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SEISMIC ANALYSIS OF TALL TV TOWER COSIDERING DIFFERENT BRACING SYSTEMS

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Abstract*: Television towers are constructed to transmit the television signals on the wider areas and this television towers are also used for the purpose of transmitting the radio as well as telecommunication signals. These towers must be properly designed so that they will not fail during the natural disasters such as earthquakes. In past researchers had studied the effect of different earthquakes on 3 legged tall telecommunication towers. In the present study earthquake response of 4 towers of different height are studied considering different bracing system of the tower. The towers of different height are modeled in SAP 2000 software and static and dynamic analysis of the tower has been carried out. In addition to this time history of the bhuj earthquake is applied on all tower and the response of the tower is studied*

Keywords*: Television tower, seismic analysis, time history analysis, response of tower*

I. Introduction

The television and telecommunication industry plays a great role in human societies and thus much more attention is now being paid to telecommunication/tv towers than it was in the past. During the natural disasters such as the earthquakes telecommunication and TV towers have the crucial task of instant transmission of information from the affected areas to the rescue centres. So that relief works and evacuation of the people can be done as early as possible, In addition, performance of infrastructure such as dams, electric, gas, and fuel transmission stations, depends extensively on the information being transmitted via these towers. These tall towers are also used by Military and defence industries so it create the necessity for further research on telecommunication towers. There are three types of steel telecommunication towers mainly known to engineers as guyed towers, self-supporting towers, and monopoles. Guyed towers normally provide an economical and efficient solution for tall towers of 150 m and above, compared to self-supporting towers. Self-supporting towers are categorized into two groups of 4-legged and 3-legged lattice towers.

The researchers have studied static and dynamic response of the 3 legged tv towers.as well as some tall tv towers such as milad, cannon tv tower are also studied. In my work the actual drawings of the towers are collected from the Indian government authorities. The various dimensions that is the width of the tower at base, height of the tower and different bracing system used are studied. The bracing system provided in the tower must be such that it has minimum weight so it gives less earthquake forces as well as higher stiffness so it can resist the earthquake forces more efficiently. For the analysis purpose the 3 bracing system as shown in the figure.1 are considered to study the earthquake response of the structure.

To study the effect of different system on television towers different height of the tower such as 80 meter, 110 meter, 150 meter and 175 meter is considered. The towers of this 4 different height considering cross type, M type and K type bracing are modeled in SAP 2000 software. Figure 2 shows the model of 80 meter and 110 meter high tower modeled in SAP 2000 software.

Fig. 1: Different bracing system of the towers

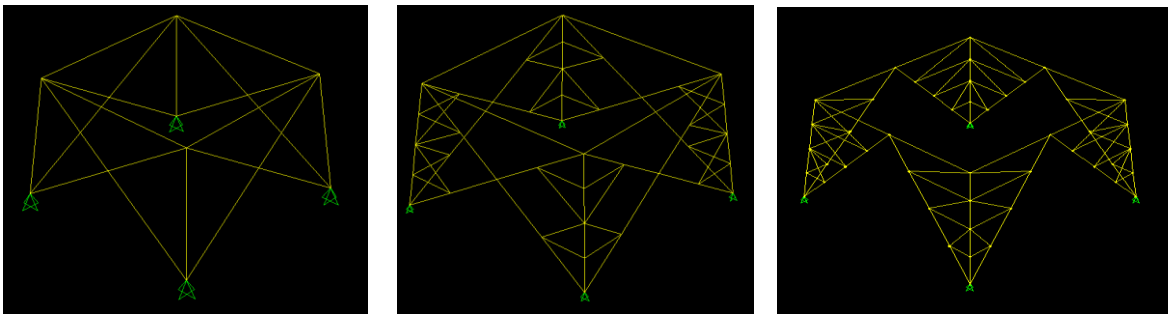


Fig. 2: Model of tower in SAP software

(a) 80 meter high tower **(b) 110 meter high tower**

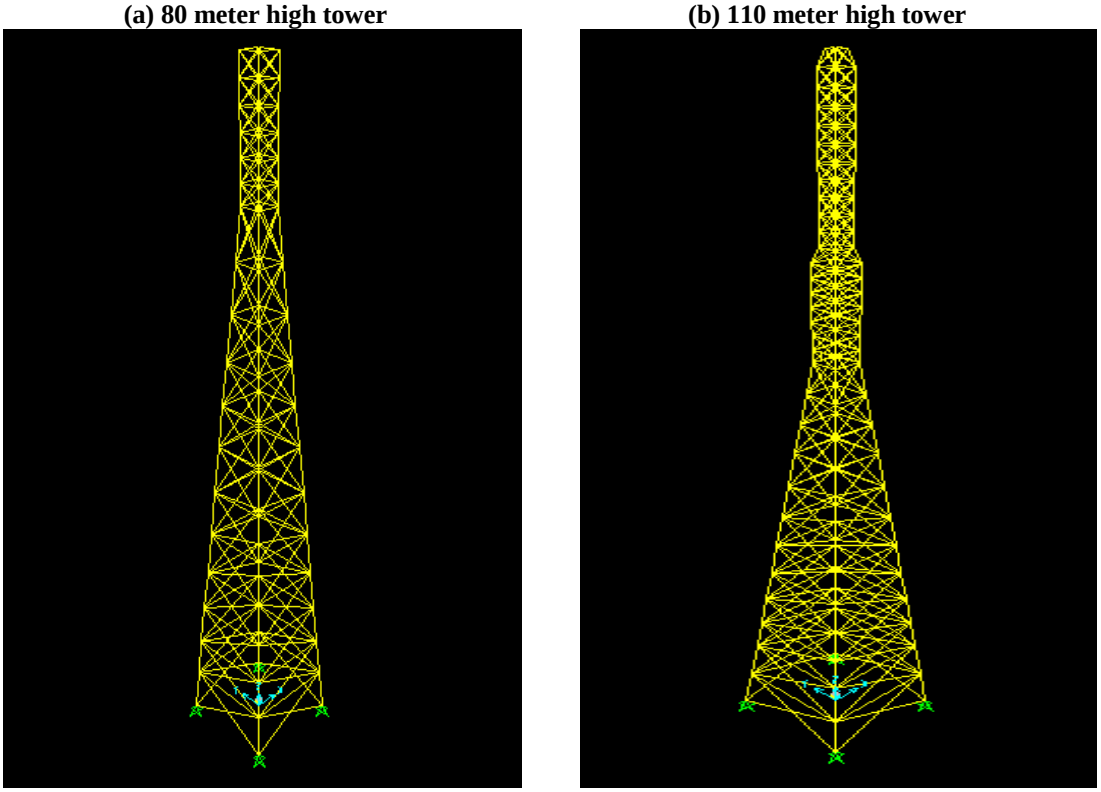
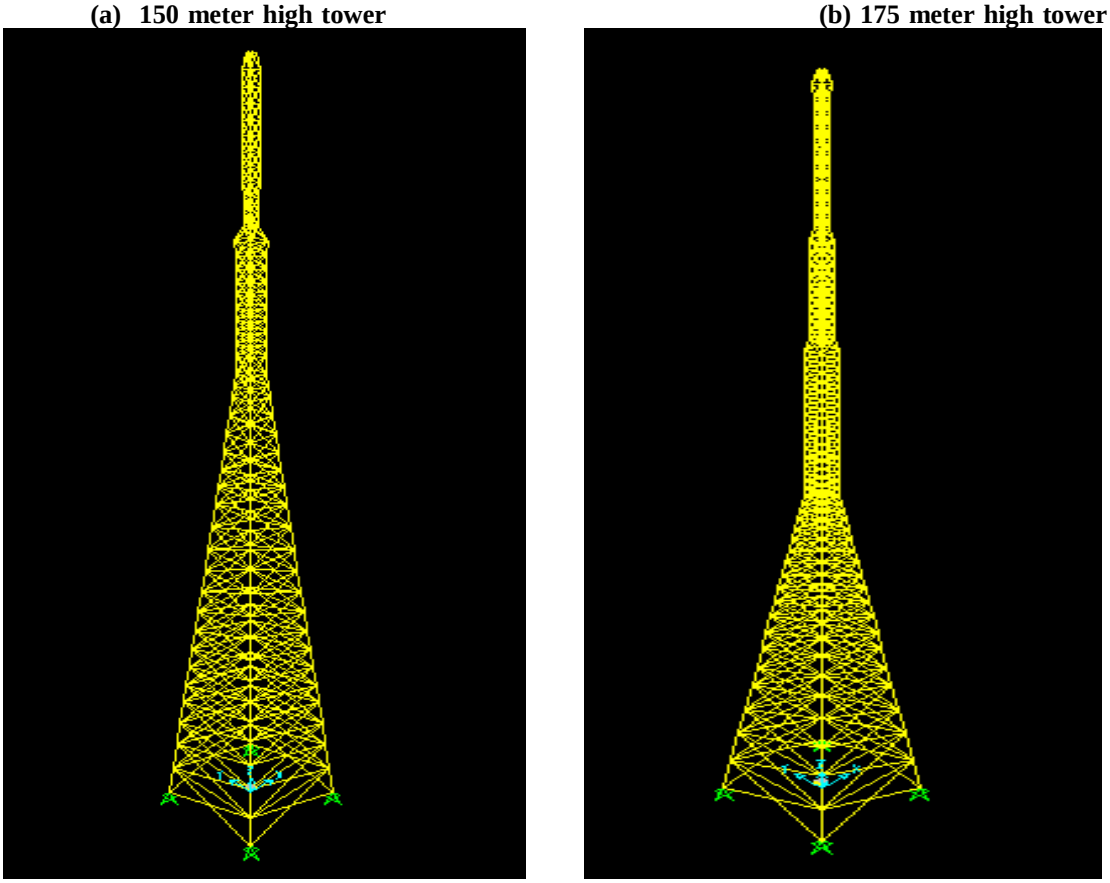


Fig. 3 model of tower in SAP software

(a) 150 meter high tower **(b) 175 meter high tower**



After modeling all 12 towers in the sap software the towers were analyzed for the dead loads and result are obtained. The static and dynamic seismic analysis of all the 12 towers considering following data as per Indian standard I.S.- 1893-2002 has been carried out.

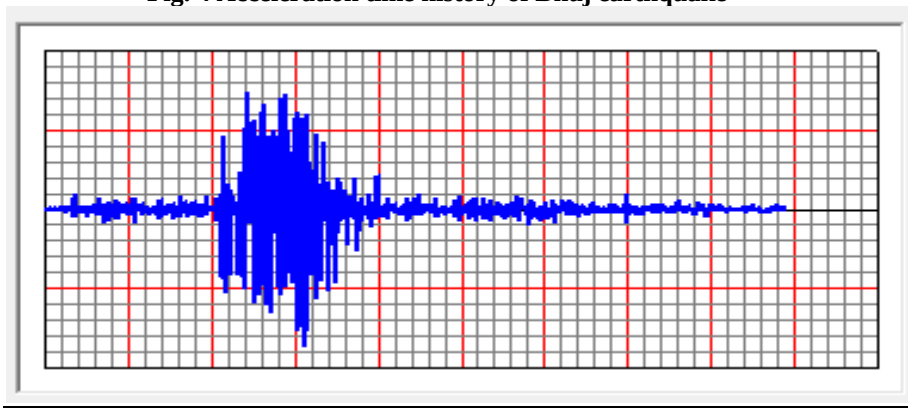
Data for static analysis:

1) Zone : Zone -II , Zone -III , Zone -IV and Zone - V
2) Type of soil : Type –II medium soil
3) Importance factor : 1.5
4) Response Reduction factor : 5

In addition to static analysis of the towers the dynamic analysis of the tower considering time history method is also carried out. For time history method, the data of BHUJ earthquake occurred in Gujarat, India on 26 January 2001 is used and it is applied on the tower. The linear time history analysis of the tower has been carried out. The details of bhuj earthquake are as under. Fig. 4 shows the acceleration time history of bhuj earthquake.

1) Name of time history : Bhuj
2) Magnitude : 7.7
3) Duration of earthquake: 133.53 second
4) Peak ground acceleration : 1.0382 m/sec2
5) Time for PGA : 46.940 second
6) Duration: long
7) Total no of acceleration records : 26706
8) Time step :0.005 second

Fig. 4 Acceleration time history of Bhuj earthquake



The static and dynamic analysis of all 12 towers has been carried out in sap software. The no of mode shapes considered in dynamics analysis are such that dynamic participation factor is more than 90 percentage as per the recommendation of the I.S. -1893-2002. To study the seismic response of all 12 towers the base shear due to static and time history method has been compared. As the leg member near the ground level in each tower is severely loaded by dead and seismic forces, the axial forces in the main leg member due to the dead+static load case and dead + time history analysis has been considered.

Fig. 5 Base shear for 80 meter tower

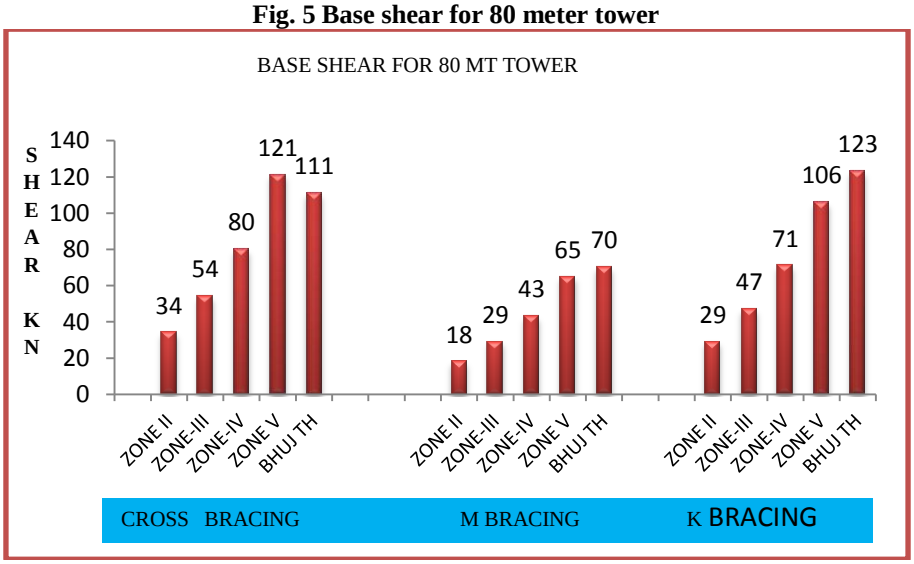


Fig. 6 Axial Forces for 80 meter tower

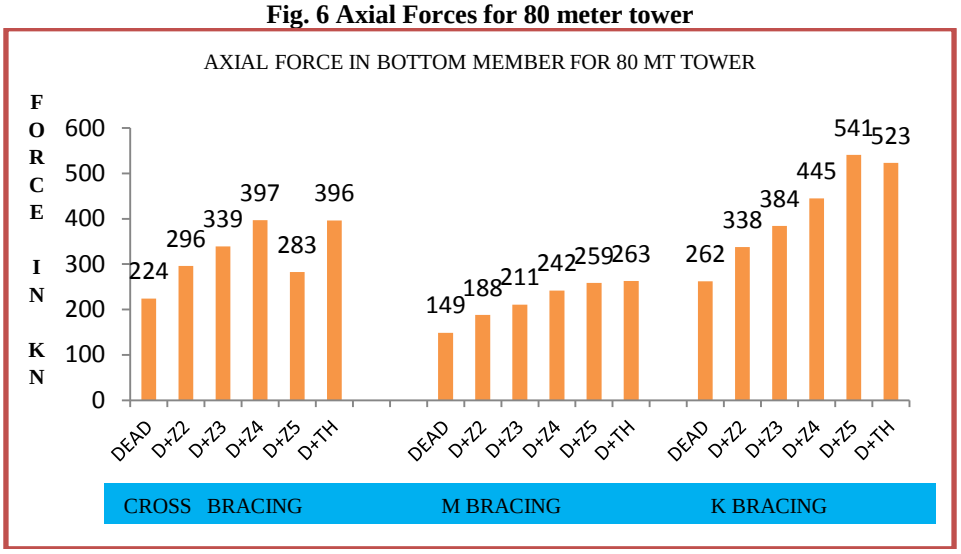


Fig. 7 Base shear for 110 meter tower

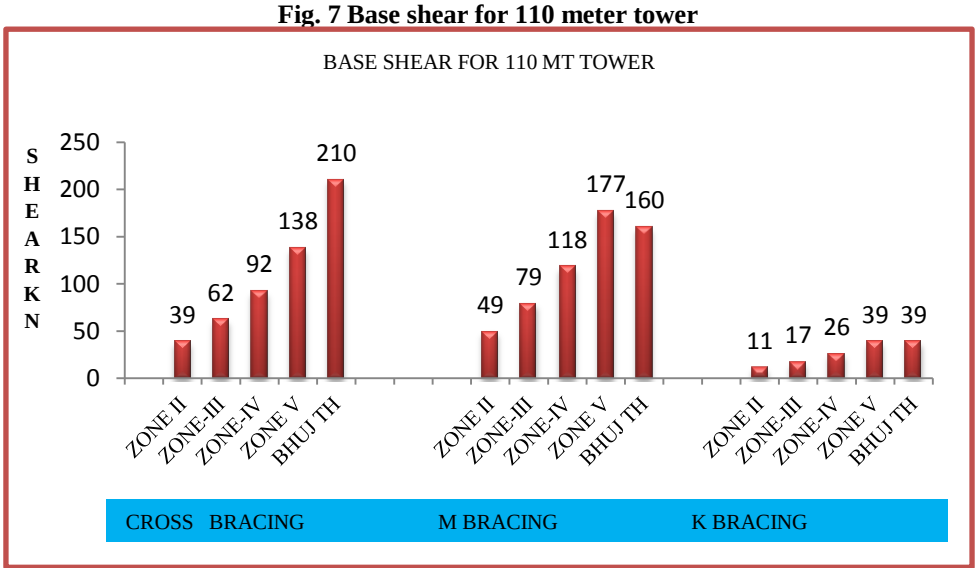


Fig. 8 Axial Forces for 110 meter tower

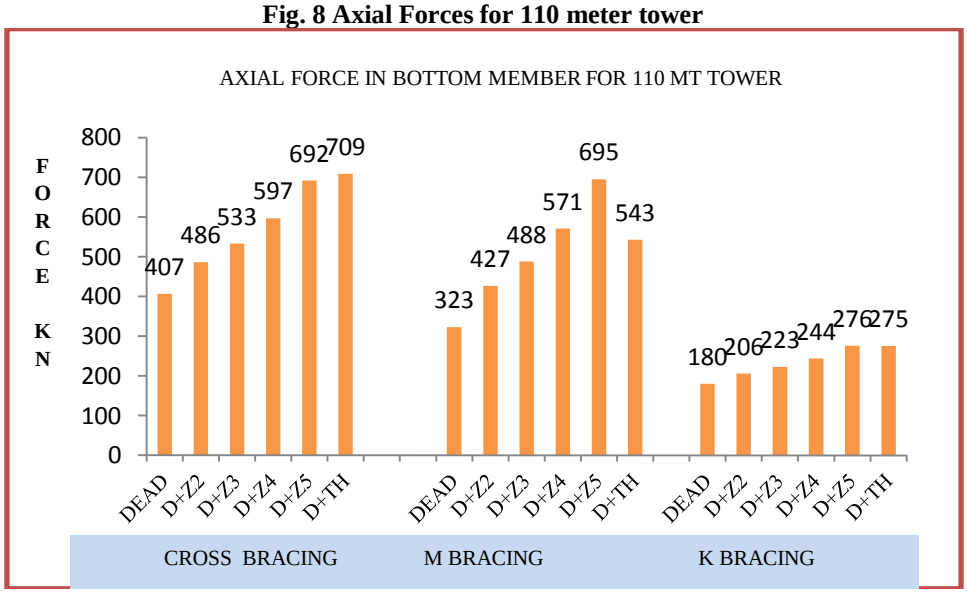


Fig. 9 Base shear for 150 meter tower

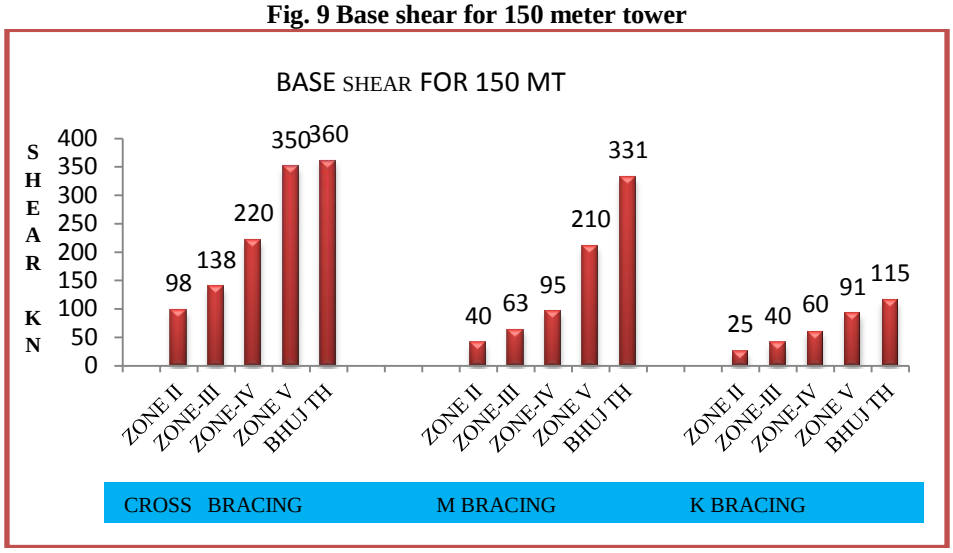


Fig. 10 Axial Forces for 150 meter tower

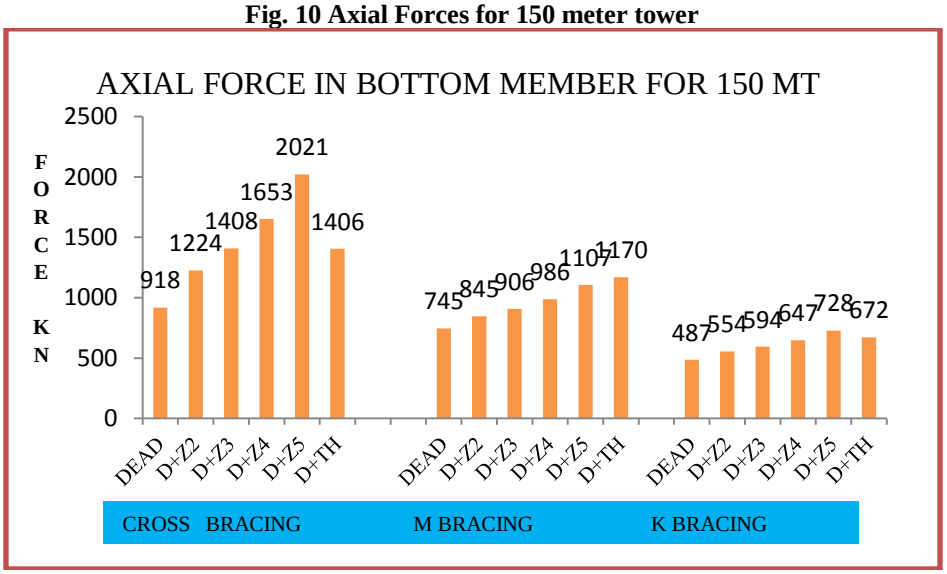


Fig. 11 Base shear for 175 meter tower

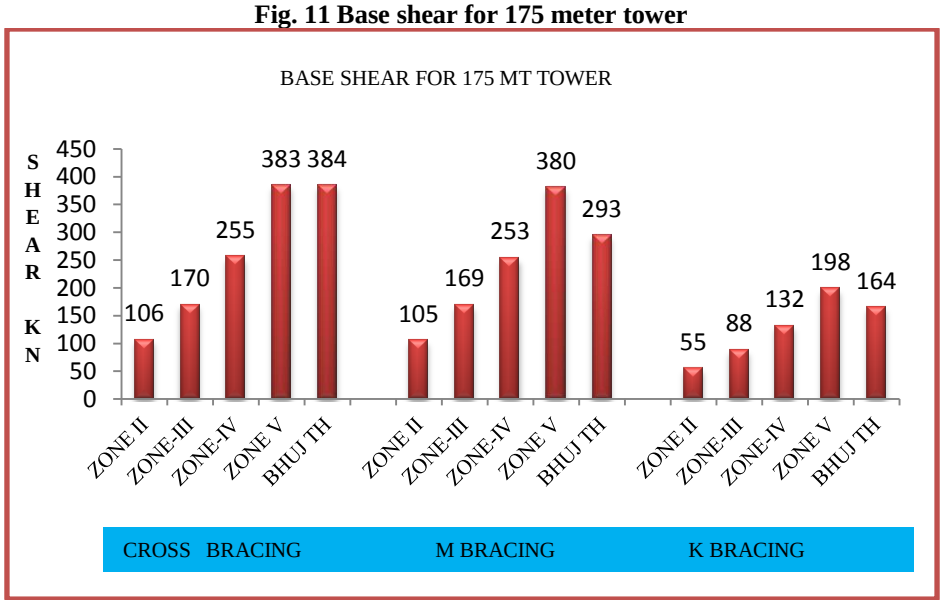
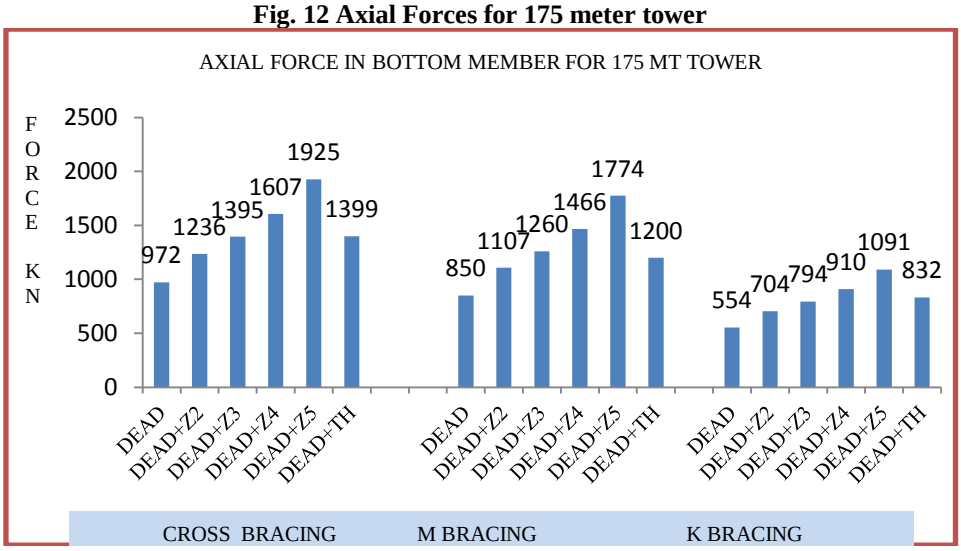


Fig. 12 Axial Forces for 175 meter tower



II. Conclusions

Figure 5 to 12 shows the details of base shear for zone-2 to zone-5 as per I.S.-1893-2002 and Bhuj time history considering different bracing system. The graph also shows the axial forces in bottom member of the tower for different seismic zones.

The following conclusions were drawn from the study.

[1] As the height of tower increase the weight of the tower increase, and hence the earthquake forces at the base i.e. base shear increases. We are getting maximum base shear for cross type bracing system in all 4 towers, hence the cross bracing is most uneconomical system for tall towers.

[2] For the 80 meter high tower we are getting minimum base shear in the M bracing system so it is economical for the medium height tower up to 80 meter height.

[3] As the seismic zone changes the earthquake forces increases and the increase of forces are linear.

[4] We are getting minimum value of base shear in K type bracing for 110 meter, 150 meter and 175 meter high towers. So K type bracing is most economical system to resist seismic forces for tall towers.

[5] The axial forces in bottom member due to the dead+ seismic forces are also less in m type bracing for 80 meter tower so it is economical bracing system for medium height towers.

[6] The axial forces in bottom member due to the dead+ seismic forces are less in K type bracing for 110 to 175 meter tower so K type system is economical bracing system tall tv towers.

[7] The base shear for 175 meter tower by static method is 31 percentages higher than dynamic method so for seismic analysis of tall structures dynamic methods such as response spectrum or time history method must be used.

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