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Study the Comparative Effect of Different Link Dampers on G+25 High Rise Buildings in Seismic Zone IV

Rajat Yadav[1], Kumar Vanshaj[2], Abhishek Mishra[3]
[1]MTech Student Structural Engineering, Institute of Engineering & Technology Lucknow
[2, 3]Assistant Professor CED, Institute of Engineering & Technology Lucknow

Abstract: The usefulness of a high-rise building equipped with different types of link dampers (such as bilinear dampers, fluid viscous dampers, and frictional dampers) for the purpose of controlling seismic vibration is discussed in this study. Due to their safe, efficient, and cost-effective design, dampers have gained a lot of popularity in recent years for the purpose of controlling vibration in structures. They are frequently employed in structural vibration control to reduce seismic risks and, with the use of passive energy dissipation devices, can enhance the dynamic responsiveness of both new skyscrapers and existing high-rise structures. The structure's structural safety and serviceability are improved, and the controlling devices stop the building from collapsing during an earthquake, thereby greatly reducing damage. This paper would discuss the high rise RCC structures (G+25), with different Link dampers for seismic vibration control and study the effect of dampers on it using ETABS software.
Keyword: frictional dampers, Fluid viscous Dampers, Bilinear dampers, seismic vibration control, ETABs, Seismic analysis.

I. INTRODUCTION

A significant portion of India is at risk from earthquakes. As a result, the seismic load must be taken into account while building a high-rise construction. Tall buildings are susceptible to the lateral stresses brought on by earthquakes. These lateral pressures may result in the structure experiencing critical stresses, unintended tensions, unwelcome vibrations, or excessive lateral sway. Sway or drift refers to the degree of lateral movement at the top of the building in relation to its base. According to classic seismic design principles, the structure should be able to tolerate small, frequent shaking intensity without suffering any damage so that it can continue to be used after the event.[1] Passive control techniques have been effectively used to lessen the dynamic response of buildings that have experienced earthquakes or very strong winds. Since friction dampers have a great energy-dissipation potential at a low cost and are easy to install and maintain, they are widely used as part of these systems. This passive control mechanism is designed to spread seismic input energy and protect buildings from structural and non-structural damage during moderate and strong earthquakes. [2] A target seismic intensity is generally taken into account while designing passive control systems. In fact, the design PGA or PGV corresponds to an agreed chance of exceedance, highlighting the necessity of a thorough evaluation of the system's performance and sensitivity under a variety of seismic input conditions (lower and greater than the design level).[2] Structures are subjected to oscillating lateral stresses as a result of earthquake ground motions, which forces them to sway back and forth with an amplitude corresponding to the energy input. If the input energy can be controlled and the majority of it is dissipated during building motion, the level of distress can be significantly reduced.[3]

Structures are subjected to oscillating lateral stresses as a result of earthquake ground motions, which forces them to sway back and forth with an amplitude corresponding to the energy input. If the input energy can be controlled and the majority of it is dissipated during building motion, the level of distress can be significantly reduced.[4] Friction dampers are provided in the steel bracing of concrete frames. Friction dampers reduced the need for reliance on member ductility, while steel bracing eliminated the need for pricey concrete shearwalls. It is common to see friction-damped bracing in elevator shafts, around stairwells, and in partitions. They were adopted because they allowed for more creative space design because, unlike shear walls, they do not need to be placed constantly one above the other. It is not essential to run friction-damped bracing through the basements to the foundation because it does not bear any gravity loads.[5]

The improvement of the wind and seismic responses of various buildings and high-rise structures has received special attention in recent years as a result of the extensive research and development that has gone into structural control techniques like passive control systems, active control systems, and semi active control systems.

[6] Many energy dissipation methods have been put forth in the last few decades to advance the seismic design of structures beyond the usual ductility design approach. Friction damping has demonstrated particularly strong potential among these novel technologies. When strong earthquake excitations occur, friction damping devices are installed into a structure and slide at a specified optimal load before any yielding of the structural elements has taken place. Instead of the structure deforming inelastically as a result of the devices slipping, the structure can dissipate the seismic energy mechanically through friction. [7]
The goal of this paper is to study seismic response of dampers on high-rise building of G+25 Storey building by performing Seismic analysis as well as to evaluate effects of damper utilized in the modelling of structure for the purpose of vibration control.

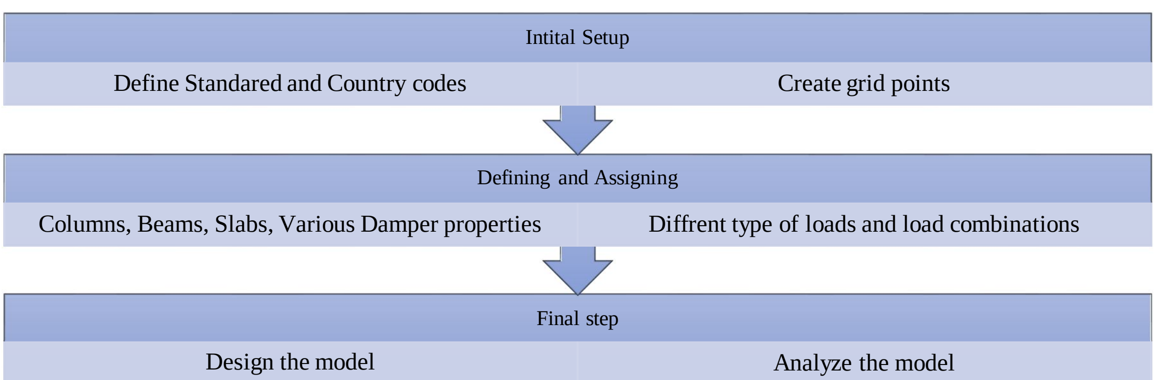
II. LITERATURE REVIEW

In previous Studies by Tharwat A. Sakr (2015) proposed a novel method for employing partial floor loads as numerous TMDs on a restricted number of levels Where they explored the impacts of applying the proposed approach to structures of various heights and attributes. A parametric research is carried out to demonstrate how the number of stories and the fraction of the floor used as TMDs impact the behaviour of a structure. They found that the results show that the proposed control approach is successful in improving the drift, acceleration, and force response of structures to wind and earthquakes. Buildings' resistance to wind and earthquakes was shown to be improved by increasing story-mass ratios and the number of floors used as TMDs.[8] The study by Chen, B.Xu, Y. L. (2008) where they studied about a semi-active friction damper-based integrated process for vibration management and building structural health monitoring. The notion of an integrated system employing semi-active friction dampers is first proposed. Where they surmised For vibration control, a local feedback technique with a Kalman filter has been proposed for the semi-active friction dampers to minimise seismic reactions of the building by employing the same accelerometers as utilised in system identification.[9] The research by Cedric MARSH where they work on The widespread usage of friction joints in new and renovated structures has proved the economic benefits of this type of technology for controlling the magnitude of building motion caused by seismic action. The research focuses on the employment of friction devices in conjunction with stiff structural frames made of steel or concrete, for which three levels of performance are established. Elastic overall behaviour under wind loads, sliding joints with an elastic frame when operated on by the design earthquake, and slipping joints with a yielding frame when acted on by the severe earthquake that the structure can withstand. The second stage avoids major structural damage while minimising secondary harm. The energy dissipation capability of yielding parts is added to that of the friction joints in the third stage. Structures for which friction dampers are appropriate, as well as the selection of slip loads and damper sites, are examined, as is the quality control necessary for the produced device.[10]

III. OBJECTIVES

1) To compare the seismic behaviour of high-rise buildings with different types of link dampers and without dampers of RC frame, in seismic zone IV.
2) To evaluate seismic parameters like story displacement, story drift ratio, story shears and story stiffness for proposed structural models.
3) To investigate the seismic performance of G+25 multi-story structure with linear response spectrum analysis under gravity and lateral loading.

IV. METHODOLOGY



V. BUILDING PARAMETERS

Table 1. Parameters of Building

Area of building	$20*25\ m^2$		
Height of building	78 m		
Shape of building	Rectangular		
Seismic zone	IV		
Zone factor	0.240		
Soil type	II		
Importance Factor, I	1.2		
R	5		
IS Codes adopt for research	IS 1893:2016 (part1)		
Member	Dimensions		Grade
Slab	170mm		M30
Column	C1	700*800	M30
	C2	800*950	
Beam	550*750		M30

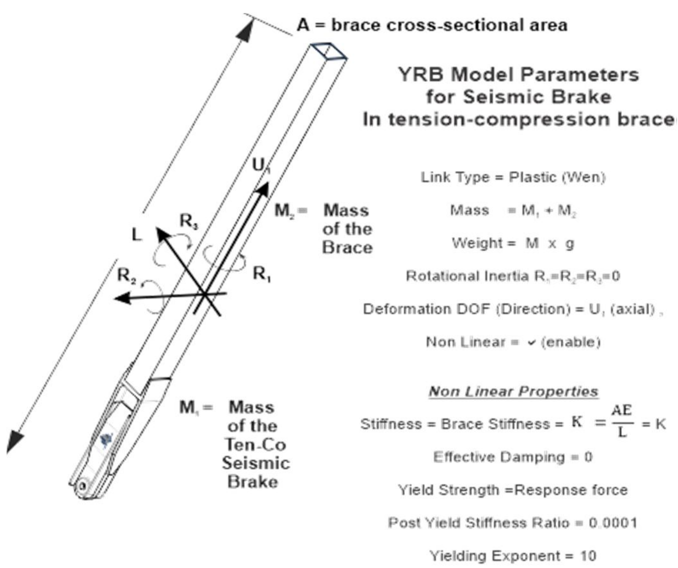


Fig 1. Properties of friction Dampers[11]

Table 2. Properties of Dampers

Damper	Link Type	Mass (M)	weight	Direction
Friction Damper	Plastic(wen)	M_1+M_2 =500Kg	4900Kn	U1, U2 Non-linear
Bilinear damper	Bilinear	500 Kg	1500Kn	U1, U2 Fixed
Fluid Damper	Exponential	500Kg	200Kn	U1, U2, Non-linear

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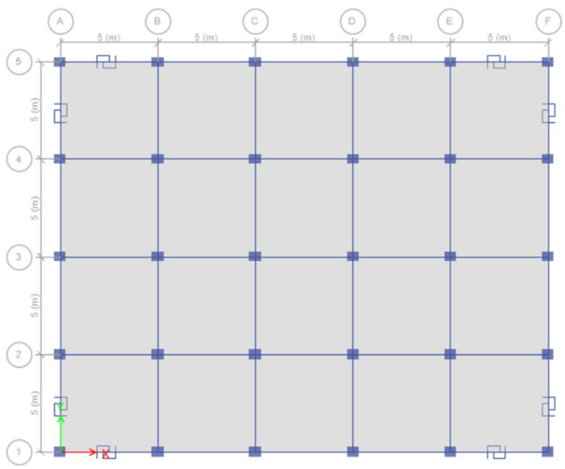
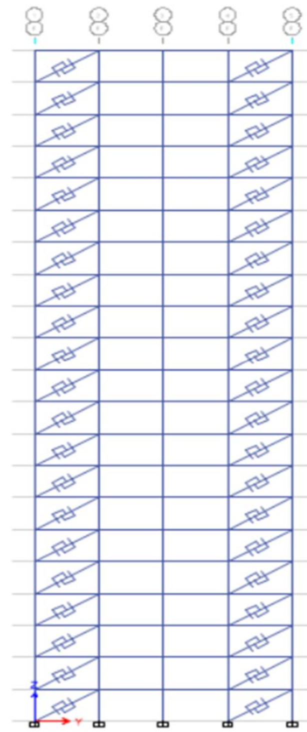
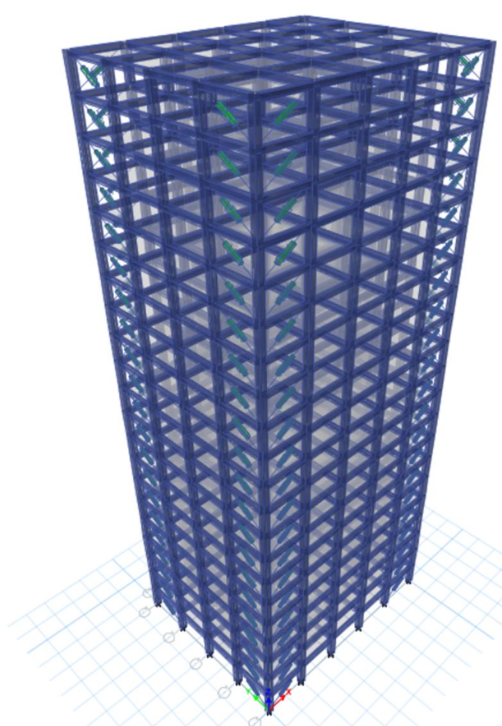
VI. MODELS



a)Plane view

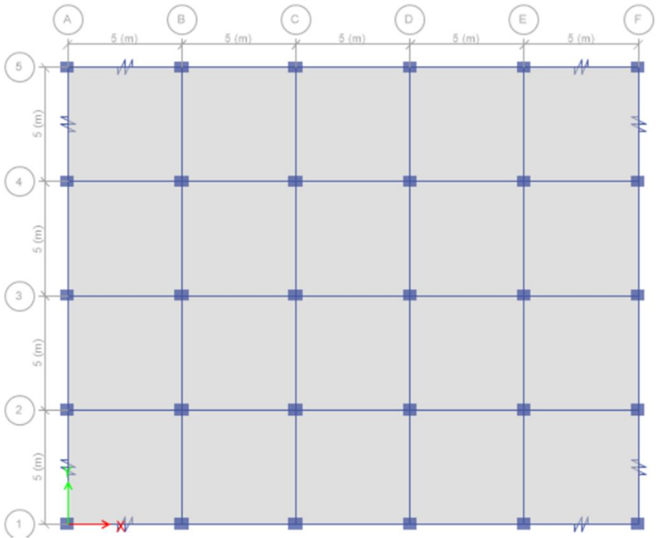


b) Elevated view

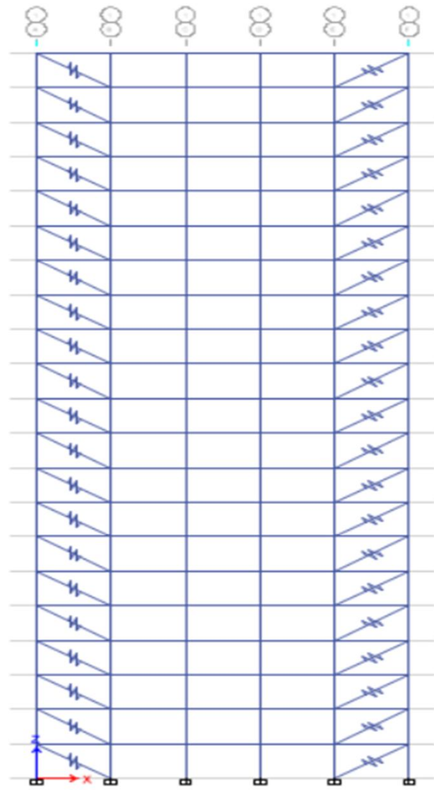


c)3D view

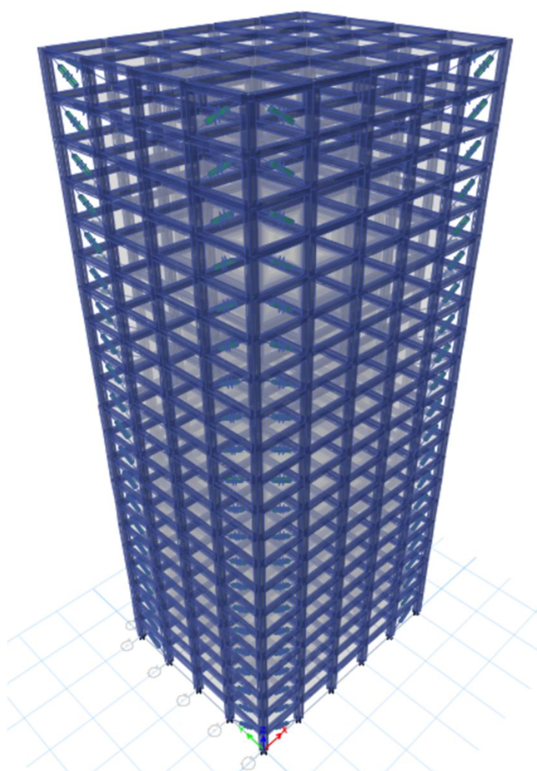
Fig 2. a) b) c) Plan of frictional Dampers (FD)



a)Plane view



b) Elevated view



c)3D view

Fig 3. a) b) c) Plan of Bilinear Dampers(BD)

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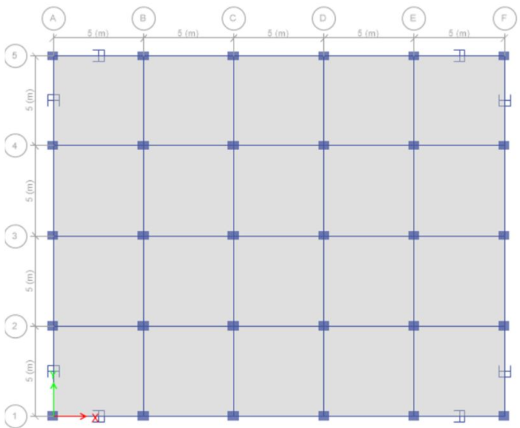
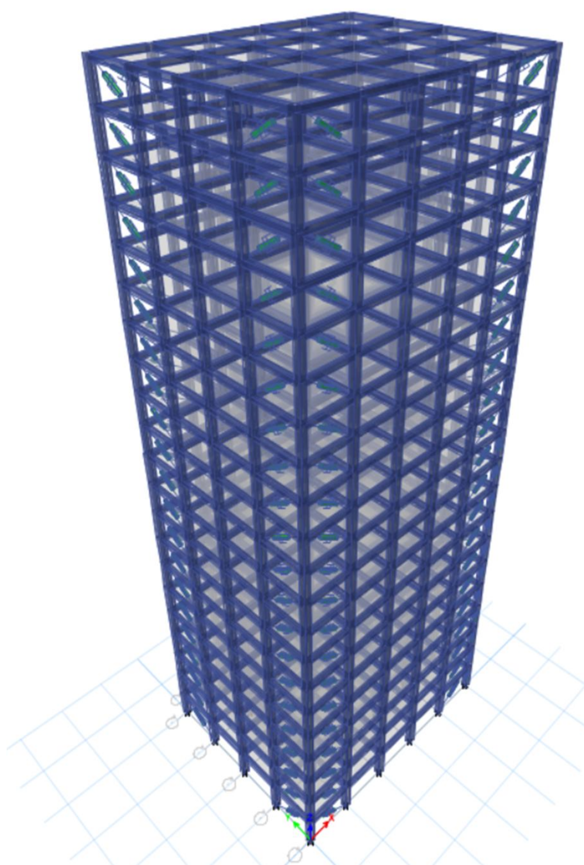


a)Plane view

b) Elevated view



c)3D view

Fig 4. a) b) c) Plan of Fluid Viscous Dampers(FVD)

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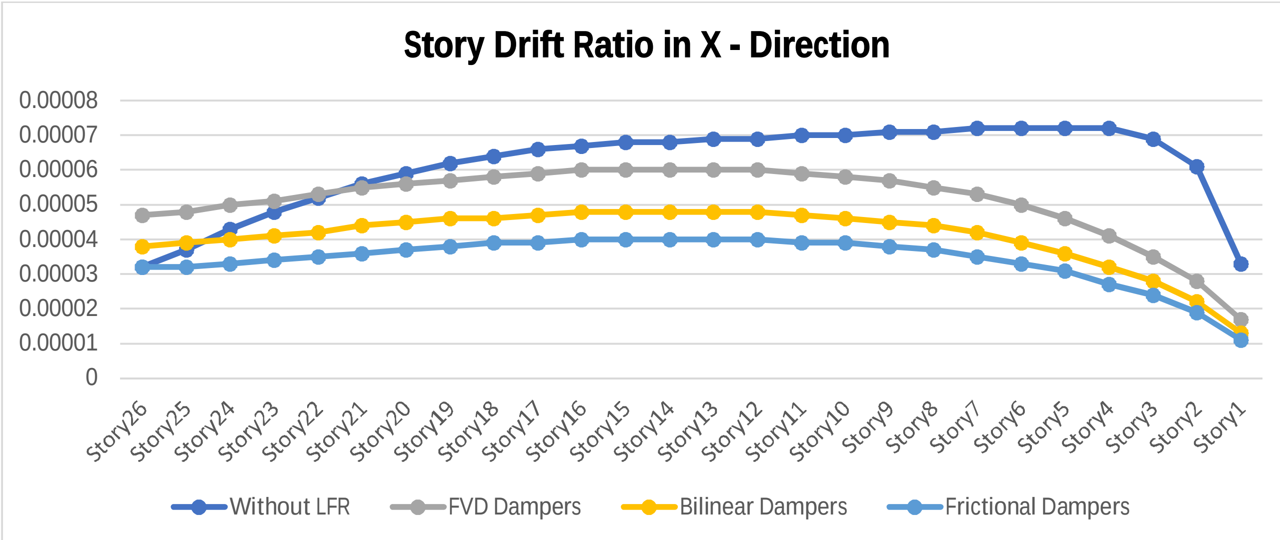
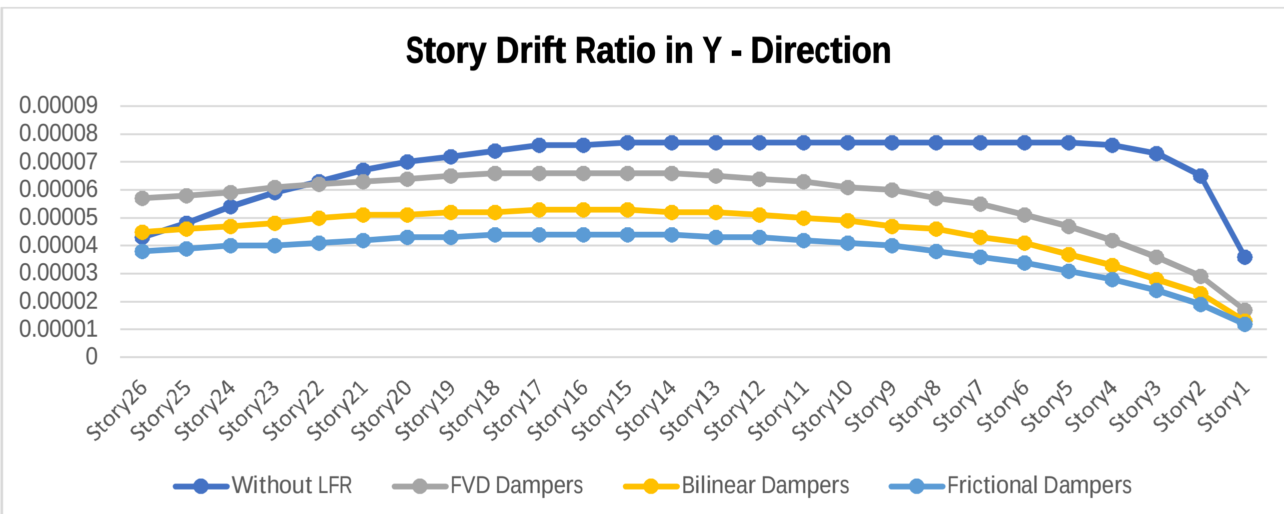
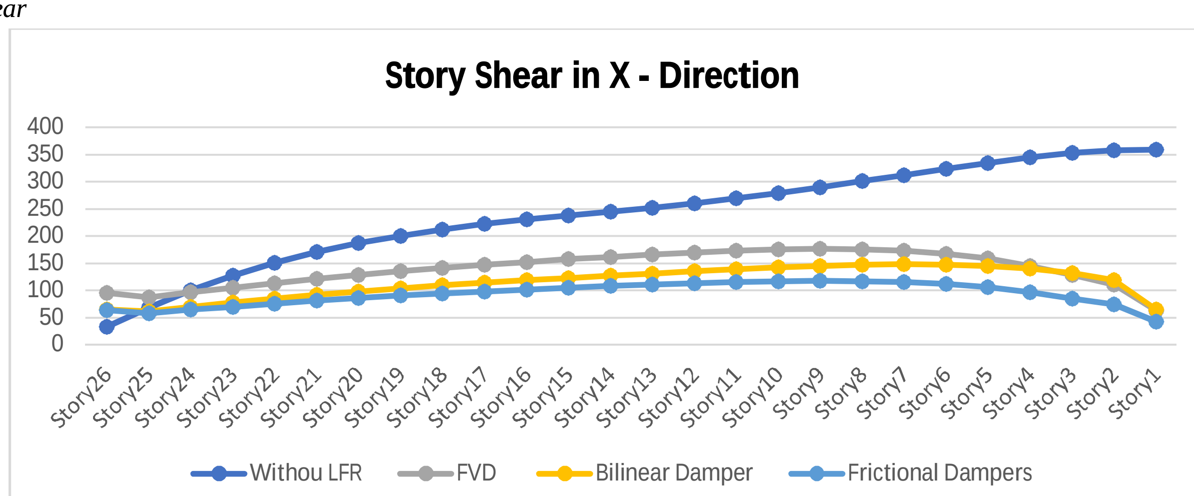
VII. ANALYSIS & RESULTS

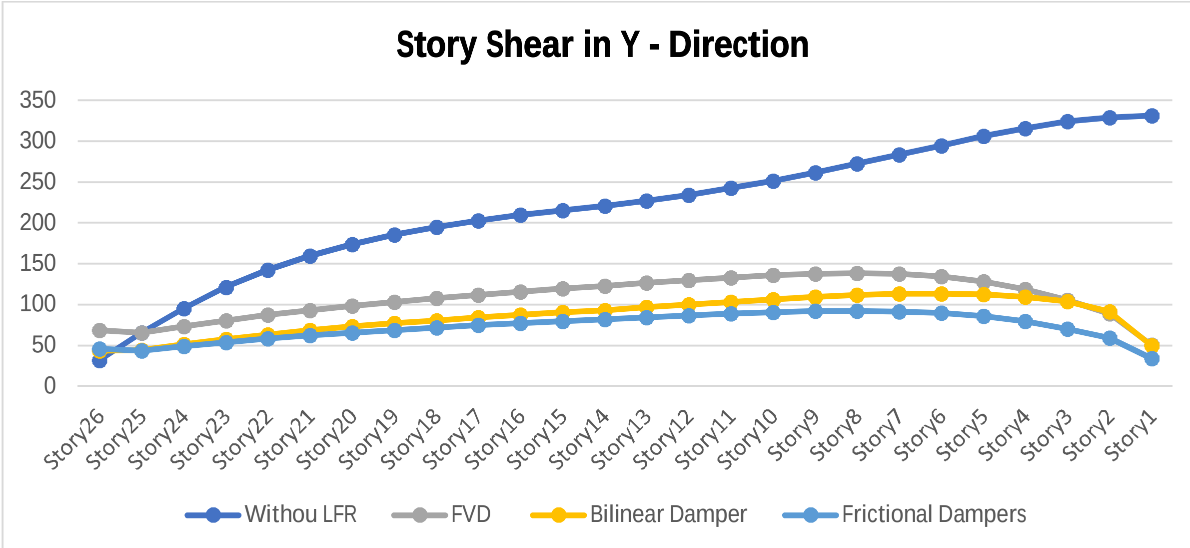
A. Storey Drift Ratio



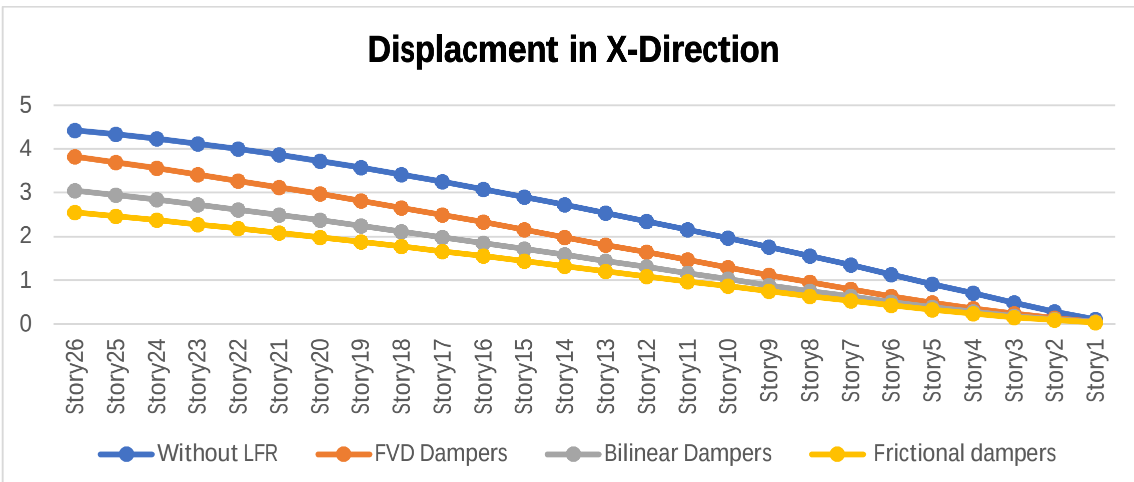


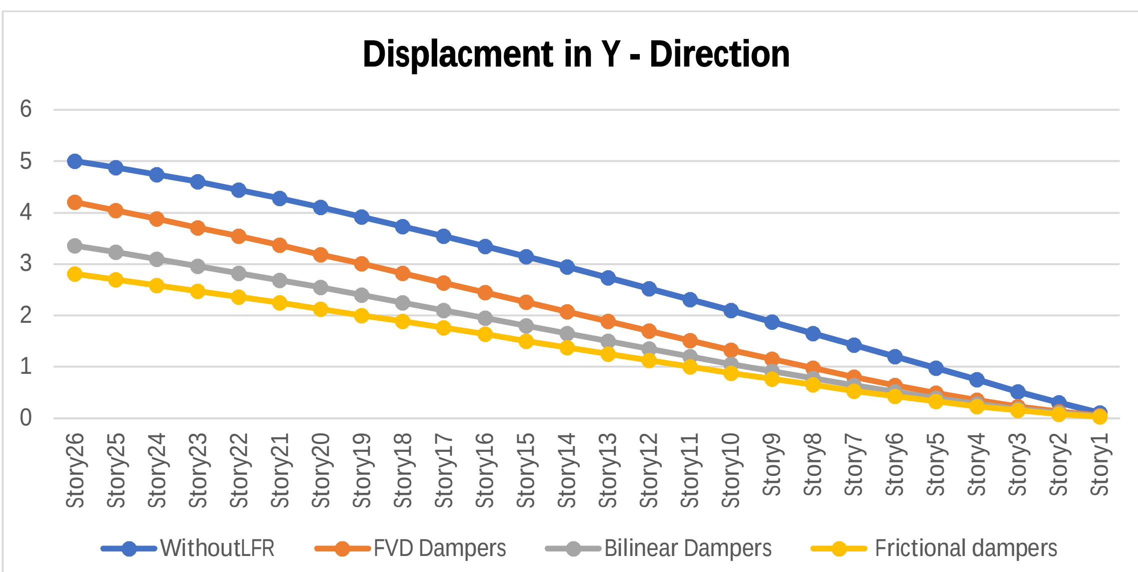
B. Story Shear





C. Storey Displacement





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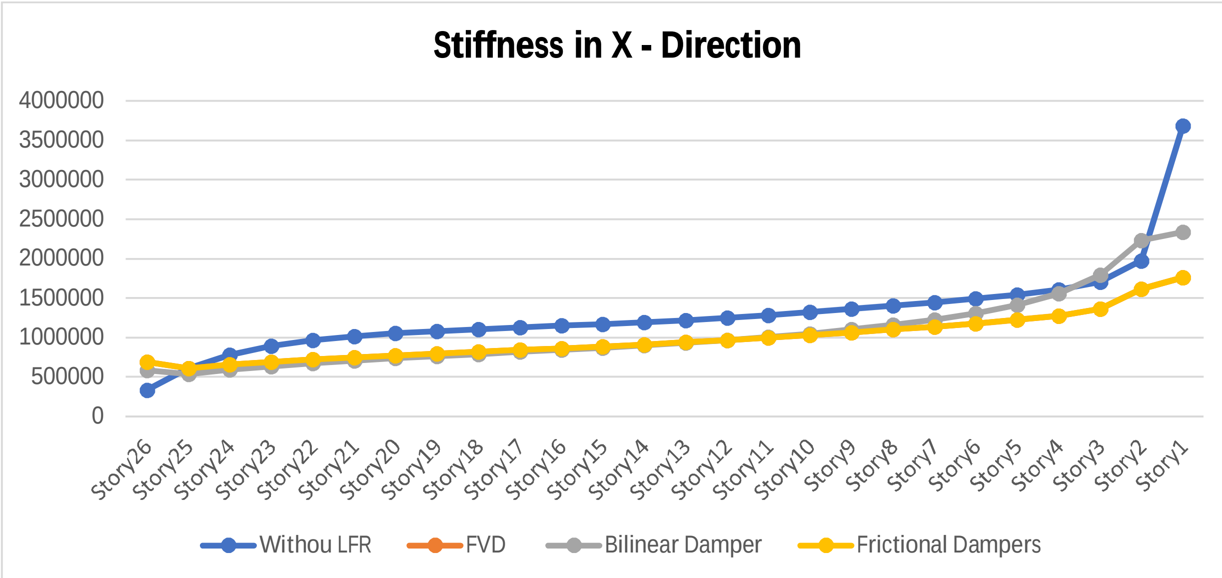
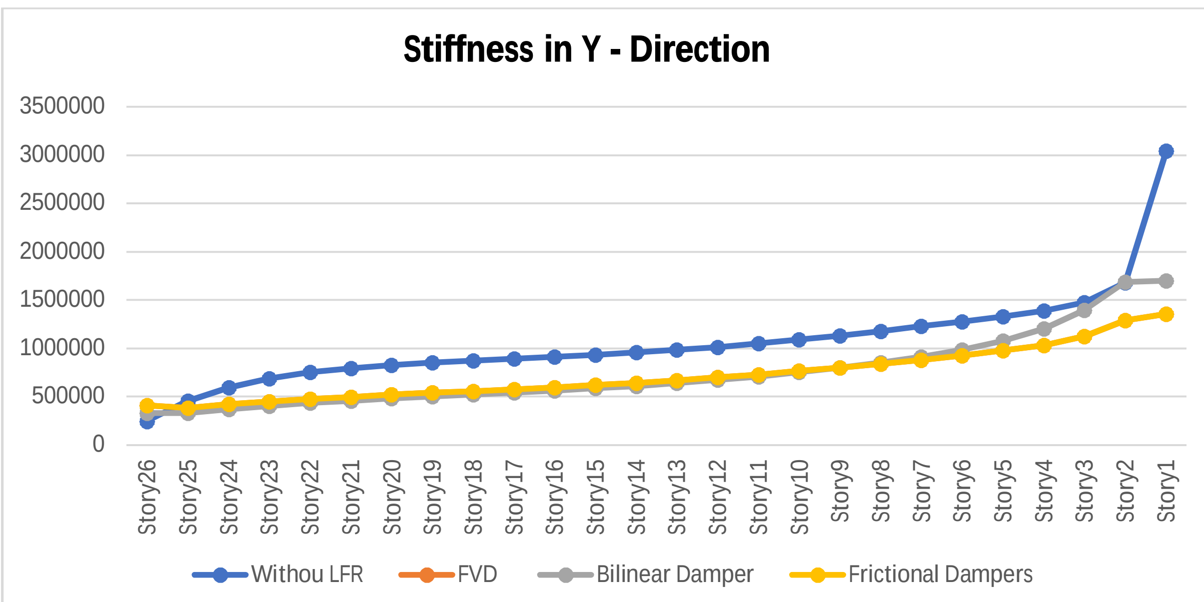
D. Stiffness





VIII. CONCLUSIONS

Based on Response spectrum analysis, conclusions for structural framework with various Link dampers and without dampers results have been established for high-rise G+25 structure in India in seismic zone IV.

1) After analysis it is observed that deflection in a building without dampers is maximum where as it is reduced in building having Friction dampers(FD) as compare to other dampers.
2) It is concluded that building without dampers is failed for drift ratio therefore we required to provide dampers and it observed that building having dampers is minimum drift ratio and with FD is much lesser to other ones.
3) Stiffness of building without dampers is observed to be maximum since it is RC frame structure as compare to stiffness of structure with dampers is minimum and for FVD and FD it is same and minimum to Bilinear damper.
4) Story shear is maximum in building without dampers whereas it is minimum in building having Frictional dampers.
5) It is observed that building with Dampers is safer as compare to without dampers and building with Frictional Damper (FD) is safer than other dampers.

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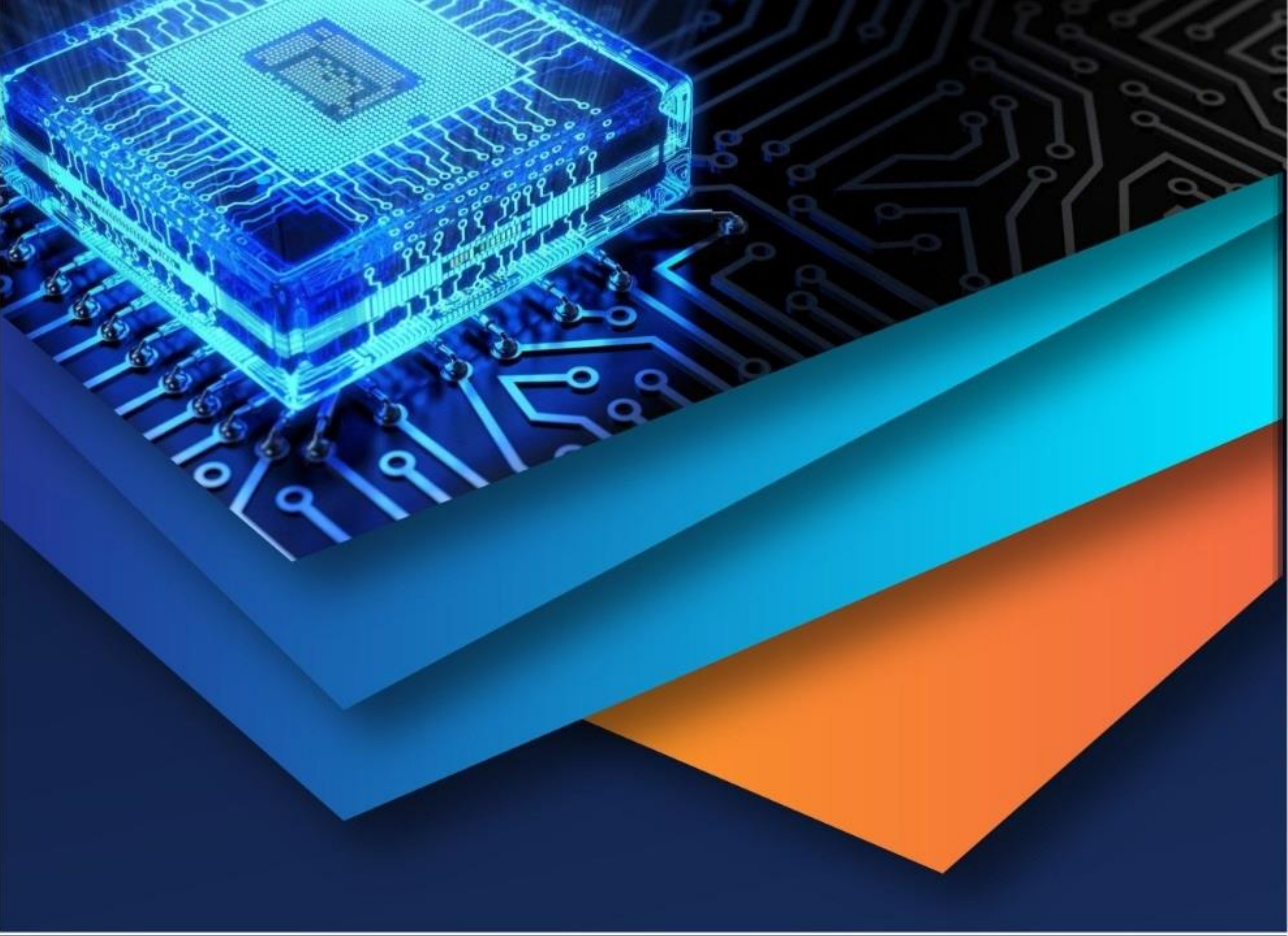

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