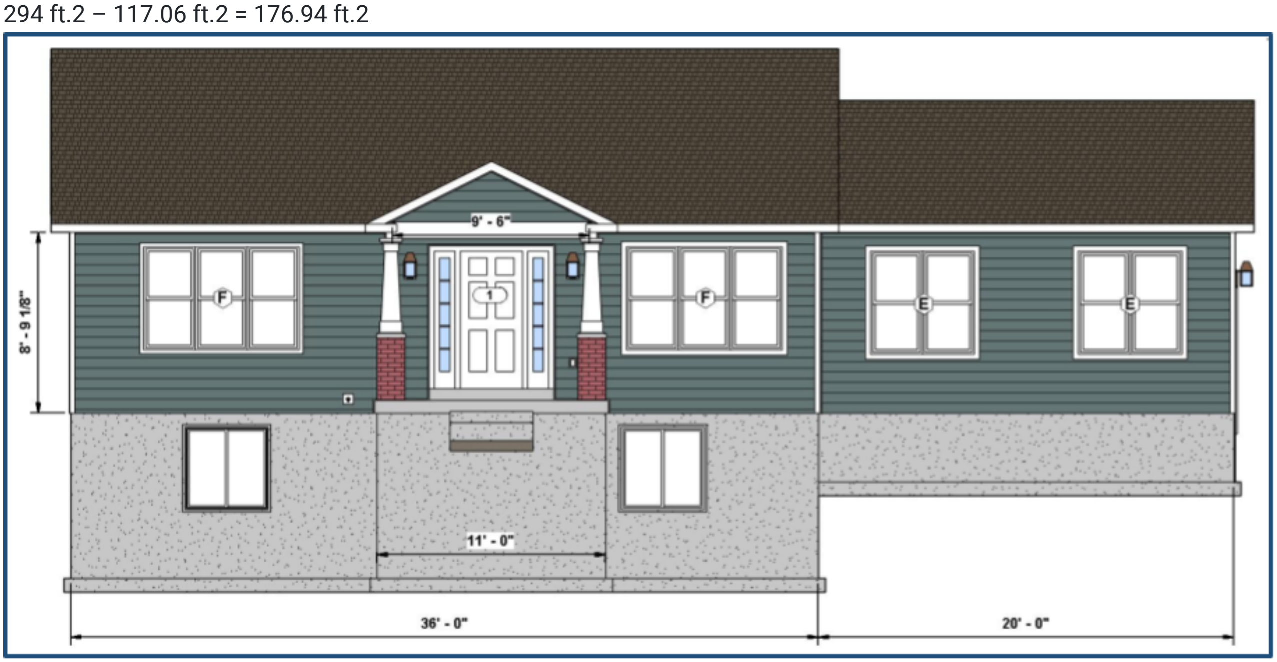


Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 158 Front elevation view.

The right gable end area was previously calculated as follows:

The quantity is also entered into the wall siding area calculator with a 30 percent waste factor.

Figure 10-158 shows the front house elevation. The siding for the front elevation is calculated with the following:

263.13 ft.2 + 175.42 ft.2 = 438.55 ft.2

The window and door sizes can be obtained from the window and door schedules or from the basic takeoffs in the estimating template. Excel Figure 10-21 shows a portion of the basic takeoffs with the applicable cells highlighted.

Main Floor Windows								
Description	Type Mark	Number of Windows	Width (FT)	Height (FT)	Perimeter	Total Perimeter	Area	Total Area
Double Window Unit	B	1	6	5	22	22	30	30
Vinyl Sliding	C	1	3	1	8	8	3	3
Vinyl Dbl Hung Window	D	1	3	3	12	12	9	9
Double Window Unit	E	2	5	5	20	40	25	50
Triple Window Unit	F	2	7.5	5	25	50	37.5	75
Total		7			87	132	104.5	167

Exterior Doors					
Description	Door Number	Width (FT)	Height (FT)	Perimeter (FT)	Area (FT)
Single-Raised Panel with Sidelights	1	5.5	6.7	18.9	36.85
Gladiator Ext 6 Panel	2	3	6.7	16.4	20.1
Gladiator Ext Glass	3	3	6.7	16.4	20.1
Gladiator Ext 6 Panel	4	3	6.7	16.4	20.1
				0	0
Total		14.5		68.1	97.15

Excel Figure 10-21 Basic takeoffs with front windows and doors highlighted.

The windows and doors are subtracted from the total.

2 Windows Type Mark E: 5 ft. 0 in. × 5 ft. 0 in. = 50 ft.2

2 Windows Type Mark F: 7ft. 6 in. × 5 ft. 0 in. = 75 ft.2

1 Door, Door Number 1: 6 ft. 8 in. × 5 ft. 6 in. = 36.852

50 ft.2 + 75 ft.2 + 36.85 ft.2 = 161.85 ft.2

Wall Area – Opening Area: 438.55 ft.2 – 161.85 ft.2 = 276.70 ft.2

This number is entered into the wall area calculator with a 10 percent waste factor. The width dimension of 9 feet, 6 inches, and the known roof slope is used to calculate the gable end area of the front porch, and that quantity is entered into the spreadsheet with a 30 percent waste factor.

Figure 10-159 shows the left elevation view.

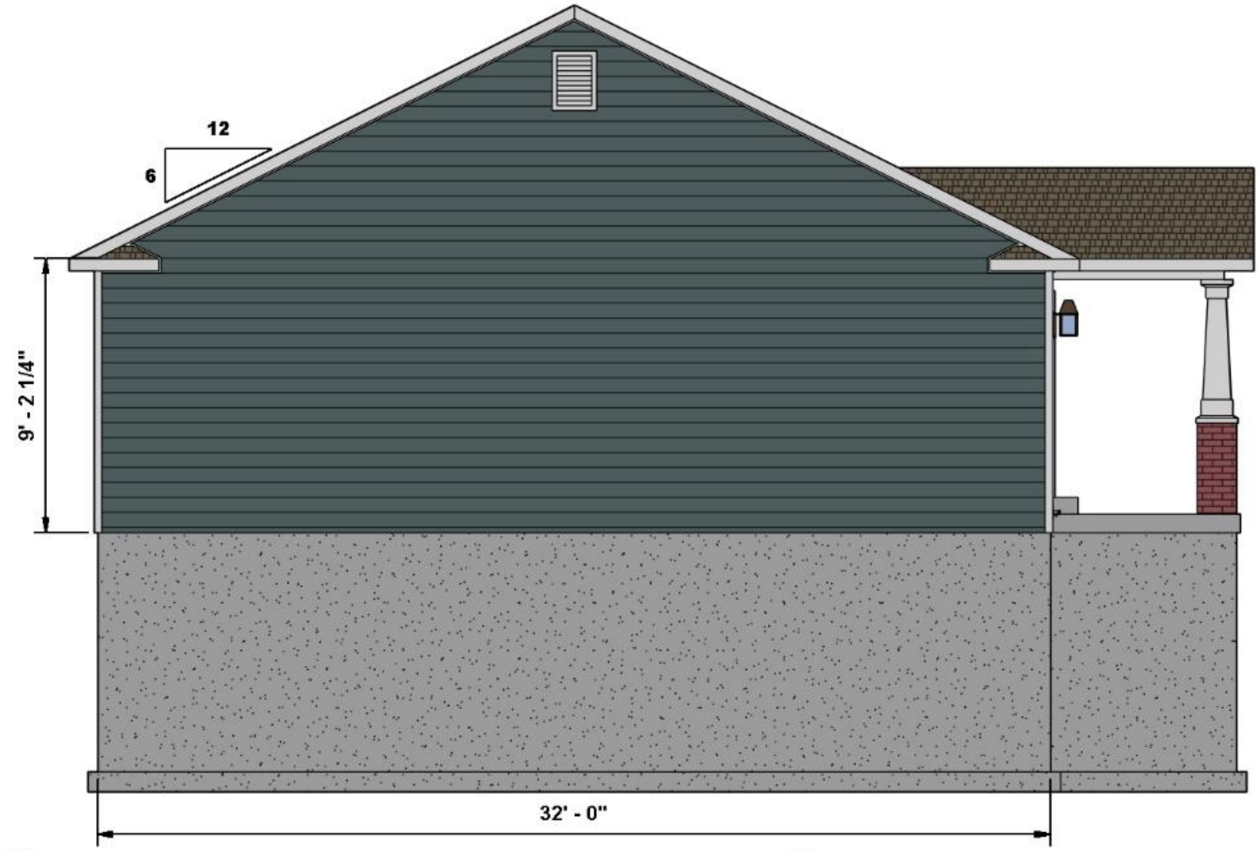


Figure 10-159 Left elevation view.

The building width and wall height is used to calculate the wall area.

Left Wall Area: 32 ft. 0 in. × 9 ft. 2-1/4" in. = 294.67 ft.2

This quantity is entered into the wall siding area calculator with a 10 percent waste factor. The left gable end area is calculated the same as the right gable end area.

Figure 10-160 shows the rear elevation of the house. The area of the rear wall siding is calculated from the dimensions.

Rear Wall Area: 56 ft. 0 in. × 8 ft. 9-1/8 in. = 491.17 ft.2

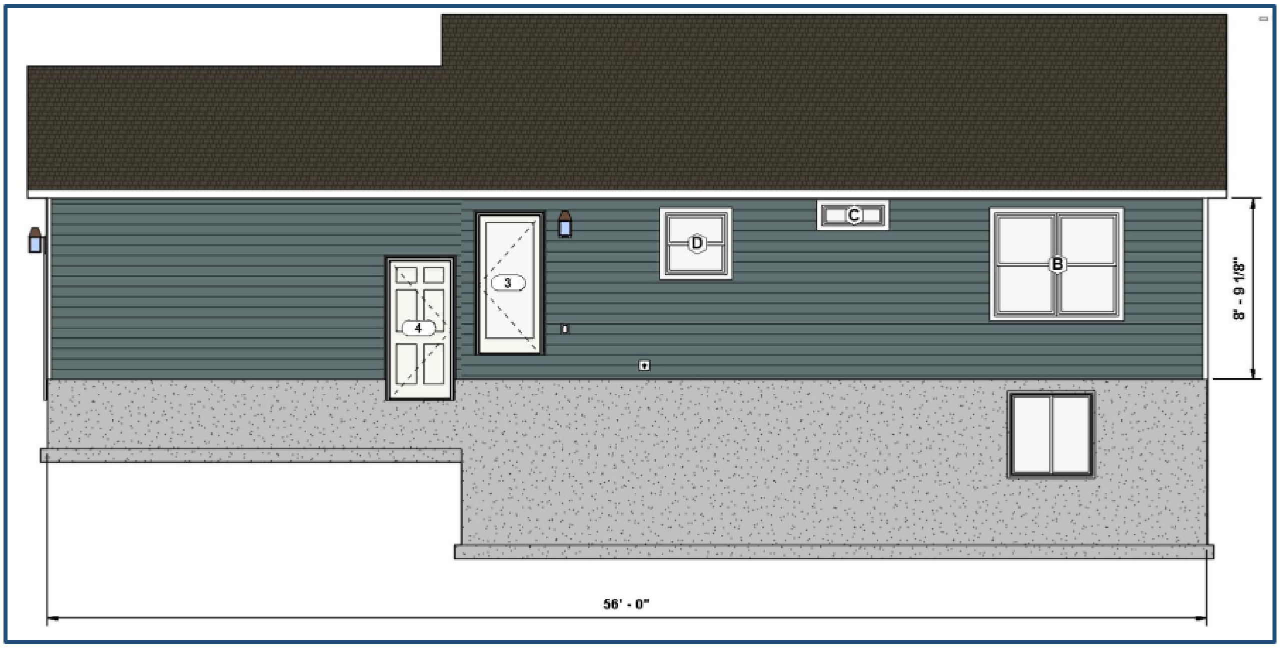


Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 160 Rear elevation view.

The double window unit with the Type Mark B is the only window or door opening on this elevation that is over 25 square feet. The area of this window will be subtracted from the wall area total, and all other windows and doors will be ignored.

Wall Area – Opening Area: 491.17 ft.2 – 30 ft.2 = 461.17 ft.2

This quantity will be entered into the wall siding area calculator with a 10 percent waste factor. Excel Figure 10-22 shows all of the wall area totals entered into the wall siding area calculator.

Wall Siding Area			
Wall	SF	Waste Factor	Total
Right Side Walls	176.94	10%	194.634
Right Gable End	128	30%	166.4
Front Side	276.7	10%	304.37
Front Porch Gable	11.28	30%	14.664
Left Side Walls	294.67	10%	324.137
Left Side Gable	128	30%	166.4
Back Side Walls	461.17	10%	507.287
			0
		1677.892	

Excel Figure 10-22 Wall siding area complete.

Lineal Feet of Starter Strip

Starter strip will be used anywhere the siding course starts with a full width siding piece. The length can be estimated from the elevation views. The right elevation view, Figure 10-156 shows one 10-foot wall and the short walls on each side of the garage door. The length of the starter strips on both sides of the garage doors can be determined by subtracting the width of the garage door from the width of the wall.

Starter Strip on Garage Wall: 22 ft. – 16 ft. 4 in. = 5 ft. 8 in.

This is added to the 10-foot length on the right house wall for a total of

Total Right Elevation Starter Strip: 10 ft. + 5 ft. 8 in. = 15 ft. 8"

The starter strips for the front elevation; Figure 10-158, is determined by subtracting the front porch width of 11 feet from the house width of 36 feet. The starter strip for the garage portion of the front wall is added for an additional 20 feet. Finally, the starter strip for the gable end above the front porch is added for an additional 9 feet, 6 inches.

Total Front Starter Strip: (36 ft. – 11 ft.) + 20 ft. + 9 ft. 6in. = 54 ft. 6 in.

The starter strips for the left elevation; Figure 10-159 has no areas where the starter strip is not needed, so the quantity of starter strip is simply the length of the left-side wall of 32 feet.

Total Left Elevation Starter Strip: 32 ft.

The starter strips for the rear wall; Figure 10-160 has starter strip along the total length of the 56-foot wall with the exception where it is cut out for the garage entry door (Door number 4). This will subtract 3 feet from the total length of starter strip.

Total Back Elevation Starter Strip: 56 ft. – 3 ft. = 53 ft.

15 ft. 8 in. + 56 ft. 6 in. + 32 ft. + 53 ft. = 157 ft. 2 in.

Lineal Feet of Siding J Channel

Calculating the lineal feet of siding J channel is one of the more challenging items to estimate with siding. Essentially, J channel is used wherever the siding is cut to conceal the ragged cut edge with the exception of cut edges that are concealed by the inside or outside corner trim. Figure 10-161 shows the front elevation view with the vinyl trim elements highlighted.

The J channel is highlighted in bright red. J channel is located along the top of the wall where it intersects with the soffit. This includes both horizontal and angled J channel. J channel is also located around the door and along the side and top of the front porch. The total front elevation J channel working from the top down includes

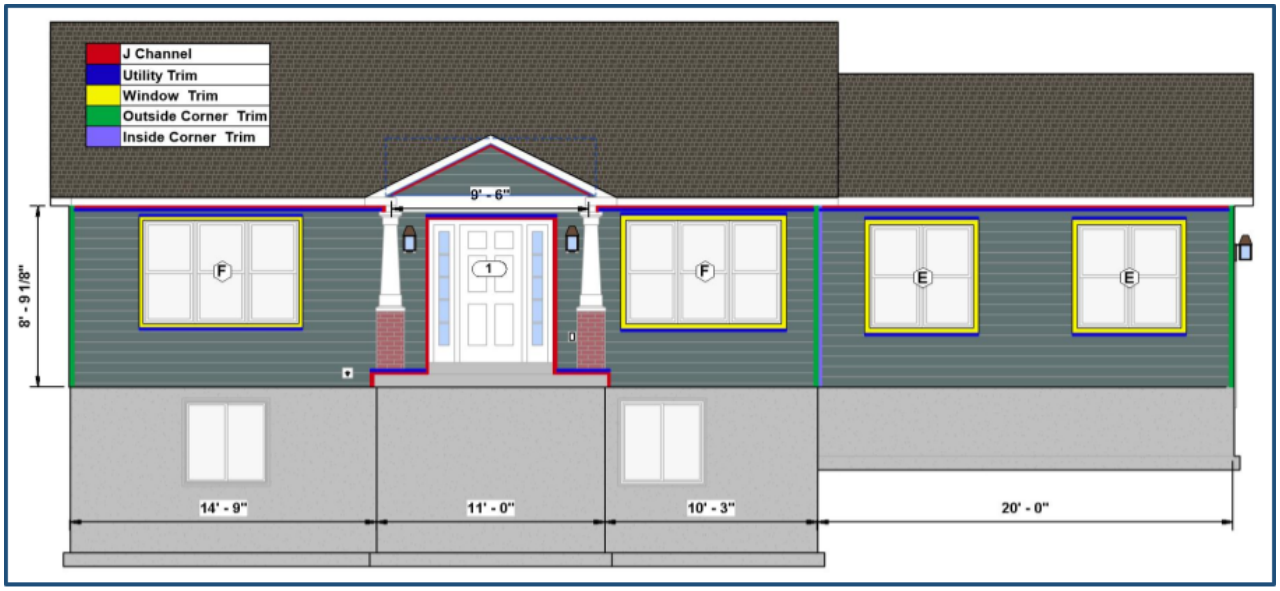


Figure STYLEREF 1 \s 10 SEQ Figure * ARABIC \s 1 161 Front elevation with vinyl siding trim details highlighted.

2 Angled front porch soffit trim pieces: 5 ft. 4 in.

1 Front left wall horizontal soffit piece: 14 ft. 9 in.

1Front Wall horizontal soffit piece: 10 ft. 3 in.

1 Garage Wall horizontal soffit piece: 20 ft. 0 in.

1 Horizontal door top edge piece: 5 ft. 6 in.

2 Vertical door edge pieces: 6 ft. 8 in.

2 Horizontal porch top pieces: 2 ft. 10 in.

2 Vertical porch edge pieces: 6 in.

Total lineal footage of front elevation J channel

(2 × 5 ft. 4 in.) + 14 ft. 9 in. + 10 ft. 3 in. + 20 ft. 0 in. + 5 ft. 6 in. + (2 × 6 ft. 8 in.) + (2 × 2 ft. 10 in.) + (2 × 6 in.) = 81 ft. 2 in.

The J channel for the other elevations would be calculated in the same manner.

Lineal Feet of Utility Trim

The utility trim is identified in Figure 10-161 by a bright blue color. It is placed in the horizontal J channel and in the window trim at the top and the bottom of the windows. Utility trim calculations for the front elevation include

1 Horizontal soffit piece: 14 ft. 9 in.

1 Horizontal soffit piece: 10 ft. 3 in.

1 Horizontal soffit piece: 20 ft. 0 in.

1 Horizontal door top edge piece: 5 ft. 5 in.

2 Horizontal porch top pieces: 2 ft. 10 in.

4 Horizontal window trim pieces: 7 ft. 6 in.

4 Horizontal window trim pieces: 5 ft. 0 in.

Total lineal footage of front elevation utility trim

14 ft. 9 in. + 10 ft. 3 in. + 20 ft. 0 in. + 5 ft. 6 in. + (2 × 2 ft. 10 in.) + (4 × 7 ft. 6 in.) + (4 × 5 ft.) = 100 ft. 8 in.

Lineal Feet of Outside Corners

Outside corner trim is located at each outside corner where vinyl siding is installed. Corner trim is purchased in standard lengths of 8, 10, o r 12 feet long. The trim is usually not seamed unless the corner is longer than the longest length of trim. One standard length piece is purchased for each outside corner. The front elevation view shows three outside corners. Two additional pieces are also shown on the back elevation. 10 foot lengths of corner trim will be purchased. This total of 50 feet is entered into the header section.

Lineal Feet of Inside Corners

Inside corners are calculated in the same fashion as outside corners. The front elevation view shows only one inside corner. This is the only inside corner piece in the project.

Lineal Feet of Door and Window Trim

The window trim for this project will be decorative three inch-wide window trim. The quantity is calculated by determining the lineal feet of window perimeter. In addition, three inches will be added each end of the window trim piece to allow for the miter cuts at each window corner. This adds six inches of length to each window piece, which would result in a total of two feet per window. The window trim for the front elevation would be

Type Mark E Windows

8 window edge pieces: 5 ft. 6 in. = 44 ft. 0 in.

Type Mark F Windows

4 window edge pieces: 8 ft. 0 in. = 32 ft. 0 in

4 window edge pieces: 5 ft. 6 in. = 22 ft. 0 in.

Total front window trim

44 ft. + 32 ft. + 22 ft. = 98 ft. 0 in.

The window trim for the rear elevation would be

Type Mark D Window

4 Window edge pieces: 3 ft. 6in. = 14 ft.

Type Mark C Window

2 Window edge piece: 3 ft. 6 in. = 7 ft.

2 Window edge pieces: 1 ft. 6 in. = 3 ft.

Type Mark B Window

2 Window edge pieces: 6 ft. 6 in. = 13 ft.

2 Window edge piece: 5 ft. 6 in. = 11 ft.

Total rear window trim

14 ft. + 7 ft. + 3 ft. + 13 ft. + 11 ft. = 48 ft.

Lineal Feet of Soffit

The lineal feet of soffits are the amount equal to the lineal feet of roof edge which was one of the basic takeoff quantities. The total of 186 lineal feet is carried forward from the basic takeoffs.

Soffit Width

The soffit width can be determined from detail drawing as shown in Figure 10-162. This shows a soffit width of 12 inches.

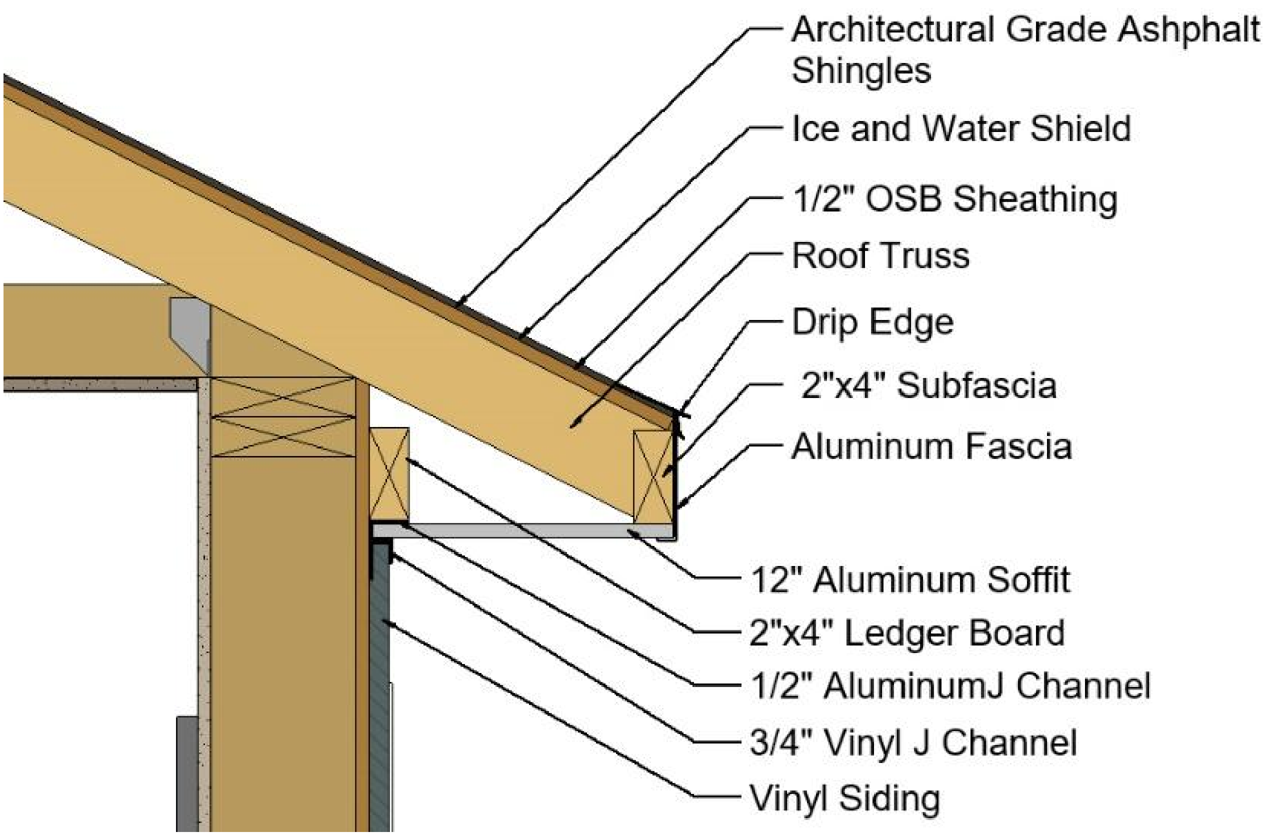


Figure 10-162 Wall section detail showing soffit construction.

Square Footage of Porch Soffit Area

Figure 10-163 shows a view of the front porch soffit area. The dimensions inside of the support beams define the porch soffit area. The front porch soffit area is calculated by the following:

Width 9 ft. 8 in. Depth 5 ft. 7 in = 60 ft.2

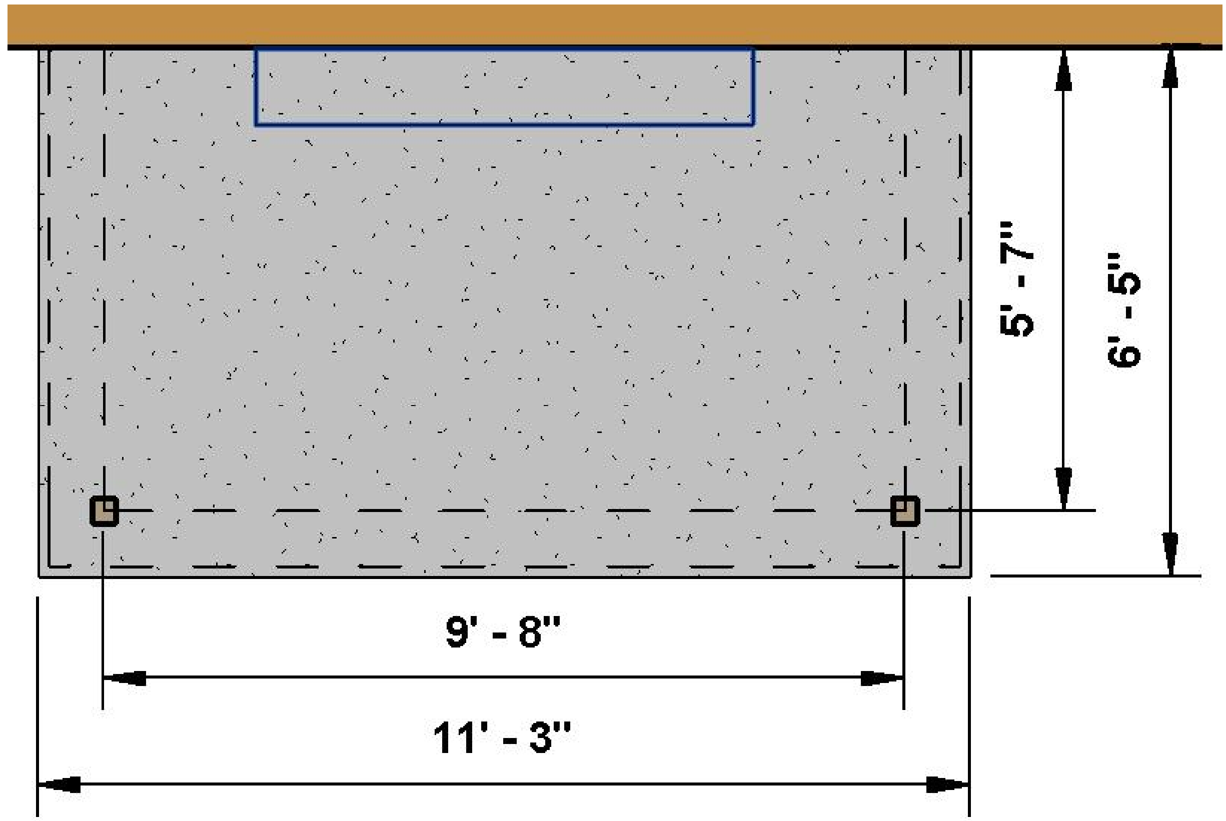


Figure 10-163 Front porch soffit area.

Completing the Vinyl Siding Material Section

Most of the quantities for the vinyl siding materials will be calculated based upon the total in the vinyl siding section and the Excel custom functions used to calculate the totals. A few quantities will need to be manually estimated.

Moisture Protection

The moisture protection subsection includes house wrap, door and window flashing, and house wrap tape.

Estimating House Wrap

The Tyvek house wrap material will be determined using the measurements you have already determined.

Estimating Door and Window Flashing

A self-adhered flashing tape will be installed around all main floor windows and exterior doors. The perimeter of the windows and doors from the basic takeoffs can be used to estimate the quantity of flashing needed. Excel Figure 10-21 shows the main floor windows and exterior door section of the basic takeoffs. The total perimeter for the windows is listed as 132 lineal feet and the total perimeter for the exterior doors is listed at 68.1 lineal feet. The estimating template calculates the door perimeter for three sides based upon the two sides and top of the door. Flashing will need to be installed at the bottom of the door, so an additional 14 feet, 6 inches will need to be added based upon the total for the width of each door.

Door Widths: 5 ft. 6 in. + 3 ft. + 3 ft. + 3 ft. = 14 ft. 6 in.

Total Window and Door Perimeter: 132 ft. + 68.1 ft. + 14.5 ft. = 214.6 ft.

In addition, flashing material will need to be added to the estimate to account for the lapping requirement. The amount added is dependent upon the width of the flashing material used on the projects. Figure 10-164 shows an exterior window elevation detail with the flashing requirements. The detail identifies the self-adhered flashing as 9 inches wide. 9 inches will need to be added to both the beginning and end of each flashing piece to account for the overlap for an added length 18 inches (2 × 9"). Each window and door would need an additional 72 inches (6 ft. 0 in.) of flashing for the four corner overlaps.

4 pieces' × 18 in. = 72 in.

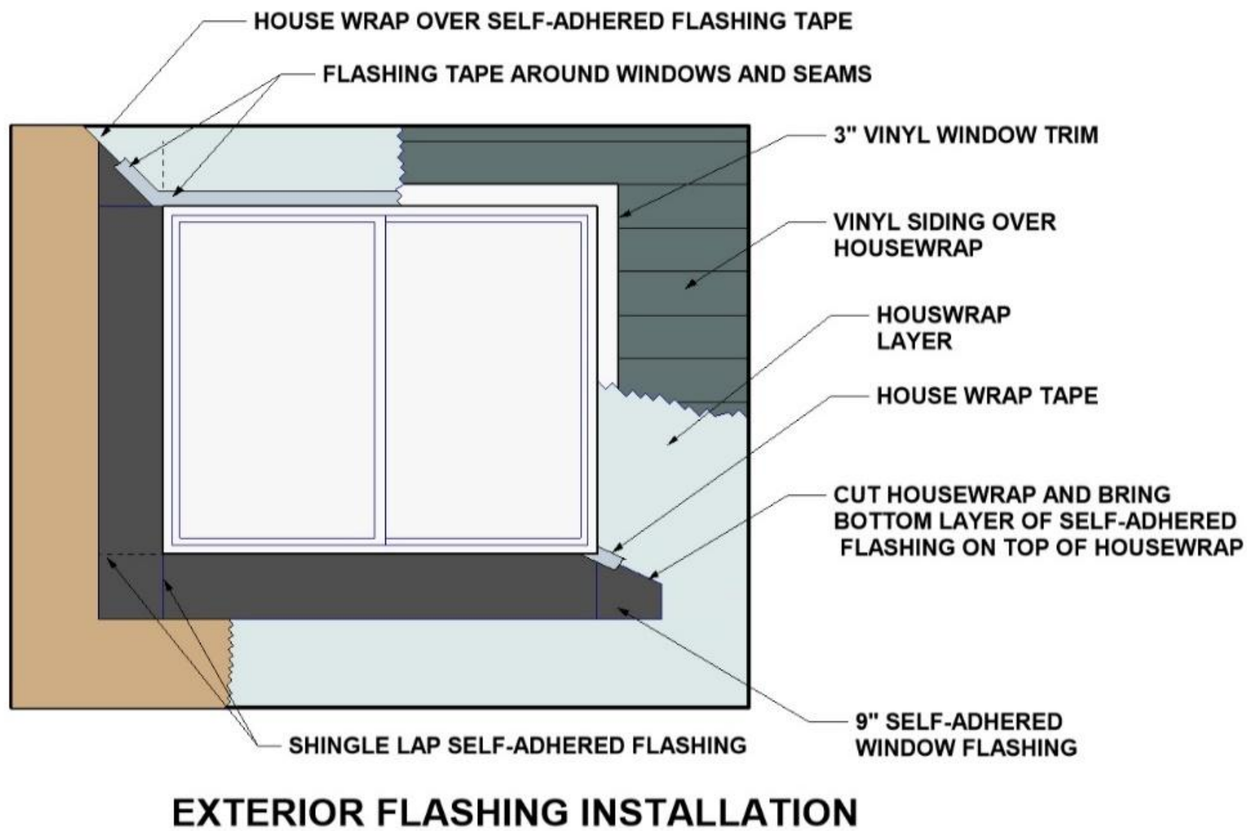


Figure 10-164 Exterior window flashing detail drawing.

The basic takeoff lists seven windows and five doors for a total of 11 extra pieces of six-foot-long flashing that will need to be purchased to account for the lapping requirement.

Total Window Flashing Overlap: 11 pcs. × 6 ft. = 66 ft.

The total window flashing that will need to be purchased is

Total Window and Door Flashing: 214.6.6 ft. + 66 ft. = 280.6 ft.

Estimating House Wrap Tape

House wrap tape will be needed around the perimeter of all windows and doors to adhere the house wrap to the window or door frame. In addition, it will be needed wherever there is a horizontal seam in the house wrap, such as when a separate piece is installed on the gable ends. Previously, the total window and exterior door perimeter was calculated as 214.6 lineal feet. Additional flashing tape will be needed on each gable end. The two gable ends shown in Figure 10-156 equal a total of 32 feet, and the gable end shown in Figure 10-159 is also 32 feet wide. The two gable ends add a total of 64 feet of additional house wrap tape. The amount for house wrap tape for the project is

Total House Wrap Tape: 214.6 ft. + 60 lf. = 274.6 ft.

Misc. Exterior Finish Materials

The miscellaneous exterior finish material includes electrical and plumbing mounting blocks, gable end vents, and vinyl shutters.

Electrical Mounting Blocks

Electrical mounting blocks are used whenever there is an electrical fixture that is mounted on the walls with vinyl siding. Both the elevation views and the floor plan views typically show the location of electrical fixtures. The elevation views shown in Figure 10-156, 10-158, 10-159, and 10-160 show wall mounted light fixtures and outlets.

Plumbing Mounting Blocks

The elevation views also show one hose bib on the front elevation and one on the rear elevation.

Gable End Vents

The gable end vents are also taken off from the elevation views which show three gable end vents.

Exterior Finishes Labor Estimates

This document is a deteailed overview of the processes for estimating roofing labor. The roofing labor will be completed using the National Construction Estimator. The roofing costs will be taken from two areas of the estimator: the roofing subsection and the flashing subsection.

Table of Contents

Roofing Labor

Roofing Felt

The labor cost from the Roofing Materials subsection in the Residential section of the NCE will be used to estimate the cost of roofing felt. Careful reading of the header section reveals that the cost in this section is for roofing felt that is nailed down. The NCE also provides the cost for roofing felt a few pages later, however, careful reading of the header section reveals that this cost is for attaching the felt using the hop mopped process. NCE Figure 10-1 shows a screenshot of the NCE with the roof felt cost highlighted.

Roofing Materials

Mineral surface roll roofing. Roll covers 1 square (100 square feet).					
90-pound fiberglass mat reinforced	R1@.200	Sq	45.50	7.12	52.62
GAF Mineral Guard	R1@.200	Sq	45.50	7.12	52.62
SBS-modified bitumen, Flintlastic	R1@.200	Sq	70.30	7.12	77.42
Add for mopping in 30-pound hot asphalt	R1@.350	Sq	16.70	12.50	29.20
Roofing felt. Asphalt saturated. Per square. 15-pound roll covers 400 square feet. 30-pound roll covers 200 square feet. Nailed down.					
15-pound, ASTM compliant	R1@.140	Sq	5.71	4.98	10.69
30-pound, ASTM-D226	R1@.150	Sq	11.40	5.34	16.74
Add for mopping in 30-pound hot asphalt	R1@.350	Sq	16.70	12.50	29.20

NCE Figure 10-1: Roofing felt installation cost.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.257.

The quantity of roofing felt needed can be taken from the SF Sloped Roof Area. The quantity will be divided by 100 to convert the square foot area to a square, which is the unit of labor for roofing felt in the NCE. The calculation to convert the square footage to squares would be

The calculation would be as follows:

The Composition Roofing Shingles subsection of the NCE will be used to calculate the labor cost for installing the roof shingles. Several different classifications and qualities of shingles are listed in this section, and it can be a little confusing trying to determine the correct type; however, each of the types has the same installation cost per square. The architectural grade laminated shingles will be used. The SF sloped roof area in the header section can be used for determining the quantity of roof shingles. Again, the quantity will need to be converted from square feet to squares (NCE Figure 10-2).

Install Starter Strip

The Composition Roofing Shingles subsection of the NCE will be used to calculate the labor cost for installing the shingle starter strip. The cost is priced per lineal foot of starter strip. The calculation would be

Install Hip or Ridge Shingles

The Composition Roofing Shingles subsection of the NCE will be used to calculate the labor cost for installing the hip or ridge shingles. The cost is priced per lineal foot of hip or ridge. The calculations would be

Composition Roofing Shingles Material costs include 5% waste. Labor costs include roof loading and typical cutting and fitting for roofs of average complexity. Class A shingles have the highest fire rating.

3-tab asphalt fiberglass® shingles, Three bundles per square (100 square feet). 5" exposure, Class A fire rating. 60 MPH wind resistance.					
20 year, no algae-resistance	R1@1.83	Sq	55.10	65.10	120.20
25-30 year, algae-resistant	R1@1.83	Sq	81.70	65.10	146.80
Architectural grade laminated shingles, Owens Corning, GAF and similar. Three bundles per square (100 square feet). Class A fire rating. 110 MPH to 130 MPH wind resistance. Limited lifetime warranty.					
No algae resistance	R1@1.83	Sq	97.60	65.10	162.70
Algae resistant, 110mph	R1@1.83	Sq	97.20	65.10	162.30
Algae resistant, 130mph	R1@1.83	Sq	97.70	[illegible]	162.80
5-inch exp[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5-inch exposure, cool roof Title 24, 130MPH	R1@1.83	Sq	220.00	65.10	285.10
Premium, to 8-inch exposure, 130mph	R1@1.83	Sq	268.00	65.10	333.10
Hip and ridge shingles with sealant, Per linear foot of hip or ridge.					
ProEdge hip and ridge	R1@.028	LF	1.54	1.00	2.54
StormMaster hip and ridge	R1@.028	LF	1.82	1.00	2.82
Decorative ridge	R1@.028	LF	2.58	1.00	3.58
Shingle starter strip, Peel 'n' stick SBS membrane. Rubberized to seal around nails and resist wind lift.					
9" x 33' roll	R1@.460	Ea	20.20	16.40	36.60
Per linear foot	R1@.014	LF	.61	.50	1.11

NCE Figure 10-2: NCE cost for installing roof shingles, starter strip, and hip and ridge.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.258

Install Ice and Water Shield

The Building Paper subsection of the Residential section of the NCE will be used to calculate the labor cost for installing ice and water shield. The self-adhesive, typical option will be used and priced per square footage of ice and water shield (NCE Figure 10-3).

Labor to install building papers					
Felts, vapor barriers, infiltration barriers, building papers on walls					
Tack stapled, typical	BC@.002	SF	—	.07	.07
Heavy stapled, typical	BC@.003	SF	—	.11	.11
Felts, vapor barriers, infiltration barriers, building papers on ceilings and roofs					
Tack stapled, typical	BC@.004	SF	—	.15	.15
Heavy stapled, typical	BC@.006	SF	—	.22	.22
Self-adhesive, typical	BC@.006	SF	—	.22	.22

NCE Figure 10-3: NCE price for installing ice and water shield.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.258

The LF Ice and Water Shield will be multiplied by the three-foot width of the ice and water shield material. The calculation to determine the quantity would be

The calculation to determine the labor cost would be

= $93.06

Install Drip Edge

The Galvanized Steel Flashing subsection of the Residential section of the NCE will be used to determine the labor cost for installing the drip edge. The drip edge 2 ½" x 1" x 10' option will be used. The labor is estimated based upon 10-foot lengths of drip edge (NCE Figure 10-4). The calculation for determining the quantity is

The calculation to determine the labor cost for the drip edge is

Install Valley Flashing

In this instance, the ice and water shield will be used as the valley flashing. This was previously calculated with the ice and water shield, and no additional cost will be needed.

Install Step Flashing

The Galvanized Steel Flashing subsection of the Residential section of the NCE will be used to determine the labor cost for installing the step flashing. The step flashing bent 8" x 8" brown will be used as it most closely resembles the flashing used (NCE Figure 10-4). The installation is priced per each with the quantity taken from the materials you determined.

Install Plumbing Vent Flashing

The Galvanized Steel Flashing subsection of the Residential section of the NCE will be used to determine the labor cost for installing the plumbing vent flashing. The vent pipe flash cone 3" pipe will be used. Even though there are several sizes of plumbing flashing used, the installation price is the same for each, so the quantity will be combined in a single estimate line (NCE Figure 10-4).

Galvanized steel flashing Galvanized mill (plain) finish except as noted. 26 gauge. Galvanized steel flashing has a zinc coating which resists corrosion. Bonderized steel flashing adds a colored phosphate coating which improves paint adhesion.

ACQ-compatible flashing, 8" x 20'	SW@1.00	Ea	31.10	41.60	72.70
Dormer flashing, 7", mill finish	SW@.250	Ea	8.89	10.40	19.29
Drip cap, 1-1/2" x 10'	SW@.400	Ea	3.72	16.60	20.32
Drip edge, 2-1/2" x 1" x 10', white	SW@.400	Ea	4.92	16.60	21.52
Drip edge, 5" x 2' x 10', mill finish	SW@.400	Ea	7.02	16.60	23.62
Drip edge, 6" x 10', Beige,	SW@.400	Ea	9.61	16.60	26.21
Vent pipe flash cone, 1" pipe	SW@.250	Ea	8.33	10.40	18.73
Vent pipe flash cone, 3" pipe	SW@.311	Ea	9.34	12.90	22.24
Vent pipe flash cone, 4" pipe	SW@.311	Ea	10.70	12.90	23.60
Shingle flashing, 5" x 7", box of 10	SW@.400	Box	13.90	16.60	30.50
Starter strip, 4-1/4" x 10', bonderized	SW@.500	Ea	5.56	20.80	26.36
Step flashing, bent 2" x 3" x 7", .031"	SW@.040	Ea	.45	1.66	2.11
Step flashing, bent, 4" x 12", bonderized	SW@.040	Ea	1.71	1.66	3.37
Step flashing, bent, 8" x 8", brown	SW@.040	Ea	.96	1.66	2.62

NCE Figure 10-4: NCE costs for installing flashings.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.268-69

Install Roof Vents

The ridge ventilators option in the Vents and Louvers subsection of the Residential section of the NCE will be used to price the installation of the ridge vents (NCE Figure 10-5). The price is based per 10-foot length. The quantity will need to be divided 10 ten to account for the 10-foot length estimated in the NCE.

Ridge ventilators, 1/8" louver opening, double baffle, aluminum					
10' long, black	BC@.650	Ea	18.80	24.00	42.80
10' long, brown	BC@.650	Ea	17.80	24.00	41.80
10' long, white	BC@.650	Ea	17.80	24.00	41.80
4' long, hinged for steep roof	BC@.255	Ea	11.40	9.42	20.82

NCE Figure 10-5: NCE cost for ridge vents.

2018 National Construction Estimator, Richard Pray, Craftsman Book Company, 2018, 66th Ed. P.292

Window Labor Estimating (Detailed

This document provides a detailed overview of how to estimate labor for window installation.

Window Labor

NCE Figure 10-6 shows the vinyl sliding window section of the Residential section of the NCE. The window section of the NCE is multiple pages long detailing the material and labor cost for many different window types and construction.

A careful review of the labor cost will reveal that there are only three installation costs: a low cost, a medium cost, and a high cost. Each level of cost is color coded to match the color code of the window schedule.

Horizontal sliding insulated low-E glass vinyl windows. Argon filled. For new construction. By rough opening size, width × height. With screen.

2'0" x 2'0"	BC@.500	Ea	85.70	18.50	104.20
2'0" x 3'0"	BC@.500	Ea	93.60	18.50	112.10
2'4" x 4'6"	BC@.500	Ea	152.00	18.50	170.50
2'8" x 4'6"	B1@1.00	Ea	161.00	33.40	194.40
3'0" x 2'0"	BC@.500	Ea	109.00	18.50	127.50
3'0" x 3'0"	BC@.500	Ea	111.00	18.50	129.50
3'0" x 4'0"	B1@1.00	Ea	153.00	33.40	186.40
3'0" x 5'2"	B1@1.50	Ea	173.00	50.20	223.20
3'0" x 6'0"	B1@1.50	Ea	173.00	50.20	223.20
4'0" x 2'0"	BC@.500	Ea	155.00	18.50	173.50
4'0" x 3'0"	B1@1.00	Ea	151.00	33.40	184.40
4'0" x 4'0"	B1@1.50	Ea	152.00	50.20	202.20
5'0" x 4'0"	B1@1.50	Ea	209.00	50.20	259.20

NCE Figure 10-6 Horizontal sliding section of the NCE.

Vinyl Siding Labor Estimating (Detailed)

This document contains a detailed overview of the process for estimating vinyl siding labor.

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Install House Wrap

The house wrap and window flashing paper labor cost is taken from the Building Paper subsection of the Residential subsection of the National Construction Estimator. NCE Figure 10-9 shows the labor cost for installing building paper.

Labor to install building papers					
Felts, vapor barriers, infiltration barriers, building papers on walls					
Tack stapled, typical	BC@.002	SF	—	.07	.07
Heavy stapled, typical	BC@.003	SF	—	.11	.11
Felts, vapor barriers, infiltration barriers, building papers on ceilings and roofs					
Tack stapled, typical	BC@.004	SF	—	.15	.15
Heavy stapled, typical	BC@.006	SF	—	.22	.22
Self-adhesive, typical	BC@.006	SF	—	.22	.22
Curing papers, protective papers and vapor barriers, minimal fasteners	BC@.001	SF	—	.04	.04
Flashing papers, 6" to 8" wide	BC@.010	LF	—	.37	.37

NCE Figure 10-9 Labor to install building papers subsection of the NCE.

The Tack stapled, typical option of felts, vapor barriers, infiltration barriers, building papers on walls subsection will be used for pricing the house wrap. The price is calculated per square foot.

Install Window Flashing

The flashing papers 6" to 8" wide subsection will be used to calculate the labor cost for installing the window flashing.

Install Siding and Siding Trim

NCE Figure 10-10 shows the Vinyl Siding subsection of the Residential section of the NCE that will be used to calculate the vinyl siding and vinyl siding trim accessories labor costs.

Install Siding

The NCE lists several different types of siding, however, the labor cost for each one is listed as $112.00 per square.

Install Starter Strip

The crew, craft hours, unit, and labor cost for installing starter strip are entered into the spreadsheet. The quantity of starter strip is automatically carried forward from the header section.

Siding

	Craft@Hrs	Unit	Material	Labor	Total
Vinyl siding Solid vinyl. Embossed wood grain texture.					
Double 4" traditional lap profile, 12' 6" long panels, 8" exposure. Each panel covers 8.33 SF before cutting waste. Case of 24 panels covers 200 square feet. Cost per square (100 square feet).					
.040" thick, lighter colors	B1@3.34	Sq	62.50	112.00	174.50
.040" thick, darker colors and textures	B1@3.34	Sq	85.70	112.00	197.70
.042" thick, lighter colors	B1@3.34	Sq	79.60	112.00	191.60
.042" thick, darker colors and textures	B1@3.34	Sq	84.40	112.00	196.40
.044" thick, most colors and textures	B1@3.34	Sq	82.40	112.00	194.40
Double 4.5" traditional lap profile, 12' 1" long panels, 9" exposure. Each panel covers 9.09 SF. Case of 22 panels covers 200 square feet. Cost per square (100 square feet).					
.040" thick, most colors	B1@3.34	Sq	77.20	112.00	189.20
.040" thick, darker colors and textures	B1@3.34	Sq	77.20	112.00	189.20
Double 5" traditional lap profile, 12' long panels, 10" exposure. Each panel covers 10 SF. Case of 20 panels covers 200 square feet. Cost per square (100 square feet).					
.042" thick, lighter colors	B1@3.34	Sq	84.90	112.00	196.90
.042" thick, darker colors and textures	B1@3.34	Sq	84.90	112.00	196.90
Trim for vinyl siding					
Starter strip, 2-1/4" x 12.6'	B1@.030	LF	.45	1.00	1.45
"J"-channel trim at wall openings, 12.5' long	B1@.033	LF	.48	1.10	1.58
Outside or inside corner, 10' long	B1@.033	LF	2.01	1.10	3.11
Casing and trim, 12.5' long	B1@.033	LF	.53	1.10	1.63
Mini mounting block, 4" x 6"	B1@.350	Ea	11.80	11.70	23.50
Vinyl "J"-block, 7" x 9"	B1@.350	Ea	12.70	11.70	24.40
Add for R-3 insulated vinyl siding	B1@.350	Sq	73.40	11.70	85.10

NCE Figure 10-10

Install J Channel

Labor cost for installing J channel will be taken from the NCE.

Install Outside and Inside Corners

Labor cost for installing outside and inside corners will be taken from the NCE.

Install Window Trim

The casing and trim, 12 feet, 6 inches long, taken from the NCE, is used to price the installation of the window trim.

Install Mounting Blocks

Two types of mounting blocks are listed in the NCE, and both sizes show the same price of $11.70 for each one.

Install Soffit and Fascia System

NCE Figure 10-11 shows the Soffit Systems subsection of the Residential section of the NCE. The soffit and fascia is priced as a complete system including six-inch-wide fascia, J channel, and soffit. The prices for 12-inch, 18-inch, and 24-inch-wide soffit are all priced at the same one-dollar-per-foot cost.

Soffit Systems					
Baked enamel finish, 6" fascia, "J"-channel, 8" perforated or solid soffit, .019 gauge aluminum.					
12" soffit	B1@.047	LF	4.31	1.57	5.88
18" soffit	B1@.055	LF	5.00	1.84	6.84
24" soffit	B1@.060	LF	5.67	2.01	7.68
Vinyl soffit systems					
12" soffit	B1@.030	LF	3.63	1.00	4.63
18" soffit	B1@.030	LF	4.18	1.00	5.18
24" soffit	B1@.030	LF	4.71	1.00	5.71

NCE Figure 10-11 Soffit and fascia system in the NCE.

Installing Gable End Vents

The vents and louvers subsection of the NCE will be used for pricing the labor costs for installing the gable end vents. Vents are priced per each based upon the size and shape of the vent.

	Craft@Hrs	Unit	Material	Labor	Total
Vents and Louvers					
Attic and gable louver vents, UV stabilized copolymer, screened, rough opening sizes					
12" x 12", 38 sq. inch vent area	SW@.448	Ea	34.90	18.60	53.50
12" x 18", 86 sq. inch vent area	SW@.448	Ea	39.00	18.60	57.60
18" x 24", 140 sq. inch vent area	SW@.871	Ea	49.40	36.20	85.60
21" x 27" oval	SW@.871	Ea	94.80	36.20	131.00
22" x 34", half round, 100 sq. inch vent area	SW@.871	Ea	62.50	36.20	98.70
16" round, 50 sq. inch vent area	SW@.448	Ea	67.40	18.60	86.00

NCE Figure 10-12

Interior Finishes Construction Processes and Material

Energy efficiency is a significant factor of all modern residential construction. The International Energy Conservation Code (IECC) created by the International Code Council (ICC) in 2000 set the standard for energy efficiency requirements for building construction, including residential buildings. Each successive version of the energy code since that time has increased the requirement for energy efficiency in building construction. This include the standards for a wide variety of building components and assemblies such as windows, doors, walls, floors, and ceilings. Adoption of a specific version of the energy code is done on a local state by state, or county by county basis. Some jurisdictions have no requirements while others have requirements that are significantly more stringent than the IECC code standard. In addition, a local jurisdiction may choose the adoption of an older or newer code year standard.

For Example, in the year 2018 the city of Rexburg, Idaho required residential construction to meet the standards for the 2012 IECC code, while at the same time requiring commercial construction tomeet the standard of the 2015 IECC code standards. The 2015 IECC requires a significant increase in the energy efficiency requirements. The energy efficiency of a building is commonly calculated using the R value of the various building components. The R value is a measure of a materials resistance to heat transfer. The higher a materials R value the slower the transfer of heat will be. The R value of individual building components are published in charts such as can be found at:

https://books.byui.edu/-FDt

https://books.byui.edu/-IUCWf

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R Value and Efficiency Codes

Insulation material typically has either the total R value, or the R value per inch of thickness of the material listed in the product literature. The total R value of a building component such as a wall is determined by the total of all of the materials in the assembly. In addition, the air film on the exterior and interior of the wall can add a small amount to the total R value of the assembly. Figure 11-1 shows examples of several wall assemblies with the total R value calculations. The wall on the left is a standard 5-1/2 stud wall with fiberglass insulation with a total R value of 21.53. The wall on the right has the addition of three quarter inch extruded foam insulation for a total of R25.28

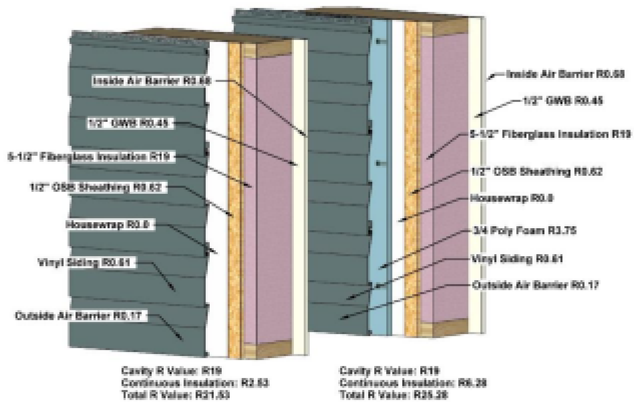

Figure 11-1 Wall assemblies R value totals

Software such as REScheck by the Department of Energy can be used to check a wall if a wall assembly meets the code requirements for a specific area. The software can be downloaded at: https://www.energycodes.gov/rescheck

The REScheck establishes the assemblies' compliance using two variables, the cavity insulation and the continuous insulation. Figure 11-2 shows an example of the REScheck compliance for the 21.53 wall assembly with the IECC 2009 code requirements. The example shows that this insulation assembly exceeds the 2009 code requirements by 8.9%

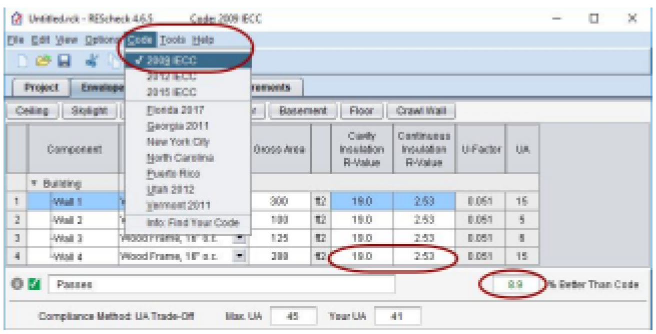

Figure 11-2 REScheck of 21.53 wall insulation assembly check for compliance with the 2009 IECC.

Changing to the 2012 code requirements shows that the same assembly does not meet the 2012 code requirement and is deficient by 7.1%. Replacing the cavity insulation with a high performance R21 insulation would meet the minimal 2012 requirements.

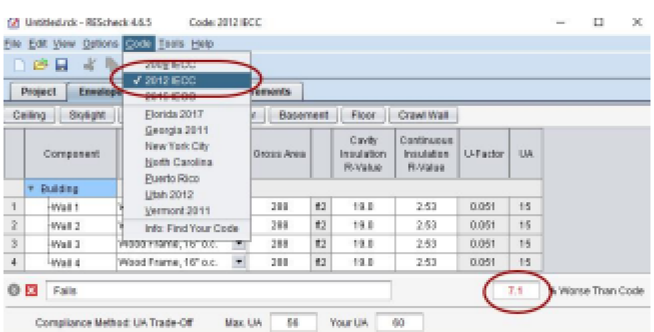

Figure 11-3 REScheck of 21.53 wall insulation assembly check for compliance with the 2012 IECC.

The 2015 IECC code increases the requirements even further. The current insulation system would fail by over 15%. In addition, the 2015 code requirements have minimum requirements for both the cavity insulation and the continuous insulation. The code requirements read 20 + 5 or 13 + 10. The first number is the minimum cavity requirements and the second is the continuous insulation minimum requirements. The reason for this change is to minimize the effect of thermal bridging. This is caused because the two by six studs which are placed at sixteen inches on center only have an R value of 6.88 which is less than half of the R19 wall insulation. Ten percent of the wall area only has an R value of 9.1.

Installing three quarters of an inch of extruded polystyrene insulation which has an insulation value of R3.75 on the exterior of the wall would work together with the other building components to meet the 2015 requirements (Figure 11-4).

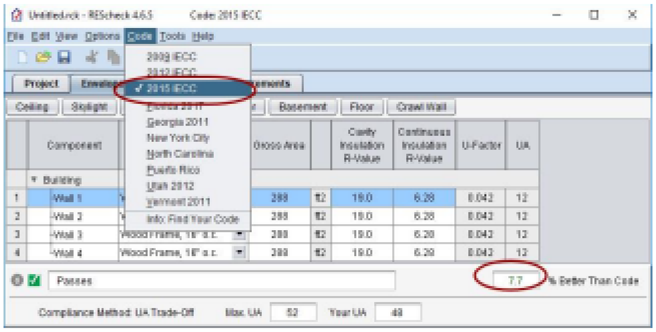

Figure 11-4 REScheck of 25.28 wall insulation assembly check for compliance with the 2015 IECC.

Types of Insulation

The energy codes seek to establish minimum standards for energy efficiency without being overly prescriptive of the actual building assemblies. A wide range on insulation materials and systems can be used to meet the energy requirements. Insulation material can be classified by both the insulation material and the installation method. Figure 11-4 shows an example of a mock wall assembly using innovative structural framing method designed to test the use of two by four wall construction with two inch ridged insulation sandwiched on the outside to meet the IECC 2015 insulation requirement of 13+10

Figure 11-5 Structural testing of innovative framing method to allow for two inch rigid sheathing insulation.

Insulation materials include, fiberglass, cellulose, mineral wool, polystyrene, polyisocyanurate, and polyurethane. Installation meth ods include rolls or batts, loose fill, ridged sheets, and formed in place. Some insulation materials can be installed using a number of installation methods, and some are only available using a single installation method. One of the most vertical and popular installation material is fiberglass.

Fiberglass Insulation

Fiberglass insulation is made from extremely fine glass fibers. It is made from molten glass that is blown or spun into extremely fine glass fibers. It is estimated the forty to sixty percent of fiberglass insulation is made from recycled material. Fiberglass is available in several different forms including blankets (batts or rolls), loose fill, and rigid sheets.

Fiberglass Blanket Insulation

Fiberglass blanket insulation is available in an array of lengths, widths, thickness, and densities. The length is usually classified as either a roll or batt. Roll insulation is long continuous roll of material that is cut to finished length on the job site. Batts are lengths that are precut into individual pieces, usually sized to fit within standard wall stud heights such as 93 inches which can save some installation time. Blanket insulation is also made in widths to match standard wall stud framing spacing such as sixteen inches or twenty-four inches on center. In addition, blanket insulation is available in a number of standard thicknesses to correspond with standard framing material such as three and a half and five and a half inches thick.

Figure 11-6 Fiberglass blanket insulation.

Blanket insulation is also available in I number of densities and R Values. Densities include low density, medium density, and high density. For example, Insulation sized to fit into standard two by four wall cavities are available in a low density of R11, a medium density of R13 and a high density of R15. Insulation sized for two by six wall cavities can be purchased in a medium density of R19 and a high density of R21. Wider batts can have a R value such as R38 for twelve-inch-thick batts and R49 for fifteen and a half inches thick.

Figure 11-7 Fiberglass blanket insulation is available in a wide variety of thick nesses.

Fiberglass insulation is also available with a number of different facing including foil faced, Kraft faced, and unfaced. Foil faced insulation in not as popular as it used to be because of the higher cost than Kraft faced or unfaced fiberglass insulation. Usually it is now considered a special order item and can cost as much as a third more than other types. The advantage of foil faced is the foil can serve as a radiant barrier when installed adjacent to a dead air space which can add an addition R 2 to the insulation assembly. Radiant barriers can also be purchased as a separate item. In addition, foil faced has a higher rating as a vapor barrier.


Figure 11-8 Foil faced fiberglass insulation.

Kraft Faced Insulation

The facing on kraft faced insulation is made by sandwiching a layer of tar or other bituminous material between layers of kraft paper. The kraft paper give the insulation a level of vapor barrier resistance and provides a convenient means of attachment to the wall framing.

Figure 11-9 Kraft faced insulation.

 Unfaced fiberglass insulation has no facing and is usually friction fit between the wall framing. Unfaced insulation also requires a separate vapor barrier to be installed when a vapor barrier is required.


Figure 11-10 Unfaced insulation

Fiberglass blanket insulation can also be used in attic insulation. Batts can be installed between the ceiling joists. Additional layers can be installed on top of the first layer crosswise to the preceding layer. Figure 11-11 shows an example of two layers of fiberglass insulation installed in an attic. Attic blanket insulation is usually installed unfaced.

Figure 11-11 two layers of fiberglass blanket insulation installed in an attic space.

Fiberglass Loose Fill Insulation

Fiberglass insulation is also available in loose fill form for use in attics and walls. Fiberglass insulation installed in open attic space is usually installed by using a commercial insulation blowing machine to spread loose fiberglass fibers in a layer in the attic. The required R value is achieved by filling the space to the required depth. Loose fill fiberglass has an R value of 2.5 to 2.7 per inch of thickness. Using a figure of R2.5 per inch, 19.6 inches of loose fill fiberglass insulation would need to be installed to meet the R49 ceiling 2012 IECC code requirement for Rexburg, Idaho. The code also requires one depth marker for every 300 square feet of attic area to be installed in the space to confirm the proper amount of insulation is installed (Figure 11-12).

6

Figure 11-12 Fiberglass loose fill attic insulation.

Loose fill fiberglass insulation can also be installed in wall cavities. The traditional method for installing loose fill fiberglass insulation in wall cavities is to install barrier over the face of the studs and fill the cavities by blowing in insulation. The barrier can be a vapor barrier material such as is shown in Figure 11-13, or netting material. One trade name for loose fill wall insulation is known as the “blow-in-blanket system”.


Figure 11-13 Loose fill fiberglass insulation installed behind plastic vapor barrier.

Newer methods of installing loose fiberglass insulation in wall cavities mix the glass fibers with a small amount of adhesive and it is sprayed in the wall cavity. The insulation sticks to itself and into the cavity without the need for barriers. As the fibers are being sprayed, a second technician vacuums the surplus material and it is put back into the blower where it is mixed with new material and reapplied to the wall. One trade name for this type of insulation in known as “Spider” insulation by the John Manville company. The insulation is sprayed into the cavity and then compacted and smoothed using a roller that spans across the studs. One major advantage that loose fill fiberglass has over traditional blanket fiberglass insulation is the ability to completely fill the wall cavity, particularly behind wires, pipe, and other obstructions in the stud cavity (Figure 11-14).

Figure 11-14 Spray fiberglass wall insulation.

Rigid Fiberglass Insulation

Rigid fiberglass is formed into panels and a large variety of shapes and sizes such as insulation for ductwork and piping. It is also available in a wide variety of thicknesses and densities. Figure 11- 15 shows example of some rigid insulation panels. A wide variety of surface covering are also available.

Figure 11-15 Rigid fiberglass insulation.

Cellulose Insulation

Cellulose insulation is made from recycled paper products such as newspaper. The newspaper is ground into small pieces and turned into fibers. The majority of cellulose insulation is made from recycled paper products. The fibrous pieces are treated with Borate to increase fire and insect resistance. Cellulose insulation can be used for both attic and wall insulation in both loose fill and compacted form.

Loose Fill Cellulose Insulation

Loose fill cellulose insulation is most often used as insulation in open attic space. Packages of tightly packed bundles of cellulose insulation are placed into commercial insulation blowers which break up the compacted fibers and allow them to be placed in the attic space in evenly compacted layers. Loose fill cellulose insula tion has an R vale between 3.2 and 3.8 per inch of thickness which is higher than for fiberglass blown in insulation. Using a figure of R3.5 per inch would require fourteen inches of attic insulation to meet the Rexburg, Idaho R49 attic insulation requirements. The building code also requires the placement of one level marker for every three hundred square feet of attic space (Figure11-15).

Figure 11-16 Installing loose fill cellulose insulation in an attic space.
https://www.energy.gov/energysaver/weatherize/insulation/insulation-materials

Cellulose Wall Insulation

Cellulose is installed as wall insulation using both the damp spray and dense pack method of installation. Damp spray cellulose is installed using a sprayer that adds a small amount of moisture or adhesive to the cellulose as it is sprayed into the cavity. When using water, the water activates the natural starches inherent in the fibers which act to bind the fibers together and to the structure. Adhesives also glue and bind the fibers together. The cellulose is compacted

flush to the stud cavity surface using rollers and any excess is trimmed off. The damp fibers need time to dry before the insulation is covered. Drying can take twenty-four to thirty-six hours depending upon the air temperature and humidity. (Figure 11-16).

Figure 11-17 Damp spray cellulose insulation installed in a wall stud cavity.

Dense pack cellulose is installed be attaching a strong fabric membrane to the wall surface. Holes are made in the membrane in each stud cavity and a special blower is used to fill and pack the cavity with cellulose material (Figure 11-17).

Figure 11-18 Dense pack cellulose installation is able to completely fill wall cavities in spite of the blocking and other obstruction in the wall cavity.

The R value of both wet spay and dense pack cellulose is dependent upon the density of the installation, but is commonly between 3.6 and 3.8 per inch which is comparable to high density fiberglass blan ket insulation, but has the added advantage of significantly reduce air infiltration.

Mineral Wool Insulation

Mineral wool insulation is one of the oldest forms of insulation material. It is made in a process where rock or other minerals are heated to high temperatures until they become molten and streams of air, or other processes are used to create very fine mineral fibers that are formed into insulation materials. Mineral wool goes by other names and trade names such as rock wool, slag wool, stone wool, or glass where the prefix identifies the type of mineral used in creating the product such as rock or blast furnace slag. Mineral wool is able to stand high temperatures and in impervious to moisture damage.

Mineral wool can be formed into blankets, sheets, or fibers that can be installed using standard insulation techniques. Mineral wool insulation products have seen a resurgence in availability and use in recent years. Mineral wool has a slightly higher R value per inch than fiberglass with a standard five-and-a-half-inch thickness having a value of R23 as opposed to R19 from comparable fiberglass. Rockwool is sold only unfaced, so a separate vapor barrier should be installed when required. (Figure 11-19).

Figure 11-19 Rockwool insulation.

By Øyvind Holmstad [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], from Wikimedia https://commons.wikimedia.org/wiki/File:Matter_av_steinull_1.JPGCommons:

Rigid Foam Insulation

Rigid sheet foam insulation is available in a number of product types including, expanded polystyrene and extruded polystyrene and polyisocyanurate foam sheathing.

Expanded Polystyrene Insulation

Expanded polystyrene (EPS) is easily recognized in the form of commercial consumer products such as foam plate, trays and drinking cups by its white color and beaded texture. It is made by expanding hard polystyrene beads using heat. As the beads expand they adhere to each other in the shape of the mold form. A common name for expanded polystyrene is bead board. Expanded polystyrene is an excellent insulation material that has a wide range of application in the construction industry. It if formed into sheets of standard size such as four feet by eight feet and thickness from one half inch to thirteen inches. Expanded polystyrene can also easily be formed into shapes such as for insulating concrete forms, or substrates for a stucco base.

Figure 11-20 Expanded polystyrene.

By Motokichirou [CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0)], from Wikimedia Commons

The R value of expanded polystyrene is rated at approximately R4 per inch of thickness. Although EPS has a lower R value per inch than extruded polystyrene is considered the best value as it is half the cost per square foot. Expanded polystyrene is not rated for ground contact it does absorb moisture and needs to be treated with insecticides to resist insect damage. It is also more fragile than extruded polystyrene and is sometimes manufactured with foil or plastic facing material (Figure 11-20).

Figure 11-21 Expanded polystyrene insulation.

https://commons.wikimedia.org/wiki/Category:Expanded_polystyrene#/media/File:Beton2.jpg

Extruded Polystyrene Insulation

Extruded polystyrene insulation is recognized by it typical blue, pink, or green color which is specific to the manufacture such as Dow, Blue Styrofoam; Owen Corning, Pink; Kingspan, Green Guard; or Orange, Knauf Polyfoam. Other manufactures also supply it in different colors. Extruded polystyrene foam (XPS) is stiffer, stronger, and offers a higher R value per inch than expanded polystyrene foam and is rated at R5 per inch of thickness. The higher R value also comes with an increased price per square foot. It is also considered a better product for below ground insulation and is often used in installations such the foundation insulation shown in Figure 11-21. The foundation will be backfilled and a concrete slab pour upon the top for the main floor of the residence.

Figure 11-22 Extruded Polystyrene insulation installed in a below ground application.

XPS foam is also frequently used in a variety of other insulation situations such as the example in Figure 11-22 which shows the installation of a Dow Styrofoam© product which is manufactured with grooves for installing batten strips to anchor the exterior siding to.

Figure 11-23 XPS insulation with grooves to installing batten strips for attaching exterior siding.

Figure 11-23 shows an example of extruded polystyrene insulation being installed underneath a concrete basement floor. This help to make the basement living space less cold and damp and more comfortable.

Figure 11-24 Extruded polystyrene insulation being installed underneath a concrete basement floor slab.

Polyisocyanurate Foam Sheathing

Polyisocyanurate is also known as PIP, Poly, or Iso. The process of manufacturing the foam produces a low-conductivity gas within the cells which result in a material with a higher R value than other types of foam, typically around R8 per inch. Tests have shown that the foam loses some R value over time as the low-conductivity gas diffuses out of the panels and is replaced by air in a process known as thermal drift. Tests have also shown that the majority of thermal drift occurs in the first two years, after which the R value remains stable. It is also costlier than both expanded and extruded polystyrene. Often the sheathing has a reflective foil facing which help to limit the thermal drift. The reflective surface of the foil facing when place adjacent to an air space can add R2 to the effective insulation value of the foam (Figure 11-25).

Figure 11-25 Polyisocyanurate Foam Sheathing.

Spray Foam Insulation

Polyisocyanurate foam can also be used for spray, or foam-in-place application. Spray polyurethane foam (SPF) is supplied to the installer in two pressurized containers, a Part A and Part B. One container is poly and the other is isocyanate. The chemicals are mixed in an application gun and sprayed on the surface where it adheres and expands thirty to sixty times the original volume. Spray foam can be categorized into two types, light-density open-cell and medium-density closed-cell foam.

Light-density open cell spray foam is a semi rigid material that expands during the application to fills the crack and voids and adheres to irregular surfaces. It is lower in cost than closed-cell spray foam and has a lower R value of around R4 per inch. The greater volume of expansion makes it ideal for fill deep wall cavities. While it does slow down the transmission of vapor, it is not considered a vapor barrier, but at thickness over five and a half inches it serves as an air barrier.

Medium-density closed cell spray foam is stronger and more rigid and also has a higher R value of five to six per inch. The higher R value does come at a higher cost. Closed-cell spray foam serves as both a vapor and air barrier.

Spray polyurethane foam is measured and estimated using the board-foot method of measurement. One board foot is the measure of volume of spray foam that is one-foot by one-foot square and one inch thick. The square footage of the wall area (in FT2) multiplied by the thickness in inches determines the board-foot quantity of insulation needed.There are a number of formulation of spray foam, some utilize a petroleum base and other a soy base.

Figure 11-27 Spray polyurethane foam installation.

Vapor Barriers

Increased standards for building energy efficiency and insulation requirements also lead to additional challenges with moisture control, particularly, within the building wall cavities. All air contains moisture in the form of water vapor and is measured by the relative humidity. Relative humidity is the amount of water vapor in the air measured as a percentage relative to the amount of water need

Figure 11-26 One board foot

Spray polyurethane foam is used in conjunction with dense pack cellulose in a hybrid application. One or two inches of foam is sprayed in the cavity on the outside of the wall and the balance of the wall is filled with cellulose insulation. This allows for many of the benefits of both. The increase insulation and water/air barrier benefits of the SPF and the lower cost of the dense pack cellulose.

to achieve full saturation at a given temperature. In simple terms warmer air is able to contain more moisture than is cold air. When warm moist air cools, the water vapor in the air condenses out of the air in the form of liquid water.

Heated buildings in cold climates contain warm moist air because the building is heated and moisture is produced by a wide range of normal human activities such as cooking, bathing, sweating, and even breathing. In the natural course of events, heat moves from warm to cold, or outward, from the building through floor, roof, and wall cavities. As the warm moist air contacts cold surfaces such as the exterior wall framing or sheathing it cools and is no longer able

to sustain the previous level of moisture and the water vapor con denses on the framing components. Damp moist building components which are not able to properly dry become an ideal medium for mold to grow and flourish. This problem is exacerbated when the moisture is not allowed to naturally dry and gets trapped inside the building cavity (Figure 11-28).

Figure 11-28 In cold climates the warm moist air migrates out of the building. When the warm moist air hits the cold wall sheathing the moisture condenses in the wall cavity.

The opposite situation occurs in hot moist climates. In this situation the warm moist air is on the outside of the building and when the building is air conditioned the cold dry air is on the interior of the building. As the warm moist air transfers through the wall cavity it

Figure 11-29 In warm climates the warm moist air migrates into the building. When the warm moist are contacts the cold drywall the moisture condenses in the wall.

Figure 11-30

shows an

example where

warm moist air in

a kitchen created

significant mold

damage as it

migrated through

a wall cavity and

condensed upon

the exterior OSB

eventually contacts the cold dry inside face of the drywall and

sheathing.

Figure 11-30 Mold formed on cold OSB sheathing

condenses onto the inside surface (Figure 11-29).

It is impractical to design buildings that never get wet as moisture can enter into the building cavities from both the inside and outside of the building. Vapor barriers are used to help slow the transmission

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of water vapor into the building cavities. Materials have a vapor transmission rate which is measured in perms. The International Residential Code (IRC) identifies three classifications of vapor bar riers which are shown in Table 11-1.

IRC Water Vapor Retarder Classification

Class Material that Meet the Class

Vapor Permeance (Grains/hr./sq.ft./in. Hg) 0.1 perm or less
0.1< perm ≤ 1.0 perm

(per the IRC)

Class I Sheet polyethylene, unperforated aluminum foil

Class II Kraft-faced fiberglass batts Class III 1.0< perm ≤ 10.0 perm Latex or enamel paint Table 11-1 IRC Water vapor perm table.

The local climate conditions have an important influence on the need, material, and placement of the vapor barrier. In northern climate where the need for winter heating is the greatest, the vapor barrier should be place in the inside of the building envelope to slow the transmission of the warm moist interior air towards the outside colder air. The colder the climate, and the greater the temperature difference between the warm moist interior air, and the cold dry exterior air, the greater the need for a more robust vapor barrier.

In warm southern climates the vapor barrier should be placed towards the exterior side of the building envelope because the need for air conditioning is greater and the warm moist air is on the outside of the building, while the cold dry air is on the inside of the building. In mild or balanced climates there may not be a need for a vapor barrier.

The IECC establishes seven climate zones (1-7) in the United States and outlying territories and further subdivides into three moisture regions, Moist (A), Dry (B), and Marine (C). Specific vapor barrier requirements are established by climate zone and moisture region.

Figure 11-31 IECC climate zone and moisture region map.

https://www.energy.gov/sites/prod/files/2015/10/f27/ba_climate_region_guide_7.3.pdf

The document also lists climate zones and moisture regions on a county by county basis. Rexburg, Idaho is located in Madison County, Idaho and has a climate zone/moisture region designation of 6B (Figure 11-33).

Figure 11-32 IECC climate zone and region information for Madison County, Idaho. https://www.iccsafe.org/wp-content/uploads/proclamations/TN06-Vapor-Retarders_pdf.pdf

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The IECC requirements for climate zone 6B identifies two types of wall/vapor barrier assemblies that are approved. The first is identi fied as vented cladding over wood structural panels with fiberboard or gypsum board sheathing. This is essentially traditional wood framed construction with stud framed walls and sheathing on the exterior and drywall on the interior. The vapor barrier can be Class I or Class II, however, Class II is generally recommended and Class I is not recommended when air conditioning is operated for an extended period of time during the cooling season. Figure 11-33 shows an example of this type of construction.

The second approved assembly method is fashioned around the IECC 2015 energy requirements for higher R value continuous insulation. The intent of this wall assembly is to dry towards the interior of the building. The extruded polystyrene foam is listed as a Class II vapor barrier. The vapor barrier on the interior of the wall is general not required. The continuous insulation on the exterior of the building keeps the interior of the of the wall assembly warmer and reduces the moisture condensation within the wall assembly. A Class I vapor is not approved on the interior of the building because of the possibility of creating a double vapor barrier condition which could trap the moisture within the wall and limit the ability of the wall assembly to dry in the case that any moisture gets into the wall cavity (Figure 11-34).

Figure 11-33 Vapor barrier requirements in Zone 6B.

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Smart Vapor Barriers

A newer class of vapor barriers have been developed which are known as smart vapor barriers. These type of vapor barriers are able to react to changing temperature and moisture conditions. During warm temperatures when walls can become saturated with vapor the vapor barrier opens up and becomes more permeable and allows the vapor to exit from the wall cavity. During colder times the vapor barrier acts more like a traditional vapor barrier and becomes less permeable and blocks the entry of moisture (Figure 11-34). Some smart vapor barriers are:

• Pro Clima: INTELLO PLUS

• CertainTeed: MemBrain

Figure 11-34 CertainTeed MemBrain vapor barrier installed.

In addition, some manufactures are creating blanket insulation with smart vapor barrier technology.

Figure 11-35 Wall assembly with continuous an exterior XPS foam insulation vapor barrier.

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Door and Window Sealer

Door and window sealant is poly spay foam that has been conveniently package in small canisters. Spray foam is available in many different formulations and uses. The most common usage is sealing around window and door installations. It is also excellent for use in sealing crack in general. The average home construction has many cracks crevices and holes where air and moisture vapor can get through which can significantly increase the energy usage requirement for the home. Common areas that need additional attention to air sealing include penetrations for electrical boxes and fixtures, holes drilled in plates for the

installation of electrical wires and pipe, and joint cracks between walls and floors, or ceilings.

Door and window sealant is available in

single use disposable cans, usually

twelve or sixteen ounces in size. They

are designed for a single use application.

After the initial use the foam in the can

hardens in the applicator nozzle and

straw and cannot be reused.

Professional application guns are also

available with larger canisters that

can be improved by lightly misting the area to be foamed with water before applying the sealant.

Figure 11-37 Door and window sealant.

CC-BY-Housing Inovation Alliance-NC-SA:

https://www.flickr.com/photos/labhomepittsburgh/4941991004/

In spite of the difficulty, an estimate could be made. One

screw onto the application gun. Also available are screw on cans of cleaner that allow the gun to be cleaned and the canister to be reused (Figure 11-35).

Figure 11-36 Professional spray foam application system. https://www.google.com/search?site =imghp&tbs=sur:fm&tbm=isch&q=g reat+stuff&chips=q:great+stuff,g_1:s

manufacturer claims that a single twelve ounces can contains enough sealant as twenty-two tubes of calk, or seven quarts1. This converts to an expanded volume of approximately one quarter of a cubic foot or 404 cubic inches per can. This would mean that each

Estimating the quantity of door and window sealant can be difficult because of variations in the type of foam and the application method.

ounce of spray foam would expand to a volume equal to 33.7 cubic inches:

The polyurethane spray foam reacts with water in the atmosphere

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the cause the foam to expand and cure. Over dry air can have a detrimental effect on the expanding and curing process. The process

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Making an assumption that spray foam was installed around a door or window opening filling a one quarter inch wide crack two inched deep, each lineal foot of window crevice would require six cubic inches of spay foam:

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Each ounce of spray foam would fill six lineal feet of window open ing.

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The twelve ounce can of spray foam would be able to fill seventy two lineal feet of window opening.

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Obviously this would only be an estimate as the width and depth of the opening to be filled would change with each situation, but this would be a good place to start to establish and basis for an estimate. Professional application spay foam is available in twenty-four and thirty ounce cans of professional foam. The professional foam has a greater expanding capability which the manufacture claims equals twenty-two and thirty-three quarts of caulk respectively which would equate to almost nine lineal feet per ounce. In addition to the smaller fill capacity for disposable cans of spray foam, there is also more waste. A standard will be established in this class of five lineal feet per ounce for the disposable spray foam and ten lineal feet for professional spray foam.

Insulation Material Estimating (Detailed)

This document provides a detailed overview of how to estimate the Insulation Material section of the Estimating Workbook

Table of Contents

Insulation Material Header

Completing the Insulation Material Header Section Excel Figure 11-1 shows and example of the blank header section of the insulation material subsection of the interior finish phase of the estimating template. The header allows for inputs with two different types of insulation and information about the square footage of attic insulation, square footage of wall insulation, square footage of floor insulation, square footage of window area, square footage of door area, rim joist length, and rim joist space height. In addition, once the header inputs are complete the wall insulation area will be calculated.

Excel Figure 11-1 Header section of the insulation material sub-section.

Square Footage of Attic Area Insulation

The square footage of attic insulation is determined by the square footage of the attic area. Often this will be equal to the square footage of floor area quantity in the basic takeoffs. There may be modification to that amount based upon the building construction. For example, a building may have sloped cathedral ceiling that is insulated using fiberglass blanket insulation, in contrast, the rest of the building is a flat ceiling with blow-in fiberglass or cellulose insulation. The header section allows for the input of two different type of insulation should there be a need. Building and wall section detail shown in Figure 11-38 has the insulation details highlighted. This shows that the ceiling insulation requirements will be for R49 blown-in insulation.

Figure 11-38 Wall section detail.

The wall section shows the attic insulation as R49 Blow-in type. No further details are provided and it is likely the building estimator could choose either a blown-in fiberglass or a blown-in cellulose application. The building ceiling is flat, so the square footage of floor area can be used for the square footage of attic area and that number is brought forward from the basic takeoffs and entered into the cell for Type 1insulation. Since there is only one type of insulation, the Type 2 cell is left blank.

Square Footage of Wall Insulation

The square footage of wall insulation is the square footage of the walls that have this type of insulation. The square footage quantity entered is the total square footage of the wall area. Doors, windows, and other openings are not subtracted from the total. The next two inputs will subtract the square footage of insulation for the openings. The square footage of wall insulation can be determined by totaling the square footage of wall are for all walls with the specific type of insulation from the basic takeoffs. Since there are two type of wall insulation, an R21 kraft faced insulation in the main floor walls and a R19 unfaced insulation in the basement insulation walls. In addition, the basement insulation walls have a six mill polyethylene vapor barrier installed. The square footage of wall areas is brought forward from the basic takeoffs.

Square Footage Type 1 Insulation

The square footage of wall area for type one includes both the total area of the exterior walls and the common wall as each wall type has the same insulation requirements. These quantities are added together and brought forward from the basic takeoffs.

Square footage of exterior walls + Square footage of common walls = Total type 1 wall area.

or

Type 1 Insulation Area: 912 ft2. + 176 ft2. = 1088 ft2.

Square Footage Type 2 Insulation

The square footage of Type 2 insulation is the total of the basement insulation walls. This quantity is brought forward from the basic takeoffs and entered into the header sections.

Square Footage Floor Insulation

The square footage of floor insulation allows for input of insulation installed in the floor area. This could include insulation in the floor joist area, or under slab rigid foam insulation. This project has no insulation identified and the totals will be left blank.

Square Footage Window Area

This cells allows input of the window area in the walls where insu lation is installed. This will subtract the window area from the total wall area quantity already input. The square footage of each window can be determined from the basic takeoffs and added together. Windows in walls without insulation such as the garage walls will be excluded from the total.

Square Footage Door Area

This cells allows input of the door area in the walls where insulation is installed. This will subtract the door area from the total wall area quantity already input. The square footage of each door can be determined from the basic takeoffs and added together. Doors in walls without insulation such as the garage walls will be excluded from the total.

Rim Joist Length

The rim joist length inputs allow for input of the length of rim joist where insulation is installed along the rim joist. This is the insulation in the floor cavity along the outside walls between the foundation walls and the first floor walls (Figure 11-38). The length of the rim joist was previously determined when calculating the floor framing and the length could be brought forward from the floor framing subsection of the framing phase of the estimating template.

Figure 11-39 Floor joist space insulation.

Rim Joist Space Height

This cell allows for the input of the rim joist height. This is equal to the total height of the floor joist space. The height of the rim joist space is determined an entered into the cells. Excel Figure 11-2 shows the completed insulation material header section.

Excel Figure 11-2 Insulation material header section complete.

Completing the Insulation Material Subsection The material is entered into the appropriate cells of the materials subsection using the materials userform based upon the type of insulation installed.

Ceiling Insulation Materials

The correct type 1 ceiling material information is placed in the Materials, Size, Units, and Unit Cost cells using the Materials userform. The Quantity is calculated by entering the SFQuantity formula in the cell based upon the square footage of attic area from the header section. The correct formula is shown as follows:

SFQuantity(E20, F9,B20,F20)

The completed formula in the spreadsheet is shown in Excel Figure 11-3.

Excel Figure 11-3 Formula for the type 1 ceiling insulation entered into the spreadsheet.

There is no Type 2 ceiling insulation and the cells will be left blank.

Wall Insulation Materials

The correct wall insulation material information is placed in the Materials, Size, Units, and Unit Cost cells using the Materials userform for both type of materials. The Quantity is calculated by using the SFQuantity formula in the cell based upon the square footage of each wall area from the header section. The correct formula for the Type 1 Wall Insulation is as follows:

SFQuantity(E23, F16, B23, F23)

Excel Figure 11-4 Formula for the Type 1 wall insulation.

The Type 2 wall insulation quantity would be calculated in the same manner.

Floor Insulation Material

There is no floor insulation material and the cells are left blank. Misc. Insulation Materials

The miscellaneous insulation materials include rim joist insulation, door and window seal, vapor barrier, and header insulation.

Rim Joist Insulation

The rim joist insulation will be calculated using the SFQuantity custom function. The quantity of rim joist insulation will be equal to the area of the rim joist length multiplied by the rim joist space height from the header section. Some modification will need to be made by including the multiplication of the rim joist length by the rim joist space height in the SFQuantity formula as is shown outline in red below:

SFQuantity(E29,F14*F15, B29, F29)

Excel Figure 11-5 Rim joist quantity formula.

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Door and Window Seal

The door and window seal will be calculated using the LF quantity cell. The length will be calculated by adding the total perimeter of the windows and doors from the basic takeoffs and dividing by the 5.6 lineal feet per ounce factor that was previously calculated in the door and window seal section on page 20. The completed formula would be as follows:

LFQuantity(E30,(BasicInfo!G80+BasicInfo!G88+ BasicInfoE96)/5.6),B30,F30)

The parenthesis is required around the formula to add the totals from the basic takeoffs. Excel Figure 11-?? Shows the pertinent cells in the basic takeoffs.

Excel Figure 11-6 Basic takeoffs showing the door and window perimeter totals.

Excel Figure 11-7 Door and window seal formula.

Vapor Barrier

The kraft faced insulation will serve as the vapor barrier for the main floor type 1 insulation and no additional vapor barrier will be needed for that, however, there will be a six mill poly vapor barrier installed in the basement insulation walls. The SFQuantity custom function will be used to calculate the quantity of vapor barrier based upon the square footage of wall are from the header section. The information will be taken from the Square Footage of Wall Insulation, not the Wall Insulation Area calculated with the doors and windows areas removed. The formula will be as follows:

SFQuantity(E31, G10,B31,F31)

Excel Figure 11-8 Vapor barrier formula entered into the spreadsheet.

Header Insulation

The header insulation allows for a different type of header insula tion than is installed in the walls. This project uses the same wall insulation type and no addition header insulation will be used. Estimate Example 11-1 shows the completed insulation material sub-phase.

All About Drywall

Drywall is also known as gypsum wallboard (GWB), sheetrock, plasterboard, and wallboard. It is manufactured by crushing the naturally occurring mineral, calcium sulfate dehydrates (gypsum) and then heating the powder in ovens to 350° F to drive off excess water. The dried powder is remixed with and other additives and extruded between layer of paper into sheets that are cut into standard sizes. Drywall in its modern from was first developed in 1916 and used in construction for the next quarter of a century, it wasn't until after World War II that its use in residential house construction began to rapidly expand as is slowly replaced traditional lathe and plaster wall construction.

Drywall Types

Modern drywall can be purchased in a variety of types, thicknesses, widths, and lengths. Types of drywall include standard drywall, fire resistant (Type X), water resistant drywall (green board), mold resistant drywall, and plaster baseboard (blue board)

Standard Drywall

Standard drywall is the most common type of drywall used and is available in the widest range of thickness, lengths and widths. It is commonly faced with white or cream colored paper on the face and brown on back. Standard drywall is manufactured in both standard weight walls and ceiling panels and lightweight wall and ceiling panels. It is available in a wide range of thicknesses, widths and widths. Available thicknesses from one quarter of an inch thick to one-inch-thick and widths of twenty-fours inches, forty-eight inches, and fifty-four inches and lengths from eight feet to sixteen feet. Recommended usage for different thicknesses include:

• ¼” Double layer walls, curved surfaces, sound attenuation systems.

• 5/16” Manufactured housing.

• 3/8” remodeling, base for rigid panels, double layer walls/ceilings, and curved surfaces.

• ½” & 5/8” any interior and some exterior surfaces. • ¾” & 1” interior walls; shaft walls, area separation walls, party walls, fire walls, stairways, duct enclosures.

Table 11-2 shows the sizes that standard drywall in manufactured in.

Gypsum Drywall Size Chart

Width in.		24	24	24	24	48	48	48	48	48	48	54
Length ft.		8	9	10	12	8	9	10	12	14	16	12
Thickness	¼”					*	*	*				
	5/16”					*	*	*	*			
	3/8”					*	*	*				
	½”					*	*	*	*	*	*	*
	5/8”					*	*	*	*	*	*	*
	3/4	*	*	*	*	*	*	*	*			
	1”	*	*	*	*							

Table 11-2 Standard drywall size chart.

Standard drywall is used in residential construction for most applications on the walls or ceilings. The most common thickness used is one half inch thick, however, standard one half inch thick drywall is not approved for installations on ceilings that have a truss or joist spacing of twenty-four inches on center. In this situation either 5/8-inch standard drywall, or lightweight ½ inch drywall that is approved for ceiling twenty-four-inch installation is used.

Figure 11-40 Standard twelve feet sheets of one-half inch drywall.

Fire Resistant Drywall

Standard drywall is naturally resistant to fire damage. The drywall contains water within the gypsum which, when heated, turns to steam and much of the thermal energy of the fire is dispersed. Eventually the heat of the fire will cause the drywall to crack in the same fashion as a dry lake bed. Type X drywall has glass fibers included in the gypsum core. The purpose of the glass fibers is to reinforce the drywall and minimize the cracks which give the wallboard a longer time period before it breaks down. Increased fire resistance can be increased by installing additional layer of drywall.

Figure 11-41 Firecode drywall label.

In a residential application the most common usage of fire resistant drywall is for the firewall that code requires to be installed between the house and an attached garage. The building code requires the firewall to be installed from the floor to the roof, however, if the ceiling garage ceiling is fire rated the fire wall can end at the ceiling. The building code requires that the fire resistant dry be installed on the exterior (garage side) of the wall. The minimum code thickness requirement for fire resistant drywall is one half inch, however, Type X drywall at one half inch thickness does not meet the requirement. Test have shown that 5/8-inch-thick Type X drywall will last for fifty-seven minutes when exposed to an 1850° F fire, whereas standard 5/8-inch drywall will last only twelve minutes. The code approved one half inch thick fire resistant drywall is known as Type C. This special drywall has additional glass fibers and vermiculite in the core. It has been shown that Type C can withstand an 1850° F fire for over two hours without any sign of failure.

Figure 11-42 Type X drywall installed on garage walls and ceilings.

Water Resistant Drywall

Water resistant drywall is commonly called green board because of its green color. It is drywall that is manufactured with a special water resistant gypsum core and water repellant paper. It is designed to be used as a base for ceramic or plastic wall tiles, or other finish panels in non-wet areas. It is not designed for the installation of ceramic tile where the tile will be exposed to running water. It is recom

mended that glass mat faced gypsum board, or cement board be used as a substrate for tile when it is exposed to running water. It is also not recommended that water resistant drywall be installed on a ceiling unless the framing members are no more that twelve inches on center. This product is available with both a regular and type X core in one half inch and five eights inch thicknesses and lengths of eight, ten and twelve feet.

Figure 11-43 Water resistant drywall installed on bathroom walls. CC-BY-Garann-SA:https://www.flickr.com/photos/iluvrhinestones/4548702334

Mold Resistant Drywall

Mold resistant drywall is manufactured to address the problem of mold forming in the surface of the drywall in areas where it is exposed to moisture. The gypsum core of drywall in impervious to mold, however, the paper facing on drywall can serve as food for mold spores and can encourage their growth where the moisture conditions are right.

Mold resistant drywall is manufactured with either a fiberglass facing or treated mold resistant facing. Some types can be used as an approved backing for direct installation of ceramic tile and others with the same limitation as water resistant drywall. It is available in both one half inch and five eights inch thicknesses and eight, ten and twelve foot lengths.

Figure 11-44 Mold resistant drywall installed in a bathroom on the walls and ceiling. CC-BY-Jesus Rodriquez: https://books.byui.edu/-MvDs

Plaster Baseboard

Plaster baseboard is recognized by its blue color. It is a special type of drywall that is used as a base for plaster coated walls. These wall types are finished by skim coating the entire walls will a plaster

coating. It is not appropriate for use with traditional gypsum wallboard compound.

Figure 11-45 Plasterboard drywall.

Drywall Accessories

The installation of gypsum wallboard requires a number of additional accessory items to complete the installation and finishing including, adhesive, screws and nails, outside corner trim, joint tape, and drywall mud.

Adhesive

While it is not required to install drywall using adhesives the instal lation can be improved with the use of adhesives, particularly in helping to reduce nails pops in the finished drywall. The adhesive is used to attached the wallboard to the wall studs and plates. Types of adhesives commonly used are construction adhesive and spray foam type adhesives.

Figure 11-46 Gel adhesive (Need new Picture)

https://youtu.be/WQYS9_y2cqE

The makers of Touch and Seal foam adhesive suggest that a single twenty-four ounces can will create 480 lineal feet of one half inch glue bead. Traditional sixteen-inch stud spacing requires seven studs for every eight-foot piece of drywall. This means on eight-foot piece will need twenty-eight lineal feet of adhesive. A single twenty-four once can will attach 550 square feet of drywall, or 22 square feet of drywall per ounce.

Screws and Nails

Drywall is attached to wall and ceiling framing with either nails or screws, or a combination of both. Both the IRC and the Gypsum Association specify minimum nailing or screwing requirement for the attachment of drywall on both walls and ceilings. The requirement specifies both the spacing requirements and fastener size. Two nailing/screwing patterns are approved; the single nailing pattern and the double nailing pattern.

Figure 11-47 Drywall screws and nails.

Single Nailing Pattern

The single nailing pattern requires nails to be spaced 3/8 inch to ½ inch from the butt edges of the drywall fastened to the framing and 3/8 inch to 1 inch from the edge perpendicular to the framing. The drywall is nailed in the field of the panel a maximum of seven inches on center for ceilings and eight inches on center for wall. Using screws for attachment increases the maximum spacing requirements to twelve inches on the ceiling and sixteen inches on the walls. Figure 11-42 shows a diagram of the approve single nailing pattern.

Figure 11-48 Drywall single nailing pattern.

Double Nailing Pattern

The double nailing pattern requires nails or screws to be spaced 3/8 inch to ½ inch from the butt edges of the drywall fastened to the framing and 3/8 inch to 1 inch from the edge perpendicular to the framing. The edge nail or screw spacing follows the same spacing of a maximum of seven inches on center for the ceilings and eight inches on center for the walls. The first set of nails or screws for the drywall field are spaced a maximum of twelve inches on center for both ceilings and walls. A second set of nails or screws is placed two to two and a half inches away from the first nails. After nailing or screwing the second set, the first set of nails or screws are re-nailed to tighten and loose nails (Figure 11-43).

Estimating Screws and Nails

1.75 screws per square foot

Figure 11-49 Double drywall nailing pattern.

Drywall Trim

Outside corners of drywall need to be reinforced and protected from damage. Corner trim (bead) is typically installed on each outside wall corner. Several different type of drywall corner bead are avail able in addition to square corners. Other popular profiles include radius corners and beveled corners. Corner trim can also be installed on the corners of drywall openings for passageways and around window jambs. Other types of trim are also available such as inside corners, edge trim, and expansion joints.

Kinds of drywall trim can be classified into three main types, metal trim, paper faced trim, and vinyl trim. (Figure 11-45).

Figure 11-50 Three types of drywall corner trim.

Metal Drywall Trim

Metal trim is the most common type of drywall trim used. It is available in many different profiles and uses. It is usually attached to the edges with nails or staples. In addition, a special drywall corner crimping tool can be used. This would also be the procedure for installing metal corners on metal stud walls as nails won't hold to the metal studs and the head of drywall screws protrude to much for use on the corner bead. The short You Tube video below shows the installation of metal drywall corner bead using a crimping tool.

https://www.youtube.com/watch?v=qA9FNU7x_kM Figure 11-46 shows a basement room with several pieces of metal corner bead installed along the edge of a shelf wall, around a ceiling ductwork protrusion, and around an entrance to a hallway.

Figure 11-51 Metal drywall corner bead installed ready for taping. CC-BY-nusitegroup-NC: https://www.flickr.com/photos/90985226

Paper Faced Drywall Trim

Paper faced drywall trim is manufactured with a metal corner or edge bonded to a paper facing. The drywall trim is installed by spreading a bead of drywall mud on both sides of the corner and pressing the paper tape into the wet mud and smoothing the seam with drywall taping knife. The drywall mud is allowed to dry and several additional coats of mud are placed over the trim to smooth and finish it. Figure 11-47 shows and example of forty-five-degree paper faced drywall trim installed on the outside corners of a pantry closet and square corner trim around door openings.

Figure 11-52 Paper faced drywall trim installed. Forty-five-degree angle trim installed on outside closet corners and square corner trim installed around door opening.

CC-BY-Kevin Haggerty-NC: https://www.flickr.com/photos/haggaret/75726156 Vinyl Drywall Trim

Vinyl drywall trim is manufactured in a wider range of shapes and style than the other types of drywall trim. There are two installation methods for installing vinyl drywall trim. The mud set method and the glue and staple method. Vinyl trim that is set using the mud set method is installed by placing a bead of drywall mud on each side of the corner and pressing the trim into the corner and smoothing it flat with a drywall knife. A second covering coat can be placed immediately over the bedded drywall trim.

The glue and staple method is installed by using a special spray-on adhesive. The adhesive is sprayed onto the back side of the trim and the trim placed over the corner. Staples are used to further anchor the trim to the drywall and a layer of taping compound placed over the corner bead. Short videos demonstrating both the mud set and glue and staple method of installing vinyl drywall trim.

http://explore.trim-tex.com/content/comparing-corner-bead installation-methods

Figure 11-53 Rigid and flexible vinyl drywall corner trim.

https://www.wconline.com/articles/90384-cornerbead-in-basements-and-bathrooms-vinyl-solution Estimating Drywall Trim

Drywall Trim Finish Methods and Materials

Estimating drywall trim requires the construction estimator to be aware of a variety of finish trim methods and materials and to be able to determine and understand the specific method that is going to be used on the construction project. Places that drywall trim can be used include, outside corners of walls and ceilings, around window openings, and around door openings.

Drywall trim on outside corners of walls and ceilings The most common place for installing drywall trim is on the exterior corners of walls and ceilings. Figures 11-48 through 11-51 shows examples of wall and ceiling corners which will require the application of corner trim.

Figure 11-54 Fireplace will need two forty-five-degree corners installed.

Figure 11-55 Wall and plant shelf corners.

Figure 11-56 Corner and door opening square corners.

Figure 11-57 Trey ceiling alcove will need square corner bead around perimeter.

Figure 11-52 shows a portion of a room which required drywall trim in a number of places including, corners at the hallway entrance, around the arched door opening, and the hallway opening in the background. Of note is the alcove above the door. Corner trim was used on the alcove sides and the sides and bottom of the alcove base projection. The top of the base projection, however uses a painted wood base and trim instead of drywall trim.

Figure 11-58 Multiple pieces of finished drywall corner trim.

Drywall trim around windows

Determining if drywall trim will be needed around window open ings will require the construction estimator to understand the method that will be used to trim the window. Some windows are manufactured at the full depth of the wall, or can be ordered with factory supplied jamb extensions, and require no drywall trim, but, instead, use wooden molding trim to finish the window such as the window shown in Figure 11-53.

Figure 11-59 Windows manufactured with frame designed to be installed flush to the drywall face will not require additional drywall corner trim.

Windows that are not manufactured with frames that are flush to the interior drywall face can also be installed with site fabricated jamb extensions and window trim can be installed in the same fashion as windows with flush manufactured frames. If this is the design intent as is shown in Figure 11-54, then the window will not need any additional drywall trim for the installation.

Figure 11-60 Window with site fabricated jamb extensions and trim will not require additional drywall trim.

Windows that are not manufactured with frames that are flush to the interior drywall face can also be installed with drywall returns on the head and jamb of the window. This installation will require drywall window trim on three sides of the window and the base of the window opening will have a window sill installed using wood or other material. Figure 11-55 shows and example of two windows that utilized drywall trim on three sides. the window in the left has the wallboard return installed, but not corner trim. The arch at the top of the window will require trim that can be made to conform to the arch shape such as flexible vinyl corner trim. The window on the left has had radius corner trim installed that has been taped and painted.

Figure 11-61 Two windows that require drywall corner trim to finish three sides of the window and a wood sill.

Windows can be installed with drywall corner trim on all four side such as is shown in Figure 11-56.

Determining the quantity of drywall trim for a specific project requires the construction estimator to gain an understanding of the specifics for that project. This may not be something explicitly spelled out in the construction documents. As has been shown, much depends upon the particular windows installed and the trim requirements for those windows. In addition, a residential construction company may have a certain standard such as basic trim package which offers drywall trim on three sides of the window opening with a wood sill and apron. They may offer the full window casing as an upgrade that can be purchased by the customer. Regardless of the particular situation, the construction estimator will need to make the effort to understand and become clear about the project specifics.

Figure 11-62 Drywall corner trim installed on all four side of the jamb return on this window.

Drywall Trim Around Doors and Other Openings

Drywall trim around door and other openings. The same situation as with windows openings also applies to doors and other openings. The opening may be trimmed with wood or other material, or it may utilize drywall trim to finish the opening. Figure 11-57 shows an example of a closet door opening that has no trim, either wood or drywall, installed. This door opening will most likely have a closet door installed in the space. The opening can be completed using one of several methods such as drywall corner trim, or wood door jambs and trim, or a combination of both.

Figure 11-63 Unfinished closet door opening.

Figure 11-58 shows a closet door finished with drywall corner trim. Estimating the drywall trim for this door would be two times the perimeter of the door opening.

Figure 11-64 Closet door jambs finished with drywall corner trim. CC-By-Lee Cannon-SA: https://www.flickr.com/photos/leecannon/10180496614

Figure 11-59 shows an exterior patio door that has drywall corner trim on one side of the opening. Estimating this door trim will be equal to the perimeter of the door opening.

Figure 11-65 Drywall corner trim on one side of this patio door.

Figure 11-60 shows and example of an elliptical archway that has been finished with drywall radius corner trim.

Drywall Tape

The two basic types of drywall tape are paper tape and mesh tape. Both can be used for finishing drywall joist and each has its plus and minuses.

Paper Tape

Paper tape is the most common type of drywall tape used. It does not have any adhesive on the tape so it must be installed by applying a layer of joint compound over the joint or seam and pressing the tape into the compound and smoothing it down with a taping knife. Because it is embedded into joint compound, if gaps are allowed in the layer of compound, the air bubbles can form which doesn't allow the tape to stick. Paper tape is not a s strong as mesh tape, but, doesn't stretch like mesh tape, so it results in a stronger joint. Paper tape is also pre-creased, so it is easier to install in a corner. Equipment is also available that runs the paper tape through joint compound in a container so that it is pre-coated before installing. Both normal and setting joint compound can be used when installing paper tape.

Figure 11-67 Paper drywall tape. http://www.tymaterial.com/Drywall-Joint-paper tape-p23.html: Labeled for Non-commercial reuse with modifications

Figure 11-66 Elliptical archway finished with radius corner trim.

Mesh Tap

Mesh tape is made from a fiberglass mesh that has an adhesive on it, so the tape can be adhered to the drywall without the step of adding joint compound to the wall. This means that the tape can be installed in the entire room before covering with joint compound. Mesh tape is harder to install in corners because it is not pre-crease, however, some tools are available for installing mesh tapes the crimp and press the tape in the corner while installing. Although paper tape can be installed on paperless mold resistant drywall, mesh tape is recommended because it is impervious to mold. Mesh tape should be coated with a layer of compounds available, but, can be classified into two type, pre-mixed compound and setting compound.

Figure 11-68 Fiberglass mesh tape. http://www.fiberglass-tape.org/fiberglass/fiberglass drywall-joint-tape.html: Labeled for non-commercial use with modifications.

Pre-Mixed Joint Compound

Pre-mixed joint compound is most often supplied in standard 4.5 gallon buckets, or 3.5 gallon plastic lined boxes and is ready to use from the bucket or box. At times, however, it may be desirable to thin with a small amount of water depending on the intended usage.

Several different formulations of pre-mixed joint compound are available including “all-purpose”, lightweight “all-purpose”, and setting compound first, after which normal joint compound can be used.

Figure 11-69 Installing paper drywall tape.

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https://www.flickr.com/photos/fsnorthernregion/5105171137

Drywall Joint Compound

Drywall joint compound is also called drywall mud, drywall compound, or mud. Several different type of drywall joint “topping” compound. The most common type is “all-purpose” and, as the name implies, can be used for the majority of joint taping procedures. It has more adhesive in the mixture than some other types which makes it desirable for operations like embedding joint tape. It is also good to use for filling corner bead. It may be used for the finish coat, or substituted with topping compound which has less glue and is easier to sand, although some professionals believe that the harder “all-purpose” compound provides a harder and more durable surface, in spite of the extra work.

Light-weight all-purpose joint compound is lighter in weight than traditional all-purpose joint compound. It can be used for all taping operations. It is easier to sand than standard all-purpose joint compound.

Topping joint compound, it used for the last and final coat. It is a little smoother and easier to apply than all-purpose and is easier to sand for the final coat. It has less glue so it is softer and not appropriate for taping operations such as bedding joint tape. It is typically whiter in color and dries lighter than all-purpose joint compound so that the two types can be distinguished from each other in use.

Figure 11-70 Buckets of all-purpose drywall joint compound.

Setting Type Joint Compound

Setting type joint compound is sold as a dry powder that is mixed with water into a smooth paste like consistency. Mixing the com pound with water activates a chemical process the begins the hardening process. The manufacture can mix different quantities of hardener into the powder to accelerate or slow down the setting process. Setting mud is commonly sold in formulation that have a setting time of five, twenty, forty-five, sixty, and ninety minutes. This is the time it takes the compound to harden, but, additional time will be needed for it to dry completely.

Setting compound dries harder and stronger than pre-mixed drywall compound. It is a good choice for bedding the drywall tape, and is the recommended choice when using mesh tape. It is also commonly used for the first coats filling drywall trim such as corner bead all it allows multiple coat to be applied on the same day, and does not shrink like regular joint compound.

Setting mud is usually not used for the finish taping coat because it is harder and more difficult to sand than regular mud. It is available in both regular and lightweight mixes. The regular mix is harder and stronger than the lightweight version, but is more difficult to use.

Figure 11-71 lightweight setting type joint compound.

All About Window Trim

Window Trim

There are number of potential approaches for finishing the interior of windows. The construction and materials of the particular window unit can in part dictate the interior trim method. Other choices are based on financial, style, or esthetic considerations. As was previously discussed in Chapter 10, contemporary window units can be manufactured from wood, vinyl, fiberglass, composite, aluminum, or combination of these materials. The construction materials of the window frame can have some application of the in the choice window trim material such as the windows shown in Figure 11-71 which have a stained hardwood frame with matching stained hardwood interior trim.

Figure 11-72 Windows with stained hardwood frames and matching stained hardwood interior trim.

Another important factor in the application of window trim is the design of the window frame in relation to the interior face of the wall. Some windows are manufactured with a window frame that is flush to the interior face of the drywall, or are supplied with flush jamb extensions by the manufacturer, others are manufactured with window frames that are recessed into the window opening and required additional material to finish the window returns.

Windows with Flush Fames

Figure 11-72 shows an example of a window frame that has been manufactured to be flush with the interior face of the wall. These are often premium window types and the interior trim is an essential element in style and look of the finish installation.

Figure 11-73 Window unit manufactured with frame flush to interior wall surface.

These windows types typically require interior trim to be installed on all four side of the window frame. The style of the window trim can have many variations such as, picture frame casing, or traditional window casing, sill, and apron. In addition, other trim pieces can be installed to achieve a specific style or design condi tion.

Picture Framed Cased Windows

The most basic style of interior trim can be classified as picture frame style. With this style of trim casing is installed on the face of the four sides of the window frame. Figure 11-73 shows and example of picture framed window casing.

Figure 11-74 Picture frame cased window.

The length of each piece of trim is determined by the width and height of the window plus two times the casing width. For example, if the window is and forty-eight inches tall and forty-eight inches wide, and the casing is three and one quarter of an inch wide, the length of casing for each window side would be:

������������ �������� �������� ������������: ���� ����. +�� × ����������. = ������������. The total window trim length would equal:

���������� ������������ �������� ������������: ������������.× �� = ������ ����. Traditional Casing, Sill, and Apron

The most common traditional method of casing windows is composed of five trim pieces, one head casing, two side casings, one window sill (sometimes called the stool), and one apron molding. Figure 11-74 shows an example of window cased using a five-piece traditional casing.

Figure 11-75 Traditional five-piece casing set.

Estimating the five-piece casing set would include estimating four pieces of casing the same as for a picture frame window. In addition, the window sill would be as wide as twice the casing thickness and two inched longer than the head casing length. The sill can be made out of a three quarter inch thick piece, or it could be thicker such as one inch thick. If the window in this example were forty-eight inches wide by forty-eight inches tall the window trim estimate would be:

������������ ������������: �� ������. �� ����������. × ������������.

������������ ��������: ��������. �� �� ����. × ������������.

Other Window Casing Styles

Many other casing styles are possible that use other trim pieces, in cluding back bands, fillets, frieze boards, cap trim, and crown. Back Band Trim

Figure 11-75 shows and example of a style window using 5/8-inch thick, ¾ inch wide flat casing and ¾ inch thick, 1-1/4-inch-deep back bands.

Figure 11-76 Window casing style with flat casing and back band trim.

If the window in this example were forty-eight inches wide and forty-eight inches tall the casing would equal:

������������ ������������: �� ������. �� ����������. × ������������.

The back bands would be longer than the casing as they would also have to include the thickness of the back bands on each side: �������� ����������: ������������. +�� ×��������. = ���� ����.

Total back band length would include the length of the back bands for the four window sides, plus a small amount for the back bands on the right and left side of the window apron:

�������� �������� ����������: �� ������.× ���� ����. +�� ������.× ����������. = ��������������. Fillet, Frieze Boards and Crown Trim

Figure 11-76 shows an example of window trim that includes fillet trim, a frieze board, and crown trim.

Figure 11-77 Window casing style with fillet, frieze board, and crown molding trim.

Estimating this type of trim would include estimating three casing sides, one window sill, one fillet trim, one frieze board trim, and one crown molding trim using methods similar to estimating other window trim styles discusses.

Windows with Inset Frames

The desire to make more buildings more energy efficient has led to an increase in the thickness of the walls of typical residential construction and most exterior wall framing is two by six construction instead of two by four construction. Many window units are manufactured at widths that are shallower than the depth of the wall they are installed in. With this type of window additional material will need to be installed at the site to finish the jamb returns. One option is to install drywall jamb returns on three or four side of the window as was shown previously in Figures 11-59 to 11-61. Another option is to install site fabricated window jamb and sill extensions.

Figure 11-78 Window manufactured with frame insert from the face of the wall.

The cutaway window view shown in Figure 11-73 shows a window manufactured so that the frame of the window sets back from the face of the wall requiring additional site applied jamb material. Any of the window casing styles previously discussed can be used to trim windows with inset frame, however, the estimate will require the addition of jamb extension material. In addition, other window trim options are available such as using drywall returns for the head and sides of the window opening and installing only window sill and apron trim.

Drywall Corner Bead and Wood Sill and Apron

Figure 11-78 shows and example of a window with drywall corner bead installed on both side and the top of the jamb returns. The bottom of the window has a wood sill and apron molding installed. The wood sill material will need to be wider to accommodate the deep window depth of the inset window installation. The two by six exterior wall framing will require a sill material that is at least five and a half inches wide and three to four inches longer than the width of the window opening. The apron molding will need to be one or two inches longer than the width of the window opening. Using the example of a window that is forty-eight inches wide and forty-eight inches tall the following material will need to be purchased:

������������ ��������: ��������. ×��������. × ����������. × ���� ����. ������������ ����������: �� ������. × ����������. × ���� ����.

Figure 11-79 Inset window with drywall corner bead and wood sill and apron molding.

Figure 11-79 shows a photograph of a wood sill and apron molding with drywall corners on the sides and top.

Figure 11-80 Photograph of and inset window with a wood sill and apron molding.

Picture Frame Molding

Picture frame molding are also another possible option for insert windows. The casing would be calculated in the same way as with a flush frame window. In addition, jamb material will be required on all for side of the window opening.

Figure 11-80 shows and example of an inset widow with picture frame molding around four sides.

Figure 11-81 Inset Window with picture frame molding on four sides.

Traditional five-piece window trim. Windows with inset frames can also be trimmed with the traditional sill, apron, side and head casing profiles. The estimates for the casing pieces would be the same as for a flush frame window, however, both side and head jam material will need to be purchased. In addition, the sill will need to be wider in relation to the side and head jamb widths. Figure 11081 shows and example of a traditional five-piece casing installation on an inset window.

Figure 11-82 Inset window installation with traditional five piece casing style.

The depth of the extension jambs and the window sill is dependent upon the installation and the thickness of the wall it is installed in. For example, Figure 11-82 shows jamb extension on a window installed in a basement. The extra wide jamb extensions are built using a frame and panel construction. The wide window sill is part of the wainscot top rail. Figure 11-83 shows a window jamb and sill installed in a typical two by six stud wall. The estimator will need to be able to determine the width of the wall assembly and the window frame inset distance.

Figure 11-83 Wide basement window well jambs and sill.

Figure 11-84 Inset window sill and jamb on typical two by six exterior wall.

Figure 11-85 Window schedule.

Window Trim Material Estimating (Detailed)

The window trim materials for a project can be determined from the plans and specifications for the project. For example, Figure 11-84 shows the window schedule which identifies which windows on the project will have trim installed and the type of trim that will be in stalled. Some windows such as those installed in the unfinished basement and garage will not have trim installed.

Figure 11-85 shows a window detail section from the project with the applicable window trim highlighted. The section detail shows that the windows are trimmed in a traditional sill, casing, and apron style. The window sill and returns are completed using three quarter inch thick MDF material and the top, side, and apron moldings are 2-1/4” finger jointer pine casing.

Window Trim Material Header

Excel Figure 11-9 Shows an example of the header section of the window trim materials subsection. The windows in the project are brought forward from the basic takeoff’s The number of windows, window width and height are also listed. The header allows for a manual input of the number of windows for each style that will have trim. This is to account for windows such as those in the garage which do not have trim installed.

Figure 11-86 Window trim section detail.

Excel Figure 11-9 Blank window material header section.

Manual inputs are also required at the bottom of the horizontal width and vertical height column.

Number of Casing Sides

The first input required is the number of casing sides. One of three inputs are needed. A zero, a one, or a two. The number represent the number of pieces of casing that will be installed along the horizontal direction on the window on the top or the bottom. For example, the window with only a sill and apron casing shown in Figure 11-78 has only one horizontal apron casing and a one would be input into the cell. The windows shown in Figures 11-80 and 11-81 have casing along both the top and bottom sides of the window and a two would be input into the cell.

The cell at the bottom of the vertical height column allows for input of the number of casing pieces along the vertical direction of the window casing. The window with only a sill and apron casing shown in Figure 11-78 would have a zero input as there are no casing sides on this window. The windows shown in Figures 11-80 and 11-81 have casing on both sides and a two would be input.

Jamb Extensions

The cells that correspond to the jamb extensions input allows for a zero, one, or two to calculate the number of pieces of jamb extension material that will need to be purchased. The cells at the bottom of

the horizontal width column records jamb extensions that are required along the top and bottom of the window in the horizontal direction. This input does not include window sills that are installed at the base of the window in the traditional sill and apron style window trim. For example, the window shown in Figure 11-78would have a zero input as there is no jamb extension along the top side, and the window sill on the bottom would be counted in the window sill column below. The window shown in Figure 11-80

would have a two input into the cell as this picture frame window has a jamb extension on both the top and the bottom. The window shown in Figure 11-81 would have a one input as there is a jamb extension along the top and a sill is installed along the bottom, which will be accounted for in the window sill cell below.

Window Sill

The window sill input is only below the horizontal width column because the window sill is installed only along the bottom horizontal side of the window. This includes only traditional apron, casing style window trim such as installed on the windows in Figure 11-78 and 11-81. To estimate windows of this type, a one would be input in this cell. The picture framed casing style in Figure 11-80 would be counted as two jamb extensions in the cell above and a zero would be input into the cell.

Casing Width

The width of the window casing used in the project would be input into the casing width cell. Double the casing width would be added to the length of each casing piece to account for the extra amount needed to cut the miters in the corners, or the miter returns on the apron casing.

Completing the Window Trim Materials Subsection Excel Figure 11-10 shows the window trim materials header section filled out based upon the information shown in the window schedule in Figure 11-84 and the window detail section in Figure 11-85.

Excel Figure 11-10 Completed window trim header.

The correct jamb extension, window sill, and window casing mate rials determined from the window schedule and detail section is entered into the spreadsheet using the materials userform. The quantities are set up to be automatically calculated from the information in the header section. Figure 11-86 shows the completed window materials subsection. Two bundles of shims are manually input into the appropriate cells.

Excel Figure 11-11 Completed window trim materials.

All About Interior Door Materials

Estimating interior door finish includes estimating the interior passage doors, closest doors, exterior and interior door trim and moldings, and door hardware.

Types of Interior Doors

Interior Passage Doors

Interior passage doors are available in a wide number of materials and styles. Materials for interior doors include solid wood frame and panel doors, flat panel solid and hollow core, and composite wood doors. In addition, some interior doors can have glass panels.

Solid Wood Frame and Panel Doors

Solid wood frame ad panel doors are frequently used in high end construction or for traditional style interior finishes. They are available in a wide range of wood species and door styles such as is shown in Figures 11-86 and 11-87.

Figure 11-87 Four wood panel door styles.

Figure 11-88 Wood panel door styles.

Interior solid frame and panel doors are constructed using the same methods as exterior solid wood frame and panel doors as previously discussed with exterior doors in Chapter 10. Figure 11-88 shows an explode view of typical construction of an interior frame and panel door.

Figure 11-89 Exploded frame and panel door.

Molded Fiberboard Doors

Molded composite doors are a common modern alternative to solid wood frame and panel doors. Composite doors are constructed by bonding molded wood fiber face panels to an interior frame of wood, wood fiber, or other material. They can be purchased in either a hollow core or molded solid core construction. They are most often manufactured pre-primed and ready for a coat of finished paint of the desired color. They are manufactured in a wide range of sizes and styles, many that mimic traditional frame and panel construction.

Figure 11-90 Molded composite door styles.

Figure 11-90 shows an example of a cutaway view of a molded fiberboard door. Molded fiberboard skins are bonded to a core fame made from Medium Density Fiberboard (MDF) or solid wood. The frame serves as a base for hollow core doors. The core can also be filled with solid wood or other material to make a solid core door for increased sound transmission and fire resistance.

Figure 11-91 Cutaway view of a hollow core molded fiberboard interior door.

Flat Panel Interior Doors

Flat panel interior doors are constructed in a fashion similar to molded fiberboard interior doors. They can be either hollow core or solid core interiors. The skins on the doors can be either a veneer plywood material, or fiberboard material. Often hardwood veneers are used for making these type of doors.

Figure 11-92 Flat panel hardwood veneered doors.

Hollow core flat panel doors often have an outside frame constructed of either solid wood or MDF and a center core of honeycomb material as is shown in Figure 11-92.

Figure 11-93 Cutaway view of hollow core flat panel door.

Door Sizes

Exterior and interior doors for residential construction are made in a variety of standard widths, heights, and thicknesses. Standard Door Widths.

The vast majority of doors used in both residential and commercial construction are manufactured in standard widths ranging from two feet to three feet wide. Doors can be specified using either an inch measurement or a feet measurement. Standard doors widths include the following:

1 ft. – 0 in. or 12 in.

1 ft. – 2 in. or 14 in.

1 ft. – 3 in. or 15 in.

1 ft. – 4 in. or 16 in.

1 ft. – 6 in. or 18 in.

1 ft. – 8 in. or 20 in.

1 ft. – 10 in. or 22 in.

2 ft. - 0 in. or 24 in.

2 ft. – 2 in. 0r 26 in.

2 ft. – 4 in. or 28 in.

2 ft. – 6 in. or 30 in.

2 ft. – 8 in. or 32 in.

2 ft. – 10 in. or 34 in.

3 ft. – 0 in. or 36 in.

The doors shown in bold are the most often stocked sizes with the other doors usually available through special order. Other widths are sometimes specified when wider doors are needed, such as in a hos pital situation, but, most residential doors installed use standard widths. Doors two-feet-six inches or wider are usually used for entrance doors to rooms such as living rooms, bedrooms, kitchens and bathrooms. Occasionally, bathrooms, or other utility rooms use the narrower size down to two-feet-four-inch. The smaller sizes are used for closets or in tandem with multiple doors such as bifold doors. Doors to rooms that need to meet ADA requirements are specified as three feet wide. In addition, exterior doors are usually also three feet wide, but, occasionally, doors thirty-two inches wide are installed. The International Residential Code requires are least one three-foot-wide exterior door to a residence.

Standard Door Heights

The most common standard doors heights used are six feet eight inches tall, seven feet tall, and eight feet tall. Doors used in commercial construction are typically seven feet tall, while doors used in residential construction are typically six-feet-eight-inches

tall, although, seven-foot-tall doors are occasionally used in residential construction, particularly, in high end residential construction. Doors heights can also be specified using inches:

6 ft. – 8 in. or 80 in.

7 ft. – 0 in. or 84 in.

8 ft. – 0 in. or 96 in.

Occasionally, other door heights are used including six-feet- ten inches tall. High end residential construction also occasionally uses taller doors, particularly, for architectural styled entranced doors. Standard Door Thicknesses

Two standard door thickness are commonly used in construction. Residential interior doors are commonly one-and-three-eights-inch thick and exterior doors are one-and-three-quarters-inch thick. Commercial doors, both interior and exterior are most often one and-three-quarters-inch thick. Closet bifold doors are occasionally thinner at one-and-one-eighth-inch thick. Occasionally, architecturally styled entrance doors are also thicker such as two and-one-quarter-inch thick. The thickness would be listed as:

1-1/8 in.

1-3/8 in.

1-3/4 in.

2-1/4 in.

Pre-Hung Doors and Slab Doors

Most doors can be purchased as either a pre-hung door which includes the door slab and other trim and hardware, or as the door slab only with the additional items purchased separately as needed. It is important for the construction estimator to understand all of the elements and circumstances for door installation in order to prepare accurate construction door estimates. There are situations which may require the estimator to price only pre-hung doors, only slab doors, or both door types on a single project.

Pre-Hung Doors

Most residential passage doors are delivered to the job site pre-hung upon the door jambs. This means that the door is supplied with the hinges installed and the door hanging on its own frame, ready to be placed into the prepared door opening. This significantly reduces the time and cost required to installed doors on the jobsite. Most building materials suppliers have facilities to provide pre-hung doors to meet their client's needs. Different materials and methods are commonly used for pre-hung exterior and interior doors.

Pre-hung Exterior Doors

Residential exterior doors are typically thicker, stronger, and heavier than the interior doors. The minimum thickness is usually one and three quarters of an inch and the minimum height is six feet eight. In addition, pre-hung exterior doors are installed on rabbeted exterior jambs and often have a threshold and weather stripping preinstalled. Figure 11-93 shows a cutaway view of a typical exterior door installation.

Figure 11-94 Pre-hung exterior door.

The pre-installed threshold and weather stripping is a distinct advantage with pre-hung exterior doors because if they are installed properly, they are weather-tight off of the shelf and don't require the installation of the threshold on the site, or the weather stripping which can be time consuming and difficult.

Pre-hung exterior doors often also come with the exterior brick molding trim already installed. If this is the case, the only additional trim needed for door installation is the interior casing trim. If the door does not come with the exterior brick molding supplied, exterior brick molding will need to be also purchased to complete the installation. The construction estimator will need to determine what specific elements are supplied with the pre-hung exterior door. Figure 11-94 shows a picture of exterior doors and windows delivered to the job site ready for installation. These doors have the brick molding trim, threshold, and weather stripping already installed. In addition, the lockset and deadbolt installation holes have been pre-drilled. The only trim item needed to finish these doors will be the interior casing trim.

Figure 11-95 Pre-hung exterior doors delivered to the job site ready for installation.

Pre-Hung Interior Doors

Interior doors are commonly installed on jambs that are made from nominal one-inch-thick material and are not rabbeted like exterior door jambs. Instead separate door stop molding trim is installed. The jambs are supplied in different widths to account for installation of walls of different thicknesses. For example, the jambs on doors mounted on interior two by four partition walls are typically 4-9/16- inch-wide to account for 3-1/2-inch stud width and one half in drywall on each side of the wall. An additional one sixteenth of an inch is added to the width to account for variation of the wall. Doors mounted on two by six walls, and walls with 5/8-inch-thick drywall will have door jambs that are wider. Figure 11-96 shows a cutaway view of an interior pre-hung door.

Figure 11-96 Cut-away view of interior pre-hung door.

Figure 11-97 shows pre-hung molded fiberboard interior doors delivered to the job site pre-hung ready to install. These pre-hung doors are supplied with the molded fiberboard door slab, the 4-9/16-inch-wide door jambs, the door stop molding trim, and three pair of hinges. The doors have also been predrilled for the lockset installation. The only trim items needed to complete the installation of these doors are casing trim on both the interior and exterior side of the door.

Figure 11-97 Interior pre-hung molded fiberboard interior doors delivered to the job site ready to install.

Slab Doors

In both commercial and residential construction pre-hung exterior and interior doors are commonly used whenever possible. There are circumstances, however, when pre-hung doors cannot be used and door slabs will need to be purchased and installed on site. Two examples of a situations where pre-hung doors cannot be used are metal door jambs in masonry construction and some closet and other door installations.

Hollow Metal Door Jambs

Figure 11-95 shows an example of a metal door jamb that was installed at the same time that the masonry block wall was laid. A prefabricated metal door may be used. If a wood or composite door in needed, a slab door will need to be purchased and hinged and fit to the jambs on the job site. The metal door jamb acts as the casing and stop trim and no other door trim is needed.

Figure 11-98 Metal door jambs installed in a masonry block wall. The door will need to be hinged and fit at a later time.

Closet and Pocket Door Installation

Closet door installations include single hinged doors, double hinged doors, single and double bifold doors, and bypass doors. In addition, pocket doors and double pocket doors can be used for both closest and entry door installations.

Hinged and Double Hinged Doors

Both single and double hinged doors can be used for closet doors and are typically provided to the job pre-hung the same as for passage doors. The installation of single hinged closet doors is essentially the same as for single hinged pre-hung passage doors. The only additional trim items needed as the interior and exterior casing trim.

Double hinged closet doors are also usually provided to the job site pre-hung on the jambs. The installation is also

similar to single prehung doors and the only additional trim items needed are interior and exterior and casing trim. There is usually some difference in the hardware for double hinged closet doors which will be discussed

later in the chapter.

Figure 11-99 shows an example of a double hinged closet door installation.

Figure 11-99 Double hinged closet door.

Single and Double Bifold Doors

Single and double bifold doors are a popular option for installing closets doors. A Single bifold door consists of two door slabs that are hinged together in the center between the door slabs. The door is mounted by installing a pivot in the top and the bottom of the doors. The door is opened by pulling on a knob in the center of the two doors and the doors rotate on the pivot folding at the hinge in the middle. Figure 11-99 shows a single bifold installed.

Figure 11-100 Single bifold closet door.

Double bifold doors are used in wider door opening and have four doors slabs hinged as two single bifold doors. Figure 11-100 shows an example of two closet openings each with double bifold doors, one open and one closed.

Figure 11-101 Double bifold closet doors.

Estimating both single and double bifold doors require the construction estimator to understand the installation and trim methods for closet doors. Bifold doors are usually supplied to the job site with the hinges installed on the doors, however, they are not considered pre-hung doors because the doors themselves are not installed on door jambs prior to the delivery at the job site.

The items included when purchasing a bifold doors typically includes the hinged door panels, either one or two pairs depending upon if it is a single or double bifold, the bifold door tract, and installation hardware. Figure 11-101 shows an example of a bifold door track. The length of the track is size to correspond to the width of the bifold doors. The track will also have one or two pivot mounting brackets installed depending upon if it a single or double bifold door.

Figure 11-102 Bifold door track.

https://www.swisco.com/BiFold-2-Open/pd/Wood-Folding-Closet-Door-Replacement Accessories/23-

514?gclid=CjwKCAjw1tDaBRAMEiwA0rYbSErL7TkOMLLpUmGLZUGWnoFDeNTCwh4g6Md
b83BeiIwd9TBO0UpIDhoC8QAQAvD_BwE Need New Picture

Also included with the door is door mounting hardware are one or two floor mounting brackets, One or two pairs of top and bottom pivots, one or two track rollers, one spring bracket, and mounting screws. Figure 11-102 shows an example of bifold hardware for a single bifold door. The hinges and screws would be preinstalled in the bifold door slabs.

Figure 11-103 Hinges and mounting hardware for a single bifold door. The hinges would be preinstalled on the bifold doors.

Figure 11-102 shows an exploded view of a single bifold door including the track and hardware installation.

Figure 11-104 Exploded view of installation of bifold door hardware.

Estimating the trim and casing for bifold doors requires the con struction estimator to understand possible methods for trimming bifold doors. Possible methods include drywall jambs and corner bead; drywall jambs, corner bead, and wood stop molding trim; wood jambs and casing trim; wood jambs, stop molding trim, and casing trim; or wood half jambs and casing trim.

Drywall Jamb and Corner Bead

Bifold doors can be installed on openings that have been finished with drywall and drywall corner trim such as was shown in Figure 11-104. Gypsum wall board is installed on both the inside and outside of the wall. In addition, the jambs return have wallboard also installed. The corners are finished with drywall corner bead. No wood trim is used in this type of installation.

Figure 11-105 Cutaway view of bifold door installed on drywall jambs and corner bead.

Estimating material for this type of installation on a 3’-0” x 6’-8” bifold door would include the following:

Drywall Trim

Drywall Corner Bead: 4 pcs. x 6 ft. – 8 in.

Drywall Corner Bead: 2 pcs. x 3 ft. – 0 in.

Drywall Jamb, Corner Bead, and Wood Stop Molding Trim Bifold doors typically require a minimum of one quarter inch clearance on each side between the door and jamb openings. The installation works fine, but there is a gap between the door and jambs which can be unsightly. One method of coving the gap is to install some type of wood stop trim to cover the gap. Trim that can be used include quarter round, cove molding, and door stop trim. Figure 11- 105 shows an example of a bifold door installed on drywall jambs with a wood cove molding installed as a stop molding. Figure 11-99 also shows an example of this type of installation.

Figure 11-106 Cutaway view of bifold door installed on drywall jambs and corner bead with wood cove stop molding.

Estimating material for this type of installation on a 3’-0” x 6’-8” bifold door would include the following:

Drywall Trim

Drywall Corner Bead: 4 pcs. x 6 ft. – 8 in.

Drywall Corner Bead: 2 pcs. x 3 ft. – 0 in.

Wood Trim

Wood Stop Trim: 2 pcs. 1in. x 2 in. x 82 in.

Wood Stop Trim: 1 pcs. 1 in. x 2 in. x 36 in.

Closet bifold doors can also be installed in openings that have drywall on each side of the wall, but the jamb returns are left with the framing exposed and the corners do not have drywall corner bead installed on the corners such as is shown in Figure 11-106. Figure 11-107 Door opening left rough without any drywall returns installed.

Wood jambs and trim are often installed to finish the openings that are left rough and bifold doors are installed in the opening. The opening can have wood jamb and trim, or wood jambs, trim, and stop molding.

Wood Jambs and Trim

Bifold door installed on wood jamb and trim have wood jambs installed on each side and the top of the opening. Wood casing is also installed around the opening on both sides and top of the door. The casings are installed on both the inside or outside of the door opening as is shown in Figure 11-107.

Figure 11-108 Bifold doors installed in opening with wood jambs and casing trim, but not door stop trim.

Estimating material for this type of installation on a 3’-0” x 6’-8” bifold door would include the following:

Wood Trim

Wood Jambs: 2 pcs. 3/4in. x 4-9/16” in. x 82 in.

Wood Jambs: 1 pcs. 3/4in. x 4-9/16” in. x 36 in.

Wood Casing Trim: 4 pcs. 2-1/4 in. x 84 in.

Wood Casing Trim: 2 pcs. 2-1/4 in x 42 in.

Doors installed on these type of openings have a finished trim look, but still have a gap along the edges of the door where it is installed against the side jambs such as is shown in Figure 11-108.

Figure 11-109 Double bifold doors with jamb and trim but no stop molding.

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https://www.google.com/search?biw=1920&bih=947&site=imghp&tbs=sur%3Afm&tbm=isch&sa=1&ei=SkpVW5z7C4bE0PEP_fen2AY&q=folding+closet+doors&oq=folding+&gs_l=img.1.1.35i39k1j0i67k1l2j0l2j0i67k1j0l3j0i67k1.3554.6112.0.10000.8.8.0.0.0.0.256.1061.3j2j2.7.0....0...1c.1.64.img..1.7.1060....0.OGw77d1pDWQ#imgrc=_FHlv2nHLD1dFM:

Wood Jambs, Trim, and Stop Molding

Stop molding trim can also be installed on bifold doors with wood jambs and casing trim to give the installation a more finished look. This is done by installing stop molding trim around both sides and the top of the door opening as is shown in Figure 11-109.

Figure 11-110 Bifold door installed on wood jambs with casing and door stop trim.

Figure 11-110 also shows a picture of this type of bifold closet door installation. Estimating material for this type of installation on a 3’- 0” x 6’-8” bifold door would include the following:

Wood Trim

Wood Jambs: 2 pcs. 3/4in. x 4-9/16” in. x 82 in.

Wood Jambs: 1 pcs. 3/4in. x 4-9/16” in. x 36 in.

Wood Casing Trim: 4 pcs. 2-1/4 in. x 84 in.

Wood Casing Trim: 2 pcs. 2-1/4 in x 42 in.

Wood Stop Trim: 2 pcs. 1in. x 2 in. x 82 in.

Wood Stop Trim: 1 pcs. 1 in. x 2 in. x 36 in.

Figure 11-111

Wood Half Jambs and Casing Trim

The method of trimming bifold door with wood half jambs and casing trim is a hybrid of both drywall jamb and corner bead and wood jamb and trim methods of trimming bifold doors. Gypsum wallboard is installed on the walls on both the inside and outside of the door and also installed on the jamb returns. Drywall corner bead trim is installed on the inside corner of the door and the outside corner is covered with one by two jamb material and wood casing trim. Figure 11-111 shows and example of a bifold door trimmed using this method.

Figure 11-112 Wood half-jamb and casing trim.

The method of trimming bifold doors give the look of fully cased and trimmed doors with a considerable savings in cost. Estimating material for this type of installation on a 3'-0" x 6'-8" bifold door would include the following:

Drywall Trim

Drywall Corner Bead: 2 pcs. x 6 ft. – 8 in.

Drywall Corner Bead: 1 pcs. x 3 ft. – 0 in.

Wood Trim

Wood Half Jambs: 2 pcs. 1in. x 2 in. x 82 in.

Wood Half Jambs: 1 pcs. 1 in. x 2 in. x 36 in.

Wood Casing Trim: 2 pcs. 2-1/4 in. x 84 in.

Wood Casing Trim: 1 pcs. 2-1/4 in x 42 in.

Bypass Closet Doors

Bypass closet doors operate with two or more doors installed in a single opening. The doors are installed on a sliding track and are opened by sliding one door behind the other door. This type of door installation is not as common as other types of installations because only one door can be opened at a time which make access to the closet less efficient. Still, this method has the advantage of allowing closet access in situation where opening a swinging door or bifold door is difficult because of lack of operating space.

Bypass doors are purchased as separate door slabs and a hardware kit that consists of a door track, door rollers, and a floor mounted bracket to keep the doors apart. In addition, flush mounted door pulls can also be included (Figure 11-112).

Figure 11-113 Bypass closet door hardware kit.

Figure 11-112 shows an example of a double bypass door installa tion.

Figure 11-114 Double bypass door installation.

In addition to purchasing the door slabs and track hardware package, the estimator will need to account for the door trim. Bypass doors can be trimmed using any of the previously described methods including drywall jamb and corner bead; drywall jamb, corner bead, and wood stop molding trim; wood jambs and trim; wood jambs, trim, and stop molding; and wood half jambs and casing trim. Estimating trim materials would be the same as for other types of doors installations.

Pocket Doors

Pocket doors are similar to sliding doors in that they operate by moving on a special top mounted track, however, the doors disappear into a crevice, or pocket in the wall. They are useful in installations where space is tight, or for convenience in sealing off a normally open space for to allow for a more private setting. Pocket doors can include both single and double pocket doors.

Pocket doors are usually purchased as separate door slabs and a pocket kit that consists of a door track, door rollers, and a frame for creating the door pocket in the wall framing. The door frames are installed during the framing phase of construction. Figure 11-114 shows an example of a pocket door track installed in a framed wall. Figure 11-115 shows a close-up of a pocket door track and rollers.

Figure 11-115 Pocket door track and frame installed in framed door opening.

Pocket doors are most often trimmed with wood jambs and casing. The strike side of the jamb uses a standard ¾" inch by 4-9/16" door jamb and the pocket and top sides of the opening uses jamb material cut into narrow strips to finish each side of the pocket. Door casing is installed on the top of both sides of the opening. Figure 11-116 shows and example of the trim installation on a pocket door.

Locksets and other Door Hardware

In addition to the hinge and track hardware needed for the installation of doors, other hardware is also usually part of the standard installation requirements. The hardware can be as basic as a simple pull knob to open a closet bifold door, or a complex package of safety and security hardware. Common residential door hardware commonly includes lockset, deadbolts, door stop hardware, door closers, and other hardware.

Figure 11-117 Pocket door trim installation.

Figure 11-116 Close-up view of a pocket door track and rollers.

Locksets

In addition to the requirement for a method to open and close a door, there is often a need to provide a method for a way to securing the door and preventing unwanted opening or access. Some doors need only a simple latch or catch to keep the door closed. Others have to provide for a significant level of security. Many styles and types of door hardware are available and door hardware style can also be an important element in an architectural style. Lockset can be classified by their locking or latching mechanism and by the method of installation.

Locking or Latching Mechanisms

Locking or latching mechanisms refer to the level of locking security that the door hardware provides. Types of locking or latching mechanisms include pull, or dummy knobs, passage latches, privacy locks, keyed locks, and deadbolts.

Pull or Dummy Knobs

Pull or dummy knobs are usually attached to only one side of the door and are used to operated doors that do not need to provide any level of security restriction. Pull knobs are usually smaller knob in the style that would be common on kitchen cabinets (Figure 11-117). These type of knobs are commonly used on bifold style doors. They are most often attached with one or two screws that are drilled through the door and threads into the knob such as the pull knobs shown in Figure 11-108.

Dummy knobs are full size knobs manufactured to look the same as standard operating door knobs, however, that are attached to just the face of the door and are used to operate the doors. These type of knobs also usually require the installation of a separate latching method to hold the closet doors closed. Figure 11-118 shows an example of double swinging closet doors with dummy knobs installed. In addition, small ball catches can be seen at the top of the doors to hold them closed.

Passage Locksets

Passage latches are operating door knobs that latch to keep the doors close, however they do not have a locking mechanism that can be secured to prevent access. These type of knobs are most commonly used on closet and storage room hinged doors. They a typically installed in the same manner as other locking type door knobs. Figure 11-119 shows a passage lockset installed on a closet door. It can be identified as a passage lockset by the absence of any keying or unlocking mechanism of the exterior of the door handle.

Figure 11-119 Dummy door knobs on closet doors

Figure 11-118 Cabinet style pull knobs can also be used on bifold type doors. By Tomwsulcer [Public domain], from Wikimedia Commons

Figure 11-120 Passage lockset installed on a closet door.

Privacy Locksets

Privacy locks can be locked from the inside by a button or turn knob. They do not usually have a key function. They are used in situations such as bedroom or bathroom doors where it is desirable to be able to lock the door to provide needed privacy, but do not provide the same level of security as a keyed lock. Most privacy lock have an emergency release button that allows the lock to be unlocked from the outside by inserting a small pin in a hole in the lock handle so that the lock can be opened in an emergency situation such as when a small child locks themselves in a bathroom or bedroom doesn't know how to get out. Figure 11-120 shows and example of a privacy lock which can be identified by the small pin hole on the locks exterior.

Figure 11-121 Privacy bedroom lock identified by the small emergency unlocking hole on the lockset exterior.

Keyed Lockset

Keyed locks are used to provide security and limit access to places. There are several types of keyed lockset function including, entry locksets, storeroom lockset, and classroom locksets. Entry lockset are the most common type used in residential situations. The locks require a key t operate from the exterior when the lock is locked, however the lock can be opened from the inside by pushing a small button or lever. They can also be locked from the inside using that same button or lever.

Storeroom locksets require a key to operate. There is no mechanism on the inside for locking the door and the door is always locked and requires a key to open it each time.

Classroom locksets require a key to lock or unlock the door. There is not button or knob on the lock on the inside than will allow it to be locked or unlocked. A key, however, can be used to unlock the door and leave it unlocked, or to unlock the door and leave it locked. Figure 11-121 shows an example of a keyed lockset.

Figure 11-122 Keyed lockset.

Deadbolts

Deadbolts provide an added level of security over keyed other keyed locks which use spring activated catch to hold the door closed. Spring locking catches can often be jimmied by inserting a piece of ridged thin material between the lock and catch plate to withdraw the spring catch. Deadbolt require the key turn knob to operate. There are two basic types of deadbolts, a single cylinder deadbolt and a double cylinder deadbolt.

A single cylinder deadbolt operated from the outside of the lock using a key and has a turn knob on the inside to open the lock. Double cylinder deadbolts require a key to operate both the inside and outside of the deadbolt. Figure 11-122 shows and examples of both single and double cylinder deadbolts. Double cylinder

Figure 11-123 Single and double cylinder deadbolts. CC-BY-whykkk-SA: https://www.flickr.com/photos/whykkk/6939864444

Door Entry Handles

Entry doors are often considered an important architectural feature and often they have upscale doors locks and handles to emphasize the desired architectural style. Door entry handle are available in a wide range of styles and cost price points. Some can be a significant expense both for materials and installation labor. The estimator will need to accurately determine these cost (Figure 11-123.).

Lockset Installation Methods

deadbolts provide for more security and don't allow the door to be opened from the inside without a key, but they do raise safety issues, particularly in the event of a fire when occupants can be trapped in cylindrical locks. The two lock types are not typically interchangeable and projects tend to utilize one method or the other. Locksets are typically manufactured to be installed using one of two methods. They can be mortise locks or bored

Figure 11-124 Door entry handles.

Mortise Locksets

Mortise style locks require a pocket or mortise to be cut into the door edge for the lock installation. Most older style locks were manufactured to be mortise style and were the most common style of lockset installed before World War II. The large mortise required for the lock installation is time consuming and difficult to create, resulting in a higher installation cost.

They are also considered higher quality than cylindrical locks

Figure 11-126 Mortise style deadbolt lock.

CC-BY-whykkk-SA: https://www.flickr.com/photos/whykkk/6939864440

Figure 11-125 Mortise style combination lock. CC-BY-whykkk-SA:

https://www.flickr.com/photos/whykkk/693987545

Bored Cylindrical Locks

Bored cylindrical locks were first patented in 1923 by Walter Schlage in 1923. They were designed to be a more cost effective and are usually significantly more expensive to purchase. They are still frequently used in high end residential construction.

Figure 11- 123 shows an example of mortise style lock that has both the latch and deadbolt combined in one lock.

Figure 11-124 shows an example of a mortise style deadbolt lock.

This lock style requires only two holes to be drilled in the door for installation. One large 2-1/8-inch diameter hole through the face of the door for the lock assembly and a smaller one-inch diameter hole in the edge of the door for the latch assembly. The distance the larger face hole is drilled from the edge of the door is known as the backset distance. Two common backset distances are 2-3/8-inches and 2-3/4-inches. Residential doors commonly used a 2-3/8-inch backset, and doors in commercial projects a 2-3/4-inch backset. Figure 11-125 shows an example of a typical bored cylindrical lock.

Figure 11-127 Bored cylindrical style lock.

CC-BY-whykkk-SA: https://www.flickr.com/photos/whykkk/7085930413

Doors that require both a lockset and deadbolt require two sets of holes to be drilled for the installation of both locks. Pre-hung doors are typically supplied with the lockset holes pre-bored in the door as is shown in the pre-hung interior doors in Figure 11-96 or two holes in the exterior pre-hung doors such as is shown in Figure 11- 94. Figure 11-126 shows an example of both a cylindrical keyed lockset and deadbolt installation.

Figure 11-128 Separate keyed lockset and deadbolt installed in a door.

Door Stop Hardware

Swinging style doors often require some form of stop to keep the door from swinging back into the wall or other objects which can cause damage to both items. Door stop are available in a number of styles and installation types. This include wall mounted, floor mounted, baseboard mounted, and hinge mounted. Figure 11-127 shows examples of a wall, floor, and baseboard mounted door stop.

Figure 11-129 Floor, wall, and baseboard mounted door stops

Door Closers

Automatic door closers are not as common in a residential setting as they are in commercial installations, still, there are times when an automatic closing mechanism is needed. For example, some building code jurisdictions require any door installed in the common wall between the attached garage and the living space to be selfclosing. The self-closing requirement can be achieved using a number products including spring loaded hinges that close the door. Another option is to install a door closer. These are typically installed at the top of the door between the jamb and the door. These types of closers provide more control over the closing motion that spring loaded hinges. Door closers are manufactured in a wide variety of sizes, styles and installation methods. Figure 11-128 shows and example of a typical door closer.

Figure 11-130 Door self-closing mechanism.

Other Door Hardware

Other door hardware can consist of items such as kick plates, mail slots, peepholes, and door knockers as is shown in figure 11-130 Each of these items should be counted and added to the estimate.

Figure 11-131 Front door with entry handle and other hardware including kick plate, mail slot, door knocker and peephole.

Interior Door Trim Materials Estimating (Detailed)

The door trim materials for a project can often be determined from the plans and specifications for the project. For example, Figure 11- 131 shows the door schedule which identifies the doors on the project that will have trim installed, and the type of trim. Some doors, such as those installed in the unfinished basement and garage, will not have trim installed, or have trim installed on only one side such as an exterior garage door which would have trim on the outside of the door, but, may not have trim installed on the inside if the garage wall did not have drywall installed on it.

Interior Door Materials Header

The door description, mark, and perimeter are brought forward from the header section. Hovering over the Trim Style cells displays a comment that shows there are five different trim numbered styles possible.

0 = No Trim 3 = Outside Trim Only 1 = Inside & Outside Trim 4 = Trim & Jambs

2 = Inside Trim Only 5=Trim, Jamb, & Stop

Excel Figure 11-13 Header section of the interior door materials subsection.

Figure 11-132 Door Schedule showing door trim.

Each door will have a trim style applied to it. In order to apply the correct trim style to each door, it is essential that the estimator understand the difference between the trim materials that are supplied with the door and additional material that will need to be purchased for the project to complete the door installation.

The door schedule shows the trim material that each door will have, however, some of the trim material will be supplied when the prehung door is purchased. For example, the doors in the schedule numbered one through four are exterior pre-hung entry doors. It is expected that when these doors are purchased they will be supplied prehung on the appropriate exterior door jambs with the exterior brick molding trim pre-attached such as was shown in Figure 11-94.

The only additional trim that will need to be purchased is the interior trim which is identified in the schedule as Colonial Casing, 2-1/4" FJ Pine. In addition, door number four will be installed in the garage rear wall. This wall has no drywall attached to it, so no casing will be needed (Figure 11-132).

Figure 11-133 No interior casing will be installed on this exterior garage door.

Excel Figure 11-14 shows the exterior door portion of the header section completed. Doors 1,2, & 3 have the number two entered to represent that interior trim will need to be purchased for these doors. Door number 4 has the number zero entered to show that no additional trim will need to be purchased for this door. The totals for LF Ext Trim shows that 51.7 lineal feet of interior trim material will need to be purchased for the four exterior doors.

Excel Figure 11-14 Complete header section for exterior doors.

Excel Figure 11-15 shows the completed header section for the interior doors. Doors five through twelve are all per-hung interior swinging doors. Each of these doors will be supplied pre-hung on the appropriate jamb with door stop trim installed, so, the only additional trim that will need to be purchased will be interior and exterior trim. The number two is entered into the trim style in the header section and quantity of trim for the interior and exterior of the doors is calculated. Door number thirteen is a cased door opening. No door will need to be purchased, however, door jamb material and interior and exterior casing trim will need to be provided to complete the installation. Door stop is not traditionally installed on opening without a door, so no stop will need to be supplied Figure (11-134). A number 4 is entered into the trim style to calculated the quantity of jamb, interior, and exterior casing that will need to be bought. The width of the interior and exterior trim is also entered into the appropriate cells in the header section to add additional length to the purchased trim to allow for making the trim miter cuts. Excel Figure 11-15 shows the completed interior door header section and the total lineal feet of door trim that will be needed for this project.

Excel Figure 11-15 Completed door materials header section.

Completing the Interior Door Materials

The door and window database in the estimating template uses a number of abbreviations and it helps to understand what the abbreviations mean. For example, Excel Figure 11-16 shows a screenshot of the first few lines of the door and window database showing the available sizes of the "Bostonian" styles pre-hung doors.

Excel Figure 11-16 Bostonian pre-hung doors in the door and window database (Dr&WinDB).

The first four numbers in the description represent the size of the door in feet. For example, the first door is listed as 2068. This means the door is two feet wide and six feet eight inches tall. This same door could also be expressed in inches as 24 inches wide by 80 inches tall. The second is a description of the door style. “Bostonian” is a specific style of six panel molded composite door produced by the Jeld Wen corporation (Figure 11-133). The next group of letters and number “PH 4-1/2 FJJB identify the door as (PH) pre-hung on (4-1/2) four-and-a-half-inch wide door jambs (for installation in 2x4 interior walls), (FJJB) made from finger jointed solid lumber jamb material such as is shown in Figure 11-134

Figure 11-134 Bostonian style interior door.

Completing the Interior Doors Subsection

The exterior doors were purchased and installed during the exterior phase of construction and will not need to be estimated again. The interior doors will be put into the spreadsheet using the materials userform and the quantities manually input. Excel Figure 11-17 shows the completed interior door materials subsection of the estimating template.

Excel Figure 11-17 Completed interior doors subsection.

Completing the Exterior and Interior Door Trim Subsections The exterior and interior trim materials will also be input using the materials userform. The quantities of trim material are automatically calculated based upon information input into the header section (Excel Figure 11-18).

Excel Figure 11-18 Completed door trim subsections.

Completing the Interior Door Hardware Subsection Hardware will also need to be purchased for each door. The door hardware schedule also typically shows the hardware requirements for each door. Figure 11-135 shows an example of a door hardware schedule.

Figure 11-135 4-1/2” Cased door opening with finger-jointed door jamb material.

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Figure 11-136 Door hardware schedule.

Information from the door hardware schedule is transferred to the estimating template. The materials are entered using the Material userform and the quantities are manually input. The shim shingles are calculated at one shingle per lineal foot of door perimeter. The perimeter of the doors is taken from the header section. The perimeter of the garage door is not included in the door count. The shims are listed as 24 hinges per bundle (Excel Figure 11-19).

Excel Figure 11-19 Interior door hardware subsection completed.

Interior Finishes Labor Estimates

Completing the Insulation Labor Subsection The insulation subsection of the of the residential section of the National Construction Estimator will be used to establish the insulation labor costs.

Ceiling Insulation Labor

NCE Figure 11-1 shows the stabilized cellulose category of the insulation subsection. The insulation is priced per square foot of

area, however, the instructions explain that cost is for six inches of blown-in insulation. To achieve an R48 insulation value, fifteen inches will need to be installed. To accomplish this the cost per square foot will be multiplied by the required depth divided by six inches.

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NCE Figure 11-1 Stabilized cellulose insulation subsection.

The crew, craft hours, unit, and labor cost are put into the spread sheet. The quantity of attic insulation area will be brought forward from the header section and multiplied by 2.5 to achieve the correct quantity.

Wall Insulation Labor

NCE Figure 11-2 shows the insulation category of the insulation subsection which will be used to estimate the wall labor insulation cost.

NCE Figure 11-2 Wall insulation subsection.

The labor is priced per square foot. The crew, craft hours, unit, and labor cost are put into the spreadsheet. The quantity of wall insulation area will be brought forward from the header section and placed in the quantity cell of the spreadsheet.

Rim Joist Insulation

The wall insulation will also be used to price the rim joist installation labor cost.

Window and Door Seal Installation

NCE Figure 11-3 shows the polyurethane door, window, and siding sealant subsection of the National Construction Estimator. The price is estimated using a cost per lineal foot. The 1/8” option will be used. The lineal footage of the window and door perimeter of the windows and doors will be brought forward from the basic takeoffs.

The crew, craft hours, unit, and labor cost are put into the spreadsheet and the lineal footage of door and window perimeter brought forward from the basic takeoffs.

Install Vapor Barrier

NCE Figure 11-4 shows the felts, vapor barriers, infiltration barriers, building paper on walls category of the building paper subsection of the National Construction Estimator. The Tack stapled, typical will be used

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NCE Figure 11-3 Building paper subsection of the National Construction Estimator.

The price is calculated using the square footage of the wall area of the basement insulation walls. The crew, craft hours, unit, and labor cost are put into the spreadsheet and the square footage of basement insulation walls will be brought forward from the header section and entered into the spreadsheet.

Estimate example 11-2 shows the completed insulation labor sub phase.

Window Trim Labor Estimating (Detailed)

Completing the Window Trim Labor Subsection The windows trim category of the finish carpentry subsection will be used to estimate the labor costs. NCE Figure 11-4 Shows a screen shot with the applicable window trim items highlighted. The craft hours, unit, unit cost and quantities are entered into the appropriate cells in the estimating template shown in Excel Figure 11-12.

NCE Figure 11-4 Window trim category of the carpentry, finish subsection.

Excel Figure 11-12 Completed window trim labor sub-section.

Interior Door Labor Estimating (Detailed)

Completing the Interior Door Labor Subsection

The Interior doors category of the Carpentry, Finish subsection of the Residential section of the NCE will be used to estimate the interior door trim labor. NCE Figure 11-5 Shows a screenshot of

the Interior doors subsection with the appropriate pre-hung interior doors highlighted. The NCE does not list a separate cost for installing the double swing closet doors, so the pre-hung interior doors will be used for the double doors also.

NCE Figure 11-5 Labor costs for installing pre-hung interior doors.

The Set casing around framed opening subsection of the Residential section of the NCE will be used to price the installation of door casings. Door casing installation costs are priced per side with the costs separated into casing set up to four feet wide and those over four feet wide. NCE Figure 11-6 shows the appropriate costs highlighted.

Subcontractor Phase

Leave Feedback

All About Job Overhead

JOB OVERHEAD

Job overhead can be known as job costs or indirect project costs. These are expenses that can be thought of as the general supervision, administrative, and overhead expenses that result from the building of a specific construction project. They are different from general construction company overhead costs in that they are tied to a specific construction project and not to the general operation of the construction company. Job costs can be usually thought of as charges that meet two criteria. The first is that the cost is directly attributed to the project. In other words, it is an expense that results because the project is being built, and if the project was not undertaken, the construction company would not have incurred that particular expense. The second criterion is that it is a cost that is not directly related to a specific project element. Examples of job overhead include jobsite facilities, utilities, supervision, bonds, and insurance.

Jobsite Facilities

Jobsite facilities are the temporary structures and other enclosures that are used in the management of the building process or construction site. Included are items such as the jobsite office trailer (Figure 6-1), fencing, barricades, guardrails, and portable sanitation facilities.

Figure 6-1 Portable jobsite trailer.

Very often these resources are rented, and estimating is a simple matter of calculating the rental costs over the time period that they will be used. In addition, there can be other costs associated with the rental such as delivery, setup, and utility hookup.

Job Site Facilities — Cost Code

	Supplier	Item Description	Details	Size	Units	Unit Cost	Quantity	Override	Total
100		Field Office	108 SF Portable Office Trailer	1	Mo	$ 138.00	6		$ 828.00
101		Field Office Setup	Delivery and Setup of feld Office	1	LS	$ 260.00	1		$ 260.00
102		Field Office Pickup	Dismantle & Pickup of Field Office	1	LS	$ 260.00	1		$ 260.00
103		Elecrical Hookup	Electrical Hookup of Filed Office	1	LS	$ 156.00	1		$ 156.00
104		Field Office Delivery	Delevery and Pickup over 15 Miles	1	Mile	$ 3.60	20		$ 72.00
105		Storage Facilities	**Not Required**						$ -
106		Sanitary Facilities	1 portable chemical toilet						$ -
107									$ -
108						**Total Job Site Facilities**	$		1,576.00

Estimate Example 6-1 shows the total job site trailer rental cost taken from the Temporary Structures section of the National Construction Estimator for a six-month period of time, including a onetime $260.00 lump sum delivery and setup fee, a onetime $260.00 dismantle and pickup fee, a onetime $156.00 hookup fee for the electricity. In addition, a $72 delivery and pickup fee has been included because the trailer will be need to be delivered and picked up from a location that is 25 miles away and that is ten miles outside of the allotted fifteen mile delivery zone. The total rental cost for the job site trailer is $1,576.00.

An additional concept to consider is that even if the portable job trailer were owned by the company and not rented from an outside vendor, the cost for that portable trailer over the time it is used on a particular job would be included in the estimate for that job in a fashion similar if it were rented.

Temporary Utilities

Electricity, fuel, water, and other resources are consumed in the construction process. The cost for these resources needs to be accounted for in the estimate. Just as in the previous example with the portable field office, there may be several separate elements to consider when estimating the cost of a utility on a project. One example of this is electrical power. Electricity is essential to virtually all phases of the construction process and, as a result, is one of the first components installed on the job site. This is usually before any temporary or permanent structure is erected. As a result, there needs to be some temporary method for bringing in electricity. One common method of doing this is to have a temporary power pole installed and then have the electrical lines run from the public utility to the pole and from there to a temporary power panel that would have spaces for the various trades to plug in their power tools (Figure 6-2).

Figure 6-2 Temporary power service

The overall size of the installed temporary power system would depend upon the extent and needs of the project. The larger and more complex a project, the bigger and more expensive the size of the temporary electrical service will need to be. The size of the temporary electrical service for a residential project is usually a single phase 100-amp or 200-amp service. The installation of this service would typically be estimated as a one-time lump sum cost.

In addition to installing the electrical service, there will be a cost for the electricity that is used. Electricity is sold by a unit of measurement known as the kilowatt-hour (kWh). In simplest terms, this is the amount of electricity needed to keep ten 100-watt light bulbs operating for one hour. The cost for electricity per kilowatt-hour can vary widely by geographic location, time of day, and even season of the year. In addition, other charges and taxes may be added to the electrical bill. Figure 6-3 shows a sample electric bill where the contractor has used 1,680 kWh of electricity and has been billed at a rate of approximately eight cents per kWh, for a total energy cost of $134.47. Other charges and taxes have been included to bring the total monthly bill to $160.09.

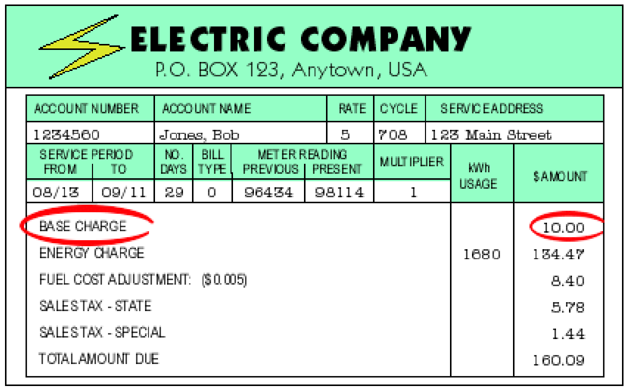

Figure 6-3 Sample electric bill.

Estimate Example 6-2 shows the electrical utility costs from the temporary utilities section of the National Construction Estimator. The installation cost for a 100-amp temporary service is calculated at $370.00, and the cost of electrical usage is determined to be approximately 1,000 kWh per month. This is multiplied by the six-month time frame for the project and multiplied again by the rate of fourteen cents per kilowatt-hour. The total estimate for electrical usage is $1,219.00. Estimates for other temporary utilities are calculated in similar fashion.

84		Temporary Utilities				Cost Code			
85									
86									
87	Supplier	Item Description	Details	Size	Units	Unit Cost	Quantity	Override	Total
88		Temporary Power	Single Phase, 100 Amps	1	LS	$ 379.00	1		$ 379.00
89		Electricity Use	1000 kwh/ month x 6 Months	1	kwh	$ 0.14	6000		$ 840.00
90		~~Gas Use~~	~~Not Required~~						$
91		Water Use	Gallons per days x days on the Job						$ -
92									$ -
93									$ -
94						Total Temporary Utilities	$		1,219.00

Estimate Example 6-2 shows the total electrical utility costs from the Temporarily Utilities section of the National Construction Estimator. A 100-amp temporary power service is installed at a cost of $379 and an estimated electrical usage of 100 kWh per month is established. This is multiplied by the six-month time fram and multiplied by a rate of fourteen cents per kWh. The total for electrical utilities is $1219.00.

Supervision

The labor costs for supervising a construction project are also considered part of the job overhead. This is consistent with the concept of job overhead because their efforts are part of moving the overall project forward rather than a specific element of the project. There are a number of different scenarios that could be considered when calculating supervision cost. If a supervisor's time were wholly committed to overseeing a single construction project, then that supervisor's total compensation for that given period of time would be considered as part of the job overhead for that project. Other situations are also possible. One example would be the residential project manager who was overseeing the construction of a number of homes at the same time. In this situation, the construction manager's total compensation for a given period of time would be divided by the percentage of time that the manager spent on each separate project, and that portion of his wage spent on each project would be assigned to that project. An additional possibility would be a supervisor, or contractor, who is involved in the actual physical construction of the project part of the time and part of the time involved in the management of the project as a whole. In this case, the wage for the portion of the time that was spent on the supervision would be assigned to job overhead, and the portion assigned to construction to its particular phase of construction. The example shown in Estimate Example 6-3 shows a situation where a project manager, Jack Hammer, is overseeing the construction of 16 homes in a single year. In this case, 1/16th or 6.25% of his total yearly compensation of $83,214.45 is assigned to one project.

Figure 6-4 Supervision is part of the overhead costs

Bonds

Construction owners will often require the contractor to provide a number of different bonds as part of the construction process. A bond is issued by a bonding agent or what is known as a surety. In essence, the bond is a guarantee by the surety that the bonded party will perform in a certain manner, and in the case of default by the bonded party, the surety will step in and make the other party whole by hiring others to complete the project or provide financial remuneration to the owner.

115	**Job Site Supervision**						Cost Code		
116									
117									
118	Supplier	Employee	Position	Yearly Wage	Month Sal	Duration	TOJ	Override $	Total
119		Jack Hammer	Foreman	$ 83,214.45	$ 6,934.54	12.0 Months	6.25%		$ 5,200.90
120									
121									
122									
123						Total Job Site Supervision	$		5,200.90

Estimate example 6-3 shows the supervision costs for a single project in a situation where the supervisor Jack Hammer's total yearly compensation is $83,214.45 and he is overseeing full time the construction of 16 homes in a one-year period of time. Therefore, 1/16 or 6.25% of his yearly wage, or $5,200.90, is assigned to one project.

There are three types of bonds that are important to consider as part of the job overhead. The three types are bid bonds, payment bonds, and performance bonds. Bid bonds are provided by the contractor at the time that a bid is presented and guarantees that if the contractor is selected as the low bidder, then he or she will enter into a contract to complete the work bid and provide the required payment and performance bonds. The payment bond guarantees that the vendors, subcontractors, and supplies on the project will be paid. The performance bond guarantees that the contractor will complete the construction project.

The cost of the bond can increase the cost of the construction project but can also provide a measure of security to the owner that the project will be completed and the outside parties paid. The cost of the bond is included in the cost of the project estimate.

Calculating the cost of the bond can be as simple as a percentage of the project cost, or it can be on a sliding scale that, as the bonded amount increases, the cost of the bond as a percentage decreases. This is shown in Table 6-1.

Total Estimate ($)	Bond Rate (%)

$0 to $50,000	1.50%
$50,001 to $100,000	1.25%
$100,001 to $250,000	1.00%
$250,001 to $500,000	0.90%
$500,001 to $1,000,000	0.80%
$1,000,001 PLUS	0.75%

Table 6-1 Sample bond rate table.

The cost of the various types of bonds are highly variable based upon a number of factors, primarily the bonding capacity of the construction company and the construction company's track record.

Insurance

A construction company needs several forms of insurance to protect it from financial loss in the event of an unforeseen mishap. At a minimum, three forms of insurance, general liability, tool and equipment, and builder's risk insurance, should be purchased. The first two, general liability and tool and equipment, are usually estimated as part of the general company overhead, and since they represent costs that are just an ongoing part of doing business, they will be discussed in a different chapter. Builder's risk insurance is usually tied to a specific job and is the insurance that protects the job in the event of loss due to events such as theft, vandalism, or the destruction of the property due to wind, fire, or other disasters. Builder's risk insurance can cover the structure itself or other structures on the site such as job and equipment trailers, materials, and supplies that are onsite for building the structure. Builder's risk insurance usually doesn't include natural disasters such as earthquakes, floods, or wind along beach areas, unless it is specifically written to do so. It also usually doesn't cover items such as contractor's tools and equipment, even though they are onsite for use in the building process.

Cost for builder's risk insurance can vary greatly based upon the risk factors involved, but it is usually expressed as a percentage of the cost of the project. For example, if the cost was stated as 0.25% of the cost of the project and the total project cost was $100,000, then the builder's risk insurance cost for the project would be $100,000 × 0.0025 = $250.00.

Overhead Principles

Overhead expenses must be taken into account when keeping the books for a business.

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Overhead

What is Overhead?

Overhead are cost items that cannot readily be charged to any one project, but represent the cost of operating a construction company. They are incurred regardless of any specific project. There are two types of overhead items, Overhead Expense Items and Job Overhead Items.

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Overhead Expense Items

Overhead Expense Items include, but are not limited to, costs in the following categories:

Office Expenses

- Rent (If the building is owned then the cost of the building plus a return upon your investment)
- Electricity
- Heat
- Water
- Office Supplies
- Postage
- Insurance
- Taxes
- Telephones
- Office Machines
- Furnishings

Salaries

Exempt Employees (Employees you are exempt from paying overtime)

- Salaried Employees

- President
- Vice President
- Controller
- Chief Estimator
- Human Resource Director

Non-Exempt Employees (Dept of Labor requires paying overtime when overtime is worked)

- Hourly employees

- Secretaries
- Payroll clerk
- Accounts payable clerk

Other Expenses

- Advertising
- Trade journals
- Donations
- Legal Services
- Accounting Services
- Club and Assoc.. dues
- Travel and Entertainment
- Cars and Insurance

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Job Overhead Items

Job Overhead includes items that can be charged to a specific project, but cannot readily be charge to a specific item of work on the project. They may include, but are not limited to, the following catagories.

Salaries

- Superintendent
- Assistant Superintendent
- Timekeeper
- Materials Clerk
- Foreman

Temporary Office

- Heat
- Lights
- Equipment

Temporary Buildings

- Barricades
- Enclosures
- Signals

Temporary Utilities

- Power
- Water
- Fuel

Other Items

- Sanitary Facilities
- Drinking Water
- Photographs
- Surveys
- Cleanup
- Insurance
- Winter Construction

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