



IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY



VOLUME : 4 ISSUE : 12 Print / Issue Publication Date: 10-Jun-2020



ISSN : 2455-2143



DOI : 10.33564/IJEAST.2020.v04i12.116

Indexed In



WWW.IJEAST.COM

editor@ijeast.com



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

Siddharth Pastariya
 Department of Civil Engineering
 Sri Aurobindo Institute of Technology Indore, M.P, India

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 land 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 antenna 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

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

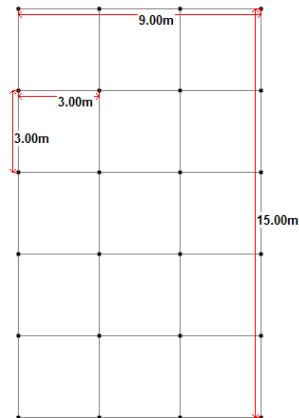


Figure 1: Plan Model -1 & 6

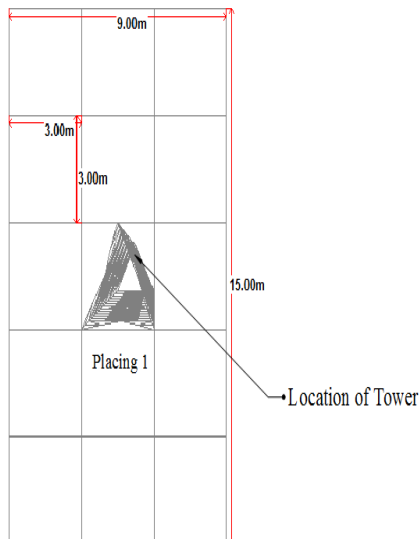


Figure 2: Plan Model -2 & 7

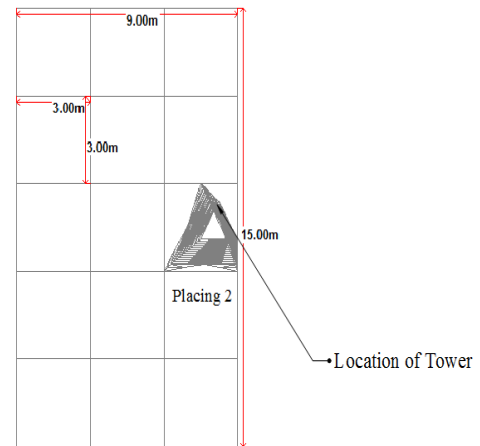


Figure 3: Plan Model -3 & 8

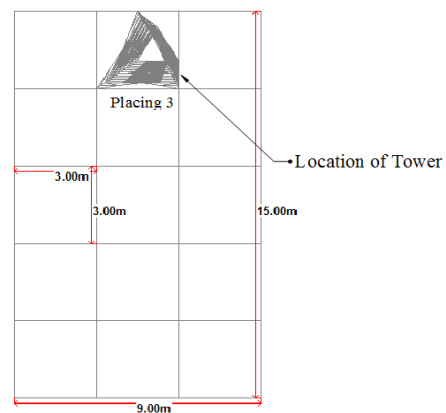


Figure 4: Plan Model -4 & 9

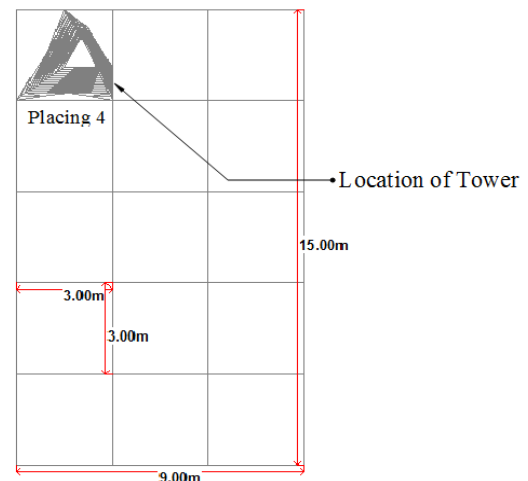


Figure 5: Plan Model -5 & 10

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

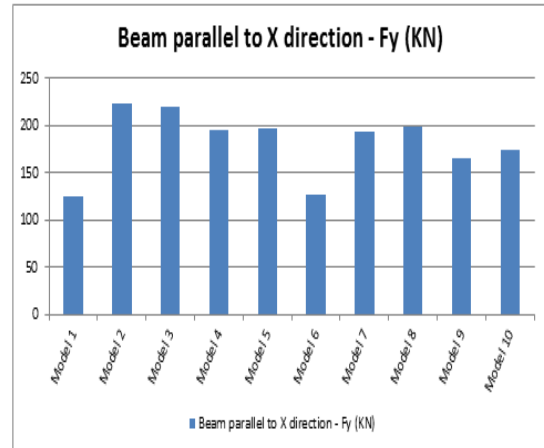
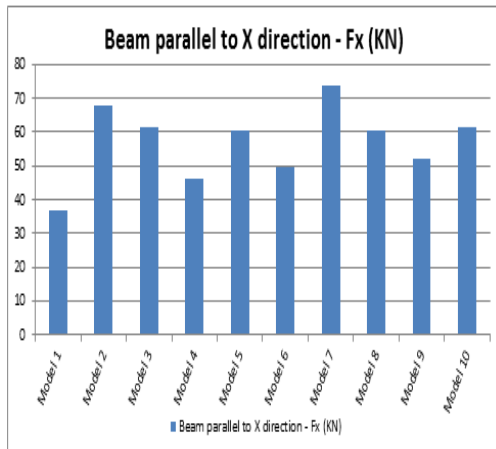
tower (G+10) all models for different location of telecommunication tower on roof are assessed for building areas which is situated in earthquake zones i.e. Zone IV.

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

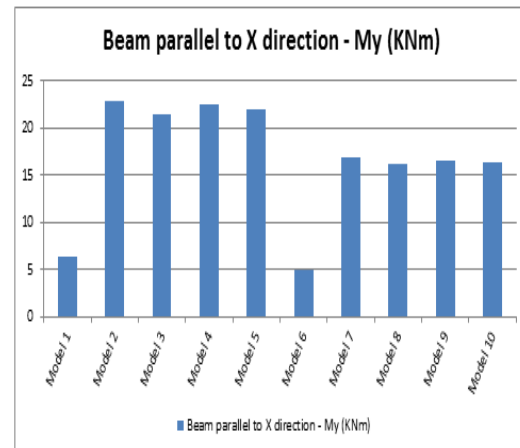
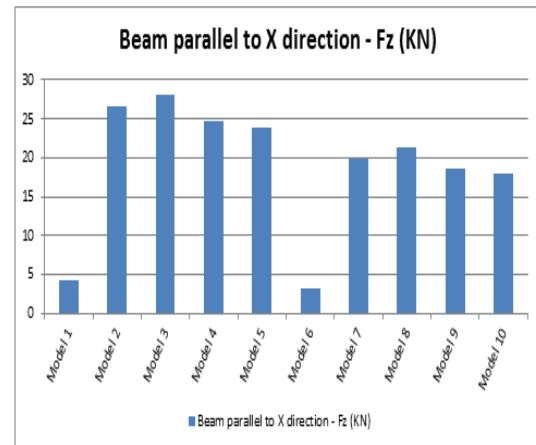
Table 3: Shear Forces and Moments in Building (Beam Parallel to X direction) for different Models

Different models		For Buildings				
		Beam parallel to X direction				
		Fx (KN)	Fy (KN)	Fz (KN)	My (KN m)	Mz (KN m)
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

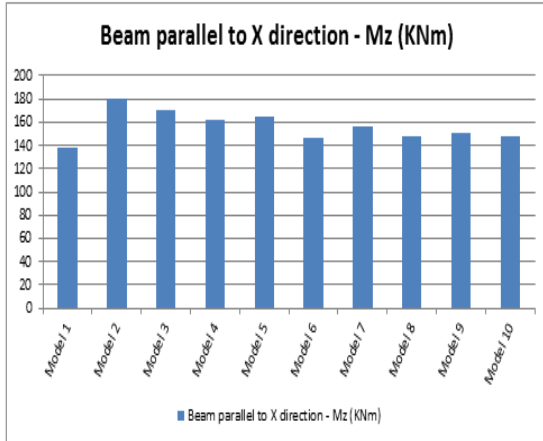
Minimum value of shear forces and moment when beams are parallel to X direction seems to be in model 4 in G+6 storey building and model 9 in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.



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)

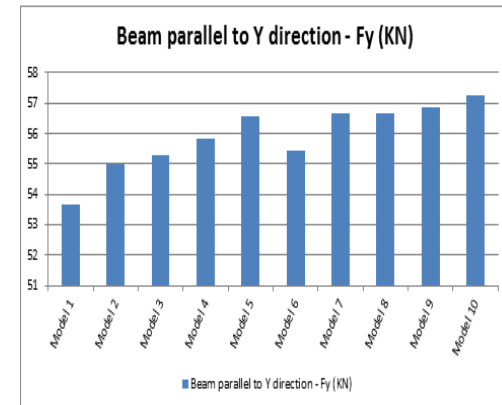
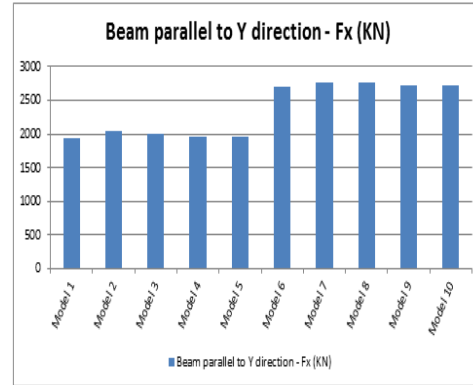


Graph 5: Graphical representation of Moments (Mz)

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

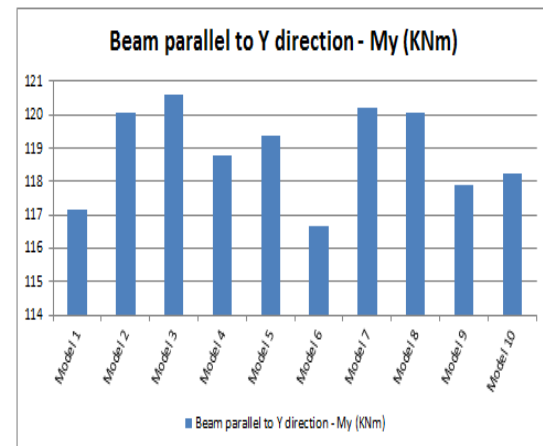
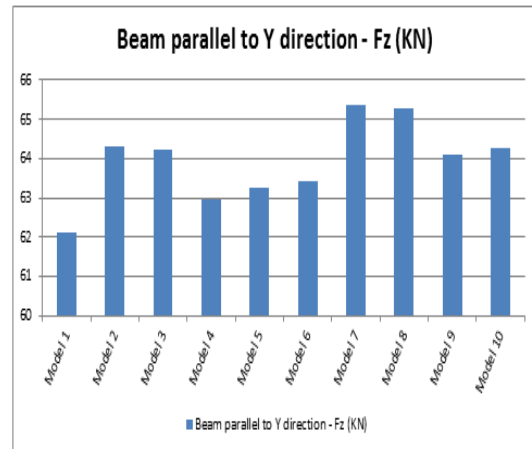
Different models		For Buildings				
		Beam parallel to Y direction				
		Fx (KN)	Fy (KN)	Fz (KN)	My (KN m)	Mz (KN m)
G+ 6	Mode 11	1930	53.6	62.1	117.	99.6
		.154	71	34	158	01
	Mode 12	2043	55.0	64.2	120.	105.
		.435	01	97	067	143
	Mode 13	2008	55.3	64.2	120.	124.
G+ 10		.606	09	32	620	323
	Mode 14	1952	55.8	62.9	118.	104.
		.751	48	71	781	383
	Mode 15	1953	56.5	63.2	119.	113.
		.293	81	65	351	938
G+ 10	Mode 16	2699	55.4	63.4	116.	101.
		.864	39	41	689	517
	Mode 17	2776	56.6	65.3	120.	106.
		.011	66	5	235	038
	Mode 18	2764	56.6	65.2	120.	122.
G+ 10		.260	6	79	087	485
	Mode 19	2728	56.8	64.0	117.	104.
		.62	78	88	874	123
G+ 10	Mode 110	2730	57.2	64.2	118.	107.
		.72	38	86	234	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.



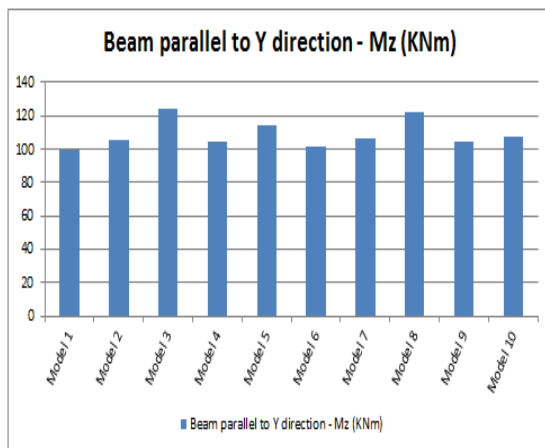
Graph 6: Graphical representation of Shear Forces (Fx)

Graph 7: Graphical representation of Shear Force (Fy)



Graph 8: Graphical representation of Shear Forces (Fz)

Graph 9: Graphical representation of Moments (My)

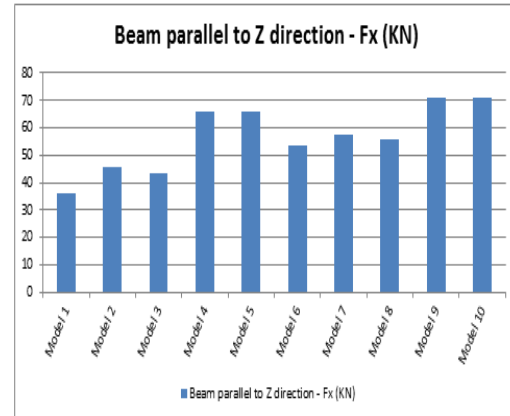


Graph 10: Graphical representation of Moments (Mz)

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

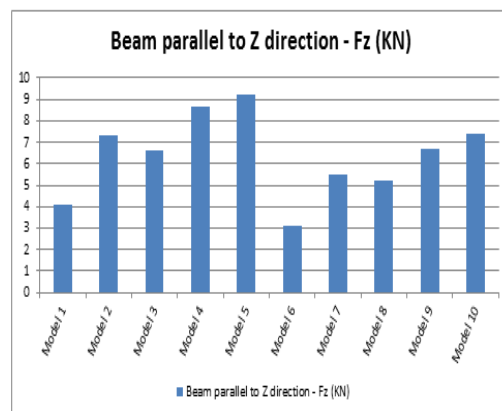
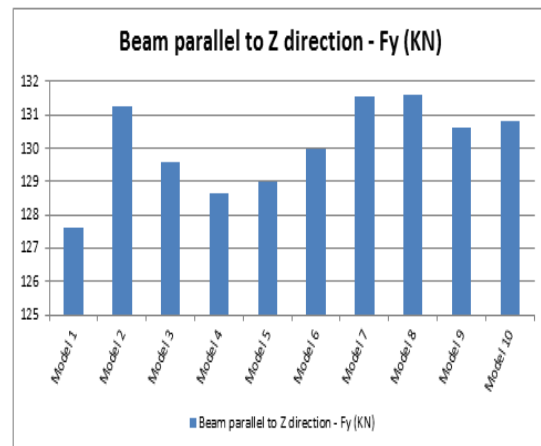
Different models		For Buildings				
		Beam parallel to Z direction				
		Fx (KN)	Fy (KN)	Fz (K N)	My (KN m)	Mz (KN m)
G+ 6	Mo del 1	36.0 78	127.6 37	4.1 15	6.38 0	152.8 51
	Mo del 2	45.4 47	131.2 81	7.3 27	12.4 02	155.7 84
	Mo del 3	43.1 66	129.5 70	6.5 96	11.5 95	156.0 17
	Mo del 4	65.8 81	128.6 42	8.6 63	15.0 24	154.4 38
	Mo del 5	65.9 53	129.0 02	9.2 43	14.3 57	155.0 04
G+ 10	Mo del 6	53.3 11	129.9 73	3.0 90	4.79 9	156.5 57
	Mo del 7	57.5 58	131.5 37	5.5 26	9.32 4	159.0 99
	Mo del 8	55.9 25	131.6 12	5.2 42	9.10 2	159.1 87
	Mo del 9	71.1 24	130.5 97	6.6 98	11.2 54	157.5 99
	Mo del 10	70.8 85	130.8 20	7.3 90	11.6 97	157.9 11

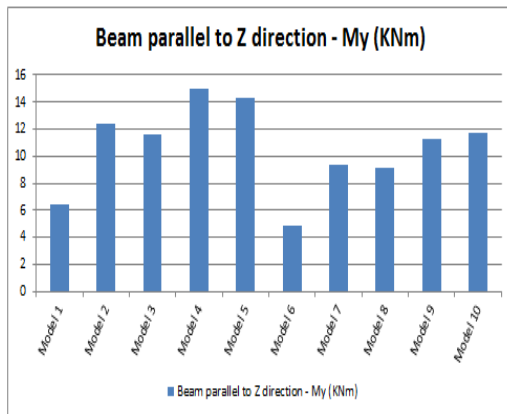
Minimum value of shear forces and moment when beams are parallel to Z direction seems to be in model 4 in G+6 storey building and model 9 in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.



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

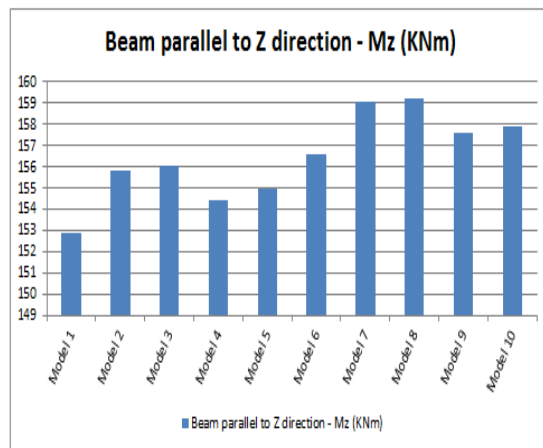
Graph 12: Graphical representation of Shear Force (Fy) in Building (Beam Parallel to Z direction) for different Models





Graph 13: Graphical representation of Shear Forces (Fy)

Graph 14: Graphical representation of Moments (My)



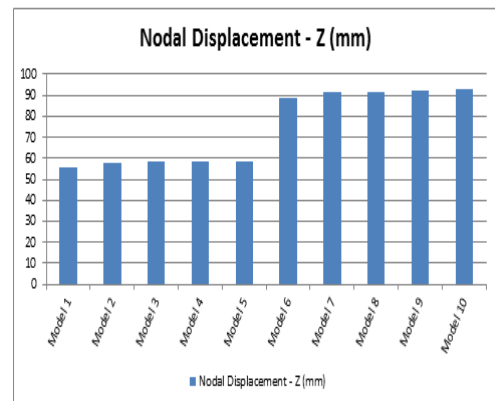
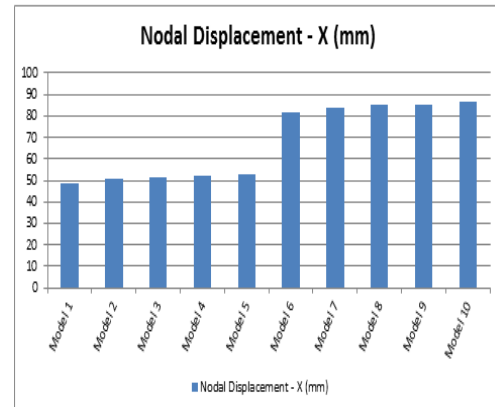
Graph 15: Graphical representation of Moments (Mz)

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.



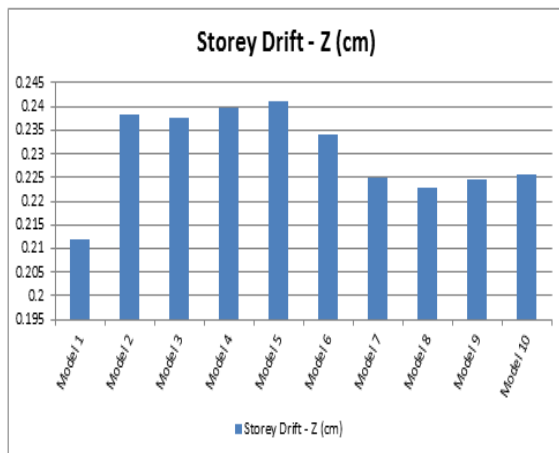
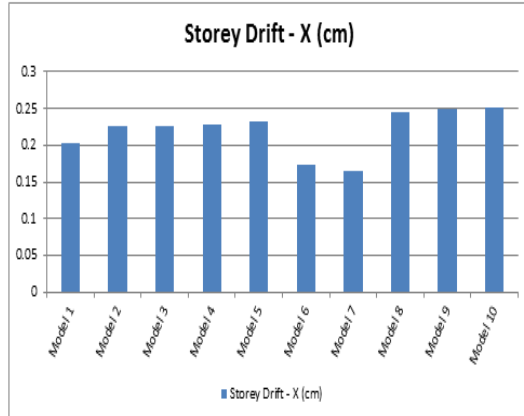
Graph 17: Nodal Displacement in Building (in Z-direction)

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)

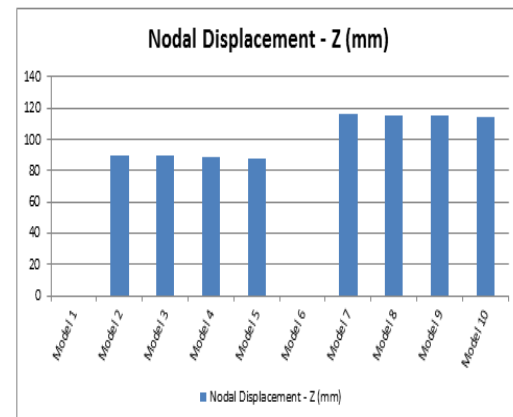
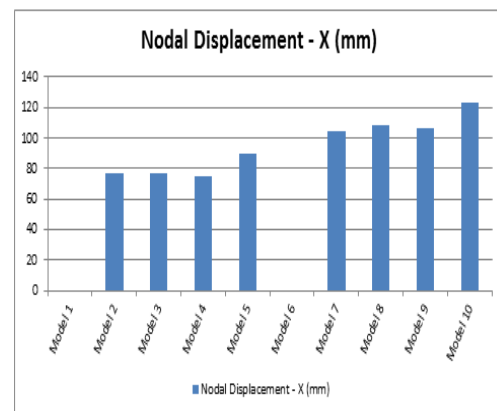
Graph 19: Storey Drift in Building (in Z-direction)

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+	Mod	-	-	-	-

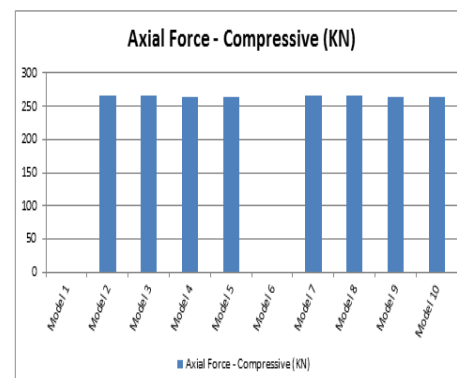
10	el 6				
	Mod el 7	104.893	116.345	265.461	225.661
	Mod el 8	108.842	115.687	265.679	225.627
	Mod el 9	106.857	115.600	264.943	224.679
	Mod el 10	123.619	114.089	265.104	224.866

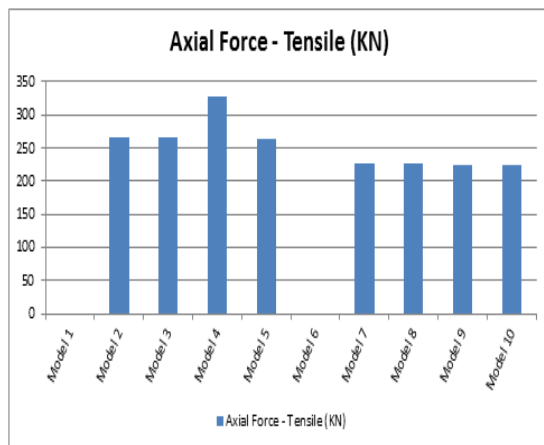
Minimum value of nodal displacement and axial forces in steel tower seems to be in model 4 and 9 for both X and Z direction in G+6 and in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.



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 F_x , F_y and F_z for building when beam parallel to X direction, other than model 1 and 6 which is structure without tower, the value of F_x , F_y and F_z has seems to be least in model 4 and model 9. When determining moments M_y and M_z 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 F_x , F_y and F_z when beam parallel to Y direction, other than model without tower, the value of F_x , F_y and F_z has seems to be least in model 4 and model 9. When determining moments M_y and M_z 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 F_x , F_y and F_z when beam parallel to Z direction for building other than model without tower, the value of F_x , F_y and F_z has seems to be least in model 3 and 8 for F_x and F_z , model 4 and 9 for F_y . When determining moments M_y and M_z when beam parallel to Z direction, other than model without tower, again model 4 and 9 expresses the least values for M_z model 3 and 8 for M_y .
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. Gajendra Verma**, Assistant Professor, Department of Civil 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.

VII. REFERENCES

- [1]. Malviya Suyash, Jamle Sagar, (2019), , "Determination of optimum location of rooftop telecommunication tower over multistorey building under seismic loading", pp. 65-73.
- [2]. Rajoriya Sourabh, Pathak K.K., Vyas Vivekanand (2016), "Analysis of Transmission Tower for Seismic Loading Considering Different Height and Bracing System", pp. 108-118.
- [3]. Shailesh S. Goral, Prof. S. M. Barelikar (2015), "Influence of Structure Characteristics on Earthquake Response Under Different Position of Rooftop Telecommunication Towers", International Journal of Engineering Sciences & Research Technology, ISSN 2277-9655, Vol. 4, Issue 10, pp. 73-78.
- [4]. Soltanzadeh Gholamreza, Shad Hossein, Vafaei Mohammadreza, Adnan Azlan (2014), "Seismic Performance of 4-Legged Self-supporting Telecommunication Towers", pp. 319-332.
- [5]. Shah Hemal J, Dr. Desai Atul K (2014), "Seismic Analysis of Tall TV Tower Considering Different Bracing Systems", pp. 113-119
- [6]. Rajasekharan Jithesh, Vijaya S (2014), "Analysis of Telecommunication Tower Subjected to Seismic & Wind Loading", pp. 68-79.
- [7]. Preeti C. and Mohan K. Jagan (2013), "Analysis of Transmission Towers with Different Configurations", pp. 450-460.
- [8] Bhatt J. Richa,.Pandey A.D, l Prakash Vipul (2013), "Influence of modeling in the response of



steel lattice mobile tower under wind loading”, pp. 137-144.

[9]. Bhosale Nitin, Kumar Prabhat, Pandey A. D. (2012), “Influence of Host Structure Characteristics on Response of Rooftop Telecommunication Towers”, pp. 737-748.

[10].H Siddesha (2010), “Wind Analysis of Microwave Antenna Towers”, pp. 574-584.

[11] Veena G1, Sowjanya G.V2, Naveen K3 (2017): Seismic Analysis of Four Legged Telecommunication Towers using Fluid Viscous Dampers. Pp 2343-2349.

[12] Rola Assi and Ghyslaine McClure (2017) A simplified method for seismic analysis of rooftop telecommunication towers

IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

ABOUT IJEAST

International Journal of Engineering Applied Science and Technology (IJEAST) is a peer-reviewed, open access journal that publishes high-quality research papers in the field of Engineering, Applied Science and Technology.

IJEAST aims to provide a platform for researchers, academicians, and professionals to share their innovative ideas, research findings, and practical experiences with the global scientific community.

FOCUS AREAS

- Engineering
- Applied Science
- Technology
- Innovation & Development
- Interdisciplinary Studies



PEER REVIEWED

All submissions are rigorously peer reviewed to ensure quality.



OPEN ACCESS

Free and unrestricted access to research for all.



GLOBAL REACH

Connecting researchers and professionals worldwide.



TIMELY PUBLICATION

We ensure a swift and efficient publication process.



For more information, visit our website

www.ijeast.com



INTERNATIONAL JOURNAL

OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY



editor@ijeast.com



www.ijeast.com



India



2455-2143