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Study on Behavior of Outrigger System on High Rise Structure by Varying Outrigger Depth in Seismic Zones of India by Using Staadpro

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ABSTRACT

These Tall building development is rapidly growing almost everywhere in the world acquainting new difficulties that need to be met with, through engineering evaluation. In tall buildings, lateral loads generated by earthquake or wind load are frequently resisted by providing coupled shear walls. But as the height increases, the building becomes taller and the efficiency of the tall building greatly depends on lateral stiffness and resistance capacity. So, a system called outrigger is introduced which improves overturning stiffness and strength by connecting shear wall core to outer columns. When the Structure is subjected to Lateral forces, the Outrigger and the columns resist the rotation of the core and thus significantly reduce the lateral deflection and base moment, which would have arisen in a free core. During the last three decades, numerous studies have been carried out on the analysis and behavior of outrigger structures. But this question is remained that how many outriggers system is needed in tall buildings. (Using Staad-Pro)

KEYWORDS: *couple Shear wall core, outrigger depth, rotation, stiffness, seismic load, dead load live load, load combination*

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INTRODUCTION

Earthquake is one of the most hazardous among all the natural hazards. Thus for building safety, it is essential that structures should have designed with adequate lateral stability, strength, and sufficient ductility as it affects the life of Peoples and property of the people harshly. For Lateral load resistance for reducing the effect of earthquake forces for RC buildings there are various Structural Systems. The Shear wall and Cross Bracing (X-bracing) is one of the system used in skyscraper to improve its structural stability to prevent it against the Lateral loads due to Earthquake. In present research work Comparison in between RCC Framed building with Coupled Shear wall in combination with X bracing & Simple RCC frame building is done. The Diagonal member of Cross bracing take the compression and tension stresses effectively while the Coupled Shear wall reduces the Bending moment, Shear force. The Structure conveyed the lateral loads by axial action by which stresses reduces over the column and beams as compared to stresses developed in columns and beams in the conventional building system. For present research analysis a regular 15 storey RCC frame having square plan of size 20 m × 20 m with Outriggers at Different Story levels which is considered. For the analysis of structure STAAD. Pro Software is used and the Seismic zone consideration is as per IS 1893 (Part 1): 2002.The Structure is analyzed for Earthquake loads for Various Seismic Zones along with Dead Load & Live Loads. Cross bracing system utilized in RC structures in which diagonal supports intersect. Cross bracing is usually made up of two diagonal supports placed in an X shaped manner; and these elements take compression and tension forces. Cross bracing can enhances an edifice capacity to withstand against lateral forces due to seismic activity.

LIERATURE REVIEW

For the proper functioning of our project I have undergone various national and international papers published. The summary of some important papers gone through are as below.

1. Ashish Raghuwanshi (2020)
To study the behavior of frame to the new concept of combine coupled shear wall and x bracing system.

2. Dr. Mahdi Hosseini et al (2019)
This research is done on response spectrum method of dynamic analysis of RC frame with shear walls under the effect of Seismic attack.

3. Dharanya et.al. (2017)
Published their research worked on the analysis and comparison of shear wall and bracings system with seismic loading condition.

AIM AND OBJECTIVE

1. Prepare To study the Behavior of frame with Outriggers at Different Story Positions.
2. To determine the variation in forces due to provision of Diagonal member and cross bracing system on structure under seismic forces in different seismic zones.
3. Comparison of results concluded from the analysis in terms of Max story drift, max story displacement, base shear in seismic case, story shear, time period and frequency

METHODOLOGY

In the primary step modelling of conventional bare frame structure and combine couple shear wall and X braced frame generated in Staad software. All the structure are formed with same plan area.

After modelling in design load as per IS 875 and seismic forces as per Indian standard 1893 :(Part-1)-2016 is applied over the structure in Staad-Pro.

Relative comparative study is done on the structures to understand its behavior in helping the reduction of lateral forces.

All the results obtained from results are plotted in graph using MS word

Loadings such as Dead Load, Live Load, Seismic Loads as per IS code provision is considered and the model is analyzed.

LOADING

The loadings were calculated partially manually and rest was generated using STAAD. Pro load generator. The loading cases were categorized as:

1. Seismic load (As per IS: 1893 (Part-1)-2016)
2. Dead load (As per IS: 875 (Part-1)-1987)
3. Live load (As per IS: 875 (Part-2)-1987)
4. Load combinations (As per IS: 875 (Part-5)-1987)

MODEL DATA:-

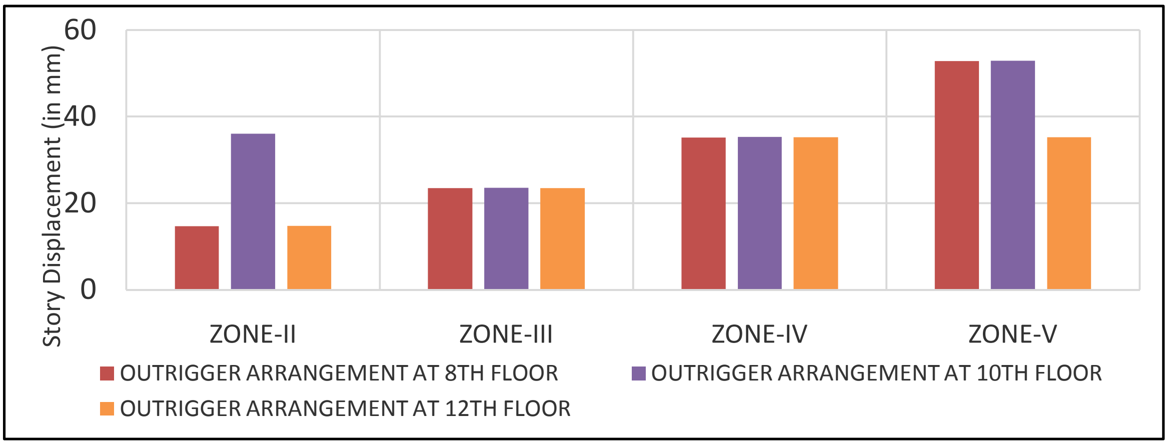
Plan Dimension = 20 m x 20 m (Grid)
Number of Storey of Building = 15 Storey
Shear Wall Thickness = 200 mm
Typical Storey Height = 3.00 m
C/C Distance of Column = 4.00 m
Slab Thickness = 150 mm
Concrete Grade = M25, Steel = Fe500.
Trial Beam Dimension's = 230 x 450 mm
Trial colunmn Dimension's = 450 x 450 mm
Outriggers Positions at 8th Floor, 10th Floor & 12th Floor are compared

RESULT AND COMPARISION

1. MAXIMUM STORY DISPLACEMENT (in mm)

Following Table & Figures shows Maximum Story Displacement for Different Outrigger Positions.

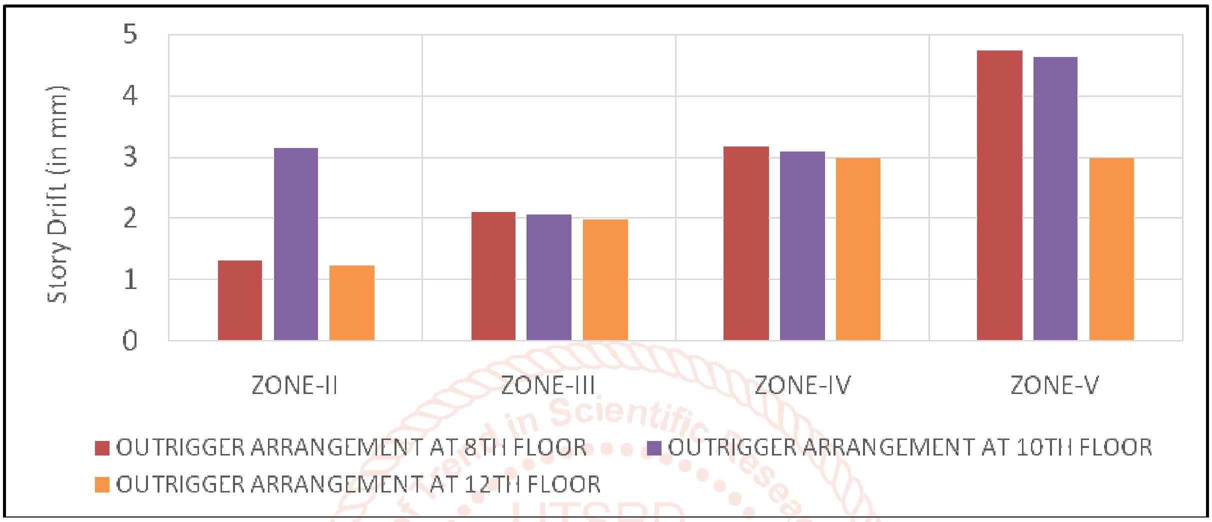
BUILDING TYPES	OUTRIGGER ARRANGEMENT AT 8TH FLOOR	OUTRIGGER ARRANGEMENT AT 10TH FLOOR	OUTRIGGER ARRANGEMENT AT 12TH FLOOR
ZONE-II	14.666	36.031	14.742
ZONE-III	23.465	23.592	23.516
ZONE-IV	35.198	35.286	35.214
ZONE-V	52.797	52.827	35.214



2. MAXIMUM STORY DRIFT (in mm)

Following Table & Figures shows Maximum Story Drift for Different Outrigger Positions in all Seismic Zones

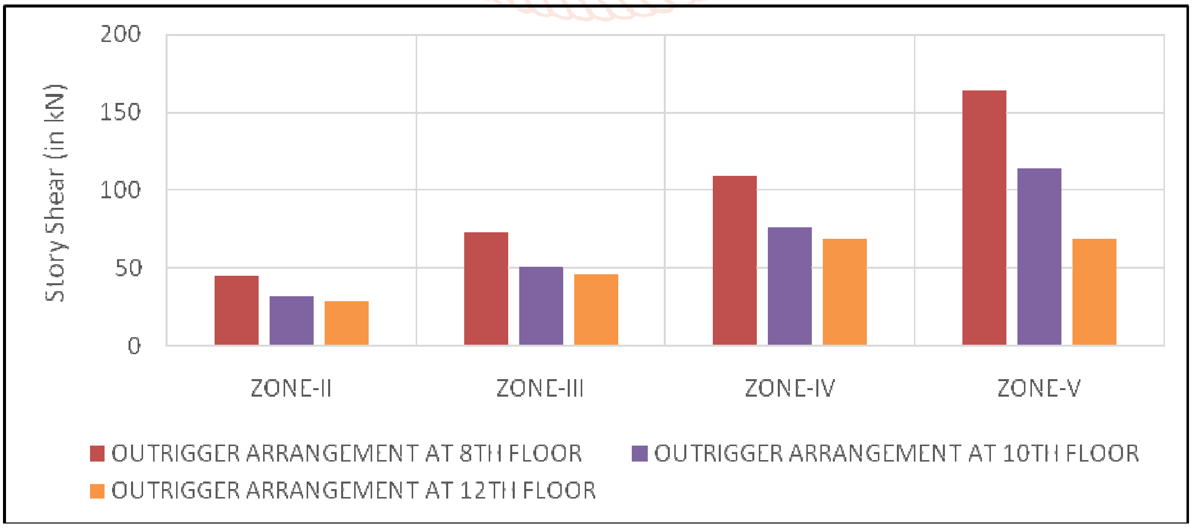
BUILDING TYPES	OUTRIGGER ARRANGEMENT AT 8TH FLOOR	OUTRIGGER ARRANGEMENT AT 10TH FLOOR	OUTRIGGER ARRANGEMENT AT 12TH FLOOR
ZONE-II	1.315	3.146	1.239
ZONE-III	2.105	2.055	1.982
ZONE-IV	3.157	3.080	2.972
ZONE-V	4.735	4.618	2.972



3. STORY SHEAR (IN KN) AT 16TH STORY

Following Table & Figures shows Story Shear for Different Outrigger Positions in all Seismic Zones.

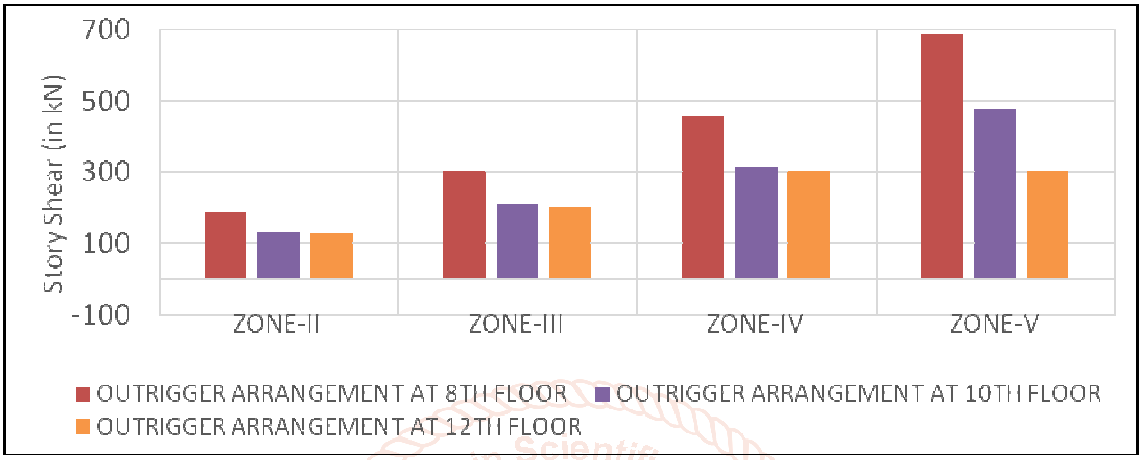
BUILDING TYPES	OUTRIGGER ARRANGEMENT AT 8TH FLOOR	OUTRIGGER ARRANGEMENT AT 10TH FLOOR	OUTRIGGER ARRANGEMENT AT 12TH FLOOR
ZONE-II	45.450	31.660	28.650
ZONE-III	72.730	50.660	45.840
ZONE-IV	109.090	75.980	68.760
ZONE-V	163.630	113.970	68.760



4. STORY SHEAR (IN KN) AT BASE

Following Table & Figures shows Story Shear for Different Outrigger Positions in all Seismic Zones.

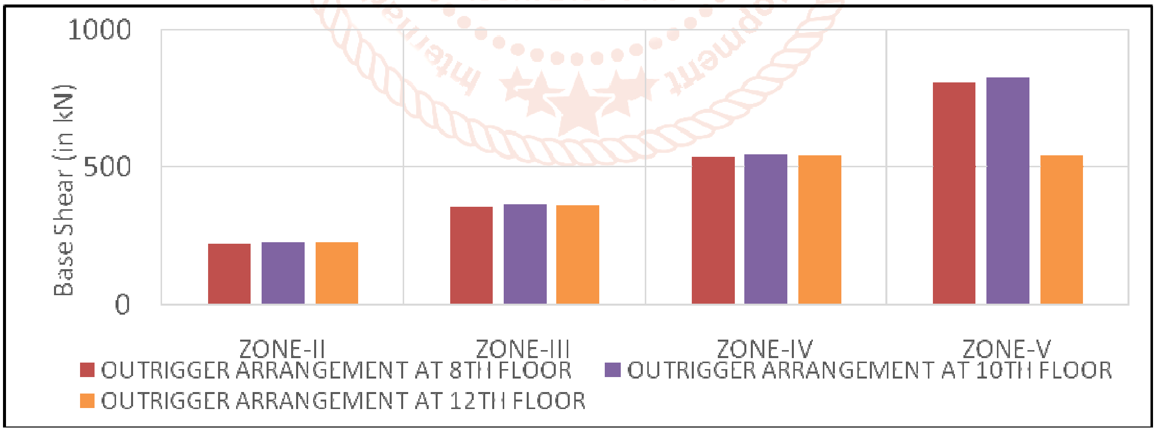
BUILDING TYPES	OUTRIGGER ARRANGEMENT AT 8TH FLOOR	OUTRIGGER ARRANGEMENT AT 10TH FLOOR	OUTRIGGER ARRANGEMENT AT 12TH FLOOR
ZONE-II	190.430	131.670	126.620
ZONE-III	304.680	210.670	202.590
ZONE-IV	457.020	316.000	303.880
ZONE-V	685.530	474.000	303.880



5. BASE SHEAR (IN KN)

Following Table & Figures shows Story Shear for Different Outrigger Positions in all Seismic Zones.

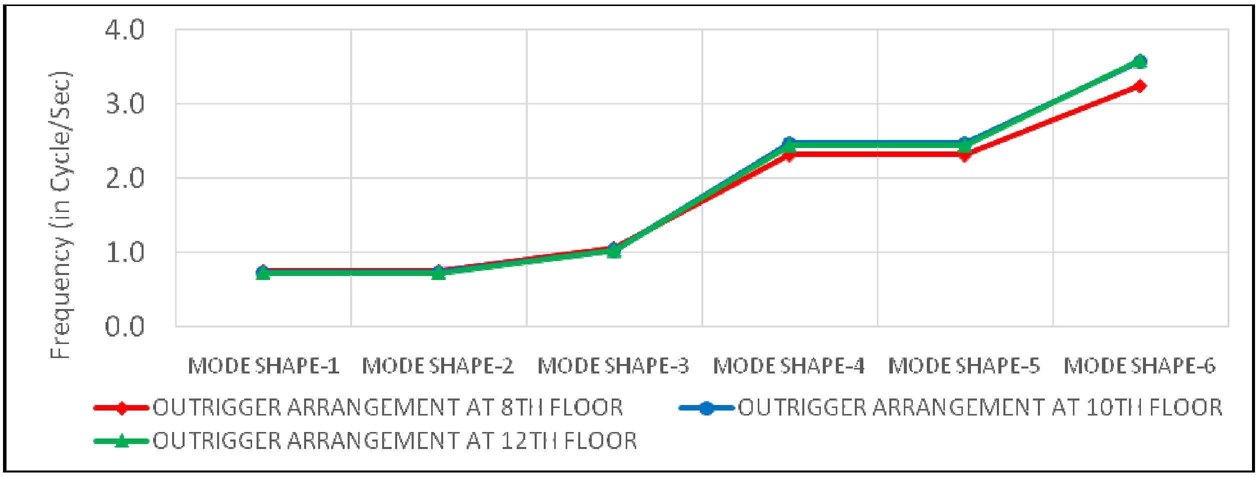
BUILDING TYPES	OUTRIGGER ARRANGEMENT AT 8TH FLOOR	OUTRIGGER ARRANGEMENT AT 10TH FLOOR	OUTRIGGER ARRANGEMENT AT 12TH FLOOR
ZONE-II	223.330	228.490	225.880
ZONE-III	357.330	365.580	361.410
ZONE-IV	535.990	548.370	542.110
ZONE-V	803.990	822.550	542.110



6. FREQUENCY (IN CYCLE/SEC) CALCULATED FOR RESPONSE SPECTRUM

Following Table & Figures shows Frequency calculated for Response Spectrum for Different Outrigger Positions & Mode Shapes.

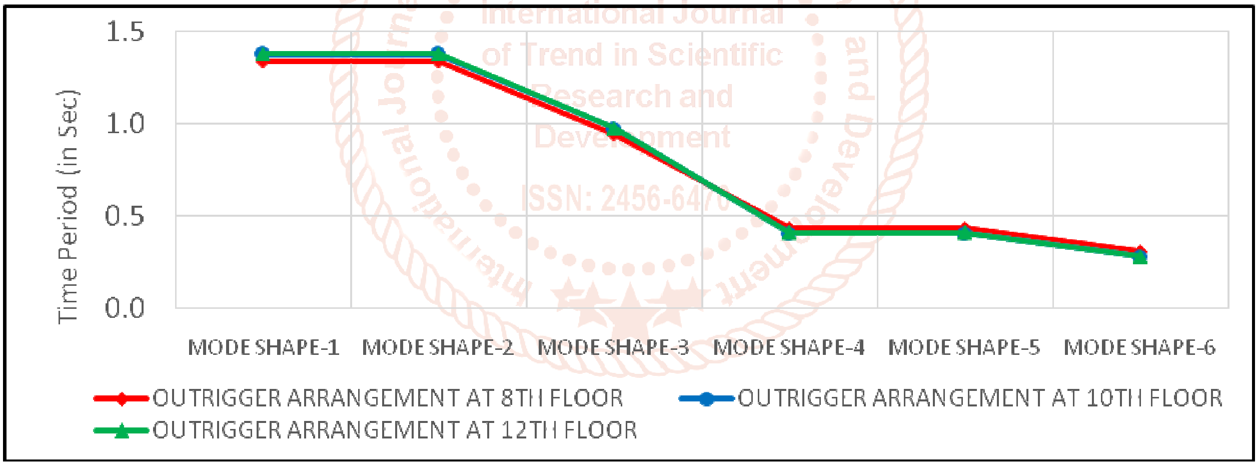
BUILDING TYPES	OUTRIGGER ARRANGEMENT AT 8TH FLOOR	OUTRIGGER ARRANGEMENT AT 10TH FLOOR	OUTRIGGER ARRANGEMENT AT 12TH FLOOR
MODE SHAPE -1	0.747	0.728	0.726
MODE SHAPE -2	0.747	0.728	0.726
MODE SHAPE -3	1.060	1.028	1.028
MODE SHAPE -4	2.314	2.473	2.445
MODE SHAPE -5	2.314	2.473	2.445
MODE SHAPE -6	3.247	2.473	3.589



7. TIME PERIOD (IN SEC) CALCULATED FOR RESPONSE SPECTRUM

Following Table & Figures shows Time Period calculated for Response Spectrum for Different Outrigger Positions & Mode Shapes.

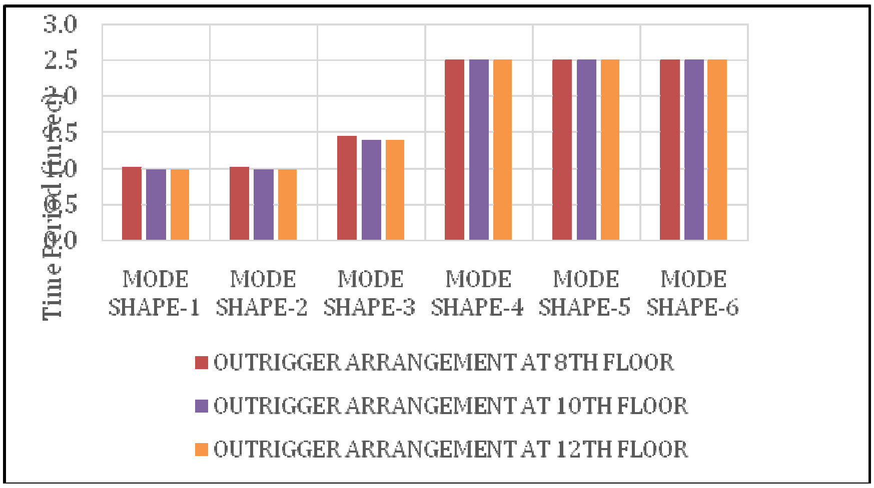
BUILDING TYPES	OUTRIGGER ARRANGEMENT AT 8TH FLOOR	OUTRIGGER ARRANGEMENT AT 10TH FLOOR	OUTRIGGER ARRANGEMENT AT 12TH FLOOR
MODE SHAPE -1	1.339	1.375	1.377
MODE SHAPE -2	1.339	1.375	1.377
MODE SHAPE -3	0.944	0.973	0.973
MODE SHAPE -4	0.432	0.404	0.409
MODE SHAPE -5	0.432	0.404	0.409
MODE SHAPE -6	0.308	0.280	0.279



8. SPECTRAL ACCELERATION CALCULATED FOR RESPONSE SPECTRUM

Following Table & Figures shows Spectral Acceleration calculated for Response Spectrum for Different Outrigger Positions & Mode Shapes

BUILDING TYPES	OUTRIGGER ARRANGEMENT AT 8TH FLOOR	OUTRIGGER ARRANGEMENT AT 10TH FLOOR	OUTRIGGER ARRANGEMENT AT 12TH FLOOR
MODE SHAPE -1	1.016	0.989	0.988
MODE SHAPE -2	1.016	0.989	0.988
MODE SHAPE -3	1.441	1.398	1.397
MODE SHAPE -4	2.500	2.500	2.500
MODE SHAPE -5	2.500	2.500	2.500
MODE SHAPE -6	2.500	2.500	2.500



CONCLUSION

1. It has been observed that for Earthquake Analysis of Building Storey Displacement and Drift is reducing with provision of Outrigger at Higher height.
2. The Maximum Story Displacement & Drift is reduced by the use of Outrigger arrangement in Building.
3. For 16 storey Building with provision of Earthquake load, Storey Displacement reduces from 52.797 mm with Outrigger at 8th Floor to 35.214 mm for Outrigger at 12th Floor under Seismic Zone-V, which shows that Displacement reduction with Higher the Outrigger Position.
4. The Outrigger structural systems not only efficient in controlling the top displacements but also play significant role in reducing the Story Shear at Top.
5. The use of Outrigger structural systems in high-rise buildings increases the stiffness and makes the structural more efficient under lateral load.
6. Outrigger system is quite efficient in reducing effect of Seismic load.

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