

SECTION 313223 DEEP SOIL MODIFICATION WITH POLYURETHANE MATERIAL

1.1 DESCRIPTION

- A. This work shall consist of soil modification with the intent of increasing bearing capacity with deep soil stabilization at locations shown on the drawings. The desired outcome for this project is to stabilize the soils surrounding the existing corrugated metal arch pipe utility tunnel and create a structural soil bridge over the tunnel.
- B. The work covered by this section consists of providing project control, supervision, all labor and equipment, and performing all operations in connection with soil densification and filling any void that may be present by injection of chemical grout. Chemical grout injection shall be performed within the approximate limits and depths as shown on the drawings, or as directed by Engineer of Record.

1.2 MATERIAL REQUIREMENTS

- A. The material used for soil modification shall be a closed cell, hydro-insensitive, high-density polyurethane system made in the USA. The material shall be a polyurethane-forming mixture, having a water insoluble diluent, which permits the formation of polyurethanes in excess water. The presence of these water insoluble diluents provides polyurethane foam with improved dimensional stability properties. The product formula and these characteristics must be certified by the manufacturer.
- B. The material shall have the following specifications:

Physical Property	Test Method	Standard
Free Rise Density	ASTM D 1622	4 lbs/ft <sup>3</sup> , Minimum
Compressive Strength	ASTM D 1621	60 psi, Minimum
Compressive Modulus	ASTM D 1621	2000 psi, Minimum
Dimensional Stability	ASTM D 2126	
	Volume Change @ -40°F	< 2%
	Volume Change @ +200°F	< 2%
Flexural Strength	ASTM D 790	90 psi, Minimum
Flexural Modulus	ASTM D 790	2000 psi, Minimum
Shear Strength	ASTM C 273	45 psi, Minimum
Shear Modulus	ASTM C 273	900 psi, Minimum
Tensile Strength	ASTM D 1623	60 psi, Minimum
Tensile Modulus	ASTM D 1623	1700 psi, Minimum
% Water Absorption	ASTM D 2842	< 2%
Closed Cell Content	ASTM D 6226	90%, Minimum

### 1.3 EQUIPMENT REQUIREMENTS

- A. The contractor shall provide at a minimum, the following equipment:
1. A truck-mounted pumping unit capable of injecting the high-density polyurethane material as specified. The pumping unit shall be capable of controlling the rate of flow of material as required. The unit shall be equipped with a flow meter to measure the amount of high-density polyurethane injected at each location. The flow meter shall output readings in both pounds and gallons.
  2. Pumping systems shall have pressure and temperature control devices capable of maintaining proper temperature and proportionate mixing of the polyurethane component materials without requiring operator input.
  3. Pneumatic or electric drills capable of efficiently drilling 5/8" to 1" diameter injection holes through the pavement without damaging the structural integrity of the existing pavement.
  4. The contractor shall provide vertical survey control in the vicinity of each injection point to determine if and when surface heave has occurred.
  5. All necessary safety equipment, light towers, electric generators, compressors, heaters, hoses, containers, valves and gauges to efficiently conduct and control the work.

### 1.4 CONSTRUCTION REQUIREMENTS

- A. For soil modification and compaction of unconsolidated base soils, a series of 5/8" – 1" holes (as required for tube placement) shall be drilled at approximately 18-inch intervals horizontally and approximately 3-foot intervals vertically. The injection area shall extend approximately five feet around the sides and top of the tunnel. The exact location, spacing, hole size and depth shall be selected by the contractor's engineer and approved by the engineer of record. The polyurethane material shall then be injected through injection tubes inserted into the drilled holes to the proper depth or depths as determined by either the on-site testing or contractor's engineer. The rate and amount of material injected shall be determined by the contractor to obtain proper modification of the base and sub-base soils. Per US Patent for increasing bearing capacity, Patent No. US 6,634,831 B2.
- B. Continuous laser leveling or dial indicator micrometer readings shall be in place and monitored by the contractor during injections. Contractor shall monitor both the ground surface and the utility tunnel.
- C. In-situ Testing shall be utilized to determine sufficient material usage and soil bearing capacity increases as related to potential settlement calculations. Testing shall be performed at treatment depths by a qualified third-party testing agency or the installer as needed. Results from the tests shall be utilized to determine if additional material is required to achieve the desired bearing capacity determined by the contractor's engineer. Pre- and post-testing of bearing capacity is required.

## 1.5 CONTRACTOR SUBMITTALS

- A. To be considered responsive, the successful bidder must provide the following documents to the Agency NO LATER THAN 48 HOURS AFTER THE BIDS ARE DUE:
1. Contractor must have successfully completed a minimum of 25 polyurethane projects within the last 10 years and shall submit current contact information for all 25 projects. Of these projects, a minimum of 10 must have involved Deep Soil Modification.
  2. Contractor must employ a full-time Engineer, licensed in the state of South Carolina, with a minimum of ~~five (5)~~ three (3) years of experience in Deep Soil Modification with Polyurethane Material. Submit the Contractor's Engineer's professional resume and professional license number.
- B. Prior to beginning the chemical grout injection, the contractor shall submit the following documents to the engineer of record and found to be acceptable:
- a. Contractor shall submit a milestone schedule with an overall construction duration. The schedule shall start with the notice to proceed set forth by the University.
  - b. A list of equipment to be used in performance of the specified chemical grout injection, specifically detailing the equipment production and quality assurance capabilities.
  - c. A detailed description of the work procedure, instrumentation program, heave monitoring techniques, leak and seepage control.
  - d. Product and Safety Data sheets for all materials that will be used.
  - e. Proposed injection tube locations, depths, and intervals.
  - f. Settlement calculations performed by the contractor's engineer demonstrating that AASHTO HS-20 loading will be carried by the proposed improved soil structure around the tunnel.
  - g. Heave monitoring instrumentation and procedures.
  - h. The contractor shall provide a surface profile from laser level measurements at each injection area. Each profile shall be accepted by the engineer prior to performing the work.

- C. Upon completion of soil improvement and in-situ testing, contractor shall submit the following documents:
- a. Settlement calculations, stamped and signed by the contractor's engineer, demonstrating that AASHTO HS-20 loading will be carried by the improved soil structure provided around the tunnel.
  - b. Injection records noting the location, grout injection pressure and quantity of material installed at each injection tube location.

#### 1.6 BASIS OF PAYMENT

- A. A responsive bid shall be submitted on the SE-330, Bid Form, and shall contain the following information:
1. Base Bid Amount – This is based on 180 LF of Soil Improvement at the location shown on the drawings and shall include one mobilization and installation of up to 55,000 lbs. of injection material.
  2. Add Alternate #1 Amount – This is based on 20 LF of Soil Improvement at the location shown on the drawings and shall include installation of up to 12,800 lbs. of injection material.
  3. Add Alternate #2 Amount – This is based on 45 LF of Soil Improvement at the location shown on the drawings and shall include installation of up to 11,000 lbs. of injection material.
- B. Contractor shall bill for the actual amount of material used. If needed, the total contract amount will be adjusted by Change Order using the Add/Deduct Unit Prices included in the AIA A101 contract.

END OF SECTION 313223