CIVL451

Methods of Soil Exploration
• Introduction
• Methods of investigation
• Methods of boring
• Soil samplers and sampling
• Location and number of pits and borings
• Penetration tests
• Borehole logs
• Geophysical methods
Introduction

• Soil exploration is a part of site investigation.
• Site investigation, in general deals with determining in general, the suitability of the site for the proposed construction.
Site Investigation
• Attempt at understanding the subsurface conditions such as:
  – Soil and rock profile
  – Geological features of the region
  – Position and variation of ground water table
  – Physical properties of soil and rock
  – Contamination, if any
  – General data of adjacent structures, hydrological data, topography, soil maps, seismicity, etc.
– To determine the type of foundation required for the proposed project at the site, i.e. shallow foundation or deep foundation.

– To make recommendations regarding the safe bearing capacity or pile load capacity.

– Ultimately, it is the subsoil that provides the ultimate support for the structures.
Failures
Leaning Tower of Pisa and Sinkholes
• The three important aspect are **planning, execution and report writing**.

• Planning
  – To minimize cost of explorations and yet give reliable data.
  – Decide on quantity and quality depending on type, size and importance of project and whether investigation is preliminary or detailed.
• **Execution**
  
  – Collection of disturbed and/or undisturbed samples of subsurface strata from field.
  
  – Conducting in-situ tests of subsurface material and obtaining properties directly or indirectly.
  
  – Study of ground water conditions and collection of sample for chemical analysis.
  
  – Geophysical exploration, if necessary.
  
  – Laboratory testing on samples
• Report writing
  – Description of site conditions – topographic features, hydraulic conditions, existing structures, etc. supplemented by plans/drawings.
  – Description of nature, type and importance of proposed construction
  – Description of field and lab tests carried out.
  – Analysis and discussion of data collected
  – Preparation of charts, tables, graphs, etc.
  – Calculations performed
  – Recommendations
A complete site investigation will consist of:

– Preliminary work
  • Collecting general information and already existing data such as study of geologic, seismic maps, etc. at or near site.
  • Study site history – if previously used as quarry, agricultural land, industrial unit, etc.

– Site Reconnaissance: Actual site inspection.
  • To judge general suitability
  • Decide exploration techniques
• Exploration
  – Preliminary Investigations: Exploratory borings or shallow test pits, representative sampling, geophysical investigations, etc.
  – Detailed Investigations: Deep boreholes, extensive sampling, in-situ testing, lab testing, etc.
  – Depth and spacing: In general, depth of investigation should be such that any/all strata that are likely to experience settlement or failure due to loading.
  – Spacing depends upon degree of variation of surface topography and subsurface strata in horizontal direction.
Methods of Investigation

• Test pits:
  – Permits visual inspection of subsurface conditions in natural state.
  – Max. depth limited to 5-6 m.
  – Especially useful for gravelly soil where boreholes may be difficult.
  – Sampling/testing done on exposed surfaces.
## Stratigraphy and Findings

<table>
<thead>
<tr>
<th>Layer</th>
<th>Soil</th>
<th>Soil Colour</th>
<th>Finds</th>
<th>Chronology</th>
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<td>Fill</td>
<td>1980s</td>
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<tr>
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<td>original decomposed soil</td>
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<tr>
<td>L6</td>
<td>Loamy soil</td>
<td>Reddish yellow 5YR 6/8</td>
<td>original decomposed soil</td>
<td></td>
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<tr>
<td>L7</td>
<td>Loamy soil, with some decomposed bed rock texture</td>
<td>Light red 2.5YR 6/8</td>
<td>original decomposed soil</td>
<td></td>
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</tbody>
</table>

### Test Pit Wall Photograph

#### Western Wall Section

![Test Pit Wall Photograph](image)

### Test Pit Wall Drawing

#### Western Wall Section Drawing

![Test Pit Wall Drawing](image)
Methods of Boring

• Auger Borings
  – Simplest method of exploration and sampling.
  – Power driven or hand operated.
  – Max. depth 10 m
  – Suitable in all soils above GWT but only in cohesive soil below GWT
  – Hollow stem augers used for sampling or conducting Standard Penetration Tests.
Hand operated augers

Power driven augers
Methods of Boring

• Wash Boring:
  – A casing is driven with a drop hammer. A hollow drill rod with chopping bit is inserted inside the casing.
  – Soil is loosened and removed from the borehole using water or a drilling mud jetted under pressure.
  – The water is jetted in the hole through the bottom of a wash pipe and leaves the hole along with the loose soil, from the annual space between the hole and wash pipe.
  – The water reaches the ground level where the soil in suspension is allowed to settle and mud is re-circulated.
Methods of Boring

Another example of wash boring is called mud rotary drilling (soil) or core drilling (rock).

• Mud rotary
  – Hollow drill rods with a drill bit is rotated into the soil. Drilling mud is continuously pumped into the hole. The bit grinds the soil and the return flow brings the cuttings to the surface.

• Core drilling
  – Used for obtaining rock cores.
  – A core barrel is fitted with a drill bit is attached to hollow drill rods.
  – Examples: diamond coring, calyx or shot core drilling
Schematic for wash boring
Figure 11-1. Core-drilling equipment
Methods of Investigation

• Percussion drilling
  – Grinding the soil by repeated lifting and dropping of heavy chisels or drilling bits.
  – Water is added to form slurry of cuttings.
  – Slurry removed by bailers or pumps.

• In general, a machine used to drill holes is called a drill rig (generally power driven, but may be hand driven).

• A winch is provided to raise and lower the drilling tools into the hole.
Methods of Investigation

• Probing or sounding methods:
  – Drive a pipe or rod into the soil.
  – Measure the resistance offered by the soil. Ex. CPT, SPT, etc.

• Geophysical methods:
  – Seismic refraction method
  – Electrical resistivity method
  – Crosshole method