

# COMPARATIVE STUDY ON SEISMIC RESPONSE OF RC STRUCTURES WITH AND WITHOUT FLUID VISCOUS DAMPER.

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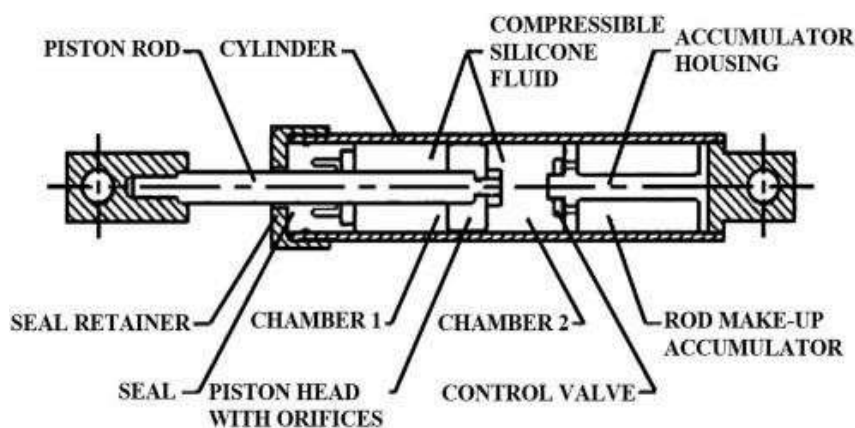
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**I. Abstract :** The three main types of loading circumstances that have an impact on a structure are defined loads, live loads, and dynamic loads such as wind and earthquake loads. This study therefore suggests installing fluid viscous dampers (FVD) in the structure at various locations and patterns to lessen the impact of earthquakes on the structure. The response spectrum method is utilized for dynamic analysis, and E-tabs is the program used for this study. A total of twelve models with various locations and patterns are examined. The results indicate that FVDs work best when placed diagonally and in chevron patterns at corners. To improve the structure's rigidity and regulate its seismic response, fluid viscous dampers are recommended.

## II. Introduction

A seismic occurrence is a natural thing that takes place when there is an abrupt release of energy within the Earth's crust, leading to seismic waves that spread through the ground. These seismic waves source the ground to shake, leading to tremors and vibrations that can be felt across large distances. Earthquakes are single of the record powerful and unpredictable forces of nature, and they have the potential to cause significant destruction and loss of life. Base isolation, bracing systems, and dampers are essential earthquake-resistant technologies used to avoid damage to buildings during earthquake. Each method works to mitigate the effect of earthquake forces on buildings in different ways. A damper is a mechanism used to absorb or dissipate energy during dynamic movements, such as earthquakes, strong winds, or vibrations. Dampers play a vital role in enhancing the structural resilience and reducing the effect of such forces on the building or structure. Fluid viscous dampers utilize the principle of fluid viscosity to dissipate energy. They consist of a piston moving through a viscous fluid (usually oil). When the building experiences movement, the piston's motion generates heat in the fluid, turning kinetic energy to thermal energy. This heat is then dissipated, effectively dampening the motion.



**Fig: 1 Fluid Viscous Damper(FVD).**

### Need of the study

The study of Fluid Viscous Dampers (FVDs) in high-rise buildings is crucial because these structures are highly vulnerable to dynamic loads from earthquakes and strong winds. FVDs function as passive control systems, significantly increasing a building's damping (typically 15% to 35%) to dissipate seismic and wind energy. This dissipation is essential to drastically reduce structural displacement, inter-story drift, and floor accelerations, which minimizes damage to both structural and non-structural elements and enhances occupant comfort. Ultimately, research on FVDs is vital for improving the resilience, ensuring functional recovery after a major event, and enabling more cost-effective and efficient structural design of tall buildings

### 1.1 Other Key Benefits and Research Areas

**Improved Resiliency and Functional Recovery:** By keeping the structure largely undamaged, FVDs improve the building's ability to remain operational or quickly return to service following a major event, a concept known as resilience.

**Cost-Effectiveness and Design Optimization:** Research demonstrates that using FVDs can allow designers to utilize smaller structural elements and less complex foundations, offsetting the damper cost and resulting in a more economical overall structure.

**Retrofitting and Upgrades:** FVDs are an efficient method for seismic retrofitting existing high-rise buildings, reducing force demands below the existing structural capacity without requiring widespread system strengthening.

**Dual Performance:** FVDs can be designed to effectively mitigate both high-velocity (earthquake) and low-velocity (wind) induced vibrations, often requiring a tailored design approach.

**Modeling and Placement Optimization:** Ongoing research focuses on the optimal number and placement of FVDs within a structure to maximize the benefits in terms of drift reduction and cost-effectiveness.

The study of FVDs is critical for ensuring the structural integrity and safety of the rapidly growing number of tall and super-tall buildings in seismically active and high-wind regions globally.

## III. RESEARCH METHODOLOGY

In this research G + 10 RCC building is considered. 12 models are done with different patterns and locations which are model 1 - diagonal arrangement of FVD at corners, model 2 - alternative diagonal arrangement of FVD at corners, model 3 - diagonal arrangement of FVD at centre, model 4 - alternative diagonal arrangement of FVD at centre, model 5 - X-type arrangement of FVD at corners, model 6 - alternative X-type arrangement of FVD at corners, model 7 - X-type arrangement of FVD at centre, model 8 - alternative X-type arrangement of FVD at centre, model 9 - chevron type arrangement of FVD at corners, model 10 - alternative chevron type arrangement of FVD at corners, model 11 - chevron type arrangement of FVD at centre, model 12 - alternative chevron type arrangement of FVD at centre.

The RCC structure is presumed to be situated in Zone 5 of India, characterized by medium stiff soil conditions.

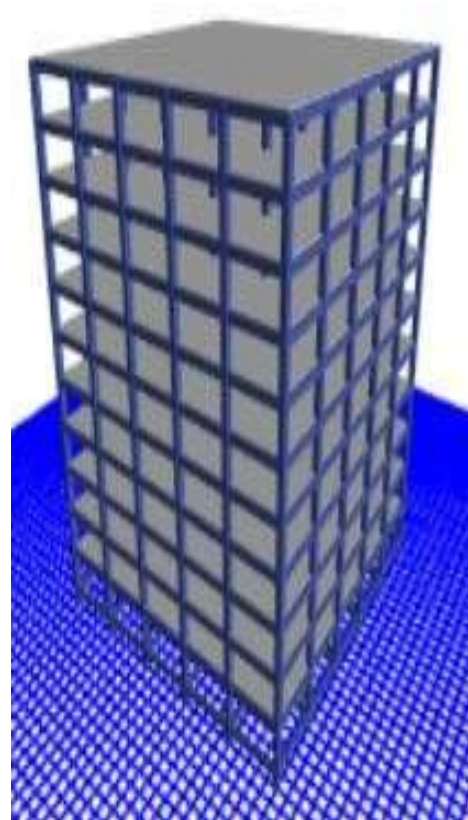
Table 1: Parameters considered for analysis of Model

BUILDING DESCRIPTION	
Plan Dimension	25mx25m
Each bay dimension	5m
Response Reduction Factor [R]	5
Damping Ratio	0.05
Structure Type	SMRF
Importance Factor	1
Soil type	Medium (type-II)
Number of Storey	G+10 Storey
Height of typical floor	3m
Height of Building	34.5 m
Column size	500mm x 600mm
Beam size	400mm x 600mm
Damper type	FVD 250

Live load	3kN/m <sup>2</sup>
Floor Finish	1.5kN/m <sup>2</sup>
Live load on roof	1.5kN/m <sup>2</sup>
Wall load	11.04kN/m <sup>2</sup>



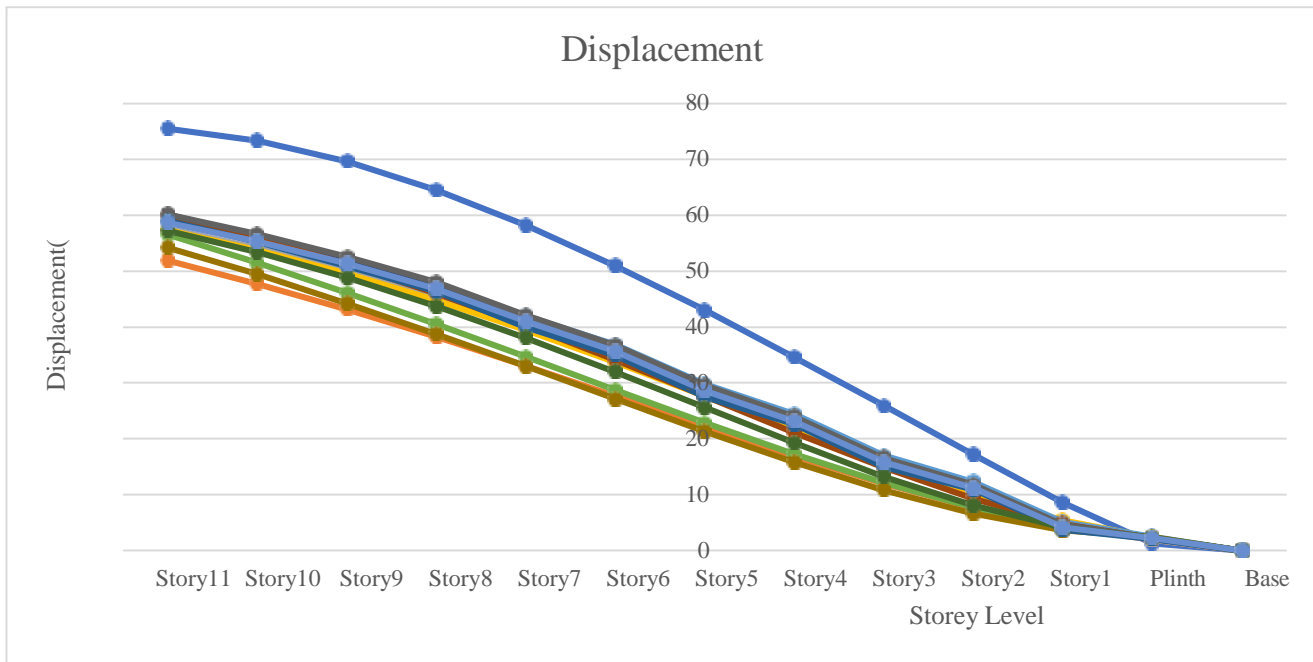
**Fig 2: Front View of Model**



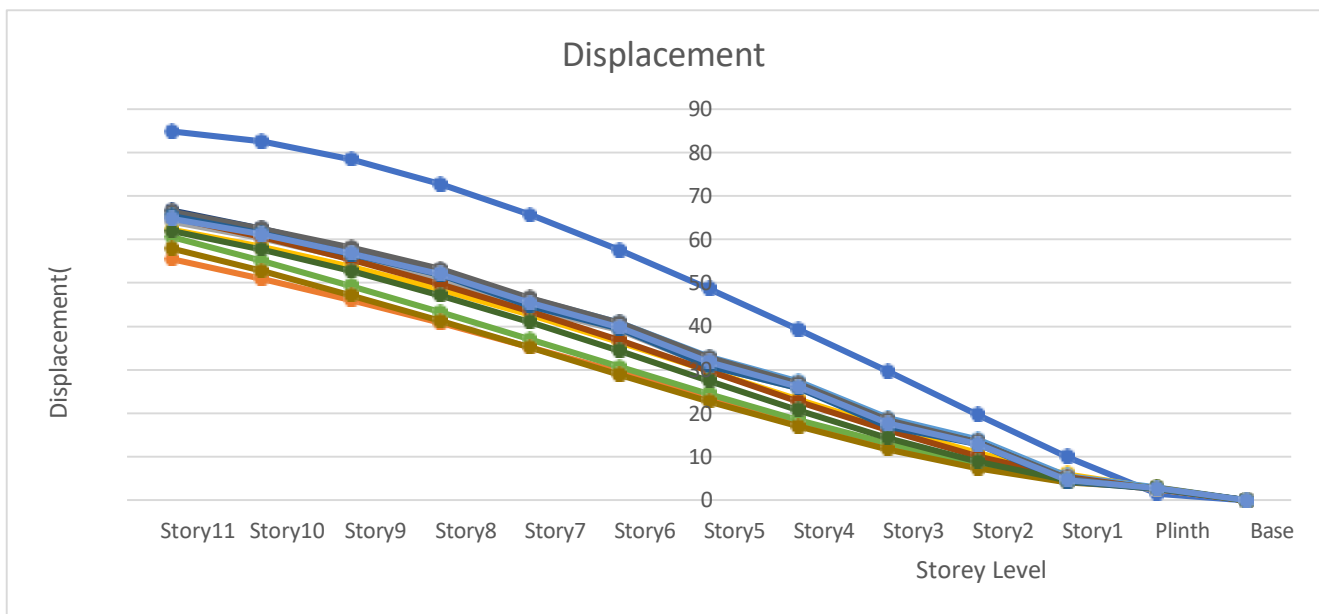
**Fig 3: 3D Rendered View of Model**

## IV. RESULTS AND DISCUSSION

### 4.1 Storey Displacement



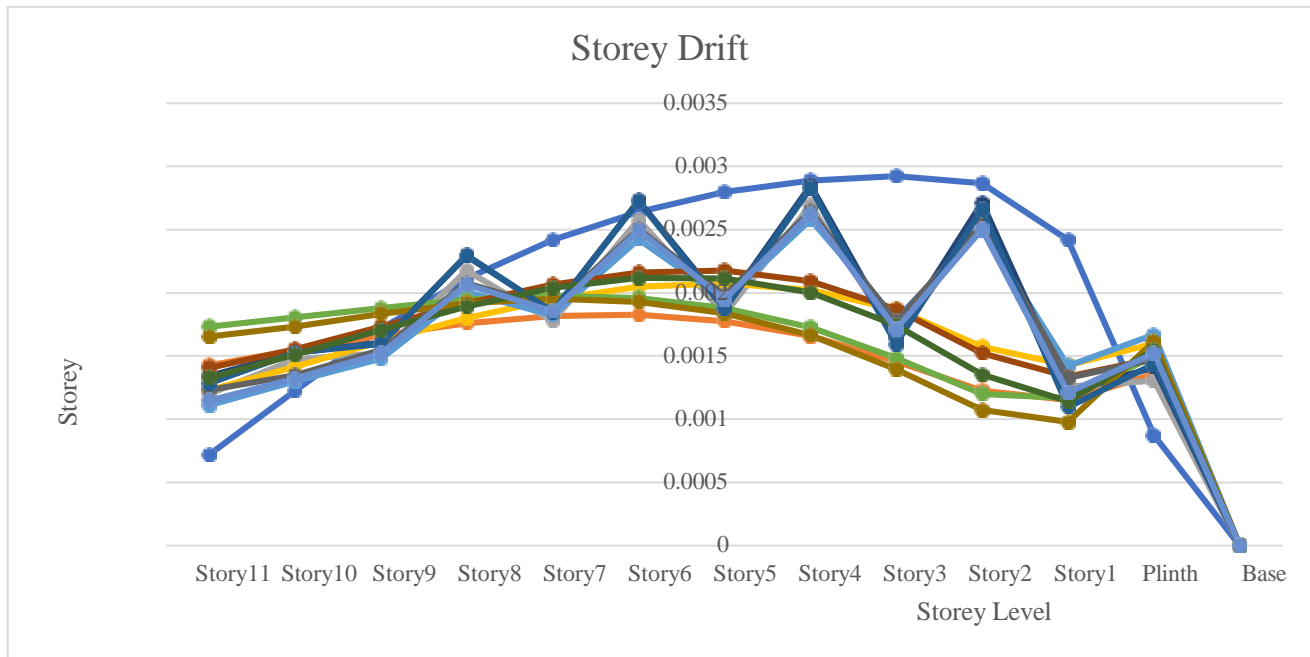
**Fig 4: Storey Displacement Along X- Direction**



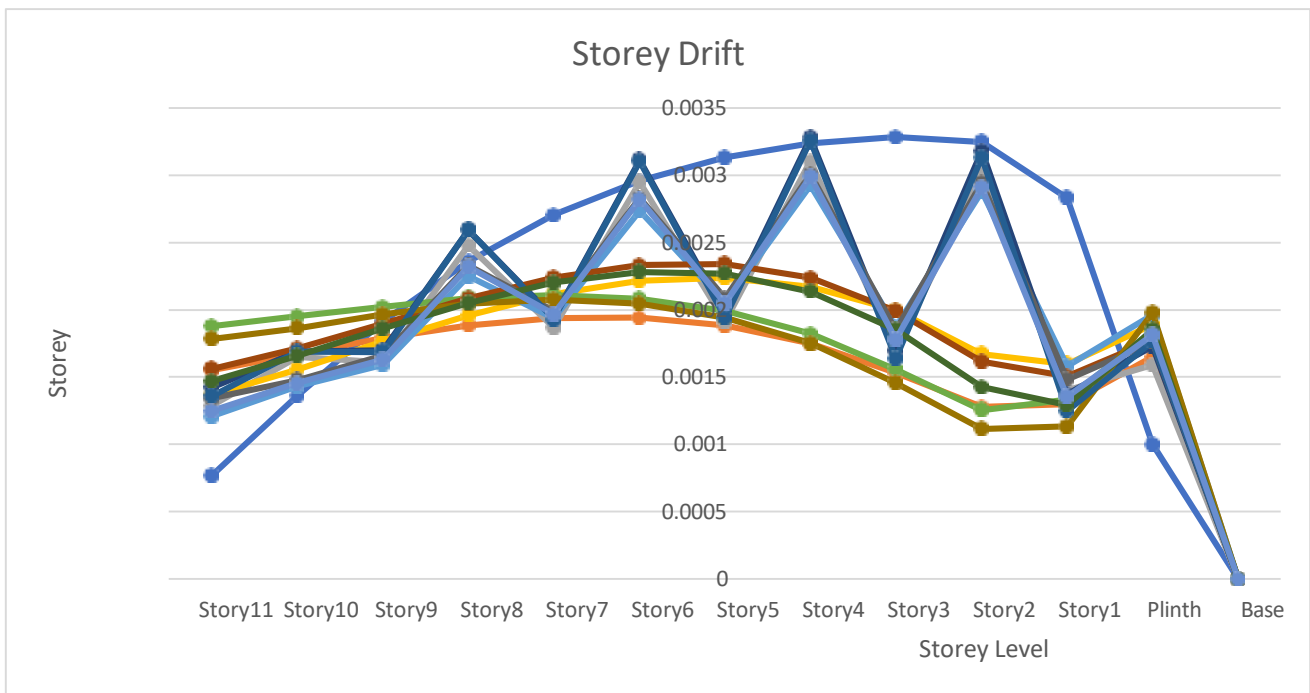
**Fig 5: Storey Displacement Along Y- Direction**

Maximum storey displacement for the model according to IS:1893(2016) is 138mm. The storey displacement is safe for all the models. By observing all the models there is 31.275% of reduction in storey displacement along X- Direction and 34.61% reduction in storey displacement along Y- Direction in model 1. So according to the results obtained we can reduce the storey displacement effectively if we arrange FVD diagonally at corner as shown in model 1 than any other arrangement. The displacement in model 1 is 51.899mm in X-direction and 55.523mm in Y-direction. We are getting better compared to previous results because in [4] they have done for zone 2 and in [4] they have done analysis for zone 4 but with this arrangement we are getting good results for zone 5 where the earthquake is more compared to other zones.

### 4.2 Storey Drift



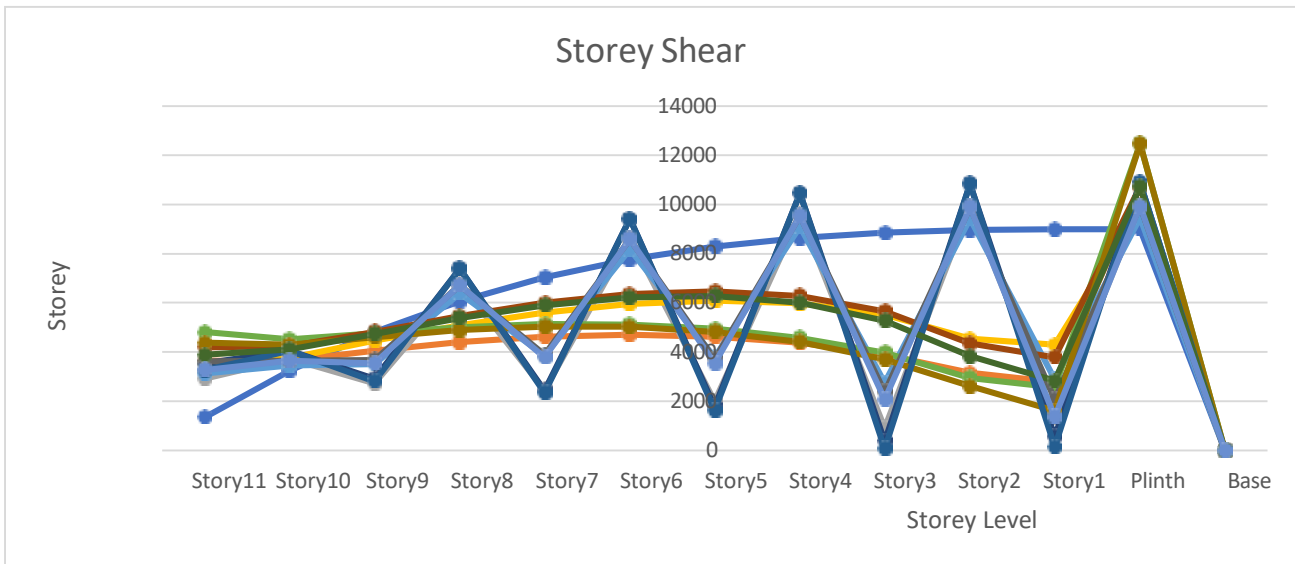
**Fig 6: Storey Drift Along X- Direction**



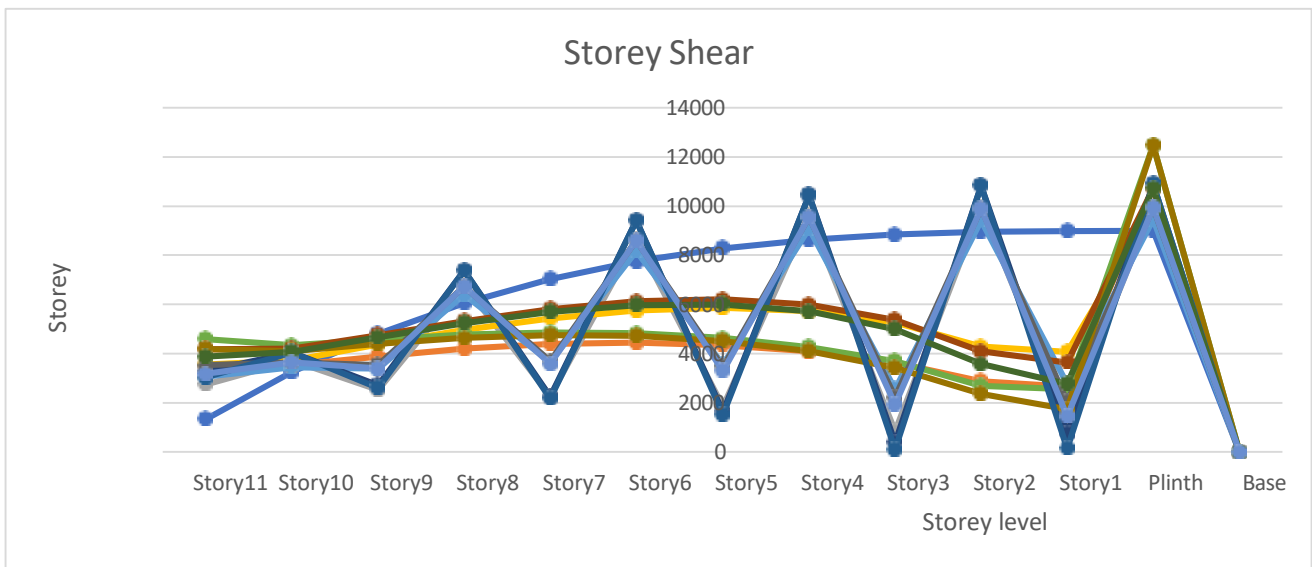
**Fig 7: Storey Drift Along Y- Direction**

Maximum storey drift for the model according to IS:1893(2016) is 0.004H which is 138mm. By observing all the models storey drift is maximum in storey 3, from the results we can observe that storey drift is reduced 52.36% along X-direction and 55.56% along Y-direction in Model 9. So, in order to decrease the storey drift chevron type arrangement at the corner is recommended because the obtained values are 0.001667mm in X-direction and 0.00146mm in Y direction.

### 4.3 Storey Shear



**Fig 8: Storey shear Along X- Direction**



**Fig 9: Storey shear Along Y- Direction**

By observing all the models storey shear is maximum in model 5 and 9, from the results we can observe that storey shear is increased by 27.83% with respect to model without damper along X and Y-direction.

### 4.4 Conclusion

In this research, fluid viscous dampers are placed in structure at 12 different places. The analysis is done by response spectrum method using E-tabs software and the models are compared for the parameters such as Storey displacement, Storey drift, Storey shear and time period. There is 31.275% of reduction in storey displacement along X- Direction and 34.61% reduction in storey displacement along Y- Direction in model 1. So according to the results obtained we can reduce the storey displacement effectively if we arrange FVD diagonally at corner as shown in model 1 than any other arrangement. The displacement in model 1 is 51.899mm in X-direction and 55.523mm in Y-direction. Storey drift is maximum in storey 3, from the results we can observe that storey drift is reduced 52.36% along X-direction and 55.56% along Y-direction in Model 9. So in order to decrease the storey drift chevron

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