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Severity of Earthquake Forces against Wind Forces for Multistorey RCC Building

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ABSTRACT: *By virtue of its height, multistorey buildings are affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. In some cases effects of earthquake are found to be dominant and more critical than wind effects and in some cases wind effects are dominant. This depends on various factors defined by IS codes. Seismic zone V and wind zone VI are the most severe zones for earthquake and wind respectively according to IS codes. Hence in this paper an attempt has been made to analyze multistorey buildings situated in wind zone VI and compare their performance to the buildings situated in seismic zone V of India so as to study the severity of wind forces against seismic forces. This analysis is done according to the Indian standard codes IS: 875 and IS: 1893 (Part 1) for wind and earthquake respectively. Multistorey buildings are modeled and analyzed by software ETABS. Design parameters such as storey shear, storey displacement, storey drift are calculated and compared for all models, so that the severity of wind forces against earthquake forces can be checked for different heights of the building.*

Keywords: *Multistorey building, seismic analysis, wind analysis*

I. INTRODUCTION

Indian sub-continent is highly vulnerable to natural disasters like earthquakes, draughts, floods, cyclones, landslides, avalanches etc. Majority of states or union territories are prone to one or multiple disasters. These natural calamities are causing many casualties and innumerable property loss every year. There has been an increasing trend in the occurrence of hazardous events over the last few decades. High wind storms occur in many parts of India, the coastal states of Gujarat, Tamilnadu, Andhra, Orissa and West Bengal get more seriously affected because of the occurrence of cyclonic storms [1]. Each such storm causes widespread damage. Also, a large portion of India is susceptible to damaging levels of seismic hazards. Hence, the response of structures under wind and earthquake effects are very important area where the researchers should concentrate and bring out effective disaster mitigating techniques so that the structures remain in function. In case of low-rise buildings effects of earthquake and wind are not so important during designing. But as height of buildings goes on increasing, the effects of both earthquakes and wind are increases. Therefore, it is essential to consider effects of lateral loads induced from earthquakes and wind. The effects can be found out by analyzing buildings for earthquake and wind forces. In present study, four buildings with different heights are modeled to know the effects of height on performance of building under wind and earthquake forces so as to check the severity of earthquake forces against wind forces.

Importance of multistorey building and its study

Population of India is increasing at alarming rate. This large population not only needs job but also needs housing and infrastructure facilities. With the advent of Industrial policy most Industries are coming in middle level cities and large cities. Hence, large population is migrating to these cities. Thus, the number of structures and buildings required for them is very large in these cities. This massive population increase will put great pressure on agriculture land near big and middle level cities. Medium or Hi-rise would be the only answer to this urbanization .Land will become scarce and therefore, there will be the urgent need to build multistorey structures in greater number in middle level cities also. At present these cities are expanding horizontally in mix manners but with the scarcity of land there is need for vertical expansion. This is specially needed for saving the agriculture land for growing food items. Hence, the concept of multistoried buildings or Hi-rise buildings comes into existence.

II. MODELING WITH ETABS

In present study, analysis of muiltistorey building in most severs zones for wind and earthquake forces is carried out. Here the buildings situated at wind zone VI and earthquake zone V are taken for analysis .3-D model is prepared for G+5, G+10, G+15, and G+20 multistorey building in ETABS. Building has typical plan size 24m×42m.Fig.1 shows position of beams, columns and shear wall in plan of building for all the floors.

The basic parameters considered for the analysis.
Typical storey height: 3m
Foundation: column is fixed at support
Slab depth: 125 mm thick
Live load in office area: 4 kN/sq m
Live load in passage area: 4 kN/sq m
Live load in urinals: 2 kN/sq m
Floor finish load: 1.5 kN/ sq m
Stair case loading: 4 kN/sq m
Urinal area: 192 sq m

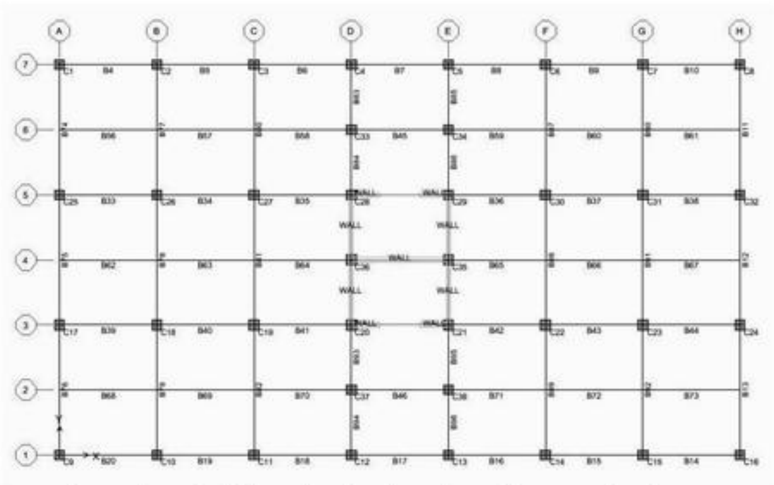

Fig.1 Plan of building showing location of beams and columns

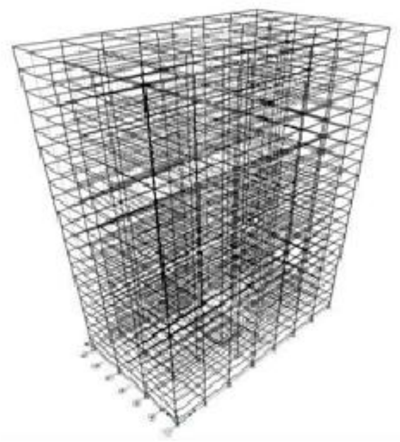

Fig.2 Elevation in 3D

Earthquake parameters considered [2]
Zone: V
Soil type: Medium soil
Importance factor: 1
Seismic zone factor: 0.36 for zone V
Earthquake load in X direction
Rigid frame diaphragm
Method: Response spectrum method
Wind parameters considered [3]
Zone: VI
Basic wind speed: 50 m/s
Opening in the building: 50%
Terrain category: 1
Risk coefficient: 1

Wind load in X direction
Rigid frame diaphragm
Material Grade: M20, Fe415
Codes used: IS 875: 1987, IS 456:2000, IS 1893:2002(part 1)

The sizes of members in different model have been taken as per strength requirements. For all models the sizes are curtailed at intermediate storey to achieve economy and reduce dead weight of structure. Table.1 shows the sizes of structural elements used in the analysis.

Table.1 Sizes of structural elements

Building	Shear wall thickness	Floor	Beam type	Beam sections	Column sections
G+5	100 mm	Foundation to ground floor	Main	0.25m x0.5m	0.5m x0.5m
		1st floor to 5th floor	Main	0.25m x0.5m	
			Secondary	0.23m x0.3m	
G+10	200 mm	Foundation to ground floor	Main	0.3m x0.45m	0.6m x0.6m
		1st floor to 10th floor	Main	0.3m x0.45m	
			Secondary	0.23m x0.38m	
G+15	200 mm	Foundation to ground floor	Main	0.25m x0.5m	0.75m x0.75m
		1st floor to 7th floor	Main	0.25m x0.5m	
			Secondary	0.23m x0.4m	
		8th floor to 15th floor	Main	0.25m x0.5m	0.6m x0.6m
			Secondary	0.23m x0.4m	
G+20	250 mm	Foundation to ground floor	Main	0.3m x0.55m	0.9m x0.9m
		1st floor to 10th floor	Main	0.3m x0.5m	
			Secondary	0.25m x0.45m	
		11th floor to 20th floor	Main	0.25m x0.5m	0.6m x0.6m
			Secondary	0.25m x0.45m	

III. RESULTS AND DISCUSSIONS

The variation of storey shear, storey displacement, and storey drift are evaluated for all the models. Comparison of results obtained from earthquake analysis with wind analysis is shown in fig.3, 4, and 5.

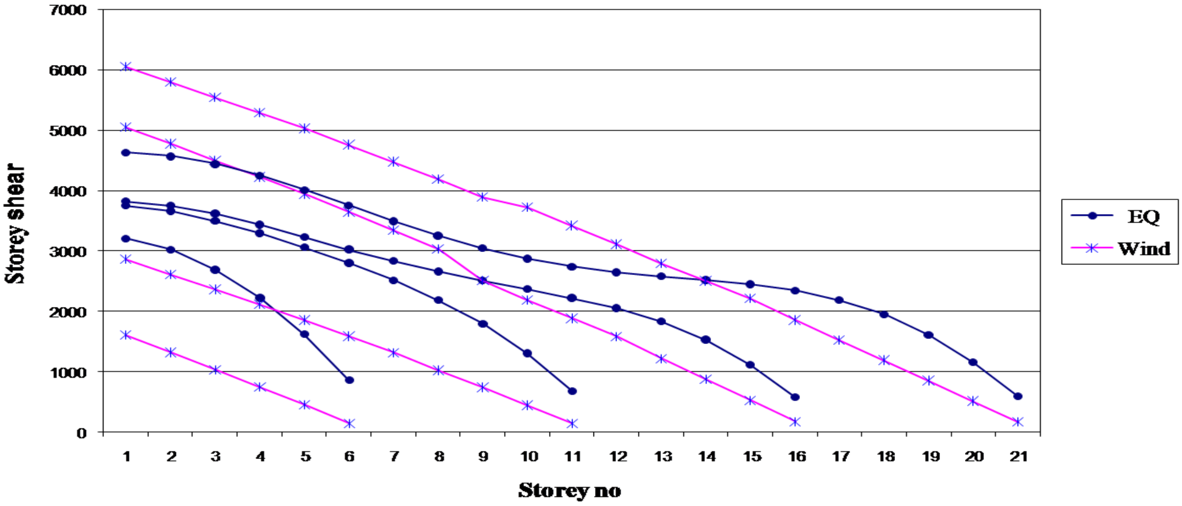

Fig.3 Comparison of storey shear in kN for wind and earthquake effect

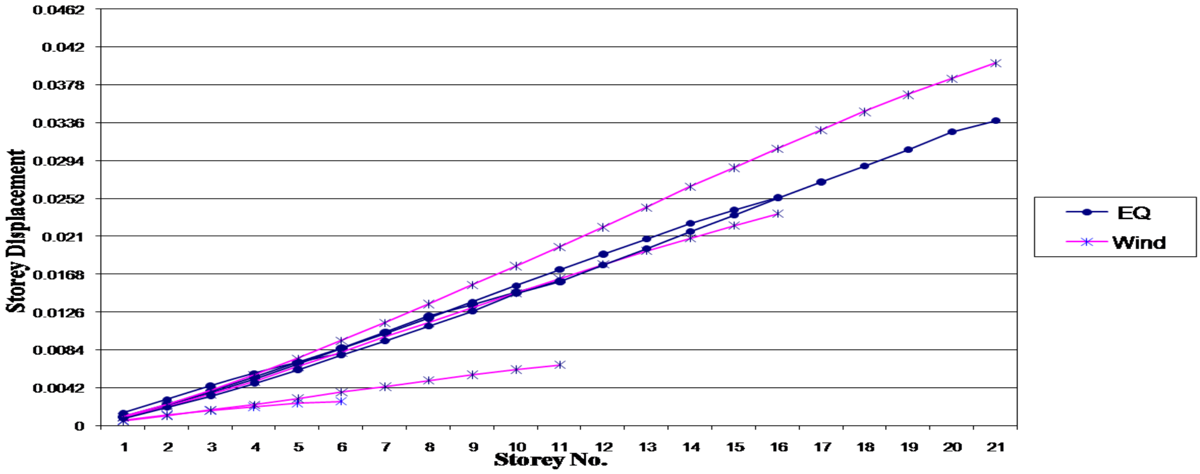

Fig.4 Comparison of storey displacement in meter for wind and earthquake effect

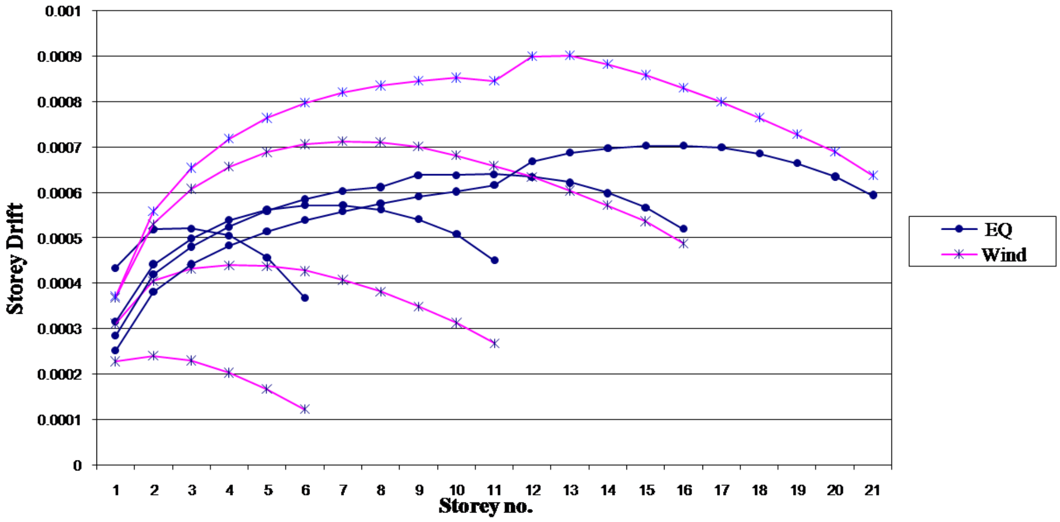

Fig.5 Comparison of storey drift in meter for wind and earthquake effect

From the above graph it is observed that height of building affects the structural behavior of multistorey building under earthquake and wind excitation.

Effect on base shear

For G+5 multistorey building, base shear obtained from wind analysis is 49.97% less than that obtained from earthquake analysis. For G+10 multistorey building, base shear obtained from wind analysis is 23.75% less than that obtained from earthquake analysis. However, the base shear obtained from wind analysis for G+15 is 30.55% more than that obtained from earthquake analysis. For G+20 multistorey building, base shear obtained from wind analysis is 30.66 % more than that obtained from earthquake analysis.

Effect on storey displacement

For G+5 multistorey building, top Storey displacement obtained from wind analysis is 66.25% less than that obtained from earthquake analysis. For G+10 multistorey building, top Storey displacement obtained from wind analysis is 58.12% less than that obtained from earthquake analysis. For G+15 multistorey building, top Storey displacement obtained from wind analysis is 7.11% less than that obtained from earthquake analysis. However, the top Storey displacement obtained from wind analysis for G+20 is 15.92% more than that obtained from earthquake analysis.

Effect on storey drift

For G+5 multistorey building, maximum storey drift obtained from wind analysis is 54.03% less than that obtained from earthquake analysis. For G+10 multistorey building, maximum storey drift obtained from wind analysis is 23.12% less than that obtained from earthquake analysis. However, the maximum storey drift obtained from wind analysis for G+15 is 11.26% more than that obtained from earthquake analysis. For G+20 multistorey building, maximum storey drift obtained from wind analysis is 28.20% more than that obtained from earthquake analysis.

IV. CONCLUSION

The effect of both earthquake forces and wind forces on multistorey building increases with increase in height of building. It is observed that base shear and storey drift is less in case of wind analysis for G+5 and G+10 building whereas for G+15 and G+20 building it more in case of wind analysis. Effect of earthquake forces compared with the effect of wind forces on performance of muiltistorey buildings situated in seismic zone V and wind zone VI, earthquake is less effective than wind effect for tall buildings since tall buildings are more flexible and for short buildings earthquake is found to be more effective. Hence the severity of wind forces increases from medium rise to high rise building than that of earthquake forces. Building should be design for more sever load to achieve safer design under both earthquake and wind excitation.

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