STUDY OF BEHAVIOUR OF MULTISTOREY BUILDING WITH FLOATING COLUMN

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Abstract- *In the modern multi-storey construction in urban India, Floating columns is a classical feature and is highly undesired in buildings built in seismically active areas. Static analysis of a multi-storey building with and without floating columns is done in this paper. By varying the location of floating columns floor wise different cases of the building are examined. The structural response of the building models with respect to Storey drift and Storey displacements is compared for both buildings. Software ETABS is used to carry out the analysis.*

Keywords: **Multistorey building, Floating Column, Storey displacement, Storey drift, ETABS.**

1. INTRODUCTION

In todays scenario, due to limited space, increasing population and also for aesthetic and functional requirements multi-storey buildings in urban areas are required to have column free space. For this, buildings are provided with floating columns at one or more storey. To reduce the no. of columns in a building to make the maximum space available floating columns are used where in the columns are made to rest upon the beams. In case of the first floor and the consecutive floors above, the beam is being used to support the columns and the bottom ground floor with the minimum no. of columns which would take the entire load that will come from beams to the basement columns and then transfer it to the earth. Floating column structures has got the attention of the architects from all over the world due to its ability to provide aesthetical view for the building. The benefit of floating column is more open space is available due to the limited use of columns without many obstacles. These are more advantageous in urban areas where space is an issue.

In the seismically active areas these floating columns are highly destructive. The earthquake forces that are established at different floor levels in a building need to be carried down along the height to the ground by the shortest path. Deviation or discontinuity in this load transfer path results in poor performance of the building. Buildings overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground tells us about its behaviour during earthquakes. During the 2001 Bhuj earthquake in Gujarat many buildings with an open ground storey intended for parking collapsed or were severely damaged.

1.1 Floating Column:

The floating column is a vertical member which doesn't have a foundation and is made to rest upon a beam and. The floating column acts as a point load on the beam and this beam then transfers the load to the columns below it. But such column cannot be implemented easily and is hard to construct practically since the true columns below the termination level are not constructed with care and hence finally cause to failure. Hence, in seismic regions, the structures already made with these kinds of discontinuous members are endangered. But those structures cannot be destroyed, rather they can be studied and they can be strengthened or some remedial features can be suggested to increase its strength. The stiffness of these columns can be increased by retrofitting or these may be provided with bracing to decrease the lateral deformation and in this way the columns of the first storey can be made stronger. The column is a concentrated load on the beam which supports it. As in the regard of the study, the column is often supposed pinned at the base and hence it is taken as a point load on the transfer beam.

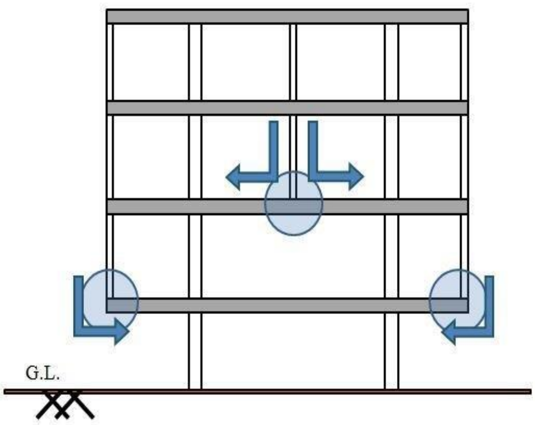

Fig- 1: Floating Column

2. LITERATURE REVIEW

Literature review related to the seismic analysis of multistorey building was carried out. The main aim of the study was to find out the stability of different multistorey buildings in the different seismic zones and study its behaviour. It was noticeable about the study on the seismic zone by numerous researchers, academicians and consultants.

GAURAV PANDEY, SAGAR JAMLE [2018] studied on, "Optimum Location of Floating Column in Multistorey Building with Seismic Loading". In this paper Response spectrum analysis was performed against various load with multiple load combinations on all the model comprises of normal structure and all the cases of structure with floating column at various locations. Nodal displacement, story drift, maximum shear force, maximum bending moment and maximum axial forces was analysed and compared for various cases.

SHIVAM TYAGI, B. S. TYAGI [2018] worked upon, "Seismic Analysis of Multistorey Building with Floating Column". In this paper they compared behaviour of models on the basis of the storey displacement and storey drift. they concluded that, the unavoidable requirements of space at the time of its shortage can be fulfilled by floating column leading to increase in their demand within residential building as well as commercial building. Building provided with floating column shows more storey drift and storey displacement as compared to building without floating column in seismic prone area.

KIRANKUMAR GADDAD, VINAYAK VIJAPUR [2018] examined about "Comparative Study of Multi Storey Building with and without Floating Columns and Shear Walls". They perform Seismic analysis of G+20 storey structure is done by both equivalent static and response spectrum method to obtained the parameters storey displacements, storey shear, storey drift, time period for seismic zone V. From equivalent static method and response spectrum method, they concluded that, storey drift was increased by 9% in building with floating columns as compared to buildings without floating columns. Also, storey shear was obtained as decreased by 4.5% in buildings with floating columns as compared to building without floating columns.

SHIWLI ROY, GARGI DANDA DE [2015] analysed the, "Behavioural Studies of Floating Column on Framed Structure". In this paper, G+3, G+5, and G+10 buildings with floating columns and RCC columns was analysed by using STAAD PRO V8i. The G+3, G+5 and G+ 10 structures are compared with tables and graphs of shear force and bending moment. From graph conclusion was given as, shear force is maximum for floating column but is minimum for normal column. If the shear force in floating column increases the normal column also increases. This means that if the height of structures increases the shear force also increases. It also concluded that in G+3 structures the moment is maximum for normal column and the moment is constant in normal column and the moment suddenly increases from G+3 to G+10 structures. This means that the moment for floating column increases with increase in its structure increases.

WAYKULE S. B. et al. [2016] studied on , "Study of Behaviour of Floating Column for Seismic Analysis of Multistorey Building". Here in this paper G+5 Building with and without floating column in highly seismic zone v was analysed. For these four models are created such as floating column at 1st ,2nd, and 3rd floor buildings and without floating column building. Linear static and time history analysis were carried out of all the four models .from linear static analysis compare all the of models result obtained in the form of seismic parameter such as time period, base shear ,storey displacement ,storey drift. this paper concluded that building with floating column has more time period as compared to building without floating columns. It was also observed that in building with floating column has less base shear as compared to building without floating column

3. METHODOLOGY, MODELLING AND ANALYSIS OF FRAMES

A G+9 storied model of building is analyzed having 4 bays in x direction and 4 bays in y direction for a total of 4 cases with and without floating column at various locations within the floor level and in different stories as mentioned below-

Model 1: Modelling and analysis of G+9 building without floating column.
Model 2: Modelling and analysis of G+9 building with floating column at all four corners in ground floor only.
Model 3 : Modelling and analysis of G+9 building with floating column at all four corners in G+4 floor only.
Model 4 : Modelling and analysis of G+9 building with floating column at all four corners in G +8 floor only.

The dimensions and the factors considered in the modelling and analysis are as shown in the following tables,

Table-1 : Multi-Storey Building Geometrical Dimensions

Type of building		SMRF
Type of soil		Medium
Seismic zone		Zone V
Seismic zone factor		0.36
Member dimensions		
Slab	Thickness	150 mm
Beam	Normal building	(350 x 500) mm
	Floating column building	(350 x 500) mm
Columns	Normal building	(650 x 650) mm
	Floating column building	(650x650) mm
Brick infill wall thickness	Exterior wall	250 mm
	Interior wall	150 mm
Loads		
Unit weight of concrete		25 KN/m2
Unit weight of brick infill		20 KN/m2
Floor loads	Live load	3 KN/ m2
	Floor finish	1 KN/ m2
Roof loads	Live load	1.5 KN/ m2
Grade of rebar		
Beams		Fe 500
Columns		Fe 500
Grade of concrete		
Normal building		M25
Building with floating column		M25
Architectural data		
Number of stories		G+9
Floor height		3 m
No. of bays in X direction		4
No. of bays in Y direction		4
Length of each bay		5 m

4. RESULTS AND DISCUSSIONS

MODEL – 1: Modelling and analysis of G+9 building without floating column.

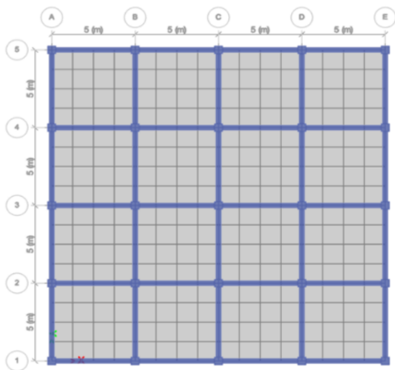

Fig-2: Plan of normal building

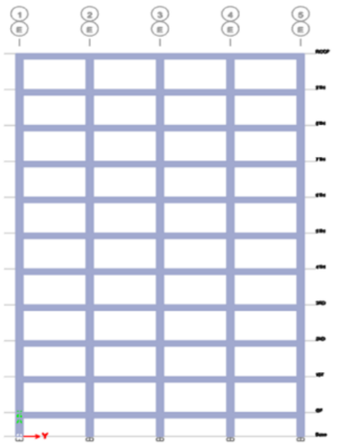

Fig-3: Elevation of normal building

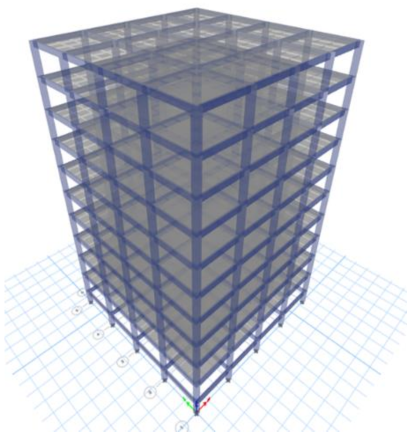

Fig-4: 3D elevation of normal building

Table-2: Maximum storey displacement of model-1

Storey	Elevation (m)	Location	Storey displace-ment (mm)
Base	0	Top	0
Ground floor	2	Top	0.926
1st floor	5	Top	4.243
2nd floor	8	Top	8.259
3rd floor	11	Top	12.432
4th floor	14	Top	16.55
5th floor	17	Top	20.488
6th floor	20	Top	24.136
7th floor	23	Top	27.365
8th floor	26	Top	30.043
9th floor	29	Top	32.059
Roof	32	Top	33.419

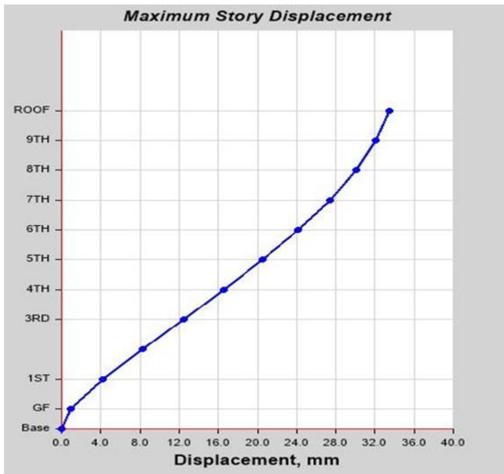

Chart-1: Graph showing maximum storey displacement of model 1

Table-3: Storey drift of model 1

Storey	Elevation (mm)	Location	Storey drift (mm)
Base	0	Top	0
Ground floor	2	Top	0.463
1st floor	5	Top	1.106
2nd floor	8	Top	1.339
3rd floor	11	Top	1.391
4th floor	14	Top	1.373
5th floor	17	Top	1.313
6th floor	20	Top	1.216
7th floor	23	Top	1.076
8th floor	26	Top	0.893
9th floor	29	Top	0.673
Roof	32	Top	0.46

Chart-2: Graph showing storey drift of model 1

MODEL–2: Modelling and analysis of G+9 building with floating column at all four corners in ground floor only.

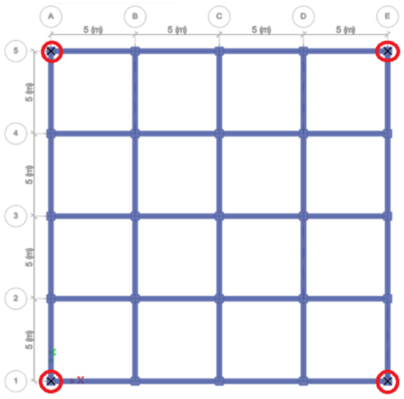

Fig-5: Plan of model 2

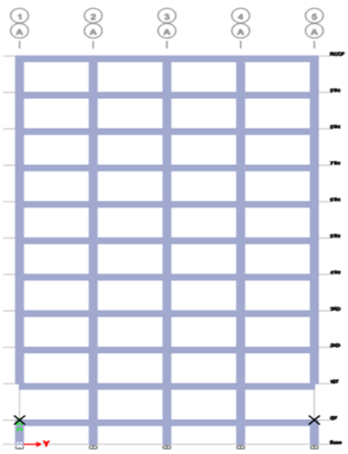

Fig-6: Elevation of model 2

Table-4: Maximum storey displacement of model 2

Storey	Elevation (mm)	Location	Storey displacement (mm)
Base	0	Top	0
Ground floor	2	Top	0.878
1st floor	5	Top	4.342
2nd floor	8	Top	8.546
3rd floor	11	Top	12.868
4th floor	14	Top	17.155
5th floor	17	Top	21.267
6th floor	20	Top	25.102
7th floor	23	Top	28.536
8th floor	26	Top	31.445
9th floor	29	Top	33.723
Roof	32	Top	35.385

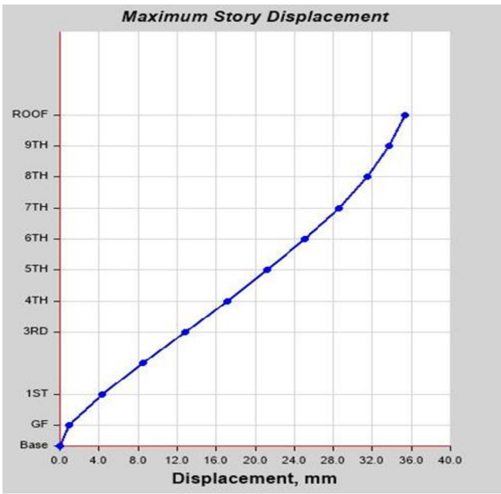

Chart-3: Graph showing maximum storey displacement of model 2

Table-5: Storey drift of model 2

Storey	Elevation (mm)	Location	Storey drift (mm)
Base	0	Top	0
Ground floor	2	Top	0.439
1st floor	5	Top	1.155
2nd floor	8	Top	1.401
3rd floor	11	Top	1.456
4th floor	14	Top	1.429
5th floor	17	Top	1.371
6th floor	20	Top	1.279
7th floor	23	Top	1.145
8th floor	26	Top	0.97
9th floor	29	Top	0.761
Roof	32	Top	0.563

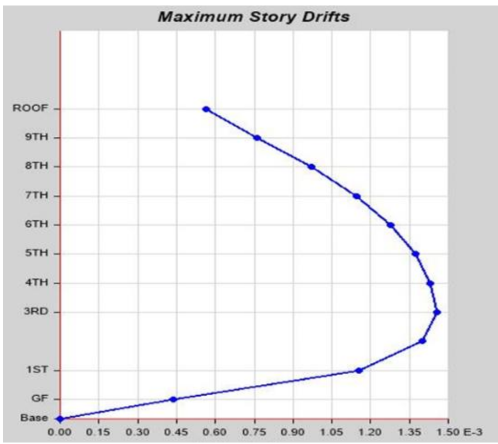

Chart-4: Graph showing storey drift of model 2

MODEL–3: Modelling and analysis of G+9 building with floating column at all four corners in G+4 floor only.

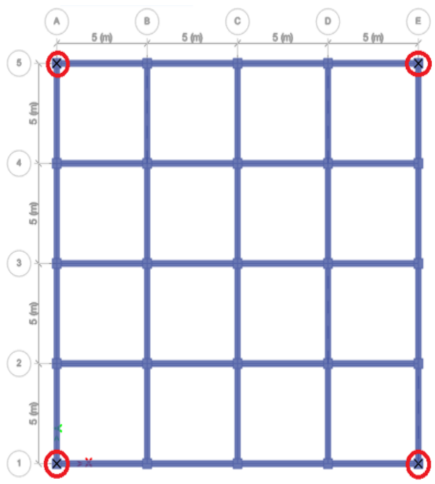

Fig-7: Plan of model 3

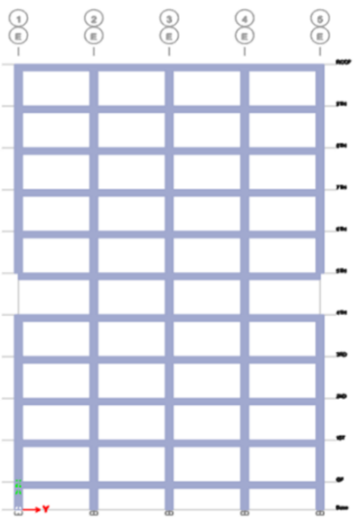

Fig-8: Elevation of model 3

Table-6: Maximum storey displacement of model-3

Storey	Elevation (mm)	Location	Storey displacement (mm)
Base	0	Top	0
Ground floor	2	Top	0.912
1st floor	5	Top	4.178
2nd floor	8	Top	8.134
3rd floor	11	Top	12.276
4th floor	14	Top	16.347
5th floor	17	Top	20.545
6th floor	20	Top	24.301
7th floor	23	Top	27.748
8th floor	26	Top	30.667
9th floor	29	Top	32.936
Roof	32	Top	34.567

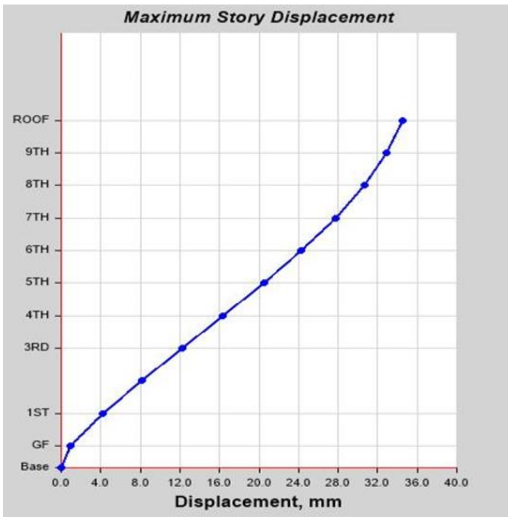

Chart-5: Graph showing maximum storey displacement of model 3

Table-7: Storey drift of model 3

Storey	Elevation (mm)	Location	Storey drift (mm)
Base	0	Top	0
Ground floor	2	Top	0.456
1st floor	5	Top	1.089
2nd floor	8	Top	1.319
3rd floor	11	Top	1.382
4th floor	14	Top	1.369
5th floor	17	Top	1.407
6th floor	20	Top	1.285
7th floor	23	Top	1.16
8th floor	26	Top	0.973
9th floor	29	Top	0.758
Roof	32	Top	0.552

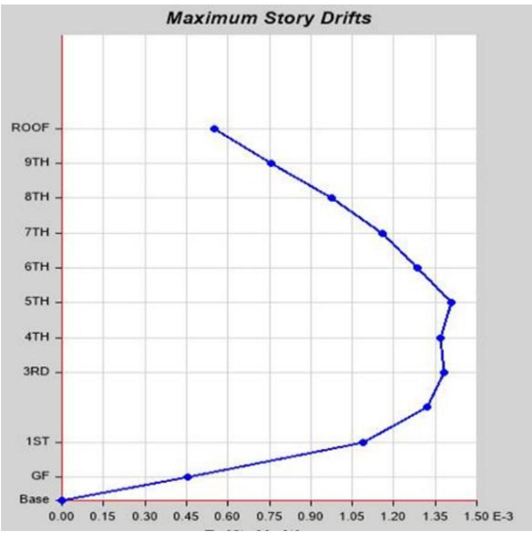

Chart-6: Graph showing storey drift of model 3

MODEL–4: Modelling and analysis of G+9 building with floating column at all four corners in G +8 floor only.

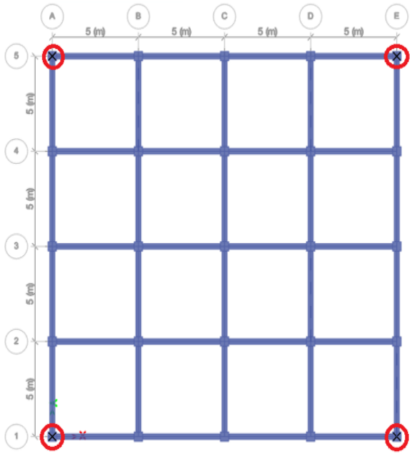

Fig-9: Plan of model 4

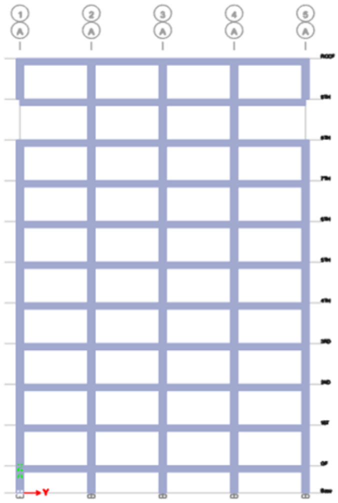

Fig-10: Elevatiom of model 4

Table-8: Maximum storey displacement of model 4

Storey	Elevation (mm)	Location	Storey displacement (mm)
Base	0	Top	0
Ground floor	2	Top	0.925
1st floor	5	Top	4.238
2nd floor	8	Top	8.249
3rd floor	11	Top	12.416
4th floor	14	Top	16.527
5th floor	17	Top	20.458
6th floor	20	Top	24.1
7th floor	23	Top	27.34
8th floor	26	Top	30.048
9th floor	29	Top	32.214
Roof	32	Top	33.581

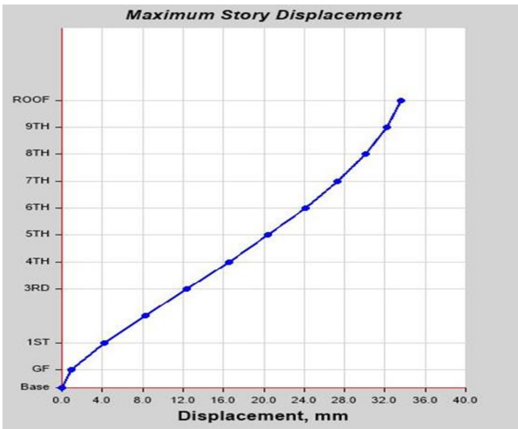

Chart-7: Graph showing maximum storey displacement of model 4

Table-9: Storey drift of model 4

Storey	Elevation (mm)	Location	Storey drift (mm)
Base	0	Top	0
Ground floor	2	Top	0.463
1st floor	5	Top	1.104
2nd floor	8	Top	1.337
3rd floor	11	Top	1.389
4th floor	14	Top	1.371
5th floor	17	Top	1.311
6th floor	20	Top	1.214
7th floor	23	Top	1.081
8th floor	26	Top	0.911
9th floor	29	Top	0.722
Roof	32	Top	0.488

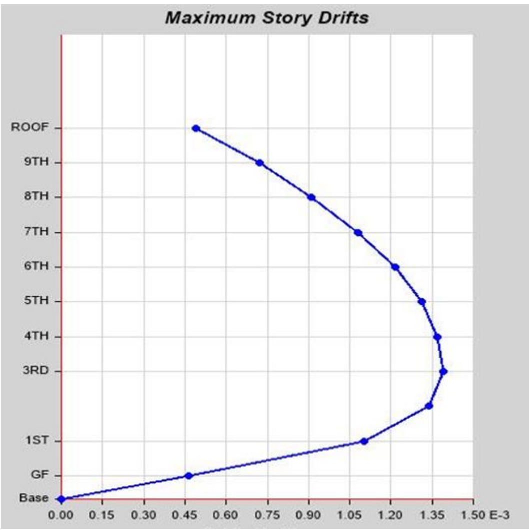

Chart-8: Graph showing storey drift of model 4

Comparison of the results observed in the above models that is Maximum displacements, Story drifts of the normal building, floating column building -

In here we compared the results observed from the analysis of the models, considering the parameters like maximum displacements and story drifts.

Table-10: Maximum storey displacement of all model

Storey	Maximum storey displacement (mm)			
	Model 1	Model 2	Model 3	Model 4
Base	0	0	0	0
Ground floor	0.926	0.878	0.912	0.925
1st floor	4.243	4.342	4.178	4.238
2nd floor	8.259	8.546	8.134	8.249
3rd floor	12.43	12.86	12.27	12.41
4th floor	16.55	17.15	16.34	16.52
5th floor	20.48	21.26	20.54	20.45
6th floor	24.13	25.10	24.30	24.1
7th floor	27.36	28.53	27.74	27.34
8th floor	30.04	31.44	30.66	30.04
9th floor	32.05	33.72	32.93	32.21
Roof	33.41	35.38	34.56	33.58

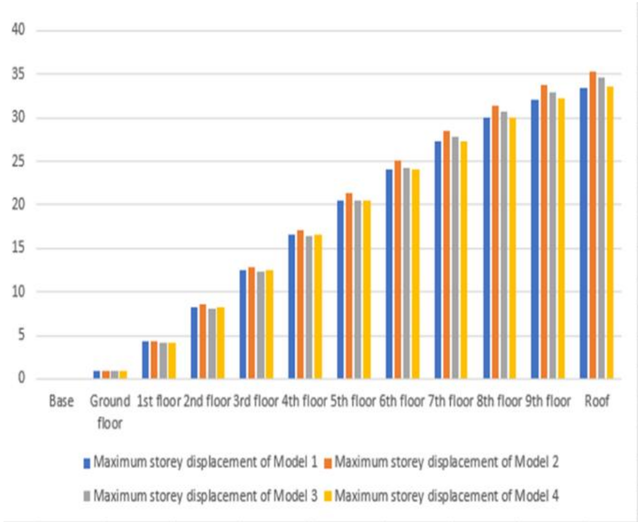

Chart-9: Graph showing comparison of maximum storey displacement

Table-11: Storey drift of all model

Storey	Storey drifts in (mm)			
	Model 1	Model 2	Model 3	Model 4
Base	0	0	0	0
Ground floor	0.463	0.439	0.456	0.463
1st floor	1.106	1.155	1.089	1.104
2nd floor	1.339	1.401	1.319	1.337
3rd floor	1.391	1.456	1.382	1.389
4th floor	1.373	1.429	1.369	1.371

5th floor	1.313	1.371	1.407	1.311
6th floor	1.216	1.279	1.285	1.214
7th floor	1.076	1.145	1.16	1.081
8th floor	0.893	0.97	0.973	0.911
9th floor	0.673	0.761	0.758	0.722
Roof	0.46	0.563	0.552	0.488

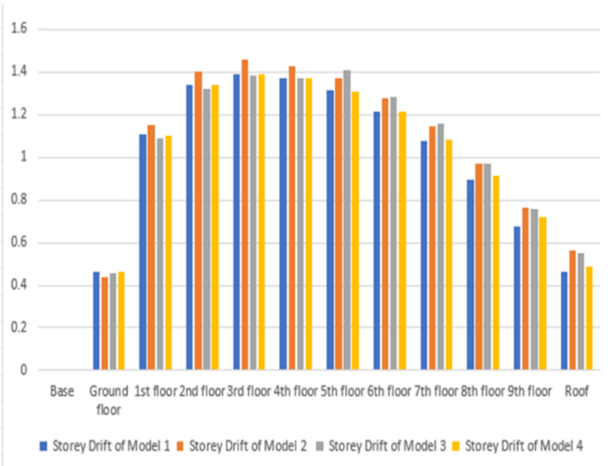

Chart-10: Graph showing comparison of storey drift

5. CONCLUSIONS

The study in this paper mainly comprises the difference between a normal column building and a floating column building and following conclusions are drawn from the analysis,

1) Generally, a building becomes expensive if it is designed to sustain any damage during an strong earthquake shaking.

2) In the present study, it is observed that the normal column building is more efficient when compared with other models i.e. floating column buildings.

3) On comparison of the results obtained for each model, it is observed that the building with normal column building have lesser displacements and story drifts when compared with the floating column models.

4) Similarly, when the floating column models are compared with each other, it is observed that the floating column building in which floating columns are situated at corners of ground ground floor have higher displacements and story drifts as compared to the other model with floating column.

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