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STUDY OF DIFFERENT TYPES OF FOOTING ON SOIL USING STAAD

[1]Muzammil Durrani, [2]Prof. Dharmendra Singh
[1]Scholar M.Tech (Structure), [2]Guide & HOD
Department of Civil Engineering, RNTU, Bhopal (M.P).

Abstract: ***The lowest part of a structure which transfers its load to the soil beneath is known as foundation. The stability of a structure mostly depends on the performance of foundation. Its design should be done properly, considering its importance. Depending on the depth of embedment, foundations can be classified as shallow or deep. The ultimate load which can be sustained by the soil is identified as bearing capacity. Bearing capacity and settlement are two parameter requirements for the design of shallow foundation. It is essential for engineers to estimate the foundation's bearing capacity subjected to vertical loads. Settlement of foundation under load due to the movement of soil particle horizontally and vertically below the footing. Settlement of the footing caused by eccentric loading which results to non-uniform stress distribution and unequal settlement below the footing.***
In this research work we are comparing different shaped footing for same loading condition also soil bearing capacity to determine the best suitable and stale type of footing which can transfer load and also we are preparing cost analysis of all to determine the economical section using analysis tool staad.pro.

Keyword: finite element method, soil bearing capacity, shallow foundation, Structure Analysis

1. OBJECTIVE OF THE RESEARCH

- Objective of this research is to study the effect of different types of footing geometries for same building with same loading conditions in unsymmetrical shape (irregular) building considering dynamic analysis using response spectrum method as per 1893-I 2016, Modelling of RCC frame building and different footing is analyzed using STAAD Pro and STAAD foundation software.
- To study the soil interaction ratio using Staad Pro.
- Analysis of different footing type and shape for same soil bearing capacity.
- To develop a tool for justifying soil interaction with respect to its bearing capacity.
- To determine the best suitable footing type and Shape for a considered soil property.

2. PROBLEM FORMULATION

This includes comparative study of structural behavior considering four different shapes of footing (Stip Circular, Pad and oval shaped) for building frame is prepared using STAAD. Pro software. A comparison in analysis results is done on certain important parameters such as deflection, support reaction, Axial force, Quantity of steel, concrete, torsion and Shear force. Configuration and material specification of the building are shown in Table 5.1 and Table 5.2.

Table 5.1 Material Specification

Sr. No	Material Specification	
1	Grade of Concrete, M-25	fck = 25 N/mm2
2	Grade of Steel, Fe-415	fy = 415 N/mm2
3	Density of Concrete	ϒ"c = 25 KN/m3
4	Density of Brick wall considered	ϒ"brick = 18 KN/m3
5	Live Load	4KN/m2
6	Wall Load	12KN/m2

3. METHODOLOGY FOLLOWED FOR THE WORK

In this study, we are comparing different shapes of footing for same loading conditions.
Following steps are followed in a row to complete the study are as follows:

Step-1 First step is to review the literature related to our work done in past to justify the scope of work.

Step-2 second step is to select analysis tool in which finite element analysis can be performed.

Step-3 Third step is to model the different shape geometries for comparative analysis.

Step-4 Fourth step is to calculate load including seismic load and apply same loading conditions on all different cases.

Step-5 To analyze the footings for finite element and prepare results of all nodes to determine maximum values of forces, deflection and support reaction.

Step-6 To prepare graphs and sheets using M.S. excel to compare results of all cases.

Step-7 To determine the quantity of concrete and steel for each case.

Step-8 To prepare a cost analysis for each case as per S.O.R. rates.

Step-9 To conclude our study in terms of results and cost analysis.

Table 5.2 Building Description

Sr. No	Building Description	
1	Plan Area	453 m2
2	X-Y Direction Grid Spacing	5m x 5m
3	Storey Height	3.0 m
4	Number of storey	12
5	Beam Dimension	350mm x 450mm
6	Column Dimension	450mm x 450mm
7	Slab Thickness	120mm
8	Thickness of shear wall	100mm
9	Thickness of wall	130mm
10	Bottom Support Condition	Fixed
11	Seismic Zone	V
12	Zone Factor	0.36
13	Soil Type	As per soil bearing capacity
14	Importance Factor	1.5
15	Response Reduction Factor	5
16	Eccentricity Ratio	0.05

4. ANALYSIS AND RESULTS

Analysis

- Response Spectrum Analysis is performed in order to compare seismic response of RCC structure in different footing shapes.
- The main difference between the equivalent static analysis and dynamic analysis lies in the magnitude and distribution of lateral forces over the height of the building.
- In the equivalent lateral force procedure, the magnitude of forces is based on an estimation of the fundamental period and on distribution of forces, as given by simple formula in IS 1893- 2016.
- In the dynamic analysis procedure, the lateral forces are based on the properties of the natural vibration modes of the building, which are determined by the distribution of mass and stiffness over height.
- The maximum sagging and hogging bending moment, shear force, axial force of each footing type is calculated and tabulated below.

Cost analysis as per S.O.R.

Table: Cost Analysis

SN	Footing	Reinforcement (Kg)	Rate of Reinforcement (Kg) as per S.O.R.	Cost of Reinforcement in INR (Rupees)	Remark
1	OvalFooting	7953.65	160 / Kg	12,72,584.00	Here Result shows that for same loading condition and soil bearing capacity variation in load distribution occurs due to shape of footing
2	Circular Footing	8021.672	160 / Kg	12,83,467.52	
3	Combined Footing	7651.23	160 / Kg	12,24,196.80	
4	Pad Footing	7867.43	160 / Kg	12,58,788.80	

As quantity estimation is done and rate is analyzed as per S.O.R it is concluded that combined footing results in economical type of footing for same conditions whereas circular is costlier in comparison.

5. CONCLUSION

The dynamic analysis of RCC building shows that dynamic analysis not only gives better understanding of the structural behavior but also following conclusion remarks can be made. Circular footing shows less unbalanced forces comparing to Hexagonal shape footing case. In comparison of five different type of footings it is observed that Circular type of footing in economical and best suitable whereas Square & rectangular are second and third best whereas hexagonal is least suitable type of footing. Bending moment is observed minimum in Circular shape which results in minimum reinforcement requirement. The value of deflection is observed maximum in Pad where as in oval shape condition

it results in minimum. Thus it can be said that deflection will occur minimum in this condition and second best will be oval one. In oval shape footing deflection is comparatively low. As quantity estimation is done and rate is analyzed as per S.O.R it is concluded that Combined footing results in economical type of footing for same conditions whereas circular is costlier and in comparison difficult to build. In this study is can be concluded that Combined footing is comparatively more suitable and best in comparison with Oval or other cases whereas Oval footing is second best and Pad footing is showing worst result.

\ *Future scope*

- In future study further following conditions can be implement are as follows:
- In this study dynamic seismic analysis is considered, in future wind and temperature effect can be considered.
- In future matt footing and pile can be consider for study.
- In future different soil conditions can be considered.

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