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# Comparative Study on Seismic and Wind forces on RCC Structure

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**Abstract –** *This paper gives the comparative study on seismic and wind forces on G+10 RCC Residential building. The results are taken from the Major Project done by the students. The Seismic and wind forces parameters are selected for Hyderabad city, Telangana state. Planning is done by AutoCAD software. Analysis and Design is done by STAAD PRO Software. The footing is designed as Mat Footing using STAAD PRO Foundation. The parameters like design of corner and mid columns are compared. Maximum nodal displacement is compared. Footing soil pressure, reinforcement and base pressure is compared.*

***Key Words*: Seismic force, Wind Force, Base shear, deflection, Bending Moment.**

## 1. INTRODUCTION

In this study the analysis and design has been done for G+10 Residential building. The plan of the building is kept same for both the studies. For distinguishing two studies the following cases will be referred:

**Case–I:** For seismic forces with load combination of 1.2(DL+LL±EQ).

**Case–II:** For wind forces with load combination of 1.2(DL+LL±WL)

DL: Dead Loads IS875 Part-I
LL: Live Loads IS875 Part-II
WL: Wind Loads IS875 Part-III
EQ: Earthquake Loads IS1893
Both Wind load and Earthquake loads are lateral loads. Wind is a constant force and Earthquake is an instantaneous force.

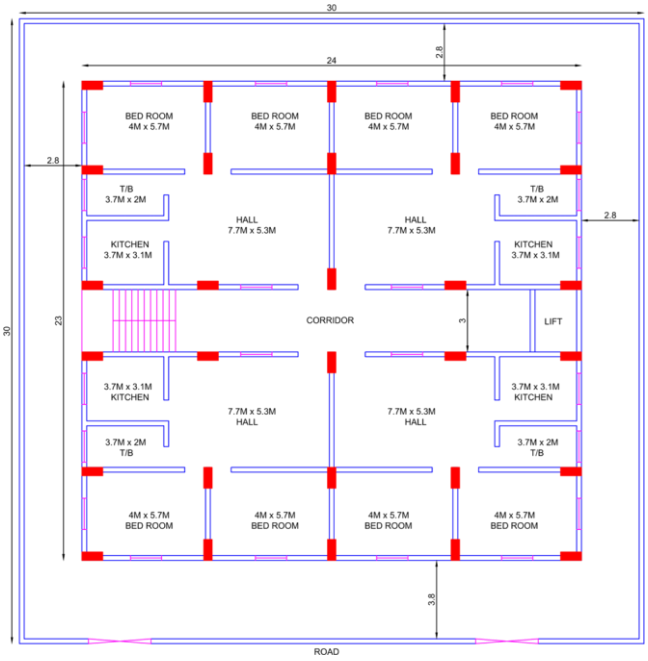
The magnitude of Wind load depends on height of building, Velocity of wind and the amount of Surface area the wind attacks.

The magnitude of earthquake load depends on mass of structure, stiffness of the structural system and the acceleration of surface of earth.

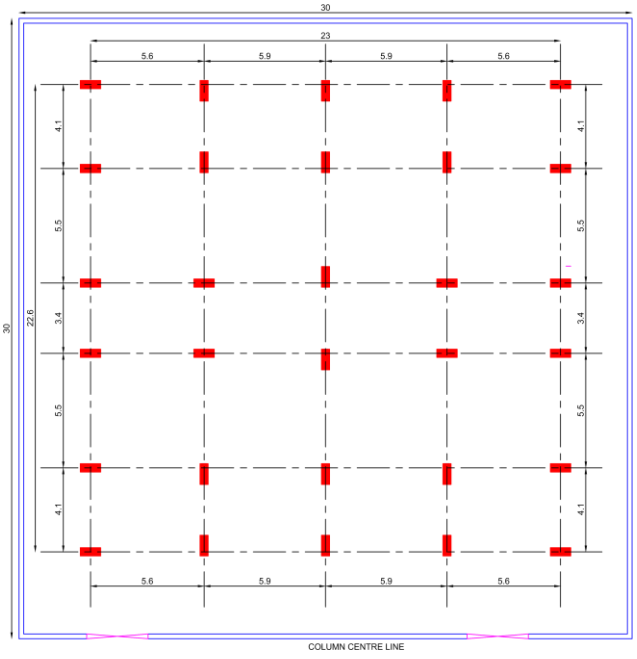
Damping will be considered in seismic forces calculations. Under normal conditions damping is not considered in Wind force calculations.

The soil type has effect on Seismic forces but not on Wind forces.

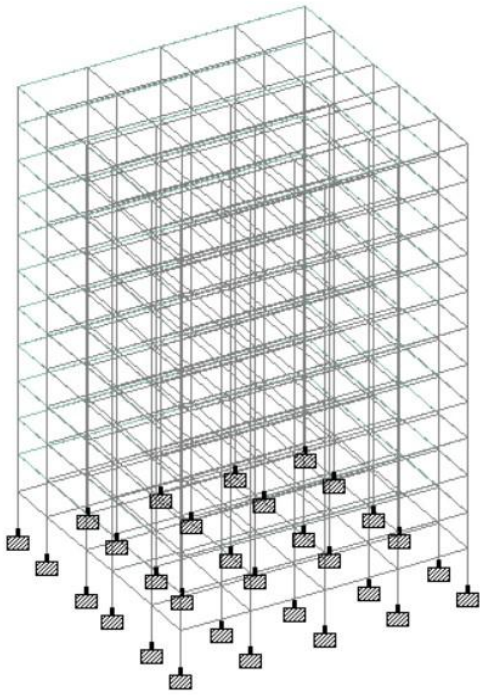
## 2. ARCHITECTURAL PLAN (Case I & II)



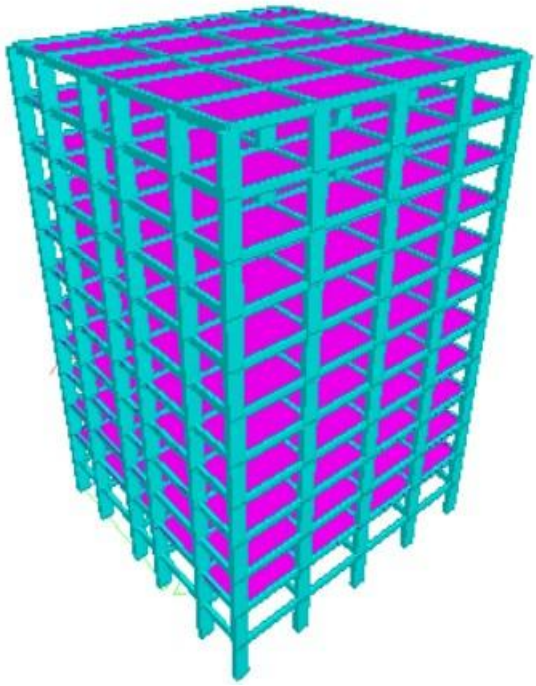

## 3. COLUMN CENTRELINE (Case I & II)



## 4. STAAD PRO MODELLING (Case I & II)



## 5. STAAD PRO 3D MODEL (Case I & II)



## 6. ANALYSIS AND DESIGN PARAMETERS

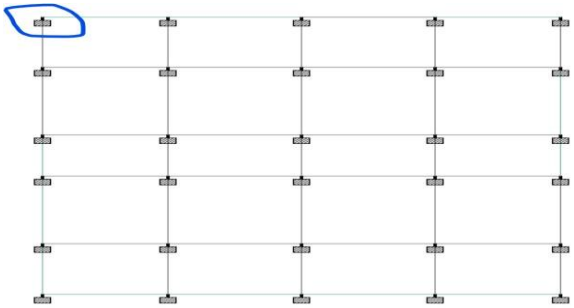
**Table -1** CASE – I (DL+LL+EQ)

| **GENERAL DATA** | |
|---|---|
| Plot Area | 900m² |
| Built up Area | 552m² |
| Number of storeys | G+10 |
| Foundation depth | 3m |
| Typical Floor Height | 3m |
| Grade of Concrete | M25 |
| Grade of Steel | Fe550 |
| Size of Column | 400x1000mm |
| Size of Beams | 230x500mm |
| Footing type | Mat Footing |
| Floor Finish Load | 1Kn/m² |
| Member loads (Wall loads) | 12Kn/m²(Exterior)<br>6Kn/m² (Interior)<br>3Kn/m² (Parapet) |
| Live Load | 2Kn/m² |
| **SEISMIC PARAMETERS** | |
| Seismic Zone | II |
| Zone Factor | 0.1 |
| Response Reduction Factor | 3 |
| Importance Factor | 1 |
| Damping Ratio | 0.05 |

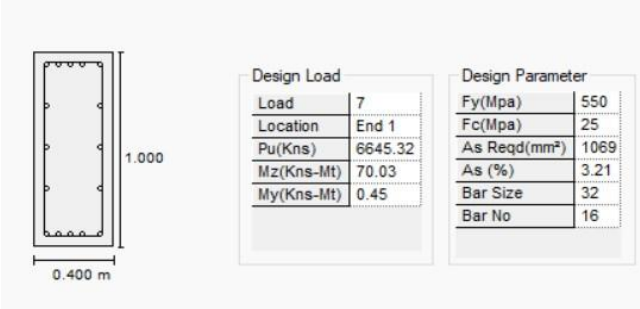
**Table -2** CASE – II (DL+LL+WL)

| **GENERAL DATA** | |
|---|---|
| Plot Area | 900m² |
| Built up Area | 552m² |
| Number of storeys | G+10 |
| Foundation depth | 3m |
| Typical Floor Height | 3m |
| Grade of Concrete | M25 |
| Grade of Steel | Fe550 |
| Size of Column | 400x1000mm |
| Size of Beams | 230x500mm |
| Footing type | Mat Footing |
| Floor Finish Load | 1Kn/m² |
| Member loads (Wall loads) | 12Kn/m²(Exterior)<br>6Kn/m² (Interior)<br>3Kn/m² (Parapet) |
| Live Load | 2Kn/m² |
| **WIND PARAMETERS** | |
| Vb Basic wind speed | 44m/s |
| Vz Design wind speed | = Vb*K1*K2*K3 |
| K1 Risk coefficient | 1 |
| K2 Terrain height factor (Category-2) | 1.12 |
| K3 Topography factor | 1 |
| Pz Design Wind Pressure | 0.6*Vz² |

## 7. CORNER COLUMNS COMPARISION



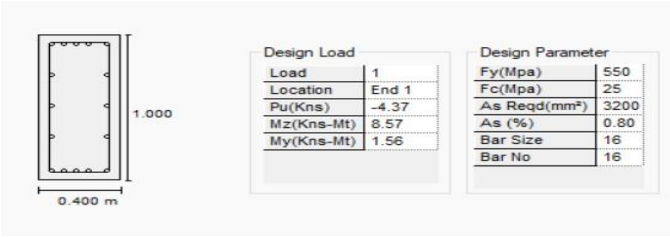
*Corner Column GF for Case-I*




| Design Load | |
|---|---|
| Load | 7 |
| Location | End 1 |
| Pu(Kns) | 6645.32 |
| Mz(Kns-Mt) | 70.03 |
| My(Kns-Mt) | 0.45 |

| Design Parameter | |
|---|---|
| Fy(Mpa) | 550 |
| Fc(Mpa) | 25 |
| As Reqd(mm²) | 1069 |
| As (%) | 3.21 |
| Bar Size | 32 |
| Bar No | 16 |

*Corner Column 10th floor Case-I*




| Design Load | |
|---|---|
| Load | 1 |
| Location | End 1 |
| Pu(Kns) | -4.37 |
| Mz(Kns-Mt) | 8.57 |
| My(Kns-Mt) | 1.56 |

| Design Parameter | |
|---|---|
| Fy(Mpa) | 550 |
| Fc(Mpa) | 25 |
| As Reqd(mm²) | 3200 |
| As (%) | 0.80 |
| Bar Size | 16 |
| Bar No | 16 |

*Corner Column GF for Case-II*


| Design Load | |
|---|---|
| Load | 1 |
| Location | End 1 |
| Pu(Kns) | -3.34 |
| Mz(Kns-Mt) | 11.26 |
| My(Kns-Mt) | 1.44 |

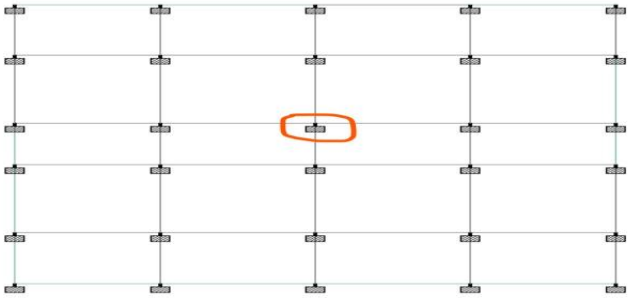
| Design Parameter | |
|---|---|
| Fy(Mpa) | 550 |
| Fc(Mpa) | 25 |
| As Reqd(mm²) | 3200 |
| As (%) | 0.80 |
| Bar Size | 16 |
| Bar No | 16 |

*Corner Column 10th floor Case-II*


| Design Load | |
|---|---|
| Load | 8 |
| Location | End 1 |
| Pu(Kns) | 6409.96 |
| Mz(Kns-Mt) | 14.95 |
| My(Kns-Mt) | 55.34 |

| Design Parameter | |
|---|---|
| Fy(Mpa) | 550 |
| Fc(Mpa) | 25 |
| As Reqd(mm²) | 8568 |
| As (%) | 2.41 |
| Bar Size | 32 |
| Bar No | 12 |

## 8. MID COLUMNS COMPARISION

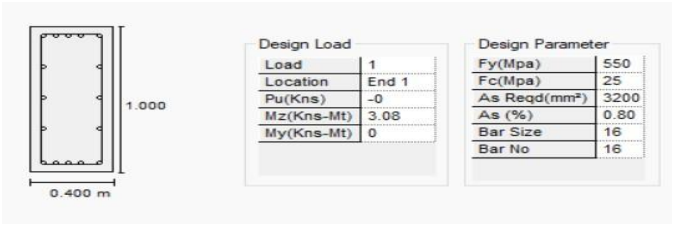


*Mid Column GF for Case-I*


| Design Load | |
|---|---|
| Load | 1 |
| Location | End 1 |
| Pu(Kns) | -0 |
| Mz(Kns-Mt) | 73.67 |
| My(Kns-Mt) | 0 |

| Design Parameter | |
|---|---|
| Fy(Mpa) | 550 |
| Fc(Mpa) | 25 |
| As Reqd(mm²) | 3200 |
| As (%) | 0.80 |
| Bar Size | 16 |
| Bar No | 16 |

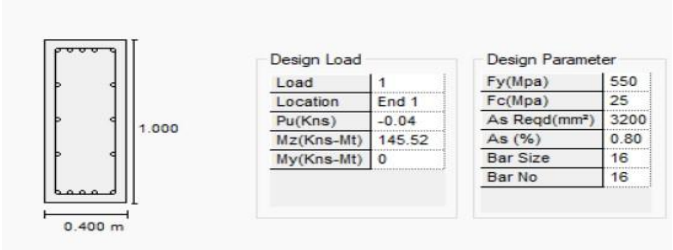
*Mid Column 10th floor for Case-I*




| Design Load | |
|---|---|
| Load | 1 |
| Location | End 1 |
| Pu(Kns) | -0 |
| Mz(Kns-Mt) | 3.08 |
| My(Kns-Mt) | 0 |

| Design Parameter | |
|---|---|
| Fy(Mpa) | 550 |
| Fc(Mpa) | 25 |
| As Reqd(mm²) | 3200 |
| As (%) | 0.80 |
| Bar Size | 16 |
| Bar No | 16 |

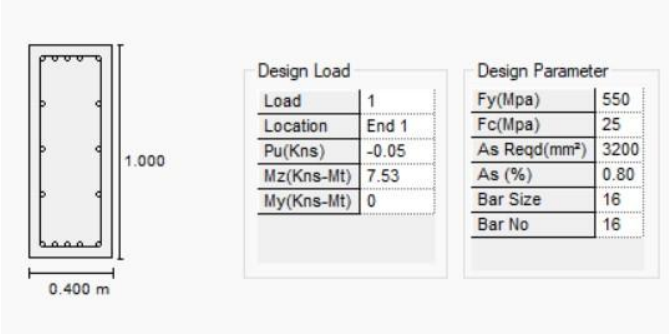
*Mid Column GF for Case-II*




| Design Load | |
|---|---|
| Load | 1 |
| Location | End 1 |
| Pu(Kns) | -0.04 |
| Mz(Kns-Mt) | 145.52 |
| My(Kns-Mt) | 0 |

| Design Parameter | |
|---|---|
| Fy(Mpa) | 550 |
| Fc(Mpa) | 25 |
| As Reqd(mm²) | 3200 |
| As (%) | 0.80 |
| Bar Size | 16 |
| Bar No | 16 |

*Mid Column 10th floor for Case-II*




## 9. MAXIMUM NODAL DISPLACEMENT

**Node Displacement Summary** CASE - I

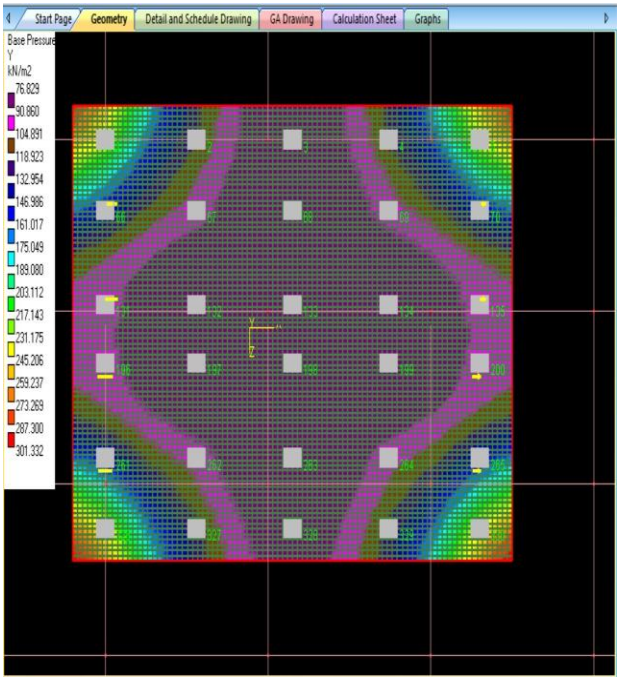
| | Node | L/C | X (mm) | Y (mm) | Z (mm) | Resultant (mm) | rX (rad) | rY (rad) | rZ (rad) |
|---|---|---|---|---|---|---|---|---|---|
| Max X | 386 | 7:1.2(DL+LL+E | **22.344** | -15.818 | 0.111 | 27.376 | 0.001 | 0.000 | -0.000 |
| Min X | 386 | 2:EQ -X | **-18.554** | -0.242 | -0.001 | 18.556 | -0.000 | -0.000 | 0.000 |
| Max Y | 61 | 3:EQ +Z | -0.001 | **0.291** | 18.709 | 18.711 | 0.000 | 0.000 | 0.000 |
| Min Y | 386 | 8:1.2(DL+LL+E | 0.080 | **-16.458** | 22.560 | 27.926 | 0.001 | 0.000 | -0.000 |
| Max Z | 325 | 8:1.2(DL+LL+E | -0.176 | -7.198 | **22.562** | 23.683 | 0.001 | -0.000 | 0.000 |
| Min Z | 61 | 4:EQ -Z | 0.001 | -0.291 | **-18.709** | 18.711 | -0.000 | -0.000 | -0.000 |
| Max rX | 356 | 8:1.2(DL+LL+E | -0.004 | -12.101 | 13.065 | 17.809 | **0.001** | -0.000 | -0.000 |
| Min rX | 342 | 4:EQ -Z | -0.000 | 0.138 | -4.728 | 4.730 | **-0.001** | -0.000 | 0.000 |
| Max rY | 325 | 7:1.2(DL+LL+E | 21.140 | -7.545 | 0.123 | 22.446 | 0.001 | **0.000** | -0.000 |
| Min rY | 130 | 7:1.2(DL+LL+E | 21.140 | -7.545 | -0.123 | 22.446 | -0.001 | **-0.000** | -0.000 |
| Max rZ | 351 | 2:EQ -X | -7.865 | -0.171 | -0.000 | 7.866 | -0.000 | -0.000 | **0.001** |
| Min rZ | 286 | 7:1.2(DL+LL+E | 9.058 | -4.425 | -0.009 | 10.081 | 0.000 | 0.000 | **-0.001** |
| Max Rst | 386 | 8:1.2(DL+LL+E | 0.080 | -16.458 | 22.560 | **27.926** | 0.001 | 0.000 | -0.000 |

**Node Displacement Summary** CASE-II

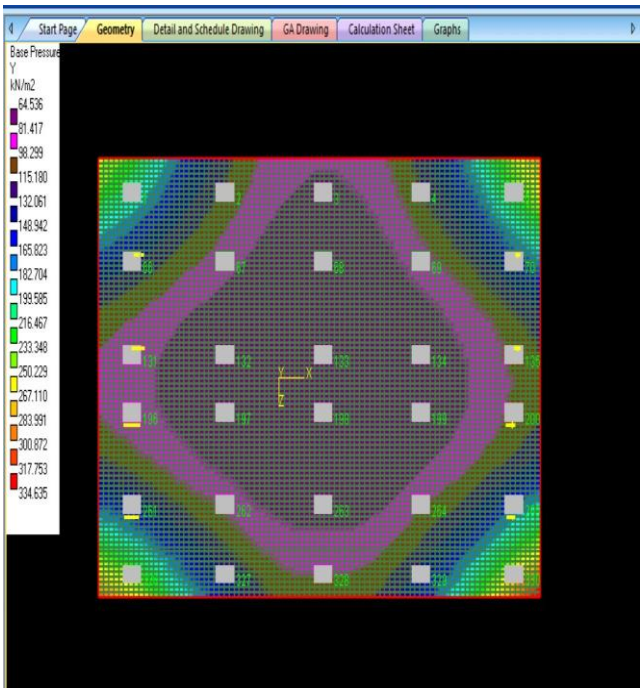
| | Node | L/C | X (mm) | Y (mm) | Z (mm) | Resultant (mm) | rX (rad) | rY (rad) | rZ (rad) |
|---|---|---|---|---|---|---|---|---|---|
| Max X | 191 | 7:1.2(DL+LL+W | **30.979** | -4.870 | -0.039 | 31.359 | -0.000 | 0.000 | -0.000 |
| Min X | 195 | 2:WL -X | **-25.652** | 0.271 | -0.001 | 25.654 | -0.000 | -0.000 | 0.000 |
| Max Y | 58 | 3:WL +Z | 0.000 | **0.368** | 29.471 | 29.474 | 0.000 | -0.000 | -0.000 |
| Min Y | 386 | 8:1.2(DL+LL+W | 0.064 | **-16.181** | 30.903 | 34.883 | 0.001 | 0.000 | 0.000 |
| Max Z | 63 | 8:1.2(DL+LL+W | 0.000 | -5.134 | **36.057** | 36.421 | 0.000 | -0.000 | 0.000 |
| Min Z | 388 | 4:WL -Z | 0.000 | 0.368 | **-29.906** | 29.908 | -0.000 | 0.000 | -0.000 |
| Max rX | 13 | 8:1.2(DL+LL+W | 0.000 | -1.439 | 8.049 | 8.177 | **0.002** | -0.000 | -0.000 |
| Min rX | 338 | 4:WL -Z | 0.000 | 0.159 | -6.728 | 6.730 | **-0.001** | 0.000 | -0.000 |
| Max rY | 126 | 7:1.2(DL+LL+W | 28.802 | -6.480 | -0.129 | 29.522 | -0.001 | **0.000** | -0.000 |
| Min rY | 321 | 7:1.2(DL+LL+W | 28.802 | -6.480 | 0.129 | 29.522 | 0.001 | **-0.000** | -0.000 |
| Max rZ | 150 | 2:WL -X | -6.956 | 0.142 | -0.001 | 6.958 | -0.000 | -0.000 | **0.001** |
| Min rZ | 146 | 7:1.2(DL+LL+W | 8.337 | -2.024 | 0.001 | 8.579 | -0.000 | 0.000 | **-0.001** |
| Max Rst | 128 | 8:1.2(DL+LL+W | 0.000 | -7.779 | 35.981 | **36.812** | 0.000 | -0.000 | -0.000 |

## 10. FOOTING SOIL PRESSURE

**CASE-I**




**CASE-II**




## 11. FOOTING REINFORCEMENT

CASE-I

Required Reinforcement Summary

| | X (m) | Y (m) | Z (m) | Moment (kN-m/m) | Area Reqd. (sq. mm) | Load Case |
|---|---|---|---|---|---|---|
| Longitudinal Top | 25.000 | 0.000 | 15.966 | 673.549 | 1800.000 | 201 |
| Longitudinal Bottom | -0.169 | 0.000 | 22.703 | -1818.991 | 3663.549 | 201 |
| Transverse Top | 3.492 | 0.000 | 24.500 | 602.366 | 1800.000 | 201 |
| Transverse Bottom | -0.169 | 0.000 | 22.703 | -1740.789 | 3520.444 | 201 |

OK

CASE-II

Required Reinforcement Summary

| | X (m) | Y (m) | Z (m) | Moment (kN-m/m) | Area Reqd. (sq. mm) | Load Case |
|---|---|---|---|---|---|---|
| Longitudinal Top | 19.508 | 0.000 | 24.600 | 1998.320 | 4043.260 | 201 |
| Longitudinal Bottom | 23.169 | 0.000 | 22.797 | -5338.435 | 11946.327 | 201 |
| Transverse Top | 25.000 | 0.000 | 15.583 | 2245.591 | 4601.620 | 201 |
| Transverse Bottom | 23.169 | 0.000 | 22.797 | -5174.958 | 11601.894 | 201 |

OK

## 12. FOOTING BASE PRESSURE

CASE-I

Base Pressure Summary

| - | Node | X-Coor(m) | Y-Coor(m) | Z-Coor(m) | Load Case | Base Pressure (kN/m2) |
|---|---|---|---|---|---|---|
| Maximum Base Pressure | 4 | -2.000 | 0.000 | 24.500 | 201 | 461.17087 |
| Minimum Base Pressure | 1 | -2.000 | 0.000 | -2.000 | 6 | 5.67247 |

Base Pressure Summary for Service Load conditions

| - | Node | X-Coor(m) | Y-Coor(m) | Z-Coor(m) | Load Case | Base Pressure (kN/m2) |
|---|---|---|---|---|---|---|
| Maximum Base Pressure | 3 | 25.000 | 0.000 | 24.500 | 101 | 307.44716 |
| Minimum Base Pressure | 1 | -2.000 | 0.000 | -2.000 | 6 | 5.67247 |

CASE-II

Base Pressure Summary

| - | Node | X-Coor(m) | Y-Coor(m) | Z-Coor(m) | Load Case | Base Pressure (kN/m2) |
|---|---|---|---|---|---|---|
| Maximum Base Pressure | 3 | 25.000 | 0.000 | 24.600 | 201 | 1531.53866 |
| Minimum Base Pressure | 1 | -2.000 | 0.000 | -2.000 | 6 | 5.66833 |

Base Pressure Summary for Service Load conditions

| - | Node | X-Coor(m) | Y-Coor(m) | Z-Coor(m) | Load Case | Base Pressure (kN/m2) |
|---|---|---|---|---|---|---|
| Maximum Base Pressure | 3 | 25.000 | 0.000 | 24.600 | 101 | 1021.02532 |
| Minimum Base Pressure | 1 | -2.000 | 0.000 | -2.000 | 6 | 5.66833 |

## 3. CONCLUSIONS

1) Area of reinforcement is more in Corner columns, comparing than mid columns for both the cases.

2) Nodal displacement in Case-II is higher.

3) There is variation in pattern of Soil Pressure for Case-I and Case-II.

4) Mat footing reinforcement requirement is higher in Case-II.

5) Footing Base pressure is more in Case-II.

## REFERENCES

[1] IS: 456-2000, Code of Practice for concrete design.

[2] IS: 875-1987 (Part 1) – 1987, Code of Practice for Design Loads for buildings and structures – Dead loads.

[3] IS: 875-1987 (Part 2) – 1987, Code of Practice for Design Loads for buildings and structures – Imposed loads.

[4] IS: 875-1987 (Part 3) – 1987, Code of Practice for Design Wind loads for buildings and structures.

[5] IS 1893 Code of Practice for Earthquake resistant design.

## BIOGRAPHIES

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