STUDY ON EFFECT OF FLOATING COLUMN ON BUILDING IN EARTHQUAKE PRONE ZONE BY RESPONSE SPECTRUM METHOD

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Abstract
The concept of horizontal development of structure is becoming obsolete due to space constraint. Adoption of vertical system (high rise buildings, floating column buildings, shopping malls) is need of the era. An earthquake(a natural disaster) causes impulsive ground movement, which are irregular and complex in nature, with every change in period and amplitude lasting for a small fraction of time duration. Not enough empirical data is available at present to make a reliable predictions the character of the critical earthquake motions (i.e. amplitude, frequency, characteristics and duration) to which a proposed structure may be subjected during its lifetime. Analysis by elastic assumptions does not take into account the change in the properties of the building material during the progress of an earthquake. The main criteria of designing of earthquake-resistant building or structures with floating column is that buildings should be able to resist small intensity of earthquakes without much loss and damage to life, and also resist moderate earthquakes without structural damage but with some nonstructural damage. In this paper the study has been carried out to investigate storey drift, displacement in X and Y direction with floating column subjected to regular position, at edge and corner.

IndexTerms – Building, Column, Floating Column, Storey Drift, Displacement, Earthquake.

I. Introduction

A vertical structural member whose effective length is greater than 3 times its least lateral dimension subjected to compressive loads is called as a column. The main function of the column is to carry the load and transfer it to the foundation or footing of the structure. A vertical element which terminates (due to architectural design of structure/site condition) at its lower level (termination level) rests on a beam which is a horizontal structural member is known as floating column. One of the major contributors to structural damages in structures during strong earthquakes is the discontinuity/irregularity in the load path for transfer of the seismic force, which develops due to accelerations of individual elements, to the ground.

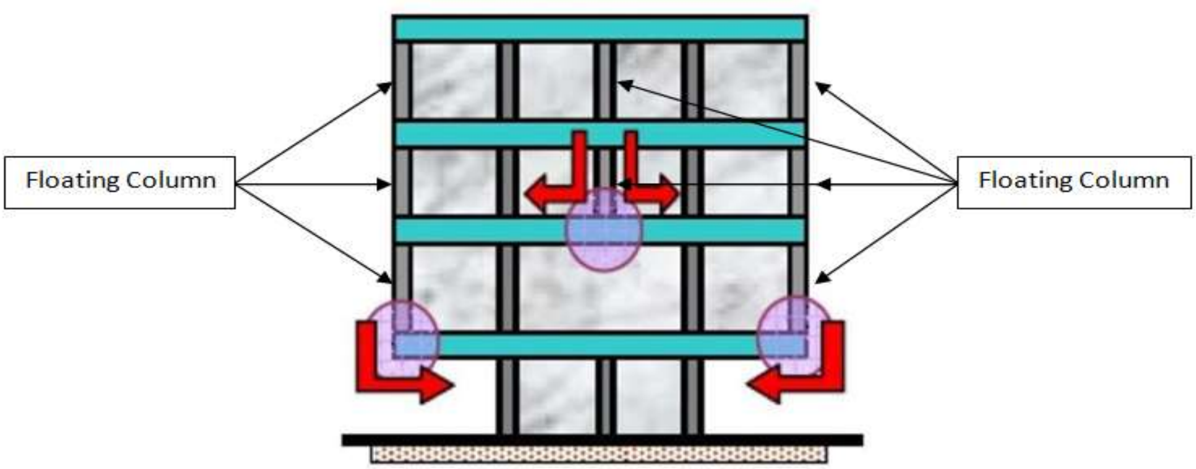

Fig 1.1 floating column structure

The value of E(elastic modulus) of materials used for the static analysis, unless required by more definite value is available for use in such a condition. It must be noted that the values of E(modulus of elasticity) for various construction materials shows large variations. The basic notion of design theory for earthquake-resistant building or structures is that buildings should be able to withstand or resist minor earthquakes without much loss and damage, resist moderate earthquakes without structural damage but with some nonstructural damage, and resist major earthquake without collapse but with some amount structural and nonstructural loss damage.

a) Objective Of Present Work: The main objective of the study is to do a comparative analysis of R.C.C. framed regular column structure with a floating column structure. The work is done by using ETABS software.

II Methodology:

In RCC framed structures floating columns play an important role on their seismic behavior. This study is an attempt to analyze the behavior of RCC framed structures with floating columns subjected to different variable constrains alike seismic zones.

a) METHODOLOGY AND ITS CONSIDERATION

The modelling and analysis of a g+5, g+10 and g+15 story floating column and regular column framed model are carried out using Etabs software. the sizes of structural members, geometric parameters and load consideration of both the structural model are given in table 3.1 and 3.2 respectively. The dead load (as per is 875-1987, part-i), live load (as per is 875-1987, part-ii), earth quake (as per is 1893-2002, part-i) and wind load (as per is 875-1987, part-iii) and all load combinations are applied to the all models. The characteristics compressive strength of concrete is 25 N/mm2. the yield strength of main reinforcement 415 N/mm2.

SPECIFICATIONS OF BUILDING'S MODEL

Specifications	Data
Typical Storey Height	3.5 m
Base Storey Height	2.0 m
No. Of Bays along X-Direction	4
No. Of Bays along Y-Direction	4
Bay Length along X-Direction	4 m
Bay Length along Y-Direction	5 m
Concrete Grade	25
Density of R.C.C.	25 kN/m^3
Density of Wall Masonry	20 kN/m^3
Density of mild steel	76.97 kN/m^3
Regular Columns	450 mm x 450 mm
Floating Columns	300 mm x 300 mm
Beams	350 mm x 450 mm
Slab Thickness	130 mm
Bottom Support Conditions	Fixed
Live Load- **On Roof** **On Rest of the structure**	1.5 kN/m^2 3.0 kN/m^2
Soil Conditions	Medium
Damping Ratio	5%
Poisson Ratio	0.2
Response Reduction Factor	5

TABLE 3.1 SPECIFICATIONS OF BUILDING'S MODEL

b) STEPS OF METHODOLOGY

Above cases are considered in the analysis and following sequence has been followed to analyze those using ETABS.

STEP-1 Start the ETABS and Designing the Unit system and Types of Structures.

STEP 2: Preparing the model of plane 3 D building frame

STEP 3: Defining the other parameter related to properties of members and support Condition

STEP 4: Defining the load Patterns.

STEP 5: Defining the load condition

- Defining the load case
- Defining load combination

STEP 6: Analysis of the Structure.

STEP 7: Comparative Analysis of Results In Terms Of maximum stoery displacement, Maximum Base Shear, maximum story drift and Maximum Reaction.

STEP 8: Critical Study of Results.

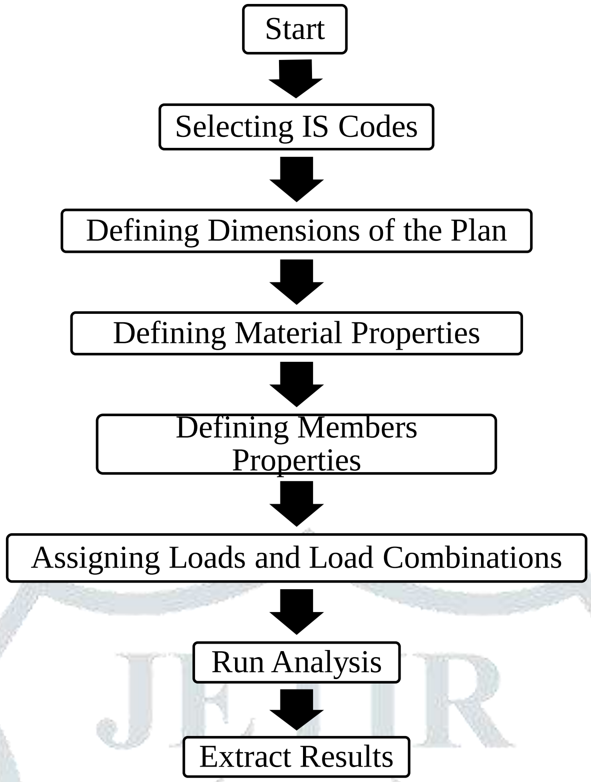

Fig: Flow chart diagram of methodology

III A) CASES FOR THE ANALYSIS

a) **MODEL 1** G+5 story rcc structure

- **CASE 1** G+5 Regular column structure
- **CASE 2** G+5 Floating column structure having floating column at **Corners** at G+1, G+3, G+5
- **CASE 3** G+5 Floating column structure having floating column at **Edges** at G+1, G+3, G+5

b) **MODEL2** G+10 story rcc structure

- **CASE 4** G+10 Regular column structure
- **CASE 5** G+10 Floating column structure having floating column at **Corners** at G+1, G+3, G+5, G+7, G+9.
- **CASE 6** G+10 Floating column structure having floating column at **Edges** at G+1, G+3, G+5,G+7, G+9.

B) Load Case Details

In the analysis of structure various types of loading conditions studied are given below: -

a) Static Load:

i) Dead Load (IS 875: part I)

Dead load are calculated by multiplying cross sectional area by their densities
Density of RCC member: 25kN/m^3
Density of brick wall: 20kN/m^3

ii) Live Load (IS 875: part II &IV)

The load which changes their position and magnitude and act vertically downward on the structure are called live load such as load on roof etc.

iii) Load Combinations :(IS 875 Part V)

iv) Seismic load [IS :1893(2002)]

The seismic force is evaluated as per IS:1893 (2002).

Iv) Model Discription

a) **MODEL 1** G+5 story rcc structure

- **CASE 1** G+5 Regular column structure

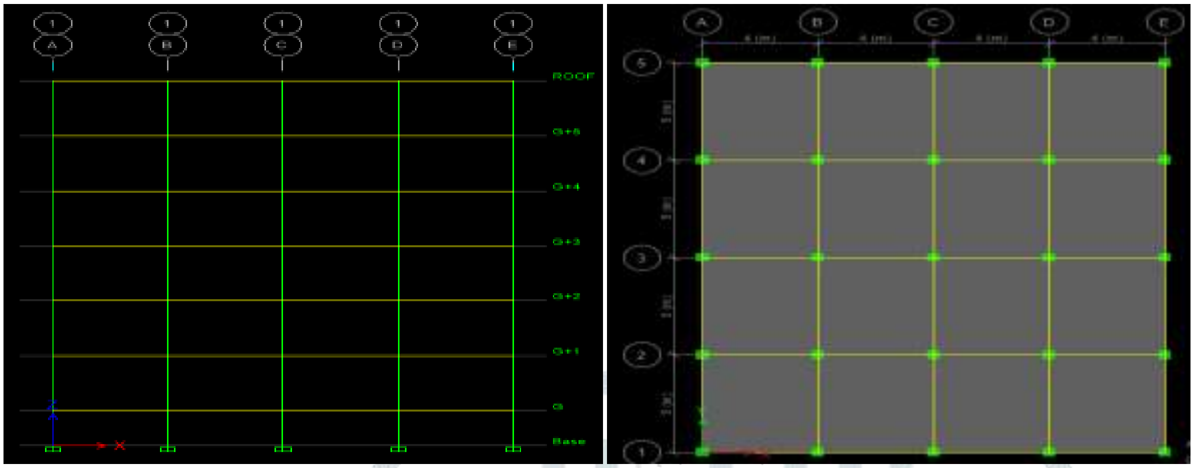

FIG 4.1: G+5 Regular column structure

- **CASE 2** G+5 Floating column structure having floating column at **Corners** at G+1, G+3,G+5

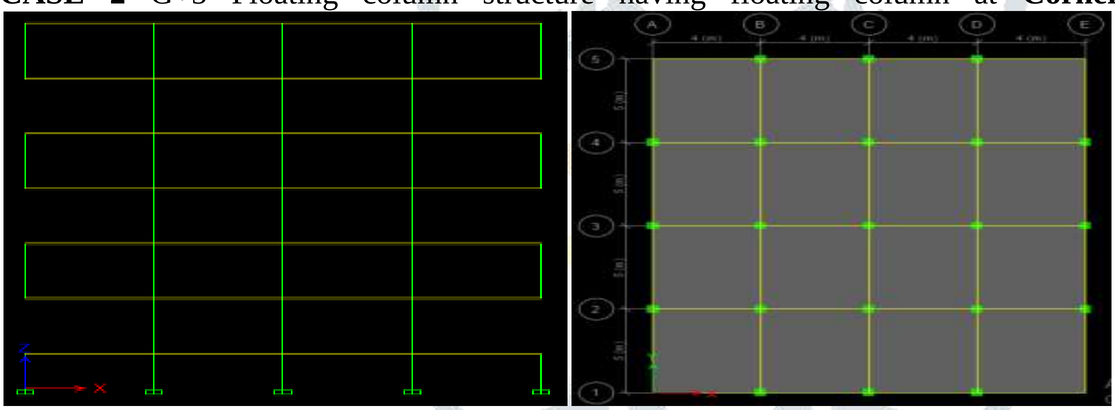

FIG 4.2: G+5 Floating column having floating column at Corners at G+1, G+3, G+5

- **CASE 3** G+5 Floating column structure having floating column at **Edges** at G+1,G+3,G+5

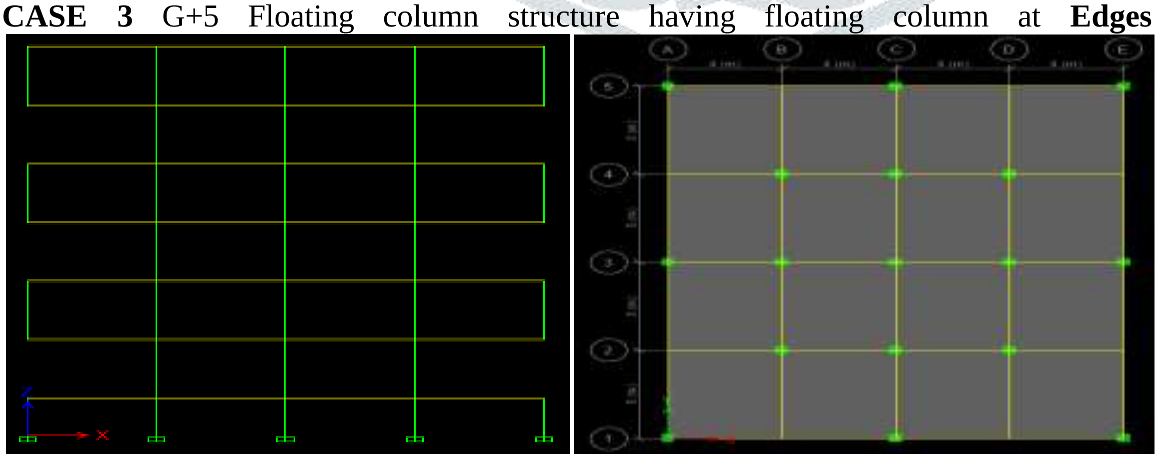

FIG 4.3: G+5 Floating column structure having floating column at Edges at G+1, G+3, G+5

b) MODEL 2 G+10 story rcc structure

- **CASE 4** G+10 Regular column structure

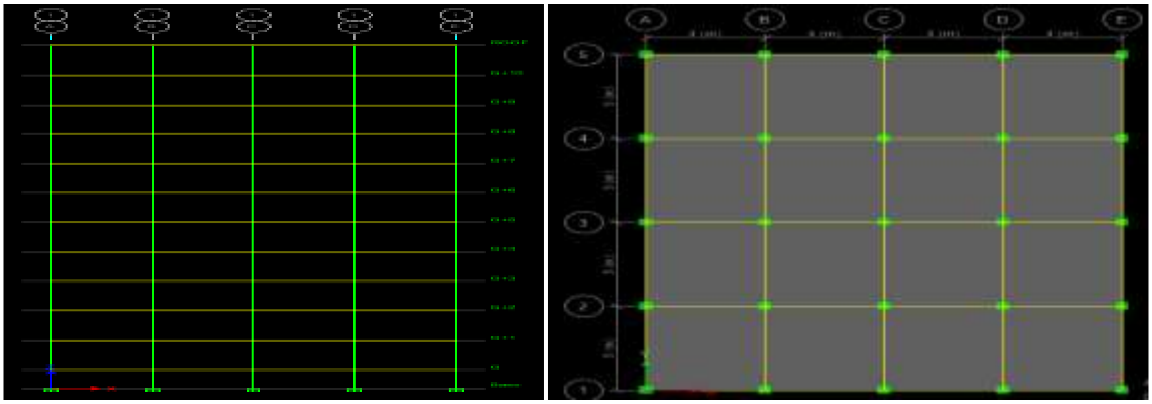

FIG 4.4: G+10 Regular column structure

- **CASE 5** G+10 Floating column structure having floating column at **Corners** at G+1, G+3, G+5, G+7, G+9.

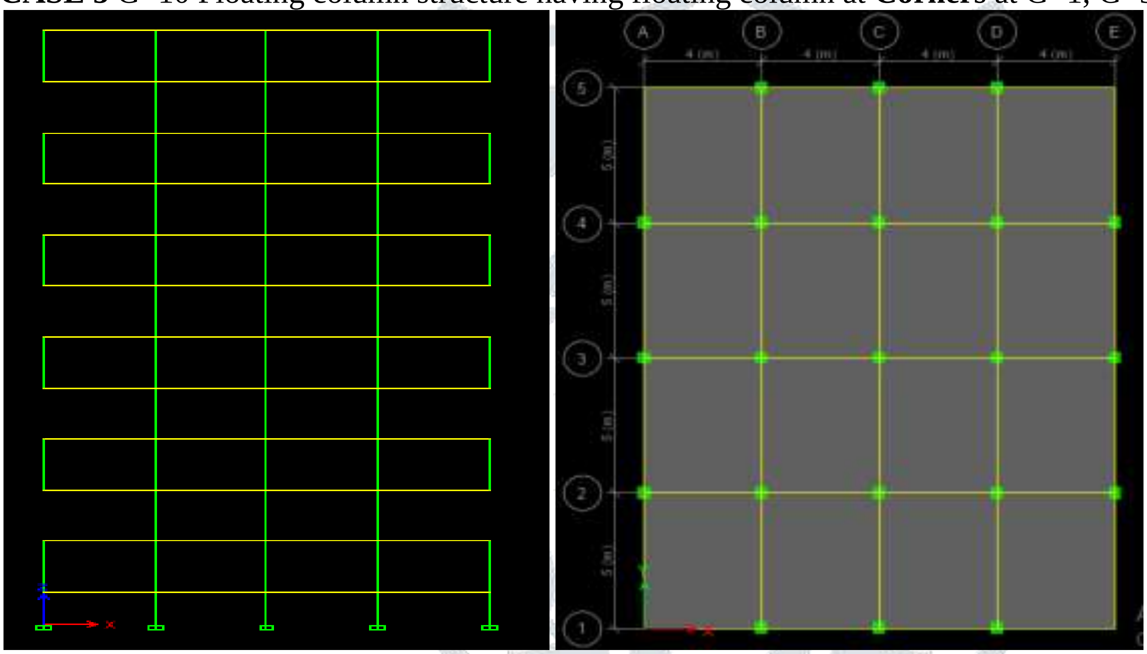

FIG 4.5: G+10 Floating column structure having floating column at Corners at G+1, G+3, G+5, G+7, G+9.

- **CASE 6** G+10 Floating column structure having floating column at **Edges** at G+1,G+3,G+5,G+7,G+9.

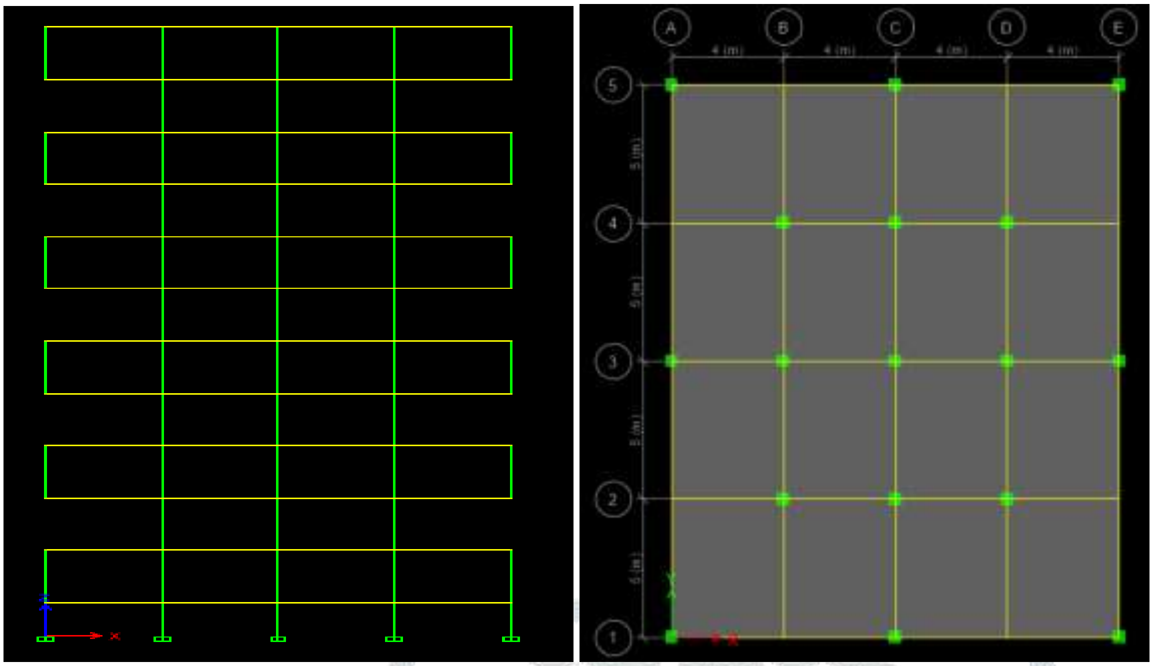

FIG 4.6: G+10 Floating column structure having floating column at Edges at G+1, G+3, G+5, G+7, G+9.

V RESULT AND DISCUSSION

Seismic analysis has been carried out using response spectrum method by ETABS software in terms of Maximum Reactions, Maximum Story Displacement, maximum base shear and Maximum Story Drift.

a) MAXIMUM DISPLACEMENT IN X DIRECTION IN MODEL 1

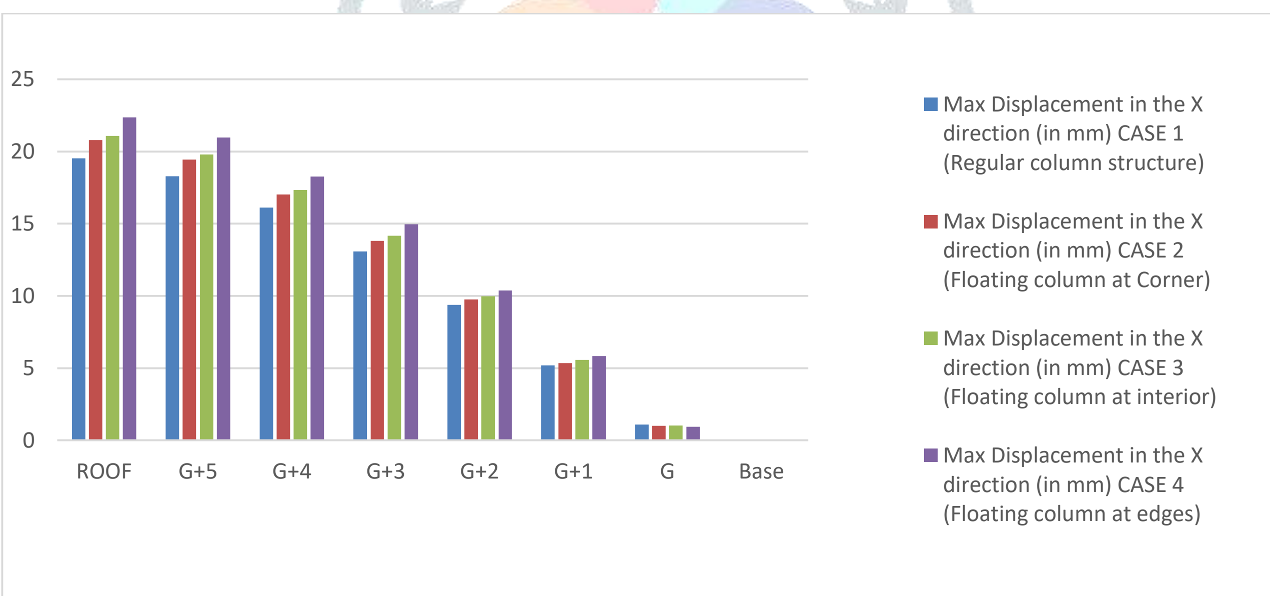

Fig 5.1 Showing Maximum Displacement In X Direction (in mm) In Model 1

It can be observed from fig. 5.1 that maximum story displacement is occurred in case 4 i.e. floating column at edges and maximum story displacement in case 3 and 2 and 1 is almost same.

b) MAXIMUM DISPLACEMENT IN X DIRECTION IN MODEL 2

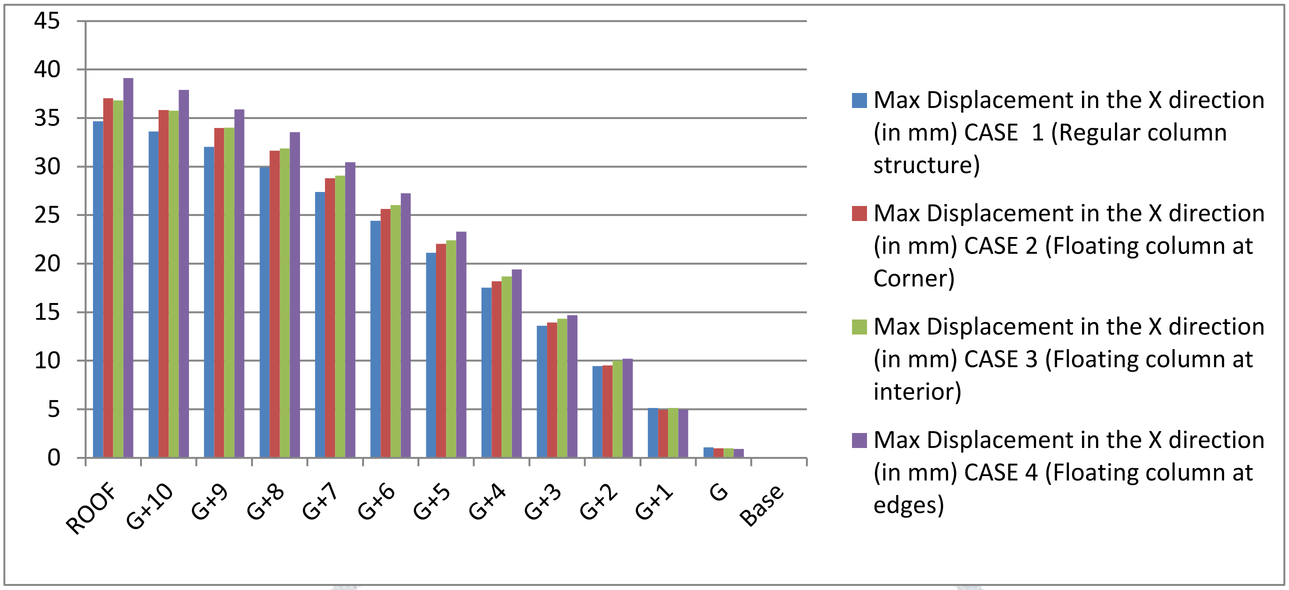

Fig 5.2 Showing Maximum Displacement In X Direction (in mm) In Model 2

It can be observed from table 5.2 and fig. 5.2 that maximum story displacement is occurred in case 4 i.e. floating column at edges and maximum story displacement in case 3 and 2 is almost same.

c) MAXIMUM DISPLACEMENT IN Y DIRECTION IN MODEL 1

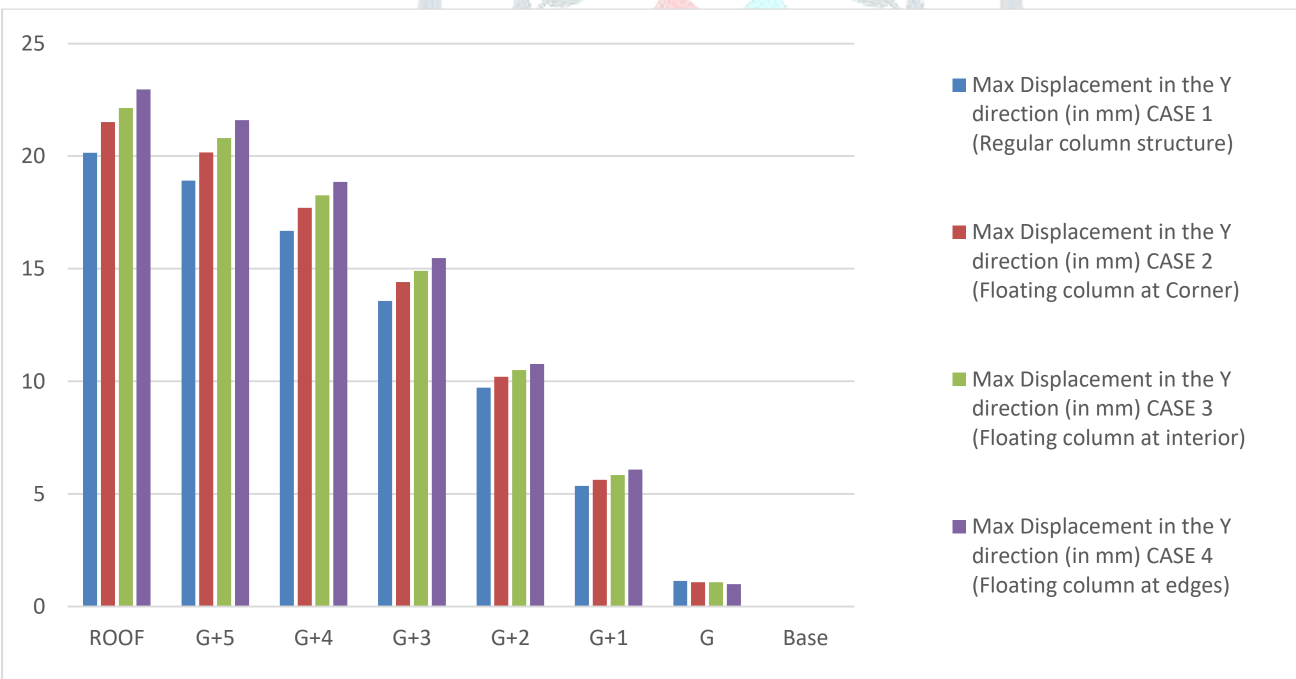

Fig 5.3 Showing Maximum Displacement inY Direction (in mm) In Model 1

It can be observed from fig. 5.4 that maximum story displacement is occurred in case 4 i.e. floating column at edges and maximum story displacement in case 3 and 2 is almost same.

d) MAXIMUM DISPLACEMENT IN Y DIRECTION IN MODEL 2

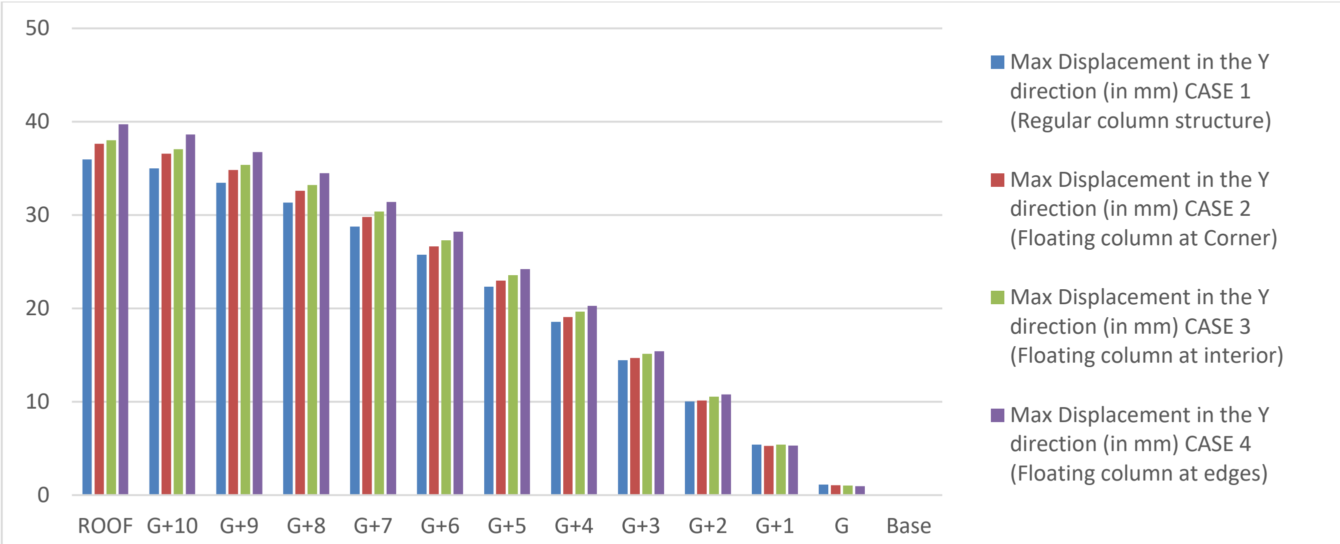

Fig 5.4 Sshowing Maximum Displacement inY Direction (in mm) In Model 2

It can be observed from table 5.4 and fig.5.4 that maximum story displacement is occurred in case 4 i.e. floating column at edges and maximum story displacement in case 3 and 2 is almost same.

e) MAXIMUM STORY DRIFT IN X DIRECTION IN MODEL 1

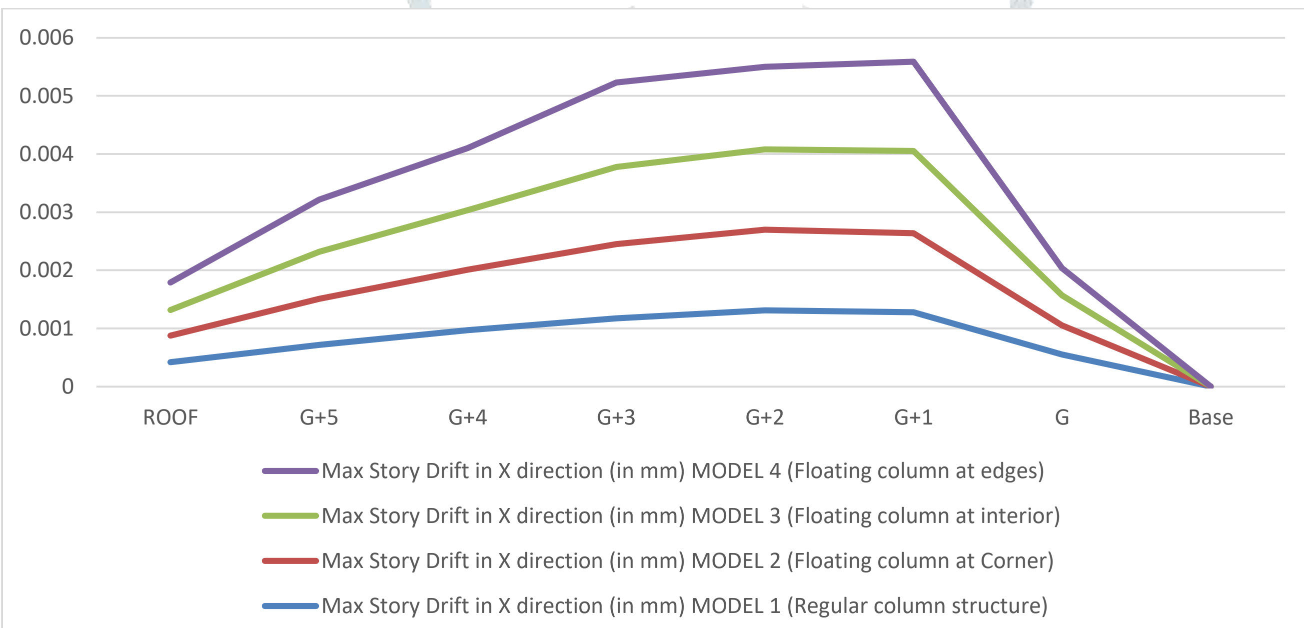

Fig 5.5 Showing Maximum Story Driftin X Direction (in mm) In Model 1

It can be observed from fig. 5.5 that maximum story drift is occurred in case 4 i.e. floating column at edges and maximum story displacement in case 3 and 2 is almost same.

f) MAXIMUM STORY DRIFT IN X DIRECTION IN MODEL 2

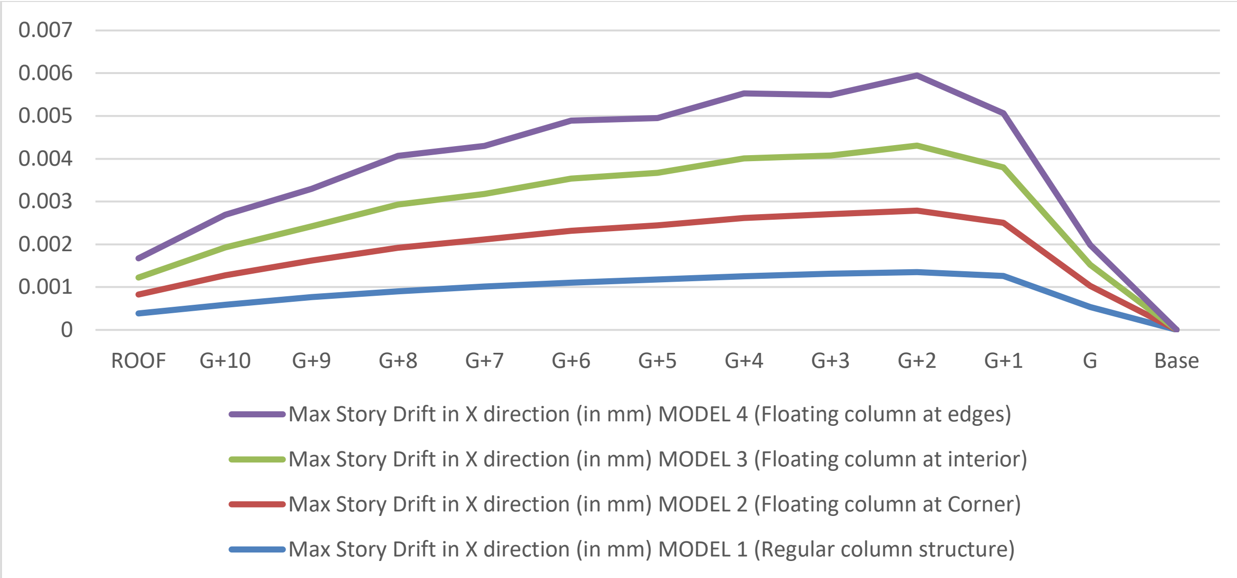

Fig 5.6 figure showing Maximum Story Driftin X Direction (in mm) In Model 2

It can be observed from fig. 5.6 that maximum story drift is occurred in case 4 i.e. floating column at edges and maximum story displacement in case 3 and 2 is almost same.

g) MAXIMUM STORY DRIFT IN Y DIRECTION IN MODEL 1

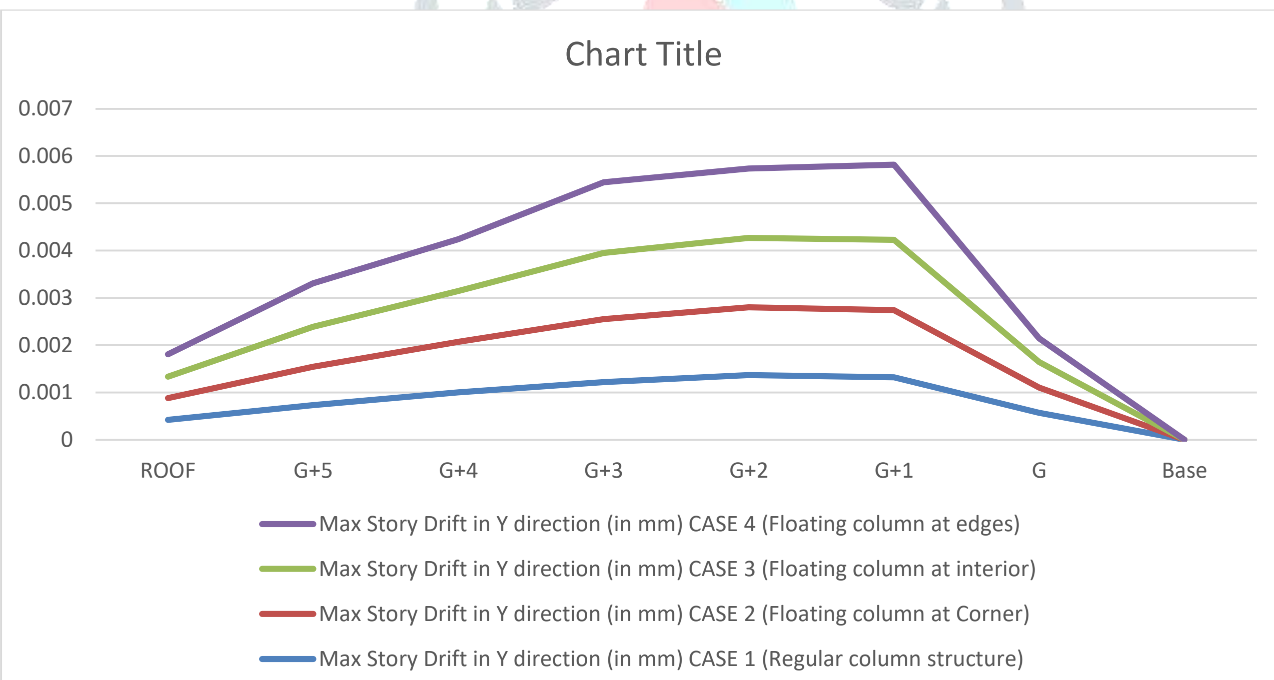

Fig 5.7 figure showing Maximum Story DriftinY Direction (in mm) In Model 1

It can be observed from fig. 5.7 that maximum story drift is occurred in case 4 i.e. floating column at edges and maximum story displacement in case 3 and 2 is almost same.

h) MAXIMUM STORY DRIFT IN Y DIRECTION IN MODEL 2

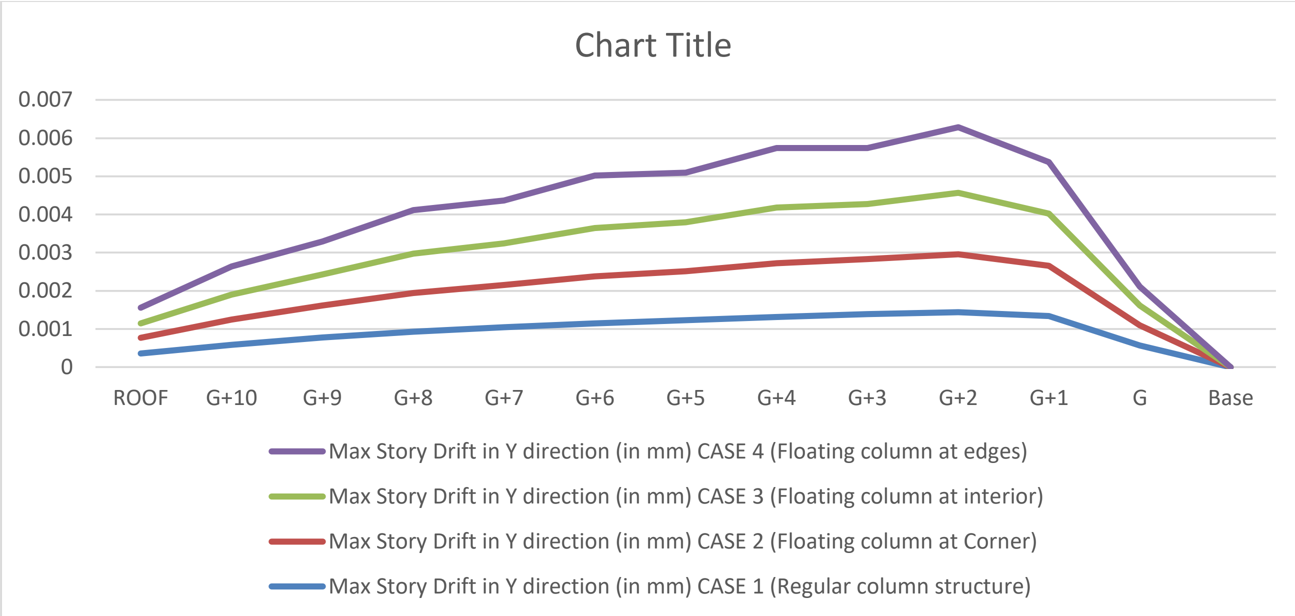

Fig 5.8 figure showing Maximum Story Driftin X Direction (in mm) In Model 2

It can be observed from fig. 5.8 that maximum story drift is occurred in case 4 i.e. floating column at edges and maximum story displacement in case 3 and 2 is almost same.

VI CONCLUSION

After the analysis following points can be concluded

- Maximum lateral storey displacement in Floating column structure is higher than that of the conventional moment-resisting frame having a regular column
- Value of maximum storey displacement in the lateral direction is maximum in **case 4(Floating column at edges)**in all the 4 models.
- Value of maximum storey displacement in the lateral direction in minimum in **case 3 (Floating column at corners)**in all the 3 models having floating column in any position.
- Lateral displacement in model 1 increased by 14.46% with the introduction of floating column at edges.
- Lateral displacement in model 2 increased by 12.78% with the introduction of floating column at edges.
- Lateral displacement in model 1 increased by 14.46% with the introduction of floating column at edges.
- Lateral displacement in model 1 increased by 14.46% with the introduction of floating column at edges.
- Maximum storey in Floating column structure is higher than that of the conventional moment-resisting frame having a regular column
- Value of maximum storey drift is maximum in **case 4(Floating column at edges)** in both models.
- Value of maximum storey displacement in the lateral direction is minimum in **case 2(Floating column at edges)**in both models having floating column in any position.
- Maximum Vertical Reaction in Z direction occurred in Regular Column Structure in Each Model.
- The value of Vertical Reaction Increasing with increasing story height.

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