International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

SEISMIC ANALYSIS OF MULTI STOREY BUILDING WITH FLOATING COLUMNS USING ETABS

Harsha P V[1], Shilpa Valsakumar[2]

[1]PG Student, Department of Civil Engineering, Sree Narayana Guru College of Engineering & Technology, Payyanur, Kerala, India-670307
[2]Assistant Professor, Department of Civil Engineering, Sree Narayana Guru College of Engineering & Technology, Payyanur, Kerala, India-670307

---***---

Abstract - *In recent years, multi-storey and commercial buildings are constructed with architectural complexities. The floating columns buildings in seismically active areas are very dangerous. This paper studies the analysis of a G+10 storey normal building and G+10 storey floating column building for external lateral forces. The main objectives of this project are, to study the behaviour of multi storey buildings with floating columns under earthquake excitations, to find whether the structure is safe or unsafe with floating column when built in seismic zone III, to find the most critical and best position of floating column in G+10 building. Floating column building with shear wall also considered for the study.*

***Key Words*: Floating column, ETABS software, Zone III, G+10 storey, Earthquake, etc…**

1. INTRODUCTION

In Modern construction technology major concern is given for architectural and other features, most of the multi storied buildings having open ground storey as an obligatory feature to afford parking area, reception lobbies and for other architectural needs. Now a days multi-storey building construction for residential, industrial or commercial purpose has become a common feature, These multi-storey building need more parking or open spaces below. This open ground storey concept leads to interruption of columns called floating columns, which makes the building lateral irresistible. This concept of floating column is driven from the architectural needs to bring out aesthetic view to building, and also to overcome FSI (Floor Space Index) restrictions. Even in commercial building there might be a need for conference hall or banquet hall on the floors below. For these purposes we prefer to have open space rather than having columns in between. In this case floating columns come into the picture. Floating columns gives the liberty to change the floor plans above. Like in any other structure, the load from the floors above is transferred to the column. The entire load is then transferred to the beam on which the floating column rest. The floating column is designed as a regular column. The beam on which the floating column rests is designed as a beam carrying all the load of the column as a single point load. This beam referred to as girder beam or transfer beam usually having big cross section with heavy steel. This girder beam is also subjected to torsion. The design and detailing of this girder beam is very crucial in the construction of floating columns buildings. During earthquakes the behaviour of a building 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 in a building need to be brought down along the height to the ground by the shortest path. Any deviation or discontinuity in this transfer load results in poor performance of the building.

1.1 Floating Column

A column is a vertical member starting from foundation level and transferring the load to the ground. The floating column is also a vertical element which (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a horizontal member. The beams transfer the load to other columns below it. Usually columns rest on the foundation to transfer load from slabs and beams. But the floating column rests on the beam. The floating column is designed as a regular column. The beam on which the floating column rests is designed as a beam carrying all the load of the column as a single point load.

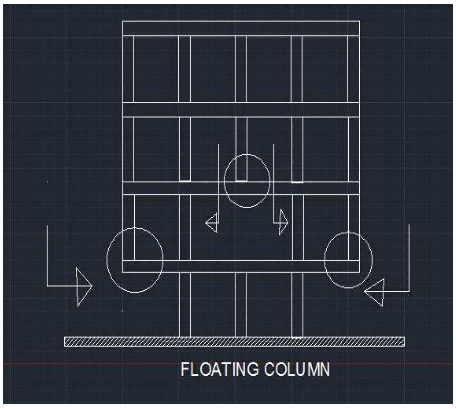

Fig -1: Floating column

Floating columns are adopted in many projects, especially above the ground floor, where transfer girders are employed, so that more open space is available in the ground floor. These open spaces may be used for assembly hall or parking purpose. The transfer girders have to be designed and detailed properly, especially in case of earthquake zones.

Column is a concentrated load on the beam which supports it. As far as analysis is concerned, the column is often assumed pinned at the base and is therefore taken as a point load on the transfer beam. STAAD Pro, ETABS and SAP2000 can be used to do the analysis of this type of structure. Floating columns are competent enough to carry gravity loading but transfer girder must be of adequate dimensions (Stiffness) with minimal deflection.

2. OBJECTIVE

Floating column are usually provided at the bottom storey in order to have more space at ground floor for parking or other purposes. In this study G+10 building with and without floating column are considered. Different positions of floating column also considered for the study. The main objectives of this project are,

- To study the behaviour of multi storey buildings with floating columns under earthquake excitations
- To find whether the structure is safe or unsafe with floating column when built in seismic zone III
- To find the most critical and best position of floating column in G+10 building
- To study behaviour of floating column building while providing shear wall

3. SCOPE

Multi-storey buildings in urban cities are required to have column free space due to shortage of space and for aesthetic and functional requirements. Strengthening of floating column building using shear wall can be studied. Seismic zone III is considered for this study. ETABS software is used for the modelling and analysis.

4. MODELLING AND ANALYSIS

A. Modelling

A G+10 storied building with floating column and without floating column located in zone III of India as per code IS 1893(Part1):2002 were taken for the investigation. Different positions of floating column in first storey of the building is also considered for the study. Modelling and analysis of the building is done by using ETABS software. Seismic analysis is also done to check the structure is safe or not. Response spectrum method is used to find the values of storey drift, displacement and shear. Behaviour of shear wall in floating column building is also considered for the study.

B. Building configuration

Table -1: Building configuration

Number of storey	G+10
Utility of the building	Residential
Grade of concrete	M25
Grade of steel	HYSD415
Column size	500x500mm
Beam size (B1) (B2)	450x300mm 750x230mm
Number of bays along X-direction	5
Number of bays along Y-direction	5
Storey height	3m
Slab thickness (S1) (S2)	150mm 125mm
Bay width along X-direction	5m
Bay width along Y-direction	5m

C. Seismic data of G+10 building

Parameters		Values
Seismic zone factor	Zone III	0.16
Importance factor		1.0
Response reduction factor		5.0
Percentage of damping		5%
Soil type		II

Table -2 : Seismic data of G+10 building

Modelling and analysis of G+10 building with and without floating column is done using Etabs software. Response spectrum method is used to find displacement, storey shear and storey drift. The critical and best positions of floating column can be determined from this analysis. Floating column provided at first storey of the building. 10 models are studied in this analysis.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

Model 1 : Normal building

Model 2 : floating column provided at four corners of the building and inside the building

Model 3 : floating column provided at outer periphery of the building

Model 4 : floating column provided inside the building

Model 5 : floating column provided at centre

Model 6 : floating column provided outside the building

Model 7 : floating column provided at parallel position

Model 8 : floating column provided inside the building

Model 9 : floating column provided outside the building

Model 10 : all inner columns are floating

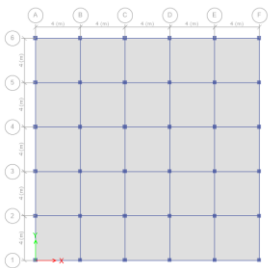

Fig -2: Model 1

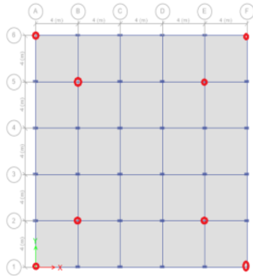

Fig -3: Model 2

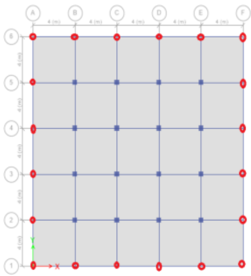

Fig -4: Model 3

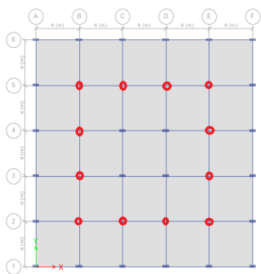

Fig -5: Model 4

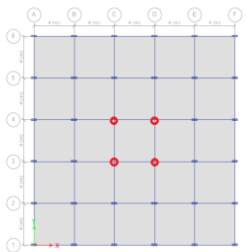

Fig -6: Model 5

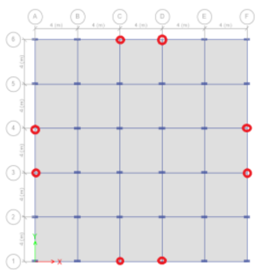

Fig -7: Model 6

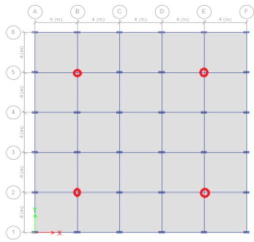

Fig -8 : Model 7

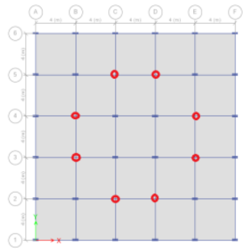

Fig -9 : Model 8

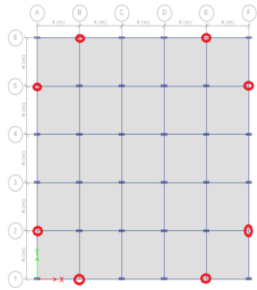

Fig -10: Model 9

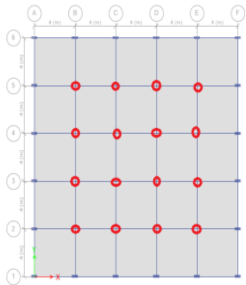

Fig -11: Model 10

10 models are completed using ETABS software. Seismic analysis is done by response spectrum method. The values of storey drift that is the inter storey displacement for two consecutive floors, displacement and storey shear obtained from Response spectrum analysis is tabulated below.

Table -3 : Maximum storey drift

Storey height (m)	Model 1	Model 2	Model 3	Model 4	Model 5
0	0	0	0	0	0
3	0.00349	0.00416	0.00667	0.00617	0.00416
6	0.00538	0.00543	0.00876	0.00536	0.00533
9	0.00549	0.00563	0.00932	0.00560	0.00545
12	0.00524	0.00548	0.00894	0.00540	0.00522
15	0.00484	0.00511	0.0084	0.00496	0.00483
18	0.00434	0.00463	0.00776	0.00443	0.00435
21	0.00377	0.00407	0.00703	0.00381	0.00377
24	0.00315	0.00345	0.00624	0.00315	0.00316
27	0.00249	0.00278	0.00539	0.00248	0.00250
30	0.00181	0.00209	0.00452	0.00179	0.00181
33	0.00119	0.00151	0.00377	0.00117	0.00120

Table -4 : Maximum storey drift

Storey height (m)	Model 6	Model 7	Model 8	Model 9	Model 10
0	0	0	0	0	0
3	0.00421	0.00397	0.00398	0.00436	0.00785
6	0.0056	0.00532	0.00513	0.00557	0.00668

9	0.00586	0.00545	0.00543	0.00571	0.00579
12	0.00562	0.00522	0.00527	0.00547	0.00557
15	0.00520	0.00484	0.00488	0.00508	0.00552
18	0.00472	0.00436	0.00437	0.00461	0.00530
21	0.00415	0.00378	0.00377	0.00406	0.00391
24	0.00355	0.00316	0.00315	0.0034	0.00326
27	0.00288	0.00250	0.00249	0.00278	0.00258
30	0.00219	0.00181	0.00180	0.00208	0.00188
33	0.00154	0.00119	0.00119	0.00145	0.00126

Table -5 : Storey displacement

Storey height (m)	Model 1	Model 2	Model 3	Model 4	Model 5
0	0	0	0	0	0
3	10.5	12	62.9	18.7	13.2
6	26.6	26.9	77.5	30.9	27.7
9	43.1	43.8	95.3	46	43.8
12	58.8	60	114.3	61	59.5
15	73.2	75.1	133.5	75.2	73.9
18	86.2	88.8	152.1	88.1	86.8
21	97.3	100.6	169.6	99.4	97.9
24	106.3	110.4	185.5	108.5	106.8
27	113	118	199.7	115.3	113.5
30	117.3	123.1	211.9	119.7	117.8
33	119.6	126.3	222.5	122.1	120.1

Table - 6: Storey displacement

Storey height (m)	Model 6	Model 7	Model 8	Model 9	Model 10
0	0	0	0	0	0
3	12.5	12	12.7	12	23.8
6	29.1	26.4	26.9	27.6	37.4
9	46.7	42.7	42.7	44.7	53.4
12	63.5	58.4	58.5	61.1	68.9
15	79.1	72.8	73.1	76.2	83.1
18	93	85.7	86.1	89.9	95.9
21	105.1	96.8	97.2	101.7	106.7
24	115.1	105.8	106.3	111.5	115.5
27	122	112.5	113.1	118.9	122.8
30	126.1	116.9	117.4	124	128
33	128.2	119.2	119.7	127	131.2

Table - 7 : Storey shear

Storey height (m)	Model 1	Model 2	Model 3	Model 4	Model 5
0	0	0	0	0	0
3	9538.35	9545.40	9961.68	9709.05	9578.49
6	9367.79	9361.34	9659.53	9467.04	9390.87
9	8999.10	8994.98	9227.95	9072.51	9016.84
12	8449.26	8448.50	8640.33	8506.07	8463.67
15	7736.81	7738.80	7903.67	7781.01	7748.31
18	6876.52	6880.58	7026.63	6911.19	6885.22
21	5880.16	5892.67	6015.63	5907.56	5886.16
24	4757.24	4778.11	4875.67	4778.52	4763.72
27	3514.52	3539.19	3611.85	3528.82	3521.20
30	2159.72	2181.70	2230.82	2165.83	2163.46
33	699.94	709.98	731.18	694.79	697.79

Table - 8 : Storey shear

Storey height (m)	Model 1	Model 2	Model 3	Model 4	Model 5
0	0	0	0	0	0
3	9566.35	9481.51	9588.70	9538.69	9951.02
6	9377.52	9300.42	9386.66	9352.09	9648.65
9	9006.36	8949.04	9014.11	8987.76	9207.51
12	8457.81	8417.88	8463.79	8444.83	8603.34
15	7749.24	7722.32	7751.21	7739.78	7845.80
18	6895.08	6876.85	6890.79	6887.02	6946.97
21	5905.64	5885.67	5894.14	5897.54	5917.79
24	4787.78	4760.63	4770.57	4779.42	4767.91
27	3545.76	3504.45	3526.26	3538.21	3515.64
30	2184.62	2137.41	2167.35	2179.77	2158.46
33	709.53	684.78	701.43	708.67	702.10

10 models are modelled and analysed using ETABS software. Response spectrum analysis is used to find displacement, drift and shear. From the result obtained best and worst models using floating column can be determined. For the better performance of best model using floating column shear wall can be provided. In this project shear wall is provided at different positions of Model 7.

- Shear wall at centre (Box type)
- Shear wall at corner L-shape
- Shear wall on sides

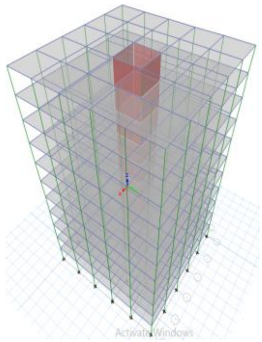

Fig -12: Shear wall provided at centre of Model 7

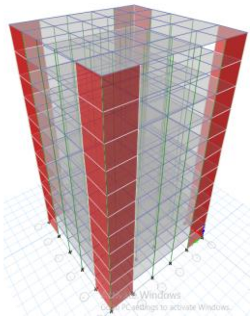

Fig -13: Shear wall provided at the corner of Model 7

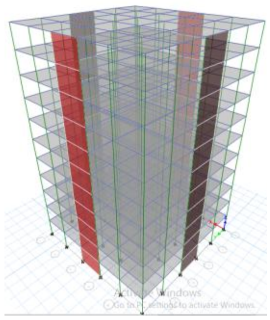

Fig -14: shear wall provided on sides

Shear wall is provided at three different positions of the building to determine the best position of shear wall. Shear wall is provided at corner, sides and centre. The values of storey displacement and storey drift is obtained by response spectrum method. The values of storey drift and displacement are tabulated below.

Table - 9 : Storey drift when shear wall is provided

Storey height (m)	Without Shear Wall (mm)	Shear Wall at Centre (mm)	Shear wall at Corner (mm)	Shear Wall at Sides (mm)
0	0	0	0	0
3	0.003979	0.001854	0.001816	0.002268
6	0.005326	0.002919	0.002827	0.003595
9	0.005454	0.003003	0.002859	0.003678
12	0.005222	0.002831	0.002688	0.003484
15	0.004848	0.002544	0.002417	0.003166
18	0.004362	0.002161	0.002043	0.002752
21	0.003783	0.001927	0.00171	0.00258
24	0.00316	0.001944	0.001745	0.002567
27	0.002502	0.001932	0.001755	0.00252
30	0.001816	0.001904	0.001749	0.002465
33	0.001199	0.001875	0.00175	0.002405

Table - 10 : Storey displacement when shear wall is provided

Storey height (m)	Without Shear Wall (mm)	Shear Wall at Centre (mm)	Shear wall at Corner (mm)	Shear Wall at Sides (mm)
0	0	0	0	0
3	12	5.6	5.4	6.8
6	26.4	14.2	14	17.6
9	42.7	23.2	22.6	28.6
12	58.4	31.6	30.6	39
15	72.8	39.2	37.7	48.4
18	85.7	45.6	43.6	56.6
21	96.8	50.5	48.1	63.2
24	105.8	53.7	50.8	68
27	112.5	55.1	51.4	70.7
30	116.9	54.6	49.8	71.3
33	119.2	52.7	46.6	70.1

5. RESULT AND DISCUSSION

The analysis of 10 models using ETABS software is completed and response spectrum method is used to determine the storey drift, storey displacement and storey shear.

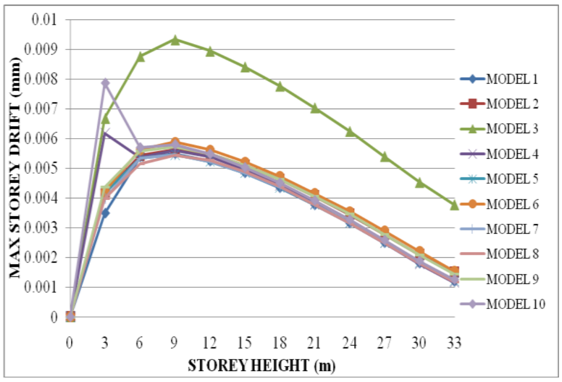

Chart -1: Comparison of storey drift

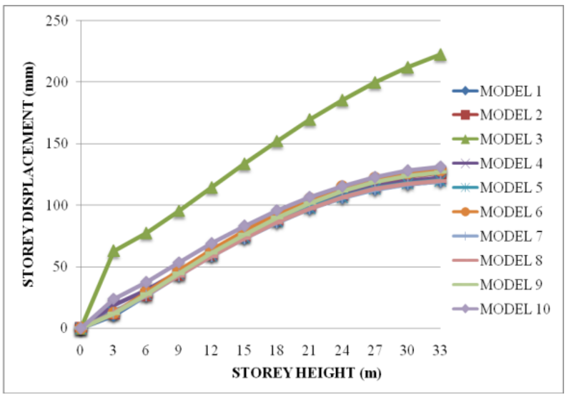

Chart -2: comparison of maximum storey displacement

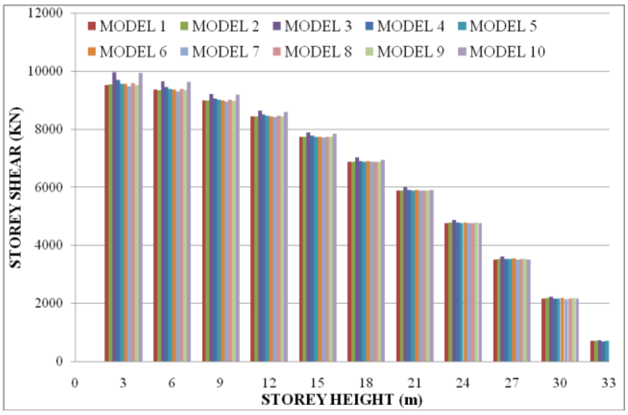

Chart -3: Comparison of storey shear

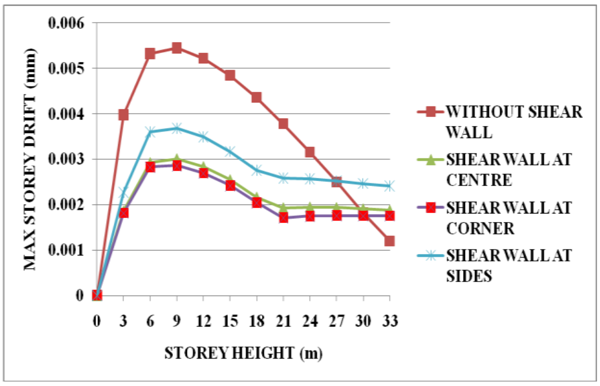

Chart -4: Comparison of storey drift when shear wall is provided

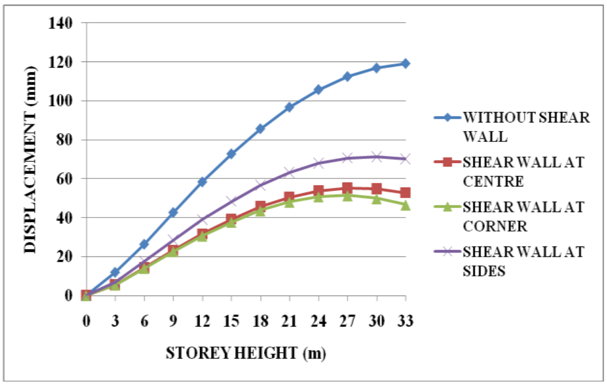

Chart -5: comparison of storey displacement when shear wall is provided

6. CONCLUSIONS

- The behaviour of multi storey building with and without floating column is studied under seismic Zone III
- Response spectrum method is used to find storey drift , displacement and storey shear
- The structure with floating column is subjected to maximum displacement than normal column structure. Value of Displacement is greater for floating column provided at outer periphery (Model 3) and Model 10 (all inner columns are floating in the first storey)
- Displacement increases from lower storey to higher storey for all cases
- As per Response Spectrum Analysis, the storey shear force was found to be maximum for the first storey and it decreased to a minimum in the top storey in all cases and it is maximum in floating column provided at outer periphery (model 3) and Model 10
- Storey drift also increase in structure as column discontinuity increase and it is maximum in lower stories for all cases. Model 3 and Model 10 having higher values compared to other models.
- From these results it can be concluded that Model 3, Model 10 are more critical compared to all other models and Compared to other floating column buildings Model 7 is having less values of displacement, drift and shear
- Displacement varies in each model for corner shear wall, internal shear wall and side shear wall and shear wall provided at corner having less displacement compared to other models
- Shear wall at corner also having less values of drift compared to shear wall provided at centre and sides
- It can be concluded that building with shear wall at corner worked well compared to other models

REFERENCES

[1] **Ashwin Sanjay Balwaik,** Comparative Analysis of G+1 Structure With and Without Floating Column, International Journal of Scientific & Engineering Research, Volume-6, Issue-6, June 2015

[2] **Shiwli Roy, Gargi Danda de,** Comparative studies of Floating Column of different multi storied building, International Journal for Research in Applied Science & Engineering Technology(IJRASET), Volume-3 Issue-8, August 2015

[3] **Badgire Udhav S, Shaikh A.N, Maske Ravi G,** Analysis of Multi storey Building with Floating Column, International Journal of Engineering Research, Volume-4, Issue-9, Sept 2015

[4] **SK.Shama banu, G.Shani Priyanka,** Study of Behaviour of Seismic Evaluation of Multistoried Building with Floating Column, International Journal of Computer Engineering In Research Trends, Volume-2, Issue-12, December 2015

[5] **Jayashri Sarode, Amol.S. Pote,** Analysis of floating column building of composite and r.c.c beam girder & comparison with r.c.c frame structure by using etabs

v9.7.0, International journal of advanced research, 2016

[6] **Hirani Pravin, K.C.Koradia,** A Study on Effect of Column Discontinuity on Behavior of Structure, International Journal for ScientificResearch & Development, Volume-4, Issue-3, 2016

[7] **Apurv Joshi, Mohd, Afaque Khan, Abhishek Kumar,** Seismic analysis of multi storey building with floating column, International Research Journal of Engineering and Technology (IRJET), March 2016

[8] **Meghana B .S, T.H. Sadashiva Murthy,** Effect of floating column on the behaviour of composite multi storied building subjected to seismic load, International Research Journal of Engineering and Technology(IRJET), Volume-3, Issue-6, June 2016

[9] **Pooja Suresh, Aiswarya S**, Comparative Study on Seismic Behaviour of Multi Storey Building with and Without Floating Colum, International Journal of Science and Research (IJSR), Volume-5 Issue-7, July 2016

[10] **Kadam.S.S, Lale S.V,** Study of behaviour of floating column for seismic analysis of multistorey building, International Research Journal of Engineering and Technology(IRJET), Volume-3 Issue-8, Aug 2016

[11] **Allacheruvu Raghavendra, T.appa reddy, G.N.Sreekanth**, Comparative seismic study on strengthening of floating column building using bracings**,** International Journal of Advances in Mechanical and Civil Engineering, Volume-3, Issue-5, Oct 2016

[12] **S.B. Waykule, Dr. C.P. Pise,** Study of behaviour of floating column for seismic analysis of multistorey buildings**,** International Journal of Civil Engineering and Technology (IJCIET), November-December 2016

[13] **Prasad B. Shermale, R. S. Talikoti**, Seismic Analysis of Multi-storied RC Building with Soft Storey Floating Column at different level**,** International Journal for Scientific Research & Development, Volume-5, Issue-7, 2017

[14] **Y.Abhinay, H.Sudarsana Rao,** Comparison of Seismic Analysis of a Floating Column Building and a Normal Building**,** International Journal of Materials Science, Volume-12, 2017

[15] **Waykule.S.B, C.P.Pise**, Comparative Study of floating column of multi storey building by using software**,** International Journal of Engineering Research and Application, Volume-7, Issue-1, January 2017

[16] **Snehal Ashok Bhoyar**, Effect of floating column on building performance subjected to lateral load**,** Vishwakarma Journal of Engineering Research, Volume-1 Issue-2, June 2017

[17] **Amit Namdeo Chaudhari, Dr. R. S. Talikoti,** Study of Seismic Behaviour of Building with Different Positions and Types of Floating Column, International Journal of Engineering Science and Computing(IJESC), July 2017

[18] **Pradeep D, Chethan V R, Ashwini B T,** Seismic analysis of multi-storey building with floating columns using Etabs**,** International Journal of Scientific Development and Research(IJSDR), Volume-2, Issue-9, September 2017

[19] **Preethi G, Sudha P H, Maganur D S,** Study The Behaviour Of Seismic Evaluation Of Multistoried Building With Floating Columns**,** International Journal of Scientific Engineering and Ap plied Science (IJSEAS),Volume-3, Issue-9, September 2 017

[20] **N.Elakkiyarajan, G.Iyappan, A Naveen,** Seismic Analysis of Multi story Building with Floating Column**,** IOSR Journal of Engineering(IOSRJEN), 2018

[21] **Ashwin Sanjay Balwaik,** Comparative Analysis of G+1 Structure With and Without Floating Column**,** International Journal of Scientific & Engineering Research, Volume-6, Issue-6, June 2015

[22] **Kapil Dev Mishra,** Comparative Study of Floating and Non Floating Column of Plaza Building Subjected to Seismic Loading by Using Staad-Pro Software**,** International Journal of Engineering Development and Research(IJEDR), Volume-6, Issue-3, 2018

[23] **Kishalay Maitra, N. H. M. Kamrujjaman Serker,** Evaluation of Seismic Performance of Floating Colum Building**,** American Journal ofCivil Engineering, volume-6, April-2, 2018

[24] **Virendra Pratap Singh Solanki, Prof. Sumit Pahwa,** Seismic Analysis of Multi Storey Building with & without Floating Column**,** International Journal for Scientific Research & Development(IJSRD), 2018

[25] **Mo Farhan**, Behaviour of a Floating Column in a Building**,** International Journal for Scientific Research & Development(IJSRD), Volume-7, Issue-5, 2019