



**SPECIAL PROVISIONS
FOR
GROUND IMPROVEMENT**

**Black Hawk County
NHSX-063-6(96)--3H-07**

**Effective Date
March 21, 2017**

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150244.01 DESCRIPTION.

- A.** This section covers ground improvement using chemical grouting method at the area specified on the plans. The work shall consist of design, performing, monitoring and testing to meet the acceptance criteria presented in this Special Provision.
- B.** Chemical grouting is a form of permeation grouting, which involves injection of chemical solution grouts that bond the individual grains together into stone like masses.
- C.** The intent of the chemical grouting specified herein is to increase the strength and stiffness of the soils within the limits indicated on the plans to achieve the average unconfined compressive strength of 50 pounds per square inch within 7 days and the average hydraulic conductivity of 5×10^{-5} centimeters per second.
- D.** Work hours restriction near and at the Canadian National Railway shall comply with contract documents.
- E. Qualifications.**
 - 1.** The Ground Improvement Contractor (the Contractor) shall have at least 10 continuous years of documented experience in permeation grouting and a minimum five previously completed projects of similar scope and purpose.
 - 2.** The Contractor shall provide experienced management, supervisory and key personnel as required to implement the permeation grouting program, as follows:
 - a.** The project manager shall have at least 5 years of continuous experience in permeation grouting, with at least the last 2 years in the full-time employ of the Contractor.
 - b.** The superintendent shall have at least 5 years of experience in permeation grouting.

150244.02 MATERIALS.

A. Grouting Equipment.

1. All permeation grouting equipment shall be of a type, capacity and mechanical capability suitable for doing the work.
2. The grout plant shall be of the continuous mixing type and shall be capable of supplying, proportioning, mixing and pumping the grout with a set time between 5 minutes and 50 minutes. Batch-type systems will not be permitted.
3. Each main pump shall be equipped with recording, positive displacement meters. The meters shall be constructed of materials that are non-corrodible for the intended products and shall operate independently of the viscosity of the metered fluid. The pumping unit shall be capable of varying the flowrate while maintaining the component ratios constant.
4. The pumping unit shall be equipped with piping and/or hoses of adequate capacity to carry the base grout and reactant solutions components separately to the point of mixing. The component hoses shall come together in a 'Y' fitting containing check valves to prevent backflow. The 'Y' fitting shall be followed by a suitable baffling chamber for thorough mixing. A sampling valve shall be placed beyond the point of mixing and the baffling chamber, and shall be easily accessible for sampling mixed grout. A water flushing connection or valve shall be placed behind the 'Y' to facilitate flushing the grout from the mixing hose and baffle between grouting sessions. Distribution of proportioned grout, under pressure, to the grouting locations shall be monitored and controlled by separate, automatic recording, flow rate meters and gauges.
5. Chemicals shall be stored in metal tanks, suitably protected from accidental discharge by valving and other necessary means. Tank capacity shall be sufficient to supply at least one day's volume of grouting materials so as not to interrupt the work in the event of chemical delivery delays.

B. Grouting Pipes.

Grout pipes may be installed horizontally, inclined, or vertically to obtain the specified minimum grout coverage. The grout pipes shall be either steel or PVC sleeve-port type. After being placed in a borehole, the sleeve-port grout pipes shall be encased in a continuous brittle mortar sheath. An internal double packer shall be used to inject grout at a specific sleeve port.

C. Grout Materials.

1. Structural chemical grout shall be composed of liquid sodium silicate, approved reactant, water and accelerator, if required. The design chemical grout mix shall be such that, when injected into medium dense Ottawa 20-30 sand, will provide an unconfined compressive strength of 75 pounds per square inch or more.
 - a. The base material for the structural chemical grout shall be liquid sodium silicate, having a specific gravity of 1.4 to 1.5 and a silicate to soda ratio ranging from 3.20 to 3.35. The minimum sodium silicate concentration shall be 40% of the mix by volume. The sodium silicate shall be delivered in sealed containers or certified tank truck and shall be accompanied by the supplier's certificate of origin. Sodium silicate in non-gelled liquid form, while not considered toxic, is strongly alkaline and shall be handled by authorized personnel only.
 - b. The reactant shall be of organic base type and shall, when properly mixed with the other grout components, provide a permanent, irreversible gel with controllable gel times. Injected samples shall exhibit less than 2% syneresis within 30 days.
 - c. The accelerator, if required, shall be technical grade, water soluble calcium chloride or other approved metal salt.
 - d. Water used with grout shall be free of impurities that will affect the grout.

2. All grouts shall have a gel time between 5 and 50 minutes. The Contractor shall take samples of grout for gel time checks at least once every hour of pumping or for every 1000 gallons of grout pumped, whichever is more frequent.

150244.03 CONSTRUCTION.

A. Submittals.

1. Submit the following to the Engineer prior to the start of the work:
 - a. Contractor's qualifications:
 - 1) A list of the Contractor's previous completed project of similar scope and purpose, including a description of the project, relative size, and contact person with phone number.
 - 2) Resumes of the Contractor's personnel showing required qualifications.
 - b. Resumes of the management, supervisory, and key personnel, for approval by the Engineer.
 - c. Canadian National Railway's training record, as required by Canadian National Railway, for all on site personnel.
 - d. Mix design.
 - e. Work procedures and control criteria (including injection volumes and maximum pressure for each stage).
 - f. Location of test grout zone and test grout pattern.
 - g. Details of any proposed earth work associated with grouting operations.
2. Submit the following to the Engineer during the work:
 - a. Testing records.
 - b. Accurate and timely records of all permeation grouting. These records shall include, but not be limited to:
 - 1) grout mix and gel time
 - 2) injection date and time
 - 3) injection pressure and flowrate
 - 4) injection volumes
 - 5) exact injection location

In addition, these data shall be displayed in an acceptable chart-type format that facilitates rapid visual evaluation of the results of the work. This display shall be updated daily.
 - c. Any change in the predetermined grouting program necessitated by a change in the subsurface conditions.

B. Site Examination.

Thoroughly inspect the provided soils information and conduct a site inspection prior to mobilizing for ground improvement work.

C. Site Constraints and Preparation.

1. There is limited space for grouting operations and multiple construction activities in the adjacent area. Coordinate with other construction activities, such as temporary shoofly embankment, Canadian National Railway bridge demolition, temporary dewatering system, temporary shoring, and groundwater suppression system.
2. Coordinate with the Canadian National Railway for access to railroad right of way and facilities.
3. Remove any surface obstructions to allow drilling for sleeve port pipe installation.
4. Provide a firm base upon which grouting equipment can be operated.

5. Use survey stakes in the field to accurately identify the limits of the grouting work.
6. Earthwork may be needed to assist grouting operations. The Contractor shall be responsible for all earthwork needed for the grouting operations.
7. Move the rig to multiple locations as needed for grouting access.

D. Permeation Grouting.

1. Grouting Mixing Method

- a. The method of injection for permeation grouting shall be the continuous mixing method, with the proper amounts of sodium silicate base material, water, reactant, and accelerator automatically proportioned and continuously supplied at proper flow rates and pressures. The batch system of mixing grout shall not be permitted.
- b. The base material and the water-accelerator-catalyst solution shall pass through parallel separate hoses to a suitable baffling chamber near the top of the hole. To allow frequent gel time checks, a sampling cock shall be placed after the baffling chamber. Suitable check-valves shall be placed in the grout lines at the proper locations to prevent backflow.

2. Injection Procedures

- a. Using double (straddle) packers, inject chemical grouts through the grout ports of the sleeve pipes into the design zones. The grouting pressure for any one pipe shall not be more than 2 pounds per square inch per foot of overburden.
- b. Temporary very high injection pressures will be permitted to crack open sleeve-ports, but these pressures shall not be permitted for longer than a 1 minute duration. The rate of injection into any port shall not exceed three gallons per minute.

E. Field Quality Control.

1. All permeation grouting shall be performed under the inspection of the Engineer.
2. Monitor and maintain a log of permeation grouting operations for both testing and production work.
3. Prior to the commencement of auger boring through the grouted zone, demonstrate, using either soil sampling or probing methods, that the grouting zones have been thoroughly impregnated and stabilized with chemical grout. Do not commence auger boring through the grouted areas until the chemical grouting work has been completed and accepted by the Engineer.

F. Testing and Inspection.

1. Provide at the site all necessary chemical quality control testing apparatus, including but not limited to: hydrometers, pH paper, graduates, and all other devices that are required to conduct chemical material acceptance tests, chemical proportioning tests, and grout quality tests for proper quality control of the work.
2. Install test grouting prior to commencement of the production grouting. Core the test grouted zone to verify that the required unconfined compressive strength is achieved. The test grouted zone can be incorporated into the production work, upon approval of the Engineer.
3. Retrieve a minimum of two core samples from the test grouted zone. Each sample shall be at least 1 foot long. Sampling locations shall be selected by the Engineer.
4. The test grout zone shall be at the auger boring launching pit and shall have the minimum

size of 5 foot long by 9 foot wide by 9 foot tall at the same depth as the production grouting.

5. Submit the unconfined compressive strength test results from a certified laboratory at least 10 days prior to the commencement of production grouting operations.

150244.04 METHOD OF MEASUREMENT.

The Method of Measurement for Ground Improvement will be lump sum and will be the quantity shown in the contract documents.

150244.05 BASIS OF PAYMENT.

- A. Payment for Ground Improvement will be at the contract unit price per lump sum.
- B. Payment is full compensation for ground improvement within the envelope shown in the plans and all associated works described in this special provision.