Study on the Performance of Reinforced Concrete Structure with Fluid Viscous Damper

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Abstract - The major forms of loading conditions that affect structure include specified loads, live loads and dynamic loads like earthquake and wind loads. So, in this research, to decrease the effect of earthquakes on structure, fluid viscous dampers (FVD) with different location and patterns are proposed to install in the structure. The software used for this analysis is E-tabs and response spectrum method is used for dynamic analysis. Total twelve models are analysed with different patterns and locations. Outcomes show that FVDs are effective when we arrange diagonally at corners and with chevron type arrangement at corners. Fluid viscous dampers are suggested to the structure, to control the seismic response and increase the stiffness of the structure.

Keywords: Fluid Viscous Dampers, E-Tabs, Response Spectrum Method, Seismic Analysis, Earthquake.

I. 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.

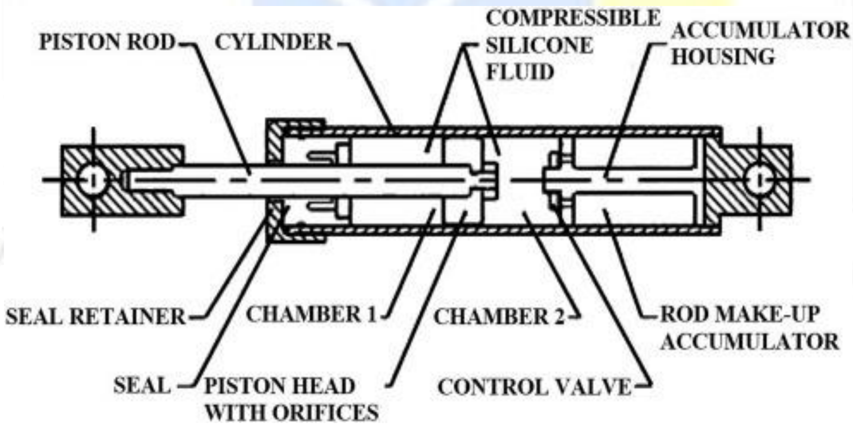

Fig-1: Fluid Viscous Damper

II. LITERATURE REVIEW

Mayur B Prajapati, Arjun M Butala, Nirmal S Mehta (2023) published "Performance of RCC Structure with Viscous Damper" In this research study, analysis of an RC structure with viscous damper was the main objective. By applying earthquake time history method to earthquake recordings from the Bhuj and El Centro earthquakes in the ETABS software, the goal was to evaluate how the structure would behave under seismic loads. This analysis was done as part of the study's attempt to shed light on the displacement, story drift, and base reaction behaviour of the RC structure with viscous dampers. The goal was to use earthquake time history analysis and records from the Bhuj and El Centro earthquakes to determine how the structure would respond to seismic loads.

Sairam Baikhan, D Karunakar, G.Mallikarjuna rao, Oggu.Praveen (2022) published "Optimization of Fluid Viscous Damper Diagonal & Combined Bracing Arrangement in G+9 RCC Structure." In this work, an experiment, done with a G+9 reinforced concrete structure while seismic analysis in SAP-2000 has become more prevalent. The connection of fluid viscous dampers placed in various patterns in two different systems, such as diagonal bracing and combined bracing system, has been employed to analyse the G+9 RCC structure. A total of 30 types have been advocated by trial-based in various stimulating patterns. By means of the resulting structural performances, such as lateral displacement, energy dissipation, storey drift, and base response, among others, the effectiveness of those structural models that were analysed had better be plainly pragmatic. It had been advised to assume the best possible configuration of FVDs for the vibrating control system in seismic response resistant structures.

Summary: The software used for the modelling of the structure are ETABS and STAADPRO and SAP. The analysis of the structure has been performed for the different seismic zones. Response spectrum method, time history method and push over analysis methods are used for the analysis of the structure. FVD damper are installed for different storey height buildings at positions.

III. 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	$3kN/m^2$
Floor Finish	$1.5kN/m^2$
Live load on roof	$1.5kN/m^2$
Wall load	$11.04kN/m^2$

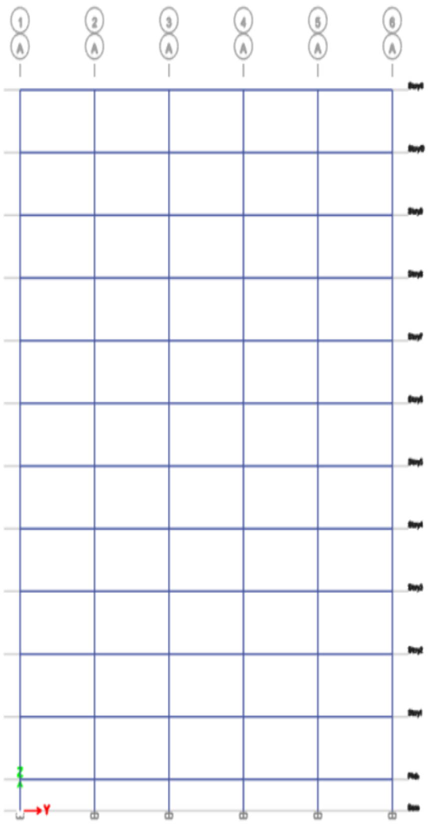

Fig 2: Front View of Model

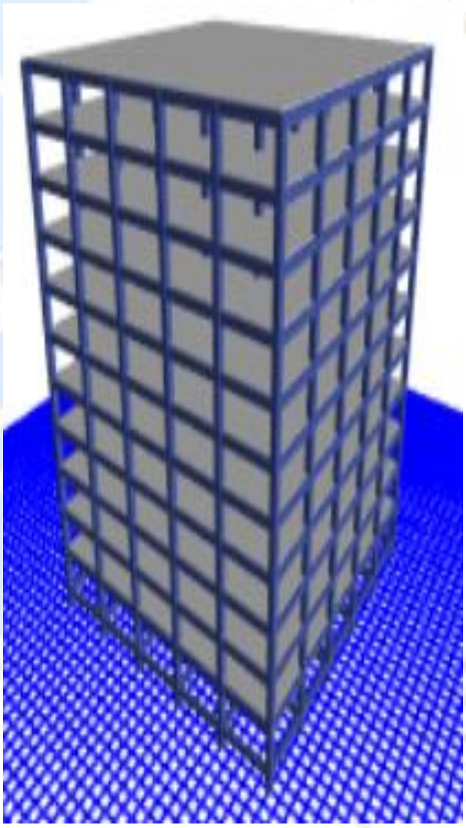

Fig 3: 3D Rendered View of Model

IV. RESULTS AND DISCUSSIONS

1. Storey Displacement

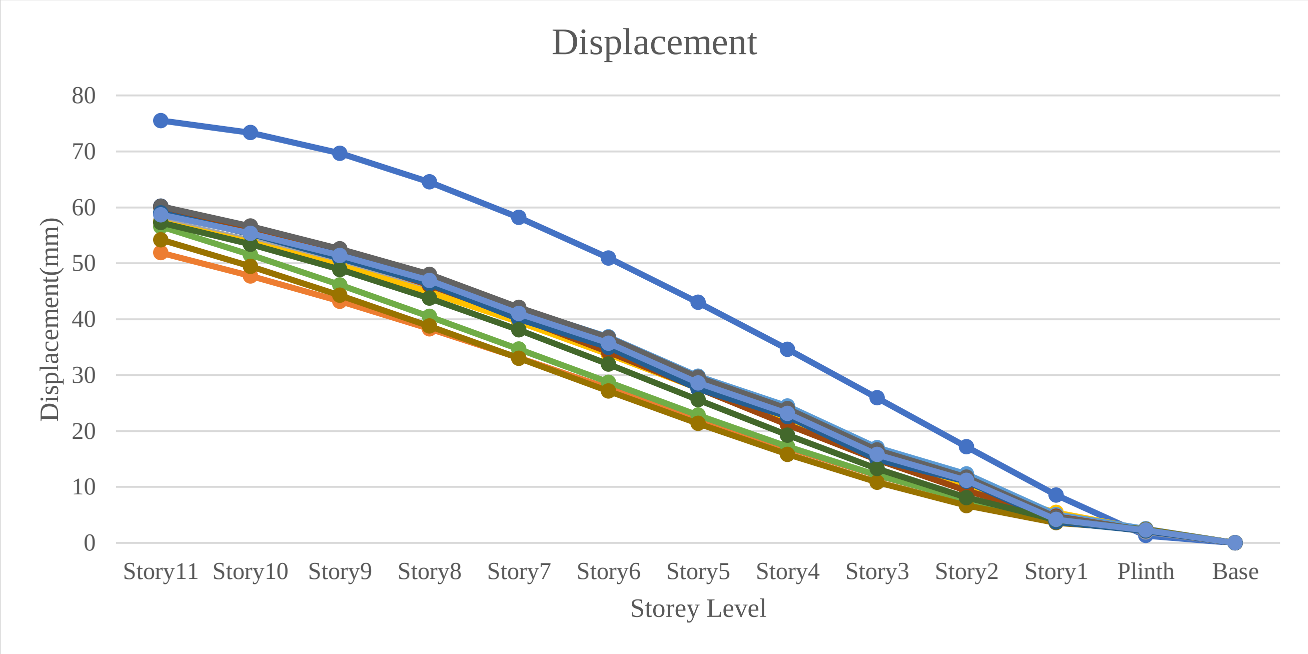

Fig 4: Storey Displacement Along X- Direction

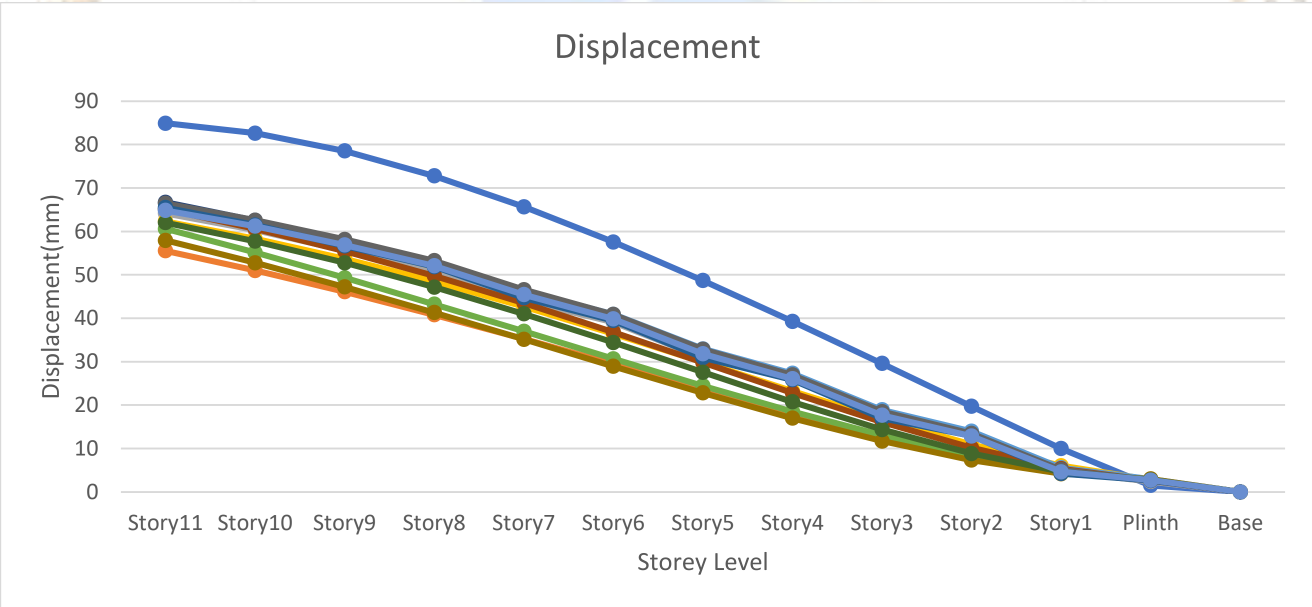

Fig 5: Storey Displacement Along Y- Direction

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.

2. Storey Drift

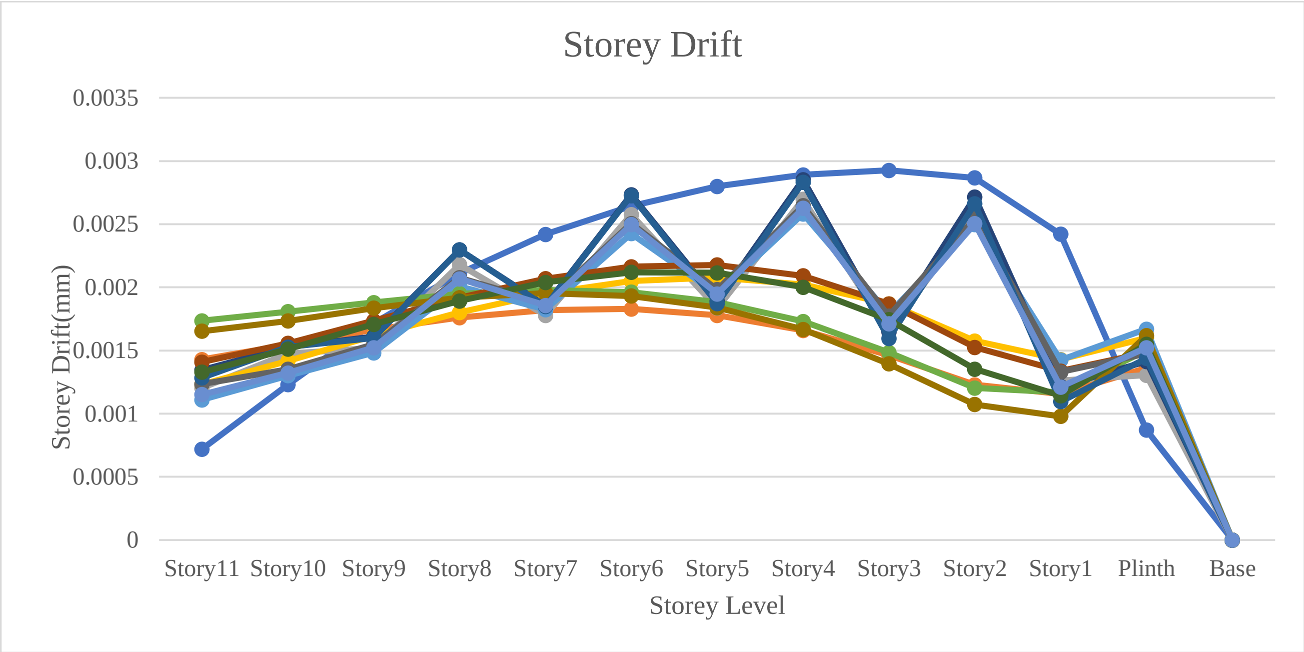

Fig 6: Storey Drift Along X- Direction

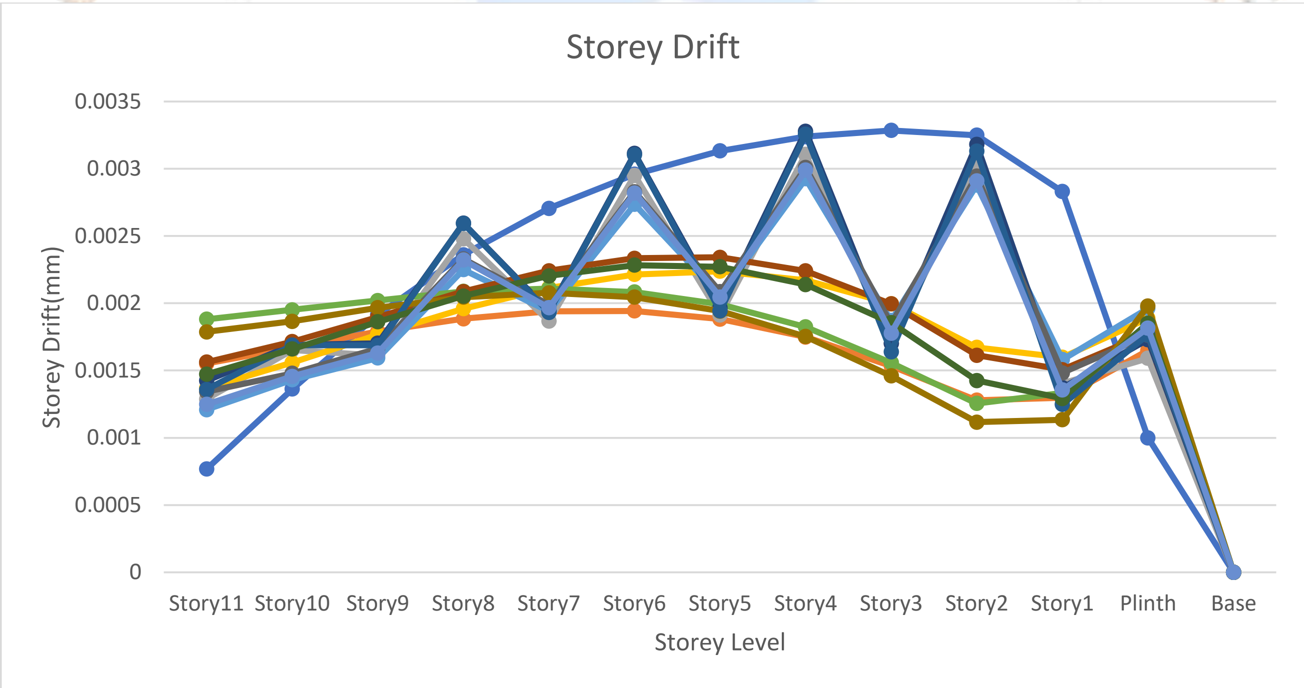

Fig 7: Storey Drift Along Y- Direction

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.

3. Storey Shear

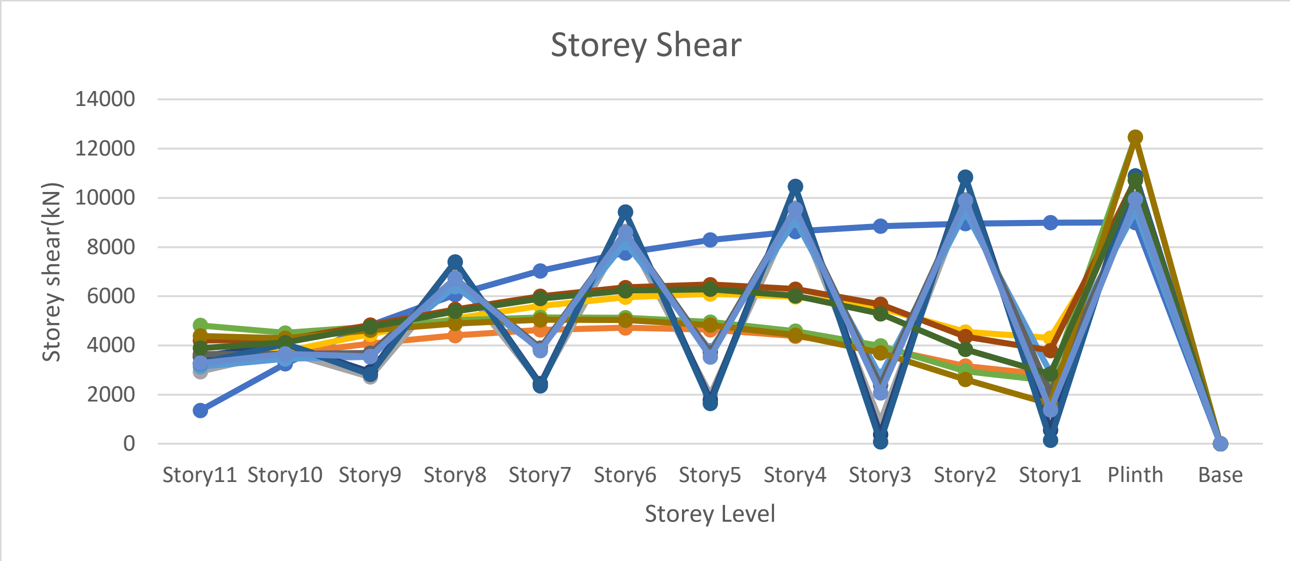

Fig 8: Storey shear Along X- Direction

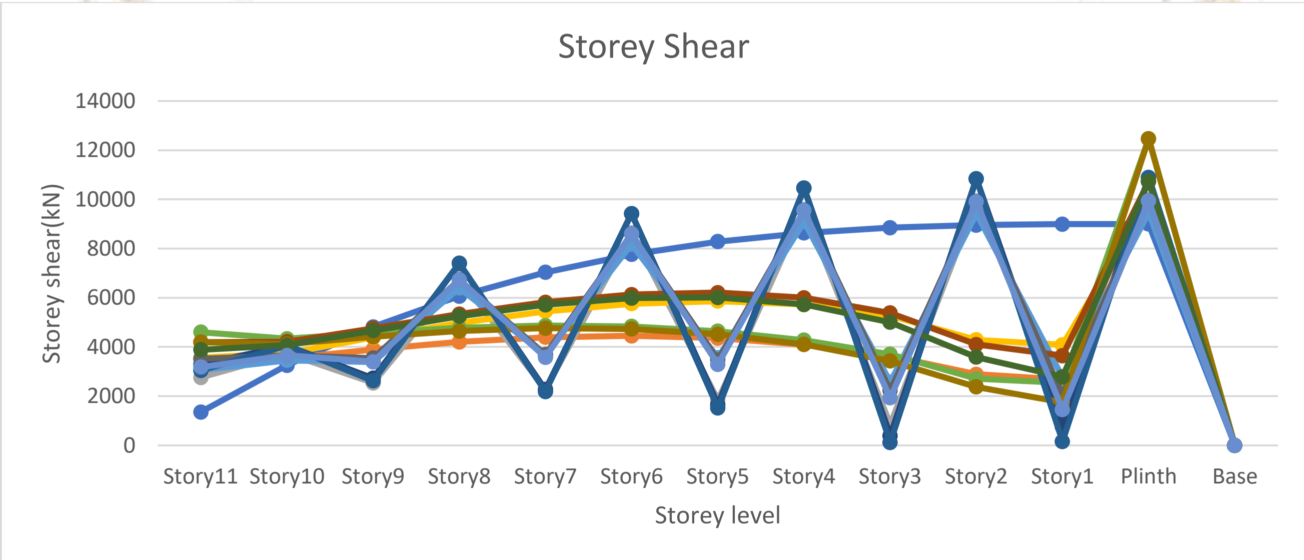

Fig 9: Storey shear Along Y- Direction

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.

V. CONCLUSIONS

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 type arrangement at the corner is recommended because the obtained values are 0.001667mm in X-direction and 0.00146mm in Y direction. Storey shear is maximum in storey 5 and 9, from the results we can observe that storey shear is increased by 27.83% along X and Y-direction.

VI. References

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