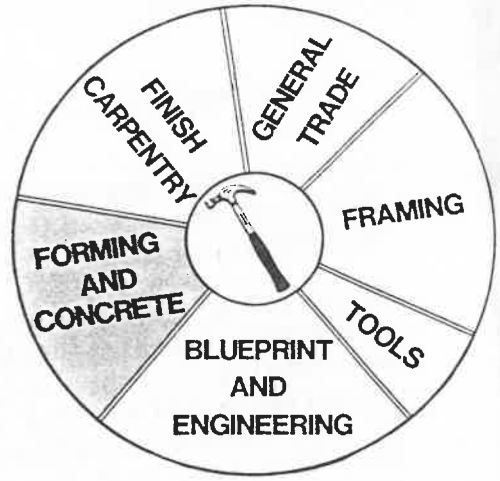
Task Module 10504



FORMING FOUNDATIONS AND FLATWORK

Objectives

Upon completion of this module, the trainee will be able to:

1. Define the basic terminology related to concrete.
2. State the basic concrete handling and small batching methods.
3. List the basic concrete admixtures and their effects on concrete.
4. State the effects on concrete of adding water on the job and segregation.
5. Define the terms related to formwork.
6. Explain how to construct foundation and slab formwork.
7. State how to strip footing forms and lay out the foundation lines on the footings.
8. State how anchor bolts are set in foundations.
9. Construct flatwork (slab-on-grade), footing and low wall formwork.
10. Setup and level a builder's level or transit level.

INTRODUCTION

Before the carpenter can effectively construct the various types of formwork he/she should understand the characteristics of reinforced concrete. This module will introduce the reader to these characteristics. This will be followed with a discussion on the construction of slab, footing and wall foundation formwork; activities which every carpenter will be involved in at some time in his/her professional career.

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INTRODUCTION TO CONCRETE

To understand the principles of form building, one must first comprehend the characteristics of plastic concrete.

After all of the ingredients of concrete are mixed, hydration starts. The concrete remains in a semi-liquid state and is workable and mouldable for a period of time before it hardens. It is in this time span that the concrete must move from its point of origin to the final mold or the place it will remain permanently. It is referred to as plastic concrete while it is in this workable and unhardened state.

The forms must be strong enough to hold the plastic concrete in place until it sets and cures. A form that fails can injure or kill persons working on the job site as well as causing the loss of materials, time in erection and clean up. The reverse of this fact is that one can over build forms beyond sensible safe limits and therefore waste time and materials.

Noted below are some definitions that are used in this module.

1. Ready-mixed concrete: Concrete manufactured for delivery to a purchaser in a plastic or unhardened state.
2. Plastic concrete: Freshly mixed concrete in its unhardened state.
3. Curing: The hardening of concrete over a period of time during which it gradually gains strength. Maintenance of humidity and temperature of freshly placed concrete during some definite period following placing, casting or finishing to assure satisfactory hydration of the cementitious materials and proper hardening of the concrete.
4. Hydration: The chemical reaction between the cement and the water.
5. Cement: A substance made by burning a mixture of clay and limestone; in essence, a mixture of silicates and aluminates of calcium. When burned in a kiln they form clinkers that are ground into a fine powder and are used as an ingredient of mortar and concrete.
6. Concrete: A composite material which consists of a binding medium within which are embedded particles of aggregates. In Portland Cement concrete, the binder is a mixture of Portland Cement and water. When cured, it attains hardness and strength not unlike stone. The terms cement and concrete are not interchangeable. Cement is technically an ingredient of concrete.
7. Aggregate: Any one of several hard materials such as sand, gravel, stone, slag, cinders or other inert materials used for mixing with a cementing material to form concrete.
8. Admixtures: Any materials or chemicals added to a concrete batch before or during mixing other than Portland Cement, water and aggregates.
9. Air-Entraining Agent: An addition or an admixture for concrete or mortar which causes air to be incorporated as minute bubbles in the concrete or mortar during mixing, usually to increase its workability and frost resistance.
10. Slump: A measure of consistency of freshly mixed concrete, mortar or stucco. A slump cone is used for this test. Upon pouring fresh mix into the cone, immediate removal of the cone should produce a pre-determined amount of slump measured in inches. Refer to Figure 1.

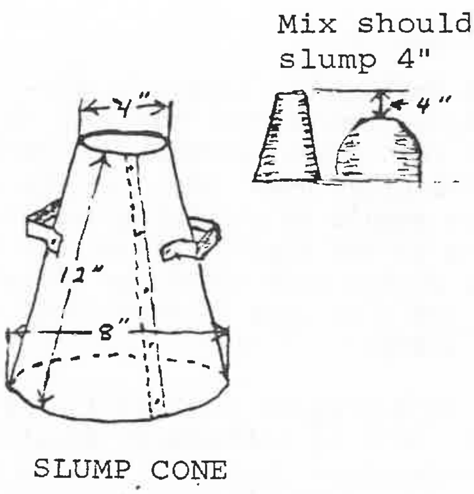


Figure 1

11. Slump Cone: A mold in the shape of a truncated cone with a base diameter of eight inches, top diameter of four inches and height of twelve inches; used to fabricate a specimen of freshly mixed concrete for the slump test. See Figure 1.

12. Honey combing: Concrete that is poorly mixed and vibrated creating voids or open spaces which are caused by incomplete filling of the form.

Concrete Ingredients

The ingredients which makeup concrete are as follows:

1. Portland Cement
2. Potable Water
3. Fine and Coarse Aggregate
4. Admixtures (optional)

As water is mixed with the cement, it forms a paste which coats the aggregates. The chemical reaction known as hydration begins and causes the concrete to cure and harden. The concrete must be kept wet and protected from freezing temperarures in order for it to cure properly. Although concrete hardens in a few hours, it is called "green" until its safe load carrying capacity is reached. Most concrete reaches this point 28 days after it has been placed. At this point it is considered cured concrete.

The aggregates used in concrete must be clean, free of loam, clay and vegetable matter. They should be hard, sound and not easily worn away or flaky. Foreign materials prevent the cement paste from properly coating the aggregate, thus affecting the quality of the concrete.

The mixing water should be clean, free of oil, alkali and acids. In essence if the water is drinkable it can be used in the concrete.

Air-entraining admixtures are used to improve the durability of the concrete that will be exposed to moisture during freezing and thawing cycles. Concrete resists surface scaling caused by ice removal agents if air-entraining is used. Frest concrete workability is also significantly improved and segregation and bleeding are reduced or stopped by using admixtures.

Water reducing admixtures reduce the quantity of water required to produce concrte of a given consistency. These admixtures increase the slump of the concrete with less water content. An increase in strength is generally gained if the water content for a given mix is reduced and slump is kept the same. This process, however, will probably create an increase in drying shrinkage.

Some water reducing admixtures also retard the settling time while others may entrain air in the concrete.

Retarding admixtures are used to slow down the curing time of concrete. High temperature of wet concrete can cause it to harden too fast, thus affecting its strength and making it difficult to place and finish. During hot weather or when placement is going to be difficult, retarders are often used to reduce the setting time of concrete.

Sometimes the water or aggregates are pre-cooled since the retarders will not lower the initial temperature of the concrete.

The disadvantage of retarders is the reduction of strength in the concrete for as much as three or four days. Its effect on shrinkage can also be unpredictable. To be sure of the results, it is best to test retarders under actual job conditions.

Accelerating admixtures spped up the strength gain and setting time of concrete. At the same time they can also increase the drying shrinkage. Calcium chloride is most commonly used for this process. However, it should not be used in concrete that will be in contact with alkali or sulfates, pre-stressed concrete, galvanized steel or in concrete which contains embedded aluminum.

Ready-Mix Concrete

Most construction jobs use ready-mixed concrete that is transported to the job site in specially designed trucks from a central batch plant. The trucks have a capacity of several cubic yards of concrete which is rotated in the drum of the truck until delivery is made. Timing is of utmost importance. Delays should not be allowed. If prolonged delays occur, the final strength of the concrete can be severely decreased since hydration starts immediately upon mixing together the ingredients of the concrete.

Job Site Mixing

Often on small jobs, ready-mix concrete may be impractical for some reason. In such cases, portable mechanical mixers are often used. The capacity of the mixer should be carefully measured according to the specifications for the job. The mixing time should be closely watched and also done in accordance with the job specs.

The coarse aggregate is added to the mixer first. This is followed by about one-half of the water. Next the drum is started in motion. Gradually add the required amounts of sand and cement along with the remainder of the water. The mixing time starts when all the solid ingredients are in the drum. A good rule of thumb to follow relative to the total time of mixing is to allow three to four minutes for the first cubic yard with 15 seconds additional time for each additional cubic yard in the same mix. After the mixing time has elapsed, the mixture should be tested for stiffness or slump. If it is too stiff for workability, more water may be added up to the maximum amount allowed in the specification. The specified amount of water should not be exceeded since it is critical to the strength of the hardened concrete. If the mix is still too stiff to be workable, check the specification to see what chemical admixtures can be used to overcome the problem.

Hand Mixing

Sometimes it is impractical to employ the use of a portable mixer and a small batch of concrete may have to be mixed by hand. In this case a shovel and hoe will be used to mix the concrete by hand.

The cement and aggregate are thoroughly mixed on a clean, dry waterproof surface. The dry mixture is placed into a pile and a depression is made in the middle where water is added gradually. The mixture is turned with the shovel or hoe. The mixing should be continued until all the ingredients are thoroughly homogenized and the aggregate is completely coated with paste and ready for use.

Dangers of Adding Too Much Water

There will be times when one will be tempted to add more water to the concrete batch to make it more workable or prolong its workability. Adding water changes the properties of the design and too much will result in weak concrete. Also it will cause water gain on the surface which causes a weak nondurable surface called laitence. Furthermore, too much water also impairs the water tightness of the concrete.

Methods of Placing Concrete

The following things can happen to concrete if it is not handled and placed properly:

1. Honeycombing

2. Cement paste tends to flow ahead of the coarser aggregate materials causing possible segrgation.

3. Water bleeding to the top surface which can cause defective concrete.

To properly place concrete in flatwork, it is best to start around the perimeter at one end and place each batch against the previously placed batches. Do not make piles and then attempt to level or work it out over long distances. This could cause all three of the above mentioned conditions.

Transporting the concrete from the mixer to the forms should be conducted in the shortest possible distance. If a wheelbarrow or buggy must be used for transferral, a roadway of planks or plywood should be used to make it as smooth as possible, thus avoiding segregation before the concrete ever reaches the forms. If other methods are used to place the concrete, such as pumps or bucket and crane, remember to avoid segregation of the concrete ingredients.

LETS TALK SAFETY

1. Concrete has ingredients that may be harmful to the skin or eyes. Wear protective clothing such as gloves, rubber boots and goggles. Concrete ingredients can cause poisoning, rashes or infections. Make sure that the gloves and boots are without holes and in good condition. If concrte comes in contact with the skin, rinse with water and then use a lanolin fortified cream style hand cleaner and thoroughly clean the contacted area.

2. Be alert and aware of trucks backing into position and equipment, such as overhead buckets, delivering concrete to the forms.

3. Never insert hands, shovels or hoes into rotating mixers.

4. Watch the forms closely for weakening joints or braces under severe strain. Exercise caution in the use of vibrators, slumping devices or tamping tools since this equipment can exert added stresses on the forms.

5. Be aware and observant of the people working with you and around you.

6. Be on guard for electrical shock caused by broken or frayed electrical cords. Do not let wheelbarrows or buggies run over the cords. Make sure cords are outdoor, grounded types suitable for construction activities. The hazard of electrical shock is greatly increased with the presence of water, rough forms and rebar.

FORMWORK

As an introduction to formwork, one must address themselves to the shape and dimensions of the finished concrete specified on the working drawings. This is rather simple when the building is square or rectangular in shape and the grade is level or nearly level. However, formwork is hardly ever that simple except in the case of a sidewalk or driveway.

The carpenter has to be able to build forms of irregular shape such as for offsets or stepped foundations, footings, pilasters, fireplaces, doorways and concrete stairs. All require the knowledge of form building.

Forms must be accurately placed to provide proper footings and foundations for whatever they are to support, whether it be walls, columns, an air conditioner or a hot water tank. They must be built tight enough so the liquid concrete does not leak out between the forms and of material that will leave the desired appearance when the forms are removed. This is especially important if the finished work is to be exposed.

Forms must be built strong enough to withstand the stresses that wet concrete places upon them. Occasionally the forms are left in place long after the required hydration curing time to help support construction activities that may be going on. This serves to protect edges from chipping and crushing.

Parts of Flatwork Forms

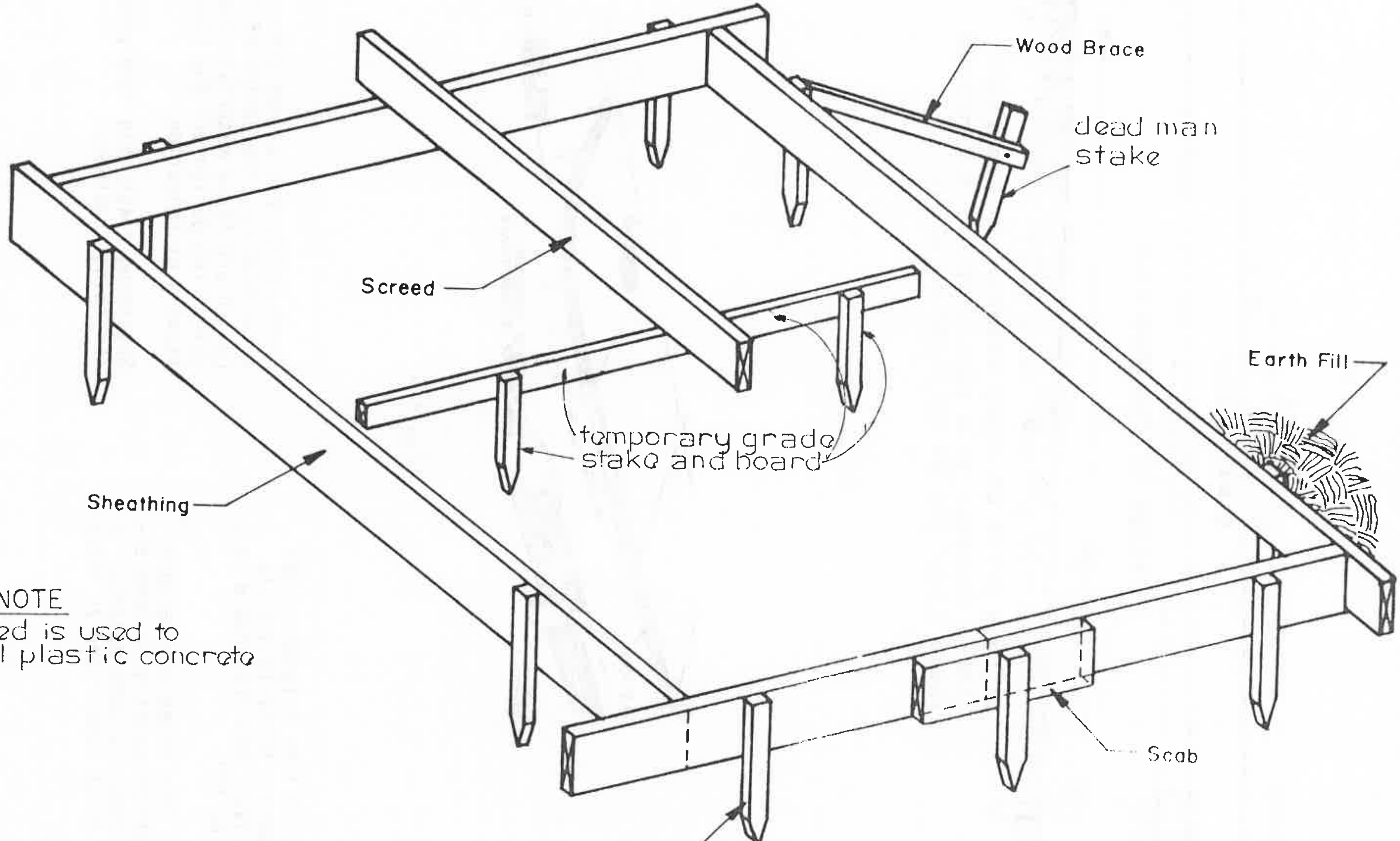
Parts of this type formwork are shown in Figure 2. There are stakes, sheathing on four sides, sheathing scabs, braces and screeds. Parts that are associated with flatwork forming are grade boards, grade stakes and screeds.

The form must provide a surface to which the concrete may be finished. In most instances, the top edge of the form is used to accomplish this. There are occasions when the concrete is poured to a line which may be a strip of wood mailed to the form. This is done when the form material extends above the finished depth of the concrete. In this case, a mark is made to indicate the finished level.

Not all flatwork is perfectly flat and often does not have straight edges. Some concrete work requires a slight slope or even a steep slope, as shown in Figure 3. This is typical for driveways or patios needing drainage.

Edges can also be curved or odd shaped as shown in Figure 4.

Stakes are usually made from 1"x2", 1"x4", 2"x2" or 2"x4" lumber that has been cut to length and pointed at one end. Lengths depend upon the height of the form and condition of the earth.



NOTE
screed is used to
level plastic concrete

Figure 2

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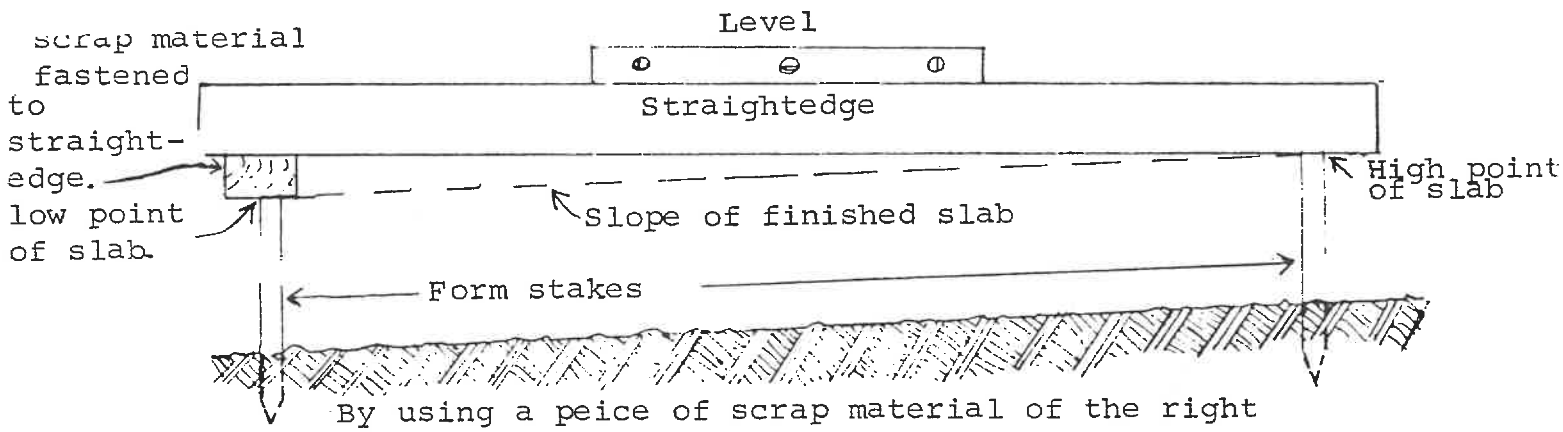


By using a peice of scrap material of the right thickness fasteted to a straightedge, a conistant drainage slope can be obtained as shown

Figure 3

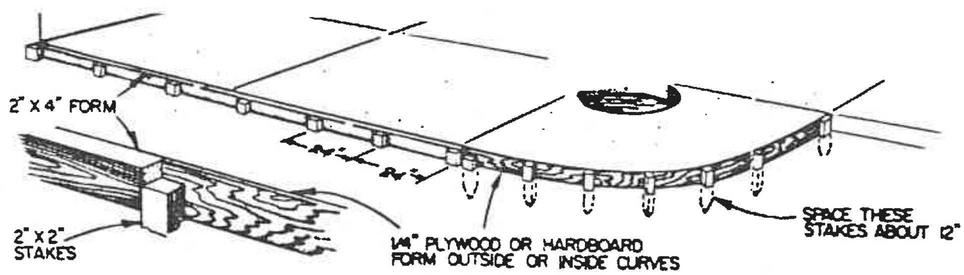


Figure 4

Soft earth will take a longer stake than solid earth. Normally a stake should be driven into the ground to a depth of 8" or 10".

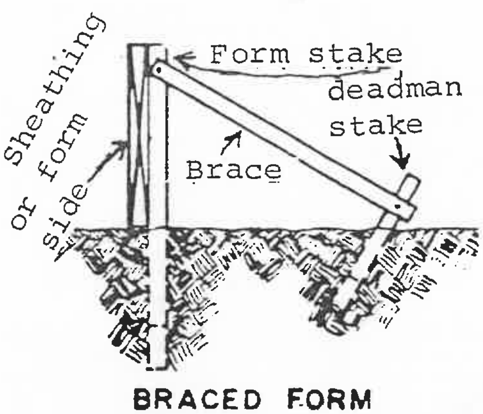
Sheathing or form sides may be made from a variety of materials. Some examples of frequently used material is plywood, 1" thick lumber and 2" thick lumber.

Forms can be built from other materials also. However, the design of the finished job and those materials that can achieve the design are the important factors of selection.

Sheathing scabs hold long pieces of sheathing together.

Braces hold the form in place while the concrete is placed and worked. Two types of bracing are shown in Figure 5.

Wood braces are made of 1"x2"'s, 1"x4"'s, 2"x2"'s and 2"x4"'s and may be made by even larger sizes of lumber depending upon the desired strength of the bracing. A stake, sometimes called a dead man, is driven some distance from the form and the brace is nailed to the stake after the form has been aligned to its proper place. Refer to Figure 5.



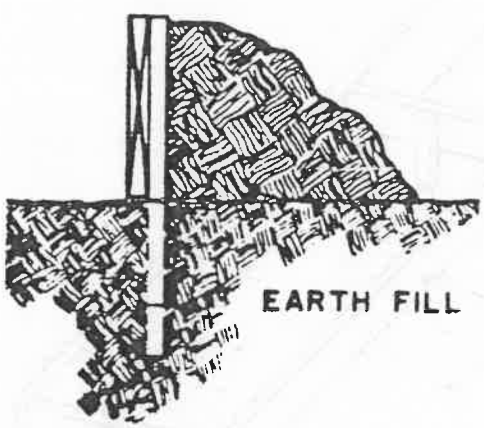


Figure 5

Earth fill is sometimes used on small forms or wher a lot of stress is not present. It's a quick way to brace small forms as shown in Figure 5.

After the area has been rough graded, corner stakes are driven and marked at the finished height of the project. A line is stretched between the corner stakes at the marked height and intermediate stakes are driven along the line. See Figure 6.

The sheathing is then nailed to the stakes, the corners fastened and the form sides braced. The tops of the stakes should not protrude above the form sides of the temporary grade board. Protruding stakes could cause interference while working on conrete placed into the form.

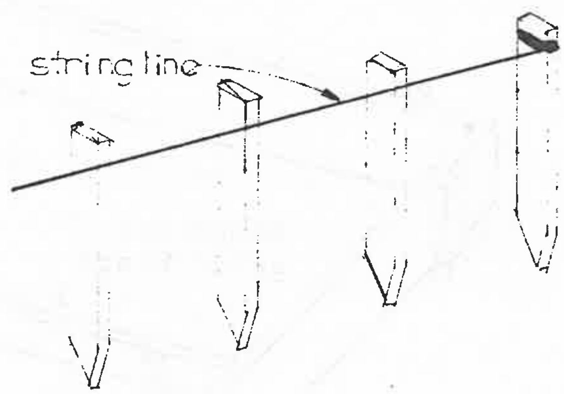


Figure 6

Next a screed is needed to provide a method of grading the wet concrete to a given level within the form. This tool is nothing more than a length of lumber or pipe. Refer to Figure 7.

Screeds are moved back and forth across sides to level concrete to the grade, as is illustrated in Figure 8.

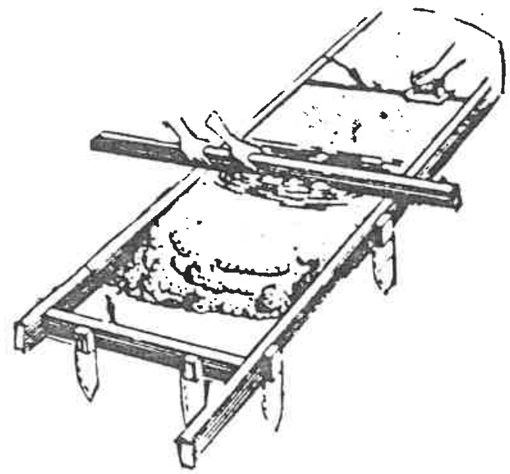


Figure 8

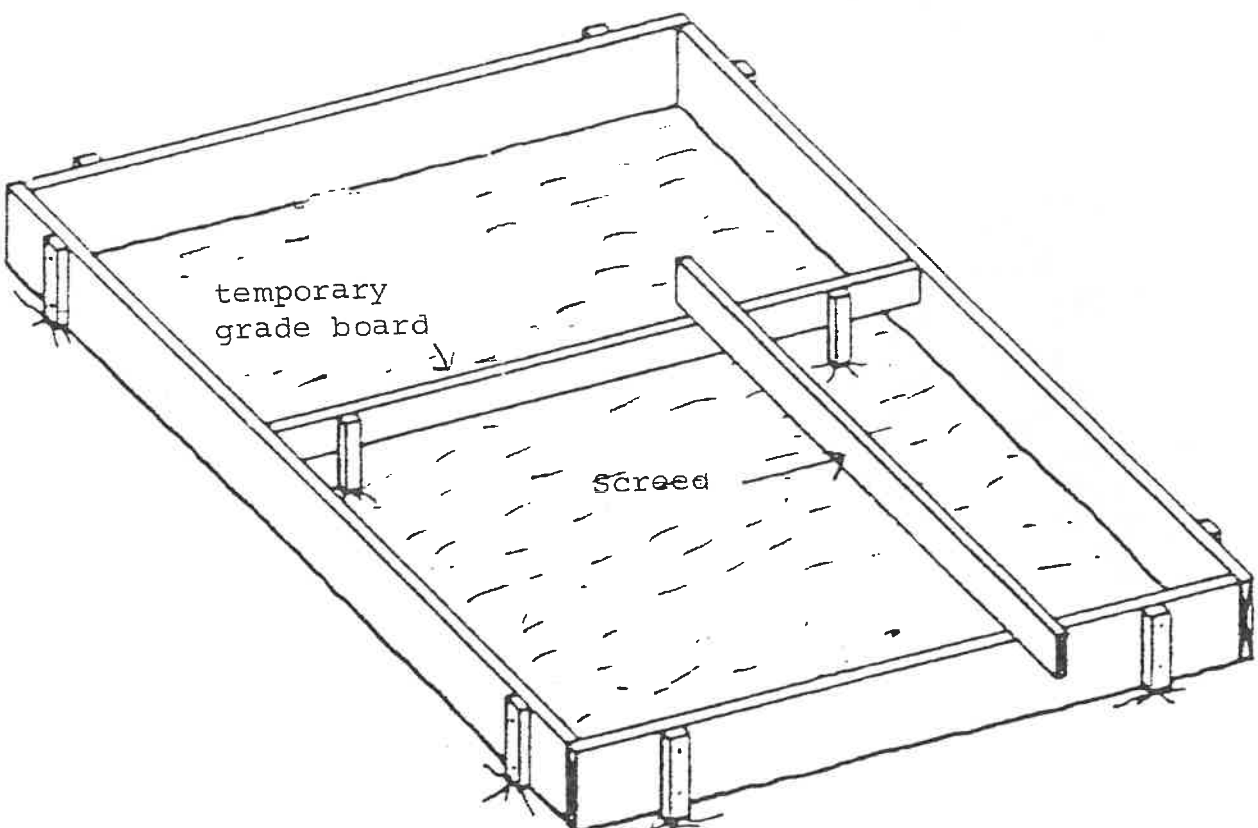


Figure 7

Foundation Formwork Systems

One of the primary concerns in construction is to prevent the settling of buildings. Uneven settling can cause cracks in finished walls and ceilings, tilted floors with the binding of doors and windows, etc. If settling is severe enough it can cause total failure and collapse of a building. The foundation is that part of a building's sub-structure that resists settling.

Footings: these are usually wider than foundation walls because they provide the extra support that stops uneven settling. They are required to transfer the building loads to the ground. These footings are usually made from concrete. They are classified as being either plain, reinforced, continuous, stepped or isolated. Plain footings are designed to carry light loads and are not reinforced with steel. They can be continuous (Figure 9), stepped (Figure 10) or isolated (Figure 11).

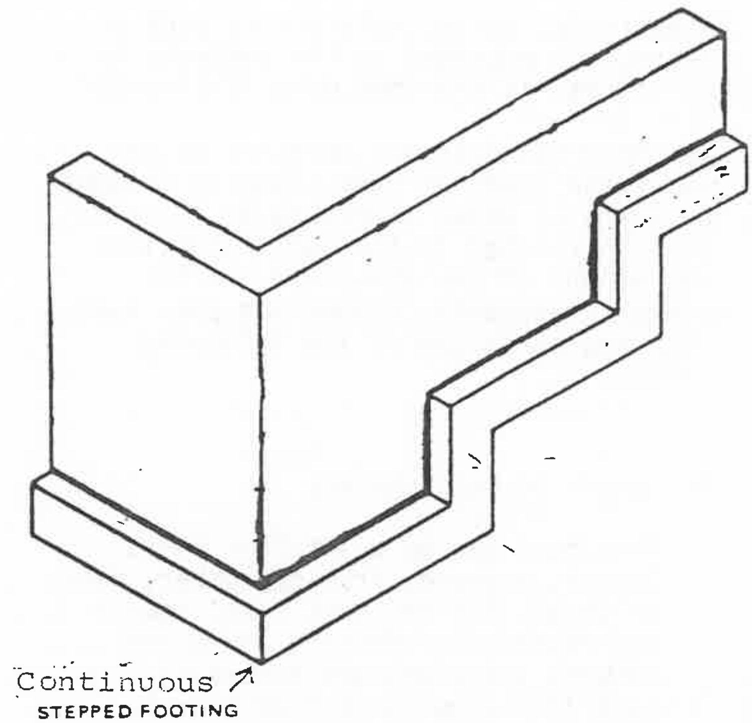


Figure 10

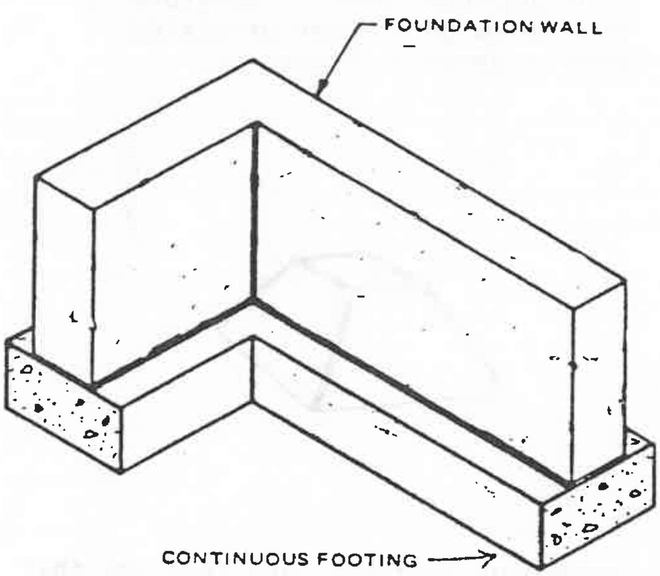


Figure 9

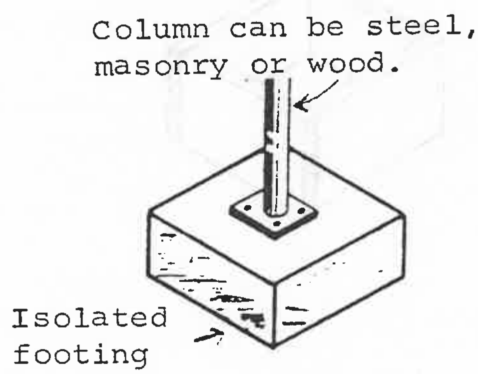


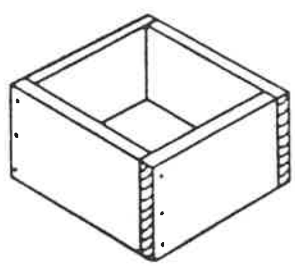
Figure 11

Steel rods, called reinforcing bars or rebar, are embedded in the concrete to reinforce it and thus make it stronger.

Isolated footings are designed to receive the loads of free standing columns or piers as shown in Figure 11. Footing size is related to the soil conditions and weight of the structure and the loads it supports. Column and pier footings may be in one of the following shapes.

A. Square or Rectangular:

This type can be built from board lumber, plywood, framing lumber, fiber or steel. For the most part, square and rectangular footing forms for columns and piers are generally made from plywood or 1 or 2 inch thick lumber. The form is constructed in such a way that it can be easily removed after the concrete is cured and then can be reset for another pier footing.

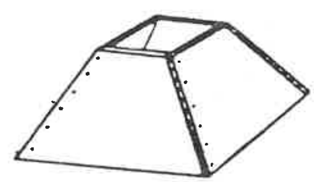


B. Round:

Round forms are generally manufactured as patented steel forms or fiber tube forms and cut to length on location. Steel forms can be used over and over again, where fiber forms are only usuable once. Both types are set to grade height and staked.

C. Truncated Pyramid or Battered Column Footing.

These forms are made of the same type of material as a square or rectangular forms using the same principles. The angles involved should be specified in the working drawings. When the concrete is placed in a form of this shape, it exerts pressure that tends to push the form upward. Therefore it must be weighted down or staked down as shown in Figure 12.



Continuous Footings: are footings that support walls. The walls they support are generally poured concrete or concrete block. Only poured walls will be covered in this module.

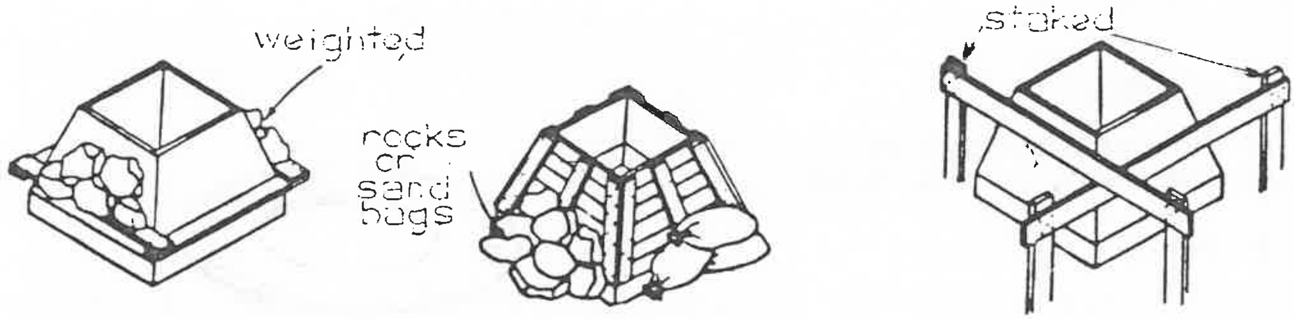


Figure 12

Continuous footings can be formed on the ground, in the ground or partially in and out of the ground. The method used depends on the soil conditions and the specifications defined on the working drawings. With in-the-ground footings, a trench is dug very carefully and the earth acts as the sides of the form. The form can be dug with a machine called a trencher or by hand. An in-the-ground footing form is most often used when the foundation footing is low and the frost line is close to grade or ground level. After the trench is dug, a dry line is stretched along each side of the trench at the grade elevation level, as described on the working drawings. Nails can then be pushed into the sides of the trench every 16 to 18 inches at the line level leaving a portion of the nail exposed. The dry line is then removed and the concrete is placed in the trench to the level of the nails as shown in Figure 13.

For forming footings on the top of the ground and partially in and out of the ground, the forming materials may differ but the procedures for forming are identical. The tools required are a leveling instrument and rod, carpenter's level, saw, hammer, sledge hammer and folding rule or tape.

The top elevations of wall footing forms are set to grade from an established bench mark.

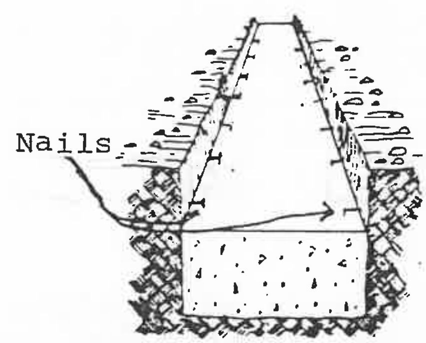


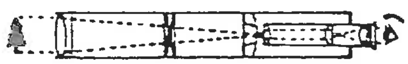
Figure 13

LAYOUT OF FOOTINGS

Leveling Instrument

There are three main parts to any surveying instrument, as noted below.

1. The Telescope:

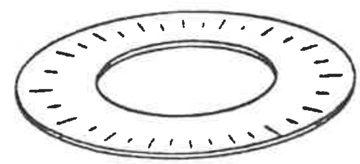


The telescope is a precision made optical sighting device with a set of carefully ground and polished lenses that produce a cleat, sharp magnified image. The magnification of a telescope is described as its power. An 18 power telescope will make a distant object appear 18 times closer than when viewed with the naked eye. Crosshairs in the telescope permit the object sighted on to be centered exactly in the field of vision.

2. The Leveling Vial:

The vivals also called the bubbles work just like the carpenter's level but is much more sensitive and accurate. Four leveling screws on the instrument (some have only three) base permit the user to center (level) the vial bubble perfectly and thus establish a level line of sight through the telescope. This is a vital first step in using the instrument. Instrument vials are available in various degrees of sensitivity. In general, the more sensitive the vial, the more precise the results that may be obtained.

3. The Circle:



The circle is a perfectly flat plate upon which the telescope rotates. It is marked in degrees and can be rotated in any horizontal direction. With the use of an index pointer, any horizontal angle can be quickly measured.

Most instruments also have a vernier scale which is an additional scale which subdivides each degree into minutes for added accuracy in precise construction or when sighting over a long distanc is necessary. There are 60 minutes in each degree and 360 degrees in a complete circle. One can furthermore divide a minute into 60 seconds.

There are two basic types of surveying instruments:

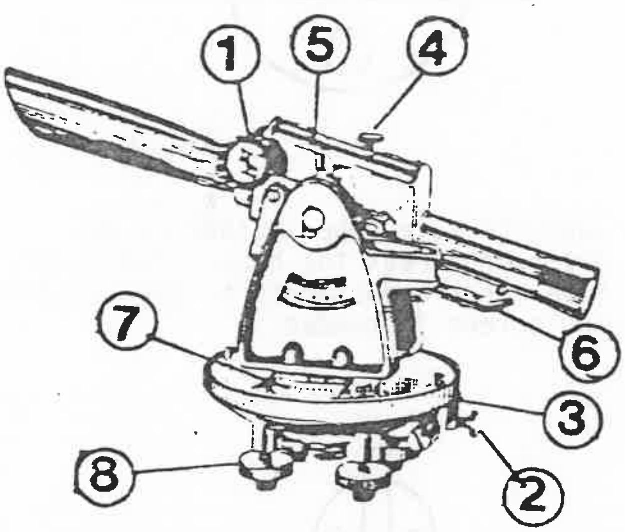
1. The level: this type of instrument has a telescope in a fixed horizontal position. But it can be moved sideways 360 degrees to measure horizontal angles.

2. The level transit or builder's level: is a combination instrument. The telescope is able to move up and down 45 degrees as well as from side to side 360 degrees. It can measure vertical as well as horizontal angles.

   A lock lever or levers permits the telescope to be securely locked in a true level position for use as a level. A full transit instrument, in addition to the above features, has a telescope that can rotate 360 degrees vertically.

Since the builder's level or level transit is more popular, we will discuss this particular instrument.

Noted below are the most important components one will need to know to properly use the instrument.



1. Focusing Knob: used to adjust clarity and brightness of object image.

2. Horizontal Clamp Screw: used to control horizontal telescope movement.

3. Horizontal Tangent Screw: permits very precise telescope movement.

4. Vertical Tangent Screw: permits very precise vertical telescope movement when the clamp screw is tightened.

5. Vertical Index Pointer: used for determining and reading vertical angles.

6. Lock Lever: in the open position it permits the telescope to be plunged or elevated. When engaged, it locks the telescope in a true level position for use as a level.

7. Horizontal Index Pointer: used for determining and reading horizontal angles. In some instruments, the index pointer is combined with the vernier scale.

8. Leveling Screws: used for leveling the instrument prior to use.

<u>Setting Up The Instrument</u>

Each of the following steps is important in preparing to use the instrument.

1. It is important that the tripod is set up firmly. Make sure that the tripod points are well into the ground. On paved surfaces, be sure the points hold securely. The legs of the tripod should have about a 3½ foot spread. The tripod should be positioned so that the top of it appears level. If using a tripod with adjustable legs, be sure the leg clamp wing nuts are securely hand tightened.

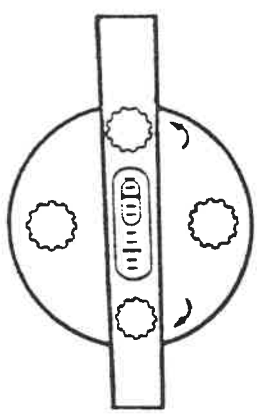
2. Open the container and remove the instrument. Don't pick up the instrument by the telescope. Pick it up by grasping the base.

3. Attach the instrument to the tripod by hand tightening the instrument base to the tripod head. If setting up over a point, attach a plumb bob and move the tripod and instrument over the point. Be sure the tripod is set up firmly again as described in step 2 above. Loosen the leveling screws and shift the instrument laterally until the plumb bob is directly over the point.

4. Turn down the leveling screws until firm contact is made with the base of the instrument. Be careful not to over tighten the leveling crews. The base of the screws should sit firmly on the base of the instrument.

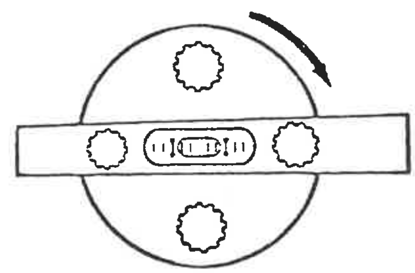
5. Next level the instrument so the vial bubble remains centered through a 360 degree rotation of the telescope. This is the most important operation in preparing to use the instrument. When leveling the instrument, be sure not to touch the tripod.

6. Line up the telescope so that it is directly over a pair of leveling screws. Grasp these two leveling screws with the thumb and forefinger of each hand. Turn both screws at the same time by moving the thumbs toward each other or away from each other until the bubble is centered.

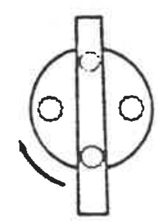


7. When the bubble is centered, rotate the telescope 90 degrees over the second pair of leveling screws and repeat the thumbs-in, thumbs-out leveling procedure until the bubble is again centered.

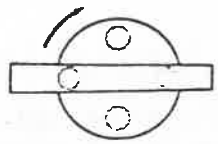
8. Move the telescope another 90 degrees so that the telescope is completely reversed from the first leveling step. Check the bubble for level. Make any minor adjustments in the leveling screws if needed.



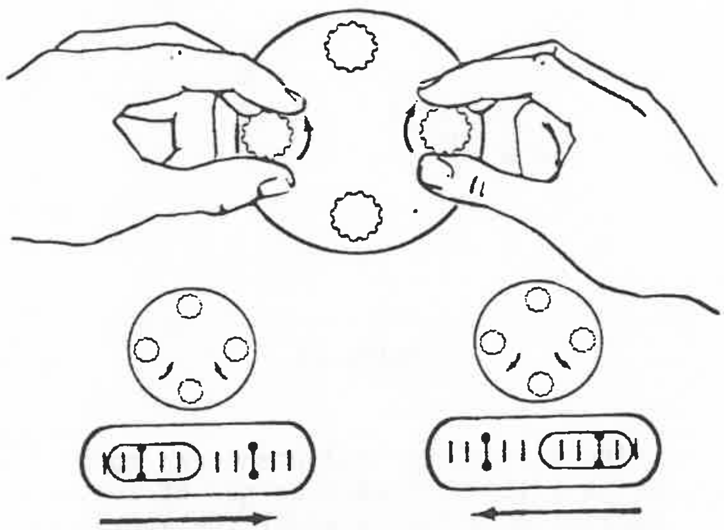
9. Turn the telescope another 90 degrees and check the bubble for level. Make minor adjustments to the leveling screws if needed.



10. Return the telescope to the original position. At this point, the instrument should be level. In order to insure the level of the instrument, turn the telescope 360 degrees while watching the bubble. The bubble should remain level. If for some reason the bubble doesn't stay level, repeat the leveling steps above.



The golden rule for simple leveling is thumbs-in, thumbs-out. Turn both screws equally and simultaneously. Keep in mind that the direction of the left thumb will be the same direction the bubble will move.



Care And Handling of Instrument

The following rules should be followed to insure a long life time for the delicate piece of equipment.

1. Keep the instrument clean and free of dust and dirt. Clean the objective and eyepiece lenses using a soft brush or lens tissue. Rubbing with a cloth may scratch the lens coating and impair the view.
2. If the instrument is wet, dry it before you return it to its case.
3. When the instrument is not being used put the lens cap over the lens and keep the instrument in its carrying case.
4. When moving the instrument over a long distance by foot or vechicle, remove it from the tripod and place it in its protective case.
5. When moving a tripod-mounted instrument, handle it with care. Carry only in an upright position. Do not carry an instrument over your shoulder or in a horizontal position. Improper handling may result in instrument damage.
6. Handle the instrument itself by its base from the case.
7. Never use force on any part of the instrument. All moving parts will turn freely and easily by hand.
8. All precision instruments should be cleaned, oiled, checked and adjusted only by a qualified person, at least once each year.

Definition of Surveying Terms

Power - The magnification of a telescope. An 18 power telescope will make a distant object appear 18 times closer than when viewed with the naked eye.

Vernier - A graduated scale that subdivides each degree division of the circle into equal parts for more precise measurements of horizontal and/ or vertical angles.

Horizontal Circle - A flat plate upon which the telescope rotates, containing a scale for measuring angles. It is usually graduated to degrees and arranged in 4 segments of 90 degrees each.

Degree - A unit of measurement. There are 360 degrees in the circumference of a circle.

Minute - A subdivision of a degree. There are 60 minutes in each degree.

Second - A subdivision of a minute. There are 60 seconds in a single minute.

Spirit Level Deviation - Fluctuations in the length of the level vial bubble caused by temperature changes. The lower the temperature, the longer the bubble. Most level vials contain alcohol or ether to prevent freezing.

Horizontal Clamp Screw - A screw mechanism that is used to control the movement of the telescope in a fixed horizontal position.

Vertical Clamp Screw - A screw mechanism that is used to firmly hold the telescope at a certain vertical angle when used as a transit.

Tangent Clamp Screw - A screw mechanism used in conjunction with the clamp screws that permits very fine and smooth movement of the telescope to center exactly upon any target or point.

Tangent - A straight line or a curve that touches another curve at only one point but does not cut it or cross it.

Vertical Arc - A vertical scale on the level transit instrument, divided into degrees and used to determine both upward and downward angles.

Lock Levers - A mechanical device on the level transit instrument that quickly and surely locks the telescope in a true level position for use as a level.

Full Transit - An instrument with a telescope that is able to revolve a full 360 degrees so that it is possible to take a opposite reading without disturbing the horizontal readings.

Procedure For Layout of Foundations.

Batter boards are located and erected around the outside perimeter of the footing areas for the building. A dry line is then stretched on the batter boards outlining the outside edges of the foundation walls of the building. Refer to Figure 14.

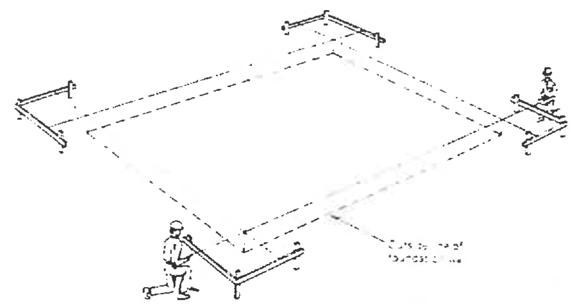


Figure 14

Using a leveling instrument and rod, drive a stake in each corner of the excavation directly under the apex where the two dry lines cross down to about ½" above the finish level of the footing elevation. Do a plumb bob line as illustrated in Figure 15 to the top of the stake. Mark the top of the stake with a pencil at this exact point. Remove the plumb bob and drive a finish nail in the stake at the mark. This locates the exact corner of the foundation wall (not the footing).

After driving the nail, check the elevation height of the stake and finish driving the stake to final elevation, as shown in Figure 16. Repeat this procedure for each corner.

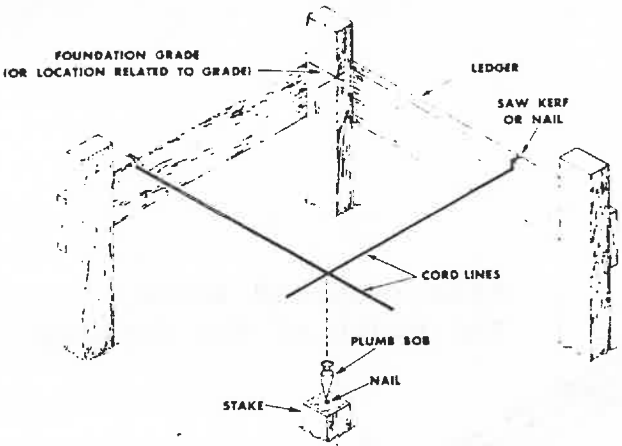


Figure 15

After this is accomplished, two important factors have been established:

1. The top grade of the footing elevation.

2. The exact locations of the corners of the foundation walls but not the footing.

Constructing Footing Forms

Next, erect the outside footing forms so that the inside of the form boards are the correct distance from the foundation wall lines and level with the top of the grade stake, Line "A" as shown in Figure 17.

Brace the stakes with diagonal braces and a dead man stake as shown in Figure 18.

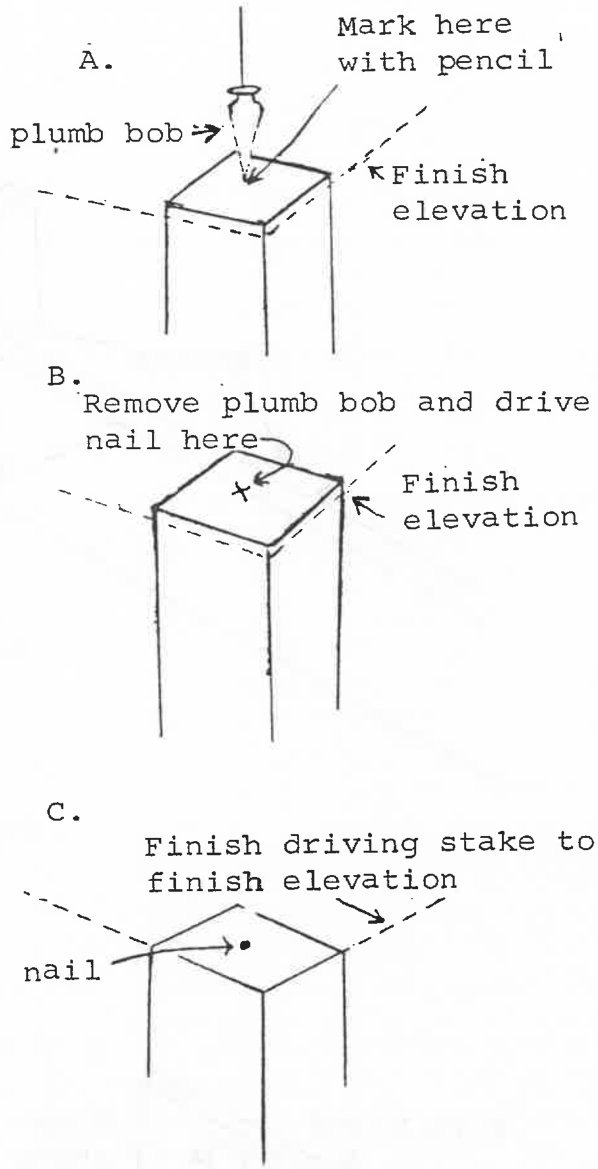


Figure 16

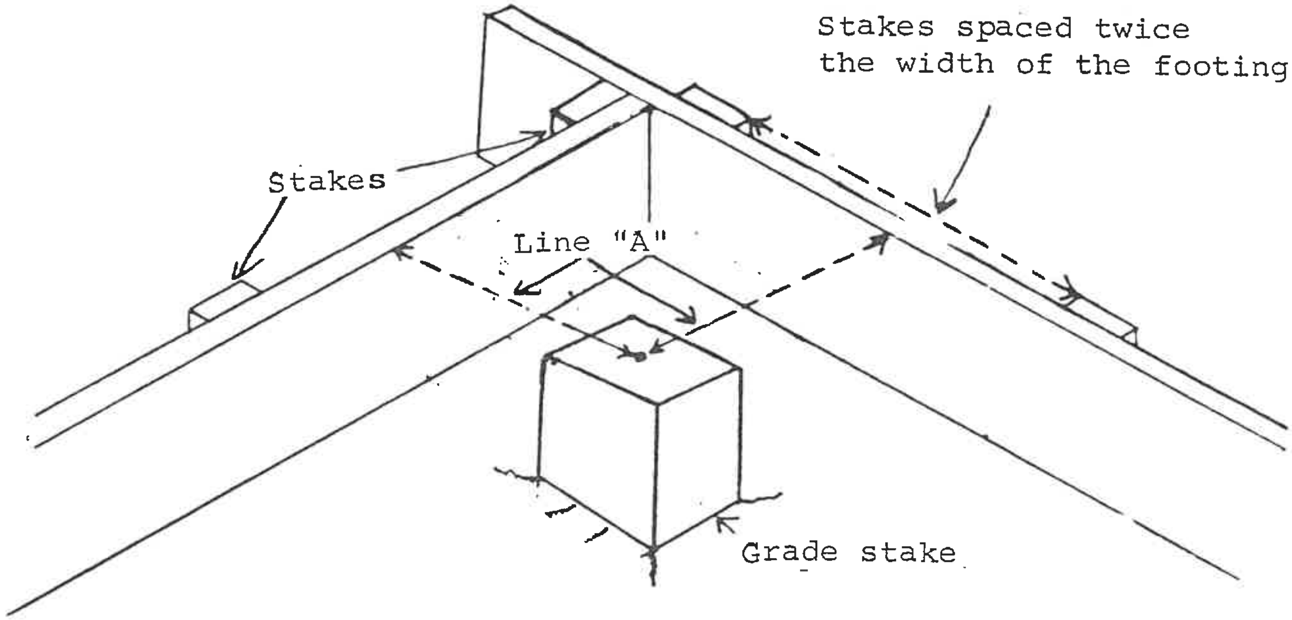


Figure 17

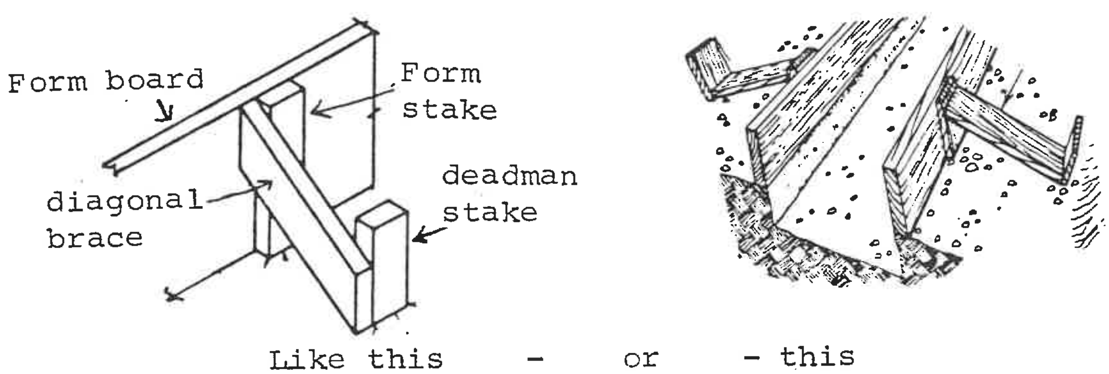


Figure 18

Cut some spreaders the exact width of the footing and erect the inside form reversing the procedure used used on the outside form. Using a carpenter's level make sure the inside and outside form boards are level with each other and with the top of the grade stakes. The spreaders help line up the inside form at the bottom so the stakes and formboards are correctly placed. As the concrete is placed in the form, the spreaders are removed. Do not nail the spreaders to the forms. If steel rebar is used the spreaders will be temporarily removed and replaced on top of the steel after it is in place.

The top of the form should have form ties which can be cut from 1"x2" material or whatever is available and fastened preferably with duplex nails. The form ties will hold the side boards of the form plumb while the concrete is being placed. Also the keyform can be nailed to the bottom side of the form ties, thus forming the keyway for poured walls. The keyway should be centered in the form. Refer to Figure 19.

After all carpentry work has been performed and all steel is in place, check the elevations of the forms with the transit level one more time and make any corrections or adjustments that are needed. When everything has been checked satisfactorily, remove the initial grade stakes from the corners of the forms. The concrete is now ready to be placed.

In summary:

1. Locate and erect batterboards.

2. Stretch drylines on the batterboards outlining the outside edge of the foundation wall.

3. Locate grade stake in each corner.

4. Drop plumb line locating exact corner on the grade stake of the foundation wall.

5. Check top of grade stake with a leveling instrument and rod for correct elevation of grade stake.

6. Erect outside footing form the correct distance from the foundation wall lines and level with top of grade stakes.

7. Plumb the outside footing form brace with diagonal braces and nail off to dead man stakes.

8. Cut spreaders exact width of footing form and erect inside of form. Do not nail in place.

9. Level inside and outside form boards with top of grade stakes.

10. Cut and place form ties.

11. Cut and place keyform.

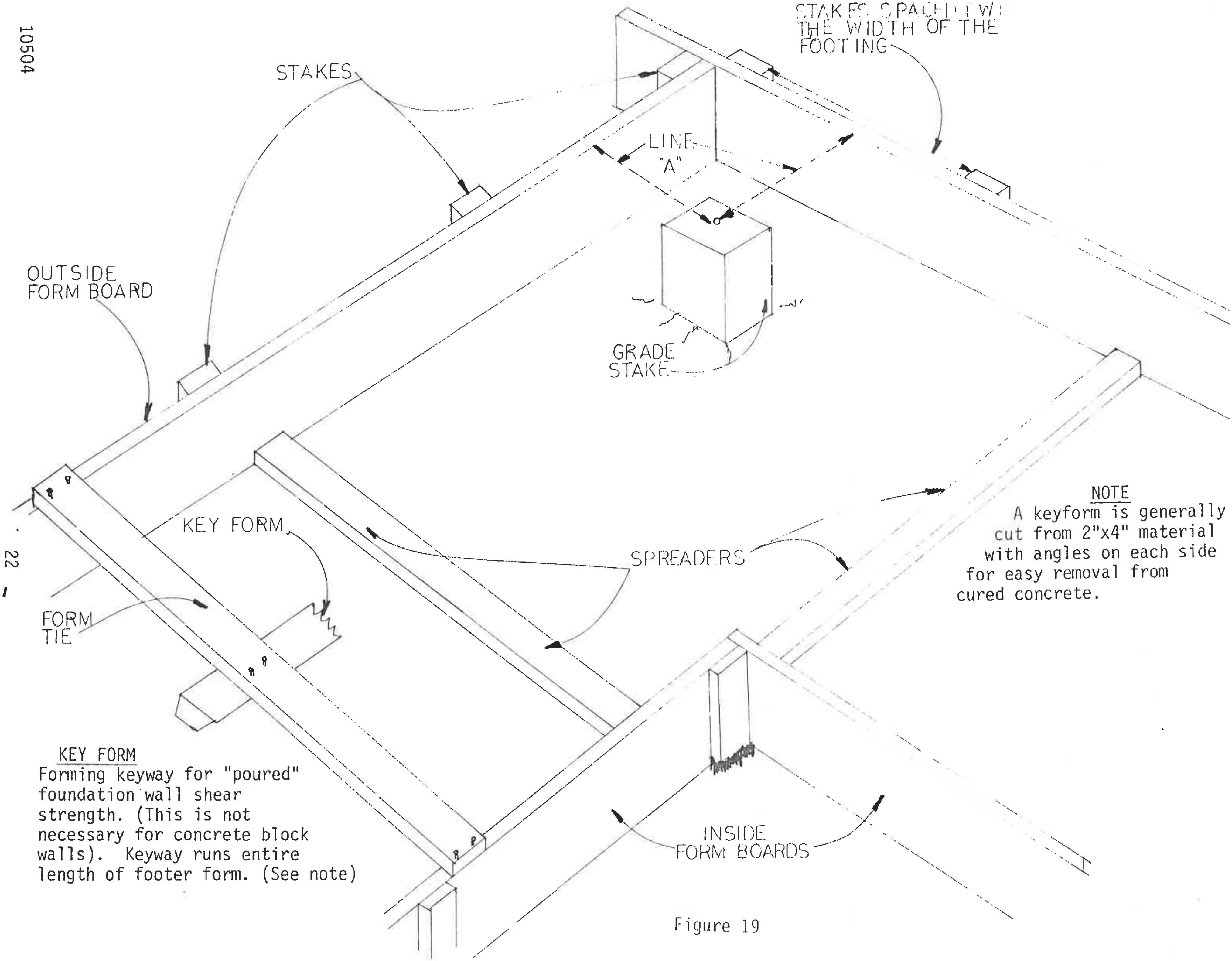
12. Check final grade of forms prior to placing the concrete.

13. Remove grade stakes from the corners.

14. Place the concrete.

<u>Definitions</u>

1. Batter Boards - Pairs of horizontal boards nailed to wood stakes adjoining an excavation and used as a guide to elevations and to outline the building.



NOTE

A keyform is generally cut from 2"x4" material with angles on each side for easy removal from cured concrete.

KEY FORM

Forming keyway for "poured" foundation wall shear strength. (This is not necessary for concrete block walls). Keyway runs entire length of footer form. (See note)

Figure 19

2. Bench Mark - A point of known or assumed elevation used as a reference in determining and recording other elevations in topographical surveys. It is sometimes referred to as Datum Point.

3. Column - A supporting pillar.

4. Finish Concrete - The final grade of concrete after curing is complete and forms are removed.

5. Footings - (1) A foundation for a column; (2) An enlargement at the bottom of a wall to distribute the weight of the super structure over a greater area to prevent soil failure and settling; (3) That portion of the foundation of a structure which spreads and transmits loads directly to the piles or to the soil or supporting grillage.

6. Form - A temporary structure or mold for the support of concrete while it is curing and gaining sufficient strength to be self-supporting.

7. Form Tie - A unit adapted to prevent concrete forms from spreading due to fluid pressure of freshly placed, unhardened concrete.

8. Foundation - The entire sub-structure below the first floor or frame of a building including the footing upon which the building rests. Also, the soil or rock upon which a building rests.

9. Frost Line - The greatest depth to which the ground may be expected to freeze.

10. Grade - The level specified by the working drawings.

11. Grade Board - Firmly established grade strips or side forms for unformed concrete which will guide the strike-off in producing the desired plane or shape.

12. Hydraulic Cement - A type of cement which hardens under water.

13. Keyway - A recess or groove in one lift or placement of concrete which is filled with concrete of the next lift giving shear strength to the joint.

14. Lightweight Aggregate - Aggregate such as vermiculite and perlite used instead of sand in plaster and in concrete for roofs of large spen. Pumice formed slag or clinker aggregates can also be used to make lightweight concrete.

15. Pilaster - A columnare projection with capitol and base from a pier or wall.

16. Pile - A long slender timber, concrete or steel structural element driven, jetted or otherwise embedded on end in the ground for the purpose of supporting a load or compacting the soil.

17. Rebar - A slang term used for reinforcing steel which is deformed cylindrical shaped bars placed in concrete to improve its tension qualities.

18. Slab - A flat, usually horizontal or nearly so, molded layer of reinforced concrete usually of uniform thickness, but sometimes of variable thickness.

19. Slab on Grade - A ground supported concrete slab.

20. Spreader - A piece of lumber cut to the exact length of the thickness of a wall or other type form and inserted temporarily to hold the inside dimensions correctly and consistently.

21. Screed - (1) Firmly established grade strips or side forms for uniform concrete which will guide the strike off in producing the desired plane or shape. (2) To strike off concrete lying above the desired plane or shape. (3) A tool for striking off the concrete surface, preferable called a strike off.

22. Screed Board - A straight edge long enough to reach from one grade board to another and moved back and forth to strike off plastic concrete to that grade level.

Foundation Walls

After the footing has cured, remove all deadman stakes and diagonal bracing from the form. Leave the side form boards and stakes in place. They will be used for the nailing of a shoe for added strength at the bottom of the form where it is needed most.

LETS TALK SAFETY

When stripping formwork, be sure all nails, wire, etc., are removed from the material. Also remove all deadman stakes and fill the holes left so they don't become stumbling blocks.

Foundation walls, like footings, are load transferring structural members. They must be able to provide anchorage for the building and support the weight as well as resist pressures from the ground. Futhermore, they must be the most durable part of the structure as well as be able to resist moisture penetration. They must be strong and sound enough to guarantee the life of the structure which is placed upon them.

For the purpose of this module, we will only discuss foundation walls from one to three feet in height. Refer to Module 10506 for discussion on higher walls.

Once again, as for footings, we must establish the corners of the foundation walls. However, rather than using a grade stake, we will mark the exact corners with a pencil or marker. Sometimes the craftperson may drive a short masonry nail at that point into the footing. When the outside corners of the foundation walls have been established, snap a chalk line from corner to corner as a guide line to set the forms. See Figure 20.

Panels can be built, using 2"x4" studding and sheathing of 3/4" plywood or boards. When using plywood, the grain must be running across the studs. The panels should be built to accomodate the height of the finished concrete.

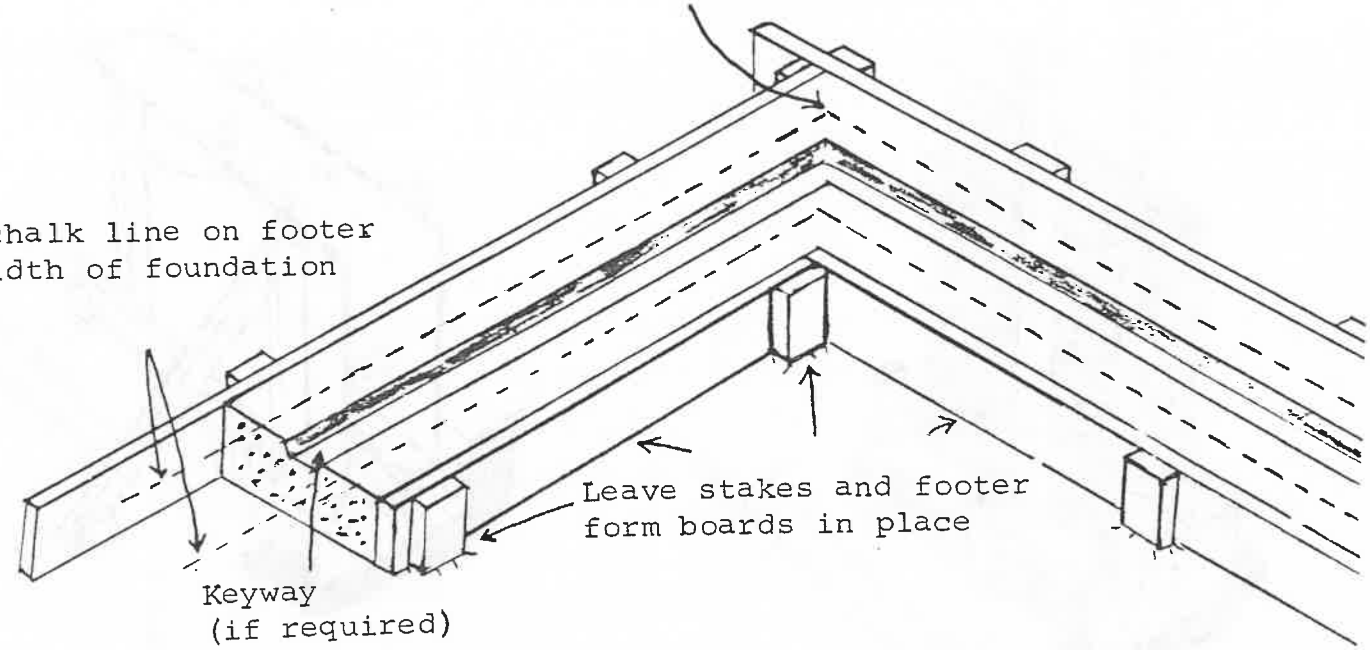


Figure 20

Figure 21 shows one suggested way of building form panels. If forms are rented, they would probably resemble this configuration. If the finish elevation of the foundation wall is below the top of the form, a chalk line can be struck and a small wooden strip is nailed to the form on the top side of the line, or a row of nails, as shown in the diagram, three to four feet apart. The finish grade of the concrete would be floated to this level or screed.

Figure 22 shows another suggested way of assembling forms. Notice the shoe is nailed to the footing form boards that were left in place after the footing was poured. If the footing forms were all removed while stripping, anchor the bottom of the foundation

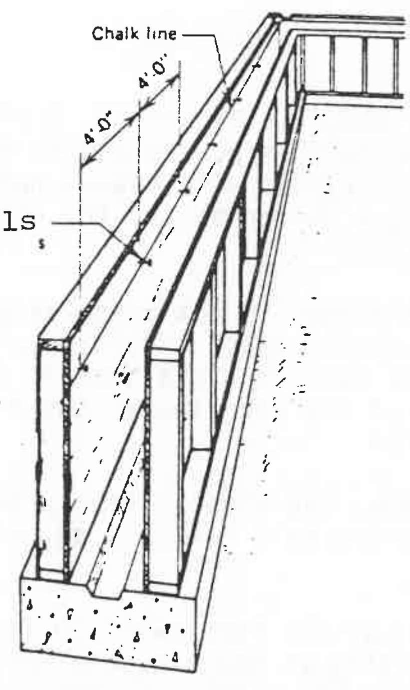


Figure 21

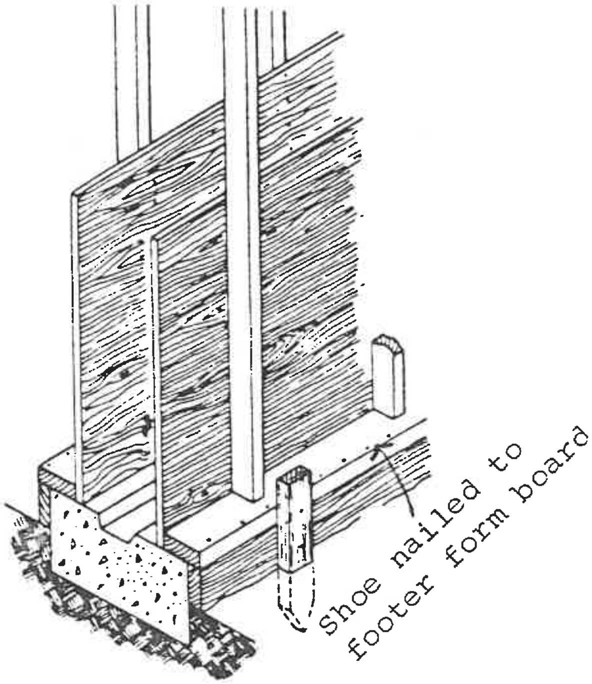


Figure 22

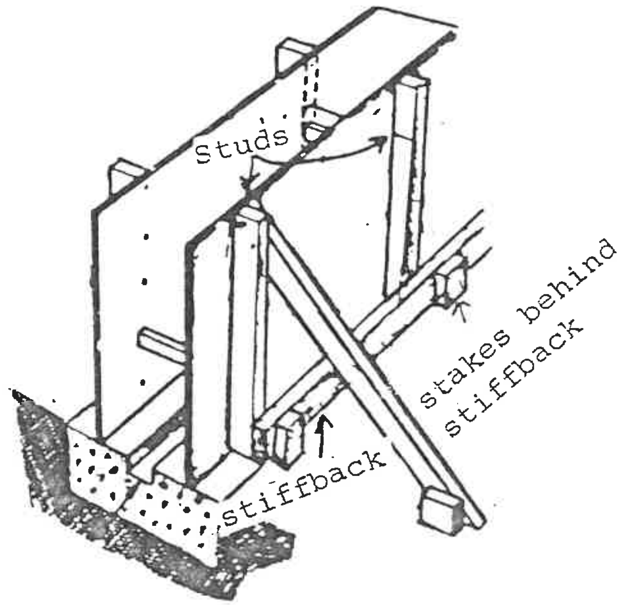


Figure 23

form as shown in Figure 23. A stiffback or strongback is placed behind the studs and nailed with duplex nails. Then stakes are driven behind the stiffback and nailed.

If a stiffback is not used, an additional horizontal brace should be placed from the deadman stake back to the bottom of the studding as shown in Figure 24.

In summary the step by step procedure for setting wall forms is as noted below.

1. The outside forms will be assembled starting at the ends and working toward the middle of each wall. The reason for starting at the corners is that any short forms or fillers will fall in the middle of the wall rather than at the ends where more strength is needed. Before installing

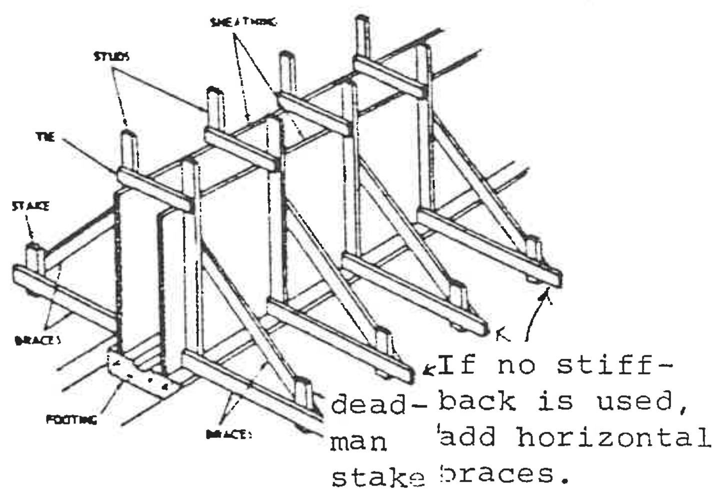


Figure 24

any of the form panels on the footer, coat the sides that will be next to the concrete with form oil for ease of stripping. This should be done well away from the footings or any steel that will be in contact with the concrete. Concrete will not stick to a surface that has oil on it. The forms should be set to the outside of the chalk line on the footing as shown in Figure 25.

2. Set the corner form that joins the corner that was set in item 1 above and nail with duplex nails as shown in Figure 26.

   After this is completed set the rest of the remaining corners using the same procedures.

3. Working from the corners toward the center, set the next adjoining panel tightly against the one already standing. Make sure the form panels are flush and nail the end panel studs together with duplex nails at the joint as shown in Figure 27.

   Undoubtedly the last panel in the wall will have to be specially built to fit the gap between the last two standard panels. Make sure it is tight and flush with the other panels.

4. After all of the outside forms are in place, drive deadman stakes outside of all the corners. Drive one duplex nail in the top of a diagonal brace and fasten it to the corner stud close to the top of the form. While someone plumbs the inside face of the form with a level, push or pull the form at the top until the level reads plumb and nail off the diagonal brace to the deadman stake. Repeat this procedure on all

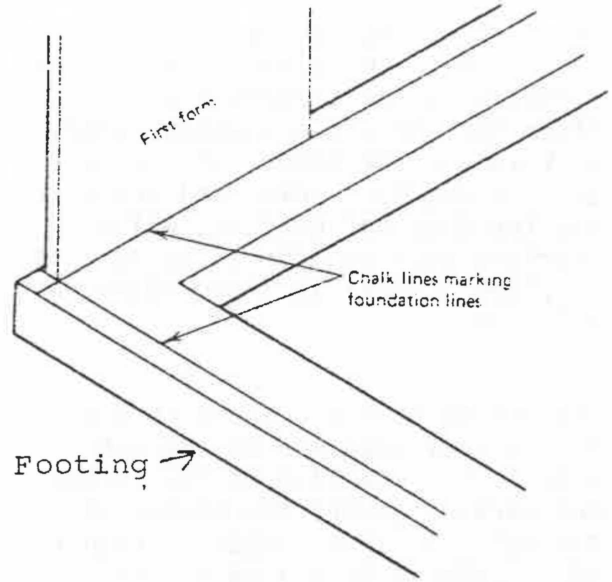


Figure 25

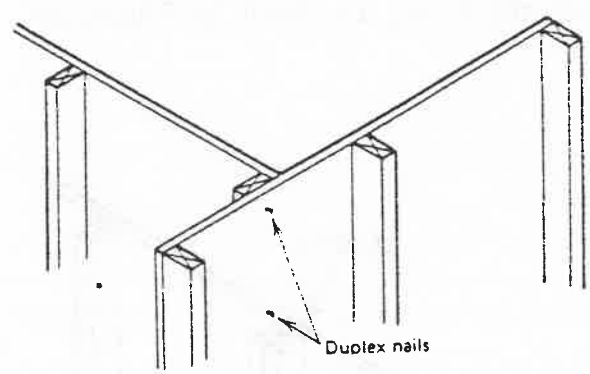


Figure 26

the corners. Add duplex nails as necessary to the diagonal braces to firmly hold the corners plumb. After the corners are established, work toward the center of the wall, driving deadman stakes and installing the diagonal bracing, while checking each station to be sure it is plumb. Repeat this procedure on all sides.

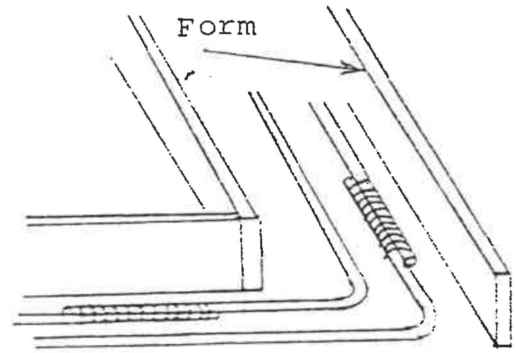


Figure 28

5. The inside form procedure is done in the same sequence as the outside forms, starting at the corners and working toward the middle of the wall. If steel rebar is required, it should be placed in the form as it is completed. The rods should be about 3 inches in from the face of the forms and bent around the corners as shown in Figure 28.

   In addition, insert temporary wooden spreaders about halfway up the form, as shown in Figure 29.

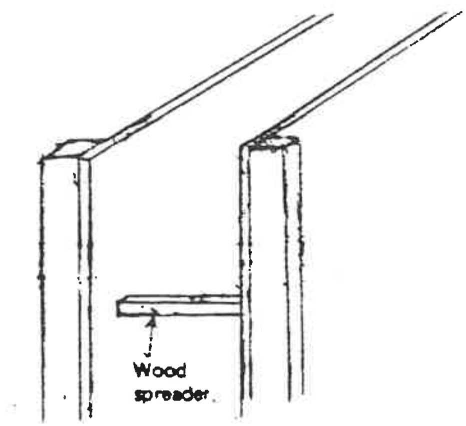


Figure 29

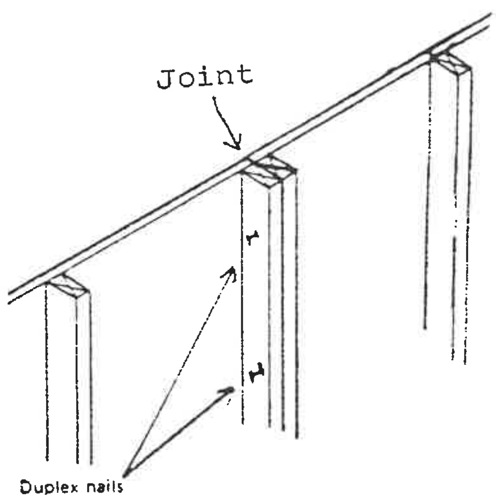


Figure 27

5. About an inch and a half above the spreader, drill a one-eighth inch hole through the form panel on each side of the studs and proceed as shown in Figure 30, Steps 1 and 2. This will hold the spreader in place until the concrete is placed. Do not nail the spreader to the forms. Also, this will automatically plumb up the inside if the outside form is plumb.

For easy spreader removal while the concrete is being placed, some craftpersons attach a piece of tie wire to the spreader with the other end

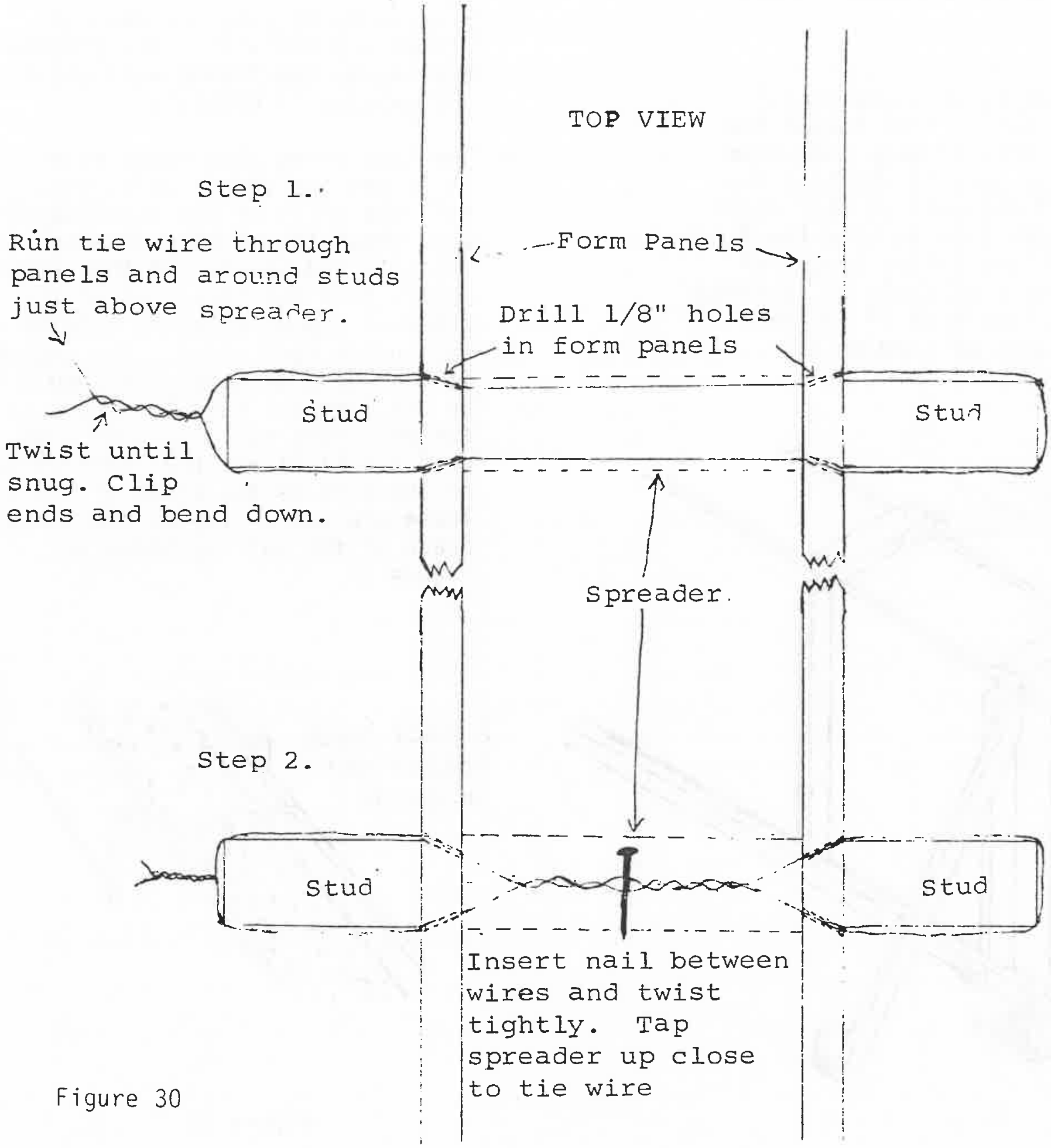


Figure 30

extending out of the top of the form and attach it to a nail outside the form.

Whenever working with tie wire, always bend the ends in or down so they don't protrude in such a manner that they can puncture an eye or skin.

7. After completing this phase,nail with duplex nails, ties across the top of the forms to keep them from spreading. Be sure to maintain the thickness of the wall at this point. Install enough ties to hold the forms in alignment the entire length of the wall. The ties could be fastened as shown in Figure 24 if you have built that type of form or as shown in Figure 31.

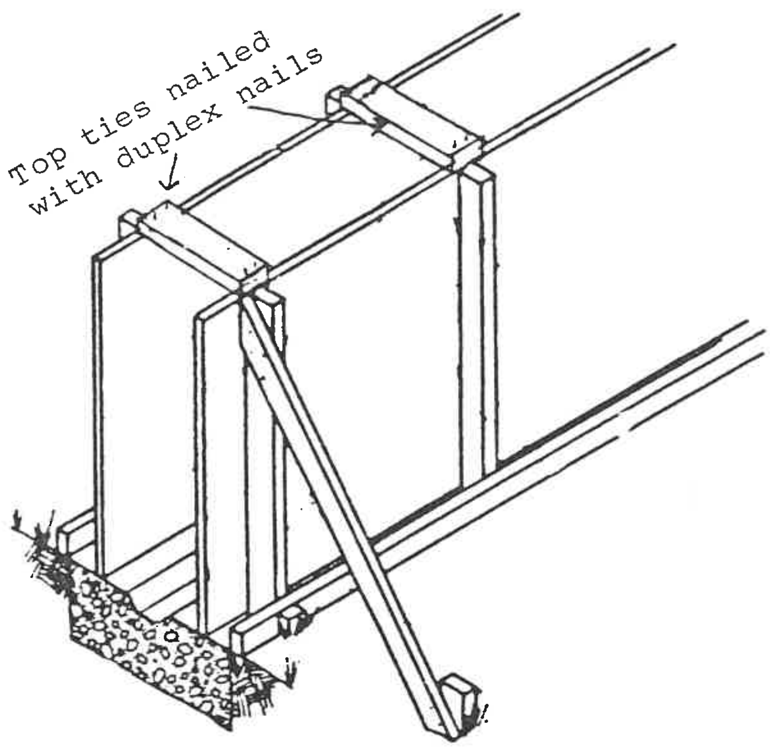


Figure 31

8. After completeing this all the way around the forms, check the walls for elevation, alignment and plumbness. Make any adjustments that are needed. Remember, any adjustments that are made will affect both walls as they are firmly tied together.

   Proceed by driving the deadman stakes and installing the diagonal bracing on the inside wall until all bracing is complete.

9. The last thing that needs to be done is to set the anchor bolts that will hold the sills of the super-structure. Check the working drawings for the size and spacing of the anchor bolts. Mark the locations on the sides or top of both the outside and inside form panels. The anchor bolt holders or templates should be cut from the same thickness as the permanent stock that will be used for sills and the length should be the same as the width of the wall These are set on top of the finish grade of the wall as shown in Figure 32.

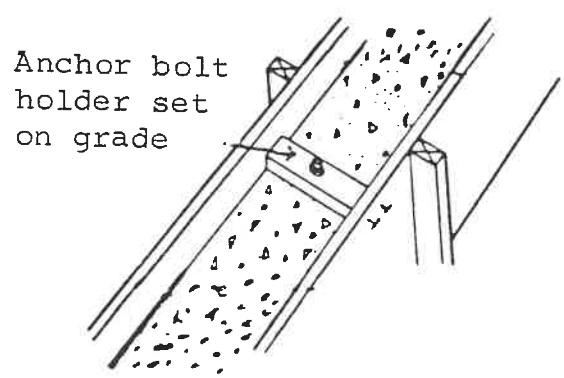


Figure 32

If the grade level is at the top of the form panels, cut the holders the width of the form panels as shown in Figure 33. They can be fastened to the form panels with duplex nails.

Check the working drawings for the dimension from the outer edge of the foundation wall to the center line of the sill plate and square a line across the bolt holder. Also make a center line lengthwise on the bolt holder and down the ends as shown in Figure 34. Drill a hole 1/16" larger in diameter then the anchor bolt where the two (2) center lines intersect through the anchor bolt holder. Insert an anchor bolt with the threaded end up. Put a washer and nut on the bolt and adjust the nut to leave about three threads showing on the top. See Figure 35.

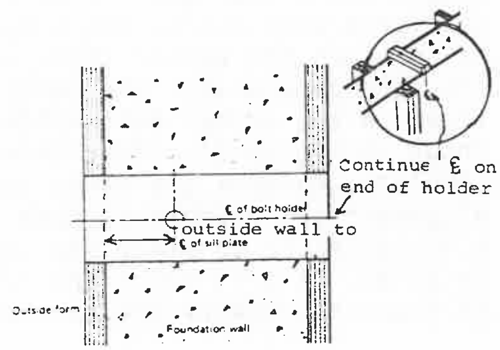


Figure 34

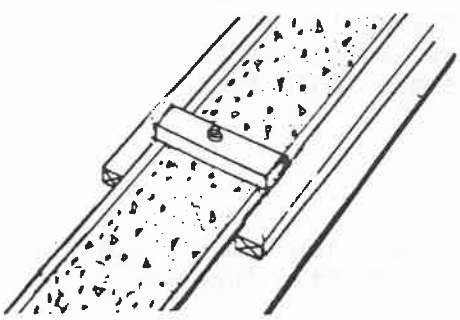


Figure 33

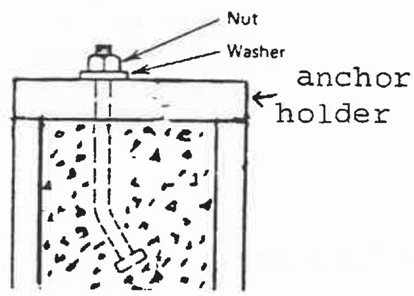


Figure 35

Attach the anchor bolt holders to the forms with duplex nails by matching up the center lines on the form panels with the center lines on the anchor bolt holders as shown in Figure 34. After this is complete, recheck the forms for alignment and plumbness. Make sure all bracing is in place and securely fastened. At this point the formwork is ready to receive the concrete.

Prior to placing the concrete the craftsperson may want to cover the top exposed nut and threads with heavy grease to prevent concrete from splattering on them.

SUMMARY

This module presented the basic information related to concrete so as to provide the carpenter with a sufficient amount of information when working with foundation and flatwork forms. The carpenter was than exposed to specific information on how to construct the above mentioned form-work including how to set anchor bolts.

Review Questions

1. What is a slump cone used for?

2. List the ingredients of concrete.

3. Describe the three methods of mixing concrete as discussed in the module.

4. List the safety precautions that should be taken when handling concr-ete.

5. List the parts of flatwork formwork.

6. What is the most important activity performed in setting up a surveying instrument?

7. Briefly describe how to layout and construct footing formwork.

8. Define screed, spreader.

9. Describe how to layout and construct wall forms.

10. Briefly state how to set anchor bolts in the wall.

Terms

The reader is referred to the lists of terms and definitions contained in this module as noted.