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Comparative Study of Conventional Steel Braces and Buckling Restrained Braces in a High Rise RC Building

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Abstract: A study was carried out on a reinforced concrete building with conventional steel braces and buckling restrained braces (BRB) for seismic analysis with dissimilar type of bracing system (V type, inverted V type, X type, Zig-Zag bracing) is considered. The bracing is providing for outer exterior columns. A twenty-five storey (G+25) building is located at earthquake zone 2 & 4. The structure models are examined by response spectrum method using ETABS2016 program. The parameters which are consider in this research to equate the seismic investigation of buildings are storey displacement, storey drift, storey shear(forces). These parameters are compared in both type of bracing systems and effective bracing is selected with respect to different zones.
Keywords: Bracing, Conventional steel, BRB, ETABS2016, Response Spectrum Analysis, storey displacement, storey drift, storey forces.

I. INTRODUCTION

A trembling of earth is a lateral force because of the sudden release of stored energy on the earth's surface within the variation of seismic waves. Earthquake mostly occurs thanks to separation of geological burdens, volcanic actions, landslides and mine explosion. The seismic load which is regularly dynamic in nature is enormously powerful and may breakdown the structure in a very segment of seconds. The collapse of constructions may cause main loss of both life and property. Many of the assemblies undergo adjacent forces produced thanks to seismic motion and wind forces. So we've provided a lateral load resisting system, shear wall, dampers etc to counterattack or transfer these lateral pressure to the structure uniformly without upsetting the soundness and strength of the assembly. Sidelong loads can foster high anxieties, produce influence development or cause vibration. Accordingly, it's noteworthy for the construction to have adequate strength against vertical loads alongside satisfactory solidness to oppose sidelong powers. General lateral relocations on primary constructions are of incredible worries for engineers. It as to constrict the impact of quake and wind powers, special diagonal aligned members, called braces, are utilized effectively. Be that as it may, these individuals when exposed to compressive force display buckling deformation and show unsymmetrical hysteretic conduct in regions of stress and strain. If a chance that structure has a buckling of steel support can limited and, in this manner, a similar strength is guaranteed both in region of stress and strain, the energy integration of the support will be uniquely expanded and therefore the hysteretic behavior will be efficient. These fundamentals inspire specialists and design engineers to adopt a special kind of bracing systems, like buckling restrained brace support (BRB). The idea of the BRB is simple, limiting buckling of the bracing system so the support shows the identical performance conduct in both stress and strain properties. the most unique property of a BRB is its capacity to yield both tension and compression without buckling. A BRB is in a situation to yield in compression since it's detailed and manufactured determined its two primary parts perform different tasks while staying de-coupled. The load limiting capability part of a BRB, the steel core, is controlled against total buckling by reliability of components or restrictive mechanism, the external outer covering is with concrete. the standard perspective on Buckling Restrained Brace is as displayed in Fig. 1

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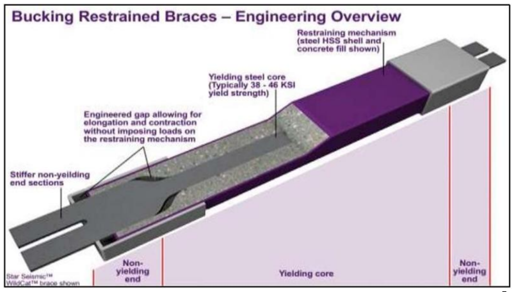

Fig.1. Buckling restrained brace

Bonding of the steel center to the concrete isn't permitted to ensure that the BRB segments stay independent and composite move not permitted to makes place. The BRB support is set during a concentric braced frame and turns into a buckling restrained brace frame (BRBF) framework. The braced frame is frequently utilized for assemblies where seismic program is likewise experienced, regardless of whether wind or seismic attack directs the development of design of a building. In this manner the core of the Buckling-Restrained Braces can go to a significant yielding, under both tension and compression, and withstand considerable energy, in contrast to conventional bracing. Testing considered on BRBs has suggested that BRB is ability fit for withstanding various seismic forces without failure or loss of strength. However, the progress of the BRB gives off an impression of being simple, poor design plan of BRB may wind up in casing buckling, connection letdown, and poor BRB performance, so important to incorporate just completely tested fabricated product at facilities with work force who are prepared in BRB producing and join thorough production of quality strategies.

II. OBJECTIVE OF PROPOSED STUDY

A. *Introduction*

In the case study, a study is carried out on G+25 storey RC Regular frame building, and with conventional steel bracing and buckling restrained bracing with same configuration is existing here. A normal floor plan of 18m x 18m size was taken. The study was agreed to be done for G+25 storey building with floor height of 3m and the outcomes were obtained in relations of storey displacement, storeydrift and storey forces are presented. In the present study evaluation of seismic response of the G+25 storey RC frame structure by using conventional steel bracing and buckling restrained bracing is discussed. A simple computer based modelling in ETABS software was performed for response spectrum method (RSM) subjected to earthquake loading in zone 2 & 4.

B. *Objectives*

1) To prepare a thought and grid system using ETABS software.
2) To determine the sizes and properties of components within the frame structure.
3) Modelling of frame structure for various zones 2 & 4.
4) Modelling of various connection for the identical configuration of structure.
5) To Studying the building by means of response spectrum method as per IS:1893-2016.
6) Checking various parameters corresponding storey displacement, storey drift and storey forces.
7) Comparing both Conventional steel braces and BRB in several zones 2 & 4.
8) Concluding which bracing system is more effective in different zones.

C. *Methodology*

1) At First a 25 story Square concrete moment resisting frame is considered, having dimension 18 m x 18 m in X and Y direction. Baysize is 6 m uniform along both the direction. Modelling and analysis is carried out using ETABS ver.16
2) The moment resisting frame is analyzed for Dead, Live, Earth quake and load combinations. After the moment resisting frame fails for the above combinations the lateral load resisting systems are introduced to the moment resting frame
3) Then the model is analyzed for Dead, Live, Earth quake with lateral load resisting systems incorporated in the structure.
4) Behavior of lateral load resisting system i.e., Conventional steel and BRB bracing systems are studied.
5) Earth quake analysis is carried out with response spectrum method with different type of connections like V type, inverted V type, X type, Zig-Zag type of lateral bracing connections in both bracing systems.

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III. ANALYSIS OF G+25 STOREY BUILDING

A. Building Configuration

Structure	Concrete
Plan dimension	18mX18m in both X and Y direction
No.of Storey	G+25
Height of structure above GL	75m
Storey height	3m
Grade of Concrete (fck)	M40
Grade of reinforcement steel	HYSD500
Column	Storey 1-8 – 600 x 600 mm Storey 9-14 – 550 x 550 mm Storey 15-19 – 500 x 500 mm Storey 20-15 – 500 x 500 mm
Beam	Storey 1-8 – 400 x 600 mm Storey 9-14 – 350 x 550 mm Storey 15-19 – 300 x 500 mm Storey 20-15 – 300 x 500 mm
Slab	150mm
Conventional steel bracing	ISMB 500 & ISMB 550
BRB brace section	Star BRB_5.0
Wall load (glass panels) 50mm	2 KN/m
Floor finish	1.5 KN/m^2
Typical live	3 KN/m^2
Roof live	1 KN/m^2
Earth quake zones	Zone 2, Zone 4
Response reduction factor	4 & 5
Type of Soil	Medium

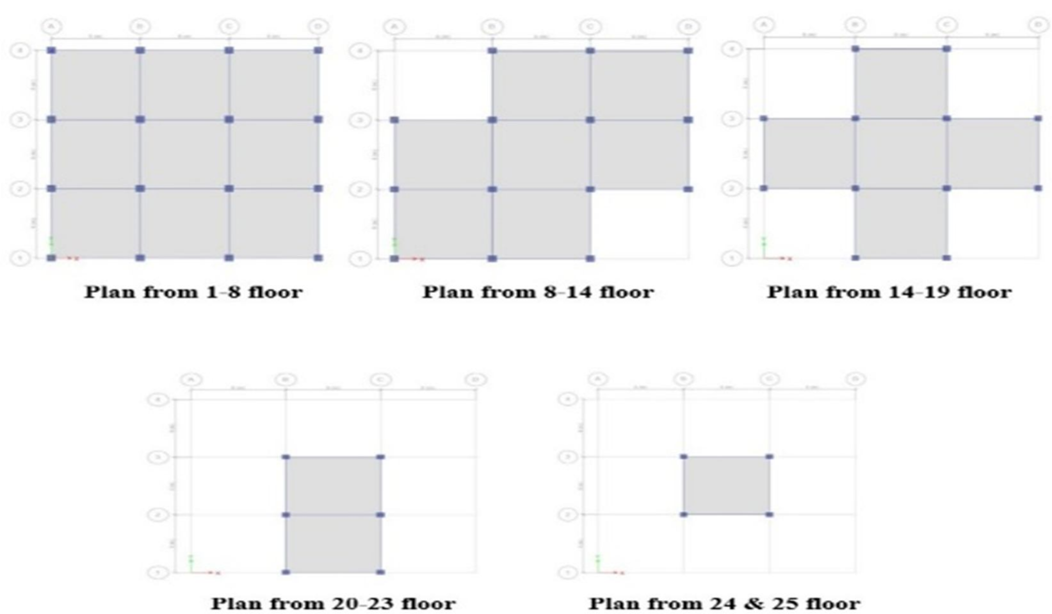

Fig.2 Plan

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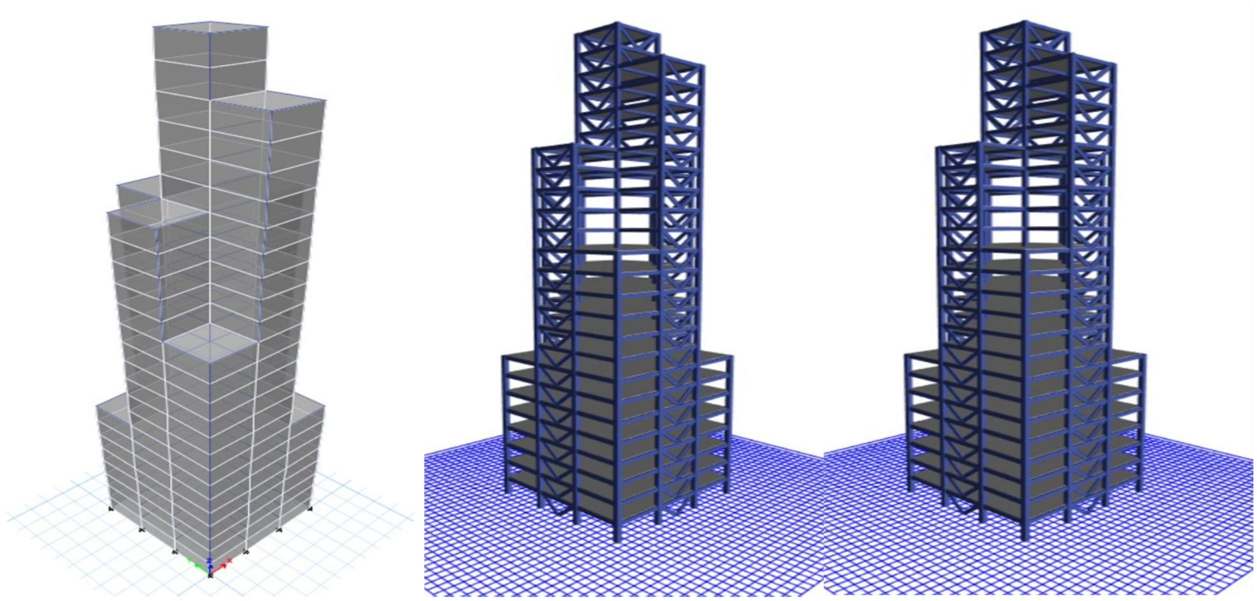

Fig.3-3D view of the Regular, Conventional steel and BRB braced structure

IV. RESULTS AND DISCUSSIONS

The study on Reinforced concrete high rise structures are very different to model as structural arrangements for study. The present version of the IS 1893(Part 1): 2002 needs that virtually all high rise constructions be analysed as 3D systems. In the present study the presentation evaluation of Reinforced concrete structure having regular configuration and along with conventional steel and buckling restrained braces. The study as a whole makes an effort to evaluate the effect of conventional steel bracing and buckling restrained bracing on RC constructions, in relations of dynamic features and classifies the manipulating parameters which can governor the outcome on storey displacement, storey drift, storey forces.

This paper presents results of seismic analysis and wind analysis carried out on G+25 storied square shaped 3-D RC Regular frame and frame with conventional steel bracing and buckling restrained bracing. The analysis is performed by taking into account of earthquake loads in EQX and EQY directions. The response obtained from the analysis is storey displacement, storey drift and storey forces. The results presented are discussed in detail with reference to relevant Tables and Figures.

A. *Response Spectrum Analysis in zone 2*

1) Storey Displacement in zone 2

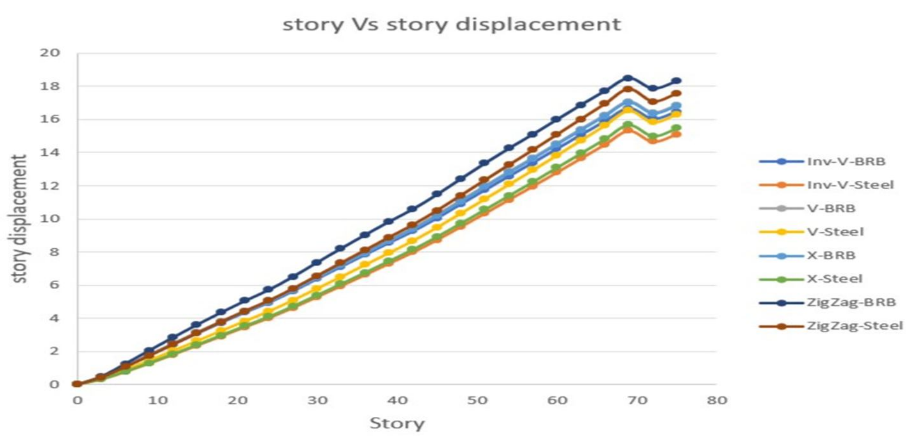

Fig 4 shows the story v/s displacement of Inv-V, X, V and Zig-Zag both conventional steel and brb in both X and Y direction of Zone 2.

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	Maximum in Steel	Maximum in BRB
Inverted-V-Type	15.32	16.67
V-Type	16.53	17.07
X-Type	15.68	17.02
Zig-Zag-Type	17.83	18.49

Fig 5 It is detected from the table that storey displacement is reduced to major extent for Inv-V category of steel bracing systems, however displacement is also reduced to an extent in BRB bracing system.

2) Storey Drift in zone 2

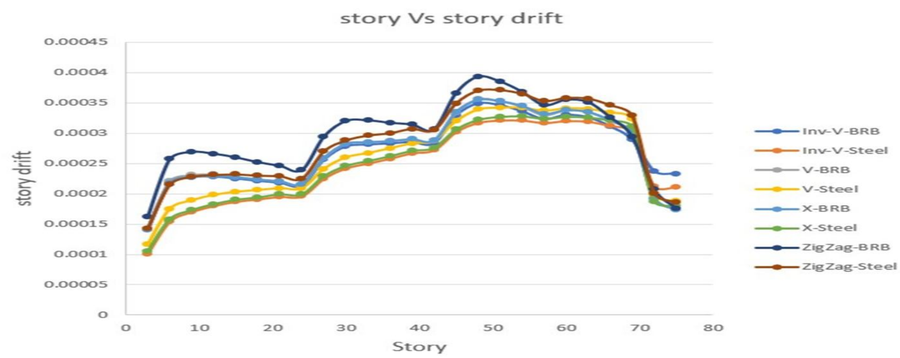

Fig 6 shows the story v/s drift of Inv-V, X, V and Zig-Zag both conventional steel and brb in both X and Y direction of Zone 2.

	Maximum in Steel	Maximum in BRB
Inverted-V-Type	0.000321	0.000349
V-Type	0.000342	0.000356
X-Type	0.000328	0.000355
Zig-Zag-Type	0.000371	0.000393

Fig 7 It is concluded from the table that storey drift is reduced to major extent for Inv-V category of steel bracing systems, however drift is also reduced to an extent in BRB bracing system.

3) Storey forces in zone 2

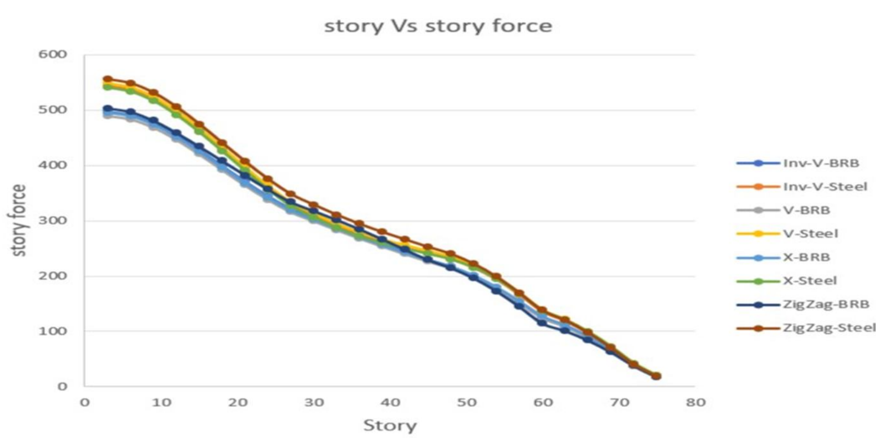

Fig 8 shows the story v/s force of Inv-V, X, V and Zig-Zag both conventional steel and brb in both X and Y direction of Zone 2.

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	Maximum in Steel	Maximum in BRB
Inv-V-Type	543.37	497.06
V-Type	548.66	499.62
X-Type	540.17	495.21
Zig-Zag-Type	555.38	503.26

Fig 9 It is detected from the table that story forces are summary to major extent for X category of BRB bracing systems, by the reduction of forces on structure the parameters of fundamentals in building can be varied leads to reduction the overall dead load of the structure and increases the stability of the structure.

B. Response Spectrum Analysis in Zone 4

1) Storey Displacement in zone 4

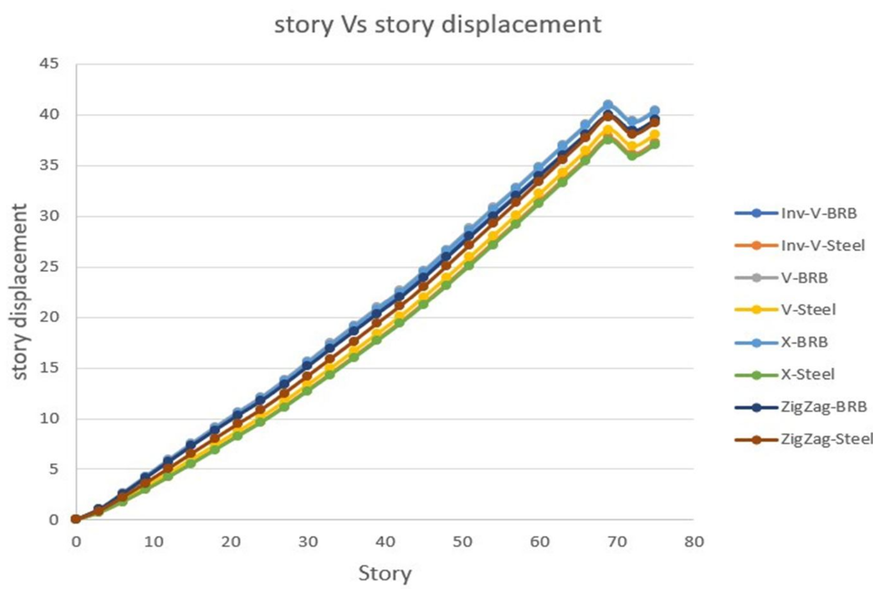

Fig 10 shows the story v/s displacement of Inv-V, X, V and Zig-Zag both conventional steel and brb in both X and Y direction of Zone 4.

	Maximum in Steel	Maximum in BRB
Inverted-V-Type	37.78	39.96
V-Type	38.52	40.96
X-Type	37.46	40.85
Zig-Zag-Type	39.75	39.93

Fig 11 It is observed from the table that story displacement is reduced to largest extent for X category of steel bracing systems, however displacement is also reduced to an extent in BRB bracing system.

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2) Storey Drift in zone 4

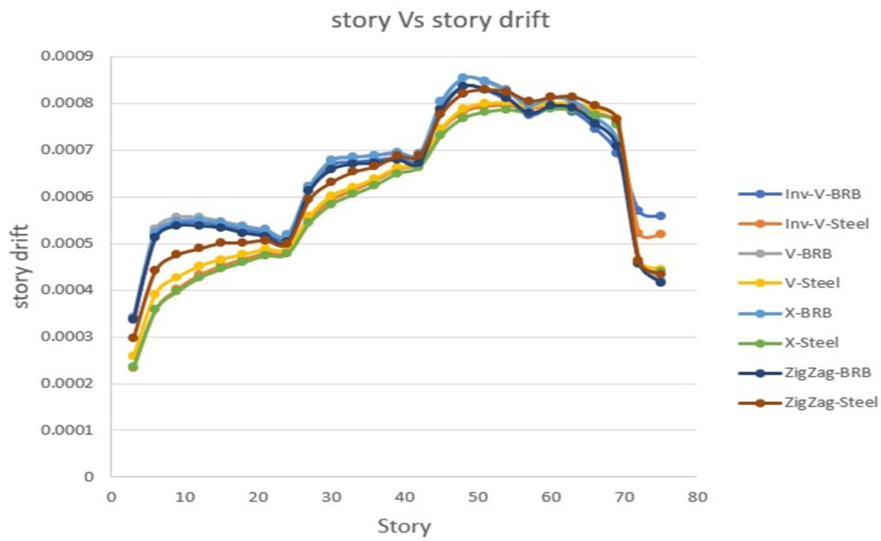


Fig 12 shows the story v/s drift of Inv-V, X, V and Zig-Zag both conventional steel and brb in both X and Y direction of Zone 4.

	Maximum in Steel	Maximum in BRB
Inverted-V-Type	0.000797	0.000836
V-Type	0.000801	0.000854
X-Type	0.000787	0.000853
Zig-Zag-Type	0.000829	0.000835

Fig 13 It is detected from the chart that story drift is reduced to major extent for X category of steel bracing systems, however drift is also reduced to an extent in BRB bracing system.

3) Storey forces in zone 4

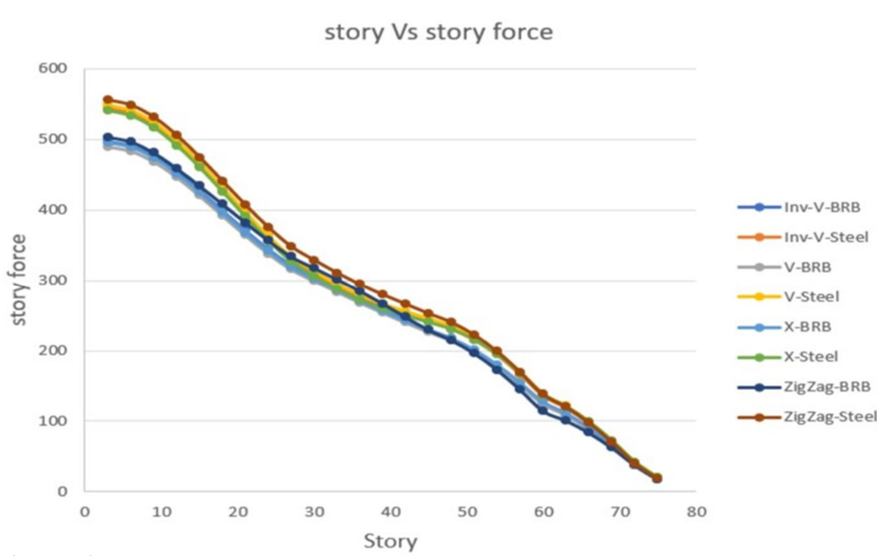


Fig 14 shows the story v/s force of Inv-V, X, V and Zig-Zag both conventional steel and brb in both X and Y direction of Zone 4.

	Maximum in Steel	Maximum in BRB
Inverted-V-Type	1326.21	1369.54
V-Type	1297.80	1175.11
X-Type	1316.37	1188.57
Zig-Zag-Type	1302.58	1206.29

Fig 15 It is detected from the graph that story forces are reduced to major extent for X category of BRB bracing systems, by the reduction of forces on structure the parameters of fundamentals in building can be varied leads to reduces the overall dead load of the structure and increases the stability of the structure.

V. CONCLUSIONS

A. After the investigation of the assembly of structure with various types of structural arrangements, it has been decided that limitations like displacement, drift and story forces of the building is reduced when the application of both type of bracing system are considered.

B. The Critical parameters of building is a reduced by using V type, inverted V type, X type and Zig-Zag type of bracing system respectively in both conventional steel bracing and buckling restrained bracing.

C. The comparison in Zone-2 it shows that Inv-V-type Steel bracing system reduces the story displacement when compared to other bracing system along with the normal bare frame structure.

D. However, from the comparison in Zone-2 it shows that X-type BRB system reduces the story forces to a large extent when compared to other bracing system along with the normal bare frame structure. It concludes that the story forces are reduced on the frame structure which helps in reducing the size of columns, beams and foundation and increase the stability of structure.

E. The comparison in Zone-4 it shows that X-type Steel bracing system reduces the story displacement when compared to other bracing system along with the normal bare frame structure.

F. However, from the comparison in Zone-4 it shows that X-type BRB system reduces the story forces to a large extent when compared to other bracing system along with the normal bare frame structure. It concludes that the story forces are reduced on the frame structure which helps in reduce the size of columns, beams and foundation.

G. It can be concluded that based on the Zone factor and parameters of the building, the new type of BRB system is economical and efficient to withstand the lateral forces which will help in reducing other parameters of the building and increase the stability of the building.

REFERENCES

[1] Nikhil D. Sontakke, P. S. Lande., "Comparative Study of Buckling Restrained Braces and Conventional Braces in a Medium Rise Building", International Journal of Engineering Research (IJER), Volume-5, Feb 2016.

[2] Arunraj E, Vincent Sam Jebadurai S, Samuel Abraham D, Daniel C, Hemalatha G., "Analytical Investigation of Buckling Restrained Braced Frame Subjected to Non-Linear Static Analysis", International Journal of Engineering and Advanced Technology (IJEAT), Volume-8, June 2019.

[3] Gopika P ,Najma Ananthakumar., "Analysis of Seismic Behavior of RCC and Composite Structure with Buckling Restrained Braces", International Research Journal of Engineering and Technology (IRJET),Volume -4, June 2017.

[4] Javed U Islam, Mayank Mehandiratta, Rohit Yadav., "Earthquake Resistant Design-A comparative analysis of various bracing system with RC-frame", International Journal of Engineering Development and Research (IJEDR), Volume-7, July 2019.

[5] Pooja.B.Suryawanshi, Prof. H.G.Sonkusaree., "Analysis of Seismic Design Steel Braced Frame", International Journal of Science Technology & Engineering (IJSTE), Volume-2, May 2016.

[6] Omkar Shelar, Karanveer Singh Parihar., "Experimental Analysis of Buckling Restrained Brace under Cyclic Loading", International Research Journal of Engineering and Technology (IRJET), Volume-5, Dec 2018.

[7] Harsha C.S, Nikhil R., "Seismic Strengthening of Steel Buildings using Bracings", International Research Journal of Engineering and Technology (IRJET), Volume-7, July 2020.

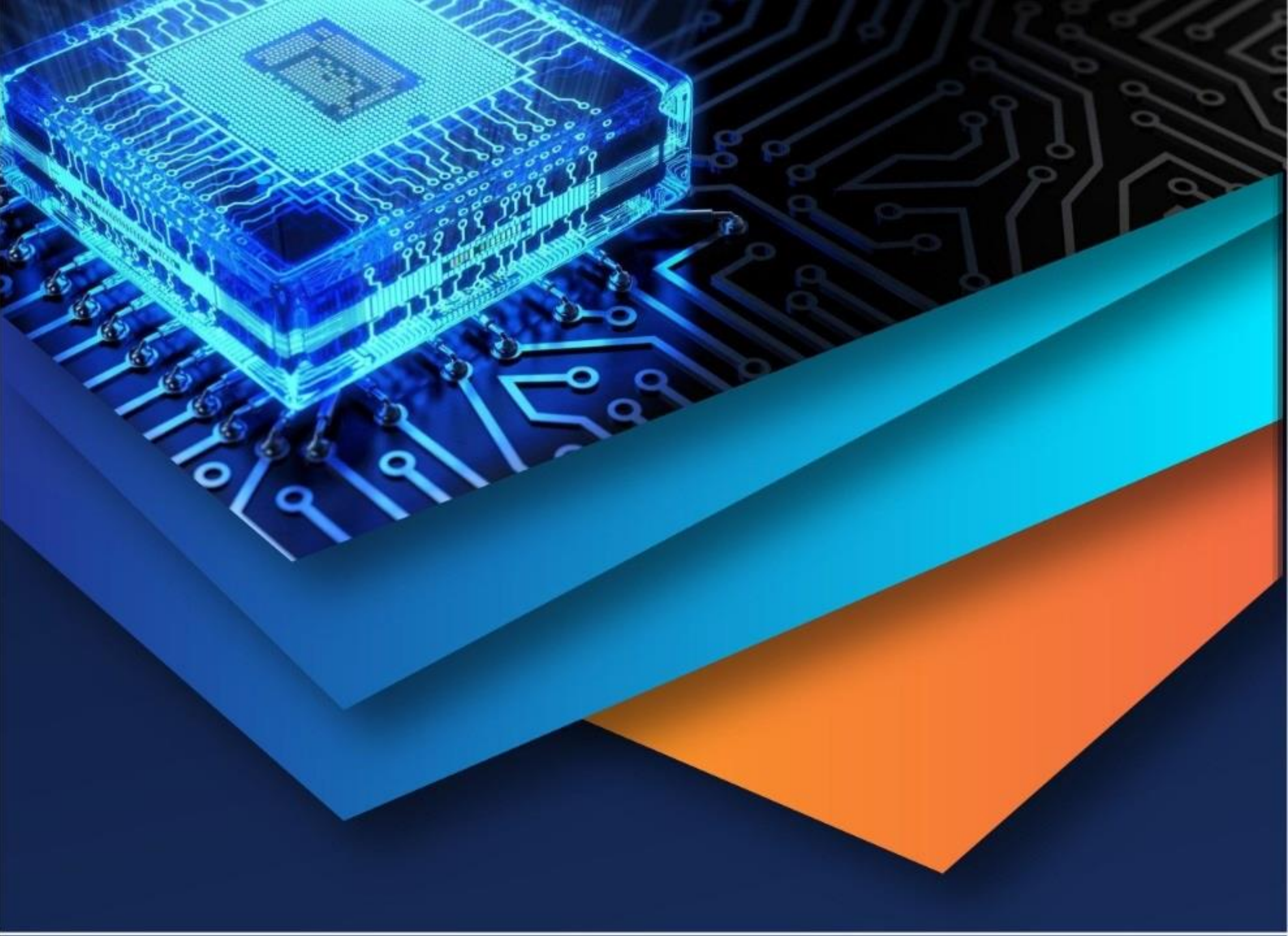
[8] Sarang H. Kshirsagar, Abhijeet A.Galatage., "Seismic Evaluation of RC Building with Different Arrangement of Steel Bracing", International Research Journal of Engineering and Technology (IRJET), Volume-7, Sep 2020.

[9] Vishwanath K.G, Prakash K.B, Ananth Desai., "Seismic Analysis of Steel Braced Reinforced Concrete Frames", International Journal of Civil and Structural Engineering, Volume-1, 2010.

[10] Rishabh Sharma1, Dr. Shailendra Kumar Tiwary, Sonu Mangla, Mohd. Tauseef Husain., " Seismic Analysis and Retrofitting of a Multi-Storey RC Building", International Research Journal of Engineering and Technology (IRJET, Volume-5, May 2018.

[11] Mohammed Hyderuddin, Md Mubassir Imran, Syed Mohsin., "Retrofitting of Reinforced Concrete Frames using Steel Bracing", International Journal for Scientific Research & Development (IJSRD), Volume-4, July 2016.

[12] Ronald L. Mayes, Craig Goings, Wassim Naguib, Stephen Harris, Jennifer Lovejoy, Jerome P.Fanucci.," Comparative Performance of Buckling-Restrained Braces and Moment Frames", 13th World Conference on Earthquake Engineering, Paper no.2887, Aug 2004.



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