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## STUDY ON SEISMIC EFFECT OF FLOATING COLUMNS IN STRUCTURAL PERFORMANCE

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### ABSTRACT

Multi-story buildings with floating columns play a virtual part in modern India's construction. Column-free gaps in structural buildings can be filled with these floating columns, which are primarily employed to provide a pleasing architectural perspective. In seismic zones, a floating column has been built for this building at one or more levels. Structures in active prone areas and earthquake zones are the focus of this study, which examines how floating columns affect structural performance. Response spectrum analysis has been presented as a method for studying the impact of earthquakes on structural buildings. Structural response of the structure in relation to time period, story drift and story displacement has been studied. The goal is to arrive at a definitive conclusion. ETABS has been used to conduct the research.

**KEYWORDS:** Stories in Drift, Stories in Displacement, ETABS, Floating Columns, Earthquake.

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### I. INTRODUCTION

Any vertical structural member that transmits load via compression is known as a "column." The structure's weight is dispersed downward from the upper levels to the lower ones. The term "floating column" refers to a column with a lower level that rests on a beam and does not extend to the foundation level. When a building has floating columns, they rest on an intermediate structural element, which does not extend all the way down to the foundation. Load transformation is disrupted in structures with floating columns. Multi-story buildings with an open ground store, whether for residential, commercial, or

industrial use, are becoming more frequent. Typically, the ground floor of a building is left untouched save for the columns that support the weight of the structure. Multi-story buildings in metropolitan locations are often constructed with floating columns at the ground level to provide the aforementioned functions. Gravity loads are taken into account when designing these floating column structures.

Many reinforced concrete (RC) buildings have been damaged by earthquakes in the past for a variety of reasons.

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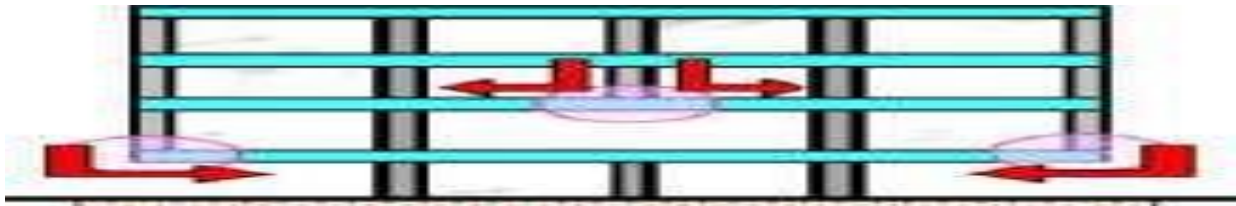
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Inadequate ductile detailing of members and sagging of surrounding structures are all because of the buildings' soft stories, sagging foundations, floating columns, and other mass abnormalities. There has been a great deal of investigation into the procedural assumptions that have been made in various seismic codes in order to analyze seismic

capacity of existing buildings and the inertia force developed at different floor levels need to be brought down along the height of frame through the shortest possible path and any discontinuity in transfer path results in poor performance of the RC building under earthquake excitation.

**Fig1 Typical arrangement of floating column**

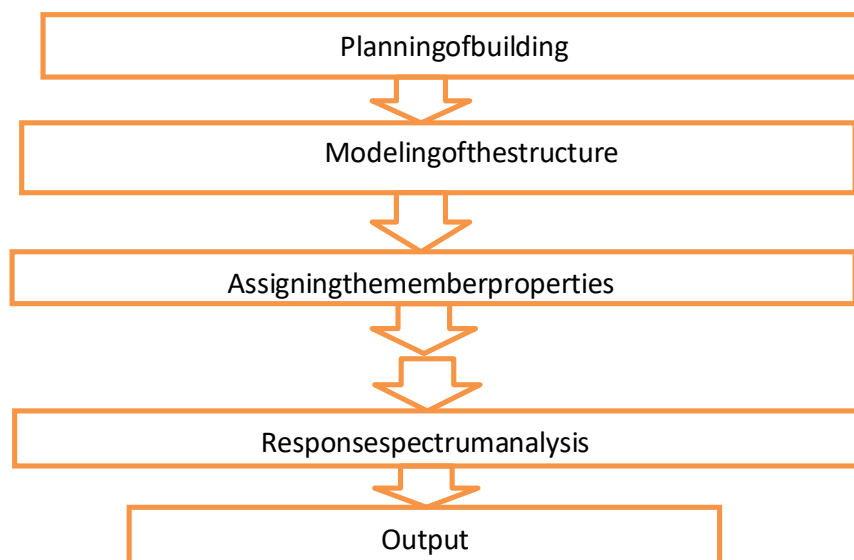


## II. METHODOLOGY

ETABS incorporates all aspects of the engineering design process, starting with the conceptual design and ending with the production of schematic drawings. With commands, we can quickly generate floor and elevation frames as well as execute capacity checks on steel connections and base plates, making the development of buildings much easier.

### MODELING OF BUILDING

Two types of models are designed for the analysis of structure, which is provided with and without floating columns in seismic and normal conditions. This analysis is carried out by using response spectrum method which is based on structural program for the analysis and the interpretation which of the will be expressed in terms of story displacements and story drifts.



**Fig2 Proposed methodology of analysis of floating column.**

## III. SEISMIC BEHAVIOR OF BUILDING WITH FLOATING COLUMN

3.1. During an earthquake, a structure that appears to be robust enough crumbles like a house of cards. Buildings that are built to withstand earthquakes are known as earthquake resistant constructions. The open first floor is a frequent characteristic of many modern multistory structures in India. In accordance with Indian building rules, these structures are meant to withstand large earthquakes. When structures like parking garages or reception lobbies are built with floating columns, earthquakes can quickly bring them down. The response of a structure to an earthquake is largely determined by the structure's size, shape, and geometry, as well as the manner in which earthquake forces are transferred to the soil. A building's seismic forces must be channeled down the structure's height to the foundation using the shortest path possible when the structure is irregular and the load transfer path is unclear, resulting in poor building performance. When compared to a structure with vertical setbacks, such as a commercial building with a few floors that are more extensive than the rest of the stories, a dramatic jump will occur. During the 2001 Bhuj earthquake, numerous structures in Gujarat fell or were seriously damaged.

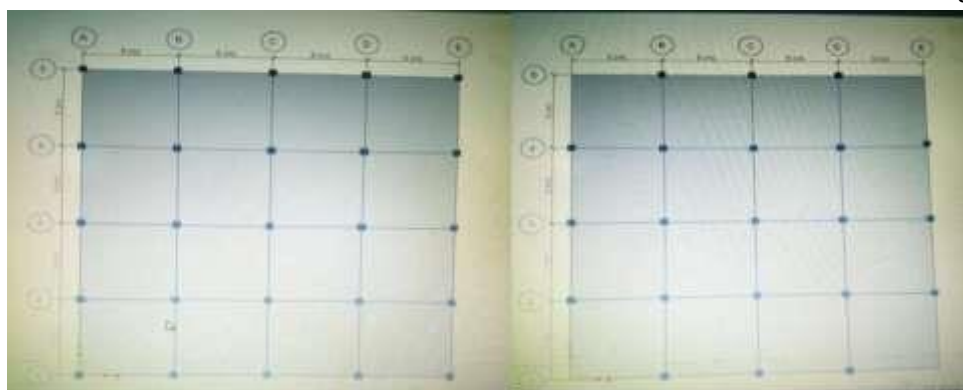
3.2.

Seismic analysis of building with floating column

important part of structural engineering. In earthquake-prone areas, structural design and analysis must include seismic analysis. Investigate story drifts and displacements using response spectrum analysis.

### 3.2.2. Response Spectrum Analysis

There are curves drawn between maximum responses of single-degree-of-freedom systems exposed to their time period or frequency, which are referred to as response spectra. It is possible to obtain the seismic forces created in a building by measuring the peak structural response under a linear range using response spectrum. Similar to each node of vibration in an elastic structure, response spectrum analysis is measured. In order to observe the consequences of earthquakes on a structure, this magnitude of forces must be taken into account. The frequency record is necessary for earthquake analysis of a building in a specific area. In order to determine the design earthquake force, a linear dynamic statistical analysis approach should be used to determine the distribution of this force along the structure's



3.2.1. ETABS can be used to analyze floating column structures utilizing the response spectrum approach. It is utilized to provide a dynamic connection between the floating column and the rest of the floating structure in residential buildings. Under both static and dynamic loads, ETABS can simulate the member linear dynamic performance of plan and space frames. Section geometry's linear dynamic and the material's inelasticity are taken into account. The study of a building's seismic reaction and seismic forces is an

height and to various lateral load resisting parts.

### MODELLING&ANALYSIS

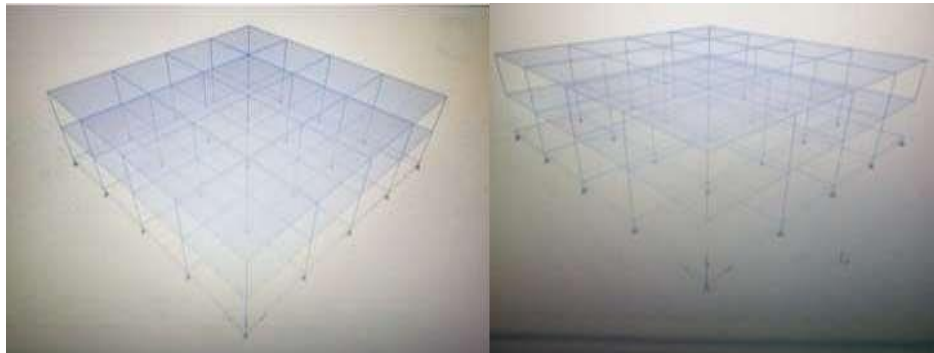
.The column space center-to-center distance is 5 meters in a multi-story building 20 meters by 20 meters of size G+1 and G+5. It is expected that the floor is 3.0 meters high. Seismic loads was assessed on two buildings, one with and one without floating columns. The chosen structures ranged in height from 6 meters to 18 meters. On Type II (medium) soil, it's situated in Zone II & model 2 in Zone-V.

A non-floating and a floating column, the floor elevations of which are depicted in the

It is divided into X and Y directions in the plan's layout. With respect to X-Direction, the grids are displayed in alphabetical sequence (A through E), separated by a distance of five meters (m). There is a 5 m separation between each Y-Direction grid, hence the grids are shown in numerical order, starting with 1, 2, 3, 4, and 5. Between each floor, there is a space of 3 meters. The total number of tales is supplied. "G+1" and "G+5"

Fig3G+1&G+5structurewithoutfloatingcolumn

Fig4G+1&+5structurewithfloatingcolumn  
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picture, are initially modeled in this work.

4.1. ModelingoftheStructure

4.2. Four separate building modifications were made to examine the impact of seismic loading, resulting in a total of four distinct examples. Seismic zones are taken into consideration when selecting building models in this step.

4.3. For the Model 1 FC: G+1 Columns can be floated.

4.4. Non-floating columns are used in place of floating columns in the Model 1 WFC.

4.5. G+5 floating columns are also supplied in the Model 2 FC building.

4.6. • Model 2 WFC: This model is identical to Model 2 FC, except that floating columns are transformed to non-floating columns in this version.

Fig5G+1structurewithoutfloatingcolumn

Fig6G+1structurewithfloatingcolumn

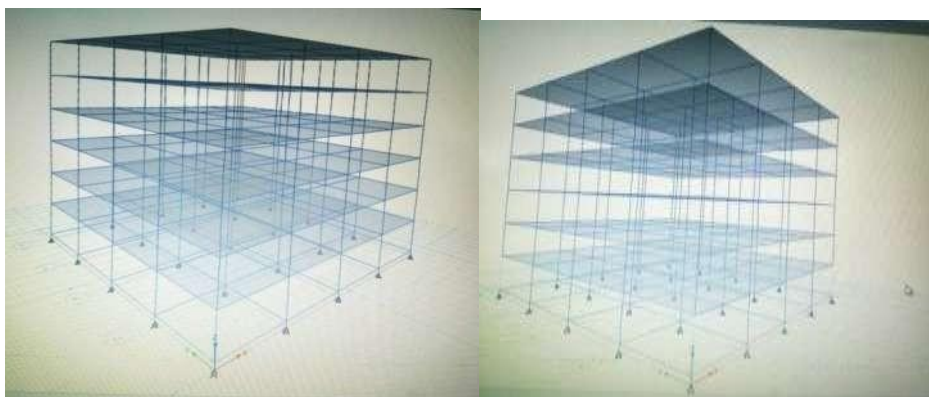


Fig7G+5structurewithoutfloating column

Fig8G+5structurewithfloatingcolumn

4.7. GeometricalProperties

4.8. 1. Storey height is 3 meters.

4.9. 2. 3 m is the height of the ground floor.

4.10. 3. The building's total length is 20 meters.

4.11. 4. The building's total width is 20 m.

4.12. 6. The buildings' heights are 6 m and 18 m.

- 4.13. 6 = G+1 & G+5 = Number of stories
- 4.14. 7. The wall's thickness is 230 mm.
- 4.15. 8. The slab's thickness is 120 mm.
- 4.16. 9. The concrete grade is between M25 and M30.
- 4.17. HYSD415 is the steel grade.
- 4.18. Definition of support:
- 4.19. Sizes of columns The distance from the ground floor to the fifth storey is 0.45 m X 0.45 m.
- 4.20. Sizes of the beams 0.30 0.45 m from ground to fifth floor
- 4.21. 14. Transfer Beam diameters ranging from 300 to 500 m
- 4.22. Dimensions of plinth beams = 350m450m
- 4.23. Soil Properties  
Zone:-II&V
- 4.24. - II soil type (Medium) Reduction Factor(R):- 5 Importance Factor(I):- 1
- 4.25. Load Combinations
- 1.5(DL+LL)
  - 1.2(DL+LL+EL)
  - 1.2(DL+LL-EL)
  - 1.5(DL+EL)
  - 1.5(DL-EL)
  - 0.9DL +1.5EL
  - 0.9DL-1.5EL
- 4.26. Earthquake loads are imparted in the X- and Y-direction directions. DL stands for "dead load."

4.27. LL stands for "live load" and refers to the weight of the object under consideration. Earthquake load (EL).

#### **4.28. Response Spectrum Analysis:**

It is a linear dynamic statistical method known as response spectrum. The following steps are taken into consideration when analyzing this approach.

For further information, see "Define," then "Load Cases." add the seismic load, as updated by Indian standard IS1893-2002, by clicking on it.

The EX-Direction should be chosen eccentrically under seismic zones II and V with medium-type soil.

EX-direction earthquake loads are identical to Y-direction earthquake loads.

- In the next step, which is the updated load factor entry, enter the values of the dead load, live load, and masonry load.

In order to define and add a new model case, name it Model, you must first define the model cases.

Adding a new fictitious name has a response spectrum, which is the final stage.

#### **IV. RESULTS AND DISCUSSION**

##### **5.1. Story Displacement Values**

Lateral loads applied on the structure in the X-direction and Y-directions. The structure can be analyzed for various load combinations for the load combinations maximum story displacement values in model 1 and model 2 under different zones i.e. Zone II and Zone V given below

##### **5.1.1. Story displacement values in model 1**

Table1Storydisplacementvaluesinmodel1

| Story | StorydisplacementinX-Direction |                         |                       |                        | StorydisplacementinY-Direction |                         |                       |                        |
|-------|--------------------------------|-------------------------|-----------------------|------------------------|--------------------------------|-------------------------|-----------------------|------------------------|
|       | Model1<br>FC<br>ZoneII         | Model<br>1WFC<br>ZoneII | Model1<br>FC<br>ZoneV | Model1<br>WFC<br>ZoneV | Model1<br>FC<br>ZoneII         | Model1<br>WFC<br>ZoneII | Model1<br>FC<br>ZoneV | Model1<br>WFC<br>ZoneV |
| 0     | 0                              | 0                       | 0                     | 0                      | 0                              | 0                       | 0                     | 0                      |
| 1     | 0.539                          | 0.420                   | 1.158                 | 0.952                  | 0.583                          | 0.495                   | 0.838                 | 0.537                  |

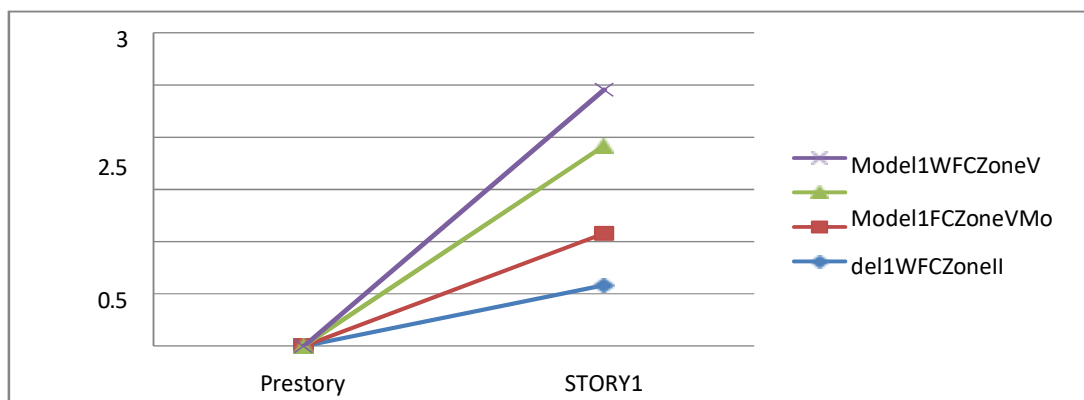
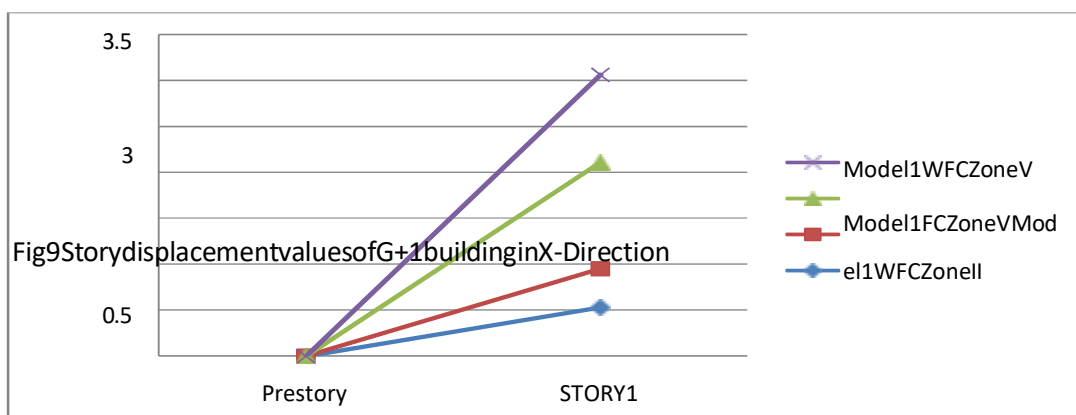
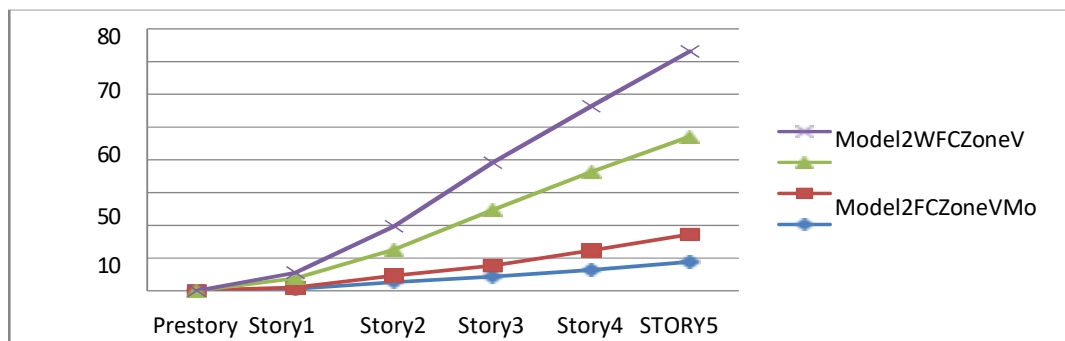


Fig10StorydisplacementvaluesofG+1buildinginY-Direction

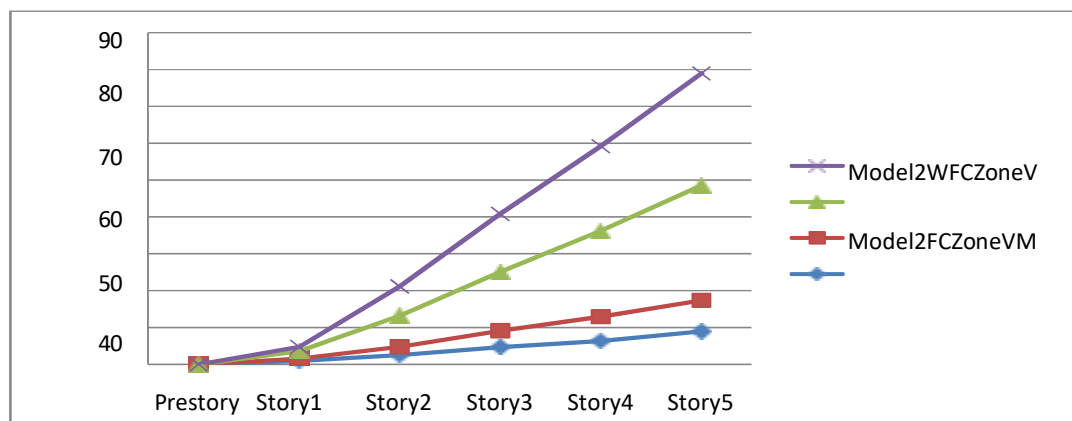
### 5.1.2. Storydisplacementvaluesinmodel2

**Table 2 Story displacement values in model 2**

| Story | Story displacement in X-Direction |                    |                  |                   | Story displacement in Y-Direction |                    |                  |                   |
|-------|-----------------------------------|--------------------|------------------|-------------------|-----------------------------------|--------------------|------------------|-------------------|
|       | Model 2FC Zone II                 | Model 2WFC Zone II | Model 2FC Zone V | Model 2WFC Zone V | Model 2FC Zone II                 | Model 2WFC Zone II | Model 2FC Zone V | Model 2WFC Zone V |
| 0     | 0                                 | 0                  | 0                | 0                 | 0                                 | 0                  | 0                | 0                 |
| 1     | 0.532                             | 0.402              | 2.840            | 1.705             | 0.586                             | 0.522              | 2.020            | 1.101             |
| 2     | 2.189                             | 2.017              | 69.230           | 6.125             | 2.549                             | 2.242              | 8.481            | 7.895             |
| 3     | 4.293                             | 3.328              | 16.970           | 14.527            | 4.728                             | 4.422              | 15.960           | 15.70             |
| 4     | 6.285                             | 5.934              | 24.050           | 20.020            | 6.389                             | 6.628              | 23.270           | 22.896            |
| 5     | 8.790                             | 8.343              | 29.870           | 26.048            | 9.002                             | 8.428              | 31.120           | 30.380            |



**Fig 11 Story displacement values of G+5 building in X-Direction**



**Fig 12 Story displacement values of G+5 building in Y-Direction**

## 5.2. Story Drifts Values:

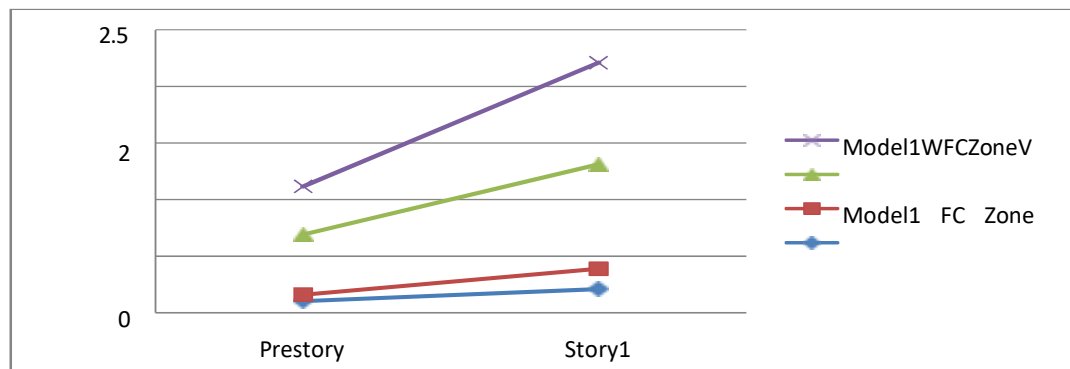
The structure is subjected to lateral loads in the X and Y directions. Various combinations of the Indian standard IS1893:2002 can be assessed for the structure. Following are the maximum story drift values in models 1 and 2 for the various load combinations under Zones II and V..

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### 5.2.1. StorydriftvaluesinModel1

**Table3StorydriftvaluesinModel1**

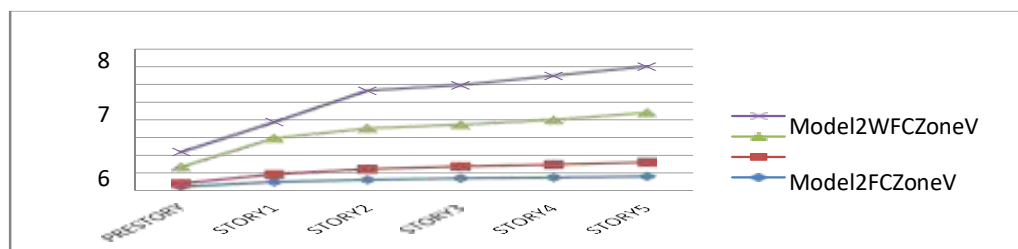
| Story | Story driftinX-Direction |                         |                       |                        | StorydriftinY-Direction |                         |                       |                        |
|-------|--------------------------|-------------------------|-----------------------|------------------------|-------------------------|-------------------------|-----------------------|------------------------|
|       | Model1<br>FC<br>ZoneII   | Model<br>1WFC<br>ZoneII | Model1<br>FC<br>ZoneV | Model1<br>WFC<br>ZoneV | Model1<br>FC<br>ZoneII  | Model1<br>WFC<br>ZoneII | Model1<br>FC<br>ZoneV | Model1<br>WFC<br>ZoneV |
| 0     | 0.103                    | 0.059                   | 0.530                 | 0.425                  | 0.092                   | 0.086                   | 0.580                 | 0.459                  |
| 1     | 0.210                    | 0.180                   | 0.920                 | 0.898                  | 0.220                   | 0.198                   | 0.962                 | 0.925                  |



### 5.2.2. StorydriftvaluesinModel2

**Table4StorydriftvaluesinModel2**

| Story | Story driftinX-Direction |               |              |               | StorydriftinY-Direction |               |              |               |
|-------|--------------------------|---------------|--------------|---------------|-------------------------|---------------|--------------|---------------|
|       | Model<br>2FC             | Model2<br>WFC | Model<br>2FC | Model<br>2WFC | Model<br>2FC            | Model<br>2WFC | Model<br>2FC | Model<br>2WFC |
|       | ZoneII                   | ZoneII        | ZoneV        | ZoneV         | ZoneII                  | ZoneII        | ZoneV        | ZoneV         |
| 0     | 0.227                    | 0.183         | 0.925        | 0.842         | 0.259                   | 0.202         | 0.953        | 0.865         |
| 1     | 0.502                    | 0.427         | 2.031        | 0.910         | 0.625                   | 0.595         | 2.123        | 1.923         |
| 2     | 0.623                    | 0.599         | 2.296        | 2.125         | 0.715                   | 0.693         | 2.415        | 2.326         |
| 3     | 0.710                    | 0.659         | 2.350        | 2.225         | 0.759                   | 0.726         | 2.495        | 2.486         |
| 4     | 0.752                    | 0.723         | 2.520        | 2.485         | 0.799                   | 0.750         | 2.612        | 2.586         |
| 5     | 0.815                    | 0.792         | 2.790        | 2.610         | 0.834                   | 0.783         | 2.832        | 2.625         |



## V. CONCLUSIONS

In this study, an attempt has been made to study on seismic effect of floating column and its structural performance. The following conclusions are taken by observing the above results. The analysis and its results were noted in terms of story displacement and story drift. Based on the study, we can conclude that, Each and every floor of the structure is subjected to lateral loads in the X and Y orientations. Model 1 WFC and Model 2 WFC values have less story displacement than Model 1 FC and Model 2 FC. As a result, unlike conventional structures, floating column buildings pose a safety risk.

- Loads applied to the structure in the X and Y axes at every floor level. Model 1 WFC and Model 2 WFC values drift less than the Model 1 FC and Model 2 FC drifts. As a result, unlike conventional structures, floating column buildings pose a safety risk.

The values of story displacements and story drifts increase as the height of the building's floating column rises.

- With rising load combination, tale displacement and story drift rise.

According to the analysis, it is not recommended to supply floating columns in a seismically prone area zone V.

Model 2 FC in zone V story displacement and drift values have been increased, therefore the maximum load combination of floating column structures in higher seismic zones is a little rejected.

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