## Section 2539. Concrete Pavement Undersealing by Pressure Grouting

### 2539.01 DESCRIPTION.

**A.** Underseal and support the concrete pavement to specified grade tolerances by drilling and injecting cement/fly ash grout as shown in the contract documents.

**B.** The contract may also include patches, longitudinal subdrains, pavement surface repair, and crack and joint sealing.

### 2539.02 MATERIALS.

**A. Mix Design.**
The mix design for the pressure grout for undersealing is as follows:

**1.** One part by volume of Type I Portland cement, and three parts by volume of Class C fly ash. Use fly ash from a source approved for this use according to Materials I.M. 491.17.

**2.** Add water to achieve required fluidity, according to Paragraph B of this article.

**3.** Obtain the Engineer's approval for additives.

**4.** The mix design approval will include a suggested set time, intended for ideal temperature conditions.

**B. Fluidity.**
Measure fluidity of the grout slurry using the Corps of Engineers flow cone method according to their specification CRF-C611-80. Time of efflux shall range from 10 seconds to 16 seconds. A more fluid mix having a flow cone time of efflux of 9 seconds to 15 seconds may be used during the initial injection at each hole. These measurements will be made by the Engineer, normally at least once every 4 working hours.

**C. Material Proposal.**
Submit to the Engineer the proposal for materials and additives to be used for the mix design.

### 2539.03 CONSTRUCTION.

**A. Contractor Qualification.**

**1.** Competency in concrete pavement undersealing is required.

**2.** Before the work is started, submit to the Engineer evidence of competence and previous experience with this type of work. Include in the evidence:
- An equipment list,
- Personnel and their experience, and
- A detailed undersealing procedure which will be followed.

**3.** Submit this evidence to the Contracts Engineer prior to the letting. Specific approval will be required before this work is started.

**B. Equipment.**
Furnish all equipment necessary for the adequate performance of the work of this contract. As a minimum, these are as follows:

**1. Grout Plant.**

**a.** Mixing may be with a colloidal mixer or other type of mixer as approved by the Engineer. Ensure the mixer has the capability of thoroughly mixing the various components of the grout.

**b.** Ensure the following:
- The plant includes a positive action or rotor injection pump, capable of forcing grout through a hole drilled in the pavement so that grout will fill voids and cavities beneath the pavement slab.

- The pump is capable of supplying a pressure up to 200 psi (1380 kPa) at the end of the discharge pipe so as to be able to lift the slab without damaging the pavement.
- The pressure is monitored by an accurate pressure gage in the grout line.
- The supply tank is equipped with paddles or other means of agitation to maintain a homogeneous mixture.

**c.** Measure the dry materials by weight (mass), if in bulk, or use materials packaged in uniform volume sacks. Batch the water through a meter or scale.

**2. Water Tanker.**
Supply water from a water truck with adequate capacity and pressure for delivery to the grout plant.

**3. Drilling Equipment.**

**a.** Furnish compressed air or hydraulically operated rock drills, or other devices, which have the capability of drilling grout injection holes through the pavement and subbase material, if any.

**b.** Ensure the equipment is in good condition and is operated in a manner that the holes are vertical and not "out-of-round."

**4. Transport.**
Furnish the material transport as well as the handling equipment.

**5. Miscellaneous Equipment.**
Furnish the following:

- All necessary hoses, valves, and valve manifolds to control pressure and volume,
- Pressure gage protectors,
- Expanding packers for the grout injection,
- Wood plugs,
- Hole washing tools,
- Drill steel and bits, and
- All miscellaneous tools, equipment, and supplies that may be required to complete the work.

**C. Undersealing by Pressure Grouting.**
Underseal the pavement by pressure grouting as shown in the contract documents. The Engineer will designate specific locations for pavement undersealing.

**1. Drilling Holes.**

**a.** Drill 1 1/4 inch to 1 1/2 inch (30 mm to 40 mm) diameter holes through the concrete pavement at the locations designated by the Engineer and in a pattern designated in the contract documents or approved by the Engineer. If a pattern is not designated, a three hole pattern will normally be used at each joint or crack in each lane:

- One hole is to be placed in the approach panel, 1.5 feet (0.5 m) from the joint or crack, and 4 feet to 8 feet (1.2 m to 2.4 m) from the center line.
- Two holes are to be placed in the leave panel, 3 feet (1 m) from the joint or crack, and 3 feet (1 m) from the panel edges.

**b.** For holes nearest the edges of the slab, the joints, or a major crack, a maximum tolerance of 3 inches (75 mm) from the precisely marked location is considered to be reasonable. For other holes, a maximum tolerance of 6 inches (150 mm) is considered to be reasonable. Comply with the following:

**1)** Do not drill holes directly over joints or cracks.

**2)** Rotate the drills to avoid cracking the pavement and to provide satisfactory holes of the proper diameter for effective operations in pressure grouting.

**3)** When drilling holes, hold the drills perpendicular as possible to the pavement surface.

**4)** Plug irregular or unsatisfactory holes which cannot be satisfactorily used in pressure grouting by filling with the hole patching mixture. Drill new holes.

**5)** Ensure the downward weight (mass) does not exceed 200 pounds (100 kg) during drilling.

**c.** Ensure concrete spalling resulting from drilling does not exceed 20% of the pavement thickness. When such spalling occurs, the Engineer may require a lower down feed pressure to be used.

**d.** Ensure the holes do not extend more than 4 inches (100 mm) below the base of the pavement or stabilized subbase, if any.

**2. Washing Holes.**
Holes may be washed to create a small cavity, allowing initial spread of grout.

**3. Undersealing.**

**a.** When undersealing, pump grout under the pavement panel until movement in the slab is detectable. For the purpose of detection, use:
- A beam having a base length of at least 4 feet (1.2 m), and
- At least two accurate gages (capable of detecting movement of 0.010 inch (0.25 mm)) placed so that relative movement can be checked between both adjacent panels and the shoulder.

**b.** Comply with the following:
**1)** Limit panel movement to 0.10 inch (2.5 mm) or less.
**2)** Limit the initial pressure to 20 psi (150 kPa) or less.
**3)** After pumping has been started, limit the pumping pressure to 7 psi (50 kPa) or less.

**c.** If the Engineer determines that continued grout injection at a specific location is no longer feasible due to major voids, the Engineer may direct the Contractor to cease grout injection at that particular location.

**4. Water Displacement.**
Allow water that is displaced from the void structure by the grout to flow out freely. Excessive loss of the grout through cracks, joints, or in the shoulder area will not be tolerated.

**5. Inspection Holes.**

**a.** The Engineer may require inspection holes to be drilled in the shoulder area at the pavement edge. The purpose shall assure that the grout is not infiltrating existing underdrains during the pumping operation.

**b.** Drilling of inspection holes will be limited to areas where there are existing subdrains.

**6. Radial Cracks.**
Cracks extending radially from the grout injection holes will be presumed to have been caused by improper injection techniques by the Contractor.

**7. Hole Patching.**

**a.** Upon completion of the undersealing, plug all drill holes by tamping the hole full of very dry concrete (1 part cement, 2 parts sand).

**b.** Finish the plug flush with the pavement surface.

**c.** Fill inspection holes with material similar to that in the shoulder area.

**D. Limitations of Operations.**

**1.** Do not perform pavement undersealing when the temperature at the bottom of the pavement slab is below 40°F (4°C).

**2.** Do not allow grout to be held in the mixer or injection pump sump for more than 45 minutes after mixing. Do not use grout held for a longer time than this. Grout held in the mixer for more than 45 minutes will be deducted from the pay quantity.

**3.** Traffic will be permitted on the undersealed pavement slab when the grout has obtained a set satisfactory to the Engineer. Use the minimum set time included in the mix design approval intended for ideal temperature conditions. It is anticipated that the set time will be extended to approximately 6 hours at 40°F (4°C) and 4 hours at 50°F (10°C). The minimum set time will vary with individual material combinations.

**4.** Conduct the work on only 50% of the pavement width at a time.

**5.** Allow traffic to use the pavement during construction operations. Conduct all operations to provide a minimum of inconvenience to traffic.

6. Adjust the work schedule so that all traffic lanes can be opened to public traffic during nonworking hours.

7. Limit drilled holes to the amount that can be grouted during the following working day, unless the Engineer approves otherwise.

8. If unforeseen conditions should result in uncompleted sections being left overnight and requiring protection, provide a sufficient number of traffic control devices and flaggers to warn and direct traffic from the time construction operations have stopped until they have resumed again. No extra payment will be made for the necessary traffic control devices and flaggers.

9. Apply Articles 1107.08, 1107.09, and 1108.03. When there is a contract item for Traffic Control, furnish, erect, and maintain all signs, barricades, and other traffic control devices required by the contract documents.

10. Remove debris resulting from the operations from the traffic lanes and shoulders as the work progresses and before the traffic lane is opened to public traffic.

11. Shoulder adjustments will be made by the Contracting Authority, as the Engineer deems appropriate. Except when additional shoulder work is required by the contract, the Engineer will provide and maintain signing for vertical drop-offs at the pavement edges that remain after the Contractor has completed the pressure grouting operation. Provide signing, barricades, and other traffic control required by the contract documents for the shoulder while work at the specific location remains uncompleted.

12. When other work is included in the project, sequence the operations so that undersealing, longitudinal subdrains, patching, diamond grinding, and crack and joint sealing are done in an area in that order. All of these operations required by the contract documents should be completed in an area in the same construction season, or not started until the following construction season.

**E. Acceptance.**
Before final acceptance, clean up all unused material. Ensure the surrounding areas are left in a neat and orderly condition as provided in Article 1104.08.

## 2539.04 METHOD OF MEASUREMENT.

**A.** Measurement for Pavement Undersealing by Pressure Grouting will be as follows:

1. **Holes (for Pressure Grouting).**
By count for Holes drilled through the pavement at locations designated by the Engineer. Irregular or unsatisfactory holes which cannot be satisfactorily used in pressure grouting will not be counted.

2. **Portland Cement (for Pressure Grouting).**
Calculated from the bulk weight (mass) in tons (megagrams) or number of sacks of cement furnished and used in the work. This will include the quantity used in pressure grouting and in filling drilled holes. Cement that is not used will be deducted.

**B.** When grouting is discontinued at any specific location, as directed by the Engineer, the holes drilled and the Portland cement used will be included in the measured quantities.

**C.** Inspection holes will be counted separately.

**D.** Water and fly ash will not be measured for payment.

## 2539.05 BASIS OF PAYMENT.

**A.** Payment for Pavement Undersealing by Pressure Grouting will be the contract unit price as follows:

1. **Holes (for Pressure Grouting).**
Each.

2. **Portland Cement (for Pressure Grouting).**
   Per ton (megagram) for cement used in the work.

**B.** When the contract documents include an item for Traffic Control, payment will be the lump sum contract price according to Section 2528.

**C.** When the undersealing operation results in radial cracking, payment will be reduced by $0.50 ($1.60) for each linear foot (meter) of crack measured by the Engineer, to the nearest foot (0.1 m).

**D.** Payment for the number of inspection holes drilled will be 50% of the contract unit price for a hole for pressure grouting.

**E.** Payments are full compensation for:

- Furnishing all materials, including fly ash and water and hole sealing mixture,
- Proportioning and mixing,
- Drilling holes,
- Pumping and repumping,
- Filling the holes, and
- Furnishing all equipment, tools, labor, and incidentals necessary to complete the work in accordance with the contract documents.