Seismic Analysis of Reinforced Concrete Building Using Fluid Viscous Damper

Ansh Jindal[1], Farhaan Majied[2], Gaurav Singh[3], Hrishikesh Dubey[4]

[1,2,3] *Undergraduate Student, Department of Civil Engineering, Delhi Technological University, Delhi, India*
[4]Assistant Professor, *Department of Civil Engineering, Delhi Technological University, Delhi, India*

Abstract - *Structure are lifeline to our modern world. We as human are dependent on them to commute, to work, or to power our economies. As India grows further, more and more different types of structures will be required whether it is for accommodation, Housing, warehouse, office spaces or more. As civil engineers, it is our duty to make sure that we design and construct our structures responsibly, and efficiently so as service to our needs. As we know, in Delhi, the major natural disaster that occur is earthquake. So, an earthquake is the only disaster that can cause harm to our structures. Thus, it becomes utmost important that we pay attention to earthquake resistance by building or how our structure could survive a possible earthquake and seismic wave. So, it is very important to carry out seismic analysis of structure in this case a building. We are here interested to learn and apply the fundamentals concept of seismic analysis and to learn about the application of the use of fluid viscous damper that help dissipates and absorb seismic waves itself, thus protecting the structure. The use of dampers that actually work as energy dissipators have been taken up to meet the safety and serviceability requirements of structures.*

Key Words: Earthquake Resistant Buildings, Earthquake, Structural Analysis, , Energy Dissipators, Fluid Viscous Dampers, Time History Analysis, Pushover Analysis, Response Spectrum Analysis, Fast Non Linear Analysis

1. INTRODUCTION

In the present era of high population, construction of high-rise buildings is becoming the need of the hour. With massive work going on in construction sector, utmost priority is given to safety and serviceability of structures. The seismic waves produced by earthquakes pose a major threat to the safety of structures. To counter this, the use of energy dissipating devices has been encouraged in the construction setup. These energy dissipators, technically known as dampers enhance the safety of buildings. This paper deals with comparative structural analysis of structures both with and without dampers, using different software tools like ETABS and thereby getting a view of the efficiency in the safety of structure by the introduction of dampers.

The earthquake creates vibrating forces at the base of the structure, which in turn result in the creation of oscillations in the structure. These oscillations produced at the base are transferred to the top of structure which may prove disastrous for the structure.

The basic aim of this paper is to find optimum methods that would decrease or control these vibrations and enhance the safety of the structure. For it, we will be doing detailed analysis by carrying out comparative study of four models using 5 earthquake ground motion data. For this we do Pushover Analysis, Response Spectrum and Time History. We try to differentiate the best most optimized floor position for damper results with the least.

2. LITERATURE REVIEW

In recent years, a lot of literature work has been done with regards to the safety and serviceability of structures. The conventional approach to the construction of earthquake resistant structures depends on the construction of buildings with enough strength, stiffness and inelastic deformation capacity that can withstand the amount of vibrations and oscillations caused by the earthquake in the structure.

Prof Y. G. Zhao and T. Ono (2001) noted about “second strategies for structural reliability” in which they said, to perform a correct analysis a structural engineer ought to decide such information as structural hundreds, geometry, guide conditions, and materials properties. The effects of such an analysis normally encompass assist reactions, stresses and displacements. This record is then compared to standards that imply the situations of failure. superior structural evaluation may additionally study dynamic reaction, balance and non-linear behavior.

H.kit Miyamoto et al, (2013) Studied the use of four story industrial building. For three-D mathematical fashions SAP software program is used. Nonlinear fvd is employed to regulate memories go with the flow. Nonlinear time history executed to decide performance. two tiers of seismic risks investigated first (MCE) and 2d one (DBE).in the end the most response quantities which include displacement, acceleration, and tale shear evaluated.

D.Lee et al (2001) an in-depth summary given on working method of FVD, installation method, and its future scope. In this paper effect of linear and non linear damper and their relationship studied. Various software like SAP and ETABS for modelling of dampers were suggested for seismic response reduction purposes. Also describe various bracing method of putting in dampers.

3. MODELING AND ANALYSIS OF STRUCTURE

Our aim is reduction in seismic response. We have formulated 4 models with difference in positions of dampers.

For sourcing the earthquake data, we have referred to Center for Engineering Strong Motion Data, & Pacific Earthquake Engineering Research Center (PEER), for the Ground Motion Database. Here we wanted to collect the best possible ground motion database available so that we can apply and use that in ETABS 19 to carry out analysis our models. The Best 5 Ground Motion Database we have found are as follows

A) Friuli, Italy 1976
B) Kobe, Japan 1995
C) Managua, Nicaragua 1972
D) Tabas, Iran 1978
E) Imperial Valley, Usa & Mexico 1979

3.1 Modeling

Pushover Analysis, Response Spectrum and Time History Analysis is carried out on four different RC models with and without shear wall at different locations. All the models are of G+6 story and having a floor area of 15 m x 20 m. We have place 8 FVDs at each corner of the floor.

Model 1: Bare Frame model
Model 2: Model with dampers at 2nd story
Model 3: Model with dampers at 3rd story
Model 4: Model with dampers at 4th story

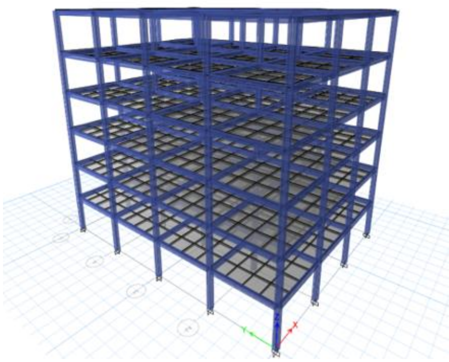

Fig 1 :- 3D model 1: Bare Frame

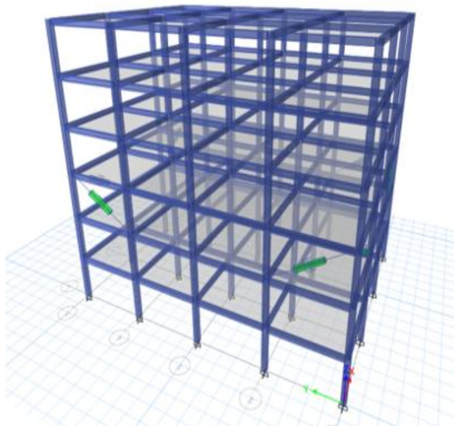

Fig 2 :- 3D model 2: Model with damper at 2nd Storey

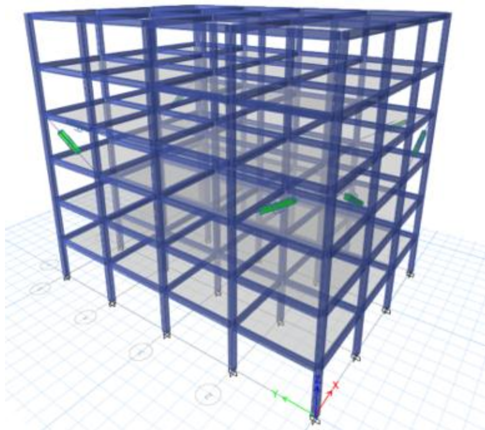

Fig 3:- 3D model 3

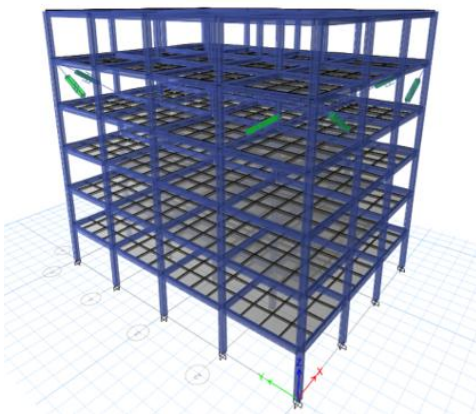

Fig 4:- 3D model 4

4. METHODOLOGY

The seismic performance evaluation of the building is studied based on pushover analysis. The building models with and without Fluid Viscous Damper at different locations are modeled and Time History Analysis and Response Spectrum Analysis is carried out using ETABS 2019 software and then best floor for least reduction in response is found out. The Pushover analysis reports are taken in terms of Maximum Story Displacement and Story Drift of the building. Comparative Study of four models using Time History Analysis and Response Spectrum Analysis were carried out.

In Time History Analysis, using 5 earthquake data, we have compared the bare frame and a damper model, thus establishing the use case of damper. After that, Response Spectrum Analysis, we again using 5 earthquake data compare the seismic performance in bare frame and damper models and lays down results. Next, we strive to find out best floor locations to put damper.

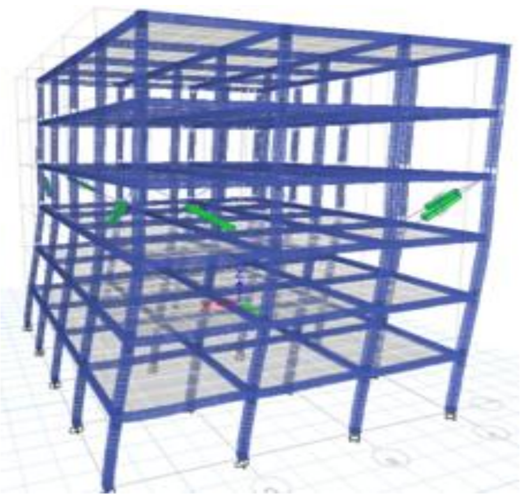

Fig 5:- Model subjected to force

5. RESULTS

Comparatives Study of Building With And Without Fluid Viscous Damper:-

The models which we have designed in ETABS 2019 were analysed statically. Here we have tried to lay down the results we have obtained through vigorous analysis of structure. We have presented tables and graphs of Time History analysis and Response Spectrum Analysis.

5.1 Performing Time History Analysis Of Various Earthquakes

Here taking the four models we have performed Time History Analysis using 5 Earthquake data.

A) Friuli, Italy 1976
B) Kobe, Japan 1995
C) Managua, Nicaragua 1972
D) Tabas, Iran 1978
E) Imperial Valley, Usa & Mexico 1979

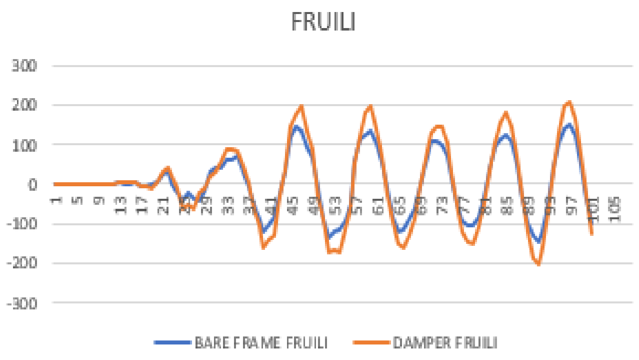

Fig 6: Comparison between bare frame and damper model

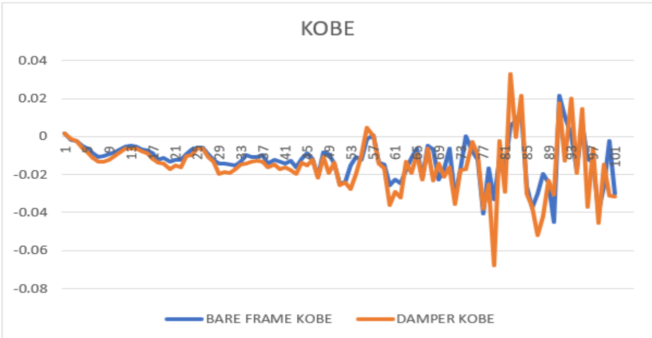

Fig 7: Comparison between bare frame and damper model

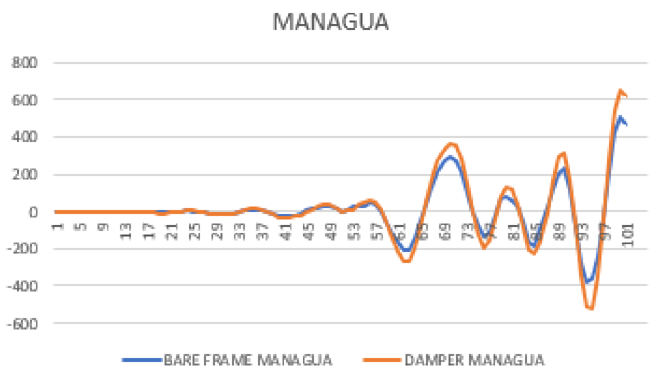

Fig 8: Comparison between bare frame and damper model

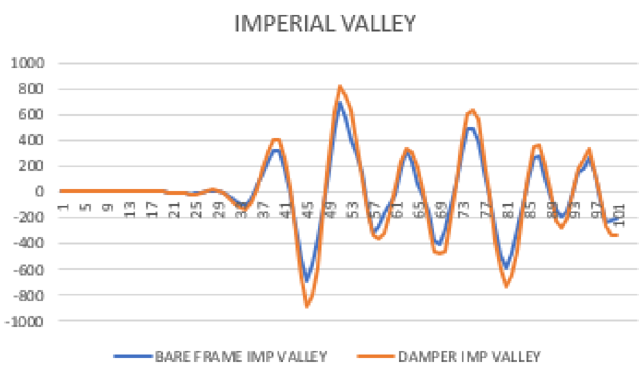

Fig 9: Comparison between bare frame and damper model

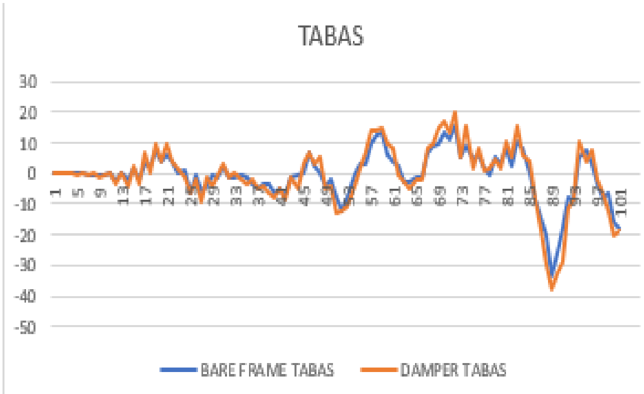

Fig 10: Comparison between bare frame and damper model

5.2 Performing Response Spectrum Analysis

With fluid viscous dampers, the base shear is coming much less than that of without fluid viscous dampers and story displacements are also less compared to bare frame.

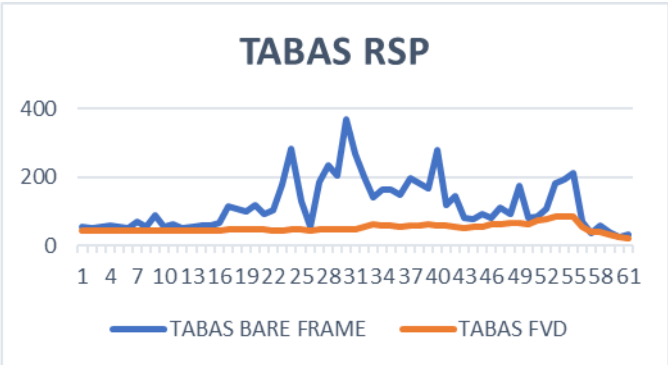

Fig 11: Comparison between bare frame and damper model

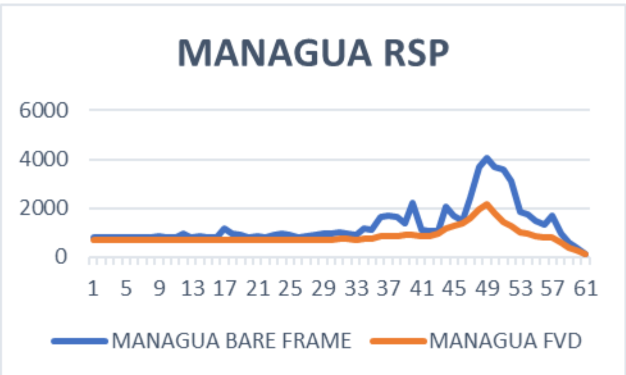

Fig 12: Comparison between bare frame and damper model

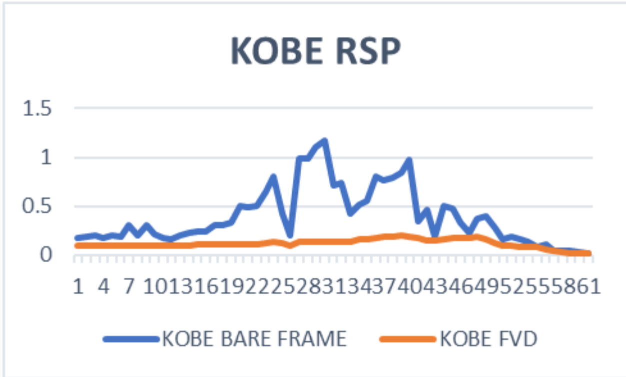

Fig 13: Comparison between bare frame and damper model

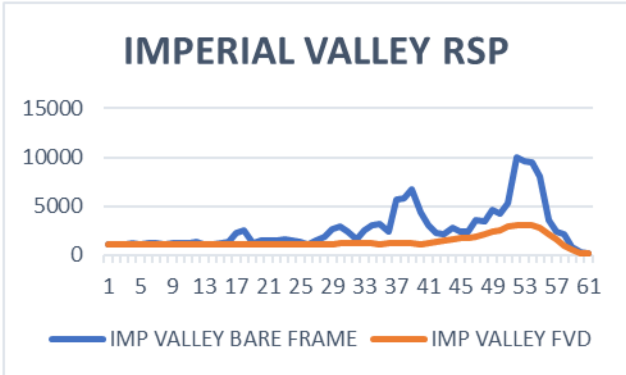

Fig 14: Comparison between bare frame and damper model

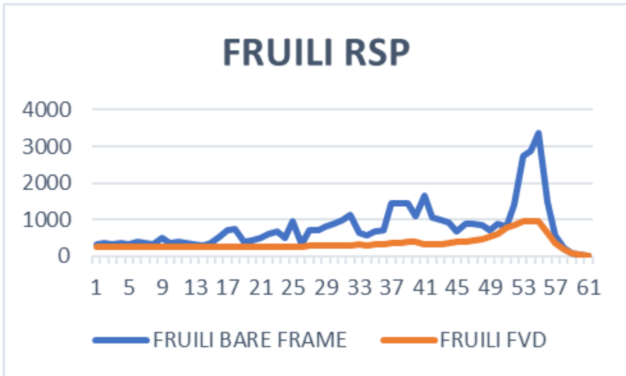

Fig 15: Comparison between bare frame and damper model

5.3 Choosing The Optimum Location To Place Dampers

For this we have done non-linear static analysis of the various structures discussed above and found their maximum story displacement and maximum story drift for X and Y direction separately

Story Drift

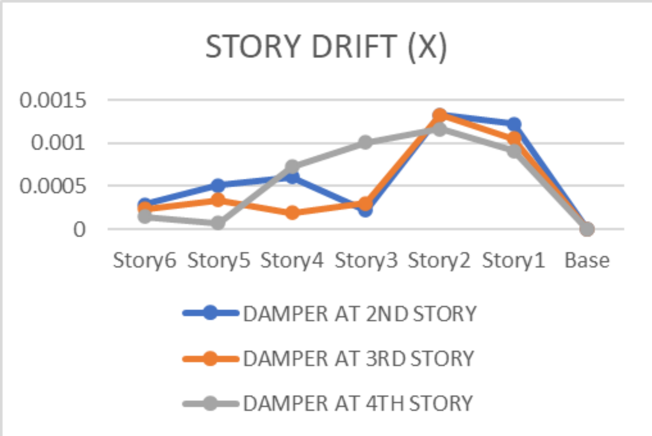

Fig 16: Comparison between damper at 2nd, 3rd & 4th Story

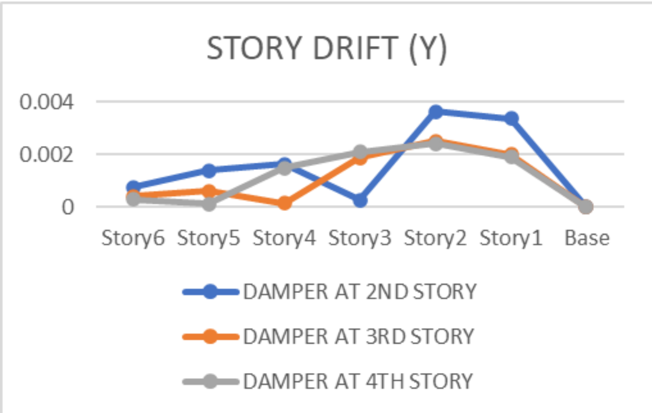

Fig 17: Comparison between damper at 2nd, 3rd & 4th Story

Story Displacement

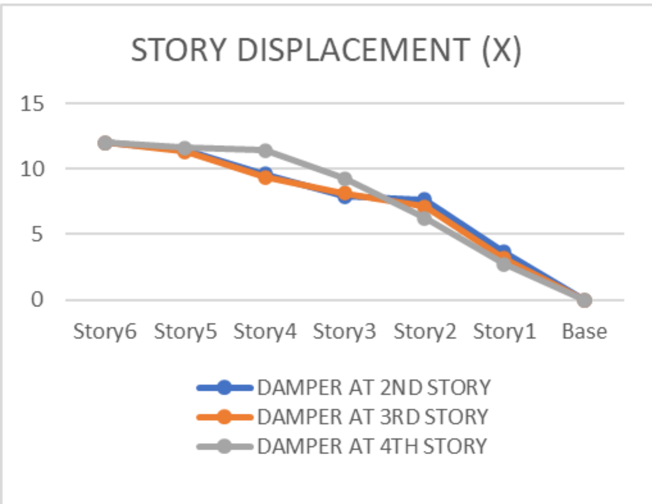

Fig 18: Comparison between damper at 2nd, 3rd & 4th Story

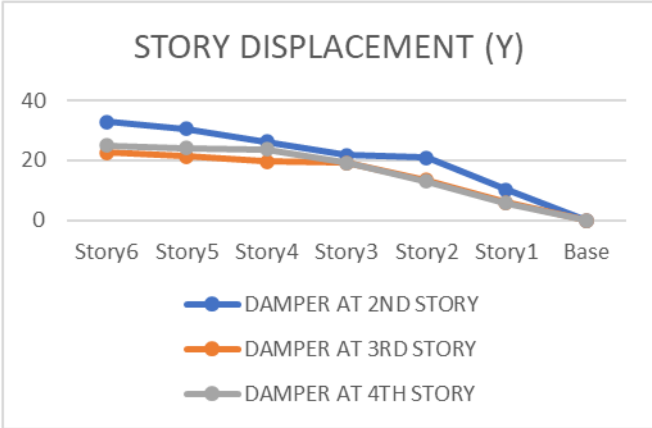

Fig 19: Comparison between damper at 2nd, 3rd & 4th Story

5.4 Time History Analysis Of Structure With Dampers At Different Story

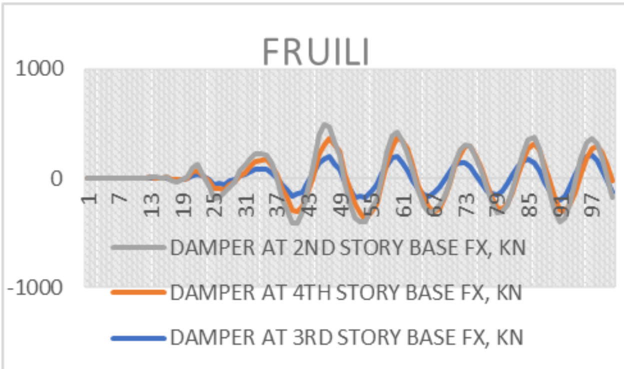

Fig 20: Comparison between damper at 2nd, 3rd & 4th Story

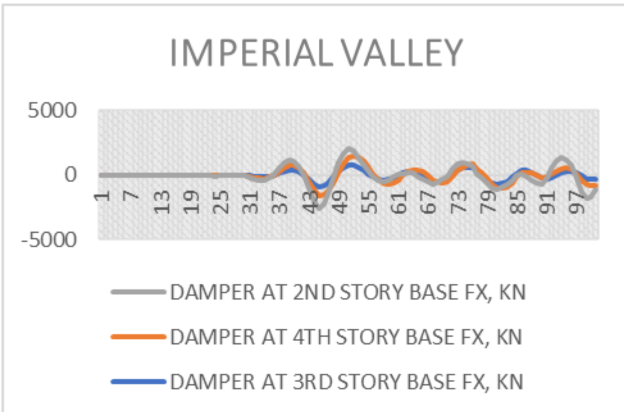

Fig 21: Comparison between damper at 2nd, 3rd & 4th Story

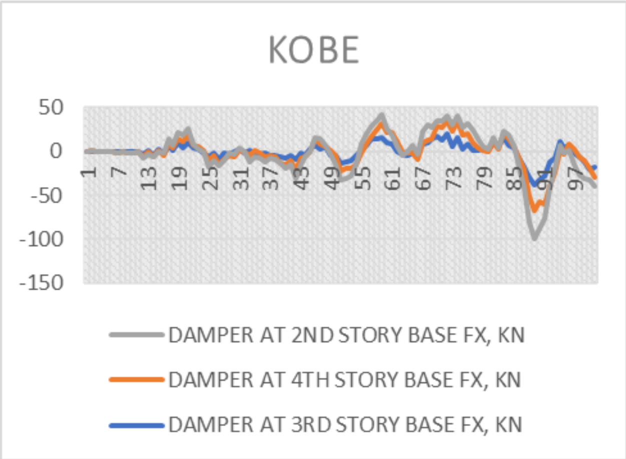

Fig 22: Comparison between damper at 2nd, 3rd & 4th Story

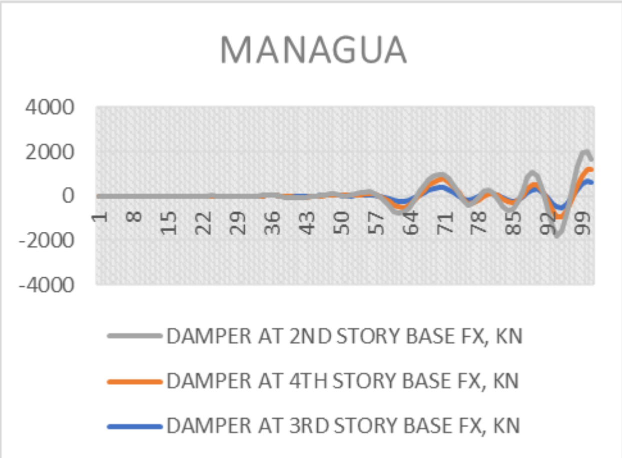

Fig 23: Comparison between damper at 2nd, 3rd & 4th Story

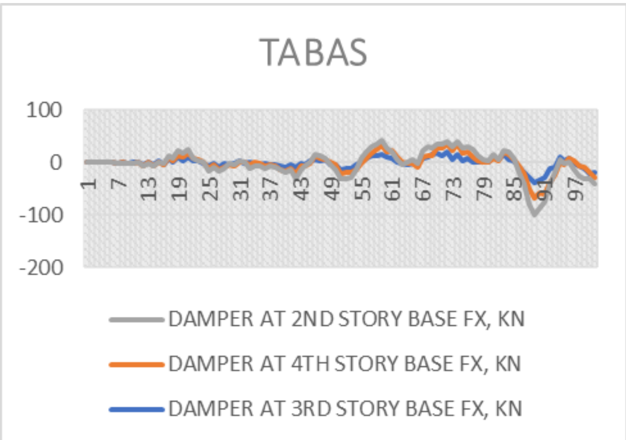

Fig 24: Comparison between damper at 2nd, 3rd & 4th Story

According to the time history analysis it can be seen that the structure with damper placed on 3rd story (model 3) performs well than the other two i.e., when placed at 2nd (model 2) and 4th story (model 4) respectively.

Model 3 is 60% more effective in reducing base shear than Model 2 and is 30% more effective than Model 4

6. CONCLUSIONS

- According to the time history analysis it can be seen that the structure with damper placed on 3rd story (model 3) performs well than the other two i.e. when placed at 2nd (model 2) and 4th story (model 4) respectively.
- Model 3 is 60% more effective in reducing base shear than Model 2 and is 30% more effective than Model 4.
- There is at the least 60% decrease in term in response spectrum curves while Fluid Viscous Damper is used. FVD 500 reduces the base Shear of the structures by means of 60% in Time history evaluation. The top story displacements are minimized by 20 % with use of FVD
- It's miles most optimum to location damper at third story rather than 2d and 4th tale because it substantially reduces base shear.
- In evaluating the seismic overall performance of systems, the prediction of damage in structures are tough to estimate by way of the usage of the frenzy-over evaluation whilst in comparison with the Time history evaluation.

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