

23CE707: GROUND IMPROVEMENT TECHNIQUES

Topic: Physical and Chemical Modification

Dr. G. Veeraswamy

**Assistant Professor, Civil Engineering
Narsimha Reddy Engineering College (Autonomous)
Secunderabad, Telangana, India- 500100.**



NARSIMHA REDDY ENGINEERING COLLEGE
UGC AUTONOMOUS INSTITUTION

Maisammaguda (V), Kompally - 500100, Secunderabad, Telangana State, India

UGC - Autonomous Institute
Accredited by **NBA** & **NAAC** with '**A**' Grade
Approved by **AICTE**
Permanently affiliated to **JNTUH**

Ground Improvement Objectives

- Increase bearing capacity; Reduce settlement; Improve shear strength; Reduce permeability; Improve durability; Enable construction on problematic soils.

Physical Modification

- Physical modification changes the arrangement of soil particles without altering their chemical composition. Common methods include compaction, densification, drainage, vibroflotation, stone columns,

Soil Compaction

- Compaction is the densification of soil by reducing air voids through mechanical energy. It increases dry density, shear strength, and stability while reducing compressibility.

Methods of Compaction

- Static Rolling, Vibratory Rolling, Ramming, Dynamic Compaction, Vibro-compaction. Selection depends on soil type and project requirements.

Dynamic Compaction

- Heavy weights are dropped repeatedly from considerable heights to densify loose granular soils. Suitable for deep ground improvement.

Vibroflotation

- A vibrating probe is inserted into the soil to rearrange particles and increase density. Effective in loose saturated sands.

Preloading and Surcharge

- Temporary loads are placed on soft soils before construction to induce consolidation and reduce future settlement.

Sand Drains and Wick Drains

- These provide shorter drainage paths and accelerate consolidation of soft clays.

Stone Columns

- Columns of compacted aggregate installed in weak soils improve load-carrying capacity and drainage.

Introduction to Chemical Modification

- Chemical stabilization involves mixing soil with additives that react chemically and improve engineering properties.

Objectives of Chemical Stabilization

- Increase strength, reduce plasticity, reduce swelling, improve durability, increase resistance to moisture.

Lime Stabilization

- Lime reacts with clay minerals and reduces plasticity. Benefits: increased strength, reduced shrink-swell behavior, improved workability.

Cement Stabilization

- Cement forms cementitious compounds that bind soil particles. Benefits: high strength, reduced compressibility, improved durability.

Fly Ash Stabilization

- Fly ash acts as a pozzolanic material and reacts with lime to improve soil properties.

Bituminous Stabilization

- Bitumen coats soil particles and reduces water penetration.
Applications: pavement construction and road subgrades.

Admixtures

- Lime, cement, fly ash, polymers and resins. Selected based on soil type and project requirements.

Soil Stabilization Process

- Site investigation, laboratory testing, selection of additive, mix design, field application and quality control.

Introduction to Grouting

- Grouting is the process of injecting suitable fluids under pressure into soil or rock to fill voids and improve strength and impermeability.

Applications of Grouting

- Seepage control, tunnel construction, foundation strengthening, soil stabilization, vibration control, repair of cracks and voids.

Types of Grouts

- Suspension grouts, solution grouts and colloidal solution grouts.

Compaction Grouting

- A stiff grout is injected under pressure to form grout bulbs that displace and densify surrounding soils.

Applications of Compaction Grouting

- Improvement of loose sands, settlement control, underpinning structures, alternative to deep vibro techniques.

Compensation Grouting

- High-pressure grout is injected to compensate for settlement and stress relief. Commonly used in tunneling projects.

Jet Grouting (Soilcreting)

- High-pressure jets cut and mix soil with grout to form soil-cement columns having high strength and low permeability.

Types of Jet Grouting

- Single Direct Process, Double Direct Process and Triple Separation Process.

Applications of Jet Grouting

- Tunnel support, cut-off walls, cofferdams, soil stabilization and groundwater control.

Introduction to Thermal Modification

- Thermal methods improve soil by heating or freezing. Changes in temperature alter water content and soil structure.

Heating Methods

- Ground surface heating, borehole heating, thermal piles and geothermal piles.

Ground Freezing

- Ground freezing converts pore water into ice, increasing soil strength and reducing permeability. Types: Indirect freezing, Direct freezing, Liquid Nitrogen Freezing.