# Material and Methods of Construction

**Lecture # 5 Foundation**

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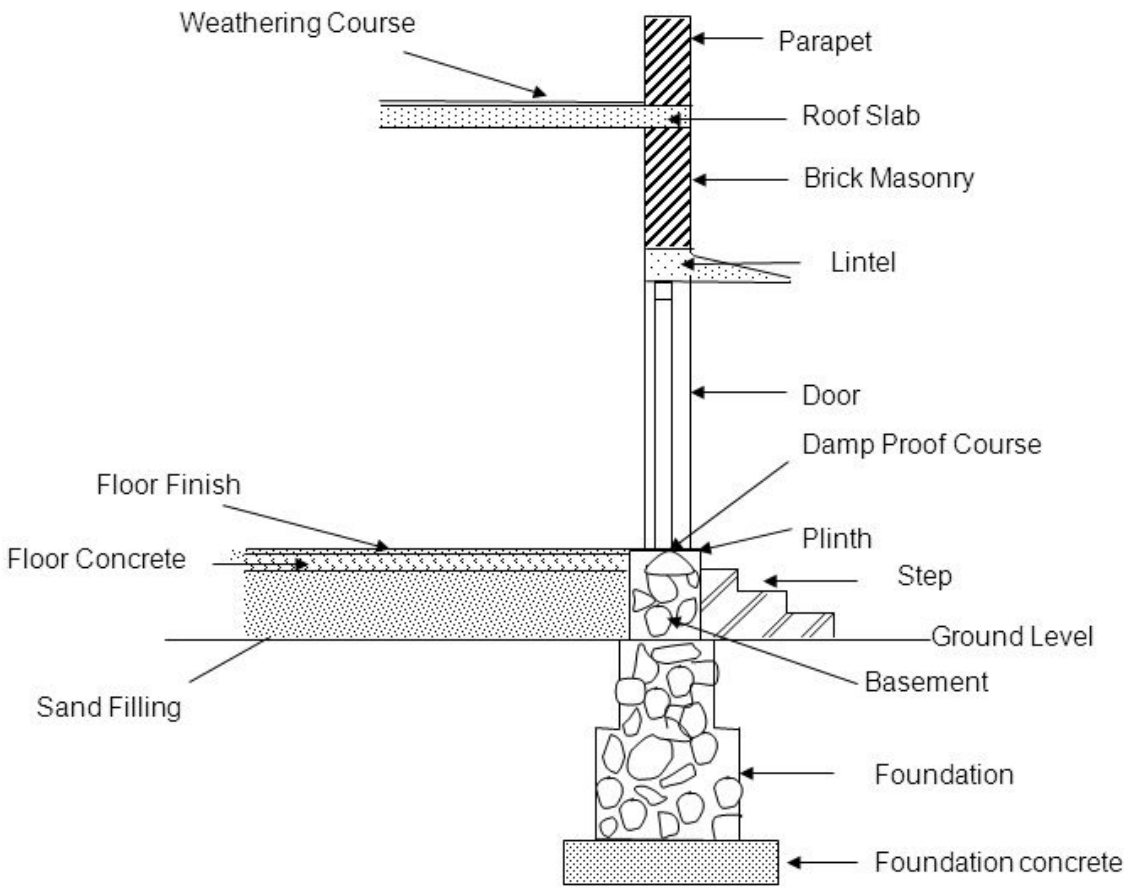
# Foundation

## 12.1 Introduction

A building has two main components, *i.e.* foundation or sub-structure and super structure. The *foundation* or *sub-structure* is the lowest part of the structure which transmits the load to the soil. The *super structure* is that part of the structure which is above the ground level. A part of the super structure, located between the ground level and the floor level is known as *plinth*. The level of the floor is usually known as *plinth level* and the built up covered area measured at the floor level is called *plinth area*.

# Foundation




COMPONENTS OF A BUILDING

# Purpose of Foundation

The soil which is located immediately below the base of the foundation is called the *sub-soil* or *foundation soil*, while the lower most portion of the foundation which is in direct contact with the sub-soil is called *footing*. The basic function of the foundation is to transmit dead loads, super-imposed or live loads and wind loads from a building to the soil on which the building rests, in such a way that the settlements are within permissible limits, without causing cracks in the super-structure and the soil does not fail. Since the load of the structure is ultimately coming on the soil, therefore it is very important to know the strength and behaviour of the soil.

# Bearing Capacity

The ability of the sub-soil to support the load of the structure without yielding or displacement, is known as *bearing power* or *bearing value* or *bearing capacity of the soil*. It is defined as the maximum load per unit area which the soil can resist safely. The minimum load which will cause failure of a foundation is called *ultimate bearing power* of the soil. When the ultimate bearing power of the soil is divided by the factor of safety, we get *safe bearing capacity of the soil*. The bearing capacity of the soil can be improved by

# Types of Foundations

## 12.2 Types of Foundations

The foundations may be broadly classified as shallow foundations and deep foundations. A foundation is said to be a shallow if its depth is equal to or less than its width. When the depth is equal to or greater than its width, the foundation is termed as deep foundation.

## 12.3 Types of Shallow Foundations

The shallow foundations are of the following types :

1. *Spread footing.* The spread footings are those which spread the super-imposed load of the structure over a large area. The spread footings may be of the following types :

# Types of Foundations

(a) Single footing for a column,
(b) Stepped footing for a column,
(c) Sloped footing for a column,
(d) Wall footing without steps and with steps, and
(e) Grillage foundation.

The base for the first three types of footings is made of concrete. When heavy structural loads from column are required to be transferred to a soil of low bearing capacity, the most economical foundation is grillage foundation. The depth of such a foundation is limited to 0.9 to 1.6 m.

# Types of Foundations

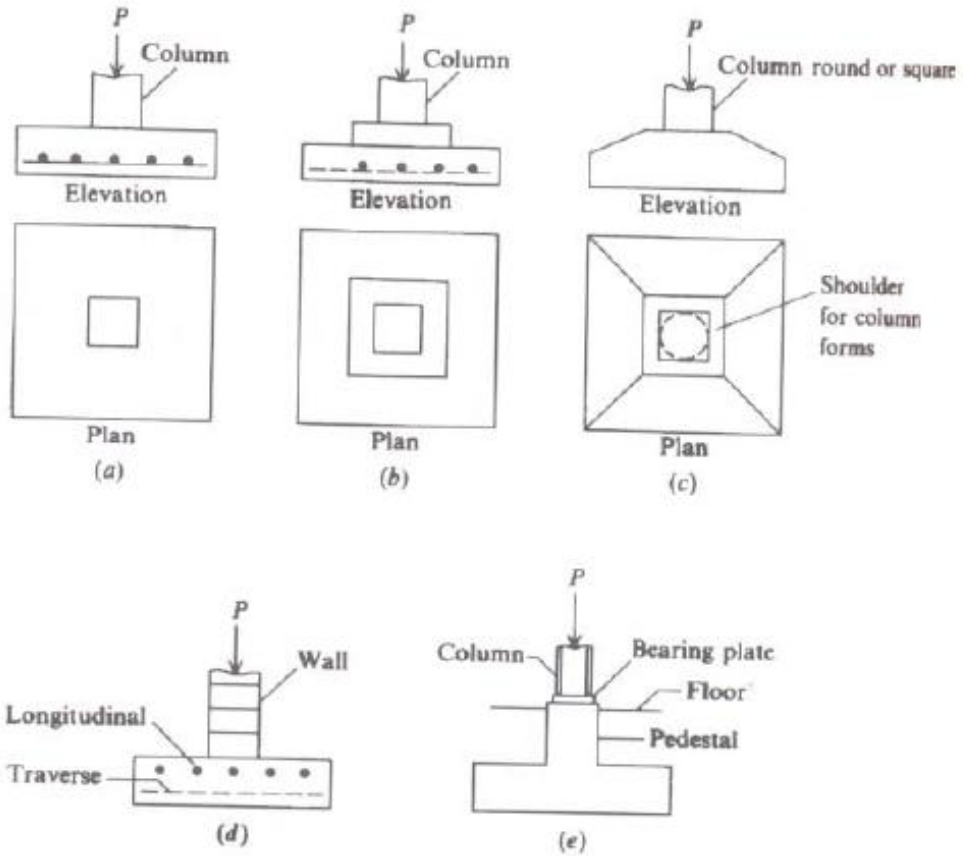
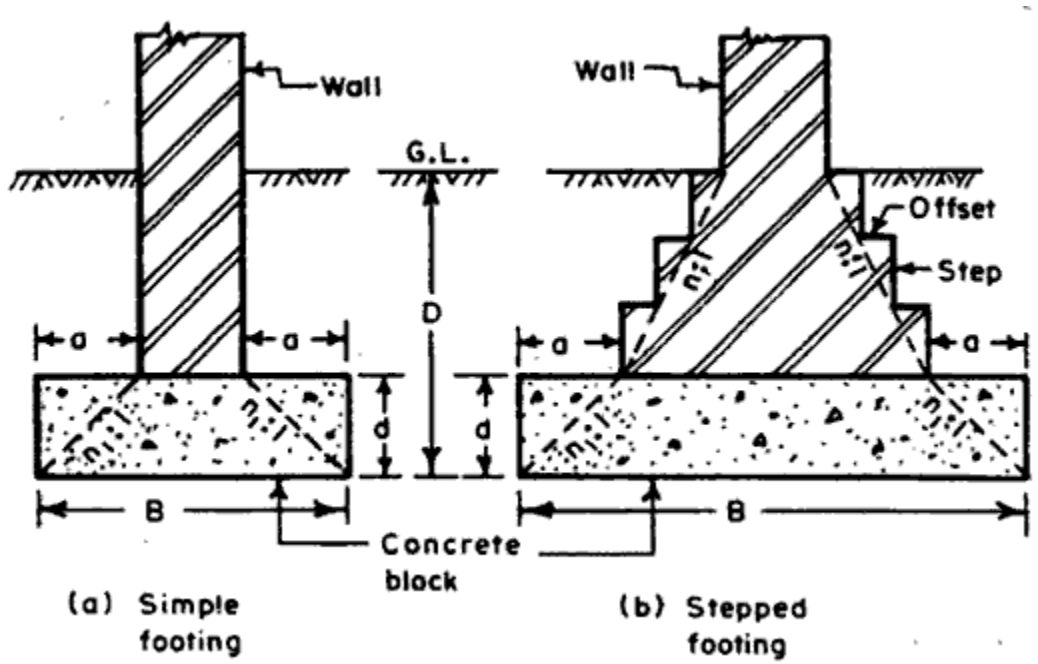



**Figure 1.1 Types of spread footings**



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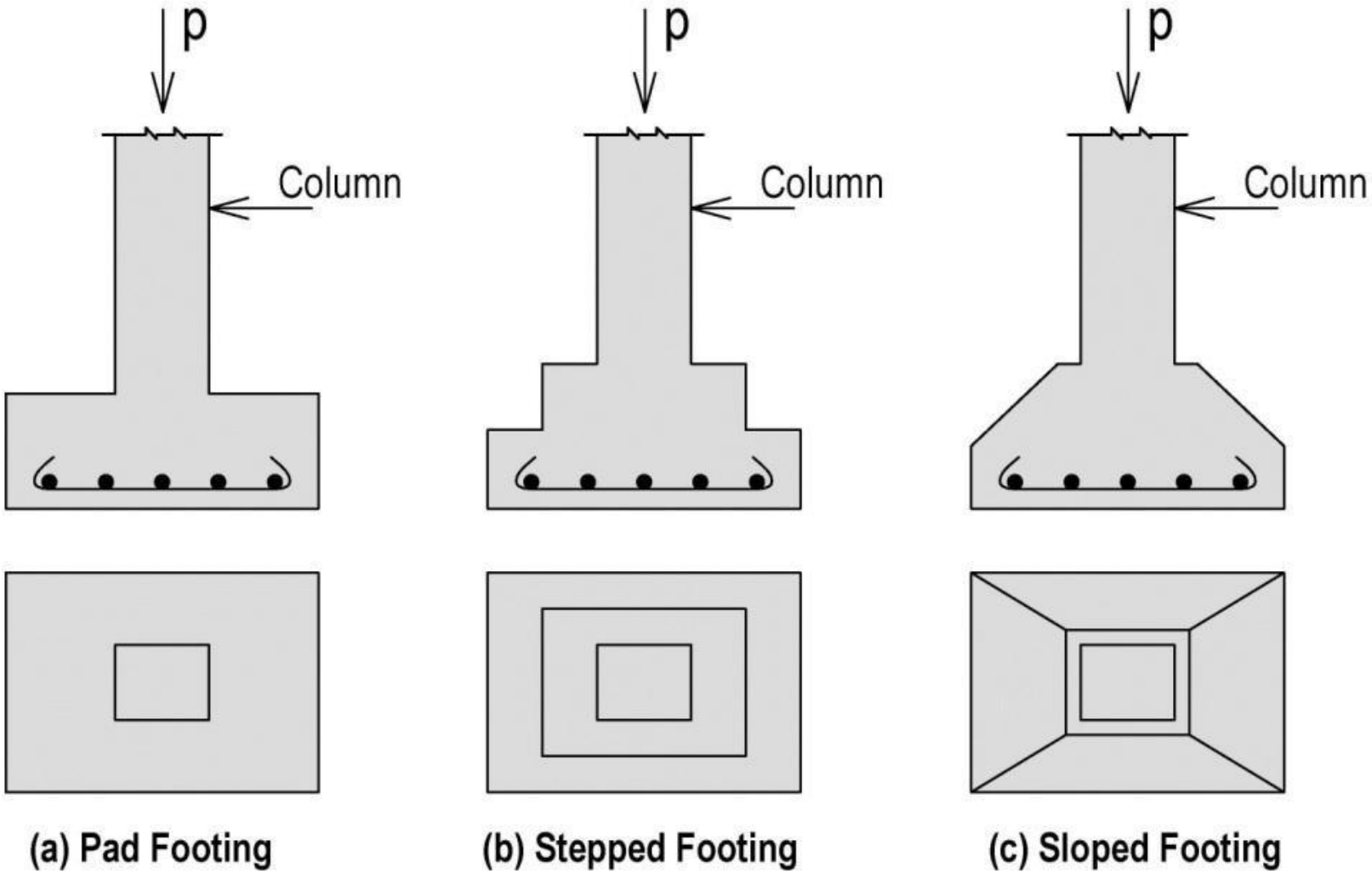

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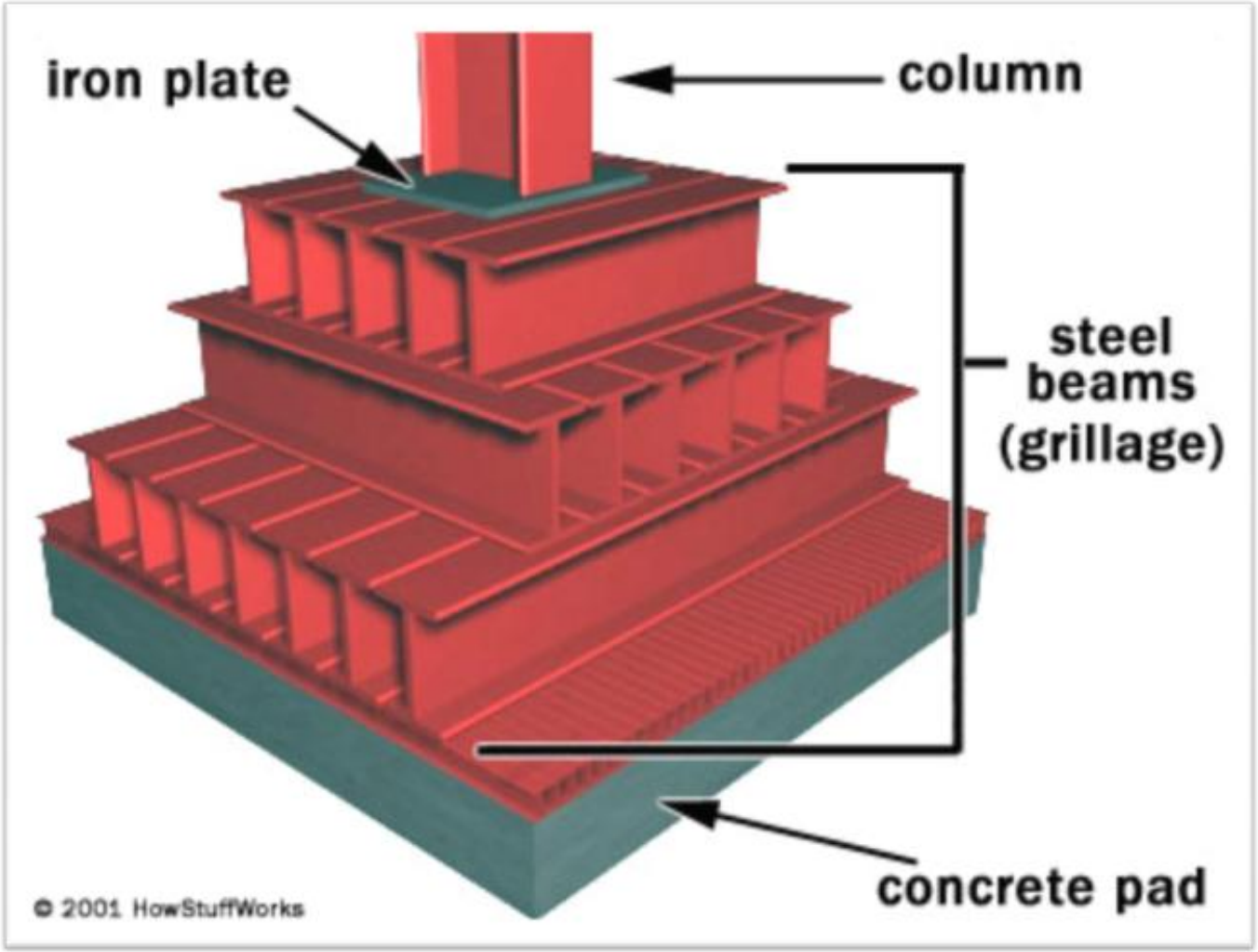


# Types of Foundations

2. *Combined footing*. The common footing which is constructed for two or more columns, is called combined footing. The shape of a combined footing is so proportioned that the centre of gravity of the supporting area is in line with the centre of gravity of the two column loads. The general shape of a combined footing is either rectangular or trapezoidal. A combined rectangular footing is provided where loading condition is such that either of the two columns are equally loaded or the interior column carries greater load. A trapezoidal combined footing is provided under any condition of loading.

# Types of Foundations

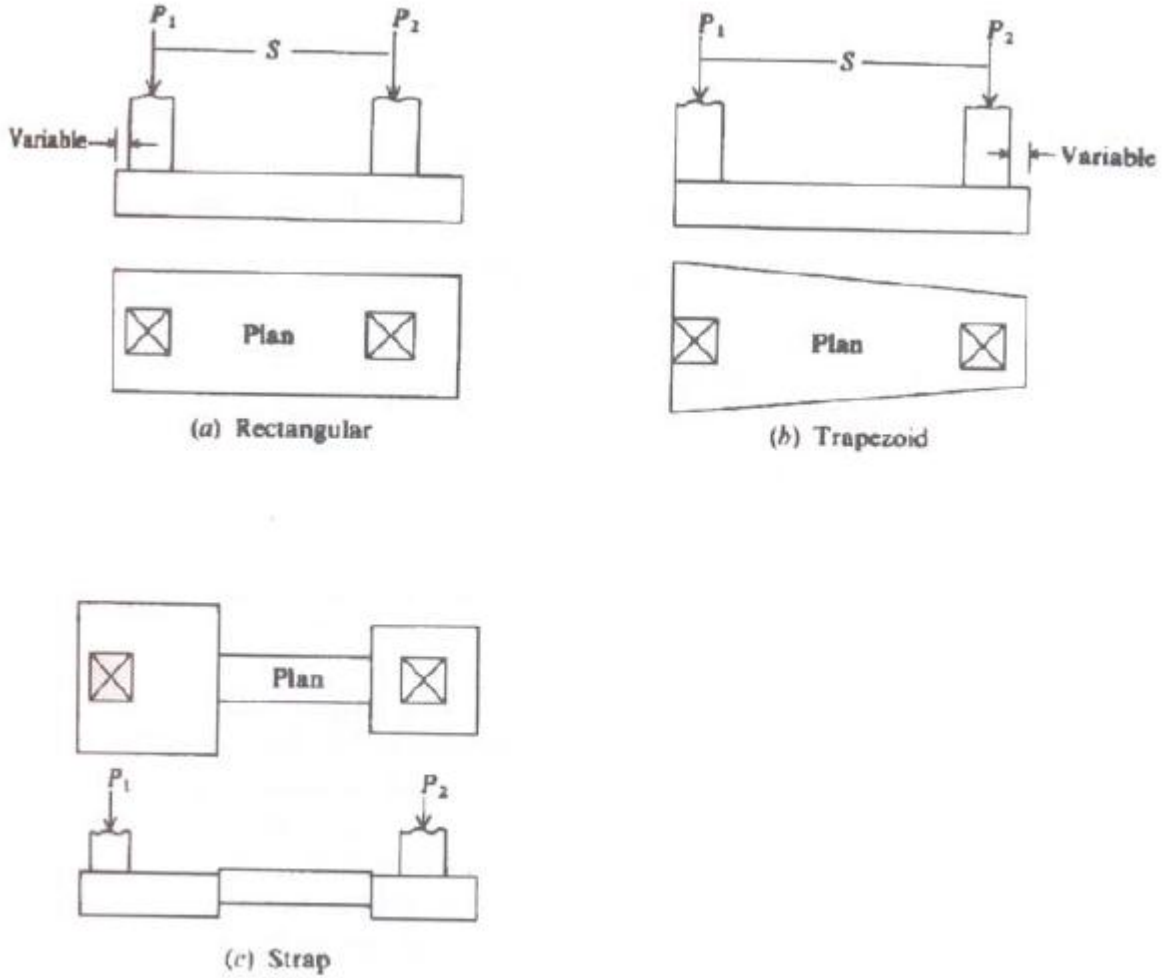


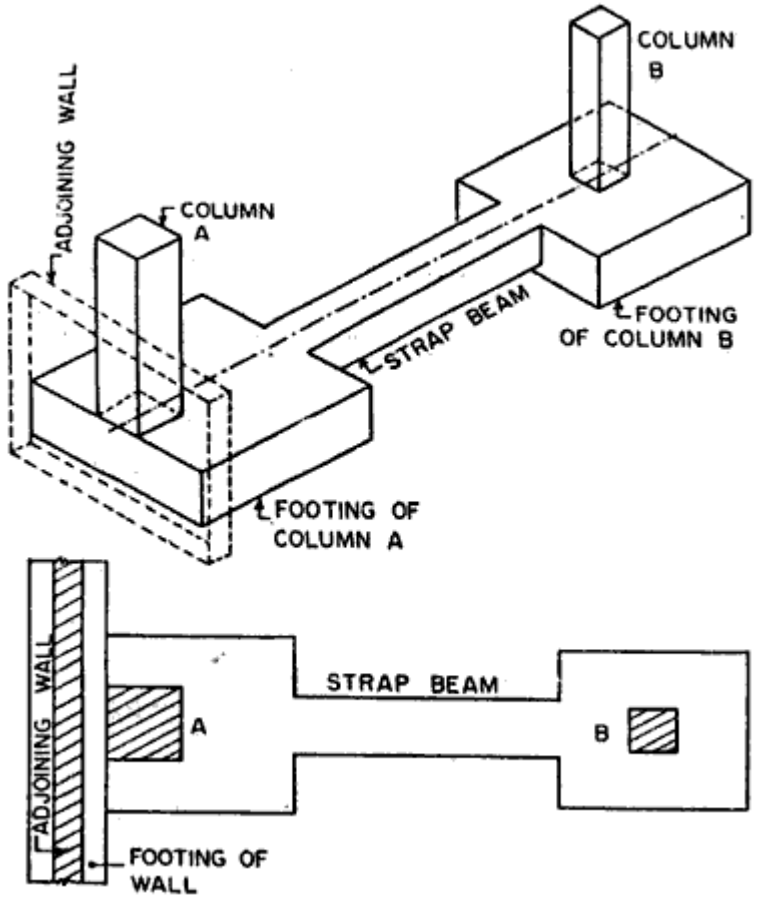

**Figure 1.3 Types of combined footings (a) Rectangular (b) Trapezoidal (c) Strap**

# Types of Foundations

3. *Strap footing.* When two or more footings are connected by a beam, it is called a strap footing. It may be used where the distance between the columns is so great that a combined trapezoidal footing becomes quite narrow, with high bending moments.

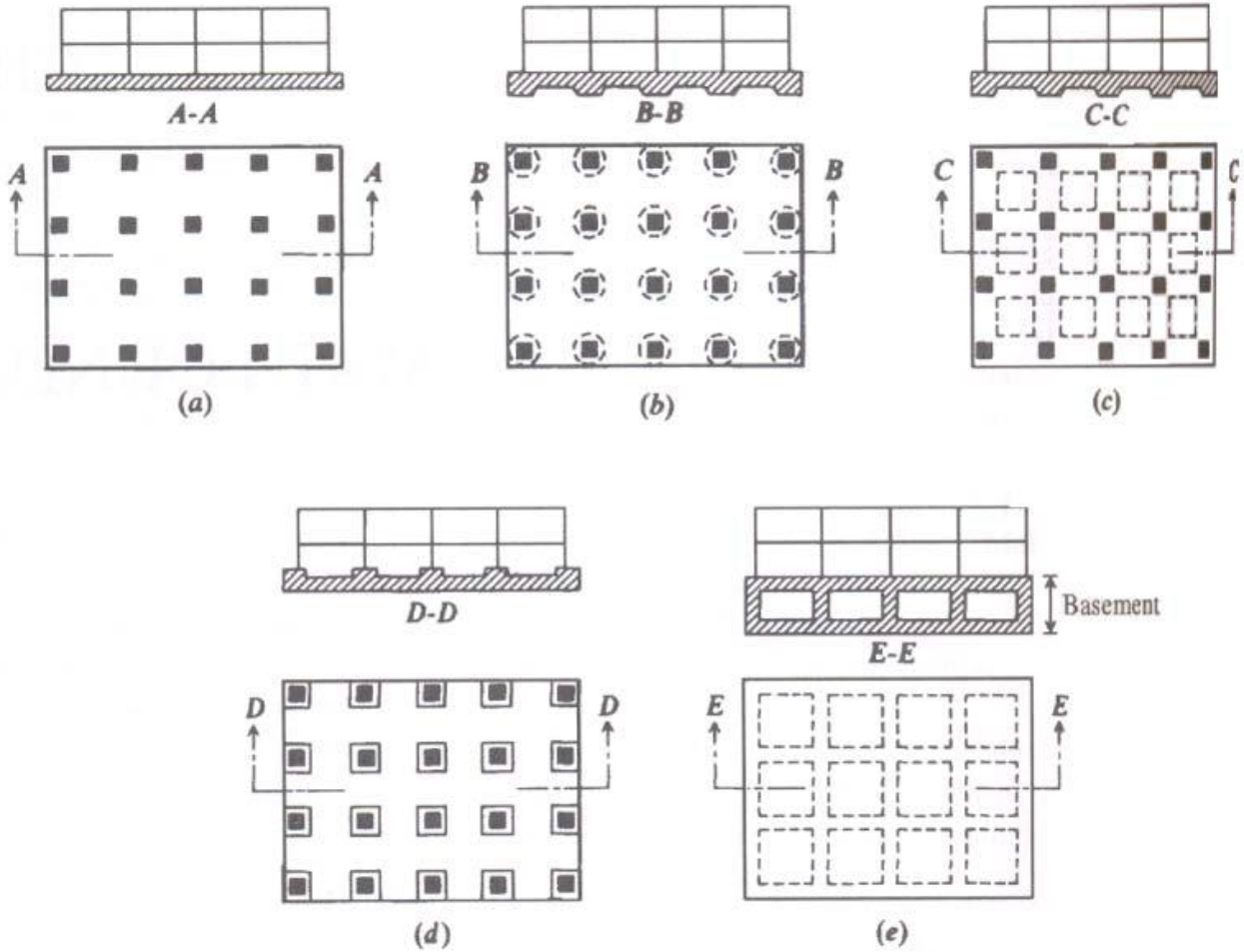
4. *Raft or mat foundation.* A foundation consisting of thick reinforced concrete slab covering the entire area of the bottom of the structure, is known as raft or mat foundation. When the allowable soil pressure is low or the building loads are heavy and if the required area of footing is more than half the total area of the structure, then it is more economical to use raft or mat foundation.

# Types of Foundations




Strap Foundation

# Types of Foundations




**Common types of mat foundations. (a) Flat plate (b) plate thickened under columns (c) waffle slab (d) plate with pedestals (e) basement walls as part of ma**

# Design of Shallow Foundations

The design of shallow foundations involves the following two aspects :

1. *Width of foundation* : The width of foundation is obtained from the following relations :

(*a*) For walls, width of foundation

$$= \frac{\text{Total load per metre length}}{\text{Allowable bearing capacity of the soil}}$$

(*b*) For piers, width of foundation

$$= \frac{\text{Total load on the pier}}{\text{Allowable bearing capacity of the soil}}$$

Usually, the walls and piers are given footings such that the width at the base becomes equal to twice the width of wall at the plinth level.

2. *Depth of foundation* : According to Rankine's formula, the minimum depth ($d$) of foundation (in metres) is given by

$$d = \frac{p}{w}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)^2$$

where $p$ = Safe permissible pressure on base in $kN/m^2$,

$w$ = Unit weight of soil in $kN/m^3$, and

$\phi$ = Angle of repose of the soil.

The minimum depth of foundation for the load bearing wall of a building is restricted to 900 mm

# Any Questions?