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CONSTRUCTING THE BUILDING SHELL

Lesson One

Footings, Foundations, and Forms

TPC Training Systems

36201

Lesson

1 Footings, Foundations, and Forms

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OBJECTIVES

After studying this lesson, you should be able to…

- Demonstrate how to lay out a right angle without using instruments.
- Explain how to set up batterboards and building lines for an excavation.
- Tell what you can do to assure your own safety when working around an excavation.
- Describe how to erect a form for a concrete footing.
- Show how to mix a small batch of concrete using the "bottomless box."
- Describe how to prevent concrete slabs from cracking.

KEY TECHNICAL TERMS

Batterboards 1.14 boards nailed to vertical members at corners of an excavation to hold building lines in position
Excavation 1.19 removal of earth for the portion of building below ground level
Footing 1.23 masonry section wider than a foundation, on which wall or column rests to distribute weight of building
Concrete 1.33 mixture of cement, sand, gravel, and water used in construction
Forms 1.43 molds, usually wood, for holding wet concrete until it sets
Wales 1.46 the horizontal reinforcement members of forms
Tie rod 1.47 steel rod that controls wall thickness by tying together the inside and outside walls of a form

Footings and foundations bear the load of a building and keep it from shifting with the natural movement of the ground. They are generally constructed from concrete (poured or blocks) because of its great strength and its resistance to decay caused by moisture.

Though most footings and foundations are masonry, carpenters construct most of them. Often, a carpenter must lay out the building lines for guiding the masons who do the pouring or set the blocks. When poured concrete is used, it's the carpenter who constructs the forms and sets them in place.

Because he's involved with almost every phase of a project, the carpenter must very often coordinate the entire job. So he must be familiar with all aspects of the job—even those outside his own trade. He must know and understand each step of building construction from the ground up.

Laying Out Building Lines

1.01 You will use a drawing called the site plan for laying out building lines. First, you must locate the boundaries of the lot. Usually, they are marked at the corners by metal or concrete markers. If you find no markers, you can perhaps use trees, rocks, or other natural features to define the boundaries. If you are unsure of the property lines, get a qualified professional to survey the lot and mark the boundaries with stakes at the corners.

1.02 Always have plenty of wooden stakes on hand when laying out building lines. Make the stakes from 2 in. square lumber, and shave one end to a point so you can drive it into the ground easily. Mark the exact center on top of each stake with an "X" connecting the four corners. Drive a nail into the center of the "X." Use a long tape to measure the distances between stakes. You must lay out the lines accurately to avoid problems in the later phases of construction. To lay out lines accurately, all you need to do is apply a few principles of geometry.

1.03 First, let's be sure you understand some of the terms that are basic to the language of layout. A *line* in layout always means a straight line-the shortest distance between two points. You can establish a lot line by stretching a string between the markers at the corners. Lines that are the same distance from each other at all points are called *parallel* lines. Parallel lines never meet or intersect. Lines that intersect each other at right angles (90° angles) are called *perpendicular* lines. In carpentry, lines that meet at right angles form square corners for a building.

1.04 As you learned in an earlier lesson, layout tools help you to build straight, square, and plumb. But ordinary layout tools are too small to lay out building lines. However, you can still use the basic principles of geometry to make large layouts.

1.05 **Perpendicular lines**. To establish perpendicular lines at a building site, drive a stake at a selected point A on the line from which you wish to project a perpendicular (Fig. 1-1A). Then, attach a string to a nail driven into the exact center of the top of the stake. With the string drawn tight, strike arcs of equal length at points B and C on the line on either side of point A (Fig. 1 -1A).

1.06 Now, with points B and C as centers, use a radius two or three times as long as the length of the line between points A and B to locate a fourth point,

Fig. 1-1. Drawing perpendicular and parallel lines

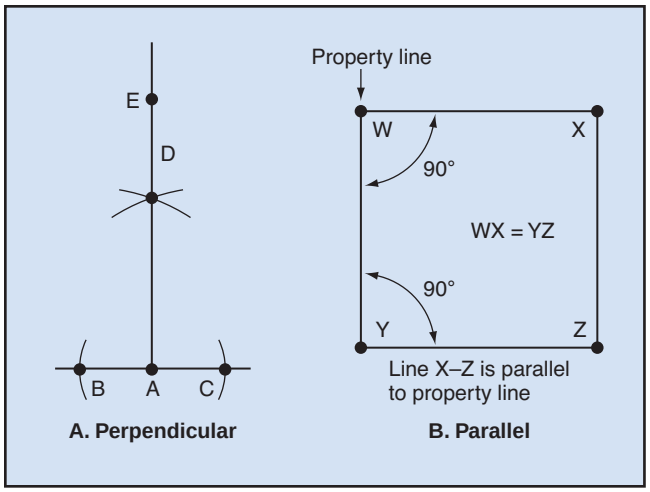
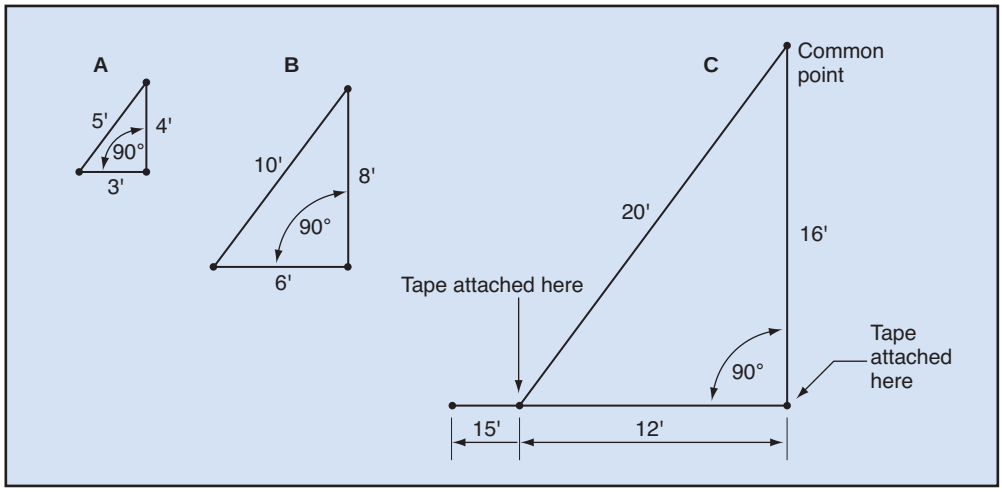


Fig. 1-2. Making a right angle for building lines



D. Point D lies where the two radii or arcs intersect. A line drawn through points A and D will be perpendicular to the line with which you started.

1.07 If you must extend the perpendicular line beyond point D and still keep it straight, fasten a long string to the center of the stake at point A. Draw the string perfectly tight, and extend it so that it passes directly over point D. Now drive another stake, with the end of the string attached to its center, at point E. Because points A, D, and E line up, a line drawn through them is straight—and it is also perpendicular to the original line.

1.08 **Parallel lines**. To lay out parallel lines, start with an established straight line such as a property line. At two widely separated points, lay out lines of equal length perpendicular to the property line, by the method described above. Then, extend a line between the end points of the perpendicular lines. This line will be exactly parallel to the property line (Fig. 1-1B).

Fig. 1-3. Transit level for laying out building lines

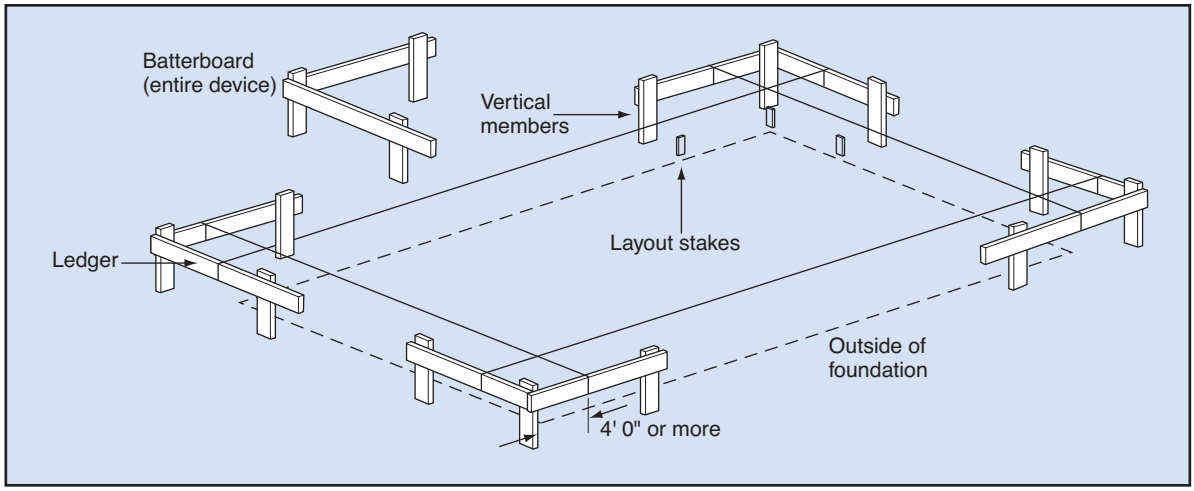
A Right Angle Without Instruments

1.09 Mathematics tells us that, if the ratio of the sides of a triangle is 3-4-5, the angle opposite the longest side is a true (90°) right angle. Depending on the size of the construction area, this ratio may be 6-8-10 or 12-16-20, etc. The bigger the sides you can lay out, the more accurate the right angle that you create (Fig. 1-2).

1.10 For example, if you've laid out a 15 ft side of a foundation wall, measure off 12 ft from one of the ends and drive a temporary stake at that point (Fig. 1-2C). Then attach a measuring tape that is a little longer than 16 ft to one end point of the 12 ft line and a tape that is a little longer than 20 ft to the other end point. Place marks on the tapes to indicate the exact lengths of 16 ft and 20 ft.

1.11 Now pull the tapes to a common point where the two marks coincide. This becomes the third point of a right triangle. The other two points are the stakes at the ends of the 12 ft length. The comer formed by the 12 ft and 16 ft lines is a true right angle, useful for laying out a corner.

Fig. 1-4. System of batterboards properly set up



Using a Transit Level and a Builder's Level

1.12 The methods described so far produce reasonably accurate layouts. If extreme accuracy is required, however, you need two highly accurate instruments called a transit level and a builder's level. Each is mounted on a tripod (three-legged support), and each has built-in fluid levels to help you adjust the line of sight precisely. While both are designed to operate in a horizontal plane, the transit level (Fig. 1-3) can also be used to plumb vertical lines and measure vertical angles.

1.13 Both the transit level and the builder's level are complex devices that require proper handling and special training to operate. That training is beyond the scope of this lesson. If you need an extremely accurate layout, have it done by a professional—or find a qualified person to give you guidance and suggestions.

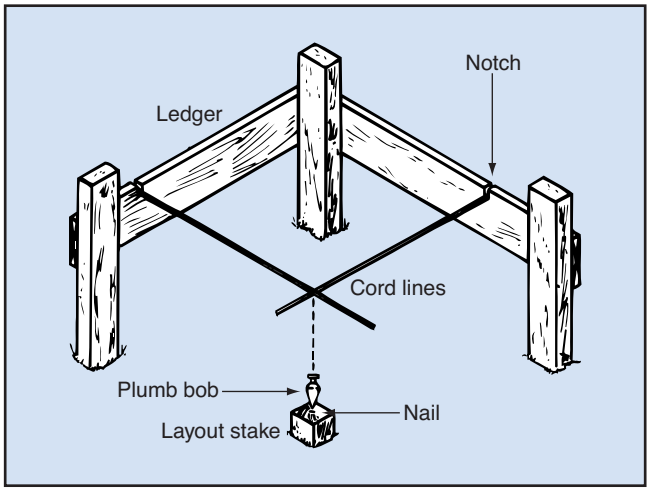
Setting Up Batterboards

1.14 After you have established the building's corners and marked them with stakes, set up the boards (or ledgers) as shown in Fig. 1-4. The entire setup of ledgers and vertical members is referred to as *batterboards*. Note that three vertical members (pointed 2×2 stakes) are driven into the ground at each corner. The vertical members should be placed near the layout stakes, but far enough away so digging doesn't disturb them. Be sure the boards (usually 1×6s) are sturdy and are firmly fastened to the vertical members. Nail the boards to the vertical members in a level position. All sets of boards should be level with each other.

1.15 To establish accurate guidelines for a building's exterior walls, extend strings between opposite batterboards, as shown in Fig. 1-5, so they intersect directly over the centers of the layout stakes. Use a plumb bob to make sure the intersections are exactly above the centers of the "X's" you marked on the layout stakes. You can place the strings in position during any phase of construction. You must remove the layout stakes when digging starts. The strings supported by the batterboards then serve as permanent references.

1.16 As a quick final check, measure the diagonals of the rectangle formed by the building lines. If the

Fig. 1-5. Details of a batterboard assembly



rectangle has perfectly square corners, the diagonals will be equal in length. Finally, cut small saw cuts or notches about 1/16 in. deep in the horizontal members of the batterboards to hold the strings in the correct position. Notching also makes it easy to replace the strings if you must remove them to admit excavating equipment to the site.

Grading and Excavating

1.17 Clear and rough grade the building site even before you set the layout stakes for the corners. The land contours should be established more or less as they will be on the finished site. Tractors and bulldozers are the usual equipment for clearing and grading. You can rent this heavy equipment. It pays to hire an experienced operator to do the work. Lay out the stakes and batterboards as soon as the grading is complete. Then you can begin excavating.

1.18 Footings and foundations are usually set below grade, based on the wall height above grade and firm soil depth below grade. Where temperatures fall below freezing, be sure to place all footings below the frost line (the depth to which the ground freezes). This prevents frost-heave—the lifting of that portion of the structure by moisture freezing under the footing.

1.19 The depth of the excavation and the height of the finished foundation walls are usually specified by the architect. To prevent moisture from rotting the wooden framing members, the tops of the foundation walls should project 8 to 12 in. above the finished grade. Holes and trenches for footings should be 2 to 3 ft wider than the specified width of footing. This gives workmen adequate space to construct forms.

1.20 The floor of the excavation should be level at the specified depth. Inspect it to be sure no infirm surface or uncompacted soil exists that can cause the building to settle unevenly. Only the tops of footings need be precisely level. If you must dig deeper at some point to find solid earth for a footing, it shouldn't create a problem.

1.21 When the rough excavating is done, restring the building guidelines on the batterboards. Then drop plumb lines from their intersections to locate the corner stakes on the floor of the excavation, as shown in Fig. 1-6. The stakes serve as guides while you construct the forms for the concrete footings.

Safety in Excavating

1.22 Everyone involved in excavating building sites must use common sense. Perhaps the greatest danger in all excavations is cave-ins. Every year a number of tradesmen preparing foundation forms are crushed or buried alive when the walls of excavations give way and crumble. Always follow these rules for excavation safety:

- In holes or trenches more than 4 ft deep, slope the sides of the hole back (wider at the top) to keep the soil from sliding into it.

Fig. 1-6. Projecting a corner downward from grade

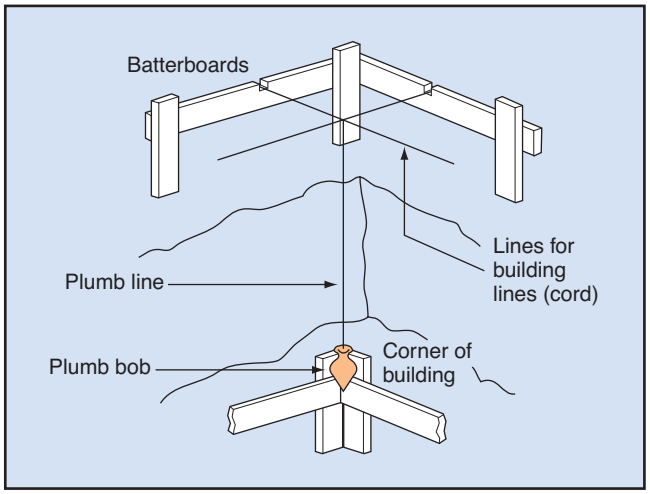
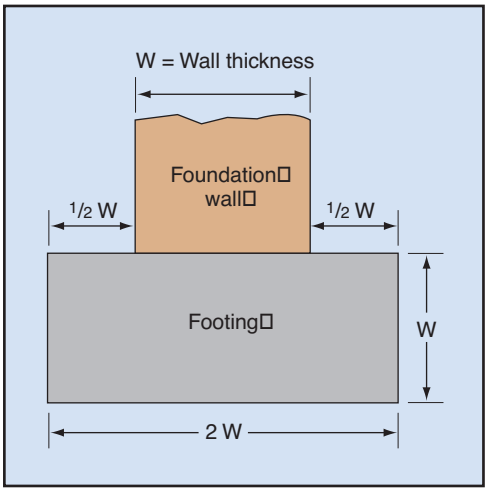


Fig. 1-7. Typical footing for a frame building



- Never pile heavy materials near the edge of an excavation. Keep heavy equipment well back from the edge of the hole.
- Tradesmen should stay out of holes and trenches whenever heavy equipment operates in the area.

- To assure personal safety, backfill all excavations for footings and foundations just as soon as possible after they're complete.

Footings

1.23 Footings are usually made from poured concrete. They distribute the weight of load-bearing walls and other members, thus preventing the foundation from settling unevenly. The design of footings varies with the loads they carry and the conditions of the soil.

1.24 The details and specifications for concrete footings should be included in a sectional view on the foundation plan. The footing shown in Fig. 1-7 is typical for a wooden frame building. It is twice the width of the foundation wall, and its depth corresponds to the thickness of the wall.

1.25 Wooden *forms* (shown in Fig. 1-8) are built to act as molds—to hold the poured concrete in place until it hardens. When constructing the forms, make sure the guidelines for the building's walls are in place. Locate the forms with plumb lines dropped from the guidelines.

1.26 You can build forms from boards or plywood. Use any number of boards to make the height of the form equal to the specified height of the footing. Start setting the boards for the outside surface of the footing first. Use stakes at 2 to 3 ft intervals to hold the boards in place.

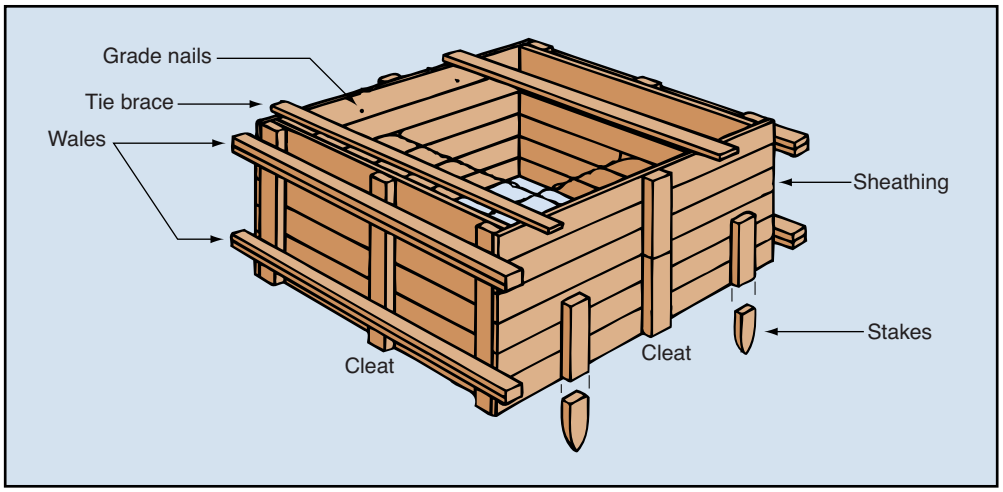
1.27 When fastening a form for a footing to its stakes, place the stakes on the outside of the form and drive the nails into the stakes—then through the boards. Use double-headed nails or common nails driven only part way into the boards. You must remove the forms after the concrete hardens. And driving the nails from the inside out makes it a lot more difficult to remove the forms.

1.28 As you erect the boards for the outer surface of the form, level the tops of all forms with a carpenter's level. After filling the form with concrete, scrape off the excess and flatten the wall. Use the top of the form as a guide for scraping. This is called *screeding*. Anchor bolts should be pushed into the concrete after screeding.

1.29 After erecting the form for the outside perimeter of a footing, cut some wooden spacer strips for guides to set the boards for the inside perimeter in place. The spacers (all the same length) save a lot of time and measuring as you erect the forms to produce a footing of uniform width. Inspect the soil as you work to be sure there is no loose earth on which the footings will be poured.

1.30 Dig by hand, if necessary, to assure that all footings will be poured on firm ground. As you set the

Fig. 1-8. Typical form for a large concrete footing



inner form for each footing, check constantly to be sure that the top of the form is level and that the form is firmly supported with stakes. Remember: all forms must be plumb (truly vertical).

1.31 After erecting the forms for the footings on the building's perimeter, erect those for the posts or columns that bear the load inside the perimeter. Locate their positions by dropping plumb lines from the guidelines strung to the batterboards. Then check your work by taking measurements from the perimeter to the forms.

1.32 So that the forms won't bond to the poured concrete, coat all surfaces of them that come into contact with the concrete. The best coating to use is a petroleum-based oil. However, if the finished surface of the concrete is to be painted, coat the forms with lacquer instead of oil. Oil on concrete prevents paint from sticking to the concrete. After erecting all the forms and double-checking their measurements, you are ready to pour concrete.

The Programmed Exercises on the next page will tell you how well you understand the material you have just read. Before starting the exercises, remove the REVEAL KEY from the back of your Book. Read the instructions printed on the Reveal Key. Follow these instructions as you work through the Programmed Exercises.

1-1. To lay out lines for a building, follow the designer's instructions on the _____.	1-1. SITE PLAN Ref: 1.01
1-2. Lines that are the same distance apart at all points are said to be _____.	1-2. PARALLEL Ref: 1.03
1-3. You can plumb vertical lines and check vertical angles with a transit_____.	1-3. LEVEL Ref: 1.12, Fig. 1-3
1-4. The horizontal members of a batter-board assembly are sometimes called _____.	1-4. LEDGERS Ref: 1.14, Fig. 1-4
1-5. If the rectangle formed by building lines is perfectly square, the_____ of the rectangle will be equal.	1-5. DIAGONALS Ref: 1.16
1-6. Perhaps the greatest danger to tradesmen preparing foundation forms is_____.	1-6. CAVE-INS Ref: 1.22
1-7. Locate forms on an excavation's floor with_____ dropped from the intersections of the building's guidelines.	1-7. PLUMB LINES Ref: 1.25
1-8. Scraping off excess concrete to level it is called _____.	1-8. SCREEDING Ref: 1.28

Concrete: How It Works

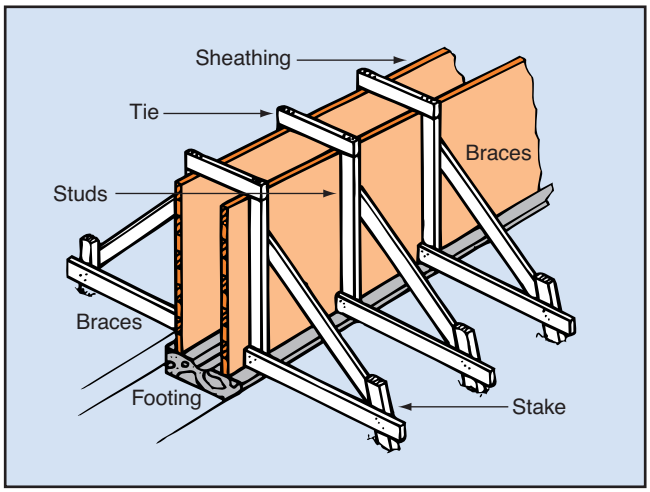
1.33 Concrete is a mixture of portland cement, sand, gravel, and water. The cement—the hardening and bonding agent of concrete—is made from a mixture of limestone, shale, and clay. The use of sand and gravel (called aggregate materials) makes the concrete strong and economical to use. The aggregates act as fillers in the mixture.

1.34 For general construction, gravel for concrete should be no larger than 1 1/2 in. Finer aggregates are needed for mortar and for smooth finishing. Fine sand particles fill the voids (air spaces) in the gravel and help form a paste to hold the mix together. You must see that all concrete is mixed thoroughly to assure that the fine particles interlock. This will produce strong concrete that's free of voids.

1.35 Concrete dries and sets, not through water evaporating from it, but through water molecules bonding with the cement. Adding water to a mixture of cement and aggregates starts a chemical process called *hydration*. First, the cement becomes pasty. But, as hydration continues, it hardens. Hydration goes on long after the concrete appears hard, so it becomes harder as time passes. Hydration slows down until the concrete is considered cured. Always let *cured* concrete sit for several weeks before building on it.

1.36 The actual proportions of cement and aggregates for concrete were given in Lesson Four of TPC Training Course 361, and Lesson Five of Course 106. You can buy large batches of premixed concrete, or mix small batches yourself. If you prefer to mix the ingredients by volume, build a bottomless box with a volume of 1 ft^3 (cubic foot). Set it on a nonabsorbent surface where you'll be mixing, and fill it with cement. Then lift up the box and leave the cement in a pile.

Fig. 1-9. Common form for a low concrete wall



1.37 Spread the cement out a little; then add two boxes of sand and three of gravel to the pile in the same manner. Mix the ingredients thoroughly; then add water. Use only water that is clear enough to drink. Add it a little at a time while mixing the materials with a shovel.

1.38 When you think the concrete mix is right for pouring, try to smooth its surface with the shovel. If you can't smooth it, add a little water. If water comes to the surface when you press with the shovel, add a little more cement. Pick up a handful of the mix and squeeze it together. If it sticks together and stays more or less in shape, you can then pour it into the forms.

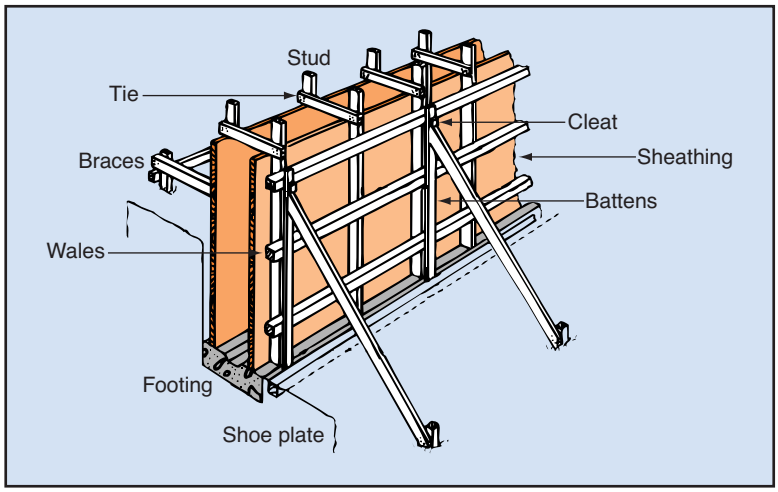
1.39 Don't mix more concrete than you can use in half an hour. Carry concrete to the form in a bucket or wheelbarrow. As you pour, prod and pack the concrete into the form with your shovel to be sure there are no voids. Cover the bottom of the form with concrete first, then build up layers evenly towards the top. Level the top with the edge of a board. Leave the filled form in place at least a couple days. After removing the form, wet down the new concrete every couple hours for another day or so.

1.40 Mixing concrete by hand is hard and slow work. On small jobs, you can save time and labor by buying bags of cement and aggregate to which you need only add water. For bigger jobs, mixer trucks that hold about 5 yd will deliver to your job site. The smallest premixed delivery is about 1/2 yd.

1.41 Be prepared for fast pouring when you expect a concrete delivery by truck. All the forms should be in place. Have plenty of help on hand to carry and place the concrete. In large pours, like continuous footings, place the concrete in horizontal layers, taking care to cover the bottom of the form first.

1.42 Prod and pack the concrete so the form is filled and there are no voids. For small jobs, order

Fig. 1-10. Common form for a high concrete wall



about 10% more concrete than you need to cover the waste and loss in handling. For jobs of more than 200 yd, allow 5% more than you need.

Forms for Foundation Walls

1.43 Forms for foundation walls must be built to withstand the great outward pressure that wet concrete produces. For walls up to 4 ft high (Fig. 1-9), you can build forms from 1 in. boards nailed to 2×4 studs spaced 24 in. OC. For walls higher than 4 ft (Fig. 1-10), use 1 in. boards or ¾ in. plywood. Spacing of the studs should be no more than 16 in. OC. Many builders prefer plywood. It saves time and produces a much smoother finish.

1.44 In Fig. 1-9 the form is erected on top of a footing and is supported by vertical studs and braces. Wooden ties maintain a uniform width at the top of the form. A groove (called a key) is cast down the center of the footing so new concrete, when poured, flows into the groove and locks the wall to the footing. You can form the groove by placing a wooden strip in the wet concrete as the last layer is poured. You must be sure to remove it, however, as soon as the concrete sets and can support itself.

1.45 Many builders use prefabricated forms, either manufactured or homemade, for foundation walls. Prefab forms, made from 4×8 plywood panels and 2×4s, can be nailed or bolted together for long walls. Joints between forms must be carefully aligned and tightly fastened to prevent concrete from leaking. Leakage not only wastes material, but causes voids to form in the walls. Corners must be fastened and reinforced as shown in Fig. 1 -11.

1.46 It is recommended that you reinforce forms for high walls (more than 4 ft) with wales and tie rods to support the weight of the wet concrete. *Wales* are long 2×4s extending horizontally across the backs of the forms to give extra support to the joints between forms.

1.47 Tie rods (Fig. 1-12 on the following page) come in varying lengths from builders suppliers. Insert the rods through holes drilled in the forms. Note that the rod shown has spreaders to maintain the uniform width of the form. It must be long enough to extend through the wales and provide space for nuts

Fig. 1-11. Reinforcement for the corner of a form

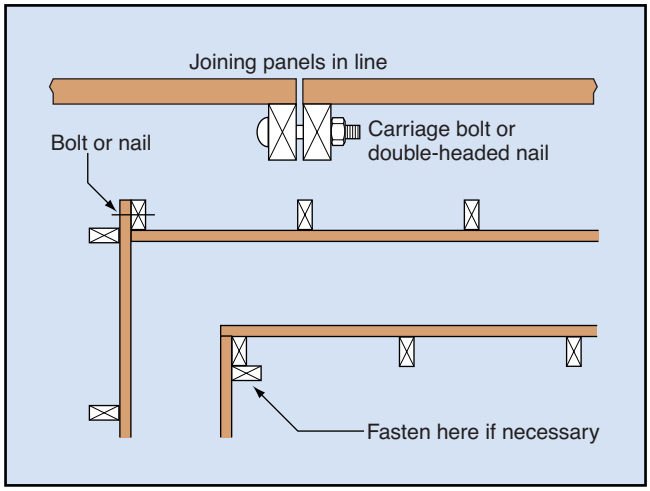
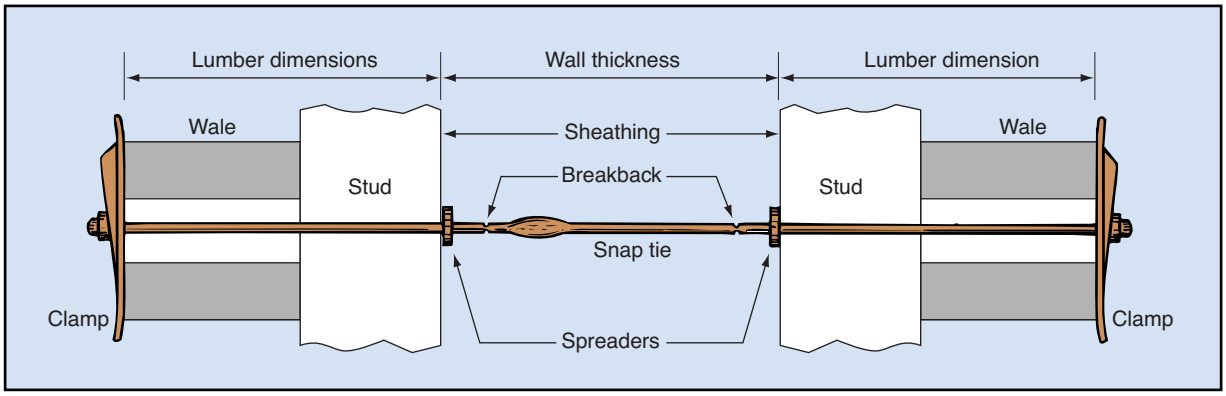


Fig. 1-12. Metal tie rod for reinforcing a wall



to draw the assembly together. After the concrete sets and the forms are stripped (removed), you can break off the ends of the rod (below the finished surface) with a special tool. Patch the holes that remain in the concrete with mortar. The remaining rod stays buried in the wall.

1.48 Before pouring, coat the insides of the forms to prevent concrete from sticking to them. Place the concrete in layers not more than a foot thick. Prod and pack it with a vibratory tool to eliminate voids and make it settle evenly. Pour the concrete continuously, and cast the foundation in one piece. Key projecting walls with a slot and a reinforcing rod projecting from the first wall.

1.49 When placing the last layer of concrete, insert special anchor bolts (Fig. 1-13) in the wet concrete with the threads projecting upward. The anchor bolts are used for fastening the wooden sills in place. The sills form the base for all the framing operations that will follow.

Openings in Foundation Walls

1.50 Windows and doors require that openings be made in the foundation walls. Before the concrete is poured, nail boards into the forms to stop the flow of concrete. Refer to the elevation views in the working drawings, and the schedule for windows and doors. Determine the sizes of the rough openings required in the foundation. Now build a box from stout boards, whose outside dimensions match the outside of a window or door.

1.51 All boards for a box must be the same width (the inside width of the form) to keep the concrete from leaking. Nail or screw the box in place from the outside of the form. If you decide to leave a box in an opening to serve as a nailer for a window or door, you must insert special bolts in the concrete—like those in the foundation walls to which the sills are bolted.

1.52 Be sure to brace each box from its inside so it can carry the weight of the concrete pressing on its

Fig. 1-13. Anchor bolt for sill set in concrete

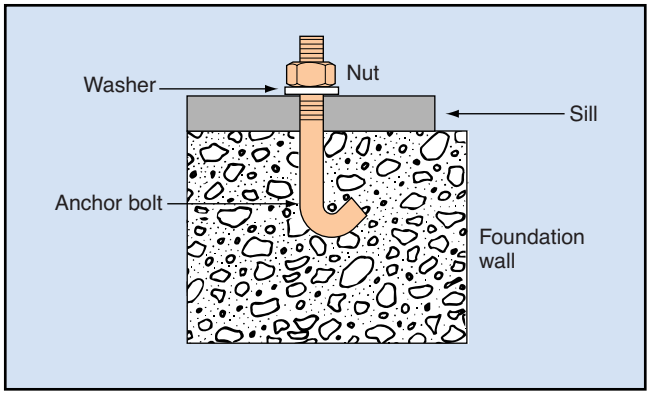


Fig. 1-14. Pattern of steel rods reinforces concrete

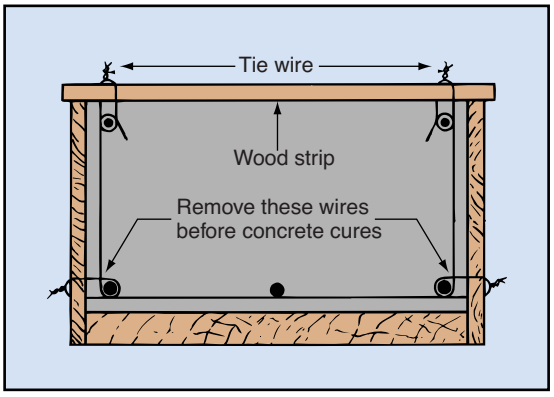


Fig. 1-15. Walls tied with metal rods at corner

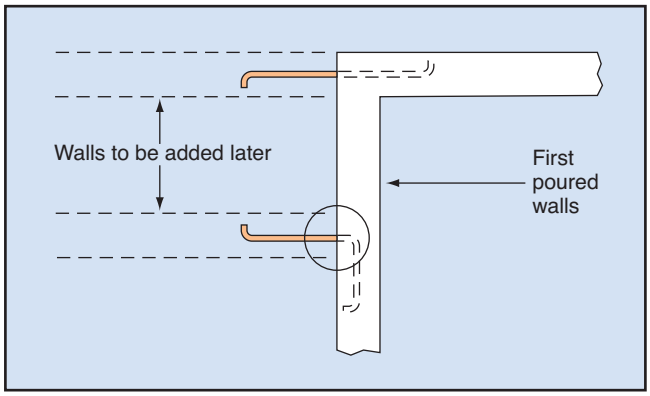


Fig. 1-16. Levelling a concrete slab with a float

top and sides. Then pour the concrete as you normally would, making sure that the space *under* the box is filled with concrete. Use extra care to prod and pack the concrete into this hard-to-reach area.

Reinforced Concrete

1.53 When resting on soil or rock, concrete is very strong under compression—that is, it can support heavy loads. In areas over windows and doors, however, it cannot support itself. It must be reinforced—usually with steel rods embedded in it. To do this, proceed as in Fig. 1-14. Drill small holes in the form for the tying wires that suspend the rods in position for pouring. To prevent cracking, embed the rods a couple inches below the finished surface.

1.54 You can remove the wires when the concrete is set, but before it is cured. You can also use rods to tie adjoining concrete surfaces together as shown in the layout of a corner in Fig. 1-15.

Pouring Concrete Slabs

1.55 Concrete slabs are used for walks, basement floors, and other construction that rests directly on the ground. Slabs for basement floors are usually poured after the footings and foundations are poured, after plumbers have installed the piping, and after electricians have completed the wiring that enters through the basement. You can erect forms for slabs by staking boards on edge around the perimeter of the slab.

1.56 Because their thickness is small in relation to their length and width, concrete slabs crack rather easily. To reduce the possibility of cracking, always use joints that leave space between a floor slab and a foundation wall to permit the slab to expand. You can insert well-oiled bevel siding between the slab and the wall while pouring. Then, after the slab is set, remove the siding and insert a bituminous padding made of layers of compressed paper impregnated with tar.

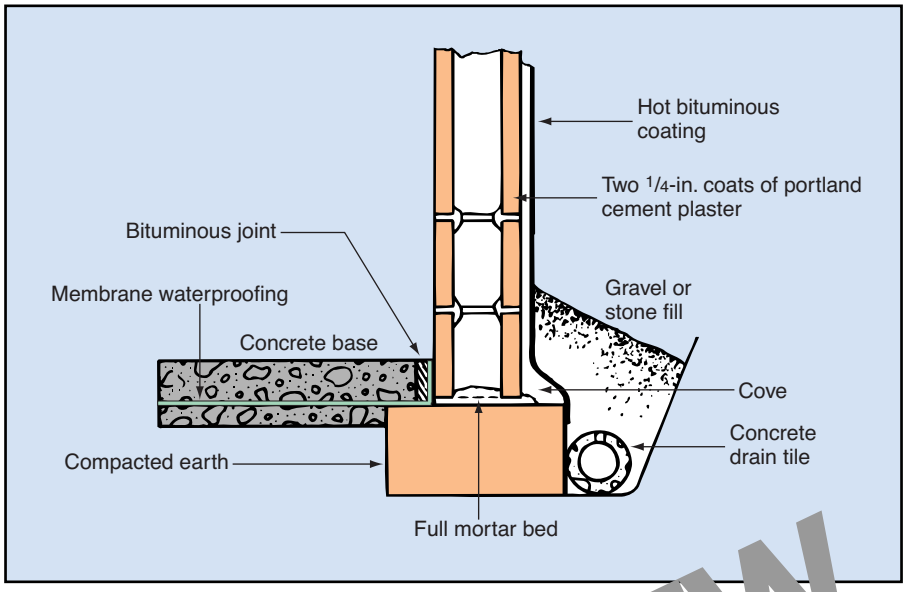
1.57 Any part of a floor slab that will have a load-bearing wall resting on it must have a proper footing beneath it. (This should always be specified in the working drawings.) Slabs should be finished by experienced masons and provided with wire mesh or steel rods for reinforcement. You can screed small slabs using the formwork as a levelling guide. Large slabs are generally levelled with floats, as shown in Fig. 1-16.

Waterproofing Your Concrete

1.58 When the soil is wet, ground moisture tends to seep into concrete. This can cause basements to flood. A lot of moisture can reduce the strength of concrete in basement walls. To guard against seepage, first prepare a bed beneath the slab using a fill of sand and gravel. Then, lay a sheet of plastic film over the fill as a vapor barrier. To guard against seepage through foundation walls, coat them with tar or a similar bituminous material.

1.59 It also helps to place drain tiles around the perimeter of a basement, as shown in Fig. 1-17 on the following page. Backfill the area immediately around the footing with gravel to improve the drainage. Finish the grade around the building so it leads water down a slope, away from the foundation.

Fig. 1-17. Drain tiles for waterproofing concrete wall



Care of Concrete Forms

1.60 After stripping forms from concrete, scrape off the excess concrete from them and wash them with water. Paint the forms that will be reused, or treat them with wood preservatives. Paint helps keep concrete from sticking to the forms. You can reduce your setup time for the next job by sorting and stacking the forms according to size. Keep track of loose pieces like stakes and braces. Handle all items with care, and store them under cover to prevent damage.

1-9. Concrete is a mixture of portland cement, sand, _____, and water.	1-9. GRAVEL Ref: 1.33
1-10. Adding water to a mixture of cement and aggregates starts a chemical process called_____.	1-10. HYDRATION Ref: 1.35
1-11. Do not mix more concrete than you can use in _____ min.	1-11. 30 Ref: 1.39
1-12. To cover waste and loss in small jobs, order _____ more concrete than than you need.	1-12. 10% Ref: 1.42
1-13. For concrete walls higher than 4 ft, you need both tie rods and _____ to reinforce the concrete forms.	1-13. WALES Ref: 1.46
1-14. In areas over windows and doors, concrete must be reinforced with _____ embedded in it.	1-14. STEEL RODS Ref: 1.53, Fig. 1-14
1-15. A part of a floor slab that will have a wall resting on it should have a proper _____ beneath it.	1-15. FOOTING Ref: 1.57
1-16. To prevent seepage of moisture through basement walls, coat them with a material like _____.	1-16. TAR Ref: 1.58

Answer the following questions by marking an "X" in the box next to the best answer.

1-1. When laying out the guidelines for a new building, follow the layout on the

- ☐ a. foundation plan
- ☐ b. site plan
- ☐ c. elevation
- ☐ d. floor plan

1-2. If the short sides of a 3-4-5 triangle are 48 ft and 64 ft, the longest side is

- ☐ a. 100 ft
- ☐ b. 90 ft
- ☐ c. 80 ft
- ☐ d. 75 ft

1-3. Which of the following does the word batterboard refer to?

- ☐ a. Assembly of vertical and horizontal pieces
- ☐ b. A vertical (2×2) stake
- ☐ c. A horizontal (1×6) board
- ☐ d. A stake under the intersection of the lines

1-4. In finishing an excavation, which surfaces must be precisely level?

- ☐ a. Surface of floor slab
- ☐ b. Tops of footings
- ☐ c. Surface of center beam
- ☐ d. Tops of foundation walls

1-5. You can usually find footing details in a sectional view on the

- ☐ a. site plan
- ☐ b. floor plan
- ☐ c. elevation view
- ☐ d. foundation plan

1-6. With what can you coat forms so that poured concrete will not stick to them?

- ☐ a. Asphaltic-based oil
- ☐ b. Lacquer
- ☐ c. Petroleum-based oil
- ☐ d. Shellac

1-7. Concrete becomes pasty, slowly hardens, and finally cures through the process of

- ☐ a. efflorescence
- ☐ b. hydration
- ☐ c. spalling
- ☐ d. evaporation

1-8. You can save time and produce a better finish with concrete forms made of

- ☐ a. plywood
- ☐ b. matched-end planks
- ☐ c. particleboard
- ☐ d. 1 in. boards

1-9. When pouring the last (top) layer of concrete for a foundation wall, you must

- ☐ a. edge the surface with a jointer
- ☐ b. prod and pack it vigorously
- ☐ c. finish it with hand floats
- ☐ d. place the anchor bolts for the sills

1-10. Which of the following operations should be the last one that you perform?

- ☐ a. Pouring the basement floor slab
- ☐ b. Installing piping for plumbing
- ☐ c. Pouring the foundation and footings
- ☐ d. Bringing in the electric wiring

SUMMARY

Very often the carpenter is the tradesman who must coordinate the construction of a building. He must know how to Jay out straight, accurate building lines using a site plan. He must also know how to set up stakes and lines using basic geometric principles and drafting techniques. Knowing how to use a transit level and a builder's level will be helpful in large projects.

The system of stakes and lines provides accurate limits for excavating and dimensions for placing footings and foundations. One of a carpenter's main tasks is building forms that will withstand the enormous pressure of wet concrete. This entails proper support and bracing. A carpenter should also know how to pour concrete so that it is free of voids and pockets that could weaken it.

A carpenter must understand how to form openings in the concrete for windows and doors. He should also be aware of the need to reinforce concrete under certain conditions, and know how to secure reinforcing materials within the formwork. Finally, he should be familiar with the methods of preventing water seepage through concrete.

Answers to Self-Check Quiz

1-1. b. Site plan. Ref: 1.01

1-2. c. 80 ft. Ref: 1.09, Fig. 1-2

1-3. a. Assembly of vertical and horizontal pieces. Ref: 1.14, Fig. 1-4

1-4. b. Tops of footings. Ref: 1.20

1-5. d. Foundation plan. Ref: 1.24

1-6. c. Petroleum-based oil. Ref: 1.32

1-7. b. Hydration. Ref: 1.35

1-8 a. Plywood. Ref: 1.43

1-9. d. Place the anchor bolts for the sills. Ref: 1.49

1-10. a. Pouring the basement floor slab. Ref: 1.55

Contributions from the following sources are appreciated:

Figure 1-3. Realist, Incorporated
Figure 1-16. Portland Cement Association