Analysis of RC Multistorey building with Zipper bracing and Conventional bracing system.

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Abstract – Bracing elements are vertical elements added at the intersection of the braces above the first floor and designed to carry upward the unbalanced loads resulting from buckling of the braces. It is found that adding braces enhances the global capacity of the building in terms of strength, deformation and ductility compared to the case with no bracing, and the X and Zipper bracing systems performed better depending on the type and size of the cross section. A detailed literature review is done for analysis of the multistorey building. E-tabs software is used for the modelling as per IS 1893-2002. Analysis is carried out for different seismic zones that is Zone 3 and Zone 5. Lateral loads are applied for the analysis of the structure by Response spectrum. Finally, comparative study of RC tall structure with and without Zipper bracing system is done in terms of storey drift, storey stiffness and time period.

Index Terms – Zipper Brace, Response Spectrum, Storey Stiffness, Storey Drift, E-tabs, Seismic Analysis.

I. INTRODUCTION

Buildings made of reinforced concrete were damaged to varying degrees by several severe earthquakes, particularly those that were constructed decades or more ago. The negative consequences of earthquakes made engineers to retrofit existing buildings to prevent damages of probable future earthquakes. One of the main retrofitting approaches is installing new structural element, such as steel knee braces to upgrade the seismic performance of existing undamaged structures before being subjected to a severe earthquake.

Although it is common to employ steel braces in steel frames and use shear walls in reinforced concrete structures. Such systems consist of frames with vertical trusses. Both fixed and pinned frames are usually used in conjunction with the vertical trusses. In some bays of frame, diagonal members are provided within the story height and this pattern is repeated throughout the height of the building forming a vertical truss type structure. These vertical trusses increase the strength and stability of the buildings against lateral loads. Zipper braced frames are one of the patterns for providing braces in an inclined direction order to avoid horizontal deflection, hinge development, and flexural forces caused by earthquake forces.

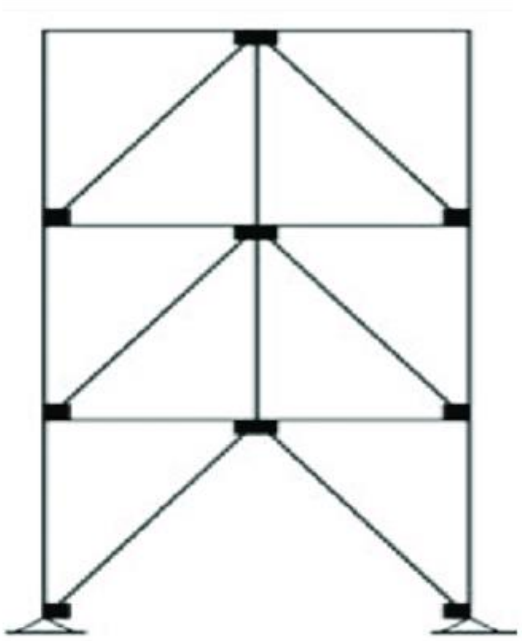


Fig 1. Zipper bracing system

II. LITERATURE SURVEY

Mona Dilipkumar K et al [2018] [1]have described bracing frames are one of the patternsfor prove braces in inclined direction for avoiding horizontal deflection, formation of hinges and flexural forces due to earthquake forces. Tremendous research has been done on bracing frames byresearchers in steel by using software. This paper represents the review on the analysis of bracing frame.

J K Shah et al [2018] [2] have described Seismic Performance of 5, 10 and 15 storied Zipper Braced Frames designed using Performance Based Plastic Design (PBPD) method and Force baseddesign (FBD) method has been evaluated. Non Linear Static Pushover analysis is used as evaluationtool and the parameters for comparison of the performance of study frames are (a) Deformation andCapacity (b) Response Reduction Factor and (c) Failure Pattern. Results indicate better seismic performance of PBPD frames in terms of deformation and capacity.

A Kadid et al (2011) [3] have described This paper investigates the seismic behaviour ofRC buildings strengthened with different types of steel braces, X-braced, inverted V braced, ZX braced, and Zipper braced. Static non linear pushover analysis has been conducted to estimate the capacity of three story and six story buildings with different brace-frame systems and different crosssections for the braces. It is found that adding braces enhances the global capacity of the buildings in terms of strength, deformation and ductility compared to the case with no bracing, andthe X andZipper bracing systems performed better depending on the type and size of the cross section.

III.METHODOLOGY

The structure with g+15 and g+25 stories situated over medium-quality soil. There will continue to be 5 bays in each of the x and y directions, each measuring 4 meters, with a storey height of 3 meters. Using etabs 2016 software, the building will be analyzed while taking zone iii and zone v into consideration. The response spectrum method is used for analysis. Three dimensional space frame analysis will be carried out for four different building configurations resting on flat ground under the action of seismic load. The configurations include the different types of bracings such as x bracing, inverted v bracing and zipper bracing we have used like full height of the structure.

4.6 PROJECT CONSIDERATION

MATERIAL PROPERTIES	
Concrete Grade	M30
Steel Grade	Fe 550
STRUCTURAL DETAILS	
Column	C 600 X 600
Beams	B 300 X 600
Slab	S 150mm
Bracings	ISMB 300

LOADS CONSIDERATION	
Wall Load	10 kN/M^2
Floor Finish	1 kN/m
Live Load	2 kN/m
Eathquake load	As per IS 1893 – 2000
Wind Load	As per IS 875 – 3
SEISMIC PARAMETERS	
Seismic Zone	III & V
Response reduction Factor R	5
Importance Factor I	1
Soil Medium	II

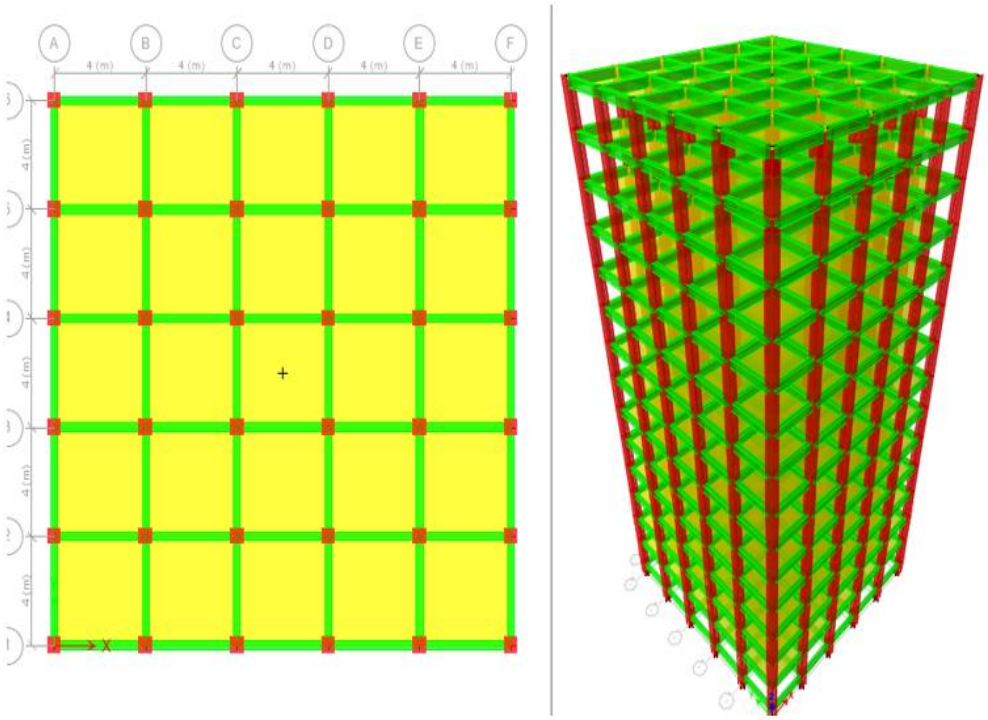


Fig 4.17 Plan and 3D view of 15 storey of regular structure

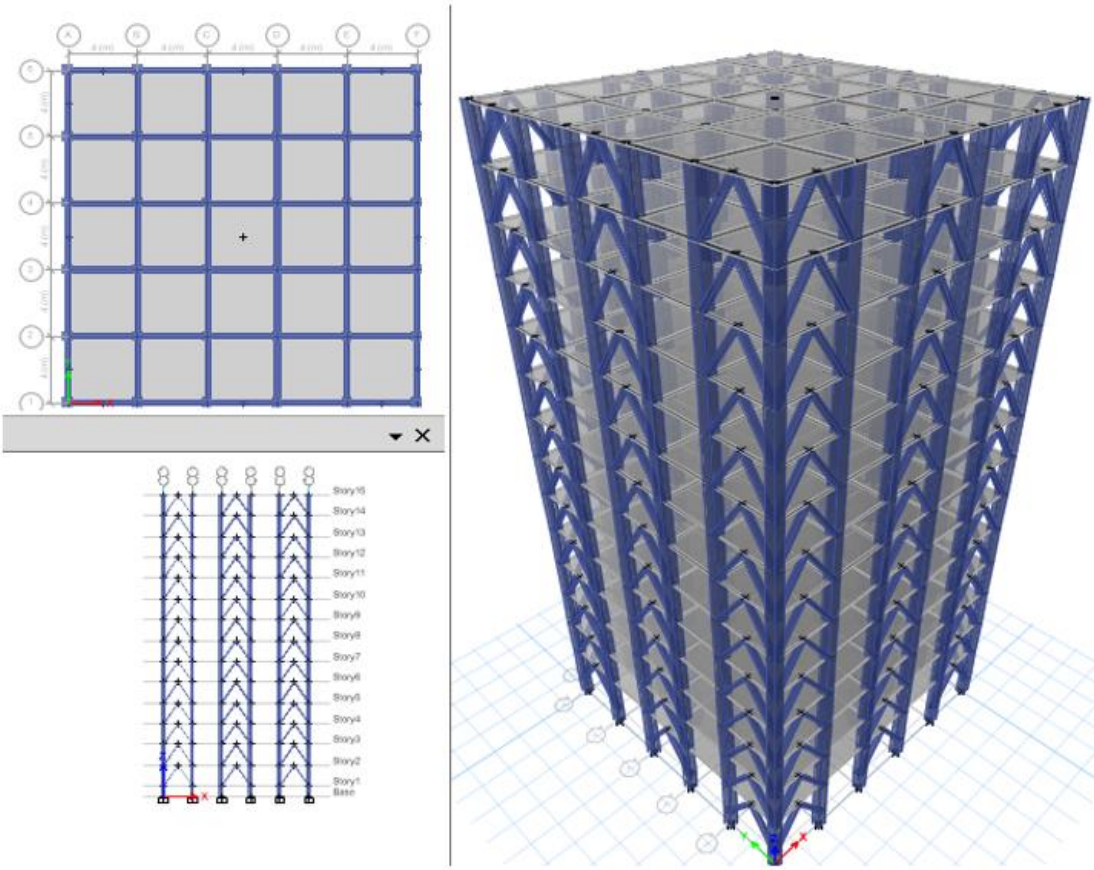
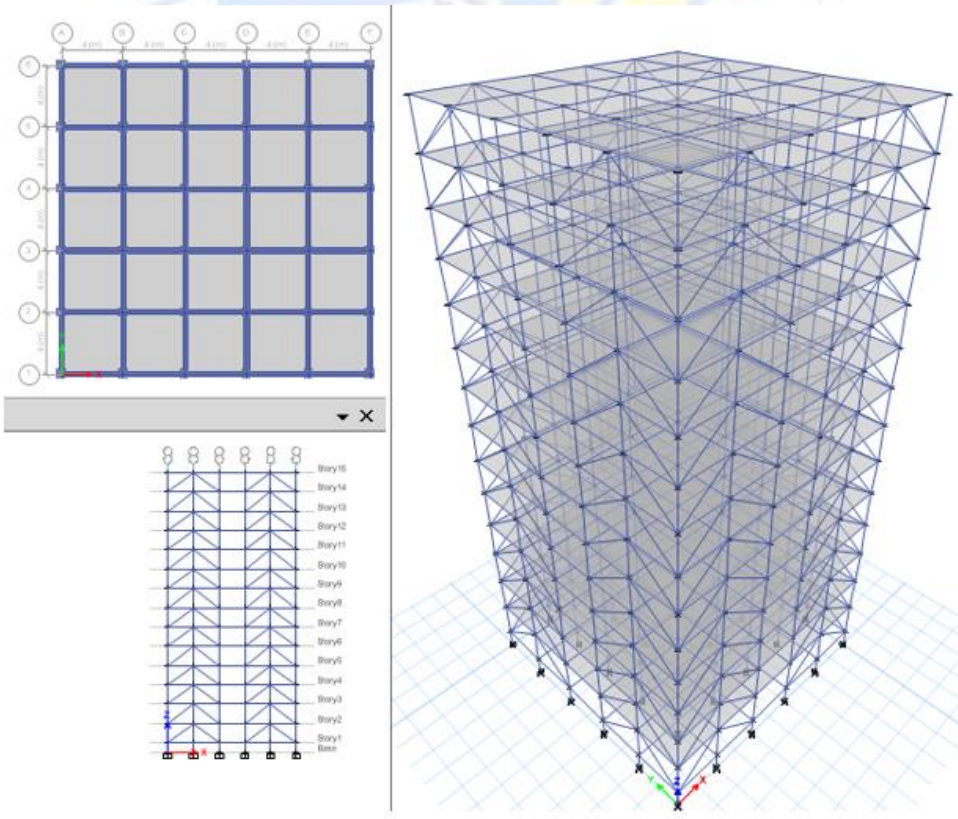


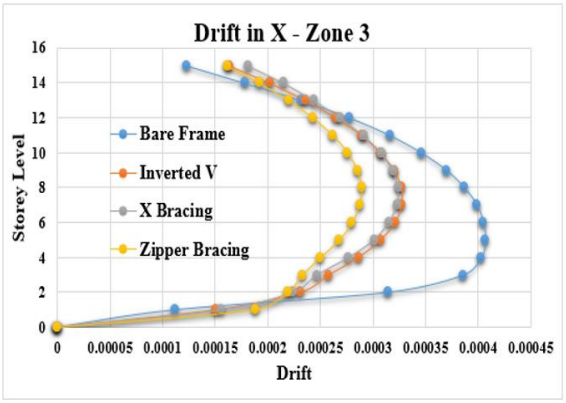
Fig Plan, Elevation and 3D view of 15 storey for Inverted V Bracing



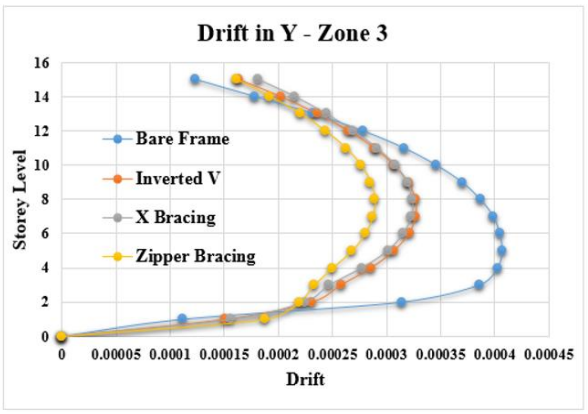
Plan, Elevation and 3D view of 15 storey for Zipper Bracing

IV.RESULTS AND DISCUSSION

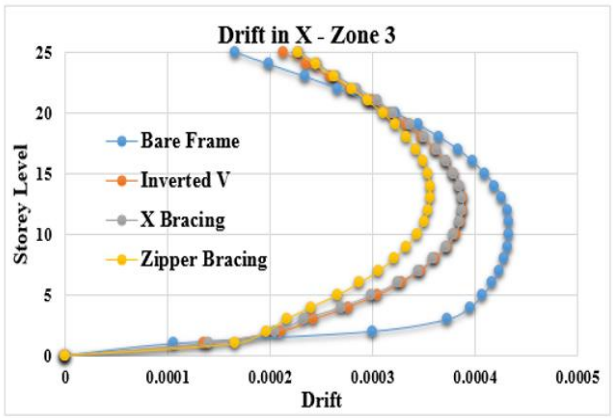
1.Storey Drift



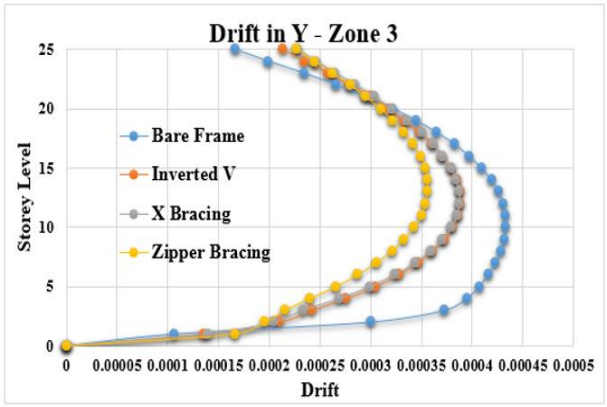
zone 3 along X – Direction



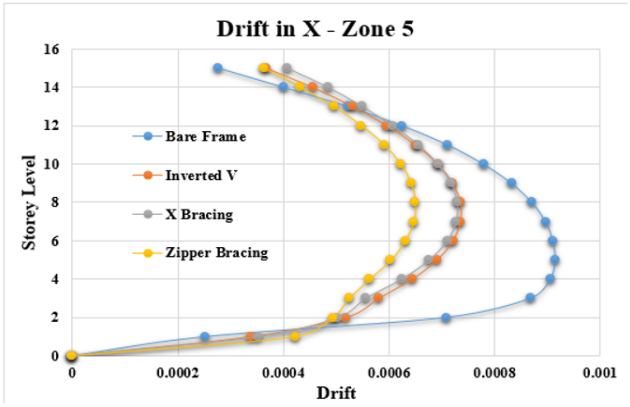
zone 3 along Y – Direction



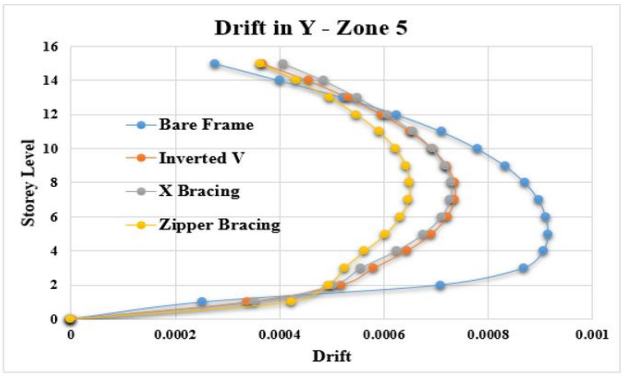
zone 3 along X – Direction



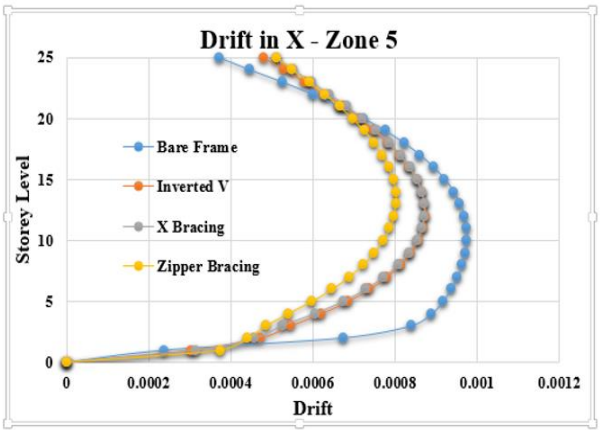
zone 3 along Y – Direction



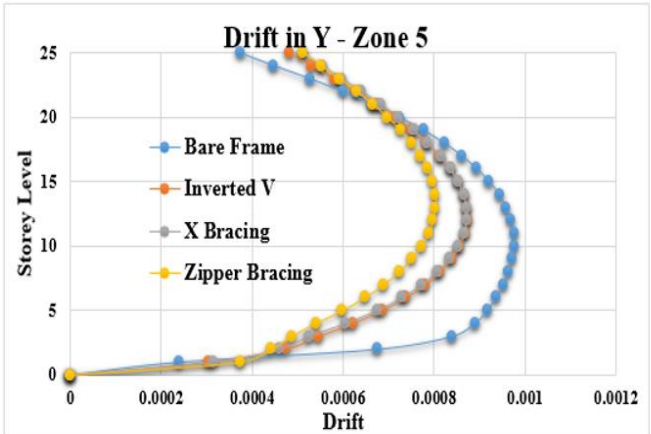
zone 5 along X – Direction



zone 5 along Y – Direction



zone 5 along X – Direction



zone 5 along Y – Direction

Comparing all of the models, the bare frame construction has the most drift values, whereas zipper bracing exhibits the least. When compared to a conventional construction in both directions, the zipper bracing structure is displaying a decrease in height in both directions of 17% for a 25-story building and 26% for a 15-story building. We can plainly observe that the storey drift for an unbraced building remains constant throughout the structure, however for braced structures, the drift values are reduced in all situations along both the X and Y directions.

2.Time Period

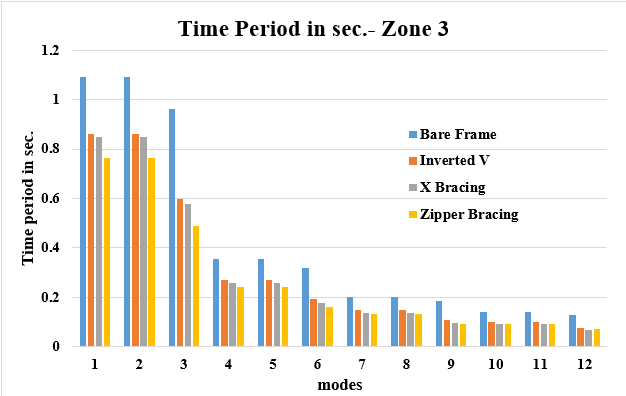


Fig. Modal time period in zone 3 for 15 story

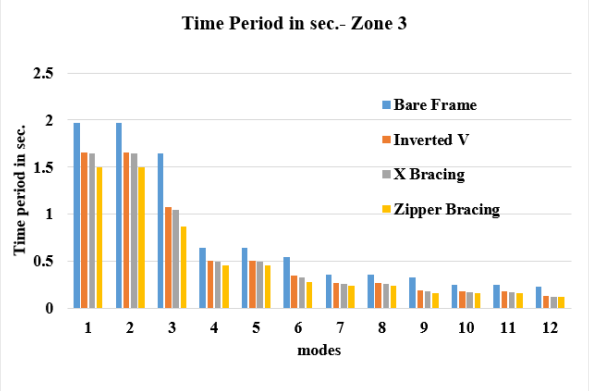


Fig. Modal time period in zone 3 for 25 story

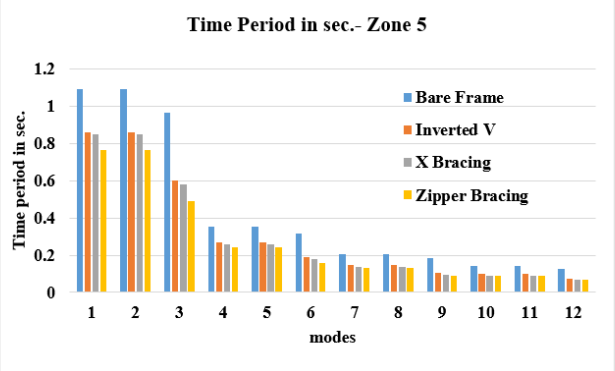
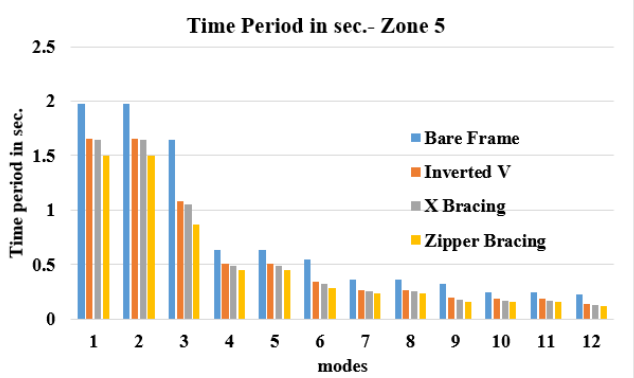


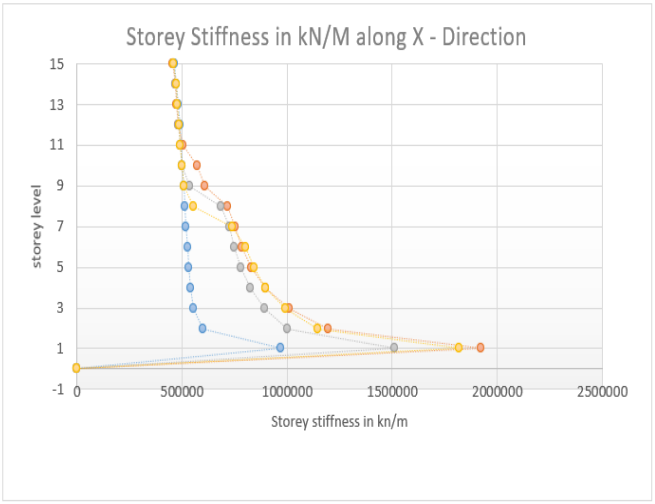
Fig. 5.27 Modal time period in zone 5 for 15 story

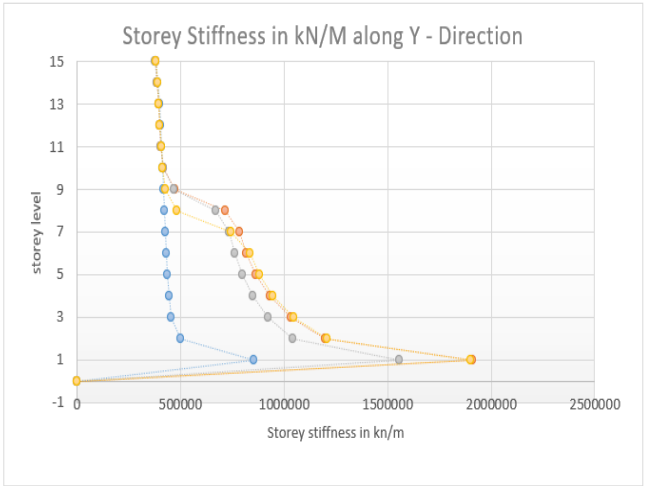


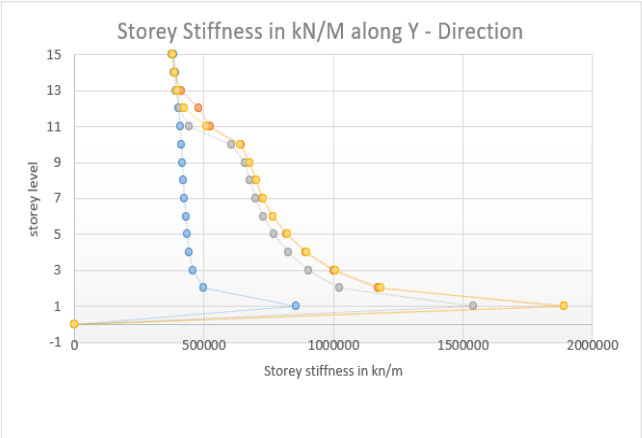
Modal time period in zone 5 for 25 story

By observing above graphs we can clearly say that the bare frame structure is showing the larger time period as compare to the bracing system structures and in the bracing frame structure the zipper bracing is showing the lesser time period of 24% for 25 storey and 18% for 15 storey structure compare to regular structure. The time period values are within the permissible limits.

3.Storey Stiffness







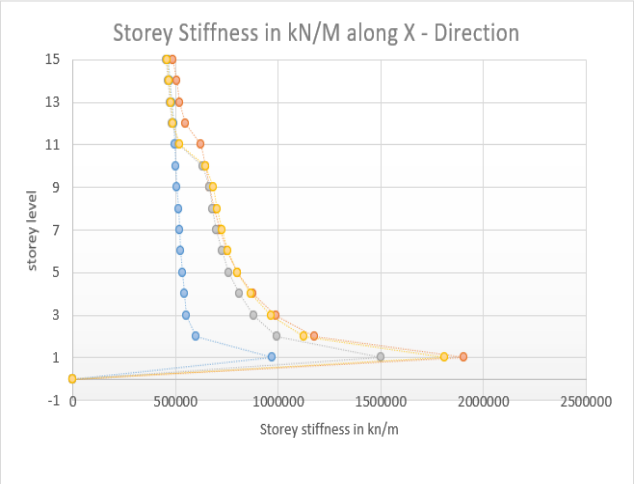


Fig. 5.22 Storey Stiffness in zone 5 along Y - Direction

The storey stiffness of the bare frame structure is lesser as compare to the all the braced structure and the stiffness of the structure is increases however the height of the bracing system is increases. After the bracing the stiffness is reducing in the higher storey respectively. The zipper type of bracing system is showing the higher stiffness in all the cases as compare to remaining all the models. In both the height of structure even in both the zones the zipper bracing structure is showing the increment in stiffness 19% for 25 storey structure and 22% for 15 storey building when compare to regular structure in both directions.

V.CONCLUSION

Following are the salient conclusions of the study:-

1. The bracing system effectively reduces the lateral displacement of the structure compared to bare frame and it also increases the safety against collapse
2. Bracing system proves as a effective member to control the story drift (up to 56%) in structures as compare to Bare frames.
3. In the view of storey drift, bracings are good to reduce the drift in case of zipper-bracing of 25% in 15 storey & 17% in 15 storey structure when compare with normal building, the displacement is higher than without bracing because of irregularity in shape of the structure.
4. The reactions and weight of the structure are more in different types of bracing structures when compared to unbraced structure with same configuration of the structure.
5. It is also seen that as there are different bracing systems employed the displacement and storey drifts, may increase or decrease for the braced buildings with the same configurations.
6. The braced buildings of the storey drift either increases or decreases, as compared to unbraced building with the same configuration for the different bracing system.
7. By providing lateral systems in the framed structures the reduction in the displacement, shear, moment thereby increasing the stiffness of the structure for resisting lateral loads due to earth quakes. By observing above graphs, we can clearly say that the bare frame structure is showing the larger time period as compare to the bracing system structures and in the bracing frame structure the zipper bracing is showing the lesser time period of 24% for 25 storey and 18% for 15 storey structure compare to regular structure. The time period values are within the permissible limits.

VI.REFERENCES

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