

INTRODUCTION

Some experts suggest that although the cost of labor and materials in weatherproofing a concrete project amount to less than one percent of the cost of the job, as much as 95 percent of the repair and maintenance costs associated with concrete structures are a result of weathering. While some damage from weathering is bound to occur, the fact remains that the damage is often more severe or happens sooner because of inadequate efforts in weatherproofing. These may be the result of choosing the wrong sealant for the application, improper installation of the sealant, poor preparation of the joint, or other factors. By following the practices presented in this unit, a cement mason can significantly improve the quality of weatherproofing.

**FOCUS
ASSIGNMENTS****FOCUS ASSIGNMENTS**

1. Look for examples of treated joints in your facility or neighboring concrete structure. Note the appearance of the joints. Are they compatible with the structure? Are they well finished? Do they provide a good seal?
2. Look for examples of weathering damage — such as cracked, crumbling, or misaligned concrete panels — in your facility or neighboring concrete structures. Evaluate the role of weatherproofing in contributing to these problems.

**UNIT
OBJECTIVE**

After completing this unit you will show the following competencies by mastering the activities on the Job Sheets and by scoring 85% on the unit test.

**SPECIFIC
OBJECTIVES**

1. Describe types of sealants commonly used with concrete structures.
2. List considerations in selecting a sealant.
3. Identify tools used in applying sealants.
4. State guidelines in applying sealants.



5. Describe types of joints.
6. List purposes of backer rods.
7. Identify types of backer rods.
8. State guidelines for the proper installation of backer rods.
9. Prepare a joint for sealant application including installation of the backer rod. (Job Sheet 1)
10. Apply sealants. (Job Sheet 2)
11. State reasons for sealant failure.
12. Test sealant adhesion. (Job Sheet 3)



OBJECTIVE 1

Describe types of sealants commonly used with concrete structures.

Because concrete structures expand and contract with changes in temperature and loads, they generally are designed to include spaces between sections of pours. These spaces are referred to as joints and they are designed to perform specific purposes. However, if the joints were to be left open, new problems can occur if dirt, water, or other contaminants enter the joints. Therefore, joints are generally filled with some sort of compound to prevent contaminants from entering the joint. These compounds are generally referred to as sealants. Sealants are manufactured to achieve specific functions, such as water resistance, flexibility, or long life. Thus, a wide variety of sealants exist, and the sealant used must be selected specifically for an intended purpose.

WORDS YOU SHOULD KNOW

Adhesion	the tendency of a substance to stick to other materials
Adhesive	material used to join two surfaces together ✓ NOTE: Adhesives are specifically designed to bond materials together. They may or may not be suitable as sealants for specific applications, and sealants — while they generally provide a degree of adhesion — may not achieve adequate bonding to serve as an adhesive.
Elastomeric	referring to a substance made of chains of large molecules that has a tendency to return to its original size and shape after being subjected to force once that force is released
Skin	dry film that forms on the surface of a sealant; to form such a film
Thermoplastic	softening with heat



WORDS YOU SHOULD KNOW

Thermosetting	becoming rigid by chemical reaction and not remeltable
Two-stage sealant	a sealant that is formed by mixing two components together in order to activate the adhesiveness of the sealant

- **Mastic** — Non-elastomeric sealant that may or may not skin but will remain elastic and pliable; may contain fillers; used only where little movement is expected and where cost outweighs appearance and durability.

EXAMPLES: Drying oils, non-drying oils, low-melt asphalt, polybutenes, polyisobutylenes.

- **Hot applied thermoplastic** — Sealants that are 100% solids that become soft on heating and harden when they cool; approved only for horizontal joints and used on applications such as pavement.

EXAMPLES: Asphalts, rubber asphalts, pitches, tars.

- **Cold applied thermoplastic** — Sealants that are 70-90% solids with solvents that set as a result of the solvents evaporating but which soften again if heated.

EXAMPLES: Rubber asphalts, vinyls, acrylics, modified butyl rubber.

- **Chemically cured thermosetting** — Sealants that become rigid and do not remelt as a result of a chemical reaction.

EXAMPLES: Polysulfides, polysulfide coal tar, polyurethanes, polyurethane coal tars, silicones, epoxy.

✓ **NOTE:** Polysulfides, polyurethanes, and silicones may be one- or two-component systems, while the others are two-component systems.

- **Solvent release thermosetting** — Sealants that become rigid and do not remelt as a result of the evaporation of a solvent.

EXAMPLES: Neoprene, butadiene styrene, chlorosulfonated polyethylene, silicones.



OBJECTIVE 2

- **Preformed** — Rigid or semi-rigid materials that are intended to be pressed into the joint

List considerations in selecting a sealant.

✓ **NOTE:** Sealants are formulated for very specific performance characteristics. Generally, for new construction, the architect or engineer will specify the sealants to be used. However, cement masons should be familiar with these materials and their uses to ensure proper installations. Further, in projects involving renovation or repair, the cement masons may be tasked with selecting the sealant.

WORDS YOU SHOULD KNOW

Cohesion the ability of a substance to hold together

- Type of joint to be sealed

✓ **NOTE:** Joints perform different functions and the sealant must be compatible with that function.

- Whether the joint is horizontal or vertical
- Estimated movement of the joint design

✓ **NOTE:** Sealants are rated according the degree to which they can stretch and return to their original dimensions. For example, a sealant may be classified as a Class 25 sealant, which means that the sealant will maintain its adhesion and cohesion through cycles of expansion and contraction where the width of the joint changes by 25 percent.

- Durability within the intended environment

✓ **NOTE:** If the sealant will be subjected to extreme temperatures, sunlight, and other environmental factors, the sealant must be able to withstand those conditions.



- Finish requirements

✓ **NOTE:** Some sealants are available only in black while others come in colors or can be painted (Figure 1).

FIGURE 1



- Adhesion to the base material
- Chemical compatibility with the application

✓ **NOTE:** Sealants may be exposed to chemicals such as fuels and solvents. The correct sealant will be able to tolerate exposure to chemicals encountered in the environment.

- Application requirements as compared to job factors

✓ **NOTE:** Some companies choose not to use multi-component sealants because of the extra labor involved. Companies that do not have the equipment for hot-applied sealants may choose not to use them.

OBJECTIVE 3

Identify tools used in applying sealants.

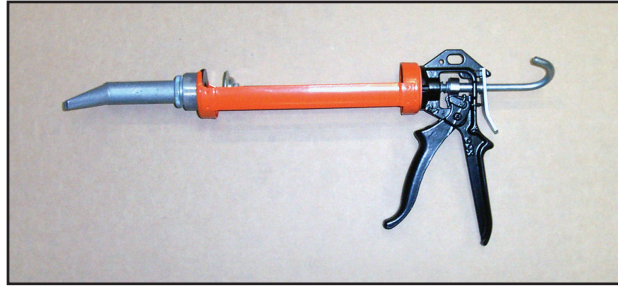
- Manual-powered bulk gun (Figure 2)

FIGURE 2



- Manual-powered cartridge gun (Figure 3)

FIGURE 3



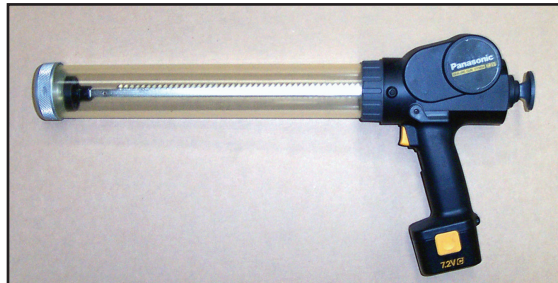
- Air-powered dispensing gun (Figure 4)

FIGURE 4



- Cordless-power bulk gun (Figure 5)

FIGURE 5



- Plastic nozzle end (Figure 6)

FIGURE 6



- Caulking detail or finishing tools (Figure 7)

FIGURE 7



- Backer rod insertion wheels (Figure 8)

FIGURE 8



OBJECTIVE 4

State guidelines in applying sealants.

WORDS YOU SHOULD KNOW

Midrange the point at which a joint is at a width that is exactly halfway between its width when fully expanded and its width when fully contracted

- Properly prepare the joint



- Use the proper sealant and follow the manufacturer's instructions for application
- Do not apply sealants in temperatures below 40° F (5° C)
 - ✓ **NOTE:** Ideally, a sealant should be installed when a joint is in its midrange. This is not usually practical but as a consideration it emphasizes the importance of not installing sealants when the joint is at an extreme width.
- Do not apply sealant when it is likely to be exposed to high winds, blowing dust, direct sunlight, or high humidity while it is curing
- Use a primer when required.
- Ensure that the correct backer rod is properly installed if used
- If cartridges or bulk guns are used, the nozzles should be cut and held at a 45-degree angle to the work (Figure 9)

FIGURE 9



- Ensure that the sealant contacts both sides of the joint
- Apply sealant with a slight pressure against the back of the joint to ensure that there are no gaps or air pockets
- Keep the nozzle buried in the sealant
- If too much sealant is applied, tape the sides of the joint and scrape off the excess sealant



OBJECTIVE 5

- If there is too little sealant in the joint, add more to obtain a proper amount
- Ensure that the sealant is properly set before tooling or painting.
- Wet the finishing tools to allow smooth working of the material

Describe types of joints.

✓ **NOTE:** Joints for concrete structures can be classified in two ways. First, they are classified by how the two surfaces intersect, either as butt joints or lap joints. Further they can be classified by their intended purpose, as described below.

WORDS YOU SHOULD KNOW

Butt joint	a joint formed by two structures meeting end to end
Lap joint	a joint formed by two structures that overlap one another

- **Contraction** — A deliberately weak line in a concrete structure that is designed to regulate the location of cracks that are likely to occur

✓ **NOTE:** Contraction joints are also referred to as control joints.
- **Expansion** — A joint between abutting surfaces that provides space for the surfaces to expand without leading to warping, buckling, or crushing

✓ **NOTE:** Expansion joints are sometimes referred to as isolation joints.
- **Construction** — A joint intended to allow the completion of a pour at a convenient point

✓ **NOTE:** Construction joints are often indicated by the architect but may allow some discretion on the part of the construction crew. Construction joints are often converted to other purposes, such as expansion joints.
- **Special purpose** — Joints designed to permit a specific type of movement of the surfaces relative to each other



OBJECTIVE 6

List purposes of backer rods.

- To regulate the depth of the sealant at the joint
- To provide a surface against which the sealant is applied and compressed during tooling to enhance the adhesion of the sealant to the joint
- To provide a third surface (backing) to which the sealant will not adhere

OBJECTIVE 7

Identify types of backer rods.

WORDS YOU SHOULD KNOW

Cell	a cavity within a material
	✓ NOTE: The materials used to form backer rods contain cells so that the rods will be lightweight, flexible for installation, and capable of compressing and expanding in response to outside pressures; the cells within the backer rod may be individual cells isolated from each other (closed cell) or open to each other (open cell)
Outgassing	a process by which gasses trapped within a material are released due to an outside force such as heat, low external pressures, or punctures
Permeability	the degree to which a material allows gasses and liquids to penetrate the material

- **Closed cell** — A backer rod with a relatively dense surface that provides a non-permeable surface that is easy to handle, though it is subject to outgassing if the surface is punctured.
✓ **NOTE:** This is the most commonly used type of backer rod.
- **Soft cell** — A backer rod that is generally like a closed cell design, though not as firm; consequently, it is subject to twisting and collapse but is more useful in joints with multiple direction changes; it is not subject to outgassing.



- **Open cell** — A backer rod in which the cells are open to each other; consequently, this type is permeable to gasses and many liquids, limiting its suitability for sealant applications.
- **Bond breaker tape** — A self-adhesive material, generally of Teflon, that is sometimes used in place of a backer rod when the dimensions of the joint do not allow the installation of a backer rod.
- **Expansion joint filler** — A generally solid, rectangular polyethylene material that is used for joints that may be subjected to point loading (such as high-heel shoes) or heavy traffic (such as fork lifts).

OBJECTIVE 8

State guidelines for the proper installation of backer rods.

WORDS YOU SHOULD KNOW

Weephole	a designed opening at the bottom of a wall or joint intended to allow the escape of moisture from within the structure
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- Select the correct backer rod for the application.
- Ensure that the backer rod diameter is approximately 25 percent greater than the width of the joint so that a snug fit will be obtained.
- Install the backer rod in a straight, uniform manner, maintaining a constant depth in the joint.
- Ensure that there are no gaps in the installation other than as required for weepholes and other construction features.
- Do not puncture the surface of closed cell backer rods.
- When using bond breaker tape, ensure that the tape covers the bottom (backside) of the joint without covering the sides of the joint.

OBJECTIVE 9

Complete Job Sheet 1.

OBJECTIVE 10

Complete Job Sheet 2.



OBJECTIVE 11

State reasons for sealant failure.

✓ **NOTE:** Joint failures can generally be assigned to one of four types: adhesive failure, cohesive failure, substrate failure, and loss of required sealant properties. Adhesive failure means that the sealant fails to adhere to the joint. Cohesive failure means that the sealant fails to hold together. Substrate failure means that the substrate breaks down. Finally, a sealant can lose its designed properties due to age, exposure to chemicals, exposure to sunlight, severe environmental factors, and other conditions. Common reasons for each of these failure classifications are given below.

WORDS YOU SHOULD KNOW

Compression set the condition that results from a sealant being compressed that acts as a limit to how closely the sealant will return to its original shape and dimensions

Shelf life the amount of time that a product can be stored before it is used and still meet its intended performance characteristics

Adhesive failure

- **Substrate contamination** — The joint was not properly cleaned of dust, dirt, chemicals, old sealant, loose materials, oil, grease, paint, or water, frost, or ice.
- **Unstable substrate** — The backing to which the sealant has adhered breaks down or moves excessively.
- **Improperly installed sealant** — The wrong sealant was used or the correct sealant was installed improperly so that good adhesion was not obtained with the joint.



- **Improper primer practices** — A primer was used when it should not have been or was not used when required. Or, the wrong primer was used or the correct primer was applied incorrectly, such as using too little primer or not allowing enough curing time before applying the sealant.
- **Excessive joint movement** — The contraction and expansion of the joint exceeds the limits of the sealant.
- **Timing of the installation** — The sealant was installed at a time when the joint was contracted far less than its midrange so that too little sealant was applied and was not able to maintain adhesion once the joint widened at lower temperatures.

Cohesive failure

- **Improperly installed sealant** — The wrong sealant was used or the correct sealant was installed improperly so that good adhesion was not obtained with the joint.
- **Excessive joint movement** — The contraction and expansion of the joint exceeds the limits of the sealant.
- **Timing of the installation** — The sealant was installed at a time when the joint was contracted far less than its midrange so that too little sealant was applied and was not able to maintain cohesion once the joint widened at lower temperatures.
- **Improper sealant bead thickness** — If the sealant is too thin it is more subject to cohesive failure because the effects of outside forces and conditions are exaggerated; if the sealant application is too thick, it is more subject to compression set.

Substrate failure

- **Friable or unstable substrate** — The substrate breaks down through deterioration, exposure to the environment, delamination, or other factors that cause the joint to fail even though the sealant maintains adhesion with the substrate.
- **Greater cohesion in the sealant than in the substrate** — The forces acting on the joint exceed the cohesive strength of the substrate so that the sealant holds but the substrate fails.



Loss of sealant properties

- **Improper mixing of multi-component sealants** — If a two-stage sealant is not properly mixed, the mixture will not exhibit all of the design properties.
- **Contamination of the sealant** — Exposure of the sealant to chemicals and materials that break down the sealant, such as exposure of urethane sealants to alcohol or uncured silicones.
- **Reversion** — A condition in which a sealant returns to a semi-liquid state as a result of exposure to conditions outside the design limits of the material, such as temperature extremes, exposure to chemicals such as chlorine, immersion in water, excessive heat and humidity together, and other effects.
- **Weathering** — Hardening, discoloration, loss of elasticity, loss of cohesion, loss of adhesion, and other failures as the result of exposure to temperature cycling, exposure to sunlight, and other natural environmental factors.
- **Failure to reach proper set** — The sealant remains soft due to improper mixing of two-stage sealants, installation at high or low temperatures, extremes of humidity, contamination with other substances, or defective sealant, such as that that has exceeded its shelf-life.
- **Bubbling or blistering** — Bubbles can form in a sealant and blisters can appear on its surface if there is moisture in the substrate, if the sealant is applied as an overly thick bead, due to outgassing from the backer rod or substrate, excessive heat during installation or mixing air in with multi-component sealants.
- **Discoloration** — Incorrect or splotchy color in the sealant is usually the result of contamination from soap, solvents, dirt, other sealants, natural gas or propane fumes or from aging and weathering.

OBJECTIVE 12

Complete Job Sheet 3.





Name _____ Score _____

OBJECTIVE 9

Prepare a joint for sealant application including installation of the backer rod.

BASIC SKILLS



Employability

**EQUIPMENT
AND SUPPLIES**

- Surface to be cleaned
- Air compressor, hoses, and nozzles
- Brushes
- Rags
- Backer rod
- Backer rod insertion wheel tool
- Personal protective equipment

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

PROCEDURE

There is no point in cleaning a joint until just before the installation of the sealant since the joint may become contaminated once more before the sealant is installed. Thus, consideration must be given to whether sealant can be installed. Major considerations are temperature, humidity, and factors such as whether the joint is going to be exposed to sunlight, dust, or extreme temperatures before it sets.

Yes No

- | | |
|---|--|
| <input type="checkbox"/> <input type="checkbox"/> | 1. Check the architectural drawings and other applicable documents to determine the required backer rod and sealant. |
| <input type="checkbox"/> <input type="checkbox"/> | 2. Run a brush over the joint to remove dirt and loose bits of concrete. |

✓ **NOTE:** If replacing existing sealant, ensure that all of the old sealant is removed and that the substrate is sound and free of contaminants that could interfere with sealant adhesion, such as paint and varnishes.



Yes No

3. Use compressed air to blow dirt and debris from the joint and to dry moisture in the joint.

✓ **NOTE:** Position the nozzle so that debris is blown away from you and other workers. On vertical joints, work the nozzle from top to bottom.

4. Inspect the joint to see that it is clean and dry.

✓ **NOTE:** Some cement masons like to rub the joint with a rag or piece of backer rod to ensure that all debris is removed and that the joint is dry.

5. Install the backer rod.

A. Select a backer rod that is approximately 25% greater in diameter than the width of the joint.

B. Begin at one end of the joint and press the backer rod into the joint.

✓ **NOTE:** Backer rod insertion wheels are recommended for uniform depth of backer rod.

C. Ensure that the depth of the joint is no deeper than one-half the width of the joint or a maximum of 1/2 inch and a minimum of 1/4 inch.

6. Repeat Steps 2-5 for the remaining joints.

7. Ask your instructor to inspect your work.

8. Clean up area and put away tools and materials.



**PRODUCT
EVALUATION**

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:

Used personal protective equipment as required	4	3	2	1
Used equipment properly	4	3	2	1
Joint was adequately cleaned	4	3	2	1
Selected correct backer rod	4	3	2	1
Backer rod properly installed	4	3	2	1

**AVERAGE
RATING**

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.

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 10

Apply sealants.

BASIC SKILLS



Employability

EQUIPMENT AND SUPPLIES

- Surface to be sealed
- Various sealants
- Caulking gun
- Mixing utensils for multi-component sealants
- Heating system for sealants that must be melted
- Primer and brushes or dauber if required
- Finishing tools
- Water
- Personal protective equipment

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

PROCEDURE

Yes No

1. Read and follow the manufacturer's instructions and recommendations.

2. Ensure that conditions are suitable for the installation.

✓ **NOTE:** Ideally, sealant should be applied when the joint is at the midrange of joint movement. Normally the temperature should not be less than 45° F. and no more than 90° F.

3. If a preformed sealant is being used, proceed to Step 6.

4. Apply primer, if required.



Yes No

5. Prepare the sealant as required.

✓ **NOTE:** If a multi-component sealant is used, mix the sealant. If the sealant must be melted, heat the sealant as required. Otherwise, prepare the sealant dispenser as required. For example, the nozzle of sealant in a tube may need to be cut open. Such tubes generally have markings to indicate the width of the bead. Cut the nozzle at a 45-degree angle along the appropriate mark. Load the tube in a caulking gun.

6. Install the sealant, maintaining an even, uniform seal (Figure 1).

✓ **NOTE:** If pre-formed sealant is used, ensure that the sealant is straight and untwisted. Apply the sealant with sufficient pressure to ensure that air is not trapped under the sealant (Figure 1).

FIGURE 1



Yes No

7. Tool the sealant to a smooth, neat surface.

✓ **NOTE:** Poured and preformed sealants should be finished flush with the surface of the joint. Site-formed sealants should be finished with a slightly concave appearance (Figure 2).

FIGURE 2



8. Repeat Steps 2-7 for other joints.
9. Clean up area and put away tools and materials.



**PRODUCT
EVALUATION**

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:

Used personal protective equipment as required	4	3	2	1
Used correct tools properly	4	3	2	1
Ensured that conditions are acceptable for application	4	3	2	1
Properly prepared sealant	4	3	2	1
Correctly applied sealant	4	3	2	1
Finished joint correctly	4	3	2	1
Cleaned and stored tools properly	4	3	2	1

**AVERAGE
RATING**

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**EVALUATOR'S
COMMENTS**



Name _____ Score _____

OBJECTIVE 12

Test sealant adhesion.

BASIC SKILLS



Employability

EQUIPMENT AND SUPPLIES

- Joint to be tested
- Utility knife
- Personal protective equipment

✓ **NOTE:** Refer to C.F.R. 1926.28 Sub Part E in regard to personal protective equipment.

PROCEDURE

Yes No

1. Cut the sealant perpendicular to the joint.
2. Beginning at the perpendicular cut, make a cut approximately two inches long between the sealant and the side of the joint.
3. Repeat Step 2 on the opposite side of the joint so that both sides of the sealant are separated from the sides of the joint.
4. Grasp the sealant near the perpendicular cut between your thumb and fingers.
5. Pull the cut sealant from the joint and along the length of the joint away from the perpendicular cut.
6. Observe the sealant.

✓ **NOTE:** If the sealant is properly adhered, the cohesion of the cut sealant will fail before the uncut sealant pulls away from the joint.



Yes No

7. Ask your instructor to evaluate your work.

8. Clean up area and put away tools and materials.



**PRODUCT
EVALUATION**

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:

Used personal protective equipment as required	4	3	2	1
Proper tools used correctly	4	3	2	1
Correctly evaluated sealant	4	3	2	1
Tools properly cleaned and maintained	4	3	2	1

**AVERAGE
RATING**

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.

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**EVALUATOR'S
COMMENTS**



