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A Study of Basic Elements, Types and Steps of a Soil Nailing System

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Abstract – Soil nailing is a proven method for shoring for a multitude of different kinds of projects. The choices of means and methods are continually growing. The key to the success of the method lies in designing the systems to meet the needs of each individual project, and the selection of a competent soil nailing team. This technique was developed in the early years of the decade of 1960. It has some basic elements which have different functions in the soil nailing system. There are various types of soil nailing techniques. It has many advantages along with some limitations. The aim of the present paper is to study the Basic Elements, Types and Steps of a Soil Nailing System.

Key Words: Multitude, Basic Elements, Soil Nailing, Soil Nailing Techniques and Steps of Soil Nailing System

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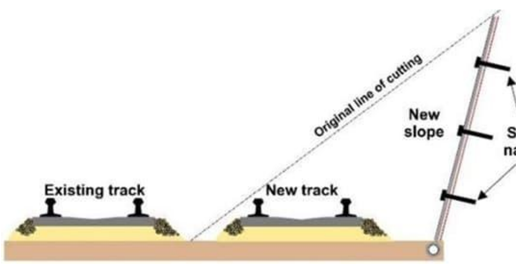
INTRODUCTION

Soil nailing is a construction technique used to reinforce soil to make it more stable. Soil nailing is used for slopes, excavations, retaining walls etc. to make it more stable. In this technique, soil is reinforced with slender elements such as reinforcing bars which are called as nails. These reinforcing bars are installed into pre-drilled holes and then grouted. These nails are installed at an inclination of 10 to 20 degrees with vertical. Soil nailing is used to stabilize the slopes or excavations where required slopes for excavation cannot be provided due to space constraints and construction of retaining wall is not feasible. It is just an alternate to retaining wall structures. As the excavation proceeds, the shotcrete, concrete or other grouting materials are applied on the excavation face to grout the reinforcing steel or nails. These provide stability to the steep soil slope. Soil nailing technique is used for slopes or excavations alongside highways, railway lines etc. Following figure shows soil nailing in railway construction:



Soil Nailing

The soil nailing technique was developed in the early 1960s, partly from the techniques for rock bolting and multi-anchorage systems, and partly from reinforced fill technique The New Austrian Tunnelling Method introduced in the early 1960s was the premier prototype to use steel bars and shotcrete to reinforce the ground. With the increasing use of the technique, semi-empirical designs for soil nailing began to evolve in the early 1970s. The first systematic research on soil nailing, involving both model tests and full-scale field tests, was carried out in Germany in the mid-1970s. Subsequent development work was initiated in France and the United States in the early 1990s. The result of this research and development work formed the basis for the formulation of the design and construction approach for the soil nailing technique in the subsequent decades.

Basic Elements of a Soil-nailed System: A soil-nailed system formed by the drill-and-grout method comprises the following basic elements:

Soil-Nail Reinforcement: Soil-nail reinforcement is the main element of a soil-nailed system. Its primary function is to provide tensile resistance. The reinforcement is typically a solid high yield deformed steel bar. Other types of materials, such as fibre reinforced polymer, can also be used as a soil-nail reinforcement.

Reinforcement Connector (Coupler): Couplers are used for joining sections of soil-nail reinforcing bars.
Cement Grout Sleeve: Cement grout, made of Portland cement and water, is placed in a pre-drilled hole after

the insertion of a soil-nail reinforcement. The cement grout sleeve serves the primary function of transferring stresses between the ground and the soil-nail reinforcement. It also provides a nominal level of corrosion protection to the reinforcement.

Corrosion Protection Measures: Different types of corrosion protection measures are required depending on the design life and soil aggressivity. Common types of corrosion protection measures are hot-dip galvanising and corrugated plastic sheathing. Heat-shrinkable sleeves made of polyethylene and anti-corrosion mastic sealant material are commonly used to protect couplers.

Soil-Nail Head: A soil-nail head typically comprises a reinforced concrete pad, a steel bearing plate and nuts. Its primary function is to provide a reaction for individual soil nails to mobilise tensile force. It also promotes local stability of the ground near the slope surface and between soil nails.

Slope Facing: A slope facing generally serves to provide the slope with surface protection, and to minimise erosion and other adverse effects of surface water on the slope. It may be soft, flexible, hard, or a combination of the three (CIRIA, 2005). A soft slope facing is non-structural, whereas a flexible or hard slope facing can be either structural or non-structural. A structural slope facing can enhance the stability of a soil-nailed system by the transfer of loads from the free surface in between the soil-nail heads to the soil nails and redistribution of forces between soil nails. The most common type of soft facing is vegetation cover, often in association with an erosion control mat and a steel wire mesh.

Types of Soil Nailing: There are various types of soil nailing techniques:

1. **Grouted Soil Nailing:** In this type of soil nailing, the holes are drilled in walls or slope face and then nails are inserted in the pre-drilled holes. Then the hole is filled with grouting materials such as concrete, shotcrete etc.

2. **Driven Nails:** Driven nailing is used for temporary stabilization of soil slopes. In this method, the nails are driven in the slope face during excavation. This method is very fast, but does not provide corrosion protection to the reinforcement steel or nails.

3. **Self-drilling Soil Nail:** In this method, the hollow bars are used. Hollow bars are drilled into the slope surface and grout is injected simultaneously during the drilling process. This method of soil nailing is faster than grouted nailing. This method provides more corrosion resistance to nails than driven nails.

4. **Jet Grouted Soil Nail:** In this method, jets are used for eroding the soil for creating holes in the slope surface. Steel bars are then installed in this hole and grouted with concrete. It provides good corrosion protection for the steel bars (nails).

5. **Launched Soil Nail:** In this method of soil nailing, the steel bars are forced into the soil with very high speed using compressed air mechanism. The installation of soil nails are fast, but control over length of bar penetrating the ground is difficult.

Effective steps of Soil Nailed System

Soil nailed structures are generally constructed in stages and it involves following steps:

- Excavation
- Drilling nail holes
- Nail installation and grouting
- Place Drainage System
- Place construction facing and install bearing plates
- Repeat Process to final grade
- Place final facing

Excavation: Initial small cut is excavated before the first row nail installation which is typically about 1 to 2 m. Ground vibration should be minimized during construction. The excavated face should be smooth so as to minimize shot Crete quantities.

Drilling Nail Holes: Holes are drilled at required location with suitable length and inclination. Drilling can be both cased and uncased depending upon stability of soils.

Nail installation and grouting: With the help of centralizers, nails are properly placed (centered) in the drill holes.

Grouting take place under gravity, or can be accompanied by some grouting pressure.

Place Drainage System: To control seepage, a prefabricated synthetic drainage is placed vertically against the excavation face before shotcreting.

Place construction facing and install bearing plates: Steel bearing plate and securing nut are placed at each nail head and the nut is tightened sufficiently.

Repeat Process to final grade: The above sequence is repeated until the final wall grade is achieved.

Place final facing: For long term stability reason and durability reason, a CIP concrete facing is used. Precast concrete can also be used as final facing for soil nail walls.

Merits and Demerits: The soil nailing technique offers an alternative design solution to the conventional techniques of cutting back and retaining wall construction.

Merits

a) It is suitable for cramped sites with difficult access because the construction plant required for soil nail installation is small and mobile.

b) It can easily cope with site constraints and variations in ground conditions encountered during construction, e.g., by adjusting the location and length of the soil nails to suit the site conditions.

c) During construction, it causes less environmental impact than cutting back and retaining wall construction as no major earthworks and tree felling are needed.

d) There could be time and cost savings compared to conventional techniques of cutting back and retaining wall construction which usually involve substantial earthworks and temporary works.

e) It is less sensitive to undetected adverse geological features, and thus more robust and reliable than unsupported cuts. In addition, it renders higher system redundancy than unsupported cuts or anchored slopes due to the presence of a large number of soil nails.

f) The failure mode of a soil-nailed system is likely to be ductile, thus providing warning signs before failure.

Demerits

a) The presence of utilities, underground structures or other buried obstructions poses restrictions to the length and layout of soil nails.

b) The zone occupied by soil nails is sterilised and the site poses constraints to future development.

c) Permission has to be obtained from the owners of the adjacent land for the installation of soil nails beyond the lot boundary. This places restrictions on the layout of soil nails.

d) The presence of high groundwater levels may lead to construction difficulties in hole drilling and grouting, and instability problems of slope surface in the case of soil-nailed excavations.

e) The effectiveness of soil nails may be compromised at sites with past large landslides involving deep-seated failure due to disturbance of the ground.

f) The presence of permeable ground, such as ground with many cobbles, boulders, highly fractured rocks, open joints, or voids, presents construction difficulties due to potential grout leakage problems.

g) The presence of ground with a high content of fines may lead to problems of creeping between the ground and soil nails.

h) Long soil nails are difficult to install, and thus the soil nailing technique may not be appropriate for deep-seated landslides and large slopes.

i) Because soil nails are not prestressed, mobilisation of soil-nail forces will be accompanied by ground deformation. The effects on nearby structures, facilities or services may have to be considered, particularly in the case of soil-nailed excavations.

j) Soil nails are not effective in stabilizing localized steep slope profiles, back scarps, overhangs or in areas of high erosion potential. Suitable measures, e.g., local trimming, should be considered prior to soil nail installation.

CONCLUSION:

Soil nailing is embarrassed by practicing engineers as a highly competitive well proven technique. Soil nailing has certain similarities to both reinforced earth and anchoring, although its particular operating principles and construction methods give it a firm and distinct identity. Similar considerations distinguish it from allied insitu soil reinforcing techniques such as reticulated root piles and soil dwelling. Most applications of soil nailing to date have been associated with new construction projects such as foundation excavations and slope stabilization, for both temporary and permanent works. The system has equal facility in a wide range of remedial projects, and indeed it is most likely that nailing will find its wide applications in the India in this field, bearing in mind the prevailing economic trends. It is to be hoped that the growth of the technique in India can be fostered by practical research collaborations between industry, the universities and government, in the manner of developed countries like France, Germany, United States of America and United Kingdom, who are the current leaders in this field.

REFERENCES:

FHWA (2003). Soil NAIL walls, Geotechnical Engineering circular No 7, Report No FHWAO-IF-03-017, Federal Highway Administration.

Guide to Soil Nail Design and Construction, Geotechnical Engineering office Civil Engineering and Development Department the Government of the Hong Kong Special Administrative Region.

http://www.classes.ce.ttu.edu/CE5331 013/

http://www.geofabrics.com/docs/Tamworth.pdf

http://www.keller-ge.co.uk/engineering/case-studies

http://www.wmplanthire.com/slope stabilisation.htm

Juran I., Gerge. B. Khalid F. and Elias V. (1990a). “Kinematical Limit Analysis for Design of Soil Nailed Structures”, J. of Geotechnical Engineering, ASCE, vol 116, No 1, pp. 54-71.

Juran I., Gerge. B. Khalid F. and Elias V. (1990b). ‘Design of Soil Nailed Retaining Structures, Design and Performance of Earth Retaining structures’, J. of Geotechnical Engineering, ASCE, Vol. 116 pp. 54-71.

New Directions in LRFD for Soil Nailing Design and Specifications, C. A. Lazarte (GeoSyntec Consultants, Columbia, Maryland, USA), G. B. Baecher (University of Maryland, College Park, Maryland, USA 0, J. L. Withiam (D’Appolonia, Monroeville, Pennsylvania, USA)

Soil Nailing for Stabilization of Steep Slopes Near Railway Tracks, Prepared by Dr. Amit Prashant, Ms. Mousumi Mukherjee, Department of Civil Engineering Indian Institute of Technology Kanpur, Submitted to Research Designs and Standards Organization (RDSO), Lucknow

www.williamsform.com/Ground_Anchors/Soil_Nails_Soil_Nailing/soil_nail_soil_nailing.html

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