

TECHNICAL SPECIAL PROVISIONS
FOR
Deep Soil Stabilization Pressure Grouting

Project Name
Project Number

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Date:

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SECTION T173

DEEP SUBSOIL STABILIZATION PRESSURE GROUTING

T173-1 Description

The following Technical Special Provisions are for stabilization and improvement of deep subsoil conditions. The work consists of furnishing all labor, equipment and materials required to inject cementitious grout to an approximate elevation of -210 ft NAVD from a work platform surface (+90 ft NAVD). The stabilization program is intended to minimize the potential for future ground subsidence.

T173-2 Scope

The scope of the stabilization program includes vertical grout injections. If directed by the Engineer, some injection locations may be deleted and/or alternate locations may be added to the program. The Contractor shall stake out the primary grout injection locations as shown on the plans. The Contractor shall stake out the primary grout injection locations as shown on the plans. The Engineer will establish the secondary grout injection locations in the field.

T173-3 Contractor

The pressure grouting contractor shall submit his qualifications to the Engineer for approval. The contractor shall have at least five years of experience in deep cement pressure grouting project and shall submit references of such activities.

T173-4 Grout Mixture

T173-4-1 General: The materials used in this work shall conform to the requirements of the FDOT Standard Specifications except that for sinkhole grouting materials only, Sections 346 and 347 shall not apply.

T173-4.2 Grout Mix. The mixture used for grouting shall be a creamy consistency which will permit the grout to flow. When samples of the grout mixture are set aside for at least 12 hours in a standard concrete test mold, the resulting free surface water height shall be less than one percent of the initial sample height. Range of slump shall be between three and five inches. The slump may be varied throughout the grouting operations at the discretion of the Engineer. One or both of the following mixtures (Mix A and/or B) may be used at the discretion of the Engineer. Minor variations of constituents may be permitted to meet the above requirements.

For 1 c.y. batch: ⁽¹⁾	<u>Mix A</u>	<u>Mix B</u>
Portland Cement (Section 921)	250 lb	250 lb
Fly Ash (Section 929)	750 lb	750 lb
Water (Section 923)	400 lb	400 lb

Sand (Section 902-3.3)	2,275 lb	2,275 lb
Air Entrainment	2-4 % ⁽²⁾	2-4 % ⁽²⁾
WRDA 79	19.0 oz	19.0 oz
Calcium Chloride ⁽³⁾ (ASTM D-98)	----	9-18 lb ⁽²⁾

(1) Batch weights shown are based on the following estimated specific gravities: 3.15 (cement), 2.2 (fly ash), and 2.63 (sand). Actual batch weights may vary slightly depending on actual material specific gravities. At the discretion of the Engineer, water quantity may be adjusted to vary slump.

(2) At the discretion of the Engineer.

(3) Calcium Chloride (CaCl) shall be introduced in solution form at a concentration of 1 pound of CaCl per quart of water.

T173-4.3 Test Cylinders. One 6 inch x 12 inch sample test cylinder will be made by the Engineer for each 50 cubic yards of grout.

T173-4.4 Slump Tests. The Engineer will perform slump sampling and testing in accordance with Standard Florida Test Method FM 1-T119. Grout slump shall be in accordance with this Technical Special Provision.

T173-4.5 Grout Time Limit: The maximum allowable time between initial introduction of water to the grout mix and injecting the grout in-place is 90 minutes. This time may be extended at the discretion of the Engineer.

T173-5 Grout Mixing & Placing

If on-site mixing is used, facilities and measuring devices shall be provided for accurately measuring the ingredients in each batch of grout to within + or – 1% of the mix design. The equipment and measuring devices used shall allow the Engineer to verify the appropriate ingredient quantities throughout the mixing process. If at any time the ingredient quantities are found to be out of tolerance, or if the Engineer cannot verify the appropriate ingredient quantities, all mixing operations shall cease until the Engineer determines that the appropriate measures have been taken to accurately produce the grout mixture and verify that it is within tolerance. The ingredients shall be thoroughly mixed and immediately pumped to the grout pipes through a flexible hose not more than 250 feet long.

T173-6 Equipment

T173-6.1 Grout Injection Equipment. A continuous flow, positive displacement model capable of pumping cement grout with a slump (ASTM C-143) of three to nine inches and pressures up to 600 psi. A pressure gauge shall be located in-line at the top of the casing or immediately before the top of the casing. The gauge shall be capable of reading pressures up to 600 psi in increments of 25 psi or better. Alternate equipment may be used at the discretion of the Engineer. Grout hose inside diameter shall be the same as the injection pipe inside diameter.

T173-6.2 Injection Pipes. Minimum inside diameter: three inches, Maximum inside diameter: four inches. Each injection pipe shall be comprised only of casing of equal diameter. Modifications of the injection pipes shall not be done without approval of Engineer.

T173-6.3 Water & other Equipment. The Contractor is responsible for providing all water and equipment necessary for grouting and clean-up operations.

T173-7 PRESSURE GROUTING PROCEDURE

T173-7.1 Pipe Installation. Grout pipes shall be installed to a depth sufficient to encounter refusal (i.e., up to about 300 feet, approximate elevation -210 ft NAVD). The Contractor may rotary drill or drive the injection pipes to the refusal depth as determined by the Engineer. The contractor shall anticipate that difficult drilling through hard material will be necessary to penetrate the deeper raveled zones. The final depth of each grout pipe must be approved by the Engineer. The method of installation shall ensure a good seal between the pipe and the surrounding soil. The installation method shall be modified subject to the Engineer approval, if grout seeps up around the outside of the pipe during injection. The Engineer may require weekend and/or 24 hours per day pipe installation.

T173-7.2 Grout Injection. Following satisfactory installation of an injection pipe, grouting operations may begin. During the grouting operation the injection pipes shall be raised in 1-foot increments to inject the entire zone between depths as deep as 300 feet and as shallow as 10 feet below the ground surface. The rate of pumping shall not exceed twelve cubic feet per minute. The pumping pressure at the top of the casing is planned to be in the range of 250 to 350 psi or as required by the Engineer. Unless otherwise directed by the Engineer, pumping shall cease, if an injection pipe takes 50 cubic yards of grout. If this excessive pumping occurs, the grout pipe shall be raised and flushed to prevent the pipe from being cemented in place. Pumping can then proceed to another grout pipe location. Pumping may resume at the excessive grout pipe location and depth after a period of 12 hours has passed. The grout pipe shall be re-installed to within 1 foot of the depth grouting was terminated unless otherwise directed by the Engineer. The Engineer may require weekend and/or 24 hours per day grout injection operations.

Most of the grouting is expected to be accomplished using Mix A. However, when directed by the Engineer, grout Mix B shall be pumped in lieu of Mix A. Mix B shall be injected using a dual pump, two-stream proportioning system which is capable of accurately controlling the ratio of calcium chloride solution to sand-cement slurry. The discharge lines from the two pumps should come together in a small, baffled mixing chamber before entering the injection pipe. A separate water source should be available so that the injection lines, mixing chamber and grout pipe can be cleaned. During any down-time periods, the lines, mixing chamber and grout pipe should be flushed to prevent "freeze-up."

T173-8 MONITORING

T173-8.1 General. The Engineer will monitor the pressure grouting operations to assure compliance with the Technical Special Provisions outlined above and the duties discussed below. All injection pipe installations and grouting operations shall be performed in the presence of the Engineer. The Engineer will assume responsibility for the quantity of grout pumped, grouting sequence, intervals of grouting and deciding if additional or less grout is necessary.

T173-8.2 Compliance. The Engineer may stop the grouting operation at any time if, in his judgment, the operation does not comply with these Technical Special Provisions or the work is unsuitable.

T173-8.3 Daily Records. The Contractor shall make all measurements of ground heave, settlement, installed pipe lengths, grout quantities pumped, maximum pumping pressure and start and end times for each interval of grouting. Records of each day's grouting operation shall be maintained for the benefit of the Department and the Contractor. The grout and pipe quantities will also be recorded by the Engineer, and the Engineer's quantities will be considered the final amounts for pay purposes.

T173-8.4 Ground Movement. During grouting, the Engineer will observe any vertical movement of the ground. If a downward movement is observed, the grouting operation shall cease and observations shall continue for 30 minutes. If the ground does not return to its original grade, pumping shall be resumed at a lower rate of injection. If upward movement is observed, the grouting operation shall cease at that grout injection location, unless directed to resume grouting by the Engineer.

T173-8.5 Protection of Existing Utilities/Structures. The Contractor shall exercise care when grouting beneath and adjacent to existing utilities or structures.

T173-9.0 Method of Measurement and Basis of Payment. The quantity of grout pumped and the lineal footage of injection pipe installed shall be paid for at the contract unit prices. Such price and payment shall be full compensation for all work and materials (in-place and accepted) necessary to complete the stabilization program. This includes all costs associated with overtime and weekend work. Compensation shall be in accordance with the following pay items:

Pay Item No. 173-76	Grout Pipe Installation - per linear foot below ground surface.
Pay Item No. 173-77-1	Pressure Grouting – Subsurface (Mix A) - Per Cubic Yard
Pay Item No. 173-77-2	Pressure Grouting - Subsurface (Mix B) - Per Cubic Foot