Lecture 2

NPTEL Course

GROUND IMPROVEMENT

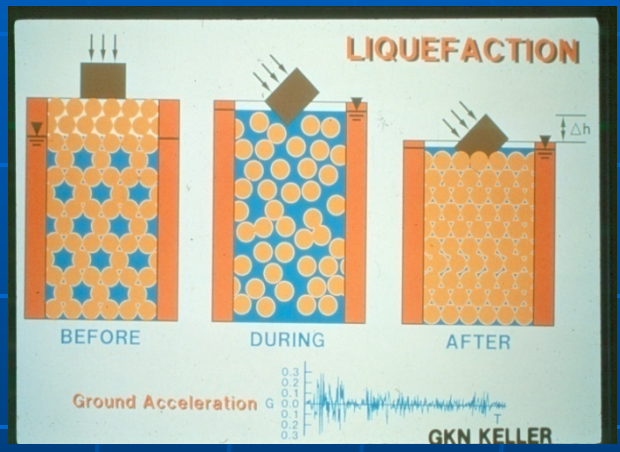
Prof. G L Sivakumar Babu
Department of Civil Engineering
Indian Institute of Science
Bangalore 560012
Email: gls@civil.iisc.ernet.in

Module I

- Need for Ground Improvement
- Different types of problematic soils
- Emerging trends in ground Improvement

Introduction

- **Scarcity of suitable construction sites**
- **Problem soils**
  - Collapsible soils
  - Liquefiable soils
  - Waste materials
  - Expansive and shrinkage
  - Marshy and soft soils
  - Karst deposits
- **Wide application**
- **Economy**



Classification of ground modification techniques

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

Methods for Soil Improvement

Ground Reinforcement

- Stone Columns
- Soil Nails
- Micropiles
- Jet Grouting
- Ground Anchors
- Geosynthetics
- Fibers
- Lime Columns
- Vibro-Concrete Column
- Mechanically Stabilized Earth
- Biotechnical

Ground Improvement

- Surface Compaction
- Drainage/Surcharge
- Electro-osmosis
- Compaction grouting
- Blasting
- Dynamic Compaction

Ground Treatment

- Soil Cement
- Lime Admixtures
- Flyash
- Dewatering
- Heating/Freezing
- Vitrification

Factors affecting the selection of ground improvement technique

- **Type and degree of improvement required**
  - Bearing capacity improvement, settlement reduction, permeability enhancement/decrease, long term/short term, liquefaction resistance.
- **Type of soil, geological structure, seepage conditions**
  - Type of clay/sand and foundation, role of pore pressure and seepage, presence of diffcult geological condition.

- **Costs, equipment, specifications**

- Size of the project, availability of equipment, transportation costs, experienced contractors, Specification of work, guidance documents.

- **Construction time**

- Construction time available, use of accelerated construction techniques

- **Possible damage to adjacent structure or pollution of ground water resources**
  - Tolerable levels of loading and deformation, pore water contamination
- **Durability of the materials involved**
  - Short term and long term, corrosion, aggressive soil condition.

Continued… :

- **Toxicity and corrosivity of any chemical additives**

- Government regulations may restrict the choice of additives
- Using Vitrification of soils to limit radio active or hazardous wastes,
- Ex: Remediation of chromium-contaminated soil through ex situ vitrification (ASCE journal paper)

- **Reversibility or irreversibility of the process**

- Ex: Lime added to expensive soil reacts in presence of sulphate

- **Reusability of components such as steel, plastics, concrete etc**

- **Reliability of methods of testing, analysis and design**

- Good methods of testing, proven methods of design and analysis should be used and empirical approaches need to be avoided

- **Feasibility of construction control and performance measurements**

- Documents of quality control and performance are required in major ground improvement projects

Objectives of ground improvement techniques

- Increase strength
- Reduce distortion under stress (Increases stress-strain modulus)
- Reduce compressibility (volume decreases due to a reduction in air voids or water content under loads)
- Ex: Additives, fibers, reinforcement