SEISMIC STUDY OF MULTI-STOREY STRUCTURE WITH FLUID VISCOUS DAMPERS USING ETABS

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Abstract — *Seismic Study of Multi-storey structure rests on normal ground with different Seismic intensities using and deprived of Fluid Viscous Dampers is carried out in this paper. Damping Plays a vital role in Earthquake Resistant Structure design, which decreases the response of the building when they are exposed to lateral force. In this paper reaction of RC structures are evaluated by means of Fluid Viscous Dampers under lateral loads. The foremost aim of a building is to withstand the lateral forces and loads and transmitting them to the footing. In order to have structure earthquake resistant, fluid viscous dampers are used. In this paper ETABS 2016 software has been used. Using Time history analysis RC structure is associated using and deprived of FVD and its response is evaluated. In Time History analysis, up to 80% reduction in the time Period is attained while FVD is in use. FVD250 has abridged the Base Shear of the buildings by 72%. In order to reduce the reaction of RC multi-storied buildings due to Earthquake effectively FVD is used.*

Key Words — Seismic, Fluid Viscous Damper, ETABS, Damping.

1. INTRODUCTION

Recent days Earthquakes are considered as major natural hazards and its impulsion on structures are merely high. Energy dissipation and Seismic isolation are extensively documented as active safety methods for attaining the functional purposes of modern codes. However, many codes include design specifications for seismically isolated buildings, while there is still essential of improved rules for energy dissipation protective systems. The fluid viscous dampers (FVD) are the more applied tools for regulating responses and dissipating energy of the structures. These tools are applied depending on diverse building techniques in order to reduce the responses of the structural from the seismic excitation.

The typical FVD comprises of viscoelastic layers fused with steel plates or solid thermoplastic rubber sheets inserted between steel plates. The viscoelastic solid materials involved in the dissipation of energy in viscoelastic dampers. The total energy released throughout Earthquake gets Dissipated due to the movement of fluid and hence the building response is reduced. The main Principle of FVD is that, the Internal force is produced by the fluid damper owing to compression difference crossways the piston head. During the gesture of the piston head, the liquid capacity is altered by the product of travel and area of piston rod. Meanwhile the liquid is compressible, this alteration in liquid volume is complemented by the expansion of a spring like restoring force. It is not permitted by the accumulator. At greater rate of recurrence, the fluid viscous dampers show durable toughness. Over-all, this cut-off frequency hangs on the strategy of the accumulator

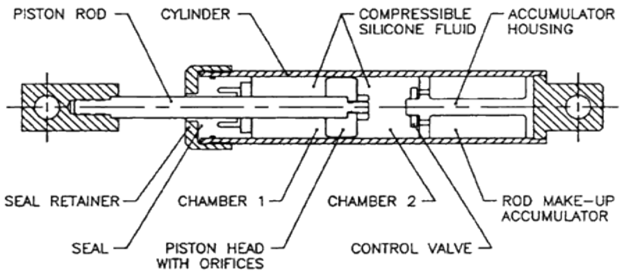

Figure 1: Longitudinal Section of FVD

2. OBJECTIVE

- This paper aims to design a structure to offers protection to life expectancy and possessions and observing the cost-effective concern.
- To Design Seismic Retrofit and Design of new structure by Fluid Viscous Dampers.
- RC Multi-Storied Building in Seismic Regions II, III, IV & V is to be Designed and identifying the most vulnerable building among them.
- The performance in terms of base shear, time period, eccentricity, storey drifts and lateral displacements in linear study by means of IS1893(Part 1):2002 code is to be studied.

- Numerical Analysis on the Performance of Construction is to be studied and Analyzed using ETABS version 16.2.1.

3. BUILDING PARAMETERS

Table 1: Details of building with and without FVD

S.No	Parameters	Various seismic zones			
		Zone 2	Zone 3	Zone 4	Zone 5
1.	Plan Dimension (m)	12.8 X 28	12.8 X 28	12.8 X 28	12.8 X 28
2.	Building Height (m)	30	30	30	30
3.	No. of Floors	10	10	10	10
4.	Height of each storey (m)	3	3	3	3
5.	Zone Factor	0.10	0.16	0.24	0.36
6.	Damping Ratio	5%	5%	5%	5%
7.	Soil Type	II	II	II	II
8.	Importance Factor	1	1	1	1
9.	Wind speed (m/s)	50	50	50	50
10.	Floor Finish (KN/m^2)	1	1	1	1
11.	Live load at all floors(KN/m^2)	3	3	3	3
12.	Grade of Concrete (f_{ck})	M25	M25	M25	M25
13.	Grade of Reinforcing Steel	Fe 500	Fe 500	Fe500	Fe500
14.	Density of concrete (KN/m^3)	25	25	25	25
15.	Damper type	FVD 250	FVD 250	FVD 250	FVD 250
16.	Mass of Damper (Kg)	44	44	44	44
17.	Weight of Damper (KN)	250	250	250	250

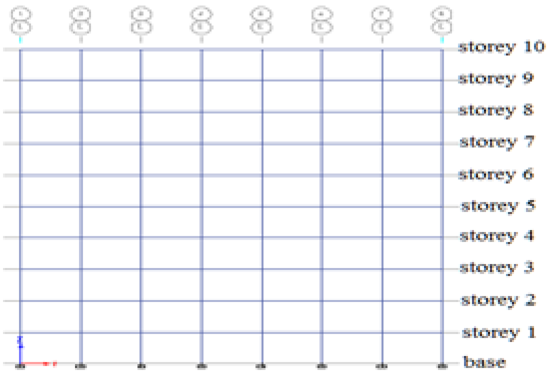

Figure 2: Elevation of the Building

Details of the building without and with FVD is tabulated in Table 1. Figure 2 shows the Elevation of building.

3.1 Details of the structure

1. Size of Column = 230mm X 650mm
2. Size of Beam = 230mm X 450mm
3. Slab Panel Area = 3.2mX 4m
4. Thickness of Slab = 125mm

Table 2: Storey Details

Name	Height mm	Elevation mm	Master Story
Story10	3000	30000	Yes
Story9	3000	27000	No
Story8	3000	24000	No
Story7	3000	21000	No
Story6	3000	18000	No
Story5	3000	15000	No
Story4	3000	12000	No
Story3	3000	9000	No
Story2	3000	6000	No
Story1	3000	3000	No
Base	0	0	No

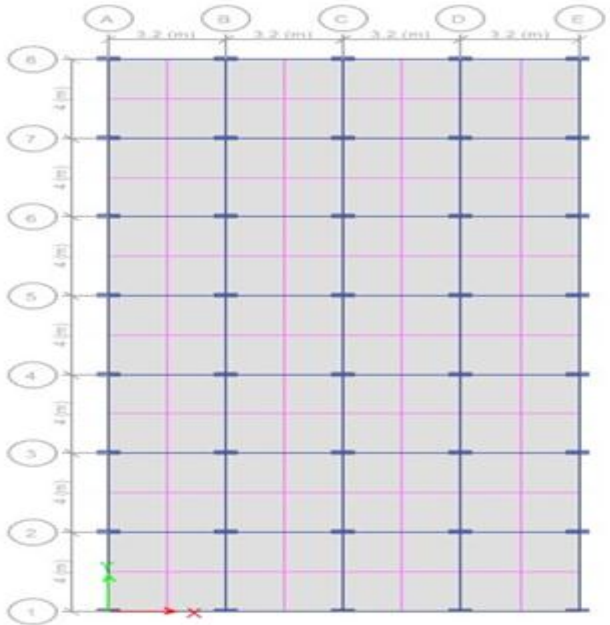

Figure 3: Plan of the Building

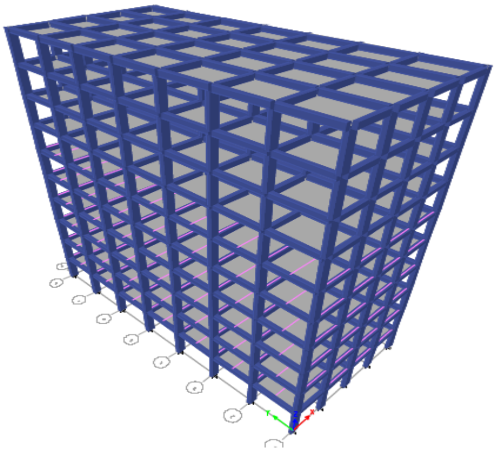

Figure 4: 3D view of building

3.2 Modelling of Dampers

Fluid viscous dampers with different forces can also be tend to use in different types of buildings, since structure modelled is of low height; smaller devices were used to start analysis. FVD is added to structure after defining in Link properties by adding a new Damper-Exponential in Link Property Data which is given in Table 3.

1. Mass of FVD = 44 Kg
2. Force of FVD = 250 KN

Table 3: Damper Property

FORCE	TAYLOR DEVICES MODEL NUMBER	STROKE (mm)	BEARING THICKNESS (mm)	MAXIMUM CYLINDER DIAMETER (mm)	WEIGHT (kg)
250	17120	±75	33	114	44
500	17130	±100	44	150	98
750	17140	±100	50	184	168
1000	17150	±100	61	210	254
1500	17160	±100	67	241	306
2000	17170	±125	78	286	500
3000	17180	±125	89	350	800
4000	17190	±125	111	425	1088
6500	17200	±125	121	515	1930
8000	17210	±125	135	565	2625

The analysis carried out on the buildings using and deprived of Fluid Viscous dampers are shown. The results obtained from the analysis are taken into consideration based on the aim of the research.

4. ANALYSIS AND RESULT

The structure is analysed and its deflection and displacement are shown below.

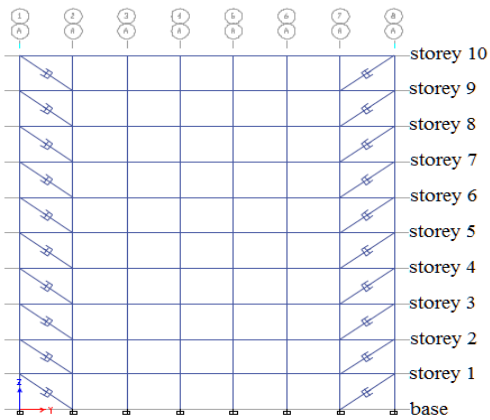

Figure 5: Elevation of building using FVD

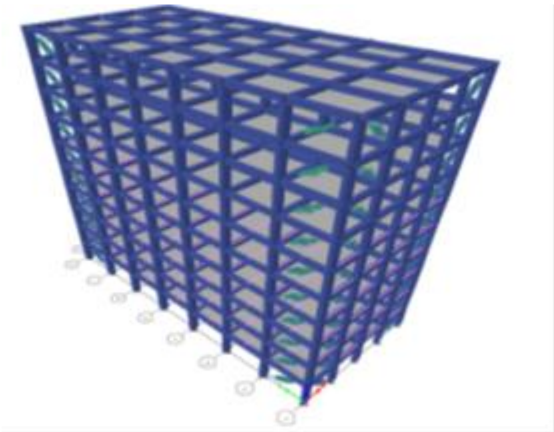

Figure 6: 3D view of building using FVD

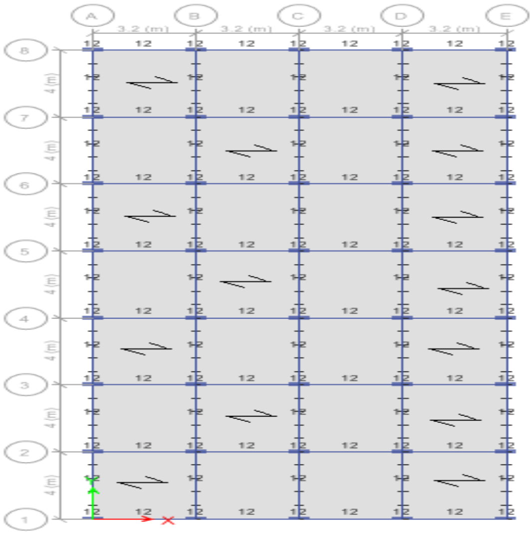

Figure 7: Load Combination

Top floor displacement of the building without and with FVD shown below.

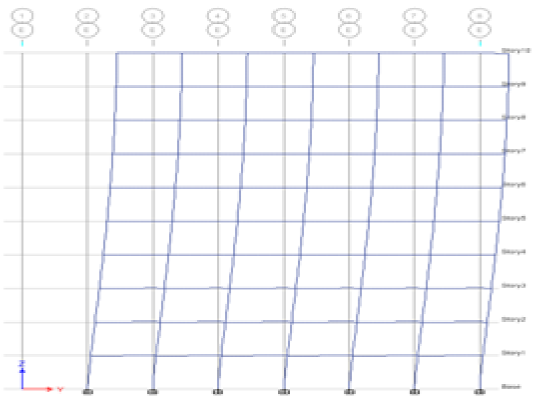

Figure 8: Top floor displacement – without FVD

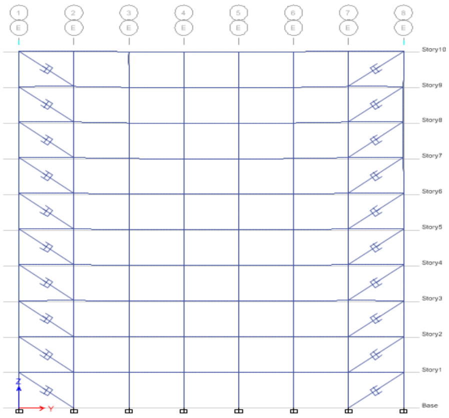

Figure 9: Top Floor Displacement – FVD

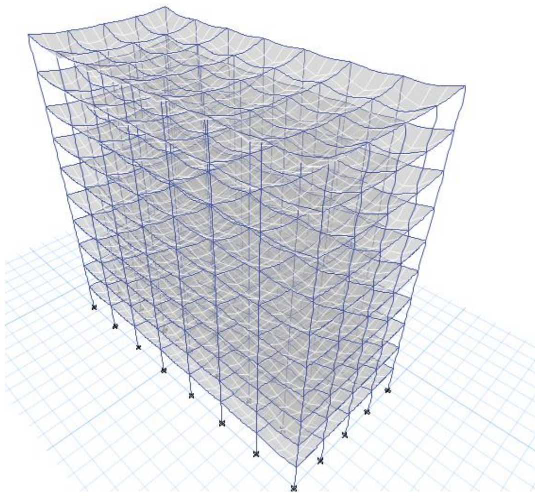

Figure 10: Deformation – without FVD

From Figure 8, it is clear that when a building subjected to Earthquake due to lateral force it tends to push it at the direction of earthquake forces. In Figure 9, at the same conditions once the structure is found to have dampers, it dissipate the lateral forces due to EQ and hence the building is safe against collapse.

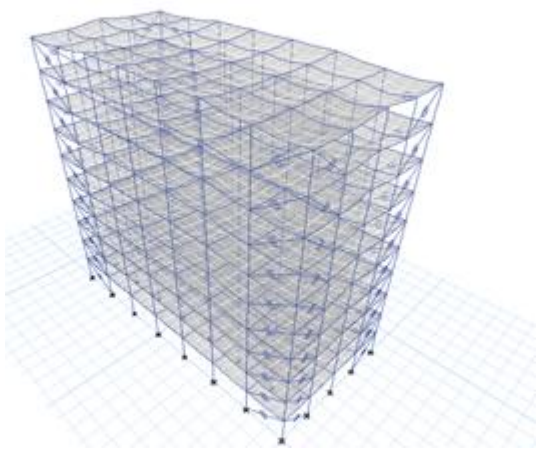

Figure 11: Deformation – FVD

5. RESPONSE SPECTRUM ANALYSIS

Figure 12: Response spectra – Soil II

It is a linear Dynamic investigation method which measures the influence from every natural mode of vibration to designate likely supreme Seismic Performance of a basically elastic structure. Response Spectrum analysis as per IS 1893:2002 code.

6. TIME HISTORY ANALYSIS

It is significant Procedure for Structural Seismic Analysis particularly when the structural response evaluated is Non-Linear. Time History Analysis is a stage by stage analysis of Dynamic response of building to an identified force that may fluctuate with time. Elcentro Earthquake records are attained and set as input for our given building. Analysing the structure resultant value is obtained as a graphical representation of Psuedo Acceleration with respect to time denoted in Figure 13.

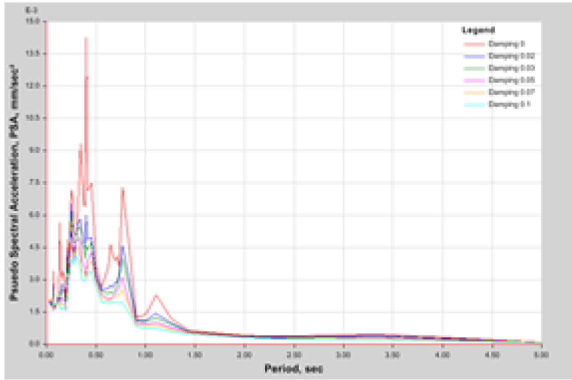

Figure 13: Elcentro - Response Spectra

7. BASE SHEAR

It is the overall Lateral Energy acting on the Building at its base, which is equal to storey shear of the bottom storey. Base shear of building with and without FVD is tabulated in Table 4.

Table 4: Base shear of building

Seismic Zone	Soil Type	Without FVD	With FVD
II	Type II (Medium)	1335.91	1459.17
III	Type II (Medium)	1332.56	1460.08
IV	Type II (Medium)	1476.9	1540.54
V	Type II (Medium)	1465.89	1650.07

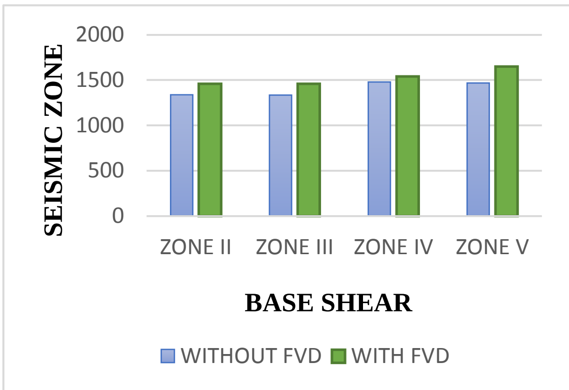

Figure 14: Base Shear Comparison

From Figure 14, it is evident that base shear is more for building with FVD than building without FVD.

8. CONCLUSIONS

This Paper concentrates on the seismic performance of the RC structure furnished using and deprived of Fluid Viscous dampers. This Paper is prepared to find declination in responses of earthquake in the structure modelled with passive energy dissipation devices.

On the source of present study and literatures go through the succeeding decisions can be drawn:

i. Seismic performance of building can be improved by only if the energy dissipating device (dampers) are used, which dissipate the input energy throughout earthquake.
ii. The responses such as acceleration, base shear, displacement are reduced when the FVD is included to the structure.
iii. The placement of the damper plays a primary part in the vibration regulator of the structure.
iv. Effectiveness is more when dampers are placed in corners instead of middle.
v. Time history analysis is an important and operative tool to envision the performance level of building under different earthquake
vi. Most of the energy imparted to the structure by earthquake is dissipated by viscoelastic dampers leading to substantial reduction in the seismic response
vii. Most vulnerable type of building is found in zone V
viii. Hence, from the present analysis, the placement of damper is very effective and recommended.

9. FUTURE SCOPE

This Paper is limited to use of FVD250 to the structures in exterior corners. The following are few recommendations for further study:

i. Same structures can be designed with FVD500 and many other models in Table 3 and can be used in exterior and interior middle position.
ii. FVD can also be used in structure like alternate bays and also with different positions.
iii. Irregular structures, High rise buildings and asymmetrical structures can be an extension lead to this work.
iv. It can be used for Various Soil Conditions under Various Seismic Zones.
v. The structural systems like M-shape and K-shape can be used along with FVD.

LIST OF ABBREVIATIONS

ETABS	-	Extended Three-Dimensional Analysis of Building System
FVD	-	Fluid Viscous Dampers
f_{ck}	-	Characteristic strength of Concrete
RC	-	Reinforced concrete
IS	-	Indian Standard
E.Q	-	Earthquake Load
t	-	Time period

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