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Effect of Shear Walls Locations in RC Multistory Building with Floating Columns Subjected to Seismic Load

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ABSTRACT: -

Now a days Floating Columns are commonly used to provide the large parking space, banquet halls, conference rooms, showrooms and other amenities in residential and commercial building in urban cities. Also, to give architectural view and functional requirement to the building, concept of floating columns is becoming widely used. But in seismic active area, it is highly undesirable to build such type of buildings as compared to normal buildings. To provide additional strength and stiffness to building, shear walls are taken into consideration. This paper aims to study the seismic behaviour of Reinforced Concrete Multi-Storey building with floating columns by conducting linear dynamic analysis i.e. Response Spectrum Analysis considering seismic zone III for most suited position and location of shear wall. Total four models are prepared in which the first model is taken without shear wall while the other three models include shear walls at centre, corner and side of the building. And each of these models are modeled and analyzed for the structure having floating column at first floor and third floor of the building. In present work, G+ 9 storey building with floating columns has been modeled using ETABS2016.The structural response such as maximum storey displacement, storey drift and storey shear for different models have been plotted to compare and discuss. It is found that G+9 storey building having floating columns with shear walls at corner gives lowest value of storey displacement and storey drift in each case. Hence, most suited location of shear wall is at the corner of the building on the basis of this study.

***Keywords*:** Floating Column, Shear Wall, Response Spectrum Analysis, Finite Element Analysis, ETABS2016.

1. INTRODUCTION

The behaviour of a building during earthquake 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 and any deviation or discontinuity in this load transfer path will result in poor performance of the building. This force transfer path is disrupted in case of floating columns. Since, they attract a lot of seismic force, which is unfavorable in the high seismic zone. As they acts well when only vertical forces are present and they are highly undesirable when lateral forces acts such as earthquake. But even then, we see a lot of buildings be it residential, commercial or industrial using floating columns in their construction. And the only reason is the flexibility to alter the plan to suit the client requirement. So, in this situation, it is the job of structural engineers like us to ensure that such buildings are not only analyzed properly, but the detailing of such building should be done properly. Floating columns, though highly discouraged, are still an important part of the construction industry.

Buildings in urban cities are required to have column free space for aesthetic and functional requirements. In multi-storey residential building, to accommodate the number of parking space and the turning radius, some of the columns from the floors above create a problem. Columns that float or hang on the beam at an intermediate storey and do not reach the foundation level are known as floating columns.

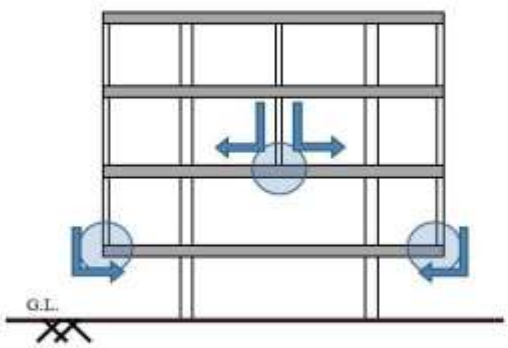

Figure.1 Hanging or Floating Column

2. OBJECTIVE OF STUDY

Many researchers had done their work on comparing building without floating column with building having floating column. Only some of them used the Shear wall, bracings or infill walls in these types of building. Different locations and positions of floating column was analyzed but with less number of floating columns in their plan. The effect of shear wall at different locations of building has not yet observed considering the Indian Standard Codes. The objective of this research is to model G + 9 storey building with floating column at Ist floor and IIIrd floor in Etabs2016 and analyze the multi-storey building by Response Spectrum analysis. Also, different seismic response such as storey displacement, storey drift and base shear are compared in this experimental work.

3. PROBLEM STATEMENT

A) Building characteristics

This paper includes modeling of G+9 storey residential building having floating columns at the different floors along with the shear walls at different location in the structure. Seismic data given in Table 3 are taken from the IS Code 1893:2002 (Part 1) - Criteria for earthquake resistant design of structures. Linear Dynamic Analysis is carried out to find the seismic response of the structure. The members are loaded with Dead Load and Live Load considering IS Code 456:2000 (Plain and Reinforced Concrete – Code of Practice). Base of the building has been considered as fixed.

Following figure given below is the plan of the building. The plan area is same for all the models. The length and width of the building is 28 meter and 25 meter respectively and the plinth area is 700 sq. meter.

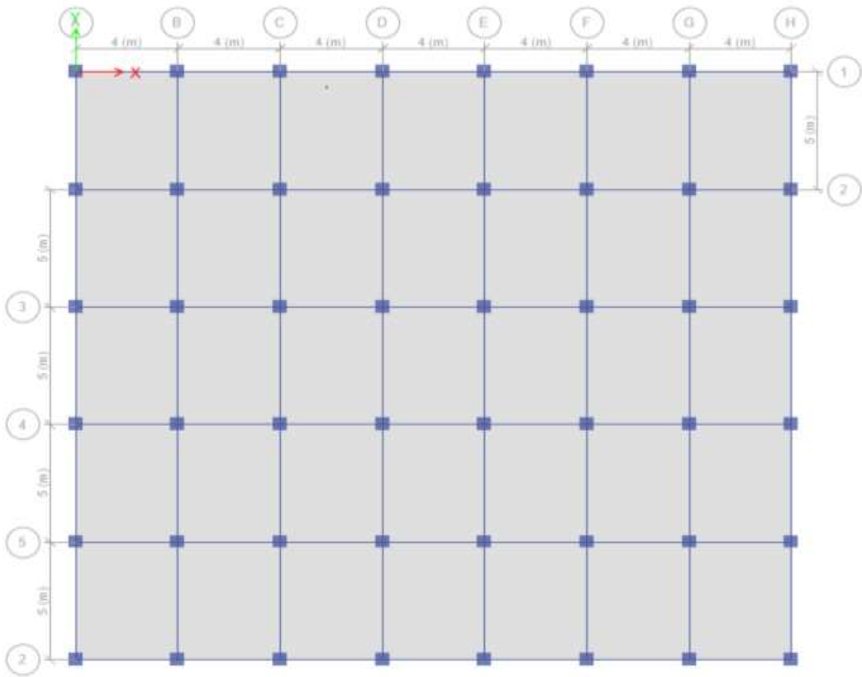

Figure.2.1 Plan of the Building

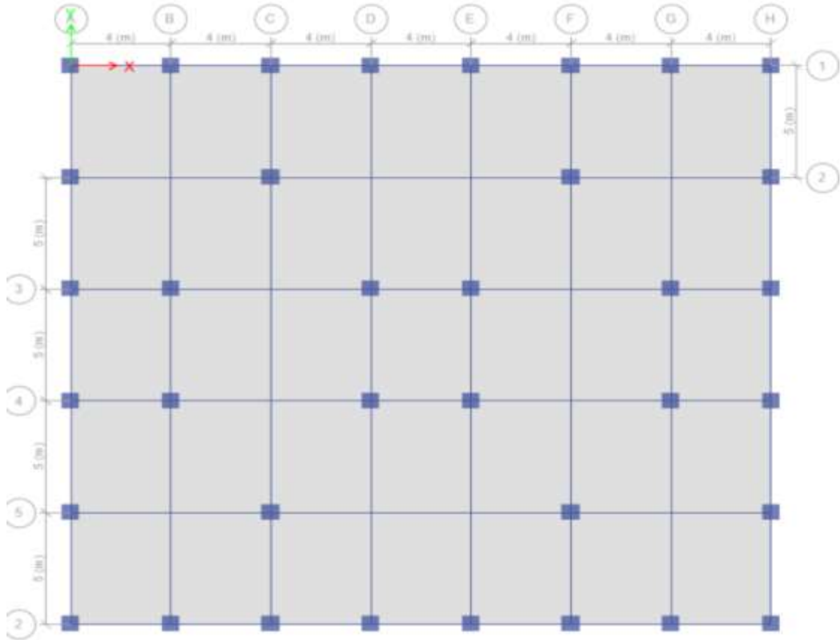

Figure.1.2 Position (Plan) of Floating Column

B) Structural Properties

In this study, a plan area of 28.00 m x 25.00 m has been considered and a building height of 30.00 m is taken. Column spacing of 5.00 m and 4.00 m c/c has been taken to form a grid in both major directions i.e. x and y directions. Structure is considered as the Special Moment Resisting Frame (SMRF) i.e. a frame in which members and joints are capable of resisting forces primarily by flexure meeting special ductile detailing requirement given in IS 13920 or IS 4326 or SP 6 (6). All the geometrical and structural properties of the models are given in the table below.

Table.3. 1Structural Properties

S .No.	Description of Parameters	Information/Dimension
1.	Structure Type	SMRF
2.	No. of Storey	10
3.	Height of Storey	3m
4.	Plan Area	28 X 25 m^2
5.	Spacing of Grid in x-direction	4m
6.	Spacing of Grid in y-direction	5m
7.	Dead Load	2KN/m^2
8.	Live Load	3KN/m^2
9.	Slab Thickness	150mm
10.	Shear Wall Thickness	200mm
11.	Support	Fixed
	Case A	
11.	Beam Size	400 × 300, 600 × 350
12..	Column Size	500 × 500, 650 × 650
	Case B	
13.	Beam Size	450 × 350, 650 × 400
14.	Column Size	550 ×550, 700 × 700

C) Building models

For the analysis purpose 2 cases have been considered namely as:

Case A: 10 stories (G+9) Special Moment Resisting Frame having floating column at 1st floor only.

Case B: 10 stories (G+9) Special Moment Resisting Frame having floating column at 3rd floor only.

Following four models are considered for both the cases:

Model M1: Building in which shear wall is not provided.

Model M2: Building in which shear wall is provided at center of the building.

Model M3: Building in which shear wall is provided at corners of the building.

Model M4: Building in which shear wall is provided at the sides of the building.

Table.3. 2Cases Designed

Floating column case	**Shear wall position**	**Models**
Case-A	Without shear wall	M1
	Centre	M2
	Side wall	M3
	Corner	M4
Case-B	Without shear wall	M1
	Centre	M2
	Side wall	M3
	Corner	M4

Model M1: Building without Shear wall

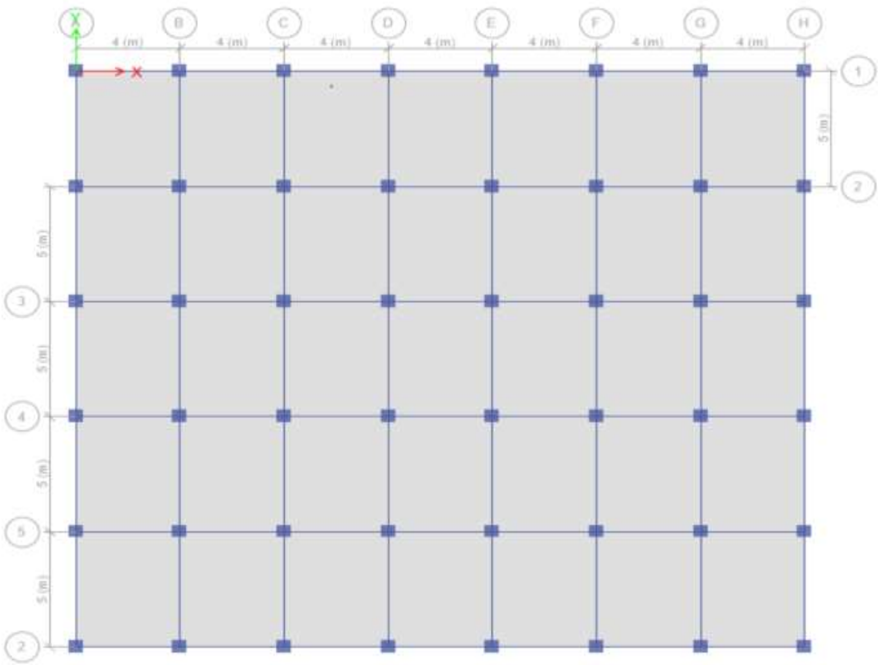

Figure.3.1 Plan of M1

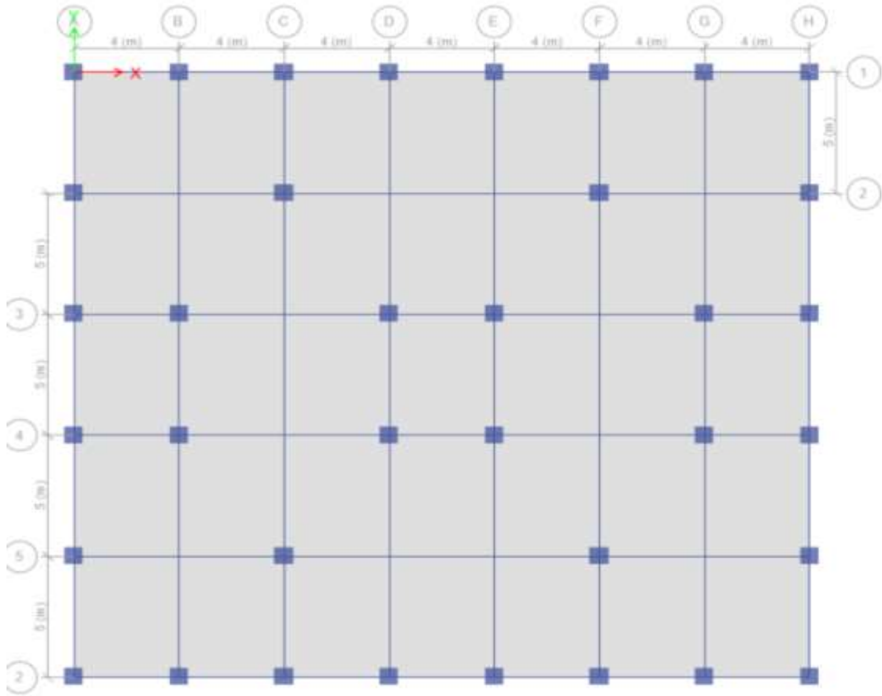

Figure.3.2 Plan of Floating Column in M1

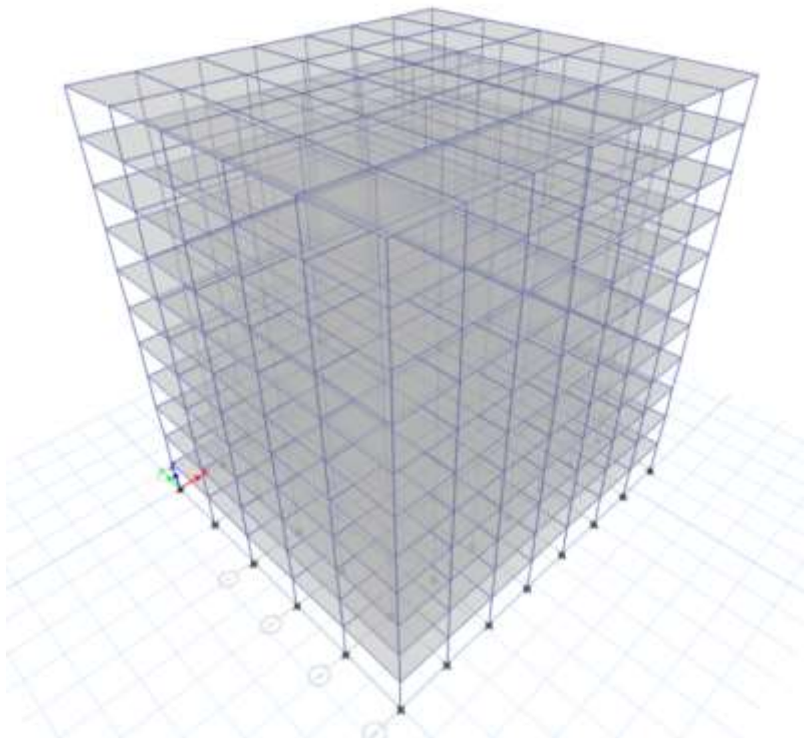

Figure.3.3 Three Dimensional model of M1

Model M2: Building with Shear Wall at Centre

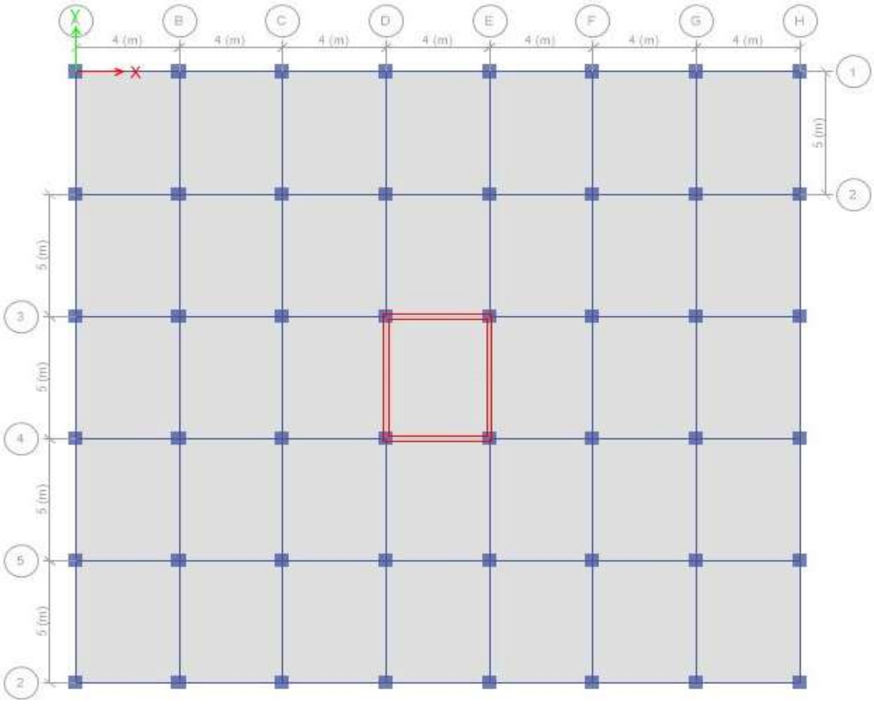

Figure.3.4 Plan of M2

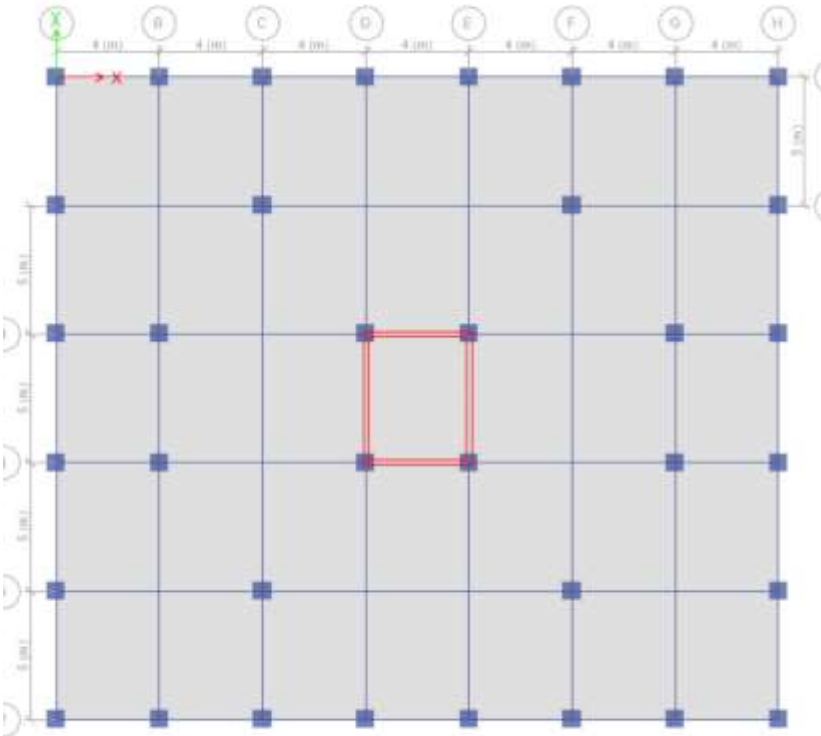

Figure.3.5 Plan of Floating Column in M2

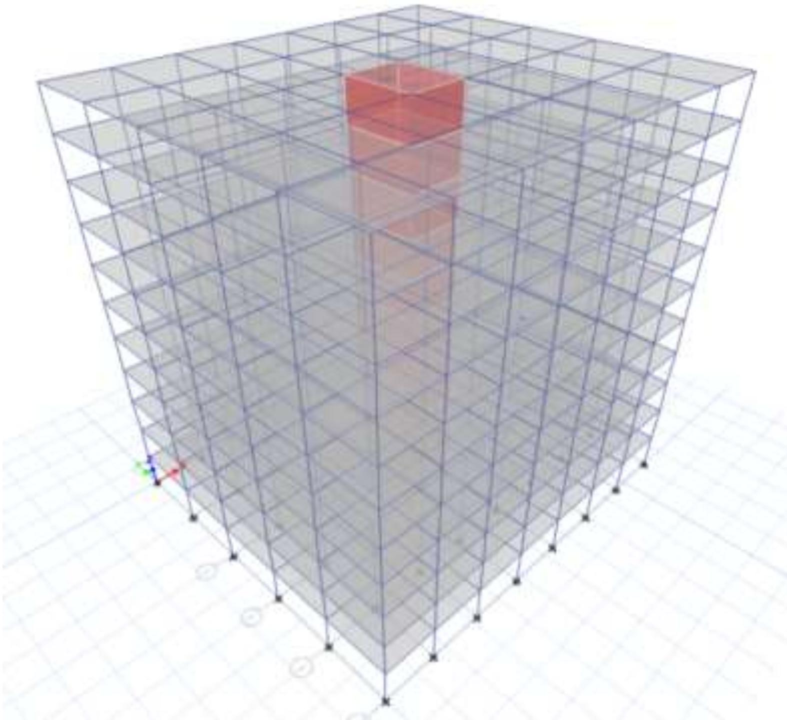

Figure.3.6 Three Dimensional model of M2

Model M3: Building with Shear Wall at corner

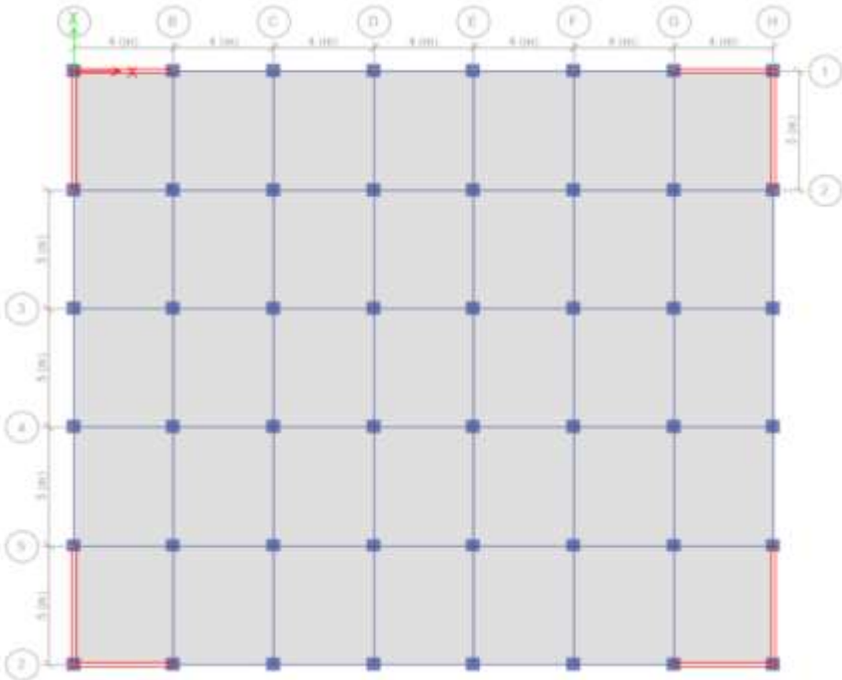

Figure.3.7 Plan of M3

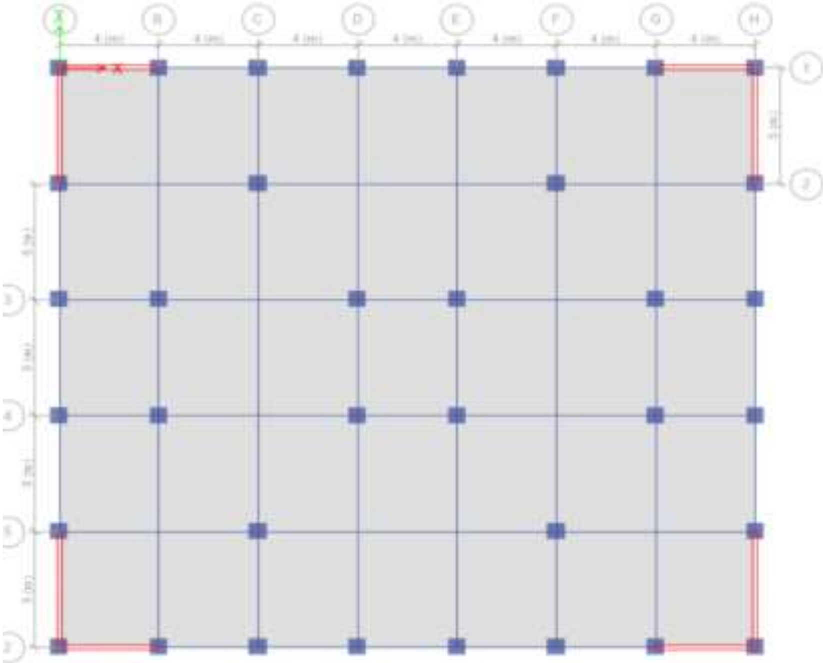

Figure.3.8 Plan of Floating Column in M3

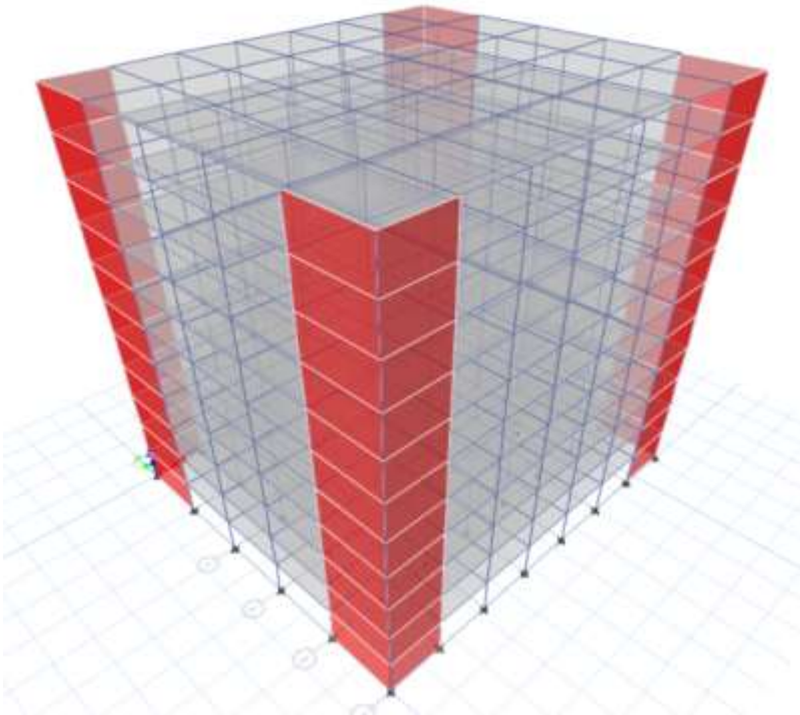

Figure.3.9 Three Dimensional model of M3

Model M4: Building with Shear Wall at Sides

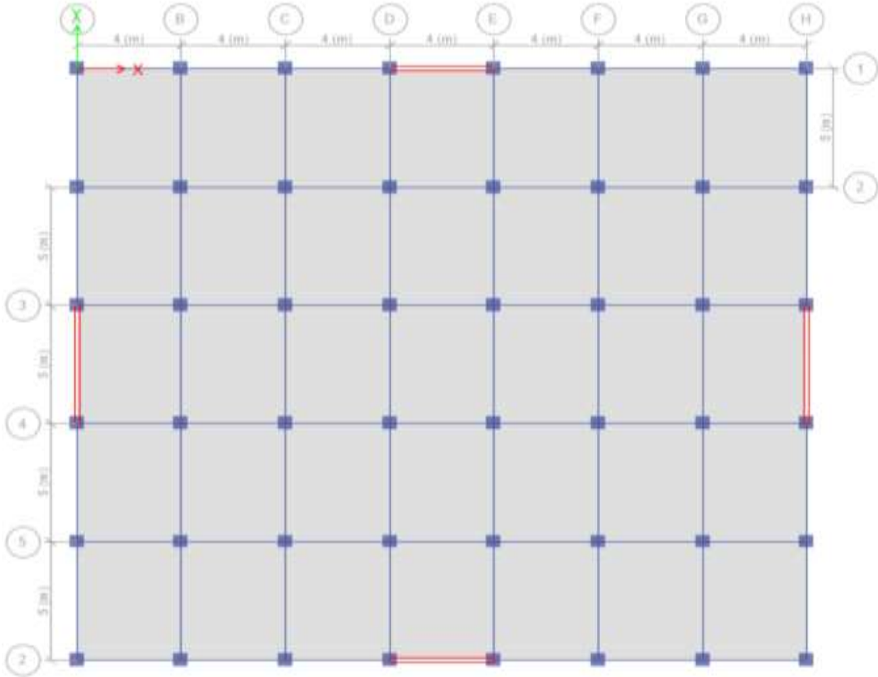

Figure.3.10 Plan of M4

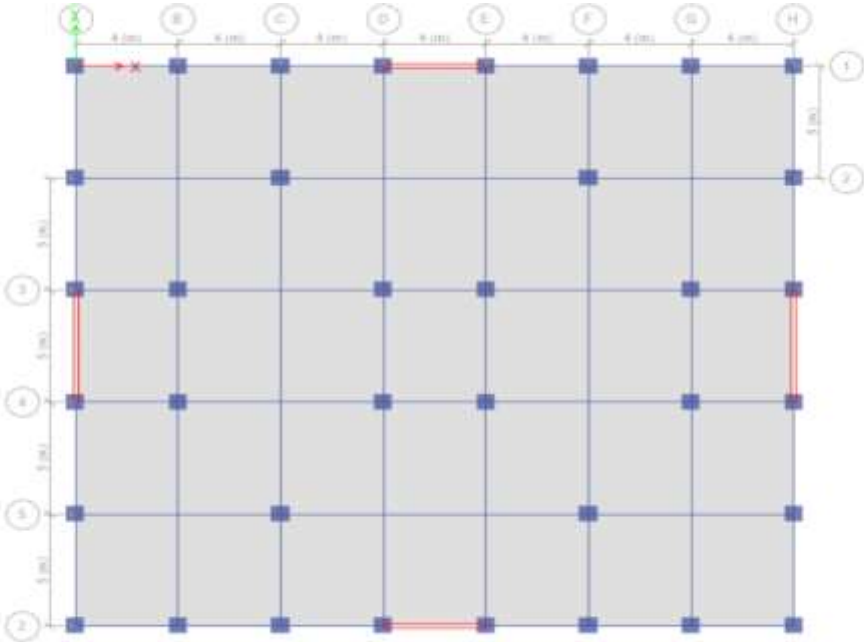

Figure.3.11 Plan of Floating Column in M4

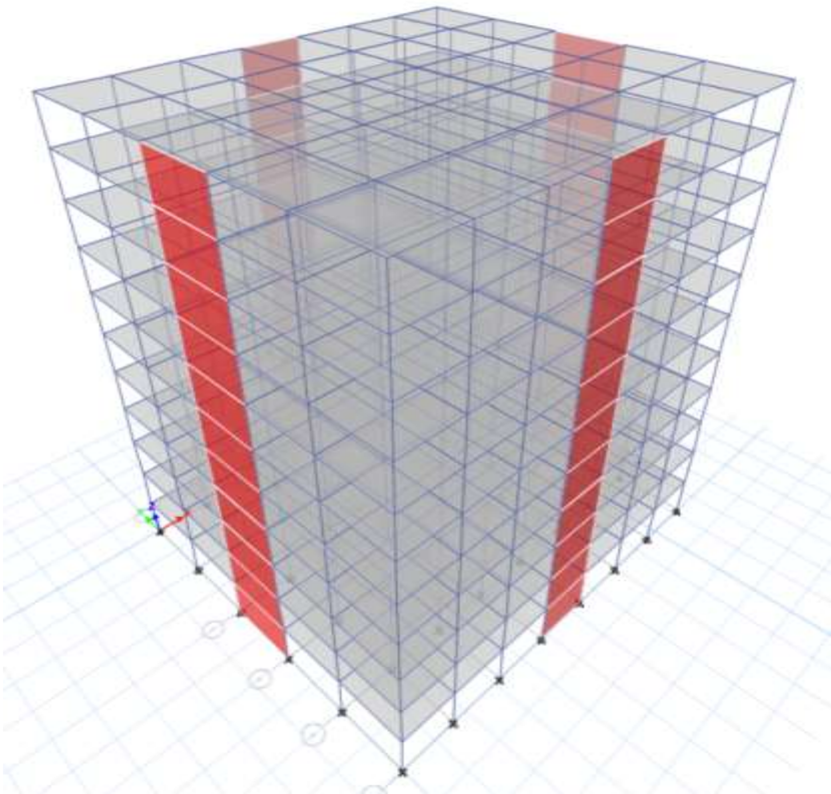

Figure.3.12 Three Dimensional model of M4

IV. Results & Discussion

Maximum storey displacement:

Table.4. 1Maximum storey Displacement (mm)

S. No.	Model	Case A		Case B	
		X-Direction	Y-Direction	X-Direction	Y-Direction
1.	M1	100.87	109.97	89.08	95.48
2.	M2	85.71	85.17	77.92	78.65
3.	M3	79.63	74.11	72.35	68.60
4.	M4	90.17	91.07	81.19	83.16

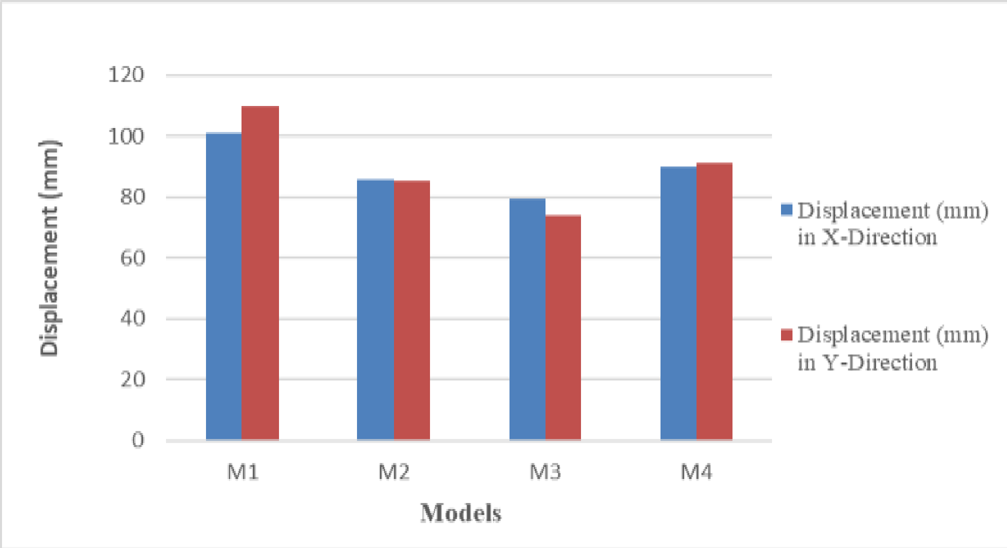

Figure.4. 1Maximum storey displacement for case A

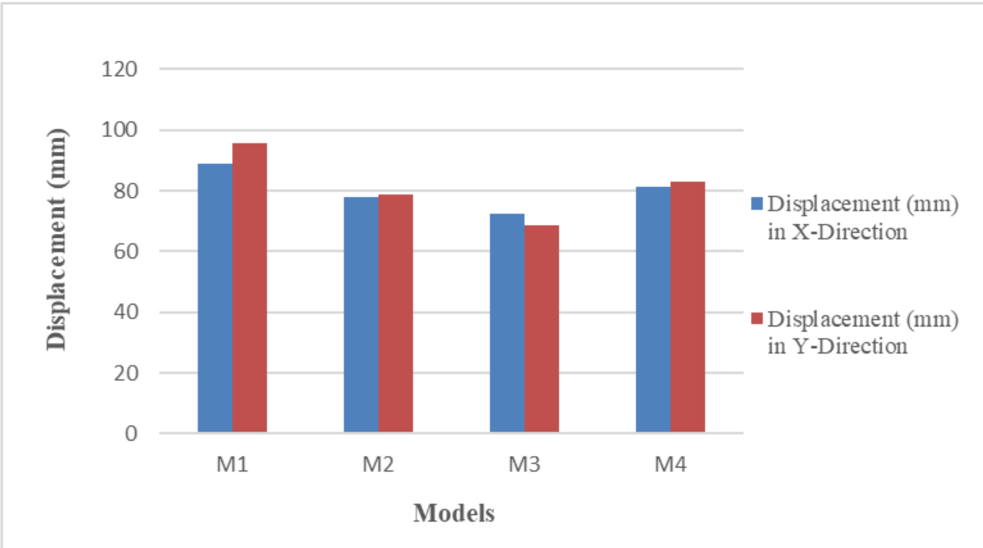

Figure.4. 2Maximum storey displacement for case B

Maximum storey drift ratio

Total storey drift is defined as the absolute displacement of any storey to the base. According to IS 1893- 2002 clause 7.11.1, the storey drift should not exceed the 0.004 times storey height due to the minimum specified design lateral force with partial load factor is 1.00. RSA is performed to obtain storey drifts for all the models and it also helps in evaluating the performance at both the floating column position.

Table.4. 2Maximum storey Drift ratio

S. No.	Model	Case A		Case B	
		X-Direction	Y-Direction	X-Direction	Y-Direction
1.	M1	0.0052	0.0057	0.0045	0.0048
2.	M2	0.0035	0.0034	0.0032	0.0032
3.	M3	0.0032	0.0034	0.0029	0.0027
4.	M4	0.0038	0.0037	0.0034	0.0034

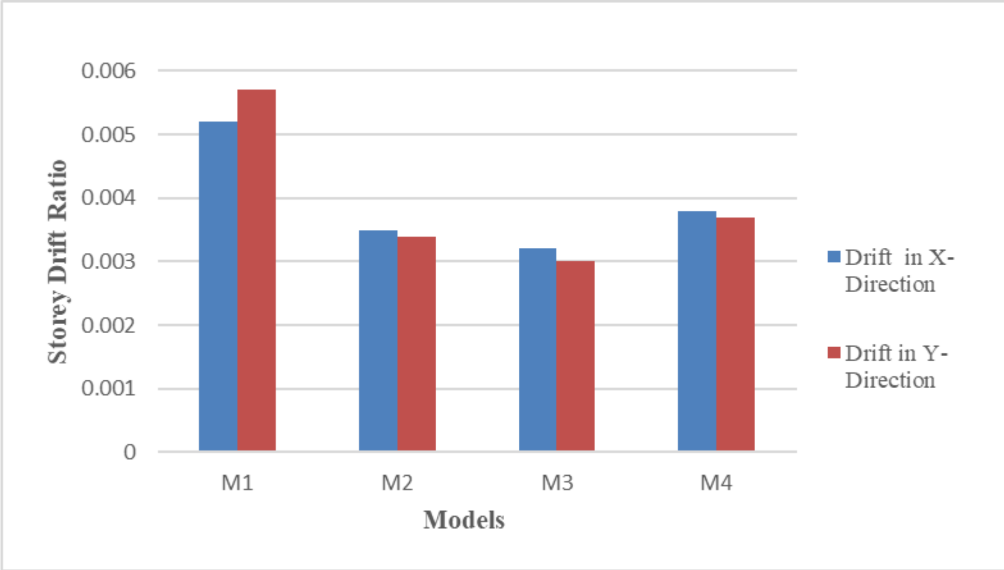

Figure.4. 3Maximum drift ratio in case A

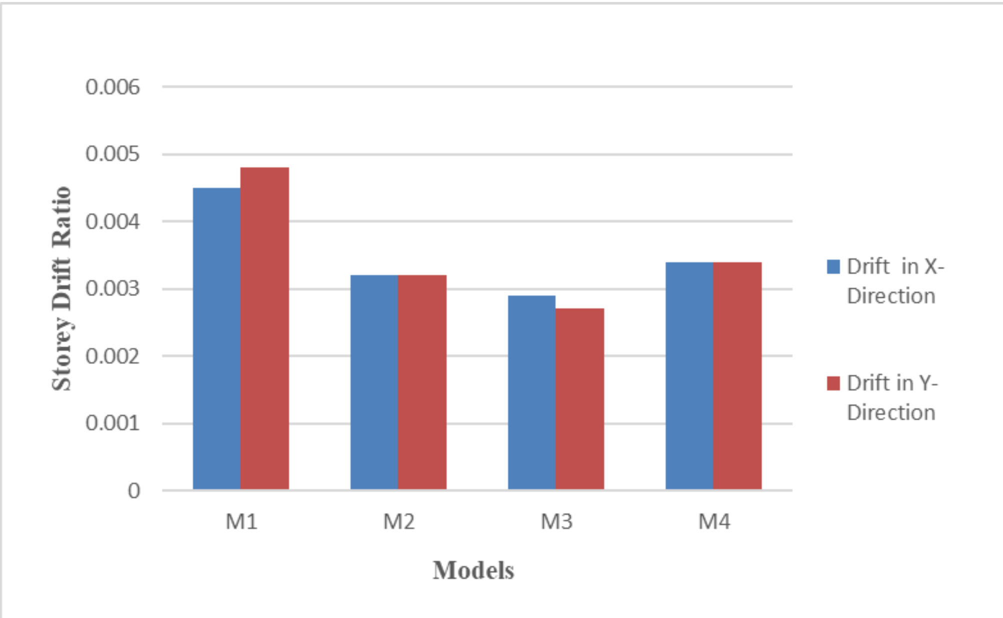

Figure.4. 4Maximum drift ratio in case B

Base shear:

Table.4. 3Base Shear (KN)

S. No.	Model	Case A		Case B	
		X-Direction	Y-Direction	X-Direction	Y-Direction
1.	M1	16100.94	15001.67	19899.42	18167.95
2.	M2	20592.99	20677.71	24292.73	24087.42
3.	M3	22459.68	23437.36	26053.62	26693.84
4.	M4	19365.68	19181.92	23387.48	22936.91

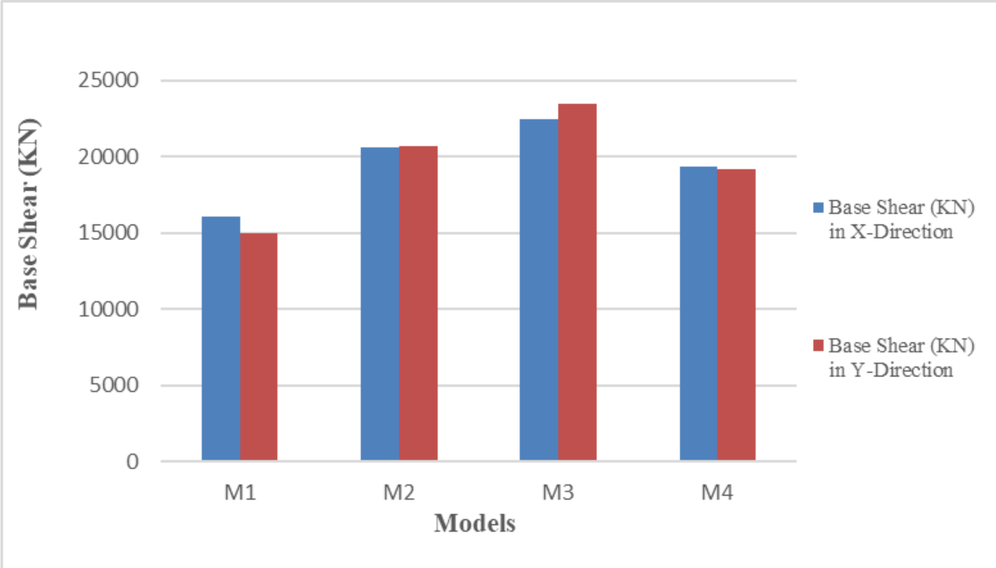

Figure.4. 5Base shear in case A

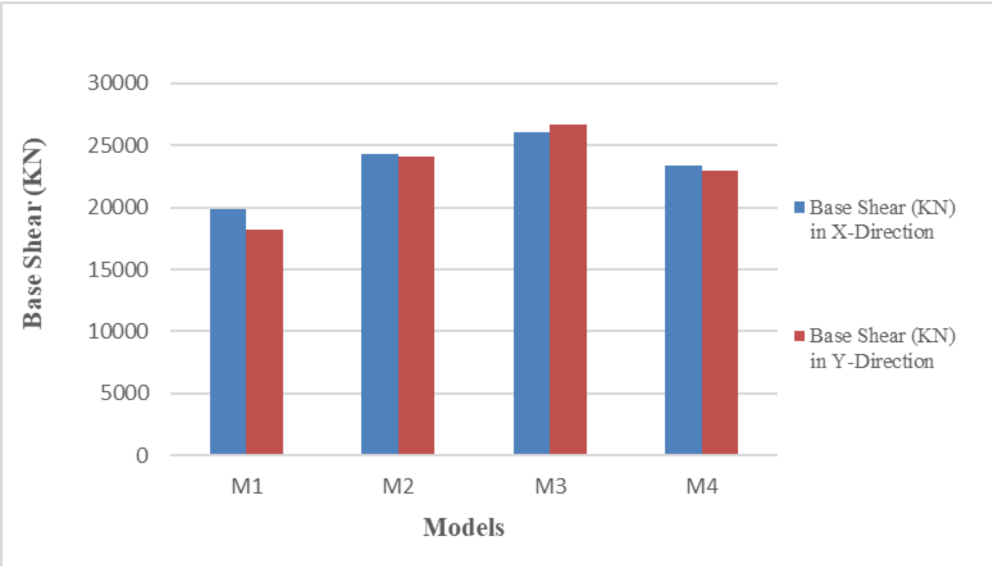

Figure.4. 6Base shear in case B

V. Conclusion

In both the cases, model M3 i.e. building with shear wall at corner shows lowest value of maximum storey displacement among all the models while the highest value of maximum storey displacement is obtained in model M1 i.e. building without shear wall. The highest value of maximum storey drift ratio has been observed in model M1 i.e. building without Shear wall while model M3 i.e. building with shear wall at corner shows least value of Drift ratio irrespective of X or Y direction or Case A or Case B. The maximum base shear is observed in model M3 i.e. building with shear wall at corner as compared to all other models while the minimum base shear is obtained in model M1 i.e. building without shear wall. Building with shear walls i.e. model M2, M3 and M4 depicts lesser value of storey displacement and storey drift than model M1 i.e. building without shear wall. It has been concluded that Building having Floating Column at any storey gives better seismic result when shear walls are provided. The most suitable location of shear wall is at the corner of the building.

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