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ANALYSIS OF TRIANGULAR TOWER ON BUILDING SUBJECTED TO SEISMIC LOADS WITH DIFFERENT POSITIONS

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Abstract: **In urban areas, the scarcity of land is a serious issue now a days with increasing the population count. It is well known fact that if the population count increases, the networking between them is also increases. Since the area of lant is less for telecommunication tower, the companies are now installing it on the roof of the multistory building to continue their supply. In this work, it has shown that the response of the triangular tower located at G+6 and G+10 storied building. Total 10 models were taken and studied for different parameters and most efficient model is selected which has least parametric values among all by the help of Staad pro**.

Keywords: **Rooftop Telecommunication Tower, Square base, Seismic Effects, Response spectrum, Staad pro.**

I. INTRODUCTION

Telecommunication towers made up of steel angle sections used to fix the anteena along with all the fixtures used in mobile communication at an optimum location and bear the load of the same and transfer it to the ground. The members of the tower transfer the loads from its intermediate members. The main approach is to transfer the total load of the telecommunication tower to the roof of the multistoried structure. The structure then transfer the upcoming load from beam column arrangement to the foundation. The main criteria in this approach is the position of tower on the roof such that the structure will not get much effect from the load of telecommunication tower. If the extra load bearing members was provided in the structure to transfer the load, it was provided only to support the self load of the structure. The position of tower will affect if there was not any of this structural member present beneath. The tower bracings are also affect the structure such that load coming from the tower might be different. X bracing and Chevron type bracings are the most common one used in telecommunication tower.

II. OBJECTIVE

This study examines different parameters like displacement, moments, stresses, shear and axial forces. The telecommunication tower is placed on roof of a building at different locations, at medium soil condition under seismic forces for earthquake zone IV.

III. STRUCTURE MODELING

The space frame has been modeled in Staad pro software. The descriptions of the host structure and tower are listed in Table 1 and details of loading used in this work listed in Table 2. The connections assumed to be rigid at base for host structure and also for triangular base tower. The arrangement idealization of triangular base tower is shown in Figure 1; Figure 2 shows different locations of triangular tower on roof respectively to show the various parametric analysis.

Table 1: Details of building & triangular base rooftop tower

Building configuration	G + 6 & G + 10
Height of building	28.62m and 43.26 m
Dimensions of building	15 m x 9 m
Size of beam	400 mm x 300 mm
Size of column	450 mm x 450 mm
Concrete and Steel Grade	M25 & Fe 415 grade
Height of tower (square base)	15 m
Effective base width (square base)	3m wide
Panel height (square base)	1.5 m long
Horizontal and vertical steel members	ISA 110 x 110 x 8
Inclined members	ISA 90 x 90 x 12

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Table 2: Details of loading

Earthquake parameters	Zone IV with RF 5 & 5% damping ratio
Period in X & Z direction	1.2978 & 1.0052 seconds
Dead load for floor and roof	12 KN/m^2 & 10 KN/m^2
Live load for floor and roof	4 KN/m^2 & 2 KN/m^2

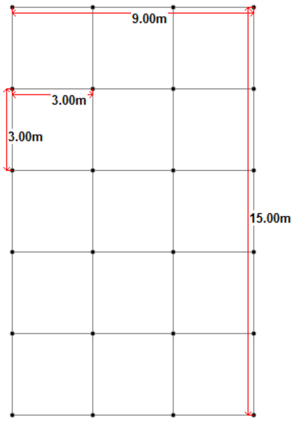

Figure 1: Plan Model -1 & 6

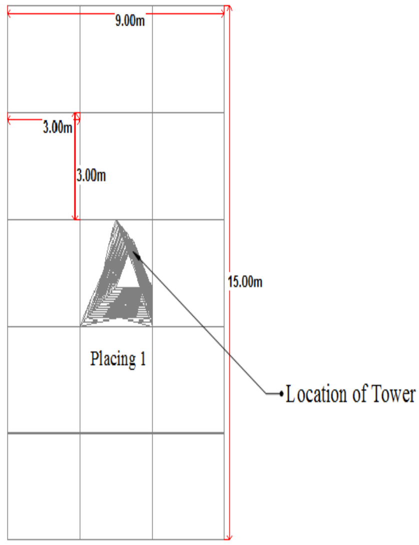

Figure 2: Plan Model -2 & 7

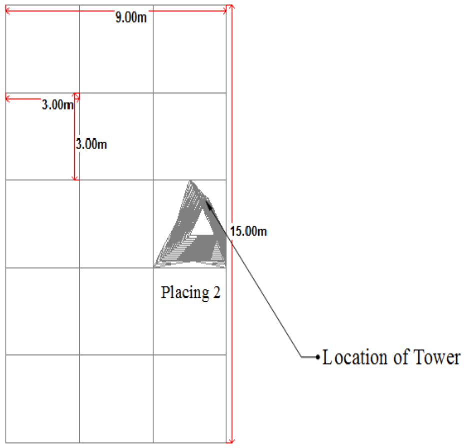

Figure 3: Plan Model -3 & 8

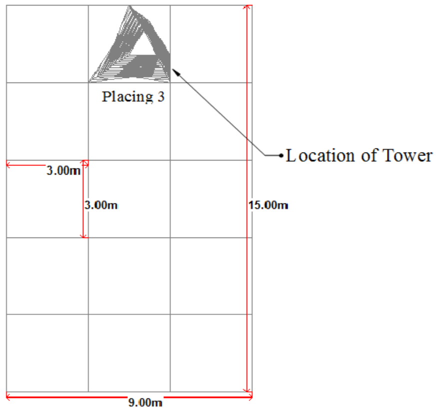

Figure 4: Plan Model -4 & 9

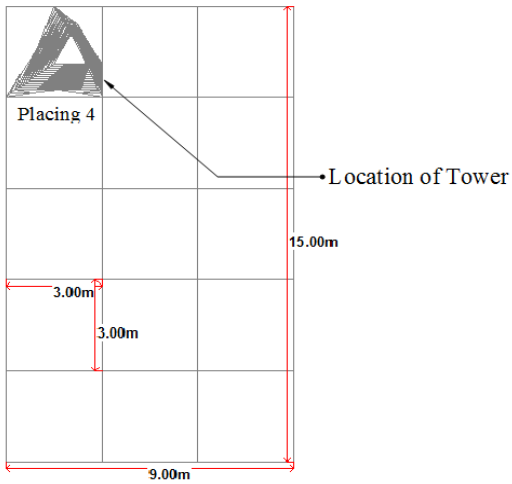

Figure 5: Plan Model -5 & 10

IV. RESULTS AND DISCUSSION

As per the objectives, the Response Spectrum Analysis has been performed on different models consist of placing without tower (G+6) model, placing with tower (G+6) all models, placing without tower (G+10) model and placing with

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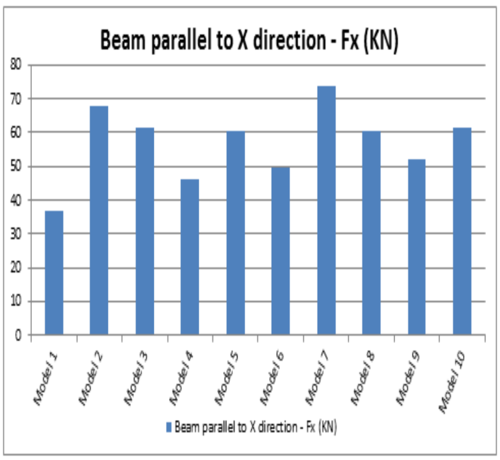
tower (G+10) all models for different location of telecommunication tower on roof are assessed for building areas which is situated in earthquake zones i.e. Zone IV.

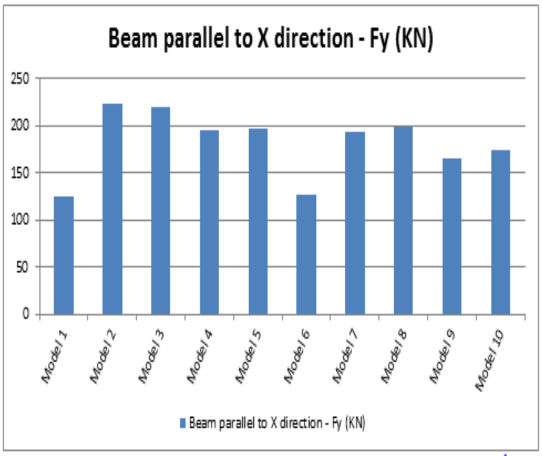
The analysis results obtained using Staad pro software is shown in tabular form along with various graphs with various parameters as follows:

Table 3: Shear Forces and Moments in Building (Beam Parallel to X direction) for different Models

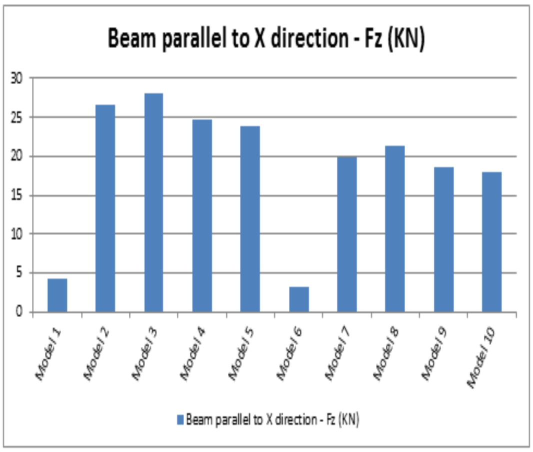
Different models		For Buildings				
		Beam parallel to X direction				
		Fx (KN)	**Fy (KN)**	**Fz (KN)**	**My (KNm)**	**Mz (KNm)**
G+6	**Model 1**	36.834	124.338	4.247	6.397	138.47
	Model 2	67.966	223.529	26.626	22.849	179.593
	Model 3	61.691	220.170	28.168	21.459	169.995
	Model 4	46.199	195.321	24.742	22.466	162.214
	Model 5	60.439	197.946	23.795	22.064	164.105
G+10	**Model 6**	49.545	127.195	3.233	4.880	145.962
	Model 7	74.022	193.269	19.898	16.828	155.811
	Model 8	60.353	199.450	21.418	16.269	147.713
	Model 9	52.086	164.852	18.510	16.575	150.741
	Model 10	61.583	174.473	17.941	16.344	147.873

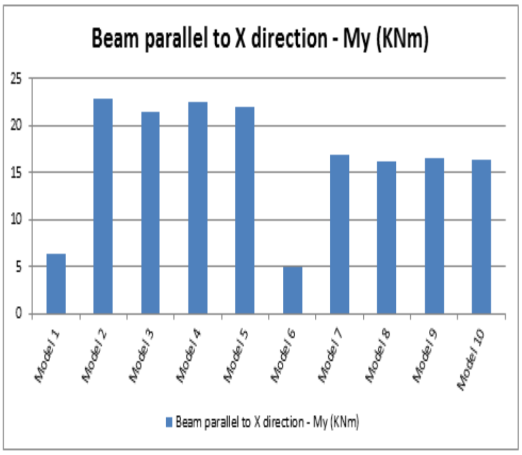
Minimum value of shear forces and moment when beams are parallel to X direction seems to be in model 4 in G+6 storey building and model 9 in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.



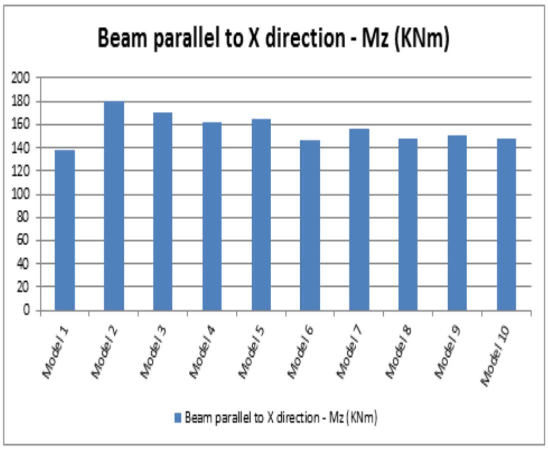


Graph 1: Graphical representation of Shear Forces (Fx
Graph 2: Graphical representation of Shear Forces (Fy)





Graph 3: Graphical representation of Shear Forces (Fz)
Graph 4: Graphical representation of Moment (My)

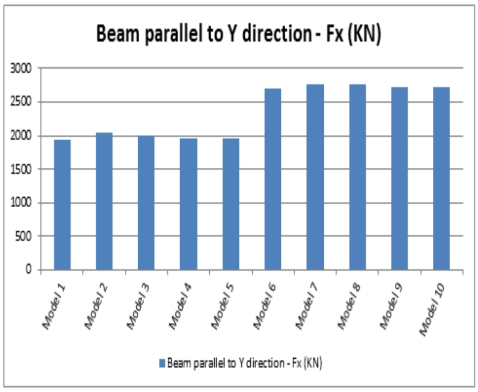


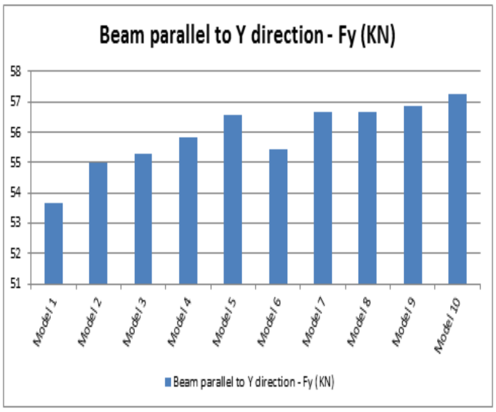
Graph 5: Graphical representation of Moments (Mz)

Table 4: Shear Forces and Moments in Building (Beam Parallel to Y direction) for different Models

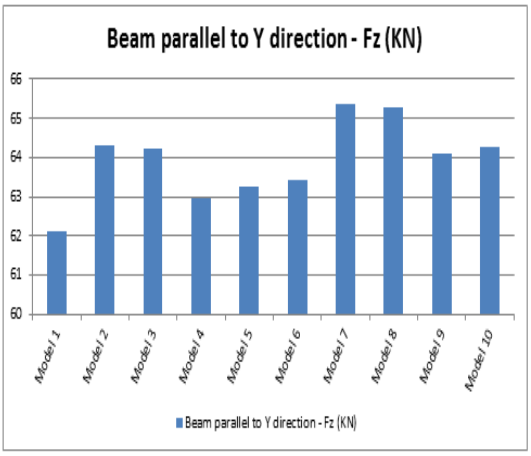
Different models		For Buildings				
		Beam parallel to Y direction				
		Fx (KN)	Fy (KN)	Fz (KN)	My (KN m)	Mz (KN m)
G+6	Model 1	1930.154	53.671	62.134	117.158	99.601
	Model 2	2043.435	55.001	64.297	120.067	105.143
	Model 3	2008.606	55.309	64.232	120.620	124.323
	Model 4	1952.751	55.848	62.971	118.781	104.383
	Model 5	1953.293	56.581	63.265	119.351	113.938
G+10	Model 6	2699.864	55.439	63.441	116.689	101.517
	Model 7	2776.011	56.666	65.35	120.235	106.038
	Model 8	2764.260	56.66	65.279	120.087	122.485
	Model 9	2728.62	56.878	64.088	117.874	104.123
	Model 10	2730.72	57.238	64.286	118.234	107.365

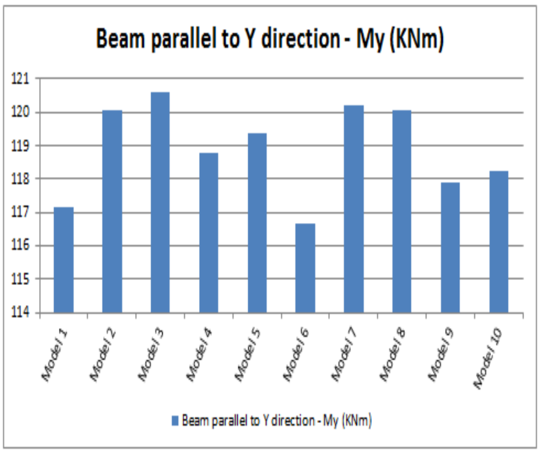
Minimum value of shear forces and moment when beams are parallel to Y direction seems to be in model 4 in G+6 storey building and model 9 in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.





Graph 6: Graphical representation of Shear Forces (Fx)
Graph 7: Graphical representation of Shear Force (Fy)





Graph 8: Graphical representation of Shear Forces (Fz)
Graph 9: Graphical representation of Moments (My)

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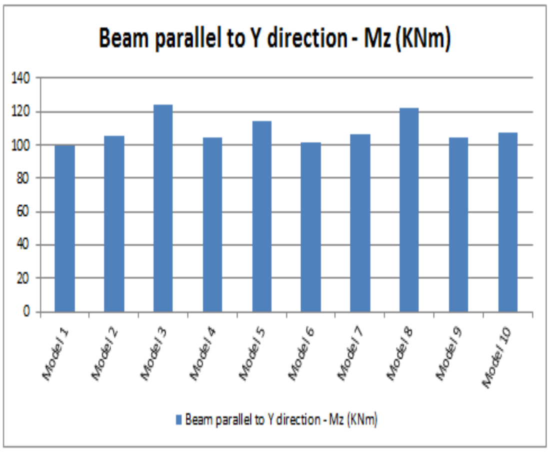
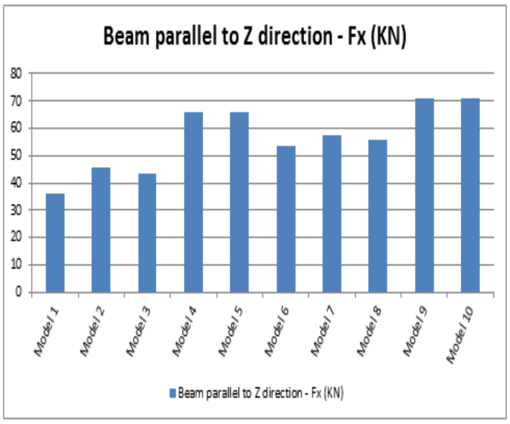


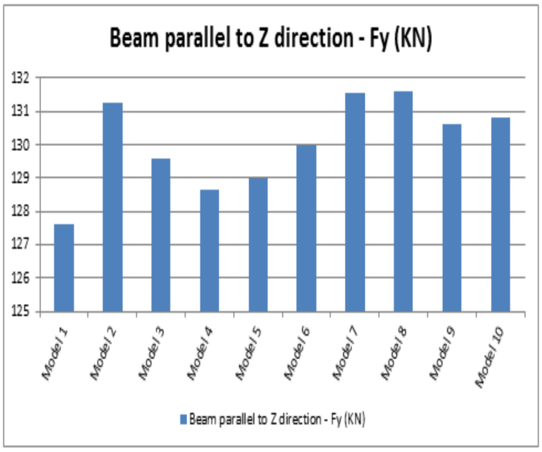
Graph 10: Graphical representation of Moments (Mz)

Table 5: Shear Forces and Moments in Building (Beam Parallel to Z direction) for different Models

Different models		**For Buildings**				
		Beam parallel to Z direction				
		Fx (KN)	**Fy (KN)**	**Fz (KN)**	**My (KNm)**	**Mz (KNm)**
G+6	**Model 1**	36.078	127.637	4.115	6.380	152.851
	Model 2	45.447	131.281	7.327	12.402	155.784
	Model 3	43.166	129.570	6.596	11.595	156.017
	Model 4	65.881	128.642	8.663	15.024	154.438
	Model 5	65.953	129.002	9.243	14.357	155.004
G+10	**Model 6**	53.311	129.973	3.090	4.799	156.557
	Model 7	57.558	131.537	5.526	9.324	159.099
	Model 8	55.925	131.612	5.242	9.102	159.187
	Model 9	71.124	130.597	6.698	11.254	157.599
	Model 10	70.885	130.820	7.390	11.697	157.911

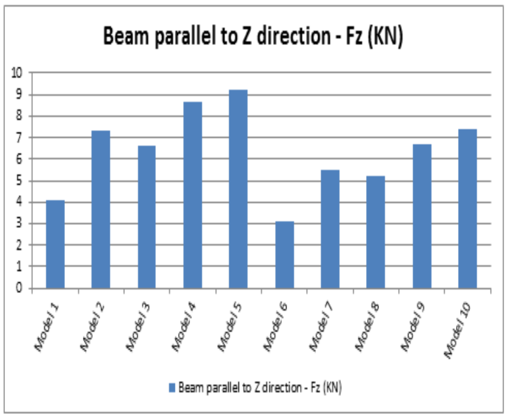
Minimum value of shear forces and moment when beams are parallel to Z direction seems to be in model 4 in G+6 storey building and model 9 in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.

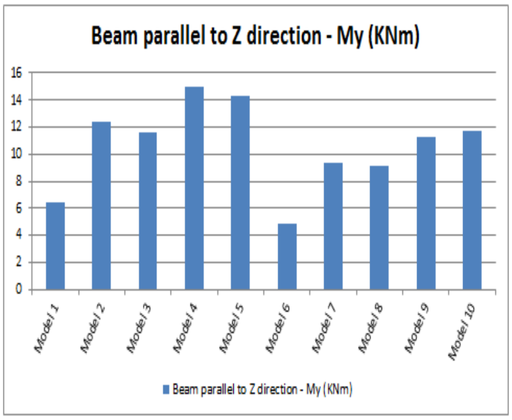




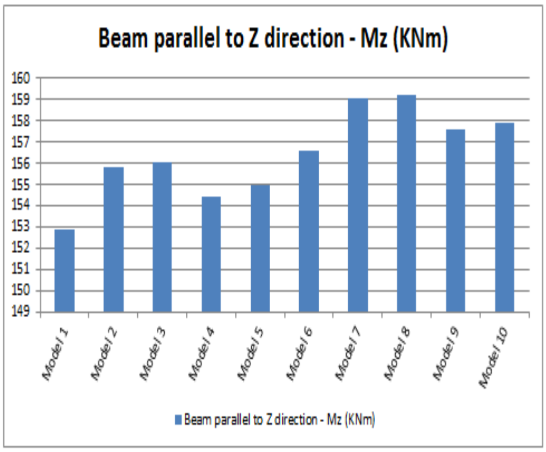
Graph 11: Graphical representation of Shear Forces (Fx) in Building (Beam Parallel to Z direction) for different Models

Graph 12: Graphical representation of Shear Forcess (Fy) in Building (Beam Parallel to Z direction) for different Models





Graph 13: Graphical representation of Shear Forces (Fy)
Graph 14: Graphical representation of Moments (My)

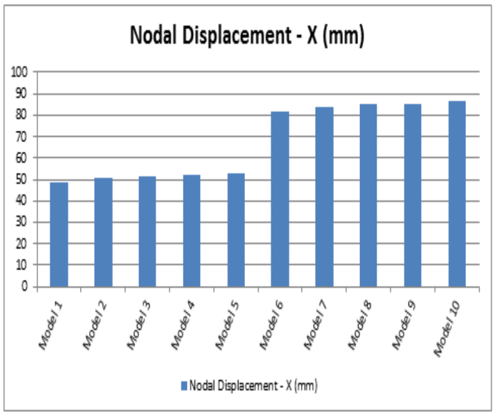


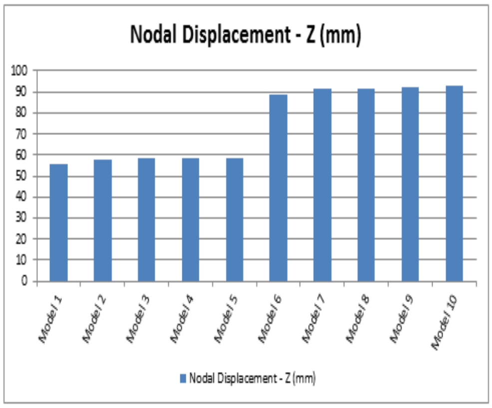
Graph 15: Graphical representation of Moments (Mz)

Table 6: Nodal displacement in Building (X and Z direction) for different Models

Different models		For Buildings	
		Nodal Displacement in different directions	
		X (mm)	Z (mm)
G+6	Model 1	48.541	55.522
	Model 2	50.890	57.965
	Model 3	51.379	58.287
	Model 4	51.895	58.341
	Model 5	52.653	58.804
G+10	Model 6	81.399	89.027
	Model 7	83.878	91.363
	Model 8	85.033	91.772
	Model 9	85.258	92.295
	Model 10	86.790	92.737

Minimum value of nodal displacement seems to be in model 2 for both X and Z direction in G+6 storey building and model 7 in G+10 storey building. Hence by observing this least values, model 2 and 7 should be preferred.



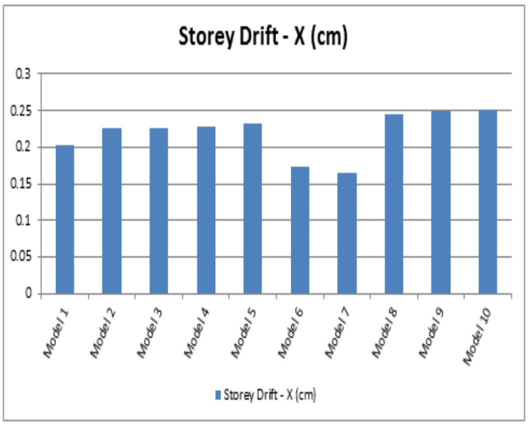


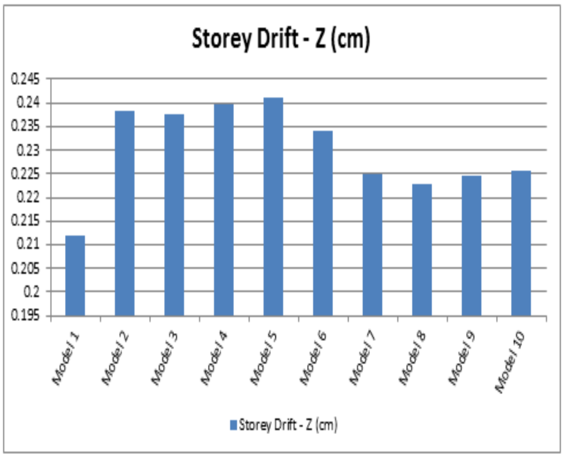
Graph 17: Nodal Displacement in Building (in Z-direction)
Graph 16: Nodal Displacement in Building (in X-direction)

Table 7: Storey Drift in Building (X and Z direction) for different Models

Different models		For Buildings	
		Storey Drift	
		X (cm)	Z (cm)
G+6	Model 1	0.2031	0.2119
	Model 2	0.2261	0.2384
	Model 3	0.2268	0.2375
	Model 4	0.2286	0.2398
	Model 5	0.2316	0.2410
G+10	Model 6	0.1728	0.2340
	Model 7	0.1649	0.2250
	Model 8	0.2446	0.2227
	Model 9	0.2486	0.2245
	Model 10	0.2507	0.2258

Minimum value of storey drift seems to be in model 2 for both X and Z direction in G+6 storey building and model 7 in G+10 storey building. Hence by observing this least values, model 2 and 7 should be preferred.



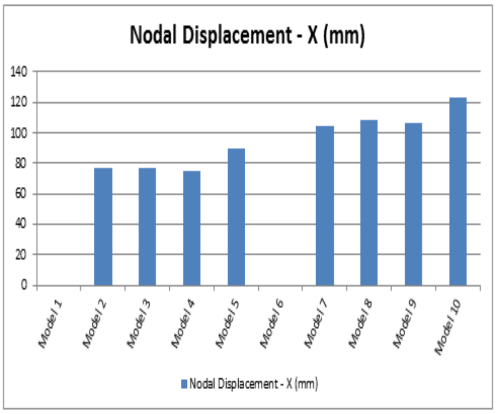


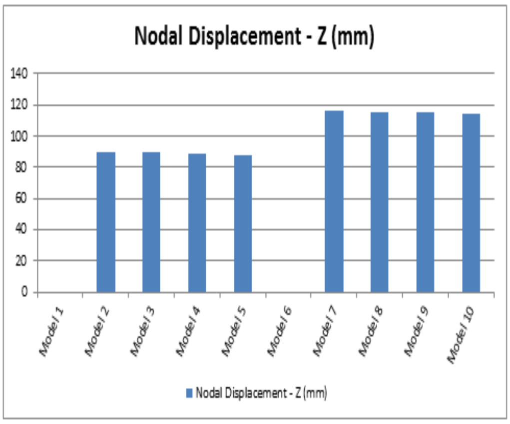
Graph 18: Storey Drift in Building (in X-direction)
Graph 19: Storey Drift in Building (in Z-direction)

Table 8: Nodal displacement (X and Z direction) and Axial Forces (Compressive and Tensile) in Tower for different Models

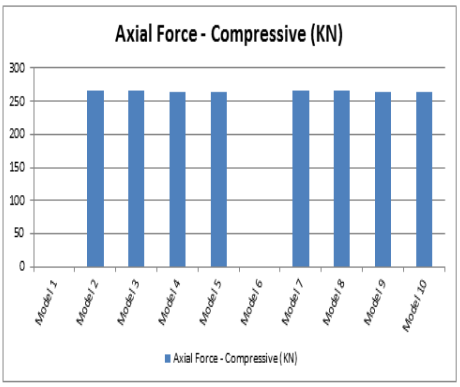
Different models		For Towers			
		Nodal Displacement		Axial Force	
		X (mm)	Z (mm)	Compressive (KN)	Tensile (KN)
G+6	Model 1	-	-	-	-
	Model 2	76.893	89.345	265.449	265.151
	Model 3	76.734	89.633	265.673	265.375
	Model 4	74.582	88.341	264.932	326.634
	Model 5	89.565	88.089	265.098	264.800
G+10	Model 6	-	-	-	-
	Model 7	104.893	116.345	265.461	225.661
	Model 8	108.842	115.687	265.679	225.627
	Model 9	106.857	115.600	264.943	224.679
	Model 10	123.619	114.089	265.104	224.866

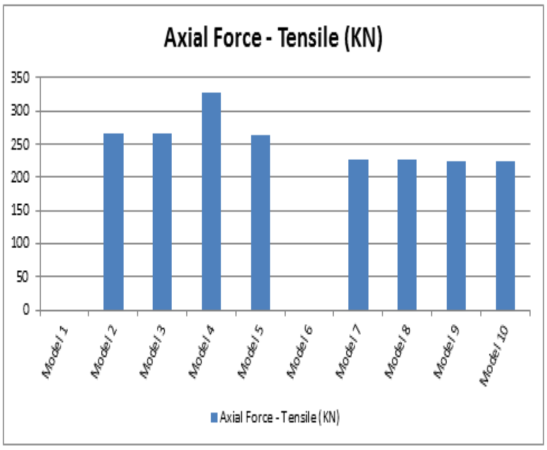
Minimum value of nodal displacement and axial forces in steel tower seems to be in model 4 and 9 for both X and Z direction in G+6 and in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.





Graph 20: Nodal Displacement in Tower
Graph 21: Nodal Displacement in Tower





Graph 22: Axial Forces in Tower (Compressive)
Graph 23: Axial Forces in Tower(Tensile)

V. CONCLUSIONS

1. It is found that when determining shear forces Fx, Fy and Fz for building when beam parallel to X direction, other than model 1 and 6 which is structure without tower, the value of Fx, Fy and Fz has seems to be least in model 4 and model 9. When determining moments My and Mz when beam parallel to X direction, other than model 1 and 6 which is structure without tower, model 3 and model 8 expresses the least values.
2. For building when obtaining shear forces Fx, Fy and Fz when beam parallel to Y direction, other than model without tower, the value of Fx, Fy and Fz has seems to be least in model 4 and model 9. When determining moments My and Mz when beam parallel to Y direction, other than model without tower, again model 4 and model 9 expresses the least values.
3. When analyzing shear forces Fx, Fy and Fz when beam parallel to Z direction for building other than model without tower, the value of Fx, Fy and Fz has seems to be least in model 3 and 8 for Fx and Fz, model 4 and 9 for Fy. When determining moments My and Mz when beam parallel to Z direction, other than model without tower, again model 4 and 9 expresses the least values for Mz model 3 and 8 for My.
4. Nodal displacement for building seems to be least in model 2 and 7 for X and Z direction and for story drift, model 3 and 8 shows least values among all tower placings.
5. Nodal displacement for tower shows the least values for model 4 and 9 for X direction, since the unit values are very less; model 4 and 9 again shows the least values for Z direction. Axial forces in compression obtained a least value for model 4 and 9 and the same model shows least values in tension.
6. Hence best suitable location of tower by considering different result parameters seems to be tower at center of short size of the building roof i.e. model 4 for G+6 storey building and model 9 for G+10 storey building.

VI. ACKNOWLEDGEMENT

We do extremely thankful and respectful to our mentor ***Prof. GajendraVerma***, Assistant Professor, Department ofCivil Engineering, Sri Aurobindo Institute of Technology, Indore (M. P.); that he always points to critical insights during the entire work, guides us, helps us discover the fun of devising the state of the art solutions.

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