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Seismic Response of Multistoried RC Structure with Floating Columns for Different Lateral Load Resisting Systems – A Comparative Study

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Abstract

Soft storeys, floating columns, vertical or plan irregularities, and large loads are common features of modern multi-storey buildings. In metropolitan India, these types of construction have grown increasingly common. According to the findings of previous earthquake research, the majority of the RC structures built with such imperfections are very unpleasant in seismically active places. These effects occurred as a result of a variety of factors, including non-uniform mass distribution, stiffness, and strength. This study explains the seismic analysis of a G+10 multi-storied building resting on floating columns with different lateral load resisting systems such as shear wall and bracings at different locations and comparison between them in seismically active areas observing its responses to the lateral stresses being applied to the structure externally in seismic zone III using the software ETABS. All models are subjected to equivalent static and response spectrum analysis, with result specified as seismic factors such base shear, storey displacement, storey drift and storey shear.

Keywords: *Floating columns, Shear wall, Bracings, Response spectrum analysis.*

1.0 Introduction

In present construction technique, open first stories are a common and inescapable element of multi-storey buildings. The main reason for adopting this is to provide parking spaces or reception areas in the first floor. While a building's overall seismic foundation shear during an earthquake depends on the earthquake's natural time. The stiffness and mass distribution along the height affect the seismic force distribution.

Along with how the ground receives the earthquake forces, a building's overall design, size, and geometry have a significant impact on how it responds to earthquakes. If the path of load transfer deviates or becomes interrupted affects the building's performance during an earthquake, which requires that the earthquake lateral forces generated at several storey levels in a building will be transported descend along the height in the lowest amount of time to the ground. During an earthquake, a structure could sway back and forth (or even a severe wind storm). A crucial tool in earthquake engineering is seismic analysis. It is typically used to quickly assess how buildings will react to earthquake forces. When it comes to structural analysis and design, earthquakes are a common occurrence. Under seismic load, the response of structures that have floating columns and also without floating columns is examined. This research has been done out using ETABS 18 to evaluate seismic behaviour of building models with floating columns and without floating columns for zone III the fundamental factors such as time period, maximum storey displacement, storey drift, storey shear and Base shear. Linear/equivalent static analysis and linear dynamic/response spectrum method are utilized for analysis.

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2.0 Objectives

1. To observe the behaviour of G+10 multi-storeyed structures with floating columns in Zone III.
2. To examine the actions of both regular and irregular buildings with floating columns.
3. To evaluate the differences between floating columns with shear walls and floating columns with diagonal bracings in terms of time period, base shear, storey shear, storey drift, and storey displacement.
4. To plot the reaction of the structure for the results.
5. Using ETABS programme to analyse and simulate the multi-story buildings.

3.0 Literature Summary

For multi-storeyed RC buildings with floating columns and without floating columns, frame models were created to facilitate a comparative analysis of structural factors as storey displacement, storey shear and base shear under unstable excitation. Finding the difference between the earthquake reaction parameters for buildings with floating columns, without floating columns and explain what will result when variation could also be large or low. It is also recommended that such buildings be designed in seismically active areas to be safer. Critical load combinations are identified in the entire study of seismic analysis. Case-by-case variation in several parameters, such as moments, displacements and forces on beams and columns at various floor levels are examined for these critical load combinations, and graphs are used to indicate a substantial co-relationship between these values. ETABS software was used to design and analyse this building. According to the study, in all seismic zones across India, the structure without floating columns exhibits greater lateral drift than the structure with floating columns.

4.0 Methodology

The aim of the present study is to understand the behaviour of buildings with floating columns that have shear walls or diagonal bracing at various positions.

The following seismic analysis methodologies are employed in this study,

1. Linear/Equivalent Static Analysis.
2. Response Spectrum Method.

5.0 Model Discription

G+10 RC framed structures are modelled and analysed using the software ETABS.

For Bare frame model

Size of beam – 200×500mm
Size of Column – 500×500mm
Thickness of slab – 150mm
Storey height – 3m each floor

For model with floating columns

Size of beam – 200×500mm, 600×700mm
Size of Column – 500×500mm, 700×700mm
Thickness of slab – 150mm
Storey height – 3.2 for GF, 3m for typical

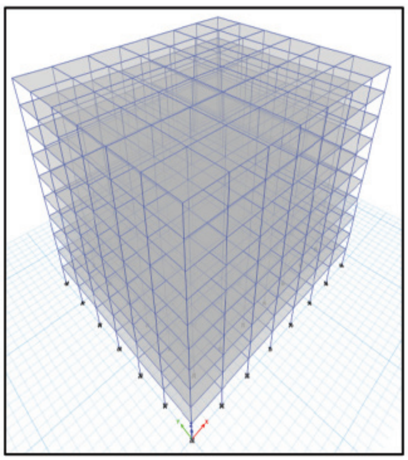

Figure 1: Regular Bare frame model – A1

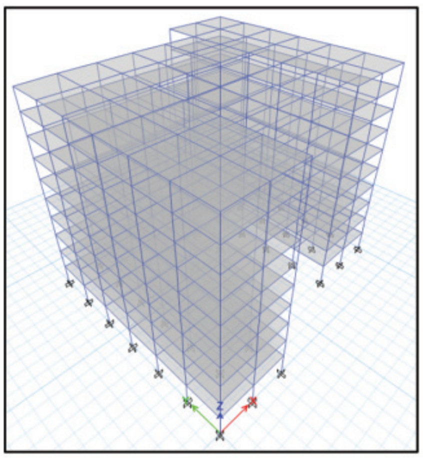

Figure 2: Irregular Bare frame model – A2

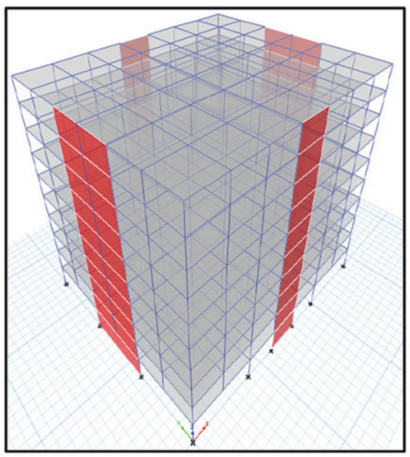

Figure 3: Regular model with floating column and shear wall at Type-1 location – A3

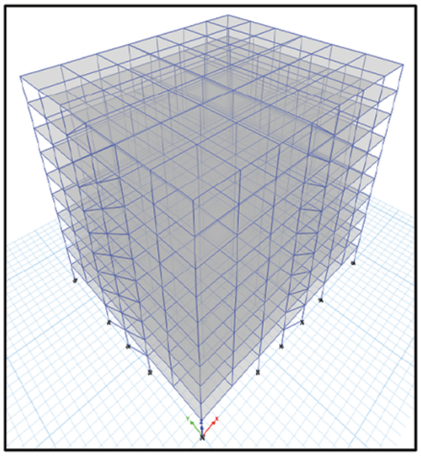

Figure 4: Regular model with floating column and bracing at Type-1 location – A4

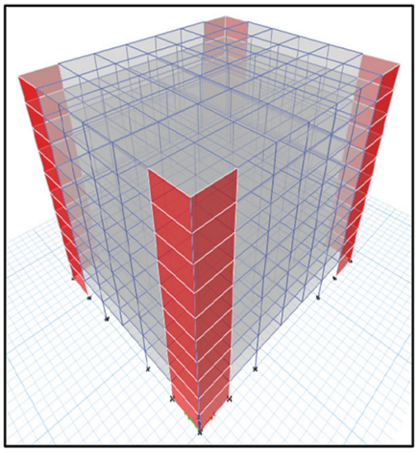

Figure 5: Regular model with floating column and shear wall at Type-2 location – A5

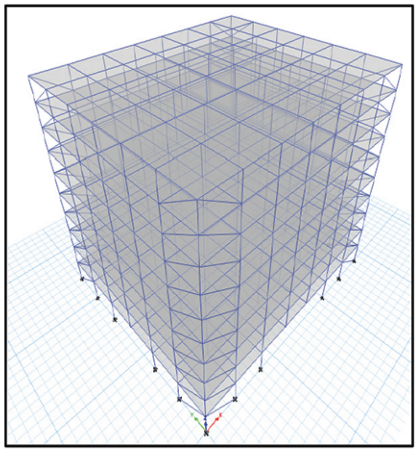

Figure 6: Regular model with floating column and bracing at Type-2 location – A6

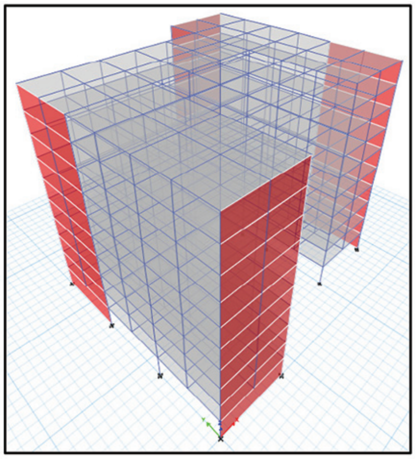

Figure 7: Irregular model with floating column and shear wall at Type-1 location – A7

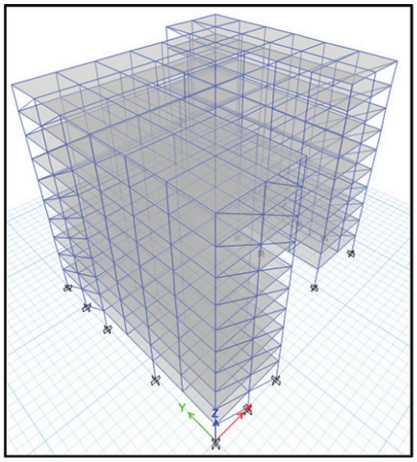

Figure 8: Irregular model with floating column and bracings at Type-1 location – A8

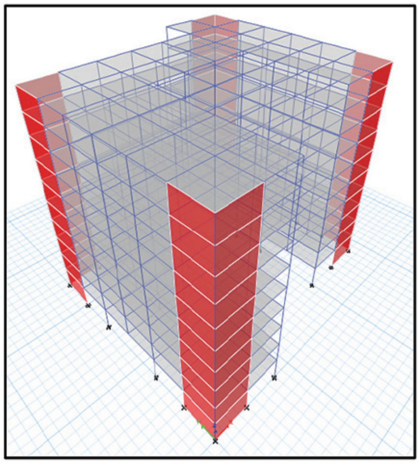

Figure 9: Irregular model with floating column and shear wall at Type-2 location – A9

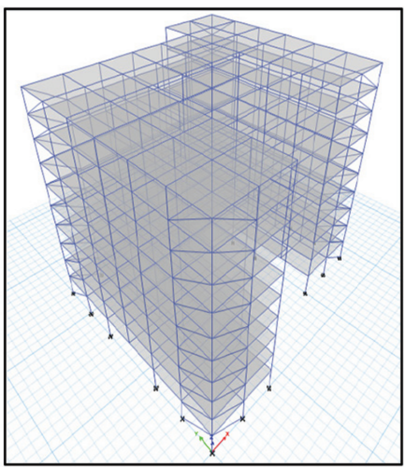

Figure 10: Irregular model with floating column and bracing at Type-2 location – A10

6.0 Results

Results for the analysis of the structure with floating columns are presented in tabular columns and graphs.

6.1 Time Period

Table 1: Time period for all models

Model No	A1	A2	A3	A4	A5
Time period (sec)	3.22	3.03	1.96	2.18	1.34
Model No	A6	A7	A8	A9	A10
Time period (sec)	1.82	1.06	1.95	1.11	1.72

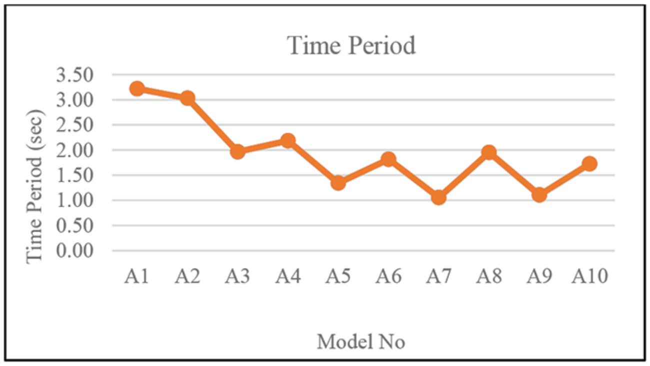

Figure 11: Plot of graph – Time period for all Models

6.2 Storey displacement

Table 2: Comparison of storey displacement for regular buildings

Storey Height	A1	A3	A4	A5	A6
30	38.757	27.872	30.033	20.089	25.526
27	37.082	24.769	27.834	17.729	23.495
24	34.559	21.531	25.017	15.290	21.000
21	31.190	18.218	21.731	12.826	18.173
18	27.098	14.872	18.117	10.377	15.127
15	22.438	11.570	14.317	8.002	11.971
12	17.370	8.408	10.470	5.766	8.818
9	12.081	5.497	6.719	3.741	5.767
6	6.852	2.962	3.366	2.017	3.081
3	2.295	0.980	0.983	0.689	0.932
0	0.000	0.000	0.000	0.000	0.000

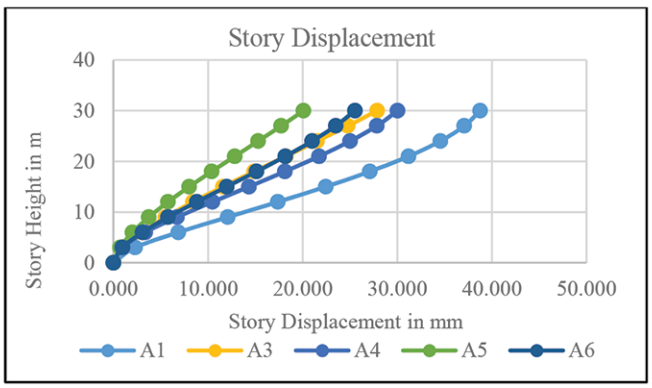

Figure 12: Plot of graph – Storey displacement vs Storey height

Table 3: Comparison of storey displacement for irregular buildings

Storey Height	A2	A7	A8	A9	A10
30	38.011	18.293	27.317	17.021	24.691
27	36.158	16.521	25.452	14.994	22.698
24	33.515	14.256	22.941	12.849	20.300
21	30.064	11.764	19.919	10.707	17.575
18	25.932	9.289	16.590	8.597	14.633
15	21.286	6.962	13.102	6.568	11.582
12	16.301	4.838	9.564	4.684	8.527
9	11.181	2.938	6.403	3.002	5.578
6	6.222	1.335	3.494	1.585	2.875
3	2.032	0.419	1.254	0.551	0.866
0	0.000	0.000	0.000	0.000	0.000

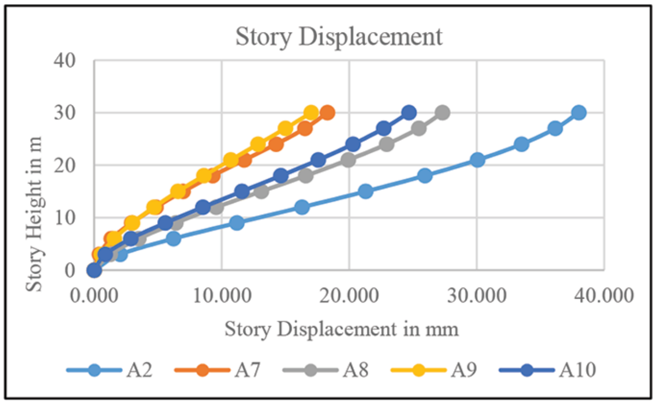

Figure 13: Plot of graph – Storey displacement vs Storey height

6.3 Storey drift

Table 4: Comparison of storey drift for regular buildings

Storey Height	A1	A3	A4	A5	A6
30	0.00056	0.00103	0.00073	0.00079	0.00068
27	0.00084	0.00108	0.00094	0.00081	0.00083
24	0.00112	0.00110	0.00110	0.00082	0.00094
21	0.00136	0.00112	0.00120	0.00082	0.00102
18	0.00155	0.00110	0.00127	0.00079	0.00105
15	0.00169	0.00105	0.00128	0.00075	0.00105
12	0.00176	0.00097	0.00125	0.00068	0.00102
9	0.00174	0.00085	0.00116	0.00059	0.00098
6	0.00152	0.00066	0.00079	0.00044	0.00072
3	0.00076	0.00031	0.00033	0.00022	0.00031
0	0	0	0	0	0

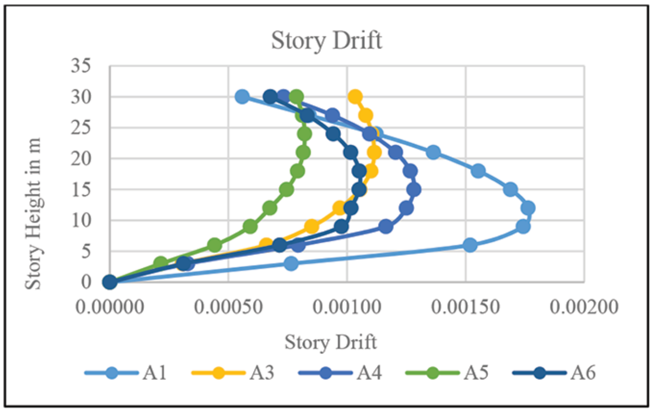

Figure 14: Plot of graph – Storey drift vs Storey height

Table 5: Comparison of storey drift for irregular buildings

Storey Height	A2	A7	A8	A9	A10
30	0.00062	0.00060	0.00068	0.00069	0.00067
27	0.00088	0.00075	0.00084	0.00072	0.00082
24	0.00115	0.00083	0.00101	0.00071	0.00092
21	0.00138	0.00083	0.00111	0.00070	0.00099
18	0.00155	0.00078	0.00116	0.00068	0.00102
15	0.00166	0.00071	0.00119	0.00063	0.00102
12	0.00171	0.00063	0.00119	0.00056	0.00099
9	0.00165	0.00053	0.00109	0.00048	0.00090
6	0.00140	0.00033	0.00076	0.00036	0.00067
3	0.00068	0.00013	0.00039	0.00017	0.00027
0	0	0	0	0	0

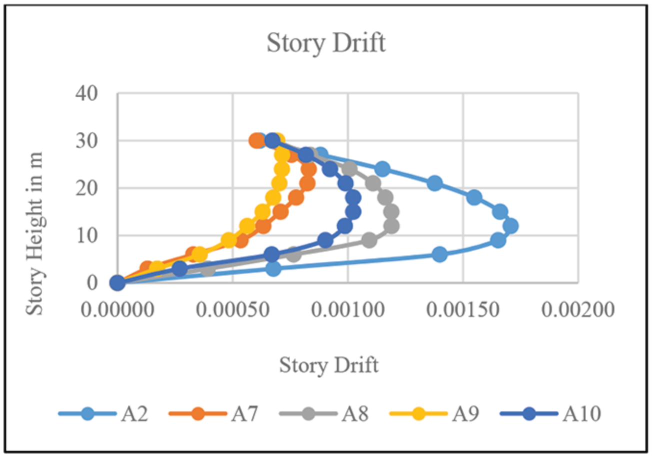

Figure 15: Plot of graph – Storey drift vs Storey height

6.4 Storey shear

Table 6: Comparison of storey shear for regular buildings

Storey Height	A1	A3	A4	A5	A6
30	286.30	430.62	409.38	649.21	484.07
27	532.11	800.80	755.31	1210.60	893.71
24	731.02	1093.82	1028.64	1654.99	1217.37
21	888.39	1318.70	1237.91	1996.02	1465.17
18	1009.49	1484.44	1391.65	2247.37	1647.23
15	1099.56	1600.04	1498.42	2422.68	1773.67
12	1163.70	1674.51	1566.76	2535.63	1854.58
9	1206.77	1716.86	1605.19	2599.85	1900.10
6	1233.14	1736.09	1622.27	2629.02	1920.33
3	1246.09	1740.66	1627.73	2638.73	1926.82
0	0.00	0.00	0.00	0.00	0.00

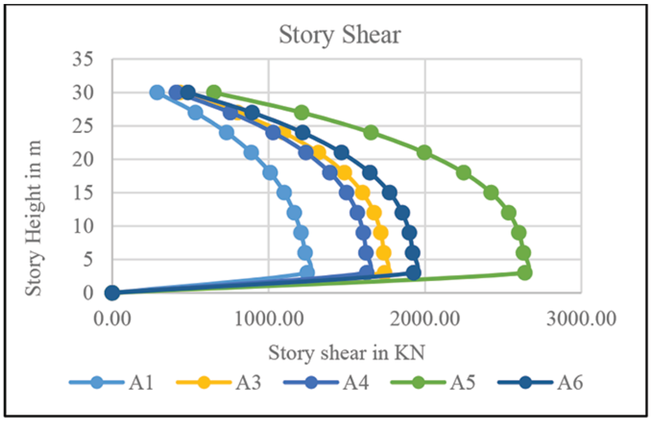

Figure 16: Plot of graph – Storey shear vs Storey height

Table 7: Comparison of storey shear for irregular buildings

Storey Height	A2	A7	A8	A9	A10
30	218.16	822.82	483.25	597.60	393.51
27	403.09	1530.06	889.21	1120.85	728.66
24	549.20	2089.90	1210.57	1535.04	993.96
21	661.07	2519.54	1457.18	1852.91	1197.56
18	743.26	2836.19	1638.94	2087.18	1347.61
15	800.34	3057.05	1765.72	2250.58	1452.27
12	836.87	3199.33	1847.39	2355.85	1519.70
9	857.42	3280.25	1893.84	2415.71	1558.04
6	866.55	3316.99	1914.93	2442.90	1575.45
3	868.83	3328.29	1921.78	2451.99	1581.44
0	0.00	0.00	0.00	0.00	0.00

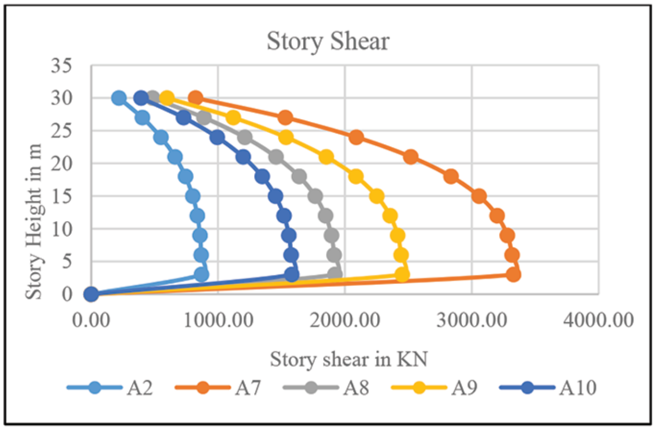

Figure 17: Plot of graph – Storey shear vs Storey height

6.5 Base shear

Table 8: Base shear for all models

Model No	A1	A2	A3	A4	A5
Base shear (kN)	1070.70	868.83	1740.66	1627.73	1740.66
Model No	A6	A7	A8	A9	A10
Base shear (kN)	1926.82	3328.29	1921.78	2451.99	1581.44

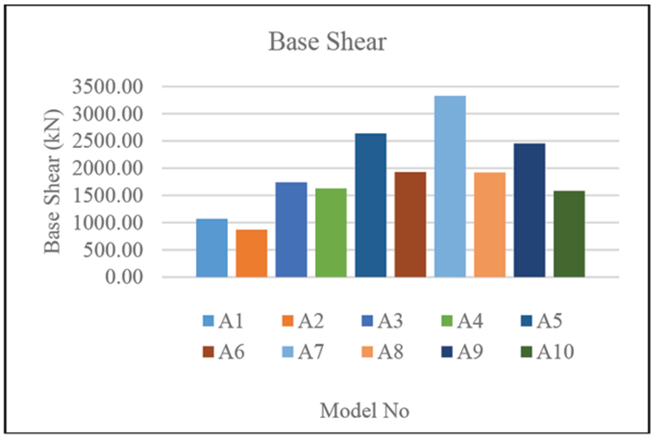

Figure 18: Plot of graph – Base shear for all Models

7.0 Conclusions

1. From the results it is noticed there is a minimum storey displacement in models with floating columns and shear walls when compared to the models with floating columns and diagonal bracings.
2. From the results it is noticed that for regular buildings there is lowest value for storey displacement and storey drift in models with floating column at Type – 2 location of shear walls.
3. For irregular buildings there is lowest value for storey displacement and storey drift in models with floating column at Type – 2 location of shear walls.
4. From overall results floating column with shear wall is showing the best performance.
5. For more effect results of bracings, instead of diagonal bracing, X-bracing may be introduced.

8.0 References

1. Mr. Rahul Sudam Khomane, Prof. Aparna Patil, (2021), "Dynamic Analysis of RCC Building with Floating Column", *International Research Journal of Engineering and Technology* (IRJET) Vol.08, Issue.05, May 2021.
2. Nikhil Dewani, Dr. Ashok Kasnale, (2019), "Study of Behaviour of Seismic Evaluation of Multistoried Building with Floating Columns", *International Journal of Innovative Research in Science, Engineering and Technology*, (IJIRSET) Vol.08, Issue.05, May 2019.
3. Nagalakshmi D, Dr. R Balamurugan, (2021), "Seismic Analysis of a Building with Floating Columns by ETabs", *Journal of Engineering Science*, (JES) Vol.09, Issue.04, May 2018.