BC CARPENTER APPRENTICESHIP PROGRAM

LEVEL 1

2017 (Harmonized)

Line G: Concrete Formwork

Competency G-2: Select Concrete Forming Systems

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Symbol Legend



Electric shock: This icon is a reminder for potential electric shock.



Explosive: This icon is a reminder for a possibly explosive situation.



Flammable: This icon is a reminder for a potentially flammable situation.



Important: This icon highlights important information.



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Program Outline

Line A – Safe Work Practices
A-1 Apply Shop and Site Safety Practices
A-2 Apply Personal Safety Practices

Line B – Documentation and Organizational Skills
B-1 Use Construction Drawings and Specifications
B-2 Interpret Building Codes and Bylaws
B-3 Plan and Organize Work
B-4 Perform Trade Math

Line C – Tools and Equipment
C-1 Use Hand Tools
C-2 Use Portable Power Tools
C-3 Use Stationary Power Tools

Line D – Survey Instruments and Equipment
D-1 Use Levelling Instruments and Equipment

Line E – Access, Rigging, and Hoisting Equipment
E-1 Use Ladders, Scaffolds and Access Equipment
E-2 Use Rigging and Hoisting Equipment

Line F – Site Layout
F-1 Lay Out Building Locations

Line G – Concrete Formwork
G-1 Use Concrete Types, Materials, Additives and Treatments
G-2 Select Concrete Forming Systems
G-3 Build Footing and Vertical Formwork
G-4 Build Slab-On-Grade Forms and Suspended Slab Forms
G-5 Install Reinforcement and Embedded Items
G-7 Place and Finish Concrete

Line H – Wood Frame Construction
H-1 Describe Wood Frame Construction
H-2 Select Framing Materials
H-3 Build Floor Systems
H-5 Build Stair Systems
H-10 Build Decks and Exterior Structures

Line J – Building Science
J-1 Control the Forces Acting on a Building

Competency G-2:
Select Concrete Forming Systems

The construction of formwork for concrete is a complex and involved procedure. An understanding of the terms and principles used to describe formwork is needed to master the required skills to build and erect quality formwork.

Learning Objectives

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

- describe concrete formwork and falsework
- describe concrete joints

Competencies

Written: "Select Concrete Forming Systems"

You will be tested on your knowledge of concrete forming technology.

LEARNING TASK 1

Describe Concrete Formwork and Falsework

Construct Footing Forms

The concrete footing supports the foundation. It must be positioned accurately and be correctly dimensioned. Placing footings level across their width makes the rest of the formwork easier and faster to assemble. Placing the footings level along their length is desirable for the same reasons, but not always possible on sloping sites. In this case the footings are placed on the sloping ground, still level across their width. The bottom on the formwork is tapered to match the slope.

Concrete footings are cast directly onto the ground and often are reinforced with steel. The reinforcing steel in the footing form is suspended from the wooden cleats of the footing forms while the concrete is being placed.

Types of Footing Forms

Formwork for footings must be correctly positioned, level, accurately dimensioned and easy to remove (strip).

Concrete footings must be cast directly on an undisturbed bearing surface. The formwork can be as simple as a trench dug in the ground if the soil is stable enough but normally the sides of the footing form are partially formed or fully formed as shown in Figure 1.

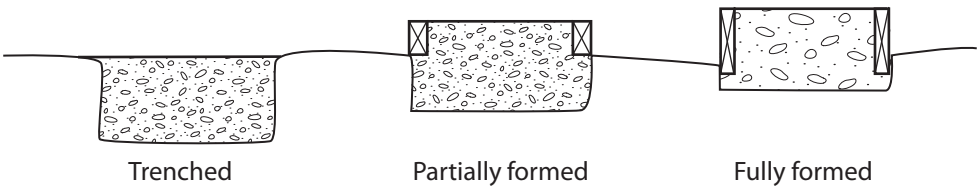


Figure 1 — Types of footing forms

Simple Forms

Simple footing forms consist of the form sides, either partial or full, held in place with wooden or steel stakes. The form boards are tied together with wooden cleats (straps), the cleats also act as spreaders to keep the footing width uniform.

When building simple footing forms, the outside form is positioned, staked and leveled. The inside form is then positioned with the cleats as spacers and staked in place. The height of the inside form is set by leveling, with a hand level, from the outside footing form.

When setting footing forms with a level, always set them a little high. Pounding the stakes slightly further into the ground makes the final adjustment.

Footing Ladders

Building footing forms with pre-built "ladders" is faster and more accurate than using simple forms. The ladder consists of nominal 2" boards held together and spaced apart by cleats, see Figure 2. The top cleats are always wooden, usually 1×4, the bottom cleats are often made with metal banding or sheet metal strips.

Bottom cleats made from wood make the ladders easy to move and set in place, but some building inspectors will not allow the wooden 1×4 straps to be left under the concrete footings.

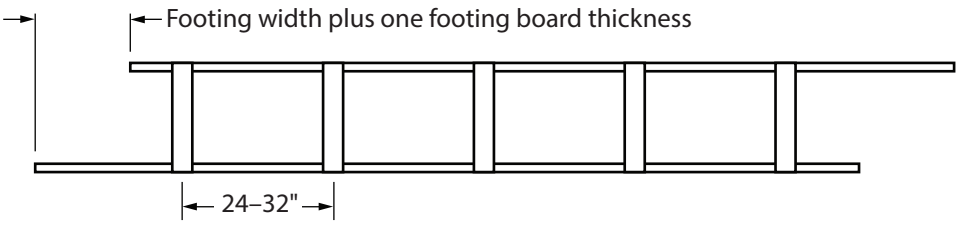


Figure 2 — Plan view of a standard footing ladder

The ladders are pre-built while the excavation is being dug and set to one side for quick installation once the excavation is finished. Full-length ladders are joined to make a right angle and positioned over the building corners. Full-length ladders and in-fill pieces are used to complete the perimeter of the foundation, as shown in Figure 3.

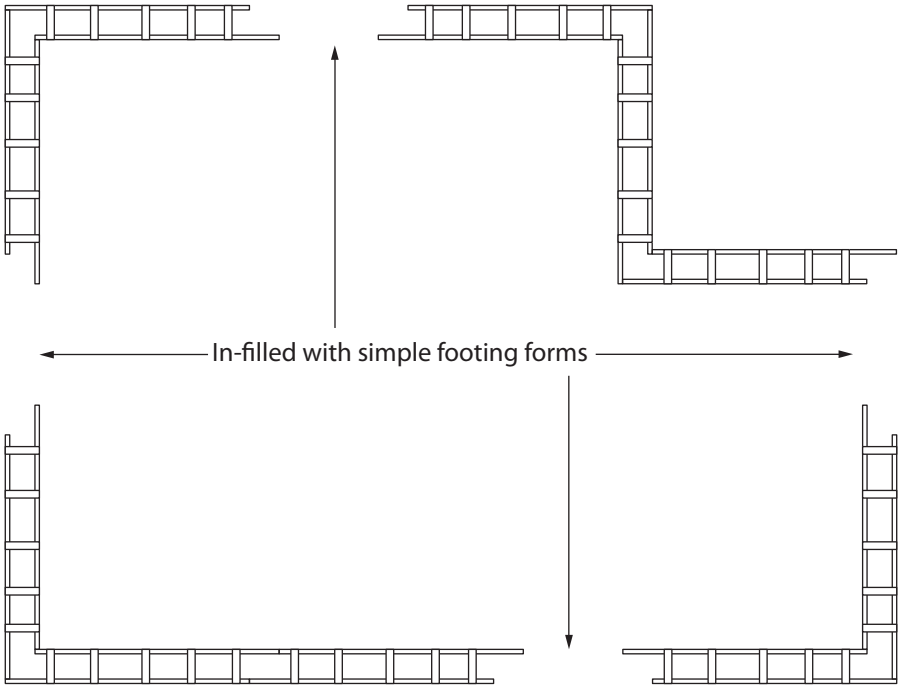


Figure 3 — Footing ladders in place

Setting the Corners

Positioning of the ladders over the building corners is critical to getting the dimensions of the building correct.

The footing always projects outside the wall (see Figure 4). Determine the amount that the footing projects beyond the wall. The projected distance must be added on to the building dimensions to get the footing dimensions.

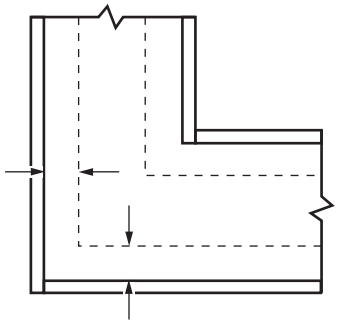


Figure 4 — Footing projection

Note: Once the footing corners are set, check the overall dimensions and then compare the diagonals to see if the layout is square.

Wall Footings

Footings that support a foundation wall are usually continuous and are referred to as "continuous strip footings."

Strip footings are usually centred directly under the foundation wall, Figure 4 shows a continuous strip footing. The strip footing supports the vertical load of the building as well as the lateral load from the backfill.

The foundation wall resists the pressure caused by the compacted backfill, the floor joists at the top and the footing at the bottom support the wall. To keep the wall from slipping sideways on the footing, a "key" is used.

Keyways

Placing a beveled 2×4 blockout into the footing form as shown in Figure 5 forms the keyways. Bevel the edges of the 2×4 at an angle of 15° to 20°. The blockout will be easily removed from the concrete if the bevel is smooth and coated with form oil.

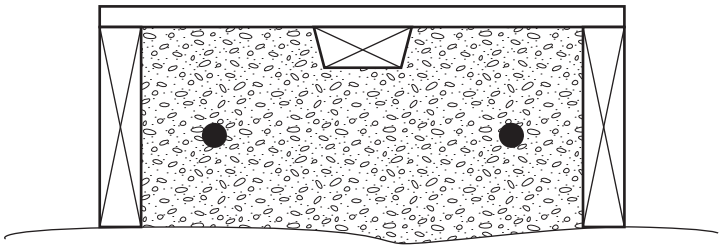


Figure 5 — Keyway and reinforcing.

Reinforcing Bars

Reinforcing bars are supported from the cleats with tie wire. The rebar must be at least 3" clear of the ground and 2" clear from the sides of the footing form. Size, location and spacing of reinforcing bars are generally determined by engineers and shown on plans.

Stepped Footings

The building site is rarely perfectly level and the foundation will have to compensate for the slope. The footings should be set level and are stepped if the ground slopes. The steps are usually in increments that match the type of wall formwork that is being used for the walls but in no case should the footings step more than 24" vertically at each step.

If the walls are being formed with plywood form panels, the steps in the footing height should be 6", 12", 16" or 24". To make forming the walls easier and more accurate, the footings must be level.

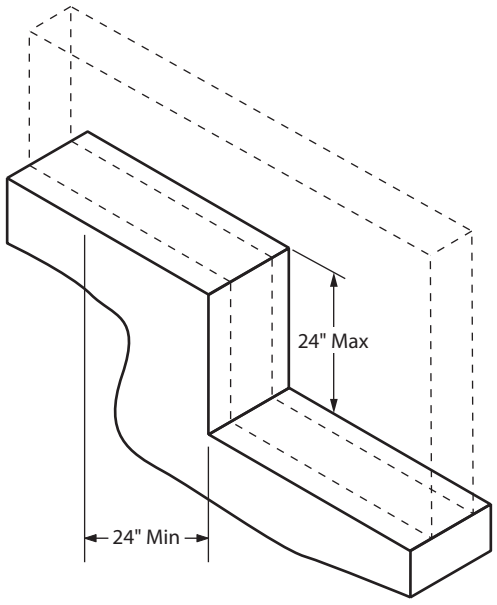


Figure 6 — Stepped footing

The maximum vertical step and the minimum horizontal distance to the next step is 600 mm (*BC Building Code*) (Figure 6).

The formwork for the step in the footing is constructed from nominal 2" material. The bulkhead at the step is formed as if it were a bulkhead in a wall form.

Figure 7 shows the formwork for the step. Ties are required if the step is the maximum 24" in height.

The upper footing should overlap the lower footing by at least the footing's thickness.

Figure 7 also shows re-bar dowels used to key the wall to the footing. Rebar dowels must have their exposed ends guarded with "mushroom caps".

Remember to always make sure the footings are resting on undisturbed soil. If the excavation is cut a little too deep, lower the footings or fill the excess depth of the footings with concrete.

Clean the bottom of the footing forms out prior to placing concrete.

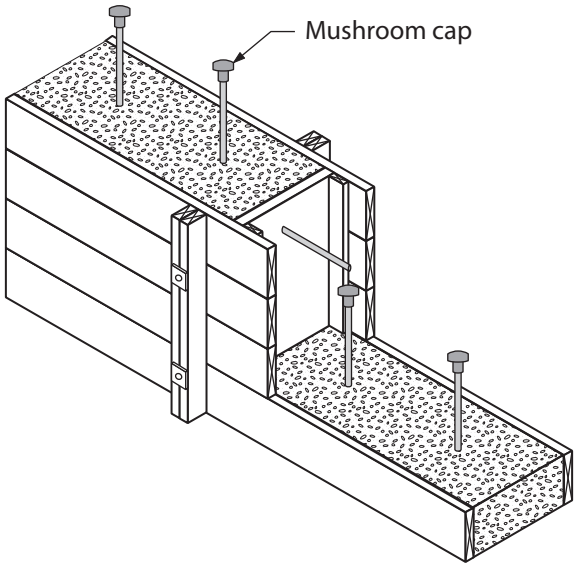


Figure 7 — Stepped footing

Steel Stakes

Steel stakes are very effective if the ground is hard. The steel stakes are either solid round rods or angle iron pointed to allow easy driving. The stakes are pre-drilled with holes at 2" o.c. to allow duplex nails to be used to set the form height.



Figure 8 — Steel stake

Column Footings

The footing forms for small column footings are usually rectangular boxes of nominal 2" material. The boxes are pre-built at the same time as the footing ladders.

The column footing form is centred over the position of the column. Like the wall footing forms, the height and position of the boxes is set with wooden or steel stakes.

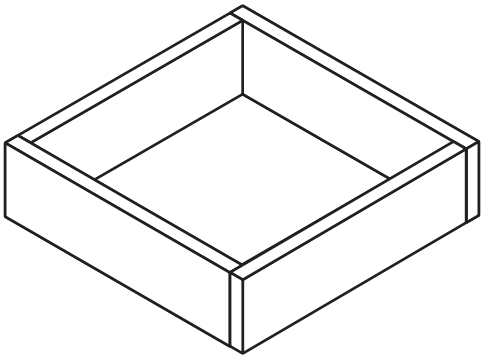


Figure 9 — Wrap-around column footing form.

Wrap-Around Method

Square column footings can be built using the wrap-around method where all four sides are cut the same length. Another method is to use pieces that are longer than needed and to run the ends long. This is economical because the material does not need to be cut to length.

Large Column Footings

The columns supporting tall buildings have huge loads at their base. The footing size for these tall buildings can be huge, often 30 feet square. The formwork for these massive footings are built similar to the formwork for a wall.

Tapered Pier Footings

Footings for lamp standards are often built as a tapered pier. The pressure from the fresh concrete always pushes outward on the forms, the force is always acting at a right angle to the form's face. Tapered column footing forms need to be weighted down to resist the upward push of the fresh concrete.

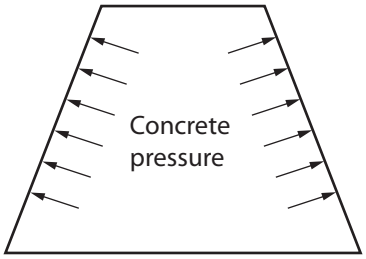


Figure 10 — Tapered footing form

Construct Wall Forms

Concrete walls are used for the foundations of residential and commercial buildings and for shear walls in a concrete frame building. Concrete frame buildings are buildings that have all of the structural members built with reinforced concrete; examples include college buildings, high-rise condominiums, office towers and sports stadiums.

Typical Wall Forms

The formwork for all concrete walls is similar and consists of the following basic components:

Form Sheathing

Supports the fresh concrete directly and must be able to resist the force without significant deflection. The sheathing consists of form plywood or lumber boards usually ¾" thick. The plywood is often faced with resin-impregnated paper.

Studs or Walers

Support the form sheathing. If the form system uses single-waler brackets then the walers support the form sheathing. If the form system uses double walers and wedges then the studs will support the sheathing. The spacing of the studs is governed by the allowable deflection of the form sheathing and the rate of pour. The studs are 2×4 for regular snap ties.

The walers support the studs in double-waler formwork. Usually the studs are vertical and the walers are horizontal. The walers are 2×4 for regular snap ties.

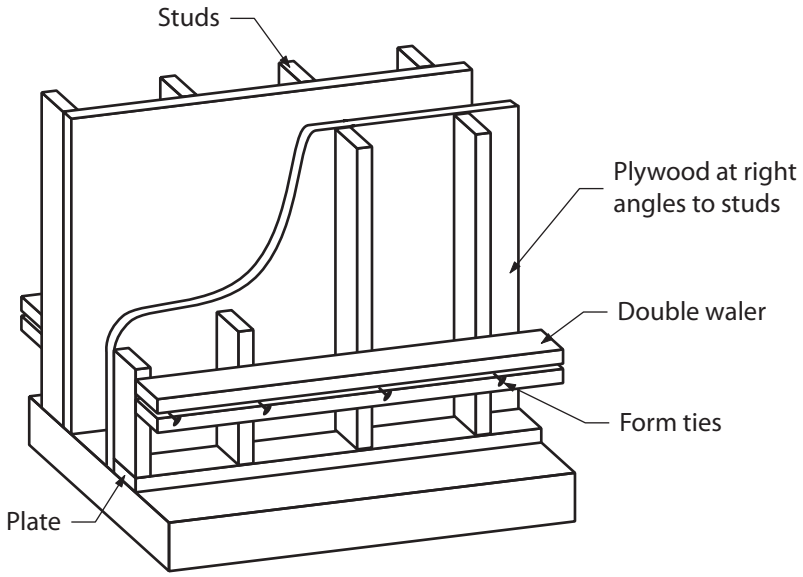


Figure 11 — Typical double waler form system

Ties

Support the walers. The load from the walers is transferred to the ties by the waler brackets or wedges. The load from the walers puts the tie under a tension load as shown in Figure 12. The types of ties vary depending upon what type of load they have to carry and what system they are used with. The load carrying ability of ties varies from 1500 lb. for quick strip ties to over 30 000 lb. for taper ties.

Basic Wall Form Design

The four components of wall formwork have to work together as a system; if any one component is not able to do its job then the system will not work. For example, if the form sheathing was not able to support the concrete without deflecting the wall could end up looking like an over-stuffed quilt, bulging at the seams; or if the sheathing was strong but the ties were weak, the whole formwork system could collapse as the fresh concrete was placed.

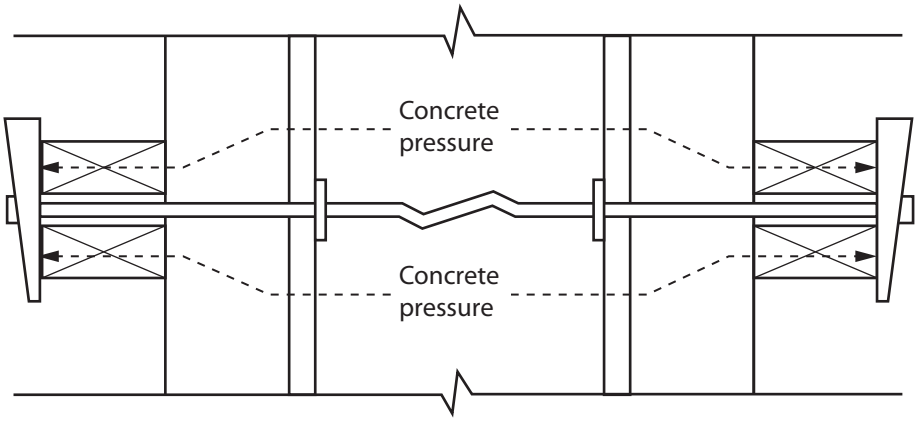


Figure 12 — Form pressures

The formwork for a concrete wall is a temporary structure that is built to hold the concrete in position until the concrete cures enough to support itself; the formwork is then stripped away and reused as forms or recycled into other parts of the building.

The loads placed on the formwork will vary depending upon the size of the wall being formed and the methods used to place the concrete but generally the load on the wall form comes from the freshly place concrete. Fresh concrete is a liquid and tends to push outward in all directions like water trying to flow downstream.

The pressure on the formwork is controlled by the "rate of placement" measured in feet per hour. When the strength of the formwork components is determined, the design is based on a specific rate of placement, the designed rate of placement must not be exceeded.

Wall forms must never be filled to their full height unless the forms are designed to support the load.



Exceeding the designed rate of placement is the most common cause of wall form failure.

Built-in-Place Forms

Built-in-place forms are forms that are built in their final location at the job site. In this system every piece of material is moved into the excavation piece-by-piece and assembled in place.

Form systems that are built-in-place are:

- Snap tie and waler forms, single waler and double waler
- Quick strip forms

Comparison of Built-In-Place Forming Systems

Form System	Speed of assembly and removal	Amount of material required	Quality of finished concrete	Uses
Single Waler	Fast	Less	Good	Commercial and Residential
Double Waler	Slow	Most	Good	Commercial and Residential
Quick Strip	Very fast	Least	Average	Residential and light commercial
Strap Tie	Very slow	More	Average	Renovations and small jobs

** The quality is based on standard use of the type of system.*

Single Waler

Single waler formwork uses short end snap ties as shown in Figure 13. The advantages of single waler over double waler formwork are that the single waler system:

- uses less lumber
- is faster to build
- is faster to strip

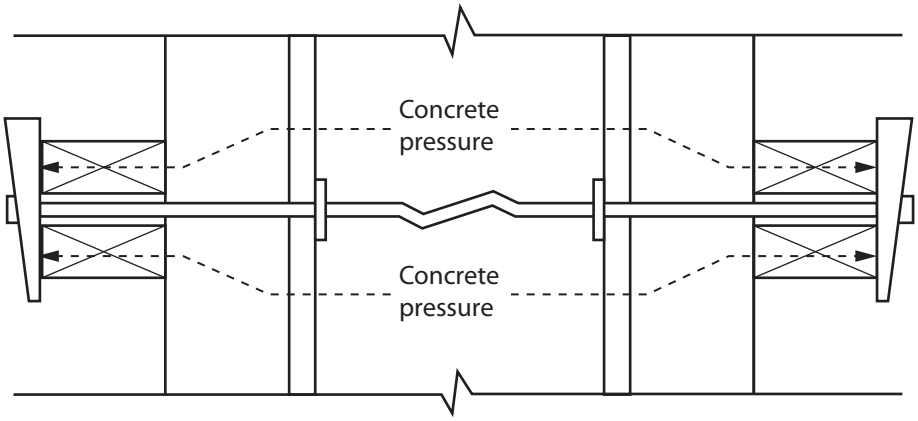


Figure 13 — Short end snap tie

For flat walls using single waler form construction, the walers may be placed horizontally or vertically with the plywood form panels installed with the face grain perpendicular to the walers.

Single waler formwork is also used for curved walls, with the walers positioned vertically and the plywood panels installed with the face grain vertical (parallel to the walers). By aligning the face grain with the walers, the plywood is easier to bend around the radius of the curve.



Figure 14 — Single waler bracket

Strongbacks

Strongbacks are used to help to straighten and align single waler walls, the strongbacks are placed at right angles to the walers as shown in Figure 15.



Figure 15 — Strongbacks and braces supporting a single waler wall.

The strongbacks are made an integral part of the formwork by using long-end ties to attach them to the wall form. Standard wedges are used at the ends of the long end ties. Bracing for the single waler walls is attached to the strongbacks.

Double Waler

Double waler formwork uses long end snap ties, see Figure 16 and Figure 17. The advantages of double waler over single waler formwork is that the double waler system allows extra studs to be placed behind the walers to add extra support to the form sheathing near the bottom of a tall wall.

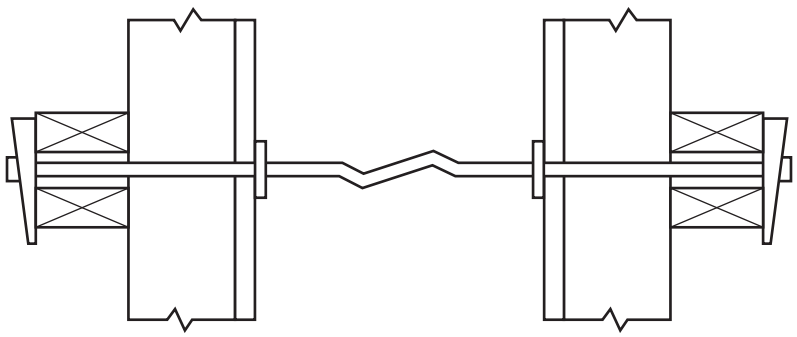


Figure 16 — Long end snap tie

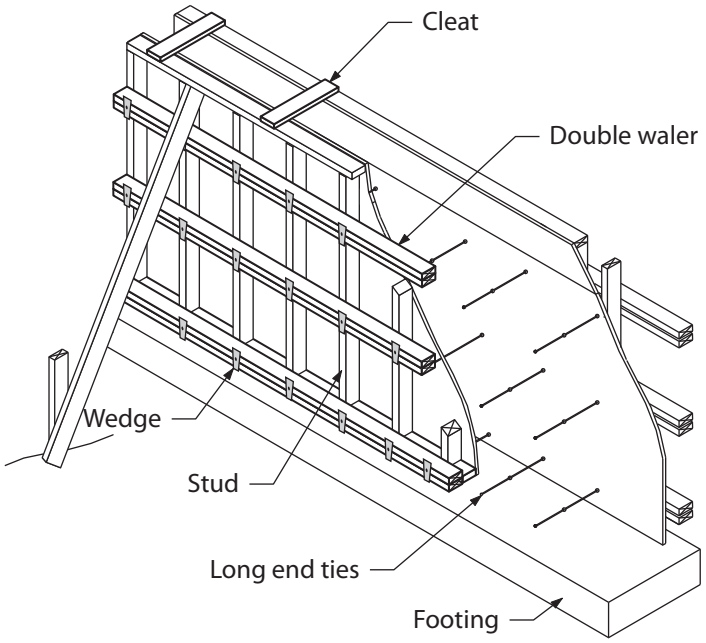


Figure 17 — Double waler formwork

Strap Tie

Strap tie formwork uses a plain metal strap with holes in the ends for nailing it to the studs, see Figure 18. The strap tie system is used for small jobs where quality is not of great importance.

The major advantage to strap tie formwork is that the system can accommodate odd wall thickness because the thickness of the wall is set with a spacer cut at the job site.

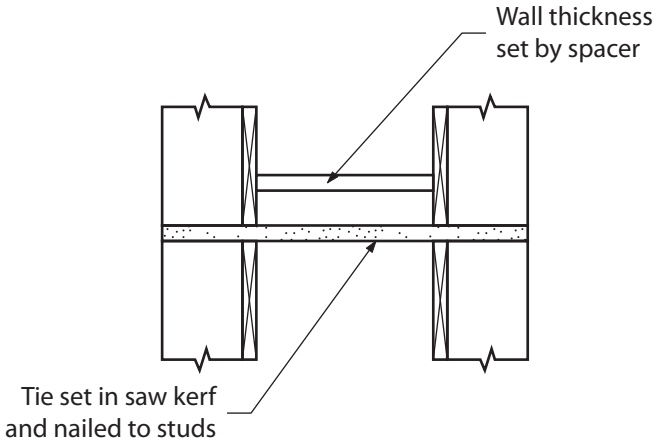


Figure 18 — Strap tie

Quick Strip

Quick strip formwork uses flat metal ties with a hole at each end that fits the metal waler bar (Figure 20). The advantages of quick strip over other formwork is that the quick strip system uses a minimum of materials and can be assembled and stripped very quickly (Figure 20).

This forming system uses either plywood or lumber sheathing and the steel waler bars can be used vertically or horizontally.

When the waler bar is used vertically the ties are placed on top of lumber sheathing boards or on top of strips of plywood that have been ripped to widths of 12" or 16" (Figure 20).

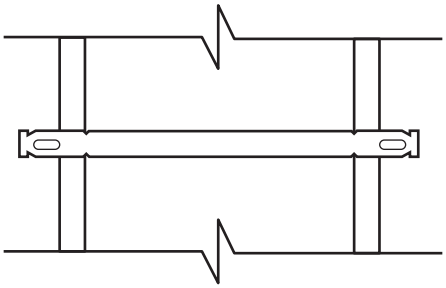


Figure 19 — Quick strip tie

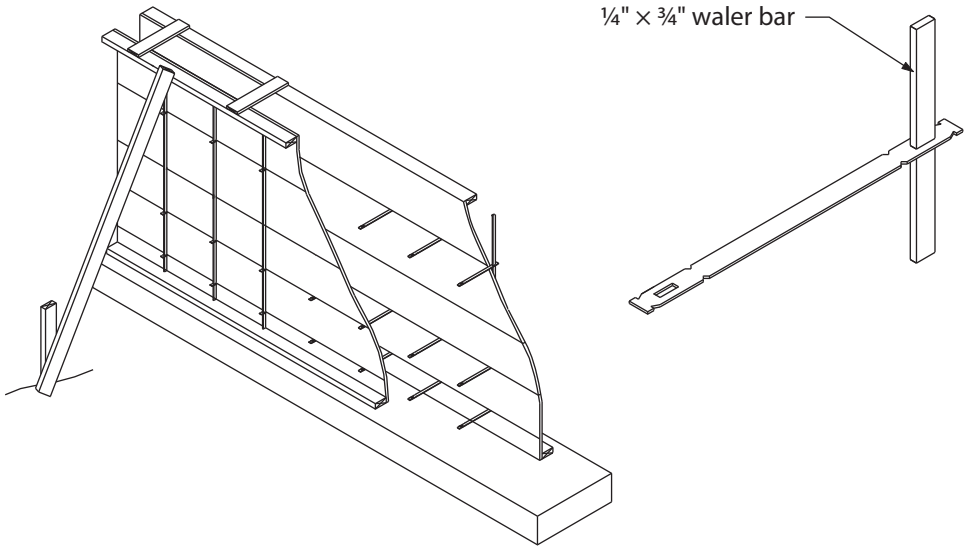


Figure 20 — Quick strip formwork

Stripping

The waler bar is removed first when stripping quick strip forms. Hammer the tie parallel to its width to break it off at the break back point. The tie end breaks off and the waler bar comes free. Collect all of the waler bars and pile neatly because they can easily be lost.

Wall Forming Systems

Formwork for concrete walls can be made more efficient by developing a forming system. The type of system will depend upon the type of concrete construction being built. Formwork for architectural concrete requires the forms to be built to a much higher standard than for concrete work that is going to be hidden from view after the building is completed.

Panel Size

Plywood is usually used as the form sheathing in a forming system. Plywood sheets are standard at 48" × 96" and come in a variety of types that are useful for formwork. Paper faced form ply is the most common type of plywood used for forming systems. The resin impregnated paper face stands up to many reuses and produces a good quality finished surface to the concrete wall.

The 4×8 panel size dictates the module sizes and tie spacing. Modules of 12" increments are common in forming systems. The tie spacing is laid out so that one panel can be butted against another and the spacing will continue from one panel to the next.

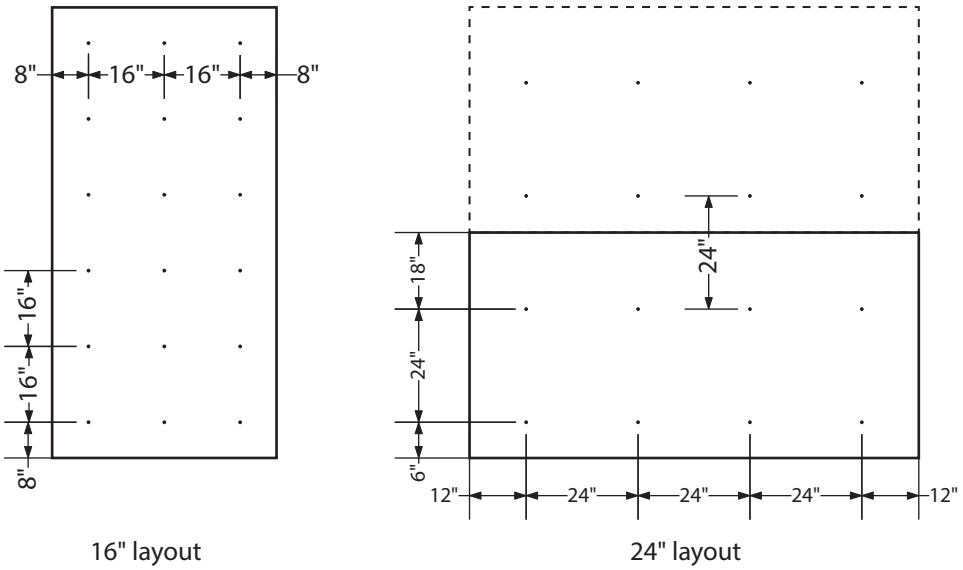


Figure 21 — Tie spacing layout

The tie spacing shown in Figure 22 can be used for single waler and double waler form construction with a maximum rate of placement of 4 ft. per hour for the 16" o.c. layout and 3 ft. per hour for the 24" o.c. layout. To maintain a maximum deflection of ¼₀₀, the supports for standard form ply would have to be closer than 16" o.c.

Special tie spacing layouts are used for single waler systems used for walls over 8 feet in height. A row of tie holes are drilled approximately 1¾" down from the top edge of the lower panel and 1¾" up from the lower edge of the upper panel. This allows for the installation of two walers back-to-back at the joint of two panels, thus strengthening an otherwise weak point.

On very tall walls, panel forms are used to "leapfrog" to a higher level for a future pour. In this case, it is common to leave the top row of ties from the lower pour in place in order to anchor the second lift of the formwork (Figure 22).

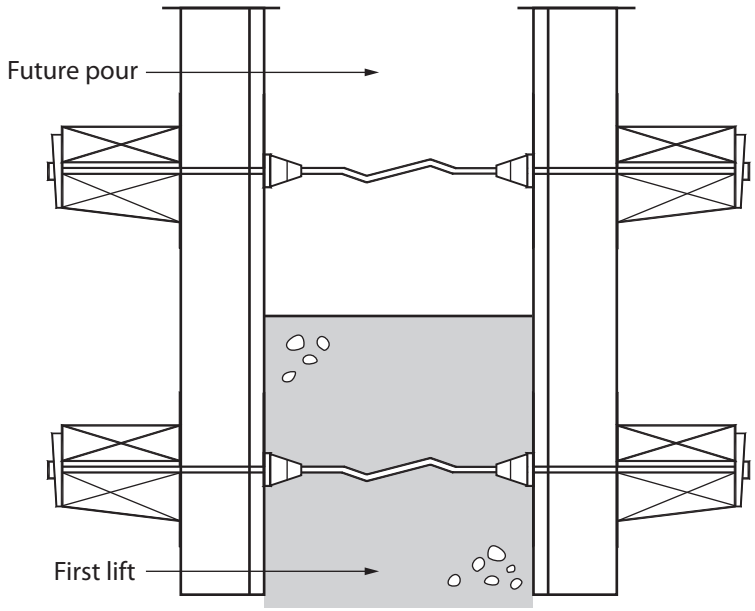


Figure 22 — Top ties hold formwork for next pour.

Corner Panels

Most forming systems incorporate prefabricated corner panels. Corner panel sizes are dependant upon the thickness of the wall being formed, corner panels for an 8" wall cannot be used for a 10" wall.

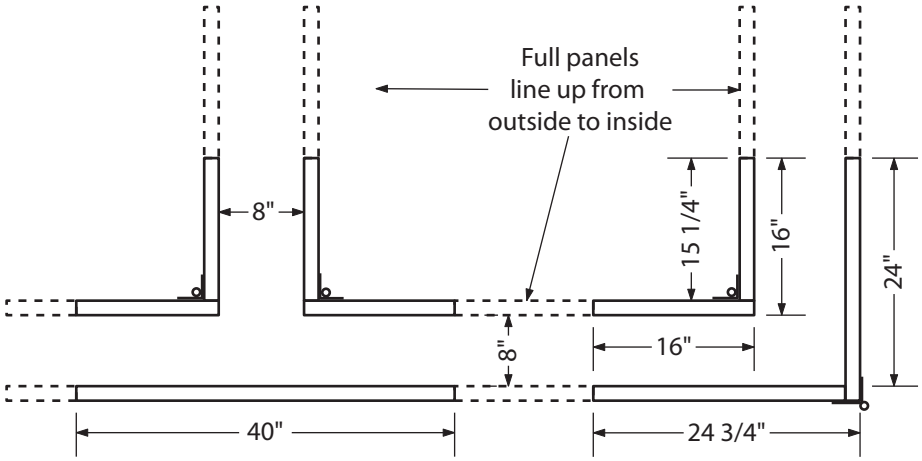


Figure 23 — Corner and "T" panels

Outside and inside corner panels are different widths to maintain alignment of interior form panels and exterior form panels as shown in Figure 23. The corner panels may be loose or joined with a hinge of some sort. When considering hinge design it is important to try to keep the joint between the two sides of the corner as tight as possible to prevent leaking of the cement paste.

Inside and outside panels are formed with the same panels. Keeping the dimensions of the corner panels the same in both directions reduces confusion and errors when setting the forms (the outside dimension of 24" is the same both ways in Figure 23).

"T" Panels

Where there is a "T" in the concrete wall, a special outside panel needs to be built. When designing a form system it is important to keep the system as simple as possible. For "T" construction a single outside panel is built, the special "T" panel should be built to that it uses two standard inside corner panels. The "T" shown in Figure 23 is for an 8" wall, like outside corners; different "T" panels are needed to accommodate walls of different thickness.

Construction Process Formwork

Regardless of the form type or form system being used, the basic steps to building the formwork are the same.

While building formwork it is important to keep in mind the fact that every nail, bolt and fastener that is used in the construction of the forms will have to be removed when disassembling the forms. Duplex nails are used where possible and finishing nails are used where the duplex head would be cast into the concrete.

Layout the Wall Position

After the footings have been cast and the cleats stripped from the top of the forms, the formwork for the wall can begin. The first step in building the formwork is to layout the position of the foundation walls on the top of the footings.

Reset the string lines on the batter boards and plumb down to position the building corners. Refer to the drawings and double check the building dimensions. Check the building for square at every opportunity.

When laying out the position of the building, locate the actual concrete wall, not the position of the wall form-plate. After the corners are laid out, snap chalk lines to create straight lines to align the form-plate to. Use a spacer equal to the thickness of the form sheathing to position the form-plate as shown in Figure 24.

The form-plates are nailed to the footing with duplex common nails.

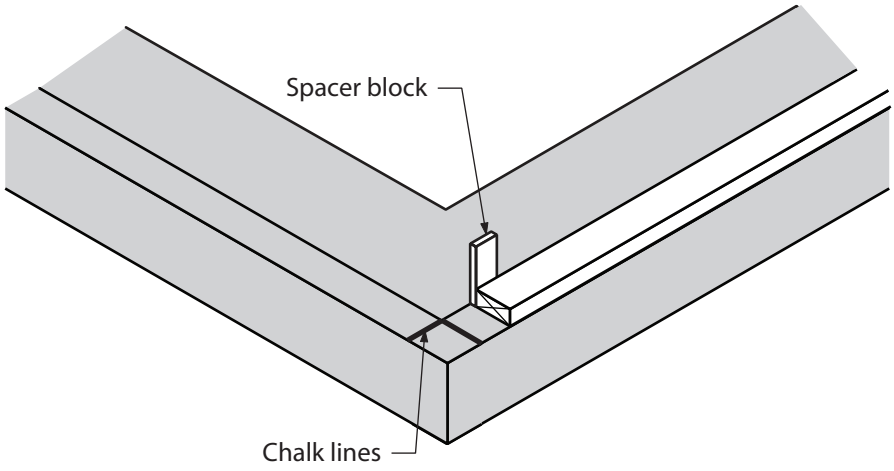


Figure 24 — Wallform-plate layout

If the formwork for the walls is being built with a pre-fabricated formwork system that includes the form sheathing, the inside face of the form panels is aligned directly with the chalk line.

Only the outside of the foundation wall needs to be laid out with chalk lines. The formwork on the inside of the wall is set from the formwork on the outside with a spacer.

Wall Form Corner Details

The construction of the formwork at the outside and inside corners of the building requires special attention. The corners define the shape of the building and are built, located and assembled first. The corners must be plumb and accurately dimensioned and they usually require extra reinforcing because of concrete pressures from two directions.

Form systems that use outside corner panels similar to those shown in Figure 25 will bulge between the hinges if the hinges are spaced too far apart.

Figure 25 shows a corner clamp used to pull the two sides of the corner tightly together to resist the pressures exerted by the fresh concrete and keep the corner from leaking cement paste.

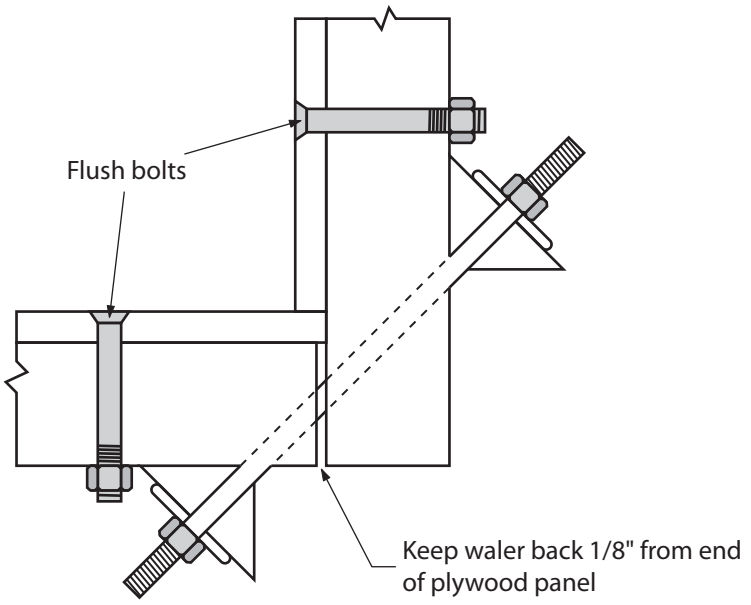


Figure 25 — Corner clamp

The cross-lapping or lacing of the walers in single waler or double waler systems give the corner the needed extra reinforcement required to make the corner strong. Kickers are added to allow one set of walers reinforce the other set of walers; Figure 26 shows the correct location of the kickers.

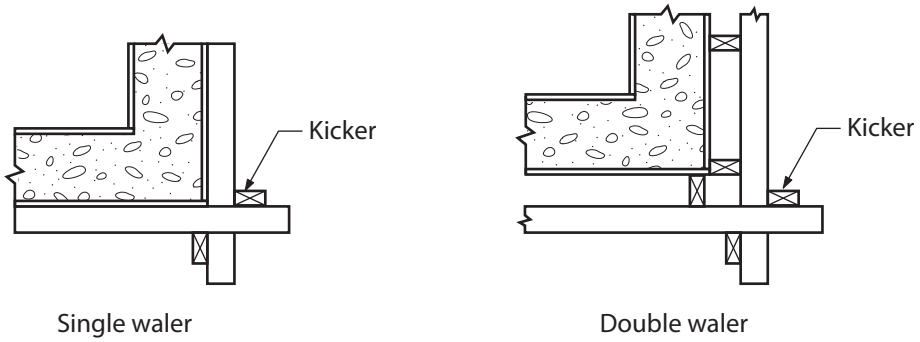


Figure 26 — The kickers supporting walers

The double waler system provides excellent support for the corner because studs can be placed near the corner allowing the support from the waler to be continuous from the footing to the top of the wall. The single waler system only provides support at each waler, usually at 16" o.c.

Wedges

Use at least two wedges to hold each piece of waler. Place at least two wedges between joints in the upper and lower member of each double waler.

When attaching wedges to tie ends, it is important to match wedge type to working load of the ties.

Steel wedges come in three styles: closed end, reversible and heavy steel. The closed end and reversible are cast steel while the heavy steel wedge is pressed from a steel sheet. The reversible wedge is useful when the tie end is just barely protruding from the walers.

Check with the manufacturer for safe working loads for the wedges, not all wedges are able to carry the same load.

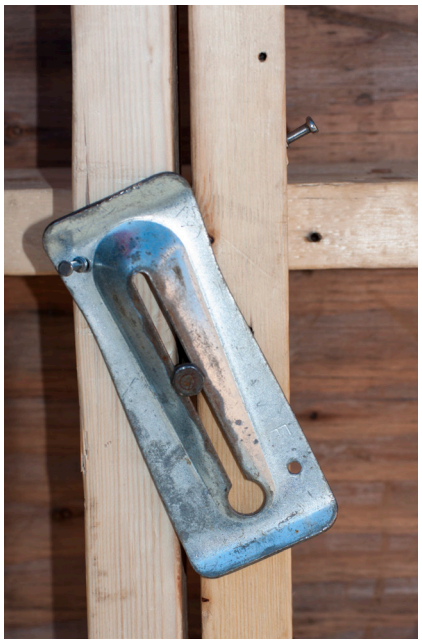


Figure 27 — Wedges

Snap tie wedges carry their full designed load best if the wedge is positioned midway on the walers with the button on the end of the ties at the wedge's midpoint. Figure 28 shows correct and incorrect positioning of the wedge.

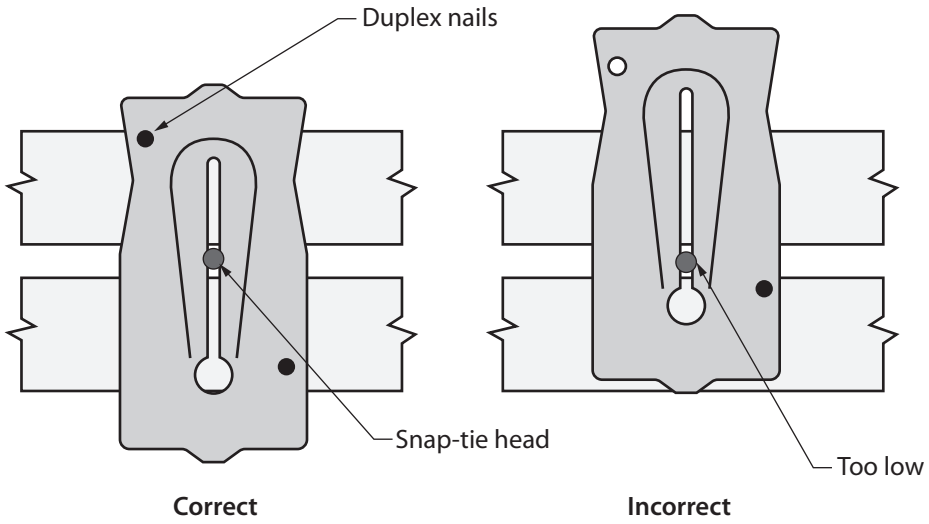


Figure 28 — Positioning the wedge

Use a duplex nail to fasten the wedges securely, so they do not loosen when the concrete is vibrated. Loosened wedges may fall off causing form failure. Do not attempt to straighten warped walers with a wedge. Putting too much load on the wedge may cause the metal spreader on the tie to slip causing a decrease in wall thickness. In architectural concrete this could mean having to re-build the wall.

Bracing

Wall forms are braced in a variety of ways but in all cases the following suggestions should be considered:

- Whenever possible use adjustable braces.
- Make sure both ends of the brace are securely fastened.
- For braces extending to the ground, keep the angle from the ground to the brace around 53°.
- Position braces so that a clear access to the formwork is maintained for the equipment required to place the concrete. A perfectly aligned wall that is well braced will be ruined if the concrete truck accidentally bumps the end of the brace.
- If braces are supported at the ground by a stake, make sure the brace is fastened to the stake at ground level, as shown in Figure 29.

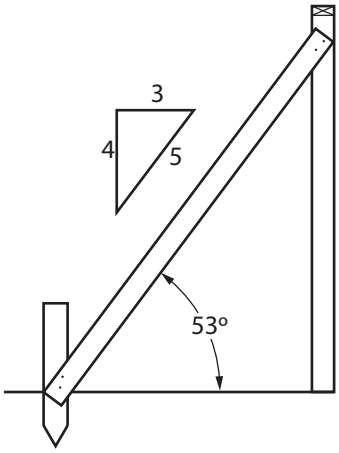


Figure 29 — Wall form brace

Setting up the Panels

Setting up the panels begins at the corners. When the outside corner panels are in place, plumb and braced, the rest of the full panels are installed. Special attention should be given to pull the form tightly together to prevent leakage of concrete.

Install all ties, walers and bracing to complete the outside wall form.

The elevation of the top of the wall is established next using a builder's level. The elevation is laid out with chalk lines. Blockouts, bulkheads, window and door bucks are all set, plumbed and leveled. Care should be taken to brace these standard accessories horizontally, vertically and diagonally so that concrete pressure will not distort their shape. If a level strip is used, it is installed and then the reinforcing bars are installed.



Figure 30 — Adjustable brace

Double-check the position of the level strip, blockouts, bulkheads, window and door bucks before beginning to set the interior wall forms.

The interior wall forms are set and cleated to the outside forms to position the tops of the walls.

Prefabricated Wall Form Panels (Gang Forms)

Saving time is saving money in construction. The time saving features of prefabricated wall form panels have made them popular for contractors who specialize in concrete construction. Form panels come in hundreds of styles and types.

Gang forms are covered in more detail later in this learning task.

Special Wall Formwork Details

Wall forms must accommodate many different shapes of recesses and projections used to support various other parts of the building.

Pilasters

Where columns are supported on foundation walls, pilasters are formed into the wall. A pilaster is a thickening in the wall used to support the extra load from the column, the footing size is also increased around a pilaster.

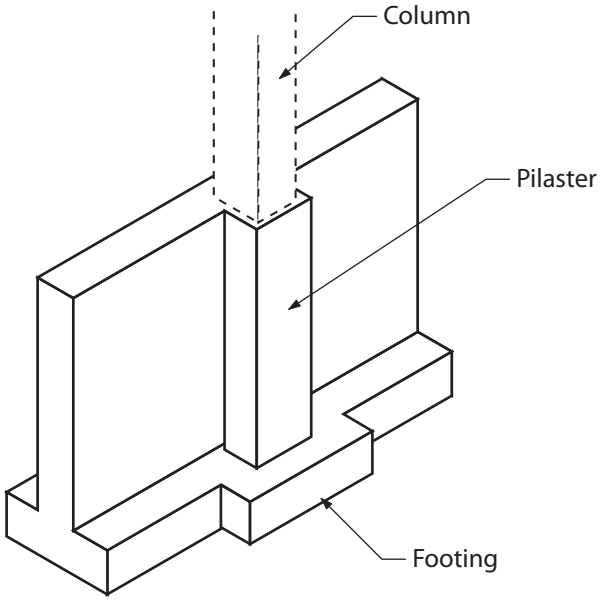


Figure 31 — Column supported by a pilaster

Longer ties are used to form the thickened wall at the pilaster, as shown in Figure 32.

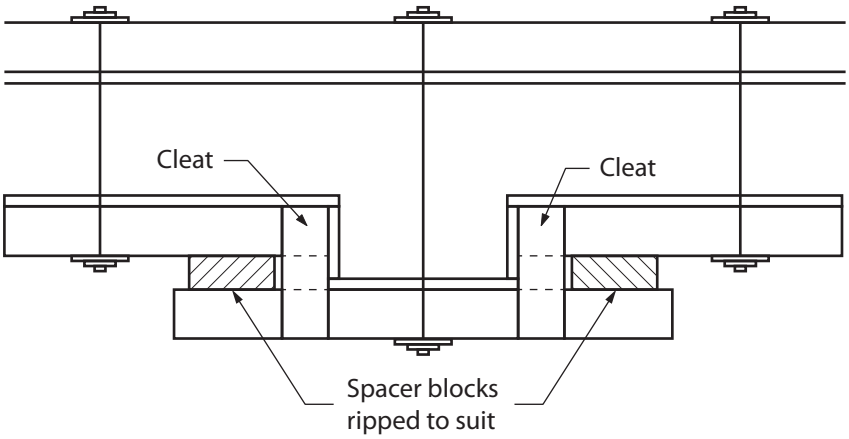


Figure 32 — Pilaster formwork

The plan view drawing in Figure 32 shows a possible form for a 12 × 14" pilaster formed into an 8″ wall. The wall form is a single waler type that uses 8″ short end ties. The tie through the pilaster is a tie for a 14" thick wall, the extra 6″ in tie length accommodates the 6" projection of the pilaster.

To stabilize the waler supporting the pilaster, spacer blocks are ripped to fit between the two sets of walers. The 2×4 cleats nailed between the walers support the sides of the pilaster. If the pilaster projected further out from the face of the wall, additional ties would be required as shown in Figure 32 and Figure 33.

The pilaster in Figure 33 is 12" × 30". Three short-end tie lengths are required to form this pilaster, 8" for the wall, 12" for the thickness of the pilaster and 30" for the width of the pilaster. Tie manufacturers stock many different lengths of ties but they can make any length needed so a 30" tie is not all that unusual.

Kickers are used to add rigidity to the pilaster formwork.

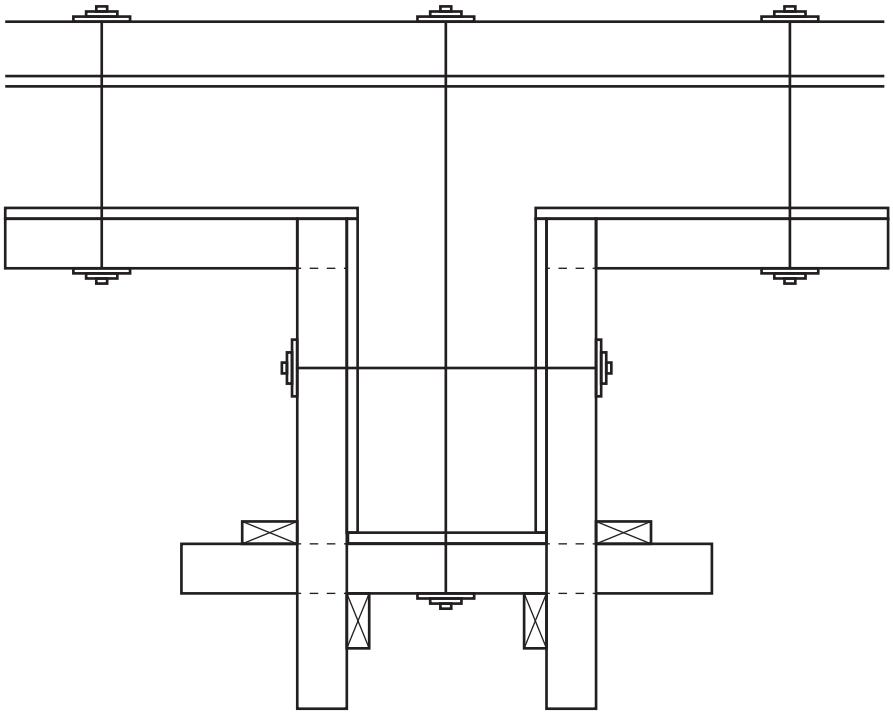


Figure 33 — Plan view of pilaster formwork

Forming a Ledge

Concrete walls often have their thickness reduced at the top to accommodate floor joists, brickwork or concrete slabs. The ledge is also called an offset because the one wall face is "offset" or stepped back from the other.

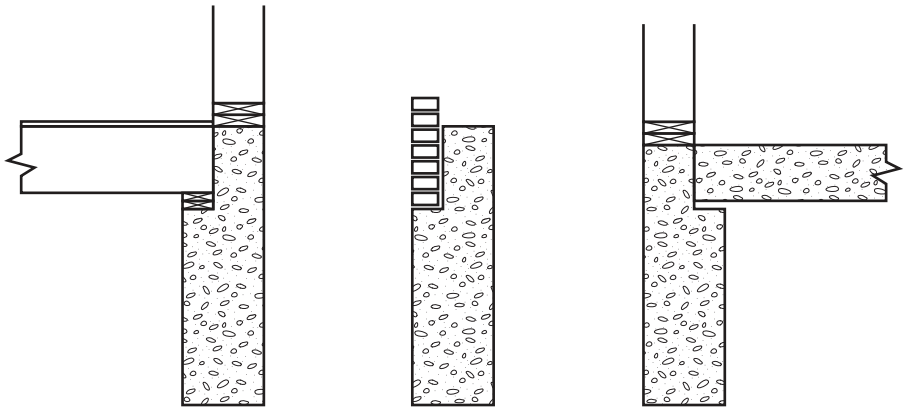


Figure 34 — Ledge in a concrete wall

Placing a blockout in the top of the form forms a ledge. The blockout must have air holes drilled in the bottom of it to allow the trapped air to escape. Even with the air holes, the freshly placed concrete at the top of the wall needs extra vibration to ensure complete consolidation.

The blockout consists of a solid vertical side ripped from the appropriate width of 2" material, the vertical is supported with spacers at 32" o.c.

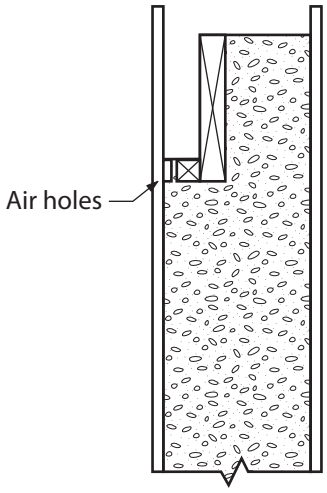


Figure 35 — Formwork to create a ledge

Corbels

A corbel is a widening in a wall, often at the top. This may be for structural or for decorative purposes (Figure 36).

To create a corbel, make one side of the wall form shorter than the other. Another method is to add an extension to the top of one side of the formwork.

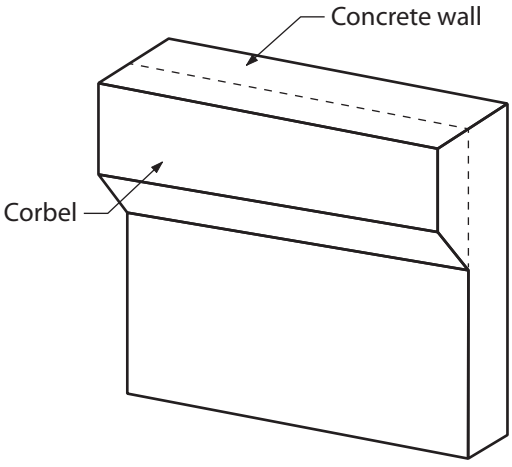


Figure 36 — Corbel in a concrete wall

The cantilevered (shelf-like) section must be supported. Do this by bracing back to the wall forms, or by adding shores to the extended section as shown in Figure 37.

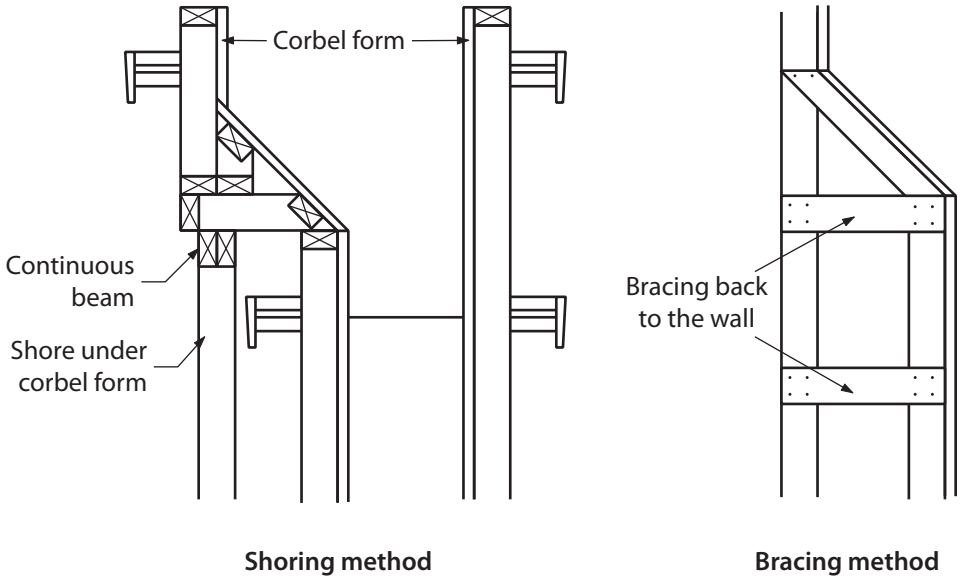


Figure 37 — Ledge in a concrete wall

Construct Gang Forms

Gang forms are large formwork assemblies that are crane lifted. Gang forms are usually used for wall forms but are occasionally used for beams and girders.

Having a crane on site allows the larger forms to be built and moved from place to place. Gang forms are designed to be set up quickly and removed easily, requiring a minimum of crane time for each cycle.

Prefabricated Wall Form Panels (Gang Forms)

Saving time is saving money in construction. The time saving features of prefabricated wall form panels have made them popular for contractors who specialize in concrete construction. Form panels come in hundreds of styles and types.

The basic panel consists of a frame made from wood or metal covered with sheathing of wood or metal. Panel sizes vary from 2 × 4 foot steel panels set by hand to 30 × 20 foot gang form panels set by crane.

The panels are held together by a variety of wall tie systems; generally, fewer ties are used in wall form panels than in built-in-place forms. For example, a 30 × 20 foot gang form panel may only have 16 taper ties holding it together while the same sized single waler form would have over 300 short-end ties. The time savings by using gang form panels is significant.

The panel shown in Figure 38 is made with a steel framework sheathed with paper-faced form plywood and would be crane lifted into place. The tie rods are fed through both panels from one side.

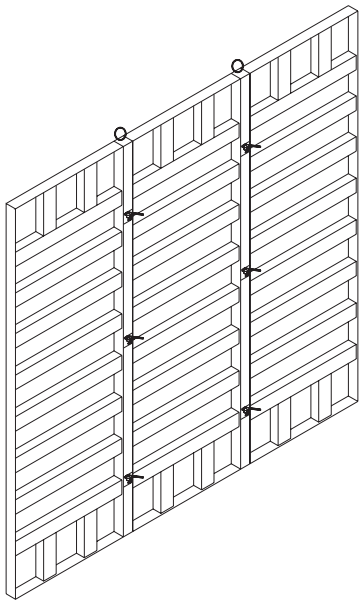


Figure 38 — Panel wall form

Form Construction

Gang forms can be much heavier than loose forms because they are crane lifted. Compared to loose forms, gang forms use fewer form-ties and have heavier studs and walers.

The strongbacks are often steel or aluminum angles or channels that are welded together. The following is a description of a typical gang form system that uses aluminum components.

Aluma Beam System

The basic component of the aluma beam system is the aluma beam, or aluma joist (Figure 39). Aluma beams work well for gang forms because they are very strong, light, and easy to connect together using the proprietary hardware designed for the system.

The usual configuration of an aluma gang form is shown in Figure 40. The aluma beams are horizontal and they are supported by aluminum strongbacks. The form-ties are taper-ties and are spaced approximately 6' on centre each way.

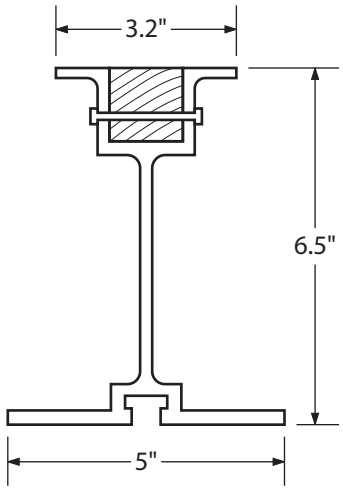


Figure 39 — Aluma beam

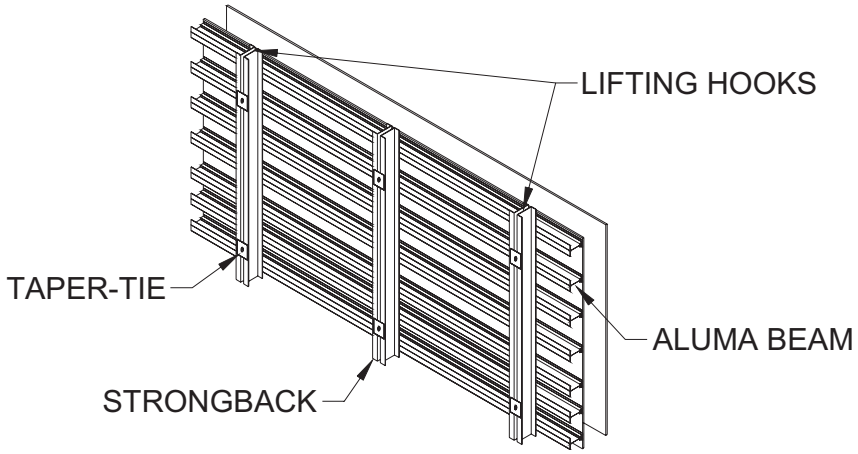


Figure 40 — Typical gang form panel

The strongbacks consist of back-to-back aluminum channels. Each channel has a slot that will accept a ½" bolt. The slots are used to insert a bolt that will bolt the shear plates into place and connect scaffold brackets to the formwork.

The aluma beams and strongbacks are clamped together with clamps on both sides of the strongback. The clamps are attached with a bolt in the slot in the aluma beam. The slot in the aluma beam is the same size as the slot in the aluminum channel so the same bolts can be used (Figure 41).

The wide faces of the strongback and the aluma beam create a very stable connection that resists the rigors of crane moved forming systems.

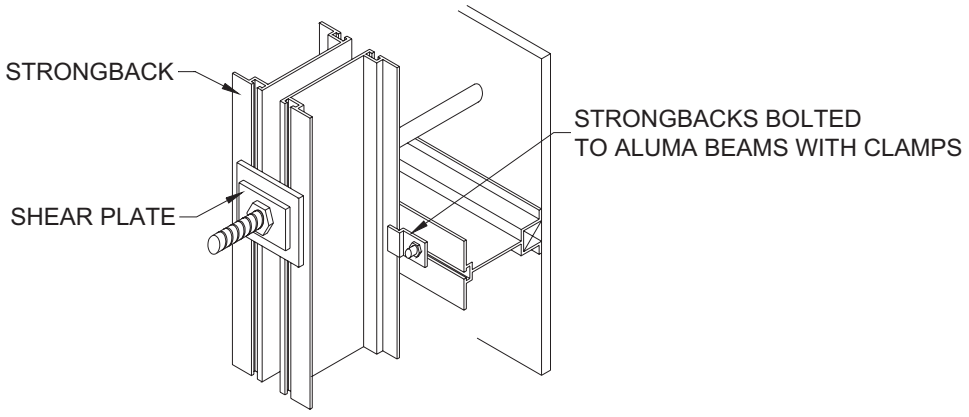


Figure 41 — Taper-tie support at a strongback

The gang form panels have lifting rings attached to the top of the strongbacks. The crane uses a spreader bar to ensure that there are no lateral forces acting on the strongbacks.

With only six ties per panel, the gang panel shown in Figure 40 can be stripped and reset quickly.

Moving Two Panels at Once

The crane can be rigged with a spreader bar that has four sling legs. Using this rigging system, the crane can be used to lift both gang form panels for a wall at the same time. By lifting two panels at once, the stripping time is almost cut in half.

Under no circumstances should the braces and ties be removed from gang forms without the panel being fully supported by the crane.

Rigging Systems

The rigging system for the gang form panel must eliminate a lateral force on the strongbacks. Figure 42 shows the forces acting on the strongbacks with and without the use of a spreader bar.

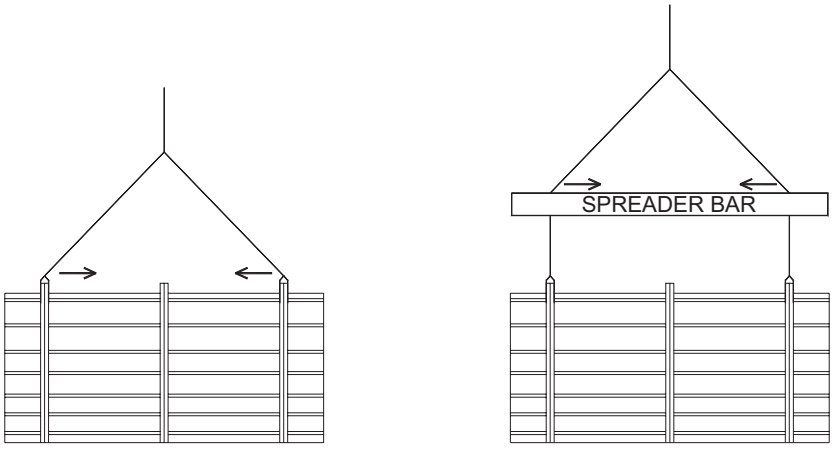


Figure 42 — Using a spreader bar

The natural tendency for the slings is to pull toward one another as the form is lifted. This lateral force is applied to the strongbacks unless a spreader bar is used. The spreader bar is designed to resist the compression forces from the slings.

Unless specifically designed to resist lateral forces, lifting eyes should never be pulled at an angle.

Lifting Procedures

Large gang panels used to form walls are very dangerous and can fall over easily if not adequately braced. Construction fatalities have occurred when un-braced gang form panels have fallen on workers.

Only qualified workers are allowed to strip gang form panels. There should be one worker designated as the lead-hand, this worker signals the crane and is responsible for ensuring safe form removal procedures are followed.

As part of the erection drawings for the formwork, there should be instructions to the workers for the correct procedures for rigging and moving the gang form panels.

The following are some general guidelines for gang form rigging and lifting:

- use proper fall protection equipment
- partially strip the form by removing some of the braces and form-ties
- attach the tag line
- connect the lifting crane to the form
- signal the crane operator to put tension on the lifting line
- remove the remaining ties and braces
- direct workers to stand clear and signal the crane operator to lift slowly
- check to see that the lift is clear of all obstacles and then signal the crane operator to lift at the normal rate



Do not lean gang form panels against one another without adequate bracing. Do not lift gang form panels if the wind is gusting to over 55 km/h (35 mph).

Gang form panels are setup and removed hundreds of times on large jobs. Because the routine is so repetitious, a change in the system must be very carefully implemented or accidents could occur.

Store the panels in an upright position, or stacked face up, so that they can be easily cleaned and prepared. When a panel is ready to be used, attach tag lines to the bottom corners. Workers on the ground, who control the panel as it moves, handle these lines. Lift the panel by crane, moving it smoothly into position.

While the crane holds the panel steadily in position, anchor it to the previously placed concrete by placing ties through one or two bottom rows of walers. Brace the wall forms to the slab using the size and spacing of braces shown in the erection drawings.

Anchoring

Gang wall forms are often lifted straight up and reset. The forms are anchored to the previous lift of concrete by bolting the gang form to an insert that was cast in the previously cast wall.

Concrete Placement

The concrete placement when using gang forms is described in the erection drawings. The rate of placement must not be exceeded. The ties holding the wall panels together will take huge stresses and it is unlikely that they will fail but it is easy to bow the strongbacks if the rate of placement is exceeded.

Use an elephant trunk or extension hose to place concrete into wall forms where the pump hose cannot be lowered to the placement level. The concrete must not fall through reinforcing steel or severe segregation can occur.

Always vibrate each lift fully and 6" into the previous lift.

Building Core Forming

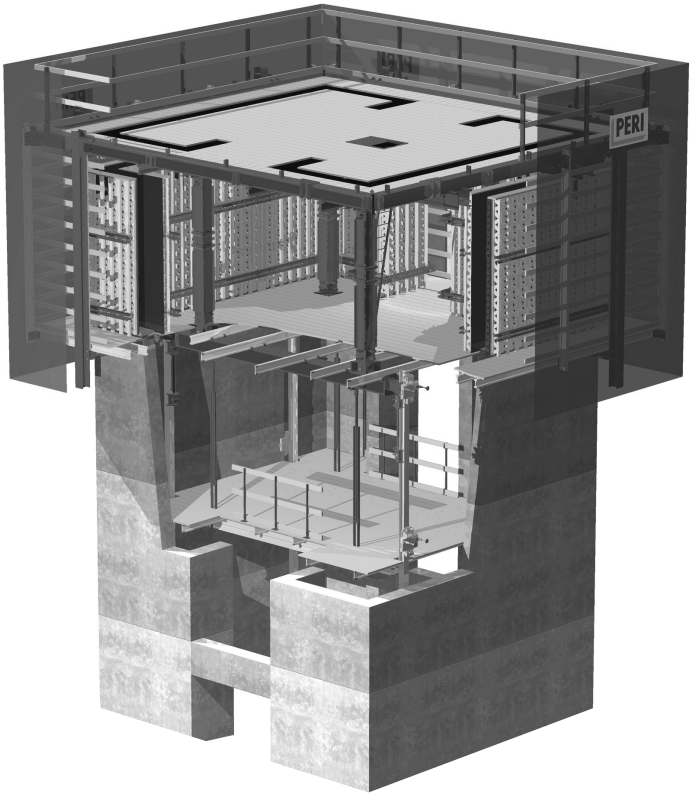


Figure 43 — Self-climbing building core

The "core" of a large structure or tall building is essentially the structural heart of that building. In high-rise construction, the core is usually an elevator shaft or a stairwell that runs continuously from foundation to roof. This is where, in most cases, the tower crane is erected and most of the building's forming will be moved and erected by the crane.

Pre-manufactured forming systems have been coming in to use more regularly. These systems have been designed specifically for this type of work. When a project has one or more cores or shafts that do not vary in shape from bottom to top, self-climbing formwork may be a suitable choice for the job Figure 43.

Although self-climbing formwork is expensive to rent or lease, it may save money overall because of the reduced labour costs and quick placement rates.

Two other methods of core forming are still widely used. They are gang forms which requires the use of a crane and slip-forming which does not require a crane.



Now complete Self Test 1 and check your answers.

Self Test 1

1. When can footings be cast in excavated forms?

2. List three requirements for footings.

3. What is the maximum step allowed for a step footing?

4. Once simple outside footing forms are in place, how are the inside forms positioned?

5. Explain the wrap-around method of building square column footings.

6. What type of footing is used under a concrete wall?

7. What type of footing form must be securely weighted or staked down to keep it from floating when the fresh concrete is placed into it?

8. Figure 1 shows a common wrap-around type of pad form. Why is this method of form construction economical?

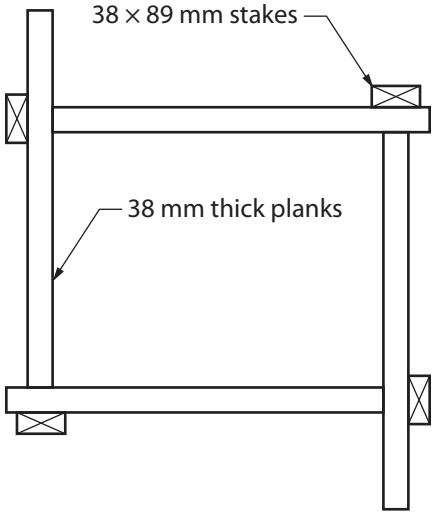


Figure 1

9. Why is the construction of an outside corner of a concrete form so important?

10. Explain how strap ties are secured to the studs.

11. Explain how the forces of the fresh concrete reach the wall form tie.

12. Describe "rate of placement".

13. What size of material is used for the walers and studs when using single or double waler form systems?

_____

14. What controls the maximum spacing of the studs in a double waler system?

_____

15. Draw a typical pilaster form showing ties and other essential members. Label the parts.

16. Draw a typical corbel form, labeling all its parts.

17. Draw a sketch of a gang form panel and label all of the parts.

18. Compare the tie spacing used in loose forming to the tie spacing in gang form panels.

19. What precautions should be taken when placing the concrete in gang form panels?

20. List the procedures used to lift gang form panels.

21. Where is a shear plate used?

22. What are the benefits of Aluma beams used for gang form panels?

23. Name one difference between self-climbing forms and gang-forms.

24. Give an example of a building core.

LEARNING TASK 2

Describe Formwork Material and Hardware

Lumber

Dimensional lumber used for formwork must be strong enough to carry the weight of the fresh concrete and the load of workers and equipment used to place the concrete. Designers specify lumber that has been graded to the specifications of the National Lumber Graders Association (NLGA). Under NLGA rules, the lumber is visually inspected for defects and is assigned a specific grade by the lumber grader. The normal grades used for formwork are standard and better or #2 and better.

Machine Stress Rated

A special type of grading is available to allow the precise strength of each piece of wood to be measured and rated. Lumber that has been measured for strength is said to have been Machine Stress Rated and is stamped with a measurement of its strength. Stress rating for the lumber gives the formwork designer assurance that each piece of lumber that is used to build the formwork will be able to support the loads imposed upon it.

Moisture Content

The moisture content of the lumber is important. Lumber that is too dry will swell when it comes in contact with moisture, and lumber that is too wet will shrink away from the form components not allowing them to fit properly. Partially seasoned stock is preferred because it will only shrink and expand in moderate amounts.

Species

Lumber used for concrete formwork is required to support heavy loads. For economy, form components are re-used many times. Douglas fir is the strongest and most durable species of lumber available in British Columbia and is often selected for use in formwork. Western Hemlock is also suitable for formwork.

Plywood

Douglas Fir plywood is used as the sheathing for formwork because of its strength and smooth uniform surface. A requirement of most building specifications is that only new materials be used for the construction of formwork for that job. Once built, the form panels may be re-used many times.

Standard form ties are made for use with 19 mm thick form sheathing. Using standard form-ties with other plywood thickness will result in finished walls that are either too thick or too thin. Special ties must be made to accommodate other thickness of plywood.

The standard 4x8 plywood panel, measures 48" × 96". Most formwork systems are based on this standard panel size. This includes the tie spacing, the stud spacing and the waler spacing.

Plywood should be coated with a form-release agent (form oil) prior to installation.

Standard Formply

Standard form plywood is a 4×8 sheet of 19 mm thick plywood that has one good face (G1S). Both faces of the plywood are coated with form release oil. Formply has its edges sealed with a paint to prevent the absorption of water.

Overlaid Plywood

Overlaid plywood is form plywood that has one face covered with a resin-impregnated paper. The paper face provides a durable surface that will produce a uniform finish during many re-uses.

Special Plywood

Some form systems are designed to use the form sheathing as the only support for the concrete. These systems use 24" × 96" sheets of plywood that are a full 25 mm thick. The form ties bear directly onto the form plywood.

Birch plywood is manufactured for formwork. It has many thin layers of veneer and is coated with a heavy plastic. This exotic material is only used for very special types of formwork where the very high quality is warranted.

Grain Orientation

For the least deflection, the face grain of the plywood should always be perpendicular to the studs that support it. As in framing, the plywood is installed across the joists or studs. If a curved concrete wall is being formed, then the face grain is placed parallel to the supports to allow it to bend around the curve.

Metal Forms

Metal formwork for concrete is much more expensive than lumber and plywood but for specific uses it is still economical. Metal forms, and steel in particular, are very strong, have consistently smooth surfaces, and will last almost indefinitely with minimum care. This makes steel forms ideal for situations where many re-uses are anticipated.

The formwork for pre-cast concrete members is usually steel; the steel forms provide the durability that is needed to produce thousands of the same size of pre-cast concrete members.

Because steel forms have an integral steel framework, their achievable clear spans far surpass those of wooden forms. Unsupported forms can be set up without costly shoring, scaffolding and other supports.

The weight of steel forms makes them difficult to move without lifting equipment, but this is an advantage if the formwork needs to be very steady during use.

Metal forms are bolted or clamped together, depending on which of several systems is employed. Typical components of a system are metal channels, beams, aligning braces and strong backs. Catwalks, handrails and scaffolding can be attached to metal wall, beam or column forms, and are simply transported with the forms when they are moved.

Plywood Forms

Plywood is usually laid at right angles to the supporting framework beneath it (Figure 1). This gives maximum strength to the assembly.

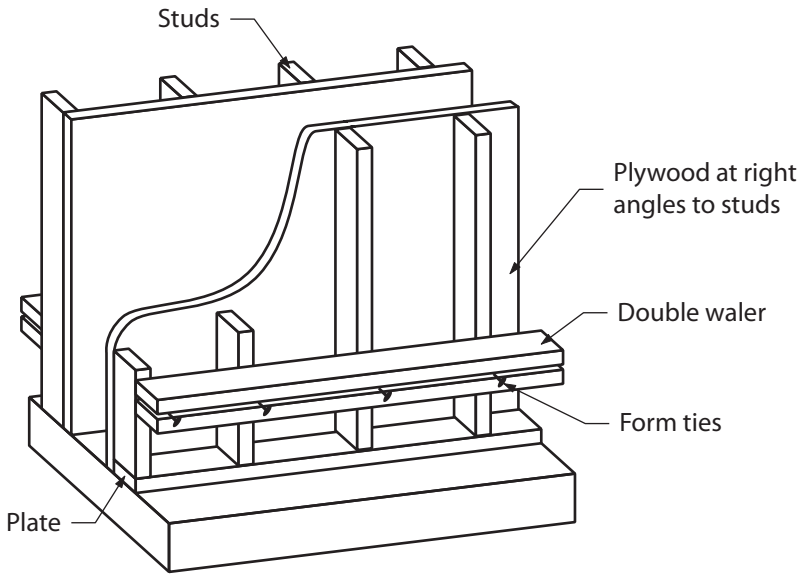


Figure 1 — Plywood formwork

Some plywood formwork is constructed in portable panels made of dimensional lumber and built like a framed plywood wall section.

These units are fabricated in suitable sizes for generic projects. They are commonly built in modules that divide evenly into the dimensions of the sheathing material e.g. 12", 16", 24" and 48".

Loose-forming

Loose-forming uses unframed panels that are sheets of form plywood simply held in place by a strip of lumber nailed to them and braced. In loose forming, concrete ties are held in place by the walers or some other mechanism designed to support the fresh concrete as well as the forms.

Gang Forms

Custom gang forms are built using 89 × 89 mm material held rigid by laminated strong backs or by metal I-channels (Figure 2).

Lifting hooks are an integral part of the design of gang or giant form panels.

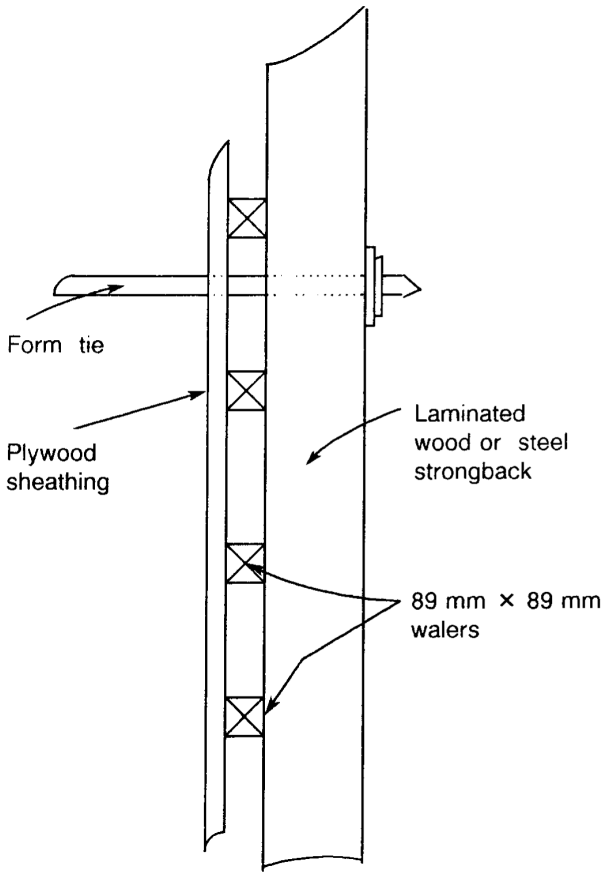


Figure 2 — Gang form panel

Ties for Concrete Forms

There are many types of ties used to secure forms while concrete is being placed. All ties consist of an internal tension unit to hold the form together and an external holding device to transfer the load from the formwork to the tie.

Concrete ties are made from steel and are available in many different strengths and cross-sectional area. Each tie has a designated Safe Working Load (SWL) that should be used when designing the formwork.

Features that are common to most ties

Break-back

Ties that are not re-used are usually notched or crimped so that the ends may be broken off below the surface of the cured concrete. This weakening is referred to as the "break-back." The Snap-tie is a very common tie that gets its name is from the tie's ability to "snap" off at the break-back location.



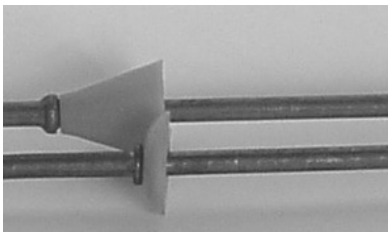
Cones

Ties may be equipped with a cone to provide a neat hole in the finished surface of the concrete. The holes may be plugged with a pre-cast concrete plug or filled and patched to a smooth surface. In some situations the tie holes are left unfilled to form an architectural design, in this case the placement of the ties in the formwork is critical.



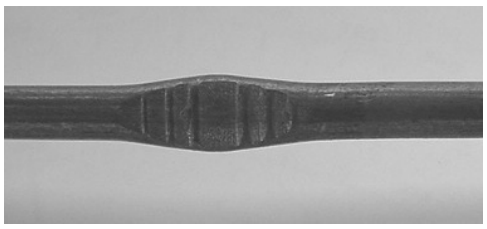
Spreaders

Most ties have washers or cones to act as spreaders. The spreaders set the form width. For tie systems using a wedge to connect the tie to the formwork, the wedge must be snug to hold the form to the correct thickness but not too tight or the spreaders may be squished together reducing the wall thickness.



Deformation

Snap ties have a deformation in the tie shape to keep the tie from twisting when the ends are being snapped off.



Types Of Ties

There are hundreds of designs of form ties and each tie comes in various lengths and strengths. Select ties carefully, choosing the appropriate tie for the given formwork application.

Ties are typically sized in metric dimensions. Common tie dimensions are 150 mm, 200 mm, 250 mm, etc.

The following is a description of some of the common form ties.

Snap Ties

Snap ties come in two basic types: long end for double waler formwork, and short end for single waler formwork. The length of the tie determines the wall thickness. Many standard lengths are available and custom lengths can be ordered.

The long end ties are used with both studs and walers (Figure 3). The long end is designed to be used with ¾" thick sheathing, studs, and two 3½" walers.

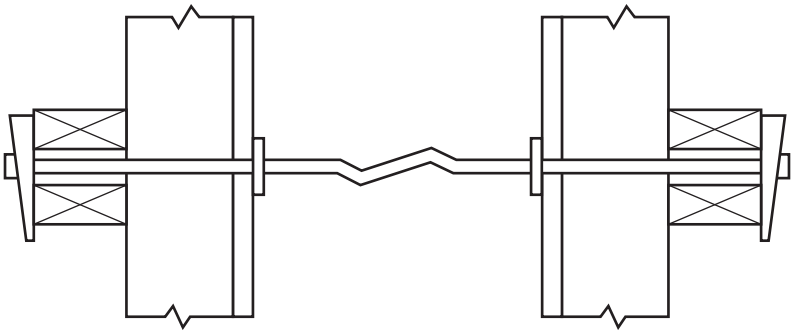


Figure 3 — Long end snap tie

Short end ties are used with a single waler that sits in a bracket (Figure 4). The tie ends are shorter than the ends for a long end tie and are designed to be used with a ¾" thick form sheathing and a single 3½" waler.

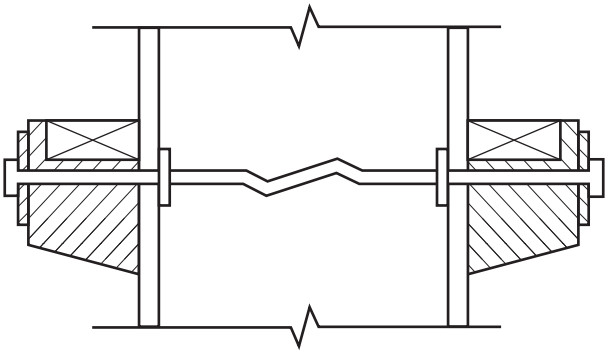


Figure 4 — Short end snap tie

Quick Strip Ties

Quick strip ties are used with the quick strip wall form system. This wall form system uses ties and metal waler bars (Figure 5). The walers transfer the pressure from the form sheathing directly to the tie.

The quick strip system uses no wooden walers or studs.

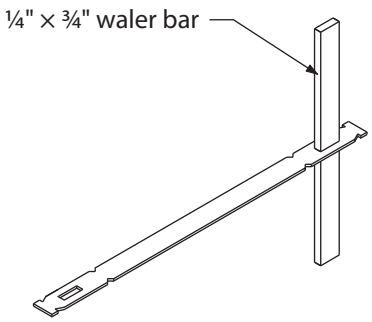


Figure 5 — Waler bar

To strip the formwork from the concrete, the ends of the ties are hammered sideways to break them off at the break-back notch.

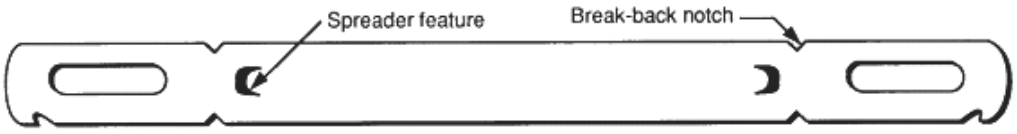


Figure 6 — Quick Strip tie

Strap Ties

Strap ties are flat metal ties used with lumber sheathing. These ties are nailed directly to the studs of the wall form using duplex nails.

This kind of tie incorporates no form spacers so a wooden spacer is used to set the ties.

To strip the ties, the duplex nails are removed, the boards taken off and the ties cut off with a cold chisel.

Strap ties are not used very often. But if an odd width wall is needed for a small job, the strap tie can be used quite effectively.

Both strap ties and quick strip ties are stamped out of sheet metal. Quick strip ties are twice as thick as the strap ties.

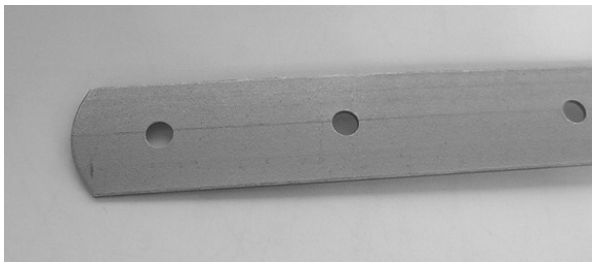


Figure 7 — Nail holes in a strap tie

Coil Ties

The coil tie gets its name from the coil of wire that forms the thread at both ends of the tie. A special bolt with a thread that matches the wire coil is used on both sides of the form. The shallow nature of "coil bolt" threads makes the bolt easy to remove from the tie before the wall form is stripped. Coil ties and coil inserts are often used to re-attach gang form panels to previously placed concrete.

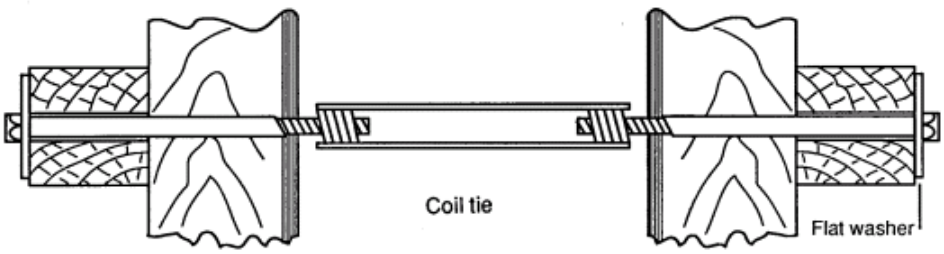


Figure 8 — Two-strut coil tie

Two-Strut Coil Tie

The coil tie shown in Figure 8 does not include a spreader to keep the forms apart. Often the coil tie is equipped with cones on both ends that act as spacers.

Coil ties can have two or four struts, the more struts, the stronger the tie. A four-strut coil tie can support the same load as a heavy-duty taper tie.

Taper Ties

Taper ties are heavy steel rods that are tapered from one end to the other. The taper of the tie makes them easily removed from the wall during stripping. The strength of these ties allows wide spacing, with each tie supporting a large area of form surface.

Heavy stringers are needed to span from tie to tie. With only a few ties to install, gang form panels can be assembled quickly with taper ties.

Taper ties need to be greased between uses to keep them easy to strip. Bent taper ties can be very difficult to remove and should be straightened before installing them in the formwork.

Wedges and Brackets

Wedges

Metal wedges are used to secure snap ties (Figure 10). The wedges are tightened over the ends of the button of the tie with a few light hammer blows. A duplex nail driven through a hole in the wedge holds the wedge from dislodging before the concrete is placed. The wedge is removed after the concrete has cured so that the formwork can be loosened and stripped.

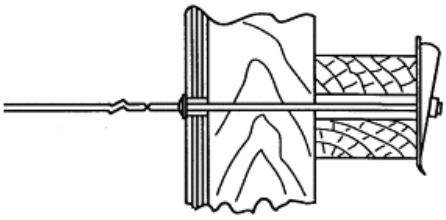


Figure 9 — Long end tie and wedge



Figure 10 — Wedge

Waler Brackets

Waler brackets perform two functions: they hold the walers in place and they transfer the load from the waler to the form tie.

Single waler brackets are designed to be used with a 38 × 89 mm waler. Once all the walers for all rows of ties are in place, the wedges are tightened over the buttons.These brackets are used with short end ties. The brackets and ties are shown earlier in Figure 4.

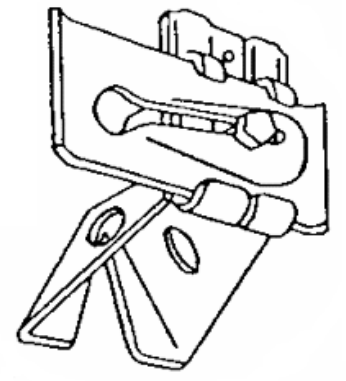


Figure 11 — Single waler brackets

Walers, Strongbacks and Bracing

A waler is any rigid member that bears against the sheathing or framework of a concrete form, transferring the load from sheathing to ties. Walers evenly distribute the pressure from the fresh concrete during placement. They also keep the forms straight and uniformly flat.

Walers can be made from metal bars, channels or beams, and laminated or solid wood. In framed panel applications, walers may be horizontal or vertical and may be supported by braces to the ground or to other parts of the structure being built.

For gang form panels, strong backs are used to support and line up the walers. Taper ties are used to support the strong backs. Lifting eyes are used to attach the slings to when lifting forms with a crane (Figure 12).

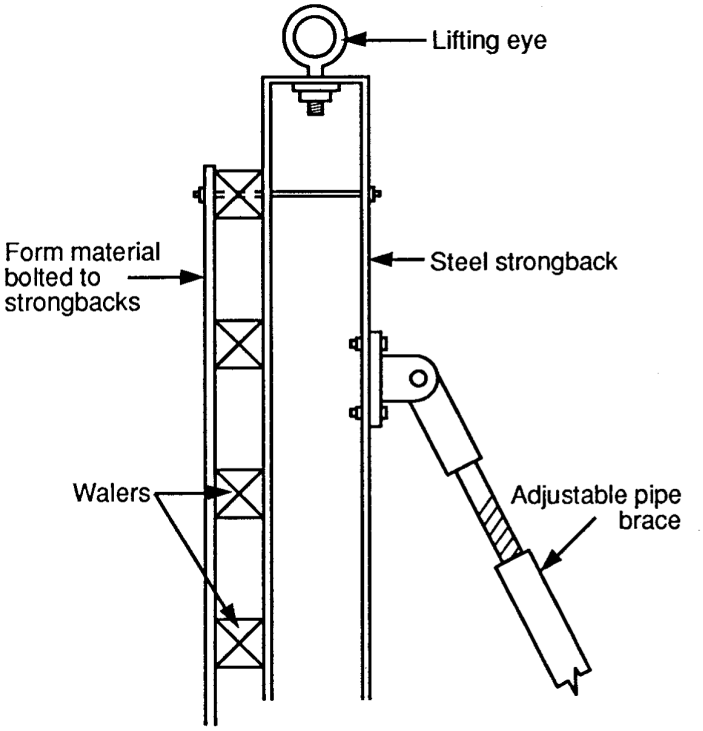


Figure 12 — Strong back and brace

Some concrete formwork uses no walers, relying on thick rigid sheathing to support the concrete load (for example, residential basement wall formwork).

In certain situations, complex bracing for large wall forms is attached to the strong backs, as shown in Figure 12. Bracing can also be laminated planks, metal turnbuckles or wooden boards nailed to wooden stakes driven into the ground. The type of bracing used depends on the type of formwork, wind loading, rate of concrete placement and other factors.

Columns are often stabilized with a continuous ribbon of bracing that joins the columns together. This gives the columns very solid support and accurately holds them in position.

Care needs to be taken to position the layout of the bracing such that it does not interfere with the concrete placement (Figure 13).

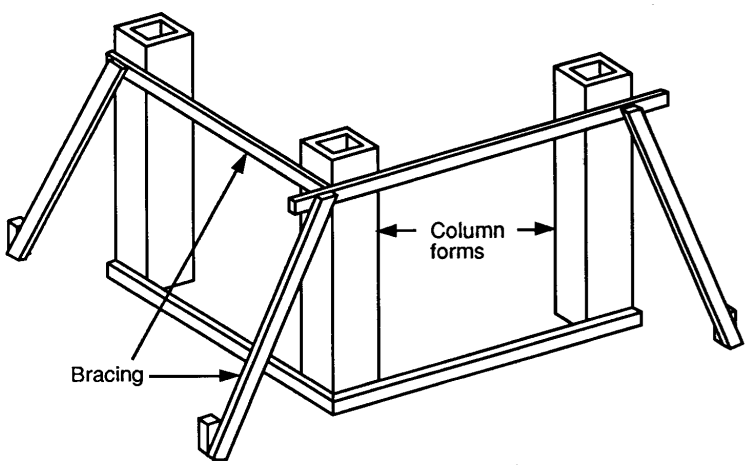


Figure 13 — Continuous bracing of column forms

Reglets and Inserts

Reglets

A reglet is a continuous groove that is cut or formed into a wall, usually above the point of intersection with a flat roof. Counter flashing strips are caulked or grouted into the reglet. The counter flashing is placed so that it slopes down, directing water away from the joint between wall and roof.

The reglet is usually at least 25 mm deep. The counter flashing fits into the reglet and overlaps the roofing material, forming a watertight seal. The cant strip reduces the sharp bend as the roofing material continues up the wall (Figure 14).

To form the reglet, a wooden strip is nailed to the form, leaving a groove when the formwork is dismantled, or a prefabricated plastic strip may be used that remains in place after the form is removed.

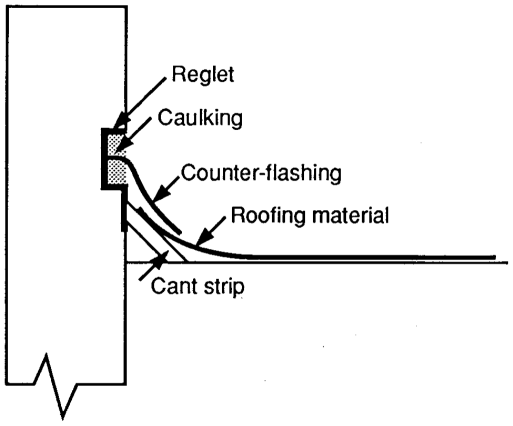


Figure 14 — Reglet

Inserts

Inserts are installed permanently in the concrete. They are used to attach other building materials to the concrete, or to support equipment or fixtures. A common use is to provide a threaded attachment for reinforcing dowels that are used to support concrete stairs.

Tilt-up wall construction uses special inserts that are cast into the wall slabs. These inserts are required to support the weight of the wall panels, sometimes over 35,000 lb. A registered professional engineer designs the type, location and number of these inserts.

Inserts are attached to the formwork or reinforcing steel to hold them in place. When the form is stripped, the opening to the insert is exposed. There is a large assortment of insert types and sizes.

Inserts that are required to support a heavy load are often welded to the reinforcing bars in the concrete (Figure 15).

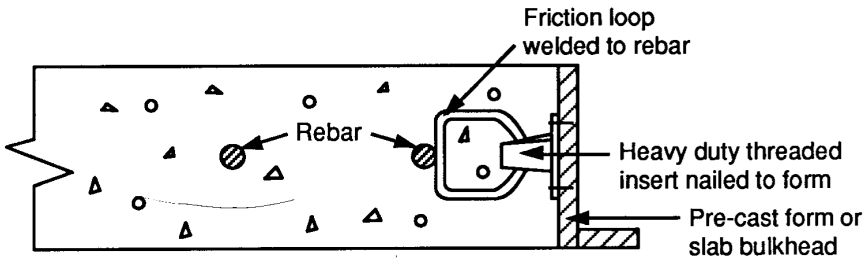


Figure 15 — Threaded insert attached to rebar

Now complete Self Test 2 and check your answers.

Self Test 2

1. What species and grade of lumber would be a good choice for formwork?

2. What is commonly done to concrete forms prior to each use?

3. List two kinds of ties that are stamped from sheet metal.

4. Described a coil tie.

5. Describe a taper tie.

6. Describe overlaid plywood.

7. What is the purpose of a reglet?

_____

8. Sketch a single waler bracket and show how the waler and tie are positioned.

LEARNING TASK 3

Describe Concrete Joints

Isolation Joints

Concrete cast on the ground will settle even if the sub-grade is well compacted. To allow even settling, isolation joints are placed around columns and at the perimeter of slabs.

Give-and-Take Strip

Give-and-take strips are used to isolate one concrete member from another and designed to allow for vertical and horizontal movement. Give-and-take strips made from asphalt-impregnated fibreboard are commonly placed against walls and around columns.

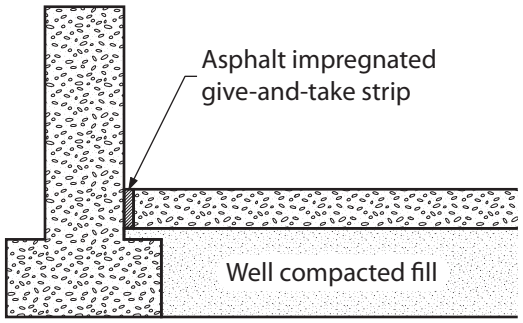


Figure 1 — Give-and-Take Strip

Notice in Figure 1 that there is a space between the footing and the underside of the floor slab. This space is used to allow the slab to settle without cracking at the edge of the footing.

If the slab were placed directly onto the footing, a crack would occur at the edge of the footing as the slab settled and the footing didn't.

Expansion Joints

Expansion joints are similar to isolation joints. They provide protection against the expansion of concrete due to high temperatures. For example, exterior slabs and sidewalks will have give-and-take strips installed in the formwork at certain intervals. These are the expansion joints and all other joints without a fibre barrier are considered control joints. Expansion joints are commonly used between two buildings or between large concrete members. In the expansion joint there is an actual space between the two building segments.

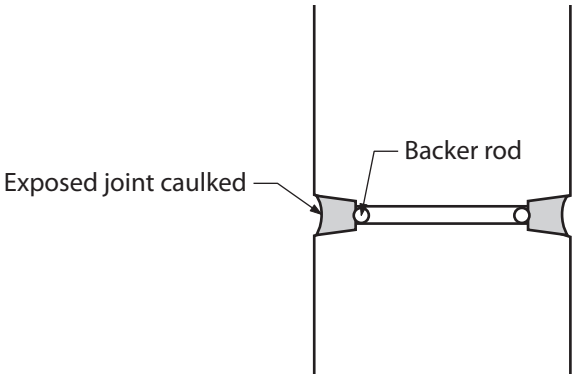


Figure 2 — Expansion joint between two concrete walls

The reinforcing steel is not continuous through an expansion joint. To keep the walls in alignment, a key or greased dowels can be used.

Control Joints or Construction Joints

Concrete will expand and contract with changes in temperature. To control haphazard cracking, control joints are used in larger sections of concrete. A control joint is a weakening in the concrete wall that is designed to control the natural cracking of a concrete member due to shrinkage. Figure 3 shows control joints vertically along the wall. The usual spacing of control joints is no more than 15 m apart.

Control joints are often placed at the corners of windows and door openings in concrete walls.

The rustication strip is actually part of the narrowing of the wall to form the control joint. Two rustication strips are placed opposite one another to weaken the wall.

The concrete is placed on both sides of the control joint at the same time with the reinforcing steel is continuous through the joint.

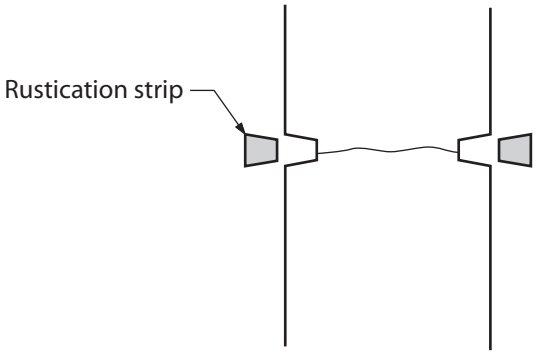


Figure 3 — Rustication at a control joint

Tooled Joints

Tooled joints are simple control joints used for concrete sidewalks and patios. A tool used for making a control joint must have a fin that will penetrate into the slab at least ¼ of the thickness of the slab.

Divider tools are used to leave a decorative line on the surface of the concrete and are not useful in creating a control joint, Figure 4 shows the difference.

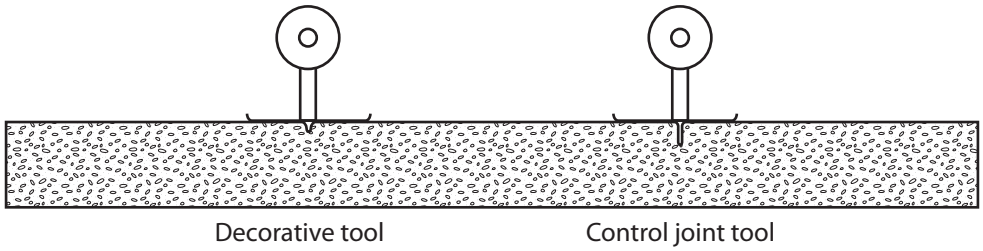


Figure 4 — The difference between a decorative jointing tool and a control-jointing tool

Plastic Control Joint Strips

A two-part, T-shaped plastic strip (called a Zip Strip) is a speedy and easy way to install control joints in slabs. Make a slot in the uncured concrete using a trowel and a straightedge. Force the bottom of the T strip into the slot (Figure 5). Float the strip flush with the top of the slab and then pull the top of the T strip off, leaving the bottom portion embedded in the concrete. Finish the concrete slab as normal and allow it to cure. The embedded plastic strip reduces the effective thickness of the slab and acts as a control joint.

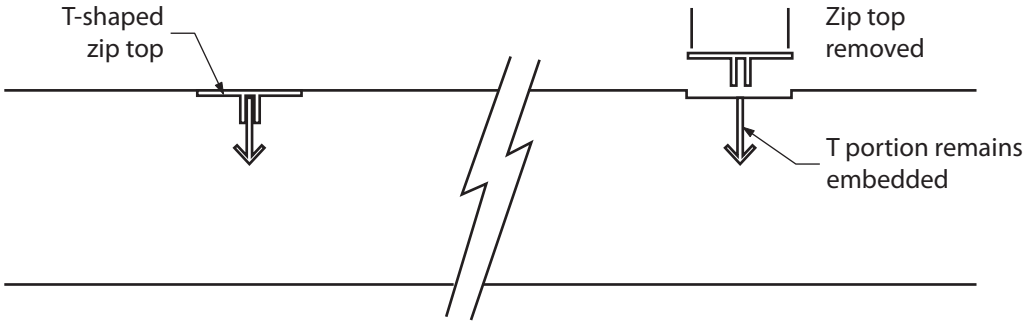


Figure 5 — Zip-top plastic control strip

Cutting Control Joints

After the concrete has cured for at least 24 hours, control joints can be cut using a saw equipped with a diamond impregnated blade. The blade is kept cool and well lubricated with a continuous stream of water running on it.

Dry cutting diamond blades are available for portable circular saws, these blades produce a huge volume of dust. The dust can be eliminated with a small stream of water from a garden hose.

The depth of cut should be a minimum of ¼ of the slab thickness.

Construction Joint

A construction joint is a surface where two succesive placements of concrete meet; a planned start and stop of a pour. Construction joints are always control joints. The horizontal construction joint in Figure 6 is where the second placement of concrete joins the previously cast concrete.

The positioning of the rustication strip hides the construction joint in the two separate placements of the concrete.

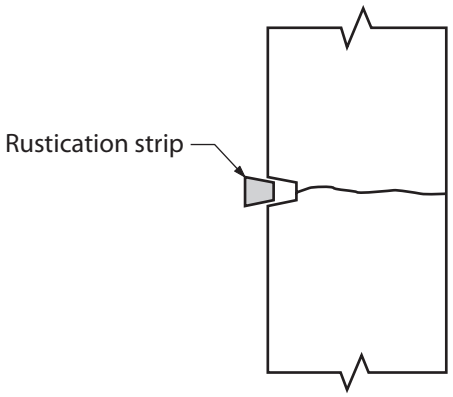


Figure 6 — Rustication at a construction joint

Cold Joint

A cold joint is an unplanned joint or discontinuity in concrete that results from a delay in placement of concrete. Delays are caused by several things including traffic delaying trucks, conrete setting too fast in warm weather, plasticizer kicking off before the next lift gets placed, or underestimating the volume of concrete.

Now complete Self Test 3 and check your answers.

Self Test 3

1. What are control joints used for?

2. What is the difference between an isolation joint and a control joint?

3. What type of blade is used to cut control joints in hardened concrete?

4. Why is the floor slab not cast directly onto the footing?

5. What is the minimum depth of a control joint for a slab on grade?

6. What material is used for a give-and-take strip?

7. Describe three ways of making a control joint in a slab-on-grade.

Answer Key

Self Test 1

1. when the soil is stable enough
2. correctly positioned, level and accurately dimensioned
3. maximum 600 mm vertical and minimum 600 mm horizontal
4. spaced and nailed to the outside form using cleats
5. all four sides are cut the same length
6. continuous strip footings
7. tapered pier footing
8. no need to cut to length
9. it defines the corner of the building and there is greater pressure there
10. nailed
11. pressure is transferred through the sheathing, to the stud, to the waler, to the tie
12. vertical feet of concrete placed per hour
13. 2" × 4"
14. allowable deflection and rate of pour
15. a beam at the perimeter of a suspended slab
16. The difference between a two way joist system and single joist system is the shape of the pans used as formwork. The pans for a two way, or waffle slab, are semi-domed shaped and set in a grid. The pans for the one way system are open at each end, lined up end for end and capped with a end pan. The pans for both systems are set onto suspended slab formwork. When the soffit of the slab is stripped away, the single joist shape can be seen running from beam to beam, or the waffle pattern is seen from below.
17. Figure 3 and 4
18. far fewer for gang forms, 6 ft o.c.
19. rate of placement not to be exceeded
20. Proper fall protection
    Partially strip the form
    Attach tag lines
    Attach crane slings
21. at tie ends

22. strong, light and easy to connect together
23. self-climbing forms do not require a crane
24. elevator shaft

Self Test 2

1. fir/larch bit in residential SPF #2 & better is used because it can be re-used within the structure
2. lubricated with a product (usually an oil) that provides for form release
3. strap ties and quickstrip
4. key characteristic is the coil of wire that forms the thread at both ends of the tie
5. taper ties are heavy steel rods that are tapered from one end to the other
6. formply that has one face covered with an resin-impregnated paper
7. counter flashing fits into the reglet and overlaps roofing material to form a watertight seal
8. Figure 4 and 11

Self Test 3

1. to control random cracking
2. an isolation joint is a space between members that prevents cracking. A control joint controls random cracking
3. diamond toothed blade
4. to allow settling without cracking
5. ⅓ slab thickness
6. impregnated fibre board
7. tooled, zip strip and surface cut after 24 hrs of curing



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