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Comparative analysis of Symmetrical and Unsymmetrical building using different combination of dampers

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Abstract - *We know that natural disasters like earthquake, flood, drought, tornadoes and hurricanes. Among these all disasters earthquake is the most destructive because they cause plenty of injuries and losses leaving behind a series of signs of panic. This earthquake disturbs the structure by increasing the energy within the structure system, by introducing the several control system this energy can dissipated. Such as passive, active, and semi-active control system. The earthquake is a wakeup call since there is necessity to implement seismic codes in building design. In this work static and dynamic analysis has been adopted for performing the structures seismic risk assessment. This work is concerned with the comparative analysis of symmetrical and unsymmetrical building using different dampers like Fluid viscous and Visco-elastic dampers. Using codal provisions IS 1893 (Part I): 2002, the structures are analyzed by Equivalent static and Response spectrum method. The modeling and analysis is done with using software ETAB 2016, Results that is seismic parameters such as displacement, storey drifts and storey shear are tabulated and then comparative study of structure with and without dampers and combination of Fluid viscous and Visco-elastic dampers has done. Summary of results from this work suggest that comparative analysis of symmetrical and unsymmetrical building using dampers are effective reducing the structural responses of the structure. Compare to building without dampers the effectiveness of added of fluid viscous dampers is reduced the seismic response up to 40 – 50 % in symmetrical and unsymmetrical building. Compare to building without dampers the adding of combination different dampers in symmetrical and unsymmetrical building is reduce the seismic response up to 35 – 45%.*

Key Words*: *Fluid viscous damper, Visco-elastic damper, Displacement, Storey drift, seismic.

1. INTRODUCTION

The energy induced during the vibrations of earthquake can be classified into horizontal forces and gravitational forces. The bracing system is provided for controlling the gravitational forces. The horizontal sway of the building can be controlled by providing damper at suitable locations. The dampers devices are economical to manufacture because the selection of material and its availability. In case damage to a damper it can easily be replaced or readjusted. Various response control methods have been implemented during the design and can be generally classified into three groups: passive control, active control, and semi active control. The first class of energy dissipating system, the passive systems are uncontrollable. The basic function of the passive devices is to absorb a part of input energy, reducing energy dissipation on structural members and minimizing the damage on structures. Contrary to semi-active or active systems there is no need of external power supply. The second class of energy dissipating devices, the active devices is controllable and require significant amount of external supply. The third class includes the semi-active devices which combine the aspects of active and passive devices. This project deals with the study of behaviour of the building with Fluid viscous damper (Passive Control) and Visco-elastic damper (Passive Control) making it earthquake resistant.

1.1 Fluid Viscous Damper

In civil engineering vibration control of a various structure is done by using fluid viscous dampers, they just like the shock absorbers present in vehicles. Initially they are used in the military and aerospace industry for many years. Fluid viscous dampers have capable of reducing simultaneously deflection and stresses with in a structure, typical representation of fluid viscous damper as shown in Fig 1

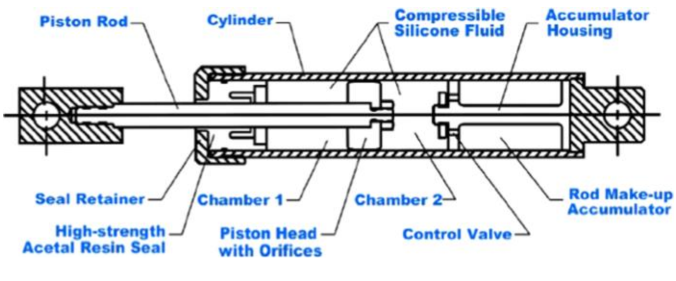

Fig 1: Typical Representation of Fluid Viscous Damper

Fluid viscous damper is generally composed of a piston head with orifices contained in a cylinder filled with a viscous fluid, usually filled with a material silicone or a similar type of oil. In this method energy is dissipated by fluid orifice when the piston head moves through the fluid. The fluid material present in the cylinder is nearly incompressible. The volume inside the cylinder is decreased when the damper is subjected to compressive force as a result in the movement of piston rod area. Due to decrease in volume results in a restoring force. This force can prevent by using a device accumulator.

1.2 Visco-elastic Damper

The Visco-elastic dampers are most promising devices and have been adopted in several building all over the world. Visco-elastic damper is a passive control type of energy dissipation material. This type of dampers converting mechanical energy into heat by dissipates the building. Many factors like ambient temperature and the loading frequency will affect the performance of the damper system, typical representation of visco elastic damper as shown in Fig 1.2

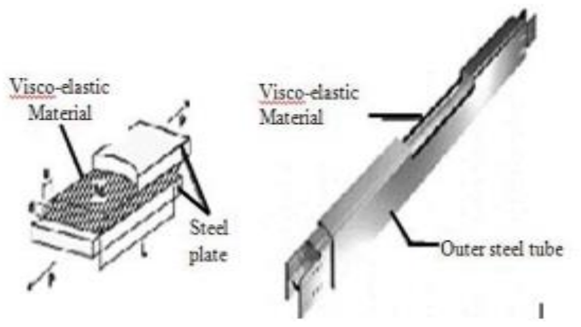

Fig: 2 Typical Representations of Visco-Elastic Dampers

Visco-elastic damper are consists of visco-elastic layer bonded with steel plates. These layers help to achieve the energy dissipation by shear deformation. Visco-elastic material may be glassy or copolymer substances they dissipate energy through shear deformation. These materials consists elastic stiffness with a displacement dependent force and velocity dependent force produced by viscous element. Rubber, bitumen material can also be used as the Visco-elastic material in energy absorbing device.

1.3 Objectives

In present study following investigations are considered for both symmetrical and unsymmetrical building.

1. To study the behaviour of structure without dampers
2. To study the behaviour of structure using fluid viscous dampers
3. To study the behaviour of structure using viscoelastic dampers
4. To study the behaviour of structure using different combination of dampers
5. To compare the overall outcomes obtained with and without dampers

2. METHODOLOGY

To find out the seismic parameters like lateral displacement, and storey drift,. The G+16 RCC multi-storey Symmetrical and Unsymmetrical buildings is are taken and equivalent static and response spectrum method of analysis were carried out using the software ETAB 2016. In this thesis we are going to take different size of columns, and columns are considered fixed at the base.

2.1 Building model details

Total number of storey	17
Number of bays in X-direction	06
Width of bay in X-direction	06 m
Number of bays in Y-direction	06
Width of bay in Y-direction	06 m

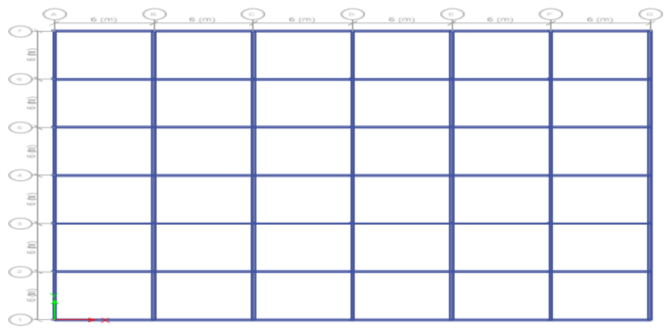

Fig 3: 2D Plan View of G+ 16 Storeys Symmetrical Building

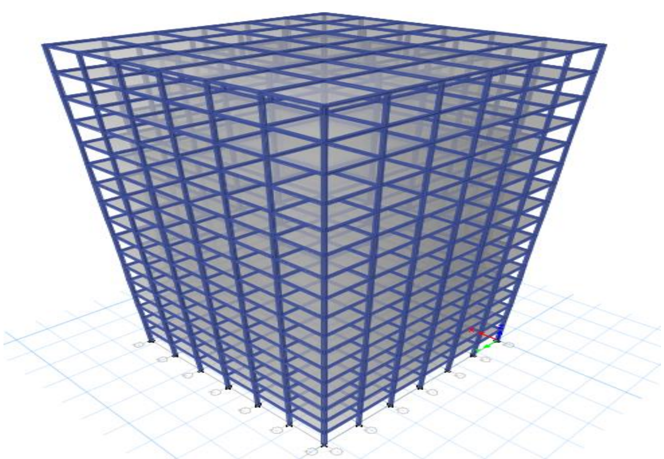

Fig 4: 3D View of G+ 16 Storeys Symmetrical Building without Dampers

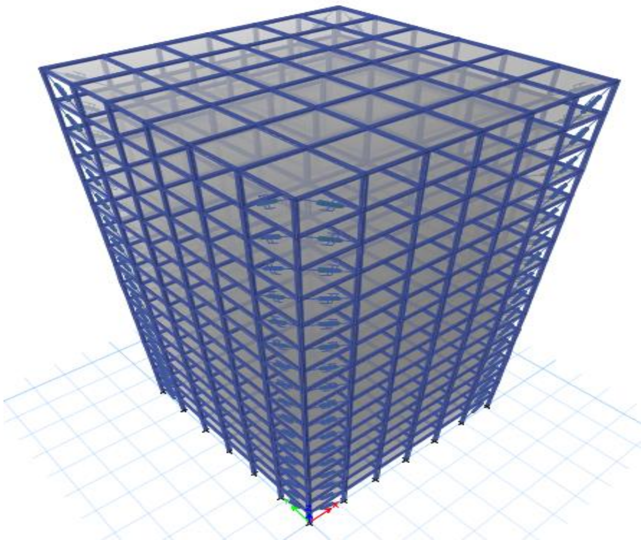

Fig 5: 3D View of G+ 16 Storeys Symmetrical Building with Dampers

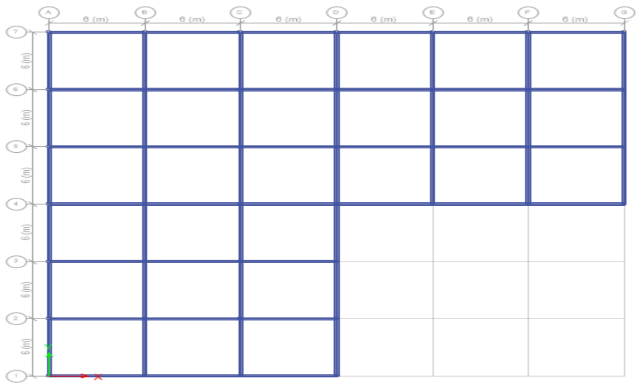

Fig 6: 2D Plan View of G+ 16 Storeys Unsymmetrical Building

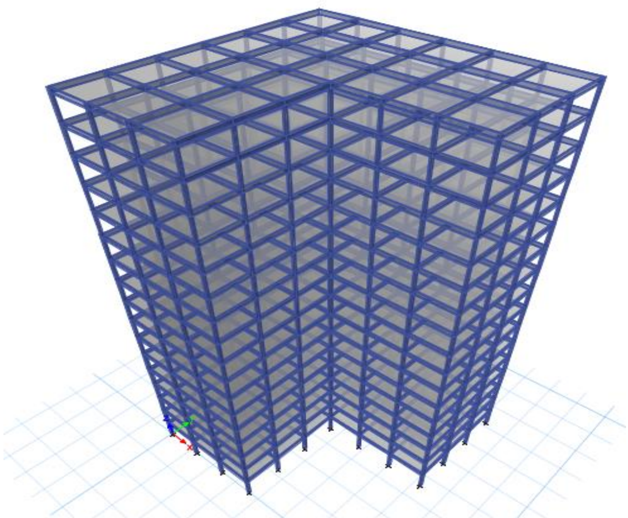

Fig 7: 3D View of G+ 16 Storeys Unsymmetrical Building without Dampers

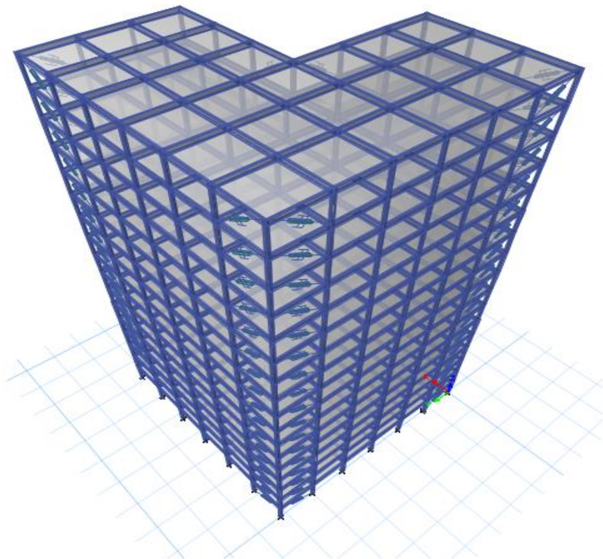

Fig 8: 3D View of G+ 16 Storeys Unsymmetrical Building with Dampers

2.2 Material properties for symmetrical and unsymmetrical building

1. Grade of concrete
   a) For Slab & Beam : M_{25}
   b) For Column : M_{30}
2. Grade of steel : Fe 500
3. Concrete density : 25 k N/m^3
4. Steel density : 78.50 k N/m^3
5. Young's modules for M_{25} : 24855580 k N/m^2
6. Young's modules for M_{30} : 24855580 k N/m^2
7. Young's modules for steel : 2x10^8 k N/m^2

2.3 Section properties for symmetrical and unsymmetrical building

1. Slab Thickness : 0.23x0.4 m

3 Columns
   a. Size up to 6th Floor : 0.4x0.4 m
   b. Size 6th to 12th Floor : 0.35x0.35 m
   c. Size 12th to 17th Floor : 0.3x0.3 m

2.4 Seismic properties from code IS1893 (part 1):2002 for symmetrical and unsymmetrical building

1. Importance factor (I) : 1.0
2. Zone factor (Z) : 0.36 (ZONE **V**)
3. Response factor (R) : 5 (SMRF)
4. Soil type : II (MEDIUM)
5. Damping ratio : 5%

Table 1: Load combination considered as per IS: 1893 (part 1)

LOAD COMBINATIONS	ANALYSIS METHOD
1.2(DL+IL+ELX) 1.2(DL+IL+ELY) 1.5(DL+ELX) 1.5(DL+ELY)	Equivalent static analysis
1.2(DL+IL+RSX) 1.2(DL+IL+RSY) 1.5(DL+RSX) 1.5(DL+RSY)	Response spectrum analysis

2.5 Link properties

Table 2: Properties of FVD and VED

Type of Damper	Stiffness (Ke) in kN/m	Damping (De) in k N-s/m	force in N	Weight in KG
FVD[1]	11000	800	250	44
VED[11,12]	3100	600	250	44

3. RESULTS AND DISCUSSIONS

In this chapter the study is carried out for to know the behaviour of the symmetrical and unsymmetrical building with and without damper, and also to know the behaviour of structure with different combination of the dampers. The schematic representation of the building with damper, without damper and combination of different damper are also shown in previous chapter

In this chapter we are going to consider four models they are

Model 1: Building without dampers

Model 2: Building with Visco-elastic dampers

Model 3: Building with Fluid viscous dampers

Model 4: Building with combination of two damper

3.1 Equivalent Static Method

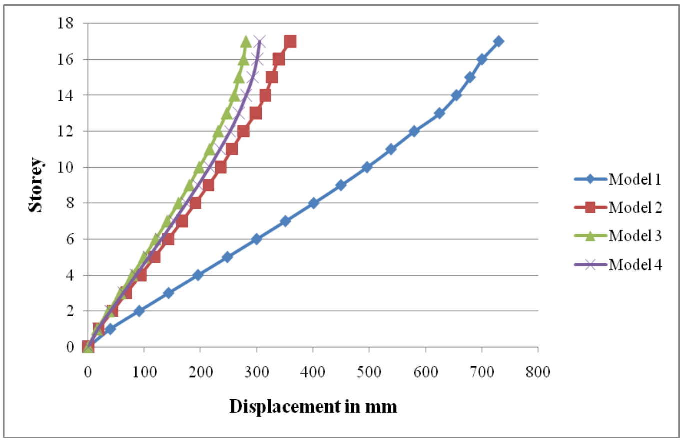

Fig 9: Displacement Curve in X direction for Symmetrical Building

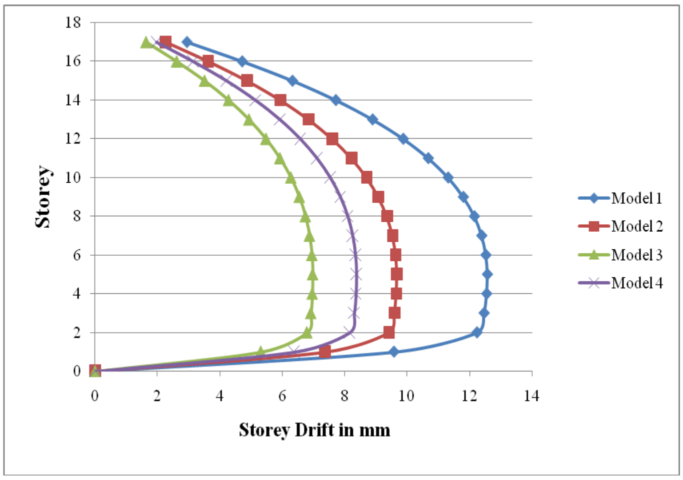

Fig 10: Storey Drift Curve in X direction for Symmetrical Building

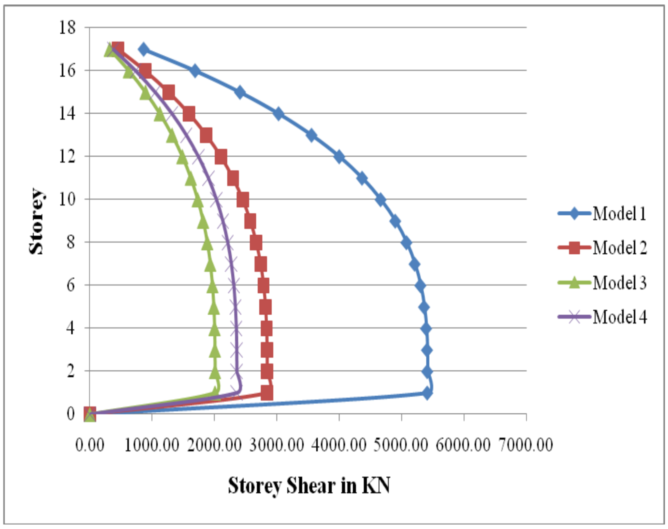

Fig 11: Storey Shear Curve in X direction for Symmetrical Building

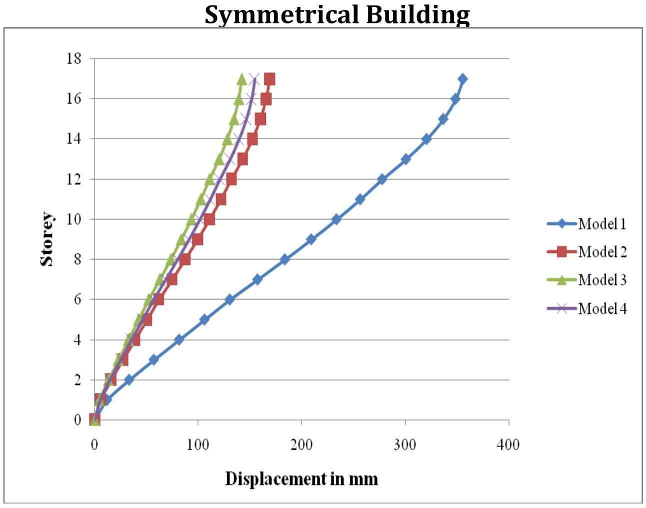

Fig 12: Displacement Curve in X direction for Unsymmetrical Building

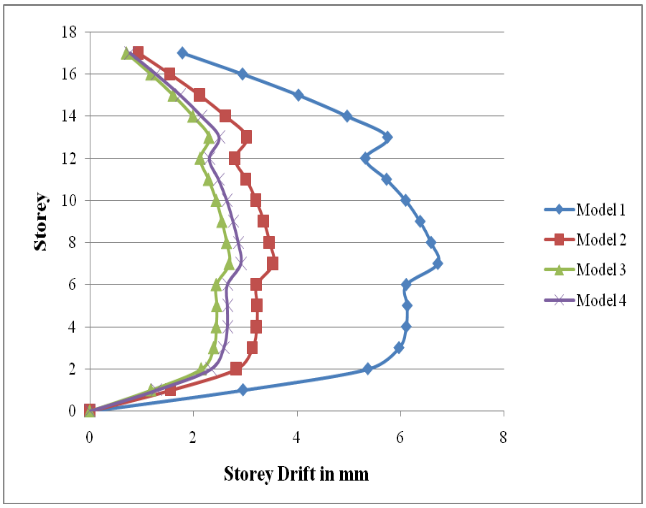

Fig 13: Storey Drift Curve in X direction for Unsymmetrical Building

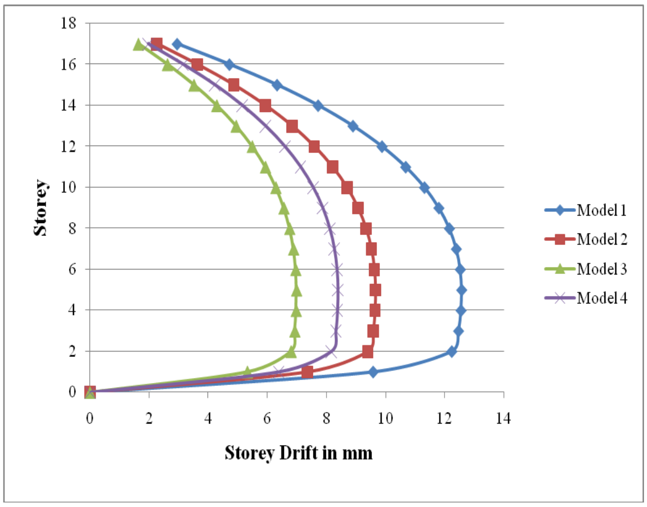

Fig 16: Storey Drift Curve in X direction for Symmetrical Building

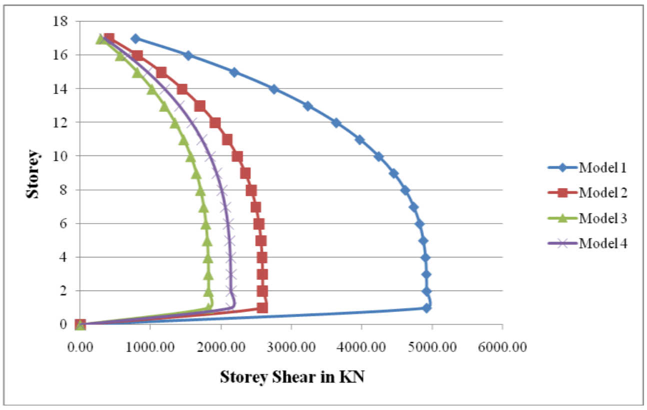

Fig 14: Storey Shear Curve in X direction for Unsymmetrical Building

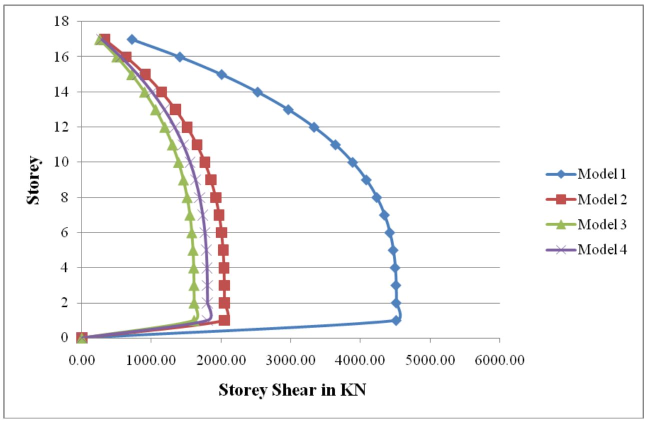

Fig 17: Storey Shear Curve in X direction for Unsymmetrical Building

3.2 Response Spectrum Method

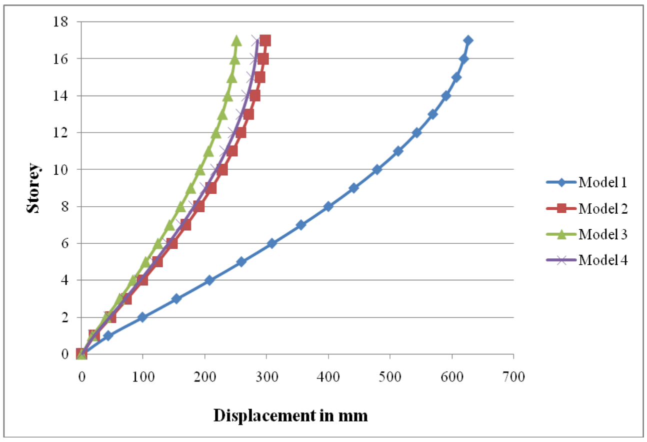

Fig 15: Displacement Curve in X direction for Symmetrical Building

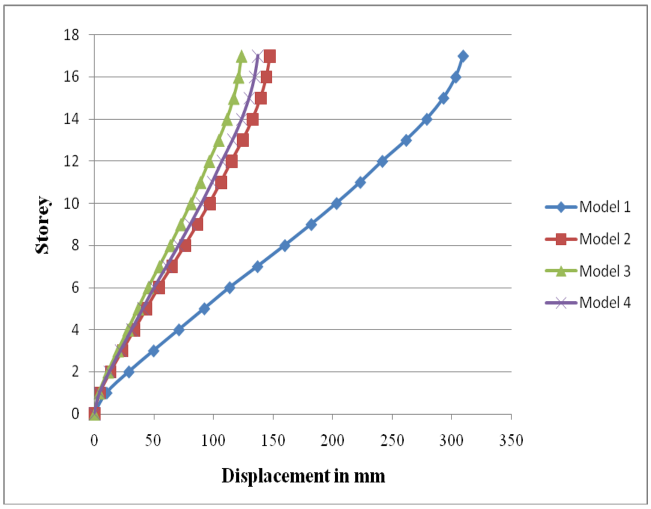

Fig 18: Displacement Curve in X direction for Unsymmetrical Building

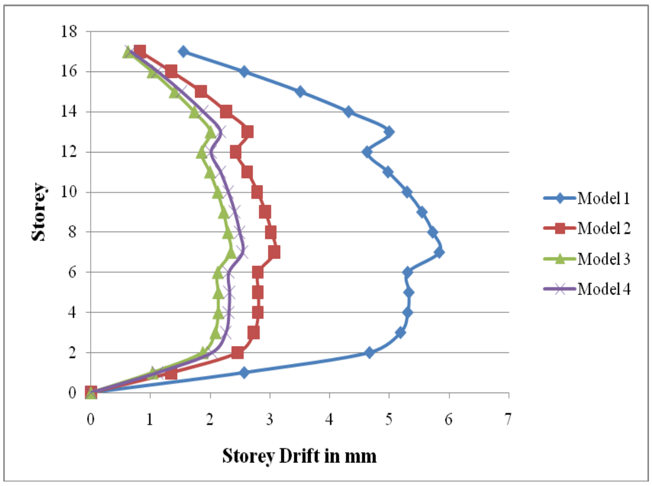

Fig 19: Storey Drift Curve in X direction for Unsymmetrical Building

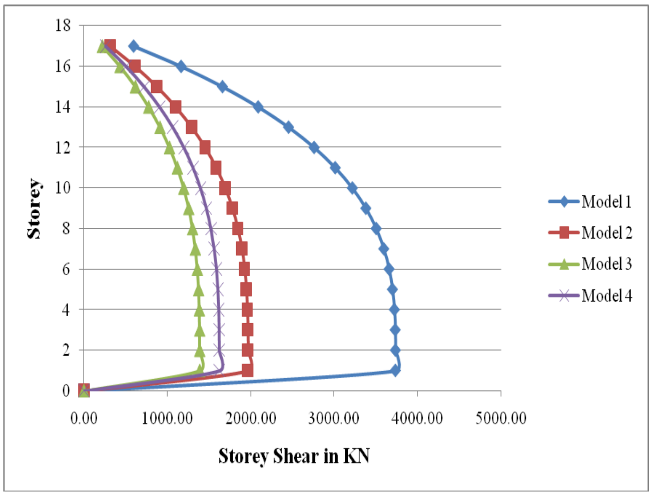

Fig 20: Storey Shear Curve in X direction for Unsymmetrical Building

4. CONCLUSIONS

1. In this study the maximum storey displacement, storey drift and Storey shear with different load combinations for symmetrical and unsymmetrical building models obtained from the equivalent static method and response spectrum method are considered.

2. Using fluid viscous dampers in equivalent static and response spectrum method of analysis the displacement, storey drift and Storey shear reduce 40 to 50 % in the both symmetrical and unsymmetrical building model as compared to building without dampers as shown in the Fig.

3. Using the combination of two different dampers also reduces Displacement, storey drift and Storey shear up to 35 to 45 % in both symmetrical and unsymmetrical building as compare to building without damper as shown in the Fig.

4. The performance of fluid viscous, visco-elastic and combination of two different dampers is much better for the tall buildings with slender design.

6. It can also be concluded that the fluid viscous dampers can be effectively used as one of the better alternatives for the conventional ductility based design methods of earthquake resistant design of structures.

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