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Influence of Storey Height on Seismic Behaviour of Structure with and without Infill Wall

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ABSTRACT

Buildings are basically designed to support vertical loads by structural components. An earthquake presents a lateral or sideways load to the building structure which is more complicated to account for. One way to make this structure more resistant to these lateral forces is to tie the walls, floors, roof and foundation into a rigid box that holds together when shaken by a quake. In this work, simplified inelastic analytical procedure commonly referred as 'Push-over Analysis' is adopted to estimate seismic response of high rise structure with and without infill walls. The effect of masonry infill panel on the response of RC frames subjected to seismic action is widely recognized and has been subjected to numerous experimental investigations. For the analysis, G+5 and G+10 RCC framed buildings are modeled and analyzed using IS 1893:2002 Part-I codal provisions, and the results of the analysis are interpreted and discussed.

1. Introduction

The construction of high rise building to accommodate more and more people especially in the metropolitan cities has increased with the decrease in land area available for the construction in India, the second most populated country in the world. Also the skyscrapers have become a symbol of economic growth of a developing or a developed country and so the desire of any country to own more and more tall and magnificent building is quiet natural. Even with all odds like accommodating for the sway and stretch of the skyscrapers due to wind loads, temperature, much deeper foundations etc., the researchers and the builders having been successful in achieving great heights for their buildings. But again to add to all these complexities, one of the most threatening odds against the construction of high-rise building is the lateral loads acting on the structure due to the frequently occurring earthquakes which has to be tackled. The earthquake cause shaking of the ground radiating from the epicenter and so, a building resting on it will undergo movements at its base. The vibration of the ground takes place randomly back and forth in all the 3 directions – along 2 lateral directions say, X and Y and in direction of height say, z. As all the structures are firstly designed for gravity loads which are downward or vertical loads as the vertical acceleration for the period of ground quaking either adds or subtracts from the gravitational acceleration, the structures will be safe in comparison with vertical shaking. But, horizontal shaking will be a concern as the structure designed to resist vertical loads may not be able to safely withstand the effects of the horizontal ground vibration. These lateral ground shaking results in structure vibration and induces inertia forces in them. Hence, the structure should also be design to resist these horizontal forces to ensure structural safety.

2. Objectives

a) To establish the influence of storey heights on seismic performance of high rise building with and without infill walls.
b) To study the analysis results such as joint displacement, base shear and storey drifts and to locate potential plastic hinge zones.
c) To evaluate the stiffness of the structure with and without infill walls.

3. Methodology

Since earthquake forces are random in nature and unpredictable, the static and dynamic analysis of the structures have become the primary concern of civil engineers. One of the emerging fields in seismic design of structures is the Performance Based Design.

Method of Analysis: There are many analysis methodologies of framed structures exposed to earthquake loads.

a) Linear-Static-Methods
b) Linear-Dynamic-Method
c) Non-Linear-Static-Method
d) Non-Linear-Dynamic-Method

In this study, we are considering a Non-linear-static-method in the form of Pushover analysis for the seismic-performance of RC framed-structure.

4. Model Detailes

In the present study, G+5 and G+10 storey buildings are considered. The typical floor height was taken as 3.0m and plinth level being 1.5m from the base providing a total height of the two structures be 19.5m and 34.5m respectively.

Geometric properties, Material properties and the Structural properties are assigned to the models

.Support condition	Fixed
Slab thickness	130mm
column sizes:	(300X600)mm
Beam sizes:	(230X450)mm
Grade of Concrete & Steel	M25 & HYSD 415
Type of structure	SMRF
Damping ratio	5%
Zone factor	0.16
Importance factor	1
Type of soil	B type
Reduction factor	5

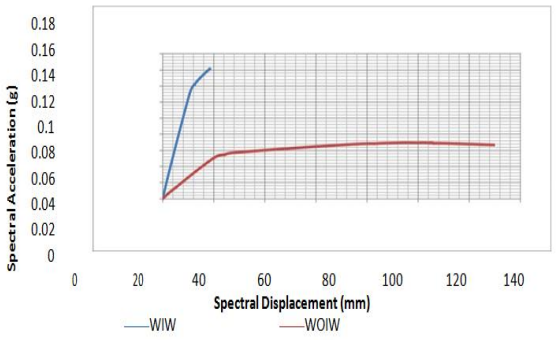
Table.1 Preliminary data

5. Results and Discussion

Results of Analysis of E-tabs are noted down below:

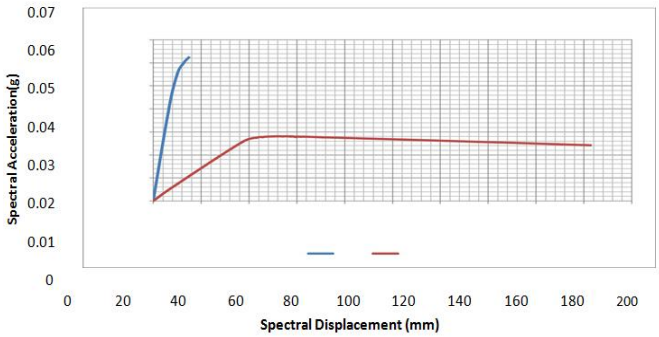
5.1 For Spectral Displacement

5 Floors Building



Graph 1 Acceleration V/S Displacement

10 Floors Building

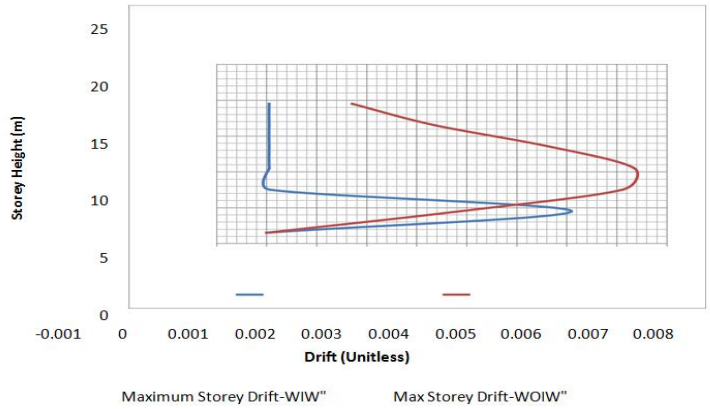


Graph 2 Acceleration V/S Displacement

There is considerable reduction in spectral displacement for model with infill walls in comparison with that without infill walls and that is for both 5 floor building and 10 floor building.

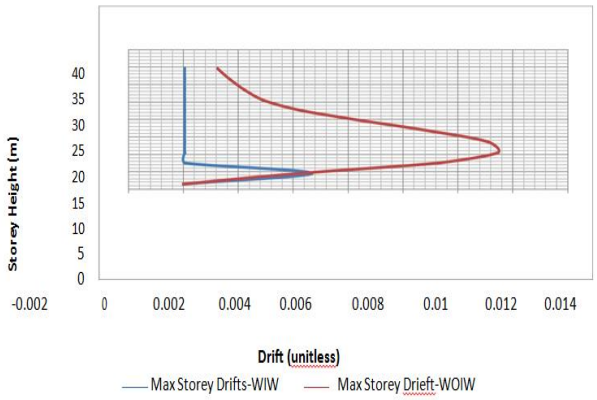
5.2 For Storey Drift

5 Floors Building



Graph3: Maximum storey drift

10 Floors Building



Graph4: Maximum storey drift

Its significant behavior of storey drift being constant above 10m storey height in structure with infill wall is also noticed.

6. Hinge Result

6.1 For 5 Storey Building

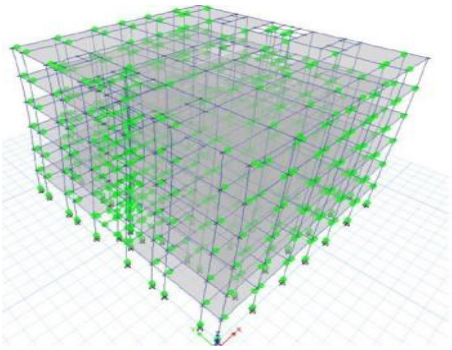


Fig. 1 Without Infill Wall

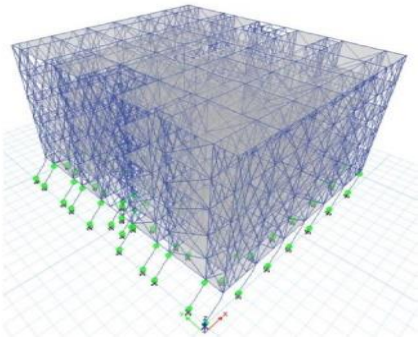


Fig. 2 With Infill Wall

6.2 For 10 Storey Building

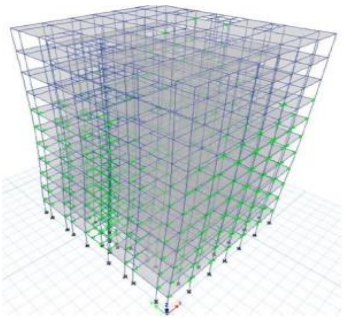


Fig.3 Without Infill Wall

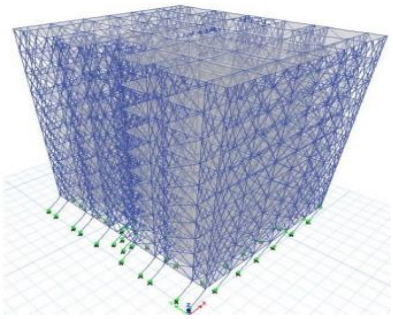


Fig. 4 With Infill Wall

In structure without infill wall the pattern of hinge formation being from the ground floor then distributes through different storey level as the step proceeds whereas in structure with infill wall the hinge formation is primarily localized at P-Storey since it is a soft storey without infill. But there are no hinge formations in storey above as a recent of addition stiffness in corporate by infill walls.

7. Conclusion

- For five storeys building there is **86.15%** reduction in spectral displacement for model with infill walls in comparison with that without infill walls.
- For ten storeys building there is **92.30%** reduction in spectral displacement for model with infill walls in comparison with that without infill walls.
- For five storeys building there is **55.88%** reduction in storey drift for model with infill walls in comparison with that without infill walls.
- For ten storeys building there is **68.57%** reduction in storey drift for model with infill walls in comparison with that without infill walls.

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