BC CARPENTER APPRENTICESHIP PROGRAM

LEVEL 1

COMPETENCY H-3:
Build Walls and Partitions

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COMPETENCY H-3

Build Walls and Partitions

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COMPETENCY H-3

Build Walls and Partitions

Exterior and interior walls must be strong and well-braced to support the floor and roof loads imposed upon them. They must also be straight, plumb, and level to allow both interior and exterior finishes to be installed.

Objectives

When you have completed the Learning Tasks in this Competency, you will be able to:

- construct exterior wall framing
- sheath and erect exterior walls
- construct interior wall framing
- calculate the quantity of materials needed for wall construction

Competencies

Written: "Build Walls and Partitions"

In the written Competency, you will be tested on your knowledge of wall framing, exterior sheathing, erection procedures, special framing details, and material quantity calculations.

Practical: You will be required to build exterior walls with door and window openings, sheath and erect exterior walls, build interior walls with door openings, and install fire stops and backing.

LEARNING TASK 1

Build Exterior Walls

NOTES

The Learning Tasks in this Competency describe methods used in the platform-framing system. In platform-framing, the exterior walls are constructed using the floor frame as a base or platform.

In addition to the traditional hand-built, piece-by-piece framing method (stick-framing), there are two modular platform framing systems: manufactured prefabricated (prefab) wall panels and structural insulated panels (SIPs).

Prefab Wall Panels

Manufactured prefab wall panels are built in an automated plant and then shipped to the job site. Panels are framed and sheathed and are typically available in lengths up to 20' and in heights up to 11'. Transportation concerns on highways and job site driveways can limit the wall heights.

Delivery includes crane time to land the panels, but extra charges are normally applied if crane time is used to stand up walls.

Some of the advantages of prefab walls are that they are built using automated truss plant technology. This produces walls that are true and square. Walls can be built regardless of weather conditions. There is less waste material on the job site and the building goes up faster.

Structural Insulated Panels

Structural insulated panels (SIPs) are made by sandwiching rigid foam insulation between panels of OSB, plywood, cement board, or metal. This provides a manufactured wall panel system that includes sheathing, structural framing, insulation, and vapour barrier all in one.

4" and 6" wall panels do not typically use studs, and the structural component is mainly supplied by the panels' sheathing. Panels are joined using top and bottom plates and with splines between the panels. Wiring is pre-planned and fished through hollow cavities (chases) located within the panels. The chases are created in the factory during the fabrication of the panel.

The 6" thick panels provide an overall R-24 insulation value. Studs are sometimes added to panels to achieve the braced wall panel requirements to meet *BC Building Code* for high wind or seismic concerns.

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The advantages of SIPs include reduced wall framing time, high levels of insulation, reduced thermal bridging, and increased lateral and compressive structural strength.

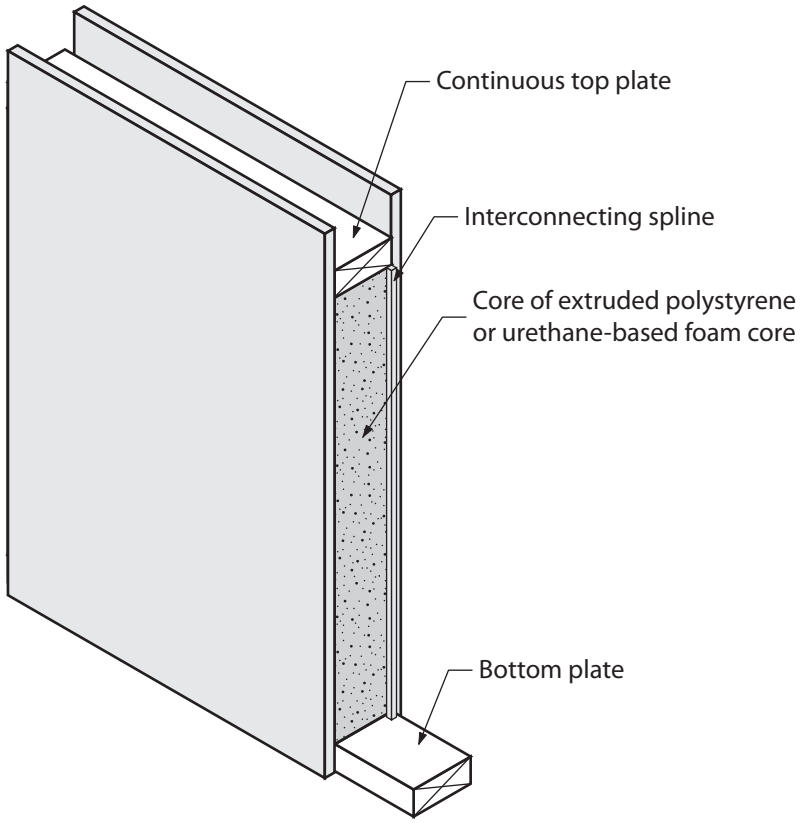

Figure 1 – SIP wall framing

Traditional Wall Framing

Unlike prefab and SIPs, traditional platform-framed walls (also called "stick-framing") are put together piece by piece using studs, plates, and sheathing. Once the stud spacing has been determined, corners and intersecting walls can be planned for. Next, the windows and doors are laid out, and the wall is framed, squared, and sheathed. Lastly, the wall is stood up, positioned, and fastened in place.

Wall framing construction, layout, and assembly are the same for all walls including foundation pony walls. Although there are situations in which walls will be built standing up and then sheathed, in general most walls are built lying down, sheathed, and then stood up.

Wall Framing Members

Although there are many terms used to describe wall framing members, the following are commonly used throughout the modules for all four levels of Carpentry Apprenticeship.

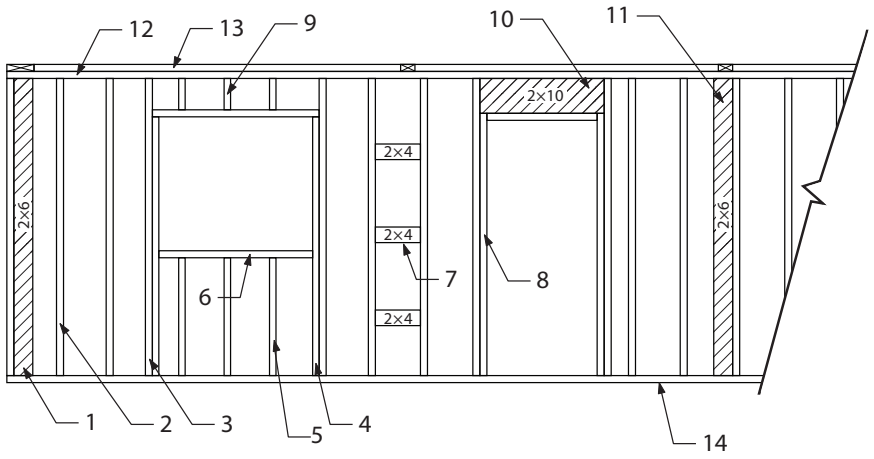

Figure 2 – Wall framing member names

1. Corner
2. Stud
3. Stud
4. Cripple
5. Lower jack
6. Rough Sill
7. Ladder blocking
8. Cripple
9. Upper jack
10. Lintel
11. Partition backing
12. Lower top plate
13. Upper top plate
14. Bottom plate

Stud Size and Spacing

There are several factors that affect the size and spacing of wall studs. Before choosing the size and spacing of studs, consideration must first be given to the structural requirements, finish materials, type of wall sheathing, and thermal insulation requirements.

Structural Requirements

The size and spacing of the exterior wall studs is found in *Part 9* of the *Building Code*. The two criteria used in determining minimum size and spacing of studs are the stud's unsupported height and the load it will carry.

Studs are typically either 400 mm (16") or 600 mm (24") o.c. The exception to this is when 2×4 exterior studs are supporting two floor loads, or 2×6 studs are supporting three floor loads. In these cases, the *Building Code* requires them to be 300 mm (12") o.c.

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Other Considerations

Other considerations include support for exterior and interior claddings, insulation values, and sheathing thickness.

16" o.c. gives better support to drywall and exterior finishes, and allows for more attachment points for cabinets than 24" o.c. It also allows for the use of thinner sheathing, which reduces costs.

24" o.c. uses less lumber, is quicker to frame, and provides a better overall R-value for the wall, helping to meet the heat loss requirements of the *BC Building Code*.

2×6 is now commonly used for framing exterior walls, since it provides more space for insulation compared to 2×4 walls.

Corner and Wall Intersection Construction

Where the walls form a corner, and where exterior and interior walls intersect, the studs must provide for the connection of the two walls as well as provide backing for the interior and exterior finishes. Concealed wall stud spaces must be avoided so that the full wall can be insulated once the building is weathertight.

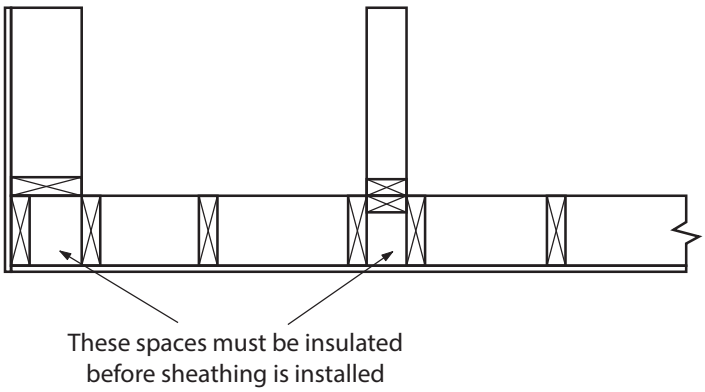

Figure 3 – Concealed spaces must be avoided

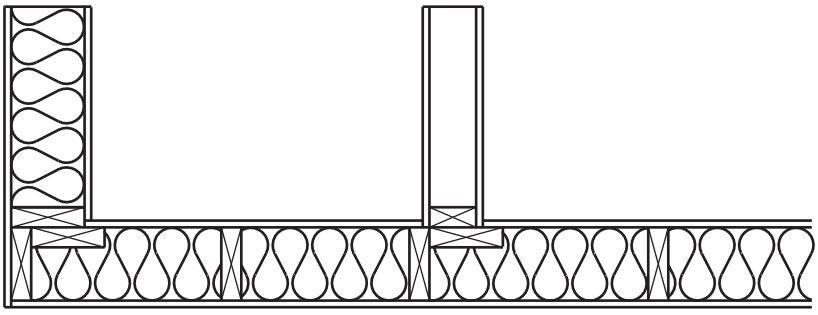

Figure 4 – Framing that allows for insulating at corners and intersections

If concealed spaces cannot be avoided, rigid foam insulation should be used to fill the cavities. Fibreglass insulation used to insulate cavities during framing will get wet. Wet fibreglass insulation will reduce the insulating capabilities of the fibreglass and may cause rot in the wood frame.

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Exterior Corners

Two wall studs are nailed together to create a corner stud. These corner studs are usually assembled prior to positioning them into the wall frame. Make sure to keep the edge of the stud flush with the face of the backing stud.

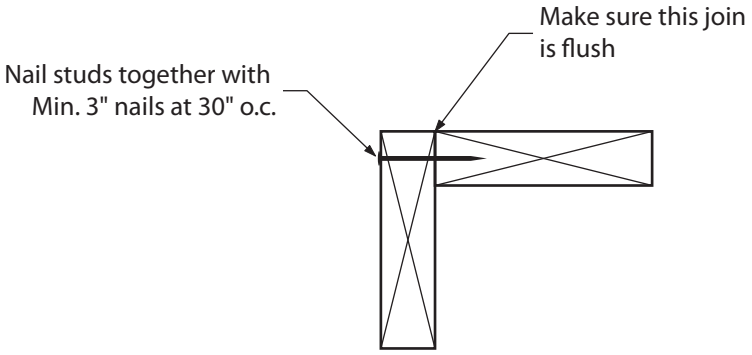

Figure 5 – Building corner studs

Intersections

Interior walls are known as "partition walls." Partition studs are used in exterior walls to provide solid attachment of the interior wall and to provide backing and attachment points for the interior finish.

For 2×4 interior partitions, a 2×6 stud is nailed to a regular wall stud, and for 2×6 partitions a 2×8 is used.

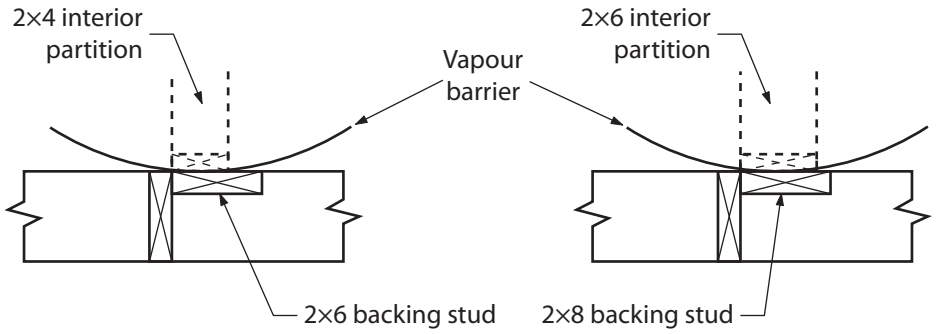

Figure 6 – Partition studs

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Another method is to build a ladder by blocking with 2×4s at 24" o.c. between the nearest two studs.

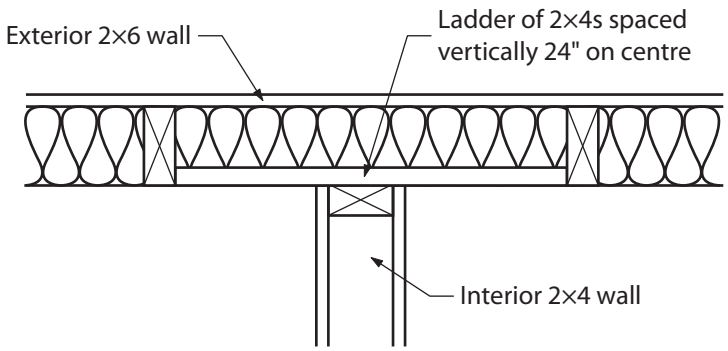

Figure 7 – Ladder-type partition framing in exterior walls

As with corner studs, partition studs are pre-assembled and nailed in a similar manner.

Door and Window Openings

The opening created in framed walls must be sized to allow the finished door or window to fit properly. The framed opening is referred to as the "rough opening." The rough opening is usually larger than the actual size of the door or window to allow for shimming the door or window to level and plumb.

Rough Openings for Doors

Most doors are purchased as pre-hung doors. They arrive at the job site with the door in the frame and with hinges installed.

The nominal size of a door is the size of the door itself. The rough opening is always larger than the door size to allow room for the frame (jamb), sill (threshold), and for clearance around the door for shimming level and plumb.

Doorframe

The thickness of the doorframe (jamb) will vary depending on the type of door the frame supports. Exterior doors usually have a solid core, which makes them heavier than interior doors. The jambs used with exterior doors are heavier than the jambs used with interior doors.

Exterior doors are usually hung using a 1¼" rabbeted jamb.

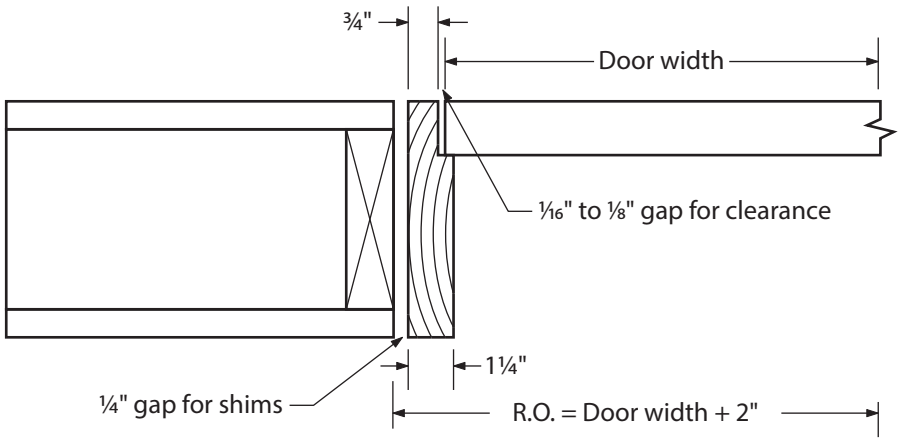

Figure 8 – Exterior door allowances

The rough opening width shown in Figure 8 is equal to the door width plus an additional 2".

Some heavier doors require a 1½" rabbeted jamb. In this case, an additional ¼" must be added to each side of the rough opening to allow for the thicker jamb.

Clearance
Space is needed between the jamb and the door to allow the door to open and close without binding. The amount of clearance varies and is set when the door is hung in the frame.

The head jamb of pre-hung doors is usually cut ⅛" or ¼" longer than the door width. This gives a clearance of 1⁄16" or ⅛" at each side of the door. The clearance at the top of the door should match the clearance at the sides.

When installing a pre-hung door in the opening, the jambs are shimmed to make the clearance space between the door and jamb perfectly even on both sides and the top. A five cent coin works well as a gauge for checking this.

Shimming Space
Pairs of thin cedar shingles are used to shim the doorframe in place. A ¼" space at each side of the frame is adequate for shimming. If the rough framing is plumb, the hinge side of the doorjamb can be fastened directly to the cripple stud without shims. This will leave ½" for shimming on the latch side.

Vertical Rough Opening
The allowance between the top of the door jamb and framing is similar to the allowance at the sides of the opening. No shimming takes place at the top, but the bottom of the doorframe may have to be shimmed to level.

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There is normally a sill (threshold) under exterior doors. Although most doors swing into the building, some doors are installed to swing out. In these cases, the threshold design will take up less room than one for an "in-swing" door.

Modern doorsills are flat on the bottom. The thick edge of the doorsill is usually 1½" thick. An allowance of ½–¾" is made for the door sweep (Figure 9).

Including the allowance for the jamb at the top of the door, the rough opening for the door shown in Figure 9 would be the door height plus 3½". Out-swing doors require 2½" added to door height.

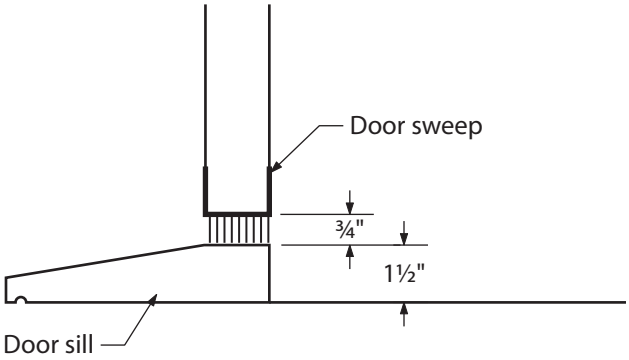

Figure 9 – Doorsill and sweep

Standard Allowances

With so many factors to consider, deciding on a standard for rough opening allowances is difficult. It's generally better to make the opening too big rather than too small. The following rough opening allowances in Figure 10 will suit most cases.

Location	Allowance
In-swing exterior doors	add 2" to width of door add 3½" to height of door
Out-swing exterior doors	add 2" to width of door add 2½" to height of door
Double in-swing doors	add 2" to combined width of doors* add 3½" to height of door *check with manufacturer
In-swing door with sidelite(s)	check with manufacturer
Garage door	on-size (nominal size of door)
Sliding patio door	on-size (nominal size of door)

Figure 10 – Standard door allowances

Lintel Sizes

The area above doors and windows is known as the "header space." A beam is normally required in the header space for structural support in load-bearing walls. This beam is known as a "lintel" by the *Building Code*, but it may be referred to as a "header" on the job site.

The depth of lintel needed for a specific opening depends upon the width of the opening and the load supported by the lintel. *Part 9* of the *Building Code* includes a series of lintel design tables. These tables provide the maximum allowable span of various sizes of lintels based on the species of lumber, snow load, and building load.

Lintel spans listed in the *Building Code* are for uniform loads only. Point-loaded lintels must be sized by a registered engineer. Often engineered beams (such as LVLs) are used for point-loaded lintels and for lintels that carry heavy loads or have long spans.

Lintels are made from multiple plies of framing lumber. The plies must be nailed together as a beam. Lintels 3 metres and less in length require 1½" of end-bearing, whereas lintels over 3 m require 3" of end-bearing. Support consists of cripples nail-laminated to studs.

To simplify the construction process, 2×10 lintels are usually used for all exterior openings. This speeds up framing, but leaves less room for insulation and can contribute to shrinkage problems. Lintels within 2×6 walls can be either 2- or 3-ply.

A 2×6 can be nailed to the underside of the lintel to support the interior finish (Figure 11) or a furring strip can be added (Figure 12). Choosing one or the other of these methods will align all the window and door top heights.

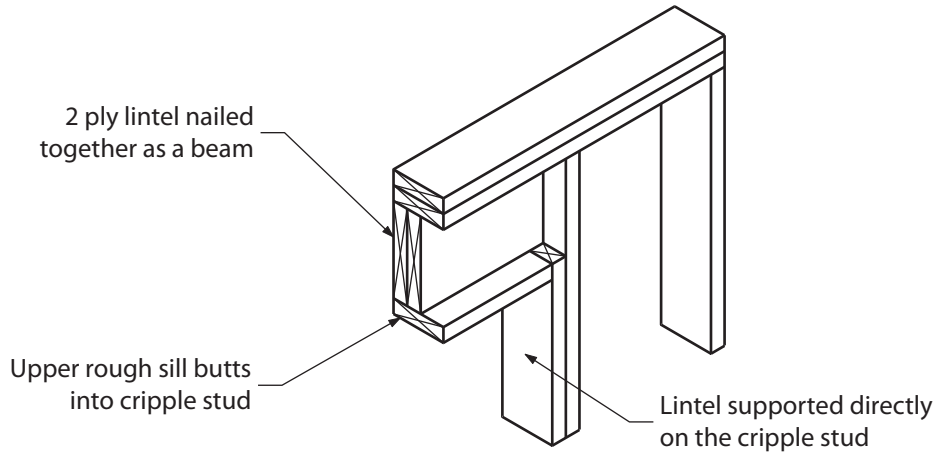

Figure 11 – Upper rough sill

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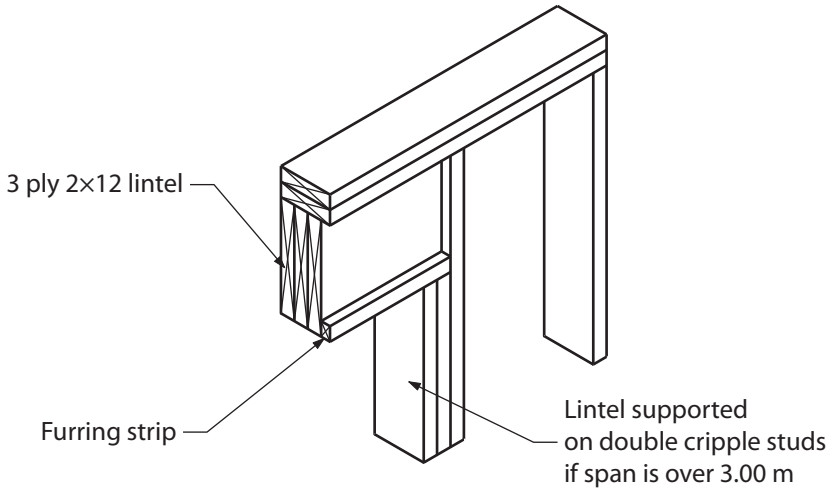

Figure 12 – 2×12 lintel

If a 3-ply 2×10 is too small for the combination load and span, 2×12s may be needed (Figure 12). If extra height is needed, one or both top plates can be eliminated if a continuous single top plate or metal strap is used as a tie across the top.

Openings for Windows

Window rough opening framing is similar to door opening framing, except that a rough sill and lower jacks are framed in below the window opening. Windows are often "on-size," meaning that the opening is framed to the window's nominal size and the heel size of the window is slightly less to allow for shimming. Unlike doors, there's no jamb or threshold to allow for. A 4' 0" × 3' 0" (40 × 30) window will typically have a rough opening framed at 48" wide by 36" high. Sliding patio door rough openings are treated the same as window rough openings, except there is no rough sill, jacks, or bottom plate under the patio door.

Rough opening sizes for windows and doors should be checked with the manufacturer prior to framing. Not all manufacturers use the same allowances.

Typically the tops of all windows are framed at the same height.

Stud Lengths

Studs are required to span the full-storey height of the wall. In other words, a piggy-backed wall on top of a wall is not allowed, as this creates a hinged connection.

Walls that are angled on top are known as "raked walls." Raked walls require each stud to be cut to a different length.

The full-length common studs are cut to a length that will provide the designed ceiling height. In standard residential construction, the ceiling height is designed to use two full widths of gypsum wallboard (drywall) as the wall finish. Two full widths measure 8 feet. An extra ¾" is added to allow for the ceiling board and to leave a small gap at the bottom to allow the sheets to be installed easily.

Notes

PETs

Precision End Trimmed studs (PETs) are available for 8-, 9-, and 10-foot nominal ceiling heights. They're used with a single bottom plate and a double top plate. All plates are 1½" thick.

The PETs are 4½" (114 mm) shorter than the framed wall height. Most PET manufacturers in BC deliver a 92¼" PET stud for an 8' ceiling, but some use 92 ⅝". Framing lumber other than PETs will vary in length by more than ½" between boards.

For specific ceiling heights, the stud length must be calculated. Drawing a sketch is often useful.

Example 1

The desired ceiling height is 103", the ceiling finish is ¾" plaster, the finished floor thickness is 1", and the underlay (panel type material used to level the subfloor) is ⅜" thick. The overall wall height is:

103" + ¾" + 1" + ⅜" = 105 ⅛"

The stud length is therefore:

105 ⅛" – 4½" = 100 ⅝"

(This example assumes that the plates are all kiln-dried material.)

Example 2

The desired ceiling height is 2620 mm, the ceiling finish is 25 mm plaster, the finished floor thickness is 20 mm, and the underlay is 15 mm thick. The overall wall height is:

2620 + 25 + 20 + 15 = 2680 mm

The stud length is therefore:

2680 mm – 114 mm = 2566 mm

(This example also assumes that the plates are all kiln-dried material.)

NOTES

Story Pole

An easy way to determine wall framing member lengths is to use a story pole. The pole consists of a piece of wood slightly longer than the wall height. The total wall height, the wall plates, the lintel depth, and the rough opening heights of all the windows are all laid out on the pole (Figure 13).

Using a story pole reduces the chances of error by using full-size layout. The lengths of the common studs, cripple studs, and jack studs are measured from the story pole.

The layout person will create the story pole before laying out the walls. This will allow the other carpenters to cut all of the studs while the layout person continues to lay out the wall plates.

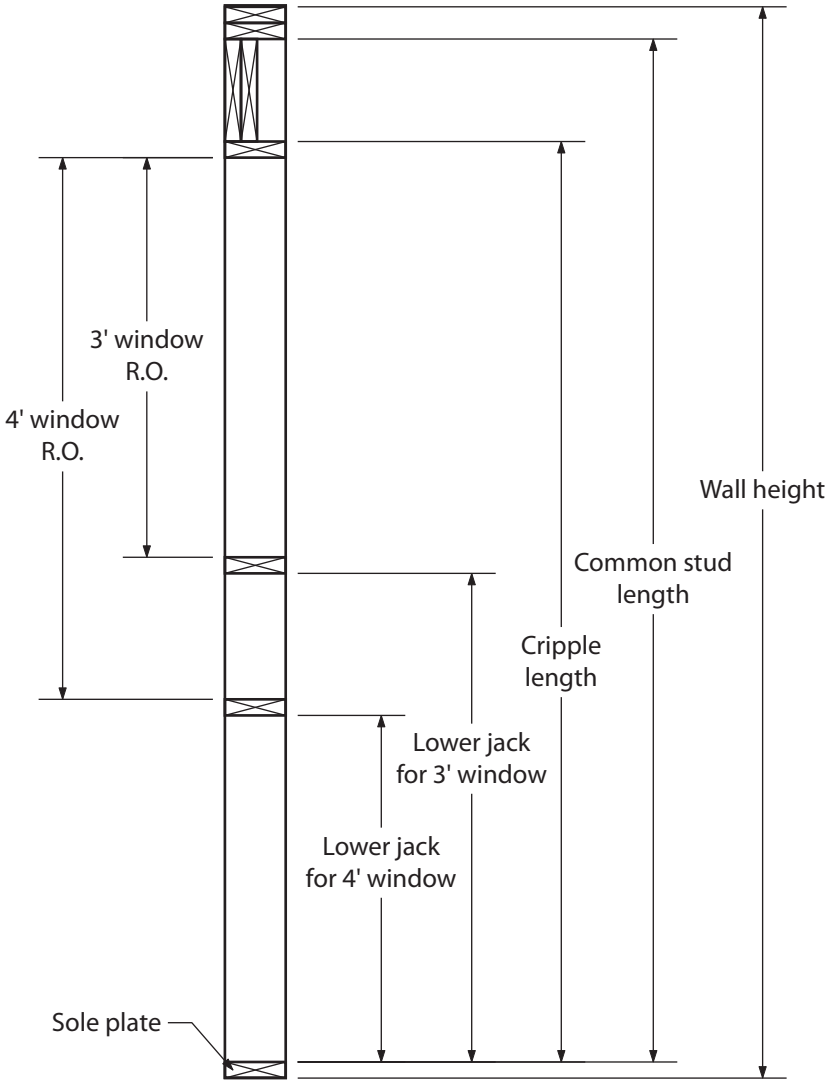

Figure 13 – Wall stud story pole

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Top and Bottom Plates

The next step in wall framing is to cut and lay out the bottom and first top plates.

Cutting Plates to Length

Before layout can begin, the wall plates are cut to length. The length of the wall plates must take into consideration the order of wall assembly and may need to be shortened if butting into another wall. Usually the walls are assembled in a continuous fashion, working around the outside of the building. This allows the subsequent walls to help brace the previous walls.

Select the longest straight material available for wall plates.

Wall Plate Layout

Wall plate layout is very similar to the laying out of floor joists. First all of the openings, partitions, and corners are laid out. Then the positions of the common studs are laid out. Laying the common studs out last allows common studs that fall on the cripple stud locations to be eliminated without creating extra confusing marks. It also helps determine the number of jacks to cut.

Windows and Doors

Windows and doors are laid out by marking the centre of the opening on the wall plate and then measuring half of the rough opening on either side of the centre mark. A "C" is used to mark the location of the cripple and an "X" for the stud location.

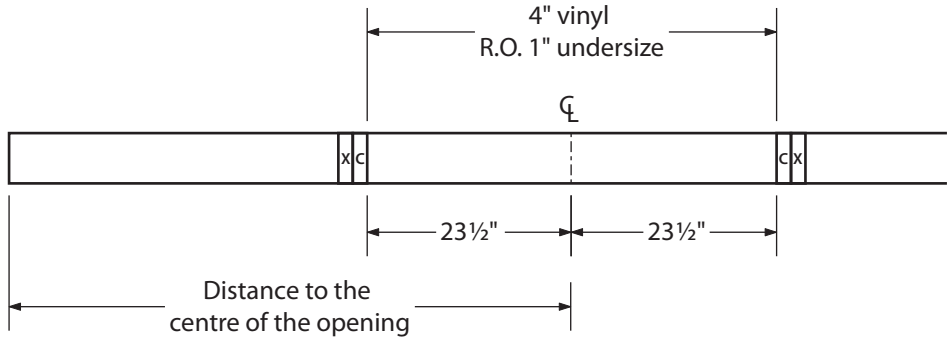

Figure 14 – Window and door layout

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Partitions

To lay out intersecting partition walls, mark the location of the centre of the partition on the plate. Then measure half of the partition width on either side of the centre mark. A large "X" or a centre line symbol is used to mark the location of the partition.

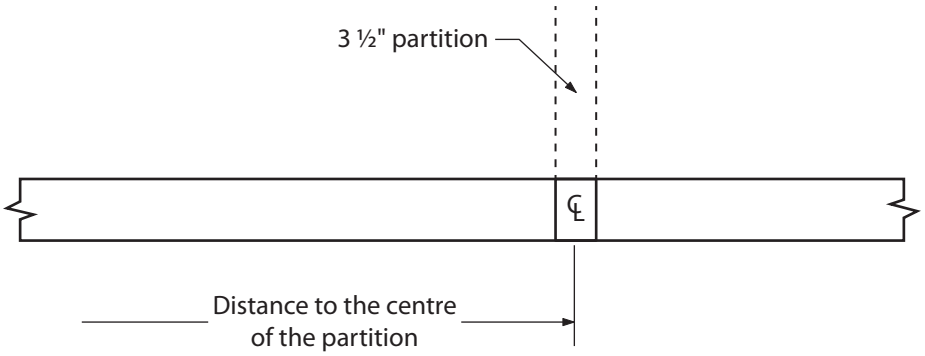

Figure 15 – Partition layout

The studs forming the partition are often not shown, as there are several ways to frame for partitions.

Common Stud Layout

The common studs are laid out to allow the sheathing to extend to the outside corners.

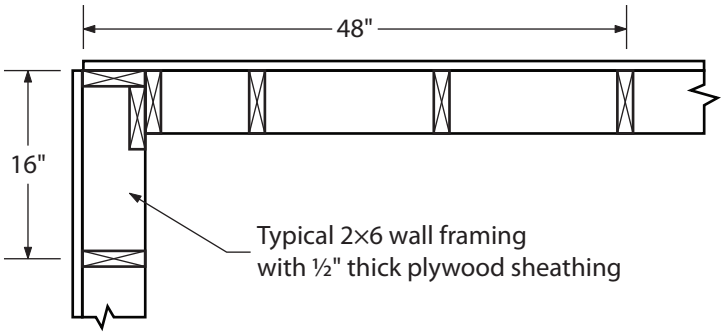

Figure 16 – Common stud layout

The stud layout will vary slightly if thicker or thinner wall sheathing is used.

Layout on the Edge

If the stud layout is done on the edge of the plates, then the marks are readily visible to the carpenter assembling the walls. Always lay out one plate and transfer the marks to the second plate using a square. Take care to make sure the ends are flush before transferring the marks. Tack the two plates together with a nail to keep them from moving while transferring the marks.

Assembling Wall Units

Walls are assembled on the subfloor and then lifted into a vertical position. Choose the straightest lumber for plates, corners, and other critical locations. The worst lumber can be cut into short pieces for framing under windows and for blocking. Where two or more studs are required to be nail-laminated together (such as under a beam), crooked studs can be used in reverse directions to straighten each other.

Order of Assembly

The order of assembly of wall units is similar to floor framing. The openings, partitions, and corners are installed first. They're completely nailed together and then the common studs are positioned and nailed in place. Assembling the wall in this order allows end-nailing of the lintel without the common studs being in the way. It's very important to keep the edges of the studs flush to the edge of the plates.

Double Top Plate

After all of the studs have been end-nailed, the double top plate is installed. Leave gaps in the double top plate of the exterior wall to allow for the double top plate of the interior partitions that will intersect the exterior walls. Allow an extra ¼" on either side of the layout position. This will allow the interior partitions to be plumbed independently from the exterior wall.

When nailing the upper top plate, nail over the stud locations, not between the studs, to prevent nails from being placed where electricians and plumbers will be drilling.

Fastening Requirements

Most wall framing connections call for 3¼" nails. Only the lamination of studs at openings and corners allows for 3" nails. When toenailing studs to plates, four 2½" nails may be used. 3¼" nails are generally substituted for 3" nails to keep the nailing simple. If 3¼" nails are used to laminate studs at window and door openings, angle the nails to keep the sharp points from sticking out the opposite side and to provide better holding power.

It's difficult to use pneumatic-operated nailing guns to position studs without putting one of your hands in danger. Hold the stud flush and put the first nail at the bottom edge of the plate. Then move your hand before continuing nailing.

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Most framing connections require a minimum of two end nails. When double studs are used at openings, corners, and wall intersections, they must be nailed together with at least one 3" nail every 450 mm (30").

Upper top plates must be nailed to the lower top plate with 3" nails at 24" o.c. It's good practice to put these nails over studs so sub-trades drilling through the plates will not hit the nails. Bottom or sole plates must be nailed to the joists or blocking (nailed through the subfloor sheathing) at 16" o.c. using 3¼" nails.

Additional nailing is needed when braced wall panels are required for buildings located in high-wind or seismic areas.

Sheathing and Erecting Exterior Walls

Exterior wall sheathing provides support for the exterior finish and acts as structural bracing for the wall against wind and other loads.

Wall sheathing requirements are based on the type of wall finish it must support, the stud spacing, and for the wind and seismic zone that the building is located in.

If the wall finish doesn't require sheathing, and wind/seismic bracing is not required, no sheathing is required as long as the walls are braced with let-in braces, metal straps, or a suitable interior finish.

If the wall sheathing is required to support the exterior finish, 7⁄16" OSB, ¼–½" plywood, or ¾" lumber sheathing may be used depending on stud spacing and if braced wall panels are required.

Refer to the *Building Code Subsection 9.23.17* for specific information.

Lumber Sheathing

Lumber sheathing is made from sawn boards. Some boards are made with matched rabbets—this type is referred to as "shiplap." Lumber sheathing is usually made from 2×8 or 2×10 boards that have been resawn into ¾" thick boards.

Lumber sheathing can be installed while the wall is lying on the subfloor, but it makes the wall very heavy to lift. For this reason, it's often applied to the walls after they are standing and braced plumb.

Unless diagonal bracing is provided within the wall, lumber sheathing must be applied diagonally 45° to the plate line. End joints must be made on the studs and joints should be staggered from row to row.

Common or spiral nails should be used to fasten lumber. No fewer than two fasteners per support are required for lumber up to 184 mm wide. Three fasteners per support are required for wider lumber.

Lumber sheathing provides two advantages over panel-type sheathing:

- If applied after the walls are erected, it can be installed in continuous boards from the foundation over the floor levels to the roof level. This provides the best bracing, tying all of the building components together.
- Lumber sheathing will usually shrink a significant amount. This leaves ¼ to ½" gaps between each board. These gaps provide excellent opportunities for venting the wall cavity.

Panel-type Sheathing

Plywood, OSB, fibreboard, and gypsum board are generally applied to the framed walls in horizontal rows. The joints in the sheets are staggered from row to row (known as breaking the joints).

The *BC Building Code* requires that a gap for expansion of not less than 2 mm be left between sheets of plywood, OSB, waferboard, or fibreboard.

If the sheathing is acting as the exterior finish, the panels may be installed with their long dimension vertical. Special 9' long sheets are made for this purpose. These sheets are installed after the walls are erected.

Installing Sheathing

Before installing sheathing, the wall is positioned, straightened, and squared.

Straighten the Bottom of the Wall

Align the bottom of the wall to a chalk line to straighten it. If the chalk line is set at the exact location of the inside face of the wall, the line can also be used to position the wall after it has been erected.

Toenail the bottom plate to subfloor in line with the chalk line. This will straighten both the bottom plate and the top plates (Figure 19).

Square the Wall

Square the wall by making the opposing diagonal measurements the same length. Adjust the length of the diagonals by moving the top of the wall from side to side. Remember to measure the diagonals from the same position on the top plates.

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After the diagonals are equal, toenail the top plate to the subfloor. The wall is now ready for sheathing.

Once lifted into place, the ends of the wall will automatically be plumb in one direction as long as the floor is level and the wall is square. By tying the walls together at the corners, the top of the walls are plumbed in both directions. (However, it's good practice to confirm they're plumb with a long level before too many nails have been placed.)

Nailing

Panel-type sheathing materials are nailed at 6" o.c. along the edges and 12" o.c. in the middle of the sheets. Required nail lengths are affected by whether or not the walls are in high-wind and seismic zones.

Panel-type Sheathing Overlap at Corners

It's good building practice to overlap the sheathing at the corners of the building. To do this, the sheathing must be allowed to hang over the end of the wall. The wall is stood up and then "walked" into place.

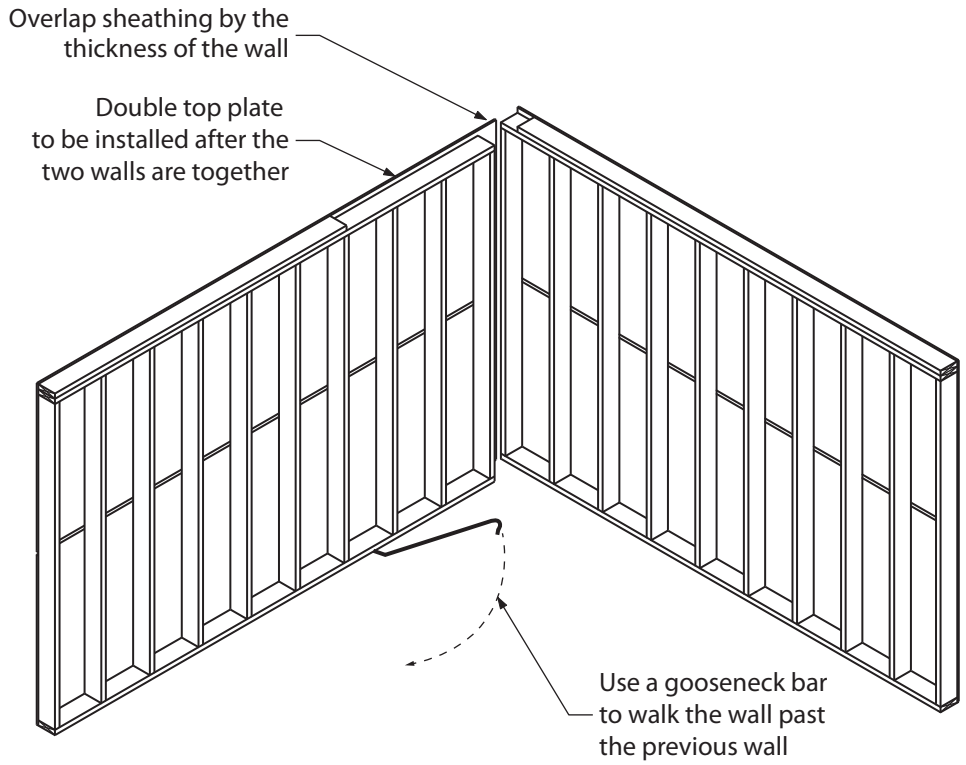

Figure 17 – Lapping the sheathing at corners

A 5½" overlap is used for 2×6 walls. This leaves a small gap at the corner, which aids in applying building paper and finished cladding (siding).

Vertical Panel-type Sheathing Overlap

If the walls are erected without sheathing, then panel-type sheathing boards can be applied starting at the foundation level. This will allow the panels to overlap the boxing joist and tie the wall to the floor and the foundation. This is an excellent way to stiffen a building, but it's very time-consuming and floor joist shrinkage may become a problem.

Overlapping Sheathing at Lintels

The *Building Code* allows increased spans for lintels if the lintel is covered and tied into the wall with structural sheathing (Figure 18). OSB and plywood can be considered structural sheathing if properly nailed and the joints are not in the wrong places.

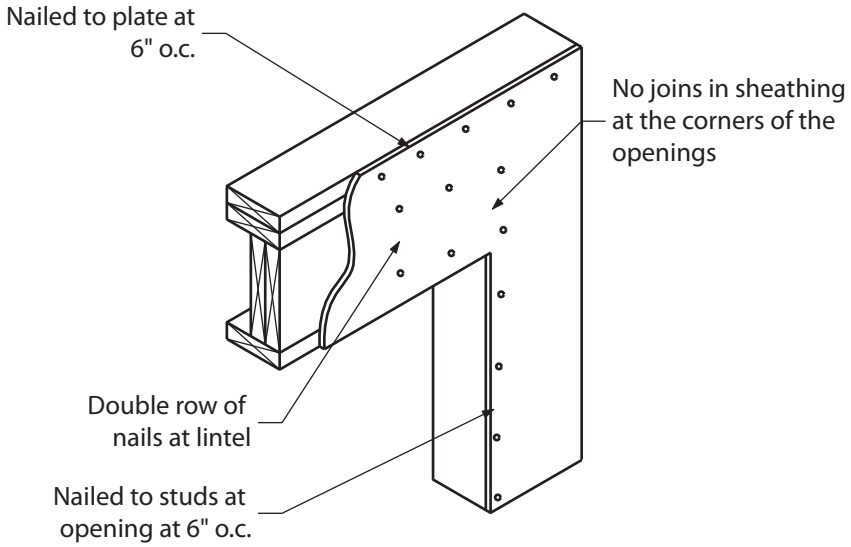

Figure 18 – Overlapping sheathing at lintels

A double row of nails at the lintel is required and the sheathing should not be joined at the corners of the opening.

This is good building practice even for non-load-bearing walls. Wall sheathing should not be joined at the corners of window and door openings, as all openings are weak points. They need the reinforcement of the panel-type sheathing.

NOTES

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Erecting Walls

Once the walls are sheathed, they can be lifted into place. A precaution must be taken to ensure that the wall will not slide off the floor. Either nail blocks (kickers) to the outside of the floor frame or toenail down the bottom plate to the subfloor (or both). If toenailing is used, the wall is aligned to the chalk line and toenailed to the subfloor from inside the wall.

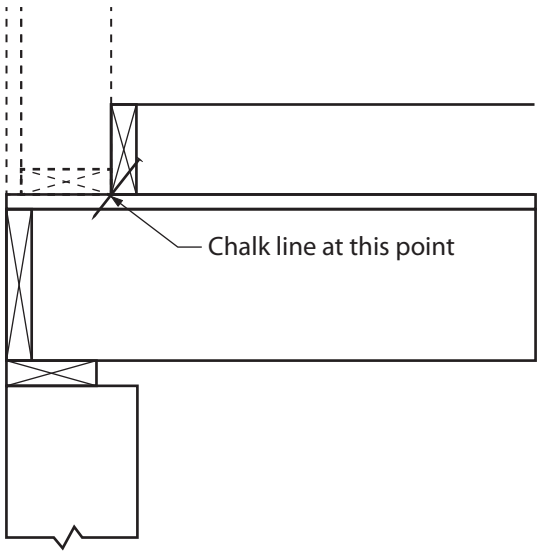

Figure 19 – Toenailing wall frame to the subfloor

After the wall has been erected, the toenails can be removed.

Lifting Walls

Walls can be lifted by hand or with wall jacks.

Hand Lifting Walls

Lifting walls by hand should only be attempted if there are enough workers to prevent any one worker lifting more than they're capable of. There should be an extra worker available for attaching braces and helping with unforeseen circumstances.

Lifting the walls in steps is possible by using blocks and saw horses. By allowing a resting point, there's less chance of injury.

Lifting with Wall Jacks

Mechanical wall jacks can be used to lift walls. Wall jacks usually incorporate a bracing system so that the wall is fully supported throughout the lift. Using wall jacks is much safer than lifting by hand and should be used whenever possible.

NOTES

Bracing Walls

Once erected, the walls must be braced immediately. Tie the newly lifted wall to a previously lifted wall and brace the rest of the wall with angle braces back to the floor.

Until all the exterior walls of a building are erected and connected to each other, they are at risk of being blown over by the wind. Install additional braces at the end of the day in case of a windstorm.

Straightening Walls

Once all walls have been erected and the double top plates have been connected, the walls must be straightened. The corners should be plumb if the walls are square and the floor is level.

Three-block Method

A string line and three equal thickness blocks are used to straighten walls. Attach one of the blocks at each end of the wall. String the line and fasten it securely after making it very taut. Use the third block to check the space left between the string line and the edge of the wall. Use braces to adjust the wall position.

Spring Brace

Using a 1×6 or 1×8 as a brace allows fine adjustment in position and generates great forces for pushing heavy walls. The brace is set up as shown in Figure 20.

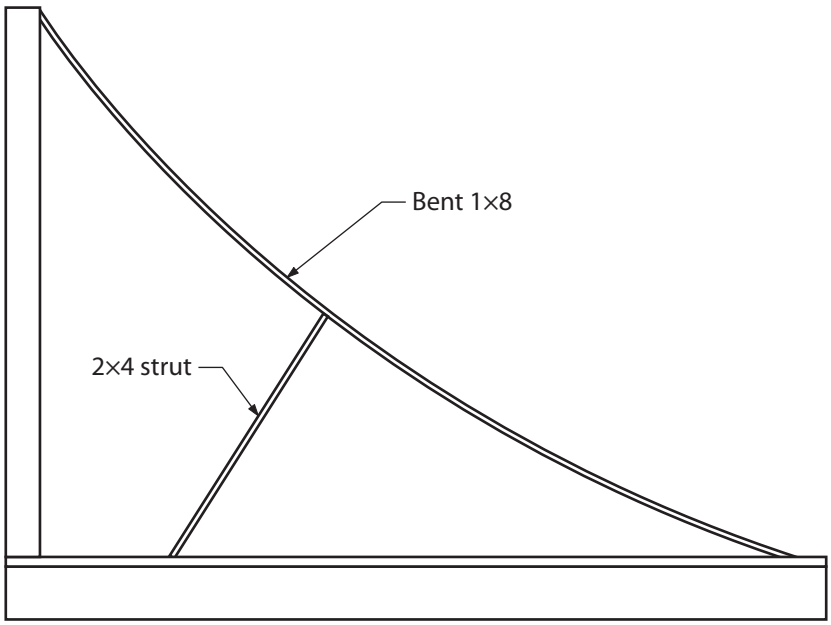

Figure 20 – Using a 1×8 as a wall brace

NOTES

The 1×8 is bent slightly and nailed to both the floor and the top of the wall. If the 1×8 is bent more, the wall will move inward, and if it's straightened, it will push the wall outward. A 2×4 is used to support the 1×8 at its final location.

Caution must be taken when working with spring boards. They can become quite stressed and can let go suddenly.

Now complete Self Test 1 and check your answers.

Self Test 1

1. List four factors that will affect the design of exterior wall studs.

2. When toenailing wall studs in place, what is the minimum length of nail that may be used?

3. What is the minimum length of nail that may be used to fasten the cripple studs to the adjacent studs? How far apart are these nails placed?

4. What is the nail spacing of the bottom plate to the floor joists?

5. Why is it not a good idea to leave concealed spaces in the wall frame?

6. What are two purposes of an "L" shaped corner stud?

7. What is meant by the "nominal" size of a door or window?

8. What is the rough opening for a 30 × 68 in-swing exterior door?

9. What is the minimum end-bearing for a lintel that spans 12 feet?

10. What does the abbreviation "PET" stand for?

11. Describe an easy method for measuring the stud, cripple, and jack lengths for a door or window opening in a wall.

12. How do you mark the opening for a door or window on the plates?

13. What size of gap is left in the double top plate of an exterior wall to allow the double top plate of an interior wall to intersect it?

14. Why should the sheathing overlap the window openings?

LEARNING TASK 2

Build Interior Walls

Notes

Interior walls are used to partition buildings into rooms. These walls are commonly known as "partitions" or partition walls. As with exterior walls, they may be non-load-bearing or be used to support floor and/or roof loads (load-bearing). Their other role is to support interior finishes. Interior walls may also be used for braced wall panels or shear walls.

The layout and assembly of interior walls is very similar to that of exterior walls, with some exceptions.

The size and spacing of interior wall studs are determined using the same principles as those for exterior walls. Wall thickness can be a design concern for interior walls. Often, non-load-bearing walls are reduced to the minimum thickness allowed by the *Building Code* to allow the maximum use of floor space.

As with exterior walls, the first step in laying out is to mark the openings on the plates. For interior walls, this mainly consists of door openings. The next step is to mark the corners and wall intersections.

Interior Doors

There are several types of doors used in partition-framing. Most interior doors are hinged swing doors, but there may also be sliding pocket doors, bi-fold type, or sliding bypassing doors. Bi-folds and bypassing doors are mainly used as closet doors.

Swing-type Doors

Interior swing-type doors are usually hung on a lighter jamb than exterior doors. In some cases, a 5/8" thick plain jamb is used with a planted stop (Figure 1). However most are the rabbeted type.

NOTES

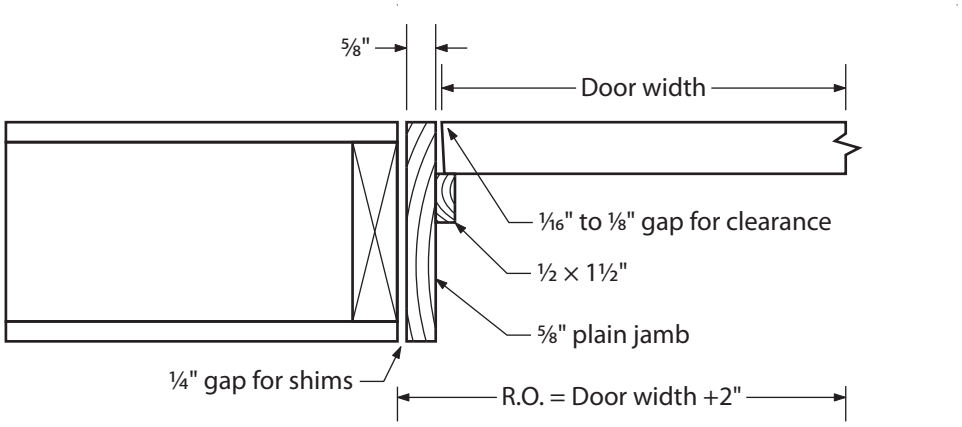

Figure 1 – Interior swing door allowances

Normally the rough opening width for swing-type doors as shown in Figure 1 equals the door width + 2".

The interior floor finish must be considered when determining the rough opening height for the door. Finished floor thickness can be as little as 1/8" to more than 2". The *Building Code* requires a ½" clearance under interior doors for ventilation purposes.

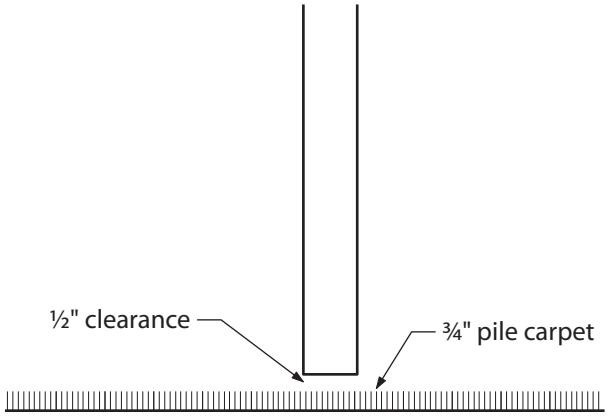

Figure 2 – Interior floor finish

Including the allowance for the jamb at the top of the door, the rough opening for the door shown in Figure 2 would be the door height plus 2¼", although many carpenters add an additional ¾".

Pocket Doors

A pocket door is a door that opens by sliding into a wall. They're most commonly used as bathroom doors.

NOTES

The frame for a pocket door is installed during the framing of the building. The rough opening width for the frame is 2" wider than twice the door width. The rough opening height is normally 84", but always check with the supplier before framing the opening.

The frame is positioned into the rough opening and secured to the framing. Drywall is attached to the 1×4 supports on either side of the pocket with 1" screws.

Bi-fold Doors

Bi-fold doors are typically used as closet doors. The wall openings for bi-folds are often finished differently than swinging doors. The sides and top of the opening are wrapped in drywall, called a "drywall return." The rough opening is 1½" wider than door size on the width to accommodate ½" drywall on each side plus ¼" for beading and mudding of drywall. The doors come slightly undersized to fit in the finished opening. A 24" door fits in a 24" finished opening.

If the door opening is finished similar to a swinging door, with ¾" jambs and casing to match, then the finished opening width is the same, but the rough opening will be the door width plus 1½" wide (¾" jamb each side).

Bi-fold doors are sized for a 80" finished opening height—this allows for the door, the top track, and the bottom pivot. The size of the rough opening is 80" + the finish at the top, drywall or wood, and the finish floor.

Example

The rough opening height for a standard bi-fold with a ½" drywall return and ¾" thick finish flooring is 80" (door, track, and pivot) + ⅝" (drywall and mud) + ¾" (finish floor).

80" + ⅝" + ¾" = 81 ⅜"

Always check with the bi-fold supplier or manufacturer for finish opening size requirements.

Bypassing Doors

Bypassing doors are sets of sliding doors and are most often used as closet doors. The doors are top hung and slide on a track. The bottom of the door is guided by low-friction nylon guide strips or nylon guide pins that fit into a metal track.

NOTES

Because the doors overlap, the width of the opening isn't as critical as with other interior doors. Typically, the finished opening should be the nominal door width by 80" high, but always check with the supplier or manufacturer to confirm.

Constructing Partitions

Once the openings, corners, and intersecting partitions are marked on the plates, laying out the on-centres for the studs can usually start from either end of the wall. Interior walls do not require straightening or squaring, as they are not normally sheathed. Once the wall is framed, it's stood up and slid in place.

After being vertically plumbed and fastened to adjacent walls and the floor system, the wall may require temporary diagonal bracing. Eventually, the top of the interior walls will be fastened to the ceiling joists above the wall.

The construction of interior partitions may include some features that are not found in exterior walls.

Thin Partitions

The *Building Code* allows 2×2 studs to be used in non-load-bearing situations. 2×2 studs are very weak so 2×4 studs are usually used with their wide face parallel to the wall (on the flat) as shown in Figure 5. A typical location for this type of framing is between two closets when space is limited.

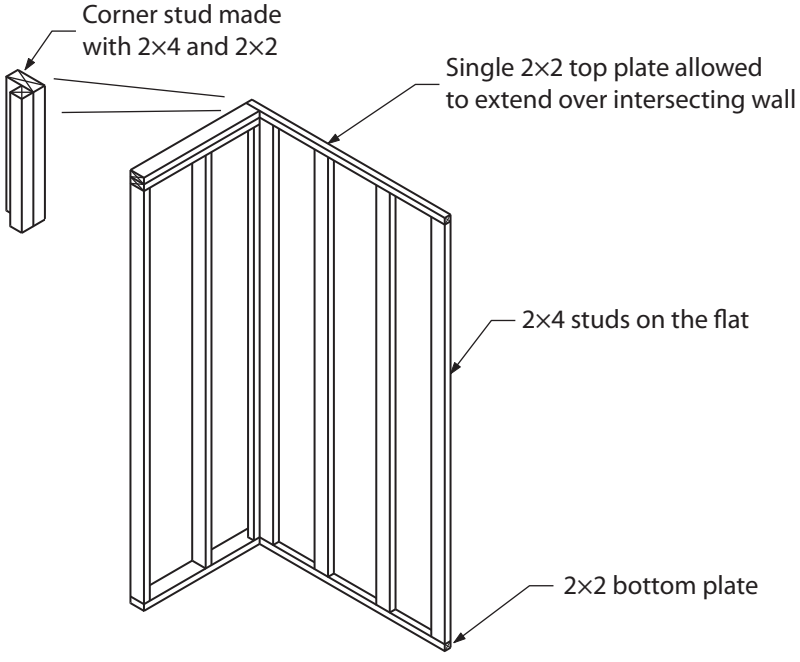

Figure 3 – Thin partition built with 2×4 studs on the flat

The single top plate is used to allow the studs to be end-nailed and to allow overlapping of the top plate onto the wider wall. Using a single top plate is acceptable if the walls are non-load-bearing or if the studs line up with the supported members. Using a single top plate requires the studs to be cut longer than the regular studs.

NOTES

Plumbing Walls

Thicker interior walls are often required to accommodate plumbing pipes. These walls are usually constructed with 2×6 studs. They can also be constructed with two sets of 2×4 studs on the flat on either side of a 2×6, 2×8, or 2×10 plate.

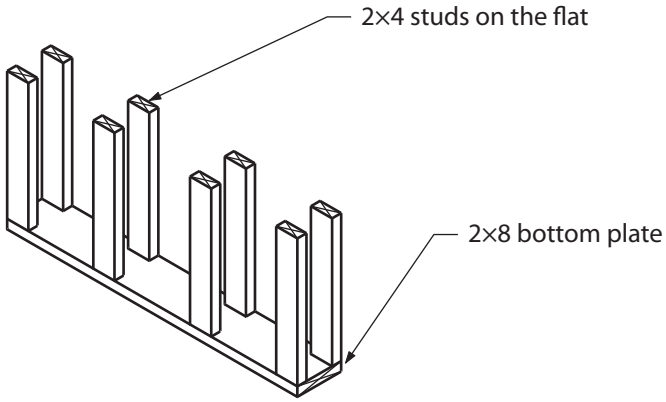

Figure 4 – Extra wide plumbing wall

2×4 studs on the flat are weak and do not support the wall very well. It's good building practice to secure opposing studs together with a plywood cleat at mid height.

Sound-resistant Walls

Sound waves are conducted through walls by vibrating the studs. Staggered stud walls significantly reduce sound transmission.

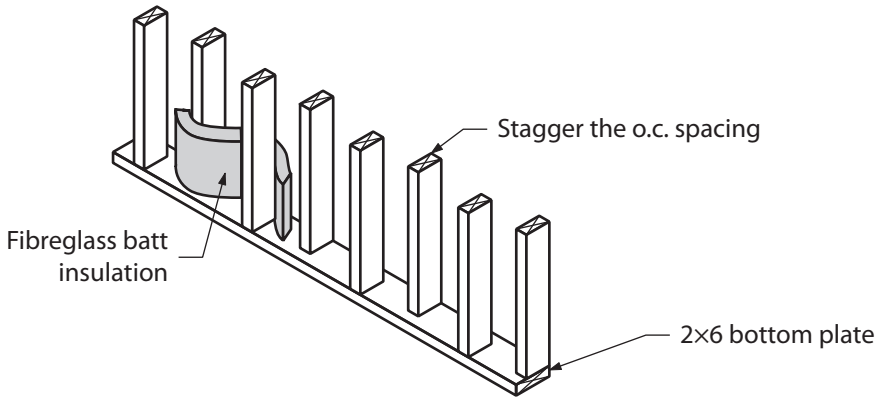

Figure 5 – Sound-resistant wall

NOTES

Weaving insulation between the studs will further reduce sound transmission. Furring the wall with resilient channel bar (res-bar) for drywall attachment works in a similar manner to a staggered stud wall.

Vapour Barrier

A barrier must be present to keep air and water vapour from entering the wall and ceiling cavities. If polyethylene is used as the air/vapour barrier, it must be continuous. To achieve this, a strip of the poly is placed between the joint where interior partitions intersect with the exterior walls and insulated ceiling.

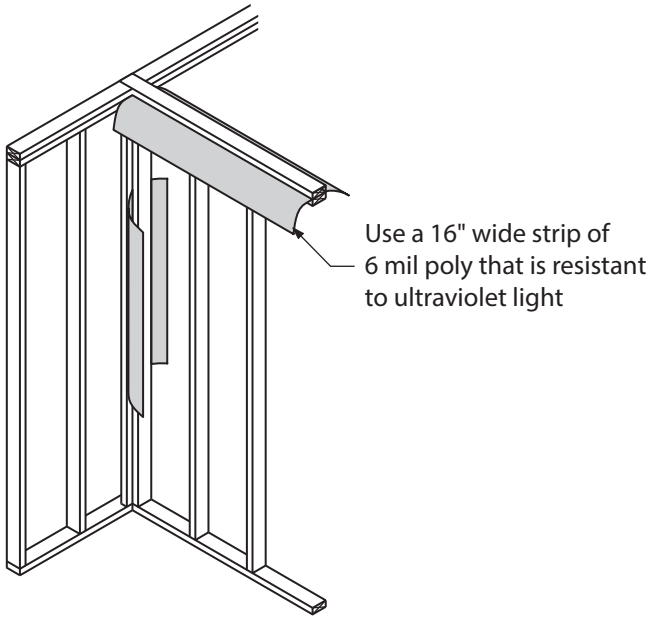

Figure 6 – Making the vapour barrier continuous

Placing the poly between the two top plates of the interior walls makes it safer for workers and protects the poly from damage during the installation of the trusses.

The width of the strip is not specified in the *Building Code*. The strip needs to be sealed to the larger sheets of poly used on the walls and underside of the trusses. A 4" overlap and tape are used to seal the joins.

Backing

Backing is required to facilitate the installation of finishes, fixtures, and equipment. Stair handrails require backing every 48", with the top of the backing approximately 36" above the line of nosing (depending on handrail bracket style).

Backing for Finishes

The corner studs and partition studs provide vertical backing.

Backing may be required for attaching the ceiling finish where an interior partition wall runs parallel to the ceiling joists. Nailing wide wooden plates to the top of the wall plates provides horizontal backing. A 2×6 can be nailed on top of 2×4 interior partitions. Leave equal amounts of the 2×6 hanging over both sides of the 2×4 top plates.

Backing for Fixtures

Installing backing for fixtures is very important. Failure to provide adequate backing may require the wall to be cut open and then refinished. This could cost hundreds of dollars to install a short piece of 2×6.

Plumbing and electrical contractors often install the backing required for their fixtures. The location of the backing for fixtures is dependent on the fixture.

Plumbing

Wall-hung plumbing fixtures require precisely positioned backing—check with the plumbing contractor. Bathtubs and laundry tubs sometimes require backing at rim height.

Electrical

Electrical fixtures are generally supported by the electrical outlet box, but some heavier fixtures require supports to be placed into the wall or ceiling. Check with the electrical contractor for the location of backing.

Towel Bars and Toilet Paper Holders

Towel bars are generally located 42" from the floor level. Installing a row of 2×6 blocks around bathrooms centred at 42" will allow the location of the towel bars to be selected after the wall finish is in place.

Toilet paper holders are normally centred 24" from the floor and 36" from the back wall.

NOTES

NOTES

Toilet and Tub Assist Bars

Toilet and tub assist bars require very strong support. Use a minimum of 2×8 blocks and secure them to studs with three 3¼" nails at each end (Figure 7). Blocking made from Douglas fir will hold installation screws better than spruce lumber.

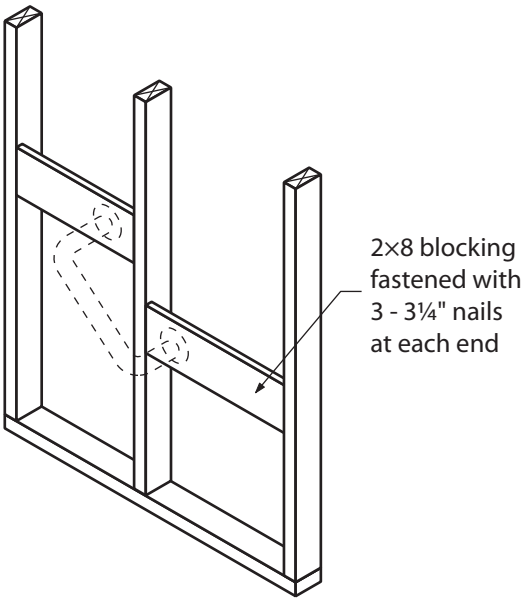

Figure 7 – Assist bars

Drapery rods

Add blocks of 2×10 at each side of window openings and include backing above upper rough sill at 48" o.c. for windows wider than 4 feet.

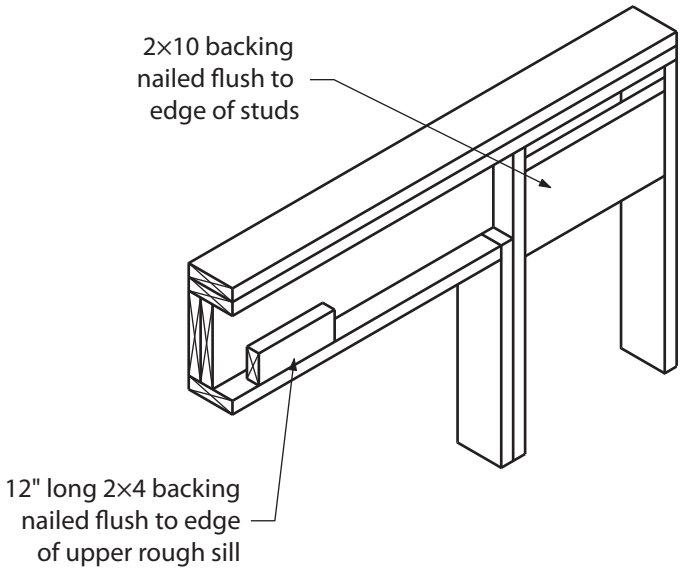

Figure 8 – Backing for drapery rods

Wood members that extend from an inside finish to the outside finish of insulated walls create a thermal bridge. This gives heat a way of escaping from the inside of the building. When possible, leave a space for insulation behind the backing.

NOTES

Backing for Equipment

Backing for heavy equipment may be required. The supplier of the equipment will provide shop drawings for this type of backing. Follow the drawings carefully. Remember, the strength of the backing is only as strong as the framing that it's attached to. Double up studs if required to support the backing.

Fire Stops

Fire stops are required in interior walls to restrict the movement of a fire. They're required if the wall is more than 10 feet in height or if there are open spaces for the fire to enter floors or ceilings.

Kitchen cabinets are sometimes fitted to framed drops in the ceiling of the kitchen. The intersection of interior and exterior walls with these drops must be protected with a fire stop.

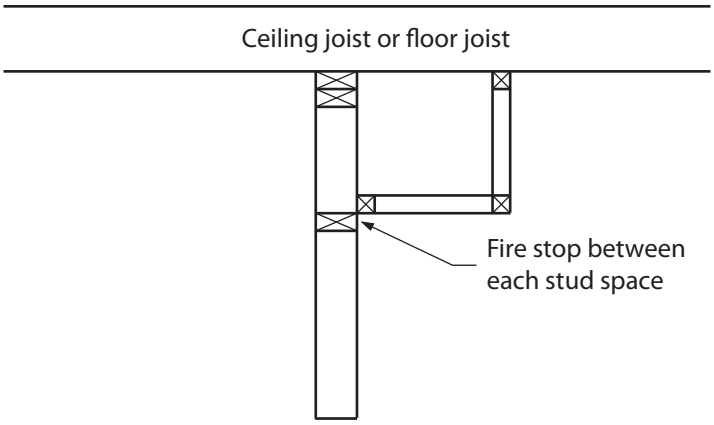

Figure 9 – Fire stops at cabinet drops

Installing the fire stops as shown in Figure 9 will position the blocking so it provides backing for the attachment of the cabinets. If the kitchen is drywalled prior to installing the cabinet drops, the fire stop is not needed.

NOTES

Renovations

When renovations are done to interior walls, it must first be determined whether or not the wall is a bearing wall. If it's bearing, then any new opening must be carefully planned. To determine if a wall is bearing, all roof, ceiling, and floor loads above must be taken into consideration.

Once an existing wall is determined to be load-bearing, the lintel for the new opening will have to be sized using the *Building Code* or by a professional engineer. Bearing for both ends of the lintel will have to be extended down to the foundation.

Never cut into an existing finished wall without first removing enough finish cladding to inspect for wires and pipes.

Now complete Self Test 2 and check your answers.

Self Test 2

1. What is the minimum size of stud required for an interior wall that supports one floor? (Use the current *Building Code*.)

2. What is the minimum size of stud required for an interior wall that supports only the attic load not accessible by a stairway? (Use the current *Building Code*.)

3. List the three installations that backing facilitates.

4. Over what height of wall are fire stops required?

5. How are joins in the vapour barrier made vapour-tight?

6. In addition to staggering the studs, what can be done to further reduce sound transmission?

7. What is the main consideration when renovating interior partition walls?

LEARNING TASK 3

Calculate Quantities of Wall Framing Materials

Calculating quantities of framing materials needed for a project is not an easy task. It needs to be done for both pricing a job and for ordering material. Estimating skills will improve with practice and job site framing experience.

Calculating the material requirements for wall framing is done separately for wall plates, wall studs, lintels, and wall sheathing. Wall openings normally require extra framing material, but may reduce the amount of sheathing required. Normally, no reduction is made for openings unless the number and size of openings are excessive.

Normal stud and plate calculations allow for the extra framing material needed for doubling studs at openings, corners, partitions, and under beams and girder trusses.

The length of the walls is the primary number used for all wall-related material calculations except for lintels. The building drawings are used to determine the total length of exterior and interior walls. In most cases, the height of the walls is constant—if not, the length of each height of wall is required.

The building shown in Figure 1 is used to illustrate the steps for doing a wall framing material quantity take-off.

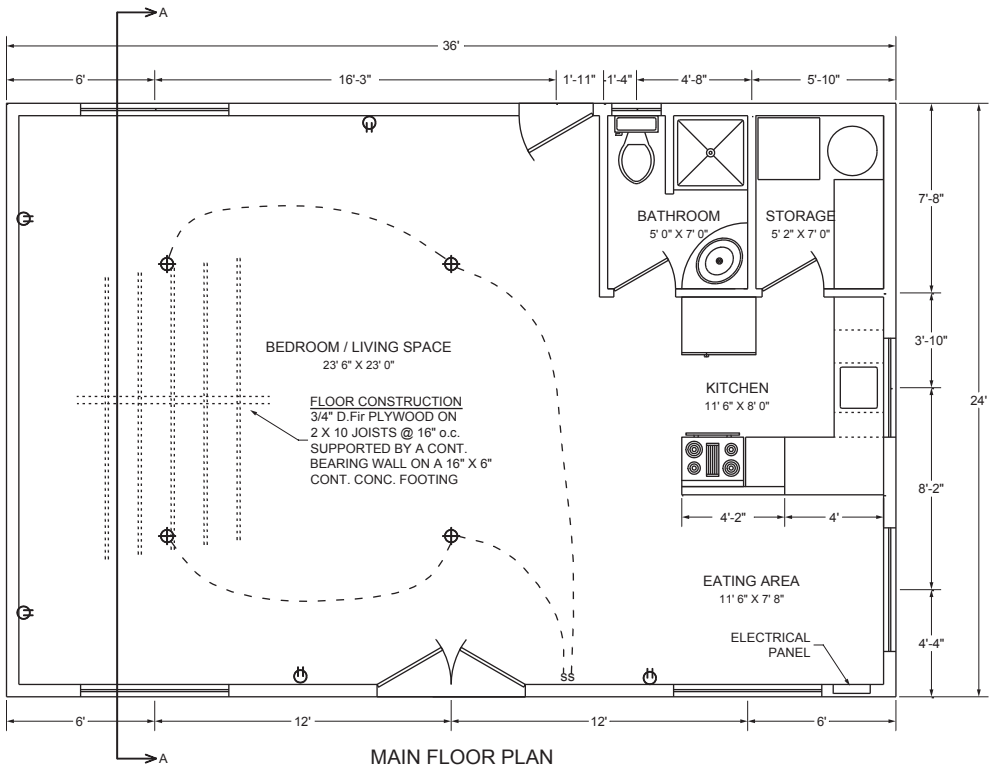

Figure 1 – Floor plan for a small building

NOTES

Wall Length

The length of exterior wall required for the building shown in Figure 1 is 120 feet. The overlap at the outside corners is not taken off. The extra length will allow a small percentage for waste.

The length of interior wall required for the building shown in Figure 1 is 27' 2" or 27.17', plus 4' 2" for the wall behind the stove, and about 3' for the wall beside the shower. That totals 34' 4", or 34.333'. Again, the required length is not reduced despite the fact that the dimensions are measured to the outside of the exterior walls.

Plates

Standard framing uses three plates for interior and exterior walls. Wall plates should be straight and as long as possible. Usually the longest available length of material is purchased. The exterior wall plates are generally 2×6 and the interior plates are 2×4.

Total Length of Wall Plates

There are two methods used to calculate the length of plates needed:

- Use the overall lengths of the walls and multiply by 3.
- Consider each wall and determine the length of boards to purchase.

Both methods have merit. Using the overall length of walls is best for large buildings with many walls. The large size of the building will produce off-cuts that can be used for the smaller walls. Using the second method, where each wall is considered, is more time-consuming, but it suits small buildings where there are fewer off-cuts.

Example

Total length of plates required for the small building in Figure 1 using the first method is:

Exterior walls	Interior walls
120 × 3 = 360 lineal feet of 2×6 plate	34.333 × 3 = 103 lineal feet of 2×4 plate

Using the second method, the total length of plates is:

Exterior walls	Interior walls
12 – 18' 2×6 for the long walls	3 – 12' 2×4 for the long wall
12 – 12' 2×6 for the short walls	6 – 8' 2×4 for the short walls and 3 – 8' 2×4 for the stove and shower walls
Total lineal feet = (12 × 18) + (12 × 12)	Total lineal feet = (9 × 8) + (3 × 12)
360 lineal feet of 2×6 plate	108 lineal feet of 2×4 plate

For the exterior wall plates, the totals are equal, but the second method required more lumber for the interior wall plates. No allowance for waste is needed when using the detailed calculation. Every piece of wood is accounted for. A waste factor should be allowed for when using the overall length method. Usually 2–5% is adequate for most construction.

NOTES

Studs

The number of studs is dependent on the spacing of the studs and the length of the wall.

Quick Method

If walls are framed at 16" o.c., the number of studs needed for a wall is approximately equal to the length of the wall in feet.

For walls with studs at spacings other than 16" o.c., use the ratio of 16 divided by stud spacing times the length of the wall in feet.

$$\frac{16}{\text{stud spacing}} \times \text{wall length in feet} = \text{number of studs needed}$$

For example, if a building has 100 feet of exterior wall and the studs are spaced at 12" o.c., the number needed is:

$16 \div 12 \times 100 = 133$ studs.

If the studs are spaced at 24" o.c., the number needed is:

$16 \div 24 \times 100 = 67$ studs.

As long as no reduction for openings is made, the above calculations should provide enough studs for all of the cripples, jack studs, rough sills, and backing studs for the exterior walls.

Detailed Calculation

For a single simple wall without openings, corners, or intersections, the detailed calculation is relatively easy. The number of spaces is found by dividing the length of the wall by the stud spacing. The result is rounded up and then an extra stud is added for the last stud. However, most walls are not that simple. A detailed calculation for the average building requires each wall framing member to be laid out on a scale drawing. This way extra studs for cripples, corners, and intersections can be counted. This isn't practical for larger jobs, so the quick method is usually used.

Raked Walls

A somewhat detailed calculation is often needed for raked walls, such as the front walls of the Ladysmith Vacation Cabin (Figure 2).

Normally, the two side walls (north and south walls) are framed and stood up, then the short front wall. It's done in this order as these are non-raked walls and are easier to frame. The two raked walls are built next and butt into the other walls. They can be built standing up in place, or lying down on the floor after chalking out the wall's perimeter.

No lintels are shown in the wall framing in Figure 2, but many framing carpenters will include a 2-ply 2×6 lintel over each opening to keep the openings true while framing and sheathing. Typically only a single top plate is used on raked walls.

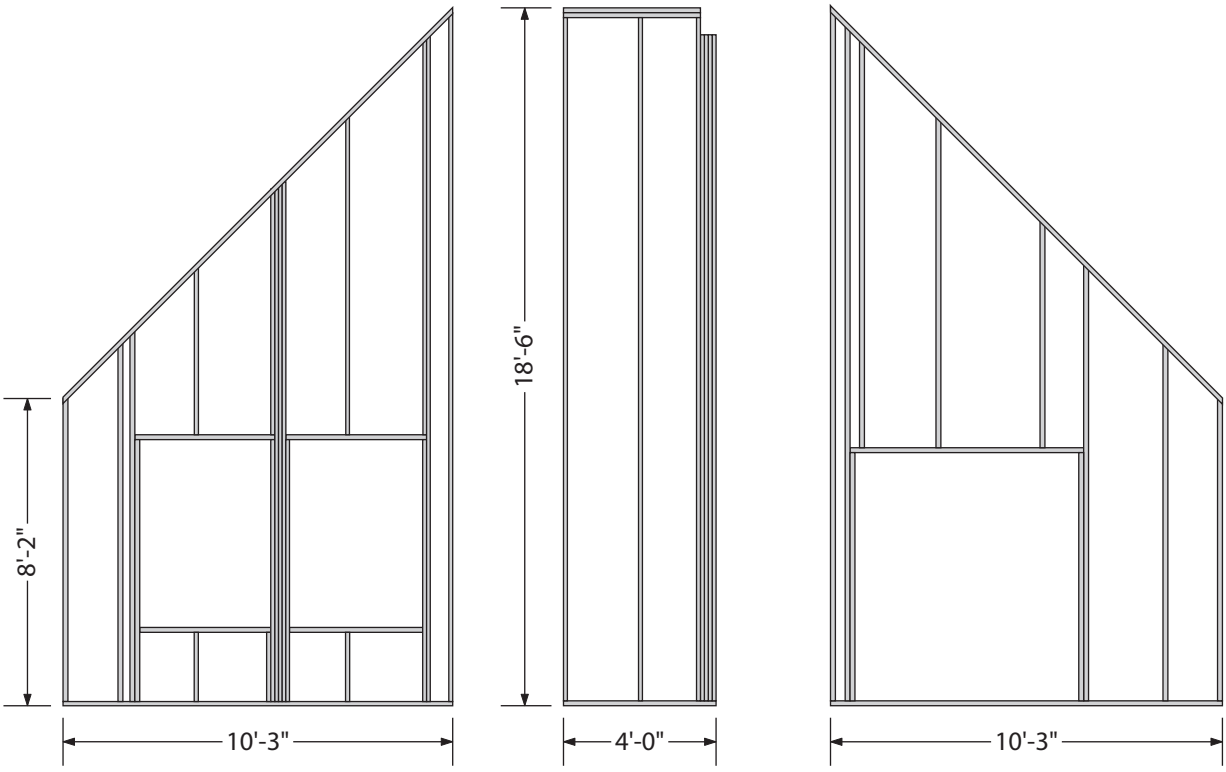

Figure 2 – Raked wall framing for front walls of the Ladysmith Vacation Cabin

For these walls, only two studs can be 8' long, but at least 7 studs will need to be just over 18' long. Three 18' studs are needed for the ridge beam bearing, and several other 18' studs are needed. The studs between the two windows require 16' studs.

By rounding up, there is 11 + 4 + 11 = 26 feet of wall. The framing is 24" o.c. The quick method indicates that 17 studs are needed (16 ÷ 24 × 26 = 17 studs). A count of studs from Figure 2 shows that this won't be enough. In cases like this, it's wise to order not only enough studs but also to order long enough studs, since studs must be full length.

A detailed calculation for these walls yields 6 – 8', 6 – 10', 2 – 12', 5 – 14', 6 – 18', and 7 – 20'. The two raked top plates each require a 16' long 2×6. As these calculations are not easy to do with a good degree of accuracy, it's best to order two extra boards of the three longest lengths in case the count missed a few studs and/or a board gets cut incorrectly.

NOTES

Lintels

Lintels need to be long enough to span the opening and the bearings on both sides. For openings of 3 metres wide or less, 1½" bearing is needed on both ends. Wider openings require 3" of bearing on each end.

The building in Figure 1 has:

- three 6' wide windows
- one 6' wide double door
- one 5' wide window
- one 4' wide window
- one 3' wide door
- one 2' wide window

Assuming that a 2-ply 2×10 lintel is used for the windows and doors for all of these openings, the requirements are:

- six lengths at 6' 3"
- two lengths at 6' 5"
- two lengths at 5' 3"
- two lengths at 4' 3"
- two lengths at 3' 5"
- two lengths at 2' 3"

Two or three of the lengths can be cut from a long board to minimize waste. For example, a 4' 3" piece, 3' 3" piece, and 2' 3"piece can be cut from a 10' length of 2×10 with only 3" of waste.

Wall Sheathing

The length of the exterior walls is used to calculate the amount of wall sheathing needed for the building.

Surface Area

The surface area of the walls is calculated by multiplying the total length of the walls by the height of the wall. The length and height should be in the same unit: either feet for imperial calculations, or in metres for metric calculations.

NOTES

For the building shown in Figure 1, the surface area of the walls is 120' × 8' = 960 square feet. A sheet of plywood or OSB covers 4' × 8' = 32 square feet.

The number of sheets needed is equal to the total area to be covered divided by the area of one sheet. For the building in Figure 1, the number of sheets needed is 960 ÷ 32 = 30 sheets.

Waste Allowance

The area used to calculate the number of sheets includes the areas of all of the openings. If there are many openings, the area of the openings should be considered. Usually the size of the openings will account for the waste during installation and no deductions are made.

Fasteners

The minimum number of fasteners per sheet of panel-type sheathing includes fasteners at 6" o.c. along the edges. The interior fasteners are spaced at 12" on centre. The minimum number of fasteners per sheet is 55 if installing the sheathing horizontally to studs 16" o.c. and 45 if the studs are at 24" o.c.

For the building shown in Figure 1, the minimum number of fasteners is;

30 × 55 = 1650 fasteners

Now complete Self Test 3 and check your answers.

Self Test 3

Use the Ladysmith Vacation Cabin plans to answer the following questions. Round up to the nearest foot for wall lengths and do not allow for waste.

1. How many lineal feet of plates are needed for the 1st floor north, east, and south exterior walls?

2. How many lineal feet of plates are needed for the 1st floor interior walls? (Include the walls under the stairs. Plans can be scaled for lengths.)

3. How many studs are needed for the 1st floor north, east, and south exterior walls? (Use the quick method of calculation with the studs spaced at 24" o.c.)

4. How many studs are needed for the 1st floor interior walls? (Use the quick method of calculation with the studs spaced at 16" o.c.)

5. How many sheets of wall sheathing are needed for the 1st floor north, east, and south walls? How many fasteners are required?

Answer Key

Self Test 1

1. i. structural requirements
   ii. finish materials
   iii. wall sheathing type
   iv. thermal insulation requirements
2. four 63 mm nails (2½")
3. 76 mm nails @ 750 o.c. (3" nails @ 30")
4. 400 mm o.c. (16") for standard walls
5. because it requires insulating before sheathing is applied
6. to provide backing for wall finishes and a nailing base for intersecting walls
7. Nominal is the listed size rather than the actual size. For doors, it's the size of the door and does not include the door frame.
8. 38" × 83½"
9. 76 mm or 3"
10. Precision End Trimmed stud
11. use a story pole
12. Mark the centre of the opening then measure 1⁄2 of the rough opening dimension on either side of centre.
13. width of the interior wall plate plus ¼" either side of the layout position
14. provide strength at the corners of the openings; also allows for increased spans of the lintels if structural sheathing is being applied

Self Test 2

1. 38 × 89 (2×4)
2. 38 × 64 (2×3)
3. i. finishes
   ii. fixtures
   iii. equipment
4. 10 feet
5. a 4" overlap and tape
6. weaving insulation between the studs
7. determine if the wall is load-bearing

Self Test 3

1. (28 + 22 + 25) × 3 = 225' (rounded up to 226')
2. (7 +12 + 11 +3 + 3 + 2 + 5 + 8) × 3 = 153' (rounded up to 154')
3. (16 / 24) × 75 = 50 studs
4. 51 studs
5. (75 × 8) / 32 = 19 sheets
   (45 × 19) = 855 fasteners

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