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R.C.C Framed High Rise Building Under Different Seismic Zones

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***Abstract*: The present project aims at comparing the cost of steel and concrete required for conventional strip foundation and Angle Shaped foundation. The effect of seismic zones, the effect of aspect ratio and the effect of height of structure are also the parameter to be studied on tall structure. Analytical study carried out for 48 numbers of cases. The foundation type considered for 48 cases are conventional strip foundation and T-Shaped foundations under different seismic zone (2,3,4 and 5) and the different aspect ratio (20mX40m, 20mX60m, 20mX60m, 20mX80m, 20mX100m) and different height of high rise buildings. The study also provides the percentage reduction of quantity of steel and concrete from conventional footing to Angle Shaped footing.**

***Keywords*: RCC, High rise building, Seismic zones.**

1. Introduction

he settlement of footing caused by the reduction in bearing capacity of soil, the bearing capacity of soil depends on different loading and soil strength parameters (cohesion, friction angle, and surface surcharge and self-weight). One of the reasons of reduction in bearing capacity of soil is due to eccentric loading in shallow footing. Many researchers concluded that the eccentrically loaded footing reduces bearing capacity of soil. No check for tilting has been discovered so far. Mahiyar H. K. has introduced angle shaped footing which gives zero tilt in eccentrically loaded condition. Edge column in most of the cases are subjected to moment along longitudinal axis. This bending develops the tilting of angle shape footing, also even if the footings are subjected to axial loads they may be located near the property line subjected to axial load in case of static nature of load.

The footing also may be subjected to dynamic loading in case of earthquake. The high rise structures are subjected to large amount of wind forces and are designed to sway under these forces, in such a case the loading which comes on the footing is considered to be inclined. The effect of the loading is such that it tends to tilt the footing in the direction of the loading. Mahiyar H. K. (2000) introduced the Angle Shaped footing in which the tilt due to eccentric was reduced to zero.

2. Design of 20X40 (G+10) 33 for Conventional Strip Footing

Size of column = 0.6*0.6m
Beam size = 0.5*0.3m
Over all depth of raft (D) = 0.65 m
Effective depth of raft (d) = 0.6 m
Length of raft (l) = 21 m
S.B.C of soil = 250 KN/m

Total axial load:

P1	P2	P3	P4	P5	P6

Factored load(W_u):

1740	2640	2700	2640	1740	11460

Unfactored load (F_u):

1160	1760	1800	1760	1160	7640

Footing size:

Required size of footing = (11460X1.1)/(1.5X250)
= 33.61 m^2

Footing size required for P1 = (1740X1.1)/(1.5X250)
= 5.104 m^2

Size of footing strip = 33.616/21= 1.6007 m

Size of Raft Strip = 22x1.46 = 33.616m^2

Upward pressure = 11460/(1.5x33.616)
= 227.2727273 KN/m^2

Pressure Per Meter Run P1 = 227.27x1.5
= 363.8095238 KN/m

For 5 meter,

=5 X 227.27 = 1136.363636KN/m

M_u =1.5X363.80X1.5X1.5/10 = 139.8359392KN-m
V_u = 1.5x.6x363.80x1.5 = 524.1351837 KN

Net shear (V) = 436.85 - (1.5X363.80X (.64+.2))
= 87.5637551KN

V_u/BD = 524.13/1500/640
= 0.091168831<.29N/mm² (SAFE)

M_u/BD^2 = 98.824/(1.5X.64²)
= 0.388433164

From sp-16 for .241 (M_u/bd^2) = 0.127

But the minimum reinforcement provided for Fe-415 is .12%

Steel for 1 m strip =127x1000x650/100 = 825.5 mm²
Using bar dia = 12mm
Area of bar =113.04 mm²
Spacing =113.04x1000/825.5 = 136.9351908 mm
Provide 12mm dia bar @134.57mm c/c
No. of bars =11.6899235 = 12 Bar

Transverse steel also .12%

Steel for 1m strip =.127x1000x650/100 = 825.5mm²
Spacing = 113.04x1000/825.5 =136.9351908
Provide 12mm dia bar @180mm c/c
No. of bars = 128

Also in top both minimum steel .012%,

Steel for 1m strip =.127x1000x650/100 = 825.5
Area of bar = 113.04 mm²
Spacing = 113.04x1000/825.5 = 136.9351908

Provide 12mmdia bar @134.57mm c/c
no. of bars =154
no of bars in translational direction =171

Total Wt. of steel required for construction=864.1191451 kg
Quantity of concrete required in 1 Raft Rtrip = 21.8504 m³

3. Design of 20X40 (G+10) 33 for T-Shaped Footing

Length of the span = 21 m
Column size = 600mmx600m
Beam size =500mmx300mm
Overall depth of raft =600 mm
Effective depth of raft = 540 mm
Length of raft L = 21m
S.B.C of soil =250 KN/m²

bf = Width of flange = 1.465791796
bw = Width of web = .4bf = 0.586316718
tw = Thickness of web =.1bf = 0.14657918

S.B.C of soil increase by 20% = 250x1.20 = 300 KN/m²
= 30 ton/m²

Total axial load:

p1 p2 p3 p4 p5

Factored load (W_u):

1740 2640 2700 2640 1740

Unfactored load (F_u):

1160 1760 1800 1760 1160

p = q (bf-tw)*l + c (bw*l) x 2 -q * l * tw

11180/(1.5x10) = (30x.9bfx) x 22+2x0.4*bfx22x2) –
30x0.1bfx22 = 764 = 521.22bf

764 = 356.40 bf +35.20 bf+39.60 bf

764 =521.22 bf

bf =1.465791796 m = 1465.791796 mm
Raft size = 21 x 1.46 = 30.78162772 m²
Upward pressure at corner =
300x1x1046+2{(0.4x1.46x1x2)}x10

Upward pressure at corner = 463.1902076 KN
Upward pressure for 5m run = 2315.951038 KN

M_u = 1.5x463.19x1.46²
= 149.2777917 KN-m
V_u = 1.5x0.6x463.19x1.46
= 611.0463657 KN
Net Shear = 326.90-(1.5x463.19x {.54+.2}) = 166.38 KN
V_u/bd = 326.90x10³/(1465x540)
= 0.210205902 <.4 its ok
M_u/bd^2 = 326.90x10³/(1465x540²)
= 0.276440355
then M_u/bd^2 Required reinforcement is =.127%

But Minimum criteria for providing steel is .12% using 12 mm dia. bar.
Area of bar = 113.04mm
Steel for 1 m strip = 1000x.12x600/100 = 762mm²
Spacing =113.04x1000/720 =148.3464567mm
Now providing 12mmdia bar @150mmc/c
No. of bars = 9.880868265 = 10
Transverse steel also .12% =.12x1000x600/100 = 762mm²
Using bar dia. = 12mm
.12x1000x600/100 = 762 mm²

Provide 12mmdia bar @150mmc/c

Also in top both side minimum steel .12%, so
Steel for 1 m strip =.12x1000x600/100 = 762mm²
Provide 12mmdia bar @150mmc/c
Total number of bar required in transverse direction
=141.5605096 steel provide in shear key
= 21x7x.62+110x.2x.62 =104.78
Total wt. of steel required for the construction=835.1737822 kg
Volume of concrete required for the shear key = 1.804778295
Total wt. of concrete required for the construction
=18.48702441m³

4. Conclusion

Analysis has been carried out for 48 number of cases. Based upon the structural analysis of forces using ready software STAAD.PRO following are the conclusions

- The percentage of reduction in steel at corner T-shape footing for G+10 storey building in all the seismic zones and all for the aspect ratio is 4%. While the percentage reduction of steel at middle footing is 8%.
- The percentage of reduction in steel at corner T-shape footing for G+15 storey building in all the seismic zones and all for the aspect ratio is 8%. %. While the percentage reduction of steel at middle footing is 10%.
- The percentage of reduction in steel at corner T-shape footing for G+26 storey building in all the seismic zones and all for the aspect ratio is 12%. While the percentage reduction of steel at middle footing is 13%.
- The percentage of reduction in concrete forT-shape footing for all building in all the seismic zones and all for the aspect ratio is 15%.

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