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COMPARATIVE STUDY OF SEISMIC ANALYSIS OF MULTI-STOREY BUILDINGS WITH FLOATING COLUMNS ON DIFFERENTIAL POSITIONS AND FLOORS IN ZONE IV AND ZONE V

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Abstract - *In an urban area, due to lack of spaces residential buildings and commercial buildings require large empty spaces for parking, auditorium halls, banquet halls and other commercial activities. To compensate this problem, floating column is generally provided in such buildings. In this study, reinforced concrete G+12 building structure is studied with and without floating column for seismic analysis methods such as equivalent method, modal analysis and time history method in Zone IV and V using ETABS software. Analysis and design have been worked out using IS code Standard specification and national building regulations. After analysis it is observed that building without floating column shows better results in terms of seismic parameters such as base shear, storey drift and storey displacement as compared to building with floating column. Building frame with floating column provided on upper and upper middle stories give better results in terms of seismic parameters in comparison of frame with floating column at lower stories.*

***Key Words*: Floating column, Time history method, Seismic analysis, Modal analysis, base shear, storey displacement etc**

1.INTRODUCTION

This The population of India is increasing rapidly, and in search of career and jobs people migrate from villages to town or cities. This leads to increase in need for commercial and other public sectors reinforced concrete buildings. Hence now-a-days in urban area the open spaces are unavoidable features for ample parking facilities or for auditorium, conference halls, fitness center and other amenities within building structure. Therefore, for fulfilling these requirements open spaces in particular storey is gained by provided floating columns in building. Since column is a structure which transfer beam loads to foundation, on that account when floating column is provided the load path get disturbed, which means the load from beam is not transferred to foundation via column. Floating column does not rest on foundation it rests on a beam of that particular storey in terms of point load. That beam is called transfer beam. So, floating column brings vertical configuration irregularity, stiffness irregularity and load path transfer mechanism irregularity within the structure. Stiffness irregularities within structure affects the ductility of building and hence it impacts structures damping behavior under earthquake loads.

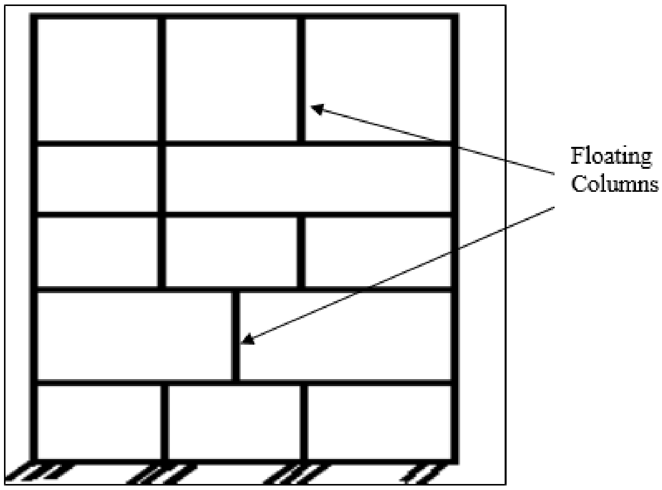

Fig-1: Floating column in building frame

2. LITERATURE REVIEW

Shaik and Kall [1] have studied that Bending moment, shear force, Max support reaction increase with increase in seismic zone structure with Floating column shows more values. Bargir and Mujawar [2] have experimented that triangular plate in floating column building reduces displacement and base shear of building. Sagar and Prassana [3] have observed that bending moment and shear force is more for structure with internally positioned floating column, whereas support reaction is more for structure with floating column at external corners of the building. Georgoussis [6] have studied in this paper that the structural configuration of minimum torsion, which implies that the building elastic response during a ground motion is more or less translational. Patel and Thakkar [7] have explained that with the introduction of bracings and shear walls to the frames with floating columns, the lateral deflections are reduced.

2.1 Objective

The main objectives of the project are:

i. To find out the seismic response of RC Building with Floating Column with respect to different seismic zones and on different storey of building.
ii. Prepare software model of G+12 Structure on ETABS software. Analyze the structure for Seismic loading and wind loading
iii. To find out the difference between Seismic parameters i.e. Base shear, Storey drift & displacement.
iv. To compare the performance results of RCC building with and without Floating Column.

2.2 Methodology

1. Prepare software models on ETABS Software.
2. Analyse reinforced concrete building structure without floating column using Time history method. For time history case, Bhuj earthquake data is used.
3. Analysis reinforced concrete building structure with floating column on lower, middle and upper storey at different location within storey such as either at extreme corner of plan of building or at interior point of plan.
4. Analyse the above-mentioned models with seismic zones IV and V.
5. Compare the obtained analytical results from ETABS.

2.3 Modeling

Model - A: RC Building G+12 without Floating Column.

Model - B: RC Building G+12 with Floating column provided on the First floor at 4 corners of building.

Model - C: RC Building G+12 with Floating column provided on the first floor at interior core position of column.

Model - D: RC Building G+12 with Floating column provided on the Fifth floor at 4 interior corners of building.

Model - E: RC Building G+12 with Floating column provided on the Eleventh floor at 4 interior corners of building.

Model - F: RC Building G+12 with Floating column provided on the First floor at 4 corners of building with Y Shaped Column on ground Floor.

Parameters of proposed building structure is given as:
No. of Storey – G+12
Plan Area – 400 Sq. mt
Plan dimension – 20m × 20m
Height of building – 39 m
Size of Beam – 0.25m × 0.45m
Size of Column – 0.45m × 0.45m
Zone Factors – 0.24 for Zone IV & 0.36 for Zone V

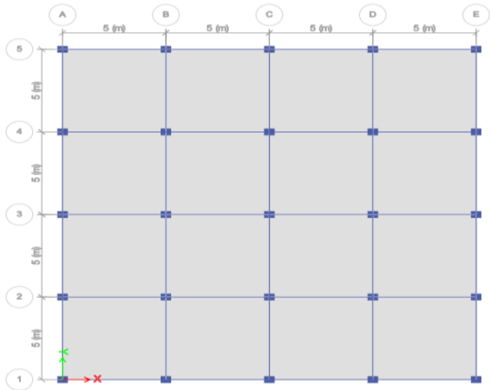

Fig-2: Plan of the building Model A

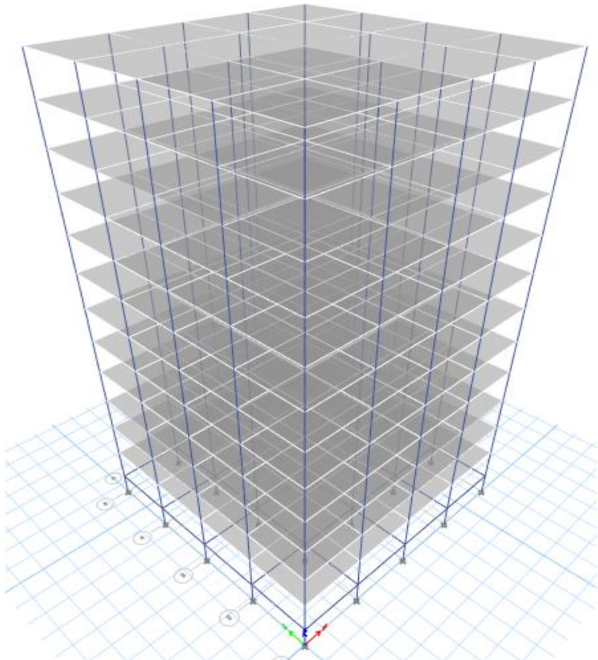

Fig-3: Elevation of building Model A

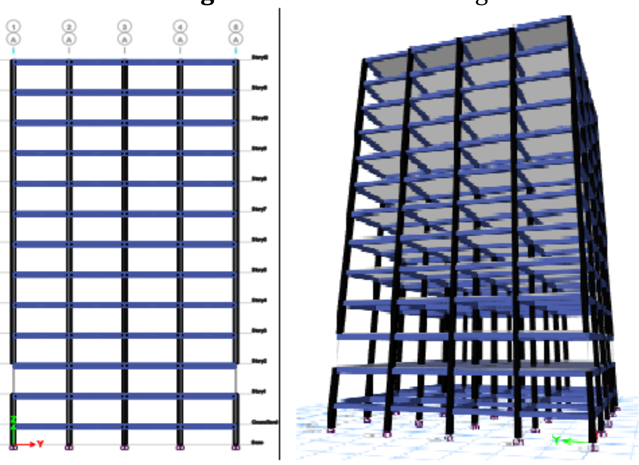

Fig-4: Elevation of Model B

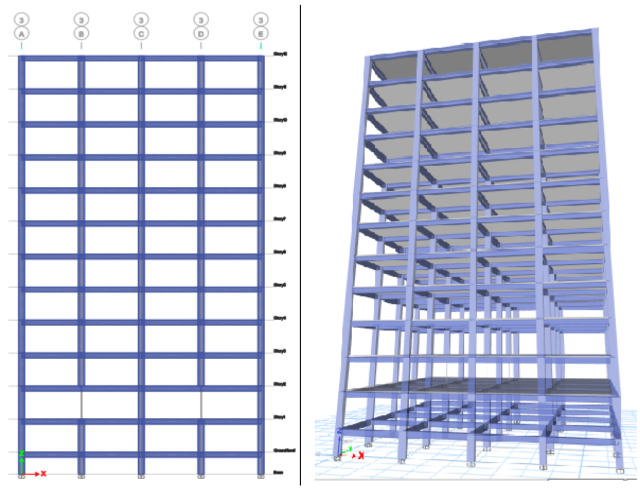

Fig-5: Elevation of Model C

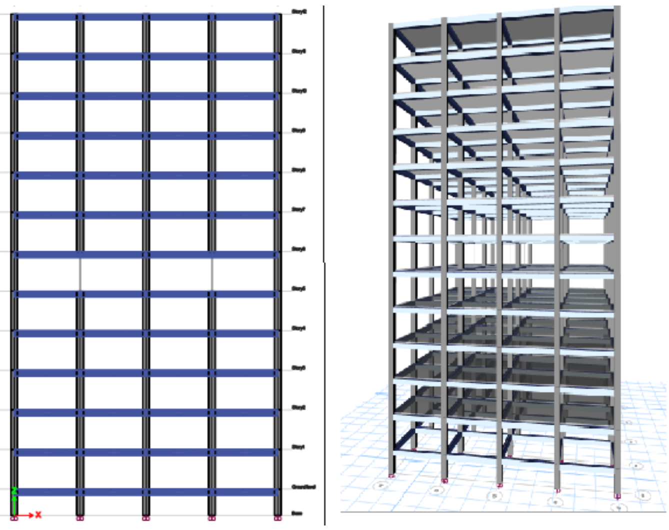

Fig-6: Elevation of Model D

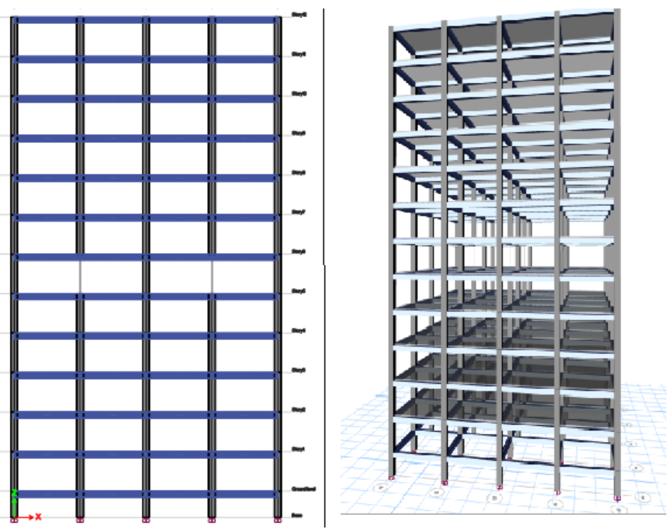

Fig-7: Elevation of Model E

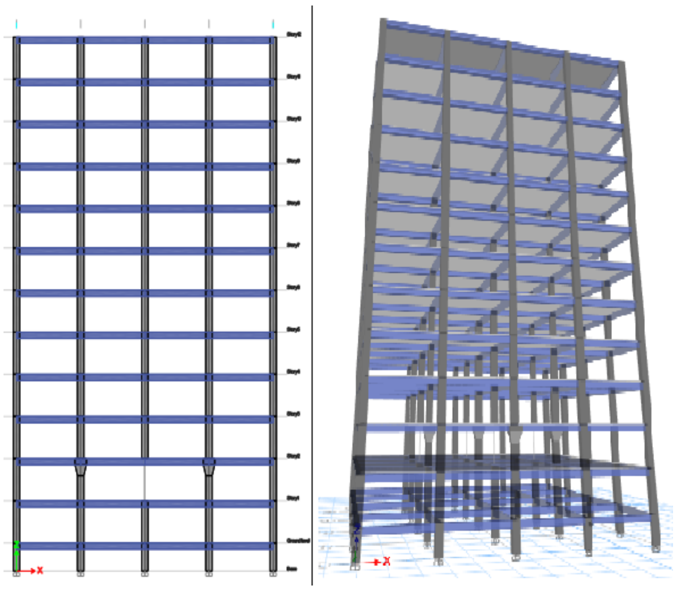

Fig-8: Elevation of Model F

2.4 Load Cases:

- **Dead Load:** 14 kN/ m²
- **Live Load:** 3 kN/ m²
- **Floor Finish Load:** 1.2 kN/ m²
- **Seismic Load: (As per IS Code 1893:2016)**
  Seismic Zones IV & V
  Z= 0.24 & Z=0.36 accordingly,
  Importance factor (I)= 1.2
  Soil Type =2

3. RESULTS:

3.1 Storey Shear: The graph shows the value of lateral load acting per storey, it is always maximum at the base of building structure and it goes on decreasing at the top.

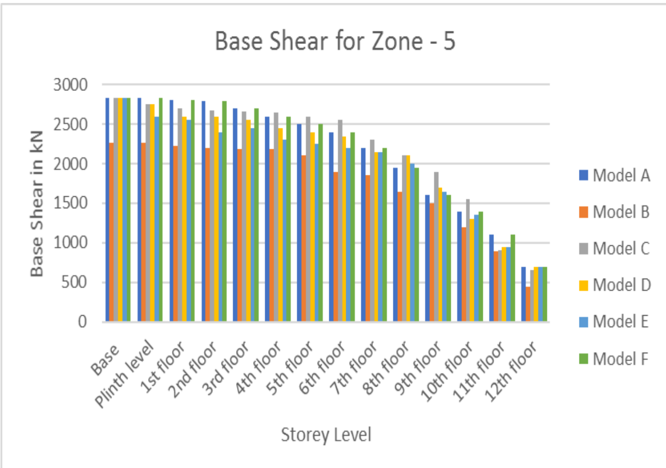

Chart -1: Base shear for Zone V

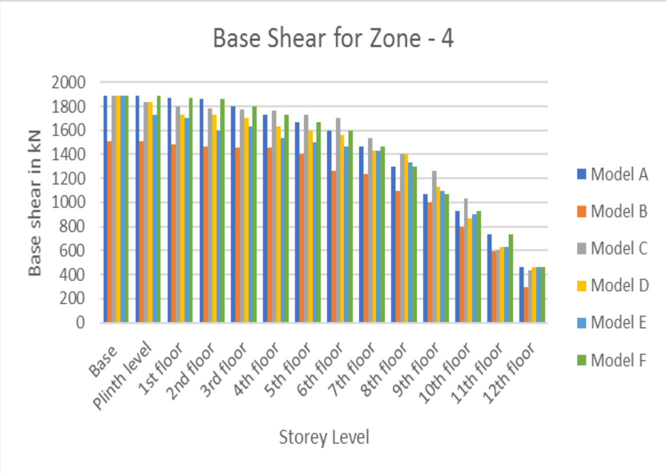

Chart -2: Base shear for Zone IV

Base shear	Model A	Model B	Model C	Model D	Model E	Model F
Base	2838	2269	2836	2836	2836	2837
Plinth level	2830	2260	2750	2750	2600	2830
1st floor	2810	2230	2700	2600	2550	2810
2nd floor	2790	2200	2680	2600	2400	2790
3rd floor	2700	2190	2660	2550	2450	2700
4th floor	2600	2190	2650	2450	2300	2600
5th floor	2500	2100	2600	2400	2250	2500
6th floor	2400	1900	2550	2350	2200	2400
7th floor	2200	1850	2300	2150	2150	2200
8th floor	1950	1650	2100	2100	2000	1950
9th floor	1600	1500	1900	1700	1650	1600
10th floor	1400	1200	1550	1300	1350	1400
11th floor	1100	890	900	950	950	1100
12th floor	700	450	650	690	690	700

Fig-9: Values of Base Shear of Zone 5

Base shear	Model A	Model B	Model C	Model D	Model E	Model F
Base	1892.00	1512.67	1890.67	1890.67	1890.67	1891.33
Plinth level	1886.67	1506.67	1833.33	1833.33	1733.33	1886.67
1st floor	1873.33	1486.67	1800.00	1733.33	1700.00	1873.33
2nd floor	1860.00	1466.67	1786.67	1733.33	1600.00	1860.00
3rd floor	1800.00	1460.00	1773.33	1700.00	1633.33	1800.00
4th floor	1733.33	1460.00	1766.67	1633.33	1533.33	1733.33
5th floor	1666.67	1400.00	1733.33	1600.00	1500.00	1666.67
6th floor	1600.00	1266.67	1700.00	1566.67	1466.67	1600.00
7th floor	1466.67	1233.33	1533.33	1433.33	1433.33	1466.67
8th floor	1300.00	1100.00	1400.00	1400.00	1333.33	1300.00
9th floor	1066.67	1000.00	1266.67	1133.33	1100.00	1066.67
10th floor	933.33	800.00	1033.33	866.67	900.00	933.33
11th floor	733.33	593.33	600.00	633.33	633.33	733.33
12th floor	466.67	300.00	433.33	460.00	460.00	466.67

Fig-10: Values of Base Shear of Zone 4

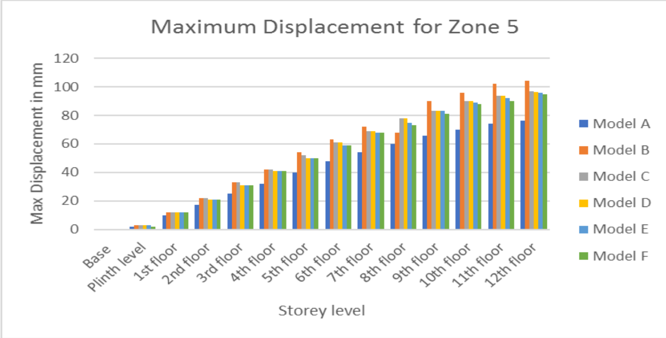

Chart -3: Maximum Displacement for Zone V

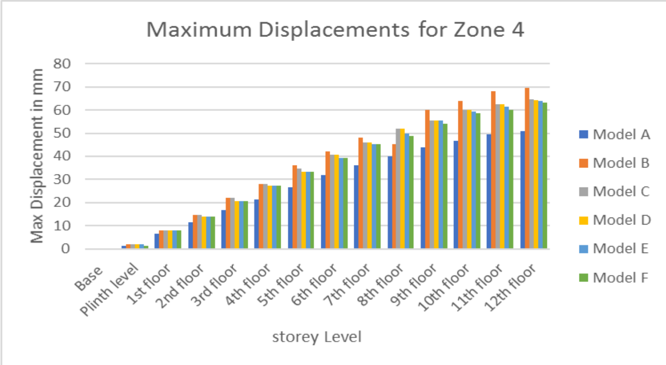

Chart -4: Maximum Displacement for Zone IV

Displacement	Model A	Model B	Model C	Model D	Model E	Model F
Base	0	0	0	0	0	0
Plinth level	2	3	3	3	3	2
1st floor	10	12	12	12	12	12
2nd floor	17	22	22	21	21	21
3rd floor	25	33	33	31	31	31
4th floor	32	42	42	41	41	41
5th floor	40	54	52	50	50	50
6th floor	48	63	61	61	59	59
7th floor	54	72	69	69	68	68
8th floor	60	68	78	78	75	73
9th floor	66	90	83	83	83	81
10th floor	70	96	90	90	89	88
11th floor	74	102	94	94	92	90
12th floor	76.25	104.5	96.9	96.5	96	95

Fig-11: values of Max. Storey Displacement of Zone 5

Displacement	Model A	Model B	Model C	Model D	Model E	Model F
Base	0.00	0.00	0.00	0.00	0.00	0.00
Plinth level	1.33	2.00	2.00	2.00	2.00	1.33
1st floor	6.67	8.00	8.00	8.00	8.00	8.00
2nd floor	11.33	14.67	14.67	14.00	14.00	14.00
3rd floor	16.67	22.00	22.00	20.67	20.67	20.67
4th floor	21.33	28.00	28.00	27.33	27.33	27.33
5th floor	26.67	36.00	34.67	33.33	33.33	33.33
6th floor	32.00	42.00	40.67	40.67	39.33	39.33
7th floor	36.00	48.00	46.00	46.00	45.33	45.33
8th floor	40.00	45.33	52.00	52.00	50.00	48.67
9th floor	44.00	60.00	55.33	55.33	55.33	54.00
10th floor	46.67	64.00	60.00	60.00	59.33	58.67
11th floor	49.33	68.00	62.67	62.67	61.33	60.00
12th floor	50.83	69.67	64.60	64.33	64.00	63.33

Fig-12: Values of Max. Storey Displacement of Zone 4

3.2 Storey Displacement: It is a lateral displacement of the storey with respect to base of the structure. Storey displacement is minimum at the base level and maximum at top floors.

3.3 Storey Stiffness: It is estimated as lateral force producing unit translational lateral deformation in particular storey, with bottom storey restrained in to deform in lateral direction. Which means bottom storey is only free to rotate and all other translational movement is restrained.

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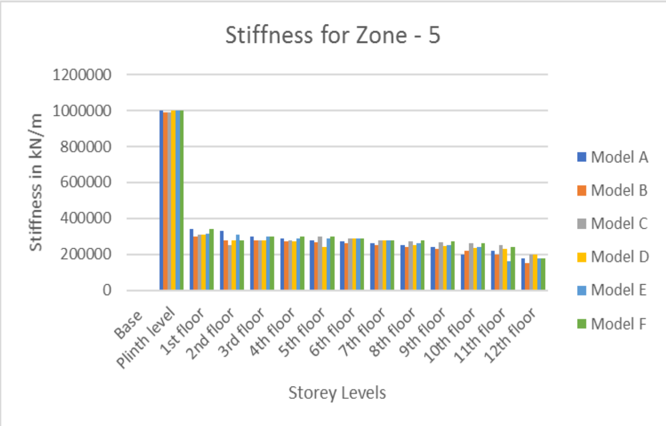

Chart -5: Storey stiffness for Zone V

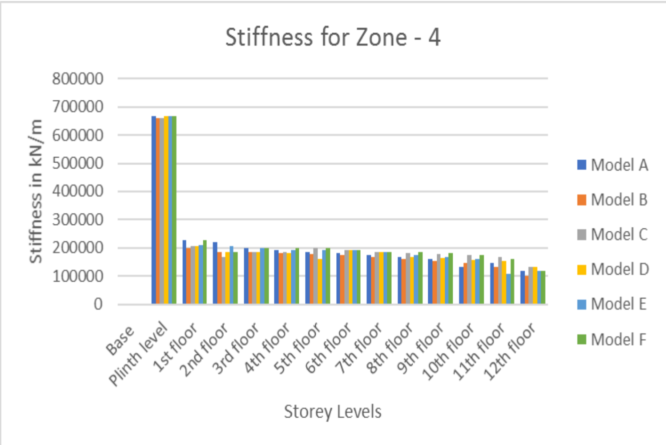

Chart -6: Storey stiffness for Zone IV

3.4 Storey Drift: It is ratio of storey displacement of one Storey level to the storey displacement of storey above or below to that storey level. As per IS code 1893, the maximum permissible storey drift is 0.004.

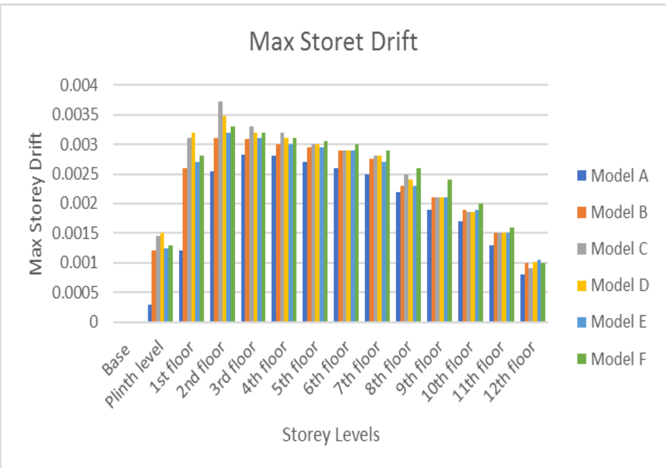

Chart -6: Max. Storey Drift

4. CONCLUSIONS

1. Building frame without floating columns gives better performance and shows greater values of seismic parameters such as base shear, storey stiffness, storey drift and displacement as compared to building with floating column.
2. When floating column is located at corner or extreme point of building plan, it shows worse performance of RCC building under seismic lateral load.
3. Whereas building with floating column located at interior location of building plan gives relatively lesser values for displacement and storey drift with comparatively more stiffness.
4. The worse seismic effect due to presence of floating column in R.C building primarily depend on position of floating column on particular floor. Similarly, when floating column provided on upper storey it reduces the worse seismic effect, which means when floating column is provided on lower storey it shows more storey displacement and drift, but when it is provided on 11^{th} floor or at high elevation it shows less storey displacement and storey drift.
5. Because of floating column, stiffness of RC frame structure gets reduced. Therefore, when Y- shaped column are provided below the beams which are just adjacent to transfer beams, it increases the stiffness of that storey level and hence help to reduce the storey displacement.

3.1 Future Scope of work

Present work is based on effect of floating column in R.C building, there is need to research about reducing the worse seismic effect of building frame with floating column structure by stabilizing the stiffness of structure, and balancing the load distribution path within structure.

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BIOGRAPHIES

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