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Dynamic Analysis of Multistorey Buildings Having Combination of Floating Columns and Shearwalls

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Abstract:

Due to a lack of space, population, and aesthetic and functional needs, multi-story structures in metropolitan areas are now obliged to include column-free space. Buildings with one or more storeys are equipped with floating columns for this purpose. The building of these floating columns is extremely hazardous in earthquake zones. The earthquake forces that emerge at different levels of a building must be carried down the shortest path along the height to the ground. The building's performance suffers as a result of any deviation or discontinuity in this load transfer line. The object of the present work is to study the behaviour of multistorey buildings having floating columns under seismic forces and observe the effect of shear wall in the same building. For this purpose three cases of multi-storey buildings are considered having 6 storey, 9 storey and 12 storey. All the three cases are considered having floating columns provided with different shapes of shear walls and without shear wall, and analyzed for zone V by using software Staad.Pro with static and dynamic analysis methods. Observation shows that the provision of floating columns is advantageous but is a risky factor and increases the vulnerability of the building. From the results it is observed that by the use of shear walls storey drift and lateral displacement values reduces in all the models. For this validation of results is also carried out.

Keywords — **Floating Column, Shear Wall, Seismic, Lateral Displacement, Storey Drift.**

I. INTRODUCTION

A column can be defined as a vertical part that starts from the foundation and transfers the load to the lowest level. A floating column is defined as a vertical element that stops at its lowest level and rests on a beam that is a horizontal member. As a result, the load is transferred to other columns below the beams. These structures can theoretically be evaluated and created. True columns below the termination level, on the other hand, are not built with care and are more prone to failure.

A shear wall is a structure designed to resist shear caused by lateral forces. Shear wall design for high-rise buildings is required by several codes. When the centre of gravity of the building area and the weights acting on the structure diverge by more than 30%, shear walls are required. Concrete walls are given to bring the centre of gravity and centre of stiffness within a 30 percent range, ensuring that lateral forces do not increase significantly. Shear walls begin at the foundation and continue up the building's height. Shear walls, like wide beams that transport earthquake stresses downhill to the foundation, are oriented vertically and are typically installed along the breadth and length of buildings. Shear walls in structures built in seismically active areas require specific attention. Shear walls are simple to build since wall reinforcement detailing is straightforward and simple to execute on the job site. Shear walls are cost-effective both in terms of construction and in terms of reducing earthquake damage to structural and nonstructural elements.

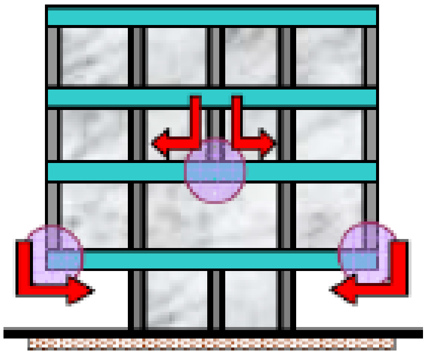

Fig. 1 Floating Column

II. OBJECTIVES

In the present work different cases of multistorey buildings having floating columns have been taken to study the behaviour under seismic loading. The objectives of the present work are:

1. To study the seismic behaviour of different multi-storey buildings with varying number of storeys along with having floating columns.
2. To perform the dynamic analysis of the multistorey buildings for lateral forces considering seismic zone V.
3. To study the effect of shear walls in the same buildings under the seismic forces for zone V.
4. To compare the behaviour of multi-storey buildings having floating columns with and without shear walls under earthquake loads.

III. METHODOLOGY

The object of the present work is to compare the behaviour of multi-storey buildings having floating columns with and without shear walls under seismic forces by using static and dynamic analysis. For this purpose three cases of multi-storey buildings are considered. To reduce lateral displacement and storey drift shear walls of different shapes in center have been provided.

In case-I, total 6 storeys are provided. Building area provided is 28 m x 28 m upto lower 3 storeys and 36 m x 36 m upto upper 3 storeys.

In case-II, total 9 storeys are provided. Building area provided is 28 m x 28 m upto lower 3 storeys and 36 m x 36 m upto upper 6 storeys.

In case-III, total 12 storeys are provided. Building area provided is 28 m x 28 m upto lower 3 storeys and 36 m x 36 m upto upper 9 storeys.

To study the behavior the response parameters selected are lateral displacement and storey drift. All the cases are assumed to be located in zone V and analyzed by static and dynamic methods using Staad.Pro software. All the three cases are analyzed with and without shear wall.

TABLE I Summary of Variables

Parameters	Variables
Zone	V
Position of Shear Walls	No Shear Walls, BoxSW, CSW, LSW
Plot size	28m x 28m upto lower 3 storeys in all cases.
Case-I	36m x 36m in upper 3 storeys
Case-II	36m x 36m in upper 6 storeys
Case-III	36m x 36m in upper 9 storeys

IV. RESULTS AND DISCUSSIONS

The study examines the performance of floating columns in multi-storey buildings of different heights with box, C shape, L shape shear walls and without shear walls for seismic forces in zone V using static and dynamic analysis methods. As it is discussed earlier that use of floating columns in buildings makes the structure more vulnerable under seismic loading, therefore, in present work floating columns are provided in different buildings with different shapes of shear walls also.

Storey Drift

1. According to IS:1893:2002 (part I), maximum limit for storey drift with partial load factor 1.0 is 0.004 times of storey height. Here, for 4.0m height and load factor of 1.5, though maximum drift will be 24mm.
2. It is observed from results that for all the cases considered drift values follow around similar path along storey height with maximum value lying somewhere near about 1st storey.
3. In all the models it is observed that by providing shear wall drift values reduces as compared to without shear wall models in both the methods of analysis.

4. From the results it is observed that drift values of dynamic analysis are less in comparison to static analysis. Hence it may be preferable to adopt dynamic analysis method in practice.
5. It is observed that with the increase of number of storeys values of storey drift also increases.
6. For improving these drift conditions of buildings having floating columns in using static analysis method also, the stiffness of columns should be increased or thickness of shear wall should be increased.

Lateral Displacement

1. According to IS:456:2000, maximum limit for lateral displacement is H/500, where H is building height. For 6 storey building model it is 48mm, for 9 storey building model it is 72mm, for 12 storey building model it is 96mm.
2. It is observed from results that for all the models considered displacement values follow around similar gradually increasing straight path along storey height.
3. By providing shear wall displacement values reduces as compared to without shear wall models in both static and dynamic analysis.
4. The lateral displacement is maximum at the top storey and least at the base of the structure.
5. As compared to with and without shear wall building models, values of displacement are more in case of without shear wall.
6. From the results it is observed that displacement values of dynamic analysis are less in comparison to static analysis. Hence it may be preferable to adopt dynamic analysis method in practice.
7. It is observed that with the increase of number of storeys values of displacement also increases.
8. As limiting value of displacement in 6 storey is 48mm, in 9 storey is 72mm and in 12 storey it is 96mm. In all the cases both in static and dynamic analysis methods due to the higher zones models fails at higher storeys. To improve this behavior from past researches it is suggested to increase sizes of columns to reduce the displacement values.

V. VALIDATION OF RESULTS

From the study it is observed that storey drift is safe in all the models except in 12 storey model. But lateral displacement crosses its permissible limits in all the models. So it is been recommended to increase the sizes of columns or shear walls.
Here to obtain structure safe, sizes of floating columns are increased from 0.4m x 0.4m to 0.6m x 0.6m and shear wall thickness is increased from 0.15m to 0.30m. After increasing the column sections as expected improved results are observed.
In 6 storey building models is crossing the permissible limit in case of without shear wall models with static analysis but it is safe in case of with shear wall and also with dynamic analysis method.
In case of 9 storey building model it fails in case of without shear wall by static analysis but with BSW and CSW it is safe, while it fails in case of LSW. Also with dynamic analysis models fails only in case of without shear wall but it is safe in case of all shear wall models.
In case of 12 storey building model with static analysis it crosses permissible limits in case of without shear wall as well as all with shear wall models also. But with dynamic analysis it fails only in case of without shear wall and with LSW model and it is safe in case of BSW and CSW model.

VI. CONCLUSIONS

Within the scope of present work following conclusions are drawn:

1. For all the cases considered drift values follow around similar path along storey height with maximum value lying somewhere near about 1^{st} storey.
2. For all the models considered displacement values follow around similar gradually increasing straight path along storey height.
3. By providing shear wall storey drift and displacement values reduces as compared to without shear wall models for all the zones.
4. It is observed that drift values and displacement values of dynamic analysis are less in comparison to static analysis. Hence it may be

preferable to adopt dynamic analysis method in practice.

5. It is observed that with increase of number of storeys values of storey drift and displacement also increases.
6. In all the models at some storeys displacement values and drift values crosses the maximum permissible limits in case of static analysis method but it becomes safe in case of building models with dynamic analysis method.
7. But in some cases it is observed that model is not safe at some storeys for both static and dynamic analysis methods. Hence it is advised and validated to increase size of column and shear wall thickness to reduce the displacement and drift values.
8. In comparison to box shear wall, C shape shear wall and L shape shear wall, it is observed that results obtained are better in box shape shear wall models.

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