Exterior and interior walls usually support the roof load and/or the ceiling loads. When ceiling joists are used, interior partitions usually sustain some of the ceiling loads. These structures also serve as a solid base for installing interior and exterior coverings.

Building plans and schedules provide the information as to where these structures are located. In addition, they will include information for bracing these structures for plumbing, windows, doors, insulation, and appliances. Knowing how to read these instructions and understanding the framing members used in their construction is critical to the soundness of the structure.

Objectives

1. Identify and define framing members used in walls, partitions, and ceilings.
2. Select methods used to brace walls.
3. Review the procedure to calculate the length of a regular stud.
4. Review the procedure to calculate rough opening (R.O.) dimensions for doors.
5. Review the procedure to calculate the length of trimmers for window and door openings.
6. Review the procedure to calculate the length of headers for rough openings.
7. Review the procedure to calculate the amount of materials for wall and partition framing.
8. Calculate the amount of materials for wall and partition framing. (Assignment Sheet)
9. Lay out wall partition locations on floor. (On The Job Activity)
10. Construct wall sections. (On The Job Activity)
Objective 1:———
Identify and define framing members used in walls, partitions, and ceilings

Walls, partitions, and ceilings consist of many different framing members to provide strength to the structure. Study the framing members and their definitions below.

- Corner assembly – consists of a post that forms an inside and outside corner providing a good nailing surface for tying together two wall frames at right angles

- Cripple stud – any part of a framing stud that is cut less than full size, as over a door or window or under a window opening

- Double top plate – a plate made of two members to allow better stiffening of the wall and for tying together splices, corners, and partitions that are at right angles to a wall

- Header – a horizontal structural member that supports the load over an opening, such as a window or door

- Partition wall assembly – an assembled wall that subdivides space within a building

- Regular stud – main vertical framing member in walls and partitions

- Rough opening – an opening in framing formed by framing members, such as for windows and doors

![Diagram of wall framing components](image_url)

FIGURE 1
**Rough sill** – a lower framing member attached to the top of the bottom cripple studs to form the base of a rough opening for a window

**Sole plate** – lowest horizontal member of a wall or partition to which the studs are nailed; rests on the rough floor

**Top plate** – an upper horizontal structural member of a wall used to carry the rafters or trusses of a roof

**Trimmer stud** – vertical framing member that forms the sides of the rough openings for the doors and windows and on which the header rests

You can learn more about wall and ceiling framing at these websites:

- Hometips.com
  
  http://www.hometips.com

- Journal of Light Construction
  
  http://www.jlconline.com/

- Hometime.com
  
  http://www.hometime.com
Objective 2:------------------
Select Methods Used to Brace Walls

Wall bracing is very important for the safety of the workers as well as the stability of the framing members during construction. Study the following methods used to brace walls below.

1. **Permanent bracing**

   NOTE: Be sure the wall is square and plumb before nailing the braces.

   - Let-in corner bracing with 1 x 4 solid lumber

     NOTE: This type of bracing is done by marking and cutting out a recess in each stud the thickness of the brace, and then nailing the brace in place so that the face of the brace is flush with the face of each stud. Let-in bracing is set at 45 degrees when possible. Sometimes because of the openings this cannot be accomplished.

   - Metal bracing

   - Plywood sheathing
     (at least on the corners)

2. **Temporary bracing (wind bracing)**

   - 2 x 4 wall brace
     (used inside or outside)

   - Adjustable metal wall brace
Objective 3:———
Review the Procedure to Calculate the Length of a Regular Stud.

- **WORDS TO KNOW**
  - Underlayment — material with low vapor resistance such as asphalt-saturated felt

**NOTE:** Precut studs are available in 92 1/2" or 93 1/4" lengths.

1. Concrete floors (slab)
   - A. Determine the height of the finished ceiling from the finished floor including 1/2" clearance for finish material.
   - B. Determine the thickness of the soleplate plus the double top plate.
   - C. Determine the thickness of the ceiling material and the flooring material.
     **NOTE:** For carpet or a resilient-type flooring material, the thickness is negligible.
   - D. Add the thickness of the ceiling and flooring material to the finished ceiling height.
   - E. Subtract the thickness of the plates from the sum achieved in step D to obtain the stud length.

**EXAMPLE:** The desired finished ceiling height is 8', the actual plate thickness is 1 1/2", the ceiling thickness is 1/2", and resilient tile flooring is used. See Figure 2.

- Finished ceiling height: 8'
- Thickness of soleplate and double top plate: 1 1/2" + 1 1/2" + 1 1/2" = 4 1/2"

**FIGURE 2**

- Thickness of ceiling and flooring: 1/2" + 0 = 1/2"
- Total wall frame required height: 8' + 1/2" = 8' 1/2"
- Required stud length: 8' 1/2" - 4 1/2" = 7' 8" or 92"
2. Wood floor

A. Determine the height of the finished ceiling from the finished floor including 1/2" clearance for the finish material.

B. Determine the thickness of the soleplate plus the double top plate.

C. Determine the thickness of the ceiling material and the underlayment.

D. Add the thickness of ceiling and the underlayment to the finished height.

E. Subtract the thickness of the plates from the sum achieved in step 4 for the stud length.

EXAMPLE: The desired finished ceiling height is 8' 1/2", the actual plate thickness if 1 1/2", the ceiling thickness is 1/2", and the underlayment thickness is 5/8". See Figure 3.

- Finished ceiling height: 8' 1/2"
- Thickness of soleplate and double top plate: 1 1/2" + 1 1/2" + 1 1/2" = 4 1/2"
- Thickness of ceiling material and underlayment: 1/2" + 5/8" = 1 1/8"
- Total wall frame required height: 8' 1/2" + 1 1/8" = 8' 1 5/8"
- Required stud length: 8' 1 5/8" - 4 1/2" = 7' 9 1/8" or 93 1/8"
Objective 4:———
Review the Procedure to Calculate Rough Opening (R.O.) Dimensions for Doors.

1. Width
   A. Check the door schedule for the door size.
   B. Add 1/4' to the door width for the clearance between the door and the side jambs.
   C. Add 1 1/4" (5/8" each) for the side jambs.
   D. Add 3/4" (3/8" each) for the clearance between the jamb and the trimmer stud.
   E. Round to the next larger half-inch to obtain the actual rough opening width.

**EXAMPLE:** To find the rough opening for a 3' x 7' door, the correct calculation procedure would read:

<table>
<thead>
<tr>
<th>Door width:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3'</td>
</tr>
<tr>
<td>Door and jamb clearance:</td>
</tr>
<tr>
<td>1/4&quot;</td>
</tr>
<tr>
<td>Side jambs:</td>
</tr>
<tr>
<td>1 1/4&quot;</td>
</tr>
<tr>
<td>Side jambs and trimmer clearance:</td>
</tr>
<tr>
<td>+ 3/4&quot;</td>
</tr>
<tr>
<td>Actual rough opening width:</td>
</tr>
<tr>
<td>3' 2 1/4&quot;</td>
</tr>
</tbody>
</table>
2. Height
   A. Check the door schedule for the door size.
   B. Add 1/8" to the door height for the clearance between the door and the header jamb.
   C. Add 5/8" for the header jambs.
   D. Add 5/8" for the clearance under the door.
   E. Add 3/4" for the header jamb and the rough header clearance.

**EXAMPLE:** To find the rough opening for a 3' x 7' door, the correct calculation procedure would read:

- Door width: 7'
- Door and header clearance: 1/8"
- Jamb header: 5/8"
- Bottom clearance: 5/8"
- Jamb header and rough header clearance: + 3/4"
- Actual rough opening width: 7' 2 1/8"
Objective 5:———
Review the Procedure To Calculate the Length of Trimmers For Window and Door Openings.

The tops of all windows and doors should be the same height from the floor unless otherwise specified. Adjustments may be necessary if 2 x 12 materials are used.

1. Concrete floor (slab)
   
   A. Determine the height of the rough opening from the finished floor.

   1) Determine the door height and add 1/8" for the door/header clearance.

   NOTE: Standard doors are 6' 8" high

   2) Add 5/8" for the clearance at the bottom of the door.

   3) Add 5/8" for the jamb header.

   4) Add 3/4" for the clearance between the rough header and the jamb header.

   B. Subtract the thickness of the soleplate.

   EXAMPLE: To find the trimmer length for a 3' x 6' 8" door, see the correct calculation procedure below.

   
   Door height: 6' 8"
   Door and header clearance: 1/8"
   Bottom clearance: 5/8"
   Jamb header: 5/8"
   Jamb header and rough header clearance: + 3/4"
   Actual rough opening width: 6' 10 1/8"
   Soleplate: - 1 1/2"
   Trimmer and stud length: 6' 8 5/8"

2. Wood floor – Repeat the procedure for the concrete floor remembering to add the thickness of the underlayment to establish the finished floor.
Objective 6:-------------------
Review the Procedure to Calculate the Length of Headers For Rough Openings.

1. Rough header length for doors

   **NOTE:** If prehung doors are used, check the manufacturer's specifications for rough opening size.

   A. Check the door schedule for the door size.

   B. Determine the rough opening width.

   C. Add 1 1/4" for the side jambs.

   D. Add 1" for clearance to install the jambs.

   E. Add 3" to the rough opening width for the trimmer studs.

   **EXAMPLE:**
   For a 3' x 6" 8" door:
   Door height: 3'
   Side jambs: 1/4"
   Side jambs and trimmer clearance: + 1"
   Rough opening: 3' 2 1/4"
   Thickness of trimmer studs: + 3"

   Header size: 3' 5 1/4" or 41 1/4"
2. Rough header length for windows – Check with the manufacturer to determine the rough opening width, then add the thickness of the two trimmer studs, while considering the return on the metal windows is to be drywall or wood. See Table 1.

**NOTE:** Table 1 gives the size of the headers normally required by various rough opening widths with several load conditions. It is to be used as a guide only. Refer to the plans and local regulations for additional restrictions.

**TABLE 1**

<table>
<thead>
<tr>
<th>Header Material (Two members on edge)</th>
<th>Single story</th>
<th>Two story</th>
<th>Three story</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 4</td>
<td>3’ 6”</td>
<td>2’ 6”</td>
<td>2’</td>
</tr>
<tr>
<td>2 x 6</td>
<td>6’</td>
<td>5’</td>
<td>4’</td>
</tr>
<tr>
<td>2 x 8</td>
<td>8’</td>
<td>7’</td>
<td>6’</td>
</tr>
<tr>
<td>2 x 10</td>
<td>10’</td>
<td>8’</td>
<td>7’</td>
</tr>
<tr>
<td>2 x 12</td>
<td>12’</td>
<td>9’</td>
<td>8’</td>
</tr>
</tbody>
</table>
Objective 7: Review the Procedure to Calculate the Amount of Materials for Wall and Partition Framing.

Building plans

1. Wall plates (2 x 4s or 2 x 6s)
   A. Determine the lineal footage of all outside walls, including the openings.
   B. Determine the lineal footage of all the inside walls, including the partitions and openings.
   NOTE: There are three plates: soleplate, top plate, and double top plate. The soleplate should be treated if used on concrete.
   C. Multiply the total inside and outside lineal footage by three.
   D. Divide the total lineal footage obtained in step 3 by sixteen and round up to the next full number to get the number of sixteen-foot 2 x 4s needed for the plates.
   NOTE: The plate material is usually ordered in sixteen-foot lengths.

2. Studs - 16" on center
   A. Determine the lineal footage of all outside and inside walls.
   B. Allow one stud for each lineal foot of wall.
   C. If sixteen-foot material is used, divide the total achieved in step 2 by two for the number of pieces of sixteen-foot material needed for the studs.

3. Studs for gable ends
   A. On buildings with gable roofs, use one-fourth the plate length for determining the number of gable studs needed on 2' centers at each gable end.
   B. Multiply one-half the plate length by three-quarters if the gable studs are on 16" centers to determine the number needed.
   C. Determine, to the nearest whole foot, the length of the longest gable stud from the double plate to the top of the roof.
   NOTE: One piece of stud material will make a long and a short gable stud; this is why only one-half of the plate length is used.
   D. Order the number calculated in step 1 or 2 in the next longest length.

4. Headers
   NOTE: The use of 2 x 12 headers require more material but the time saved more than makes up the difference.
A. Determine the size of the doors and windows from the door and window schedule.  
**NOTE:** List each door and window separately.

B. Add 5' 1/4" to each door and window width.

C. Double the length of the header for each door and window.

D. Combine the lengths obtained in step 3 into convenient lengths for ordering and to minimize waste.

**EXAMPLE:** For three headers of 4' 10" and 3' 11" use 14' 2 x 12s.

E. Order enough 1/2" CD plywood to cut for spacers.

5. Diagonal bracing (if used)

**NOTE:** Diagonal bracing is required at each end of all of the exterior walls. These braces run from the bottom plate at an approximate angle of 45 degrees. Walls 8' high would require material twelve feet long for each brace.

A. Determine the number of outside and inside corners in the exterior walls.

B. Multiply the number of corners by two to determine the number of 12’ 1 x 4s or metal strips needed for the bracing.

6. Ceiling joists on 16" centers

A. Determine the size of the joists needed from the specifications.

B. Determine the length of the longest wall.

C. Order the number of ceiling joists equal to one more than three-fourths times the wall length.

**NOTE:** A building greater than sixteen feet wide will require a combination of lengths of joists.
Assignment Sheet

Objective 8: Calculate the Amount of Materials For Wall and Partition Framing.

Introduction: Correctly estimating materials is a skill good carpenters must possess in order to save time and money. Use the procedures found in Objective 7 to accurately estimate framing materials.

Directions: Use the plan found on the next page to calculate the length and number of ceiling joists needed. Write the answer in the blank provided.

1. Wall plates (2 x 6s, 16' long): _________________________________

2. Studs (2 x 6s, 16' long): ______________________________________

3. Headers (2 x 12s): A. ____________________________________
          B. ____________________________________
          C. ____________________________________

4. Metal strap bracing: _________________________________________
Figure 4

Bedroom #1: 13'6" x 13'6"
Living Room: 15'0" x 18'6"
Bedroom #2: 12'0" x 12'0"
Garage: 15'10" x 21'2"
Kitchen: 11'10" x 18'6"
Bedroom #3: 12'6" x 13'0"

Scale: 3/16" = 1'0"
On the Job Activity
Objective 9:———
Lay Out Wall Partition
Locations on Floor.

Video: Watch the video titled "Lay Out and Partition Locations on a Floor."

Introduction: Two common types of wall framing are platform framing and balloon framing. Most construction will call for the platform type of framing to be used. Platform framing is a wood frame construction method in which studs are one story high and a platform is built on the plates over the studs and acts as a base for the next floor. Platform framing is also known as western framing. Balloon framing is a residential construction method in which one-piece studs extend from the sill to the roof plate and the joists for the upper floors are nailed to the sides of studs. The most common of the two methods is platform framing.

Partition walls or interior walls are of either bearing or non-bearing. A bearing wall supports ceiling joists, while a non-bearing wall supports only itself. The building plans will provide the sizes of the interior walls or partitions and their locations. A good understanding of the building plans is essential to the overall quality of the finished product.

Equipment and Supplies:

izzas
2 x 48d nails
25' tape
Chalk line
Framing hammer
Framing square
Personal protection equipment
Steel tape
PROCEDURE

NOTE: Refer to Figure 5 and 6 for reference.

Step 1: Put on all appropriate personal protection equipment.

Step 2: Lay out the outside walls.

A. Measure in the width of the soleplate from the outside edge of the floor on each end of the structure and mark this distance.

   NOTE: On concrete slab construction you must allow for sheathing thickness.

B. Start a nail at each mark.

C. Snap a chalk line between the marks. (Figure 7)

D. Check for square of the sub floor by using the 3-4-5 method.

   NOTE: On longer walls, be sure the line is straight and well marked. Secure one end of the line and have someone hold the other end of the line and pull the line tight. Place your thumb on the line approximately in the center. Be sure to hold the line firmly to the floor. Carefully lift one side of the line with your other hand and let it snap to the floor. Repeat this process on the other half of the line.

E. Mark the other outside walls with the chalk line.

F. Make sure the outside walls are parallel.
**Step 3:** Lay out the inside walls

**NOTE:** Check for equal diameter dimensions and ensure overall square.

A. Mark each of the partitions.

B. Repeat this procedure for the other side of the wall.

C. Stretch a chalk line very tightly along the length of the partition and snap a line.

D. If the chalk lines are to be exposed to weather, protect the lines by using a clear protective coating.

**Step 4:** Have your instructor check your work.

**Step 5:** Clean up the area and put away the equipment and supplies.
On the Job Activity
Objective 10: Construct Wall Sections.

Video: Watch the video titled "Construct Wall Sections."

Introduction: Interior walls are framed in the same method without regard to the system used for the exterior walls. There are a various ways to lay out and erect a framed wall. However, the modified tilt-up method as described in the procedure below is commonly used because of its efficiency and ease.

FIGURE 9

Equipment and Supplies:

- 2 x 4' level
- 6' step ladder
- 8d and 16d box nails
- 25' tape marked 16" on center
- Circular saw
- Corners
- Cripple studs
- Extension cord
- Framing square
- Headers
- Metal strapping brace material
- Personal protection equipment
- Plate material
- Regular studs
- Speed square
- Ts for partitions
PROCEDURE

Step 1: Put on personal protection equipment.

Step 2: Plan the sequence for raising the walls.

   NOTE: Use the most productive and efficient sequence for your situation.

Step 3: Select the materials from stock for the plates.

Step 4: Cut the sole plate and top plate for the first wall to length, following safety procedures.

Step 5: Tack the sole plate and the top plate for the first wall together and lay them on the edge at the wall location.

Step 6: From the plans, lay out the following on the plates:

   A. Rough openings
   B. Corners
   C. Partition T’s
   D. Stud locations

Step 7: Mark the plates for the corners.

Step 8: Locate the centers of the openings and lay out the trimmer stud locations. See Figure 10.

   A. Determine the distance from the end of the plate to the center of the opening, according to the plan.
   B. Measure the required distance and mark it on the plate.
   C. Measure and mark 1/2 the header length on each side of the center of the opening.

      NOTE: This locates the outside of each trimmer stud.
   D. Recheck the dimensions.
   E. Mark the trimmer stud locations with a “T”.
   F. Mark the cripple stud locations with a “C”.
Step 9: Use a tape to lay out all of the full stud locations. See Figure 11.

A. Measure 15 1/4" from the end of the outside corner to the leading edge of the first stud.

B. Drive a nail at this point and hook the end of the tape to the nail.

C. Mark 16" centers and place a small “X” to the far side of each mark.

D. Use a square to mark the stud locations across both of the plates. See Figure 12.

NOTE: Another accepted method is to mark your plates on the edge. Splices in the plate must fall at the center of the stud.
Step 10: Build the wall with the inside of the wall facing down.

Step 11: Place the soleplate at the partition line with the marked side up.

Step 12: Move the top plate to the approximate stud length.

Step 13: Place the corner and partition Ts at the appropriate mark.

Step 14: Lay the studs at each “X” mark.

Step 15: Check all the studs and turn them so that the crown is up.

**NOTE:** If the studs are bowed too badly, they should be used for cripples or blocking.

Step 16: Put the headers in place.

Step 17: Place the trimmer studs at each “T” mark.

**NOTE:** The trimmer studs and headers may be assembled prior to the wall assembly.

FIGURE 13
Step 18: Place the rough sills and cripple studs where the openings are located.

Step 19: Nail the framework together. See Figure 14.

FIGURE 14

A. Drive two 16d nails through the plate into the end of each 2 x 4 stud or three nails for 2 x 6 studs.

**NOTE:** The use of a nail gun is common practice. Special training is required to ensure safe use.

B. Install the headers and trimmers, or opening assemblies.

C. Nail the cripple studs in place.

D. Install rough sills and ensure all rough openings are the proper size.

E. Finish nailing the framework together.

Step 20: Measure and cut the double top plate. See Figure 15.

**NOTE:** Be sure to allow for the overlap of corners and Ts.

A. Cut the double top plate on the exterior walls to accept the plate from the other walls or partitions.
B. Install the double top plates by first driving two 16d nails at one end of each double top plate section.

Step 21: Drive one 16d nail on each side of the stud locations on opposite sides of the double top plate. See Figure 16.

NOTE: Some permanent bracing requires preparation prior to installation of walls.

FIGURE 15

Step 22: Raise the wall section and nail it in place.

NOTE: To do this on wood floors, use two 16d nails every other floor joist. On concrete slabs, use pre-set anchor bolts or powder-actuated pins where appropriate. The use of powder-actuated tools requires special training to ensure their safe use.

WARNING: Before using a powder-actuated tool, you must be certified and possess a safety certification card.
Step 23: Plumb the corners.

Step 24: Attach temporary exterior braces.

Step 25: Install remaining walls and brace in the same manner. See Figure 17.

Step 26: Check the corners and adjust plumb if necessary.

Step 27: Straighten the walls and nail the top of the temporary bracing in place. See Figure 18.

A. Nail a 3/4” block on each corner at the top of the walls.

B. String a line from one end of the wall to the other.

NOTE: Be sure to stretch the line very tightly so that it does not sag.

C. Use a 3/4” gauge block to check the wall line.

D. Adjust and nail the bracing during the straightening process.

NOTE: Be sure the bracing does not extrude beyond the exterior wall.
Step 28: Install the appropriate permanent bracing.

Step 29: Remove the exterior temporary bracing that is no longer needed.

Step 30: Have your instructor check your work.

Step 31: Clean up the area and put away the equipment and supplies.