ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 5, May 2018

Energy Dissipation System in Multistorey Building

[1] Abhishek Kumar Maurya, [2] V.K. Singh
[1] M. Tech Student, Institute of Engineering and Technology, Lucknow
[2] Associate Professor, Institute of Engineering and Technology, Lucknow

***Abstract*— Frequent earthquake round the globe and large number of structures vulnerable to it have necessitated the need for structural response control to gain pace in application around the globe. The seismic performance as well as behavior of structure ameliorated if this dynamic energy is vanished in a manner independent of structural component. In this present paper vibration parameter of the multi-story RC building are analyzed. The comparison between the seismic behavior of fixed base without damper building to the planned building in which dampers are incorporated at different location i.e. at Middle and at Corners bays of each story. G+10 building model is taken and it is situated in seismic zone V and the analysis is carried out on all models to get the variation in structural behavior of the fixed RC building without damper and the building linked with viscous damper at different locations. The analysis id done through Time history analysis using software ETABS 2016. For Time History Method, seismic event of India(Sikkim)-Nepal-Border Region into calculation of Mode Shapes and Base shear under dynamic loading of RC building that have been studied in this paper.**

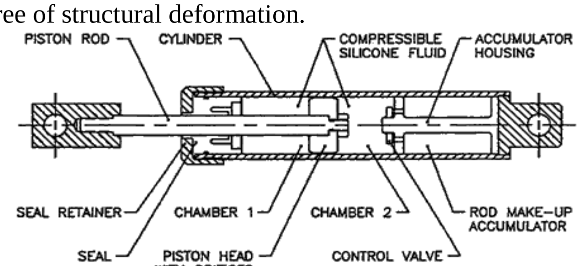
Keywords— Time History Analysis, Fluid Viscous Dampers, ETABS-2016.

I. INTRODUCTION

To minimize the damages which occurs due to ground motions is possible by the introduction of energy dissipation devices which provides damping in to structural elements. In recent years considerable amount of care is taken to mitigate the seismic response of the structure and decrease the loss of human being due to structural collapse and severe damages to the structure. As regards of existing structures, it is very obligatory to evaluate the current strength of structure and strengthen them based on evaluation criteria before an earthquake. Earthquake damage highly depends on this parameter including intensity, duration and frequency, geologic and soil condition, quality of construction. Passive energy dissipation systems exploit a wide range of materials and technologies as a means to improve the damping, stiffness and strength characteristics of structures. Dissipation may be achieved either by the conversion of kinetic energy to heat or by the transferring of energy along with vibrating modes. Recently many investigations have been conducted to evaluate the seismic response of building equipped with dampers. In present paper the viscous damper is incorporated in the building at different locations. Viscous dampers are known as effective energy dissipation device to control the seismic response, the damping force developed by viscous damper depends on the physical property of the fluid used in this device. Viscous dampers (VD) have been used in the last 30 years in major civil structures to moderate the effects of earthquakes. The main features of viscous dampers are presented:

- •High damping coefficients
- •No need to high maintenance
- •The lifetime of the viscous dampers is on average higher than the lifetime of the building where they are installed.
- •The dampers are extremely versatile for any application, without compromising the building's architecture.
- •These devices allow a reduction of the stresses and deformation of a structure, reducing the damages in the structural and non-structural elements during seismic action.

Experience shows that this dissipation system can decrease about 50% of the accelerations and displacements between floors. Fluid viscous damping is a way to add energy dissipation to the lateral system of a building structure. A fluid viscous damper dissipates energy by pushing fluid through an orifice, producing a damping pressure which creates a force. These damping forces are 90 degrees out of phase with the displacement driven forces in the structure. This means that the damping force does not significantly increase the seismic loads for a comparable degree of structural deformation.



(Fig.1-Sectional view of FVD)

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 5, May 2018

II. RELATED WORK

In this study, a multi-story RC framed building is taken into account as per IS-1893. Three different models are analyzed to study the behavior of viscous damper on the structure in zone V.

These models are as follows: -

I. Building with fixed base without Damper

II. Building with Viscous Damper at Middle bays of each story

III. Building with Viscous Damper at Corner bays of each story

All the models are analyzed while considering the parameters such as Mode Shapes and Base Shear.

III STRUCTURAL PROPERTIES AND MODELLING

A) Description of G+10 building with story is shown in table below-

Structural Part	Dimensions
Type of Building	Hospital Building
Location of Building	Northeast Indian state of West Bengal
Plan dimensions	28mx15m
Numbers of floors	11
Length in X- direction	28m
Length in Y-direction	15m
Floor to Floor height	3m
Bottom Floor height	3.5m
Total height of building	33.5m
Slab thickness	150mm
Column size	500X500mm
Beam size	450x300mm
Zone	V
Seismic Intensity	Moderate
Importance factor(I)	1.5
Response Reduction Factor (R)	5 for SMRF
Soil type	TYPE III (Soft Soil)
Grade of concrete(Beam)	M-30
Grade of concrete(Column)	M-30
Grade of concrete(Slab)	M-30
Reinforcement	Fe-415
Unit weight of concrete	25kN/m^2

Property of Viscous Damper Used-

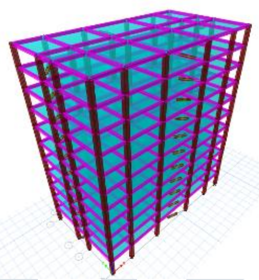
Model No. 17120

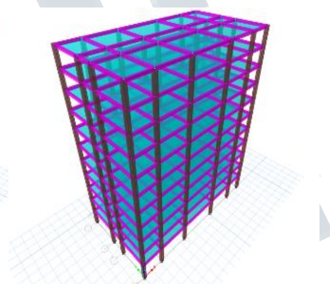
Force- 250kN & Weight-44kg

(All FVD data from the US Based company Taylor Devices Inc.)

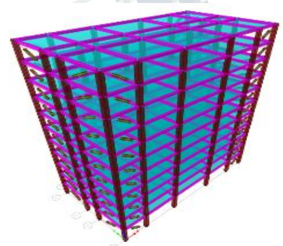
B) There are 3 models taken in the analysis-

1. Building with fixed base without Damper
2. Building with Viscous Damper at middle bays of each story
3. Building with Viscous Damper at corner bays of each story





Building without Damper ***Building with Damper at middle***



Building with Damper at Corner

IV. RESULTS AND DISCUSSION

All Graphs and images represents the Building Response including Mode Shapes and Base Shear embedded with the damper such as damper at middle and damper at corner bays of each story under seismic event of India(Sikkim)-Nepal-Border Region.

1. Mode Shapes- Mode shape is a graphical representation of the relative amplitudes of the two coordinates and their phase angle relationship.

The vibration of a building likewise consists of a fundamental mode of vibration and the additional contribution of various modes which vibrates at higher frequencies.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 5, May 2018

There are three basic modes of oscillation for a regular building

1. Pure translational along X-direction
2. Pure translational along Y-direction
3. Pure rotation about Z-axis

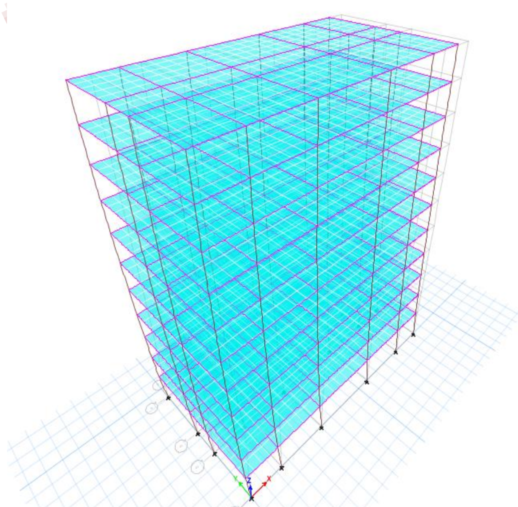
Each of these mode shapes is independent and it cannot be obtained by combining any or all of the other mode shapes. The overall response of a building is the sum of the responses of all of its modes. The contributions of different modes of oscillation vary; usually, contributions of some modes dominate. It is important to endeavor to make buildings regular to the extent possible. But, in regular buildings too, care should be taken to locate and size the structural elements such that torsional and mixed modes of oscillation do not participate much in the overall oscillatory motion of the building. There are total 12 mode shapes but Mode 1 , Mode 2 and Mode 3 is essential to study. There are following mode shapes for all three Models i.e.

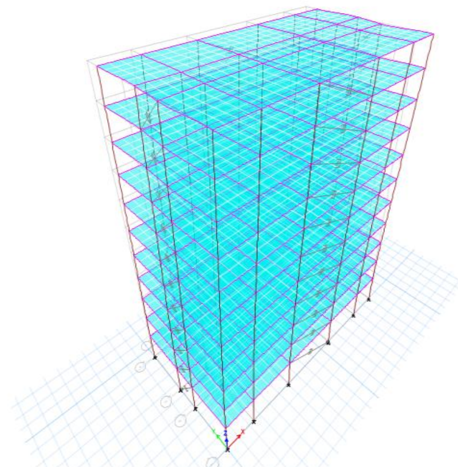
Model 1: Building with Fixed Base without Dampers.
Model 2: Building with Viscous Damper at middle bays of each story.
Model 3: Building with Viscous Damper at corner bays of each story.

which shows at which frequency the structure will absorb all the energy applied to it and what the shape looks like which corresponds to this frequency and time period-

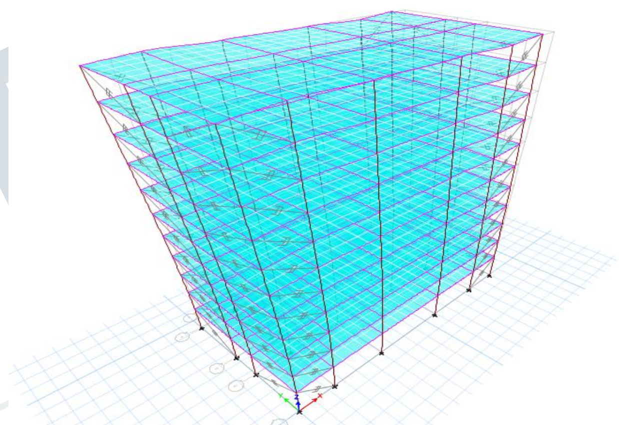
I. Mode 1-

Model-1 (T=2.638 Sec)





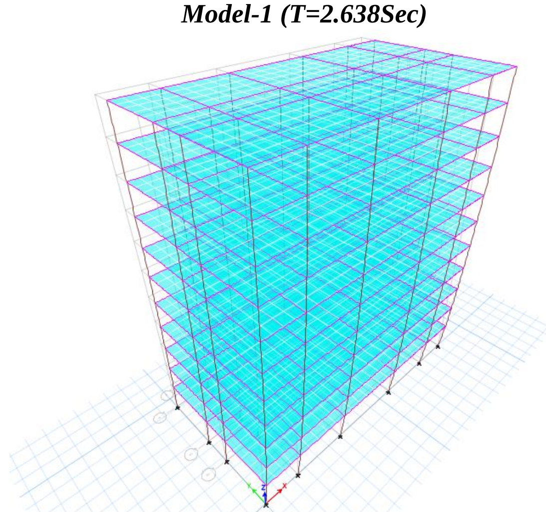
Model-2 (T=1.76 Sec)



Model-3 (T=1.305 Sec)

II. Mode 2-

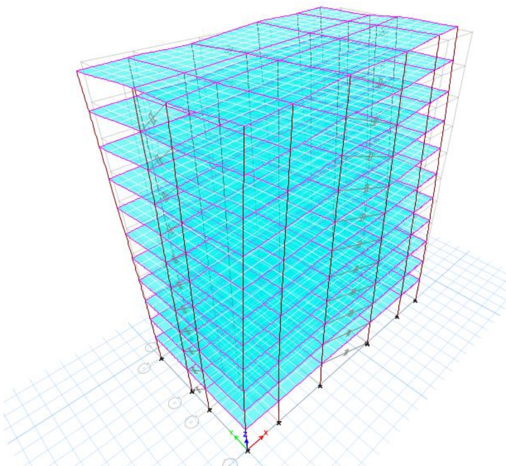
Model-1 (T=2.638Sec)



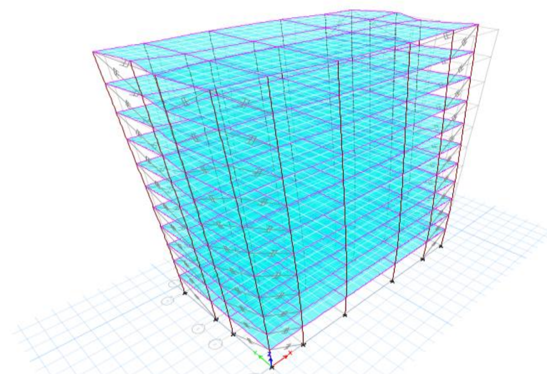
ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 3, Issue 5, May 2018



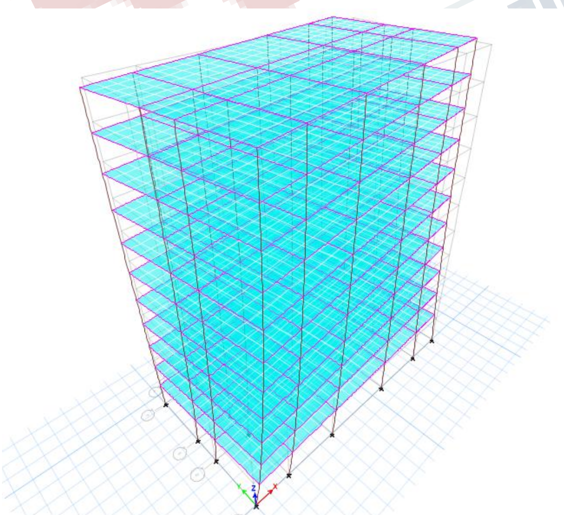
Model-2 (T=1.023Sec)

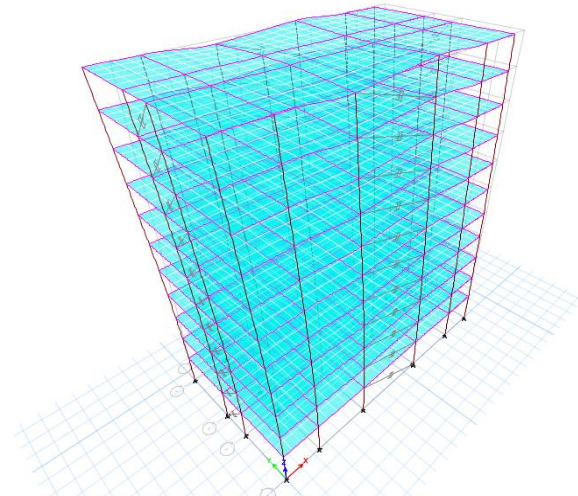


Model-3 (T=0.802 Sec)

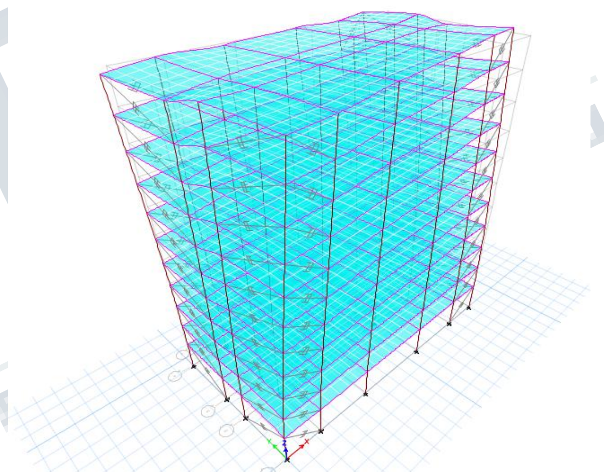
III. Mode 3-

Model-1 (T=2.281 Sec)





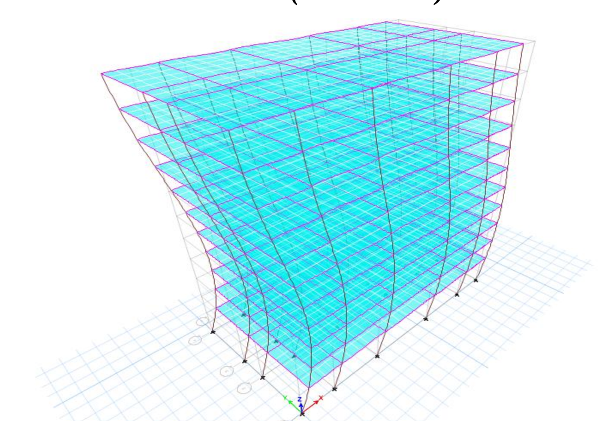
Model-2 (T=0.988 Sec)



Model-3 (T=0.586 Sec)

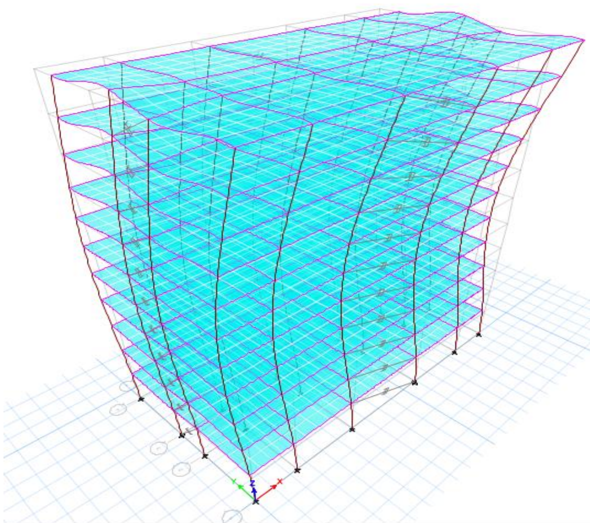
IV. Mode 4-

Model-1 (T=0.827 Sec)

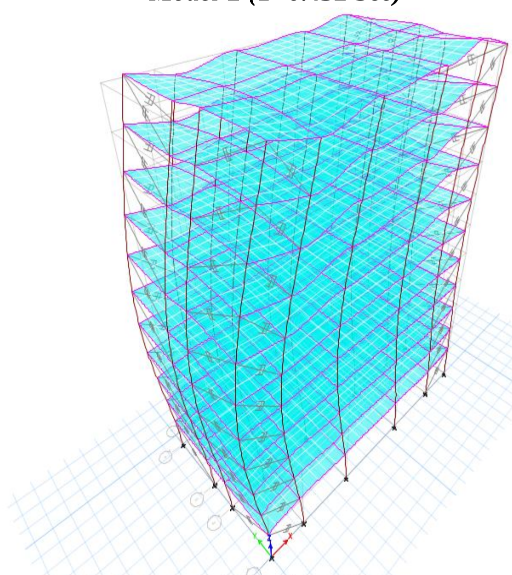


ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering
(IJERMCE)
Vol 3, Issue 5, May 2018



Model-2 (T=0.432 Sec)

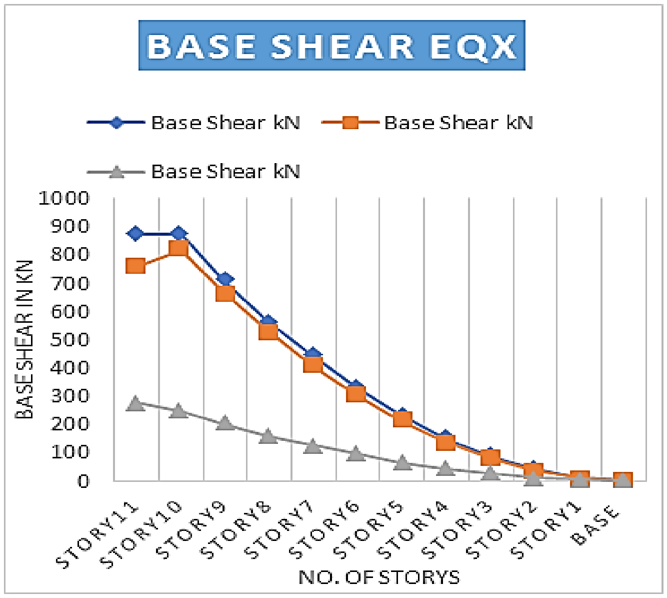


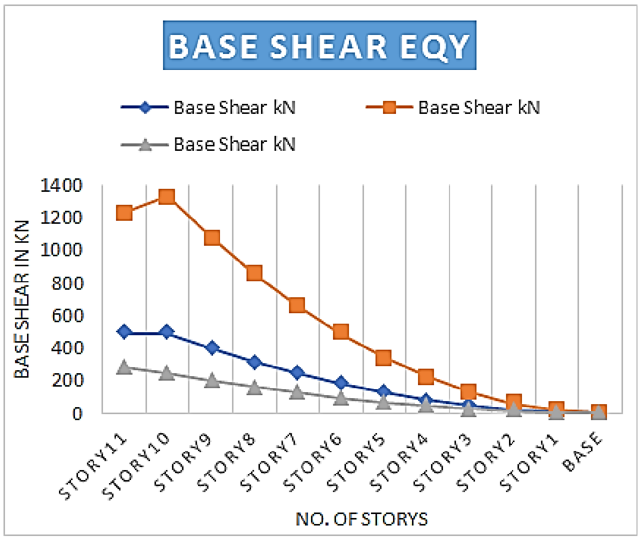
Model-3 (T=0.279 Sec)
(Fig.1 Variation of different Modes)

2.Base Shear-

Earthquake shaking is random and time variant. But, most design codes represent the earthquake-induced inertia forces as the net effect of such random shaking in the form of design equivalent static lateral force. This force is called as the Seismic Design Base Shear VB and remains the primary quantity involved in force-based earthquake-resistant design of buildings. It depends on:

- Soil condition at site.
- Proximity to potential sources of seismic activity (such as geological faults)
- Probability of significant seismic ground motion.
- The fundamental period of vibration of the structure when subjected to dynamic loading.





V RESULT AFTER ANALYSIS

In this analysis, viscous damper is used to reduce the seismic effect of the structure which are subjected to seismic loads. The frames are modelled according to the properties of the structure which are explained above in the work. The models are subjected to analyses for Gravity and Seismic loads. Dynamic analysis is carried out by Time History Method according to Indian standard code by using ETABs

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 5, May 2018

2016.

1. Mode Shapes-

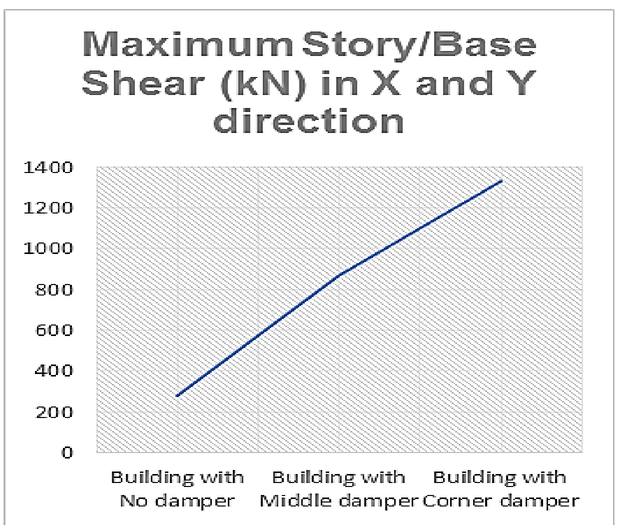
From all the Mode shapes i.e. from Mode 1 to Mode 4 it is clear that the only purpose of a modal analysis is to find the shapes and frequencies at which the structure will amplify the effect of a load and the value of modal period decreases with the implementation of damper at corner bays of each story. Mode 1, Mode 2 and Mode 3 are the mode which tends to basic modes of oscillation i.e. Pure Translational along X and Y axis and also rotation about Z-axis but rest of all the modes are showing their mixed and torsional mode of oscillation

2. Base Shear-

Base shear directly depends on the input seismic acceleration.

Base shear for building with damper located at corner bays of each story is good because it resists more lateral load as compare to other two buildings. As far as base shear concern, it does not matter whether structure has low or high base shear only it actual matters with structure is withstand or not.

Model	Maximum Story/Base Shear (kN)
Building with No damper	277.75
Building with Middle damper	873.70
Building with Corner damper	1327.89



VI CONCLUSIONS

In the present study, an attempt was made to compare the results obtained from Time History analysis. And it was carried out taking into consideration that the buildings are located in zone 'V'. The graphs and images for mode shapes and Base shear were plotted and were compared with each model. The major conclusions drawn from the study were as follows: -

1. From the different Mode shapes, it is clear that value of Time period decreases with the trending pattern of various modes. All three models are safe except model 1 as it carries non-oscillation rotation in its initial stage.

2.Corner damper building is good in practice in zone-V because Modal period reduces approximately 50% when compared to without Damper building.

3.From the result, it is also clear that Building without damper does not carries sufficient lateral load as compare to building when dampers are incorporated in corner bays of each story.

4.These viscous dampers devices perform a vital role in reducing and controlling the seismic response of the structure

REFERENCES

[1] Pankaj Agarwal &Manish Shrikhande,"Earthquake Resistant Design of Structures",PHI Learning Pvt. Ltd. 2006.

[2] IS code 1893 Part 1:2002 "Criteria for Earthquake Resistant Design of Structures"

[3] P. Sajjan and P. Biradar, "Study On The Effect Of Viscous Damper For Rcc Frame Structure,"

[4] P. Lakshmaiah Chowdary and G.karthic research paper on ," Analysis Of A High Rise Residential Building With Viscous Dampers Using Etabs,"

[5] A.K. Sinha and Sharad Singh research paper on ," Structural Response Control Of Rcc Moment Resisting Frame Using Fluid Viscous Dampers"

[6] OAPekau,R Guimond, "Controlling Seismic response of eccentric structures by friction dampers",Earthquake Engineering and structural Dynamics,vol 6,1991.

[7] John C. Dixon," The Shock Absorber Handbook",Society of Automotive Engineers Inc.

