

1.1 Scope and objectives:

Objectives of soil exploration:

Following are the objectives of site investigation or subsurface exploration.

1. Determination of the nature of the deposits of soil.
2. Determination of the depth and thickness of various soil strata and their extent in horizontal direction.
3. Location of ground water and fluctuations in ground water level.
4. Obtaining soil and rock samples from the various strata.
5. Determination of engineering properties of soil and rock strata that affects the performance of the structure.
6. Determination of in-situ properties by performing field tests.
7. To know about the order of occurrence of soil and rock strata.
8. To know about the location of the groundwater table level and its variations.
9. To select a suitable type of foundation.
10. To estimate the probable and maximum differential settlements.
11. To find the bearing capacity of the soil.
12. To predict the lateral earth pressure against retaining walls and abutments.
13. To select suitable soil improvement techniques.
14. To select suitable construction equipment.
15. To forecast problems occurring in foundations and their solutions.

Purpose of soil exploration :

- (i) To determine the basic properties of soil which affect the design and safety of structure i.e., compressibility, strength and hydrological conditions.
- (ii) To determine the extent and properties of the material to be used for construction.
- (iii) To determine the condition of groundwater.
- (iv) To analyze the causes of failure in existing works.

The nature and extent of soil exploration depends upon the ultimate use to which

the results of the investigation will be applied. For example, for structures which transmit heavy load on the soil, the aim of soil exploration is to provide data which will help in the selection of proper types of foundation, its location and design of foundations.

Planning of Subsurface Investigation:

To obtain the most useful information at minimum cost and effort, proper planning of subsurface investigation program is essential.

For planning of the program, the soil engineer-in-charge of the program should include the following steps:

- (i) Completely familiar with the kind of information required from the investigation.
- (ii) Knowledge of type, size and importance of the project.
- (iii) Preparation of layout plan of the project,
- (iv) Preparation of borehole layout plan which includes the number and spacing of boreholes, depth and frequency of sampling.
- (v) Selection of proper drilling and sampling equipment.
- (vi) Selection of personnel to supervise the field investigation.
- (vii) Marking on the layout plan any additional types of soil investigation.
- (viii) Preparation of guidelines for laboratory testing of collected samples.

Stage of Subsoil Investigation:

Different stages of sub-soil investigation of a major civil Engineering project are mentioned below:

- (i) Reconnaissance study:
 - (a) Geological data
 - (b) Serial photographs
 - (C) Pedological data
- (ii) Preliminary site exploration
- (iii) Detailed investigation:
 - (a) Boring

- (b) Sampling
- (c) Testing
 - (i) Lab test
 - (ii) Field test
- (d) Aerial photographs
- (e) Geophysical methods
- (iv) Performance study
 - (a) Further testing
 - (b) Instrumentation
 - (c) Performance evaluation
- (v) Preparation of Report of Sub-Soil Exploration

(i) Reconnaissance Study:

Site reconnaissance is the first stage of site investigation. In this stage, visual inspection of the site is done and information about topographical and geological features of the site are collected. It involves the preliminary feasibility study that is undertaken before any detailed planning is done. The main objective of this phase of exploration is to obtain rough idea about the soil type in the area. This study is aimed to get a rough soil profile and representative sampling of the major soil strata and groundwater condition which will be helpful in deciding the future programme of explorations. This study is to be done at minimum cost and no large scale exploratory work is usually undertaken at this stage.

The general observations made in site reconnaissance are as follows :

1. Presence of drainage ditches and dumping yards etc.
2. Location of groundwater table by observing well in that site.
3. Presence of springs, swamps, etc.
4. High flood level marks on the bridges, high rise buildings, etc. are observed.
5. Presence of vegetation and nature of the soil.
6. Past records of landslides, floods, shrinkage cracks, etc. of that region.
7. Study of aerial photographs of the site, blueprints of present buildings, geological maps, etc.
8. Observation of deep cuts to know about the stratification of soils.

9. Observation of Settlement cracks of existing structures.

(ii) Preliminary site exploration:

Preliminary site exploration is carried out for small projects, light structures, highways, airfields, etc. The main objective of preliminary exploration is to obtain an approximate picture of sub-soil conditions at low cost. It is also called general site exploration.

The soil sample is collected from experimental borings and shallow test pits and simple laboratory tests such as moisture content test, density, unconfined compressive strength test, etc. are conducted. Simple field tests such as penetration methods, sounding methods, geophysical methods are performed to get the relative density of soils, strength properties, etc.

The data collected about subsoil should be sufficient enough to design and build light structures. Following are some of the general information obtained through primary site exploration.

1. Approximates values of soil's compressive strength.
2. Position of the groundwater table.
3. Depth and extent of soil strata.
4. Soil composition.
5. Depth of hard stratum from ground level.
6. Engineering properties of soil (disturbed sample)

(iii) Detailed Soil Investigation:

In detailed soil investigation, boring, sampling and testing is done to obtain the engineering properties of soil.

Detailed exploration is preferred for complex projects, major engineering works, heavy structures like dams, bridges, high rise buildings, etc. A huge amount of capital is required for a detailed site exploration hence, it is not recommended for minor engineering works where the budget is limited. For such type of works, data collected through preliminary site exploration is enough.

In this stage, numerous field tests such as in-situ vane shear test, plate load test, etc. and laboratory tests such as permeability tests, compressive strength test on undisturbed soil samples are conducted to get exact values of soil properties.

Trial Pits:

Trial pits can be used for all types of soils. It is the cheapest way of site exploration and do not require any specialized equipment. In this method a pit is manually excavated and soil is inspected in the natural condition. Both disturbed and undisturbed sample can be conveniently taken. Trial pits are suitable for exploration of shallow depth only.

(v) Preparation of Report of Sub-Soil Exploration

After performing preliminary or detailed site exploration methods a report should be prepared. A sub-soil investigation or exploration report generally has the following sections :

1. Introduction
2. Scope of site investigation
3. Description of the proposed structure, purpose of site investigation
4. Site reconnaissance details
5. Site exploration details such as number, location and depth of boreholes, sampling details etc.
6. Methods performed in site exploration and their results.
7. Laboratory tests performed and their results.
8. Details of Groundwater table level and position.
9. Recommended improvement methods if needed.
10. Recommended types of foundations, structural details, etc.
11. Conclusion.