AS Unit 1: Our Built Environment

2.1.6: SUBSTRUCTURES (2 of 3)

INFORMATION FOR FOUNDATION DESIGN

Foundation selection and design is based on the results of laboratory testing of subsoil properties and the findings of site investigations.

Laboratory testing of samples taken from site will establish the subsoil's mechanical properties of strength, stiffness and permeability. These properties relate to the classification, density, ground water conditions and water / chemical content of the subsoil.

Soil classification. Soil types are classified according to particle or grain size and shape:

- Very coarse soils: Boulders and cobbles
- Coarse soils: Gravel and sand
- Fine soils Silt and clay.

(Gravels, sand and silts are further divided into 3 sub-groups: coarse, medium and fine. Particle shapes are described as either rounded, irregular, angular, flaky, or elongated).

Soil density. Density test results will help determine the level of compaction and bearing capabilities of the subsoil.

Ground water conditions and level. Identification of contaminations to be considered in relation to material specifications and health and safety of site operatives. The level and seasonal variations in the water table need to be established for consideration in the detailing of substructures, basements, and other below ground elements, such as lift pits.

Moisture content analysis to establish natural water content and its effect on shear strength of the subsoil.

Chemical analysis. As with ground water, the pH value and levels of contamination need to be established to inform material specifications and health and safety issues for site operatives and future occupants.

TYPES OF BUILDING FOUNDATION

Strip foundations (or strip footings). Shallow foundations used to provide a continuous, level support to a load bearing wall. Suitable for use in soil of relatively good bearing capacity and for light structural loadings, such as low-rise domestic buildings. The size of a strip foundation is related to the wall's overall width. Approved document A defines minimum widths for strip footings based on the type of ground and total loads. They must be deep enough to avoid frost action (450 mm unless they are bearing on rock), and at least 1m deep in high shrinkage clays.

Trench fill foundations. Shallow foundations often used when soil is loose or in areas with a high water table. It involves filling the trench excavation with concrete, typically, to within 150 mm of the surface ground level. This reduces the excavation required, as bricklayers do not need to access the trench and can save on labour, time, and temporary works.

Raft foundations. Reinforced concrete ground slabs, typically between 150 mm to 300 mm thick that spread the imposed load over a wide area, often the entire footprint of a building. They are suitable where structural loadings are low and ground conditions are poor and /or differential settlement is likely. The raft may incorporate stiffening downstand beams to support internal walls and a thickened reinforced perimeter beam to support the external walls.

Pad foundations. Generally formed by rectangular, reinforced concrete 'pads' that support localised single-point loads, such as from the structural columns of a steel frame. This load is spread by the pad to the bearing layer below. Pad foundations require limited excavation and are generally suitable where the bearing capacity of the subsoil is sufficient at relatively low depths.

Pile foundations. Deep foundations formed by long, columnar elements, made from steel or reinforced concrete, used to transfer loads from superstructures, through unsuitable subsoil onto stronger soil or rock at depth.

Typically used in situations where soil is not suitable to prevent excessive settlement. Piles may be classified by function (end-bearing or friction) or by their method of construction (driven or bored).

- End-bearing piles. Transmit load directly to firm strata at the toe of the pile.
- Friction piles. Develop most of the pile-bearing capacity by shear stresses along the sides of the pile.
- Driven piles involve displacing the material around the pile shaft outwards and downwards instead of removing it.
- Bored piles involve forming a hole for the pile which is poured insitu. Bored piles are more popular in urban areas as there is minimal vibration.
- Micropiles. Used where access is restricted, e.g. for underpinning existing structures affected by settlement.
- Pile walls. Retaining walls created by placing piles directly adjacent to one another.

Pile cap and ground beam. Piles can be used individually or grouped and linked together with a reinforced concrete cap where a point load is transferred to several piles.

The pile caps can be linked together with reinforced concrete ground beams to form and integrated foundation for the distribution of loads from structural walls and / or close-centred columns and transfer to the piles.