Comparative Study on Effect of Different Bracing Systems in RCC Structure(G+12) in Seismic Zone Iii, Zone IV And Zone V

Gundagi Mujahid Abdul Jabbar
Dept of Civil Engineering
Secab Institute Of Engineering And Technology, Vijayapur Affiliated To Vtu, Belgaum

Abstract- *Bracing is the best and effective method to make any structure stiff and rigid, which will ultimately make the structure resistant to seismic loads. In this project, a conventional RCC structure is compared to different braced structures namely eccentric forward and backward bracings, X bracings, V bracings and Inverted V bracings in Seismic Zone III, Zone IV and Zone V.*

The structure on which the analysis is carried out is an RCC composite structure G+12 multi-storied commercial complex. Modelling and analysis of this structure is carried out in ETABS 2019 software. Parameters such as displacements, story drift, base shear, stiffness and Fundamental time period are compared to conventional RCC structure to get results and conclusions. The analysis is carried out in ETABS 2019 software by Response Spectrum Method.

Keywords- Reinforced Cement Concrete, Maximum Story Drift, Maximum Base Shear, Fundamental time period, frequency and Stiffness.

I. INTRODUCTION

Structures are usually constructed out of Reinforced Cement Concrete or/and steel sections. Concrete can be made excellent in terms of properties by using less water content, adding admixtures, using high strength cement, using good quality aggregates and proper curing. Such concrete excels some incredible properties one of which is high compressive strength. As this property plays a vital role for design of huge structures. However, concrete is very weak in tension. Hence, concrete is reinforced with steel reinforcements that add to tensile strength of concrete making concrete suitable for construction of flexural members of the structure. Steel reinforcement helps to bind the tensile part of the structure keeping the structure safe and avoiding any failure in near future.

The structure made of concrete is usually prone to damage due to high seismic waves. High seismic loads may lead to structural damage and can cause any fatality to the users. However, if we add steel sections to the structure to add some more stiffness which will reduce horizontal movements of the structure due to horizontal loads, the structure can be saved from damage due to seismic waves. Structure made up of RCC as well as steel (Rolled) sections is called as composite structure.

Steel sections if used as braces adds up to the structure's stiffness as well as rigidity. Steel sections have good resistant to the dynamic loads. However, connection between the steel section and RCC structure is not that rigid but with use of bolting it can be made rigid enough to hold each other. Braces can be aligned in various pattern to the structure. They can be categorized as:

1.X Braced
2.V Braced
3.Inverted V Braced
4.Eccentric (Diagonal) Forward and Backward Braced

X-Braced are braces aligned in X shape diagonally to the structure. V braced are aligned in letter "V" shape in the structure and if the shape is inverted it will be called as inverted V braces. Eccentric forward and backward are only one diagonal shape in a structure one will be forward and the other diagonal will be backward

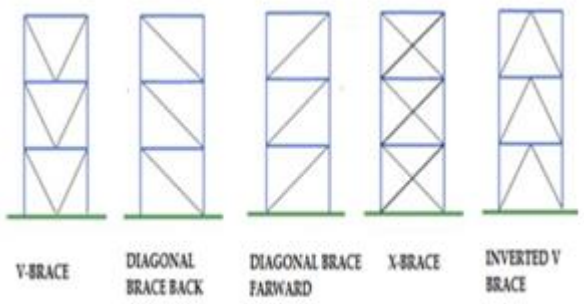

Fig no: 1

II. LITERATURE SURVEY AND REVIEW

After research and study from previous papers on similar topic following points were observed:

1. The lateral movement in RCC structure is decreased due to incorporation of the bracing system. Likewise, the peak response at the roof level at resonant frequency also gets reduced to minimum value.
2. It was observed that cross bracings and mixed diagonal bracing give better results than other type of bracings. It was also observed that there was percentage reduction in base shear in case of cross bracings but increase in base shear in other types of bracing. The fundamental time period is reduced by introducing bracings.
3. It was noted that X braced and diamond bracings have least lateral displacements and also concentric X-Diamond bracings have increased base shear than other bracings.
4. Some studied that the goods of the gusset end restraint on the hysteretic response of the brace can be dissembled directly by furnishing an fresh inelastic beam- column element of length 2t at each end of the brace.
5. It had been studied that the bracing would be fitted only where necessary to control side diversions. Structures attained by stiffness revision may have unforeseen changes in structural parcels. Abrupt discontinuities in stiffness, strength, or mass may beget malfunctioning of the structure. Also, these further flexible structures would tend to increase structural andnon-structural damage eventuality. As a result, stiffness revision is an area deserving of additional study.
6. Some concluded that the maximum storey movement of the structure is reduced by the use of X type bracing system. Movement value decreases from top storey to base. It's institute that the reduction in the movement along X direction is about 45.66% and also along y direction the reduction is about 37.21%. Storey shear is high for structures with X brace than the bare frame structure. Also, storey stiffness is high for structures with X brace than the bare frame structure. Building with X type of bracing is found to be safe and most effective against the seismic loading

III. FINDINGS

A. Objectives:

- To study the effect of different types of bracing on the characteristics of the structure against wind loads as well as seismic loads.
- To see variation in behaviour of structure in Seismic Zone 2, Zone III and Zone IV.
- To compare parameters such as story displacement, story drift, base shear, fundamental time period and frequency due to different types of bracings viz. X bracing, V bracing, inverted V bracings, eccentric backward and forward bracings and structure without any bracing.

B. Scope of the work:

A RCC structure was modelled consisting of G+12 multi-storeyed commercial complex without bracings and with X bracings, V bracings, inverted V bracings, eccentric forward and backward bracings. The structure was modelled in different seismic zones viz. Zone III, Zone IV and Zone V. The software used for analysis and modelling of this structure is ETABS Ultimate C 64-bit Version: 19.0.0, Build: 2277. The parameters story displacements, story drift, base shear, fundamental time period and frequencies were obtained as results and thus compared for conclusion.

C. Methodology:

1. A G+12 RCC Structure is modelled and analysed in ETABS for Dead loads, live loads, wind loads and seismic loads.
2. X, V, inverted V and eccentric types of bracings are provided with auto-select option with gives software flexibility to select best section for the prescribed conditions.
3. Structure is analysed in seismic Zone III, Zone IV and Zone V with different parameters as per Indian Standard codes for respective loads.
4. A total number of 15 models are analysed with 5 models in each zone with different type of bracings.
5. After analysis results are obtained in tabular form and thus, converted to graphical representation.
6. Parameters obtained and compared are base shear, story displacements, story drift, fundamental time period and frequencies.
7. Results are obtained as per the aimed objectives.
8. Conclusions are drawn based on the results obtained.

D. Structural Geometry:

A total number of 15 models are drafted in ETABS such that each zone i.e., Zone III, Zone IV and Zone V has 5 models consisting of No Braced, X Braced, V Braced,

Inverted V braced and Eccentric forward and backward braced structures, respectively.The structure is modelled in symmetric manner constituting 3 bays on each side of size 8mX8m, hence total length on each side would be 24m. Beams and columns are provided of size 230mmX450mm and 350mmX350mm respectively. RCC slab of depth 200mm is provided. Braces are provided on external bays only i.e.; the central portion of the structure is unbraced.

E. Procedure:

Steps followed for analysis of each structure are as follows:

Modelling – This is very first step on modelling in which grid lines, story data, defining beams, columns, slab sections and steel braces are provided followed by assigning of beams, columns, slab sections and steel braces along with support conditions.

Loads – In this step different loads are defined such as dead load, live load, wind load and seismic load as per Indian Standard code and they are assigned to respective members.

Analysis – In this step the structure is analysed for the given loads.

Results – Results are obtained in tabular form and they are interpreted in graphical form for no braced, Eccentric braced, X braced, V braced and Inverted V braced structures in Zone III, Zone IV and Zone V.

F. Study Findings:

Following points were observed after interpreting the results for no braced, eccentric braced, X braced, V braced and Inverted V braced structure in Seismic Zone III, Zone IV and Zone V:

- Maximum story displacement will occur on top story and maximum displacement occurs in conventional unbraced structure. Introduction of bracing decreases displacement by 60-70%. Least maximum displacement occurs in Inverted V type bracings in structure.
- Fundamental Time Period(T) is maximum for unbraced structure which gets reduced by 35-47% by introducing braces. Percentage reduction for Eccentric braces, X braces, V braces and Inverted V braces are 35.62%, 44.65%, 45.21% and 47.4% respectively.
- Stiffness increases as braces are introduced in the structure. A maximum percentage increase in Stiffness is 32.59% due to Inverted V bracings and minimum percentage increase is of about 23.83%.
- Base Shear increases in incremental order from Eccentric braced, X braced, V braced and Inverted V braced as compared to unbraced structure. Utmost base is obtained when structure is braced with inverted V bracings.
- Story Drift ratio gets reduced by introduction ofbraces. Percentage reduction in story drift ratio is in incremental order from eccentric braced, X braced, V braced and Inverted V braced.
- Graphical Comparison of various parameter of different braced RCC structure and conventional RCC structure in seismic Zone III, Zone IV and Zone V.

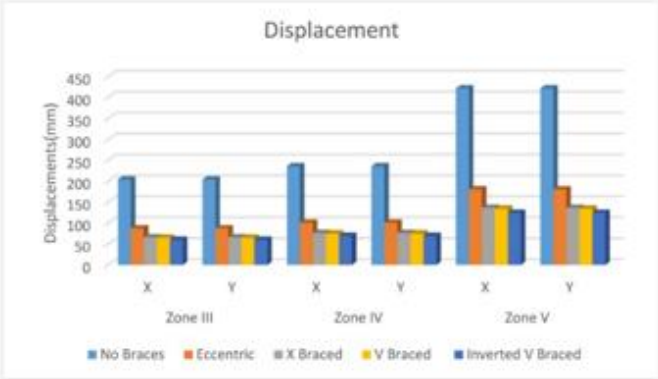

Fig no: 2
Maximum Story Displacement

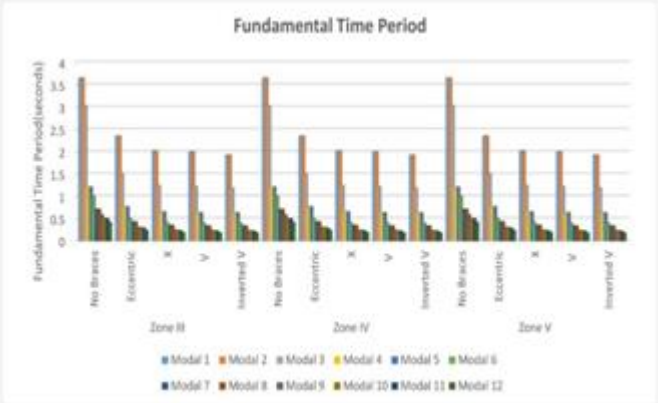

Fig no: 3
Fundamental Time Period

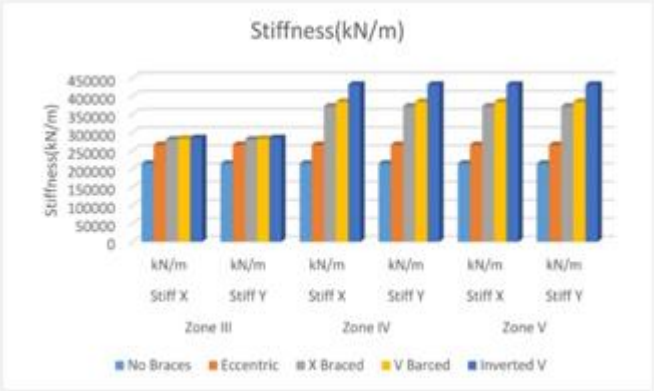

Fig no. 4
Stiffness

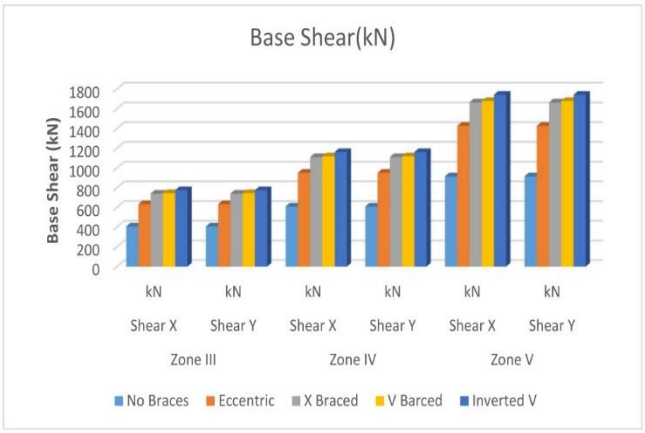

Fig no. 5
Maximum Base shear

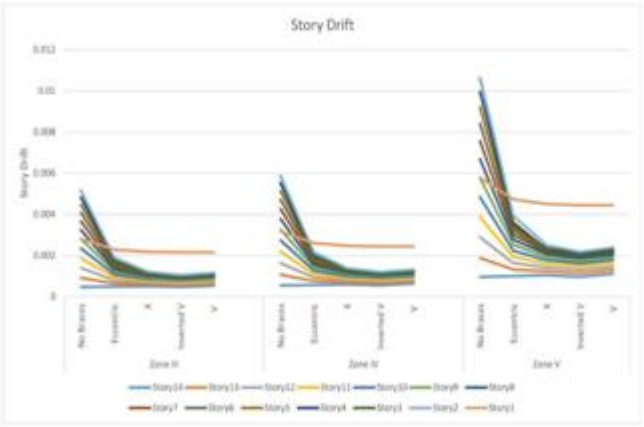

Fig no. 6

1. Maximum Story Drift

IV. CONCLUSION

After analysis and interpretation of the result, we can conclude following points:

- The best and effective way to make a structure resistant to seismic loads is by providing bracings.
- Introduction of bracing makes the structure stiffer and rigid that can resist horizontal forces that will be acting against the structure.
- The best and effective bracing system is an Inverted V type bracing system, on considering various factors such as the lateral displacement, maximum storey drift, base shear, stiffness and time period. Storey drift and lateral displacement is minimum when the Inverted V type bracing system is used. Also, the time period is least mega cross-bracing system.
- The fundamental time period for Inverted V bracing and V bracing is least with respect to other bracing systems.
- Introduction of bracing decreases displacement by 60-70%. Least maximum displacement occurs in Inverted V type bracings in structure. Which is about 70% reduced as compared to conventional RCC structure.
- Fundamental Time Period(T) is maximum for unbraced structure which gets reduced by 35-47% by introducing braces. Percentage reduction for Eccentric braces, X braces, V braces and Inverted V braces are 35.62%, 44.65%, 45.21% and 47.4% respectively.
- Stiffness increases as braces are introduced in the structure. A maximum percentage increase in Stiffness is 32.59% due to Inverted V bracings and minimum percentage increase is of about 23.83%.
- Base Shear increases in incremental order from Eccentric braced, X braced, V braced and Inverted V braced as compared to unbraced structure. Utmost base is obtained when structure is braced with inverted V bracings.
- Story Drift ratio gets reduced by introduction of braces. Percentage reduction in story drift ratio is in incremental order from eccentric braced, X braced, V braced and Inverted V braced.

V. APPENDIX

Fig no. 1 – Types of bracing systems.
Fig no. 2 – Graphical representation of Maximum story displacements for different bracing systems in Zone III, Zone IV and Zone V.
Fig no. 3 – Graphical representation of Fundamental Time period for different bracingsystems in Zone III, Zone IV and Zone V.
Fig no. 4 – Graphical representation of Stiffness for different bracing systems in Zone III, Zone IV and Zone V.
Fig no. 5 – Graphical representation of Maximum Base Shear for differentbracing systems in Zone III, Zone IV and Zone V.

Fig no. 6– Graphical representation of Maximum Story Drift for different bracing systems in Zone III, Zone IV and Zone V.

VI. ACKNOWLEDGMENT

My special thanks to our department staffs, non-teaching staffs and attainders and musketeers during prosecution of Project. Last but not the least I extend my thanks to my musketeers and all other who helped me directly or laterally in completion of this task.

REFERENCES

[1] Dhruba Jyoti Borthakur and Dr. (Mrs) NayanmoniChetia, "A Study on the Effectiveness of Bracing System for Lateral loading", International Journal of Advanced Engineering Research and Science (IJAERS), Vol-3, Issue-4, Apr- 2016.

[2] Neeraj Kushwaha, N. Binnani, V. R. Rode and SaifAzhar, "Comparative Study of Different Bracing System in Seismic Zone III and 4", Journal of Civil and Construction Engineering, Volume-7, Issue-1 (January-April, 2021).

[3] Rohit Shintre and Dr. Pandurang Patil, "Investigation of Behavior of Combined Effect of X and Diamond Bracing System for High Rise Steel Structure", International Journal for Research in Applied Science & Engineering Technology, (IJRASET); Volume 8 Issue XI Nov 2020.

[4] K.K. Wijesundara, R. Nascimbene and G.A.Rassati, "Modeling of different bracing configurations in multi-storey concentrically braced frames using a fiber-beam based approach", Journal of Constructional Steel Research, 101 (2014) 426–436.

[5] Mehul J. Bhavsar, Kavita N. Choksi and Digant A. Pastagia," Parametric Study of Various Bracing Systems in Steel Structures", Global Research and Development Journal for Engineering, Recent Advances in Civil Engineering for Global Sustainability, March 2016.

[6] E. P. Popov, K. Takanashi and C. W. Roeder, "Structural Steel Bracing Systems: Behavior Under Cyclic Loading", Earthquake Engineering Research Center, Report No. EERC 76-17 June 1976.

[7] Masood Ahmed Shariff, Owais M, Rachana C, Vinu S and AshishDubay B," Seismic Analysis of Multistorey Building with Bracings using ETABS", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 8, Issue 5, May 2019.

[8] M. Maheri and A. Hadjipour (2003), "Experimental investigation and design of steel brace connection to RC frame", Engg. Struct., Volume 25, Issue 13, pp. 1707–1714.

[9] IS 1893: Part 1 (2016), "Criteria for Earthquake Resistant Design of Structures", Bureau of Indian Standard, New Delhi.

[10] M. Youssef, H. Ghaffarzadeh and M. Nehdi (2007), "Seismic performance of RC frames with concentric internal steel bracing", Engg. Struct., Volume 29, Issue 7, pp. 1561–1568.

[11] D. M. Patil and K. K. Sangle (2015), "Seismic behaviour of Different Bracing Systems in High Rise 2-D Steel Buildings", Struct., Volume 3, pp. 282–305.

[12] T. D. Bush, E. A. Jones and J. O. Jirsa (1991), "Behavior of RC Frame Strengthened Using Structural Steel Bracing", J. of Struct. Engg., Volume 117, Issue 4, pp. 1115–1126.