# 1. Subsurface Investigation

## 1.1 General

- Site Investigation is the process by which geological, geotechnical, and other relevant information which might affect the construction or performance of a civil engineering or building project is acquired.

- Objectives
  1) Site selection
  2) Foundation and earthworks design
  3) Temporary works design
  4) The effects of the proposed project on its environment
  5) Investigation of existing construction
  6) The design of remedial works
  7) Safety check for pre-existing structures

- (Geotechnical) Subsurface exploration

  ⇒ The process of determining the structures of subsoil and their physical properties

- Informations to get from subsurface investigation

  (1)

  (2)

  (3)

## 1.2 Subsurface Exploration Program

i) Collection of preliminary information

* Information regarding the type of structure to be built and its general use
* A general idea of the topography and the type of soil to be encountered near and around the proposed site

ii) Reconnaissance

(a) The general topography of the site and possible existence of drainage ditches

(b) Soil stratification from deep cuts

(c) Type of vegetation at the site

(d) High-water marks on nearly building and bridge abutments

(e) Ground water levels from checking nearby wells

(f) Type of construction nearby and existence of any cracks in walls or other problems

iii) Site Investigation

- Consisting of planning, making some test boreholes, and collecting soil samples

- Planning the site investigation

1) Depth of Borings

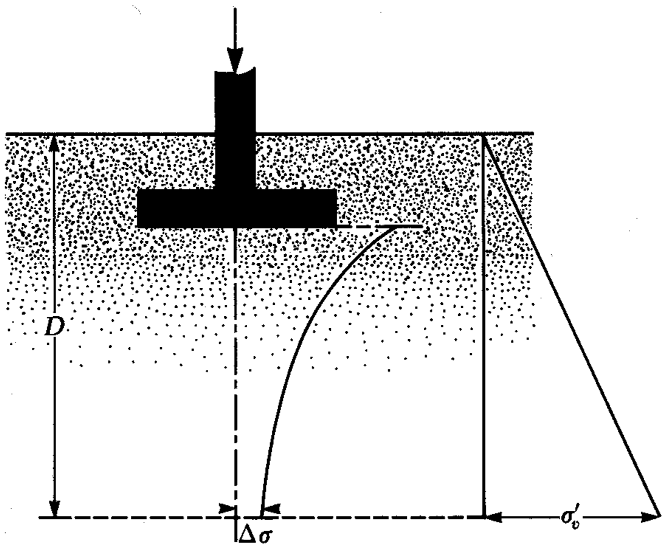
- Reservoirs : a) Depth of the base of the impermeable stratum or b) not less than 2 × maximum hydraulic head expected.
- Foundations :

a) All borings should be carried to a suitable bearing strata.

b) Determination of the approximate minimum depth of boring

i) Determine net increase of stress, $\Delta\sigma$

ii) Estimate the variation of the vertical effective stress, $\sigma_v'$




iii) Determine the depth, $D=D_1$ at $\Delta\sigma=1/10\ q$

(Here, $q$ = estimated stress at the foundation)

iv) Determine the depth, $D=D_2$ at $\Delta\sigma/\sigma_v'=0.05$

v) Minimum depth of boring is the smaller of $D_1$ and $D_2$ unless bedrock is encountered.

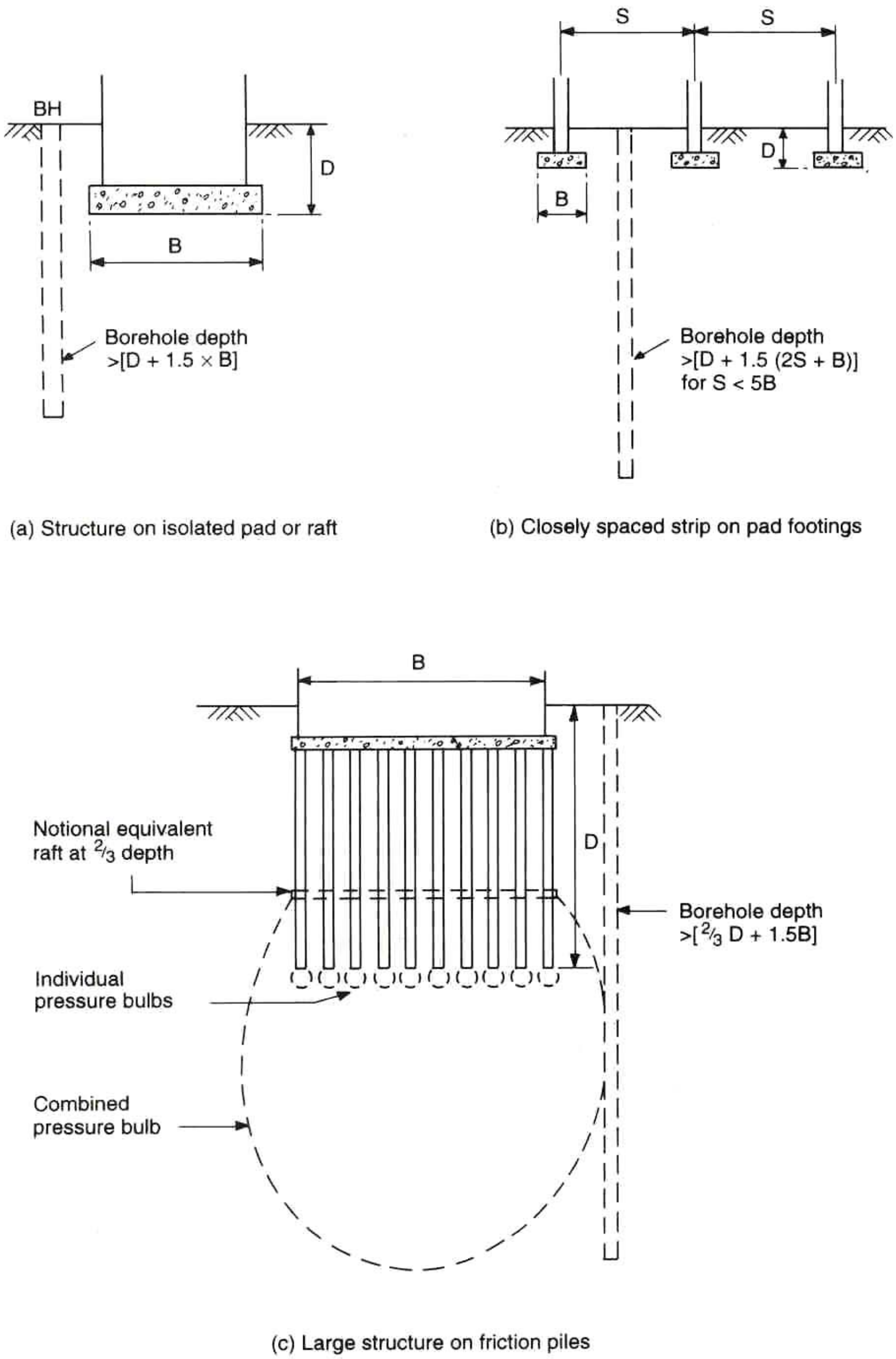



**Fig. 1.5** Necessary borehole depths for foundations.

- Foundation on bedrock ⇒

- For deep excavations ⇒

* Approximate spacing of borings

- Depending on the type of structures and soil conditions

| Type of project | Spacing(m) |
|---|---|
| Multistory building | 10~30 |
| One story industrial plants | 20~60 |
| Highways | 250~500 |
| Residential areas | 250~500 |
| Dams | 40~80 |

* Exploration cost = 0.1~0.5% of the cost of structures

## 1.3 Exploratory Borings in the Field

* Provide the opportunity to obtain samples for visual description and laboratory testing, to perform in situ testing and to allow the installation of instrumentation such as piezometers.

1) Test-pit

Max depth = 4 ~ 5m

2) Auger boring (Continuous flight auger)

* Bring the loose soil from the bottom of the hole to the surface ⇒ identifying the soil.

* Can detect changes in soil type by noting changes in the speed and sound of drilling

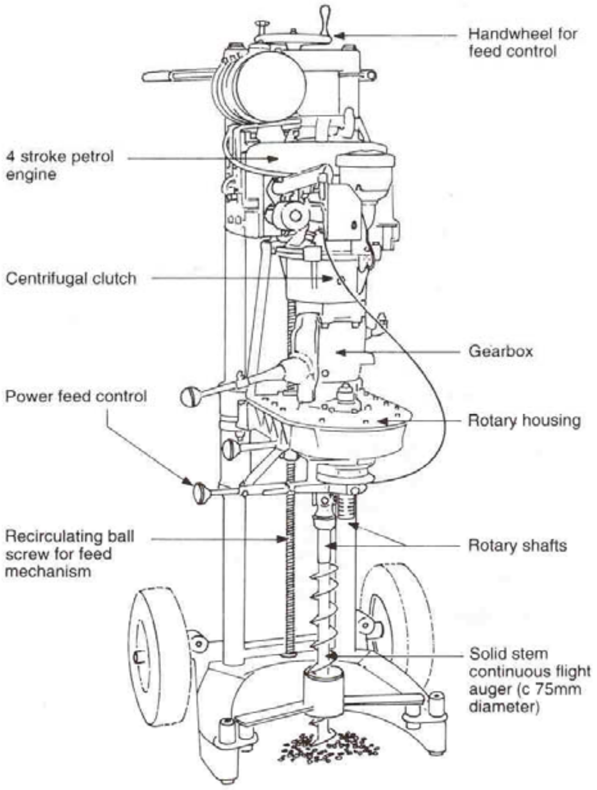



**Fig. 5.5** Mobile 'Minuteman' small diameter solid stem continuous-flight auger rig.

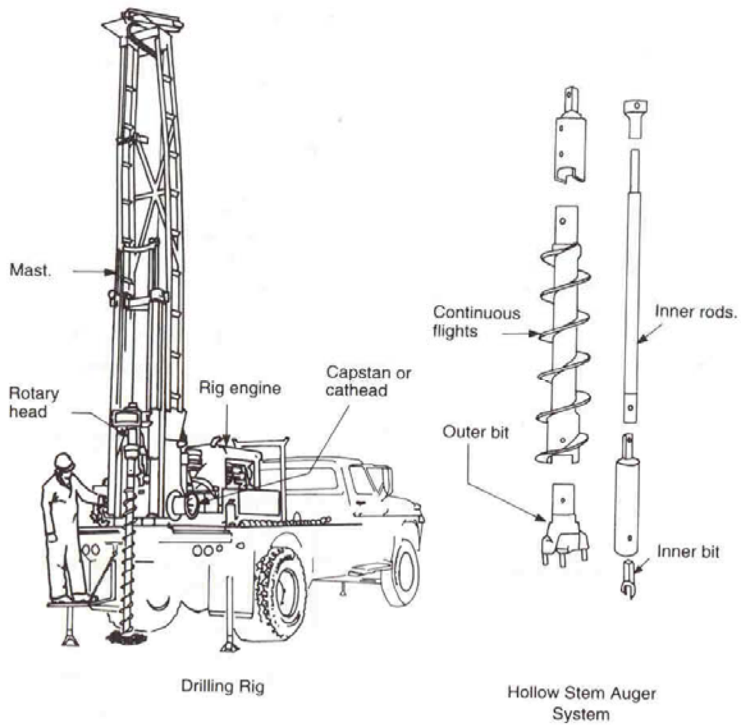



**Fig. 5.6** Acker ADII drilling rig and hollow-stem auger system.

3) Rotary drilling

* Rotary drilling uses a rotary action combined with downward force to grind away the material in which a hole is made.

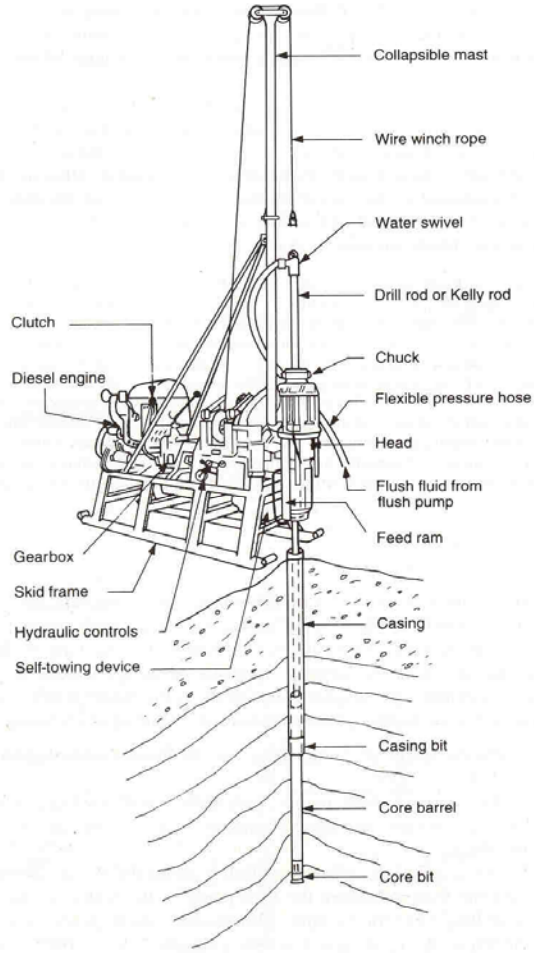



**Fig. 5.9** Layout for small-scale rotary core drilling.

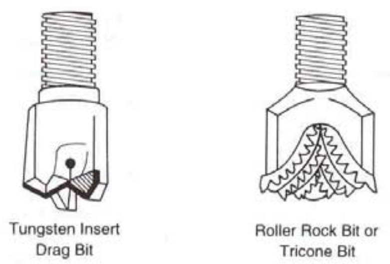



**Fig. 5.10** Bits for rotary open holing.

4) Wash boring

* Washboring is a relatively old method of boring small-diameter exploratory holes in fine-grained cohesive and non-cohesive soils.

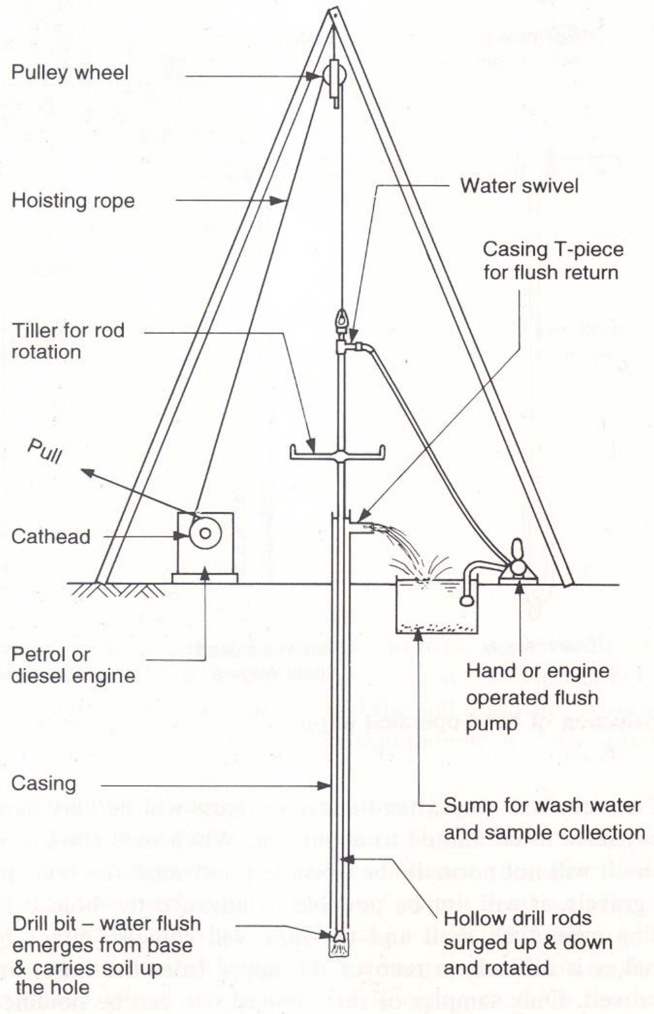



**Fig. 5.8** Washboring rig (based on Hvorslev 1949).

5) Percussion boring

* A method that advances the borehole by raising and lowering a drilling bit (a claycutter or shell) to chop the soil.