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Effect of Increasing Height of Building on Design Results

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Abstract: ***India is earthquake prone country and it is categorized into 4 seismic zones II, III, IV, V, with respect to the cruelty of the earthquakes. Guidelines as per code I.S 1893 (part 1:2002) are beneficial for regular and small, low rise buildings. When it comes to tall buildings, every structure is analyzed in an individual aspect. The response of building when dominate to seismic excitation can be classified in a number of ways. Structural analysis method can be mainly categorized into 4 methods are equivalent static, linear dynamic, non-linear static, non-linear dynamic.***
In the present paper is all about the effect of increasing height of building on design results. For analyzing the structure with their respective method static and dynamics analysis in terms of peak storey shear, base shear, lateral displacement, story drift and fundamental natural period. It includes modeling of ten cases of plan area 25m X 25m and the height is varied from 17.8m, 33.8m, 49.8m, 65.8m, 81.8m were analyzed in which five cases of seismic zone IV are taken into account and compared with five other cases of same configuration with seismic zone V. Models of different heights are developed with seismic zones IV and V in which G+4 and G+9 cases are analyzed with Fe 415, M25 and remaining G+14, G+19 G+24 cases are analyzed with Fe 500, M30 which is characterized strength of concrete and grade of concrete and compared these cases in both seismic zones IV and V with medium type of soil. All ten cases of G+4, G+9, G+14, G+19 and G+24 were analyzed through STAAD Pro. V8i by using response spectrum method.

Keywords: Peak storey shear, story drift, base shear, lateral displacement, fundamental natural period, seismic zones, dynamic analysis, response spectrum.

1. Introduction

The scope of present work is to study of behavior of structure with varying height. Structural analysis of multi-storied building having plan regularities for G+4, G+9, G+14, G+19, G+24 stories, through different seismic zones IV and V. Structure analysis of multi-storied frame using staad pro v8i and determine lateral displacement, storey drift and base shear and peak storey shear**.**

1.1 Response Spectrum Method:

i. Response spectrum of any earthquake ground motion is a plot peak (max) value of response quantities (displacement, velocity, acceleration) as a function of the natural vibration period or frequency.
ii. In this method, the maximum modal response is obtained for each mode using response spectrum.
iii. The number of modes to be combined in the analysis are such that the sum total of all modes considered is at least 90% of total seismic mass.

1.2 Estimation of Earthquake Seismic Base Shear (V_B):

Base shear is the summation of the horizontal force acting onward the structure which is measuring on the support of total seismic mass weight of the structure and fundamental period of oscillation for a similar mode shape. (I.S. 1893-1: 2002, 7.5.3).

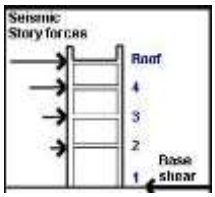

Figure 1: Seismic base shear

V_B= Ah x W (1)
Ah= Design of earthquake seismic horizontal coefficient for the structure.
W= Seismic mass weight of the building.

1.3 Design of Earthquake Seismic Horizontal Coefficient for the Structure (Ah):

The factor affecting response of the structure i.e. Importance factor (I), Zone factor (Z), Response reduction factor(R), Average acceleration response Sa/g mentioned in (I.S. 1893-1: 2002, 6.4.1) are elaborated-

$$Ah = \frac{z}{2} X \frac{I}{R} X \frac{S_a}{g} \quad (2)$$

2. Modelling in Staad

Modeling and analysis done by STAAD-Pro software and outcome should be arranged properly. The methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard code. So for high rise building response spectra method is best suitable for dynamic analysis which should analysis in STAAD-pro software. STAAD is the

supreme conception software permitted by Bentley. To calculate base shear, story drift, lateral displacement, lateral force, peak storey shear, shear force, bending Moment, axial force, deflection of composite loading it should take about an hour so this is best option for analysis the structure on STAAD. And now a days all government department accepted STAAD-pro output result file only. Finalize easily lots of calculation done in a fast and correct manner. Easy and effective comparisons is possible is done by this software.

Following steps are as follows-

i. Drawing plan & elevation of the building
ii. Locating columns and beam.
iii. Applying dimensions to the beams and columns
iv. Support and boundary condition
v. Load calculations
vi. Load combination
vii. Response spectra method applied with zone V and Zone IV
viii. Design parameters as per IS 456 (2000)
ix. Post analysis
x. Analysis to determine the base shear, story drift, lateral displacement, peak storey shear.

2.1 Geometry:

For the study 10 different cases of a G+4, G+9, G+19, G+24, G+25 storey building are considered for seismic zones IV and V. The building has storey height of 3.2 m each in all the floors and depth of foundation taken as 1.8 m. The column is kept square type.

2.2 Modelling:

The building is designed to be located in earthquake seismic zone IV and zone V and proposed for commercial use. The building is established on medium strength type soil under the columns. Factor is taken for the term as response reduction for the (SMRF) special moment resisting frame has taken as 5.0. In seismic weight calculations, 50 % of the floor live loads are considered in the analysis.

Table 1: Basic detailing for all buildings G+4, G+9, G+14, G+19 and G+24 in zone IV and V

Description	*Zone IV*	*Zone V*
Depth of foundation	1.8 meter	1.8 meter
Typical storey height for all floors	3.2 meter	3.2 meter
Seismic intensity	severe	Very severe
Soil type	Medium	Medium
Slab thickness	.150m	.150m
Unit wt. of masonry wall	20	20
For G+4, G+9 buildings		
Yield strength of distribution bar (f_y sec)	Fe-415	Fe-415
Yield strength of main bar (f_y sec)	Fe-415	Fe-415
Grade of concrete	25	25
For G+14, G+19, G+24 buildings		
Yield strength of distribution bar (f_y sec)	Fe-500	Fe-500
Yield strength of main bar (f_y sec)	Fe-500	Fe-500
Grade of concrete	30	30

2.3 Loading Calculations:

Loads are consideration for demonstrate the structure weight floor wise in STAAD.

2.3.1 Dead Load:

Dead load includes members which lie on structures i.e. self-weight of structure it includes material unit weight and it includes wall load.

Table 2: Dead load calculation for the models G+4, G+10 G+15, G+20, G+25 in Zone IV and V.

Brick masonry wall Load				
Description	*Calculation*	*Total*	*Unit*	*Remark*
External wall load	.23 X (3.2-.23) X 20	13.66	$\frac{kN}{m^2}$	L x B x H x T
Internal wall load	.115 X (3.2-.23) X 20	6.8	$\frac{kN}{m^2}$	L x B x H x T
Parapet wall load	.23 X (.90) X 20	4.14	$\frac{kN}{m^2}$	L x B x H x T
Slab Load				
Slab Load	(.15 X 25 X 1) +3	6.25	$\frac{kN}{m^2}$	3 for water proofing
Slab load at roof	6.25-1	5.25	$\frac{kN}{m^2}$	Slab load-1

2.3.2 Live Load:

Live Load on floors = 3.0 kN/m^2.

2.3.3 Earthquake Load:

All the building frames are analyzed for 2 seismic zones (Zone IV and Zone V). The earth quake loads are resulting for following seismic parameters as per IS: 1893(2002).

Table 3: Seismic load parameters for the models G+4, G+10 G+15, G+20, G+25 in Zone IV and V.

S. No.	*Parameter*	*Value*
1	Zone factor (IV, V)	0.24 & 0.36
2	Response reduction factor (SMRF)	5
3	Importance factor (I)	1.5
4	Rock and soil site factor (SS)	1
5	Type of structure (ST)	2 (medium)
6	Damping ratio	0.05

Table 4: Seismic load calculation.

S. No.	*Description*	*Factor*
1	Self-weight	1 factor in X direction
2	Self-weight	1 factor in Y direction
3	Self-weight	1 factor in Z direction
4	Floor load	6.25 $\frac{kN}{m^2}$ in global X direction
5	Floor load	6.25 $\frac{kN}{m^2}$ in global X direction
6	Floor load	6.25 $\frac{kN}{m^2}$ in global X direction

2.3.4 Possible Load Cases:

Structure should satisfy all these condition for safe structure i.e. the ultimate stability against overturning, sliding and buckling, strength, serviceability.

Table 5: Possible load cases for the models G+4, G+10 G+15, G+20, G+25 in Zone IV and V.

Load case no.	*Description*	*Loading*
1	Primary	DL
2	Primary	LL
3	Primary	RS in X and Z direction
4	Combination	1.2DL + 1.2 RS +1.2 LL
5	Combination	-1.2DL + 1.2 RS
6	Combination	1.5 RS
7	Combination	1.5 DL+1.5 RS
8	Combination	-1.5 DL+1.5 RS
9	Combination	1.5 DL+0.9 RS
10	Combination	-1.5 DL+0.9 RS
11	Combination	1.5DL + 1.5LL

2.3.5 Support Condition:

Support condition for all models of G+5, G+10 G+15, G+20, G+25 in Zone V and IV are fixed.

3. Seismic Analysis Results in Staad

3.1 G+4 Storey Building with seismic zone IV and V

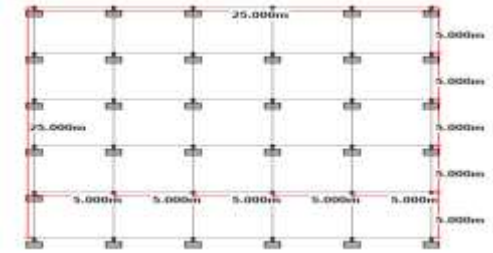

Figure 2: Planning of G+4 building

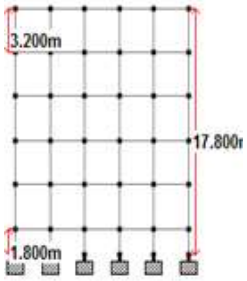

Figure 3: Elevation of G+4 building

Table 6: Result for G+4 building

Description	*Zone IV*	*Zone V*
Zone factor	0.24	0.36
Yield strength of distribution bar (f_y sec)	Fe-415	Fe-415
Yield strength of main bar (f_y main)	Fe-415	Fe-415
Grade of concrete	25	25
Fundamental natural period	0.3204	0.3204
Peak storey shear (kN)	2801	3353
Base shear (kN)	4733.3	5664.8
Lateral Displacement (cm)	3.402	4.071
Story drift (cm)	0.797	0.9538

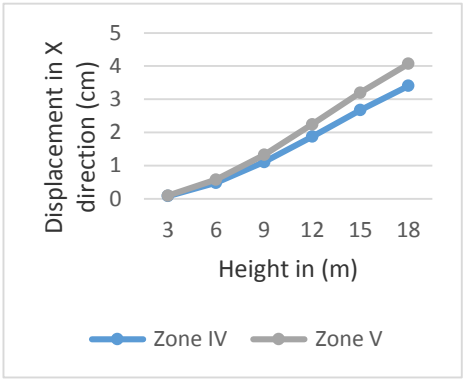

Figure 4: Lateral displacement of G+4 building in X direction in zone IV and V.

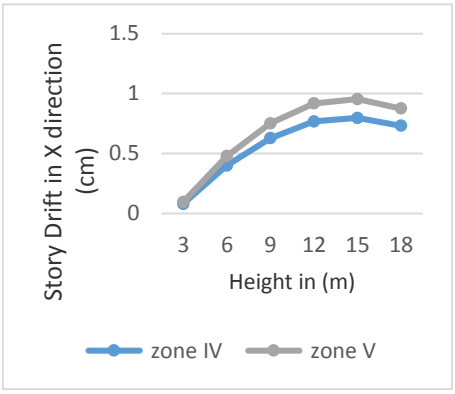

Figure 5: Story drift of G+4 building in X direction in zone IV and V.

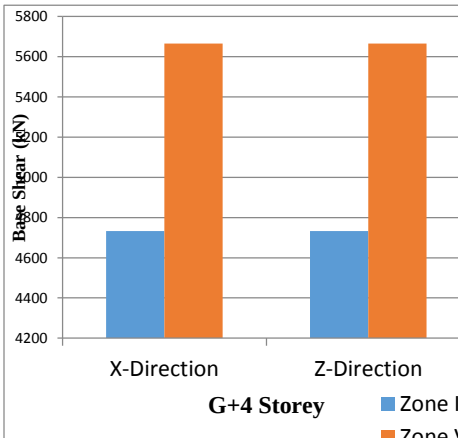

Figure 6: Base shear of G+4 building in X and Z direction in zone IV and V.

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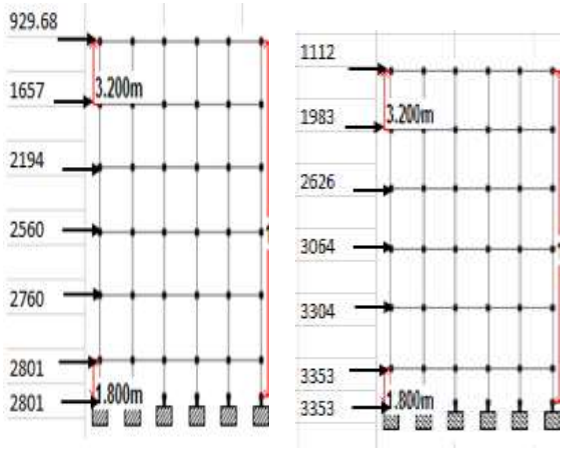

Figure 7: Base shear of G+4 building in X and Z direction in zone IV and V.

3.2 G+9 Storey Building with seismic zone IV and V

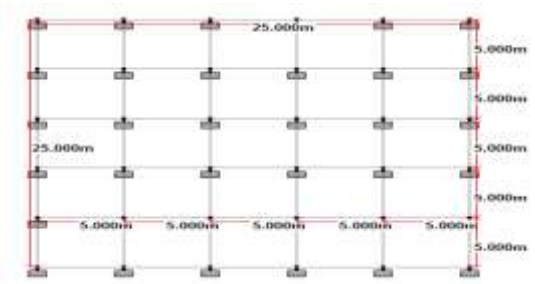

Figure 8: Planning of G+9 building

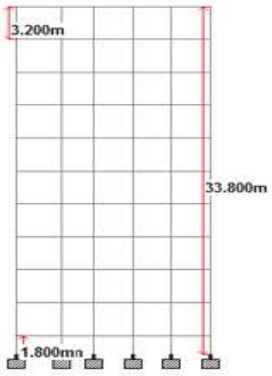

Figure 9: Elevation of G+9 building

Table 7: Result for G+9 building

Description	*Zone IV*	*Zone V*
Zone factor	0.24	0.36
Yield strength of distribution bar (f_y sec)	Fe-415	Fe-415
Yield strength of main bar (f_y main)	Fe-415	Fe-415
Grade of concrete	25	25
Fundamental natural period	0.6084	0.6084
Peak storey shear (kN)	3478	4471
Base shear (kN)	6322	8128
Lateral Displacement (cm)	7.4885	11.232
Story drift (cm)	1.008	1.5119

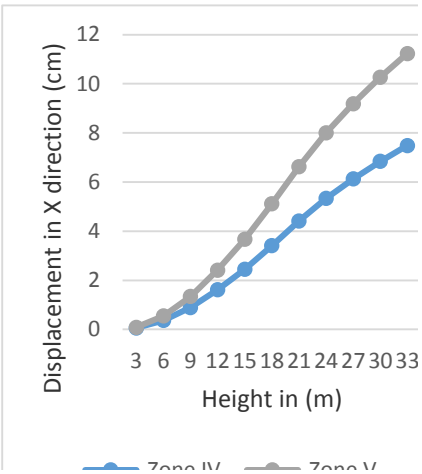

Figure 10: Lateral displacement of G+9 building in X direction in zone IV and V.

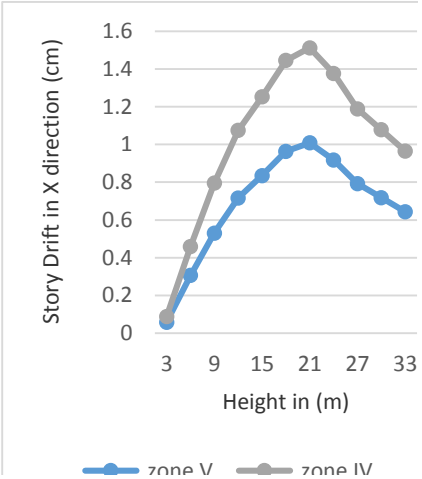

Figure 11: Story drift of G+9 building in X direction in zone IV and V.

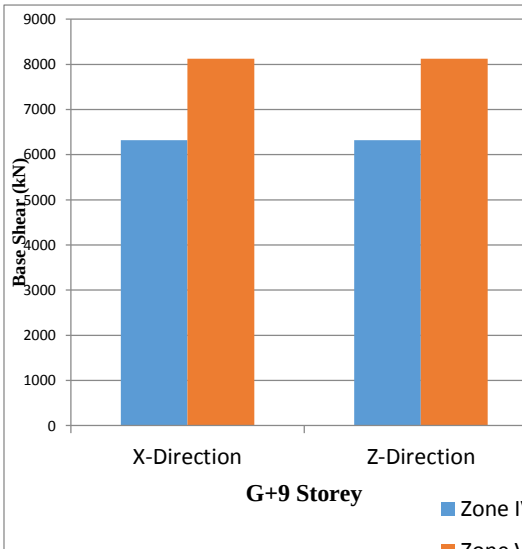

Figure 12: Base shear of G+9 building in X and Z direction in zone IV and V.

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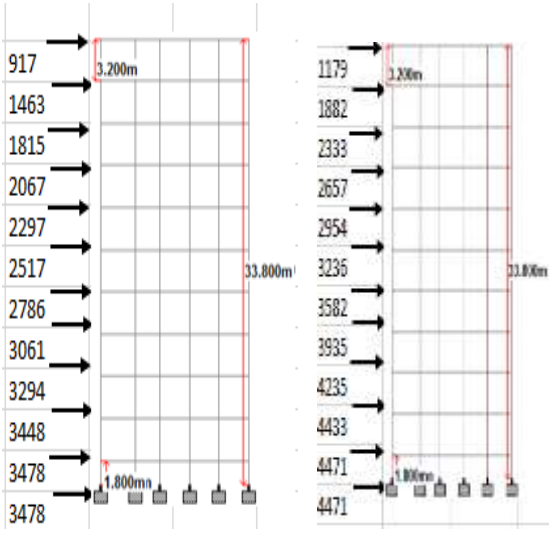

Figure 13: Base shear of G+9 building in X and Z direction in zone IV and V.

3.3 G+14 Storey Building with seismic zone IV and V

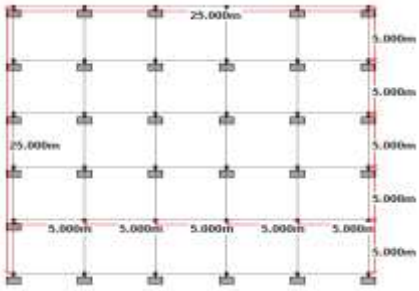

Figure 14: Planning of G+14 building

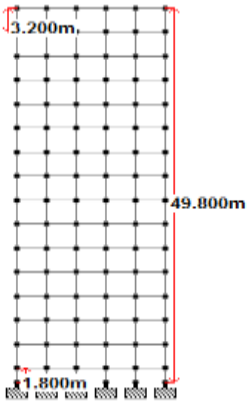

Figure 15: Elevation of G+14 building

Table 8: Result for G+14 building

Description	*Zone IV*	*Zone V*
Zone factor	0.24	0.36
Yield strength of distribution bar (f_y sec)	Fe-500	Fe-500
Yield strength of main bar (f_y main)	Fe-500	Fe-500
Grade of concrete	30	30
Fundamental natural period	0.8964	0.8964
Peak storey shear (kN)	3471	4628
Base shear (kN)	6194	8259
Lateral Displacement (cm)	9.867	14.8
Story drift (cm)	0.7981	1.1972

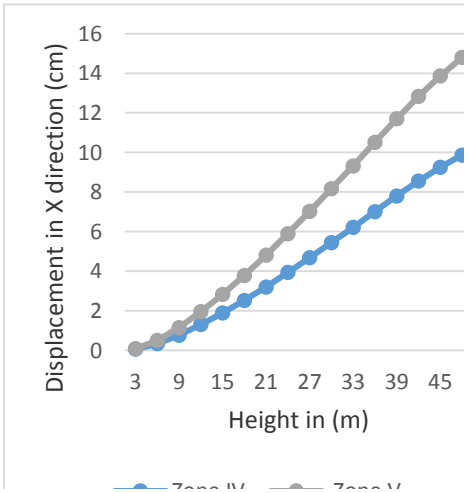

Figure 16: Lateral displacement of G+14 building in X direction in zone IV and V.

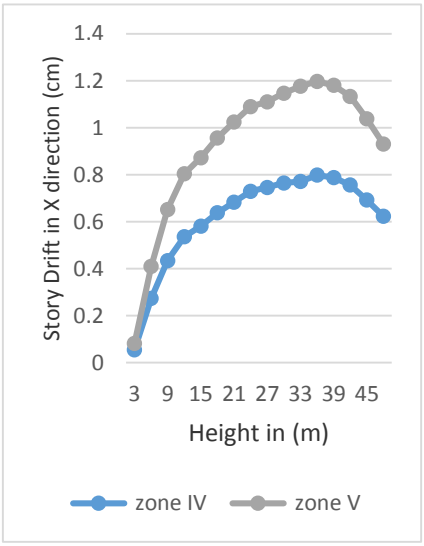

Figure 17: Story drift of G+14 building in X direction in zone IV and V.

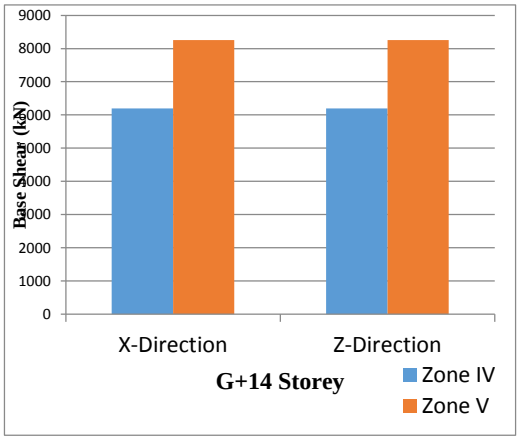

Figure 18: Base shear of G+14 building in X and Z direction in zone IV and V.

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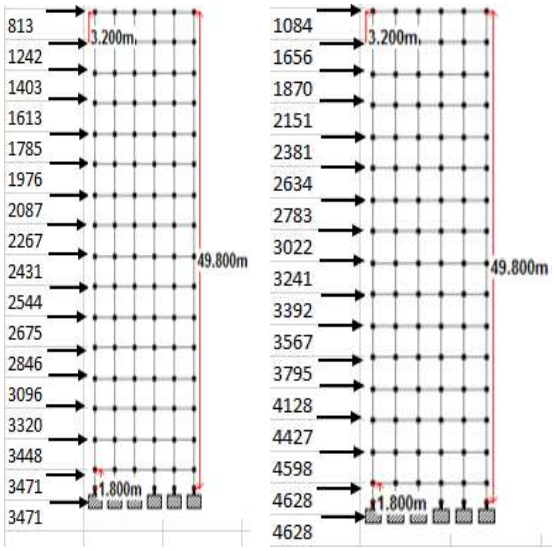

Figure 19: Base shear of G+19 building in X and Z direction in zone IV and V.

3.4 G+19 Storey Building with seismic zone IV and V

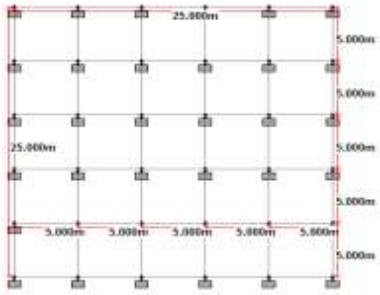

Figure 20: Planning of G+19 building

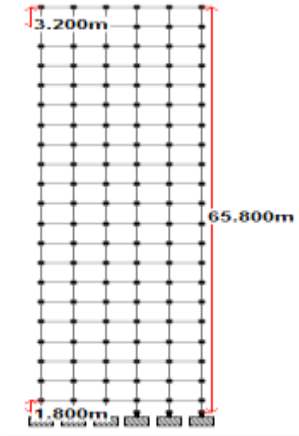

Figure 21: Elevation of G+19 building

Table 9: Result for G+19 building

Description	*Zone IV*	*Zone V*
Zone factor	0.24	0.36
Yield strength of distribution bar (f_y sec)	Fe-500	Fe-500
Yield strength of main bar (f_y main)	Fe-500	Fe-500
Grade of concrete	30	30
Fundamental natural period	1.1844	1.1844
Peak storey shear (kN)	3607	4954
Base shear (kN)	6972	9536
Lateral Displacement (cm)	13.158	19.171
Story drift (cm)	0.8806	1.2823

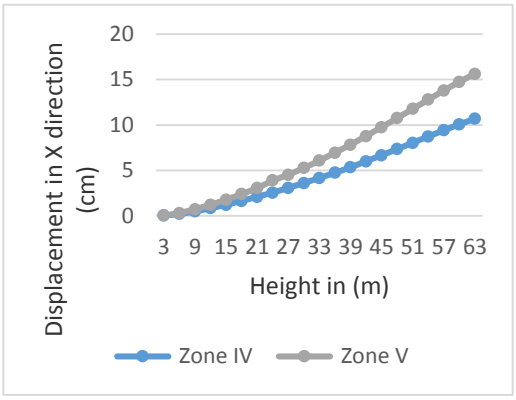

Figure 22: Lateral displacement of G+19 building in X direction in zone IV and V.

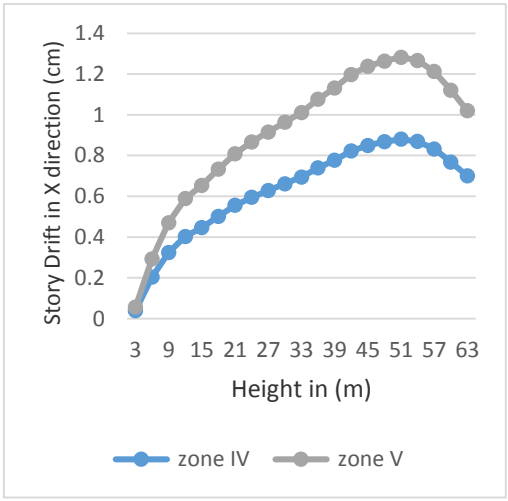

Figure 23: Story drift of G+19 building in X direction in zone IV and V.

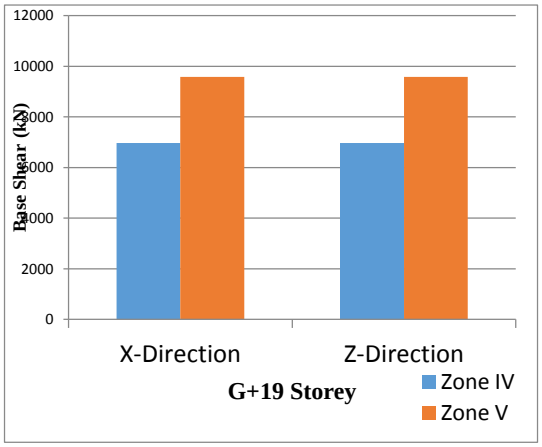

Figure 24: Base shear of G+19 building in X and Z direction in zone IV and V.

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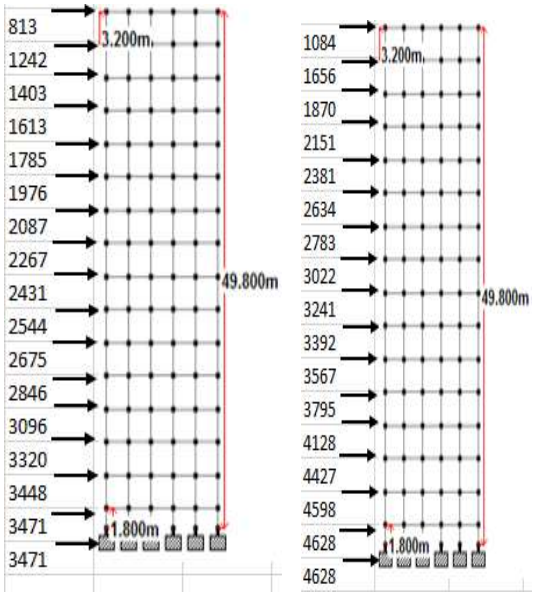

Figure 25: Base shear of G+19 building in X and Z direction in zone IV and V.

3.5 G+24 Storey Building with seismic zone IV and V

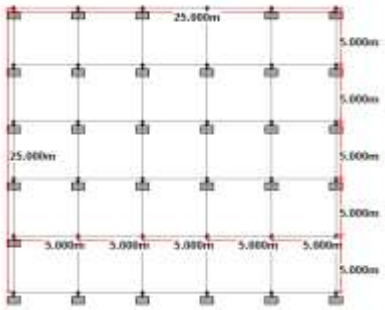

Figure 26: Planning of G+24 building

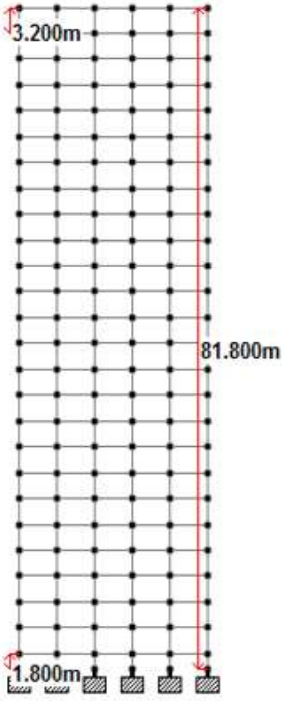

Figure 27: Elevation of G+24 building

Table 10: Result for G+24 building

Description	*Zone IV*	*Zone V*
Zone factor	0.24	0.36
Yield strength of distribution bar (f_y sec)	Fe-500	Fe-500
Yield strength of main bar (f_y main)	Fe-500	Fe-500
Grade of concrete	30	30
Fundamental natural period	1.4724	1.4724
Peak storey shear (kN)	4524	5865
Base shear (kN)	7543	9778
Lateral Displacement (cm)	12.230	15.854
Story drift (cm)	0.7426	0.9626

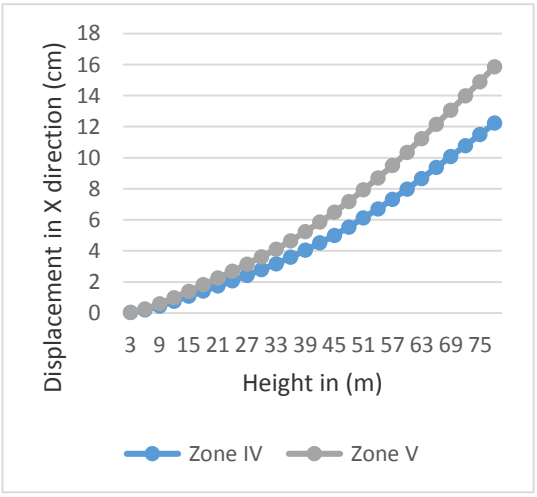

Figure 28: Lateral displacement of G+24 building in X direction in zone IV and V.

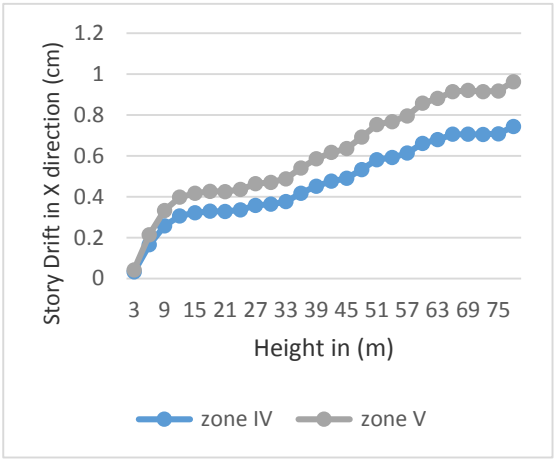

Figure 29: Story drift of G+24 building in X direction in zone IV and V.

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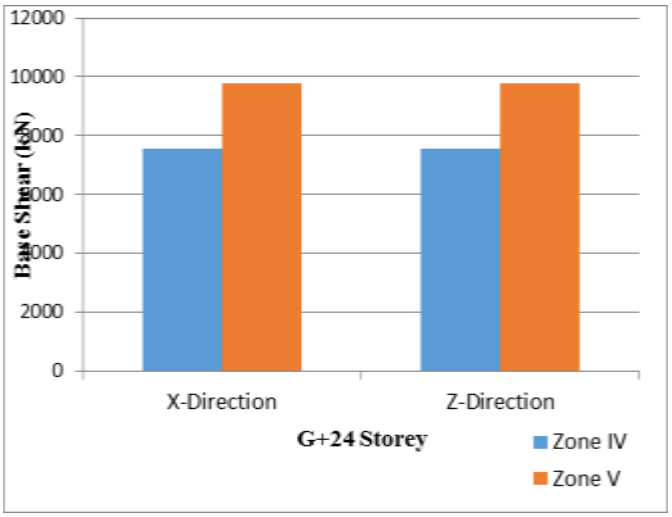

Figure 30: Base shear of G+24 building in X and Z direction in zone IV and V.

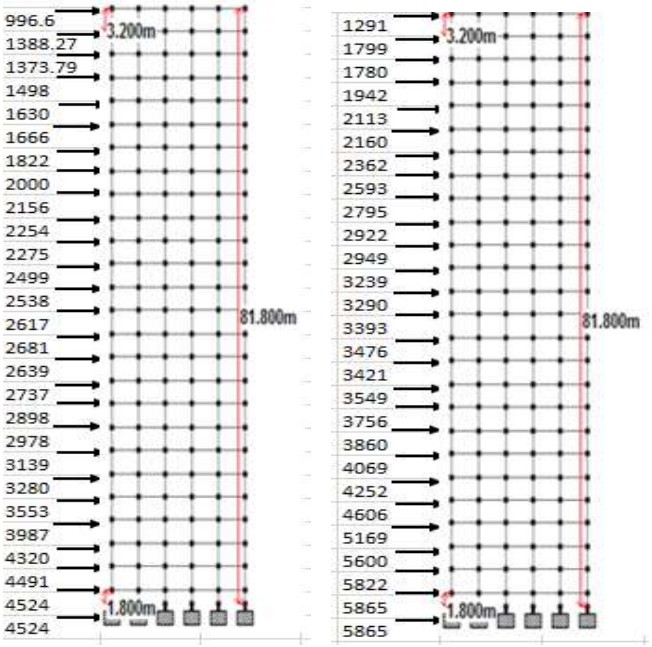

Figure 31: Base shear of G+24 building in X and Z direction in zone IV and V.

3.6 Fundamental natural period

Fundamental natural period is same for x and Z direction due to same size of length.

Table 5.1: Fundamental natural period in X and Z direction.

Description	*Height*	*X and Z direction length*	*Fundamental natural period*
G+4	17.8	25	0.3204
G+9	33.8	25	0.6084
G+14	49.8	25	0.8964
G+19	65.8	25	1.1844
G+24	81.8	25	1.4724

4. Discussion

4.1 Lateral Displacement in Zone IV

a) Maximum lateral displacement of G+4 building in X and Z direction in zone IV is 3.402 cm.
b) Maximum lateral displacement of G+9 building in X and Z direction in zone IV is 7.4885 cm.
c) Maximum lateral displacement of G+14 building in X and Z direction in zone IV is 9.867 cm.
d) Maximum lateral displacement of G+19 building in X and Z direction in zone IV is 13.1588 cm.
e) Maximum lateral displacement of G+24 building in X and Z direction in zone IV is 12.2308 cm.

Lateral Displacement in Zone V

a) Maximum lateral displacement of G+4 building in X and Z direction in zone V is 4.0712 cm.
b) Maximum lateral displacement of G+9 building in X and Z direction in zone V is 11.232 cm.
c) Maximum lateral displacement of G+14 building in X and Z direction in zone V is 14.8 cm.
d) Maximum lateral displacement of G+19 building in X and Z direction in zone V is 19.1713 cm.
e) Maximum lateral displacement of G+24 building in X and Z direction in zone V is 15.8548 cm.

4.2 Storey Drift in Zone IV

a) Maximum story drift of G+4 building in X and Z direction in zone IV is 0.797 cm.
b) Maximum story drift of G+9 building in X and Z direction in zone IV is 1.008 cm.
c) Maximum story drift of G+14 building in X and Z X direction in zone IV is 0.7891cm.
d) Maximum story drift of G+19 building in X and Z X direction in zone IV is 0.8806 cm.
e) Maximum story drift of G+24 building in X and Z direction in zone IV is 0.7426 cm.

4.3 Storey Drift in Zone V

a) Maximum story drift of G+4 building in X and Z direction in zone V is 0.9538 cm.
b) Maximum story drift of G+9 building in X and Z direction in zone V is 1.511 cm.
c) Maximum story drift of G+14 building in X and Z direction in zone V is 1.1972 cm.
d) Maximum story drift of G+19 building in X and Z direction in zone V is 1.2823 cm.
e) Maximum story drift of G+24 building in X and Z direction in zone V is 0.9626 cm.

4.4 Base Shear in zone IV

a) Base shear of G+4 building in X and Z direction in Zone IV is 4733.36 kN.
b) Base shear of G+9 building in X and Z direction in Zone IV is 6322 kN.
c) Base shear of G+14 building in X and Z direction in Zone IV is 6194 kN.

d) Base shear of G+19 building in X and Z direction in Zone IV is 6972 kN.
e) Base shear of G+24 building in X and Z direction in Zone IV is 7543 kN.

4.5 Base Shear in zone V

a) Base shear of G+4 building in X and Z direction in Zone V is 5664.89 kN.
b) Base shear of G+9 building in X and Z direction in Zone V is 8128 kN.
c) Base shear of G+14 building in X and Z direction in Zone V is 8259 kN.
d) Base shear of G+19 building in X and Z direction in Zone V is 9536 kN.
e) Base shear of G+24 building in X and Z direction in Zone V is 9778 kN.

4.6 Peak Storey Shear in zone IV

a) Peak storey shear of G+4 building in X and Z direction in Zone IV is 2801 kN.
b) Peak storey shear of G+9 building in X and Z direction in Zone IV is 3478 kN.
c) Peak storey shear of G+14 building in X and direction in Zone IV is 3471 kN.
d) Peak storey shear of G+19 building in X and Z direction in Zone IV is 3607 kN.
e) Peak storey shear of G+24 building in X and Z direction in Zone IV is 4524 kN.

4.7 Peak Storey Shear in zone V

a) Peak storey shear of G+4 building in X and Z direction in Zone V is 3353 kN.
b) Peak storey shear of G+9 building in X and Z direction in Zone V is 4471 kN.
c) Peak storey shear of G+14 building in X and Z direction in Zone V is 4628 kN.
d) Peak storey shear of G+19 building in X and Z direction in Zone V is 4954 kN.
e) Peak storey shear of G+24 building in X and Z direction in Zone V is 5865 kN.

5. Conclusion

Within the scope of present work following conclusion are drawn-

a) Percentage increase in lateral displacement of G+4 building in Zone V is 19.67% when compared with the lateral displacement of same building in zone IV.
b) Lateral displacement of G+9 building in zone V is increased by 49.99% when compared with same building in zone IV.
c) There was 49.99% increase in lateral displacement of G+14 building in zone V when compared with zone IV.
d) Percentage increase in lateral displacement of G+19 building in Zone V is 45.69% when compare with the lateral displacement of same building in zone IV.
e) There was 29.63% increase in lateral displacement of G+24 building in zone V when compared with respect to zone IV.
f) There was 19.67% increase in story drift of G+4 building in zone V when compared with respect to zone IV.
g) Story drift of G+9 building in zone V is increased by 49.99% when compared with same building in zone IV.
h) Percentage increase in story drift of G+14 building in Zone V is 50% when compare with the story drift of same building in zone IV.
i) Story drift of G+19 building in zone V is increased by 45.61% when compared with same building in zone IV.
j) There was 29.62% increase in storey drift of G+24 building in zone V when compared with respect to zone IV.
k) There was 19.67% increase in base shear of G+4 building in zone V when compared with respect to zone IV.
l) Base shear of G+9 building in zone V is increased by 28.56% when compared with same building in zone IV.
m) Percentage increase in base shear of G+14 building in Zone V is 33.33% when compare with the base shear of same building in zone IV.
n) Base shear of G+19 building in zone V is increased by 36.77% when compared with same building in zone IV.
o) There was 29.63% increase in base shear of G+24 building in zone V when compared with respect to zone IV.
p) Peak storey shear of G+4 building in zone V is increased by 19.70% when compared with same building in zone IV.
q) Percentage increase in peak storey shear of G+9 building in Zone V is 28.55% when compare with the peak storey shear of same building in zone IV.
r) There was 33.33% increase in peak storey shear of G+14 building in zone V when compared with respect to zone IV.
s) Peak storey shear of G+19 building in zone V is increased by 37.34% when compared with same building in zone IV.
t) Percentage increase in peak storey shear of G+24 building in Zone V is 29.64% when compare with the peak storey shear of same building in zone IV.

From the following results it is observed that as height increases peak storey shear and base shear increases from seismic zone IV to V. Maximum percentage increase in base shear in X and Z direction for G+19 storey building when analysed in zone V and compared with same building in zone IV is 36.77%, maximum percentage increase in peak storey shear in X and Z direction for G+19 building when analysed in zone V and compared with same building in zone IV is 37.34%, maximum percentage increase in lateral displacement in X and Z direction for G+14 and G+9 building when analysed in zone V and compared with same building in zone IV is 49.99%, maximum percentage increase in story drift in X and Z direction for G+14 building when analysed in zone V and compared with same building in zone IV is 50%.

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APPENDICES

Column Properties

Table 12: Column properties which lie in corners of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Description of floor	*G+24*	*G+19*	*G+14*	*G+9*	*G+4*
F	1.5 x 1.5	1.4 x 1.4	1.3 x 1.3	1.2 x 1.2	1.1 x 1.1
G	1.5 x 1.5	1.4 x 1.4	1.3 x 1.3	1.2 x 1.2	1.1 x 1.1
G+1 to G+3	1.25 x 1.25	1.15 x 1.15	1.05 x 1.05	0.95 x 0.95	0.85 x 0.85
G+4	0.95 x 0.95	0.85 x 0.85	0.75 x 0.75	0.65 x 0.65	0.55 x .55
G+5 to G+9	0.90 x .90	0.80 x 0.80	.70 x .70	.60 x .60	.50 x .50
G+10 to G+11	0.85 x 0.85	0.75 x 0.75	0.65 x 0.65	0.55 x 0.55	
G+12 to G+14	0.8 x 0.8	0.70 x 0.70	0.60 x 0.60		
G+15 to G+19	0.75 x 0.75	0.65 x 0.65			
G+20 to G+24	0.70 x 0.70				

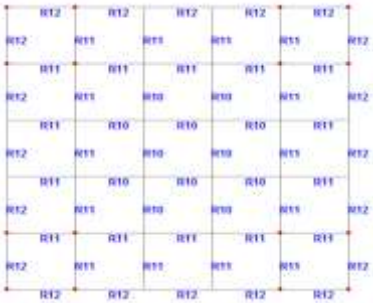

Figure 31: Column orientation which lie in corners of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Table 13: Column properties which lie in middle of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Description of floor	*G+24*	*G+19*	*G+14*	*G+9*	*G+4*
F	1.1 x 1.1	1 x 1	0.95 x 0.95	0.85 x 0.85	0.75 x 0.75
G	1.1 x 1.1	1 x 1	0.95 x 0.95	0.85 x 0.85	0.75 x 0.75
G+1 to G+3	1.05 x 1.05	0.95 x 0.95	0.85 x 0.85	0.75 x 0.75	0.65 x 0.65
G+4	1 x 1	0.90 x 0.90	0.80 x 0.80	0.70 x 0.70	0.60 x 0.60
G+5 to G+9	0.95 x 0.95	0.85 x 0.85	0.75 x 0.75	0.65 x 0.65	0.55 x 0.55
G+10 to G+11	0.9 x 0.9	0.8 x 0.8	0.7 x 0.7	0.6 x 0.6	
G+12 to G+14	0.85 x 0.85	0.75 x 0.75	0.65 x 0.65		
G+15 to G+19	0.8 x 0.8	0.7 x 0.7			
G+20 to G+24	0.75 x 0.75				

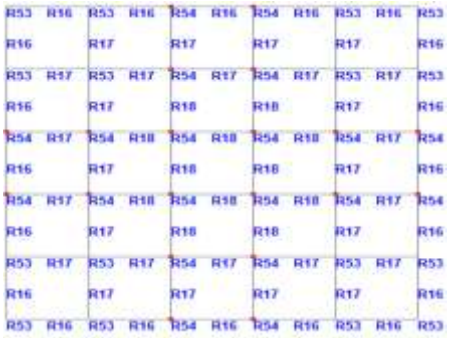

Figure 32: Column orientation which lie in middle of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Beam Properties

Table 14: Beam properties which lie in corners of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Description of floor	*G+24*	*G+19*	*G+14*	*G+9*	*G+4*
P.B	0.85 x 0.23	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23
G to G+1	0.85 x 0.23	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23
G+2 to G+3	0.8 x 0.23	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23	0.40 x 0.23
G+4	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23	0.35 x 0.23
G+5	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23	
G+6 to G+7	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23	0.40 x 0.23	
G+8 to G+9	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23	0.35 x 0.23	
G+10 to G+11	0.60 x 0.23	0.50 x 0.23	0.40 x 0.23		
G+12 to G+13	0.55 x 0.23	0.45 x 0.23	0.35 x 0.23		
G+14	0.50 x 0.23	0.40 x 0.23	0.30 x 0.23		
G+15	0.50 x 0.23	0.40 x 0.23			
G+16 to G+17	0.45 x 0.23	0.35 x 0.23			

G+18 to G+19	0.40 x 0.23	0.30 x 0.23			
G+20 to G+21	0.35 x 0.23				
G+22 to G+23	0.30 x 0.23				
G+24	0.25 x 0.23				

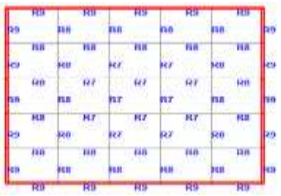

Figure 33: Beam orientation which lie in corner of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Table 15: Beam properties which lie in middle of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Description of floor	*25 storey*	*20 storey*	*15 storey*	*10 storey*	*5 storey*
P.B	0.90 x 0.23	0.80 x 0.23	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23
G to G+1	0.90 x 0.23	0.80 x 0.23	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23
G+2 to G+3	0.85 x 0.23	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23
G+4	0.80 x 0.23	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23	0.40 x 0.23
G+5	0.80 x 0.23	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23	
G+6 to G+7	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23	
G+8 to G+9	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23	0.40 x 0.23	
G+10 to G+11	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23		
G+12 to G+13	0.60 x 0.23	0.50 x 0.23	0.40 x 0.23		
G+14	0.55 x 0.23	0.45 x 0.23	0.35 x 0.23		
G+15	0.55 x 0.23	0.45 x 0.23			
G+16 to G+17	0.50 x 0.23	0.40 x 0.23			
G+18 to G+19	0.45 x 0.23	0.35 x 0.23			
G+20 to G+21	0.40 x 0.23				
G+22 to G+23	0.35 x 0.23				
G+24	0.30 x 0.23				

Figure 34: Beam orientation which lie in middle of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Table 16: Beam properties which lie in middle portion of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V

Description of floor	*25 storey*	*20 storey*	*15 storey*	*10 storey*	*5 storey*
P.B	0.95 x 0.23	0.85 x 0.23	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23
G to G+1	0.95 x 0.23	0.85 x 0.23	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23
G+2 to G+3	0.90 x 0.23	0.80 x 0.23	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23
G+4	0.85 x 0.23	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	0.35 x 0.23
G+5	0.85 x 0.23	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	
G+6 to G+7	0.80 x 0.23	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23	
G+8 to G+9	0.75 x 0.23	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23	
G+10 to G+11	0.70 x 0.23	0.60 x 0.23	0.50 x 0.23		
G+12 to G+13	0.65 x 0.23	0.55 x 0.23	0.45 x 0.23		
G+14	0.60 x 0.23	0.50 x 0.23	0.40 x 0.23		
G+15	0.60 x 0.23	0.50 x 0.23			

G+16 to G+17	0.55 x 0.23	0.45 x 0.23			
G+18 to G+19	0.50 x 0.23	0.40 x 0.23			
G+20 to G+21	0.45 x 0.23				
G+22 to G+23	0.40 x 0.23				
G+24	0.35 x 0.23				

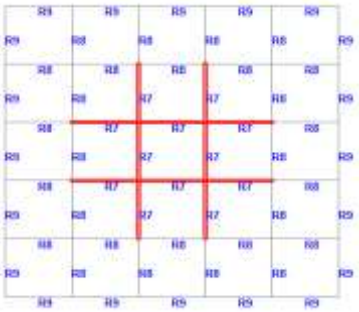

Figure 35: Beam orientation which lie in middle portion of G+4, G+9 G+14, G+19 and G+24 in Zone IV and V