

DESCRIPTION

This work shall consist of soil densification and/or soil displacement to improve subgrade and foundation soils under pavement, and under and around structures, culverts, and utilities by injecting high density polyurethane (HDP) grout at locations and depths in accordance with the contract documents and as directed by the Engineer.

MATERIALS

Provide HDP material provided by manufacturers on the Departmental Approved List of Materials and Equipment.

Basis of Approval.

In order for a HDP material to be included on the Approved List, the manufacturer must submit a certification of compliance stating that the product conforms to the requirements herein, and test results from an independent laboratory. The requirements include:

- The HDP material is a two-part, one-to-one ratio by volume, closed cell, hydro-insensitive, high density polyurethane system.
- The HDP material is a hydro-insensitive material in its component reaction so that the injected product is not significantly compromised by soil moisture or free water. Follow the Department's current version of Geotechnical Test Procedure (GTP-9) Test Procedure for Hydro-Insensitivity of High Density Polyurethane Grout – Panel Test.
- The HDP material is a polyurethane-forming mixture, having a water insoluble diluent, which permits the formation of polyurethanes in excess water.
- The HDP material has properties that conform to the requirements specified in Table 1 below.

Table 1 – HDP Material Properties

| Property | Test Method | Requirement |
|--|--------------------|--------------------|
| Free Rise Density (kN/m ³) | ASTM D 1622 | 0.597 to 0.660 |
| Compressive Strength (kPa) | ASTM D 1621 | 345 (minimum) |
| Tensile Core (kPa) | ASTM D 1623 | 345 (minimum) |

- HDP shall obtain 90% of the required values within 30 minutes of injection.

CONSTRUCTION DETAILS**Dynamic Cone Penetrometer Testing.**

Perform dynamic cone penetrometer testing at locations determined by visual survey of existing site conditions. Dynamic cone penetrometer testing will be required at each treatment location to confirm existing subgrade or foundation soil conditions, to locate voids, and to assist in determination of injection patterns.

Collate dynamic cone penetrometer test results to identify breadth of treatment area and develop HDP Injection Plan.

Submittal of the HDP Injection Plan.

Submit a detailed plan of operation to the Engineer for approval at least 14 calendar days before beginning the work that includes the following:

- A. Injection Contractor's Superintendant experience and qualifications in injecting the HDP material chosen from the Approved List. Include a list of at least 5 successful projects utilizing the chosen HDP material, each identifying the project owner and contact information.
- B. Names and qualifications of all crew members in injecting the HDP material chosen from the Approved List.
- C. The number, type, and model of equipment and material control/metering devices including current calibration documentation. This includes a calibrated flow meter.
- D. Monitoring plan for the proposed injection site including location of monitoring points and surveying equipment and intervals to ensure the final profile is accurate.
- E. Method of HDP injection, depth(s) of injection, and a Plan View depicting the hole locations, pattern and spacing.
 1. **For unconsolidated soil densification.** Ensure that the location, spacing, hole size, depth of injection tubes, the rate of injection and amount of HDP material is sufficient to obtain the proper densification.
 2. **For realigning faulted joints of concrete pavement.** Ensure that the location, spacing, hole size, depth of injection tubes, the rate of injection and amount of HDP material is sufficient to support and realign the slabs. The holes shall be spaced approximately 1.2 m to fill voids and realign the pavement. The depth of injection tubes on the low side of the faulted joint shall be approximately 1 to 1.2 m.
 3. **For correction of a dip in concrete without differential faulting.** Ensure that the location, spacing, hole size, depth of injection tubes, the rate of injection and amount of HDP material is sufficient to return the pavement to its original profile and grade. The depth of injection tubes shall be approximately 300 mm below the bottom of the base material.
 4. **For correcting settled bridge approach slabs.** Ensure that the location, spacing, hole size, depth of injection tubes, the rate of injection and amount of HDP material is sufficient to support and realign the slab. The holes shall be spaced approximately 1.2 m to fill voids and realign the pavement. The depth of injection tubes on the low side of the slab shall be approximately 1 to 1.2 m.
 5. **For grouting around culverts.** Ensure that the location, spacing, hole size, depth of injection tubes, the rate of injection and amount of HDP material is sufficient to densify soil and fill voids under, around and above the culvert.
- F. Method and control devices for maintaining proper polyurethane component material temperatures and maintaining proportionate mixing of component materials.
- G. Schedule, including the hours of operation and expected production rates for the work.

Equipment.

Provide equipment needed to perform the work, including the following:

- A. A pneumatic or electric drill capable of drilling up to 16 mm diameter holes through up to 450 mm of asphalt and/or concrete pavement.
- B. A laser leveling unit capable of accurately measuring within a tolerance of 0.5 mm to ensure that the concrete pavement is raised to an even plane or to the required elevation.
- C. A truck-mounted grout pumping unit capable of injecting HDP material at a controlled rate through tubing beneath the pavement into the subgrade to the required

depth(s). Ensure that the pumping unit is equipped with certified flow meters to measure the amount each component material injected so that an accurate quantity of HDP is recorded at each location. Ensure that the system is capable of immediate control of the material flow to ensure proper soil densification and avoid excessive lifting or blowups of the pavement. Ensure the unit is equipped with pressure and temperature control devices capable of maintaining proper temperature and proportionate mixing of the polyurethane component materials.

D. A portable dynamic cone penetrometer for on-site soils investigation.

Weather Limitations.

Perform polymer injection when the air temperature is at least 2° C and rising, and when the temperature of the subgrade and foundation soils is 2° C or warmer. Do not perform polymer injection when the foundation soils or subgrade is frozen.

Site Monitoring.

Provide a pavement profile from laser level measurements of each area where the pavement structures require HDP material injection. Provide each profile to the Engineer for acceptance prior to performing the work. Provide continuous laser level or dial indicator micrometer readings during injection to determine sufficient material usage and soils densification as indicated by pavement movement of 1 mm.

Drilling Holes.

Drill the hole pattern for HDP material injection in accordance with the Approved HDP Injection Plan. Ensure that holes do not exceed 16 mm in diameter, and are drilled vertically and round to a depth sufficient to penetrate below the pavement and into the subgrade. Clean holes to remove any obstructions to allow flow of HDP. Insert injection tubes of sufficient length into the drill holes to the required depth(s).

High Density Polyurethane Injection.

Inject HDP material according to the Approved HDP Injection Plan.

Where injection is to be performed in the area of drainable base material, keep the injection tubes at least 600 mm below the bottom of the drainable base layer.

Where edge drains are present, any injections within a lateral distance of 1.2 m to the edge drain shall be located a minimum of 450 mm below the bottom of the edge drain.

Prevent excessive loss of HDP material through cracks, joints and all drilled holes.

For realigning faulted joints of concrete pavement, inject HDP material into the subgrade to densify the area supporting the joint. If the differential settlement cannot be completely corrected due to locking of the joint, sawcut the joint to free the slabs and then inject additional HDP material to level the slabs. Any necessary sawcutting will be paid for under separate item.

For correction of a dip in concrete without differential faulting, after the subgrade is stabilized, lift the dip out of the pavement through continued injection of HDP material below the base with the intent to return the pavement to its original profile and grade.

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When the injection nozzle is removed from a hole in concrete, remove any excess HDP material from the area and seal the hole with an approved cement grout in accordance with §701-05 *Concrete Grouting and Anchoring Material*.

Remove all excess HDP material from the roadway and the project right-of-way prior to restoring normal traffic.

The finished concrete slab shall conform to the grade shown on the contract documents within a tolerance of 6 mm.

Repair any pavement blowouts, cracking, excessive lifting, or uneven pavement that results from the raising of the pavement to the satisfaction of the Engineer at no additional cost to the State.

Quality Assurance Program.

The Department will visually inspect the High Density Polymer Material to ensure that it is Hydro-Insensitive to assure quality. Inspectors will follow the Department’s current version of Geotechnical Test Procedure (GTP-8) Test Procedure for Hydro-Insensitivity of High Density Polyurethane Grout – Barrel Test.

Reporting Results.

Provide a preliminary report to the Engineer within two working days and final report within five working days of completion of injection for each improvement location. The injection results shall be presented to the Engineer in a report. The report shall include the Approved HDP Injection Plan with As-Built remarks including:

- a. Actual hole locations, pattern spacing, and depth,
- b. HDP grout take, identified for each hole, and
- c. Extent of coverage of in-place, expanded HDP material.

METHOD OF MEASUREMENT

Subgrade and Foundation Improvement – Polymer Injection:

This work will be measured as the number of kilograms of high density polyurethane material satisfactorily furnished and placed.

BASIS OF PAYMENT

Subgrade and Foundation Improvement – Polymer Injection:

The unit price bid shall include the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the work and report the results, including taking dynamic cone penetrometer readings to determine the soil conditions, drilling holes, furnishing, mixing and injecting HDP, performing site monitoring, and cleaning the site of excess HDP material.