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Effect of Floor Height in Multi-Storied R.C. Frame Buildings

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Abstract—*There are many factors that guide the safety and soundness of any building. One of the most important factors is the building's height. This is again governed by the number of stories and the story height. In this research we are to find out how the floor-to-floor height of a building affects its design parameters. Also, we will try to relate this varying floor height with the number of stories in the building. Tall commercial buildings are primarily a response to the demand by business activities to be as close to each other, and to the city centre as possible, thereby putting intense pressure on the available land space. Therefore, it is necessary to analyse seismic behaviour of building for different heights to see what changes are going to occur if the height of conventional building changes. By virtue of its height, multi-story 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. Hence in this paper an attempt has been made to analyse multi-storied buildings with respect to their number of story and story-height conforming to IS 1893: 2002 for earthquake forces.*

Keywords: *Story height, pushover analysis, base shear, performance point*

1. 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. 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 increases. Therefore, it is essential to consider effects of lateral loads induced in the buildings. The effects can be found out by analysing buildings for different story height and different number of stories. In present study, twenty buildings with different story heights and number of stories are modeled to know the effects of story height on a particular multi-storied building and its performance under different forces so as to check the various structural parameters.

2. METHODOLOGY

In this research work, SAP 2000 V14 software is used. Various models of RCC frames have been prepared for analysis and design. Each model has an outer dimension of 16m x 12m. There are in total 4 bays in X-axis and 3 bays in Y-axis. Each slab is of dimension 4m x 4m.

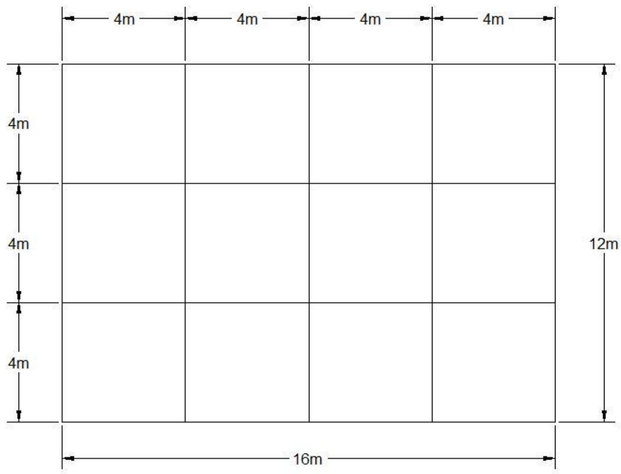

Fig. 1: Plan of the buildings.

Different story heights of 3m, 3.2m, 3.4m, 3.6m, 3.8m has been used. A total of 4 kinds of model have been prepared for detailed study. 5 story, 8 story, 10 story and 12 story models have been made. Thus a total of 20 numbers of models have been prepared varying the total height of the model from 15m to 45.6m.

The beam and column size of all the models for a particular set of buildings (story-wise) has been kept same for the ease in purpose of comparing. The thickness of slab is kept as 150mm for all the models. M25 grade concrete is used and Fe500 HYSD rebar is used.

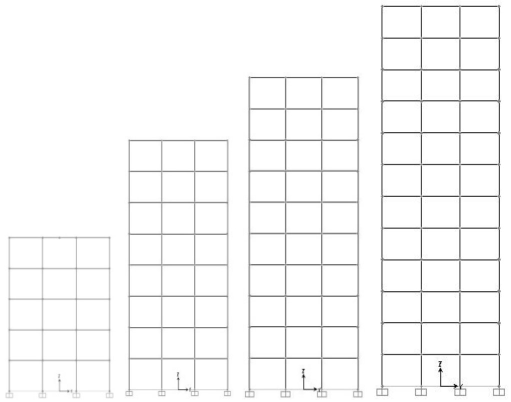

Figure 2: Elevation of Buildings.

Table 1: Details of Beams and Columns.

12 story (floor)	Column Size	Bar dia.	No. of bars	% of Steel
1st to 4th	600x600	25 mm	16	2.18 %
5th to 7th	500x500	20 mm	16	2.01 %
8th to 10th	400x400	16 mm	16	2.01 %
11th & 12th	300x300	12 mm	16	2.01 %
Beam Size	300x400			
10 story				
1st to 4th	500x500	20 mm	16	2.01 %
5th to 8th	400x400	16 mm	16	2.01 %
9th & 10th	300x300	12 mm	16	2.01 %
Beam Size	300x350			
8 story				
1st to 3rd	500x500	25 mm	12	2.35 %
4th to 6th	400x400	20 mm	12	2.35 %
7th & 8th	300x300	16 mm	12	2.68 %
Beam Size	250x300			
5 story				
1st to 3rd	400x400	20 mm	12	2.35 %
4th to 5th	300x300	16 mm	12	2.68 %
Beam Size	250x250			

Seismic zone V is considered for the analysis purpose of the structures conforming to IS 1893: 2002. Different load patterns used in the research work are Dead Load, Live Load, Roof Live Load, Infill and Earthquake Load. A total of 13 load combinations are used which are as per the provisions of IS code.

Table 2: Load Combinations.

Sl. No.	Load Combinations
1	1.2(DL+LL+EQLx)
2	1.2(DL+LL-EQLx)
3	1.2(DL+LL+EQLy)
4	1.2(DL+LL-EQLy)
5	1.5(DL+EQLx)
6	1.5(DL-EQLx)
7	1.5(DL+EQLy)
8	1.5(DL-EQLy)
9	0.9DL+1.5EQLx
10	0.9DL-1.5EQLx
11	0.9DL+1.5EQLy
12	0.9DL-1.5EQLy
13	1.5(DL+LL)

All the models are then analyzed by SAP. Static linear analysis is performed to get the results. Then the models are designed by the software conforming to IS 456: 2000. From the modal analysis results, natural time period of vibration of the structures and their natural frequencies are collected and plotted for comparison. Then pushover analysis is done and the performance points of all the models are determined.

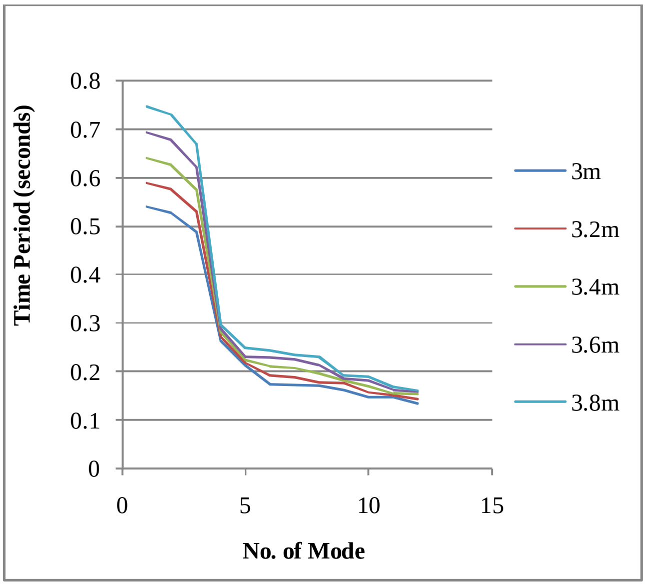

Fig. 3: Time periods for 5 story buildings.

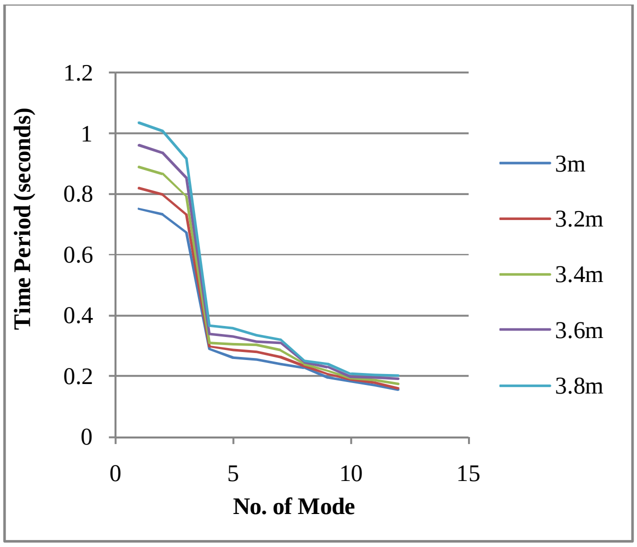

Fig. 4: Time periods for 8 story buildings.

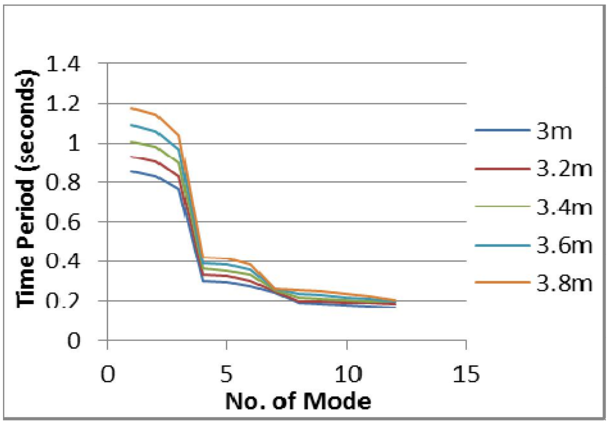

Fig. 5: Time periods for 10 story buildings.

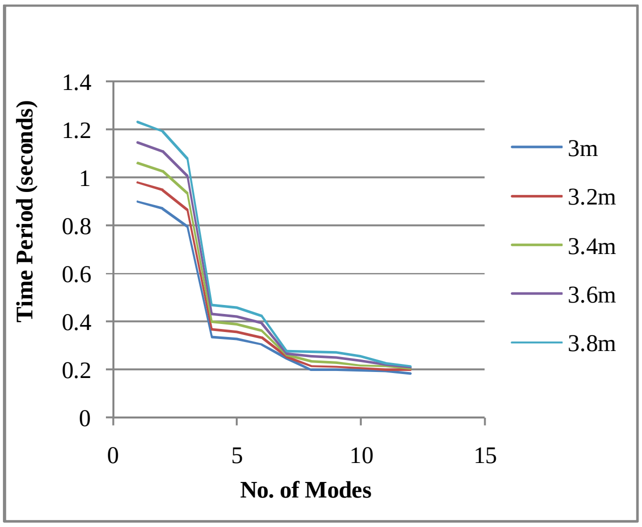

Fig. 6: Time periods for 12 story buildings.

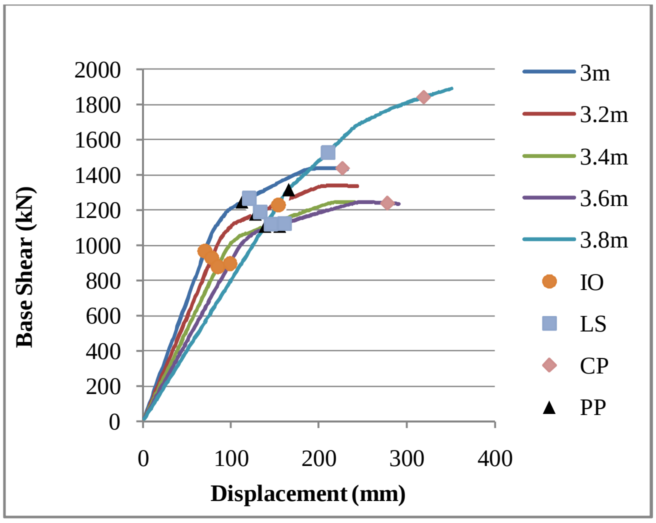

Fig. 7: Base Shear vs Displacement for 5 story building.

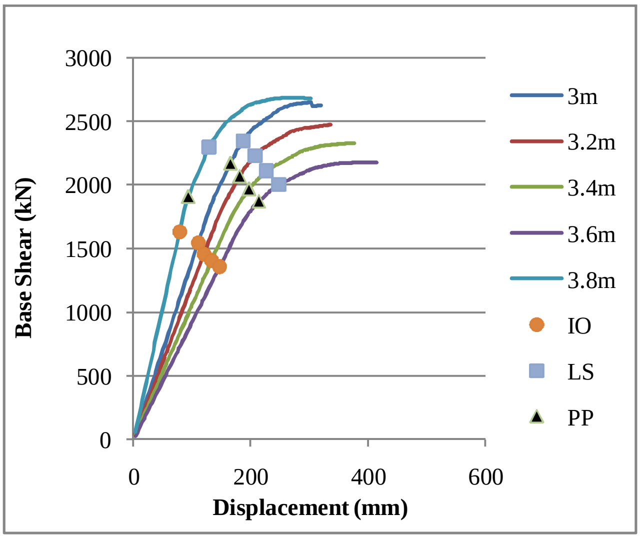

Fig. 8: Base Shear vs Displacement for 8 story building.

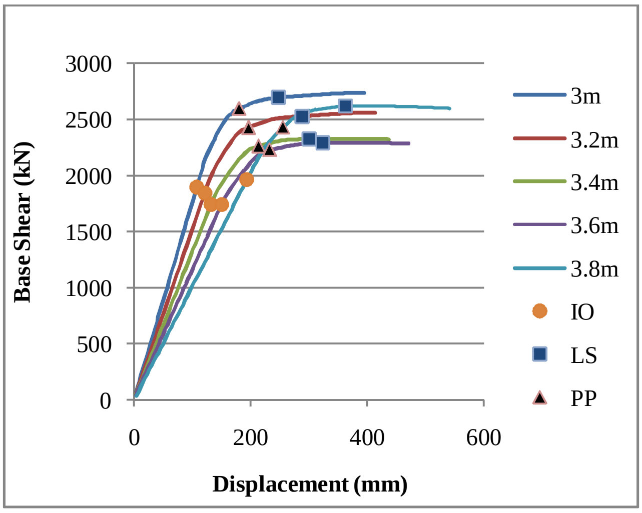

Fig. 9: Base Shear vs displacement for 10 story building

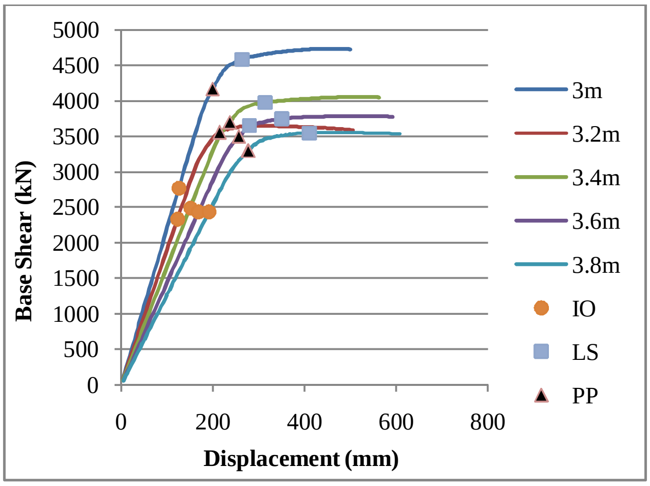

Fig. 10: Base Shear vs Displacement for 12 story building

IO : Immediate Occupancy

LS : Life Safety

CP : Collapse Prevention

PP : Performance Point

3. CONCLUSION

Thus it can be concluded, as the number of floor and the floor height increases i.e. the height of the building increases, the time period of its vibration increases. But the change is noticeable only in the first three modes. Also, it is observed that the performance point of all the models lie under life safety condition. Also, it is noted that the base shear decreases for a particular displacement in most of the cases as the story-height of the building is increased. Hence, the floor height for a particular storied building plays a vital role in the seismic behavior of the building. The proper evaluation of other parameters may also be carried out to evaluate the seismic behavior of the building with varied floor height.

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