MAT/RAFT FOUNDATION- DEFINITION AND TYPES

- Mat Foundation is basically a concrete slab that may be spread over a large area.

- Several columns transfer the load from the super structure to the soil through the mat foundation.

- They are normally user where either the soil has low bearing capacity or the column loads are so high that foundation area requirements are clashing with each other.

- They may also be supported on piles , also called pile raft foundation.

- Piles help in reducing the settlement of the mat foundation and may also be very helpful in controlling buoyancy where the water table is very high.

WHEN TO CHOOSE RAFT FOUNDATIONS !

1. The structural loads are so high or the soil conditions so poor that spread footings would be exceptionally large.

2. As a general rule of thumb, if spread footings would cover more than about one-third of the building footprint area, a mat or some type of deep foundation will probably be more economical.

3. The soil is very erratic and prone to excessive differential settlements. The same is true of mats on highly expansive soils prone to differential heaves.

4. The structural loads are erratic, and thus increase the likelihood of excessive differential settlements.

5. Lateral loads are not uniformly distributed through the structure and thus may cause differential horizontal movements in spread footings or pile caps. The continuity of a mat will resist such movements.

6. The uplift loads are larger than spread footings can accommodate. The greater weight and continuity of a mat may provide sufficient resistance .

7. The bottom of the structure is located below the groundwater table, so waterproofing is an important concern. Because mats are monolithic, they are much easier to waterproof. The weight of the mat also helps resist hydrostatic uplift forces from the groundwater.

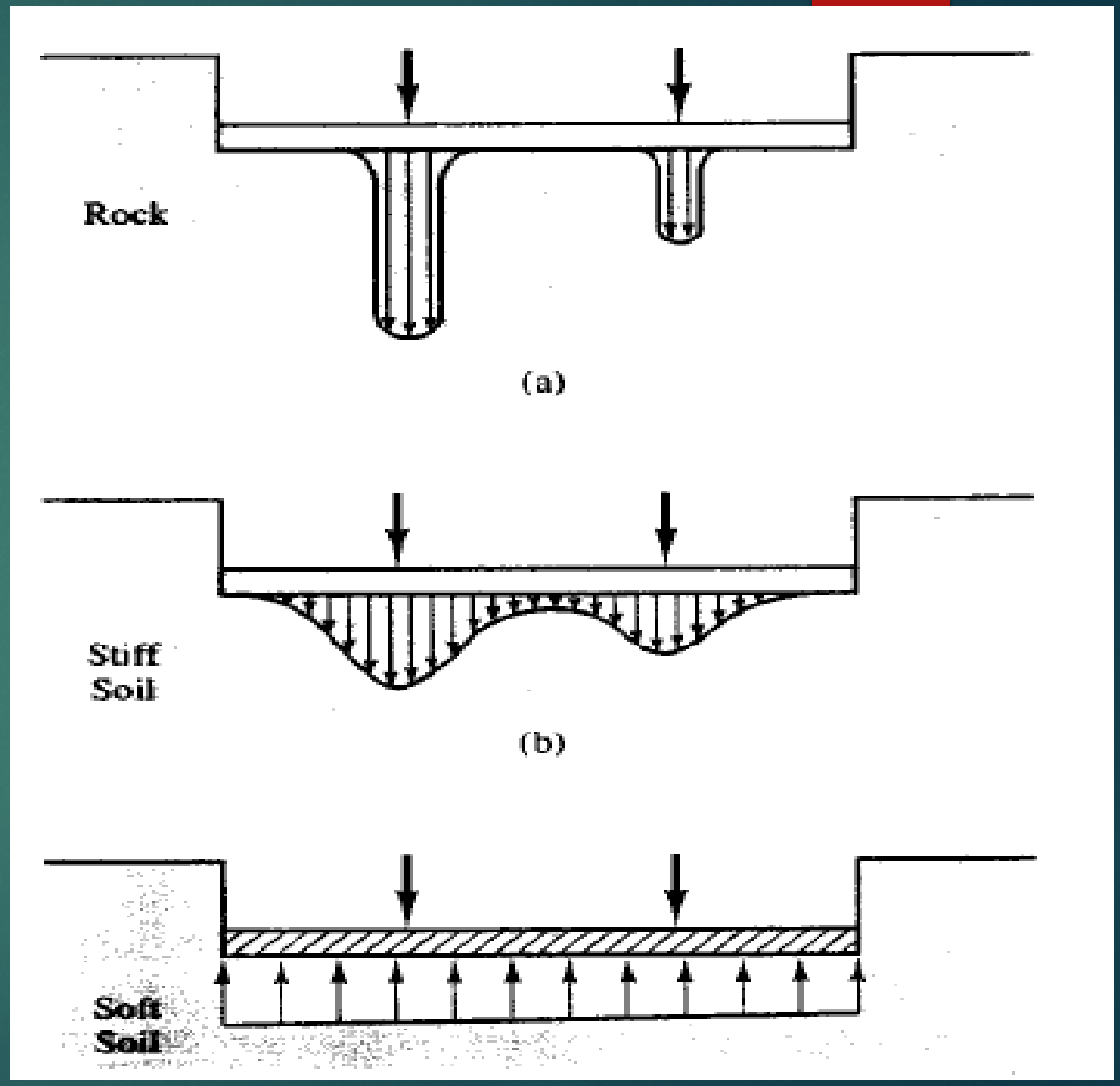
The seventy five story Texas Commerce Tower in Houston is one of the largest mat supported structures in the world.
Its mat is 3 m (9ft 9 in) thick and is bottomed 19.2 m (63ft) below the street level.

TWO TYPES OF ANALYSIS FOR DESIGN OF MAT FOUNDATION

- RIGID ASSUMPTION
- This method assumes the mat is much more rigid than the underlying soils, which means any distortions in the mat are too small to significantly impact the distribution of bearing pressure.
- For analysis purposes, the mat becomes an inverted and simply loaded two-way slab, which means the shears, moments, and deflections may be easily computed using the principles of structural mechanics.
- The engineer can then select the appropriate mat thickness and reinforcement.

- NON RIGID ASSUMPTION
- This method assumes the deformations in the mat and their influence on the bearing pressure distribution.
- They produce more accurate values of mat deformations and stresses.
- Non rigid analyses are more difficult to implement because they require consideration of *soil-structure interaction* and complex bearing pressure distribution

DISTRIBUTION OF BEARING PRESSURE UNDER DIFFERENT TYPES OF SOIL FOR RAFT FOUNDATION



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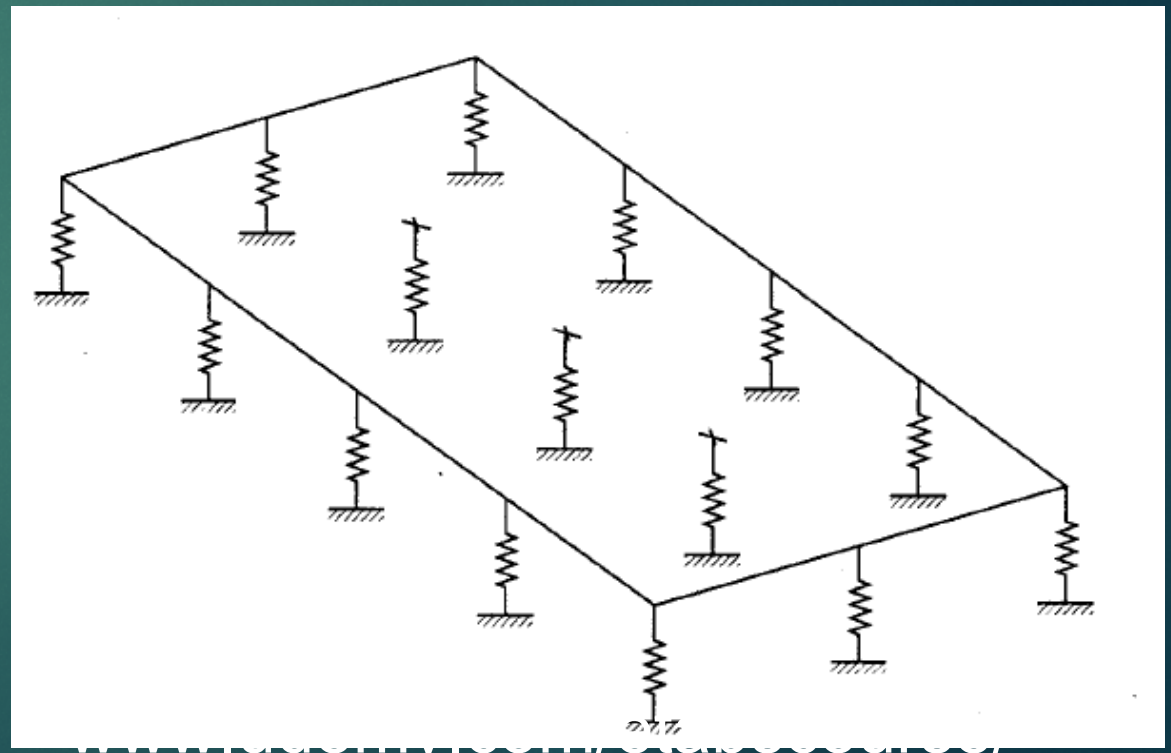
First understand about coefficient of subgrade reaction

- This term defines the relationship between settlement and bearing pressure.
- This is usually done using the *coefficient of subgrade reaction,*

$$k = \frac{p}{\Delta}$$

- k, = coefficient of subgrade reaction
- p = bearing pressure
- Δ = settlement



DESIGN OF MAT FOUNDATION IN SOFTWARES

- SOFTWARES can be used to design and analyze mat foundation.
- Engineer should have sound knowledge of mat-soil interaction.
- Mats are relatively thick concrete slabs with typical span to depth ratios varying from as low as 2 to as high as 8.
- Shear deformation would play an important role in the mat-soil interaction.
- Therefore, Designers are advised to model a mat foundation using a thick plate formulation rather than a thin plate.
- Softwares gives the user the option of modeling a mat foundation using thin or thick plates.
- The consideration of shear deformation in flexural behavior of plates make the plates more flexible, which increases differential settlement and reduces bending moments, thus the overall mat design is impacted significantly.

HOW THEY USED TO DESIGN MAT/RAFT FOUNDATION BEFORE SOFTWARES

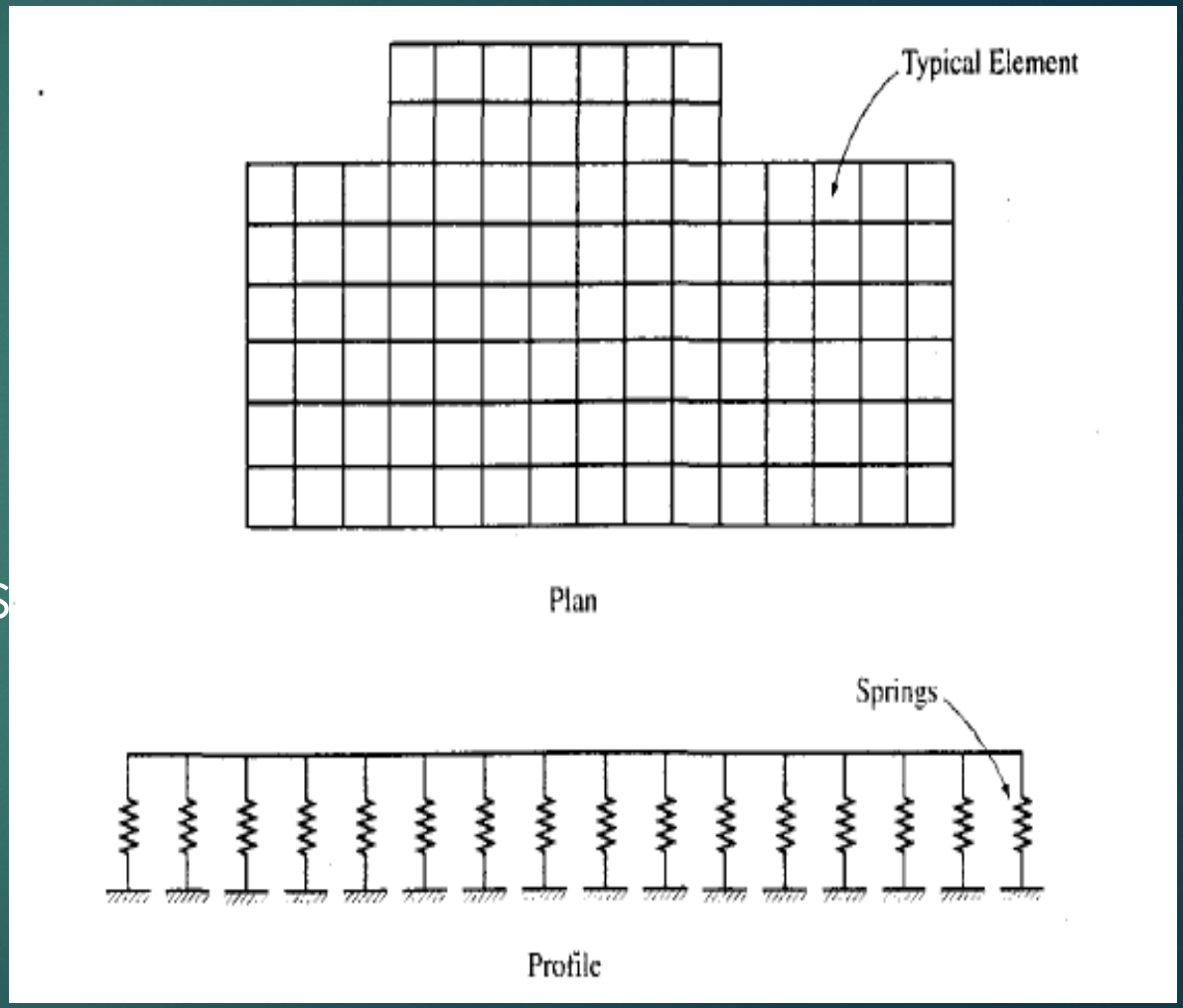
- Manually, mat/raft foundations are designed using two assumptions

1. Infinitely Rigidity
2. Bending along only one-way.

- For Fairly stiff mats i.e. high bearing capacity soils and thick rafts, these assumptions may be valid , but for thin raft on compressible soils, these assumptions may lead designer to grave errors.
- Infinite Rigid Mat foundation assumption allows determination of bearing pressure by simple static as we do in isolated foundations. With this process, high pressure concentrations areas near the columns are ignored and low pressure areas at distance from these columns are considered on conservative side.
- Second assumption of mat behavior consider one-way analysis as compared to two-way bending analysis.
- These methods addresses the mat flexibility to a certain degree and are extremely ted
- These approximation methods address the mat flexibility to a limited degree but do not include analyses for two-way bending; these are extremely tedious and cumbersome to use

HOW FEM ANALYSIS IN SOFTWARES HELP TO OVERCOME THE MANUAL CALCULATION ASSUMPTIONS

- FEM Analysis addresses the rigidity of the mat foundation and two way bending by implementing it in the computer codes.
- FEM uses the modulus of sub-grade reaction to designate the soil stiffness.
- Designers can model the four node square/rectangular/quadrilateral plates to stimulate the actual mat foundation.
- Designers model the mat in 2-D with plates having thickness equal to the thickness of the raft foundation.



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WHAT IS BASICALLY A SHELL WHICH IS USED TO MODEL THE RAFT IN SOFTWARES

- A **shell** is a three or four-node area object used to model membrane and plate-bending behavior.
- Shell objects are useful for simulating floor, wall, and bridge deck systems; 3D curved surfaces; and components within structural members, such the web and flanges of a W-Section.
- Shells may be homogeneous or layered throughout their thickness.
- Full shell behavior and the Mindlin-Reissner thick-plate formulation are recommended for analysis

- Softwares offers two options i.e. Thin Shell and Thick Shell .
- The inclusion of transverse shear deformation in plate-bending behavior is the main difference between thin and thick shell formulation.
- Thin-plate formulation follows a Kirchhoff application, which neglects transverse shear deformation,
- whereas thick-plate formulation follows Mindlin/Reissner, which does account for shear behavior.
- Thick-plate formulation has no effect upon membrane (in-plane) behavior, only plate-bending (out-of-plane) behavior.

- Softwares recognizes the fact that if the shells are thick, shear deformation must be included

CONCLUSION

- Comparing thin versus thick plate modeling, the ***thick plate deforms more yielding a smaller design moment.***
- We recommend the use of thick plate modeling for the analysis and design of mat foundations.
- Transverse shear is one of the critical design parameters in mat foundation design which dictates a design strip.