3.5 Mat Foundation:

Mat foundation is also known as the raft foundation. It is a continuous thick concrete slab on the soil that extends the entire footprint of the building and increases the earth-bearing capacity power. This foundation supports the whole building loads and safely transfers them to the ground.

Raft/Mat foundation is used in those places where we have less bearing capacity of the soil. At those places, we use mat foundations to distribute the whole loads of the structure to the earth (When the footing area increases, then the soil load-bearing capacity will also increase) because this foundation reduces the stress on the soil at the same place.

USE MAT FOUNDATION:

- There is a lot the critical reason for the use of mat foundations. We use this foundation if the bearing capacity of the soil is weak and not capable of transferring the load of the building to the ground.
- A column is placed near the property line, and walls are so close that individual footing would overlap.
- If a deep foundation (Pile foundation) cost is higher than the raft foundation, we use it to make the structure economical.
- When a spread footing, columns can cover up to 50% of the foundation area.

TYPES OF MAT/RAFT FOUNDATION:

There are the following types of mat foundation,

1. Flat plate raft
2. Plate thickened under columns.
3. Two-way slab and beam
4. Piled mat
5. Rigid frame raft
6. Cellular mat foundation

1: FLAT PLATE RAFT:

- A flat plate raft is used in the small and lightweight load structure. This type of foundation is suitable when the soil is not compressible. The reinforcement bars are provided in both directions, top and bottom, in the form of a mesh (cage).
- A minimum of 6 inches of thick RCC slab is used in this foundation.

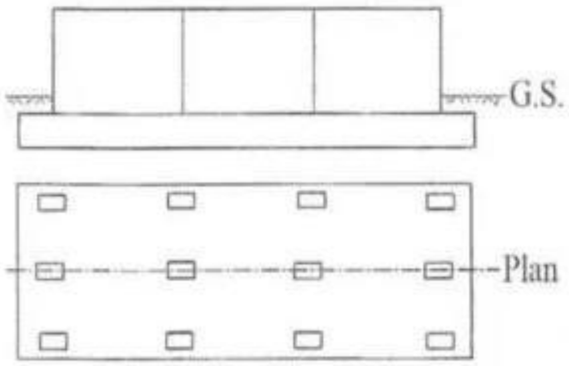


Fig 1 FLATPLATERAFT

[Fig1 https://www.civilclick.com/mat-foundation/]

2: THICKENED PLATE UNDER COLUMNS:

- The Slab thickness should be increased when the upcoming column loads are weighty. The flat plate foundation is not suitable in those structures where the column loads are very high, then the thickened flat plate is used.
- The heavy loads create the diagonal shear in the slab and create a negative bending moment on columns, so the thickness of the RCC slab under the column should be thickened.

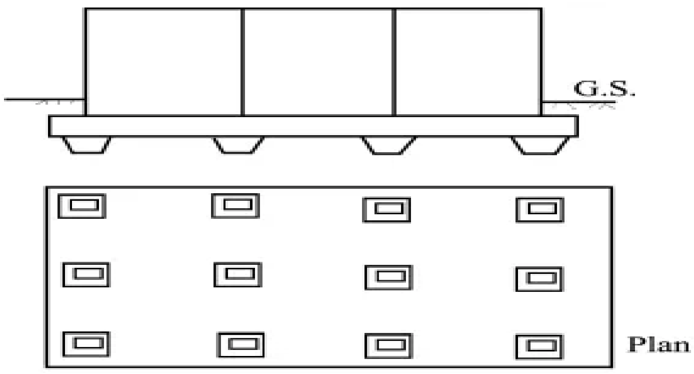


Fig2 ThickenedPlateUnderColumns

[Fig 2 https://bestengineeringprojects.com/mat-foundation-types-of-mat-foundation/]

3: TWO-WAY SLAB AND BEAM:

- In this type of mat foundation, beams are placed in perpendicular directions, and all the beams are connected by an RCC slab. The columns are placed at the intersection of beams.
- A two-way slab and beam raft foundation is suitable when the columns are carrying unequal loads and the spacing is large between them.

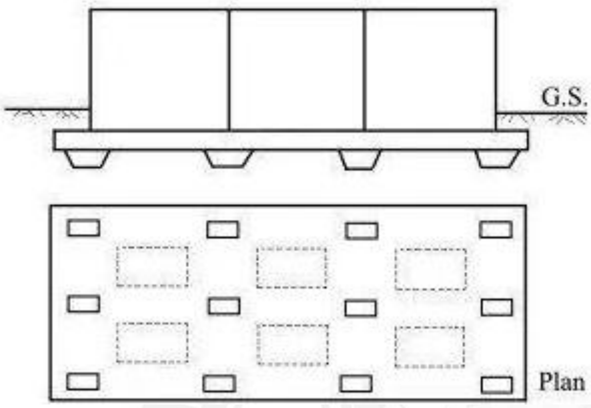


Fig3 Two-Way Slab and Beam

[Fig 3 https://www.civilclick.com/mat-foundation/]

4: PILED RAFT FOUNDATION:

- This foundation is supported by piles in the soil. The piled raft foundation is suitable for the ground of high compressibility and where the water table is high. Piled raft foundation is mainly used for high-rise buildings.
- The piles were used to reduce the amount of soil settlement(With time) and increase the soil load-bearing capacity.

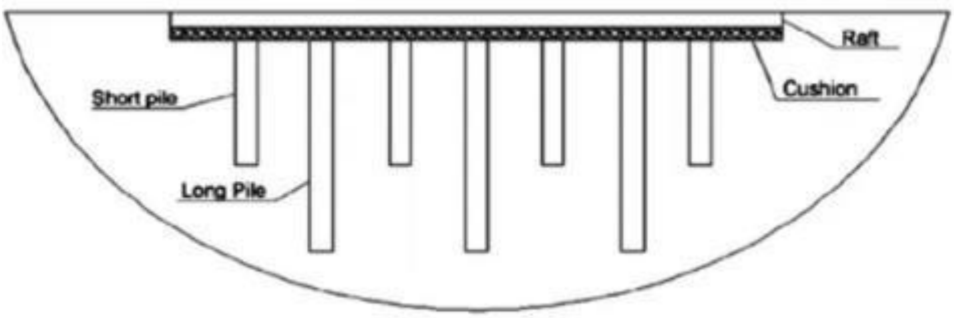


Fig 4 Piled Raft Foundation

[Fig 4 https://www.civilclick.com/mat-foundation/]

5: RIGID FRAME RAFT:

- A rigid frame mat is used when the columns have a very high load on them. In rigid frame mat design, the basement RCC wall acts as a deep beam or ribs.
- If the foundation depth is greater than 90 cm, then the rigid frame raft is used.

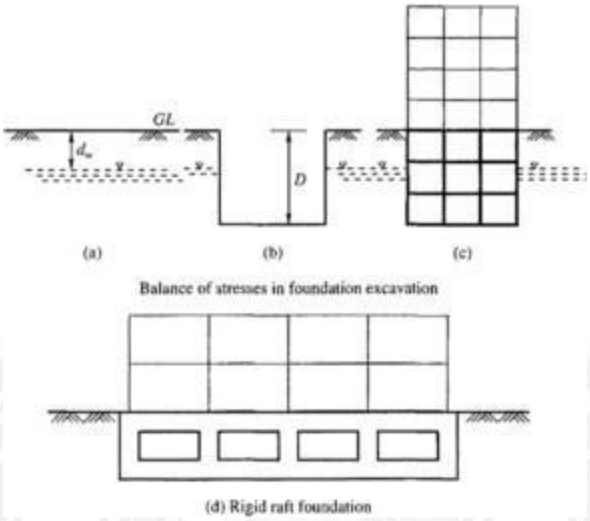


Fig 5 RigidFrameRaft

[Fig 5 https://www.civilclick.com/mat-foundation/]

6: CELLULAR MAT FOUNDATION:

- It is also termed a box mat foundation. In the cellular mat foundation, thestructures of boxes are formed, and the walls of every box act as beams. Thewalls are connected by slabs at the top and bottom.
- This type of foundation is suitable for loose soil.

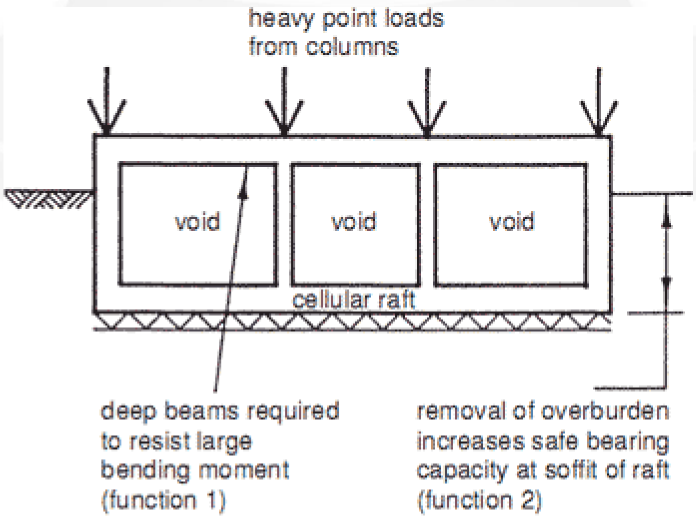


Fig6 CellularMatFoundation

[Fig 6 https://www.civilclick.com/mat-foundation/]

Advantages:

- The foundation and ground floor slab are poured simultaneously, which reduces our construction time and material.
- It requires less excavation.
- It is provided where the shallow foundation is possible, but the condition of the soil is poor.
- Reduces the cost of constructing a floor slab (But not entirely economical).
- It helps in the transferring of loads over a wide area.
- It shows good resistance and cannot slide during the flood.
- We can handle more heavy loads as compared to other types of foundations..

Disadvantages:

- Raft foundation requires a large quantity of steel and concrete.
- This foundation is costly (The volume of footing was increasing).
- It is not suitable and used for domestic home construction.
- Unique measurement is needed in the case of concentrated loads.
- In the mat foundation, skilled laborers are required.

Floating foundation:

A floating foundation is a type of foundation constructed by excavating the soil in such a way that the weight of structure built on the soil is nearly equal to the total weight of the soil excavated from the ground including the weight water in the soil before the construction of structure.

A Floating Foundation, also known as Balancing Raft is a type of foundation where the weight of the building is approximately equal to the full weight of the soil and water removed from the site of the building prior to construction.

Problems During in the Design of a Floating Foundation:

The following problems are to be considered during the design and construction stage of a floating foundation.

1. Excavation
2. De watering
3. Critical depth

Bottom heave

Excavation:

The excavation for the foundation has to be done with care. The sides of the excavation should suitably be supported by sheet piling, soldier piles and timber or some other standard method.

Dewatering:

It is better to examine the water table level prior to the excavation. If the depth of the excavation is below the water table then dewatering is essential. Care has to be taken to see that the adjoining structures are not affected due to the lowering of the water table.

Critical Depth:

If the shear strength of the soil is low and there is a theoretical limit to the depth to which an excavation can be made. Terzaghi (1943) has proposed the following equation for computing the critical depth Dc,

$$D_c = \frac{5.7\, s}{\gamma - (s/B)\sqrt{2}}$$

γ=unit weight of soil

s= Shear strength

B=width of foundation

L=Length of foundation

- Skempton (1951) proposes the following equation for D_c which is based on actual failures in excavations,

$$D_c = N_c \frac{S}{\gamma}$$

Where Nc= Skempton's bearing capacity factor.

- By using any one the above two equations, the critical depth or maximum depth of excavation can be determined.

Bottom Heave

When the soil is excavated up to some depth, the pressure of the soil below this depth is lowered which results the formation of heave.

The formed heave causes settlement to the structure or foundation. We cannot prevent the formation of heave but there are some methods to minimize the formation of heave.

There are two possible causes of heave:

- Plastic inward movement of the surrounding soil.
- Elastic movement of the soil as the existing overburden pressure is removed.

Principle of Floating Foundation

- The main principle of floating foundation is to balance the weight of removed soil by a structure of same weight which causes zero settlement to the structure. So, this foundation is also called as balancing raft foundation.
- Let's consider a ground with water table at the top .The ground is excavated up to certain depth which is below water table. Now in the next step, a building is constructed which is as same weight as of the removed soil and water.
- Even the depth of excavation is below the table the total vertical pressure in the soil below the foundation is unchanged because of its balancing weight. But here one point is to be noted that we cannot build a structure immediately after the excavation.
- During the time of construction, the effective vertical pressure under the depth of excavation may slightly increase because of unbalancing weight. So, this type of foundations can also be called as partly compensated foundations instead of fully floating or compensated foundations.

Advantages of floating foundation:-

Low Load-bearing Capacity

Floating foundations are best in areas of low load-bearing capacity — when constructing a building over loose soil — or if the soil has varying degrees of compression compatibility. Construction of deep foundations will not be viable in new fill, sand and loose soil areas but, because floating foundations spread the support overa large area, there are no points of pressure taking a heavy load. To make the floating foundation stronger it might contain beams or ribs.

Nearby buildings:

A floating foundation can be poured when other building foundations are close. To build deep foundations would interfere with the structure of other buildings.

Moisture:

Floating foundations can be used on high moisture soils. The positioning of the foundation above the earth, rather than in it, helps create a moisture barrier between the ground and the structure.

Trenches

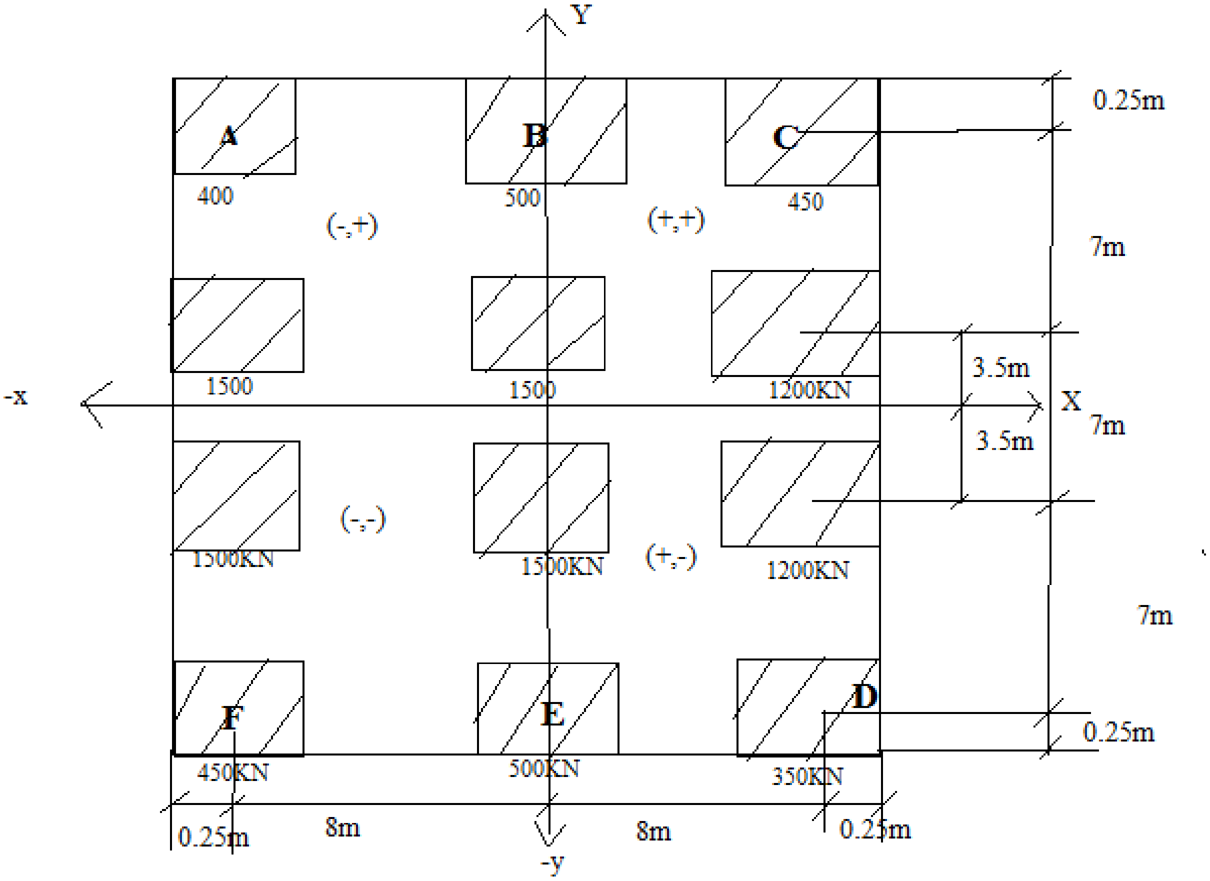
Floating foundations require far less digging because deep footer trenches are not needed. In addition, there is no need to disturb the earth beneath the building where there might be long-established tree roots or ground water.

Movement

If the earth is expected to move due to high underground moisture or high levels of vibration – as in the case of mining areas or heavily used highways -floating foundations will not be compromised.

Problem:

1.A plan of raft foundation with column load as shown in figure.Calculate the soil pressure at point A,C,D,F The size of mat is16.5x21.5m all column are 0.5x0.5m in the section .The allowable soil pressure is 60KN/m^2.Determine the soil pressure at the point.



Solution:

Step1) Area of mat

$$A = bxd = 16.5x21.5 = 354.75m^2$$

Step2) Calculate the moment of inertia

$$I_{xx} = \frac{bd^3}{12} = \frac{16.5x21.5^3}{12} = 13665.26m^4$$

$$I_{yy} = \frac{db^3}{12} = \frac{21.5x16.5^3}{12} = 8048.3m^4$$

Step 3) Calculate Moment:

$$M_y = Qxe_x$$

$$e_x = x' - \frac{B}{2}$$

$$x' = \frac{Q_1x_1 + Q_2x_2 + \cdots . + Q_nx_n}{Q}$$

$$= \frac{1}{11000}[(400+1500+1500+400)x0.25]$$
$$+[(500+1500+1500+500)x8.25]$$
$$+[(450+1200+1200+30)x16.25]$$
$$x' = 781m$$
$$e_x = 7.81 - \frac{16.5}{2} = -0.44m$$
$$M_y = 11000x(-0.44) = -4840KNm$$
$$M_x = Qxe_y$$
$$e_y = y' - \frac{d}{2}$$
$$y' = \frac{Q_1y_1 + Q_2y_2 + \cdots. + Q_ny_n}{Q}$$
$$= \frac{1}{11000}[(400+500+450)x0.25] + [(1500+1500+1200)x7.25]$$
$$+[(1500+1500+1200)x14.25] + [(400+500+350)x21.25$$
$$y' = 10.65m$$
$$e_y = 10.65 - \frac{21.5}{2} = 0.1m$$
$$M_x = 11000x0.1 = 1100KNm$$

Step 4) Calculate soil Pressure:

$$q = \frac{Q}{A} \pm \frac{M_yx}{I_y} \pm \frac{M_xy}{I_x}$$
$$q = \frac{11000}{354.75} \pm \frac{4840x}{8048.39} \pm \frac{1100y}{13665.27}$$
$$q = 31 \pm 0.6x \pm 0.08y$$

Soil pressure at A $=31 - 0.6x8.25 + 0.08x10.75 = 26.91KN/m^2$

Soil pressure at C $=31 + 0.6x8.25 + 0.08x10.75 = 31.81KN/m^2$

Soil pressure at D $=31 + 0.6x8.25 - 0.08x10.75 = 35.09KN/m^2$

Soil pressure at E $=31 - 0.6x8.25 - 0.08x10.75 = 25.19KN/m^2$