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SEISMIC ANALYSIS AND PERFORMANCE OF HIGH RISE BUILDING WITH DAMPER

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Abstract — *In day to day life, it is needed to study the behavior of every multi-storey building structure subjected to ground motion which is the common problem for construction. The earthquake creates the vibrating forces at the base of structure. These vibrations create the oscillations in building which may damage the structure tremendously. These vibrations created at the ground level gets transferred up to the top of building and because of mass of structure which produces the lateral forces on the frame which finally reduces the moment resistance capacity of building parameters such as columns beams etc. For a decade, many strong Earthquakes also occurred one after another in many country. These Earthquakes have cause severe damage to large-scale infrastructures. To protect structures from significant damage and response reduction of structures under such severe earthquakes has become an important topic in structural engineering. Structures are designed to resist and withstand dynamic forces by a combination of strength, deformability and energy absorption. It indicates that structures designed with these methods are sometimes vulnerable to strong earthquake motions. In order to avoid such critical damages, structural engineers are working on different types of structural systems that can help to resist, provide strength and can withstand strong motions. Damper is one of the effective system that withstand Earthquake. When Dampers used in high-rise buildings in seismic areas, it should reduce the vibrations induced by lateral load i.e. strong winds and earthquakes. In the present study, a building with 25 floors is analysed and also describe the study on seismic behavior of a structure with and without damper. The scope of present study is to analyse behavior of multi-storeyed building for location of damper in structure system.*

Keywords-*Seismic Analysis, High rise Building, Dampers, Viscous damper, Earthquake, Time History Analysis, Displacement.*

I. INTRODUCTION

Generally, the dampers are huge concrete block or steel body which mostly mounted in high rise building or other structure.it can be move in opposite direction to resonance frequency oscillations of the structure by fluid, pendulums or spring. Environmental forces like earthquake, wind load and etc. create unwanted vibration in high rise buildings which causing resonance or vibration in building that may be destructive, cause of that several damage happens to the structure. Application of Dampers can prevent damage, discomfort or outright structural failure. They are frequently used in power transmission, automobiles and buildings to prevent from lateral load like Earthquake and wind load. It is also known as a harmonic absorber that reduce and withstand the amplitude of mechanical vibration.

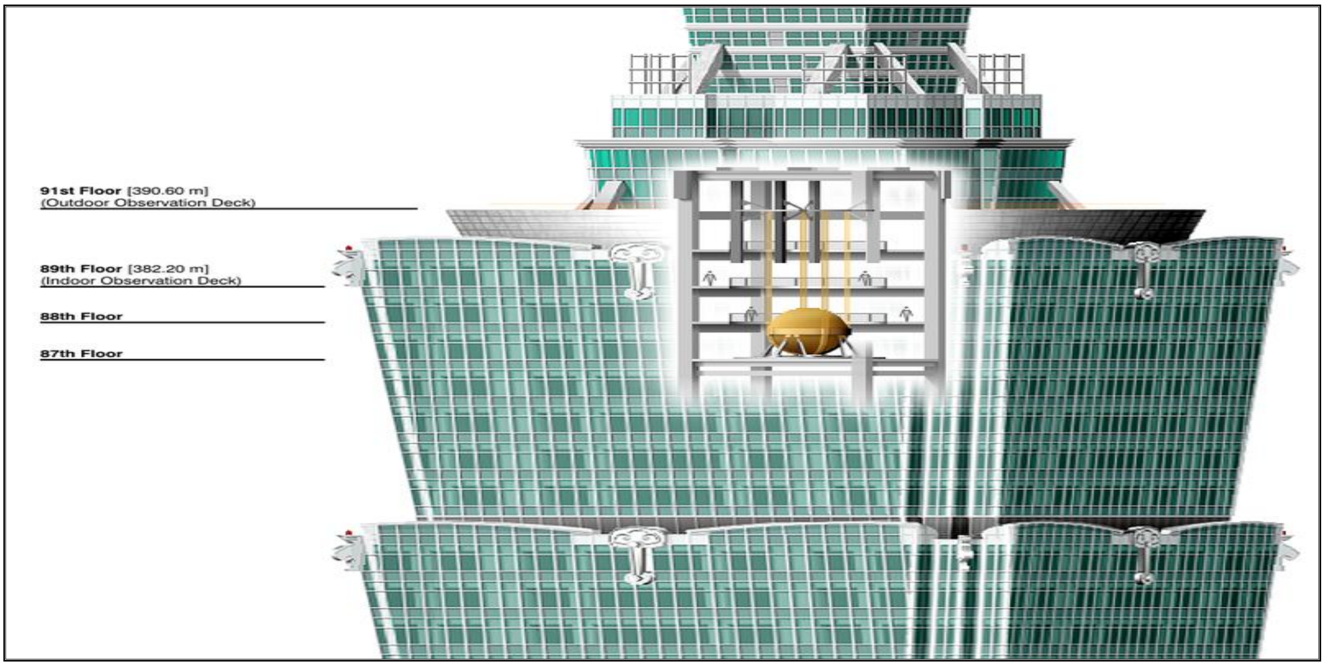

Figure 1: Damper

1.1. Types of Dampers

Dampers are classified based on their performance of friction, metal, viscous, viscoelastic, shape memory alloys (SMA) and mass dampers. The advantages of using dampers is that we can speculate to high energy absorbance, it is easy to install and replace them as well as coordination to other structure members

- Friction dampers
- Metallic dampers
- Lead Injection damper
- Viscous damper
- Mass damper
- Lead Rubber damper (LRB) and rubber damper HDRB

1.2. Benefit of Fluid Viscous Damper (FVD) for seismic analysis:

Fluid viscous Damper is beneficial for new building and for rehabilitate purpose also reduce scope of work and site construction time frame. In big scale Earthquake, FVD become more effective than bracing system and give faster reoccupation of the building.

1. FVD absorb and dissipating energy in highly and control manner with very less damage
2. It also reduce drift of structure and improve structure resilience.
3. Viscous dampers can be tuned by design to provide significant performance improvements through supplemental damping to a structure. This can be done without increasing the size of the surrounding structure, which standard bracing elements (i.e. BRBs) would typically require.
4. The reduction of acceleration and displacement also minimizes damage to the building's fit out and contents, reducing repair costs and allowing faster reoccupation after an earthquake.

II. OBJECTIVE

- Study appropriate Fluid viscous damper type for structure.
- Study dampers performance at different location.
- Study the effect of damper on Displacement, base shear, shear force, stability, moment, stiffness, strength and reducing lateral drift of structure.
- Compare the result of building with and without damper

III. METHIDOLOGY

Time History analysis: Time-history analysis provides for linear or nonlinear evaluation of dynamic structural response under loading which may vary according to the specified time function. Dynamic equilibrium equations, given by K u(t) + C d/dt u(t) + M d2/dt u(t) = r(t), are solved using either modal or direct-integration methods. Initial conditions may be set by continuing the structural state from the end of the previous analysis. The Time History response of a structure is simply the response (motion or force) of the structure evaluated as a function of time including inertial effects. The time history analysis in the advanced level of Visual Analysis allows four main loading types. These include base accelerations, base displacements, factored forcing functions, and harmonically varying force input.

IV. MODELLING AND ANALYSIS OF HIGH RISE BUILDING

High rice RC Building analyze in ETABS. Following are Its Dimension:

1. Type of structure	Multi-storey rigid jointed 3D frame (SMRF)
2. Location	Vadodara
3. Seismic zone	III
4. Zone Factor	0.16
5. Importance factor	1.00
6. Type of soil	Medium soil
7. Number of storey	G+24 Storey
8. Dimension of building	23 m x 33.7 m
9. Floor Height	3 m
10. Live load	2 KN/m^2 on all floors.
11. Dead load	4.75KN/m^2 on all floors including self weight
12. Materials	Concrete (M30) and Reinforcement Fe500
13. Beam Dimension	400 x 750 mm
14. Inner Column Dimension	300 x 1200 mm
15. Outer column Dimension	1200 x 300
16. Depth of slab	150 mm
17. Specific weight of RCC	25 KN/m^3
18. Damping	5 %

Load on the Building = Dead load, live load, Earthquake load and load combinations

Live load is taken as specified in IS: 875 (Parts 2)-1987, Earthquake load is taken as specified in IS: 1893-2000

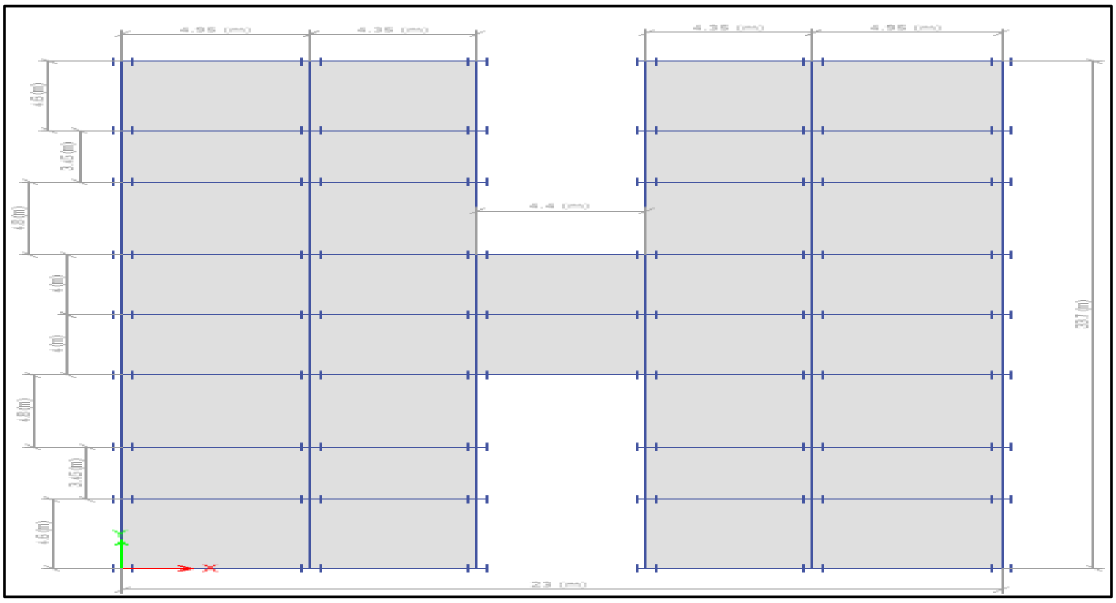

Figure 2: Plan of Building

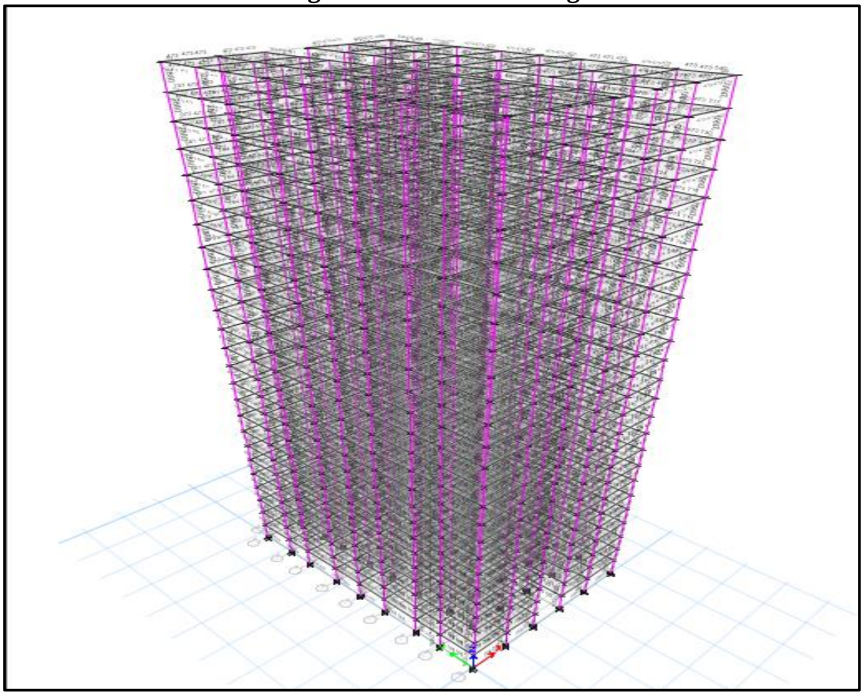

Figure 3: Model after applying load combination

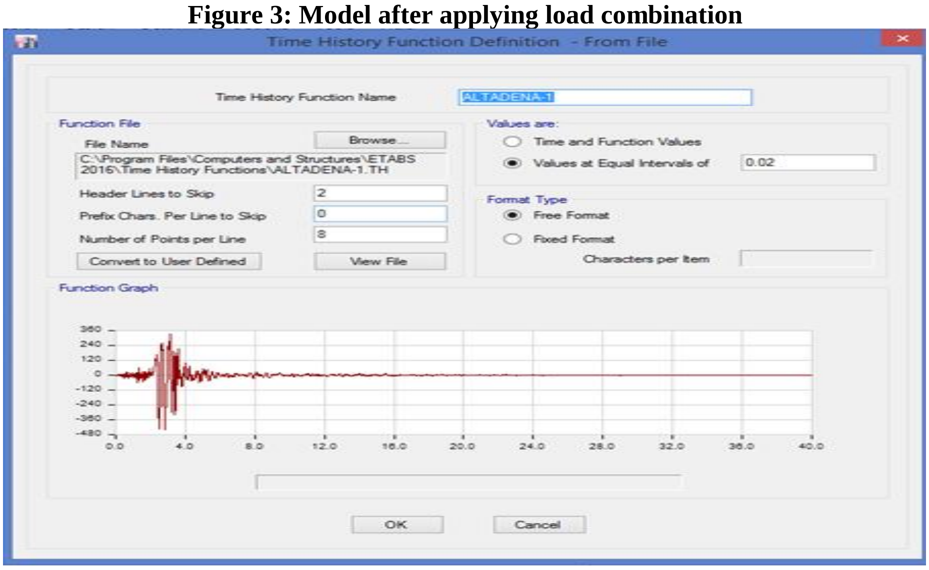

Figure 4: Time history analysis (Altadena)

FORCE (kN)	TAYLOR DEVICES MODEL NUMBER	SPHERICAL BEARING BORE DIAMETER (mm)	MID-STROKE LENGTH (mm)	STROKE (mm)	CLEVIS THICKNESS (mm)	MAXIMUM CLEVIS WIDTH (mm)	CLEVIS DEPTH (mm)	BEARING THICKNESS (mm)	MAXIMUM CYLINDER DIAMETER (mm)	WEIGHT (kg)
250	17120	38.10	787	±75	43	100	83	33	114	44
500	17130	50.80	997	±100	55	127	102	44	150	98
750	17140	57.15	1016	±100	59	155	129	50	184	168
1000	17150	69.85	1048	±100	71	185	150	61	210	254
1500	17160	76.20	1105	±100	77	205	162	67	241	306
2000	17170	88.90	1346	±125	91	230	191	78	286	500
3000	17180	101.60	1441	±125	117	290	203	89	350	800
4000	17190	127.00	1645	±125	142	325	273	111	425	1088
6500	17200	152.40	1752	±125	154	350	305	121	515	1930
8000	17210	177.80	1867	±125	178	415	317	135	565	2625

Figure 5: Data of different weight of viscous damper for consideration in analysis.

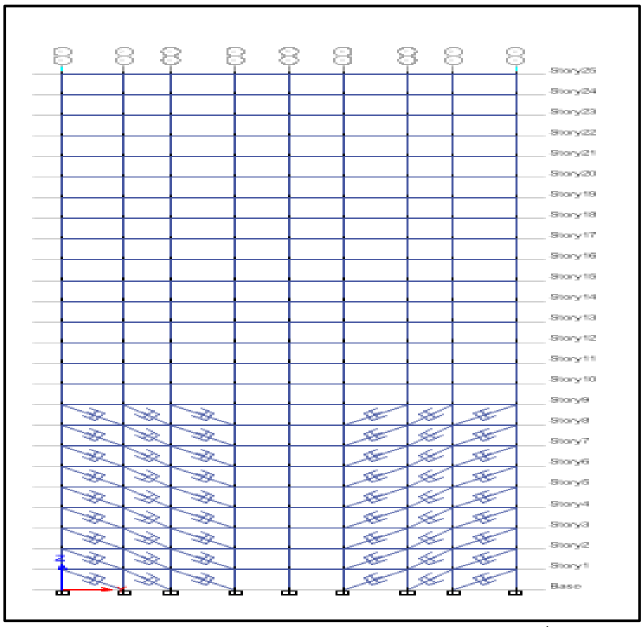

Figure 6: FVD at Bottom of the building (1st case)

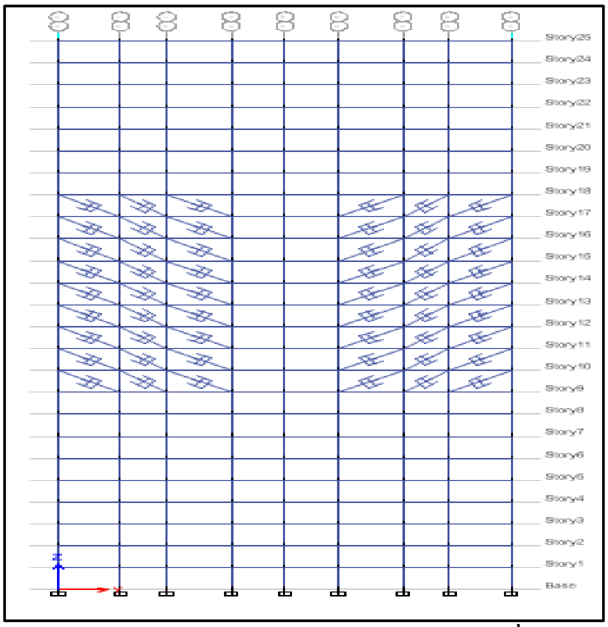

Figure 7: FVD at middle of the building (2nd case)

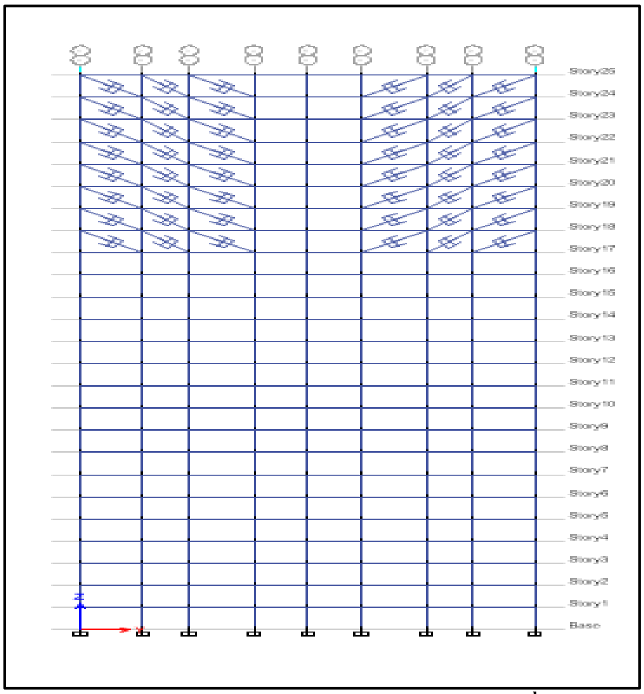

Figure 8: FVD at top of portion of building (3rd case)

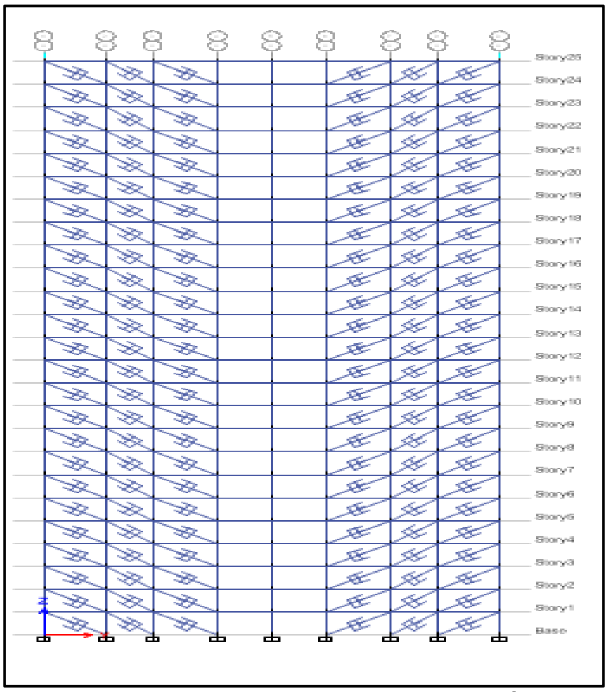

Figure 9: FVD placed in whole building (4th case)

V. RESULTS

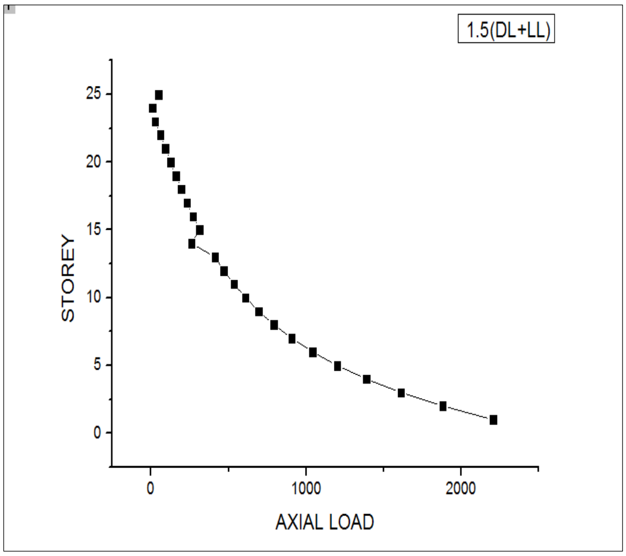

Figure 10: Axial load in 1.5(DL+LL) case without damper

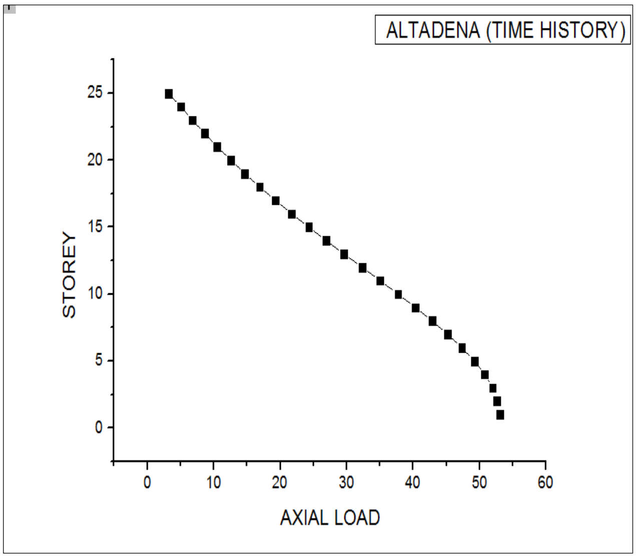

Figure 11: Axial load in Altadena case without damper

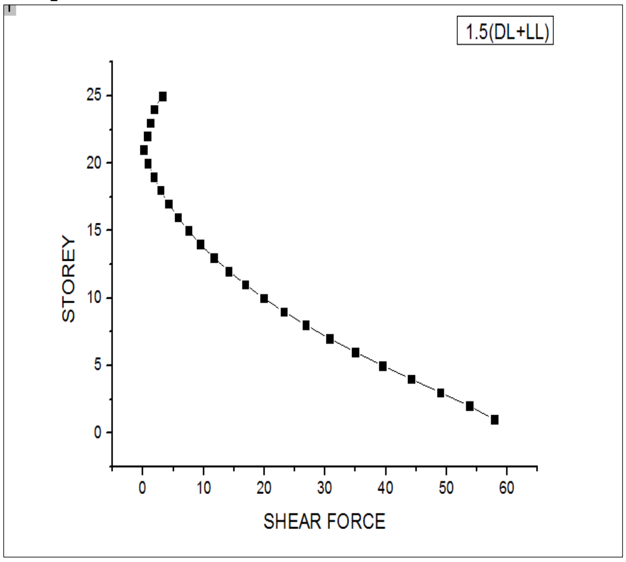

Figure 11: S.F in 1.5(DL+LL) case without damper

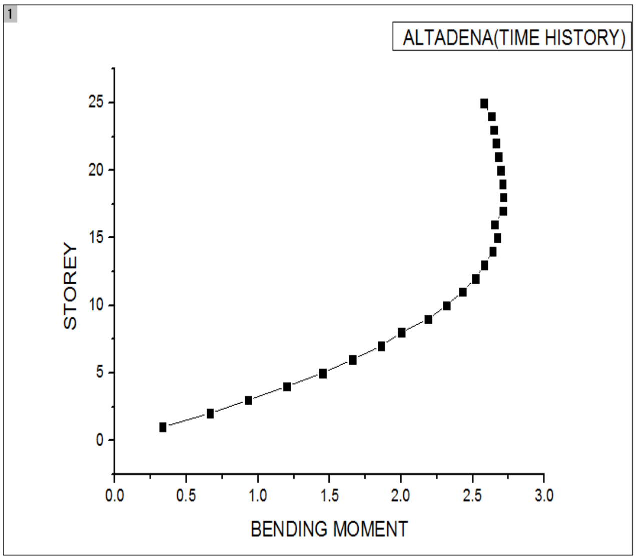

Figure 12: B.M in Altadena case without damper

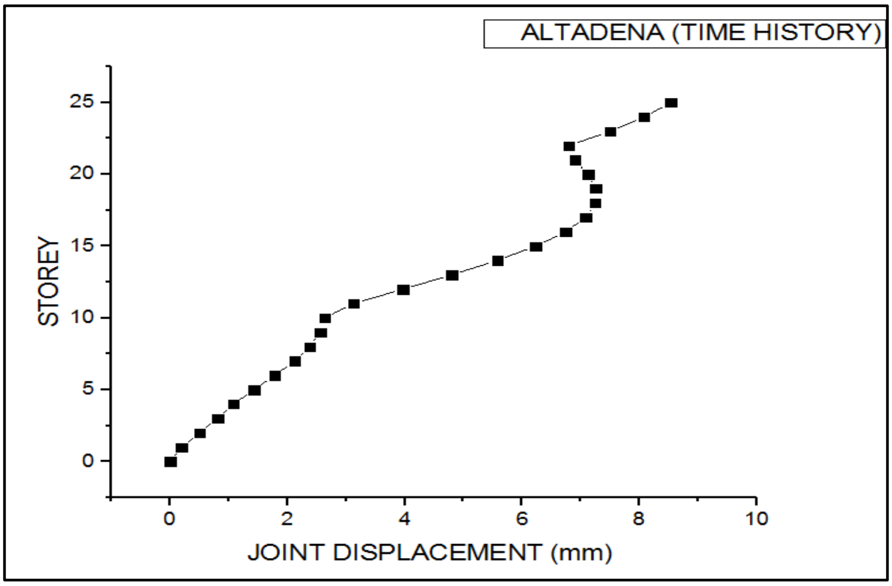

Figure 13: Displacement in X direction in Altadena case without damper

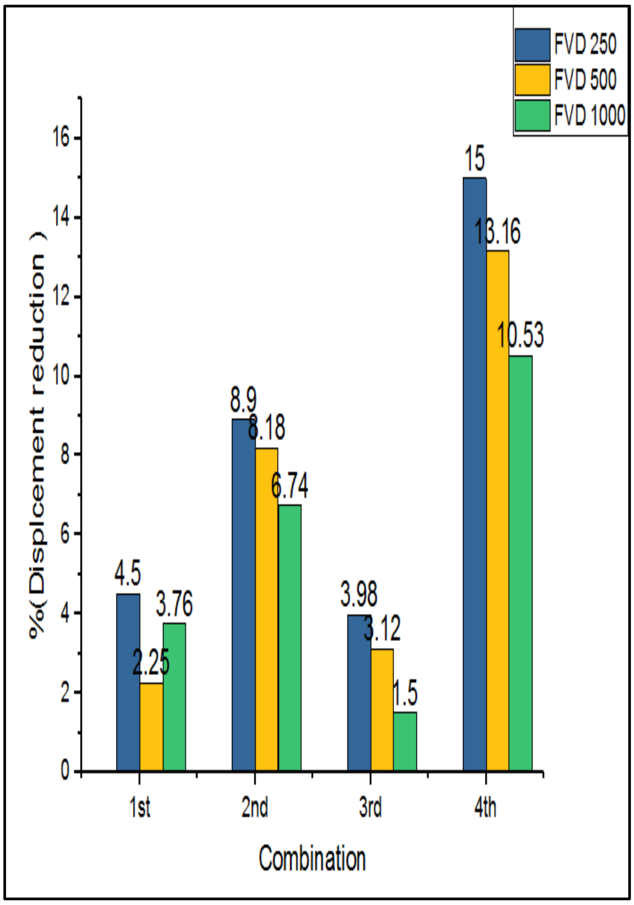

Figure 14: Displacement reduction chart in X direction

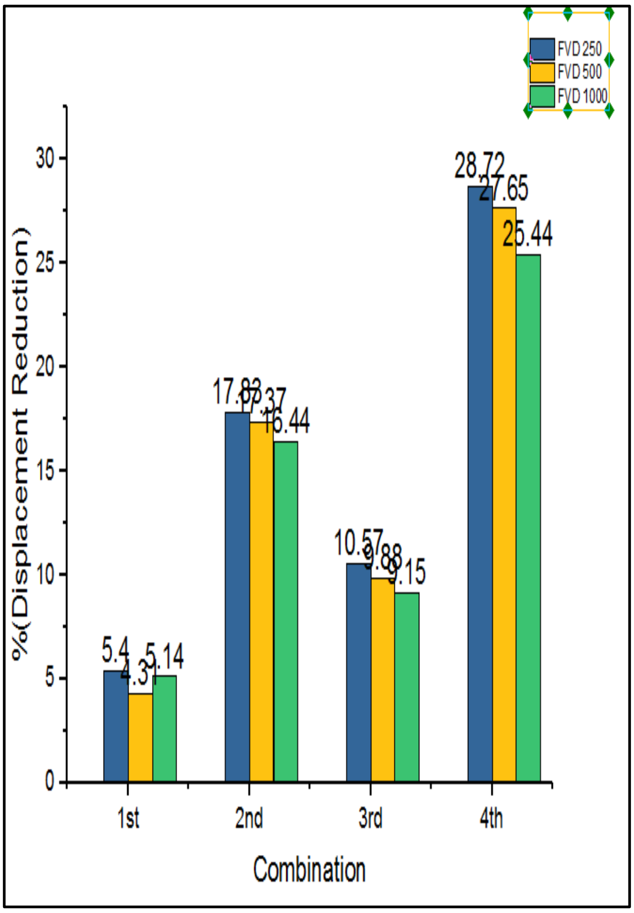

Figure 15: Displacement reduction chart in Y direction

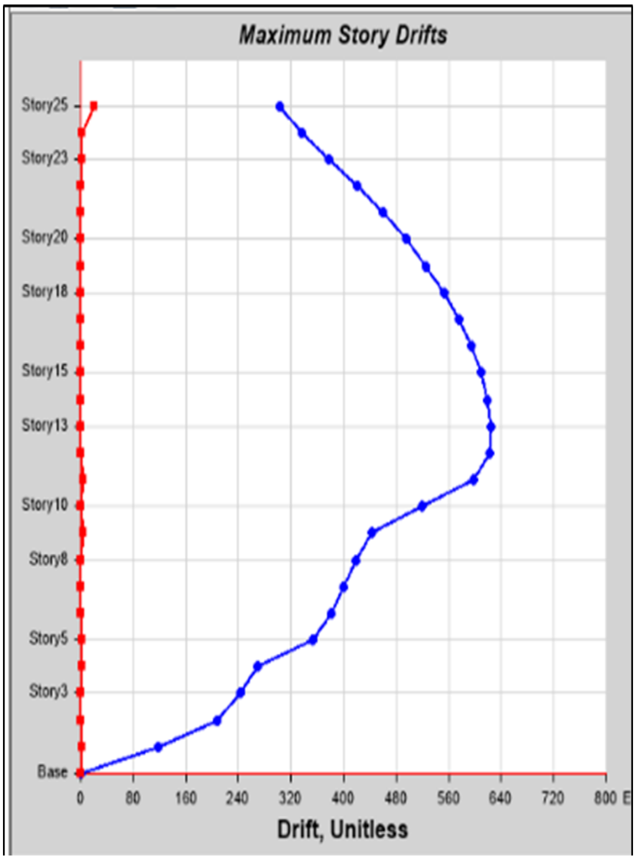

Figure 16: Story drift without damper

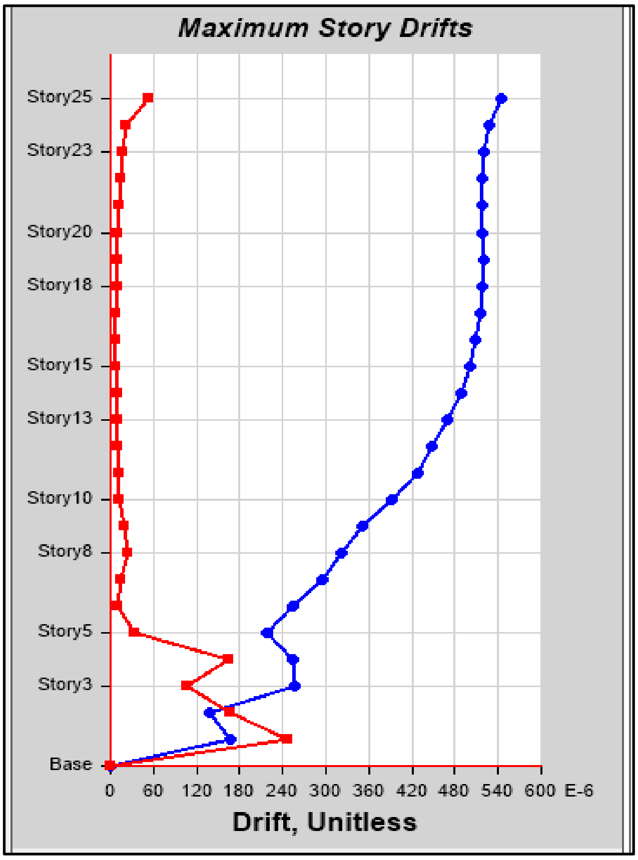

Figure 17: Story drift with damper in whole building

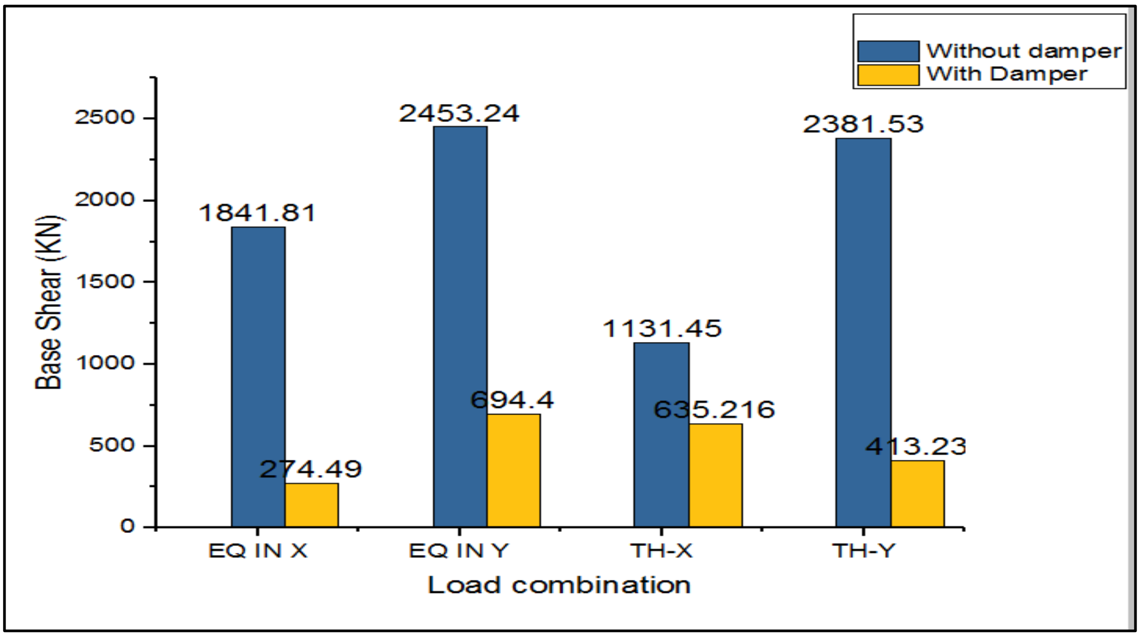

Figure 18: Base shear Without Damper & with Damper

VI. CONCLUSIONS

1. Seismic performance of building can be improve by adding energy dissipating device like Viscous Damper.
2. After adding damper in Building, there is 22 % reduction in displacement than the displacement of the building without damper.
3. The effectiveness of installing FVD depends upon nature of building. In this building case FVD 250 is best for it. If we don't want to provide damper in whole building than providing dampers in middle stories are effective.
4. Damper also reduce base shear very effectively.

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