IARJSET

ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁘ Impact Factor 8.066 ⁘ Peer-reviewed / Refereed journal ⁘ Vol. 10, Issue 9, September 2023

DOI: 10.17148/IARJSET.2023.10912

Comparative Seismic Analysis of RC Frame Structure with Floating Column and Lateral Load Resisting System

Snehal S. kalunge[1], Prof. S. P. Nirkhe[2]

PG student, Department of Civil Engineering, Deogiri Institute of Engineering and Management Studies, Aurangabad, Maharashtra, India[1]

Assistant Professor, Department of Civil Engineering, Deogiri Institute of Engineering and Management Studies, Aurangabad, Maharashtra, India[2]

Abstract: One of the causes of a structure's reduced capacity is a column that is discontinuous and is known as a floating or hanging column. It is frequently added to buildings either as result of customer requests or poor planning, making them more vulnerable during earthquakes. To increase the capacity or strength of such type of structures, lateral load resisting systems such as concrete bracing, shear wall, moment frames, dampers, etc are introduced in structures. The main purpose of the current study is to check which structure is more stable in seismic zone IV by comparing the results obtained by response spectrum analysis of three considered structures using ETABS software. By comparing all the result parameters such as displacement, storey drift, base shear, time period and storey stiffness, it can be concluded that the floating column structure with shear wall is more resistant to seismic activities.

Keywords: Floating column, bracing, shear wall, response spectrum method, displacement, storey drift, base shear, time period, storey stiffness.

I. INTRODUCTION

Seismic analysis of a structure with floating columns and lateral force-resisting systems involves evaluating the building's response to earthquake forces considering the unique characteristics of floating columns and the chosen lateral force-resisting system. The analysis aims to ensure that the structure can safely withstand seismic loads and meet the necessary design requirements.

Any structure that is hit by an earthquake wave at its base or foundation will naturally respond to the ground motion. It has been noted that the structure typically responds to ground motion more strongly. The term "dynamic amplification" refers to this enhanced structure response caused by an earthquake wave as contrasted to the ground. The dynamic amplification is influenced by the structure's technical characteristics, such as the natural period of vibration, dampening, type of foundation, and structural detailing. The response spectrum approach can be used to study this dynamic response. Unlike static analysis, dynamic analysis demonstrates the structure's actual behaviour. The equivalent static analysis method is effective for low- to medium-rise, regular, simple buildings.

Types of Seismic Analysis:

Different techniques are used for seismic analysis of structures depending on linearity and nonlinearity, and the following techniques are listed below:

- Equivalent static analysis (linear static)
- Response spectrum analysis (linear dynamic)
- Pushover analysis (non-linear static)
- Time history analysis (non-linear dynamic)

Lateral Force Resisting Systems:

Structures with lateral force-resisting systems (LFRS) are made to withstand lateral loads brought on by natural disasters like earthquakes and wind. These systems are essential for giving buildings and other structures stability and stopping their collapse from horizontal forces. The appropriate lateral force-resisting system should be chosen based on the building's height, location, occupancy, and anticipated lateral load intensity.

Typical lateral force-resisting systems are as follows:

- Shear walls
- Moment frames
- Braced frames
- Duel systems
- Steel eccentrically braced frames
- Concrete filled steel tube columns
- Special structural walls
- Diaphragms

Here We Are Studying Shear Wall and Braced Frames.

1. Shear Wall:

A shear wall is a vertical structural component of a building that is intended to withstand lateral forces brought on by lateral loads such as seismic loads, wind loads, or other forces. During earthquakes and violent winds, these walls are crucial for providing stability and minimizing lateral displacements.

2. Bracings:

Bracings are diagonal or vertical structural components that are used to increase lateral stability and resistance against horizontal forces, such as those produced on by earthquakes or wind loads, in the context of building construction and structural engineering.

Bracings are designed to act primarily in tension and compression to counteract the lateral forces that try to push or pull the building horizontally. By helping in the distribution and dissipation of these forces, they serve to prevent excessive lateral deflection and guarantee that the structure can sustain the imposed loads without suffering serious harm or failure.

2.1 Different types of Bracings:

Bracings typically consist of a diagonal member that joins the midpoint of the span or length of a beam or column or the junction of the beam and a column. The first is eccentric, and the second is concentric.

- Diagonal Bracing: These are compression as well as tension type bracings. It consists of a single brace instead of two as in case of X - bracing.
- V–Bracing: Also called as chevron bracings. Here the braces intersect at the midpoint of the beam.
- Inverted V–Bracing: These are also inverted chevron or have the shape of alphabet V.
- X–Bracing: These are the commonly used bracing systems. Here the diagonals intersect each other to form alphabet X.
- K–Bracing: K-braces connect to the columns at mid-height. K-bracing is generally discouraged in seismic regions because of the potential for column failure if the compression brace buckles.

II. LITERATURE REVIEW

Subhashini. L, Dr. Subhash Chandra Bose R, Shiva Shankar K M, Pallavi H J (2022), Compared the displacement, storey drift and base shear of three models one structure with floating column another structure with floating column and braced system and the last structure with floating column with shear wall in zone 3, 4, 5. The analysis was done by response spectrum method. The results show that the building with a bracing and shear wall experiences less story displacement and drift than the building with a floating column. It demonstrates that, when compared to zone 3, the building experiences base shear that is 17% higher in zone 4 and 40% higher in zone 5. It demonstrates that when compared to a floating column building, a floating column building with a shear wall experiences base shear that is 5.3% greater, and a floating column building with bracings experiences base shear that is 0.5% greater. The study came to the conclusion that floating column buildings with shear walls are more efficient than floating column buildings with bracings or floating column buildings after analyzing all of this. [1]

Mohd Sharooq Shaik, (2018). This study's primary goal is to demonstrate the impacts of floating columns in reinforced concrete buildings subjected to seismic stresses. Push over analysis and static linear analysis are used for this. Point displacement, storey drift, storey shear, base shear, performance level, hinge status, and pushover curve are among the elements that are taken into account. Using the analysis tool ETAB2016, three models with G+ 10 storeys are taken

DOI: 10.17148/IARJSET.2023.10912

into consideration in order achieve this target. According to the results of story shear and story drift, it appears that when building weight or mass grows, the corresponding results for the total height of the building drop, while story displacement increases. [2]

Keerthi Gowda B. S and Syed Tajoddeen (2014), the present investigation examines at the negative impact of floating columns in buildings. For multi-story RC buildings with and without floating columns, models of the frame are created in order to compare structural parameters such natural period, base shear, and horizontal displacement under seismic excitation. According to the results, lateral bracing should be used as a substitute method to lessen lateral deformation. After adding lateral bracing, the RC building with floating column is assessed. Response spectrum analysis (RSA) is carried out taking into account three models (without floating columns, with floating columns, and floating columns with bracings) for the main purpose of this study to assess seismic performance of the RC building with floating columns and seismic performance of the RC building with floating columns after providing lateral bracings.[3]

N. Lingeshwaran, Surya Kranthi Nadimpalli, Kolla Sailaja, Shaik Sameeruddin, Y. Himath Kumar, Sateesh Babu Madavarapu (2021), the article discusses the importance of floating column and the presence of a shear wall in community buildings. The stiffness balancing of the storey 1 and above storeys is another alternative approach that is believed to reduce the irregularities in the structure of the proposed building. Time history analysis has finished the current task of dynamic analysis of G + 9 multi-storeyed RCC building taken into account for Bhuj Earthquake of January 26, 2001. With the use of the ETABS (18.0.2) programming, reaction range examination and all seismic reactions to local area buildings are significantly evaluated and demonstrated. For a study of both the building with the floating column present and the building without the floating column, the floor displacement, base shear, and inter-storey drift are measured. In this investigation, they took into account three different scenarios, and to compare the results from the Time History technique and Response Spectrum approach. [4]

Dharanya A, Gayathri S, Deepika M (2017), A G+4 storey residential RC building with soft storey has to be analysed with cross bracings and shear wall. Using ETABS software, this study was conducted in accordance with IS 1893:2002 codal provisions. Cross bracings, such as X bracing, must be installed at the column's outer perimeter, and shear walls must be installed at each building's corner. Using the ETABS program, the equivalent stiffness approach is used to analyze the building model. Lateral displacement, base shear, storey drift, axial force, shear force, and time period are the primary factors that are compared. The conclusion drawn from the research is that shear walls could increase the lateral stability of the building more so than bracings. [5]

III. OBJECTIVES

1. Comparing the seismic performance of three structural systems, one with floating columns and the other two with a conventional lateral force-resisting system
2. To ensure the safety of the structures and their occupants during seismic events is the primary goal of the comparative seismic analysis.
3. To analyze how a structure behaves with a floating column, structure with lateral force resisting system (bracing and shear wall).
4. To compare the parameters such as displacement, storey drift, base shear, time period and storey stiffness of three considered structures.

IV. METHODOLOGY

The methodology used to carry out comparative linear dynamic analysis of RC structure with floating column and lateral load resisting system. The structures were designed
for seismic analysis in zone IV, the high seismic zone.
For achieving the objectives of the given research, following methodology is adopted –

- Three symmetric models are considered for analysis:

1. RC structure with floating column.
2. RC structure with floating column and braced system.
3. RC structure with floating column and shear wall.

- The height of the frames is 63m having G+20 storey.
- The frame is considered to be in zone IV having medium soil condition.
- The value of Importance Factor is considered to be 1.2.
- Structure is analyzed as per IS1893-2016 part IS code.
- Performance based evaluation is carried out using Response Spectrum Method

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

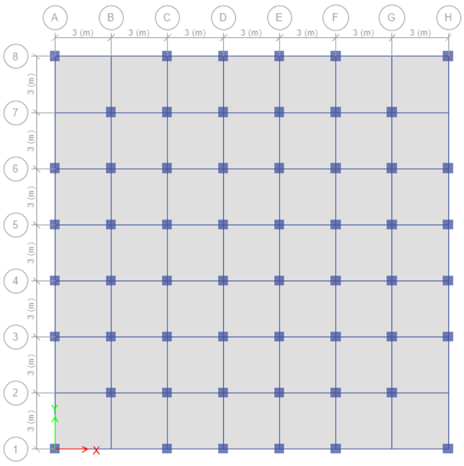
ISO 3297:2007 Certified ⁚⁚ Impact Factor 8.066 ⁚⁚ Peer-reviewed / Refereed journal ⁚⁚ Vol. 10, Issue 9, September 2023

DOI: 10.17148/IARJSET.2023.10912

- The soil structure interaction effects are not taken into account. The column bases are assumed to be fixed.
- Symmetric models of RC framed buildings are prepared and Response Spectrum is carried out in ETABS (2017)

Following are the plan elevation and 3D elevations of considered models:

1. Floating column structure a bare frame-



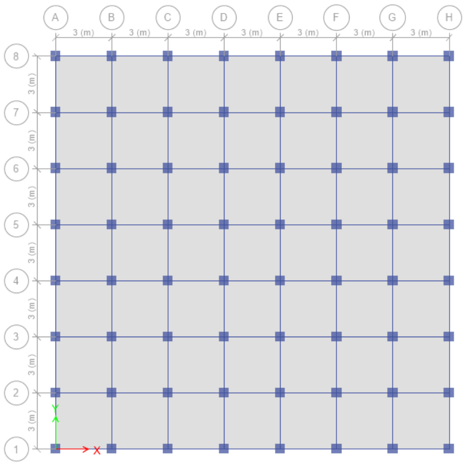
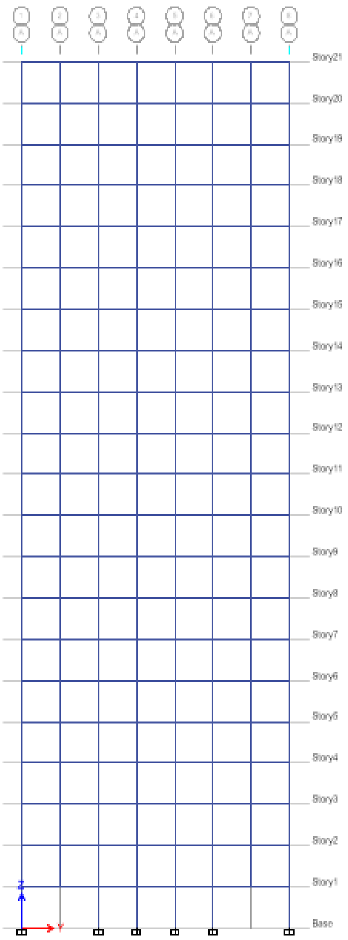


Fig.1.1 (a) Plan of storey 1 (b) Plan of storey 2 and above



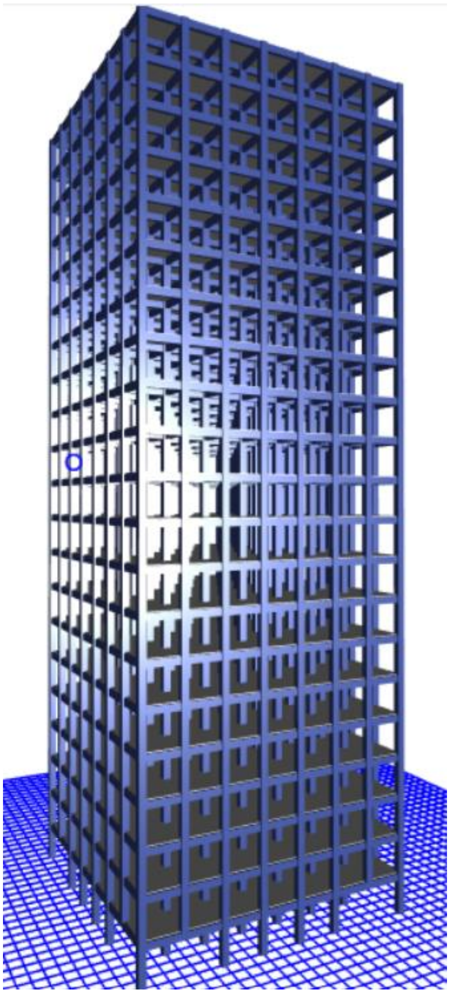


Fig.1.1 (c) Elevation (d) 3D model

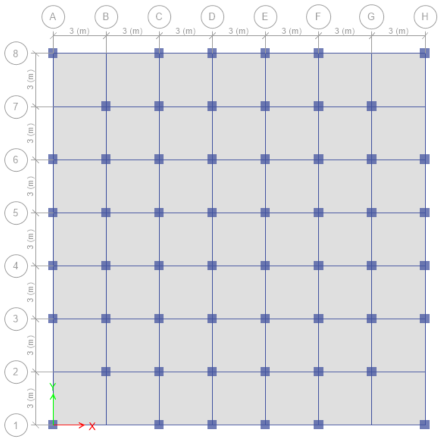
IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 8.066 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 10, Issue 9, September 2023

DOI: 10.17148/IARJSET.2023.10912

2. Floating column structure with bracing system-



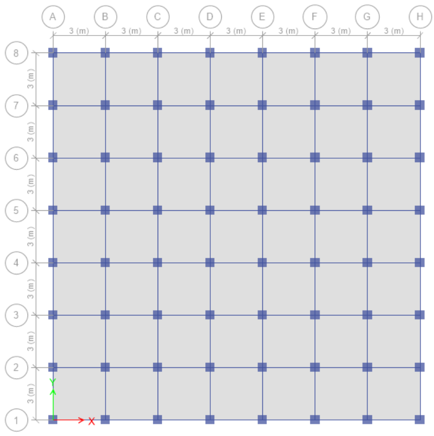
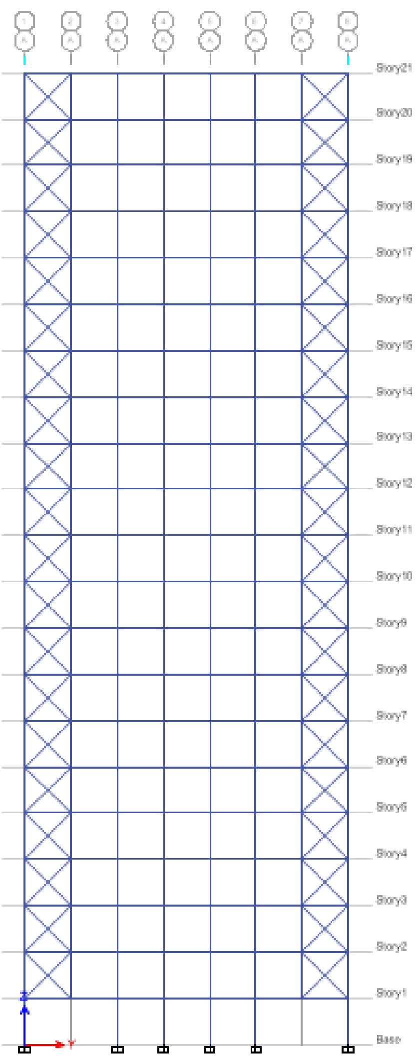


Fig.2.1 (a) Plan of storey 1 (b) Plan of storey 2 and above



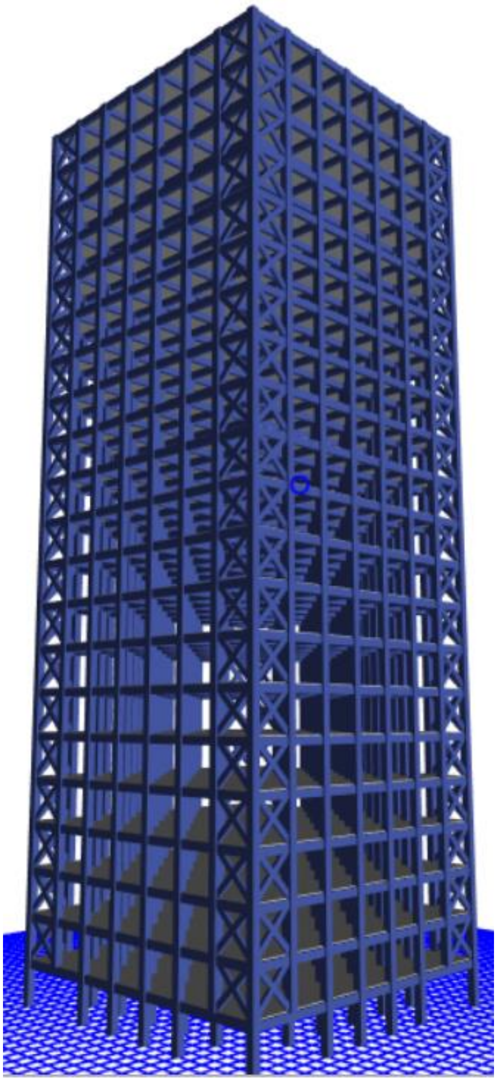


Fig.2.1 (c) Elevation (d) 3D elevation

IARJSET

ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁘ Impact Factor 8.066 ⁘ Peer-reviewed / Refereed journal ⁘ Vol. 10, Issue 9, September 2023

DOI: 10.17148/IARJSET.2023.10912

3. Floating column structure with shear wall-

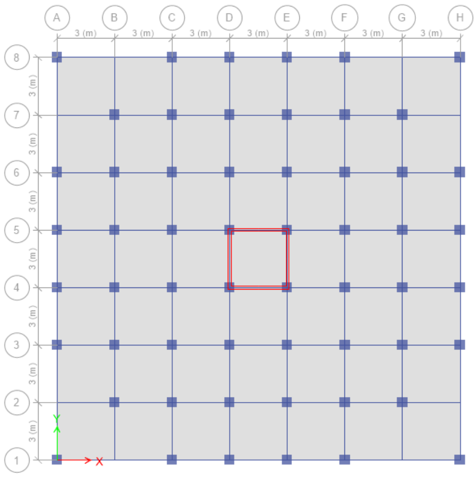
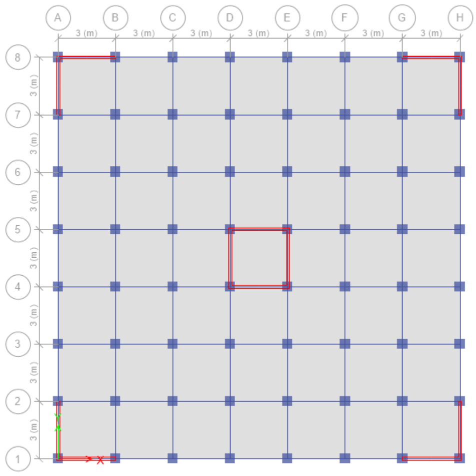


Fig.3.1 (a) Plan of storey 1



(b) Plan of storey 2 and above

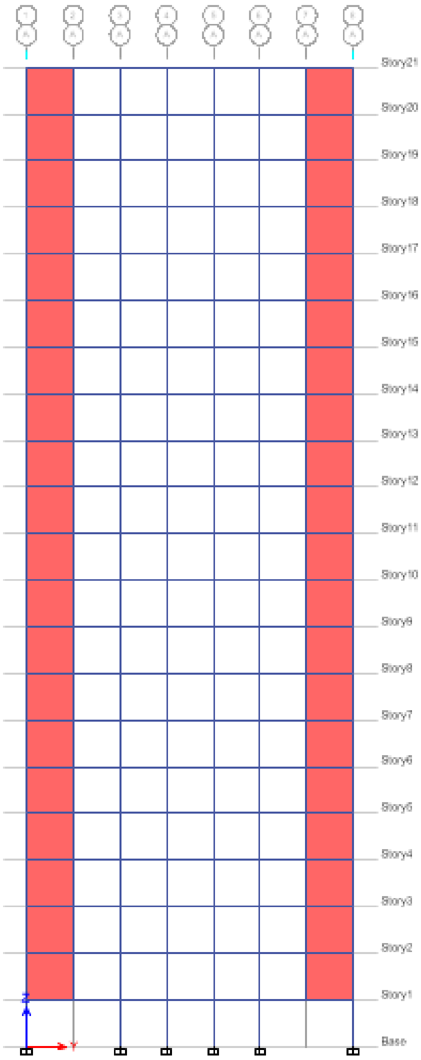
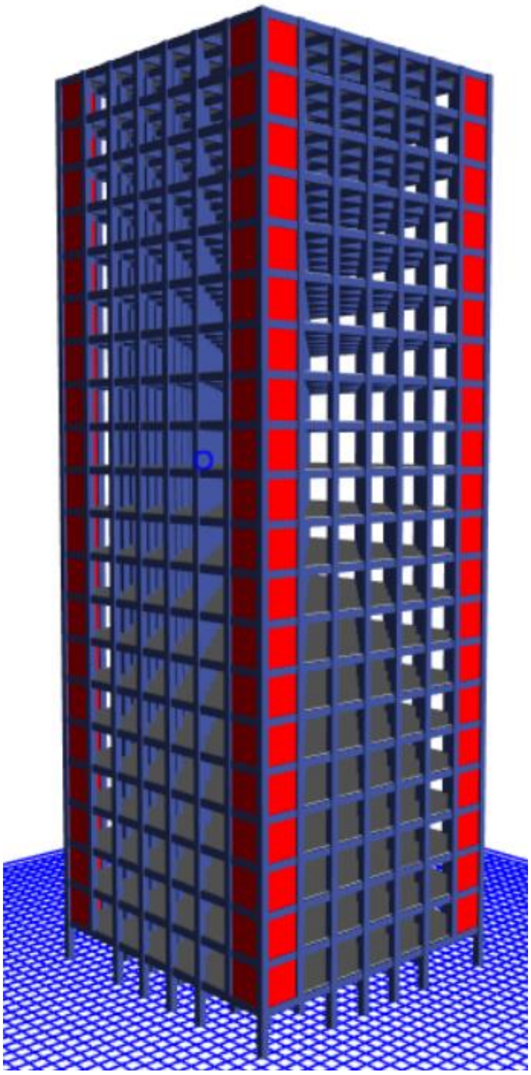


Fig.3.1 (c) Elevation



(d) 3D elevation

IARJSET

ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁘ Impact Factor 8.066 ⁘ Peer-reviewed / Refereed journal ⁘ Vol. 10, Issue 9, September 2023

DOI: 10.17148/IARJSET.2023.10912

V. RESULTS AND DISCUSSION

A brief discussion of results obtained from ETABS (2017) software used for evaluation of response spectrum analysis of considered structures is as follows:

The parameters taken for the comparison are:-
As the considered structure is symmetric, all the results in X and Y direction are same.

1. **Displacement:**

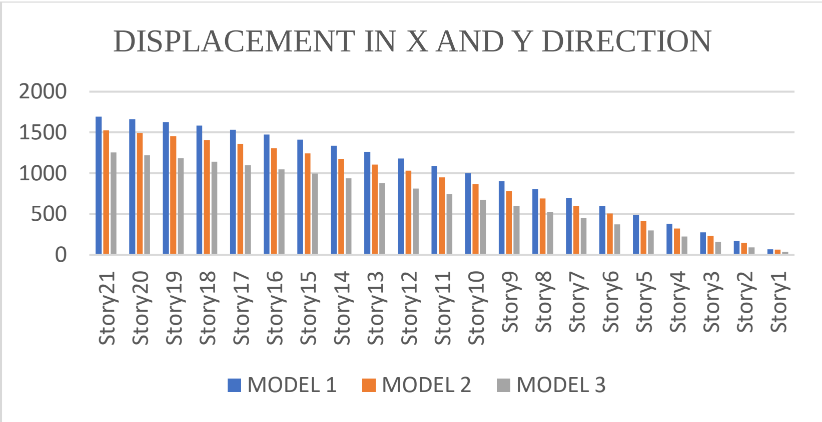


Fig.5.1 Storey vs Maximum displacement in X and Y direction.

From the response spectrum graph of displacement the maximum displacement of model 1 is 1692.087 mm, model 2 is 1522.369 mm and of model 3 is 1254.156mm. It can be conclude from these values that the floating column structure with shear wall experiences lesser displacement than floating column structure and floating column structure with bracing.

2. **Storey drift:**

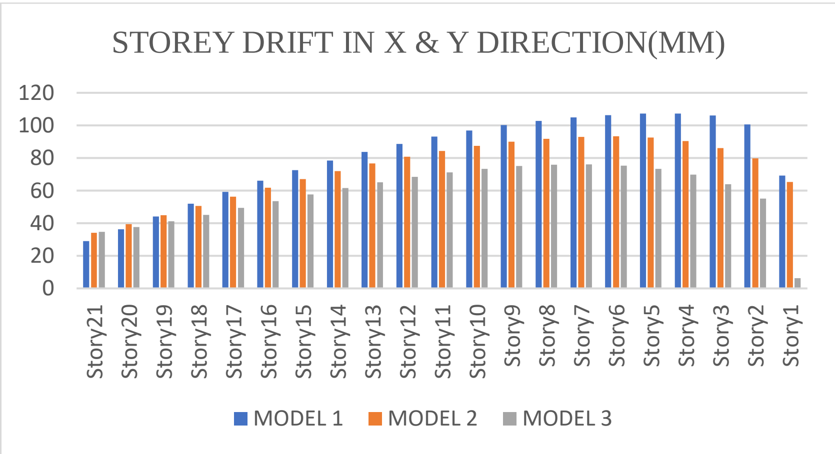


Fig.5.2 Storey vs Maximum storey drift in X and Y direction.

From the response spectrum graph of storey drift the maximum drift of model 1 is 107.228 mm, model 2 is 93.356mm and of model 3 is 76.136mm. It can be conclude from these values that the floating column structure with shear wall experiences lesser drift than floating column structure and floating column structure with bracing.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 8.066 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 10, Issue 9, September 2023

DOI: 10.17148/IARJSET.2023.10912

3. **Base shear:**

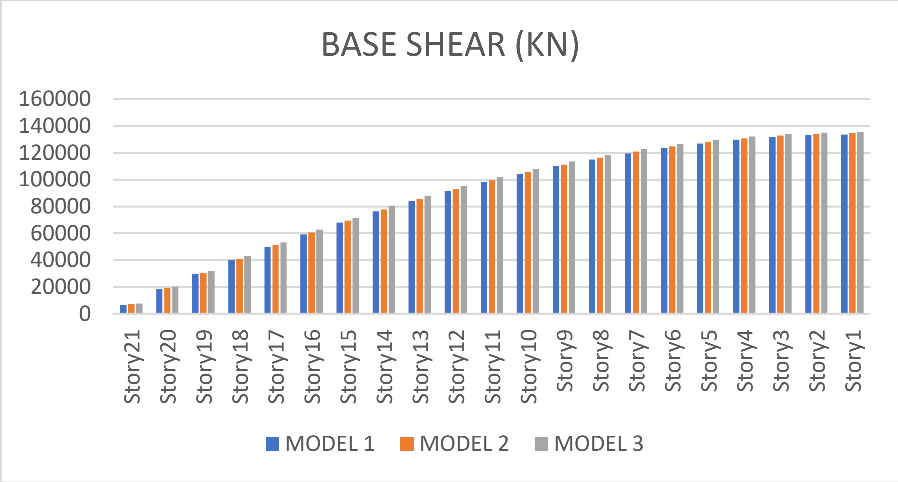


Fig.5.3 Storey vs. Maximum base shear in X and Y direction.

From the response spectrum graph of base shear the maximum base shear of model 1 is `33613.753 KN, model 2 is 134732.463 KN and of model 3 is 135480.69 KN.

It can be conclude from these values that the floating column structure with shear wall experiences more base shear than floating column structure and floating column structure with bracing.

4. **Time period:**

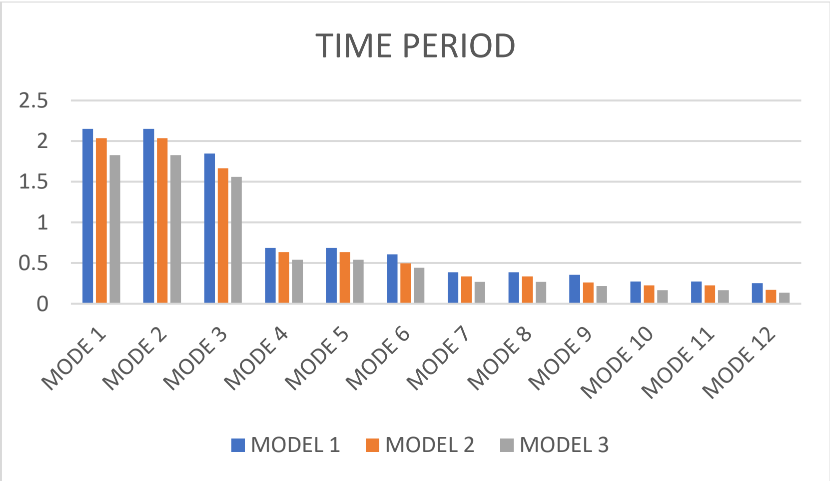


Fig.5.4 Mode vs Time period

From the response spectrum graph of time period the maximum time period of model 1 is `2.15 sec, model 2 is 2.036 sec and of model 3 is 1.827sec.

It can be conclude from these values that the floating column structure takes more time to complete one oscillation than the floating column structure with bracing and floating column structure with shear wall.

DOI: 10.17148/IARJSET.2023.10912

5. **Storey stiffness:**

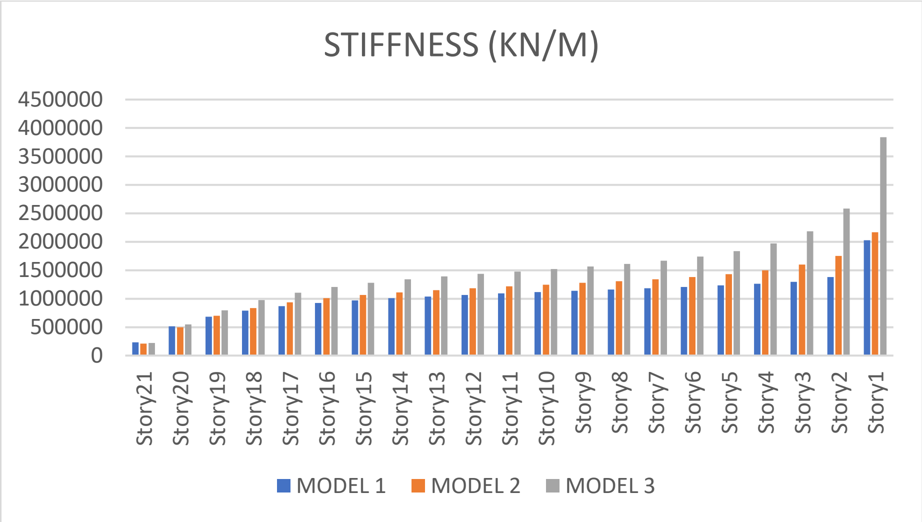


Fig.5.5 Storey vs Maximum stiffness in X and Y direction.

From the response spectrum graph of stiffness the maximum stiffness of model 1 is `2025318.298 KN/m, model 2 is 2167337.858 KN/m and of model 3 is 3840039.259 KN/m. It can be conclude from these values that the floating column structure with shear wall experiences more stiffness than floating column structure and floating column structure with bracing.

VI. CONCLUSION

1. Displacement:
   - According to the results, The building with the floating column experiences more displacement than the building with the bracing and shear wall.
   - The outcome indicates that the floating column structure with bracing experiences 9% less displacement and structure with shear wall experiences 26% less displacement than bare frame structure or floating column structure.

2. Storey drift:
   - The building with the floating column experiences more storey drift than the building with the bracing and shear wall.
   - According to outcomes, the floating column structure with bracing experiences 13% less storey drift and structure with shear wall experiences 29% less storey drift than bare frame structure or floating column structure.

3. Base shear:
   - The building with the floating column experiences less base shear than the building with the bracing and shear wall.
   - The floating column structure with bracing experiences 0.8% more storey drift and structure with shear wall experiences 1.3% more storey drift than bare frame structure.

4. Time period:
   - The building with the floating column experiences more time period than the building with the bracing and shear wall.
   - The floating column structure with bracing experiences 5.3% less time period and structure with shear wall experiences 15% less time period than bare frame structure.

5. Storey stiffness:
   - The building with the floating column experiences less storey stiffness than the building with the bracing and shear wall.
   - The floating column structure with bracing experiences 7% more storey stiffness and structure with shear wall experiences 89% more storey stiffness than bare frame structure.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⵋ Impact Factor 8.066 ⵋ Peer-reviewed / Refereed journal ⵋ Vol. 10, Issue 9, September 2023

DOI: 10.17148/IARJSET.2023.10912

REFERENCES

[1]. Subhashini. L, Dr. Subhash Chandra Bose R, Shiva Shankar K M, Pallavi H J (2022), "Seismic Analysis of Multistorey Floating Column Building with Lateral Load Resisting System", International Journal for Research in Applied Science & Engineering Technology (IJRASET).

[2]. Mohd Sharooq Shaik, (2018), "Comparative Seismic Study of Floating Column & Lateral Resisting System on RC Frame Building", International Journal of Research in Advent Technology.

[3]. Keerthi Gowda B. S and Syed Tajoddeen, (2014), "Seismic Analysis Of Multistorey Building With Floating Columns", Annual Conference On Innovations And Development In Civil Engineering (ACIDIC).

[4]. N. Lingeshwaran, Surya Kranthi Nadimpalli, KollaSailaja, Shaik Sameeruddin, Y. Himath Kumar, Sateesh Babu Madavarapu (2021), "A study on seismic analysis of high-rise building with and without floating columns and shear wall", Sciencedirect.

[5]. Dharanya A, Gayathri S, Deepika M (2017), "Comparison Study of Shear Wall and Bracings under Seismic Loading in Multi- Storey Residential Building", International Journal of ChemTech Research.

[6]. Rishi Mishra , Dr. Abhay Sharma, Dr. Vivek Garg (2014), "Analysis of RC Building Frames for Seismic Forces Using Different Types of Bracing Systems", International Journal of Engineering Research & Technology (IJERT).

[7]. Syed Muhammad Bilal Haider, Zafarullah Nizamani1, and Chun Chieh Yip (2018), "Behavioural Study of Shear Wall with Correlational to Bracing under Seismic Loading", E3S Web of Conferences.

[8]. Pallavi G. A, Nagaraja C (2017), "Comparative Study of Seismic Analysis of Multistoried Building with Shear Wall and Bracings", International Journal of Research in Engineering and Technology.

[9]. Hiba C K, Basith Ali K K, Anaswara Dileep K V, Arunima Satheesh M S (2021), "Effect of Bracing on Seismic Performance of Multi-storeyed Building Frames with Floating Columns", International Journal of Engineering Research & Technology (IJERT).

[10]. Boria Anya, Tamal Ghosh (2021), "A Study on Effect of Shear Wall in Seismic Analysis of Building", IOP Publishing.

[11]. K N Jeevan Kumar, Sabyath P Shetty (2020), "Behaviour of Multi-Storey R.C.C Structure with Different Types of Bracing against Earthquake Forces", International Journal of Engineering Research & Technology (IJERT).

[12]. Kirankumar Gaddad, Vinayak Vijapur (2018), "Comparative Study Of Multi Storey Building With And Without Floating Columns And Shear Walls", International Journal Of Engineering Research & Technology (IRJET).

[13]. Mohd Atif, Prof. Laxmikant Vairagade, Vikrant Nair (2015), "Comparative Study on Seismic Analysis of Multistorey Building Stiffened With Bracing and Shear Wall", International Research Journal of Engineering and Technology (IRJET).

[14]. Divya C. Bhuta, Umang Pareekh (2016), "Comparative Study On Lateral Load Resisting System In Tall Building", International Journal Of Science Technology & Engineering (IJSTE).

[15]. Isha Rohilla, S.M. Gupta, Babita Saini (2015), "Seismic Response Of Multi-Storey Irregular Building With Floating Column", International Research Journal Of Engineering And Technology (IRJET).

[16]. Umesh R. Biradar, Shivaraj Mangalgi (2014), "Seismic Response Of Reinforced Concrete Structure By Using Different Bracing Systems", International Research Journal Of Engineering And Technology (IRJET).

[17]. Sachin Kulkarni, Yogeendra. R. H. G (2015), "Seismic Evaluation and Comparision of Plan Irregular and Plan Irregular Soft Storey Building with Cross Bracing and Shear Wall System", International Journal of Engineering Research & Science (IJOER).

[18]. S.R. Thorat and P.J. Salunke (2014), "Seismic Behaviour of Multistorey Shear Wall Frame versus Braced Concrete Frames", International Journal of Advanced Mechanical Engineering.

[19]. Kulkarni J. G.1, Kore P. N.2, Tanawade S. B.(2013), "Seismic Response Of Reinforced Concrete Braced Frames", International Journal of Engineering Research and Applications (IJERA).

[20]. Kuldeep Singh Bhadoriya , Sourabh Dashore , Nikita Thora (2021), "Seismic Analysis Of Multi-Storey Building With Shear Wall And With And Without Floating Column Using Stadd Pro Software", International Research Journal Of Modernization In Engineering Technology And Science.(IRJMETS).

[21]. R. Harugoppa, S.M. Muranal (2019), "Design requirement for floating column under seismic forces", Pacific Conference on Earthquake Engineering and Annual NZSEE Conference.

[22]. M. Y. Laissy (2022), "Effect of Different Types of Bracing System and Shear Wall on the Seismic Response of RC Buildings Resting on Sloped Terrain", Civil Engineering Journal.

