

SPECIFICATION SOIL NAILING

1. GENERAL

The installation of soil nails, including drilling, installation, grouting and stressing shall be carried out in accordance with the requirements contained here in this Specification and the relevant British Standards.

2. SOIL NAILS

Soil nails shall mean the complete assembly and comprise of high tensile steel bars as shown in the Drawings or similar assembly approved by Engineer.

The position, inclination orientation and length of the soil nails shall be as shown on the drawings or as directed by Engineer.

The Contractor shall submit to the engineer for approval the details of the soil nail and fixtures together with the proposed method of installation and testing of the soil nails. The information to be provided shall include full details of the components manufacturing arrangements, spacer, centralizers, grouting arrangements and grout characteristics. The requirements contained herein for material and all system components shall apply whenever relevant, to materials used for the soil nail except when otherwise agreed by the Engineer. The handling storage and use materials shall comply with manufacture's instruction.

The Contractor shall install trial soil nails and carry out Pull-out tests shall demonstrate that the Contractor's equipment and proposed method of working are consistent with the requirements of Specification. Final acceptance of the system shall be based upon the outcome of site Pull-out Test as directed by the Engineer.

3. DRAWINGS

The works shall be constructed in accordance with the Drawings and such other details and drawings as may be issued or approved by the Engineer.

Prior to fabrication and in 'good time' the Contractor shall be required to submit to the Engineer for approval shop drawings. All drawings prepared by the Contractor, Sub-contractor or suppliers must be approved by the Engineer before the work for which they refer to starts.

The Contractor shall prepare and submit to the Engineer for approval working drawings indicating his proposed methods of construction of soil nails or such other operations for which Engineer may require working drawings. All drawings prepared by the Contractor, Sub-contractor to suppliers must be approved by the Engineer before the work for which they refer to starts.

On or before the completion of works, these drawings together with any other information requested shall be passed to the Engineer for the preparation of the as-built drawings.

4. CONSTRUCTION PROGRAMS

The Contractor shall submit the Construction Program in accordance with the Conditions of Contract and shall be in the form of an overall programme covering the whole of the contract period and in a Time/Location format.

No permanent work shall be undertaken without the Engineer's approval and the Contractor shall give a minimum 24 hours notice prior to the commencement of any part of work such that the Engineer may make any arrangements necessary for inspection.

5. NAILS BARS

The nails bars shall comprise of steel reinforcement of the strength, diameter and length as specified by the Engineer. The position, inclination, orientation and length shall be as shown on the Drawings or as directed by the Engineer.

The nail bars shall comply with BS 5950, and threaded at the top end for a sufficient length as approved by the Engineer, to facilitate fixing of nuts and for stressing.

No splices or couplers shall be allowed except where indicated in the Drawings or where approved by the Engineer.

6. PLASTICS

Sheading ducting and other plastic components shall be impermeable polypropylene materials or other high-density thermoplastic material approved by the Engineer.

The finished external and internal surfaces of the sheading and ducting shall be smooth, clean and free from flows, pinholes, bubbles, crack and other defects. The material used shall be homogenous, thermally stable and chemically inert and shall be resistant to chemical, bacteria and fungal attack. Sheading, ducting and other plastic protective components shall not contain any substances that will promote corrosion or stress corrosion of the steel components of the soil nails.

7. CEMENTING GROUT

For construction in general, cement shall be Ordinary Portland cement complying with BS 4027, unless otherwise approved by the Engineer. The cement shall not contain by weight more than 0.02% chlorides or 0.10% sulfides.

The total sulfate content should not exceed 4% (m/m) S03 of cement in the grout. For this purpose, the sulfate content expressed as S03 should not be calculate from all sources as determined by the test described in BS 1047, BS 3681, BS 3892 and BS 4550 where applicable, for hardened grout, sampling and chemical analyses should out as describe in BS 1881: Part 6.

The total chloride content of the grout derived from all sources should not exceed 0.1% (m/m) of cement.

Water for mixing should not contain substances or ingredient harmful to steel or cement grout, oil or organic matter shall be in accordance with Appendix A of BS 3148:1980, water should not contain more than 500mg of chloride ions per liter. The water shall be subjected to chemical analyses as directed by the Engineer.

No admixtures shall be used unless otherwise approved by the Engineer.

The water/cement ratio by weight shall not exceed 0.45 and not less than 0.40.

The grout mix shall not be subjected to bleeding in excess of 0.5% by volume 3 hours after mixing or 1% maximum when measured at 20oC in a covered glass or metal cylinder of 100mm internal diameter and with a grout depth of approximately 100mm. In addition, the water shall be reabsorbed within 24 hours.

The minimum cube strength of the grout shall at 7 days be 17Mpa and at 28 days shall be 25Mpa.

Before grouting the following properties shall be established.

- a) Details of manufacturer of the cement
- b) Water/cement ratio by weight
- c) Flow reading from viscometer, flow cone or flow meter
- d) Unconfined compressive strength development at 7 days and 28 days based on 100mm X 100mm cubes in accordance with BS 1881 or as directed by the Engineer.

8. SPACERS AND CENTRALISERS

Spacer shall be provided to ensure separation between individual components and shall generally be positioned uniformly over the cross-section of the drill hole.

Centralizers shall be provided at suitable intervals, to a maximum of 2m center to center, and shall be of a form to permit the free flow of grout and minimize potential de-bonding at grout/nail bar interface.

9. DRILLING

The hole for the soil nail shall be drilled with rotary equipment, using compress air only unless otherwise approved by the Engineer. No water is to be used for this exercise. The drilling equipment and procedure employed shall be capable to form a stable hole that is of the dimensions within the permitted tolerances specified herein and free of instructions or major protrusions in order to accommodate easily the soil nail. During the drilling operation all changes in ground type including the drill operation details shall be recorded in a format approved by the Engineer. In the event of the drilling encountering any unexpected obstructions this shall be recorded and reported to the Engineer without delay and prior to soil nail installation.

The drill hole entry point shall position within 75mm of the designed location, unless otherwise approved by the Engineer. The drill hole shall have a diameter not less than the diameter specified by the Engineer. Where drill hole shall have a diameter not less than the diameter specified by the Engineer. Where drill casing is necessary, consideration shall be given to the diameter of the borehole at the entry point and to the casing clearance required.

At the entry hole has been drilled to the length specified by the Engineer, the hole shall be cleaned to remove any loose material and the drill hole shall be probed to ascertain collapse of material and that the hole is satisfactory for complete installation of the soil nails. The drill hole shall be checked for compliance by the Engineer prior to installation of the soil nail.

If the drill hole is not compliance with the Specification contained herein, the Engineer may direct remedial works to be carried out. Any such remedial work shall not be measured for payment.

10. INSERTION OF NAIL BARS

The Contractor shall provide all necessary means for the Engineer to carry out the checking for compliance of the drill hole and the Engineer shall be given every assistance in his inspection of the drill hole and the provided with the records of drilling prior to the Contractor seeking his approval for insertion of the nail bars.

The soil nail components shall be inserted the same day as the drilling operations. The soil nail shall be installed at a controlled rate to avoid damage to the drill hole and the soil nail. The soil nail and its components shall be filled and centrally located by spacers herein and other measures as approved by the Engineer to ensure that the soil and all components are centered in the drill hole. The soil nail shall be secured to prevent movement during the grouting operations.

11. GROUTING

Grouting operations shall be carried out and completed on the same days as the drilling operations as soon as possible after installation of the soil nail. Cementitious grout shall be used in accordance with the requirements contained herein this Specification unless otherwise approved by the Engineer.

The grout shall be free from segregation, shrinking and bleeding of water and fine materials during and after placing.

High-speed colloidal mixer, unless otherwise approved by the Engineer, shall be used to mix and prepare the grout, until a uniform consistency is obtained.

Unless specifically instructed otherwise, water shall be added to the mixer before any cement. Mixing shall be carried out mechanically for a minimum of 2 minutes after adding the cement until a uniform consistency is obtained. Following completion of the mixing, the grout shall pass through a nominal 5mm sieve to remove lumps.

Grout shall be kept in continuous movement that is slow agitation on a storage tank.

The grout shall be placed in its position as soon as possible and in not more than one hour after completion of mixing operations. Unless otherwise approved by the Engineer in no instance shall the grout be used, after a period equivalent to the initial setting time. The grout be injected into the drill hole in one continuous operation, and shall continue until the consistency of the grout return is the same as that of the injection grout. In case of the tremie method being employed, the end of the tremie tube shall remain submerged in the grout at all times during the injection operation. The grout shall be injected through tubes into the lowest part of the drill hole with an air release tube provided to the highest part of the hole.

If for any reason, the grouting is interrupted or delayed beyond the setting period, the soil nail assembly shall be removed from the drill hole. The grout shall then be removed by flushing or re-drilling and the stages of soil nail insertion and grouting repeated. A record in an approved format, giving full details of the grouting operation for each soil nail shall be submitted to the Engineer.

The injection of grout can be carried out using pumps of the positive displacement type. Before grouting all air in the pump and connection lines shall be expelled. The suction circuit of the pump shall be airtight. During routing, the level of the grout in the supply tank shall not be drawn down below the crown of the exit pipe to prevent injection of air into the system.

12. STRESSING

Where stressing is required, stressing and recording shall be carried out by experience personnel under the control of a suitably qualified supervisor.

All stressing equipment shall be calibrated by an approved laboratory prior to used and the calibration certificate be made available for the inspection at all times during the works. The soil nail may be stressed by means of torque wrenches approved by the Engineer. In case where torque wrenches are used the Contractor shall undertake all the necessary measures and preventions to satisfy the requirements that the applied torque from the wrenches are effectively transferred into the nail bars. The personnel and calibration procedural requirements specified herein shall be applied to the used of such torque wrenches.

The soil nails shall not be stressed until the grout has attained a crushing strength of at least 20 MPa, as verified from cube test in accordance to BS 1881 or as directed by the Engineer.

13. TESTING

The Contractors shall provide, unless otherwise directed by the Engineer for the fixing of the soil head fixtures including bolt, washer, bearing plate, etc and the transfer of forces during testing.

The Contractor shall provide all torque wrenches, jacks and other equipment required to test the soil nails.

The Contractor shall also present up to date test and calibration certificates to the Engineer for the equipment that is proposed for testing.

Trial soil nails will be installed prior to installation of any permanent soil nails. The trial soil shall be subjected to Pull-Out Test. The contractor to submit a proposed testing procedure to the Engineer for approval before commencing any test.

All trial soil nails for the Pull-Out Test shall be tested to destruction and the mode of failure recorded. Modifications required as a result of Pull-Out Test shall be approved by the Engineer before the Contractor commences the drilling for the working nails commence until the Engineer has accepted and approved the results of the Pull-Out Test. Permanent soil nails shall be subjected to Proving Test as directed by the Engineer. The Contractor shall submit a proposed test procedure for the Proving Test for approval by the Engineer before the test commences.

14. RECORDS

The Contractor shall submit to the Engineer a full report on each soil and this shall include details of the nails, installation and the result of all tests.

15. ADJACENT ACTIVITIES

The Contractor shall ensure that any activities in the immediate vicinity such as blasting, piling, etc, operations shall not affect the installed and permanent soil nails.

16. HORIZONTAL DRAINS

- 16.1. This work shall consist of furnishing, drilling and inserting small diameter drain into slopes for the purpose of removing excess pore water pressure.
- 16.2. The drain holes are drilled at an inclined angel into the slope using a casing to support the hole unless otherwise approved by the Engineer. The drill holes shall be 100mm diameter.
- 16.3. The drilled holes are then inserted with 75mm diameter perforated PVC pipes Wrapped with non-woven geotextile filter fabric and casing where required for support during drilling subsequently withdrawn.
- 16.4. Drain locations and lengths to as shown in the Drawings or as directed by the Engineer