

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 3, March 2017

## Analysis and Design of Various Types of Isolated Footings

<sup>1</sup>S.Balachandar, <sup>2</sup>D.Narendra Prasad

M.Tech (Structural Engineering), Department of Civil Engineering, Periyar Maniammai University, Thanjavur,  
Tamilnadu. India<sup>1</sup>

Assistant Professor, Department of Civil Engineering, Periyar Maniammai University, Thanjavur, Tamilnadu. India<sup>2</sup>

**ABSTRACT:** We can able to see in many populated areas, buildings are constructed in the areas having irregular shape of boundary and with very small size of breath. While construct a building, the footing occupies some of the space apart from the building and it reduces the breath of the building. To overcome this and to use the maximum space of the plot eccentric columns are recommended. In this project following analysis were discussed. They are 1. Analysis of self-weight of footing with reference to safe bearing capacity, 2. Analysis of Depth Vs Reinforcement, and 3.comparative analysis of footing geometry between the concentric Square footings, Eccentric one way square footing, Eccentric both ways square footings.

**KEYWORDS:** Congested areas; Irregular boundary; Types of footing; Self-weight of footing; Safe Bearing Capacity; Footing Geometry.

### I. INTRODUCTION

#### *General manual design*

Most of the structures build are reinforced concrete structures. We know that the part of the structure above ground level is called as the superstructure, while the part of the structure below the ground level is called as the substructure. Footings are located below the ground level and are also referred as foundations. Foundation is that part of the structure which is in direct contact with soil. The R.C. structures consist of various structural components which act together to resist the applied loads and transfer them safely to soil. In general the loads applied on slabs in buildings are transferred to soil through beams, columns and footings. Footings are that part of the structure which are generally located below ground Level. They are also referred as foundations. Footings transfer the vertical loads, Horizontal loads, Moments, and other forces to the soil.

The important purpose of foundation are as follows;

1. To transfer forces from superstructure to firm soil below.
2. To distribute stresses evenly on foundation soil such that foundation soil neither fails nor experiences excessive settlement.
3. To develop an anchor for stability against overturning.
4. To provide an even surface for smooth construction of superstructure.

Due to the loads and soil pressure, footings develop Bending moments and Shear forces.

5. Here calculations are made as per the guidelines suggested in IS 456 2000 to resist the internal forces. To design the three types of concentric Square footing, eccetric one way square footing, eccentric both ways square footings by manual calculation by using IS456-2000

Analysis of varying the following parameters,

- Self weight of footing
- Safe Bearing Capacity

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- Depth of footing
- Reinforcement of footing
- Footing geometry

## II. ANALYSIS

### A. Analysis of Self weight of footing with reference to Safe Bearing Capacity:

In general for the footing design, self weight of footing and the soil above the footing is considered as 10% - 15%. But actual site implementation and the regular considerations the obtaining load is considered for various Safe Bearing Capacity of Soil for the same load.

Table – 1 -Analysis of Self weight of footing with reference to Safe Bearing Capacity

Axial Load (kN)	Safe Bearing Capacity (N/mm <sup>2</sup> )	Size of Footing (m * m) (m <sup>2</sup> )	Depth of footing (mm)	% of Self Weight
1000	150	2.7X2.7	450	7.87%
1000	250	2.1X2.1	450	4.76%
1000	300	2X2	450	4.32%
1000	350	1.83X1.83	450	3.62%
1000	400	1.53X1.53	450	3.12%

Thus the obtained results are shows that the axial load and the depth of footings are same. And for the various site consideration safe bearing capacity of soil is differed. For that the safe bearing capacity of soil the percentage of self weight is differed.

From the result, if the safe bearing capacity of soil is minimum it increases the size of the footing. So it shows the high percentage of self weight of footing.

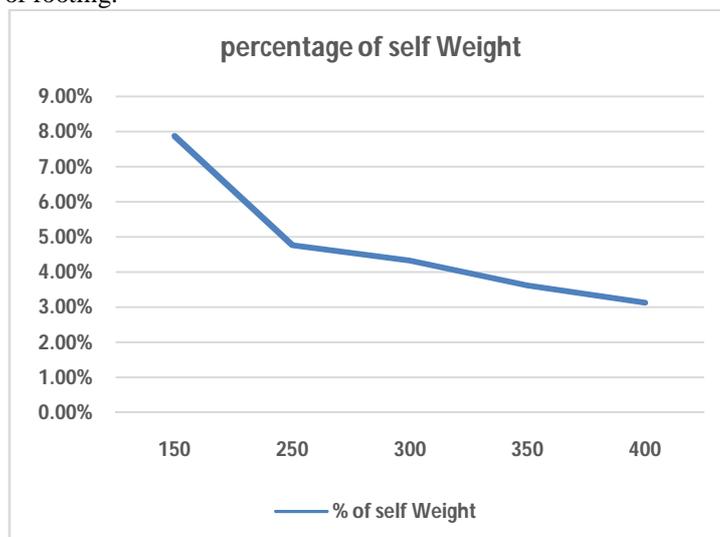


Fig.1 – Self weight with reference to SBC

Moreover the safe bearing capacity of soil is increases the self weight of footing is reduced according to the obtained load and depth of footing.

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### **B. Analysis of Depth of footing Vs Reinforcement:**

This analysis is highly preferred for the actual site basis. Because in a particular construction areas may nearby to the steel manufacturing area (or) steel industry. So there will be cost of steel is less. And now a days the ingredients of concrete of Cement, Fine Aggregate (Sand), and Coarse Aggregate (20mm jelly & 40mm jelly) availability is less. So we can reduce the depth of footing and increases the steel reinforcements in the footings. Which is not only used for footing but also all the components of the structure.

In some other case the availability of concrete is high and the steel cost is high means in that place concrete is preferred. For that this analysis process is better solution of this problem.

#### **Data:**

Axial load – 1000 kN

Size of Column – 450 mm X 450 mm

Safe bearing capacity of soil – 300 kN/m<sup>2</sup>

Grade of concrete –

Grade of steel – Size of footing – 2m X 2m

Cantilever projection from the edge – 0.78m

Minimum depth of footing – 146 mm

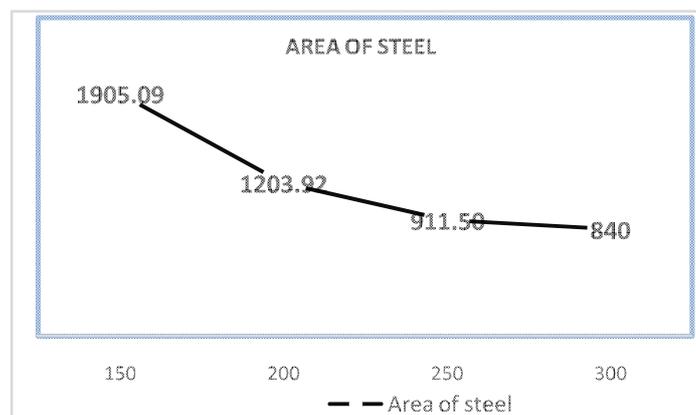
From the above data, the concentric square footing designed by providing different Depth of footing.

#### **Note:**

- Adoptable Depth of footing should not less than the minimum depth.
- Obtaining reinforcement should not less the minimum reinforcement (0.12%). And should not exceed maximum reinforcement (4%)

*Table – 2 -Analysis of Depth of footing and Reinforcement*

Effective Depth	Area of Steel
150 mm	1905.09 mm <sup>2</sup>
200 mm	1203.92 mm <sup>2</sup>
250 mm	911.50 mm <sup>2</sup>
300 mm	840 mm <sup>2</sup>



**Fig.2 – Depth Vs Reinforcement**

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### C. Comparative Analysis of footing geometry:

The comparative analysis is carried out between the concentric square footing, Eccentric one way square footing, Eccentric both ways square footing.

For that the given data is same for those three types footing. by based on Area of steel which is differentiate for cost analysis.

Adopted data's are,

$$P_u = 1000\text{kN}; b = 450 \text{ mm}; D = 450 \text{ mm}; P = 300 \text{ kN/m}^2; f_{ck} = 20 \text{ N/mm}^2; f_y = 415 \text{ N/mm}^2$$

#### 1) Concentric square footing

$$A_{st} = 327.47 \text{ mm}^2$$

Adopt 8 mm diameter bars at 150 mm centres @ both sides

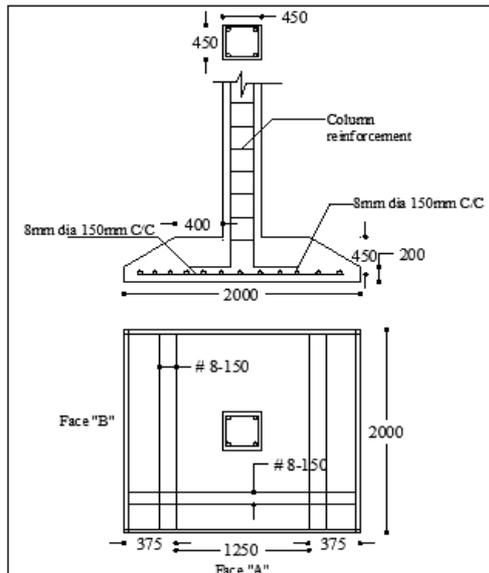


Fig.2 – Structural design of concentric footing

#### 2) Eccentric square footing (one way)

##### a) For face "A":

$$A_{st} = 327.47 \text{ mm}^2$$

Adopt 8 mm diameter bars at 150 mm centres

##### b) For face "B":

$$A_{st} = 1336.69 \text{ mm}^2$$

Adopt 12 mm diameter bars at 150 mm centres

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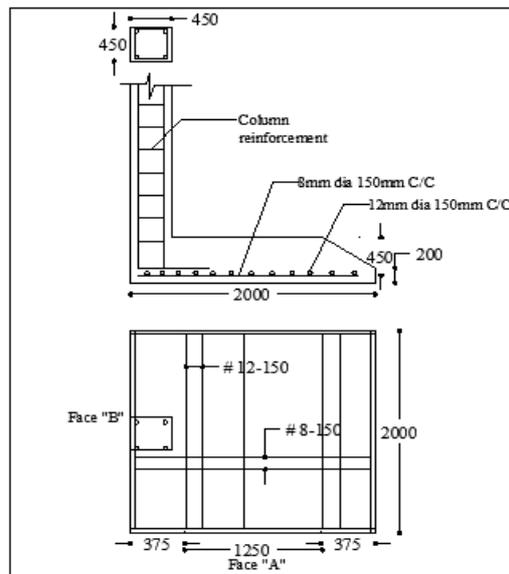


Fig.3 – Structural design of Eccentric footing (one way)

### 3) Eccentric square footing (both ways)

#### a) For face "A":

$$A_{st} = 1336.69 \text{ mm}^2$$

Adopt 12 mm diameter bars at 150 mm centres

#### b) For face "B":

$$A_{st} = 1336.69 \text{ mm}^2$$

Adopt 12 mm diameter bars at 150 mm centres

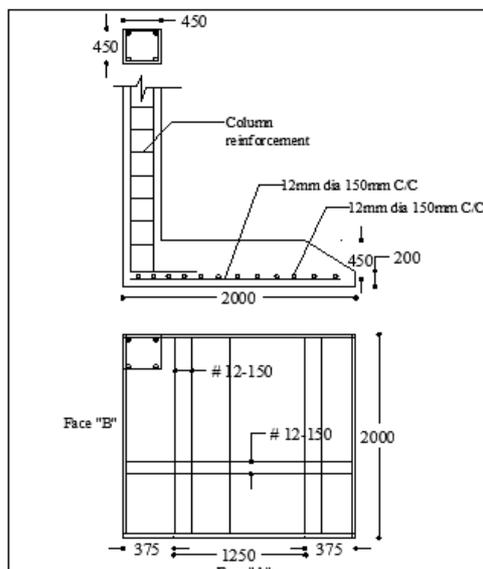


Fig.4–Structural design of Eccentric footing (both ways)

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From this analysis and design,

- The cost of steel reinforcement for the eccentric one way footing is equal to 2.54 times of the cost of steel reinforcement for the concentric footing.
- The cost of steel reinforcement for the eccentric both ways footing is equal to 4.08 times of the cost of steel reinforcement for the concentric footing.

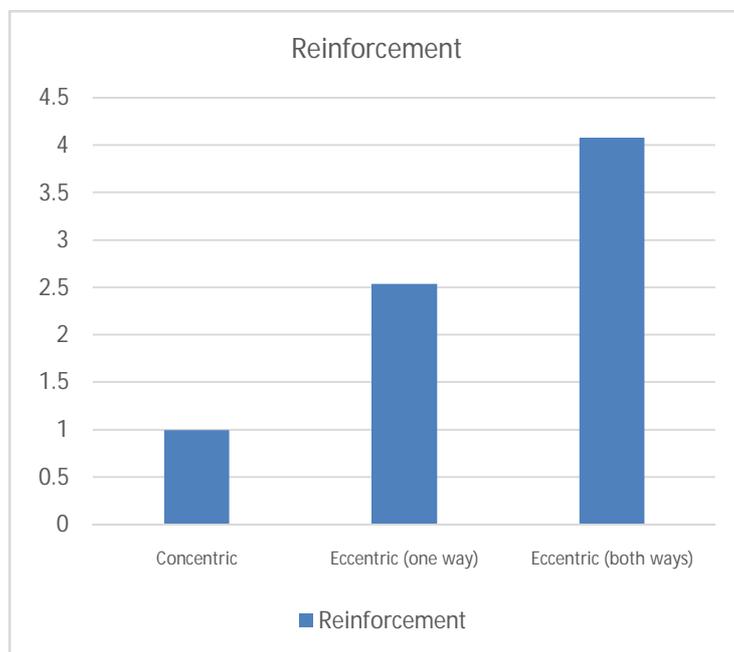


Fig.5 – Bar chart for Analysis of footing geometry

### III. CONCLUSION

From the results obtained from the various analysis parts graphical representation and tables, the following conclusions were made,

- The self weight of footing is taken for designing process is 10-15% normally. But actually which is depends on the Safe Bearing Capacity of soil. So based on the site condition the percentage of self weight is determined. And if the soil bearing capacity is decreases the percentage of self weight increases.
- The depth of footing is depends on the bearing capacity of soil. If the bearing capacity is same the depth of footing and reinforcements are related into its property. If the depth of footing is increases the reinforcement is decreases.
- Comparison of Concentric, Eccentric(one way), Eccentric (both ways) footings are designed by the same datas but reinforcements is gradually increases based on the ratio of 1: 254: 4.08.

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ISSN(Online) : 2319-8753  
ISSN (Print) : 2347-6710

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