Seismic Analysis of Tall structures with different types of Dampers

[1]Abhilash B R, [2]Dr S Vijaya, [3]Madhu K S

[1]PG Student, [2]Professor, [3]Professor
[1]Department of Civil Engineering,
[1]Dr Ambedkar Institute of Technology, Bengaluru, India

Abstract - Dampers are utilized in earthquake tall buildings upgrades as one method of reducing lateral earthquake force. The damper utilized by seismic resistance devices is also known as a seismic damper. Current research aims to analyze a structure that is on typical ground during a tectonic activity. In this research 12 models are considered with Viscous, Metallic, Friction dampers along with Bare Frame. The structure will be examined utilizing the response spectra approach and zone V using the ETABS 2016 program. Considered is a tall structure with G+15, G+20, and G+25 floors situated above medium soil. In this current study analysis is done based on the seismic response of multi-story structures using response spectrum technique using dampers in terms of storey drift, base shear, storey displacement, and time period.

Index Terms - Tall structure, Dampers, E-Tabs, Response Spectrum Method, Storey Displacement, Storey Drift, Time period.

I. INTRODUCTION

Numerous destructive earthquakes have struck the world over the past several decades, killing a considerable number of people as a result of building collapses and severe structural damage. It is crucial that structures like domestic structures, lifeline building, factual structures, and commercial structures be correctly constructed to defend against earthquakes since incidence of such destruction during earthquakes amply highlights the considerable seismic threats.

Passive control methods, however regulate structural vibration when there is not power source generated. Strong wind motion and earthquakes can both be authorized by either technique. So much of hard work has been put into developing the structural control concept into a workable technology, and such appliances are now used in constructions.

The earthquake reaction control structural design technique is broadly acknowledged and widely used in Civil Engineering. Dampers are utilized in earthquake tall buildings upgrades as one method of reducing lateral earthquake force. Lot of energy is put in to the structure during tectonic activities. These energies take the configuration of kinetic and strain energy. The structure receives this energy through absorption or transfer.

A damper is essentially a tool for releasing kinetic energies. It falls under the category of Effective Control Device for Seismic Resistance. It absorbs the vibration and shock caused by seismic energy but does not distinct the substructure from the superstructure. The damper utilized by seismic resistance devices is also known as a seismic damper.

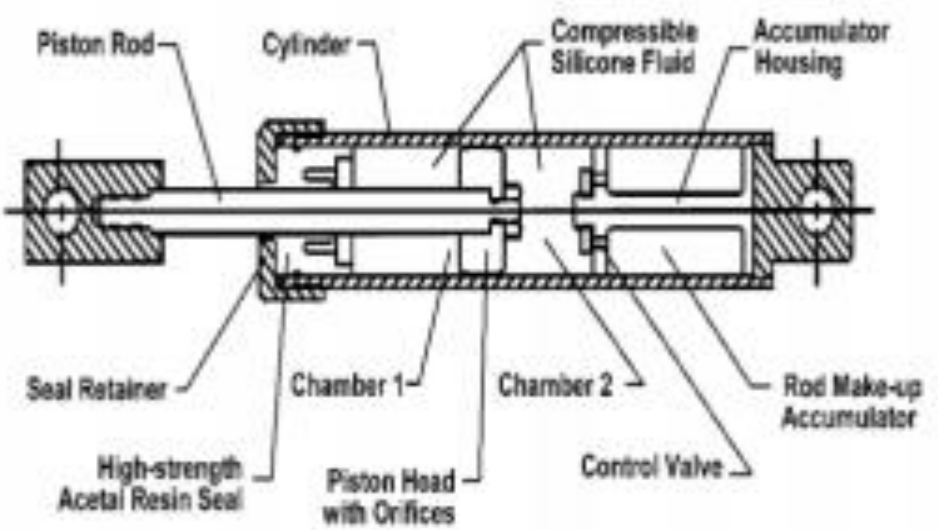

Fig.1 Viscous Damper

II. LITERATURE SURVEY

K. Sudheer kumar et.al [2019] [1] For the chosen RC frame construction, this paper examines the efficiency of several ineffective control device types. A 9 storey RC framed building with as well as without dampers is subjected to a time history study using the software SAP 2000. The analysis's findings indicated that maximum displacement, storey shears, also the storey drifts value are higher in accordance to RC-framed structures without dampers than they are in accordance to RC-framed structures with dampers.

K. Jaya Gayathri Dhevi et.al [2018] [2] In the current study, dampers for various zones and dampers are studied without and with dampers in a multistorey RC frame structure with 12 stories and a G+ rating that is 39 meters tall. The analysis involved identifying and contrasting for various scenarios the Bending Moment, shear Force, Displacements, and Time Periods. Buildings are modelled and assessed using the standard software. ETABS2016.

Puneeth Sajjan et.al [2016] [5] Using ETABS2015 program, a symmetrical, eight-story structure is examined and modelled for the present study. According to Part 1 of IS1893-2002, earthquake loads are described. Dynamic analysis is done using the response spectra function, which is defined. Viscous damper is given to the building to regulate the seismic reaction and to boost the structure's stiffness. Similar modelling and analysis approaches are used for the structure within viscous damper. Damping coefficient Cd=810 kN-s/m and exponent=0.3 are the mechanical features of the viscous dampers in this investigation. Findings are produced and contrasted using displacement, tale drift, and story shear.

III. METHODOLOGY

Current research aims to analyze a structure that is on typical ground during a tectonic activity. In this research 12 models are considered with Viscous, Metallic, Friction dampers along with Bare Frame. Considered is a tall structure with G+15, G+20, and G+25 floors situated above medium soil. In the asymmetric building, the number of bays will remain at 7 along one direction, in another direction the bay size is 5, and the storey heights will remain at 3 meters. The structure will be examined utilizing the response spectra approach and zone V using the ETABS 2016 program.
The tall structure which is considered is located in Zone V and Medium soil condition is chosen.

Member name	**Properties**	
Slab	Thickness	150mm
Column	C/S Dimension	1000mmx1000mm
Beam	C/S Dimension	500mmx600mm
Masonry Wall	Thickness	200mm
	Support Type	Fixed
Loads Considered	Wall Load	10.25 kN/m
	Live Load	3.00 kN/m^2
	Floor Finish	1.50 kN/m^2
Seismic Data	Zone Factor	0.36 (Zone V)
	Importance factor	1
	Response Reduction Factor	5
	Soil type	II
Viscous damper properties	Mass	1800Kg
	Weight	0.175 KN
	Effective Stiffness	20000KN/M
	Effective Damping	30000KN-S/M
Visco-elastic damper properties	Mass	2000Kg
	Weight	0.210KN
	Effective Stiffness	30000KN
	Effective Damping	10000 KN-S/M
Friction damper properties	Mass	2200Kg
	Weight	0.225KN
	Effective Stiffness	20000KN/M
	Effective Damping	4000 KN-S/M
Metallic damper properties	Mass	2500Kg
	Weight	0.25KN
	Effective Stiffness	5000KN/M
	Effective Damping	4000 KN-S/M

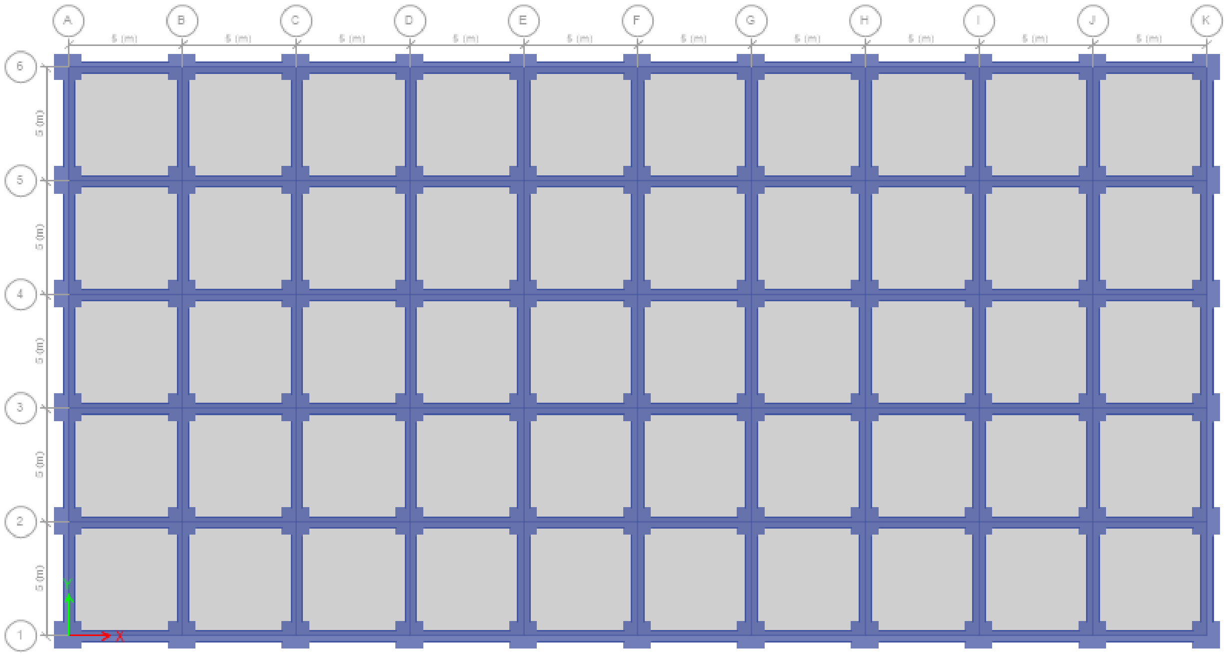

Fig 2. Tall Structure plan

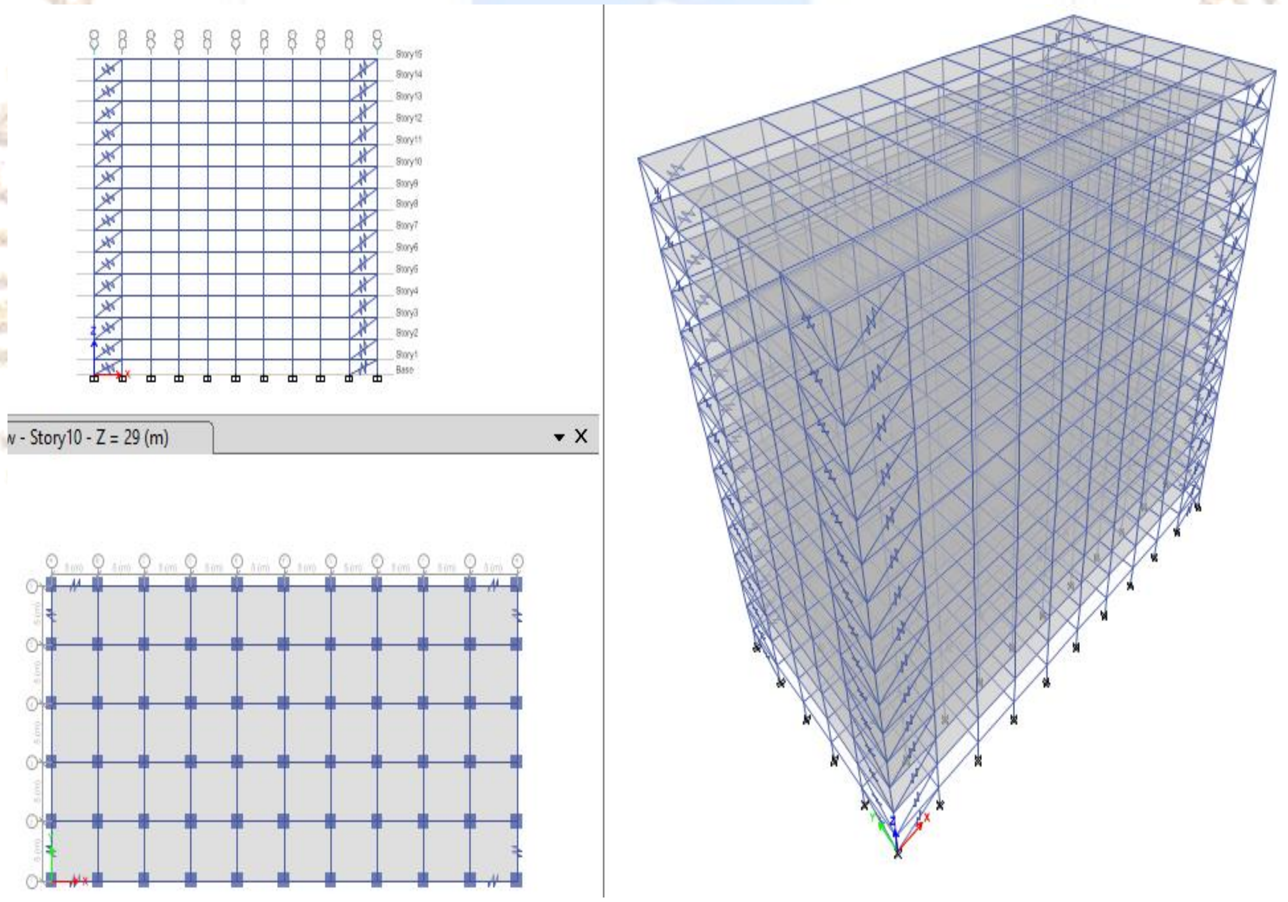

Fig 3. Plan and 3D view of friction damper

IV. RESULTS AND DISCUSSIONS

1.Storey Displacement

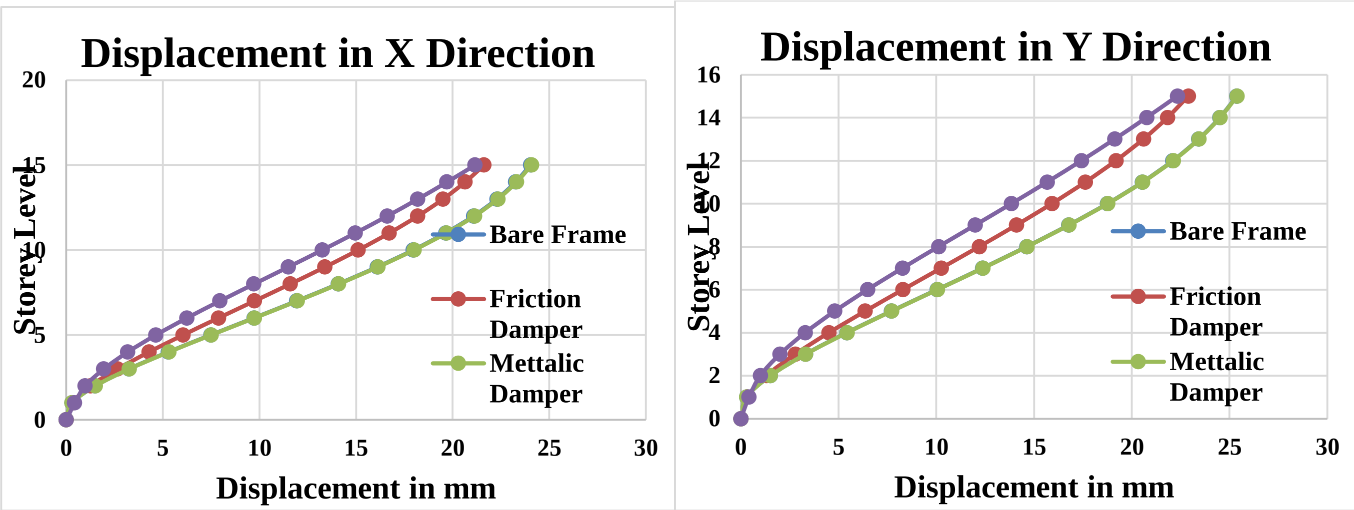

Fig 4: Displacement in mm along EQX and EQY for G+15

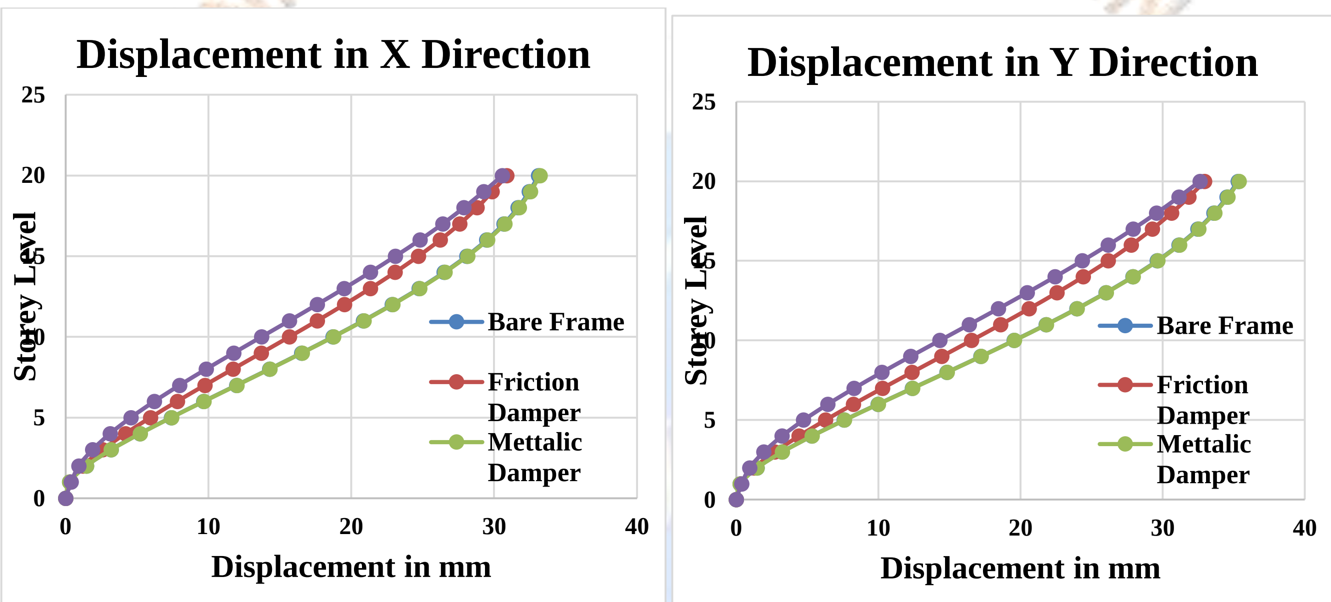

Fig 5: Displacement in mm along EQX and EQY for G+20

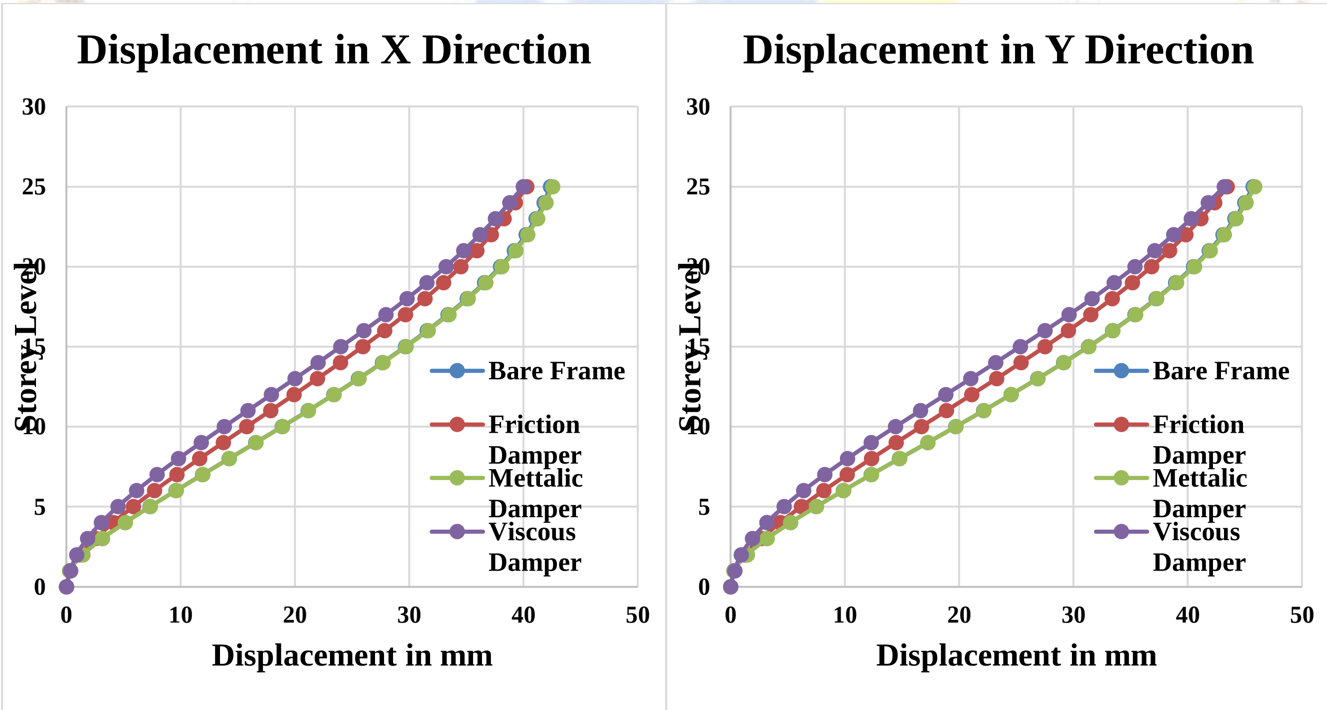

Fig 6: Displacement in mm along EQX and EQY for G+25

Maximum storey displacement for structures according to IS:1893 Part-1(2016) of clause 7.11 is H/250. According to the graphs and tables above, displacement at the lowest level is less, but as the height of the structure rises, the displacement also rises. It is evident that the displacement for higher storey buildings is greater than in lower storey buildings in both directions. In comparison to all other dampers, the viscous damper in all 15, 20, and 25 storey buildings exhibits a significantly lower displacement of 12%, 7%, and 5.6% for 15, 20, and 25 storey buildings, respectively. Every displacement value obtained from the software is within the allowed ranges.

2.Storey drift

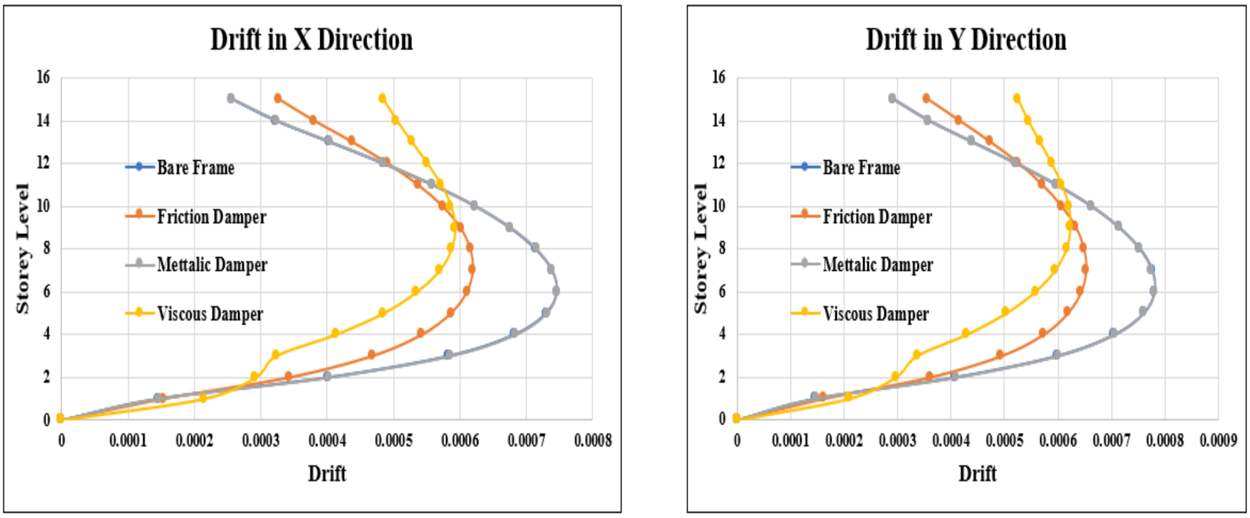

Fig 7: Storey Drift along EQX and EQY for G+15

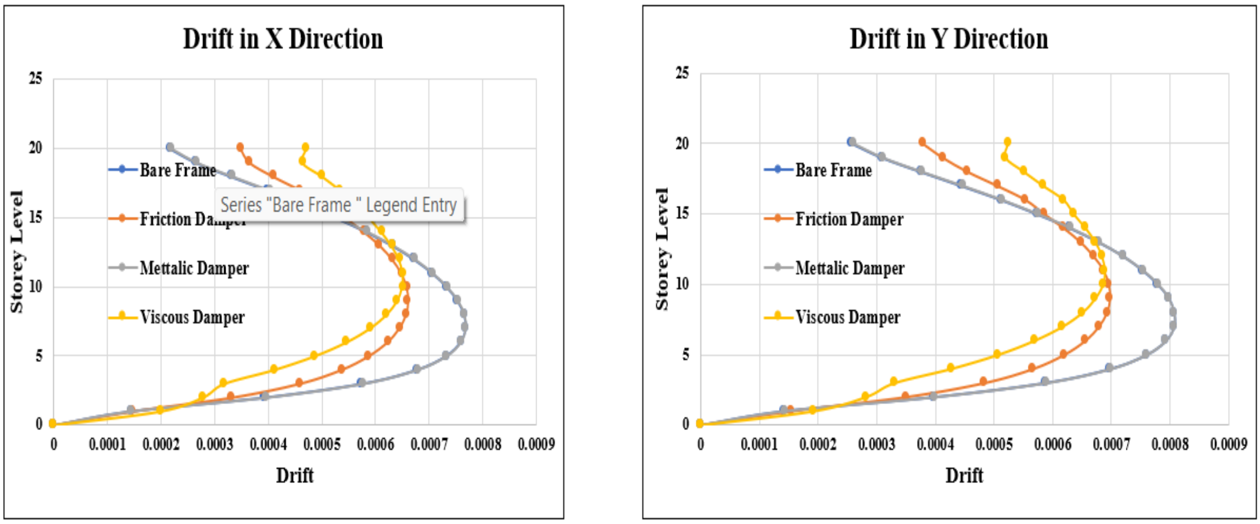

Fig 8: Storey Drift along EQX and EQY for G+20

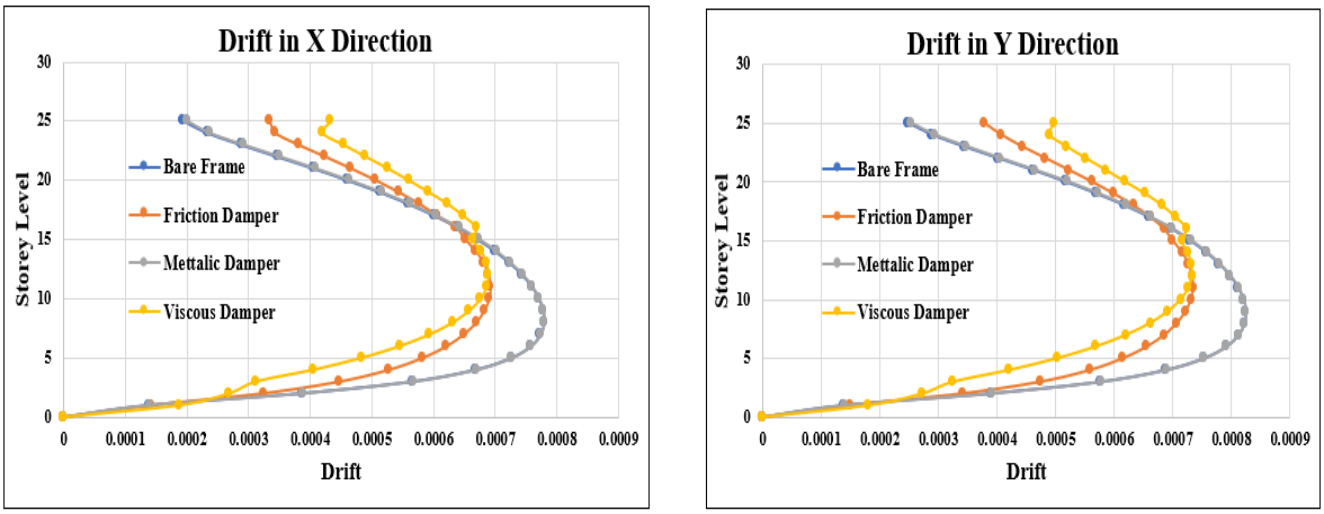

Fig 9: Storey Drift along EQX and EQY for G+25

The storey drift in any storey shall not exceed 0.004 times storey height in accordance with IS 1893 Part-1(2016). The storey drift in all the dampers acts as though the drift value is progressively increased up to a particular peak and then gradually dropped, as can be seen from the preceding graphs. In every case, the friction dampers exhibit extremely little storey drift (26%, 18%, and 14% in each direction, respectively). The software produced numbers for storey drift that are all within acceptable bounds.

3.Base Shear

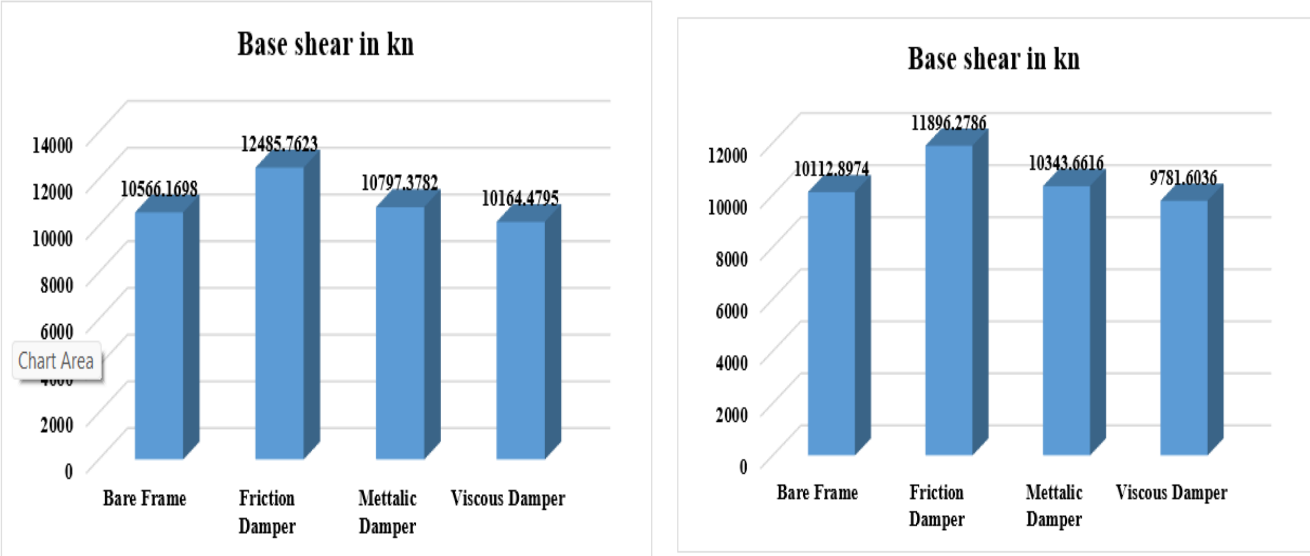

Fig.10: Base Shear in kN along EQX and EQY for G+15

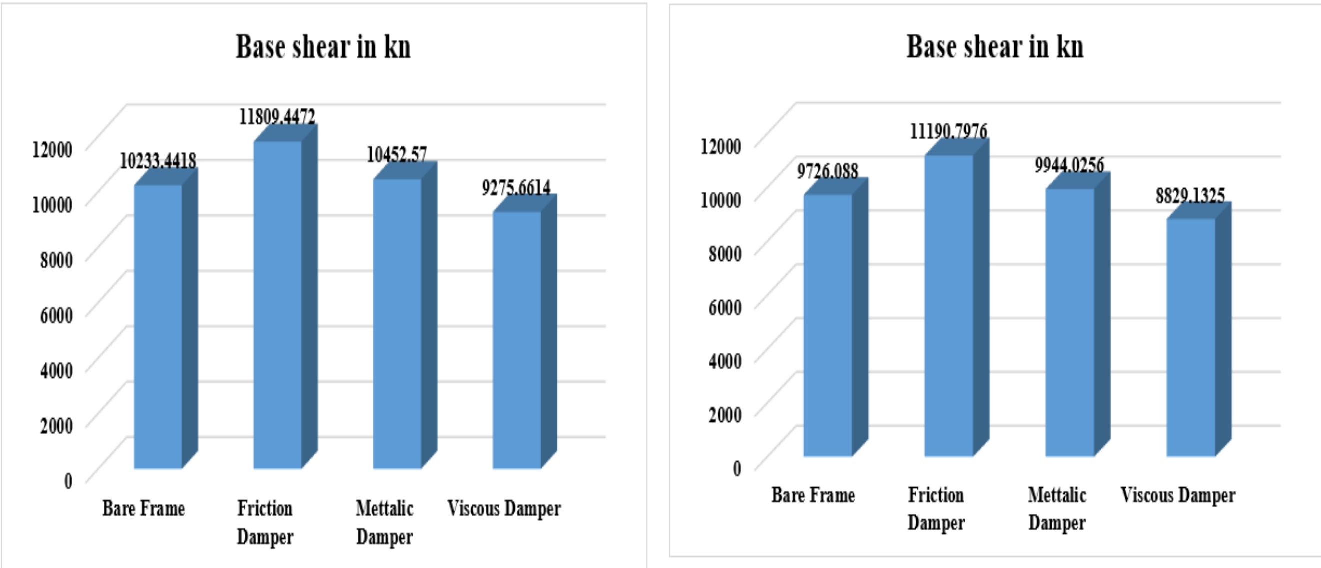

Fig.11: Base Shear in kN along EQX and EQY for G+20

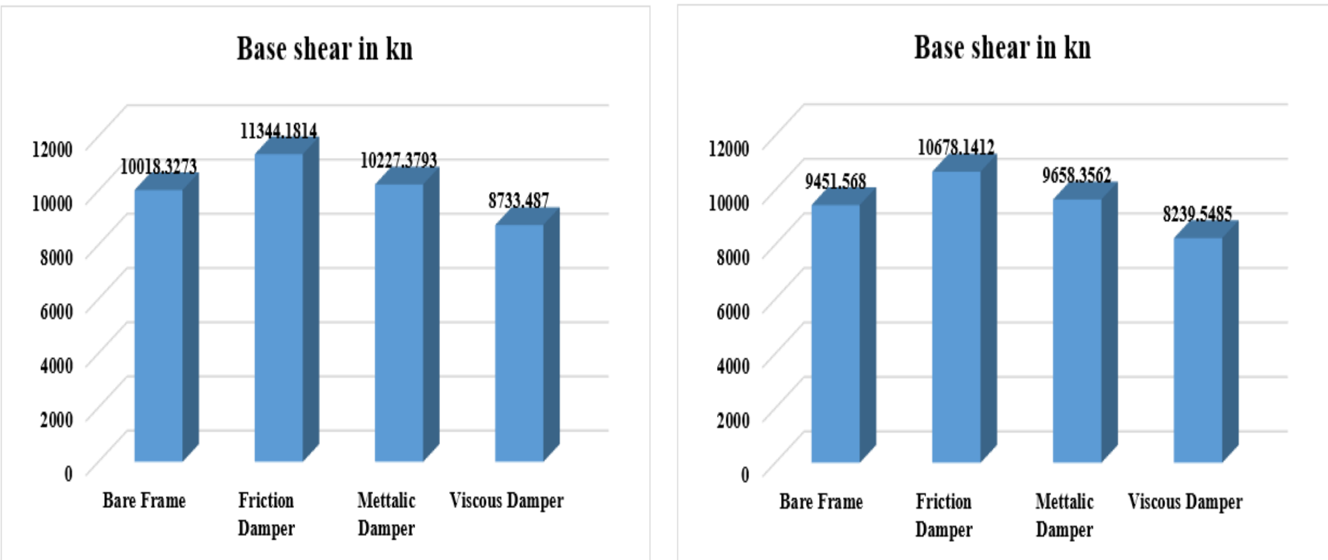

Fig.12: Base Shear in kN along EQX and EQY for G+25

The figures above make it abundantly evident that while the base shear rises as the structural member height reduces. In comparison to all other dampers, the friction damper exhibits a larger base shear of 15%, 18%, and 26% for 15, 20, and 25 story buildings, while the viscous damper exhibits a lesser base shear in both directions.

4.Time Period

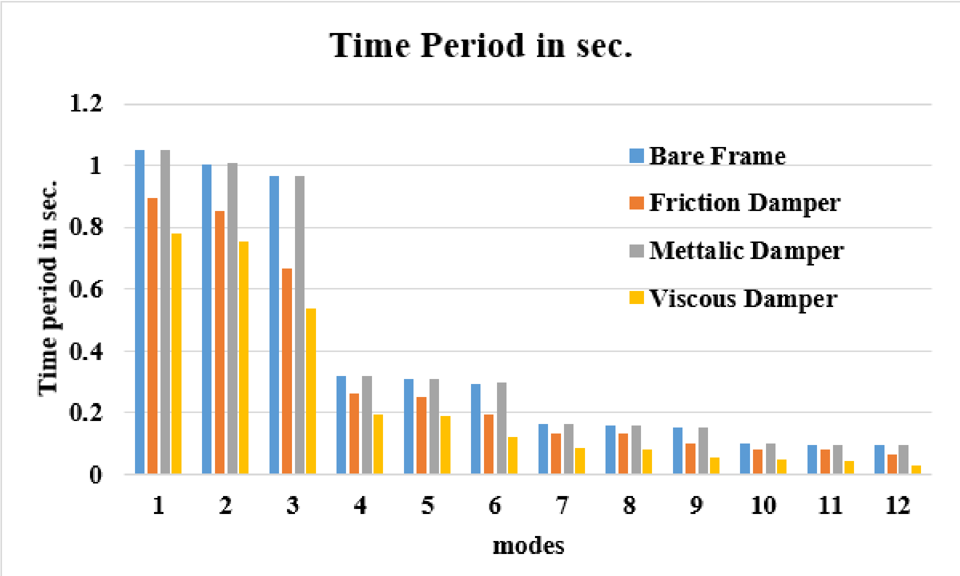

Fig 13: Time Period in sec for G+15

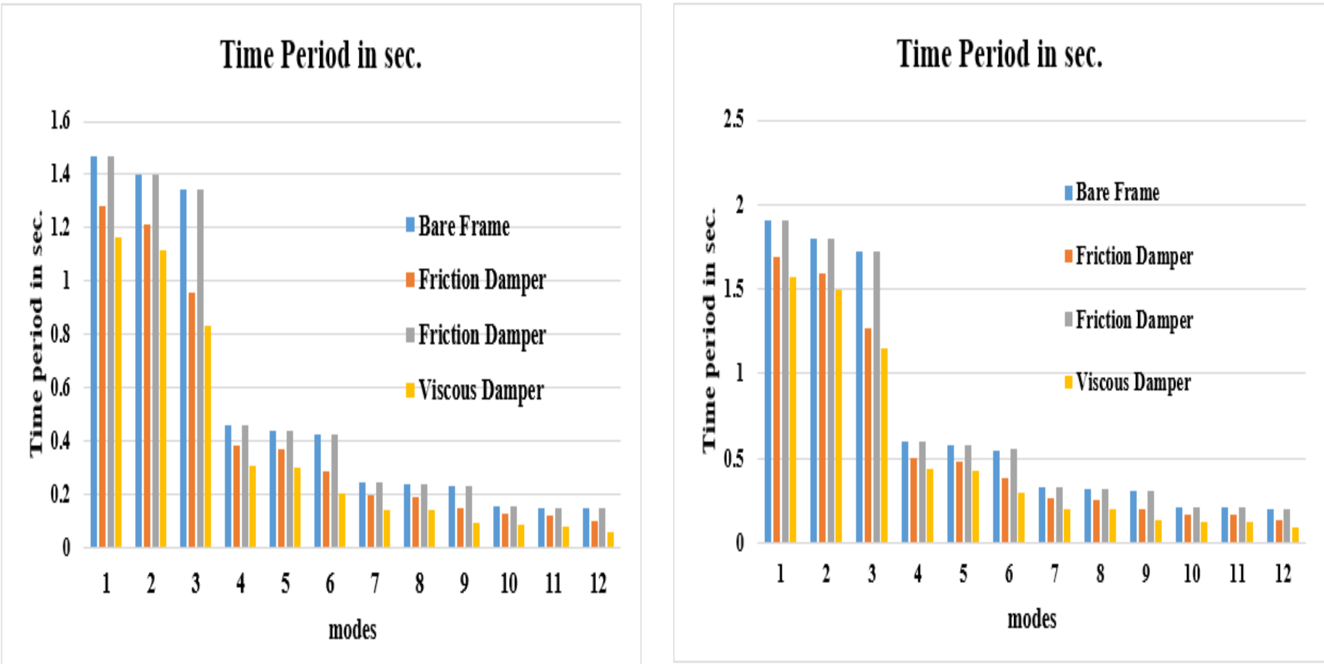

Fig 14: Time Period in sec for G+20 and G+25

By observing the graphs, we can see that the time period is increasing the however the storey height increases, regular structure is showing the greater time period as compare to all the dampers and viscous damper is showing the showing lesser time period of 25%, 20% & 15% for 15, 20 & 25 storey structure respectively as in comparison to the bare frame structure. However, when height of the structure increases the time period also increasing in permissible limits.

V. CONCLUSION

1. Viscous dampers are more efficient for ground vibrations caused by earthquakes that last a long time.
2. Viscous dampers are most effective for lightly damped structures, and they become less effective as structural damping increases.
3. From the results it is noticed that for all the 15, 20 and 25 storey building the viscous damper is showing the very lesser displacement of 12%, 7% and 5.6% respectively as compare to bare frame structure.
4. The friction dampers are showing the very lesser storey drift in the all cases of 26%, 18% & 14% for 15, 20 & 25 storey respectively when compare to regular structure in both the direction.
5. It is evidently seen that base shear as the storey height reduces. In comparison to all other dampers, the friction damper exhibits a larger base shear of 15%, 18%, and 26% for 15, 20, and 25 story buildings respectively, while the viscous damper exhibits a lesser base shear in both directions.
6. Viscous damper is showing the showing lesser time period of 25%, 20% & 15% for 15, 20 & 25 storey structure respectively as compare to the bare frame structure.

VI. REFERENCES

[1] Waseemuddin Asad and Aravind Kumar Harwalkar [2020] *"Seismic Analysis of RCC Structure with Different Types of Dampers"* International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9 Issue-12, October 2020.

[2] K.Sudheer kumar and Y.Vinod [2019] *"Seismic Response Analysis of RC Framed Structure using Dampers"* International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-6C2, April 2019.

[3] K. Jaya Gayathrri Dhevi & Dr. K Rama Mohana Rao [2018] *"Global Journal Of Engineering Science And Researches Seismic Response Of RC Structures Using Different Types Of Dampers"* Global Journal Of Engineering Science And Researches.

[4] Shilpa Chandran.P and Dr. CK Prasad Varma Thampan [2017] *"Seismic Effectiveness of Tuned Mass Damper - A Review"* International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 03 | Mar -2017.

[5] Puneeth Sajjan and Praveen Biradar [2016] *"Study On The Effect Of Viscous Damper For Rcc Frame Structure"* International Journal of Research in Engineering and Technology.

[6] Dharmesh Chandnani and Riddhi Joshi [2016]*"Characteristics & Applications of Different Types of Dampers as Seismic Energy Dissipater"* International Journal of Computer Science and Network, Volume 5, Issue 2, April 2016.

[7] Sagar Dhok and Prof. P. V. Muley [2016] *"Review on applicability of combinations of Damper for Steel Frame Structure"* International Research Journal of Engineering and Technology (IRJET).

[8] Dr. Mohan M. Murudi [2015] *"Seismic Effectiveness Of Tuned Mass Damper (TMD) For Different Ground Motion Parameters"* 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada.

[9] Vajreshwari Umachagi and Katta Venkataramana [2013] *"Applications of Dampers for Vibration Control of Structures: An Overview"* International Journal of Research in Engineering and Technology.

[10] IS 875(1987-Part 1), *Code of practice for design loads (other than earthquake) for buildings and structures, Dead loads. Bureau of Indian standards (BIS):* New Delhi; 1987.

[11] IS 875 (1987-Part 2), *Code of practice for live loads. Bureau of Indian Standards (BIS)*: New Delhi;1987.

[12] IS: 456, *Code of practice for plain and reinforced concrete code of practice. Bureau of Indian Standards*: New Delhi; 2000.

[13] IS: 1893(Part-1), *Criteria for earthquake resistant design of structures – general provisions for buildings, Bureau of Indian Standards:* New Delhi; 2016.

[14] IS: 16700, *Criteria for Structural safety of Tall concrete buildings. Bureau of Indian Standards*: New Delhi; 2017.