Chapter III

Site Exploration

Investigational Programs.

Field investigations can be divided into two major phases:

• a surface examination and

• a subsurface exploration.
Surface Examination
a. Literature review
b. Field reconnaissance
c. Local experience

Subsurface Exploration
a. Preliminary subsurface exploration
b. Detailed subsurface exploration

a. Literature Review.
The logical and necessary first step of any field investigation is

the collection of all pertinent information on geological and soil conditions at and in the vicinity of the site or sites under consideration,

including previous excavations, material storage, and buildings.
Literature review

- Review of designing plans and preliminary plans

- Review of engineering reports:
  - Reports of previous projects on the same site;
  - Reports of previous projects with similar nature of the proposed one;
  - Review of public information.

b. Field Reconnaissance

- Visual inspection of site and surrounding areas
- Vegetation types
- Site accessibility
- Nature of surface drainage
- Open cuts in nearby areas
- Inspection of nearby structures
• Visit the site by a group of experts:
  – Project manager;
  – Designer;
  – Project geologist;
  – Project engineer;
  – Construction inspection personnel;
  – Town zoning officer.

b. Field reconnaissance (cont.):

What to observe?

• Proposed location of the structure;

• Topography and vegetation;

• Surface soils, gullying (ditches and trenches), and natural slopes;

• Surface and subsurface water;

• Surface and subsurface geology.
The field reconnaissance should include an examination of the following items as appropriate:

1. **Existing cuts** (either natural or manmade).

Railway and highway cuts, pipeline trenches, and walls of river or stream valleys may reveal stratigraphy and offer opportunities to obtain general samples for basic tests, such as Atterberg limits and grain-size analysis for classification.

(2) **Evidence of in situ soil performance.**

A study of landslide scars contributes greatly to the design of excavation slopes; it may indicate need for bracing or suggest slope maintenance problems because of groundwater seepage.

Evidence of general or localized subsidence suggests compressible subsoils, subsurface cavities, or ongoing sink-hole formations as in areas of limestone formations or abandoned mine cave-ins.

Fault scarps or continuous cracks suggest bedrock movements or mass soil movements.
(3) Existing Structures.
Careful observation of damage to existing structures, such as

• cracks in buildings (or poor roof alignment),
• Misaligned power lines,
• pavement conditions,
• corrosion on pipelines, or
• exposed metal and/or wood at water lines,

may suggest foundation problems to be encountered or avoided.

(4) Groundwater.
The effects of lowering the water table during dewatering on surrounding structures, as well as potential environmental effects, should be appraised in a preliminary manner.

Drainage problems likely to be encountered as a result of topography, confined working space, or increased runoff onto adjacent property should be noted.
(5) Availability of construction materials.

The availability of local construction material and water is a major economic factor in foundation type and design.

Possible
• borrow areas,
• quarries and
• commercial material sources, and
• availability of water

should be noted.

(6) Site access.

Access to the site for drilling and construction equipment should be appraised, including the effects of climate during the construction season.
(7) Field investigation records.

Considering the value and possible complexity of a field investigation, a well-kept set of notes is a necessity.

A camera should be used to supplement notes and to enable a better recall and/or information transfer to design personnel.

c. Local experience.

Special attention should be given to the knowledge of inhabitants of the area.

Farmers are generally well informed about seasonal changes in soil conditions, groundwater, and stream flood frequencies.

Owners of adjacent properties may be able to locate filled areas where old ponds, lakes, or wells have been filled, or where foundation of demolished structures are buried.
Subsurface Exploration
a. Preliminary subsurface exploration

The purpose of preliminary subsurface explorations is to obtain:

• approximate soil profiles and
• representative samples from principal strata or
• to determine bedrock or
• stratigraphic profiles by indirect methods.

Auger or splitspoon borings are commonly used for obtaining representatives samples.

The preliminary exploration may be sufficient for some construction purposes, such as excavation or borrow materials.

It may be adequate also for
• foundation design of small warehouses,
• residential buildings, and
• retaining walls

located in localities where soil properties have been reasonably well established as summarized in empirical rules of the local building code.
Test pits and trenches can be used to depths of 450 to 750 cm by using front-end loaders or backhoes at a cost that may compare favorably with other methods, such as auger borings.

Test pits allow visual inspection of foundation soils;

also, high-quality undisturbed block samples may be obtained.
b. Detailed subsurface explorations.

For:

- important construction,
- complex subsurface conditions, and
- cases where preliminary subsurface explorations provide insufficient data for design,

more detailed investigations are necessary.

Test borings to collect:

- disturbed and/or
- undisturbed samples

for visual and laboratory investigation.

Number and depth of borings based on project type, depth of stress influence.
The purpose is to obtain:

• detailed geologic profiles,

• undisturbed samples and

• cores for laboratory testing, or

• larger and fairly continuous representative samples of possible construction materials.

Purpose of Subsurface Exploration

• Locate Water Table
• Evaluate Load Bearing Capacity
• Predict Lateral Earth Pressures
• Select Type & Depth of Foundation
• Estimate Settlements
• Determine Potential Problems
• Establish Construction Methods
Sampling Difficulty

- Penetration,
- sounding or
- in situ tests, such as vane shear, or pressuremeter tests

may be conducted depending on sampling difficulty or desired information.

Depth of Boring

1- Boring should be extended through any unsuitable foundation strata

- unconsolidated fill,
- organic soils,
- compressible layers

until soil of acceptable bearing capacity is reached.

2- In general, boring should be extended to at least 1.5 to 2 times the minimum width of the loaded area.
3- In the case of very **heavy structures (bridges)**, boring in most cases are **extended to bed rock**, or at least one boring should be extended to bedrock.

4- The following empirical equations can be used to estimate the minimum depth of borings for **heavy steel or wide concrete buildings**:

\[ D = 6S^{0.7} \] (in meter)

where \( S \) = number of stories.

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**Rough guidelines for depths of exploratory borings for buildings on shallow foundations.**

<table>
<thead>
<tr>
<th>Subsurface Conditions</th>
<th>Minimum Depth of Borings</th>
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<tbody>
<tr>
<td></td>
<td>((S: \text{number of stories}; \ D: \text{anticipated depth of foundation}))</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td>(6S^{0.7}+D)</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>(5S^{0.7}+D)</td>
</tr>
<tr>
<td><strong>Good</strong></td>
<td>(3S^{0.7}+D)</td>
</tr>
</tbody>
</table>
**Rough guidelines for spacing exploratory borings for proposed medium to heavy weight building, tanks, and other similar structures.**

<table>
<thead>
<tr>
<th>Subsurface Conditions</th>
<th>Structure Footprint Area for Each Exploratory Boring (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor quality and erratic</td>
<td>100-300</td>
</tr>
<tr>
<td>Average</td>
<td>200-400</td>
</tr>
<tr>
<td>High quality and uniform</td>
<td>300-1000</td>
</tr>
</tbody>
</table>

For **retaining walls and sewers**, one boring every 90 m, and

for **deep cuts and high fills**, one boring every 60-150 m depending on soil conditions.

If **piles** are anticipated, the boring is stopped 3 m below the estimated **bottom** of the piling.
The sampling frequency for cohesive (clay-like) materials is

every 150 cm in depth

to a depth of

2 x the footing width or

9.0 m,

whichever is greater, below the bottom of the proposed footing elevation.

The sampling frequency for sands and gravels is every

150 cm in depth where a

standard penetration (resistance to driving) test (SPT) is obtained.