Analysis of G+12 Building with Floating Column under Seismic Loading

Deepak Maheshkar[1], Kavita Golghate[2]

[1]*M.Tech. Scholar SD Bansal College Indore*
[2]*Kavita Golghate Assistant Professor SD Bansal College Indore*

---***---

Abstract - *Floating columns are a representative feature in the recent multi-storey construction in metropolitan India and are highly unwanted in buildings constructed in seismically active areas numerous structures in current times have designed and constructed for architectural complexities such as structure with floating columns at various levels and places. These floating columns are extremely harmful in structure which is constructed in seismically prone areas. The lateral forces which are developed at different levels in structure require to be carried down along the height to ground by through path, but due to floating column there is discontinuity in the load transfer passageway which results in unfortunate performance of structure. In this study the analysis of G+12 story floating column structure is considered and analysis is done using STAAD Pro. This study is also to find whether the structure is safe or unsafe with floating column is built in seismically active areas with various cases where the floating column is provided on different floors.*

Key Words: Floating column, High rise Structure, Residential Building, Stress.

1. INTRODUCTION

Now a day's, multi-storey buildings in urban cities are required to have column free space due to shortage of space, population and also for aesthetic and functional requirements. For this buildings are provided with floating columns at one or more storey. These floating columns are highly disadvantageous in a building built in seismically active areas.

Structure is subjected to Earthquake seismic forces are developed during earthquake. Structure is experienced there seismic forces. Seismic forces develops the seismic waves there waves reaches the structure during earthquake. They produce ground motions in the structure. Earthquake is the rapid movement of the earth surface. It takes place naturally at or below the surface of the earth. Many of the building structure have irregularities in both the plan and elevation. Buildings consisting of asymmetrical distribution of strength, stiffness and mass suffer severe damage during earthquakes.

When the building structure is designed for considering only the vertical ground motions in general this design is not safe. This not satisfies the horizontal ground shaking. In generally the forces generated due to Horizontal ground motions of earth is taken as important for the design of the structures. Therefore it is important that the structure is designed to resist the forces acting horizontally due to earthquake.

Floating Column:

The floating column is a vertical member which rest on a beam and doesn't have a foundation. The floating column act as a point load on the beam and this beam transfers the load to the columns below it. But such column cannot be implemented easily to construct practically since the true columns below the termination level are not constructed with care and hence finally cause to failure.

There are many buildings in which floating columns are adopted, especially above the ground floor, where transfer girders are employed, so that more open space is available in the ground floor. This open space may be utilized as party hall, assembly hall and for parking purpose. The transfer girder has to be designed and detailed properly, especially in the earthquake zones. The column acts as concentrated load on beam. As far as analysis is concerned, the column is often assumed pinned and therefore taken as point load on the transfer beam.

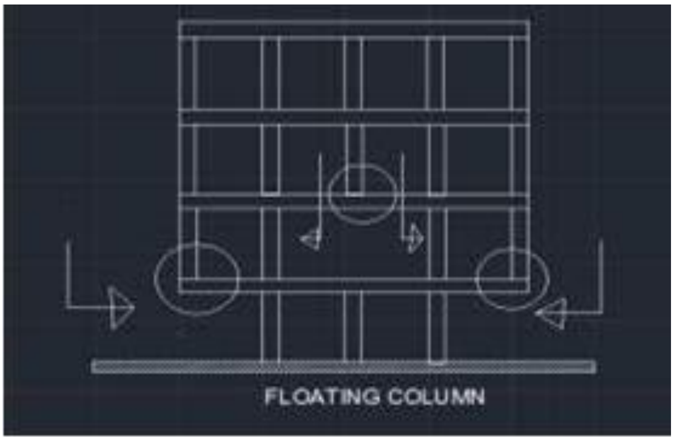

Fig 1- Floating column in building.

1.1 Condition Applied

Applied Condition Details:			
Sr. No.	Conditions		
1	General Case	General Case	Conclusion

2	Case A	3rd Floor Occupy Floating Column	1. Case A for Z direction for base shear values are found best among all the cases. 2. On analyzing beam bending moment values, Case A is effective for X
3	Case B	5th Floor Occupy Floating Column	1. On analyzing Torsional force values, Case B is effective for X direction
4	Case C	7th Floor Occupy Floating Column	1. Axial forces values are found best among all the cases. 2. On analyzing column shear force values, Case C is effective for both direction 3. On analyzing column bending moment values, Case C is effective for X and Z direction
5	Case D	9th Floor Occupy Floating Column	1. On analyzing Torsional force values, Case D is effective for Z direction.
6	Case E	11th Floor Occupy Floating Column	1. On analyzing beam shear force values, Case E is effective for X direction. 2. On analyzing beam bending moment values, Case E is effective for Z Direction 3. On comparing it has been concluded that the maximum displacement obtained for Cases E with a minimum value respectively both X and Z direction 4. As the analysis of all parameters Case E is the best case for using floating column.

in the title or heads unless they are unavoidable.

Table -1: Details of building

Building configuration	G+12
No. of bays in X direction	5
No. of bays in Z direction	5
Height of building	45 M
Dimensions of building	25 X 25 M^2
Size of beam	0.6 X 0.55,
Size of column	0.6 X 0.55
Concrete and Steel Grade	M 30 & FE415

Table -2: Details of building

Earthquake parameters	Zone III with RF 4 & 5% damping ratio
Period in X & Z direction	0.72 & 0.72 for both direction
Dead load for floor with waterproofing	2KN/m^2 & 1KN/M^2
Live load for floor and roof	3KN/M^2 & 1.2 KN/M^2

2. CONCLUSIONS

RESULT AND DISCUSSION-

Table 4: Maximum Displacement in X direction all Cases in Zone III

CASE	Maximum Displacement (mm)
	For X Direction
GC	786.362
A	797.076
B	795.223
C	793.005
D	790.829
E	788.562

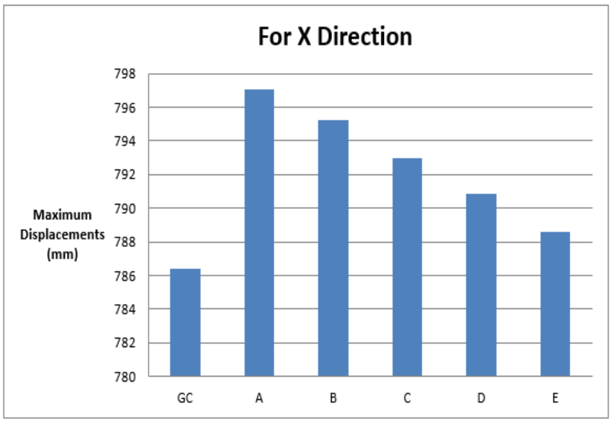

Fig.1: Maximum Displacement in X direction for all cases in Zone III

As the study shows case E is perform well among all the cases in the displacement.

Table 5: Maximum Displacement in Z direction for all cases in Zone III

CASE	Maximum Displacement (mm)
	For Z Direction
GC	1273.480
A	1318.281
B	1306.265
C	1294.876
D	1285.043
E	1277.707

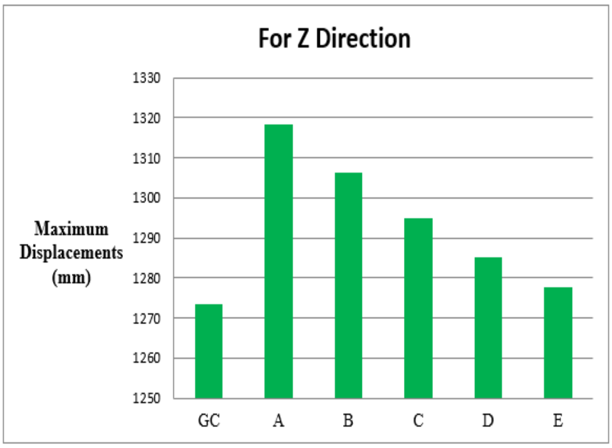

Fig.2: Maximum Displacement in Z direction for all cases in Zone III

Case E, displacement is better than other shape in direction Z

Table 6: Storey Drift in X direction for all cases in Zone III

S. No.	Height (m)	Storey Drift (cm)					
		For X Direction					
		GC	A	B	C	D	E
1	0	0	0	0	0	0	0
2	2	0.448	0.0429	0.0501	0.0499	0.0498	0.0497
3	6	0.2287	0.2370	0.2664	0.2653	0.2642	0.2329
4	9	0.2936	0.2968	0.2988	0.2972	0.2958	0.2946
5	12	0.3743	0.3874	0.3825	0.3796	0.3775	0.3245
6	15	0.4392	0.4553	0.4450	0.4461	0.4434	0.4411
7	18	0.4920	0.4529	0.4528	0.4461	04974	0.4945
8	21	0.5337	0.4933	0.4922	0.5401	0.5404	0.4787
9	24	0.5653	0.4925	0.5845	0.5834	0.5133	0.5691
10	27	0.5265	0.5468	0.5455	0.5423	0.5928	0.5922
11	30	0.6016	0.6251	0.6238	0.6204	0.6182	0.6077
12	33	0.5018	0.6327	0.5687	0.6283	0.6230	0.6107
13	36	0.6095	0.5720	0.6335	0.6303	0.6254	0.6220
14	39	0.6089	0.6337	0.6328	0.6297	0.6248	0.6182
15	42	0.5709	0.5422	0.5991	0.5962	0.5914	0.5853

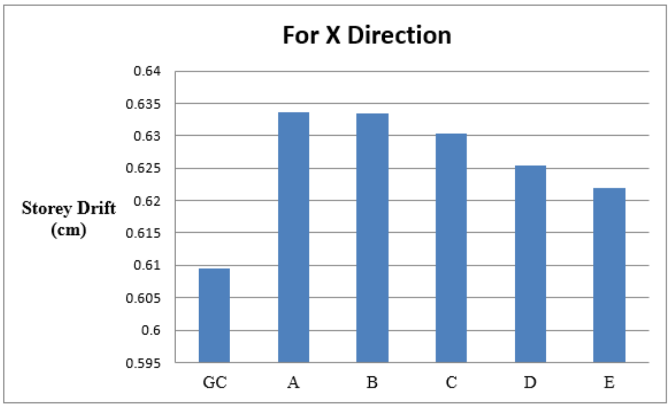

Fig. 3: Storey Drift in X direction for cases in Zone III

Amoung all the cases storey drift of case E perform good in seismic analysis

Table 7: Storey Drift in Z direction for all 5 cases in Zone III

S. No.	Height (m)	Storey Drift (cm)					
		For Z Direction					
		GC	A	B	C	D	E
1	0	0	0	0	0	0	0
2	2	0.1263	0.1266	0.1263	0.1262	0.1262	0.1262
3	6	0.6890	0.6917	0.6894	0.6886	0.6884	0.6882
4	9	0.5107	0.5109	0.5117	0.5107	0.5103	0.5102
5	12	0.5270	0.5630	0.5292	0.5274	0.5267	0.5265
6	15	0.5370	0.4544	0.5376	0.5379	0.5369	0.5365
7	18	0.5364	0.5712	0.5705	0.5384	0.5366	0.5360

8	21	0.5264	0.5624	0.5541	0.5270	0.5270	0.5260
9	24	0.5072	0.5439	0.5390	0.5372	0.5087	0.5070
10	27	0.4790	0.5161	0.5118	0.5021	0.4796	0.4790
11	30	0.4416	0.4789	0.4750	0.4685	0.4653	0.4422
12	33	0.3961	0.4327	0.4289	0.4229	0.4124	0.3956
13	36	0.3401	0.3779	0.3742	0.3685	0.3609	0.3556
14	39	0.2777	0.3155	0.3117	0.3061	0.2989	0.2883
15	42	0.2057	0.2446	0.2408	0.2352	0.2280	0.2197

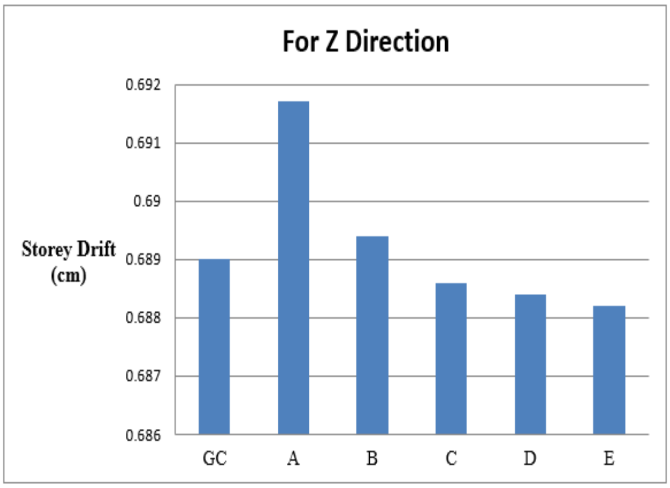

Fig. 4: Storey Drift in Z direction for all cases in Zone III

As the study shows story drift in direction Z, Case E result are better than other cases

Table 8: Base Shear in X and Z direction for all Building cases

CASES	Base Shear (KN)	
	X direction	Z direction
GC	69328.99	34144.25
A	67804.10	33189.13
B	66834.70	33403.19
C	66677.03	33589.75
D	67593.29	33786.63
E	68509.67	33981.74

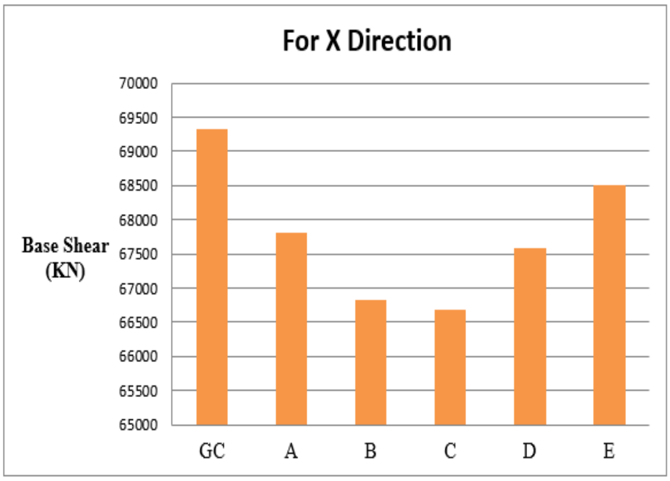

Fig. 5: Base Shear in X direction for all Building cases

On comparing base shear for X direction Case C is performing very well than other cases

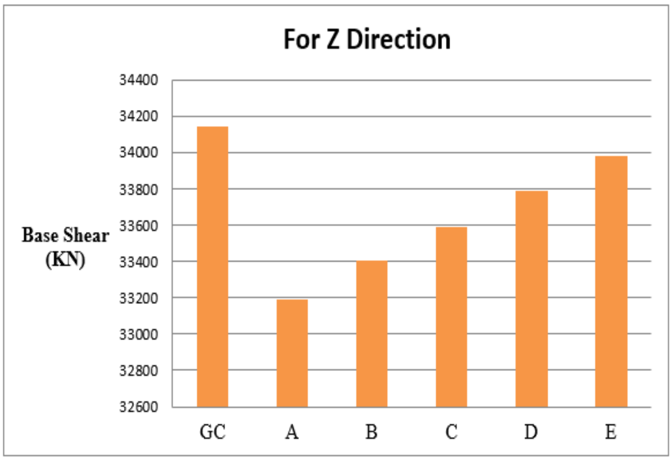

Fig. 6: Base Shear in Z direction for all Building cases

On comparing base shear for Z direction Case A is performing very well than other cases

Table 9: Time Period and Mass Participation Factor for all Building cases

CASES	Time Period (Seconds)	Participation X %	Time Period (Seconds)	Participation Z %
GC	2.159	68.475	3.490	49.675
A	2.191	68.165	3.557	50.081

B	2.185	68.104	3.528	49.872
C	2.177	68.120	3.505	49.794
D	2.169	68.204	3.491	49.787
E	2.161	68.324	3.483	49.802

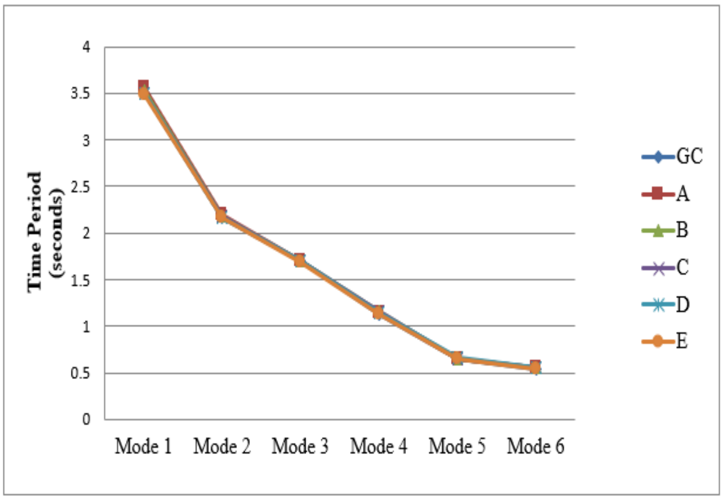

Fig. 7: Time Period for all Building cases

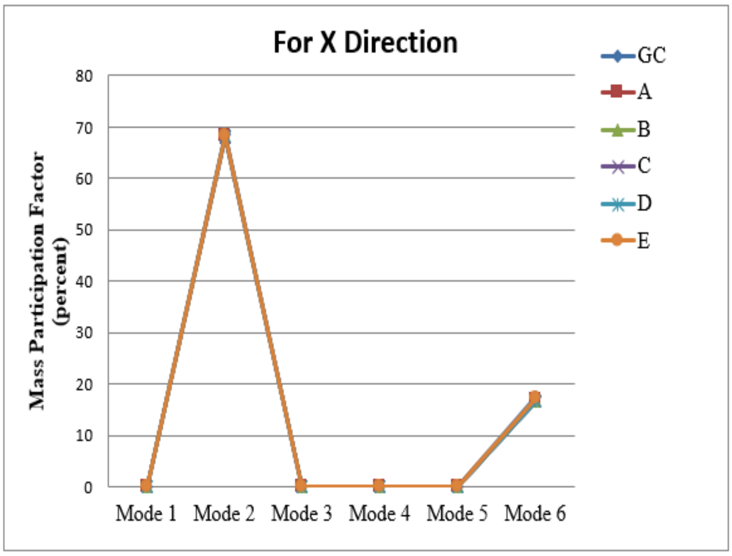

Fig. 8: Mass Participation Factor in X direction for all Building cases

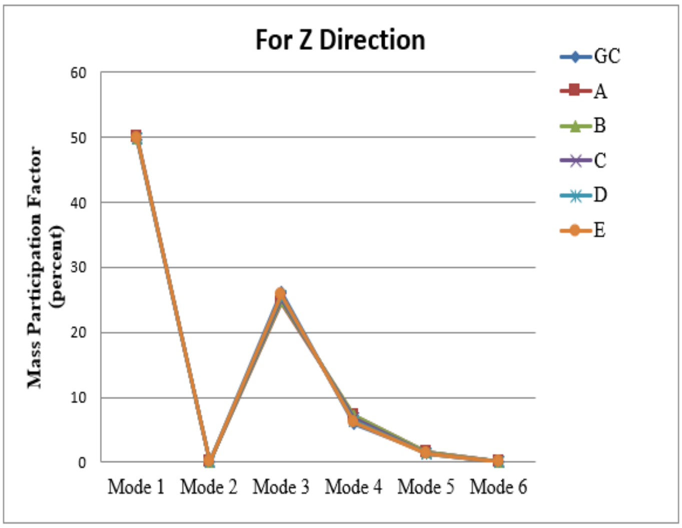

Fig. 9: Mass Participation Factor in Z direction for all Building cases

Table 10: Maximum Axial Forces in Column at ground level for all Building cases

CASE	Column Axial Force (KN)
GC	32796.023
A	32628.895
B	32425.707
C	32380.488
D	32514.461
E	32654.410

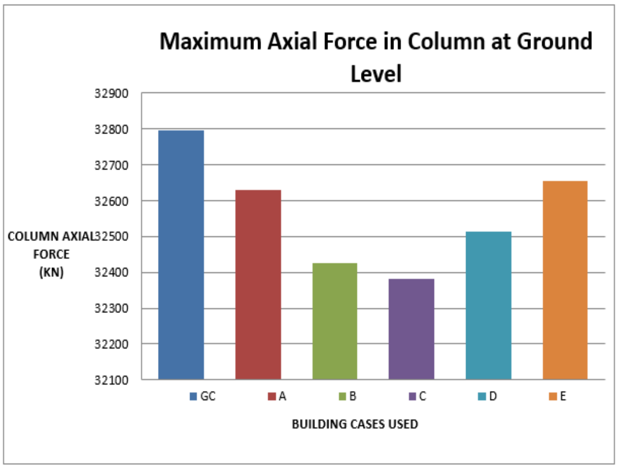

Fig. 10: Maximum Axial Forces in Column at ground level for all Building cases

In the study of mass participation factor Case C is performing well than other

Table 11: Maximum Shear Forces in Columns for all Building cases

CASE	Column Shear Force (KN)	
	Shear along Y	Shear along Z
GC	1163.116	1462
A	1186.841	1416
B	1183.918	1404
C	1183.812	1379.44
D	1186.757	1382.004
E	1184.686	1384.369

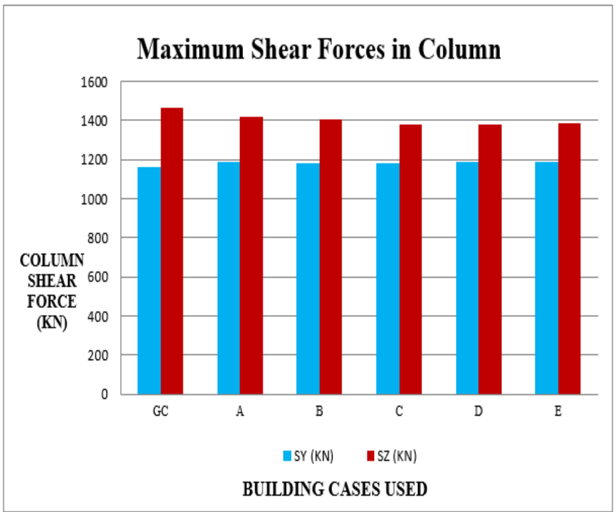

Fig. 11: Maximum Shear Forces in Columns for all Building cases

Above study of shear force in both direction Case C perform well

Table 12: Maximum Bending Moment in Columns for all Building cases

CASE	Column Bending Moment (KNm)	
	Moment along Y	Moment along Z
GC	2534.972	1948.433
A	2537.901	1987.586
B	2530.500	1982.555
C	2529.358	1982.298
D	2529.576	1987.234
E	2533.999	1983.662

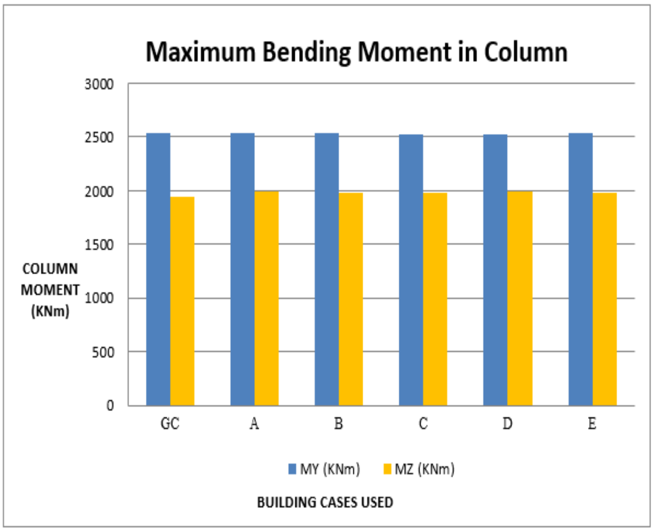

Fig. 12: Maximum Bending Moment in Columns for all Building cases

Above study of bending moment in both direction Case C perform well

Table 13: Maximum Shear Forces in beams parallel to X direction for all Building cases

CASE	Beam Shear Force (parallel to X direction) (KN)
GC	378.208
A	389.576
B	382.253
C	380.093
D	378.851
E	378.829

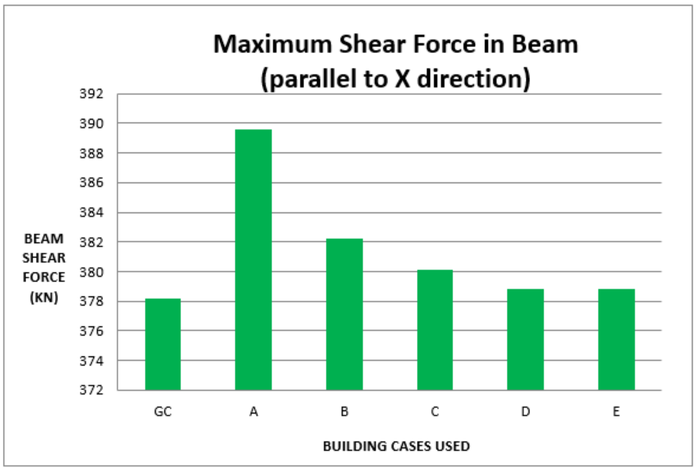

Fig. 13: Maximum Shear Forces in beams parallel to X direction for all Building cases

Above study of Beam shear force in X direction Case E perform well

Table 14: Maximum Shear Forces in beams parallel to Z direction for all Building cases

CASES	Beam Shear Force (parallel to Z direction) (KN)
FC	11.951
A	11.753
B	11.922
C	11.884
D	11.898
E	11.931

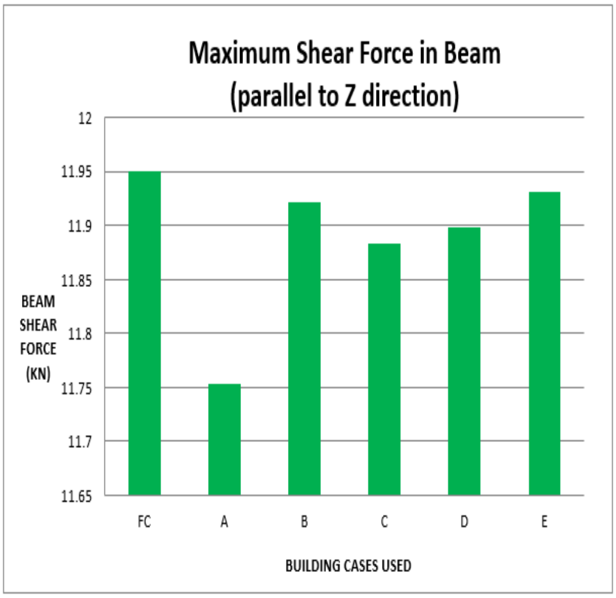

Fig. 14: Maximum Shear Forces in beams parallel to Z direction for all Building cases

Above study of Beam shear force in Z direction Case A perform well

Table 15: Maximum Bending Moment in beams parallel to X direction for all Building cases

CASE	Beam Bending Moment (along X direction) (KNm)
GC	29.878
A	29.382
B	29.806
C	29.709
D	29.746
E	29.829

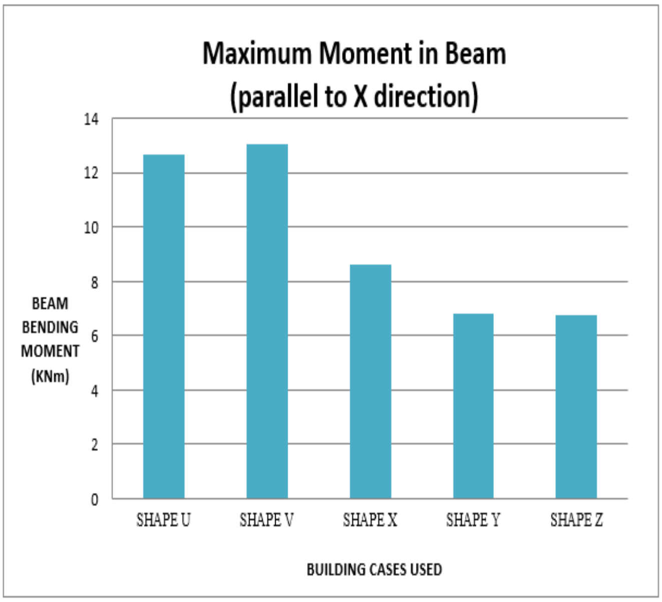

Fig. 15: Maximum Bending Moment in beams parallel to X direction for all Building cases

Above study of Beam shows shear force in X direction Case D perform well

Table 16: Maximum Bending Moment in beams parallel to Z direction for all Building cases

CASE	Beam Bending Moment (along Z direction) (KNm)
GC	985.664
A	1021.996
B	995.581
C	990.132
D	987.142
E	986.659

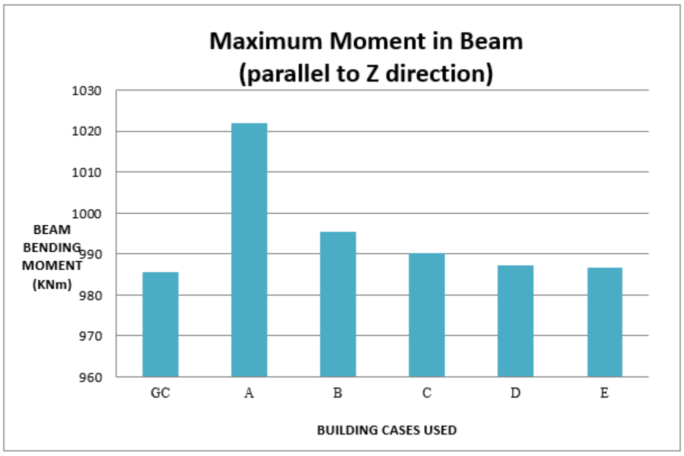

Fig. 16: Maximum Bending Moment in beams parallel to Z direction for all Building cases

Above study of Beam shear force in Z direction Case E perform well

Table 17: Maximum Torsional Moment in beams along X and Z direction for all Building cases

CASE	Beam Torsional Moment (along X direction) (KNm)	Beam Torsional Moment (along Z direction) (KNm)
GC	49.114	52.143
A	54.116	54.268
B	48.674	52.335
C	48.776	52.188
D	48.539	52.128
E	49.090	52.160

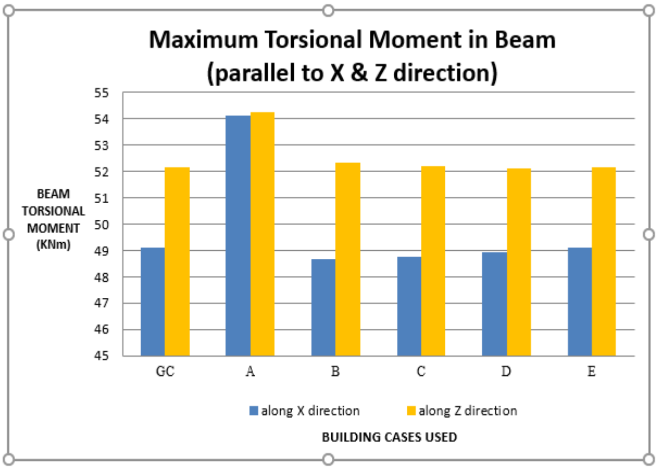

Fig. 17: Maximum Torsional Moment in beams parallel to X &Z direction for all Building cases

Above study of Torsional Moment force in X and Z direction respectively Case D perform well

4. CONCLUSIONS

On the basis of above parameters following results are obtained from this comparative study. On comparing it has been concluded that the maximum displacement obtained for Cases E with a minimum value respectively both X and Z direction as per comparative results, Case C for axial forces values are found best among all the cases. On analyzing column shear force values, Case C is effective for both directions. On analyzing column bending moment values, Case C is effective for X and Z direction as per comparative results, Case C for X direction and Case A for Z direction for base shear values are found best among all the cases. On analyzing beam shear force values, Case E is effective for X direction and case A is effective for Z direction. On analyzing beam bending moment values, Case A is effective for X and Case E is effective for Z direction On analyzing Torsional force values, Case B is effective for X direction On analyzing Torsional force values, Case D is effective for Z direction As the analysis of all parameters Case E is the best case for using floating column.

As per the above result shown that there are 6 different cases we study and we find the various result of these cases including with or without floating column condition and we concluded that the floating column we should provide on case E building where all the results are satisfactory or we can say structure is safe and efficient among all the other cases.

ACKNOWLEDGEMENT

The authors can acknowledge any person/authorities in this section. This is not mandatory.

REFERENCES

1) Syed Fahad Ali and S.A. Bhalchandra, Study on seismic Analysis of RCC and steel-concrete composite structure and cost comparison with different support condition, International journal for scientific research and development,
2) Sanhik Kar Majumder and Priyabrata Guha, Comparison between wind and seismic load on different types of structures, International journal of engineering science invention
3) U.Y.Jeong, Advance in tall building design under strong winds, Structural congress ASCE, 2015Code IS: 456(2000), Indian Standard Code of Practice for Plan and Reinforcement concrete (Fourth Revisions), Bureau of Indian Standards (BIS), New Delhi.
4) Ravinder Ahlawat and Ashok K. Ahuja, (2015), "Wind loads on 'T' plan shape tall buildings". Journal of Academia and Industrial Research (JAIR) ISSN: 2278-5213.
5) Ravinder Ahlawat and Ashok K. Ahuja, (2015), "Wind loads on 'Y' plan shape tall building". International Journal of Engineering and Applied Sciences (IJEAS) ISSN: 2394-3661.
6) Md. Rashedul Kabir, Debasish Sen, Md. Mashfiqul Islam, (2015), "Response of multi-storey regular and irregular buildings of identical weight under static and dynamic loading in context of Bangladesh". International Journal Of Civil and Structural Engineering, ISSN 0976 – 4399
7) Jawad Ahmed, H S Vidyadhar,"Wind Analysis and Design of Multi Bay Multi Storey 3D RC Frame", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181.
8) Tak, N., Pal, A. and Choudhary, M. (2020). Analysis of Building with Tower on Sloping Ground International Journal of Current Engineering and Technology, DOI: https://doi.org/10.14741/ijcet/v.10.2.10 E-ISSN 2277-4106, P-ISSN 2347-5161 pp 247-254
9) Tak, N., Pal, A. and Choudhary, M. (2020). A Review on Analysis of Tower on Building with Sloping Ground. International Journal of Advanced Engineering Research and Science, 7(2), pp.84-87.
10) Hossein Moravej, Mahdi Hatami, Reza Naghshbandi, Yaser Mousavi Siamakani , "Wind load analysis of buildings in hill-shape zone", Int. Journal of Applied Sciences and Engineering Research, Vol. 4, Issue 1, 2015.
11) Indian standard codal 875: part 2,3,5- 1987, "Code of practice for Design loads (other than earthquake) for buildings and structures."
12) Indian standard codal 456: 2000, "Indian Standard code of practice for general structural use of plain and reinforced

13) D.R. Panchal and P.M. Marathe, Comparative Study of RCC, steel and composite (G+30 storey) building, Institute Of Technology, Nirmal University, Ahmadabad, December,
14) Abhay Guleria, Structural Analysis of a Multi story buildings using ETABS for Different plan configuration, International journal of engineering research and technology.
15) Mahesh Suresh Kumawat and L.G.Kalurkar, Analysis and design of multi story building using composite structure, International Journal of Research in Engineering and Technology,3(2),
16) Codal provision IS: 875(Part 3)-1987, Indian Standard Code of Practice for Design loads (other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, New Delhi..
17) Ming Gu,"Study on wind loads and responses of tall buildings and structures"The Seventh Asia-Pacific Conference on Wind Engineering, Nov. 2009,Taipei, Taiwan.
18) J. A. Amin and A. K. Ahuja (2008), "Experimental study of wind pressures on irregular plan shape buildings".VI International Colloquium on: Bluff Bodies Aerodynamics & Applications Milano, Italy.