GROUND IMPROVEMENT TECHNIQUES

By

Engr. Liaqat Ali
MS Geotechnical Engineering
Lecturer INU Peshawar

COURSE CONTENT FOR MID TERM

UNIT-1

Introduction to ground Modification: Need and objectives, Identification of soil types, In Situ and laboratory tests to characterize problematic soils; mechanical , hydraulic, physico-chemical, Electrical, Thermal methods, and their applications.

UNIT-2

Mechanical Modification – Deep Compaction Techniques- vibrocompaction, Dynamic Tamping and Compaction piles.

UNIT-3

Hydraulic Modification- Objective and techniques, traditional dewatering methods and their choice, Design of dewatering system, electro-osmosis, electro kinetic dewatering. Filtration, Drainage and seepage control with geosynthetics, preloading the vertical drains.

UNIT-4

Physical and Chemical Modification- Modification by admixtures, shotcreting and Guniting Technology, Modification at depth by grouting, crack grounting and compaction grouting. Jet grouting , Thermal modification, Ground freezing.

UNIT-5

Modification by inclusions and confinement- Soil reinforcement, reinforcement with strip, and grid reinforced soil. In-situ ground reinforcement, and ground anchors, rock bolting and soil nailing.

Unit-1
Introduction to Ground Modification

Why ground improvement required…..??

Introduction:

Large Civil Engineering Projects are being executed in all over the country in order to enhance the infrastructure of the country. Thus it is increasingly important for the engineer to know the degree to which soil properties may be improved or other alternations that can be thought of for construction of an intended structure at stipulated site.

Need for engineered ground improvement Concerns

- Mechanical properties are not adequate
- Swelling and shrinkage
- Collapsible soils
- Soft soils
- Organic soils and peaty soils
- Sands and gravelly deposits.
- Foundations on dumps and sanitary landfills
- Handling dredged materials
- Handling hazardous materials in contact with soils
- Use of old mine pits

Leaning tower of Pisa

Effect of Swelling

Effect of shrinkage

Swelling and shrinking soils exist in many areas in India, Large tracts of Maharashtra, Andhra, Deccan plateau, Chennai

Collapsible soils

Collapse occurs due to saturation, loss of cementation bonds, specific clay structure and areas in some areas in Rajasthan and in some counties abroad this is prevalent.

Effects of liquefaction

Failure of slope

Definition.....

Ground Improvement refers to a technique that improves the engineering properties of the soil mass treated.

Usually, the properties that are modified are shear strength, stiffness and permeability.

Ground improvement has developed into a sophisticated tool to support foundations for a wide variety of structures.

Need for engineered ground improvement Strategies

- When a project encounters difficult foundation
- conditions, possible alternative solutions are
- Avoid the particular site
- Design the planned structure (flexible/rigid) accordingly
- Remove and replace unsuitable soils
- Attempt to modify existing ground
- Enable cost effective foundation design
- Reduce the effects of contaminated soils
- Ensure sustainability in construction projects using ground improvement techniques

Ground Improvement Techniques for different soil types

Ground improvement can be done through various mechanisms

- *Compaction*
- *Dewatering*
- *Reinforcement*
- *Admixtures or grouting*

Classification of ground modification techniques

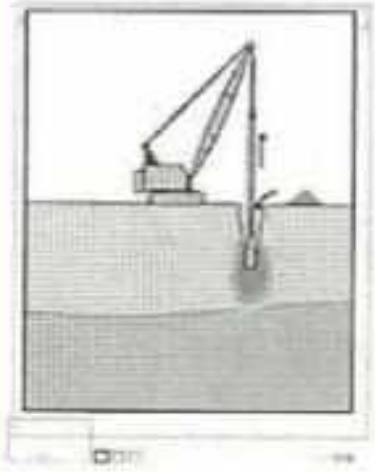
- *Mechanical modification*
- *Hydraulic modification*
- *Physical and chemical modification*
- *Modification by inclusion and confinement*
- *Combination of the above*

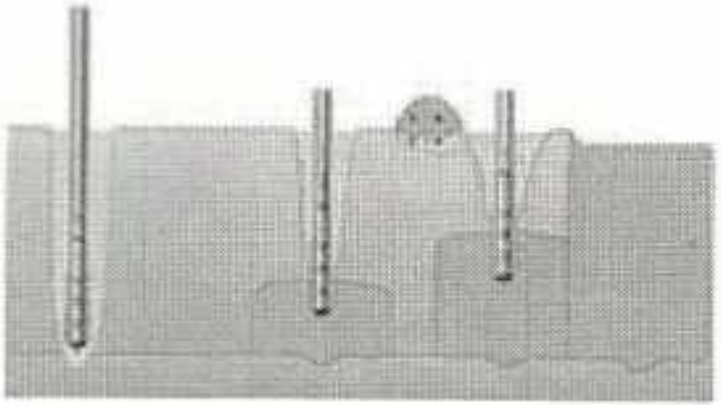
1Vibro Compaction:

Vibro Compaction is a method for compacting deep granular soils by repeatedly inserting a vibratory probe. It is also known as VIBRO DENSIFICATION.

By inserting depth vibrations, the vibrations are produced by rotating a heavy eccentric weight with the help of an electrical motor with in the vibrator. The vibratory energy is used to rearrange the granular particles in a denser state. Penetration of the vibro is typically aided by water jetting at the tip of the probe.

The Vibro-Compaction Process





Some of advantages and disadvantages of this method are given below.

- It is often an economical alternative to deep foundations, especially when considering the added liquefaction protection in seismic ares.
- It is most effective in granular soils
- It cannot be sued in cohesive soils.

Dynamic Compaction:

Dynamic Compaction is normally used under the following circumstances:

- To increase in-situ density and this way improve the bearing capacity and consolidation characteristics of soils (or waste materials) to allow conventional foundation and surface bed construction to be carried out. The technique typically improves the in-situ soils such that allowable bearing pressures of up to 250 kpa can be used with foundation settlements of the order of 10 to 20 mm.
- To increase in-situ density and in this way improve in-situ permeability and/or reduce liquefaction potential.

Blasting:

- Blasting is most effective in loose sands that contain less than 20% silt and less than 5% clay.
- Although blasting is quite economical, it is limited by several considerations, as it produces strong vibrations that may damage near by structures or produce significant ground movements.

Reinforcement Techniques:

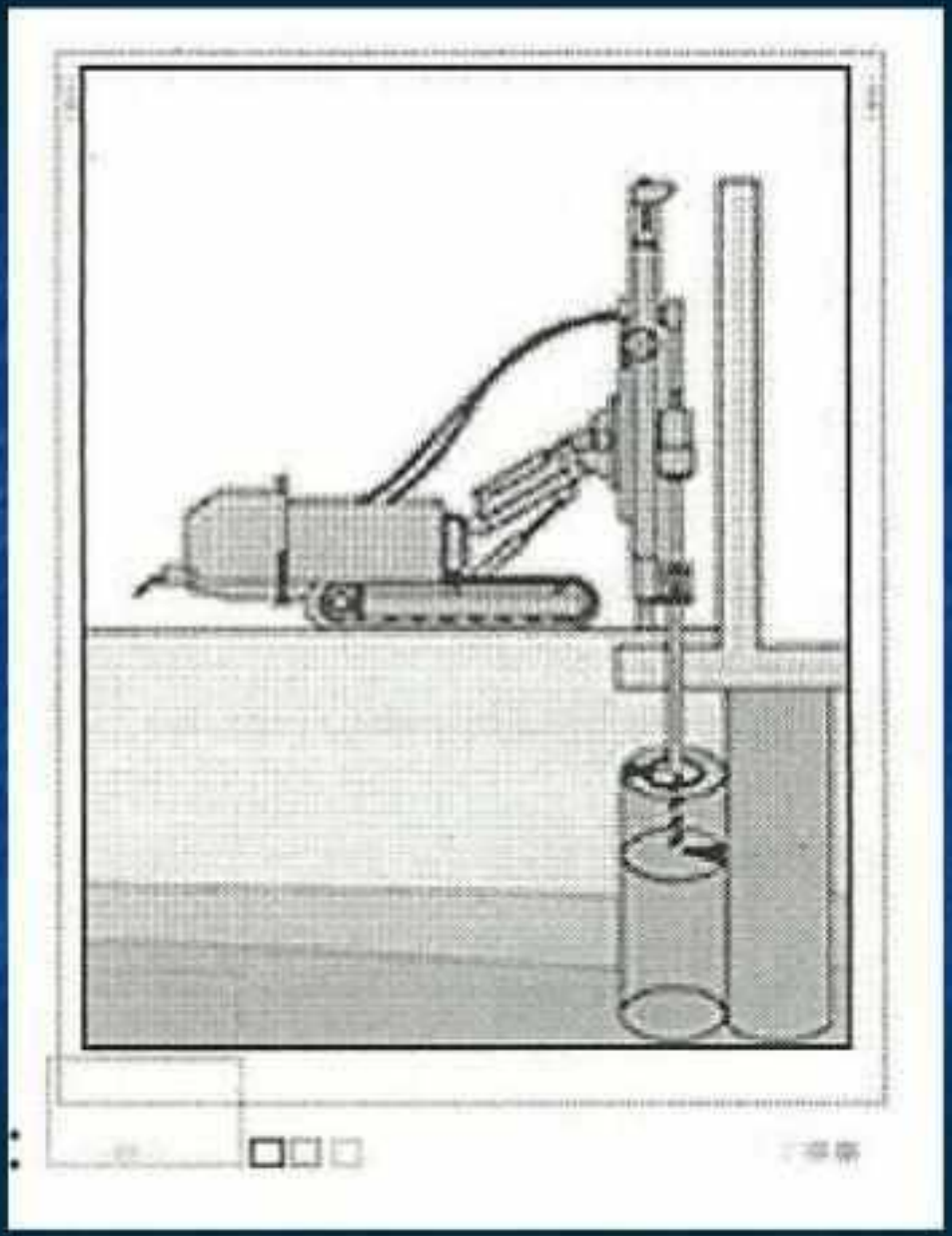
In some cases it is possible to improve the strength and stiffness of a existing soils deposit by installing discrete inclusions that reinforce the soil. These inclusions may consist of structural materials, such as steel, concrete or timber and geomaterials such as densified gravel.

Compaction Piles:

Compaction piles improve the seismic performance of a soil by three different mechanisms. First the flexural strength of piles themselves provides resistance to soil movement (reinforcement). Second, the vibrations and displacements produced by their installation cause densification. Finally, the installation process increses the lateral stress in the soil surrounding the piles.

Compaction piles generally densify the soil with in a distance of 7 to 12 pile diameters and consequently installed in a grid pattern. Between compaction piles a relative density of up to 75% to 80% are usually achieved. Improvement can be obtained with reasonable economy to depth of about 60 ft.

JET GROUTING



Electro Osmasis and Electro Chemical Hardening Method:

The electroosmasis process can be used to increase the shear strength and reduce the compressibility of soft clayey and silty soils beneath foundation. By introducing an electrolyte such as calcium chloride at the anode, the base exchange reaction between the iron anode and surrounding soil is increased, resulting in the formation of ferric hydroxides which bind the soil particles together. However because cost of electric power and wastage of electrodes, electroosmasis with or without electrochemical hardening can be considered only for special situations where the alternative of piling cannot be adopted.

Conclusion:

- Unfavorable soil conditions can frequently be improved using soil improvement techniques. A variety of soil improvement techniques have been developed. However a suitable technique has to be adopt according to necessity of the structure and economy.
- Mainly soil improvement techniques can be divided in to four broad categories; Densification technique, Reinforcement technique, grouting or mixing technique and stabilization technique.