

COMPARATIVE STUDY OF UNBRACED, CROSSED AND DIAGONALLY BRACED FRAME OF BUILDING WITH FLOATING COLUMN

Deepak Jain¹, Prof. Dr. Savita Maru²

¹PG student at Department of civil engineering, Ujjain engineering college, Ujjain, M.P., India

²Professor at Department of civil engineering Ujjain engineering college Ujjain, M.P., India

ABSTRACT

Floating column building is a new fascination for engineers. As floating column buildings provides more space and good aesthetics to the building. But have high structural challenges, when a floating column is provided in a multi-story building in a high seismic zone. This paper firstly reviews several studies conducted on the floating column building and its behavior under seismic loads, then computational experiment is done on G+10 & G +15 building frame with and without bracing. Finally, different frame configuration is compared to reach the conclusion that cross bracing provides more lateral stability to the floating column building frame under high seismic zone.

Keywords: Building frame configuration, Seismic behavior, Dynamic characteristics, Response spectrum analysis, time history analysis.

1. INTRODUCTION

In the 1950's and 1960s, some Eastern European scholars suggested the soft base level to reach the large openings at the lower level. A-frame is built on the lower level to support the upper structure in this type of structure. This type of structure is believed to work best in earthquakes, but current experience has shown the concept to be wrong. In 1978, many buildings of this type collapsed during the earthquake in Romania. A column is intended to be a vertical element that starts from the foundation level and transfers the load to the ground. The term suspension column is also a vertical element that ends at the lower level (end level) of the building. Due to architectural requirements and its support on beams. The beams in turn transfer the load to other columns below. In practice, true piers below final grade [generally still grade] are not constructed carefully and are more prone to errors. Larger openings on the ground floor are now achieved by using transfer beams to absorb vertical and lateral loads from the high-rise building component and distribute them to widely spaced supports. This research focuses on literature studies of the behavior of floating columns under buildings in a high seismic zone.

Multi-story buildings in urban cities have been required to have column-free spaces due to lack of space, population density, and also aesthetic and functional requirements. For this, the buildings have floating columns on one or more floors. These floating columns are very disadvantageous in a building that is constructed in seismically active areas. The seismic forces that arise in the different floors of a building must be carried by the shortest possible path over the height to the ground. Any deviation or discontinuity in this load transfer route will result in poor building performance. The behaviour of a building in the event of an earthquake depends fundamentally on its general shape, size, and geometry, as well as on the transfer of earthquake forces to the ground. Many open buildings intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. In the case of tall buildings, the column is interrupted on the ground floor and the first floor to allow a greater opening on the ground floor. Low to facilitate access to the public area at the base earth and masonry have no reliable strength in tension and are brittle in compression. As a rule, they should be reinforced accordingly with steel or wood.

2. METHODOLOGY

The buildings G + 10 & G + 15 have floating columns on ground floors are considered. The comparative study is performed on three different configuration of building frames without bracing, with cross bracing, and diagonal bracing to understand their seismic response and compare. In total six models are made in STAAD pro and analysis is done by using response spectrum method.

Design parameter –

Building (Floors/Bracing)	G + 10	G + 15
Unbraced	Model – 1	Model – 1
Cross-bracing	Model – 2	Model – 2
Diagonal bracing	Model – 3	Model - 3

Site condition	Jammu and Kashmir
Seismic zone	IV
Frame	SMRF
Importance factor	1
Codes	IS:456 , IS:800 , IS-1893 (Part -1), IS 875 (Part 1 - 4)
Soil condition	Hard
Software used	STAAD pro
Loads	Dead load, Live load , Wind load, Seismic load
Analysis method	Response spectrum method

Shows the characteristics of the building frame members to be analyzed.

Analysis Method The analysis is based on the following assumptions.

- The modulus of elasticity and Poisson's ratio are 25000 N / mm² and 0.20, respectively.
- Side effects Δ , contraction and creep are not considered.
- The soil membrane is rigid in its plane.
- Axial deformation of the column is taken into account.
- Each node in the frame has 6 degrees of freedom, 3 translations, and 3 rotations.
- Torsion is considered according to IS: 1893 (I) –2002.
- The material is homogeneous, isotropic and elastic

Response Spectrum Analysis (RSA)

Seismic analysis of all buildings is performed by the response spectrum method using IS: 1893 (I) –2002 [2]. This includes the effect of eccentricity (static + random). Other parameters used in seismic analysis are temperate seismic zone (IV), zone factor 0.24, importance factor 1.0, 5 ° mping and assuming a moment-sustaining framework common to all building configurations and heights. The response reduction factor is 3.0. Appropriate modes (at least 6) were considered for each construction case where the total modal mass of all modes is at least 99% of the total seismic mass. The bar force for each contribution mode with dynamic load was calculated and the modal response was combined using the CQC method. The following design spectra were used in the response spectrum analysis.

Load combinations -

Load Combinations are taken as per IS 1893 and are as follows:

In the limit state design of reinforced and pre-stressed concrete structures. Auto Load combination option of STAAD pro is used in this paper.

Analysis of results

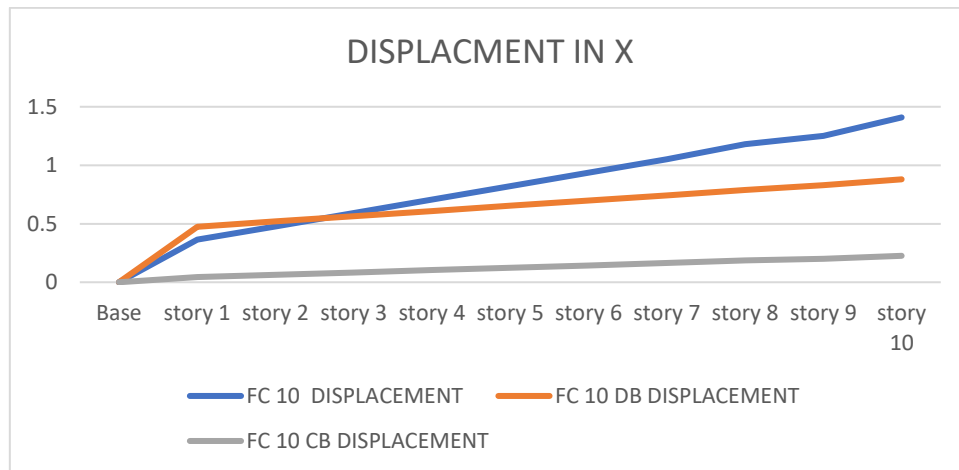
All buildings have been analyzed for seismic load with an effect of accidental eccentricity. The seismic force was applied in X direction and Z direction independently. Important results are presented in the subsequent sections.

Displacement Of G +10 & G +15 In X And Z Direction

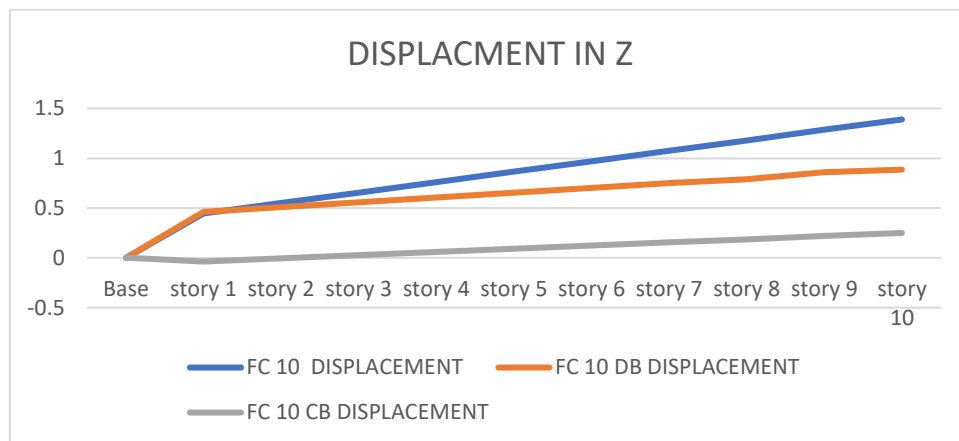
Displacement table for G + 10

FC 10 DISPLACEMENT IN X	FC 10 DB DISPLACEMENT IN X	FC 10 CB DISPLACEMENT IN X	FC 10 DISPLACEMENT IN Z	FC 10 DB DISPLACEMENT IN Z	FC 10 CB DISPLACEMENT IN Z
1.409	0.8797	0.226	1.39	0.886	0.25

Displacement in X G + 10



Displacement G + 10 IN Z



Displacement FOR G + 15

FC 15 DISPLACEMENT IN X	FC 15 DB DISPLACEMENT IN X	FC 15 CB DISPLACEMENT IN X	FC 15 DISPLACEMENT IN Z	FC 15 DB DISPLACEMENT IN Z	FC 15 CB DISPLACEMENT IN Z
2.58	2.29	1.5	2.8	2.36	1.32

Displacement in X

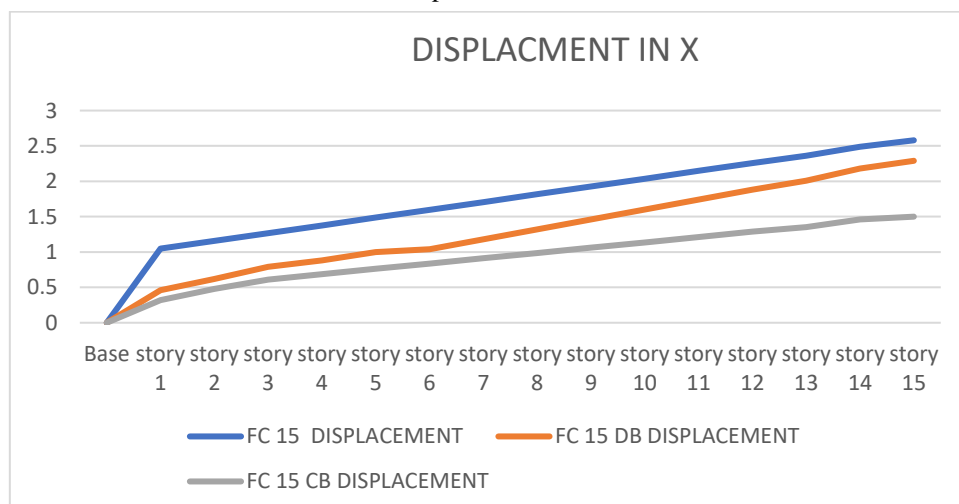
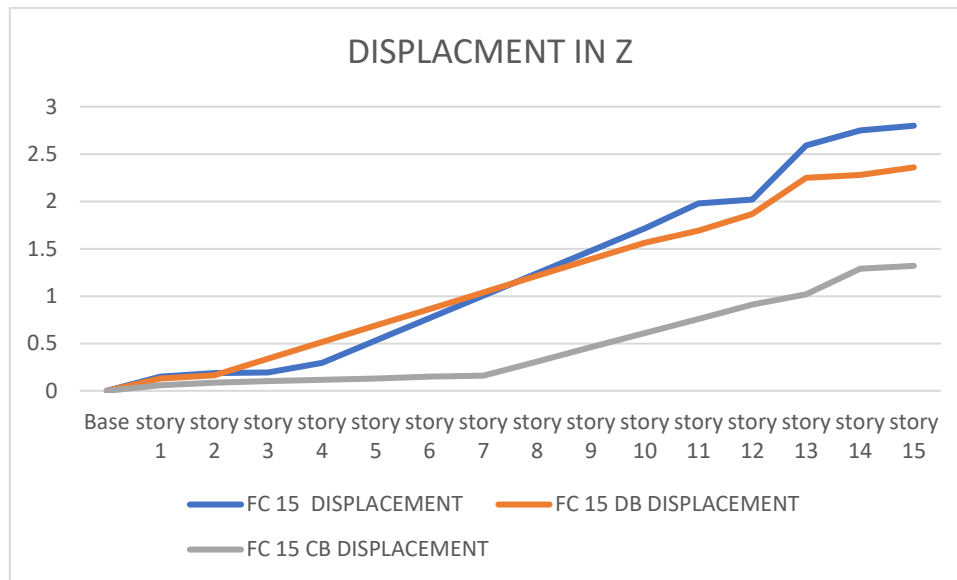


Figure 1 Displacement in z for G + 15

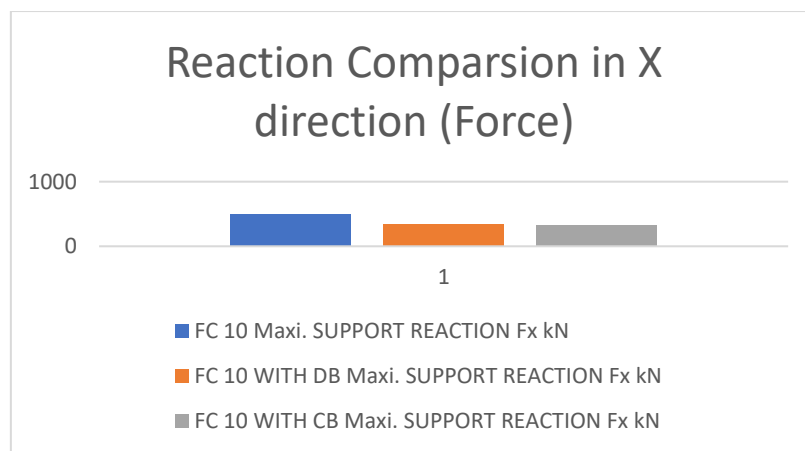


Comparison Of Reaction (Force) In X And Z Direction

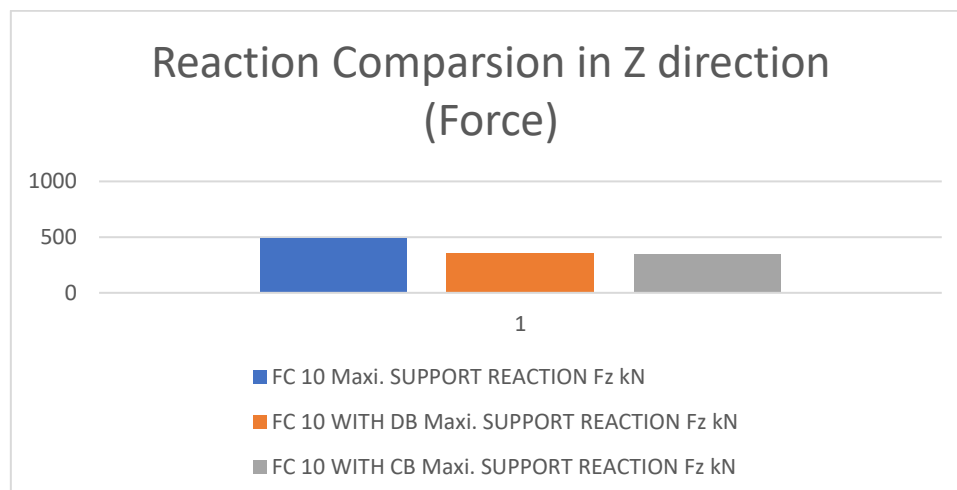
Force in G + 10

FC 10 Fx kN	FC 10 DB Fx kN	FC 10 CB Fx kN	FC 10 Fz kN	FC 10 DB Fz kN	FC 10 CB Fz kN
488.25	341.4	320.63	488.25	355.9	341.2

Forces in G + 10



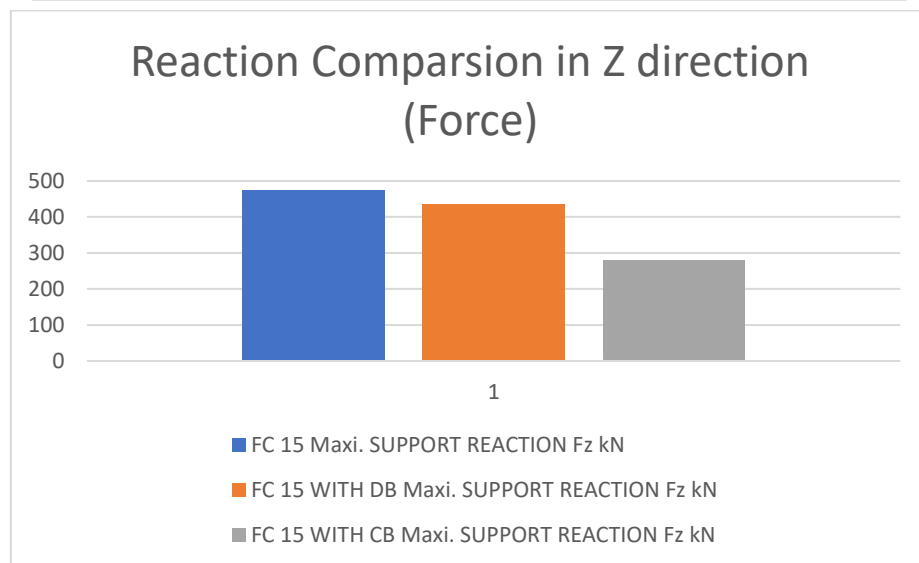
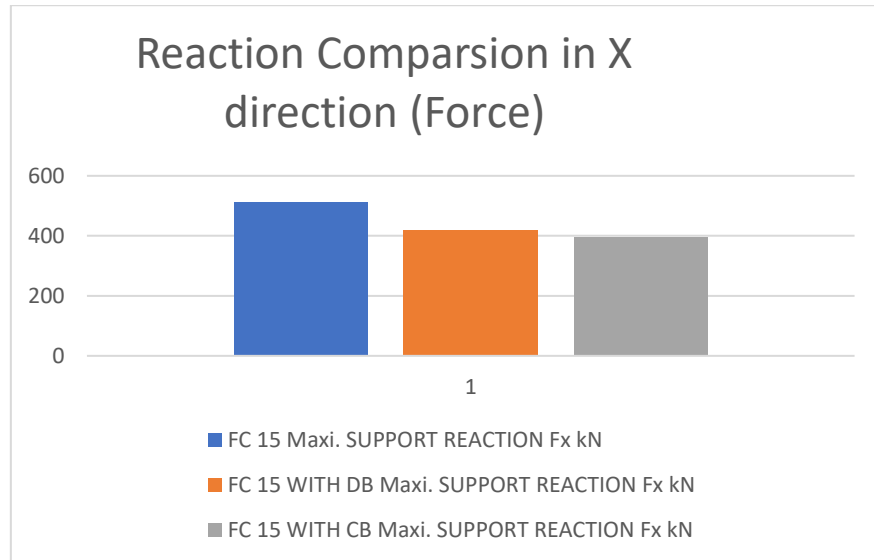
Force in X G +10



Force in G + 15

FC 15 Maxi. Force	FC 15 WITH DB Maxi. Force	FC 15 WITH CB Maxi. Force	FC 15 Maxi. Force	FC 15 WITH DB Maxi. Force	FC 15 WITH CB Maxi. Force
Mx kN	Mx kN	Mx kN	Mz kN	Mz kN	Mz kN
782.53	539.45	227.5	782.5	530	421.66

Force in X G + 15

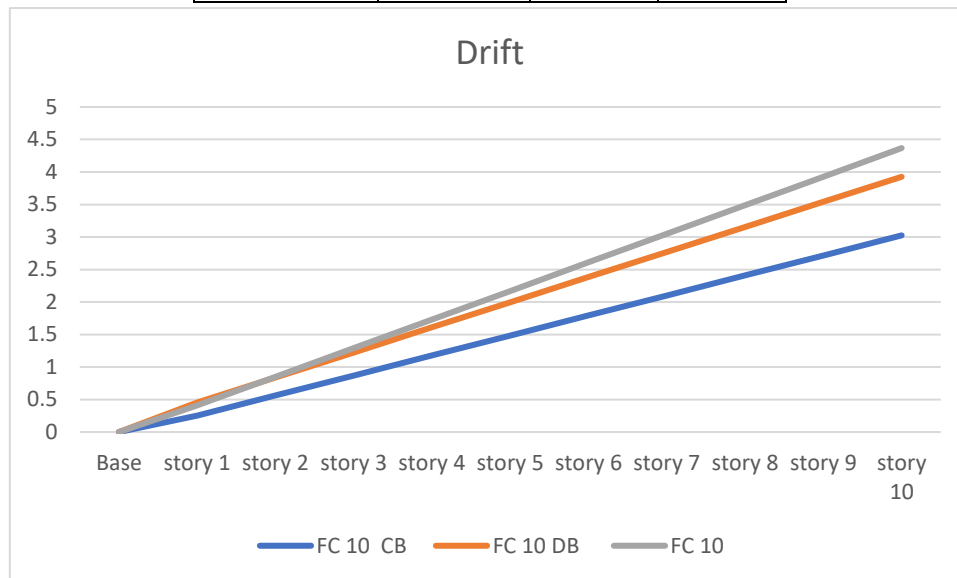


Comparison Of Drift

Drift in G +10

Story height	FC 10 CB	FC 10 DB	FC 10
Base	0	0	0
story 1	0.253	0.4529	0.4103
story 2	0.561	0.8388	0.85
story 3	0.869	1.2247	1.2897
story 4	1.177	1.6106	1.7294
story 5	1.485	1.9965	2.1691
story 6	1.793	2.3824	2.6088

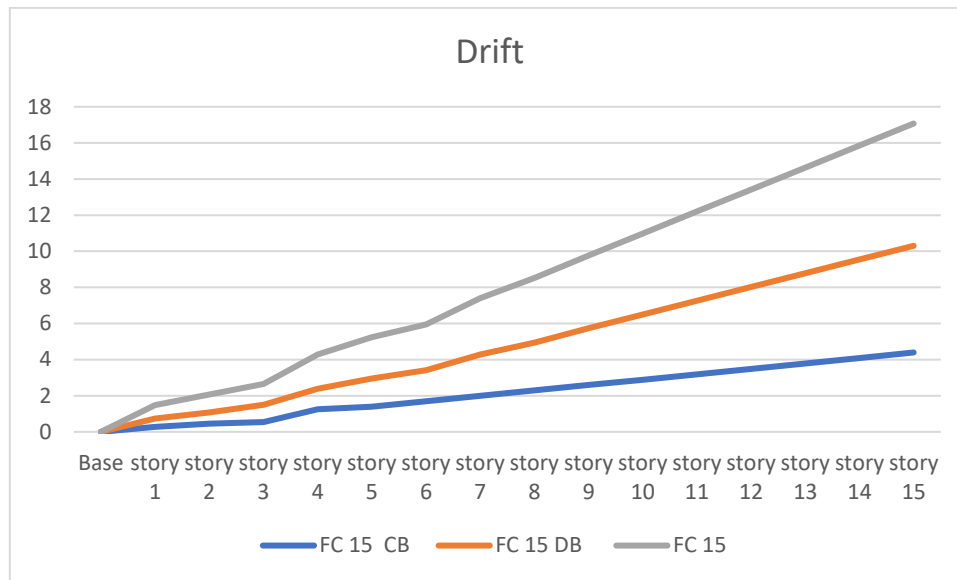
story 7	2.101	2.7683	3.0485
story 8	2.409	3.1542	3.4882
story 9	2.717	3.5401	3.9279
story 10	3.025	3.926	4.3676



Drift in G + 15

Story height	FC 15 CB	FC 15 DB	FC 15
Base	0	0	0
story 1	0.28	0.45	0.75
story 2	0.45	0.63	0.98
story 3	0.55	0.95	1.15
story 4	1.25	1.13	1.9
story 5	1.385	1.56	2.3
story 6	1.686	1.73	2.54
story 7	1.987	2.3	3.115
story 8	2.288	2.65	3.572
story 9	2.589	3.146667	4.029
story 10	2.89	3.606667	4.486
story 11	3.191	4.066667	4.943
story 12	3.492	4.526667	5.4
story 13	3.793	4.986667	5.857
story 14	4.094	5.446667	6.314
story 15	4.395	5.906667	6.771

Drift in G + 15

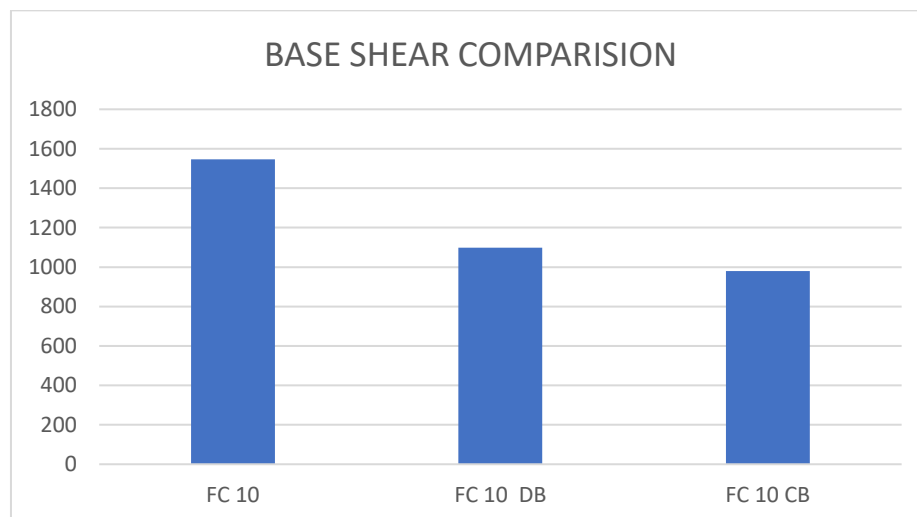


BASE SHEAR (*Force in KN)

Base shear in G +10

FC 10	1545.59
FC 10 DB	1098.04
FC 10 CB	980.33

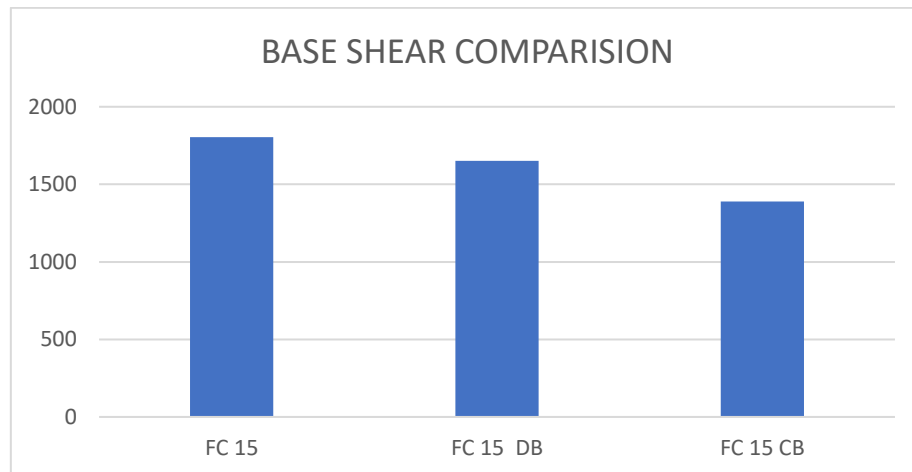
Base shear in G +10



Base shear G +15

FC 15	1804.43
FC 15 DB	1651.75
FC 15 CB	1389

Base Shear in G +15



3. CONCLUSION

Multi-story buildings in urban cities have been required to have column-free spaces due to lack of space, population density, and also aesthetic and functional requirements. For this, the buildings have floating columns on one or more floors. These floating columns are very disadvantageous in a building that is constructed in seismically active areas. The seismic forces that arise in the different floors of a building must be carried by the shortest possible path over the height to the ground. Any deviation or discontinuity in this load transfer route will result in poor building performance.

The behaviour of a building in the event of an earthquake depends fundamentally on its general shape, size, and geometry, as well as on the transfer of earthquake forces to the ground. Many open buildings intended for parking collapsed or were severely damaged in Gujarat during the 2001 Bhuj earthquake. In the case of tall buildings, the column is interrupted on the ground floor and the first floor to allow a greater opening on the ground floor. Low to facilitate access to the public area at the base.

This paper explores the seismic response of the building with floating column braced and unbraced frames and concludes that the building with cross bracing gives more lateral stability to the building since it distributes the load evenly to the structure and transfer the load to the ground. Where as in diagonally braced frame only brace members are observed to have stability where as highly unstable in other case.

4. REFERENCES

- [1] Akil Ahmed.(2016) "Dynamic Analysis of Multistorey RCC Building Frames". International Conference on Inter Disciplinary Research in Engineering and Technology (2016): 89-94. Print.
- [2] Bureau of Indian Standards: IS-875,Part 1, Dead loads on buildings and structures, New Delhi, India, 1987
- [3] Bureau of Indian Standards: IS-875,Part 1, Live loads on buildings and structures, New Delhi, India, 1987
- [4] Bureau of Indian Standards: IS-1893,Part 1, Criteria for earthquake resistant design of structures; Part 1, General provisions and Buildings, New Delhi, India, 2002
- [5] Criteria for Earthquake Resistant design of structures, Part1: General provisions and buildings, IS 1893:2002, Bureau of Indian Standards, New Delhi.
- [6] Duggal S K (2010), "Earthquake Resistance Design of Structure", Four Editions, Oxford University Press, New Delhi.
- [7] Er. Ashfi Rahma(2015) Effect of Floating Columns on Seismic Response of Multi-Store RC Framed Buildings International Journal of Engineering Research & Technology, Vol. 4 Issue 06, June-2015.
- [8] Gauav Kumar (2016) "Review on seismic analysis of rcc frame structures with floating columns." 3rd International conference on recent innovations in science engineering and management".
- [9] Isha Rohilla S.M. Gupta Babita Saini (2015) - Seismic response of multistory irregular building with floating column. International Journal of Research in Engineering & technology. Volume: 04 Issue: 03 | Mar-2015.
- [10] IS 875 (Part-I) Bureau of Indian Standards (1987) Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures: Dead Loads-Unit Weights of Building Materials and Stored Materials (Second Revision). UDC 624.042: 006.76.
- [11] IS 875 (Part-II) Bureau of Indian Standards (1987) Code of Practice for Design Loads For Buildings and

- Structures: Imposed Loads (Second Revision). UDC 624.042.3:006.76.
- [12] Ms. Priyanka D. Motghare,(2016) “Numerical Studies Of Rcc Frame With Different Position Of Floating Column”, Technical Research Organization India. Vol. 2, Issue-1, 2016,(ISSN 2395-7786)
 - [13] Ms.Waykule .S.B, Dr.C.P.Pise, Mr. C.M. Deshmukh, Mr.Y .P . Pawar, Mr S .S Kadam,Mr.D .D .Mohite, Ms.S.V. Lale,(2017), “Comparative Study of floating column of multi storey building by using software”, International Journal of Engineering Research and Application, Vol. 07, Issue 1,Pg. No. 3138, (ISSN 2248-9622)
 - [14] Prerna Nautical (2014)-Seismic response evaluation of Rc frame building with floating column considering different soil conditions, International Journal of Current Engineering and Technology, Vol.4, No.1.
 - [15] [15]Patyush Malaviya (2014) “Comparative study of effect of floating column on the cost analysis of a structure designed on staad pro v8i” International journal of scientific research and engineering research.
 - [16] Prabhakara R, Chethankumar N E, Atul Gopinath and Sanjith J. Experimental Investigations on Compression Behavior Parameters of NSC and SCC Intermediate RC Columns. International Journal of Civil Engineering and Technology (IJCIET), 6(8), 2015, pp. 100-117.
 - [17] Prince Kumar and Sandeep Nasier, an Analytic and Constructive Approach to Control Seismic Vibrations in Buildings.
 - [18] Prof. Keerthi gowda B.S, Mr. Syed Tajoddeen (2014) “Seismic Analysis of Multistory Building with Floating Columns”,1st annual conference on innovations and developments in civil engineering(19-20 May 2014), Pg. No. 528-535.
 - [19] Sharma R. K, Dr.Shelke N. L.(2016) “Dynamic Analysis of RCC Frame Structure with floating Column”, International Journal of Advanced Research in Science, Engineering and Technology.,Vol. 03, Issue 06, (ISSN 2350-0328)
 - [20] Sabari S (2015) “Seismic analysis of multistory building with floating column.” International journal of civil and structure engineering research.
 - [21] Shirule P.A (2012) “Time history analysis of base isolated multistory building”. International journal of earth science and engineering.
 - [22] Shiqli Roy (2015) “Behavioural studies of floating column on framed structure” International journal of research in engineering and technology.
 - [23] Shiqli Roy Agarwal Pankaj, Shrikhande Manish (2010), Earthquake resistant design of structures PHI learning private limited, New Delhi.
 - [24] Sreekanth Gandla Nanabala , Pradeep Kumar Ramancharla , Arunakanthi E, Seismic Analysis of A Normal Building Floating Column Building, International Journal of Engineering Research & Technology (IJERT),ISSN: 2278-0181Vol. 3 Issue 9, September- 2015.
 - [25] Sampath Kumar M.P , V.S.Jagadeesh , ” Effect Of Floating Columns On Seismic Response Of Multistory Building” International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 09 | Sep -2016
 - [26] Singh J and Kapoor K 2019 Seismic analysis of multistoried buildings with floating columns International Journal for Research in Applied Science & Engineering Technology
 - [27] Sasidhar T, P Sai Avinash and N Janardan 2017 Analysis of multi-storeyed building with and without floating column using Etabs International Journal of Civil Engineering and Technology 8 pp 91–98
 - [28] Shashikumar N S, Dr M Rame Gowda, Ashwini B T and Vijay Kumar Y M 2018 Seismic performance of braced framed structure with floating column The International Journal of Scientific Development and Research 3
 - [29] Sreadha A R, C Pany 2020 Seismic Study of Multistorey Building using Floating Column International Journal of Emerging Science and Engineering 6 pp 6-11
 - [30] Yamini Vyas, J.N. 2021 Vyas Seismic Response of Multistorey Building with Floating Column: A Review International Journal of Research Publication and Reviews 1 pp 14-18
 - [31] Building Under Seismic Load”, ISSN: 2348-4098 VOLUME 2 ISSUE 6 AUGUST 2014.
 - [32] Y. Singh and Phani Gade “Seismic Behavior of Buildings Located on Slopes” - An Analytical Study and Some Observations from Sikkim Earthquake of September 18, 2011. 15th World Conference on Earthquake Engineering Journal 2012.