

INTRODUCTION

Grout is used to fill crevices, fissures and cavities that occur in concrete and other types of construction. A typical application might be grouting the gap between a machine base plate and the substrate to reduce vibration and add support. Other uses could include grouting the cavities in tilt-up wall panels, beneath column base plates or door frames.

Different grout formulations may be used where heavy dynamic loads may exist or where placement may be difficult. Grout can be injected under pressure, gravity fed, or packed by hand.

FOCUS ASSIGNMENTS

FOCUS ASSIGNMENTS

1. Research the process of structural grouting.
2. Describe some of the primary uses of structural grouting.



Reading



Writing

UNIT OBJECTIVE

After finishing this unit you will show the following competencies by mastering the activities on the Assignment Sheet and Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. State common uses of structural grout.
2. Identify types of structural grout.
3. Give common applications of structural grout.
4. Name techniques for applying structural grout.
5. Describe techniques for applying structural grout. (Assignment Sheet)
6. List guidelines for placing structural grout.
7. Identify methods used in foundation preparation before placing structural grout.



8. Explain procedures for constructing forms for grouting application.
9. Describe techniques used in finishing the grout surface.
10. List key precautionary measures for working with grout.
11. Grout a simulated machine base or column. (Job Sheet 1)
12. Grout a column or machine base with dry pack. (Job Sheet 2)
13. Grout a metal doorframe. (Job Sheet 3)



OBJECTIVE 1

State common uses of structural grout.

The French civil engineer Charles Berigny is credited for inventing the grouting process in 1802. Responsible for maintaining the harbor of Dieppe, he was faced with the problem of water erosion that had damaged the foundation of the tide gates. He solved the problem by drilling holes in the bottom of the gate, then using a heavy hammer and wooden piston to force clay between the foundation slab and the underground. Berigny's experiment was a success, introducing the grouting process to the world of civil engineering. Modern grouting originated in the mining industries. It was employed to strengthen mines, tunnels and shafts as well as to reduce water seepage.

Some of the structural uses of grout are as follows:

- To prevent danger of erosion from the foundation
- To strengthen the material below the foundation of heavy structures
- To attach rock and ground anchors
- To maintain precise alignment of foundations
- To reduce water seepage in foundations
- To realign structures that have settled due to erosion
- To transfer loads from base plate or machine bases to concrete foundation

OBJECTIVE 2

Identify types of structural grout.

WORDS YOU SHOULD KNOW

non-shrink grout grout designed to eliminate shrinkage and prevent bleeding

bleeding the accumulation of water in the grout mass, reducing its strength and permeability



WORDS YOU SHOULD KNOW

catalyst	a substance that creates or starts a reaction or process
grout creep	the degree to which the grout shrinks under a given load

The properties of grout depend on the structural application of the material. The ingredients for each type of grout must be established in the laboratory then field-tested. The materials must meet specifications, for example, those established by the U.S. Army Corps of Engineers. A variety of structural grouts have been developed over the years to effectively fill the void between a base plate and foundation that will withstand the heavy loads for which they were designed.

Cementitious grout consists of hydraulic cement and water with the addition of other aggregates or admixtures to create a strong structural material. Epoxy grout is composed of an epoxy or resin and aggregate. The Corp of Engineers has established standard specifications for cementitious non-shrink grout. These specifications require the testing of cementitious grout for volume change and compressive strength. At present, however, no standard specifications exist for epoxy grout.

There are a variety of grouts. Some of them are as follows:

- **Dry pack grout** — A zero slump grout consisting of a mixture of Portland cement, sand and water.
- **Metallic catalyzed** — This grout contains metal aggregates and a catalyst that causes the metal to rust. After rusting, the metal aggregate increases in volume causing the grout mixture to expand.
- **Gas forming grouts** — These grouts contain materials that release gasses causing them to expand. Aluminum powder, coke or active charcoal may be added to produce gasses such as hydrogen, carbon dioxide, or oxygen.
- **Non-gassing, non-metallic** — These grouts expand by means of chemicals in the binder materials. The manufacturers control and regulate the chemical additives.
- **Metallic non-catalyzed** — These grouts contain metallic aggregates without the addition of a catalyst.



OBJECTIVE 3

- **Epoxy grouts** — Epoxy grout is composed of a resin, a hardener, and aggregate. Epoxy grout is frequently used for grouting large equipment and machinery because of its resilience. This resilience, however, may also result in “grout creep” which is seldom a problem when applying cementitious grout. An epoxy grout must be chosen carefully taking into consideration both the compressive strength and the grout’s elasticity.

Give common applications of structural grout.

Grout varies in consistency depending on the application and necessary bond strength. The consistency ranges from a watery, soupy one, to one that is thick and stiff. Fluid grouts create a stronger bond than the dryer, thicker ones.

WORDS YOU SHOULD KNOW

permeation grouting

permeation grouting fills holes or voids in the soil with a thin grout which then stiffens to increase support

compaction grouting

compaction grouting uses stiff grout to displace the soil and thus strengthen it

- **Anchor bolts** — Anchor bolts are inserted in base plates to strengthen structures. Bore holes for the anchor bolts are grouted to create a stronger support (Figure 1).

FIGURE 1



- **Column base plates** — Structural steel columns are fastened to a steel base plate placed on a concrete foundation. For larger base plates grouting between base plate and foundation is necessary to support the weight of the column (Figure 2).

FIGURE 2



- **Machine base plates** — Machine base plates require grouting for a variety of reasons (Figure 3).

FIGURE 3



- ❑ To make sure that the machine sits firmly on the foundation and is aligned properly.
- ❑ To prevent shifting of the machine.
- ❑ To support loads transferred to the foundation.
- **Foundation jacking** — It is not uncommon for structural foundations to shift due to the sinking of soil beneath them. As a result, a structure may settle unevenly requiring leveling to return it to alignment. Permeation grouting or compaction grouting may be used to realign the structure.
- **Ground anchors** — Ground anchors support structures that are subject to movement due to heavy loads placed on them. Such structures include tunnels, ski jumps, lighthouses, towers, tall buildings, pipelines and water tanks. Grouting is used to hold anchors in soil and rock to limit movement of the structures.

OBJECTIVE 4

Name techniques for applying structural grout.

- **Dry packing** — Dry packing is recommended for smaller grouting applications such as filling bolt and tie rod holes. Dry pack grout consists of one part cement (by volume), 2- _ parts sand, and enough water to hydrate the mixture. Dry packing is placed by tamping grout into the cavity with a ramming rod and a hammer (Figure 4).

FIGURE 4



- **Flowable grouts** — Flowable grouts require a form for placement. The amount of water needed for flowable grouts is determined by the manufacturer and indicated on the container. The following methods can be used to place flowable grouts (Figure 5).

FIGURE 5



- ❑ **Pushing or plunging** — In applying this method a wood plunger is placed in the throat. The plunger then pushes the grout under the plate.

✓ **NOTE:** When removing plunger, take care that suction doesn't remove or displace grout.
- ❑ **Rodding** — Rodding utilizes a wood or steel rod to force grout into place.
- ❑ **Chaining or strapping** — Chaining is accomplished by placing a small link chain or strap under the base plate then moving it back and forth to eliminate air pockets.
- **Pourable or fluid grouts** — Pumping of fluid grouts is the preferred method of grouting under larger base plates because it is easier and more economical. Follow manufacturers instructions precisely when mixing (Figure 6).



FIGURE 6



OBJECTIVE 5

Complete the Assignment Sheet.

OBJECTIVE 6

List guidelines for placing structural grout:

There are numerous placement techniques for structural grout depending on the applications required for the particular job and the type of grout used. The guidelines below cover only a portion of the knowledge needed to place grout. Other information can be found through research of specific types of placement techniques.

- Follow job site specifications for temperature of materials and substrate.
- Choose the proper consistency of grout according to the required method of placement. Each job requires a different grout consistency. Dry-packed, flowable, and fluid grout requires different flow levels.
- After the surface and base plate have been properly prepared and the grout mixed according to required consistency, the grout is ready to be placed. Workers should place the grout quickly and continuously.
- Grout should be placed from one side only to avoid air entrapment and cold joints.
- Use straps, rods and vibrators to move stiffer grouts.



OBJECTIVE 7

- In the case of flowable or fluid grouts, be careful of using vibration techniques. They may cause bleeding or entrap air lessening the grout's structural effectiveness.

Identify methods used in foundation preparation before placing structural grout.

Foundation preparation is critical to insure an effective bond of the grout to the base structure and to prevent concrete from absorbing moisture from the grout mixture. The following steps should be followed for foundation preparation.

- **Cleaning** — Remove dirt, oil and other debris from the foundation surface, using air jets or sandblasters. Oil can be removed with a degreaser followed by a water flush.
- **Pre-soaking** — Presoak substrate surface 24 hours before placing grout. This procedure prevents dry concrete from absorbing water from the grout mixture. If the dry concrete absorbs water from the grout, it can cause shrinkage of the non-shrink grout and a weakening of the bond line. Before placing grout remove excess water. This is called SSD or Surface Saturated Dry.
- **Air vents** — Air vents may be necessary to release air trapped beneath the surface of the base plate. Generally, base plates wider than 20 inches require air vents. Prior to grouting, holes are drilled where air pockets might develop such as in compartments beneath the base plate. The holes should be no more than 2 inches in diameter.

✓ **NOTE:** When polymeric materials are used (most epoxies and urethanes) the foundation preparation should be done several days in advance of grouting to insure that the foundation is completely dry.

OBJECTIVE 8

Explain procedures for constructing forms for grouting application.

Forms are frequently required for grouting fills and should be constructed after the foundation preparation. Due to their consistency, flowable grouts require forms for placement. These procedures should be followed when constructing grout formwork.



- Forms should be watertight and nonabsorbent.
- Caulk joints to insure water tightness and to keep grout from seeping.
- Provide bracing to prevent the grout from leaking.
- Forms should extend a minimum of one inch higher than the bottom of the base plate.
- Forms should provide a space of at least 1 inch around the edge of the base plate.

OBJECTIVE 9

Describe techniques used in finishing the grout surface.

After grout has set sufficiently to strip the forms, the cement mason will carve the material to a 45 degree angle then float the sides flat. The Army Corp of Engineers suggests the following techniques when finishing the surface. Place a final coating of cement slurry on the grout surface. Use these techniques when finishing the surface:

- Continue coating the surface until a smooth texture is achieved.
- Finish the surface to the bottom edge of the steel base plate.
- Avoid finishing grout higher than the plate to avoid expansion and contraction of steel thus causing cracks in the grout.
- Damp cure for 72 hours after finishing to avoid premature drying.

✓ **NOTE:** Never use structural grouts for patching. Since grouts contain expansive properties, they are meant for contained applications only. In patching they can expand off the bond line.

OBJECTIVE 10

List key precautionary measures for working with grout.

There are many factors that can reduce grouts' effectiveness. Certain practices can insure the overall success of the grouting process



- **Curing** — Without proper curing, grout may crack and shrink. Cement-based grouts must be cured with wet rags or burlap, and then covered with plastic sheeting. A curing compound may also be used to coat the grout. It is important to cure the grout as soon as possible after application.
- **Temperature** — Grout must be protected from extreme temperatures. A minimum temperature of 40 degrees Fahrenheit is preferable. The grout should be especially protected from freezing temperatures.
- **Vibration on the jobsite** — Vibrations due to jobsite machinery can adversely affect the grout placement. Try to reduce vibrations while grout is curing.
- **Specifications** — Always follow the manufacturer's job site instructions.

OBJECTIVE 11

Complete Job Sheet 1.

OBJECTIVE 12

Complete Job Sheet 2.

OBJECTIVE 13

Complete Job Sheet 3.



Name _____ Score _____

OBJECTIVE 11

Grout a simulated machine base or column.

BASIC SKILLS



Employability

**EQUIPMENT
AND SUPPLIES**

- Saw
- Tape
- Hammer and 16d duplex nails
- 1 tube of caulking and caulk gun
- 1 bag of non-shrink grout
- Buckets
- Mixing water
- 1/2-inch drill and mixing paddle
- Extension cord equipped with a ground-fault circuit interrupter
- 1 head box
- 4 feet of chain or strapping
- Margin trowel
- Float
- Small brush
- Personal protective equipment

✓ **NOTE:** Refer to CFR (Code of Federal Regulations) 1926 Construction Industry Safety and Health Regulations.



WORD YOU SHOULD KNOW

head box Box built to promote pressure on the material by gravitational force or a “head”



PROCEDURE

Yes No

- 1. Clean the substrate of dirt and debris under the machine base.
- 2. Set form. Form should be set far enough to allow for 45 degree angle and insertion of head box.
- 3. Caulk form to prevent leakage (Figure 1).

FIGURE 1



- 4. Tape bolts to protect threads.



Yes No

5. Dampen the substrate (Figure 2).

FIGURE 2



6. Read application sheet and MSDS.
7. Put on safety equipment.
8. Add recommended water into mixing bucket (Figure 3).

FIGURE 3



Yes No

- 9. Start drill with paddle in water.
- 10. Add non-shrink grout to water while mixing (Figure 4).

FIGURE 4



- 11. Mix for the time recommended on the application sheet to insure the incorporation of the plasticizers.

✓ **NOTE:** Plasticizer will “wet” the mix once it is incorporated.

- 12. Set head box.
- 13. Run chain across base.
- 14. Pour grout into head box.

✓ **NOTE:** Grout should be poured from one side until it appears on the opposing side to avoid trapping air.

- 15. Pull chain or strap back and forth in a sawing motion to help move the grout across the base (Figure 5).



Yes No

FIGURE 5



- 16. When full, allow to set up for stripping.
- 17. Strip form when grout has set enough to hold its shape, yet is still wet enough to work.
- 18. Carve the edge to a 45-degree angle (Figure 6).

FIGURE 6



**PRODUCT
EVALUATION**

**AVERAGE
RATING**

KEY

Yes No

19. Float to flatten imperfections from carving to bottom of base plate.

✓ **NOTE:** Always tool away from the edge, not toward it. Tooling toward the edge will break it off.

20. Lightly trowel to the desired finish. Broom if called for.

21. Have the instructor check your work.

22. Clean the work area and return tools and equipment to proper storage.

SKILL TEST RECORD

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of “3” or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Safety	4	3	2	1
Use of tools	4	3	2	1
General appearance	4	3	2	1
Overall performance	4	3	2	1

Evaluator Note: To obtain an average rating for the Profile of Training Mastery, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

- 4 Skilled** — Can perform job with no additional training
- 3 Moderately Skilled** — Has performed job during training program; limited additional training may be required
- 2 Limited Skill** — Has performed job during training program; additional training is required to develop skill
- 1 Unskilled** — Is familiar with process, but is unable to perform job



**EVALUATOR'S
COMMENTS**





Name _____ Score _____

OBJECTIVE 12

Grout a column with dry pack.

BASIC SKILLS



Employability

EQUIPMENT AND SUPPLIES

- Non-shrink grout
- Bonding agent
- Margin trowel
- Bucket of water
- Mixing bucket
- Packing rod
- Hammer
- Small finish brush if a brush finish is desired
- Water brush
- Personal protective equipment

✓ **NOTE:** Refer to CFR (Code of Federal Regulations) 1926 Construction Industry Safety and Health Regulations.

PROCEDURE

Yes No

1. Clean the substrate of dirt and debris under the column.



Yes No

2. Dampen the substrate (Figure 1).

FIGURE 1



3. Mix the non-shrink grout into a dry pack consistency (Figure 2).

FIGURE 2



Yes No

4. Shove the dry pack under the column using the packing rod and hammer. Where possible, pack from all sides and hold a piece of wood on one side so you have something to pack against and the dry pack does not fall out (Figure 3).

FIGURE 3



5. After the grout has been solidly packed on all sides, the grouted sides must be shaped at a 45-degree angle that helps to prevent the sides from breaking off.



Yes No

6. Cut dry pack to 45° angle (Figure 4).

FIGURE 4



7. Float and trowel to desired finish, cure the grout with plastic or liquid curing.
8. Protect grouted column from foot traffic.
9. Have the instructor check your work.
10. Clean the work area and return tools and equipment to proper storage.

SKILL TEST RECORD

PRODUCT EVALUATION

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AVERAGE RATING

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EVALUATOR'S COMMENTS





Name _____ Score _____

OBJECTIVE 13

Grout a metal doorframe.

BASIC SKILLS



Employability

**EQUIPMENT
AND SUPPLIES**

- Claw hammer
- Rubber mallet
- Straightedge
- 25-foot measuring tape
- Caulking gun and caulk
- Hand level
- Framing square
- Skill saw
- Form material
- Shims and wedges
- Margin trowel
- 5-gallon bucket
- Hand-operated pump
- Mortar bag and tips
- Scaffold or lift
- Personal protective equipment

✓ **NOTE:** Refer to CFR (Code of Federal Regulations) 1926 Construction Industry Safety and Health Regulations.

PROCEDURE

Yes No

1. Check with supervisor to make sure the doorframe is ready for grouting.
2. Using a level and a straight-edge, check the doorframe to make sure it is plumb.
3. Using the framing square, check the door for squareness.



Yes No

- 4. Caulk the side jams of the doorframe bottom to top on both sides.
- 5. Check the doorframe for potential leaks. Apply caulk to small voids in the frame (Figure 1).

FIGURE 1



- 6. Start placing grout at either the top left or right side of the door frame, either pouring grout through a funnel and/or using a mechanical hand pump (Figure 2).

FIGURE 2



Yes No

7. The door should be filled in increments of 1/4 the height of the door frame.

EXAMPLE: If you start placing the grout on the left side, fill the left side 1/4 the height of the frame and then move to the right side and repeat the process until the frame is completely grouted.

8. Using the rubber mallet, lightly tap the frame to make sure the grout is at the desired level and to help consolidate the grout.

9. During the grouting process the frame must be continually checked for movement. Use the hand level and tape to check the alignment and inside dimensions of the frame. If the frame has moved slightly, then install extra spreaders or tighten existing spreaders by wedging more shims between the 2x4s.

10. Remove caulking from the perimeter of the frame and replace with cementitious material.

11. Using fast setting cement mortar, seal the backside of the header, then dry pack the front side of the header until flush with the wall and frame (Figure 3).

FIGURE 3



Yes No

✓ **NOTE:** In some instances you must use a 1x4 inch strip of plywood on the backside of the header as a method of containing the dry pack grout.

12. Have the instructor check your work.

13. Clean the work area and return tools and equipment to proper storage.

SKILL TEST RECORD

PRODUCT EVALUATION

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**EVALUATOR'S
COMMENTS**



