Comparetive Study of 25 Storey RCC Building With Exponential (Viscous) And Bilinear (Tuned Mass) Damper At Different Storey

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Abstract- *Energy induced by strong earthquakes affects the structure. The seismic performance as well as response of the structure will be substantially improved if this energy is dissipated in a manner independent of structural components. Time history analysis of 25 storey RCC building which will be used as commercial building; typical floor area 270 sq meters was performed. The structure is modelled using the finite element program ETABS and is analyzed by dynamic analysis.*

The building is situated in earthquake zone V. Use of passive dampers for improvement of seismic performance and enhancing design of new structures has increased in recent years. The main objective of the study is to assess the improvement in response of structure achieved through use of the Exponential (viscous), Bilinear (tuned mass) and Friction damper devices.

Keywords- Dynamic Analysis. Seismic performance, viscous damper, tuned mass damper and friction damper.

I. INTRODUCTION

In recent years, there has been a constant development of the technology for seismic protection, as is the case of energy dissipation systems, resulting from the need to design increasingly taller buildings located in high seismicity areas, with the main goal being to improve the seismic performance.

DAMPERS

Seismic dampers are used in place of structural elements, like diagonal braces, for controlling deflection in structures.

Seismic Protection Systems

There are several types of seismic protection that, when included in a structure, improve the seismic behaviour (Guerreiro, 2008), classified as active or passive protection systems depending on whether or not it is necessary to provide energy for its operation. The most commonly used are the passive protection systems, due to its simplicity and proven effectiveness (Guerreiro, 2008), such as base isolation and the use of devices for energy dissipation.

Energy Dissipation Systems

The energy dissipation systems are devices specially designed and tested to dissipate large quantities of energy.

The most common energy dissipation systems are the viscous ones (force proportional to the velocity of deformation) and the hysteretic (force proportional to displacement), however there are also the visco-elastic.

II. OBJECTIVES

1. The main objective is to perform analytical analysis of R.C.C tall building with three different types of Damper of the structure using ETABS software.

a) Exponential (Viscous Damper)
b) Bilinear (Tuned Mass Damper)

2. To determine the efficiency of each Damper at different floors by comparing following parameters at different storey.

a) Drift
b) Displacement
c) Shear Forces

III. EXISTING RESEARCH

Viscous dampers themselves are old technology, dating back to more than a century ago to full-scale usage on US large Caliber military cannons in the 1860s. This technology was not available for the public disclosure or usage until the Cold War ended. In 1990, Taylor Devices received the permission to sell this technology to the public. Despite the long history and well-established usage of viscous damper, it is still a relatively new building technology yet to be further developed and studied.

Studies have been published regarding viscous dampers design methodology. Constantinou and Symans proposed a simplified method for calculating the modal characteristics of structures with added fluid dampers. The method was used to obtain estimates of peak response of the tested structures by utilizing the response spectrum approach. Gluck et al. Suggested a design method for supplemental dampers in multi-story structures, adapting the optimal control theory by using a linear quadratic regulator (LQR) to design linear passive viscous (VS) or viscoelastic (VE) devices depending on their deformation and velocity. Fu and Kasai compared frames dynamic behavior using VE or pure VS dampers, where identical mathematical expressions were derived in terms of two fundamental non dimensional parameters.

IV. MODELLING OF STRUCTURE

Description of the Building

Building analyzed is a twenty five story, 75 meter high commercial building made up of RCC structure with plan dimension as 18m X 15m meter located in Mumbai with a gross area of 270 sq. meters. The columns are placed on grid of 3 meters in X direction as well as in Y direction. The building was designed as per IS code.

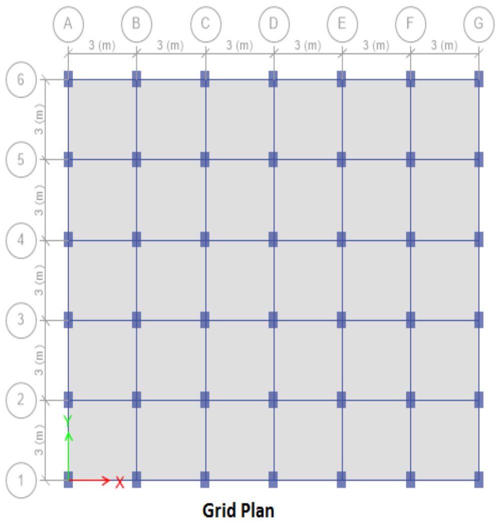

Figure 1. Plan view of building model ETABS

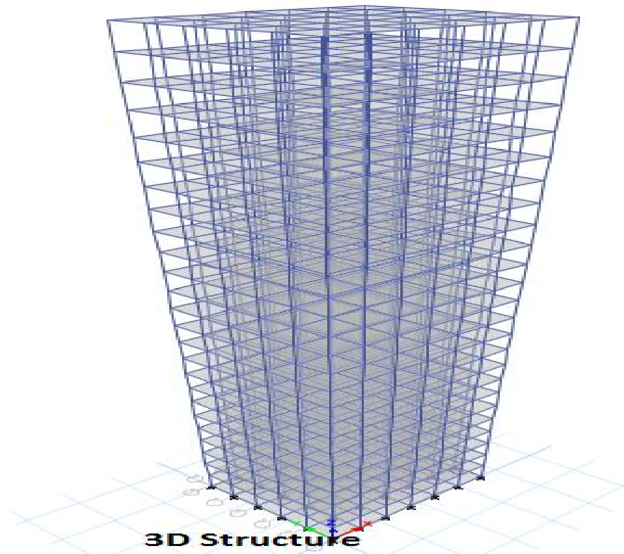

Figure 2. 3D view of building model in ETABS

ETABS (Non linear version)

ETABS is structural program for analysis and design of civil structures. It offers an intuitive yet powerful user interface with many tools to aid in the quick and accurate construction of models, along with the sophisticated analytical techniques needed to do the most complex projects, so in the present study three dimensional analyses with the help of ETABS 9.7 (Non-linear version) is used for modelling and analysis of the structure.

Table 1. BUILDING DETAILS

Dimension of beams Beam 1 Beam 2 Beam 3	 450*300 mm 300*250 mm 250*250 mm
Dimension of column	400*300 mm
Thickness of slab	125 mm
Load of wall	13.11 kn/m
Height of each storey	3 m
Live load On floor On roof	 4kn/m^2 1.5kn/m^2
Grade of reinforcing steel	Fe 415
Grade of concrete	M 30
Seismic Intensity	Very sever
Importance factor	1
Zone factor	0.36
Damping ratio	5%
Wind speed	50 m/s
Terrain category	2
Structure class	B

IV. RESULTS AND DISCUSSIONS

STOREY DISPLACEMENT WITHOUT DAMPERS

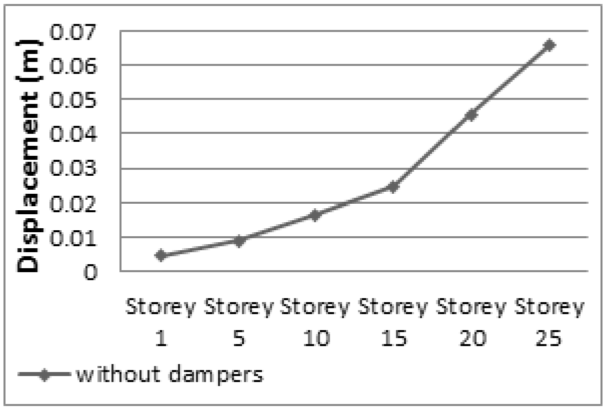

Figure 3. displacement of building by using without dampers

STOREY DISPLACENT WITH DAMPERS AT 25 STOREY

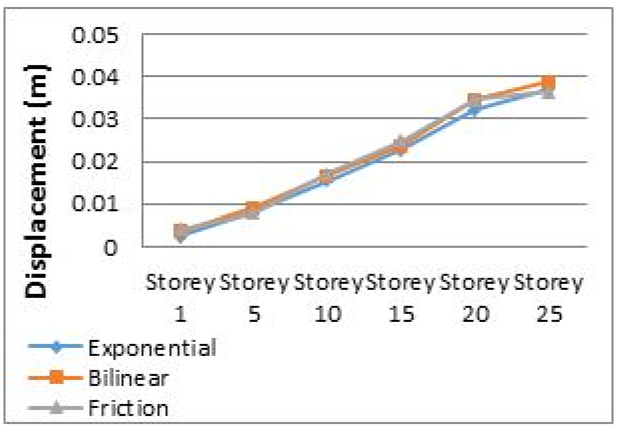

Figure 4. displacement of building by using dampers

The figure 5 shown that displacement at 20 storey is approximately same as when damper is placed at 25 storey .

STOREY DISPLACENT WITH DAMPERS AT 15 STOREY

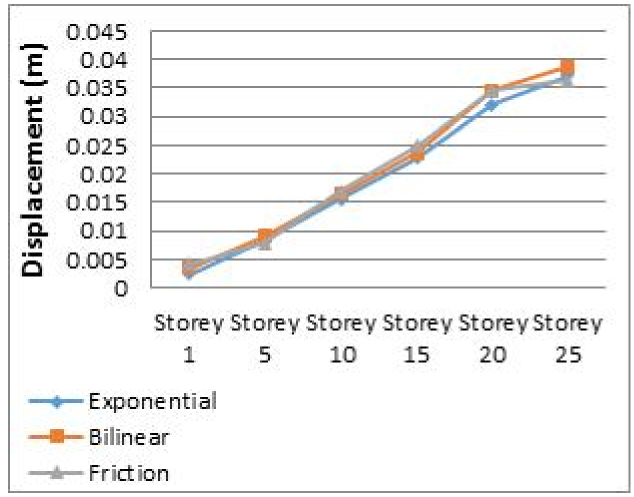

Figure 6. displacement of building by using dampers

This figure 6 when damper is placed at 15 storeyi, it shown that displacement at 25 storey is highest but in bilinear damper shows higher value than exponential damper this is show that exponential damper is better than bilinear damper.

STOREY DISPLACENT WITH DAMPERS AT 10 STOREY

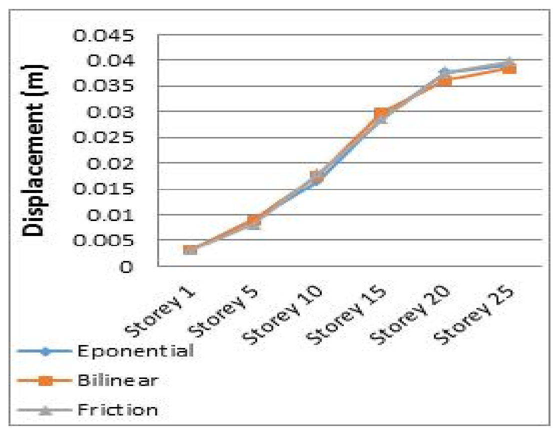

Figure 7. displacement of building by using dampers

The figure 7 shown that displacement at 10 storey with exponential damper is higher than bilinear damper and slightly down on going to bottom storey.

STOREY DISPLACENT WITH DAMPERS AT 5 STOREY

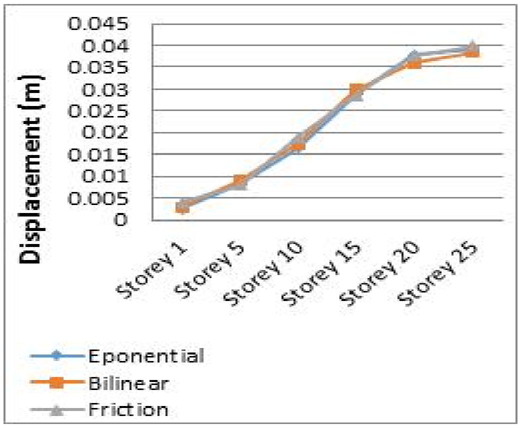

Figure 8. displacement of building by using dampers

This figure shown that when damper is placed at storey 5 displacement at 25 storey is highest but in exponential damper shows higher value than bilinear damper this is show that bilinear damper damper is better than exponential damper.

STOREY DISPLACENT WITH DAMPERS AT 1 STOREY

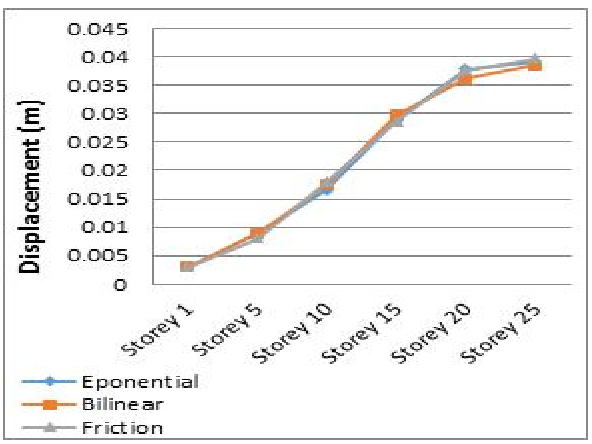

Figure 9. displacement of building by using dampers

This figure shown that when damper is placed at storey 1 displacement at 25 storey is highest but in exponential damper shows higher value than bilinear damper this is show that bilinear damper damper is better than exponential damper.

STOREY DRIFT WITHOUT DAMPERS

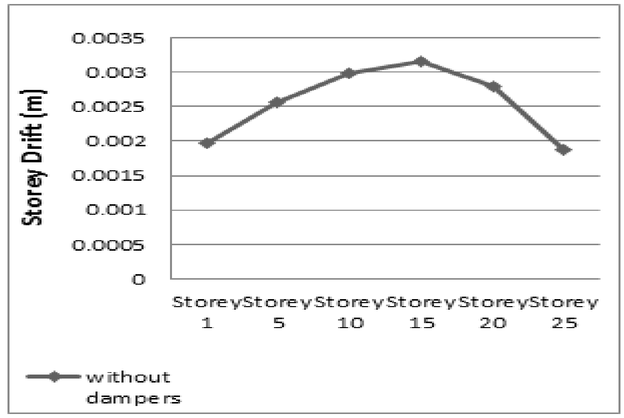

Figure 10. Storey Drift by using without dampers

STOREY DRIFT WITH DAMPERS AT 25 STOREY

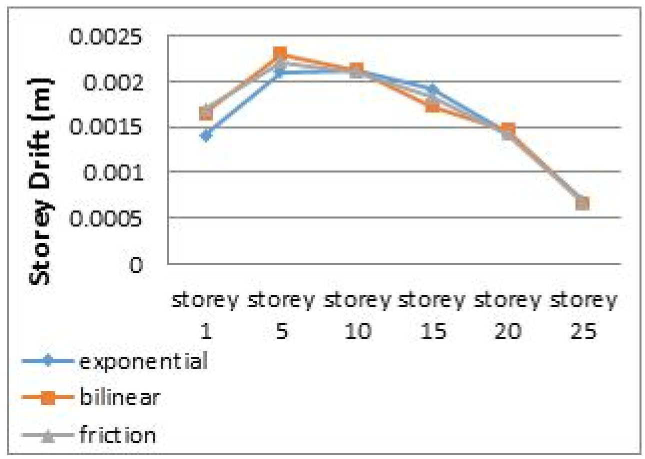

Figure 11. Storey Drift by using dampers

The figure 11 show that when damper is placed at 25 storey the storey drift is maximum at storey 5 in Bilinear damper in comparison of exponential damper.

STOREY DRIFT WITH DAMPERS AT 20 STOREY

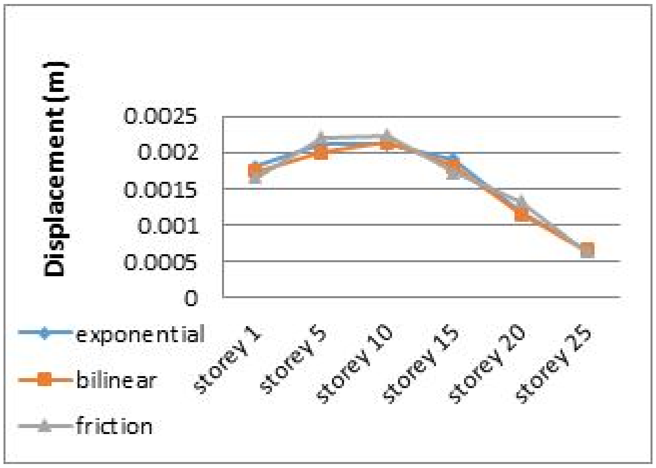

Figure 12. Storey Drift by using dampers

The figure 12 show that when damper is placed at 20 storey the storey drift is maximum at storey 10 in Bilinear damper and same as in exponential damper.

STOREY DRIFT WITH DAMPERS AT 15 STOREY

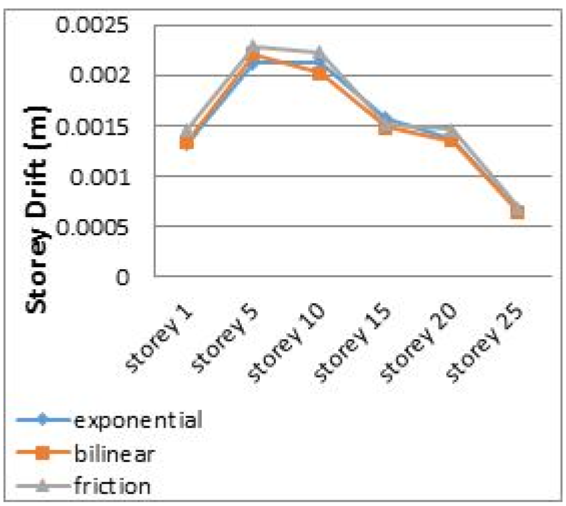

Figure 13. Storey Drift by using dampers

The figure 13 show that when damper is placed at 15 storey the storey drift is maximum at storey 5 in Bilinear damper in comparison of exponential damper.

STOREY DRIFT WITH DAMPERS AT 10 STOREY

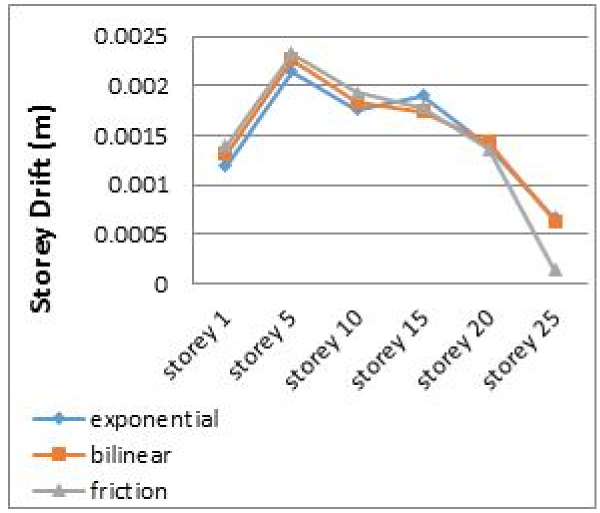

Figure 14. Storey Drift by using dampers

The figure 14 show that when damper is placed at 10 storey the storey drift is maximum at storey 5 in Bilinear damper in comparison of exponential damper.

STORY DRIFT WITH DAMPERS AT 5 STOREY

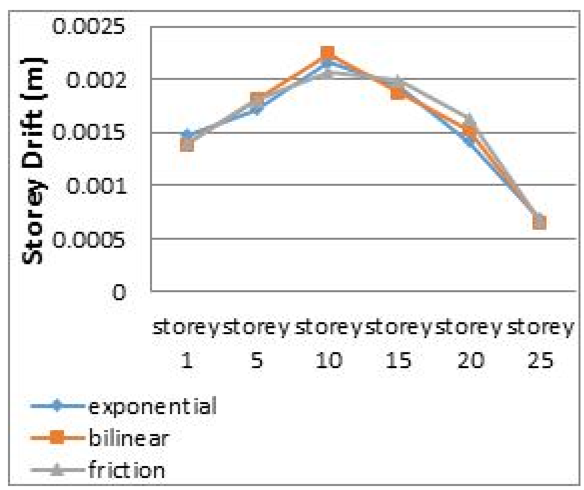

Figure 15. Storey Drift by using dampers

The figure 15 show that when damper is placed at 5 storey the storey drift is maximum at storey 10 in Bilinear damper in comparison of exponential damper

STOREY DRIFT WITH DAMPERS AT 1 STOREY

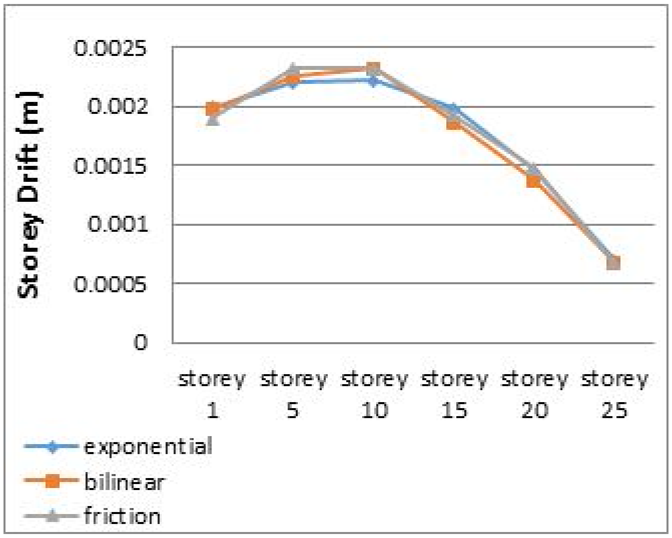

Figure16. Storey Drift by using dampers

The figure 16 show that when damper is placed at 1 storey the storey drift is maximum at storey 12 in Bilinear damper in comparison of exponential damper

STOREY FORCES WITHOUT DAMPERS

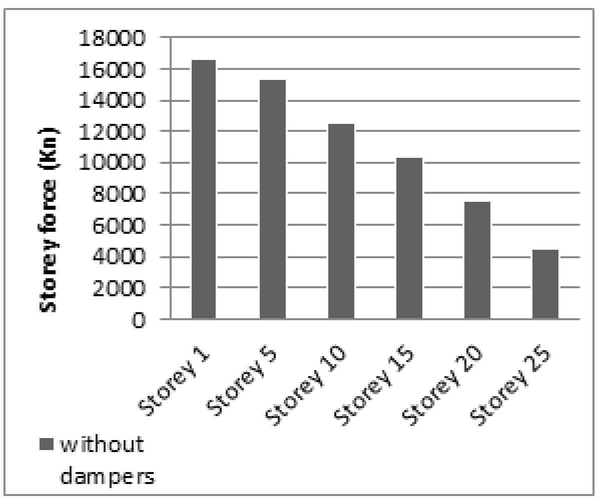

Figure17. Storey Drift by using without dampers

STOREY FORCES WITH DAMPERS AT 25 STOREY

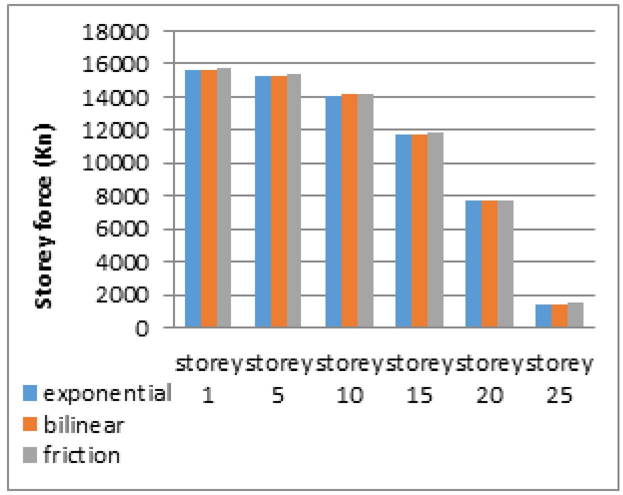

Figure 18. Storey Forces by using dampers

In this figure shows that damper is placed at storey 25, the storey forces is maximum in storey 1 and dampers is shown approximate same values but exponential damper have lower value than bilinear damper so we can say that exponential damper is quite good in storey forces.

STOREY FORCES WITH DAMPERS AT 20 STOREY

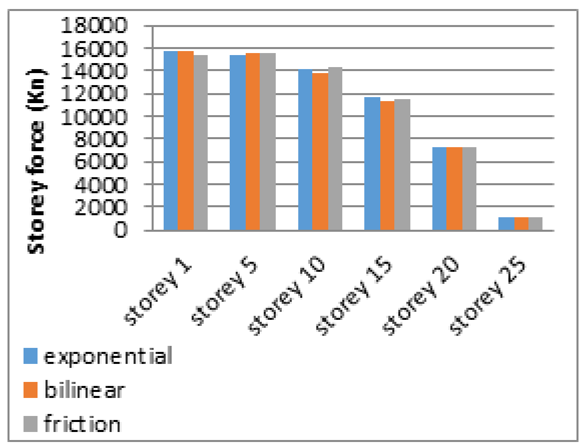

Figure 19. Storey Forces by using dampers

In this figure shows that when damper is placed at storey 20 the storey forces is maximum in storey 1 and dampers is shown approximate same values but exponential damper have lower value than bilinear damper so we can say that exponential damper is quite good in storey forces.

STOREY FORCES WITH DAMPERS AT 15 STOREY

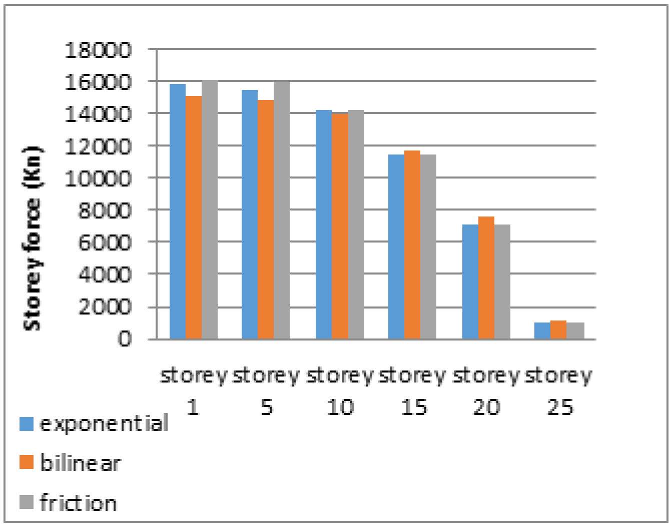

Figure 20. Storey Forces by using dampers

In this figure shows that the storey forces is minimum with bilinear damper in comparison to exponential damper.

STOREY FORCES WITH DAMPERS AT 10 STOREY

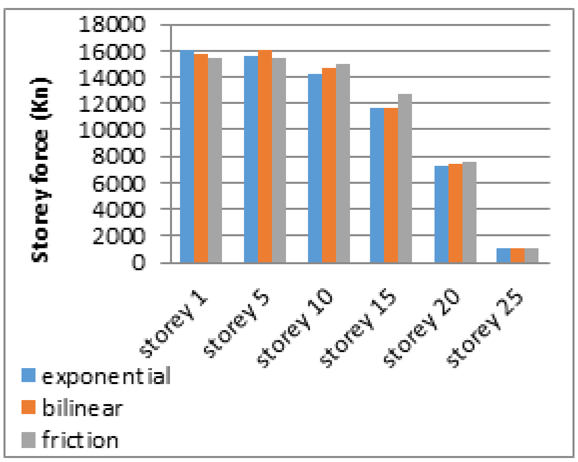

Figure 21. Storey Forces by using dampers

In this figure shows that the storey forces is minimum with bilinear damper in comparison to exponential damper.

STOREY FORCES WITH DAMPERS AT 5 STOREY

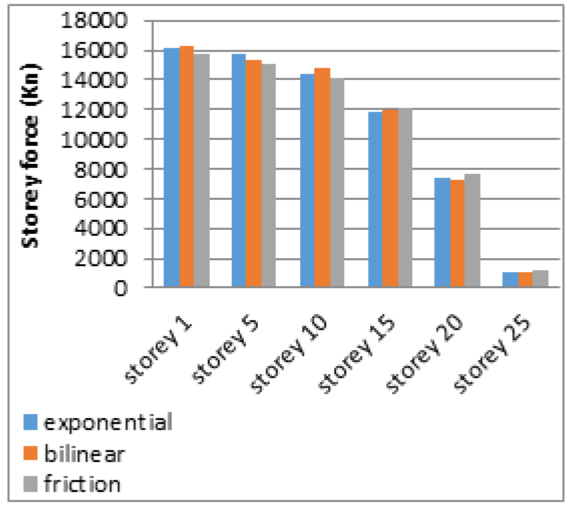

Figure 22. Storey Forces by using dampers

In this figure shows that the storey forces is maximum with bilinear damper in comparison to exponential damper.

STOREY FORCES WITH DAMPERS AT 1 STOREY

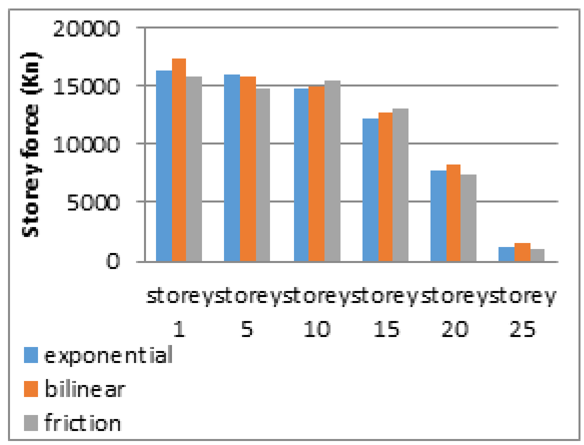

Figure 23. Storey Forces by using dampers

In this figure shows that the storey forces is maximum with bilinear damper in comparison to exponential damper.

VI. CONCLUSION

The plan configurations of structure have significant impact on the seismic response of structure in terms of, story drift, story force. According to results, the storey forces has found to be maximum for the first storey and it decreased to a minimum in the top storey in all cases. But with exponential damper gives the minimum forces in comparison to bilinear damper Large drift was observed in the middle of regular building. The storey drift with exponential dampers is less than the bilinear damper. The displacement is minimum with exponential damper in comparison to bilinear damper.

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