2nd International Conference on Current Research Trends in Engineering and Technology
© 2018 IJSRSET | Volume 4 | Issue 5 | Print ISSN: 2395-1990 | Online ISSN: 2394-4099
Themed Section: Engineering and Technology

Seismic Assessment of Response of RC Frame Building with Fluid Viscous Damper

Amru Shamil[1], Prof. D. J. Dhyani[2]

*[1] PG student, Department of civil Engineering, Sardar Vallabhbhal Patel of technology(SVIT), Vasad, Gujarat, India

[2] Professor, Department of civil Engineering, Sardar Vallabhbhal Patel of technology(SVIT), Vasad, Gujarat, India

ABSTRACT

This paper presents a study on the seismic assessment of response of ten-story RC building using fluid viscous damper. The proposed model building is placed in hawassa, seismic zone 4.It is a square shaped building and its occupancy is residential. All structural members are designed in accordance with EURO CODE 8. Load consideration is based on EBCS-1. The frame type of proposed model building used is the special RC moment resisting frame. In this study, response spectrum analysis technique is used for dynamic analysis. The analysis and design of the structure are carried out through the use of ETABS 2015 software program. Earthquakes are one of the major natural hazards in the world. In this study a fluid viscous damper is used to manipulate seismic response of the proposed building. The mechanic properties of a fluid viscous damper used in this paper are mass 44Kg and weight 250kN. The maximum storey drifts, base shears, maximum story displacements and time periods are compared.

Keywords: Response Spectrum, Fluid Viscous Damper, Seismic, Story Displacement And Story Drift

I. INTRODUCTION

Ethiopia is a developing country and population rate is highly increasing. The proposed building is located in hawassa, the second biggest city of Ethiopia. It is considered high seismic hazard because hawassa situates near the Ethiopians biggest active fault. So, it is essential to design secure buildings which can safely face up to earthquakes of reasonable magnitude. The high-rise is in fact a vertical cantilever so that the elements of structure are designed; to resist axial loading via gravity and to withstand transverse loading by wind and earthquake.

Seismic design of building structures is based totally on the concept of increasing the resistance ability of the structures against earthquakes by means of employing, the use of shear walls, braced frames, or moment-resistant frames described by Chen, W. E., & Scawthorn, C. E. (2002) [1]. The ordinary seismic design attempts to make a building that does not damage at some phase in a minor quake, moderate earthquakes with insignificant basic damage and some non-basic damage and basic tremors with some basic and non-structural damage. Earthquake is one of the most powerful and unfavorable disaster. The major intention of earthquake resistant design is acquire a structure with enough energy and ductility to assure life safely. These days, three control straightforward advances are utilized to protect construction from quakes impacts. These are base isolation, active control device and passive energy dissipation devise. In the past, quite a few years, a variety of passive energy dissipation device have been developed. Such as friction damper, Oil damper and viscoelastic damper [2].

Viscous dampers can be successfully utilized in constructions to restrict structural response and to dissipate seismic energy and they are delivered to the structure to increase the stiffness and damping of the structure. The objectives of the study are to understand seismic response of damped structure and to understand effectiveness of viscous. Fluid viscous dampers can be successfully utilized in constructions to restrict structural response and to dissipate seismic energy and they are conveyed to the structure to increase the stiffness and damping of the building [9]. The main objective of the study is to comprehend the seismic response of damped structure and to comprehend the efficiency of fluid viscous damper.

Liya Mathew & C. Prabha in 2014 studied "Effect of Fluid Viscous Dampers in Multi-Storied Buildings". In which they stated that special protective structures have been developed to decorate safety and decrease damage of building during earthquakes. The fluid viscous damper (FVD) comes into prominence here. This paper additionally deals with the find out about of reinforced concrete buildings with and without fluid viscous dampers. A parametric study for finding most proper damper properties for the reinforced concrete frames used to be conducted. Nonlinear time history examination is completed on symmetrical rectangular structures. Pushover Analysis has been done the utilization of software and correlations are presented in the graphical configuration [3].

Y. G. Zhao and T. Ono in 2001 mentioned about "Moment methods for structural reliability" In which they stated, to perform a right assessment a structural designer must decide such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis generally consist of support reactions & displacement. This data is then contrasted with measures that show the stipulations of failure. The progressed auxiliary investigation may likewise inspect dynamic response, stability and non-direct conduct [4].

V. Umachagi, K. Venkataramana, G. R. Reddy, and R. Verma in "Applications of Dampers for Vibration Control of Structures: An overview" has briefly explained that Viscous dampers works based on fluid flow via orifices. The viscous damper consisted viscous wall, piston with a wide variety of small orifices, cover filled with a silicon or some liquid material like oil, via which the fluid pass from one side of the piston to the other. Stefano et al., 2010 have manufactured the viscous damper and it was applied in three-story constructing structure for seismic control of structure with additional viscous damper. Attar et al., 2007 have proposed highest quality viscous damper to reduce the inter-story displacement of steel building [5].

S. Amir and H. Jiaxin in "Optimum Parameter of a Viscous Damper for Seismic and Wind Vibration" discovered that in most structures, even a highly low damping can additionally provide an extensive energy dissipation which considerably decreases the vibration of a structure. The description in that explains how a nonlinear characteristic is required for a damping system to optimize the vibration of a simple moment frame [6].

Y. Zhou, X. Lu, D. Weng, and R. Zhang in "A practical design method for reinforced concrete structures with viscous dampers" shown how in contrast to the retrofitting the technology of seismic isolation, the installation of viscous dampers to those existing buildings are extra realistic due to the fact of easy construction. However, the design of viscous dampers, which offers a high degree of damping in a structure, was highly new application in China for a well-established and proven technological know-how in other seismically active regions in the world [7].

Özgur Atlayan in 2008 "Effect of Viscous Fluid Dampers on Steel Moment Frame Designed for Strength and Hybrid Steel Moment Frame Design," Said, it used to be found that as the damping of the structure increases with the help of introduced dampers, the structural response gets better. Maximum and residual roof displacements, inter-story drifts, and Incremental Dynamic Analysis dispersion decreases with increasing damping. In addition, by the use of supplemental damping, most of the collapses that happen for the inherently damped frames are prevented [8].

II. METHODOLGY

To determine the seismic parameter of ten (10) storey RC buildings like maximum story displacement, story drift and story shear. The linear statics and Response spectrum method of analysis were carried out using ETABs 2015.

III. MODDELING

In the present paperwork, 10 story Reinforced concrete building with and without fluid viscous dampers is considered.

Description of Members used:

Plan dimension = 42m X 42m.
Number Of bays in x and y direction = 7
Dimension of bays in x and y direction =6
Storey height = 3.0 m.
Slab thickness = 0.150m.
Size of beams = 400mmX600mm.
Size of column: - 1-5 storey = 600mmX600mm.
6-10 storey =500mmX500mm.

Tabe1: Material properties used for analysis

Material properties	
Grade of concrete	C-40
Grade of steel(rebar)	S-450
Density of reinforced concrete	25 kN/m2
Modulus of elasticity of concrete	35GPa for C-40
Modulus of elasticity of steel	200GPa
Density of reinforcing steel	7850 kg/m
Coefficient of thermal expansion	10*10-6 per ° C
Poisons ratio of concrete	0.2
Poisons ratio of steel	0.3

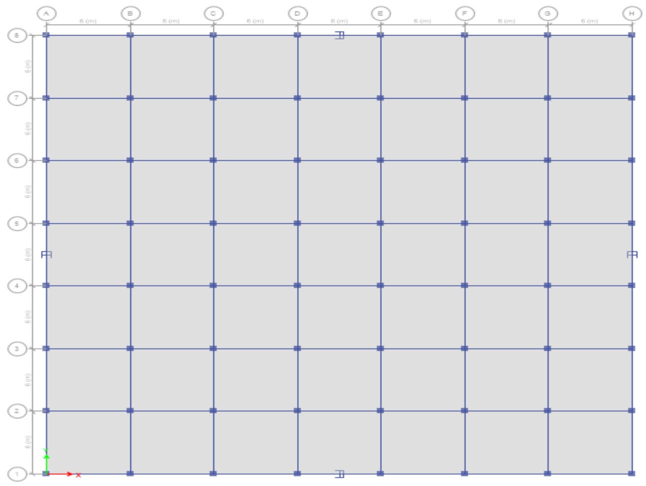

Fig1: plan view of 10 story building

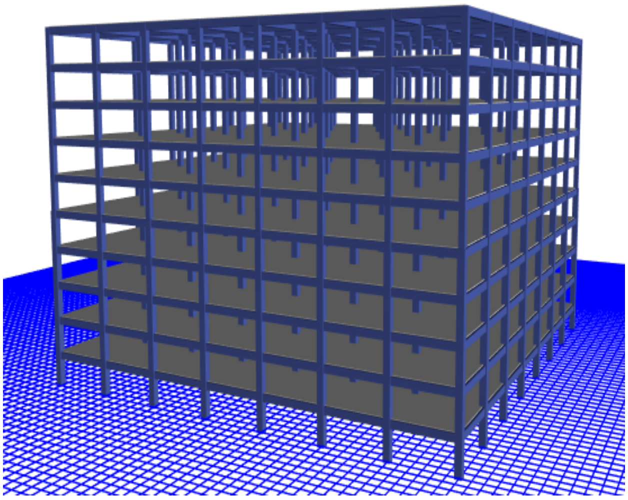

Fig2: 3D view of 10 story building without damper

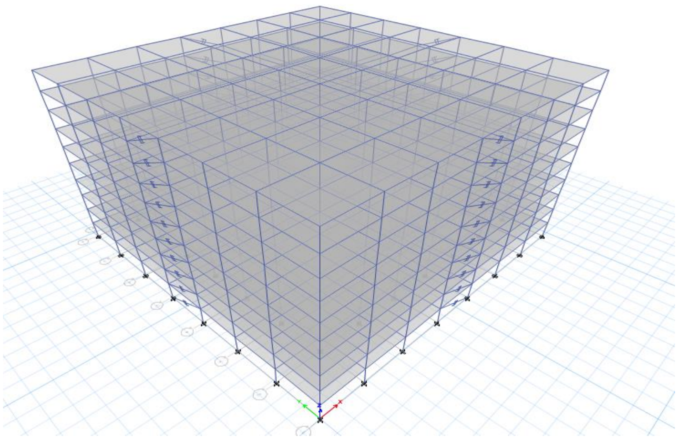

Fig3: 3D view of 10 story building with damper

Loads: - The loads considered in this structural analysis are dead loads, live loads and seismic loads.

- Wall load- 7.2 kN/m (Assumed).
- Live load and Floor load- 4 kN/m^2 & 1.5 kN/m^2

Seismic properties from EUROCODE8: EN 1998-1 (2004)

Seismic zone = V.
Importance factor, I = 1.
Behaviour factor q = 2
Ground acceleration = 0.4
Subsoil class = B.
Damping factor = 5%.

Damper parameter

The dampers utilized as a part of demonstrating these structures are from Taylor Devices Inc. made in USA. In ETABS Fluid viscous damper (FVD) is added to a structure after defining in Link properties by using adding a new Damper Exponential in Link Property Data. Since Fluid viscous damper is linear it is used for direction U1 with fixed end properties. The Mass is 44kg and Weight is 250kN from the table given by Taylor devices Inc. USA. The model considered is square buildings; dampers are introduced in similar way in both x and y directions. Hence the responses of the model buildings are going to be similar in both directions. Dampers are introduced in the centre bay, corner bays and 2nd &6th bays in the interior frames throughout the height of the building.

IV. RESULTS AND DISCUSSIONS

The linear static analysis and response spectrum analysis are carried out using analysis software ETABS2015. The response of bare frame and damped frame results are obtained and results are compared. The response parameter considered in this study is Maximum Lateral displacement, Maximum story drift, base shear and time period. The diminishment in every one of these responses at each story level is found out and reduction rate in percentage (%) is calculated.

Model 1. Bare frame model building.
Model 2. Building with damper at corner bays.
Model 3. Building with damper at centre bays
Model 4. Building with damper at 2nd and 6th bays.

Maximum story displacement

The maximum story displacements of 10 story model building without damper and with damper analysis results are given below in the table and graph respectively.
As result shown below maximum story displacement of bare fame model building was very high when no damper system provided. But the maximum story displacements reduced when damper are provided at different location. By comparison of the location of damper in the model building the maximum story

displacement was less when dampers were provided at corner location. When damper is introduced to the model building at different location lateral displacement of the building reduced such as, damper at corner location reduced up 27%, damper at centre location reduced up to 17% and damper at 2nd & 6th reduced up to 26%.

Table4: maximum story displacement of 10 story model buildings.

story	model1	model2	model3	model4
10	130.466	95.099	109.88	94.745
9	125.893	80.168	99.707	85.369
8	117.846	67.726	88.394	73.32
7	106.672	54.819	75.73	61.512
6	92.794	41.77	61.885	49.141
5	76.514	34.144	47.358	36.649
4	61.892	22.522	33.227	25.747
3	45.722	12.378	24.749	18.758
2	28.3	4.531	12.861	9.429
1	10.974	0	3.942	2.745
base	0	0	0	0

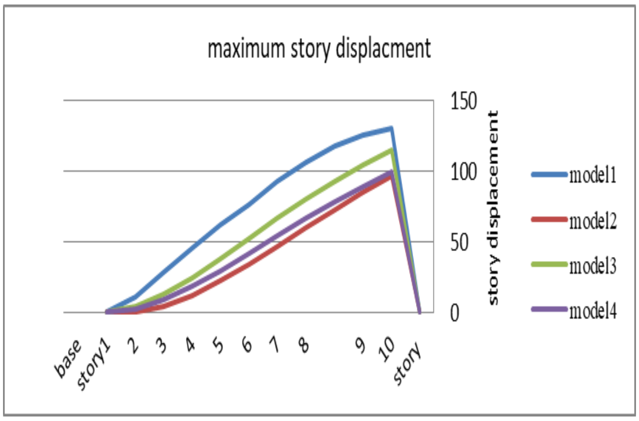

Fig4: maximum story displacement of model buildings.

Maximum inter story drift

Story drift of 10 story RC frame building with and without damper are given in table and graph as follow.

Table3: maximum story drift of 10 story model buildings.

story	model .1	model .2	model .3	model .4
10	0.001924	0.004029	0.003566	0.003548
9	0.003269	0.004206	0.003963	0.003782
8	0.004351	0.004355	0.004394	0.004026
7	0.005184	0.004387	0.004744	0.004192
6	0.005839	0.004226	0.004919	0.004204
5	0.005068	0.003882	0.004748	0.003987
4	0.005486	0.003384	0.00451	0.003672
3	0.00584	0.002616	0.003968	0.003113
2	0.00578	0.00151	0.002974	0.002229
1	0.003658	0	0.001314	0.000915
base	0	0	0	0

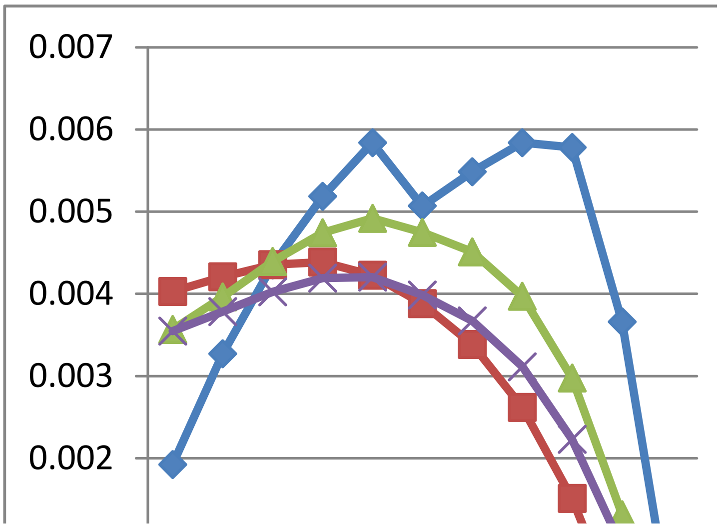

Fig 5: maximum story drift model building

When fluid viscous damper was introduced to the model buildings maximum average story drift diminished by 30% for mode2 1, 15.5% for mode3 and 27.44% for moedl4.

BASE SHEAR

The bases shears obtained from response spectrum analysis are mentioned in table4 below are the compared bar-charts

Model types	Base shear (KN)
model 1	54225.93
model 2	8580.35
model 3	9580.35
model 4	9367.53

Tabel5: base shear for 10 story model buildings.

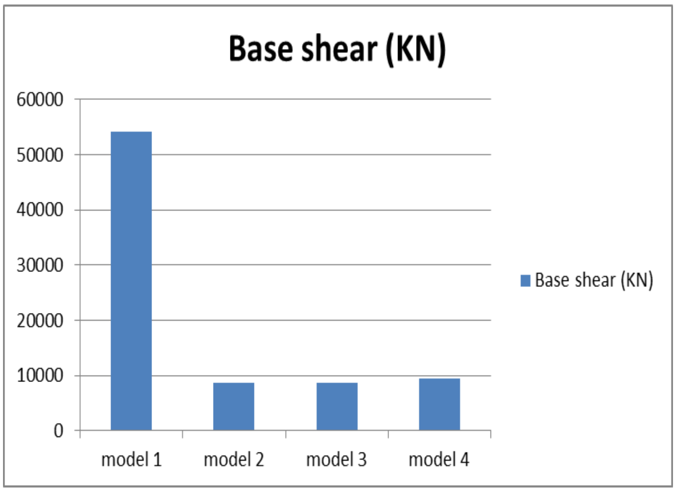

Fig6: base shear for 10 storey model buildings.

While introducing fluid viscous damper in to the model building the base shear have been reduced by 84% for model 2, 80% for model 3 and 82% for model 4.

TIME PERIODE

The fundamental time period of 10 story building is given in the table6 below.

Table6: Fundamental time period of 10 story model buildings.

model types	**Time Period in second**
model 1	1.254
model 2	0.853
model 3	1.023
model 4	0.938

Generally when providing fluid viscous damper at different location the fundamental time period decreases which means that the stiffness of the model building increases. When fluid viscous dampers were introduced to structure the fundamental period reduced by 32% for model 1, 18% for model 3, and 25% for model 4.

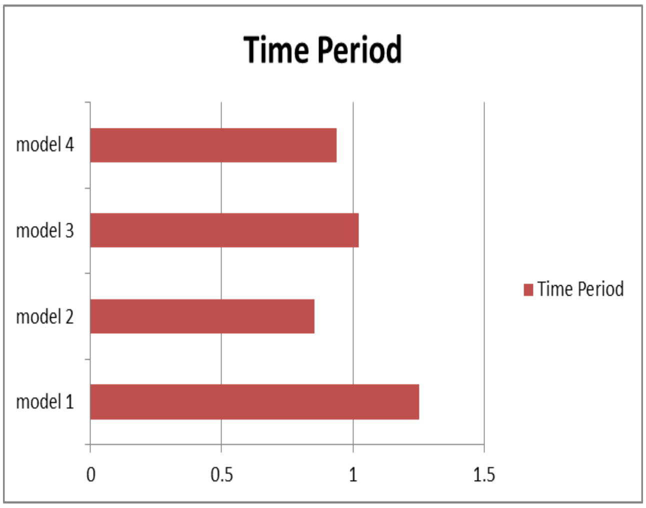

Fig7 :fundamental time period of 10 story model buildings.

V. CONCLUSIONS

Based on the analysis result and discussion the following conclusions are drawn.

- It is founded that fluid viscous damper are effective in diminishing the seismic response of the building under earth quake.
- It's also founded that when fluid viscous damper are provided to RC building the maximum lateral displacement and story drift reduced.
- The base shear and fundamental time period of the building is decreased by providing fluid viscous dampers in the structure compared to building without dampers.

REFERENCES

[1] Chen, W. E., & Scawthorn, C. E. (2002). Earthquake engineering handbook. London: Crc Press.

[2] Li, H., Wang, S., Song, G., & Liu, G. (2004). Reduction of seismic forces on existing buildings with newly constructed additional stories including friction layer and dampers. Journal of Sound and Vibration, 269(3-5), 653-667. Doi: 10.1016/s0022-460x (03)00090-7.
[3] LIYA MATHEW & C. PRABHA, "Effect of Fluid Viscous Dampers in Multi-Storied Buildings," IMPACT Int. J. Res. Eng. Technol. (IMPACT IJRET), vol. 2, no. 9, pp. 59–64, 2014.
[4] Y. G. Zhao and T. Ono, "Moment methods for structural reliability,"Struct.Saf, vol. 23, no. 1, pp. 47–75, 2001.
[5] V. Umachagi, K. Venkataramana, G. R. Reddy, and R. Verma, "Applications of Dampers for Vibration Control of Structures : an Overview," Int. J. Res. Eng. Technol.,pp. 6–11, 2013.
[6] S. Amir and H. Jiaxin, "Optimum Parameter of a Viscous Damper for Seismic and Wind Vibration," vol. 8, no. 2, pp. 192–196, 2014.
[7] Y. Zhou, X. Lu, D. Weng, and R. Zhang, "A practical design method for reinforced concrete structures with viscous dampers," Eng. Struct., vol. 39, pp. 187–198, 2012.
[8] Ö. Atlayan, "Effect of Viscous Fluid Dampers on Steel Moment Frame Designed for Strength and Hybrid Steel Moment Frame Design," Environ. Eng., 2008.
[9] S. AYE and K. AUNG "Comparative Study on Seismic Response of RC Structure Using Viscous Dampers and Viscoelastic Dampers" Int. J. Res. Eng. Techno, vol. 03,pp. 1468-1478, 2012.