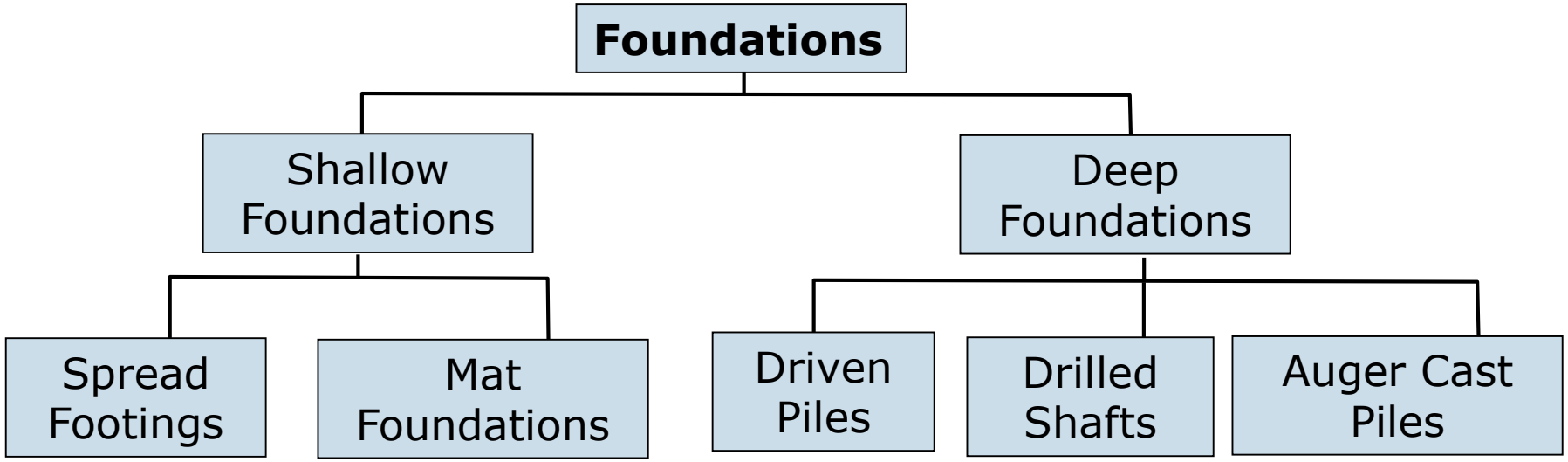
DESIGN OF SHALLOW FOUNDATIONS

Foundations

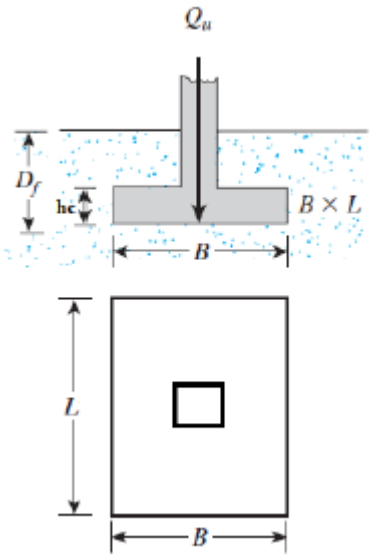


Shallow Foundations

A. Isolated Footing

Most economical

Can be rectanguar, circular or square

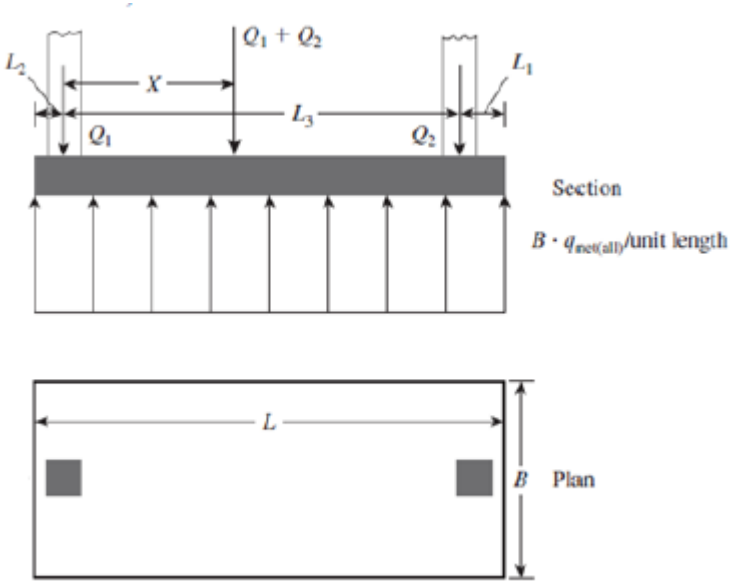


$$A = \frac{Q_1}{q_{net(all)}}$$

$$A = B \times L$$

B. Combined Footing

Two or more columns can be supported on a single rectangular foundation



$$A = \frac{Q_1 + Q_2}{q_{net(all)}}$$

$$X = \frac{Q_2 L_3}{Q_1 + Q_2}$$

$$L = 2(L_2 + X)$$

$$L_1 = L - L_2 - L_3$$

$$B = \frac{A}{L}$$

Mat (Raft) Foundations

- A **raft foundation**, also called a **mat foundation**, is essentially a continuous slab resting on the soil that extends over the entire footprint of the building, thereby supporting the building and transferring its weight to the ground.
- A raft foundation is often used when the soil is weak, as it distributes the weight of the building over the entire area of the building, and not over smaller zones (like individual footings) or at individual points (like pile foundations). This reduces the *stress* on the soil.
- A foundation system in which essentially the entire building is placed on a large continuous footing.
- Usually large concrete slab supporting many columns.
- Commonly used as foundation for silos, chimneys, large machinery.
- It is a flat concrete slab, heavily reinforced with steel, which carries the downward loads of the individual columns or walls.

HOW TO CONSTRUCT A RAFT OR MAT FOUNDATION

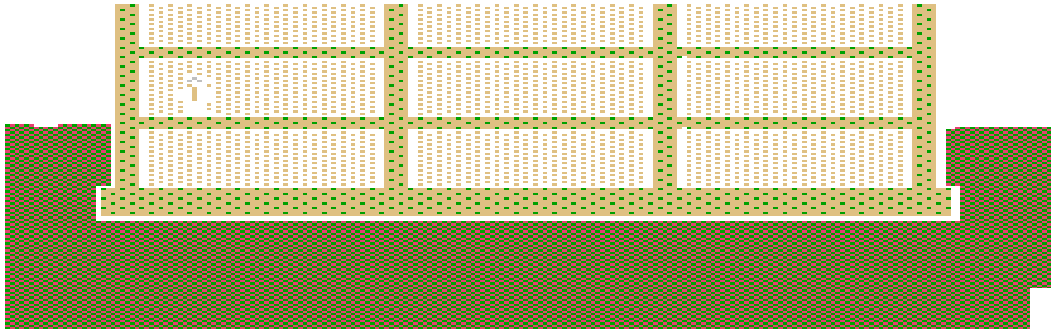
A raft foundation is constructed by first excavating the ground to a uniform, flat level.

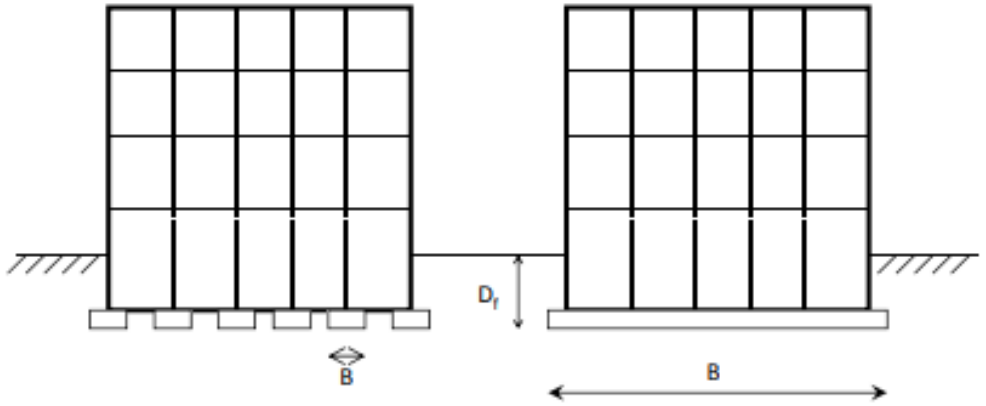
Then, a waterproof plastic sheet is laid over the earth, and a thin layer of plain cement concrete (PCC) is poured just to create a perfectly flat and level base for the foundation.

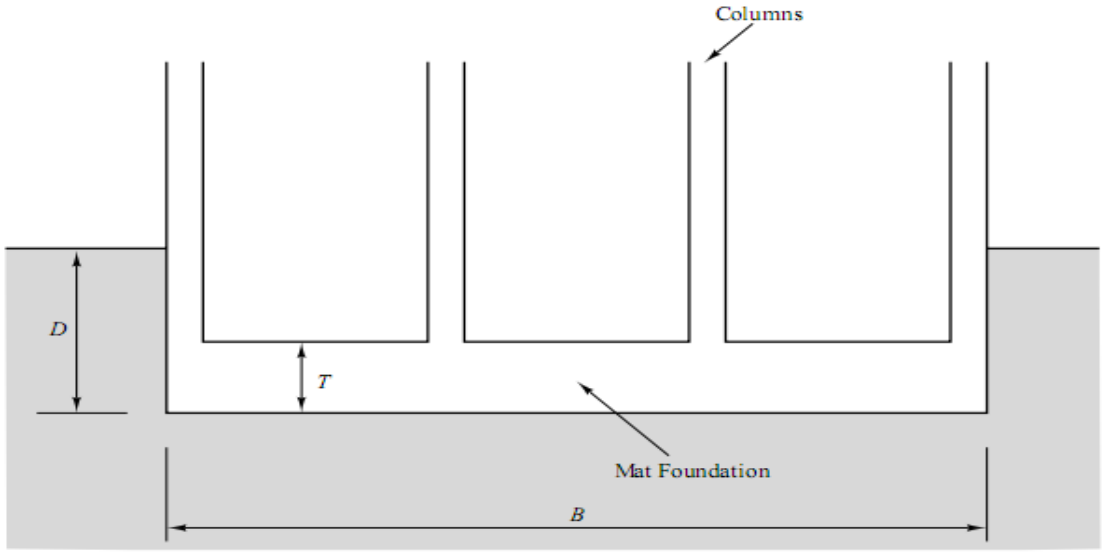
After this, a waterproofing layer is installed, and then reinforcement steel for the raft slab is tied in place. After all the steel has been put in place, concrete is poured to the desired thickness.

Mat Foundation often considered to be used when dealing with the following conditions:

- The spread footings cover over 50% of the foundation area because of large column loads.
- The soil is soft with a low bearing capacity.
- Hydrostatic uplift resistance is needed etc.
- Structures and equipment sensitive to differential settlement

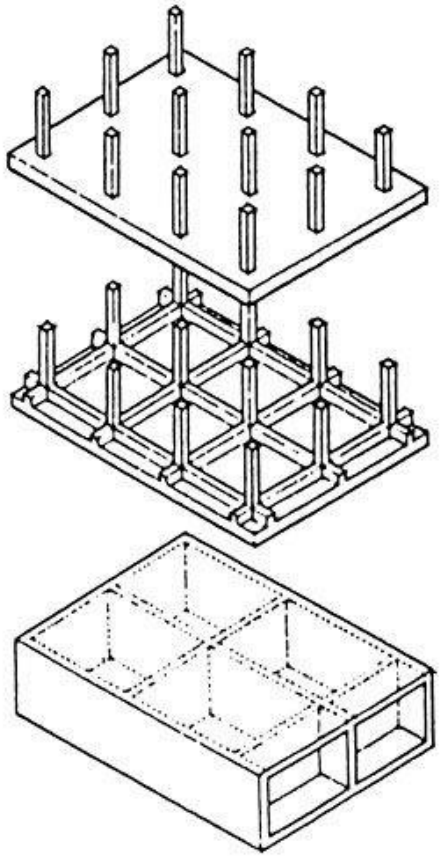






A mat foundation supported directly on soil.

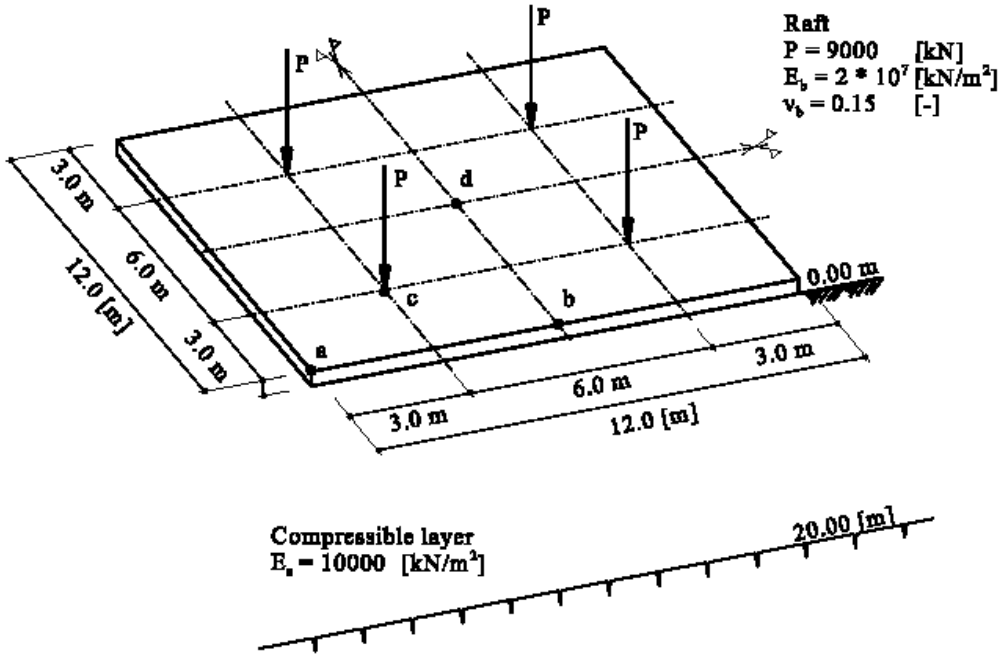
Types of Mat Foundations

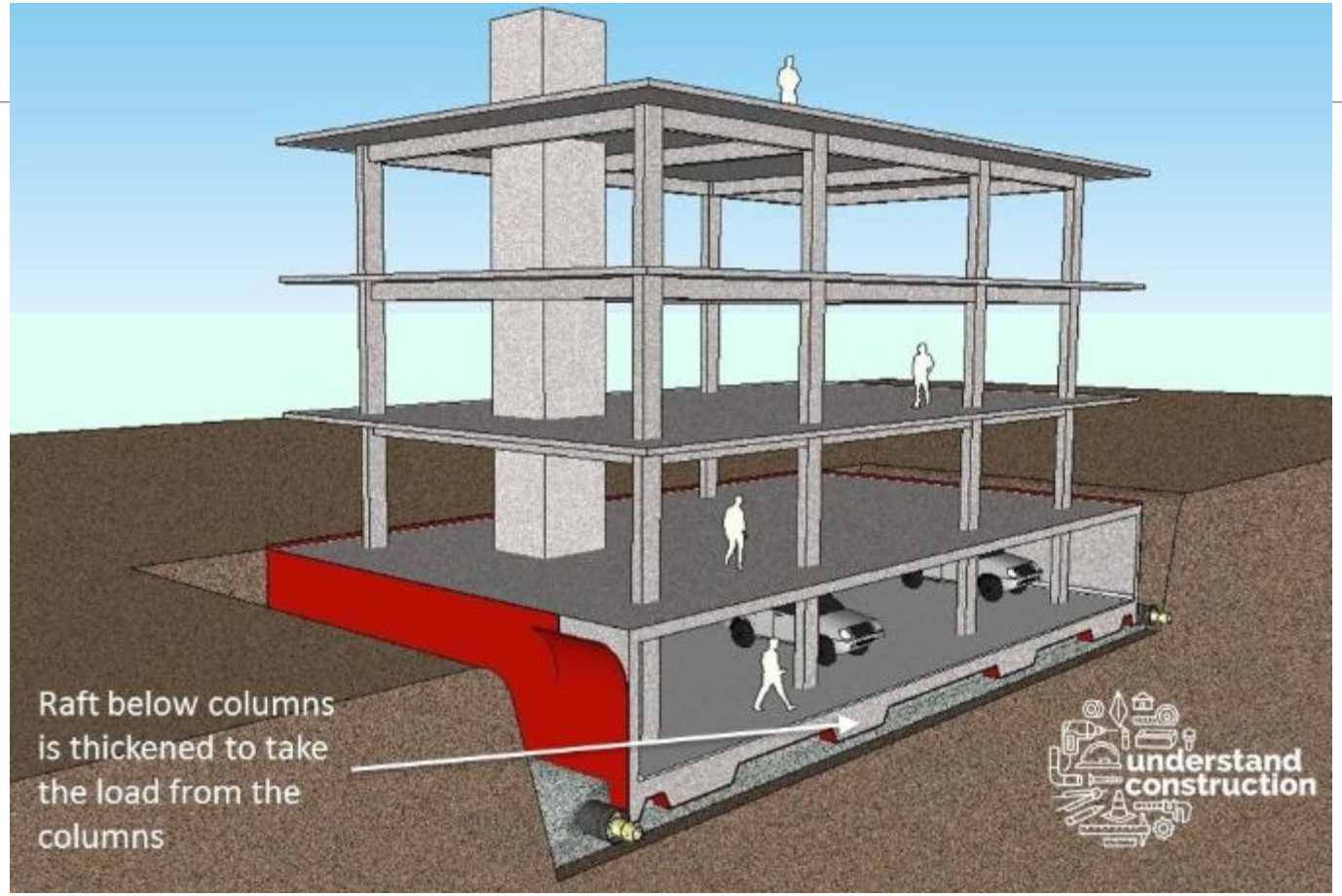


mat
A thick, slablike footing of reinforced concrete supporting a number of columns or an entire building.

ribbed mat
A mat foundation reinforced by a grid of ribs above or below the slab.

cellular mat
A composite structure of reinforced concrete slabs and basement walls serving as a mat foundation.




Raft below columns is thickened to take the load from the columns
understand construction

THE CONCEPT OF UPLIFT

When working with basements, one needs to understand the concept of *uplift*. Uplift happens when the soil outside a basement gets saturated with water, say during a period of very heavy rain. Then, the basement begins to act like a ship that floats in a sea of water. The water will exert a strong **upwards** force on the basement.

In case this upwards force is balanced by a strong downwards force, such as the weight of many floors above the basement, there is no problem. If, however, there is no balancing force, as may be the case if the basement has just been constructed, and there is nothing above, then the upwards force may be strong enough to lift the basement out of the earth, ruining it completely and causing great damage.

Design Mat Foundation:

1. Determine the capacity of the foundation
2. Determine the settlement of foundation
3. Determine the differential settlement
4. Determine the stress distribution beneath the foundation
5. Design the structural component of the mat foundation using the stress distribution obtain from 4.

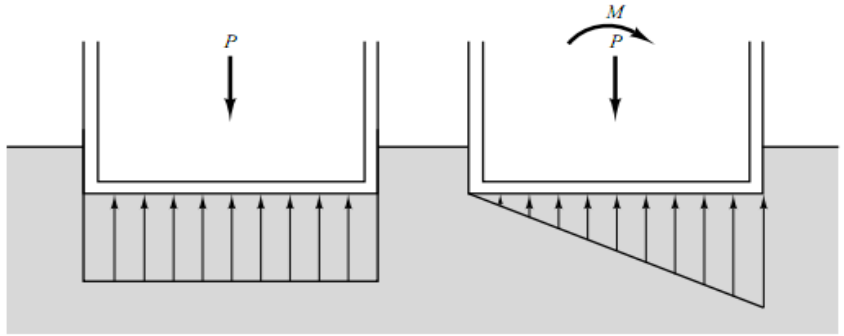
Bearing Capacity of the Foundation

- Bearing Capacity Analysis follows the same approach as for spread footings

- Factor of Safety (Das, 2004):

Under normal Dead loads = 3.0(Min)

Under extreme loads = 1.75-2.0(Min)



Bearing pressure distribution for rigid method.

Settlement of Foundation

Calculate

- Elastic settlement
- Consolidation settlement
- Differential settlement

Check it with allowable limits for your foundation

Settlement of Foundation

The settlement tends to be controlled via the following:

- Use of a larger foundation to produce lower soil contact pressures.
- Displaced volume of soil (flotation effect); theoretically if the weight of excavation equals the combined weight of the structure and mat, the system "floats" in the soil mass and no settlement occurs.

Foundation type	Expected maximum settlement, mm	Expected differential settlement, mm
Spread	25	20
Mat	50	20

By IS Code – 2950 (Part-1)

Design of Mat Foundations

Approximate Method:

- The mat is divided into strips loaded by a line of columns and resisted by soil pressure.
- This strip is then analysed as a combined footing. (This method can be used where the mat is very rigid and the column pattern is fairly uniform in both spacing and loads.)
- This method is not recommended at present because of the substantial amount of approximations and the wide availability of computer programs that are relatively easy to use.

Flexible Method:

- Compute the plate rigidity D
- Compute the radius of effective stiffness L (Note: the approximate zone of any column influence is ~ 4L).
- Compute the radial and tangential moments, the shear, and deflection.

Finite Element/Difference Methods:

- Widely used (and should be used as a check on alternative methods where it is practical).
- Reliable if the mat can be modelled using a finite-difference grid.
- Difficult to model boundary conditions of column fixity.
- Very difficult to model notches, holes, or re-entrant corners.
- Difficult to apply a concentrated moment (as from a column) since the difference model uses moment/unit of width.

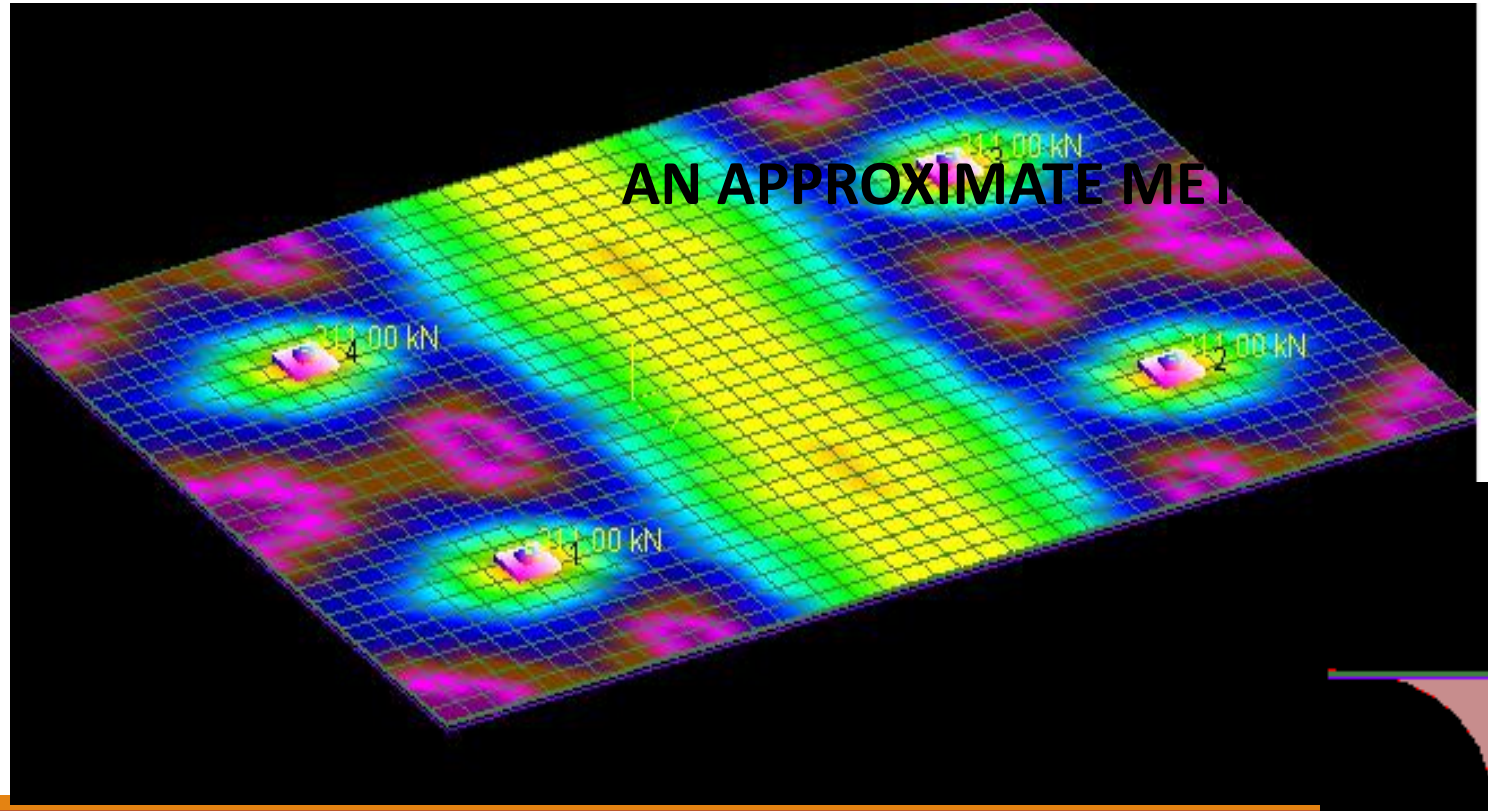
Some Highlight points of IS-2950 Part-1 (DESIGN AND CONSTRUCTION OF RAFT FOUNDATIONS)

For satisfactory design and construction of a raft foundation, the following information is necessary:

- Site Plan
- Loading Conditions
- Environmental Factors
- Geotechnical Information
- Limiting Value of Angular distortion and differential settlement
- Rigidity of foundation and Super structure

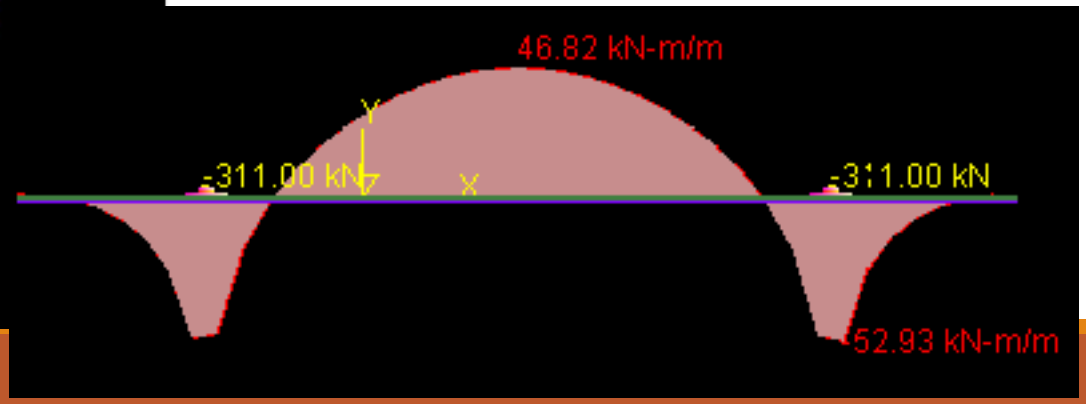
DESIGN OF MAT FOUNDATION USING SOFTWARES:

- Many types of software are available to design mat foundation some are like ABAQUS V6.8, STAAD FOUNDATION,RISA FOUNDATION, ANSYS, etc.



MODELLING OF MAT FOUNDATION

Using
STAAD Foundation 2006



Determination Of Critical Column Spacing

Evaluation of the characteristics γ is made as follows:

$$\gamma = 4\sqrt{\frac{kB}{4EcI}}$$

Where,

k = modulus of subgrade reaction in KN/m^3

B = width of raft in cm

Ec = modulus of elasticity of concrete in MPa

Z = moment of inertia of the raft in m^4

Depth of Foundation :

- The depth of foundation shall generally be not less than 1 m.