SHALLOW SUBSURFACE POLYURETHANE INJECTION
(REV 2-13-19)

The following new Section is added:

SECTION 173
SHALLOW SUBSURFACE POLYURETHANE INJECTION

173-1 General.

Furnish and inject polyurethane grout to fill voids, seal drainage structures, seal nonstructural wall openings, lift roadway panels, lift approach slabs, and correct pavement alignment issues at the locations shown in the Plans or as directed by the Engineer. Furnish all labor, equipment and materials required to inject expansive one or two-part polyurethane.

Work may be performed at night or on weekends as deemed necessary by the Department.

Review the available subsurface information and visit the site to assess the severity of issue to be corrected, the site geometry, equipment access conditions, and location of existing structures and above ground facilities. Any damage resulting from the injection operation is the sole responsibility of the contractor.

Field locate and verify the location of all utilities in the vicinity of the project site prior to starting the work. Maintain uninterrupted service for all existing utilities throughout the work

173-2 Personnel Requirements.

The on-site superintendent supervising the work described in this Section must have at least three years of verifiable experience in polyurethane injection. Provide documentation of each project successfully completed, listing the project name and location, name of contracting party with current contact number, a brief description of the work, and dates of completion.

Prior to the start of the work, submit the Contractor and superintendent qualifications to the Engineer for approval.

173-3 Materials.

173-3.1 One Component Polyurethane: Use a one component high density polyurethane grout, meeting the following requirements, that upon injection reacts with moisture for rapid expansion and curing to create a watertight mass.

173-3.1.1 Viscosity: The material must have a viscosity of 110 to 130 centipoise (cP) at 20°C to 25°C.

173-3.1.2 Compressive and Tensile Strength: The material must have a minimum cured compressive strength of 600 psi in accordance with ASTM C39 (with fine sand and without conditioning), a minimum cured tensile strength of 40 psi in accordance with ASTM D1623 or ASTM D3574, and no shrinkage in accordance with ASTM D1042 or ASTM D756.

173-3.1.3 Cure Time: The material must achieve a minimum compressive strength of 400 psi within 30 minutes. If work is performed within the travel lane, traffic must be safely restored within 30 minutes after the last injection of material.

173-3.1.4 Performance in Water: Ensure the cured material is not affected by the presence of excess water.

173-3.1.5 Certification: Submit a manufacturer's certification that the material meets the requirements of this Developmental Specification to the Engineer.

173-3.1.6 Alternate Formulations: Certain situations may necessitate the use of polyurethane formulations that provide physical characteristics exceeding the requirements above. Submit the manufacturer's certification for the alternate formulation to the Engineer for approval.

173-3.2 Two Component Polyurethane: Use a two component closed cell, hydro-insensitive, high density polyurethane system that upon injection results in rapid expansion and curing.

173-3.2.1 Apparent Density: The material must have an apparent overall density of 4.7 pounds per cubic foot to 6.5 pounds per cubic foot, tested in accordance with ASTM D1622 (without conditioning).

173-3.2.2 Compressive Strength: The material must have a minimum cured compressive strength of 75 psi tested in accordance ASTM D1621 (without conditioning).

173-3.2.3 Cure Time: The material must achieve a minimum compressive strength of 60 psi within 30 minutes. Traffic, if work is performed within the travel lane, must be safely restored within 30 minutes after the last injection of material.

173-3.2.4 Performance in Water: Ensure the injected material is not affected by the presence of excess water.

173-3.2.5 Certification: Submit a manufacturer's certification that the material meets the requirements of this Developmental Specification to the Engineer.

173-3.2.6 Alternate Formulations: Certain situations may necessitate the use of polyurethane formulations that provide physical characteristics exceeding the requirements above. Submit the manufacturer's certification for the alternate formulation to the Engineer for approval.

173-4 Equipment.

Provide mobile injection equipment, including, but not limited to, a pumping unit capable of injecting material to the locations and depths required with electric generating capabilities necessary to support the injection operations. The equipment must be capable of controlling the rate of flow of material to achieve the desired results while minimizing blowback and blowouts. Use equipment with a certified flow meter or volumetric measurement device having a visual readout to measure the amount of material injected at each location. Provide a certification for the metering device to the Engineer.

Use equipment with pressure and temperature control devices capable of maintaining proper temperature and proportionate mixing of the polyurethane materials. Ensure the equipment properly mixes two component materials when two component polyurethane materials are injected.

Use drilling equipment capable of drilling the required diameter injection holes through concrete, pavement or other masonry materials as shown in the Plans without damaging the integrity of the existing structure.

Use laser levels and target readers, zip levels and other measuring devices capable of monitoring movement at the surface of the pavement or structure to verify that the necessary void filling and improvement has occurred without adversely affecting the existing profile.

Provide all necessary equipment such as light towers, electric generators, compressors, heaters, hoses, containers, valves and gauges to efficiently conduct and control the work.

173-5 Construction Requirements.

173-5.1 Pre-Construction Submittals: Upon approval of the Contractor's qualifications, submit the following information to the Engineer for review and approval prior to performing any work:

1. The proposed start date and duration of the project sequence.
2. The type and size of all equipment to be used. Describe the methods to be used to achieve the requirements of this Specification.
3. The materials to be used and anticipated injection rate.
4. A description of construction methods to be used for site preparation, including the methods for measurement concerning slab lifting requirements, clearing of debris and a pre-construction survey documenting existing cracks/damage to concrete curb and gutters or adjacent structures.
5. A description of construction methods to be used to perform the injection of the polyurethane with a detailed sequence of injection operations.
6. Manufacturer's technical data sheet verifying that the polyurethane materials meet all requirements this Specification, including the densities (in pounds per gallon) of each individual component (resin and activator) of any two part polyurethane materials.
7. Certification for the metering device or the Contractor's plan for measuring the material.
8. Proposed plan to monitor inside subsurface drainage structures during injection and to prevent excessive polyurethane migration into any existing drainage structures.

173-5.2 Pavement Profile: Prepare a pavement and structure profile from laser level measurements of each area to document pre-existing conditions to ensure movement does not exceed 1/16 inch of the final planned elevation during the injection operations. Prior to beginning any work, submit a report documenting this inspection and the recorded elevations to the Engineer for approval. Include photographs of the area documenting the location and length of existing cracks. Prior approval of this report will not be required for emergency response work.

173-5.3 Quality Control: For polyurethane solutions which require mixing or blending of multiple components, perform a daily quality check in the presence of the Engineer, using the flow meters and/or measurement devices, on the ratio of the parts provided by the injection system. Perform a test shot of material from one component source at a time with a minimum of 5 gallons of each material, comparing the output in gallons of resin to the gallons of activator, if applicable (resin material only for one component foam system). Determine the injection ratio for two component systems. If this ratio differs from the approved solution ratio used at the test point locations, check the system for problems, make any necessary adjustments until a proper ratio is achieved. Following these checks and adjustments, and prior to performing the work each day, reset the measurement devices on the pumping units to zero.

The Engineer reserves the right to perform compressive strength testing on polyurethane samples.

173-5.4 Testing.

173-5.4.1 Pre-Production: When pre-production test injection points are shown in the Plans, complete a pre-production polyurethane injection performance testing program. Prior to the injection at production point locations indicated in the Plans, determine the rate and amount to be injected to obtain the required improvement. Assess the cure rate for the proposed process by the initial completion of pre-production polyurethane injection performance testing at

pre-production test injection points shown in the Plans. Inject at the pre-production test point locations using the proposed materials, injection rates, and processes anticipated for production.

To verify adequate subsurface improvement has been achieved, perform a minimum of two standard penetration test (SPT) soil borings in accordance with ASTM D1586, using safety or automatic hammer) or dynamic cone penetrometer (DCP) soundings in accordance with ASTM D6951, at locations approved by the Engineer. After injection of the test points, locate at least one SPT boring or DCP sounding just outside the injected area and at least one SPT boring or DCP sounding centrally within the test point grid, unless shown otherwise in the Plans. Use the same equipment for all tests. Submit the results of the SPT borings and DCP soundings, the recommended injection rate and injection cut-off criteria to the Engineer for review and approval prior to proceeding with the production point locations. The Engineer may require additional SPT borings or DCP soundings.

Do not adjust the polyurethane components, ratios or injection processes during production point injection without the approval of the Engineer.

173-5.4.2 Post-Production: Additional subsurface testing, performed using SPT soil borings or DCP soundings, may be required as directed by the Engineer on each project lane to confirm existing subgrade soil conditions based upon available subsurface information. The Engineer may require access holes to be drilled to allow the insertion of video equipment to assess the size of existing voids.

173-5.5 Injection Placement: Inject the polyurethane to the depth shown in the Plans. If not shown in the Plans, select the exact location, spacing, hole size and depth of the injection tubes with the approval of the Engineer. All one component polyurethane material must be injected at least one foot below the existing water table. When direct access to voids is available, provide a means to confine the placement and inject the polyurethane directly into the void. When direct access to voids is not available, drill a series of holes sized no larger than required for the injection tube placement, at approximately 3 to 4 foot intervals or as determined by the Engineer When drilling through reinforced concrete, determine the location of existing reinforcing prior to drilling injection holes. Do not drill into or cut existing reinforcing. If existing reinforcing is encountered during drilling, shift the hole to clear reinforcing.

Install and operate a level control system during the injection operation. Monitor the elevation of the pavement or structure profile to detect any movement within a 10 to 15 foot radius from the point of injection during injection operations, or as directed by the Engineer. Continuously monitor laser level or dial indicator micrometer readings during injection operations to determine sufficient material usage as indicated by pavement movement of 1/16 inch or less. Additionally, monitor all directly adjoining structures, such as adjacent bridge spans, road surfaces, curb and gutter to detect and prevent unintended movement.

Inject the material gradually to avoid excessive force build up. If the movements exceed 1/16 inch beyond the desired profile, take corrective actions to stop the movement and perform repairs. Immediately notify the Engineer if signs of damage are observed, such as new cracks in the pavement, increased size of existing cracks, or separation of joints in paved and unpaved surfaces. Repair any damage to the concrete slab/pavement, adjacent structures, gutters, and shoulders resulting from the injection operations to the satisfaction of the Engineer, and at no cost to the Department.

Remove any excess polyurethane material extruding from cracks or the drilled holes. Seal the drilled holes to the full depth of the slab section with cement grout.

Allow the polyurethane material to cure before allowing traffic on to approach slabs adjusted by polyurethane injection.

173-5.6 Faulted Joints. For undersealing and leveling of faulted joints of concrete pavement, inject to fill any void in the sub-base. When the void is filled and the area is stabilized, begin lifting and realigning panels to proper grade for ride improvement.

173-5.7 Drainable Bases: Ensure the material does not enter the drainable base. For stabilization of pavement with a drainable base, place injection tubes approximately 24 inches below the bottom of the drainable base. Inject the material to stabilize the subgrade and then move the subbase and base material up, compressing it against the bottom of the pavement, returning the pavement to near its original grade.

173-5.8 Lifting: In some situations for lifting, the subgrade will need to be stabilized. When stabilization is required, an injection depth will be determined by the Contractor and approved by the Engineer, but will not be at a depth greater than 3 feet below the pavement base. Inject the material until the dip in the pavement is removed and the pavement or structure is brought to the desired grade.

If stabilization is not necessary, the injection depth will be 12 or more inches below the pavement base to fill the void and lift the pavement or structure to the desired grade.

173-5.9 Sleeper Slabs: For bridge approach slabs that have sleeper support slabs, drill all holes, fully sleeved by tubes, into the base soils to prevent any injection of polyurethane between the sleeper slab and the pavement. Insert injection tubes to a minimum depth of 4 to 5 feet and a minimum depth of 1 to 2 feet below the bottom of the sleeper slab. Inject the material through each tube until the soils are stabilized as evident when movement of the pavement is detected. Continue to inject material beneath the sleeper slab to lift the sleeper slab and pavement together to the desired grade.

173-5.10 Edgedrains: If edgedrains are present, keep all injections within 4 feet of the edgedrain and at least 18 inches below the bottom of the edgedrain.

173-5.11 Punch Outs: Prior to replacement of short sections of concrete or asphalt (punch-outs) where base and subbase are suspected as contributing to the pavement failure, perform injections to stabilize the base and subbase to avoid cutout and removal of base and subbase. Ensure removal of the existing pavement does not disturb the tubes or the newly stabilized base and subbase. After removal of the pavement, cut the tubes off at the top of the base material.

173-5.12 Blowouts: Take responsibility for any pavement blowouts, excessive pavement lifting, pavement damage or exacerbation of misalignment that may occur as a result of the work. If movement exceeds 1/16 inch beyond the desired movement, take corrective actions to stop the movement. Repair the area to the satisfaction of the Engineer and at no cost to the Department.

173-5.13 Storm Drains: For lifting, sealing and filling of voids around storm drains including pipe, manholes and other built structures, submit a plan of action to the Engineer for approval. Prior to performing work, evaluate the integrity of the pipe and storm drain system through inspection, either visual or by remote camera, to determine the correct placement of polyurethane. Perform post installation evaluation of the work by similar means. Ensure that any injected material entering the storm drain system during the installation work is removed and disposed of accordingly.

173-5.14 Water Control Structures: For void filling and sealing of water control structures, culverts and sea walls, submit a plan of action to the Engineer for approval. Base the

plan of action on the specific situation and propose the injection spacing, elevations, quantities and desired result.

173-6 Report.

Submit a report to the Engineer documenting the polyurethane material injection and instrumentation. Provide before and after photos of the project, a diagram of injection ports, injection volumes per port, problems encountered during construction, resolutions made, and certification testing results in the report. Include pavement profiles before and after injection, document whether the transition at joints are smooth, and whether there are additional cracks in the pavement. Submit the report prior to final acceptance of the project. In addition, supply as-built injection drawings and grade readings within 5 days of completing the project.

173-7 Method of Measurement.

For single component polyurethane, the quantity to be paid will be the volume (in gallons) of material authorized, injected, and accepted.

For two component polyurethane mixes, the quantity to be paid will be the weight, in pounds, of material authorized, injected, and accepted. Multiply the volume (in gallons) of resin by the resin density to determine the weight of resin. Multiply the volume (in gallons) of activator by the activator density to determine the weight of activator. Add the weights of resin and activator to determine the total weight.

For pre-production testing, do not include the cost of polyurethane material. Include the quantity of material used for pre-production testing in the quantity of single component or two component polyurethane injection, as appropriate.

173-8 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section including furnishing all labor, materials, tools, equipment, testing, and incidentals necessary to complete the work.

Payment for pre-production testing will not be made until all injection placements are completed and accepted.

Payment will be made under:

Item No. 906-173- Polyurethane Injection