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Analysis and Behaviour of Raft Foundation on Sub-Soil Conditions

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ABSTRACT: A raft foundation, or a mat foundation, is a large concrete slab that supports several columns and walls under an entire structure. It is commonly utilized in construction where soil carrying capacity is low or differential settling is a concern. This kind of foundation distributes the structure's load across a vast area, reducing stress on the earth. In this paper, the structure model is prepared in E-tabs, and analysis of the raft foundation is done in safe software. In this paper there are three types of model has been done for the zone v and soft soil condition. The study explores modern advancements in analysis techniques, such as finite element modelling, to optimize raft foundation design and performance. The Settlement, Soil pressure, and Punching Shear have been also checked and the results are satisfactory.

KEYWORDS: Raft Foundation, E-tabs, Safe, Settlement, Punching Shear, Soil Pressure.

I. INTRODUCTION

Foundations are a critical component in the structural integrity of buildings, acting as the interface between the structure and the ground. Among the various types of foundations used in civil engineering, the raft foundation—also known as a mat foundation—plays a significant role, especially in situations where soil-bearing capacity is low where differential settlement poses a risk to structural stability, or where individual footings would cover more than half of the building area. Unlike isolated or strip footings, a raft foundation spreads the load from a building over a largecontinuousarea, effectively reducing the pressure on the subsoil andenhancing load distribution.

Raft foundations are particularly advantageous for heavy structures, high-rise buildings, and industrial facilities, as well as in areas with soft or compressible soils. They are also employed where basements are required, integrating both structural support and functional space. Advances in geotechnical engineering and structural analysis have led to the development of more accurate design methodologies, including the use of finite element modelling and soil-structure interaction analysis.

The design and analysis of raft foundations in India are governed by standards such as IS 456:2000, which outlines the general requirements for reinforced concrete design and IS 2950 (Part 1):1981, which specifically covers the design and construction of raft foundations.These codes provide guidelines on load considerations, material specifications, reinforcement detailing, and safety factors, ensuring structural stability and serviceability under various geotechnical conditions.

With the advancement of construction technology and computational tools, modern analysis techniques such as finite element modellingandsoil-structure interaction have enhanced the accuracy and efficiency of raft foundation design. This research paper focuses on the principles, design methodology, and practical considerations involved in the construction of compliancewith the applicable IS regulations for raft foundations.

1.1 OBJECTIVE

- To Examine the Raft Foundation Settlement.
- To Determine the Distribution of Soil Pressure.
- To Determine the Punching Shear on Raft.
- Raft foundation Design features (such as thickness of raft) affect the way the foundation interacts with the underlying soil, taking into account how this factor affect the behaviour and overall performance of the raft.
- Optimization of cost-effectiveness, safety and structural safety.

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II. METHODOLOGY

There are three types of geometry of buildings is considered of square, rectangular, and circular type.

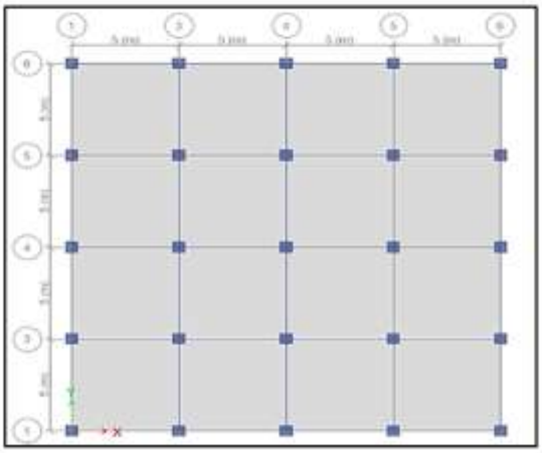

Figure1: Geometry for Square Type Building

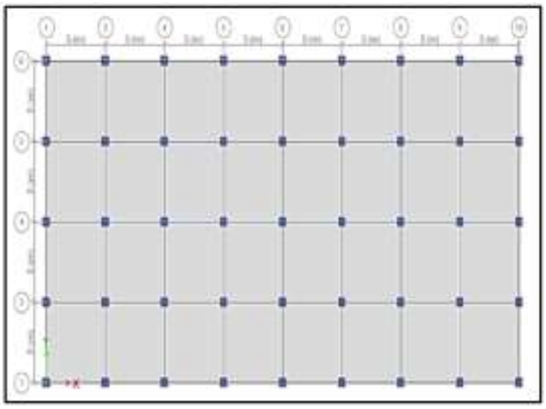

Figure 2: Geometry for Rectangular Type Building

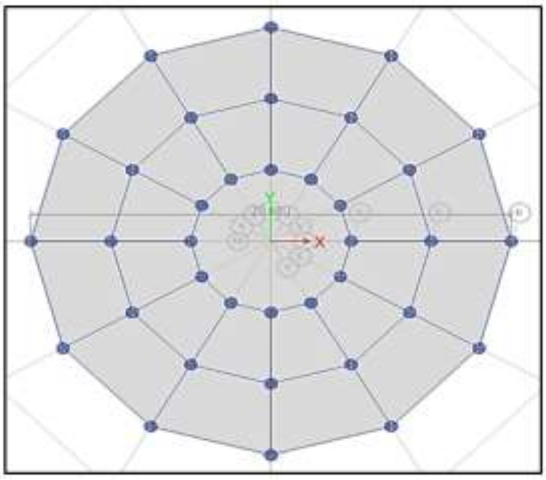

Figure 3: Geometry for Circular Type Building

Table 1: Structure Details

Type of Building	Plan Dimension	Height of Floor
Square Shape Building	20m x 20m	3.05
Rectangular Shape Building	40m x 20m	3.05
Circular Shape Building	30m Dia.	3.05

Table 2: Properties of Building

Properties	Data for all Type Building
Concrete Grade of Beam	M30
Concrete Grade of Column	M30
Concrete Grade of Slab	M30
Density of Concrete	25 KN/m3
Density of Brick	20 KN/m3
Grade of Steel	Fe500
Poisson’s Ratio	0.2
Modulus of Elasticity	27386.13 MPA

Table 3:Lateral Loading

Parameter	Data for all Type Building
ImportanceFactor, (I)	1.2
ResponseReductionFactor, (R)	5
SeismicZone (Z)	v
Site Type	Ⅲ

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The total height the of building is 24.4 m for alltypes of buildings. The time period is calculated by T=0.09*h/√D.

Table 4:Loading Data

Loadings	Data for all Type Building
Dead Load	Values Taken By ETABS Model
Live Load	3 KN/m2
Floor Finish	1.5 KN/m2
Waterproofing in Terrace	2.3 KN/m2
Wall Load for 0.23 m Thickness.	12.65 KN/m2
Wall Load for 0.15 m Thickness.	8.25 KN/m2
Parapet Load	4.3 KN/m2

Section Property of Beam is 300mm x 600 mm for Square and Rectangular building and for circular building 300mm x 600 mm for outer beams and 500mm x 800mm for inner beams. For square and rectangular buildings, the section property of the column is 600 x 600 mm with a diameter of 750 mm for Circular building. Slab thickness for all building type is 150 mm.

Load combinations are considered as per Is 456:2000.

Base Shear values for Square Building is -5347.057 KN/m^2, for Rectangular building is -10230.979 KN/m^2, for circular building is -6979.2774 KN/m^2.

III. OBSERVATIONS

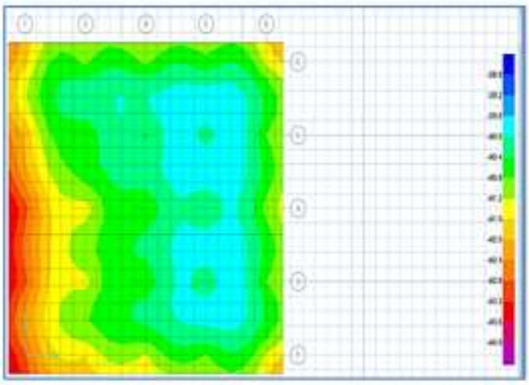

Figure 4: Settlement for Square Shape Building

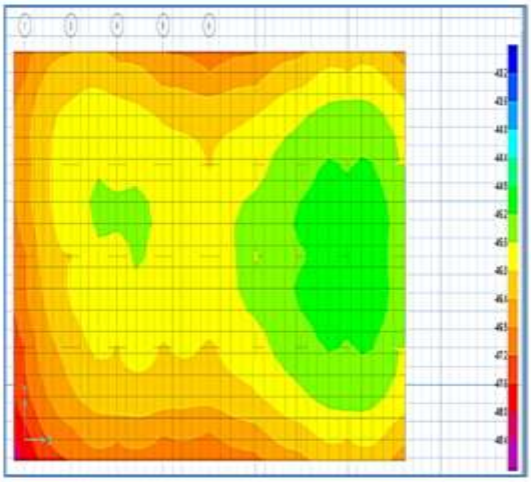

Figure 5: Settlement for Rectangular Shape Building

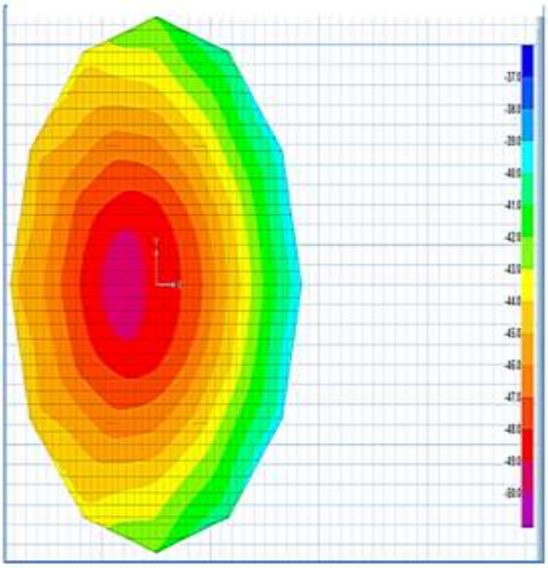

Figure 6: Settlement for Circular Shape Building

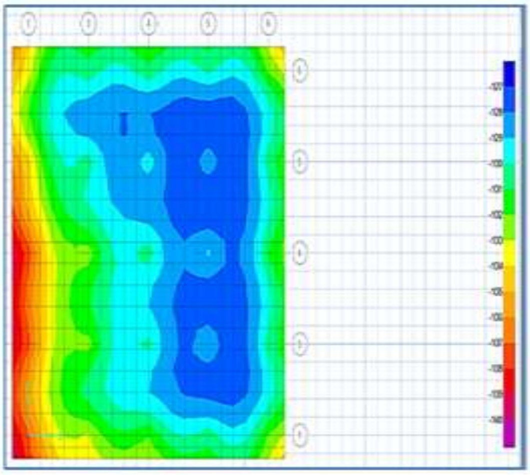

Figure 7: Soil Pressure for Square Shape Building

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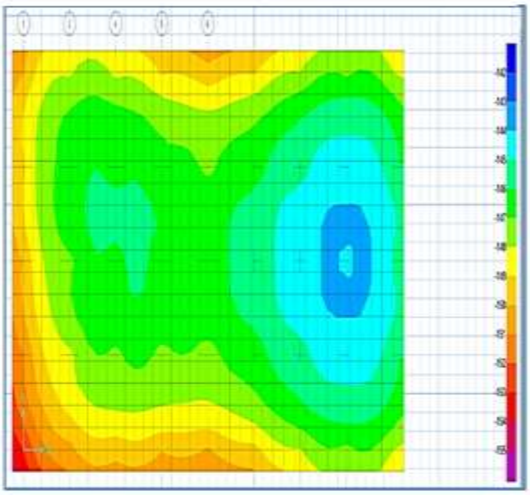

Figure 8: Soil Pressure for Rectangular Shape Building

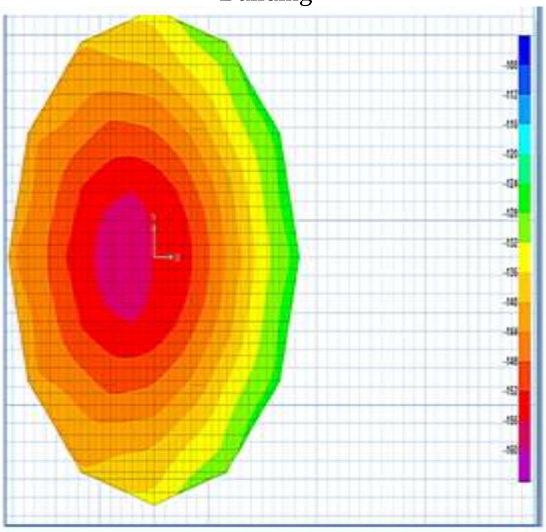

Figure 9: Soil Pressure for Circular Shape Building

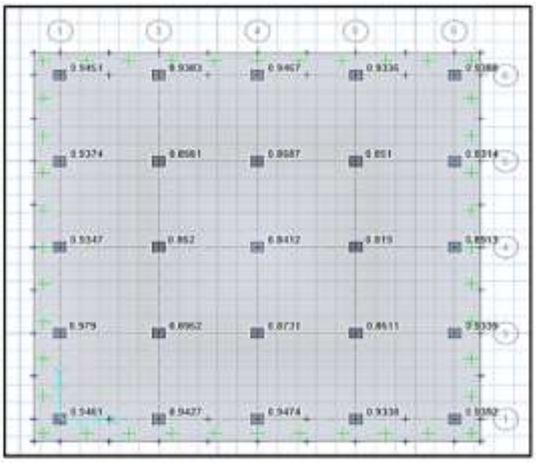

Figure 10: Punching shear for Square Shape Building

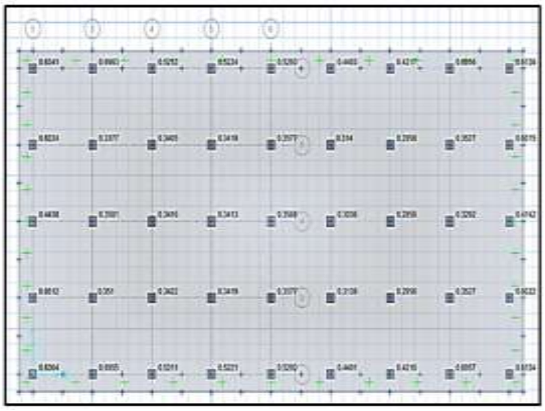

Figure 11: Punching shear for Rectangular Shape Building

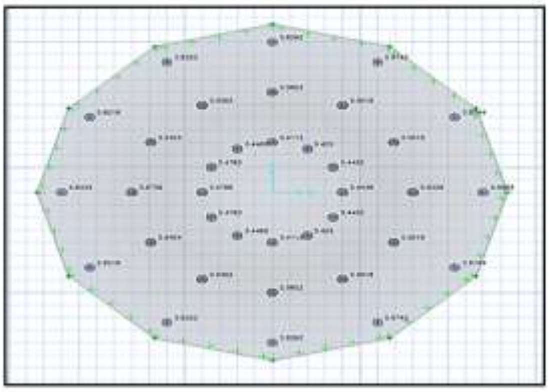

Figure 12: Punching shear for Circular Shape Building

Deformation

Permissible deformation is recommended by IS 1904 (Part 1):1986. For buildings of square, rectangular, and circular shapes, the maximum values are 44 mm, 48.4 mm, and 50 mm. The results of the deformation are displayed in Figures 4, 5, and 6.

Punching Shear

Each column's punching shear values are displayed in Safe, and each value should be smaller than 1. Figures 10, 11, and 12 display the punching shear results for the square, rectangular, and circular raft foundations, respectively.

Soil Pressure

For square-shaped buildings, the lowest pressure is -139.87 kN/m², while the highest is -127.22 kN/m². Rectangular buildings have a maximum pressure of -143.86 kN/m² and a minimum pressure of -154.51 kN/m². The Circular building has a maximum pressure of -125.53 kN/m² and a minimum pressure of -158.45 kN/m². The footing area is safe because both pressures are negative and fall within our soil's carrying capability, which is 160 kN/m² for all structure shapes.

Thickness

It is determined that the raft's thickness should be 750 mm for square buildings, 1250 mm for rectangular buildings, and 1000 mm for circular buildings.

Raft dimensions after achieving permissible values, Additionally, the raft's dimensions are 22.6 x 22.6 m, 42.3 x 22.3 m, and 33.52 m DIA.

IV. CONCLUSION

1. The raft deformation is within the permissible range specified by IS 1904 (Part-1): 1986.
2. The punching shear values displayed by the software at each column point should be less than 1.
3. The area's thickness and perimeter may both regulate soil pressure, which should be lower than the soil's SBC.
4. By expanding the building's raft's size or circumference, the punching shear is reduced.
5. Although deflection can be regulated, by increasing the raft's depth to a specific point.
6. The thickness of rectangular raft is maximum which is 50% more than square raft and 22% more than circular raft.
7. The settlement is maximuman of circular raft which is 13% more than square raft and 2% more than rectangular.
8. The soil pressure is maximum in circular raft which is 12% more than square raft and 2% more than arectangular raft.
9. The offset needed from the outer column of a circular raft is 39% more than rectangular raft and 64% more than square raft.

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