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

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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 stilt 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 baseearth 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 PΔ, 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 + 4 & G +7 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

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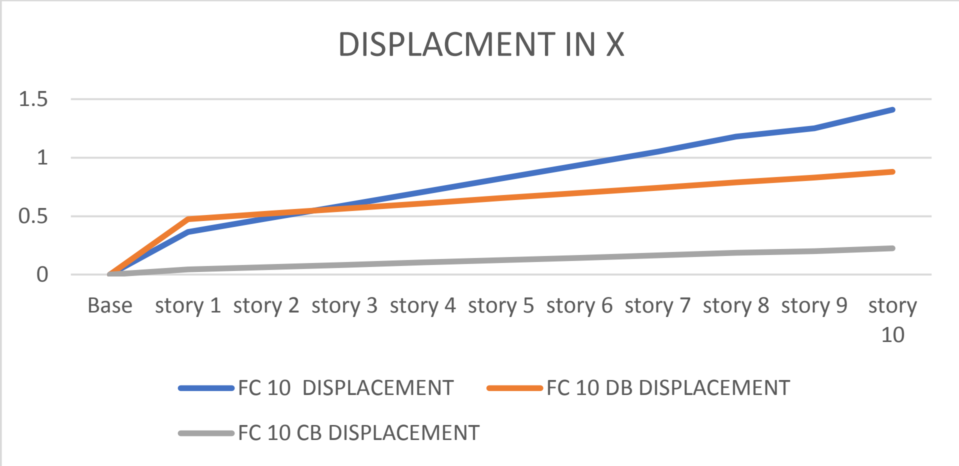
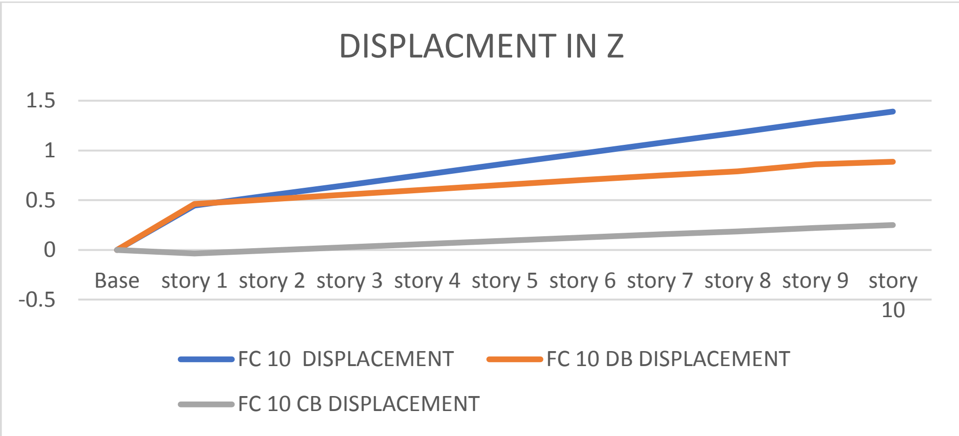
Displacement in X G + 10



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

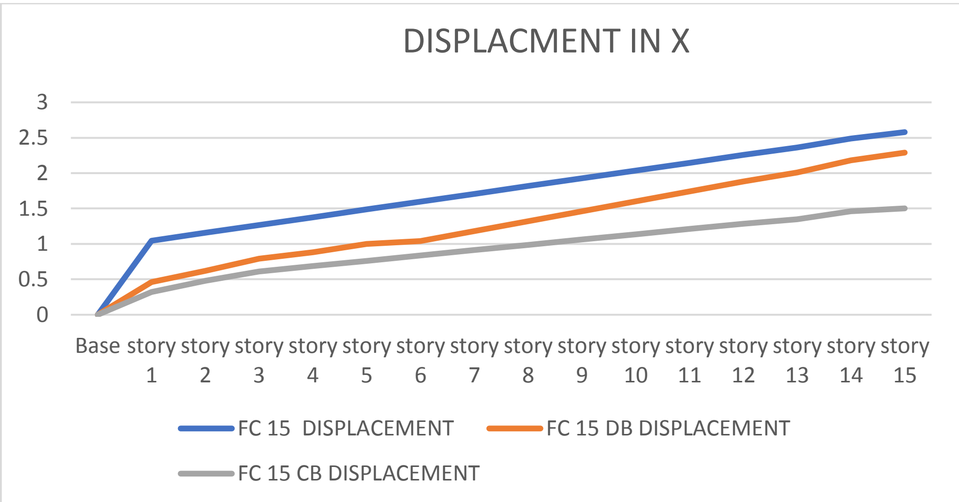


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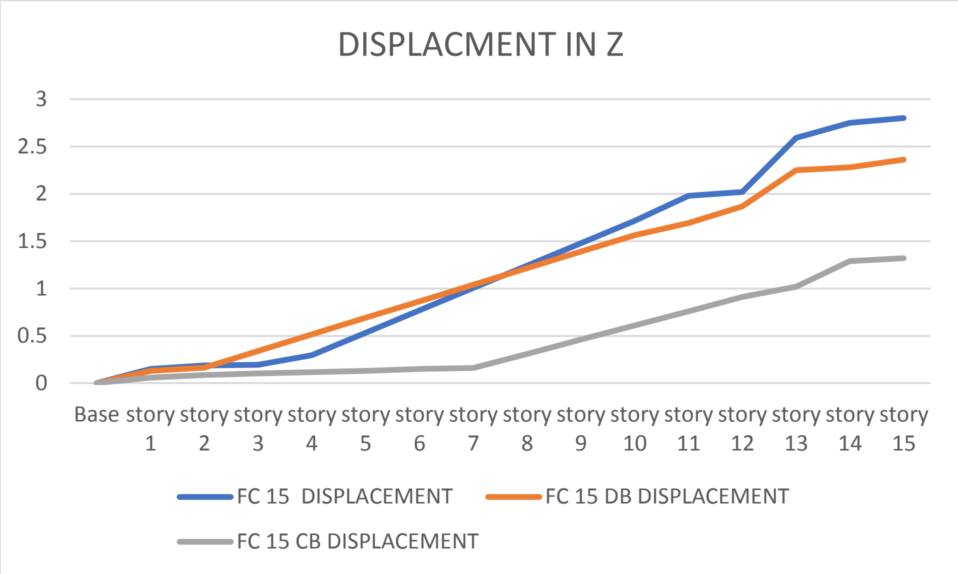
Figure 1 Displacement in z for G + 15

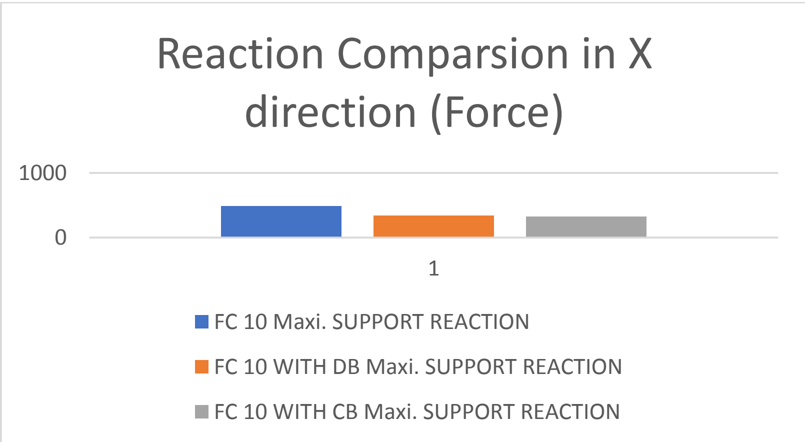


Comparison Of Reaction (Force) In X And Z Direction

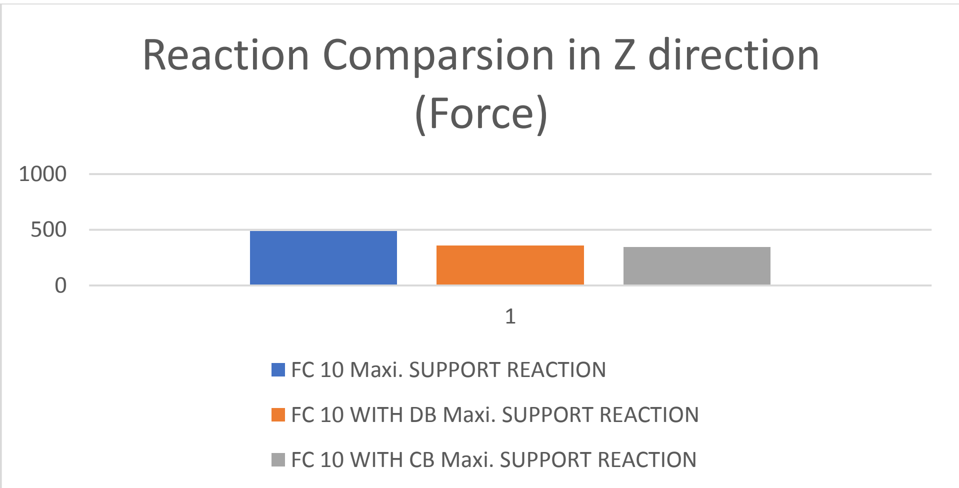
Force in G + 10

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



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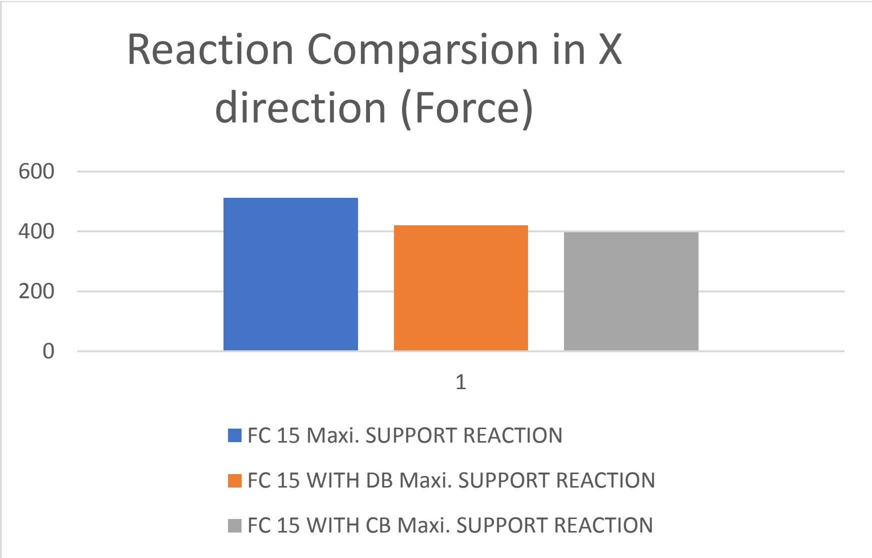
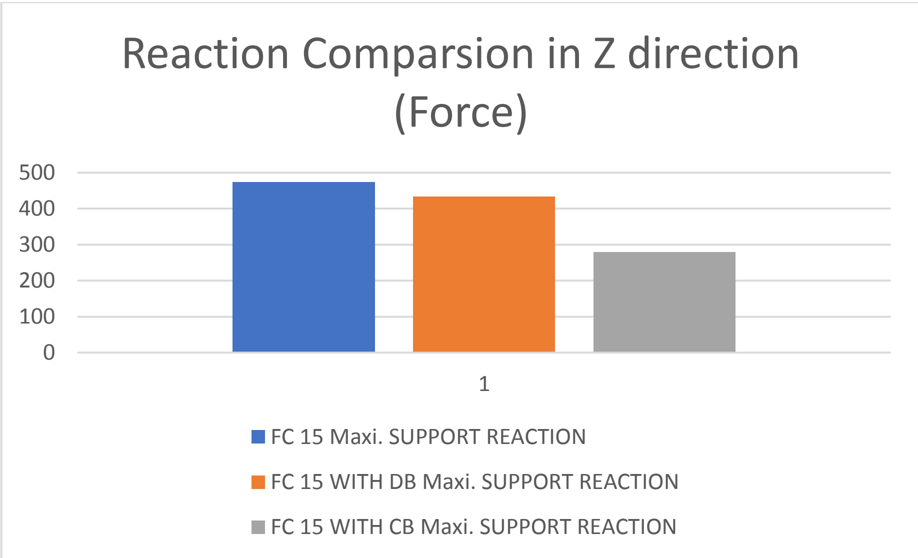
Force in G + 15

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



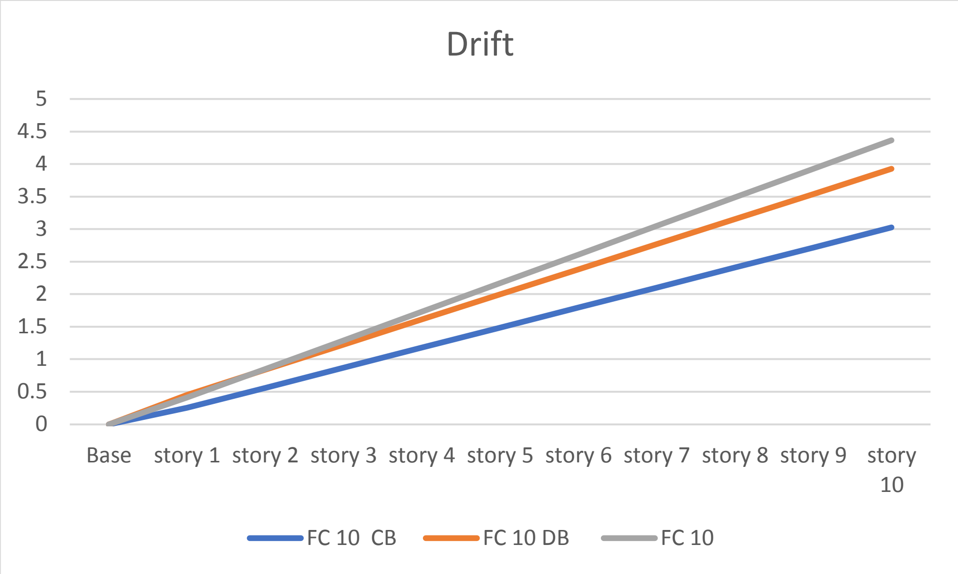


Comparison Of Drift

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

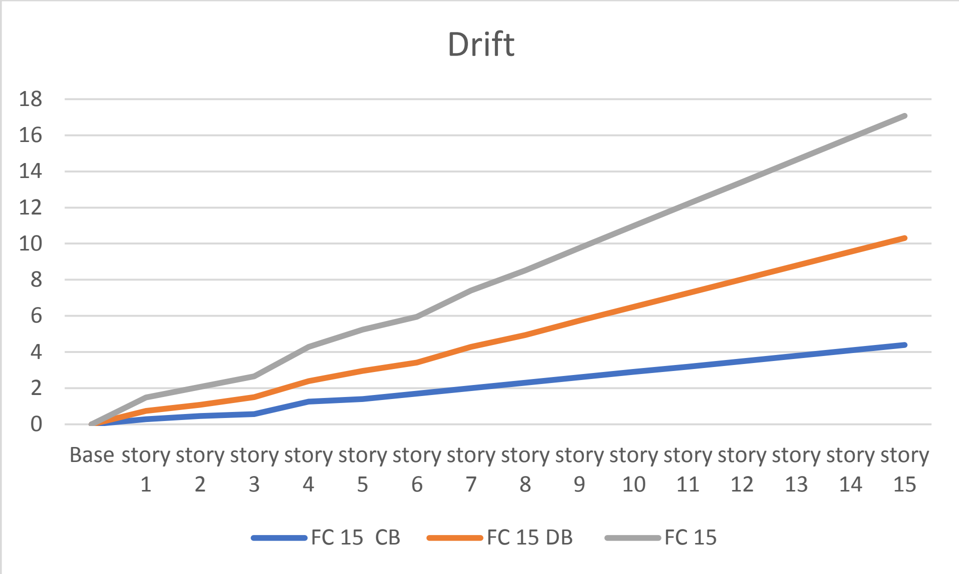
story 7	2.101	2.7683	3.0485
story 8	2.409	3.1542	3.4882
story 9	2.717	3.5401	3.9279
story 10	3.025	3.926	4.3676



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

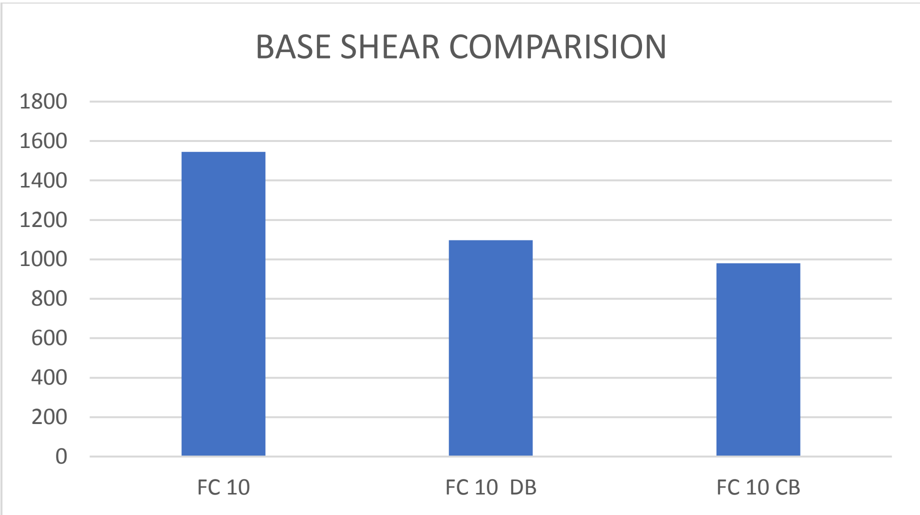


BASE SHEAR (*Force in KN)

Base shear in G +10

FC 10	1545.59
FC 10 DB	1098.04
FC 10 CB	980.33

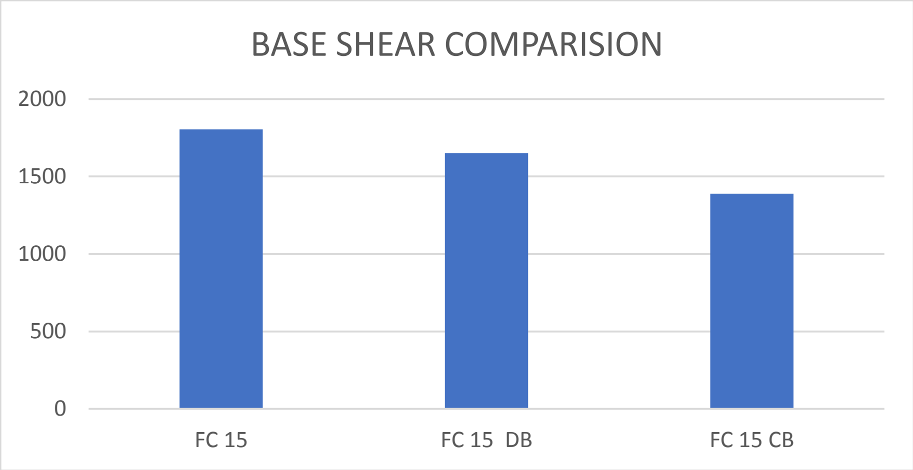
Base shear in G +10



Base shear G +15

FC 15	1804.43
FC 15 DB	1651.75
FC 15 CB	1389

Figure 2 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.

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