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# Seismic Analysis of Multistorey Building with Floating Column by using Tabs

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**ABSTRACT**

*In present scenario buildings with floating columns are of typical feature in the modern multi storey construction practices in urban India. Such types of constructions are highly undesirable in building built in seismically active areas. This paper studies the analysis of a G+4,G+9,G+14 storey normal building and a G+4,G+9,G+14 storey floating column building for external lateral forces. The analysis is done by the use of ETABS. The intensities of the past earthquakes i.e., applying the ground motions to the structures,from that displacement time history values are compared.This study is to find whether the structure is safe or unsafe with floating column when built in seismically active areas and also to find floating column building is economical or uneconomical.*

***Index Terms – Etabs,Floating column building, storydrift,displacement***

## 1. INTRODUCTION

Many urban multistorey buildings in India today have open first storey as an unavoidable future.This is primarily being adopted to accommodate parking or reception lobbies in the first storey. Whereas the total seismic base shear as experienced by a building during an earthquake is dependent on its natural period, the seismic force distribution is dependent on the distribution of stiffness and mass along the height. The behavior of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. The earthquake forces developed at different floor levels in a building need to be brought down along the height to the ground by the shortest path; any deviation or discontinuity in this load transfer path results in poor performance of the building. Buildings with vertical setbacks (like the hotel buildings with a few storey wider than the rest) cause a sudden jump in earthquake forces at the level of discontinuity. Buildings that have fewer columns or walls in a particular storey or with unusually tall storey tend to damage or collapse which is initiated in that storey. Many buildings with an open ground storey intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake.Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path.

### 1.1 Earthquake Related Terminology

**Earthquake:** An earthquake is a spasm of ground shaking caused by a sudden release of energy in the earth's lithosphere (i.e. the crest plus of the upper mantle).This energy arises mainly from stresses built up during tectonic processes, which consist of interaction between the crust and interior of the earth. In some parts of the world earthquakes are associated with volcanic activity.

**Focus:** It is also termed as hypocenter. The point on the fault where the slip starts is focus. The depth of focus from the ground is called focal depth.

**Epicentre:** The point on the earth's surface vertically above the point in the crust here seismic rupture begins.

**Epicentre distance:** The distance of the epicentre from the place of observation and recording.

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**Intensity of earthquake:** Intensity is a qualitative measure of the actual manifestation of earthquake shaking at a location during an earthquake. The intensity at a place is evaluated considering three features of shaking – perception by people, performance of buildings, and changes to natural surroundings. It is denoted in a roman capital numeral. There are many intensity scales. Two commonly used ones are the Modified Mercalli Intensity (MMI) Scale and the MSK Scale. Both scales are quite similar and range from I (least perceptive) to XII (most severe)

**Magnitude of earthquake:** Magnitude is quantitative measure of total size of earthquake. It is a number. It is defined as logarithm to the base 10 of the maximum trace amplitude expressed in microns. An increase in magnitude by 1.0 implies about 10 times higher waveform amplitude and about 31 times higher energy released. It is measured in Richter's magnitude.

**Modal mass:** It is that mass of the structure which is effective in one particular natural mode of vibration.

**Seismic weight:** It is the total weight of the building plus that part of the service load, which may reasonably be expected to be attached to the building at the time of earthquake shaking. It includes permanent and movable partitions, permanent equipment and apart of the live load.

**Seismic mass:** It is seismic weight divided by acceleration due to gravity.

**Centre of stiffness:** The point through which the resultant of the restoring forces of a system acts.

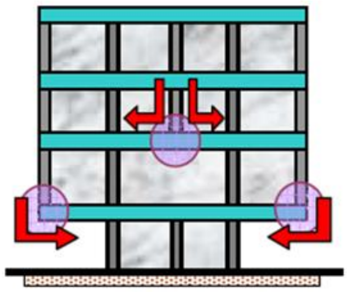
**Static eccentricity:** It is the calculated distance between the centre of mass and the centre of stiffness.

### 1.2 What Is Floating Column

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which (due to architectural design/ site situation) at its lower level (termination Level)rests on a beam which is a horizontal member. The beams in turn transfer the load to other columns below it.

There are many projects in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available in the ground floor. These open spaces may be required for assembly hall or parking purpose. The transfer girders have to be designed and detailed properly, especially in earth quake zones. The column is a concentrated load on the beam which supports it. As far as analysis is concerned, the column is often assumed pinned at the base and is therefore taken as a point load on the transfer beam. STAAD Pro, ETABS and SAP2000 can be used to do the analysis of this type of structure. Floating columns are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection.

Here are some examples of floating column buildings.



Hanging or Floating Columns

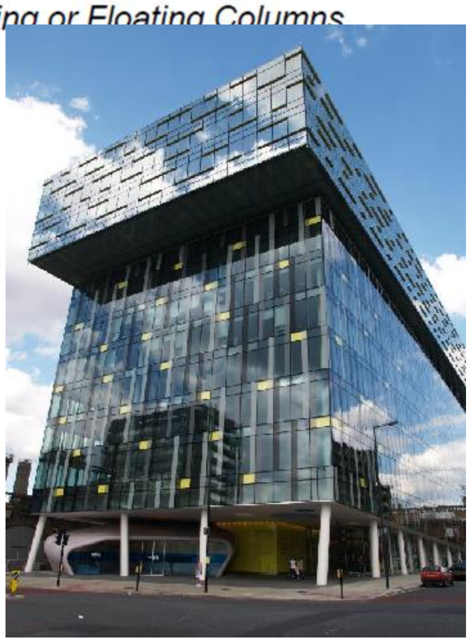


Fig.3.Palestra in London, United Kingdom

Fig.2.Housing tower one

### 1.3. Method of Seismic Analysis

Seismic analysis is a subset of structural analysis and the calculation of the response of a building structure to earthquake .It is a part of the process of structural design ,earthquake engineering or structural assessment in region where earthquake is are prevalent. A building has the potential to 'wave back and forth during an earthquake (or even a severe wind storm). This is 'fundamental mode' and is the lowest frequency of building response .most building, however higher modes of response, which are uniquely activated during earthquake.

**1.3.1. Linear Static Method** This method defines a series of forces acting on a building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when ground moves. The response is read from a design response, given the natural frequency of building. The applicability of this method is extended in many building codes by applying factors to account for higher buildings with some higher modes, and for low levels of twisting. To account for effects due to "yielding" of structure, many codes apply modification factors that reduce the design forces (example force reduction factors).

**1.3.2. Time History Method** A linear time history analysis overcomes all the disadvantages of modal response spectrum analysis, provided non-linear behavior is not involved. This method requires greater computational efforts for calculating the response at discrete time. One interesting advantage of such procedure is that the relative signs of response qualities are preserved in the response histories. This is important when interaction effects are considered in design among stress resultants.

### 1.4. PROBLEM STATEMENT

A G+4,G+9, G+14 storied building with floating column and building without floating column located in zone III of India as per code IS 1893(Part1):2002 were taken for the investigation.

In this study, first a normal building without floating column is modelled as model1.

In model 2 floating columns located at ground floor,

In model 3 floating column building with bracings at centre,

In model 4 floating column building with shear wall,

In model 5 floating column building with bracings on sides,

In model 6 floating column building with shear wall at middle,

In model 7 floating column building with shear wall on sides.

Modeling and analysis was carried out in ETABS V13.

## 2.2 LITERATURE REVIEW

**Nikhil1 & Pande,** (2014):In this paper the author has analyzed the building with all architectural complexities for all conditions including earthquake load. The building chosen was 16.8 m high building. To study the effect of various loads in various Earthquake zone the building was modelled as per plan and the plan was re-modified in four different ways so that total number of cases are four namely • Normal RC Building without any floating column.• RC Building with External floating columns.• RC Building with Internal floating columns. • RC Building with Internal and External Floating columns. The Authors Concluded that: • Provision of Case 2 (External Floating columns) may Increase displacements at various nodes. • With the provision of Case 4 (External and Internal Floating columns) and case 3(Internal Floating Columns) may increase Axial Force Fx and Shear in z direction (Fz) at all floors. • It is observed that case 4 (Internal and External Floating columns) Increases the Mx and Mz Values at all floors for All zones.

**P.V.Prasad&T.RajaSekhar**(2014):The authors have studied behaviour of multistorey buildings with floating columns under earthquake excitations. Finite element method is used to solve the dynamic governing equation. In this paper entitled study of behaviour of seismic analysis of multi storied buildings with and without floating column is carried out on floating column and other columns affected due to floating column. A four storey two bay 2D frame with and without floating column are analyzed for static loading using the present FEM code and the commercial software STAAD Pro. Following conclusion was drawn The static and free vibration results obtained using present finite element code are validated. The dynamic analysis of frame is studied by varying the column dimension. It is concluded that with increase in ground floor column the maximum displacement is reducing and base shear varies with the column dimensions. [3]Siddhartha Shah(2015): Made an attempt to reveal the effects of floating column & soft story in different earthquake zones by seismic analysis. For this purpose Push over analysis is adopted because this analysis will yield performance level of building for design capacity (displacement) carried out up to failure, it helps determination of collapse load and ductility capacity of the structure. To achieve this objective, three RC bare frame structures with G+4, G+9, G+15 stories respectively will be analyzed and compared the base force and displacement of RC bare frame structure with G+4, G+9, G+15 stories in different earthquake zones like Rajkot, Jamnagar and Bhuj using SAP 2000 14 analysis package. Authors concluded :• In existing G+4 building, First storey made with soft storey and Floating column shows its performance in Immediate Occupancy(IO) range. In existing G+9 building, First storey made with soft storey and Floating column shows its performance in Immediate Occupancy (IO) - Life Safety (LS) range• In New G+15 building, First storey made with soft storey and Floating column shows its performance in Immediate Occupancy (IO) - Life Safety (LS)range.

## 3. METHODOLOGY AND STRUCTURAL PLANNING

A G+4, G+9, G+14 storied building with floating column and building without floating column located in zone III of India as per code IS 1893(Part1):2002 were taken for the investigation.

In this study, first a normal building without floating column is modelled as model1.

In model 2 floating columns located at ground floor.

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In model 5 floating column building with bracings on sides.

In model 6 floating column building with shear wall at middle.

In model 7 floating column building with shear wall on sides.

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**3.1. <u>Project statement:</u>**

**Salient features:**

Utility of the building : Residential

Type of construction : R.C.CFramedStructure

Feature : Floating column building

**Material Properties for Regular and Irregular Configuration**

Grade of concrete=M25

Grade of steel=HYSD415

G+4:

Column sizes=0.350x0.350meters

Beam sizes=0.230x0.350meters

G+9:

Column sizes=0.450x0.450meters

Beam sizes=0.230x0.350meters

G+14:

Column sizes=0.550x0.550meters

Beam sizes=0.250x0.400meters

Slab thickness=0.115meters

Number of bays along X-direction=5

Number of bays along Y-direction=5

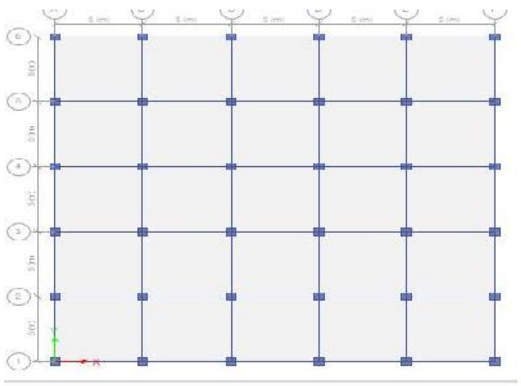
Storey height=3meters

Plinth height=3meters

Depth of foundation=1.5meters

Bay width along X-direction= 5 meters for regular configuration

Bay width along Y-direction=5meters for regular configuration



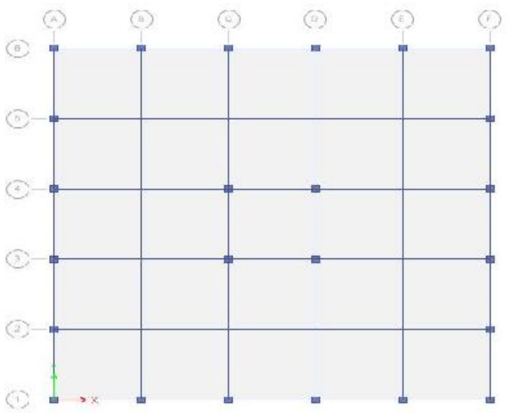
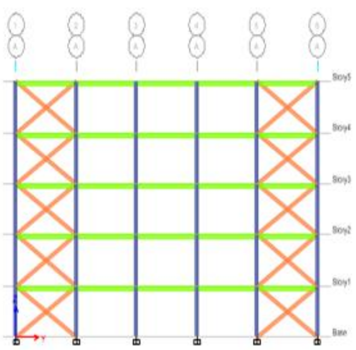


Fig: 4 model 1: normal Building – plan view Fig.5 model 2: Floating column Building – plan view



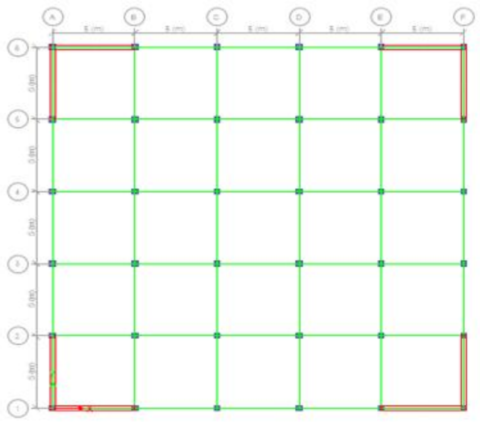


Fig.6:Model3 floating column building with bracing sides fig.7: model4 floating column building with shear wall

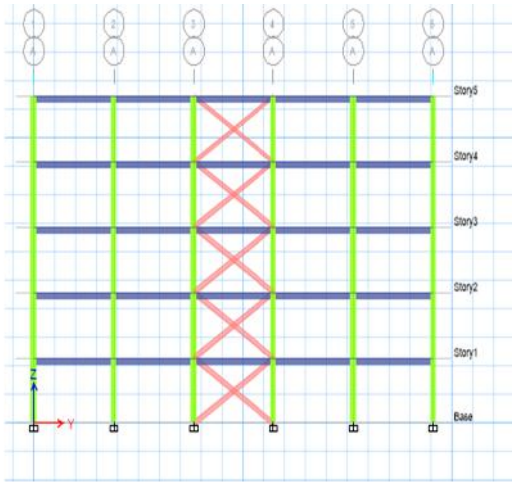


Fig8.model5 floating column building with bracing centre

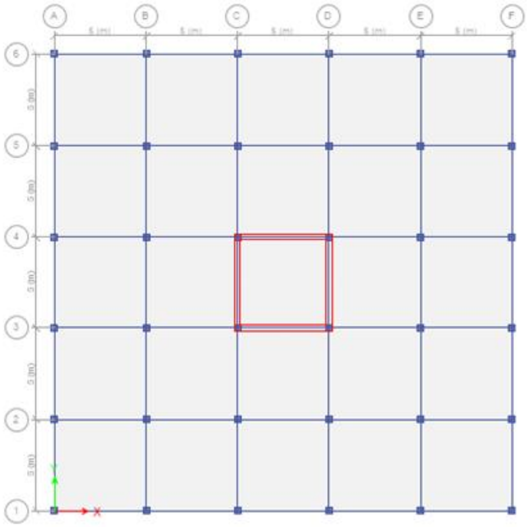


fig9.model6 floating column Building with shear wall at centre

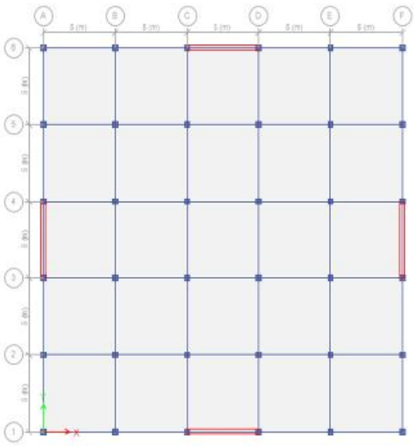


Fig10.model7 floating column building with shear wall at sides

Earthquake Live Load on Slab as per clause 7.3.1 and 7.3.2 of IS 1893 (Part-I)- 2002 is calculated as:

IS: 1893-2002 Equivalent Static method

Design Spectrum

Zone – III

Zone factor, Z (Table2) – 0.16

Importance factor, I (Table 6) – 1

Response reduction factor, R (Table 7) – 5.00

**Natural periods and average response acceleration coefficients:**

**For five – Storied building with Setback:**

Fundamental Natural period, Ta = 0.075*$h^{0.75}$ (For Bay Frame) =0.075*$15^{0.75}$

Vertical Distribution of Lateral Load,

$$f_i = V_B \frac{w_i h_i^2}{\sum_{j=1}^{n} w_j h_j 2}$$

### 3.2. CALCULATIONS

=0.57sec

For medium soil sites, Sa/g = $\frac{1.3}{T}$ (Because 0.55 ≤ T ≤ 4.00

= $\frac{1.3}{0.5}$ = 2.38

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Design horizontal seismic coefficient,

$$A_h = \frac{Z}{2} x \frac{I}{R} x \frac{Sa}{g}$$

$A_h = \frac{0.1}{2} x \frac{1}{5} x 2.38 = 0.038$

**For G+9 storied building:**

Fundamental Natural period, Ta = $0.075*h^{0.75}$ (For Bay Frame) $=0.075*30^{0.75}$

=0.96sec

For medium soil sites, Sa/g = $\frac{1.3}{T}$ (Because $0.55 \leq T \leq 4.00$)

$= \frac{1.3}{0.9} = 1.41$

Design horizontal seismic coefficient,

$$A_h = \frac{Z}{2} x \frac{I}{R} x \frac{Sa}{g}$$

$A_h = \frac{0.1}{2} x \frac{1}{5} x 1.41 = 0.022$

**For G+15 storied building:**

Fundamental Natural period, Ta = $0.075*h^{0.75}$ (For Bay Frame) $=0.075*45^{0.75}$

=1.30 sec

For medium soil sites, Sa/g = $\frac{1.3}{T}$ (Because $0.55 \leq T \leq 4.00$)

$= \frac{1.3}{1.3} = 1.04$

Design horizontal seismic coefficient,

$$A_h = \frac{Z}{2} x \frac{I}{R} x \frac{Sa}{g}$$

$A_h = \frac{0.1}{2} x \frac{1}{5} x 1.04 = 0.016$

## 4. RESULTS& CONCLUSIONS

The values of storey drift that is the inter storey displacement for two consecutive floors are correspondingly compared with the help of graphs. As the zone intensity increases, storey drift increases. The storey drift in any storey due to the minimum specified design lateral force, with partial load factor of 1.0, Shall not exceed 0.004 times the storey height. This limit is not exceeded in any storey under any seismic zone for both regular and irregular structures. X – Direction Storey Drift in MM

(G+4)

| | model1 | model2 | model3 | model4 | model5 | model6 | model7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 8.3 | 11.2 | 2.5 | 0.2 | 4.1 | 0.3 | 0.5 |
| 6 | 13.3 | 13.6 | 3.1 | 0.4 | 5 | 0.5 | 1.1 |
| 9 | 12.8 | 12.8 | 3.2 | 0.5 | 5.2 | 0.6 | 1.4 |
| 12 | 10.1 | 10.1 | 2.9 | 0.5 | 4.6 | 0.7 | 1.6 |
| 15 | 6 | 6 | 2.2 | 0.5 | 3.3 | 0.6 | 1.5 |

Table1 story drift for G+4 building

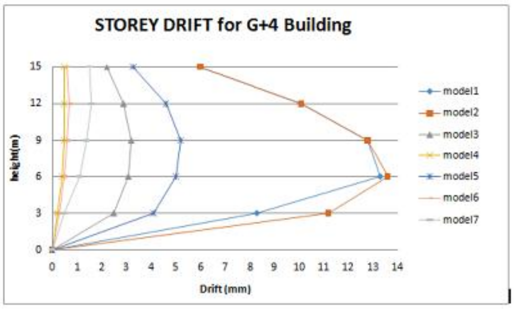


Fig11 storey drift v/s height for G+4 building

### 4.1.STOREYDRIFT:

(G+9)

| | model 1 | model 2 | model3 | model4 | model5 | model 6 | model 7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 5.3 | 7 | 2.2 | 0.3 | 3.3 | 0.4 | 0.6 |
| 6 | 10.5 | 11.5 | 3.2 | 0.7 | 5 | 0.8 | 1.5 |
| 9 | 12 | 12.7 | 3.6 | 1 | 5.6 | 1.1 | 2.2 |
| 12 | 12.2 | 12.8 | 3.9 | 1.2 | 5.9 | 1.4 | 2.7 |
| 15 | 11.7 | 12.3 | 4.1 | 1.4 | 6 | 1.6 | 3.1 |
| 18 | 10.8 | 11.3 | 4.1 | 1.5 | 6 | 1.7 | 3.3 |
| 21 | 9.5 | 10 | 4 | 1.6 | 5.7 | 1.8 | 3.5 |
| 24 | 7.8 | 8.2 | 3.7 | 1.6 | 5.2 | 1.8 | 3.5 |
| 27 | 5.8 | 6.1 | 3.3 | 1.6 | 4.5 | 1.8 | 3.5 |
| 30 | 3.7 | 3.9 | 2.7 | 1.5 | 3.5 | 1.8 | 3.4 |

Table 2 story drift for G+9 for building

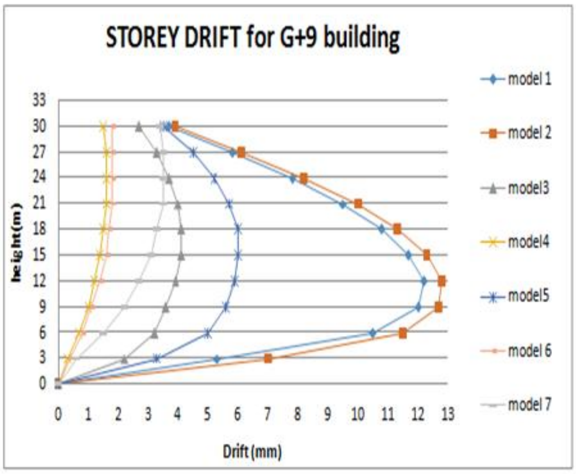


Fig12 story drift v/s height for G+9 building

(G+14)

| | model1 | model2 | model3 | model4 | model5 | model6 | model7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 4.1 | 5.1 | 2.3 | 0.4 | 3.2 | 0.6 | 0.4 |
| 6 | 8.5 | 9.1 | 3.7 | 0.9 | 5.2 | 1.2 | 0.9 |
| 9 | 10.1 | 10.3 | 4.2 | 1.3 | 5.9 | 1.7 | 1.3 |
| 12 | 10.6 | 10.7 | 4.6 | 1.6 | 6.3 | 2.1 | 1.6 |
| 15 | 10.7 | 10.8 | 4.9 | 1.9 | 6.6 | 2.5 | 1.9 |
| 18 | 10.6 | 10.6 | 5.1 | 2.2 | 6.7 | 2.8 | 2.2 |
| 21 | 10.3 | 10.3 | 5.2 | 2.4 | 6.8 | 3 | 2.4 |
| 24 | 9.9 | 9.9 | 5.2 | 2.5 | 6.7 | 3.2 | 2.5 |
| 27 | 9.3 | 9.3 | 5.1 | 2.6 | 6.5 | 3.3 | 2.6 |
| 30 | 8.5 | 8.5 | 5 | 2.7 | 6.2 | 3.4 | 2.7 |
| 33 | 7.6 | 7.6 | 4.8 | 2.8 | 5.8 | 3.4 | 2.8 |
| 36 | 6.4 | 6.4 | 4.4 | 2.8 | 5.2 | 3.4 | 2.8 |
| 39 | 5.2 | 5.2 | 4 | 2.7 | 4.6 | 3.4 | 2.7 |
| 42 | 3.8 | 3.8 | 3.6 | 2.7 | 3.9 | 3.3 | 2.7 |
| 45 | 2.5 | 2.5 | 3 | 2.6 | 3.1 | 3.2 | 2.6 |

Table 3 storey drift for G+14 building

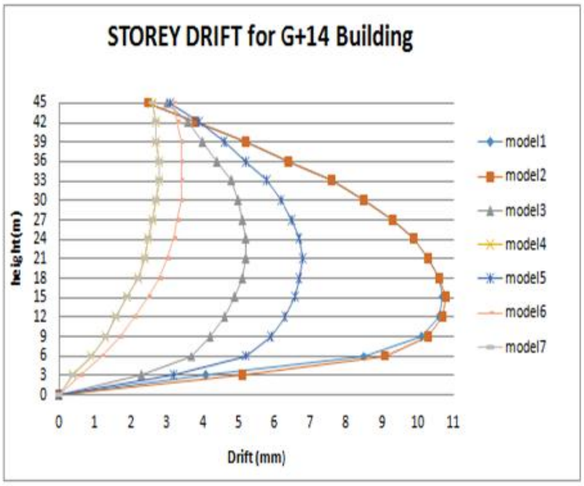


Fig 13 story drift v/s height for G+15 building

### 4.2.LATERAL DISPLACEMENT:

The deformation of a cantilever column under lateral loads usually consists of two parts: the bending deformation and the shear deformation. The bending and the shear deformations can be represented with different shape functions along the column height. Assuming that the entire frame structure behaves like a shear beam.

(G+4)

| | model1 | model2 | model3 | model4 | model5 | model6 | model7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 8.3 | 11.2 | 2.5 | 0.2 | 4.1 | 0.3 | 0.5 |
| 6 | 21.5 | 24.8 | 5.6 | 0.6 | 9.1 | 0.8 | 1.6 |
| 9 | 34.3 | 37.6 | 8.8 | 1 | 14.3 | 1.4 | 3 |
| 12 | 44.4 | 47.7 | 11.7 | 1.5 | 18.9 | 2.1 | 4.5 |
| 15 | 50.4 | 53.7 | 13.9 | 2 | 22.3 | 2.7 | 6.1 |

Table4 lateral displacement for G+4 building

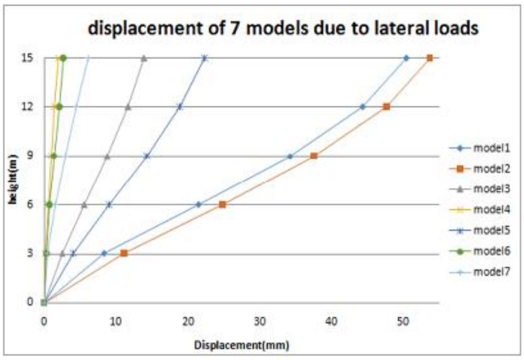


Fig14 lateral displacement v/s height for G+4 building

(G+9)

| storey | model 1 | model2 | model3 | model 4 | model 5 | model 6 | model 7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 5.3 | 7 | 2.2 | 0.3 | 3.2 | 0.4 | 0.6 |
| 6 | 15.8 | 18.5 | 5.4 | 1 | 8.2 | 1.2 | 2.1 |
| 9 | 27.8 | 31.2 | 9 | 1.9 | 13.8 | 2.3 | 4.3 |
| 12 | 39.9 | 43.9 | 12.9 | 3.1 | 19.7 | 3.7 | 7 |
| 15 | 51.7 | 56.2 | 17 | 4.5 | 25.7 | 5.2 | 10 |
| 18 | 62.5 | 67.5 | 21.1 | 5.9 | 31.7 | 7 | 13.3 |
| 21 | 72 | 77.5 | 25.1 | 7.5 | 37.4 | 8.8 | 16.8 |
| 24 | 79.9 | 85.7 | 28.8 | 9.1 | 42.5 | 10.6 | 20.3 |
| 27 | 85.6 | 91.7 | 32.1 | 10.7 | 47 | 12.4 | 23.8 |
| 30 | 89.3 | 95.6 | 34.8 | 12.2 | 50.5 | 14.2 | 27.2 |

Table5 lateral displacement for G+9 building

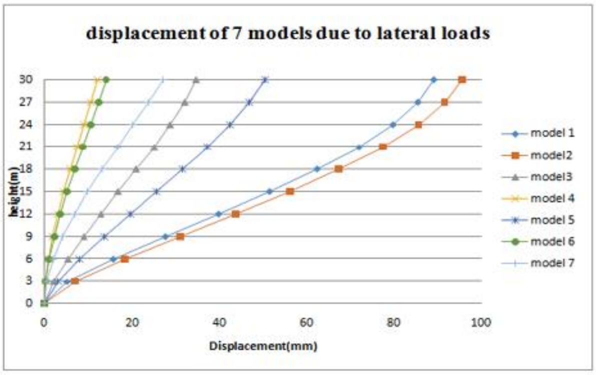


Fig15 lateral displacement v/s height for G+9 building

(G+14)

| | model1 | model2 | model3 | model4 | model5 | model6 | model7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 4.1 | 5.1 | 2.4 | 0.4 | 3.1 | 0.6 | 0.8 |
| 6 | 12.6 | 14.2 | 6.1 | 1.2 | 8.4 | 1.8 | 2.7 |
| 9 | 22.7 | 24.5 | 10.3 | 2.5 | 14.3 | 3.4 | 5.3 |
| 12 | 33.3 | 35.2 | 14.9 | 4.2 | 20.6 | 5.6 | 8.7 |
| 15 | 44.1 | 46 | 19.8 | 6.1 | 27.2 | 8.1 | 12.6 |
| 18 | 54.7 | 56.6 | 24.9 | 8.3 | 33.9 | 10.9 | 16.9 |
| 21 | 65 | 66.9 | 30.1 | 10.7 | 40.7 | 14 | 21.5 |
| 24 | 74.9 | 76.8 | 35.4 | 13.2 | 47.4 | 17.2 | 26.3 |
| 27 | 84.1 | 86 | 40.5 | 15.9 | 53.9 | 20.5 | 31.2 |
| 30 | 92.6 | 94.5 | 45.5 | 18.6 | 60 | 23.9 | 36.1 |
| 33 | 100 | 102 | 50.2 | 21.3 | 65.8 | 27.4 | 41 |
| 36 | 106.6 | 108.5 | 54.7 | 24.1 | 71 | 30.8 | 45.8 |
| 39 | 111.8 | 113.7 | 58.7 | 26.8 | 75.7 | 34.2 | 50.4 |
| 42 | 115.6 | 117.4 | 62.3 | 29.5 | 79.5 | 37.5 | 54.9 |
| 45 | 118.1 | 120 | 65.3 | 32.2 | 82.6 | 40.6 | 59.1 |

Table6 lateral displacement for G+14 building

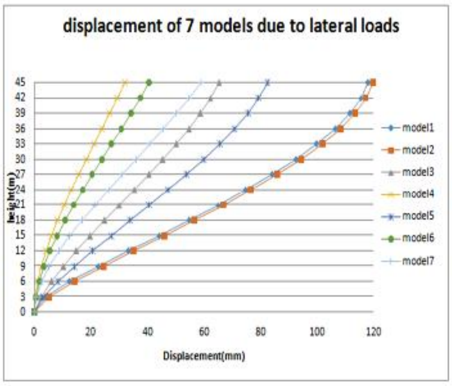


Fig16 lateral displacement v/s height for G+14 building

**4.3.RESPONSES OF TIME HISTORY ANALYSIS:**

In this present study, we made use of Nepal Earthquake data, and quote out the responses, method adopted was linear time history analysis.

(G+4)

| | model1 | model2 | model3 | model4 | model5 | model6 | model7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1.5 | 2.2 | 0.4 | 0.1 | 0.9 | 0.1 | 0.1 |
| 6 | 3.7 | 4.5 | 0.9 | 0.2 | 1.7 | 0.3 | 0.3 |
| 9 | 5.6 | 6.5 | 1.3 | 0.5 | 2.3 | 0.4 | 0.6 |
| 12 | 7 | 7.8 | 1.7 | 0.7 | 2.7 | 0.6 | 0.9 |
| 15 | 7.7 | 8.5 | 2 | 0.9 | 3.1 | 0.8 | 1.3 |

Table7 displacement for G+4 building

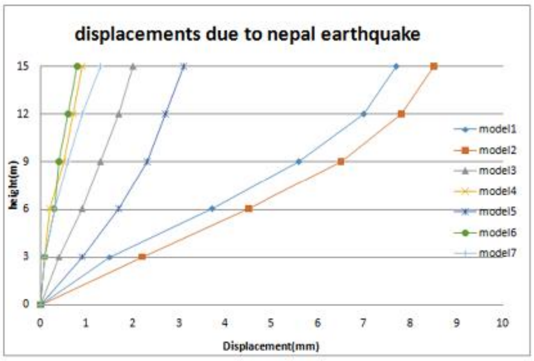


Fig17 displacement v/s height for G+4 building

(G+9)

| storey | model 1 | model 2 | model3 | model 4 | model 5 | model 6 | model 7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1.4 | 0.5 | 0.1 | 0.8 | 0.1 | 0.1 |
| 6 | 2.9 | 3.5 | 1.1 | 0.4 | 1.9 | 0.4 | 0.4 |
| 9 | 5.1 | 5.8 | 1.7 | 0.7 | 3 | 0.7 | 0.8 |
| 12 | 7.2 | 8 | 2.3 | 1.1 | 4.1 | 1 | 1.3 |
| 15 | 9.2 | 10.2 | 2.7 | 1.6 | 5 | 1.4 | 1.8 |
| 18 | 10.9 | 12.2 | 3.3 | 2.1 | 6 | 1.9 | 2.4 |
| 21 | 12.3 | 13.8 | 3.8 | 2.7 | 7 | 2.3 | 2.9 |
| 24 | 13.5 | 14.9 | 4.3 | 3.2 | 7.8 | 2.8 | 3.5 |
| 27 | 14.6 | 15.7 | 4.8 | 3.8 | 8.4 | 3.3 | 4.1 |
| 30 | 15.4 | 16.4 | 5.2 | 4.3 | 9 | 3.7 | 4.7 |

Table8 displacement for G+9 building

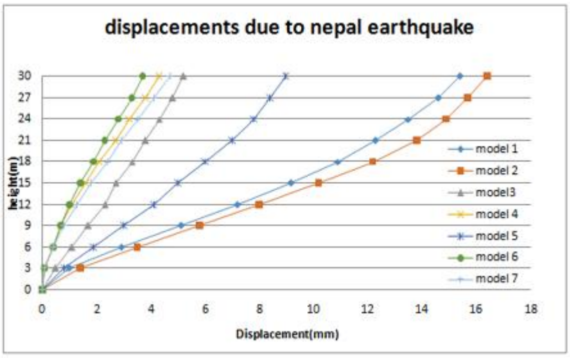


Fig18 displacement v/s height for G+9 building

(G+14)

| | model1 | model2 | model3 | model4 | model5 | model6 | model7 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0.9 | 1.1 | 0.9 | 0.1 | 1 | 0.2 | 0.3 |
| 6 | 2.8 | 3.1 | 2.2 | 0.5 | 2.6 | 0.7 | 1 |
| 9 | 4.9 | 5.2 | 3.6 | 0.9 | 4.3 | 1.3 | 1.9 |
| 12 | 7.2 | 7.5 | 5.2 | 1.5 | 5.9 | 2.1 | 3.1 |
| 15 | 9.4 | 9.7 | 6.8 | 2.1 | 7.6 | 3 | 4.4 |
| 18 | 11.5 | 11.7 | 8.5 | 2.9 | 9.3 | 4 | 5.8 |
| 21 | 13.3 | 13.5 | 10.1 | 3.6 | 11 | 5.1 | 7.3 |
| 24 | 14.9 | 15.1 | 11.6 | 4.4 | 12.6 | 6.2 | 8.7 |
| 27 | 16.2 | 16.4 | 13.1 | 5.3 | 14.1 | 7.3 | 10.1 |
| 30 | 17.2 | 17.5 | 14.5 | 6.1 | 15.4 | 8.4 | 11.6 |
| 33 | 18.1 | 18.3 | 15.6 | 7 | 16.7 | 9.6 | 13 |
| 36 | 18.8 | 19 | 16.6 | 7.8 | 17.7 | 10.7 | 14.3 |
| 39 | 19.4 | 19.6 | 17.4 | 8.6 | 18.6 | 11.8 | 15.6 |
| 42 | 19.8 | 20 | 18.2 | 9.5 | 19.4 | 12.9 | 16.8 |
| 45 | 20.1 | 20.3 | 18.8 | 10.3 | 20.1 | 14 | 18 |

Table 9 displacement for G+14 building

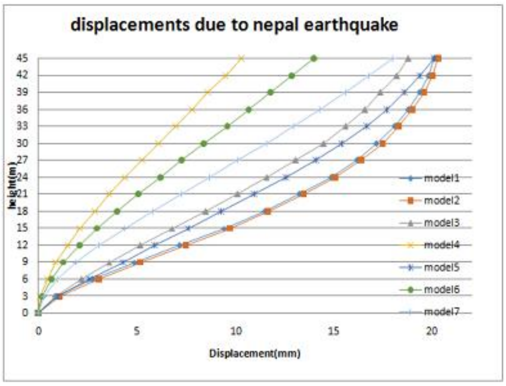


Fig19 displacement v/s height for G+14 building

**4.4.TIME PERIOD:**

Here are the time period obtained from the models in respective three modes, based on modal participation factor.

(G+4)

| | mode1 | mode2 | mode3 |
|---|---|---|---|
| model1 | 1.717 | 0.539 | 0.298 |
| model2 | 1.801 | 0.568 | 0.315 |
| model3 | 0.885 | 0.29 | 0.201 |
| model4 | 0.323 | 0.101 | 0.069 |
| model5 | 1.125 | 0.363 | 0.255 |
| model6 | 0.366 | 0.108 | 0.071 |
| model7 | 0.54 | 0.133 | 0.084 |

**Table10 time period v/s three modes**

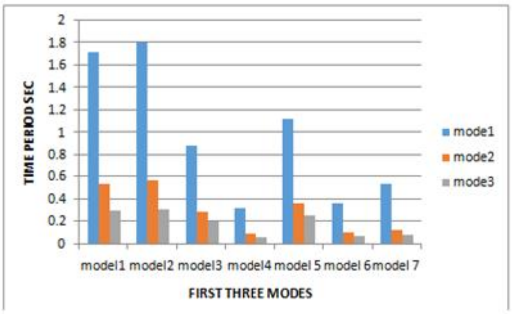


**Fig20 time period vs three modes**

(G+9)

| | mode 1 | mode 2 | mode 3 |
|---|---|---|---|
| model1 | 2.548 | 0.805 | 0.441 |
| model2 | 2.656 | 0.84 | 0.461 |
| model3 | 1.516 | 0.452 | 0.247 |
| model4 | 0.847 | 0.19 | 0.098 |
| model 5 | 1.846 | 0.568 | 0.304 |
| model 6 | 0.965 | 0.334 | 0.202 |
| model 7 | 1.264 | 0.269 | 0.123 |

**Table 11 time period for G+9 building**

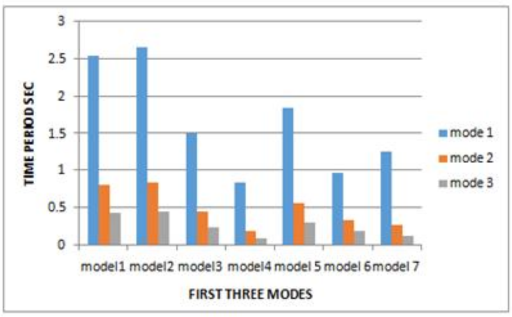


**Fig 21 time period v/s three modes**

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(G+14)

| | mode 1 | mode2 | mode3 |
|---|---|---|---|
| model1 | 3.957 | 1.269 | 0.71 |
| model2 | 4.006 | 1.286 | 0.719 |
| model3 | 2.796 | 0.852 | 0.452 |
| model4 | 1.82 | 0.39 | 0.17 |
| model5 | 3.203 | 0.998 | 0.539 |
| model6 | 2.059 | 0.458 | 0.205 |
| model7 | 2.515 | 0.595 | 0.259 |

**Table 12 time period for G+14 building**

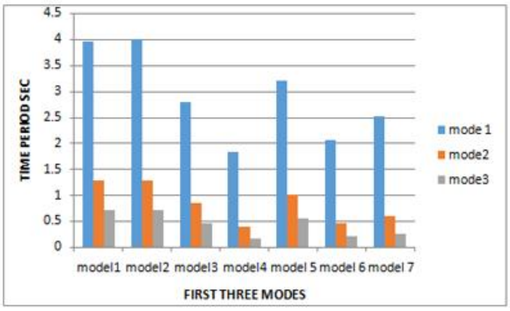


**Fig 22 time period v/s three modes**

## 4.5.CONCLUSION:

The Following conclusions are made from the present study

1. The behavior of multi storey building with and without floating column is studied under different earthquake excitation.. The static analysis is done and It is concluded that by the maximum displacement and storey drift values are increasing for floating columns.

2. By checking the drift ratios , we can clearly state by increasing the height of the building the deflections and story drifts are drastically changed

3. The axial forces are increasing in the columns other than floating columns due to transfer of loads of the floating columns to the conventional columns.

4. Visually shear wall building shown best behavior in all the cases as per safety, but installation of shear wall in buildings having lesser height won't be recommended as of economic note.

5. It is clearly shown the building with bracing system worked well in case of smaller height than in high rise building; difference is stated in higher stories of the building. Although was also a good recommendation.

6. It is observed that bending moment in columns are greater in the top stories and lesser in the bottom stories. Bending moment varies in each model for every corner column, internal column and peripheral column.

## 4.6.REFFERENCES:

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