Relative Analysis of High-Rise RC Structure with Communication Tower at Altered Location on Roof under Severe Lateral Loading

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Abstract — Basic human needs for living to sustain in various changing environments are one of the main problems in this era of construction world is the problem of vacant and stable land. This lacking urban areas has showed to the vertical! construction magnification of low-rise, medium-rise, tall buildings and even skyscraper. These buildings usually castoff framed structures open to lateral loads beside with vertical loads. In these structures, the horizontal loads from resilient winds and earthquakes are the foremost concerns to keep in mind while designing relatively than the gravitational loads caused by the self-weight of structure. The above factors considered for the analysis might be inversely proportional to each other as the building which is designed for gravitational loads do not withstand for lateral loads and vice versa. In this work, response spectrum analysis been carried out for the effect of lateral loading. Previous researches have been carried out to study the enactment of the location of rooftop tower and there is gap in the study for its better enhancement hence the study related to its better performance and locations is yet to be implemented. The objective of this study helps to determine the optimal position of tower position and to evaluate the performance of multistoried buildings having rooftop communication tower and their response under severe seismic conditions. For optimizing the position different options are considered and tower has been placed at various location for better suitability. 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. 1893-2016. The various models are assumed to be fixed at the base and are modeled using software STAAD Pro. Various parameters are computer for the buildings with and without tower and the output of the work compared on the basis of these results.

Keywords: Roof Top, Tower, Seismic, multistory, tall building, Shear Force, Nodal Displacement

I. Introduction

Multistoried reinforced concrete structures made up of different structural components viz. slabs, girders, columns and beams placed firmly to create a rigid monolithic system. Such type of arrangements are one over another so that structure can transfer its ultimate combined load from slab to beams than beams to columns than columns to firm foundation. This 3D structure made known as space structure. It creates ideally interconnected mutually perpendicular horizontal axes for analysis purpose.

Using tall structures made up of steel or a structure with a great ratio between maximum width and height with very less cross section are known as tower or mast. Pylon is also called sometimes tower. It is fixed at its base with single freely standing self- supporting structure. With bracing with guys and other elements, a mast is a pin connected structure to its foundation. Radio towers, water tank towers, towers for bridges etc. are the examples of tower. When we are discussing about power transmission towers, it delivers necessary clearance for maximum weighing sag cables. Also, they are used to support cables, electronic equipment over it. Towers require sometimes more space to stand and sometimes very less space depending upon the types of towers.

II. Scope of the Study

From the literature survey, it has been pointed out that very less work had been done for the analysis of the location of the tower which is telecommunication tower. Since no author has done the comparison of the results of such cases. Therefore, after summarizing the literature survey, these cases are taken and needed to be studied as per Indian Code of Practice

III. Objective of Study

Main objectives of the thesis are:

1) The objective of this study is to evaluate the activities of multistoried buildings having rooftop communication tower and the response of building under lateral loading.
2) The communication tower is placed at various locations to determine its effect.
3) To study the behavior of such building under lateral seismic effect, response spectrum method is used to take part in the response of the earthquake effects.
4) To study the behavior of self – supporting Telecommunication tower under wind action.
5) To Study the wind analysis of telecommunication tower for different wind zones for Indian code practice IS 875 (part3):1987.
6) Different parameters have been determined for the comparison of the building under such conditions.

IV. Problem Statement & Methodology

The only way to find the optimum result parameters is to obtain location by comparing various models as per different storied buildings with and without tower. So for that, total 10 models are prepared according to the height. Building model with and without tower in G+6 storey and G+10 storey building will be prepared. Tower is supposed to be positioned in four different places to find the result parameters. After then load is to be taken as dead load, live load, earthquake load and as per IS 1893, load combinations with response spectrum loads in both directions are taken into account.

The space frame has been modeled in Staad.pro software. The descriptions of the host structure and tower are listed in Table 4.1. The inter connection assumed to be pin for

towers. The arrangement idealization and member segment property details of triangular base rooftop tower are shown in Table 4.1. Various plans and 3D views are shown in subsequent figures.

Building configuration	G + 6 and G + 10
Height of building	28.62m and 43.26 m
Dimensions of building	15 m x 9 m
Height of each storey and depth of foundation	3.66m and 3m

Table 4.1: Details of building & rooftop tower

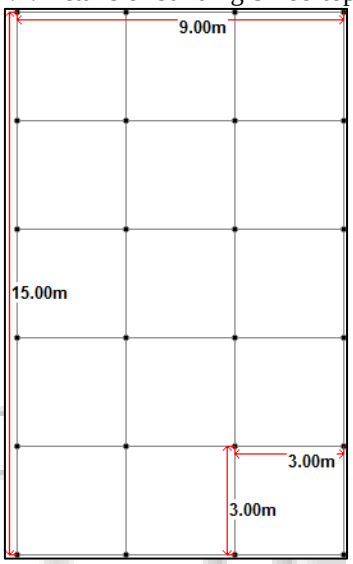


Fig. 4.1: Plan of the Building (G+6) & (G+10)

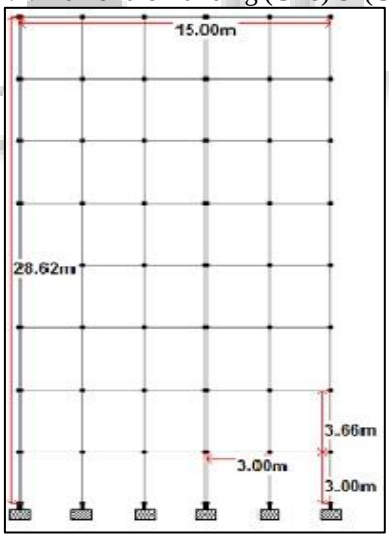


Fig. 4.2: Elevation of Multistoried Building (G+6) with & without tower

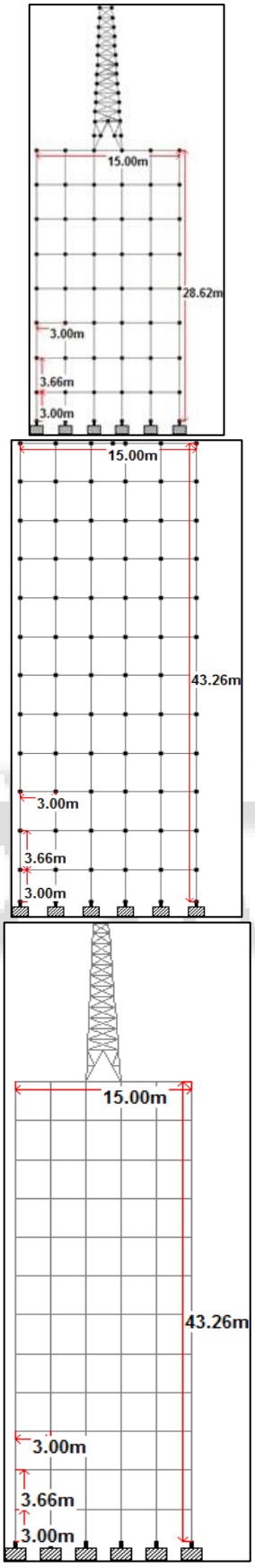


Fig. 4.3: Elevation of Multistoried Building (G+10) with & without tower

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 at corner of the roof

Table 4.2: Details of various building models

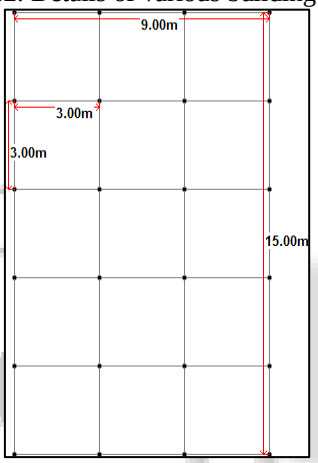


Fig. 4.4: Plan Model-1 & 6

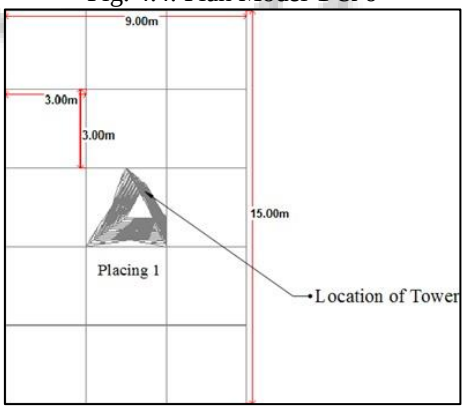


Fig. 4.5 Plan Model-2 & 7

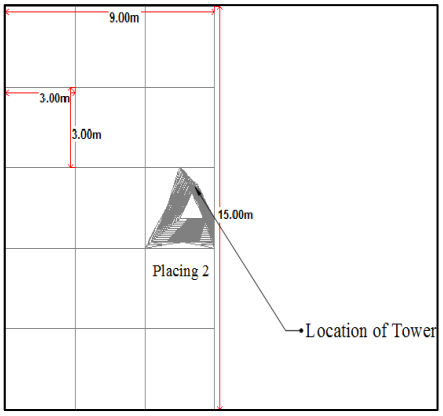


Fig. 4.6 Plan Model-3 & 8

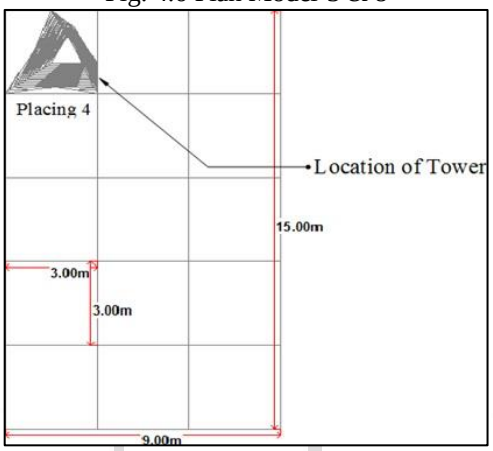


Fig. 4.7 Plan Model-4 &

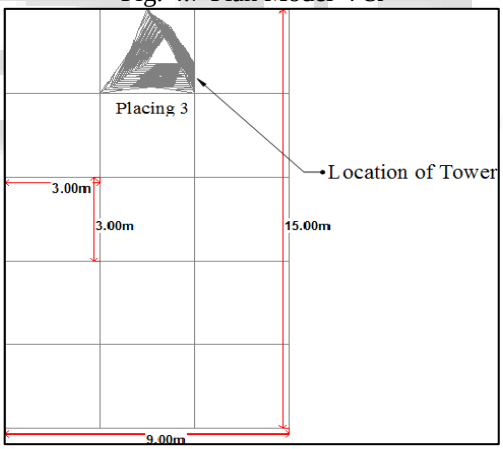
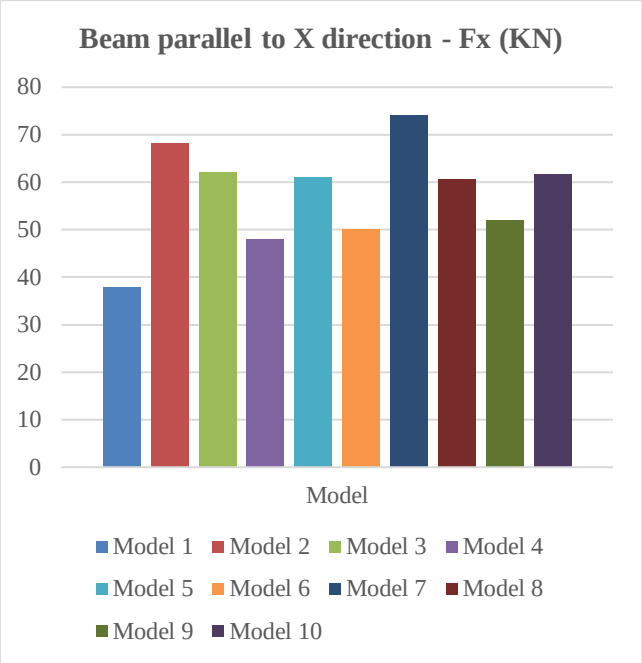


Fig. 4.8 Plan Model-5 & 10

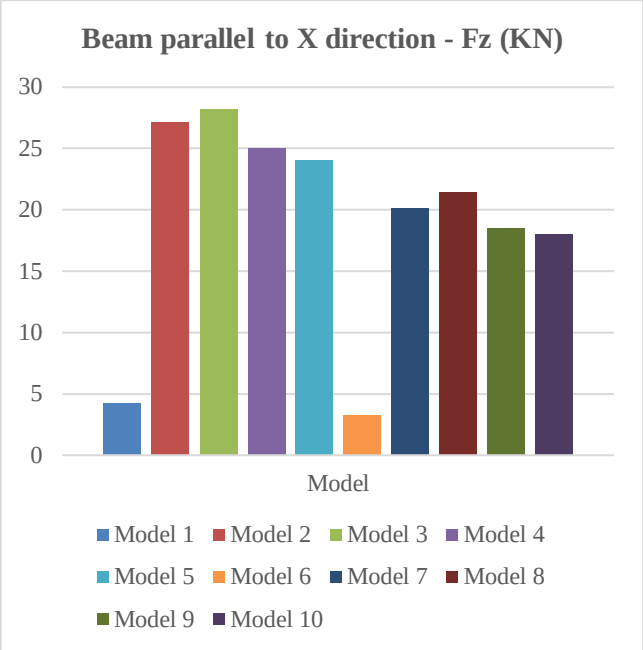
V. RESULTS AND DISCUSSION

A. Shear Forces and Moments in Building (Beam Parallel to X direction) for different Models

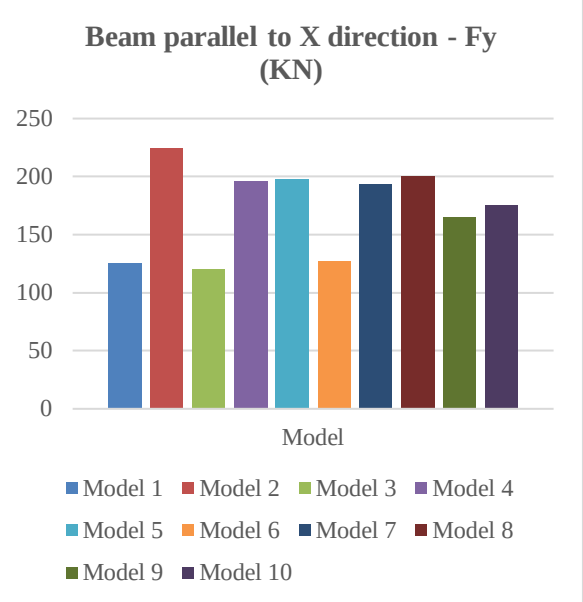
Minimum value of shear forces and moment when beams are parallel to X direction seems to be in model 4 in G+6 storey building and model 9 in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.



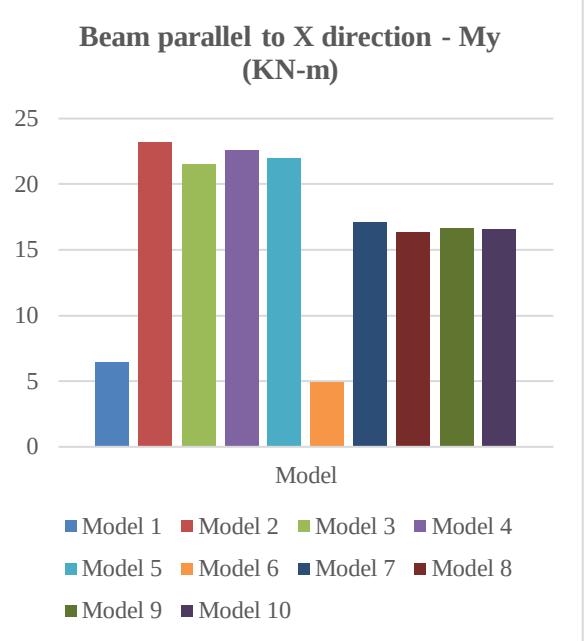
Graph 5.1: Graphical representation of Shear Forces (Fx) in Building (Beam Parallel to X direction) for different Models



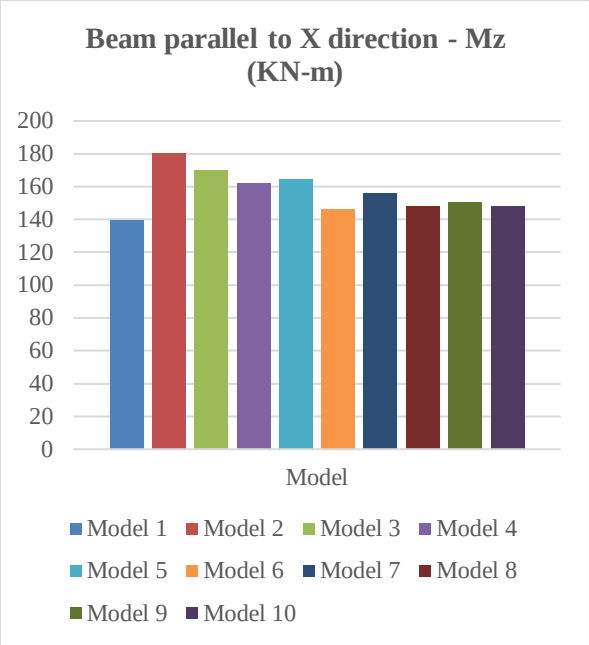
Graph 5.3: Graphical representation of Shear Forces (Fz) in Building (Beam Parallel toX direction) for different Models



Graph 5.2: Graphical representation of Shear Forces (Fy) in Building (Beam Parallel to X direction) for different Models



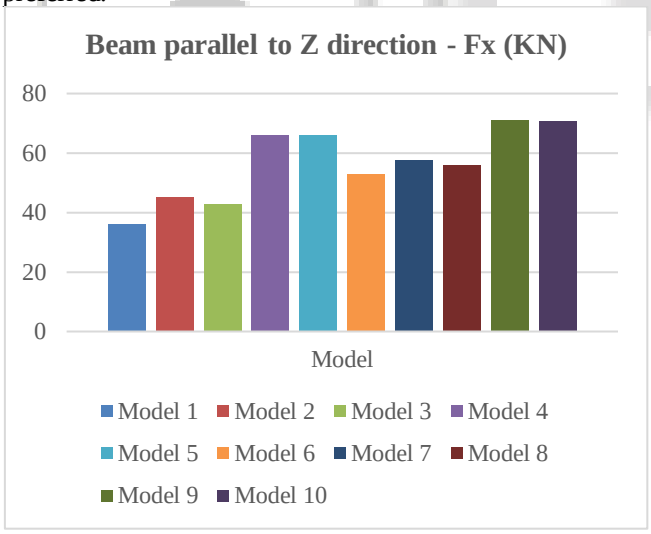
Graph 5.4: Graphical representation of Moments (My) in Building (Beam Parallel to X direction) for different Models



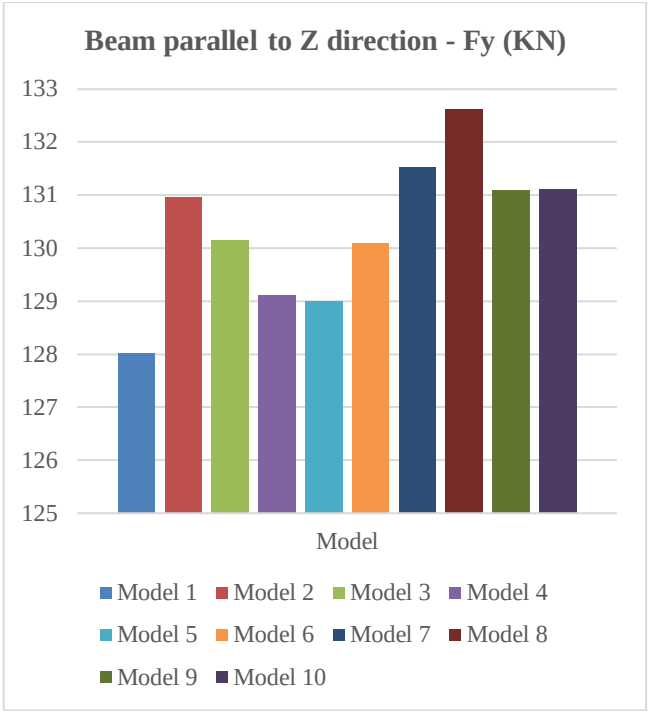
Graph 5.5: Graphical representation of Moments (Mz) in Building (Beam Parallel to X direction) for different Models

B. Shear Forces and Moments in Building (Beam Parallel to Z direction) for different Models

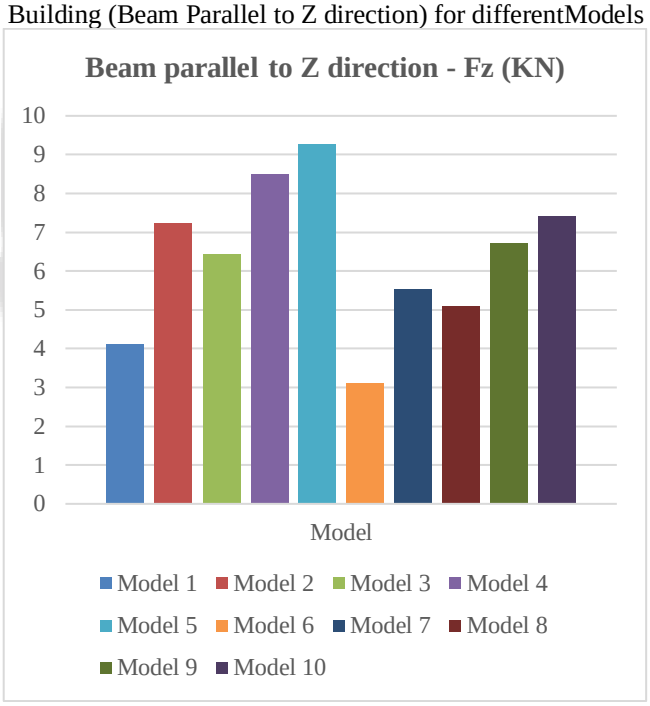
Minimum value of shear forces and moment when beams are parallel to Z direction seems to be in model 4 in G+6 storey building and model 9 in G+10 storey building. Hence by observing this least values, model 4 and 9 should be preferred.



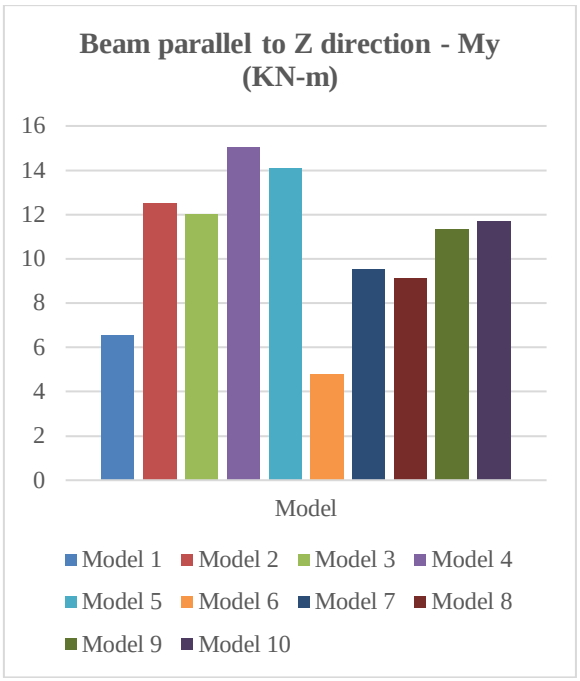
Graph 5.6: Graphical representation of Shear Forces (Fx) in Building (Beam Parallel to Z direction) for different Models



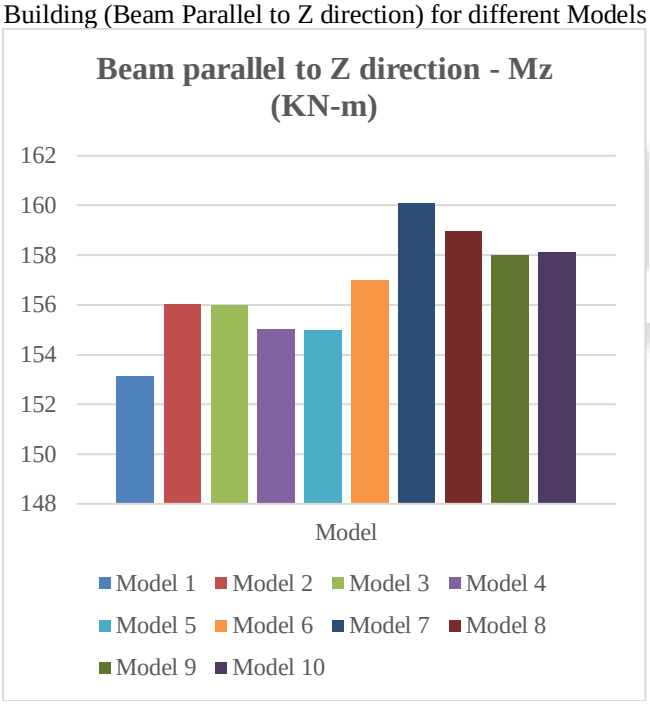
Graph 5.7: Graphical representation of Shear Forces (Fy) in Building (Beam Parallel to Z direction) for differentModels



Graph 5.8: Graphical representation of Shear Forces (Fy) in Building (Beam Parallel to Z direction) for different Models



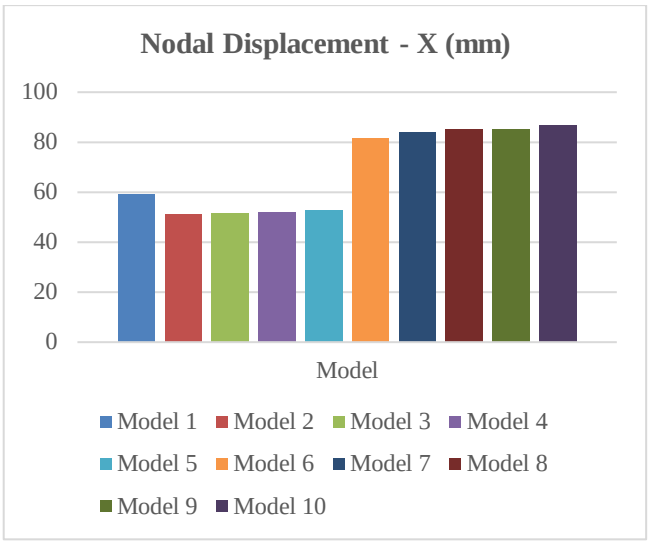
Graph 5.9: Graphical representation of Moments (My) in Building (Beam Parallel to Z direction) for different Models



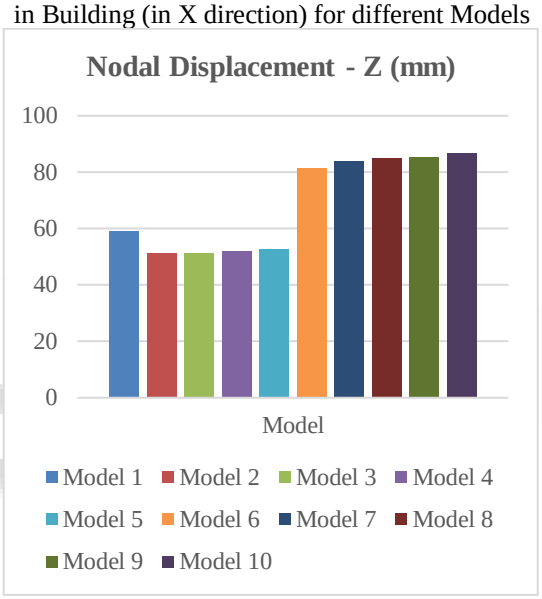
Graph 5.10: Graphical representation of Moments (Mz) in Building (Beam Parallel toZ direction) for different Models

C. Nodal displacement in Building (X and Z direction) for different Models

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.



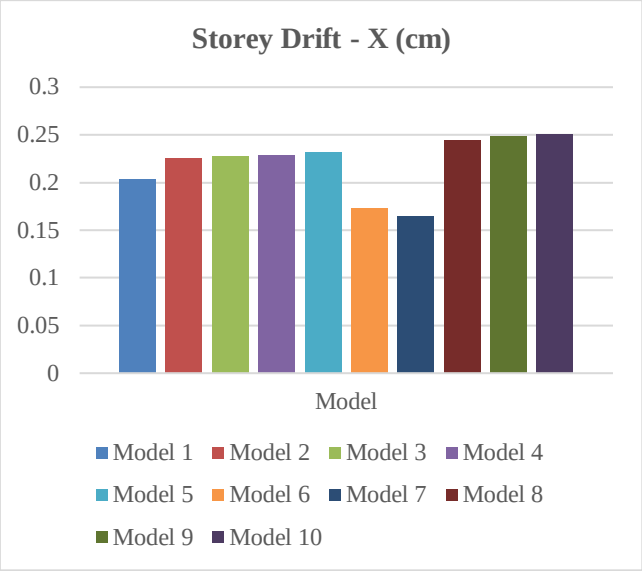
Graph 5.11: Graphical representation of Nodal displacement in Building (in X direction) for different Models



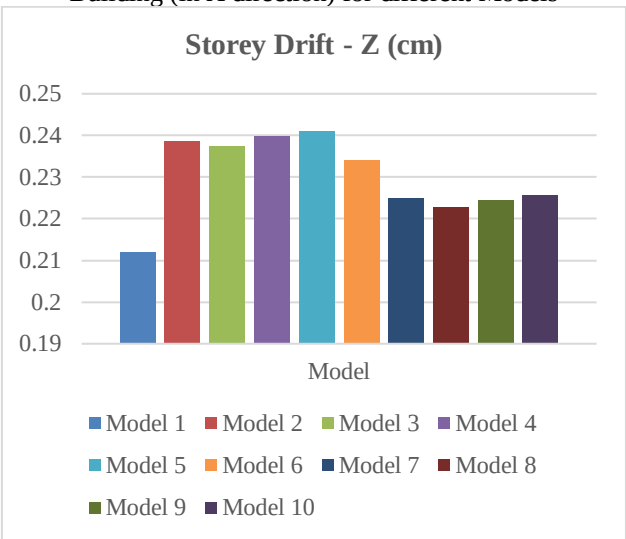
Graph 5.12: Graphical representation of Nodal displacement in Building (in Z direction) for different Models

D. Storey Drift in Building (X and Z direction) for different Models

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.



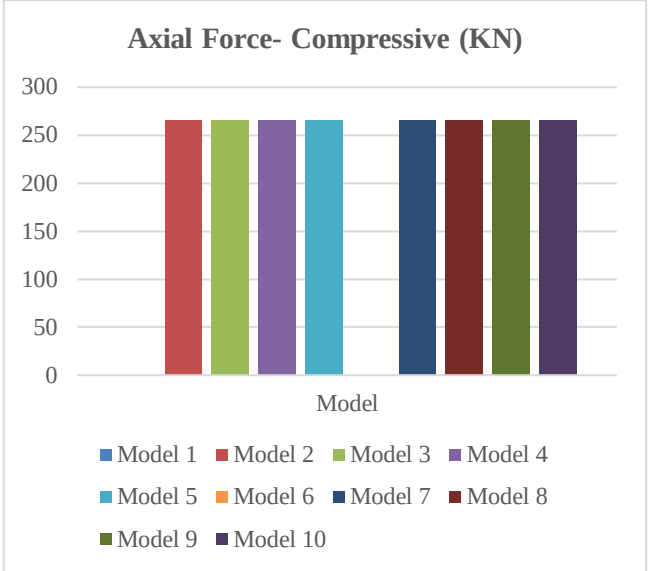
Graph 5.13: Graphical representation of Storey Drift in Building (in X direction) for different Models



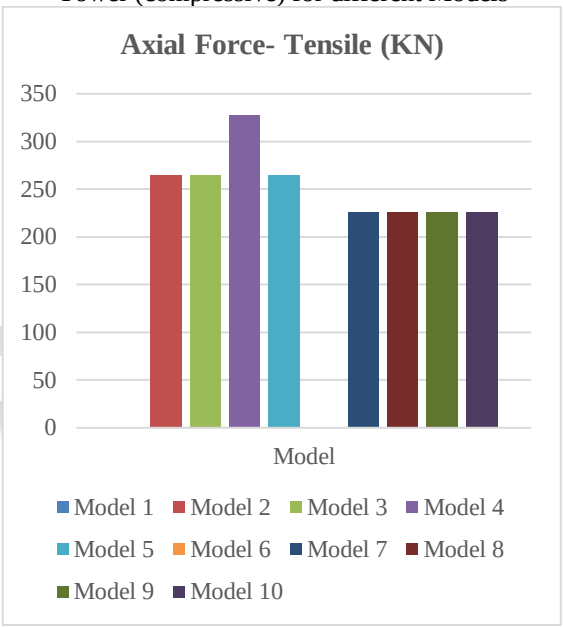
Graph 5.14: Graphical representation of Storey Drift in Building (in Z direction) for different Models

E. Axial Forces (Compressive and Tensile) in Tower for different Models

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 5.15: Graphical representation of Axial Forces in Tower (compressive) for different Models



Graph 5.16: Graphical representation of Axial Forces in Tower (tensile) for different Models

VI. Conclusion

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, i.e. the building having tower at center of shorter width parameter of building roof. 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, i.e., building with tower at center of long side of building roof expresses the least values.

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, i.e. the building having tower at center of shorter width parameter of building roof. 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.

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.

Nodal displacement for building seems to be least in model 2 and 7, i.e., building with tower located on center of roof for X and Z direction and for story drift, model 3 and 8 shows least values among all tower placings.

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