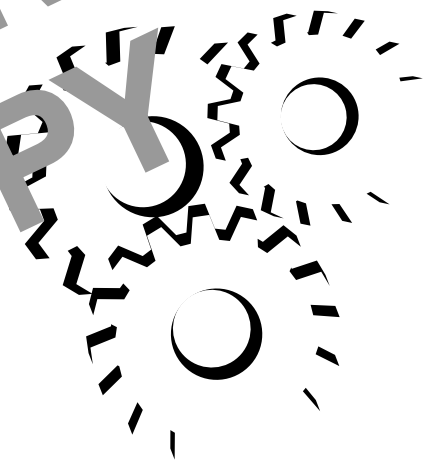
Equipment Installation

Table of Contents

EQUIPMENT INSTALLATION

Lesson One

Preparing the Site



TPC Training Systems

31901

Lesson

1 Preparing the Site

TOPICS

The Engineer Plans the Installation
The Maintenance Supervisor's Responsibilities
Relocating Underground Piping
Relocating Underground Wiring and Cables
Protecting Nearby Buildings and Equipment
Barricading the Work Area
Removing Excavated Material
Foundation and Footings
Reinforced Concrete
Materials for Reinforcing Concrete
Using Wooden Forms
The Right Concrete Mixture
Materials for Fill around Foundation
Positioning Anchor Bolts with a Template
Installing Alignment Plates
Surface Finish of Concrete
Setting or Curing Time for Concrete
Finishing Flooring around Foundation
Outdoor Foundations
Safety Precautions for Excavation Work

OBJECTIVES

After studying this Lesson, you should be able to…

- Tell who plans the installation of new equipment and list the steps involved.
- Define the terms *foundation* and *footing*.
- Tell which type of ground will support the most weight.
- Explain how steel rods are held in position when pouring a concrete footing.
- Name the best materials for filling around a foundation.
- Explain how to protect concrete that might come into contact with oil or chemicals.
- Tell how long new concrete must sit before equipment is installed on it.

KEY TECHNICAL TERMS

Core samples 1.02 soil samples used for testing and analysis
Plot plan 1.08 shows the general location of underground piping
Foundation 1.17 table-like slab of concrete on which equipment rests
Footings 1.17 leg-like columns that support a foundation in the soil
Reinforced concrete 1.20 combination of concrete and steel acting as a single unit

The first and one of the most important steps in installing equipment is preparing the equipment site. The foundation on which the equipment will rest must provide enough support so that the equipment cannot get out of line from constant vibration and pounding. The foundation must also insulate nearby machinery so that it isn't disturbed by the operation of the equipment. Concrete for the foundation must be reinforced by steel bars. Anchor bolts must be placed in the concrete to hold the equipment in position.

Many steps are involved in setting up new equipment in the plant: excavating, pouring the foundation, setting and aligning the equipment, anchoring it, and finally testing it. This unit covers all of these steps. This Lesson describes how to do just the first two steps: excavate the site, and pour the foundation. It also explains how to locate and protect underground piping and wiring while excavating, how to position reinforcing bars in the concrete, and how to finish the concrete foundation surface.

The Engineer Plans the Installation

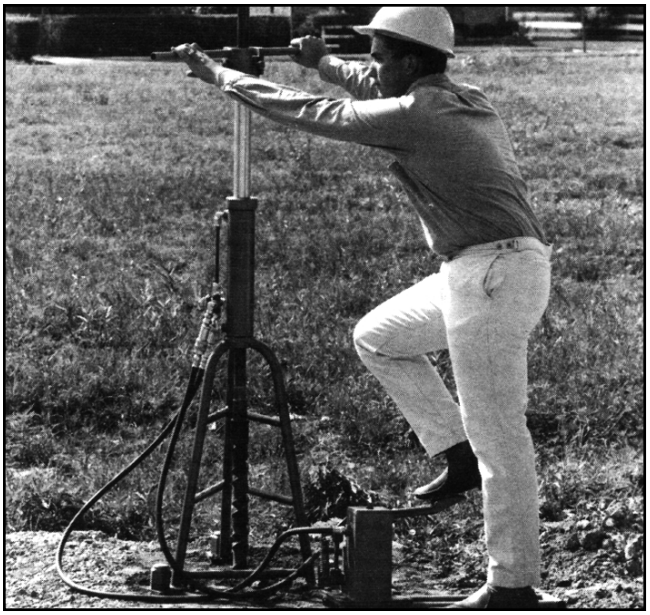
1.01 Before new equipment arrives at the plant, the plant engineer usually makes plans for installing it. Large units that require steel or concrete foundations take more planning than smaller units. The engineer first makes accurate drawings of the foundation. They must show the exact location of foundation anchor bolts, and points of heavy or concentrated weight.

1.02 Next, the engineer will carefully inspect the equipment site. As shown in Fig. 1-1, he will collect soil samples, called *core samples*, from the site for testing and analysis. He must consider the type of soil and the depths of various layers of differing soil when determining how deep to make the footings. The depth of the footings depends largely upon the weight of the equipment, and the vibration and soil compression caused by large units like punch presses and drop hammers. Depth must be enough to permit both a safe bearing pressure and a minimum amount of soil shift or settling in future years.

1.03 Testing and design engineers at the manufacturer's plant make complete studies on every type of equipment they build. They locate stress points by using laboratory apparatus under normal operating conditions. But these engineers go beyond what is considered "normal." They test the equipment to determine just how much movement, pounding, and twisting it can take. The results of these tests provide the information needed to determine the size and depth of the hole required for the footing. Equipment that is very heavy or tends to produce forces that may shift the unit during operation requires much better support than lighter or smaller units.

1.04 The engineer makes up a complete planning package. He determines the location and depth of footings under the foundation using the equipment manufacturer's information and the results of his own tests. In addition, the engineer's planning package must include written instructions, blueprints, and a copy of the manufacturer's instructions for installation.

Fig. 1-1. An engineer drilling for a soil sample



The Maintenance Supervisor's Responsibilities

1.05 The maintenance department supervisor should always receive a set of the engineer's completed plans. He should then mark with colored pencil all of the special materials and tools that he must have for the job. What he does not have in the plant he must obtain from outside sources before starting the job.

1.06 It is important to know what special tools or devices your department may need for installing the equipment. You will probably need a portable crane or some other type of moving lift for heavy units. Many large units have hold-down bolts that use nuts measuring 8 or 9 in. across flats, thus requiring a very large wrench.

1.07 Much of the equipment used in industry today requires some kind of sound reduction or "soundproofing." If high or very low temperatures are involved, you will also need some type of insulation. The engineer's plans should carefully list all of these special materials required. Check the plans and make sure you have everything you need before the project begins.

Relocating Underground Piping

1.08 Before you turn the first shovel of soil for an excavation, *always* obtain and study the *plot plan* of the site. Plot plans show the general location of underground piping in the area. It is possible that you will uncover some piping while digging. If you do, be sure to check its location against that shown on the plot plan. Tell your supervisor if the plan is incorrect, so that he can have the engineering department revise it. It may be necessary to move some piping in order to pour a foundation in the excavation. If you must move a pipe, see that its location is changed on the plot plan.

1.09 You may have to shut down a utility when relocating a pipe. Therefore pick a time to move it that is convenient to most departments and delays plant operation as little as possible. It may be necessary to use jumpers for air and water pipes until you complete the relocation. Observe the following precautions when moving pipe:

1. Before moving a pipe, be sure you know if it contains hazardous gas or chemicals.

2. *Look out* for buried piping and lines that may not be shown on the plot plan.

Relocating Underground Wiring and Cables

1.10 Relocating electrical wiring within the area of excavation is harder than relocating piping. In most cases, electrical wiring runs through some type of protective conduit or clay duct tiles. Before attempting to move any electrical wiring or cables, you must determine their voltages. Most important, be sure that *both* ends of all wires are disconnected and isolated from any possible contact with live electrical circuits. For lower voltage circuits you can provide temporary portable wiring until you can relocate the permanent underground cables. Note all relocations on blueprints and plot plans for future reference.

1.11 Follow these precautions when relocating buried wiring and cables:

1. Never assume that an electrical circuit is disconnected or deenergized. Test it with the proper instruments.

2. Be careful. A pick or shovel can pierce the conduit sheathing and short out electric power, including the phone system and fire alarm.

3. Look out for wiring and cable that may not be shown on the plot plan.

Protecting Nearby Buildings and Equipment

1.12 Unless the equipment to be installed is in an open area away from other buildings or equipment, you should provide protection for machinery and other items located near the excavation. It may be necessary to provide external braces to support the walls of nearby buildings, should the area around their foundations become weakened during digging. When the new foundation is complete, remove the supports.

1.13 Protect the foundations of conveyors, standpipes, and other equipment in the area in the same manner, if possible, so that you won't disturb them. In addition, cover precision surfaces such as the ways of lathes and mills, to prevent dirt and dust from collecting and damaging them. Be sure to cover air intakes and oil reservoir breathers also. In some cases, it may be necessary to erect temporary walls to protect previously installed equipment during digging operations.

Barricading the Work Area

1.14 Traffic control is usually a problem when excavating. Block the immediate excavation area with barricades to detour all personnel and vehicle traffic. Leave the barricades in place until the final surface finish is completed and ready for use. The barricades must be strong enough to prevent pedestrians and vehicles from entering the area accidentally. Light the barricades so they are clearly visible at night. Post warning signs to inform everyone that they are in a dangerous area. "Safety First" is always a good rule to follow.

1.15 Most people in a plant are normally curious about a new installation. They want to know what's going on. It is absolutely necessary, however, to keep them out of the work area—for their safety and to protect the project. People can accidentally move forms and templates that will require more hours of your time to realign. With management's permission, you can mount a sketch of the finished job near the barricade to satisfy the curiosity of the onlookers.

Removing Excavated Material

1.16 When the excavation is complete, clear all the trash and dirt from the site. Pile the dirt removed during digging away from the construction area so that it won't interfere with your work or normal plant operations. Have it close enough, however, so you can readily use some of it for fill after you pour the footing. After installing the equipment, use the remainder of the dirt for filling low areas and trouble spots throughout the plant.

Foundation and Footings

1.17 A **foundation** is a table-like slab of concrete, usually partly above and partly below the floor or ground, on which equipment rests. **Footings** are leg-like concrete columns that support the foundation slab in the soil. The manufacturer's instructions make allowances for the effects of equipment torque and vibration on the foundation and footings. Therefore, massive support is sometimes required at certain points. *Do not* reduce the support size or change any foundation details unless an engineer or manufacturer's representative approves the change. For mounting boilers and heating equipment, it is sometimes necessary to put expansion joints or sliding members in the foundation. Place the joints exactly as shown on the erection drawing, or the foundation may fail in use.

1.18 Figure 1-2 shows a footing used in construction. It has been poured in two parts held together with reinforcing bars. The depth and width of the footing vary with the weight of the equipment to be installed and the conditions of the soil. Every footing must be deep enough to provide a safe bearing pressure (to carry the load) under all conditions. Footings in ground that expands when it freezes should extend below the average frost line.

1.19 Generally speaking, hard clay that requires a pick to remove it will safely support 4 to 5 tons per square foot. Hard rock will support the most weight. Soft- clay and loose sand support much less. The flare or spread footer at the base of the footing spreads the

Fig. 1-2. A typical foundation and footing

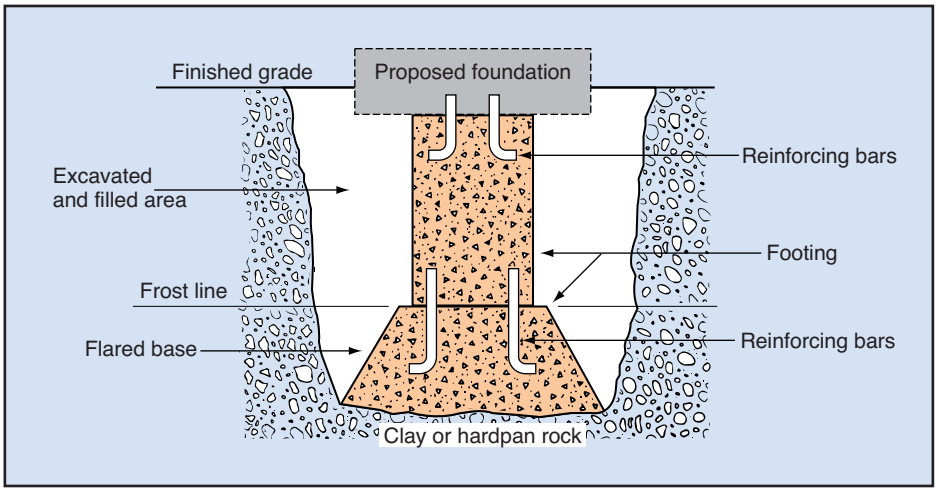
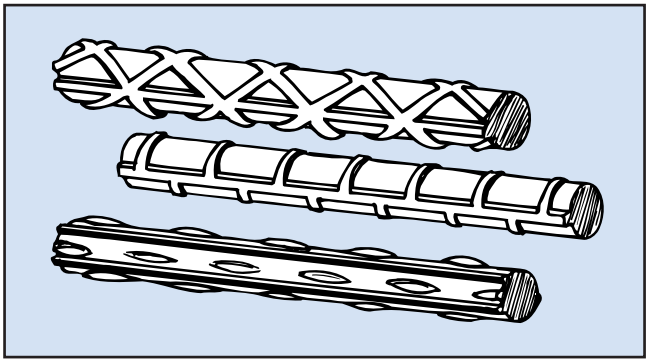


Fig. 1-3. Deformed steel reinforcing bars



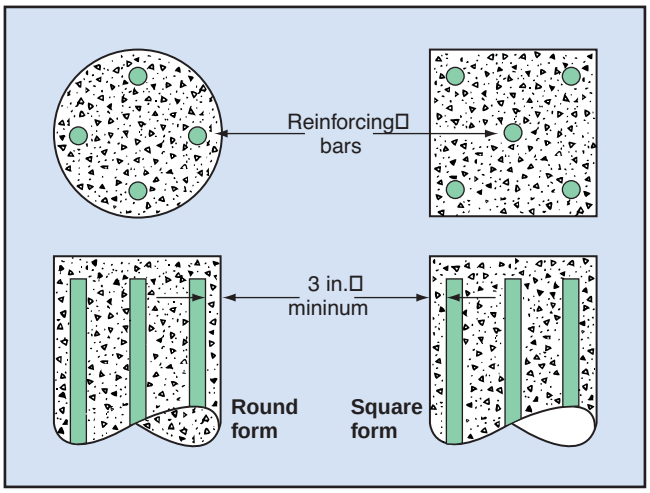
load over a larger area. This allows for larger bearing loads at the top of the footing. Manufacturer's specifications should state the bearing load at the top of each footing. Locate the footings so that the load will be directly centered on the footings.

Reinforced Concrete

1.20 Reinforced concrete is a combination of concrete and steel acting as a single unit. Steel bars or large wire mesh added to concrete help prevent cracks due to expansion caused by temperature changes. Reinforced concrete structures compare well with large single pieces of stone, because they are more rigid than steel and less affected by fire and heat.

1.21 Plain concrete has high compressive strength but low tensile strength. Compression forces result from the weight of the equipment and other downward pressures during normal operation. Tensile forces are due to vibration, torque, or angular pressures during operation. Adding reinforcing steel increases the tensile strength almost to the working limits of the compression strength.

Fig. 1-4. Position of reinforcing bars in footings



Materials for Reinforcing Concrete

1.22 Reinforcing steel can be bars with irregular surfaces (commonly called deformed bars), smooth steel bars, or welded wire mesh. Figure 1-3 shows examples of three types of deformed bars that are in general use. Deformed bars hold in the concrete better than smooth bars. Therefore, smooth steel bars are not recommended. Welded wire mesh is generally used for slabs, floors, walls, and other large flat areas.

The Right Concrete Mixture

1.23 Deformed bars are available in standard sizes from 1/4 in. diameter to about 2 1/4 in. diameter in steps of 1/8 in. Bar diameters are specified by numbers that represent the size in eighths of an inch. (No. 6 is 6/8 or 3/4 in. diameter; No. 8 is 8/8 or 1 in.) Welded wire mesh is available from slightly over 1/8 in. to about 1/2 in. wire diameter.

1.24 Reinforcing steel must be protected by concrete to prevent corrosion. The amount of concrete cover varies, depending on the installation's use, location, and amount of exposure to moisture. As a rule, cover the reinforcing steel with at least 3 in. of concrete where the footing comes in direct contact with the ground. If the foundation is to be exposed to salt, chemicals, or other corrosive elements, you must increase the amount of cover. Figure 1-4 shows the arrangement of steel reinforcing bars for a round and a square footing. Hold the rods in position with tie wires to prevent movement when pouring the 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. Plans for installing equipment are usually made by the plant _____.	1-1. ENGINEER Ref: 1.01
1-2. It is the plant engineer's job to determine the _____ and depth of the footings.	1-2. LOCATION Ref: 1.04
1-3. The location of underground piping in the installation area is shown in the _____.	1-3. PLOT PLAN Ref: 1.08
1-4. For protection, buried electrical wiring runs through clay duct tiles or _____.	1-4. CONDUIT Ref: 1.10
1-5. To detour traffic around the excavation area, you should erect _____.	1-5. BARRICADES Ref: 1.14
1-6. Footings in ground that expands when it freezes should extend below the _____.	1-6. FROST LINE Ref: 1.18, Fig. 1-2
1-7. After installing the equipment, use the remainder of the dirt for filling in _____ areas in the plant.	1-7. LOW Ref: 1.16
1-8. As a rule, cover the reinforcing steel with at least _____ in. of concrete.	1-8. 3 in. Ref: 1.24

Using Wooden Forms

1.25 Set foundation forms in accordance with the manufacturer's recommendations or engineering plans. Materials used for the forms vary. However, from the standpoint of cost, wooden forms are the least costly to use. Figure 1-5 shows one type of wooden form set for a square footing. The form can have an inner plastic liner for concrete areas exposed to view. The liner leaves a smooth or slick finish on the outer surface of the concrete after you remove the form.

1.26 *Always* construct forms with enough strength to support the load of wet concrete and reinforcing steel. You may have to brace the forms to keep them level and steady while pouring. Use fill dirt for further support if you need it. Be sure that plans allow enough clearance for removing the form after the concrete sets. Figure 1-6 shows a typical footing form with the reinforcing steel in position. Note the three tie wires. For longer lengths of steel, you will need to use more than three wires.

1.27 It is not important that you know the mixtures for all types of concrete, but you should know why some mixtures are better than others. The plant engineer or the equipment manufacturer lists the recommended mixture in the specifications. Ready-mixed concrete is ideal for most installations. It is normally cheaper, and almost always of good quality. Be sure to pour ready mixed concrete within 1 hr after mixing. A quick visual check will tell if the concrete is properly mixed. The cement should cover every particle of the sand and gravel. The covering should be like a paste.

1.28 For reinforced concrete, use only first-class portland cement, and select the aggregates carefully. Determine the portions of the mixture from the required strength and quality of the aggregates. The most common mixture for building construction contains about 5½ bags of cement per cubic yard. *Do not* use lean mixtures (less than 5½ bags of cement per cubic yard) because they do not bond well to the reinforcing steel.

1.29 For all reinforced concrete work, use a mixture that flows sluggishly, but does not separate when carried to the work. Such a mixture will embed the steel properly and fill all corners of the molds or forms. Use a stiffer concrete mixture if you are going to pack the concrete in the form using vibration tools.

1.30 The most common aggregates used in concrete are sand and gravel. The sand must have clean, hard, uncoated grains. It must be free of bits of grass and plants. Any of these particles, even those too small to see, can cause weak spots in the concrete. Gravel used for concrete is of several different types. It can range from broken stone to small pieces of ground concrete slab. The gravel must be just as clean as the sand. If the aggregates are of poor quality, increase the amount of cement in the mixture.

1.31 Remember one very important fact when pouring concrete: Freezing temperatures delay the

Fig. 1-5. A form set for a concrete footing

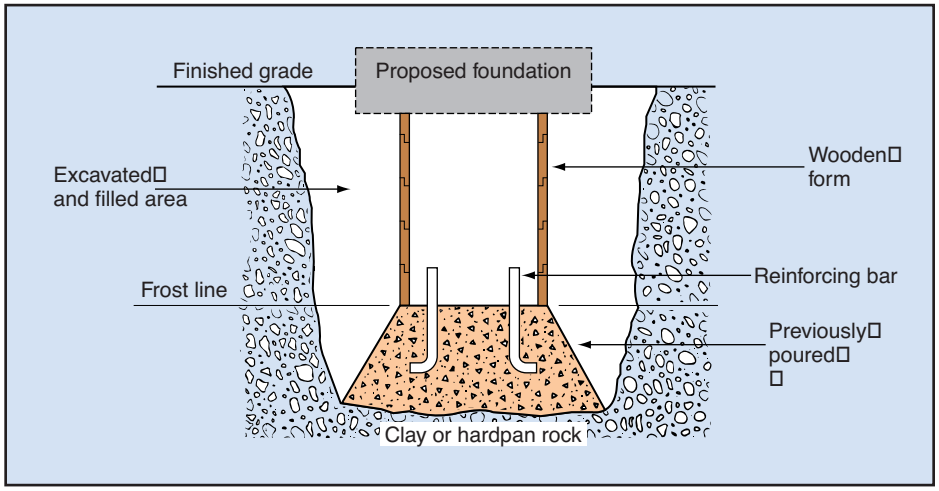
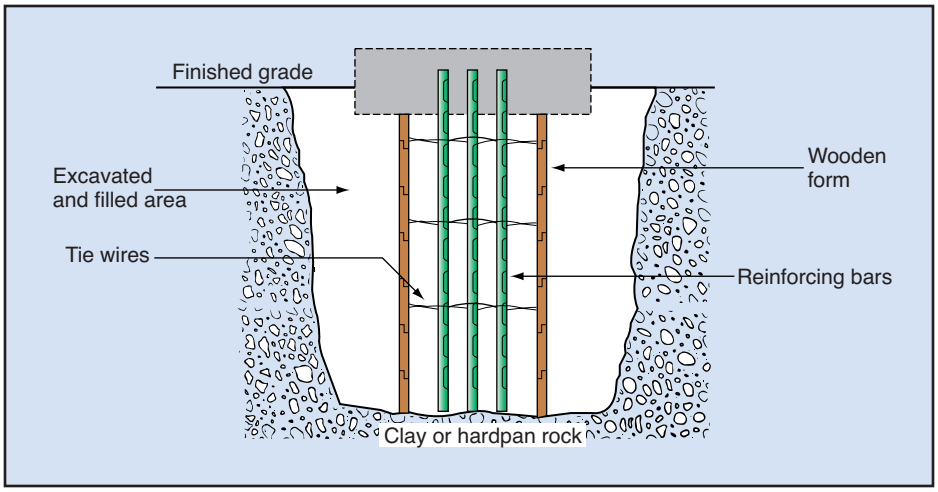


Fig. 1-6. Reinforcing bars in position in form



setting of concrete and can cause permanent damage. If you must pour concrete in freezing weather, cover it with polyethylene film, tar paper, or canvas. In temperatures below-12°C (10°F), hot air blowers or large heat lamps may be needed. Never use any form of salt to prevent freezing. Salt will cause more damage than the freezing will.

Materials for Fill around Foundation

1.32 Ground soil removed during excavation might not be good enough to fill in around the foundation. Soil with too much soft silt or sand might not give enough support to the footings. The best materials for fill are gravel and ground concrete slabs. Pack the materials tightly around the foundation and underground footings after removing the forms. Add the fill to the level required by the plant engineer.

Positioning Anchor Bolts with a Template

1.33 Anchor bolts that are embedded in the concrete must be installed while the concrete is still soft. Engineer's drawings and manufacturer's specifications indicate the exact location for each anchor. Accurately positioning the bolts is most important. The drawings allow little or no room for error. You should measure the bolthole locations on the equipment, and check the measurements against the drawings. For large areas, you can construct a lightweight template to align the bolts.

1.34 Bolt templates are normally made from lightweight metal. The metal should be strong enough to support the bolts in the correct position for installation. Yet it should be light enough to permit easy handling and removal after the concrete has hardened and the bolts are secure. If possible, place the template directly on the base of the equipment to check the hole alignment. Also, include the small utility service bolts for items such as coolant lines, electrical service, and air lines, on the template.

1.35 Sometimes the equipment manufacturer furnishes either bolt templates or drawings from which to make the template. They exactly locate all bolts required in the foundation. They usually include the small utility service bolts in addition to the anchor bolts.

1.36 Place the template on top of the form after you pour the concrete. Insert the anchor bolts through the openings in the template into the fresh concrete. The equipment manufacturer usually specifies the exact type of anchor bolt to use. Hold the bolts in place with wires or dummy nuts until the concrete sets. Support each anchor bolt in a true vertical position. Figure 1-7 on the following page shows typical anchor bolts embedded in concrete with the template removed.

1.37 Anchor bolts should be the largest size available that will fit the bolting holes in the equipment. They must be long enough to permit enough thread above the equipment base for tightening the anchor nuts. The material in the bolts must be the strongest available. Anchor bolts receive much stress during the operation and vibration of the equipment. You can make the J-rod type, shown in

Fig. 1-7. Anchor bolts set in concrete

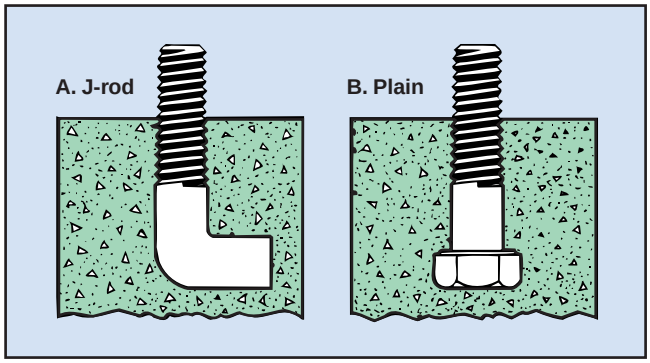


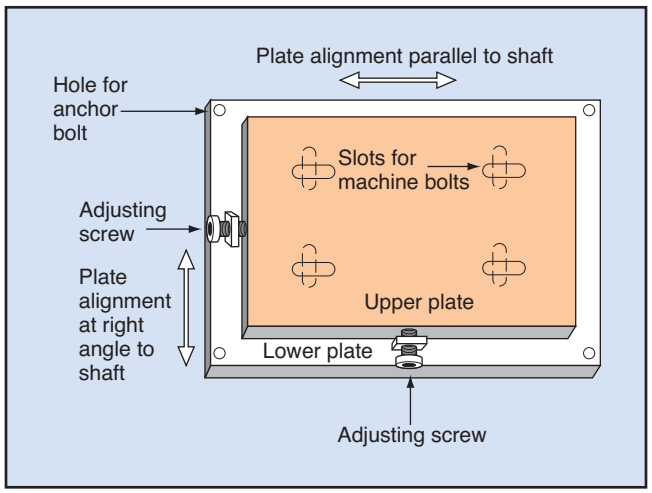
Fig. 1-7A, in the shop from mild steel rod. Larger type plain anchor bolts, as shown in Fig. 1-7B, can be furnished by the equipment manufacturer. (For information on other types of anchor bolts, see Lesson Two, "Vibration Control and Anchoring.")

Installing Alignment Plates

1.38 Equipment that requires alignment, such as motors, gear cases, and pulleys, normally needs alignment plates to allow for adjustment. Large alignment plates for equipment with critical bearing loads or shaft alignment may be furnished by the manufacturer. If the plates are to be made in the shop, locate and drill the holes very carefully. Alignment plates become a permanent part of the foundation.

1.39 Alignment plates are constructed in two pieces from heavy metal. The equipment is bolted to the top plate. Holes can be drilled in the bottom plate to anchor it in the foundation after it sets in the concrete. Or you can weld an anchor to the bottom of the plate and push it into the wet concrete. In either case, put the equipment anchor bolts in the bottom plate *before* pressing the plate into the wet concrete. Be sure to build boxes around the heads of the equipment anchor bolts so you do not cement them in place. In most cases, you can use heavy cardboard to keep the concrete away from the boltheads.

Fig. 1-8. A common two-piece alignment plate



1.40 Alignment screws on the plate shift the equipment in any direction for final true alignment. Figure 1-8 shows a common two-piece alignment plate that permits alignment in any direction. You can build this plate easily in the shop. The plate shown in Fig. 1-8 has four anchor bolts and two adjusting screws. Larger plates may require more anchor bolts and adjusting screws. On the plate in Fig. 1-8, one adjusting screw (A) shifts the equipment in a direction parallel to the shaft. The other screw (B) moves the equipment at right angles to the shaft.

1.41 Alignment plates take time to make, and they add to the cost of an installation. For this reason, use them only when equipment alignment is critical. The addition of a leveling screw at each anchor bolt permits vertical movement and adjustment. This also increases the cost. The thickness of the plates varies, depending on the weight of the equipment. The plates must be thick enough to withstand vibration from normal operation. They cannot be so thin that they warp and bend.

Surface Finish of Concrete

1.42 Generally, the surface finish of concrete foundations is not important. Normally some form of covering hides the foundation. Finish is important, however, if the surface is to be in contact with water, oil, or chemicals. It is also important if part of the foundation will be a walking surface. If surface finish is not important, you can use form liners to help in finishing the surface. Liners that absorb moisture can help to remove water from the surface of the concrete. They also eliminate air and water voids in the surface. Concrete with a smooth surface is more durable and resists wear.

1.43 In some cases, the drive motor or engine of the equipment may occupy part of the foundation. If the surfaces under the engine are constantly covered with water, oil, or chemicals, protect them by sealing them with any good concrete sealer. Some form of

epoxy base sealer usually provides the best protection for acid spills and most chemical spills.

1.44 Carborundum grits worked into the cement finish provide a good nonslip surface for wet floors. This helps the operators to maintain a good footing during plant operations. The ideal surface finish should be wear-resistant, nonslip, and easily cleaned. It should have a low maintenance and upkeep cost.

Setting or Curing Time for Concrete

1.45 After pouring, the concrete must remain a fluid long enough to surround the steel reinforcing rods and flow into the corners of the form. It should start to set (or cure) in about 45 min. It should be completely set after 10 hr. The concrete *must* be finished as soon as possible after it is poured. Do the finishing *before* the concrete begins to set.

1.46 Figures 1-9 and 1-10 show some typical tools for finishing concrete. Wooden floaters, Fig. 1-9, are moved across the surface, floating on the water that rises from the wet concrete. This helps provide a good smooth surface. Use heavy steel tamping tools, Fig. 1-10A, while pouring the concrete to help it settle and flow into all corners. You can also use steel trowels, Fig. 1-10B, for surface finish. Use wooden driving poles, Fig. 1-10C, when pouring concrete to help prevent air pockets forming next to the form.

1.47 Moisture is necessary for proper setting. Keep the concrete moist for at least 7 days. You can retain the moisture by covering the concrete with polyethylene film. In 7 days after pouring, the concrete should have half of its final strength. After 28 days it should have a compressive strength of 2500 to 3000 psi. *Do not* install equipment until the concrete is 28 days old.

Finishing Flooring around Foundation

1.48 Match the existing flooring in the shop as closely as possible when replacing the flooring around the foundation. You will have to pour new concrete for concrete floors. But you can use the material removed for the excavation to replace the flooring in many cases. For example, you can cut and fit wood-plank flooring, or replace wood-block flooring up to the foundation. (Some equipment requires vibration isolating material between the foundation and the surrounding floor. Install this material when finishing the flooring around the foundation. See Lesson Two, "Vibration Control and Anchoring.")

Outdoor Foundations

1.49 Foundations poured outside of buildings are usually easier to cover than those inside. You can simply fill and level dirt surfaces. Some settling usually occurs, so you may have to level the area again after about 6 weeks. You may also need to re-seed lawns to match the surrounding area and to prevent soil erosion. Gravel surfaces normally settle less than soil, so you usually have to add and level new gravel only once.

Fig. 1-9. Floating concrete with a bull float

Fig. 1-10. Tools for finishing concrete

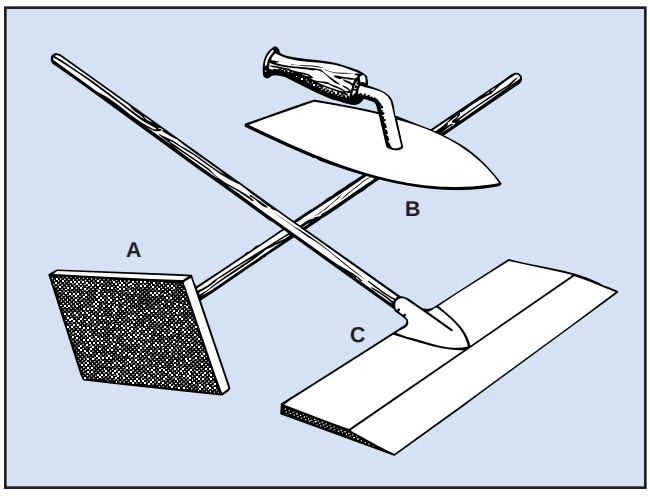
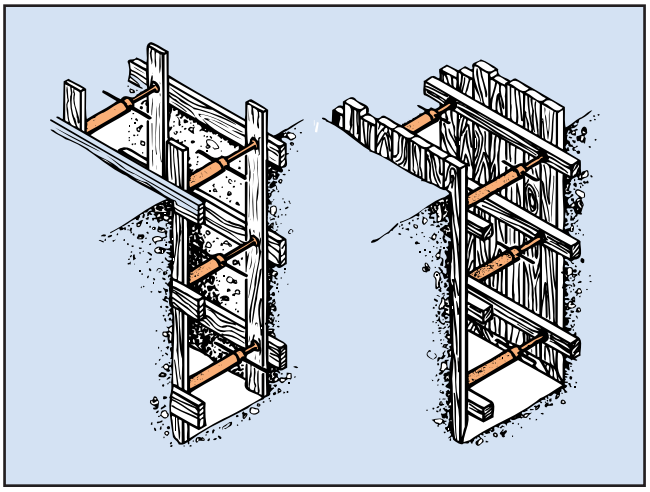


Fig. 1-11. Typical bracing for excavations



1.50 Foundations installed in blacktop or asphalt areas are more difficult to recover. After the foundation is set and forms removed, wait a few days before you repair the surface. Fill the area around the foundation with the same subsurface material as is beneath the surrounding blacktop area. After the subsoil has settled, apply blacktop to a thickness of 4 to 6 in. Level the blacktop surface to the level of the surrounding area.

Safety Precautions for Excavation Work

1.51 An excavation of any type presents a great many safety problems to craftsmen working in the area. Standard protective clothing such as hard hats, safety glasses or goggles, and safety shoes is absolutely necessary. You should *never* be in the area without all of these items. Dustproof goggles are normally better than ordinary safety glasses because they provide additional protection against flying dirt and small rocks.

1.52 The biggest danger that you must guard against when working in excavations is cave-ins. If you are digging more than 5 ft deep, you *must* either brace the walls of the hole (as in Fig. 1-11) or slope the walls toward the center of the hole. For holes less than 5 ft deep, the soil structure and excavation size will usually determine the need for bracing. You will need such materials as planking, sheet piling, and jacks for bracing. Hold the planks against the walls with the jacks placed horizontally between them.

1-9. For a smooth finish,on the concrete, use a plastic _____ in the wooden form.	1-9. LINER Ref: 1.25, Fig. 1-5
1-10. The most common aggregates used in concrete are _____and _____.	1-10. SAND and GRAVEL Ref: 1.30
1-11. The device for holding anchor bolts in place while the concrete sets is called a _____.	1-11. TEMPLATE Ref: 1.33, 1.34
1-12. Be sure that the anchor bolts have enough thread for tightening the _____.	1-12. ANCHOR NUTS Ref: 1.37
1-13. You can make a good nonslip surface by embedding _____ grits in the cement.	1-13. CARBORUNDUM Ref: 1.44
1-14. Before you install the equipment, let the concrete sit about _____ days.	1-14. 28 days Ref: 1.47
1-15. Gravel surfaces normally settle _____ than soil.	1-15. LESS Ref: 1.49
1-16. The biggest danger you face when working in excavations is _____.	1-16. CAVE-INS Ref: 1.52

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

1-1. On what does the depth of the footing for a foundation depend?

- ☐ a. Weight of the equipment
- ☐ b. Vibration caused by equipment
- ☐ c. Compression of the soil
- ☐ d. All of the above

1-2. Underground piping and wiring in the excavation area are shown on the

- ☐ a. erection drawing
- ☐ b. plot plan
- ☐ c. elevation drawing
- ☐ d. building layout

1-3. The dirt removed during digging an excavation should be piled

- ☐ a. close by so you can use it
- ☐ b. at the far end of the plant
- ☐ c. at the edge of the excavation
- ☐ d. in the construction area

1-4. Which of the following best describes a foundation?

- ☐ a. A leg-like concrete column
- ☐ b. A foot-shaped buried slab
- ☐ c. A table-like concrete slab
- ☐ d. A sliding member or joint

1-5. The material for reinforcing concrete floors and walls is generally

- ☐ a. welded wire mesh
- ☐ b. deformed steel bars
- ☐ c. smooth steel bars
- ☐ d. pieces of angle iron

1-6. Within how much time should you pour ready-mixed concrete after mixing it?

- ☐ a. 1/2 hr
- ☐ b. 1 hr
- ☐ c. 1 1/2 hr
- ☐ d. 2 hr

1-7. The most common aggregates used in concrete are

- ☐ a. sand and gravel
- ☐ b. gravel and broken stone
- ☐ c. gravel and ground concrete
- ☐ d. sand and lime

1-8. The device for holding anchor bolts in place while the concrete sets is a

- ☐ a. gasket
- ☐ b. stencil
- ☐ c. template
- ☐ d. blanket

1-9. To permit adjustment of motors and gear cases, mount them on

- ☐ a. alignment plates
- ☐ b. flexible anchor bolts
- ☐ c. expansion joints
- ☐ d. rubber pads

1-10. Concrete should be completely set how many hours after you pour it?

- ☐ a. 12 hr
- ☐ b. 10 hr
- ☐ c. 8 hr
- ☐ d. 6 hr

SUMMARY

An important step in installing equipment is preparing the site. If necessary, core samples will be taken for testing and analysis and the foundation and footings will be planned. The engineer in charge will make up a planning package that includes written instructions, blueprints, and a copy of the manufacturer's installation instructions. Next, any required tools and equipment should be ordered, and any underground piping, wiring, and cables relocated, as needed. Before beginning work, precautions must be taken to protect nearby buildings and equipment and control personnel and vehicle traffic.

It is important to follow closely the instructions of the engineer and equipment manufacturer's representative when preparing footings and foundations. Reinforced concrete, a combination of concrete and steel acting together, is often used for footings and foundations. The reinforcing steel usually takes the form of deformed bars or welded wire mesh. Wooden forms are generally used to hold the concrete in place. For reinforced concrete, use only top-quality portland cement and select the aggregates (usually sand or gravel) carefully. The mixture should flow sluggishly and not separate.

Often anchor bolts must be embedded in the concrete while it is still soft. Position the bolts accurately by measuring the bolthole locations on the equipment or making a template. Anchor bolts should be the largest size available that will fit the bolting holes in the equipment. Some installations require alignment plates, which are installed at this time. Concrete should start to set after about 45 min and should completely set after 10 hr. Keep it moist for at least 7 days. Do not install equipment for at least 28 days.

When performing excavation work of any kind, you must wear proper protective clothing and gear—hard hat, safety glasses or goggles, and safety shoes at the very least. If you are digging more than 5 ft deep, you must brace the walls of the hole or slope the walls toward the center of the hole to prevent cave-ins.

Answers to Self-Check Quiz

1 -1. d. All of the above. Ref: 1.02.

1-2. b. Plot plan. Ref: 1.08, 1.10.

1-3. a. Close by so you can use it. Ref: 1.16.

1-4. c. A table-like concrete slab. Ref: 1. 17.

1-5. a . Welded wire mesh. Ref: 1.22.

1-6. b . 1 hr. Ref: 1.27.

1-7. a. Sand and gravel. Ref: 1.30.

1-8. c. Template. Ref: 1.33, 1.34.

1-9. a. Alignment plates. Ref: 1.38.

1-10. b. 10 hr. Ref: 1.45.

Contributions from the following sources are appreciated:

Figure 1-1. Soiltest, Incorporated
Figure 1-9. Portland Cement Association
Figure 1-11. National Safety Council