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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
MANILA

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DEPARTMENT ORDER)
)
No. **36**)
)
Series of 2017 *23.24.17*)

SUBJECT: **DPWH Standard Specification for
Item 1049 – Jet Grouting**

In line with the mandate of the Department in providing effective standard specifications in the implementation of various infrastructure projects and in view of the need of setting a standard specification for soil stabilization, the attached **DPWH Standard Specification for Item 1049 – Jet Grouting** is hereby prescribed, for the guidance and compliance of all concerned.

This specification shall form part of the on-going revision of the DPWH Standard Specifications for Public Works Structures (Buildings, Ports and Harbors, Flood Control and Drainage Structures and Water Supply Systems), Volume III, 1995 Edition.

This Order shall take effect immediately.


MARK A. VILLAR
Secretary

Department of Public Works and Highways
Office of the Secretary



WIN7U01448

DPWH Standard Specification for Item 1049 – Jet Grouting

1049.1 Description

This Item shall consist of installation, monitoring and testing of jet grouting in accordance with this Specification and in conformity with location, lines, depth, spacing, and diameter shown on the Plans.

1049.2 Material Requirements

1049.2.1 Cement Grout

The cement grout shall be of Portland Cement, water, and/or additives as approved by the Engineer. Trial mixes shall be tested prior to commencement of work.

The quality as well as the suitability of the fresh grout shall be constantly assured by measuring its density using a hydrometer.

1049.2.2 Portland Cement

It shall conform to the applicable requirements of Item 700, Hydraulic Cement.

1049.2.3 Water

Water used shall be reasonably clean and free of oil, salt, acid, alkali, grass or other substances injurious to the cement grout produced. Water will be tested in accordance with and shall meet the requirements of Item 714, Water. Drinkable water may be used without test.

1049.2.4 Additives

Additives, if used, should be prepared according to the supplier's recommended procedures/proportioning prior to being incorporated in the mix.

1049.3 Construction Requirements

1049.3.1 General

The objective of the jet grouting is to improve the soil mass. Due to the specialized nature of the work, a reputed specialist Contractor shall carry out jet grouting.

The Contractor shall construct jet grout columns of nominal diameter and spacing as specified in the plans.

It shall be the Contractor's responsibility to determine and implement the systems and criteria to ensure that specified improvement is achieved.

The Contractor shall possess adequate equipment and instruments which are proven and recognized locally and internationally for the execution of jet grouting works and for quality assurance plan as required in this specification.

It shall have personnel with experience in the design, supervision and execution of jet grouting works.

1049.3.2 Submittals

The following shall be submitted by the Contractor before the commencement of work:

- a. A list of at least five (5) previously completed projects of similar scope and purpose. The list shall include a description of the project and relative size.
- b. Resumes of the management, supervisory and key personnel.
- c. A ground movement monitoring plan.
- d. A mix design for the project indicating sources and types of grout materials, with volumetric proportions, and field test data from previous projects indicating compressive strength achieved. If the Contractor intends to deviate from the material provided, they shall submit, with the bid, evidence of satisfactory use of the proposed material from past projects with similar soil conditions.
- e. Work procedures, sequence, and control criteria (including parameters for each stage).
- f. A general Work Procedures Plan outlining the spacing, location, depth and quantity of grout to achieve the specified criteria of this specification.
- g. Proposed disposal area of waste materials.

The following shall be submitted by the Contractor during the Work:

- a. Accurate daily records of all jet grouting locations, depths of treatment, start and stop times, all jetting parameters, and grout injected for each location.
- b. Any change/s in the predetermined grouting program required due to a change in the subsurface conditions.

1049.3.3 Site Investigation and Trial

1049.3.3.1 Provision

All factual site investigation information and all interpretative reports relevant to the design of jet grouting works, including assessments of any soil contamination, shall be made available to the Contractor.

The Contractor shall ensure that the soil information is adequate to characterize the ground to be treated and all physical and geotechnical properties required for jet grouting works such as particle size distribution, density, organic content, strength characteristics and groundwater level.

Jet grouting is typically very effective in cohesionless soil and cohesive soil of low plasticity. Highly plastic soil shall require special consideration.

1049.3.3.2 Hazard Assessment

All information relevant to the safe implementation of the proposed grouting works, including the location of all known buried and over-site services and the nature, proximity

and condition of adjacent structures, shall be obtained by the Contractor before work commencement. If underground utilities are anticipated, a thorough investigation may be necessary to ensure location, condition and protection requirements. If a building in distress is involved, a relevant building survey shall be carried out by the Contractor prior to initiating any work.

1049.3.3.3 Trial Columns

An appropriate preliminary field trial section shall be constructed to verify the jet grouting system and the design grouting parameters. Trial section location shall be agreed upon by the Engineer within the treatment area. A trial section shall consist of a single module comprised of at least three (3) jet grout columns. The quality of jet grout columns shall conform to the design requirements and to be verified using the appropriate testing method. Tests will be performed at the center of the module prior to and after grouting. Where excavation is possible, assessment of the geometric and mechanical characteristics of the jet grout column should be made by visual inspection. Laboratory tests on samples recovered by coring or excavation shall be made.

Prior to commencement of production grouting, trial section shall be performed. If the pre-production trial sections indicate that the required ground improvement has not been achieved, the Contractor shall revise the Work Procedure Plan and re-test.

1049.3.4 Tolerance

1049.3.4.1 Setting Out

Setting out shall be carried out from reference lines and points shown in the plans. Immediately before commencement of jet grouting works, the jet grout column positions shall be marked with suitable identifiable pins or markers.

1049.3.4.2 Position

The maximum permissible deviation of the center of each grouting point from the correct center point as shown in the setting out drawing shall be 150 mm in any direction unless otherwise specified by the Engineer.

1049.3.4.3 Verticality

Jet grouting for vertical borehole shall be carried out as near vertical as possible.

1049.3.5 Length, Diameter and Spacing of the Jet Grout Columns

The length, diameter and spacing of the jet grout columns shown on the Plans are indicative only and shall be adjusted to suit actual site conditions when deemed necessary.

1049.3.6 Compressive Strength

The average unconfined compressive strength of the selected working columns shall be a minimum of 1.0 MPa. This shall be confirmed through laboratory tests on samples collected from backflow on site.

1049.3.7 Grouting Equipment

The jet grouting equipment shall be specialized equipment and sufficiently powerful to ensure a properly formed soil-cement column for treatment area. It shall have the following:

- a. Drilling rig shall be capable of drilling down to the required depth.
- b. The cement grout batching plant shall include all storage cribs, weather proof shelter, pumps, automatic mixers, agitator and regulating devices required to continuously measure and mix cement grout.
- c. Cement grouting plant shall be capable of effectively batching, automatically mixing and maintaining grout mixtures in suspension and of delivering grout into jet grouting system in a continuous flow at required pressure.
- d. The cement grout mixer shall be a high speed colloidal type and capable to operate up to 1,500 rpm.
- e. High-pressure pumps shall be able to produce high-pressurized jet at variable pressures to cut and mix the in-situ soil.
- f. The jet grouting equipment shall be able to provide at least 400 bar at nozzle for water jetting. The equipment shall provide for continuous positive return flow during jet grouting operation.
- g. The jet grouting system shall be able to operate at different rotation and withdrawal rates within the required range in order to complete the work and produce the required jet grout columns.
- h. Real time measuring and recording devices shall be provided throughout the drilling and jet grouting operation such as column number, time, depth, pressures, flow rates, rotation speed, etc.

Spare parts and equipment shall be available on site to maintain jet grouting equipment in satisfactory operation condition at all times during execution of the jet grouting work.

1049.3.8 Obstructions

In the event of obstruction/s preventing the drilling operation, the Contractor shall inform the Engineer immediately. Remedial options shall include:

- a. Reposition the grouting point a short distance from the original position.
- b. Additional grouting point/s around the obstructions.
- c. Excavate, remove the obstruction/s, backfill and compact to the desired density and reinstall the jet grout column.

1049.3.9 Execution of Jet Grouting

1049.3.9.1 Pre-treatment

Working platforms shall be designed, constructed and maintained in a manner suitable for the safe movement and working of the grouting equipment. Material used to provide working platforms shall be suitable for the ground conditions on which it is placed and shall not prevent the drilling operation.

Site working levels for the treatment shall be provided and maintained throughout the duration of the grouting works.

1049.3.9.2 Treatment

Before starting the jet grouting works, a method statement should be submitted including grouting parameters, sequence of execution and quality control procedures.

Unless otherwise specified, drilling of 100 mm to 150 mm diameter shall be carried out to the required depth. Once at the designated depth, the in-situ soil will be eroded by highly pressurized water or cement grout jet and cement grout will be injected and mixed with the in-situ soil through grout nozzle/s at the monitor. The monitor is rotated and lifted at required constant speed to achieve a continuous jet grout column.

If the jet grouting operation is interrupted for any reason, to ensure continuity of the column, re-drilling and re-grouting may be required upon confirmation from the Engineer on site.

The Contractor shall adjust the mix design and working parameters, if necessary, throughout the course of the work in order to achieve the requirement for the jet grout columns with the approval of the Engineer.

1049.3.9.3 Supervision

Execution shall be full-time supervised by trained and experienced personnel.

1049.3.10 Drilling and Grouting Records

Comprehensive records shall be kept. The record shall include the following:

- a. Contract, section
- b. Grout hole reference number
- c. Water-cement ratio
- d. Pressures during jet grouting
- e. Flow rates
- f. Withdrawal rate
- g. Rotation speed
- h. Time for drilling, jet grouting and overcoming obstructions
- i. Details of constructions, delays and unusual ground
- j. Features of spoil return, that is, color, quantity and density
- k. Presence of ground deformation (plus estimate if detected) monitored using precise level
- l. Any other information as may be required by the Engineer.

1049.3.11 Quality Control

1049.3.11.1 General

The following quality control measures shall be implemented for each grout hole:

- a. Evaluation of the continuous drilling and grouting records from computer output
- b. Grout and spoil density tests (daily)
- c. Grout cubes tests (weekly)
- d. Ground deformation monitoring (where specified)

Any lost or damaged jet grout hole as the result of mechanical failure of equipment, inadequacy of grout, air, or water supplies, or improper drilling or injection procedures shall be backfilled with cement grout and replaced by another hole, drilled and injected by the Contractor at no additional cost.

Equipment for mixing, holding, and pumping grout shall be in a secure location and shall be operated in a way that the spillage of material will be minimized. No material will be allowed to enter storm drains or other drainage courses.

1049.3.11.2 Spoil Return

Spoil return is the most important quality control indicator on the site. During jet grouting, a visual observation of the flow and features of the spoil shall be maintained. An unexpected reduction in spoil return shall be investigated and dealt with immediately. If there is negligible spoil return, it should be ensured that there is no clogging of the borehole annulus and the jetting parameters may have to be revised. Three (3) cube samples shall be collected from spoil return during jetting at different levels of each column for subsequent laboratory tests.

During jet grouting, spoil return shall be channeled to silting pond, tank or other collection structures. The Contractor shall regularly dispose all waste materials to the approved disposal area/location.

1049.4 Method of Measurement

The work to be paid for under this Item shall be the number of meters of jet grout columns that are satisfactorily constructed.

1049.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 1049.4 shall be paid for at the contract unit price for Jet Grouting which price and payment shall include the cost of furnishing all labor, materials and equipment necessary to complete the work, including trial columns, coring, testing and disposal of waste materials. Every completed jet grouted column/s shall be supported with Jet Grout Pile Data.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
1049 (1) a	Jet Grouting, 600 mm dia.	Meter
1049 (1) b	Jet Grouting, 800 mm dia.	Meter
1049 (1) c	Jet Grouting, 1000 mm dia.	Meter
1049 (1) d	Jet Grouting, 1200 mm dia.	Meter

References:

- a) *American Society for Testing and Materials (ASTM)*
- b) *DPWH Standard Specifications for Highways Bridges and Airports, Volume II*
- c) *Specification for Jet Grouting, G&P Geotechnics SDN BHD*
- d) *The Soilcrete - Jet Grouting Process, Keller Group, UK*
- e) *Bauer Jet Grouting Process and Equipment, Bauer, Denmark*
- f) *Jet grouting, Menard Polska*