Module I

- Need for Ground Improvement
- Different types of problematic soils
- Emerging trends in ground Improvement
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, karst deposits with sinkhole formations
- 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

Kandla Port Building after 2001 earthquake
Effect of Swelling

Expansive Soil
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.
Slope Failure in Sweden
Failure of slope
Effects of liquefaction
Effect of Disturbance on a Quick Clay
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
Reinforcement

• This method improves the soil response by interaction between soil and inclusion.
• The improving period depends on the life of inclusion.
• In this technique there is no change in the state of soil.
• It is a widely used technique as it can be done for many types of soils.

Admixtures or Grouting

• Cementation plays a major role in improving the soil response.
• Short term/long term improvement techniques are possible.
• There is a change in soil state after adopting it.
Compaction

• The state of soil is improved in this technique due to high densification.

• This is a long term improvement technique.

• There is a change in soil state after adopting it.

• This technique can be adopted for silty, sandy and gravely soils.

Dewatering

• This is a technique similar to compaction.

• It is mostly adopted to clayey soils.
<table>
<thead>
<tr>
<th>SNo</th>
<th>Type of soil</th>
<th>Reinforcement</th>
<th>Admixtures</th>
<th>Compaction</th>
<th>Dewatering</th>
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<td>1</td>
<td>Organic soil</td>
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<tr>
<td>2</td>
<td>Volcanic clay soil</td>
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<td>3</td>
<td>Highly plastic clay</td>
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<tr>
<td>4</td>
<td>Lowly plastic clay</td>
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<td>Gravel soil</td>
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</tbody>
</table>

- **Red**: Soils for which the technique is not applicable
- **Blue**: Soils for which the technique is applicable
Classification of ground modification techniques

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