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## Typical Specifications of Compaction Grouting Scope

This section covers compaction with Sand/Cement/Flyash grout including the installation of injection pipes. Compaction grouting is sometimes referred to as Low Mobility Grouting (LMG).

### General

The responsibilities of the Contractor include project control, supervision, labor, materials and equipment to accomplish the following items of work:

- Submit a detailed grouting plan to the Owner or Owners representative for review prior to beginning of work.
- Drill and install Grout Pipes.
- Monitor ground and existing structure movements during grouting operations.
- Perform grouting program under the supervision of personnel experienced in grouting for settlement control.

### Quality Control

Quality control is the responsibility of the grouting Contractor. Due to the specialized nature of the grouting operation required to perform the specified stabilization, compaction grouting should only be done by qualified grouting Contractors. For most projects, the company should be pre-qualified. First, the grouting Contractor will submit a list of compaction grouting projects undertaken in the past five years. At least three of the grouting projects specified should be of equivalent difficulty and/or scope. No Contractor will be considered acceptable without a minimum of five years experience in compaction grouting.

Cylinders must be taken by the Contractor daily or when the mix design changes. Cylinders are normally 3" x 6". Three cylinders will be taken and marked with the date and time of day taken. Cylinders will be broken at 7 and 28 days with the remaining cylinder being held. A testing laboratory certified by the Owner will test cylinders for compressive strength.

The work plan must be submitted to the Owner for review and comments a minimum of 5 calendar days prior to commencement of work in the field. The work-plan should contain the

following:

- The proposed mix design.
- Hole layout and spacing
- System used to monitor movement of surface or structures.
- Estimate of the duration of the work time in the field.
- Grout pump manufacturer, model number and pressure capacities.
- Refusal criteria.

The intent of the grouting is to produce a 15% improvement in the density of the base material within the limits shown on the drawing.

The location of the proposed holes for compaction grouting will be shown on project drawings.

## Equipment



Drilling equipment is normally required for the installation of grout injection pipes. The type of equipment selected will depend upon the surface material (asphalt, concrete, soil), subsurface soil or rock. Generation of excess drilling water or air may be drilling technique. a concern. In some environments heaving sands may necessitate the need for a dual-stem or hollow-stem

The equipment used to mix and pump grout shall be specifically designed for this purpose. Because of the high pressure involved all equipment, including hoses, couplings, gauges and pipes, should be able to operate to the maximum requirements stated in the specifications. The mixing and grout pump system should be designed to provide continuous flow of the grout mixture without interruption during any single hookup for a specific stage due to inadequate batching or pump feed capacity.

**Grout mixing system:** The grout mixing system should be capable of thoroughly mixing grout over the specified range. Grout will either be supplied by transit mix or mixed on site. For each batch of transit mixed grout, a ticket will be issued by the mix plant stating the amount of sand, cement, flyash, water, any additives, the time mixed, amount of water added at the site, and the time the truck has fully discharged. Any grout over three hours old should be wasted unless it can be demonstrated that extended hold time has no detrimental effect. On site mixing systems should be capable of precisely measuring, recording, and mixing all materials.

**Grout Pump System**



**em:** The grout pump shall include a positive displacement type pump with variable speed capabilities. The grout pump shall have the capability of injecting grout at a pressure of 800 psi. The pump shall have a minimum capacity of .05 cfm and maximum of up to 5 cfm. Pumps shall be equipped with remote controls for operation in vicinity of the probe collar to control the injection process.

**Grout Delivery System.** The grout delivery system shall consist of hoses, couplings, and pipes compatible with the equipment used for this work and shall be capable of withstanding the

pressures delivered by the pump. Pressure gauges shall be provided at the pump discharge and at the top of the injection pipe to monitor pressure.

**Pressure Gauges.** All pressure gauges shall be adequately protected from the grout with suitable gauge savers to provide accurate pressure reading on a continuous basis and shall be calibrated to a Master Gauge prior to use.

Grout Injection Volume Measurement System. There should be a reliable mechanical means of measuring the quantity of grout pumped in every stage to within 0.25 cf.

## Materials

Sand: Sand should conform to ASTM C-33

Cement. Cement (if used) should be Type I or Type II Portland and free of contamination. Cement should be either supplied in water resistant paper bags or in bulk. Cement containing lumps should be rejected or screened to remove lumps.

Flyash. Flyash (if used) should conform to ASTM C-618 and be either Class C or Class F.

Lime. Lime (if used) should be hydrated agricultural lime. Lime should be supplied in water resistant paper bags or in bulk. Lime containing lumps should be rejected or screened to remove lumps.

Water. Water should be clean and free from contamination. Volume shall be as necessary to achieve the desired slump.

Admixtures. Admixtures such as a superplastizer or a pumping aid may be added to increase set time or improve pumpability.

## Grout Pipe Installation

The grout pipes will be installed utilizing the primary and secondary sequence. The adjacent primary grout pipes will be grouted prior to installing or injection into the secondary pipes. The Secondary pipes will be used to verify the densification of the soil strata.

The pipes will be either drilled or driven. The end of the pipe must be sealed to prevent strata from entering the pipe during installation. The injection pipes will be installed to prevent grout leakage and/or premature upward movement of the casing during injection of high-pressure compaction grout.

Pipes should be steel of sufficient diameter and wall thickness to allow the grout to be placed over the range of slumps and to the pressures as specified.

### Grout Injection:

Grout will be mixed on site or provided from a transit mix grout truck. The slump of the mix should not exceed 3 inches. Normally, grout will be injected at a rate not to exceed 4.0 cfm unless authorized by the Owner.

Grouting pressure will be continuously monitored at the surface connection to the injection pipe with a suitable protected gauge. A grid pattern for primary injection pipes will be established and the grout will be injected beginning at the lower depth of the grouting limits as shown on the plans.

The compaction grouting process will progress in stages within each injection pipe using the bottom up method. The bottom up method stages start at the bottom of the grouting pipe, at least 1 ft into the underlying dense material, progressing upward at 2 ft maximum intervals. The ground surface and adjacent structures will be monitored at all times during grout injection for surface movement (heave). Pre-established monitor points on any structure will be monitored during grout injection.. Grout injection shall cease for any given stage when movement is detected or when maximum injection pressure is reached or when a sudden drop in pressure is

noted. Pressure will drop when the injection pipe is raised or the pipe will be considered plugged and it will be removed and reinstalled or cleaned out by a wash hose from the surface.

After completion of primary grouting, a secondary grid pattern, split spacing the first grid pattern injection points, will be established. Grouting in secondary holes will proceed as described for primary holes. Quantities for the secondary stage will be compared with grout injected during the primary stage to ensure the subsurface material is becoming densified. The Owner will be notified of the quantities placed in the secondary holes before further split spacing or an area is determined complete.

The pumping rates and pressures should be carefully controlled.

Any hole lost due to Contractor negligence or error may have to be replaced at no charge to the Owner.

Testing and Quality Control. The Contractor will pay the cost of sampling and testing.

All daily drilling, grouting and testing reports will be submitted to the Owner within 24 hours. A level control system will be installed and operated by the Contractor for use during grouting. Changes in elevation of the control points will be tabulated and submitted to Owner at the completion of the project.

Drilling reports will contain at least the following information: Name of driller, type of drill, method used, date, location of hole, tip depth or elevation of injection pipe.

Grouting reports will contain at least the following information: Name of grouting technician, grout mix, quantity injected per stage, date, rate of pumping, beginning and final pressure obtained in each stage. The reason for refusal, such as refusal pressure, movement of the surface, or movement of a structure shall be stated.

## **Protection of Work Area and Cleanup**

During the work operations the Contractor shall take such precautions as may be necessary to permit drill cuttings, equipment exhaust, oil, wash water and grout from defacing and/or damaging the surrounding area.

The Contractor shall furnish such pumps as may be necessary to care for wastewater and grout from his operation and shall clean up all waste resulting from his operations.

**Measurement and Payment**

Mobilization/Demobilization will be measured as lump sum. Eighty percent will be paid when all equipment is on site. The remaining twenty percent will be paid after all equipment is removed from site, the site is restored, and all reports, including drilling, grouting, and elevations, are received by the Owner.

Injection pipes will be measured by each pipe installed to the depth indicated on the Plans. Payment will be made for each pipe successfully installed. Pipes that become plugged will be removed and replaced at no charge to the Owner.

Grout will be measured and paid for by the volume (i.e., cubic yard) successfully placed.

Grout wasted at the direction of the Owner as a result of grout hole refusal will be paid at the cost specified. Measurement and payment will be made by the cubic yard.

<b>Item #</b>	<b>Item Unit</b>
Mobilization	ls
Injection Pipes Installed	ea
Grout Placed	cy
Grout Wasted	cy

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