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ANALYSIS OF ROOFTOP TELECOMMUNICATION TOWER OVER BUILDING IN EARTHQUAKE PRONE AREA

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Abstract: Rooftop telecommunication towers are integral to modern communication networks. However, their placement on buildings in earthquake-prone regions raises critical structural safety concerns. This study investigates the dynamic response of buildings supporting telecommunication towers during seismic events. For the tower configurations, triangular plan is selected. G+10 buildings without tower and with tower is taken into account and G+6 buildings without tower and with tower along with analyzed in compliance of Indian Code of Practice for seismic resistant design of buildings by using I.S. 1893-2002. The various models are assumed to be fixed at the base and are modeled using software STAAD Pro. Parameters for both building with and without tower are computed and compared with each other.

Keywords*: Rooftop Telecommunication Tower, Axial Force, Storey Drift, Nodal displacement, Shear Force*

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I.INTRODUCTION:

The rapid growth of telecommunication infrastructure has been instrumental in meeting the increasing demands for connectivity in urban and rural areas alike. Rooftop telecommunication towers, commonly installed on residential, commercial, and industrial buildings, serve as pivotal nodes in communication networks. However, their integration with buildings in earthquake-prone regions introduces significant structural and safety challenges. Seismic events impose dynamic forces that interact with the mass and stiffness of a building. The addition of a rooftop telecommunication tower alters the building's mass distribution and dynamic characteristics, potentially exacerbating seismic vulnerabilities. Key concerns include amplified inertial forces, increased stress concentrations at structural interfaces, and the possibility of torsional effects due to asymmetric tower placement. These factors can compromise the structural integrity of buildings, leading to severe damage or even collapse during earthquakes. Despite these risks, the design and placement of rooftop telecommunication towers are often guided by functional requirements rather than structural considerations. Many existing buildings with such towers were not originally designed to accommodate the additional loads and dynamic effects imposed by seismic activity. Furthermore, while international and regional codes address general seismic design principles, they provide limited guidance on the integrated behavior of buildings and rooftop structures during earthquakes.

II. OBJECTIVE

- The objective of this research is as follows: Conduct a comprehensive assessment of the seismic response of buildings equipped with rooftop telecommunication towers across diverse structural configurations and tower designs.
- Identify key parameters, such as tower weight, placement, and structural irregularities that influence the seismic behavior of the combined system.

1. Investigate the dynamic interaction between the building structure and the telecommunication tower under varying seismic intensities.
2. The different location of rooftop communication tower is used to study the effect of changing location.
3. For seismic loading in this thesis response spectrum method is used to take part in the response of the earthquake effects.
4. Parameters for both building with & without tower are computed & compared with each other.

III. MODELLING APPROACH

Modeling Approach

The modeling approach includes types of cases considered for analysis of structure, the development, analysis of models and details of models. After then response spectrum analysis has been carried out for Zone IV for structural analysis. Different models are shown in table 1 below:-

Table 1: Details of various building models

Model 1	G + 6 storey building without tower
Model 2	G + 6 storey building with tower located on center of roof
Model 3	G + 6 storey building with tower at center of long side of building roof
Model 4	G + 6 storey building with tower at center of short side of building roof
Model 5	G + 6 storey building with tower located at corner of the roof
Model 6	G + 10 storey building without tower
Model 7	G + 10 storey building with tower located on center of roof
Model 8	G + 10 storey building with tower at center of long side of building roof
Model 9	G + 10 storey building with tower at center of short side of building roof
Model 10	G + 10 storey building with tower located at corner of the roof

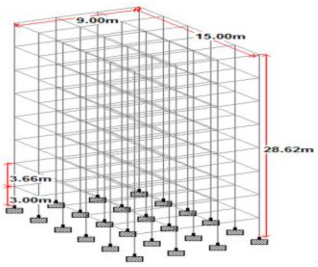


Figure: 1 3D Elevation Model-1

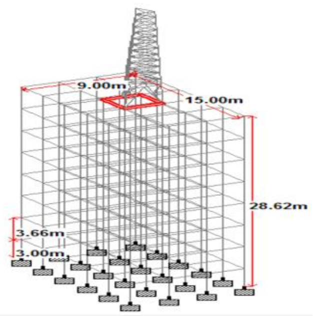
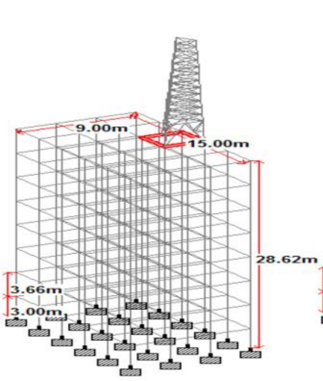


Figure: 23D Elevation Model-2



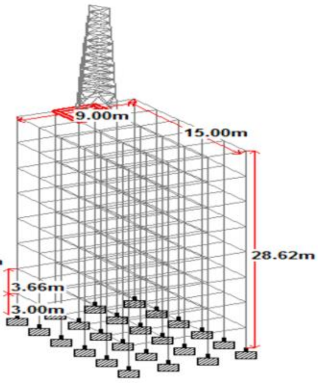
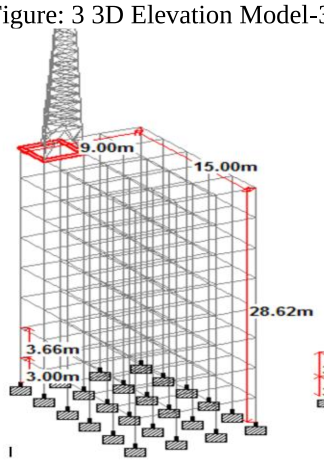


Figure: 3 3D Elevation Model-3 Figure: 4 3D Elevation Model-4



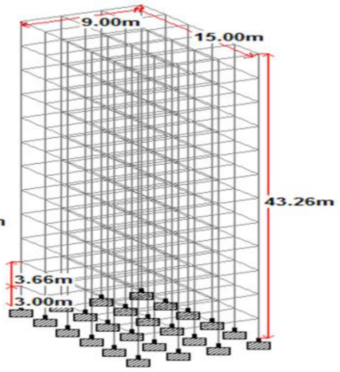
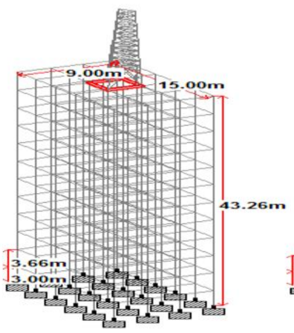


Figure: 5 3D Elevation Model-5 Figure: 6 3D Elevation Model-6



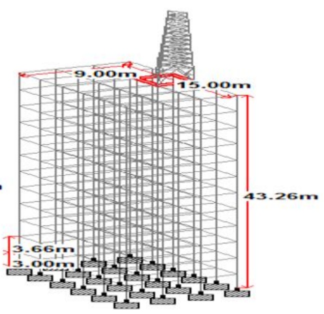
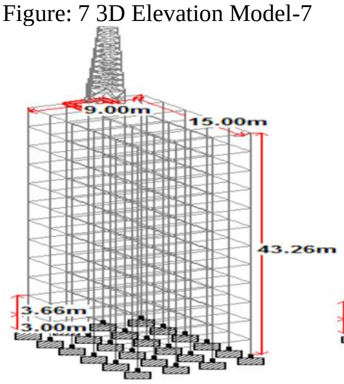


Figure: 7 3D Elevation Model-7 Figure: 8 3D Elevation Model-8



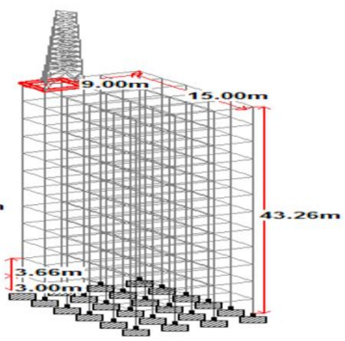


Figure: 9 3D Elevation Model-9 Figure: 10 3D Elevation Model-10

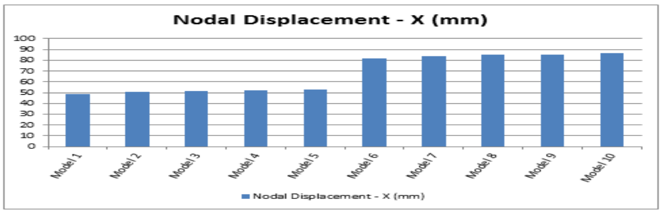
IV. RESULTS AND DISCUSSION

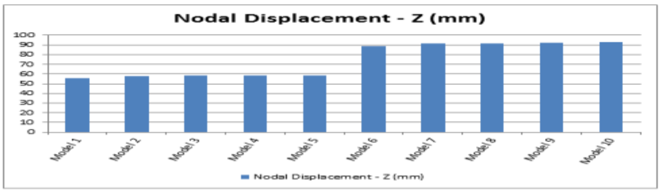
The analysis results obtained using Staad pro software is shown in tabular form along with various graphs with various parameters as follows:

Table 2: 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.



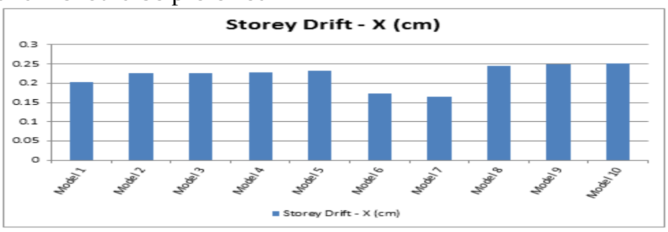


Graph 2: Nodal Displacement in Building (in Z-direction)
Graph 1: Nodal Displacement in Building(in X-direction)

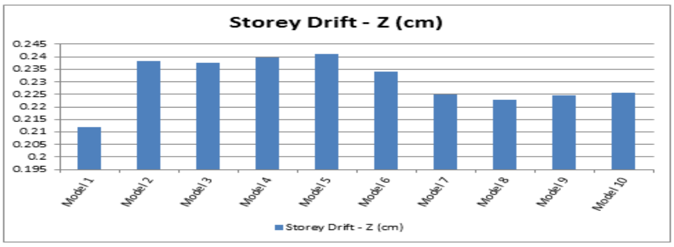
Table 3: Storey Drift in Building (X and Z direction) for different Models

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 3:Storey Drift in Building(in X-direction)



Graph 4: Storey Drift in Building (in Z-direction)

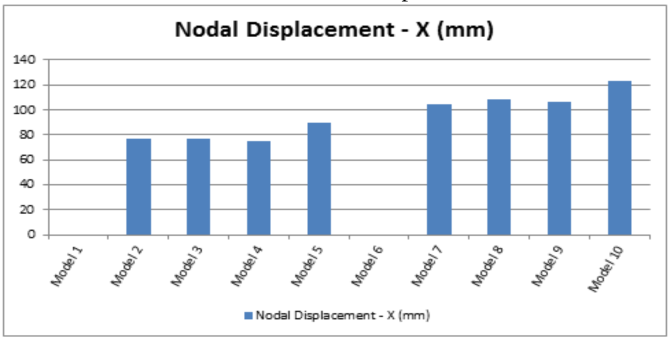
Table 4: Nodal displacement (X and Z direction) and Axial

Forces (Compressive and Tensile) in Tower for different Models

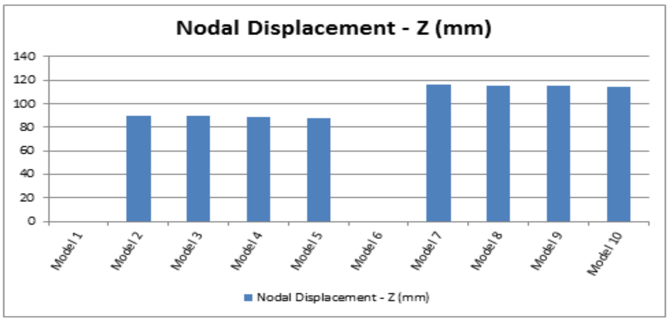
Different models		For Towers			
		Nodal Displacement		Axial Force	
		X (mm)	Z (mm)	Compressive (KN)	Tensile (KN)
G+6	Model 1	-	-	-	-
	Model 2	76.893	89.345	265.449	265.151
	Model 3	76.734	89.633	265.673	265.375
	Model 4	74.582	88.341	264.932	326.634
	Model 5	89.565	88.089	265.098	264.800
G+10	Model 6	-	-	-	-
	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

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

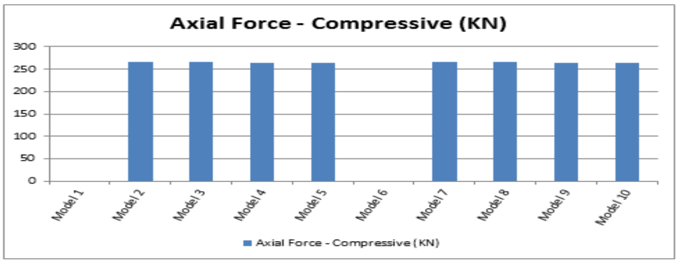
Minimum value of nodal displacement and axial forces in steel tower seems to be in model 4 and 9 for both X and Z direction in G+6 and in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred



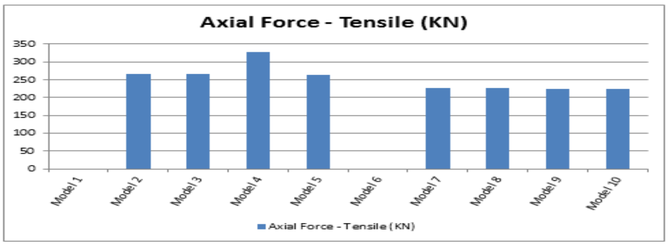
Graph 5: Nodal Displacement in Tower



Graph 6: Nodal Displacement in Tower



Graph 7: Axial Forces in Tower(Compressive)



Graph 8: Axial Forces in Tower(Tensile)

V.CONCLUSIONS

1. 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.
2. 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.
3. 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.

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