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Comparative Study of Seismic Analysis of Dampers in Asymmetrical R.C. Frame Building

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Abstract: ***At the time of earthquake the huge amount of energy applied on structure. To reduce the dynamic response of structure, it become important for structure dissipated this energy. Generally to seismic stability of structure the simply method by increasing the stiffness of structure as different structural form (i.e. shear wall, bracing etc.) and by installation of structural control system (active control system, passive control system, semi-active control system ad hybrid control system). This present paper based on the passive energy dissipation devices. These devices are regulated the motion of structure by placing devices of modifying mass and damping or both. This present on performance of namely two types of damper (tuned mass damper and viscous fluid damper) in addition to inherent damping of R.C. frame building. The 16 story unsymmetrical building modal without any damper with TMD and with VFD are analyzed by time history method under rudraprayag (2005) time history data. This work is considered to carry out the effectiveness of TMD and VFD which are designed for same damping value. The result of model frequencies, inter story drift, dynamic response like acceleration, velocity, displacement and base shear will be compared of three model. It concluded the responses of building is also reduces by using VFD of Same Damping coefficient as TMD, and Building without Dampers.***

Keyword: TMD, VFD, Stiffness, Non Linear Time History, Etabs Software Packages.

I. INTRODUCTION

Earthquake is a natural procedure of shaking ground due to movement of tectonic plate. The force of earthquake is random so the design engineer need to care full predict of these force and analyze the structure under these random force. Earthquake loads are to be carefully modeled so as to assess the real behavior of structure with a clear understanding that damage is expected but it should be regulated. So the various technics are adopted for earthquake resisting design of R C frame building. In this passive energy dissipation and base isolation systems are provide for protection to a structure under dynamic excitation. A variety of passive energy dissipating devices such as the metallic dampers, friction dampers, viscos-elastic dampers and fluid viscous dampers are in use. Amongst such devices, fluid viscous dampers (FVDs) are found to have desirable performance to control shock loads. There are several potential equipment and mechanical systems whose performance can be greatly enhanced by using the right type/configuration of these dampers. These dampers are found to be efficient as base isolation as well as energy dissipation devices for structural control. In this study the seismic behavior of RC irregular and regular buildings with viscous fluid dampers, tuned mass dampers (provided at the top) and without any damping device are planned to be evaluated seismic behavior using time history analysis.

II. PASSIVECONTROL DEVICES

Passive control systems is device which imparts force that is developed in response to the motion of the structure by absorbing some of the input energy, it reduces the energy dissipation demand on the structure.

Therefore no external power source is required to add energy to the structural system. In passive control devices the motion of structure is controlled by adding devices to the structure in the form of stiffness and damping. Passive control devices can be effective against wind and earthquake induced motion.

Base isolation, Tuned mass dampers (TMD), Tuned liquid dampers (TLD), metallic yield dampers, and viscous fluid dampers (VFD) are some of the example of passive control devices. It operates without utilization of any external energy source. Therefore, the cost of these systems' setting up is less in comparison with active systems.

These systems can control the displacement up to a certain limit. In the passive control systems, the protection systems are designed in accordance to protection level required for earthquakes of certain magnitude. These systems are composed of dampers, isolators and other devices that can easily be found and applied.

A. Tuned Mass Damper (TMD) –

Tuned Mass Damper (TMD) is a devises which combination of a mass, a sprig and a damper that attached to structure for reducing the dynamic response of structure. They work on the principal that the frequency of damper is tuned to particular structure frequency. energy is dissipated the damper inertia force acting on the structure. The properties of dampers are calculating by the following formula.

Mass Ratio $\mu = \frac{m}{M}$

Optimum frequency of Damper $f_d = \frac{fn}{1+\mu}$

Where: m = mass of TMD

M = model mass of structure

μ = mass ratio

f_n = first natural frequency of the structure

f_d = first natural frequency of the TMD.

And the other optimum parameter used in these work for single TMD as the optimum frequency ratio, damping ratio, spring stiffness and damping are as

$$\alpha_{opt} = \frac{1}{1+\mu}\sqrt{\frac{2-\mu}{2}}$$

$$\xi_{opt} = \sqrt{\frac{3\mu}{8(1+\mu)}}\sqrt{\frac{2}{2-\mu}}$$

$$K_d = 4\Pi^2\mu\alpha^2\frac{M}{T*T}$$

$$C_d = 4\Pi^2\mu\xi\frac{M}{T}$$

Where: α_{opt} = Optimum Frequency Ratio,

ξ_{opt} = Damping Ratio,

K_d = Spring Stiffness and

C_d = Damping

B. Viscous Fluid Damper (VFD) –

Viscous Fluid Damper (VFD) typically consists of a piston head with orifices contained in a cylinder filled with a highly viscous fluid, usually a compound of silicone or a similar type of oil. Energy is dissipated in the damper by fluid orifice when the piston head moves through the fluid. The fluid in the cylinder is nearly incompressible, and when the damper is subjected to a compressive force, the fluid volume inside the cylinder is decreased as a result of the piston rod area movement. A decrease in volume results in a restoring force. Taylor Devices' Fluid Viscous Dampers are applicable to both fixed and base isolated structures, including buildings, bridges, and lifeline equipment. Diagonal brace dampers are used in these research works. There is no spring force in this equation. Dampers force varies only which velocity. For any fix velocity the force will be same at any point in stroke. As damper provided no restoring force the structure itself must resist all static force. These damper decreases the response of structure which reduced the response to any vibration. The most common factor on which effectiveness of viscous fluid damper dependent are defined as-

$$F = CV^{\alpha}$$

Where; F = Output force

C = Damping Coefficient

V = Relative Velocity across the Damper

α = Exponent constant (0.3< α <2.0)

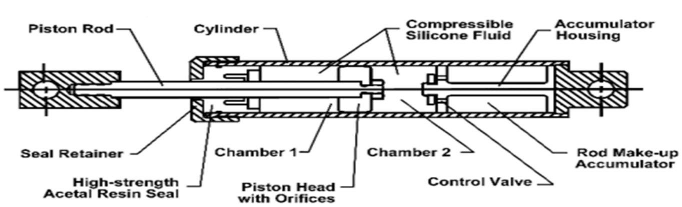

Figure 1 - Viscous Fluid Damper

The value of the constant α may be less than or equal to 1. They characterize the behavior of the viscous damper. With $\alpha = 1$ the device is called linear viscous damper and for $\alpha < 1$ non-linear FVD which is effective in minimizing high velocity shocks. Damper with $\alpha > 1$ has not been seen often in practical application.

III. MODELING

For these study work 16 story RCC building frame building having length at ground are 30x30 0f asymmetrical model of 4 m typical height. The plan and elevation of model are shown in figure. The analytical model of structure is prepared and analyses are done. The effect of soil structure interaction has been neglected and the columns are considered fixed at the base. Tuned mass damper is placed on the top story defined as damper link member with one end fixed with structure and other end is freely attached by mass of damper. The stiffness and damping properties of damper is assigned as per calculated. The viscous fluid damper is place in building as diagonally strut member (like bracing) by using link member of both end connected to structure joint. All three models are analyzed by using ETABS 2015. The time history methods are adopted in this study.

A. *Structural Modeling*

Table 1: Structural properties of model

Grade of concrete	M-20
Weight per unit Volume(KN/M^2)	25 Kn/m^3
Modulus of Elasticity, E (MPa)	27386.12
Poisson's Ratio U	0.2
Coefficient of Thermal Expansion,α (1/°C)	5.5x10^{-06}
Shear Modulus, G (MPa)	11410.89
Grade of Steel	Fe-500
Weight per unit Volume(KN/M^2)	78.5 Kn/m^3
Modulus of Elasticity, E (MPa)	2x10^5
Coefficient of Thermal Expansion	0.0000117
Slab Thickness (mm)	150 mm
Size of Beams	400mmx600mm
Size of column	800mmx800mm 700mmx700mm 600mmx600mm
Floor Finishing Load (Dead Load)	1.25 Kn/m^2
Live Load	2.5 Kn/m^2
Wall Load (on Each Beam)	13.6 Kn/m
Seismic Zone	IV
Zone Factor (Z)	0.24
Response Reduction Factor (R)	5
Importance Factor (I)	1.25
Soil Type	II
Damping Ratio	0.05

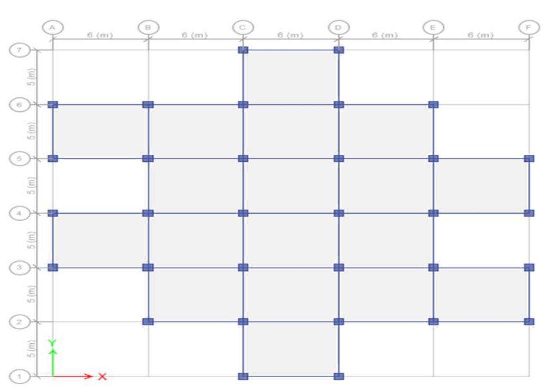

Figure 2 - 16 story building plan

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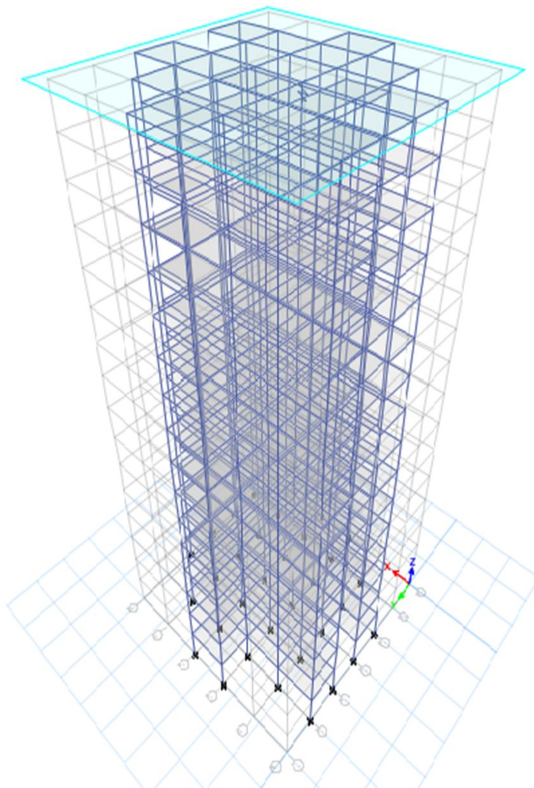

Figure 3 - 3D View of RC Building with TMD

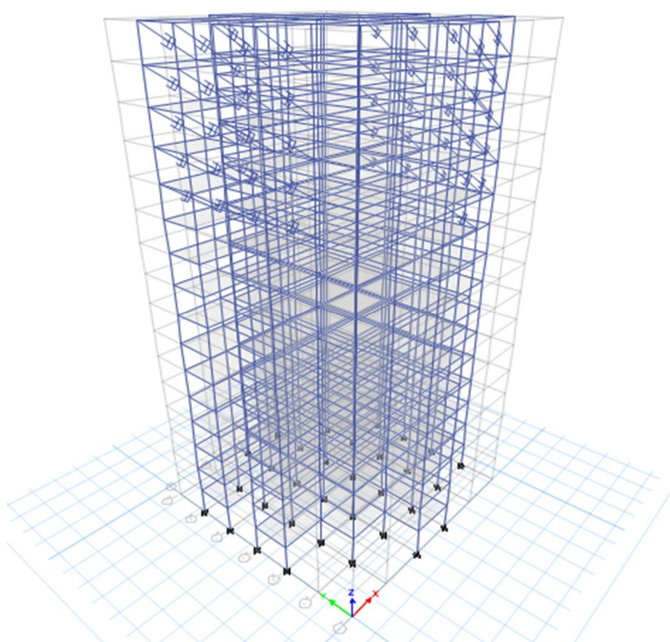

Figure 4 - 3D View of RC Building with VFD

B. Damper Properties

The single tuned mass damper which is provided at top and the viscous fluid damper (VFD) of Taylor's Device 50 Nos. of having following properties from Taylor's Devices Inc.

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Table 2: Properties of Dampers

Properties of Tuned Mass Damper (TMD)	
Parameter	Value
Mass of Building, M	152278 KN
Natural Time Period of Building, T	1.7 sec.
Critical Damping Ratio	0.05
Mass Ratio, μ	0.03
Mass of Damper, m	4570 KN
Optimum frequency Ratio, α_{opt}	0.963
Optimum Damping Ratio, ξ_{opt}	0.105
Spring Stiffness of Damper, K_d	57800 KN/M
Damping of Damper C_d	3400 KN-M/S^2
Properties of Viscous Fluid Damper (VFD)	
Force	250 KN
Spherical Bearing Bore Dia. (Mm)	38.10
MID-STROKE LENGTH (Mm)	867
STROKE (Mm)	±75
CLEVIS THICKNESS (Mm)	41
CLEVIS WIDTH (Mm)	100 MAX.
CLEVIS WIDTH (Mm)	83
Cylinder Dia. (Mm)	115 MAX.
Weight (Kg)	41

IV. RESULT AND DISCUSSION

The by static and dynamic analysis of seismic load are being carried out in accordance with Indian Codes. The result of time period, frequency and model displacement are compared in Modal Analysis. Also and the Lateral drift and responses (Acceleration, Velocity and Base shear) of three different modal in both X-direction and Y-direction are compared by Response spectrum analysis and time history analysis.

A. Model Analysis Result

The model time period of model without damper is 2.72 sec. it has been increases to 2.82 for TMD Model and 2.94 for VFD model. The result shows that the model time period is also increases in TMD and VFD model with respect to model without any damper, because of the mass, stiffness and the Damping of the Model are increasing. Due to increasing model time period the frequency are reduces that means the dynamic responses of building are also reduces, and hence building become more safe in earthquake hazards. And the overall model participation ratio for all models are approximately constant.

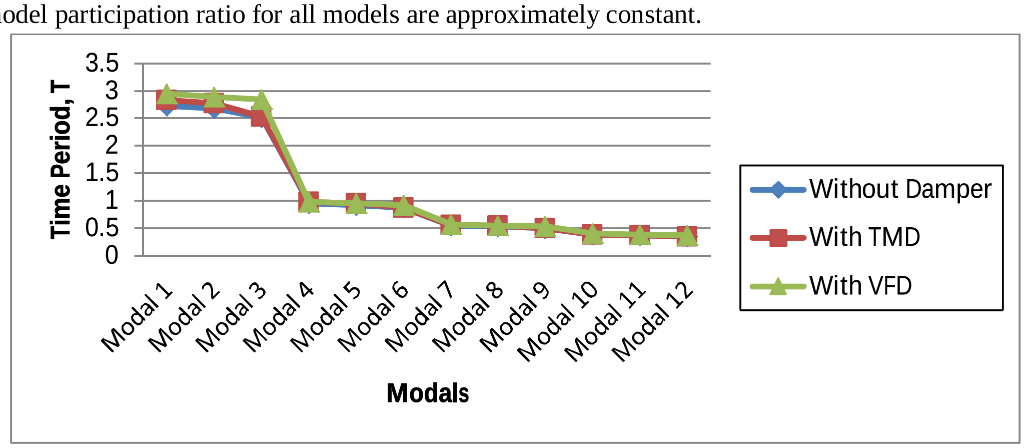

Figure 5 - Modal Time Period For different Modals

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B. Time History Analysis

The response spectral acceleration, response spectral velocity, base shear, base acceleration, base velocity and displacement are evaluated for Rudraprayag time history data by use of time history analysis. Due to increase in mass and stiffness with supplementary use of dampers that gives the result, the response of structure decreases. The result of response spectral acceleration, response spectral velocity, Base shear, Base acceleration, Base velocity and Base Displacement corresponding to time period under elastic time history method in both X direction and Y direction are considered. Response spectral acceleration (Sa/g) and response spectral velocity are compared for model without Damper, Model with TMD and model with VFD in X and Y direction. It was observed that, as for longer time period, result was converged the spectral acceleration value ad spectral velocity value.

Table 3: Maximum Response Spectral Acceleration (Sa/g) and response spectral velocity

Models	Response spectral Acceleration (Sa/g) In X direction	Response spectral Acceleration (Sa/g) In Y direction	Response spectral Velocity (mm/sec) In X direction	Response spectral Velocity (mm/sec) In X direction
Without Damper	0.294	0.266	792.06	787.49
With TMD	0.243	0.237	717.69	719.71
With VFD	0.225	0.217	634.99	638.44

The value of base shear and acceleration are presents in the given figure. And the table contains max. Base shear, acceleration velocity ad displacement under the time history analysis.

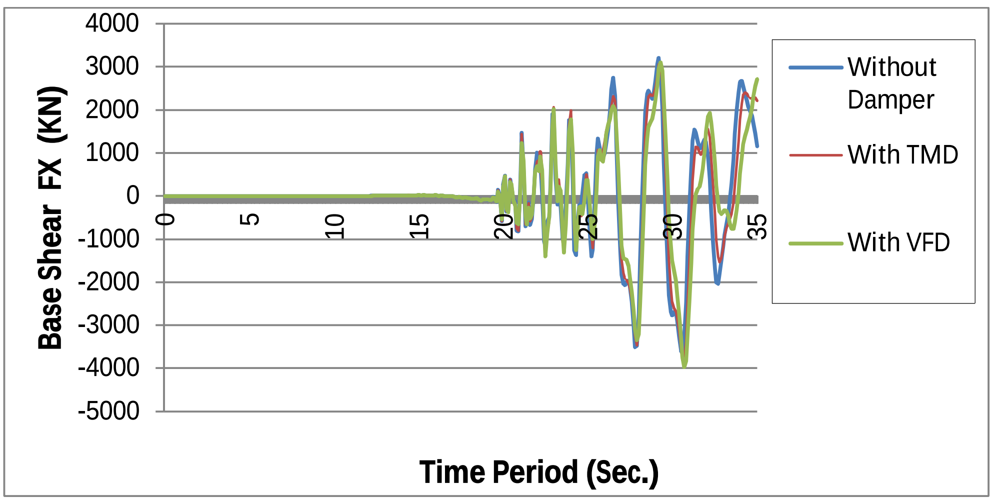


Figure 6 - Base Shear (KN) v/s Time Period (Sec.) in X Direction

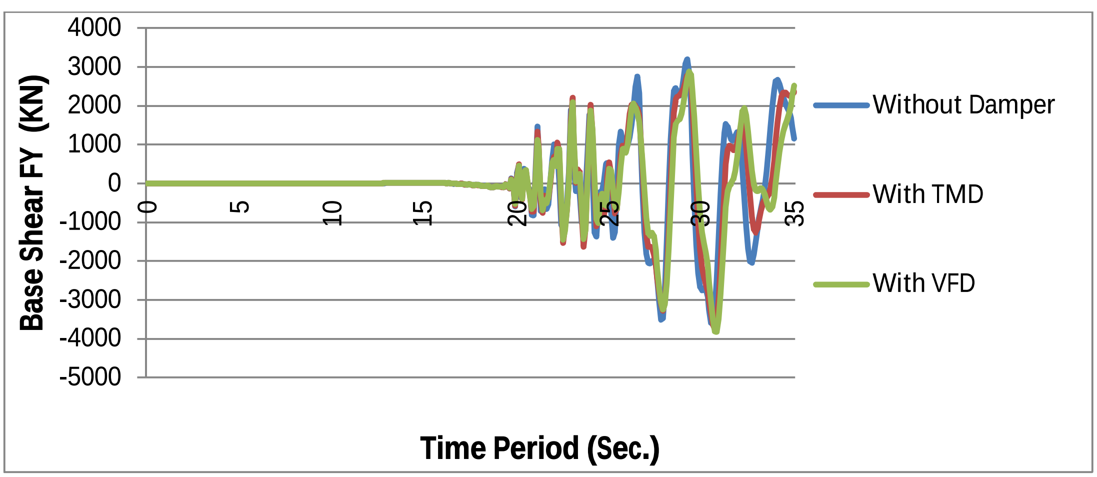


Figure 7 - Base Shear (KN) v/s Time Period (Sec.) in Y Direction

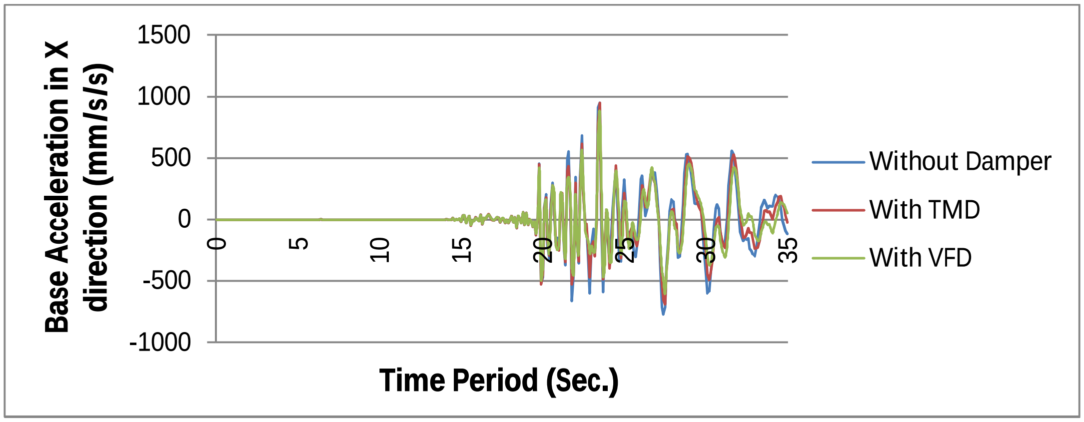


Figure 8 - Base Acceleration (mm/s/s) v/s Time Period (Sec.) in X Direction

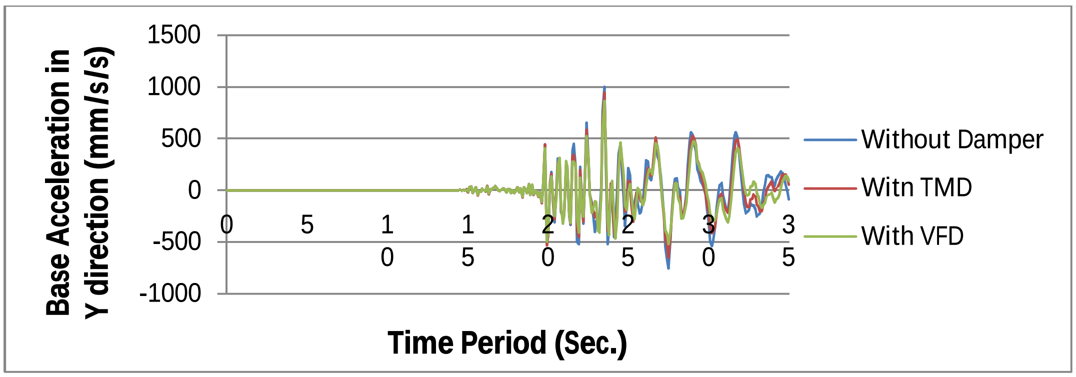


Figure 9 - Base Acceleration (mm/s/s) v/s Time Period (Sec.) in Y Direction

Table 4: Maximum acceleration, displacement and base shear under time history loading-

Models	Base Acceleration (mm/s/s) in X direction	Base Acceleration (mm/s/s) in Y direction	Base Displacement (mm) in X direction	Base Displacement (mm) in Y direction	Base Shear FX (KN) in X direction	Base Shear FX (KN) in Y direction
Without Damper	949.73	999.46	74.95	74.95	3198.34	3198.34
With TMD	949.06	943.8	73.15	72.73	3058.32	2847.45
With VFD	876.82	862.02	65.00	66.6	2903.52	2687.50

V. CONCLUSION

This study explains the behavior of dampers on structural system under the performance of dynamic loads from which the following conclusion can be drawn, based on the result:

A. The analysis shows that the time period of structure increases when TMD and VFD are mounted because of these frequencies of structure reduces when compared with bare frame structure. As the frequency of structure reduces the dynamic effect on building also reduces.

B. The value of response spectrum acceleration under time history analysis there are reduction about 17.34% of model TMD and 26.46% of model VFD as compare to model without any damper in X direction. Similarly, The value of response spectrum acceleration under time history analysis there are reduction about 10.90% of model TMD and 18.46% of model VFD as compare to model without any damper in Y direction.

C. The value of response spectrum velocity under time history analysis there are reduction about 9.06% of model TMD and 18.92% of model VFD as compare to model without any damper in X direction. And reduction about 8.60% of model TMD and 22.9% of model VFD as compare to model without any damper in Y direction.

D. There was reduction of 4.38% in value of base shear in model with TMD and reduction about 9.38% in model with VFD in X direction and reduction of 10.94% in value of base shear in model with TMD and reduction about 15.94% in model with VFD in X direction although the seismic weight in model TMD and in model VFD are increases with respected to model without any dampers.

E. On observing the base acclration value under time history analysis, there was reduction 2% in model TMD and about reduction 7.68% in model with VFD in X direction for the same coefficient of damping for both. And similarly the reduction 5.56 in model TMD and about reduction 13.75% in model with VFD in Y direction.

F. The value of base displacment under time history analysis there are reduction about 2.96 % of model TMD and 11.94% of model VFD as compare to model without any damper in X direction. Similarly, The value of base displacement under time history analysis there are reduction about 2.54% of model TMD and 13.27% of model VFD as compare to model without any damper in Y direction.

G. After comparing all models it has been observed that the VFD's gave maximum reduction in responses (Base Shear, Displacement, Velocity, Acceleration) with compare to TMD model for same damping coefficient.

REFERENCES

[1] Abdel Hameed A. A.; Fedel E. L. Seed A.M.; Salih A. M., (2013). "Growth Performance And Rumen Fermentation Of Lambs Fed Untreated Or Urea Treated Groundnut Hull With Different Protein Sources". J. Anim. Prod. Adv., 3 (3): 86-96

[2] Abe, M. and Igisa, T. (1995). "Tuned Mass Dampers for Structure with Closely Spaced Natural Frequencies," Earthquake Engineering and Structural Dynamics. Vol. 24(3), 247-261

[3] Balakrishana, G.S. and Jacob, J. (2016). "Seismic Analysis of Building using Two types of passive Energy dissipation Devices." ISOR Journal of Mechanical and Civil Engineeing.2320-334, 13-19.

[4] Bharti, Gulshan (2015). "A Review of Response Analysis of Two Parallel Building Coupled by Nonlinear Damper" International Journal For Scientific Research & Development, Vol. 3 Issue 04, ISSN : 2321-0613

[5] Chidige, Anil kumar and E, Arunakathi (2017). "A Seismic Study on Effect of Water Tank Modeled as TMD" International Journal of Innovative Research in Science, Engineering and Technology." Vo,. 6, Issue 2

[6] Chopra (1995) Dynamics of structures: theory and applications to earthquake engineering, Prentice Hall.

[7] Chopra, A. K. (2001). Dynamics of structures: Theory and applications to earthquake engineering, 2nd Ed., Prentice Hall, Upper Saddle River, N.J.

[8] Chen, G. and Wu, J. (2003). "Experimental Study On Multiple Tuned Mass Dampers to Reduce Seismic Response Of a Three Story Building Structure." Earthquake Engineering and Structure Dynamics.32 (3), 793-810.

[9] Debbarma, R., and Das D. (2010). "Vibration control of building using Multiple Tuned Mass Dampers considering real time earthquake time history." World Academy of science, Engineering and technology International Journal of civil, environment. Structural, construction and architectural Engineering. Vol. 10(2), no:6,

[10] Deore, Khemraj S.,talikoti, Rajashekher S. and Tolani Kanhaiya (2017). "Vibration Analysis of Structure using Tune Mass Damper" International Journal of Engineering and Technology, vol. 04 Issue:07, Issn: 2395-0072

[11] FEMA, NEHRP, Guidelines & Commentary for Seismic Rehabilitation of Buildings, Reports N° 273 and 274, October, Washington DC., 1997

[12] FEMA 356 (2000), ―Prestandard and Commentary for the Seismic Rehabilitation of Buildings,‖ Federal Emergency Management Agency, Washington, DC

[13] Haskell, G. and Lee, D. (2007) "Fluid viscous damper as an alternative to base Isolation", *Taylor devices inc.*,

[14] Igus, T.,andXu, k. (1994). "Vibration Control using multiple tune mass dampers." Journal of sound and vibration. Vol. 175(4), 491-503

[15] IS : 1893.(Part-1) (2016). Criteria for Earthquake Resisting Design for Structures. Part 1 General Provision and Buildings (Sixth Revision), BIS, New Dehli, India

[16] IS : 456. (2000). Plain and Reinforced Concrete – Code of Practice (Fourth Revision, BIS, New Dehli, India

[17] Joshi, A., and S. Jangid, R.S. (1996). "Optimum parameters of multiple tune Mass Dampers for Base-Exited Damped Systems. "Journal of sound and Vibration. 202(5), 657-667

[18] Kazi, Raheel and Muley, P.V. (2014) "comparison Study of Multistoried Building With and without Damper" International Journal of Computer Application, ISSN 0975-8887.

[19] Mahajan, Nitendra G and Raijiwala, D B (2011). "Seismic Response Control Of A Building Installed With Passive Dampers." International Journal of Advanced Engineering Technology, ISSN 0976-3945, Vol. 2(3), 246-256

[20] Meshram, Rujata S. and Khante, S.N. (2016). "Effectiveness of Water Tank as Passive TMD for RCC buildings." International Journal of Engineering Research, vol. 05, Issue 3

[21] Murudi, Mohan M. and Mane, Sharadchandra M. (2004) "Seismic Effectiveness Of Tuned Mass Damper For Different Ground Motion Parameters" 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004 Paper No. 2325

[22] Patil, S. S., Javheri , S.B. Lonapure, C.G. (2010). "Effectiveness of multiple Tuned Mass Dampers." International Journal of Engineering and Innovation Technology (IJEIT) . Volume 1(2), 6.

[23] Shamazu, T., and Araki, H. (1995) "Survey of Actual Effectiveness Of Mass Samper System Installed In Buildings. " Eleventh world conference on Earthquake Engineering.

[24] Ras, A. and Boumechra , N. (2016) "Seismic energy dissipation study of linear fluid viscous dampers in steel structure design." Alexandria Engineering Journal 55, 2821–2832

[25] Rai, Durgesh C. (2000) Future Trends in earthquake resisting design of structure" current Science. Vol. 79, No. 9

[26] Sadek, F. ,Mohraz, B. , Taylor, A.W. and Chung, R.L. (1997) "A method of estimating the parameters of tuned mass dampers for seismic applications", *Earthquake Eng. Struct.Dynam.*, vol. 26, pp. 617-635, 1997.

[27] Sadeghi Balkanloua, V. , Reza Bagerzadeh Karimib, M. , Bagheri Azarc , B. and Behraveshd, Alaeddin. (2013) "Evaluating Effects of Viscous Dampers on optimizing Seismic Behavior of Structures." International Journal of Current Engineering and Technology ISSN 2277 – 4106 , page no. 1150-1157.

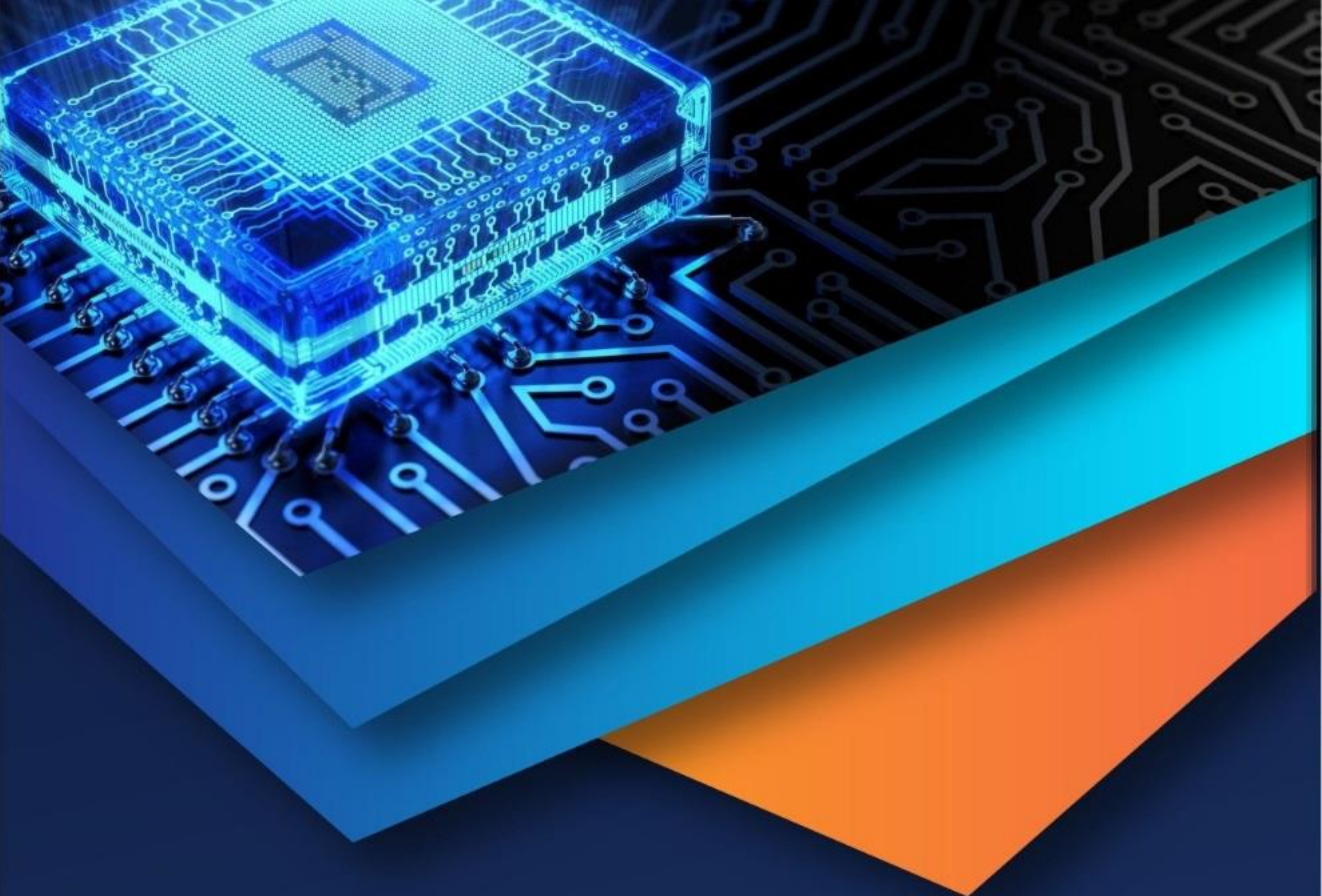
[28] Singh, M. P., and Moreschi, L. M. (2002). "Optimal placement of dampers for passive response control." Earthquake Eng. Struct. Dyn., 31, 955–976.

[29] Sophocleous, T. & Phocas, M.C. (2012). "Bracing Design in Dual Systems for Earthquake Resistance." 15th world confrende of earthquake engineering.

[30] Takewaki, I., and Yoshitomi, S. (1998). "Effects of support stiffnesses on optimal damper placement for a planar building frame." Struct. Des. Tall Build., 7(4), 323–336

[31] Taylor (2007), "Structural Applications of Fluid Viscous Dampers," Taylor Devices Inc., North Tonawanda, NY

[32] ang, J.F., and Lin, C.C.(2005). "Seismic Performance of Multiple Tuned Mass Dampers for soil-irregular building interaction system." Elsevier.com, International Journal of Solids and Structure.42 (2), 5536-554.



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