iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: VII Month of publication: July 2021

DOI: https://doi.org/10.22214/ijraset.2021.36241

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Seismic Analysis and Design of Multi Storey RC Buildings with and without Fluid Viscous Dampers

Prof. Sanjay Bhadke[1], Savin M. Lulekar[2]
[1]Assistant Professor, [2]Research Scholar, Dept. of Civil Engineering,
Tulsiramji Gaikwad Patil College of Engineering and Technology, Nagpur, Maharashtra. India

Abstract - Earthquakes are one among the foremost destructive of natural hazards. Earthquake occurs due to sudden transition motion of the ground as a result of release of energy in a matter of few seconds. This recent events remind us of the vulnerability of our society to natural hazards. The protection of civil structures, including material content and human occupants is, doubtless, a worldwide priority. The challenge of structural engineers is to raised withstand these natural hazards. In the present study reinforced concrete moment resisting frame building of G+20 are considered. The building is taken into account to be located in the seismic zone (v) and intended for commercial purpose. Model-I Building without dampers, Model-II –Building with dampers. The building of G+20 has been modeled by providing with and without damper providing all parameters using S A P 2 0 0 0 software. Results show that using fluid viscous dampers to putting together effectively reduce the building responses by selecting optimum damping coefficient i.e. when the building is connected to the fluid viscous dampers (FVD) can control both displacements and accelerations of the building. Further damper at appropriate locations can significantly reduce the earthquake response.
Keywords – SAP 2000, pushover analysis, base shear, lateral displacement, storey drifts.

I. INTRODUCTION

A. General

Earthquakes are one among the foremost destructive of natural hazards. Earthquake occurs thanks to sudden transient motion of the bottom as a results of release of energy during a matter of few seconds. The impact of the event is most traumatic because it affect large area, occurs all of a sudden and unpredictable. Vibrations induced within the earth's crust thanks to internal or external causes that virtually shake up a neighborhood of the crust and every one the structures and living and non-living things existing thereon they will cause large scale loss of life, property and disrupts essential services like water system , sewerage systems, communication, power and transport etc. The aftermath results in destabilize the economic and social organization of the state . the first objective of earthquake resistant design is to stop building collapse during earthquakes thus minimizing the danger of death or injury to people in or around those buildings. Earthquake force is generated by the dynamic response of the building to earthquake induced ground motion. This makes earthquake actions Fundamentally different from the other imposed loads. Dynamic responses are stresses, strains, displacement, acceleration etc. the planning of buildings for seismic loads is special, when compares to the planning for gravity loads (dead loads and live loads). Gravity load is relatively constant, in terms of their magnitude and are treated as 'static' loads. In contrast, seismic load are predominantly horizontal (lateral), reversible (the forces are back-and-forth), dynamic (the forces rapidly vary with time) and of very short duration. The seismic loads are more uncertain than the traditional gravity loads in terms of magnitude, variation with time and instance of occurrence. The variation of the forces with time affect the resistance of the building. the utmost magnitudes of the interior forces and their locations within the structural members are different from those thanks to gravity loads. so as to form a building seismoresistant, it should have good building configuration, lateral strength, lateral stiffness, ductility, stability and integrity. Data obtained from the NESDIS National Geophysical Data Centre, Significant Earthquake Database. Table 1.1 shown the Loss of Life and Property Damage for Recent Earthquake Disaster.

B. Structural Control

Structural control is a diverse field of study. Structural control is one area of current research that looks promising in attaining reduce structural vibrations during loading such as earthquakes and strong wind. The reduction of structural vibrations occurs by adding a mechanical system that is installed in a structure. Structural control for civil structure was born out of a need to provide safer and more efficient designs with the reality of limited resources. The purpose of structural control is to absorb and to reflect the energy introduced by dynamic loads such as winds, waves, earthquakes and traffic. Today, the protection of civil structures from severe dynamic loading is typically achieved by allowing the structures to be damaged.

$$E=Ek+Es+Eh+Ed \qquad (1.1)$$

Where E is the total energy input to the structure from the excitation, Ek is the kinetic energy of the structure, Es is the elastic strain energy of the structure, Eh is the energy of the structure dissipated due to inelastic eformation (e.g, allowing damage to the structure), and Ed is the energy dissipated by supplemental damping devices. For traditional structure, the right hand side of the equation (1.1) includes only Ek, Es and Eh. By including the energy term Ed through structural control, the energy dissipated by supplemental damping devices, the kinetic, elastic and most importantly, the inelastic deformation energy can be reduced, preserving the primary structure. There are three primary classes of supple mental damping device, categorized into three corresponding control strategies. Passive supplementary damping devices are the first class. Passive devices do not require electricity and are not controlled. Active supplementary damping devices are the second class. Active devices are controllable, but requires significant power to work. The third class of supplemental damping devices is semi-active. Semi active devices combine the positive aspects of passive and active control devices therein they're controllable (like the active devices) but require little power to work.

C. *The Effect of various Values of α, the Velocity Exponent*

Figure 1.1 shows the hysteresis loop of pure linear viscous damper when subjected to a sinusoidal input.

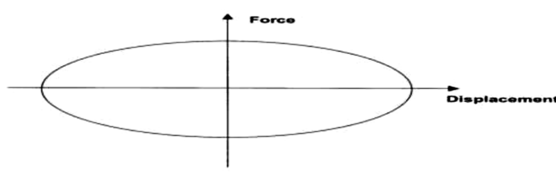


Figure 1.1 Hysteresis loop of viscous damper

The loop is a perfect ellipse. The absence of a storage stiffness makes the natural frequency of structure incorporated with the damper remain an equivalent. These advantages will simplify the design procedure for structure with supplemental viscous dampers. Fluid viscous dampers have the unique ability to simultaneously reduce both stress and deflection within a structure subjected to transient. This is because the fluid viscous damper varies its force only with velocity, which provides a response thats inherently out-of phase with stresses due to flexing of the structure. The ideal force output of viscous damper can be expressed as

$$FD=C|u.|\alpha \text{ sign}(u.)$$

Where FD is the damper force, C is the damping constant, and u is the damping constant.. is the relative velocity between the two ends of the damper, α is the exponent with 0 to 1. The damper with α=1 is called as a linear viscous damper in which the damper force is proportional to the relative velocity. The dampers with α larger than 1 have not been seen in the practical applications.

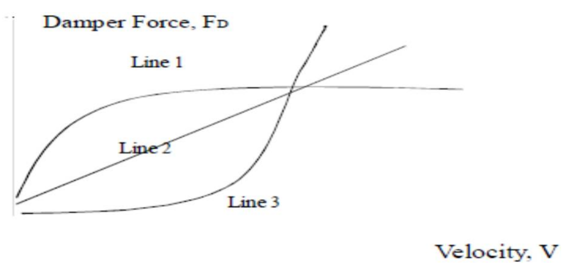


Figure 1.2 Force- Velocity Relationship Viscous Damper

The damper with α smaller than 1 is named as a non-linear viscous damper which is effective in minimizing high velocity shocks. The below figure 1.2 shows the force velocity relationship of the three differing types of viscous dampers. This figure demonstrates the efficiency of non linear dampers in minimizing high velocity shocks. For a small relative velocity, the damper with a α value less than 1 can give a larger damping force than the other two types of dampers.

Line 1: FD=CN1 Vα , Non-linear damper with (α >1).

Line 2: FD=CL Vα , Linear Damper.

Line 3: FD=CN2 Vα , Non-linear damper with (α<1).

D. Placement of FVDs in a Structure

Having determined the target building performance and required damping contribution to the response, the designer must identify appropriate locations to install the dampers. Often this is in the form of diagonal braces in which the damper device is placed in-line with the brace member. However as demonstrated by Constantinou et al. [1] and Şigaher and Constantinou [2], there are a many configurations that could be considered which can avoid significant architectural and functional compromise. The key point is that the damper must connect to points in the structure that have differential motion when the building sways. This motion can be either horizontal or vertical depending on the primary lateral force resisting system and the inherent deformed shape of the structure. The use of 'toggle-brace' configurations can significantly increase the velocity applied to the damper using geometric amplification as shown in figure 1.3, and this correspond to improved efficiency of the damper in the terms of lateral forces resistance and energy dissipation. Such setups can be used in reduction of the size of the damper, or improve the damping effect on the structure. It should be noted however that experimental studies on toggle setups have generally not achieved the calculated efficiencies due to the brace and connection flexibility reducing the velocity amplification.

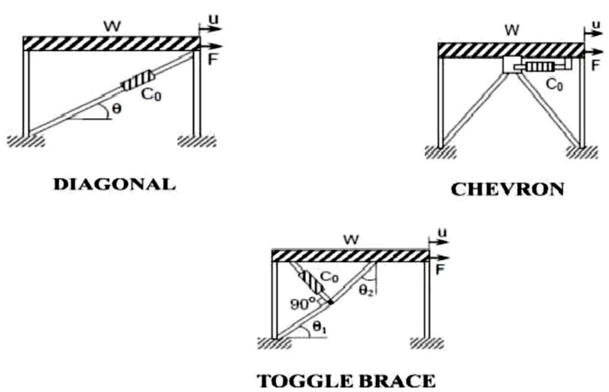
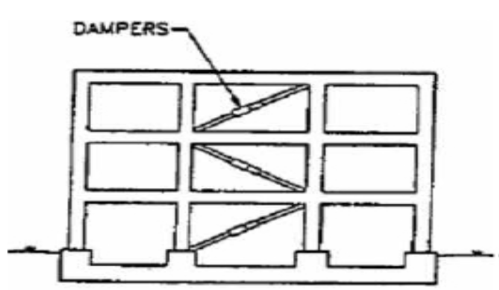


Figure 1.3 Configurations for viscous dampers within a basic structural frame.

E. Installation of FVD's

Fluid viscous dampers can be installed as diagonal members in several ways, or can tie intochevron braces. They can also be used as the two elements of the chevron braces. As show in figures 1.4 the typical fluid viscous dampers installations.

Fluid Viscous Dampers Can Be Installed In Several Ways As Shown In Following Figures



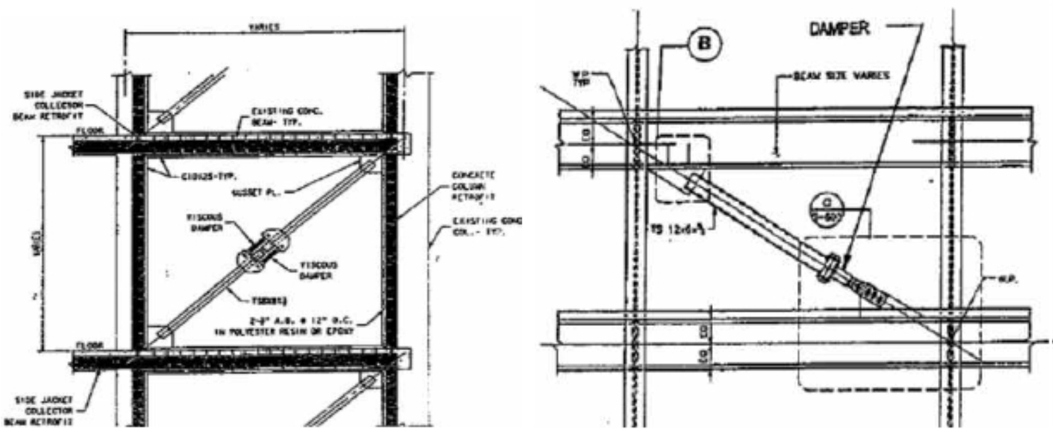


Figure 1.4 Diagonal Bracing with Dampers

II. REVIEW OF LITERATURE

Jinkoo K. and B. Sunghyuk investigated on appropriate plan-wise distribution of viscoelastic dampers to minimize the torsional responses of an asymmetric structure, with one axis of symmetry subjected to an earthquake-induced dynamic motion. The modal characteristic equation of a single-storey asymmetric structure with four corner columns and added viscoelastic dampers were derived, and a parametric study was performed to identify the design variable that influence the torsional responses. Based on the results of parametric study, the simple and straightforward methodology to find out the optimum eccentricity of added VED to compensate for the torsional effect of a plan-wise asymmetric structure was developed using modal coefficients.

Diclelia, M. and A. Mehta studied of seismic performance of steel chevron braced frames (CBFs) with and without viscous fluid dampers (VFDs) as a function of the intensity and the frequency characteristics of the ground motion and VFD parameters. For this purpose, comparative nonlinear time history (NLTH) analyses of single and the multiple story CBFs with and without the VFDs are conducted using the ground motions with various frequency characteristics scaled to represent small, medium and large intensity earthquakes. Additionally, NLTH analyses of single and multiple story CBFs with VFDs are conducted to study the effect of the damping ratio and velocity exponent of the VFD on seismic performance of the frames.

Raveesh R M and Sahana T S investigated evaluate effect of tuned mass dampers on the structural response of multistorey RC frame structures subjected to implemental dynamic analysis. A multistorey RC frame structure buildings having a ratio of height to breadth from 1, 2 and 3 is used in these study. The models were used to represent the buildings located in zone 5 of India. The systemic parameters studied are the natural time period, base shear, roof displacement, lateral displacement. A single ground motions were used in the study to generate one record Time v/s Acceleration curves namely BHUJ EARTHQUAKE. These ground motions was scaled to the design spectral acceleration earlier to the application. The effect of acceleration is examined in this analysis SAP 2000, a software that can carry out nonlinear dynamic analysis.

Huangshang and Linuo carried out work to obtain the optimal parameters of dampers linking adjacent structures for seismic mitigation, two SDOF systems connected with visco-elastic damper (VED) are considered as a object and the primary structural vibration frequency ratio, connection stiffness and linking damping ratio as a research parameters. To model earthquake excitation, a modified Kanai-Tajimi spectrum is chosen.Eventually, the seismic responses of example structures with or without connecting dampers are contrastively analyzed. The dependency of response mitigation effective on research parameters is highlighted. The findings show that dampers linking structures are helpful at reducing earthquakes to a fine degree. It is also showed that optimal parameters of damper cannot reduce the seismic responses of the primary structures connected to the best extent at the same time. Based on the studies they achieve that the seismic responses of both buildings could be considerably reduced if damper parameters are selected appropriately and the seismic mitigation effects are affected by the dynamic characteristics of adjacent structures are different enough. Finally the seismic reduction effect of the softer building can be more increased than that of the stiffer building by installing VFD's.

III. CONCLUSIONS

The Present study is focused on the study of Seismic demands of different R.C buildings high rise buildings using numerous analytical techniques for the buildings located in seismic zone V of India medium soil. The achievement of the building is studied in terms of time period, base shear, lateral displacements, storey drifts in linear static and linear dynamic analysis for with and without fluid viscous dampers building G+20 storey models.

The seismic analysis is carried out by equivalent static method and response spectrum method for G+20 storey building with unsymmetrical in plan. The below are the conclusions that can be concluded from the present study, which are as follows.

A. The fundamental natural period of the structure rises due to the lesser stiffness of the bare frame buildings compared to buildings having fluid viscous dampers.

B. The base shears due to seismic forces for the building with fluid viscous dampers are greater than the base shear obtained for without fluid viscous dampers.

C. Compared to the regular building the storey displacement reduces for the buildings having fluid viscous dampers. Addition of fluid viscous dampers in the building will result in drastic depletion of lateral displacement of the building there by in turn assures the safety of the structure.

D. The storey drift rises in regular building as compared to building having fluid viscous dampers. T h e addition of fluid viscous dampers in the building drastically reduces the inter storey drift as compared to that of building without fluid viscous dampers.

REFERENCES

[1] Constantinou, M.C., Tsopelas, P., Hammel, W., and Sigaher. (2001). Toggle-brace-damper seismic energy dissipation systems. Journal of Structural Engineering,127:2, 105–112.

[2] Şigaher AN, Constantinou MC. “Scissor-Jack- Damper energy dissipation system”. Earthquake Spectra 2003; 19(1): 133-158.

[3] B. Sunghyuk and Jinkoo K. 2002 “Optimum distribution of add on viscoelastic dampers for mitigation of torsional reactions of plan-wise asymmetrical structures” J. Eng. Struct., 24: 1257- 1269.

[4] Diclelia, M. and A. Mehta, 2007” Seismic performance of chevron braced steel frames with and without viscous fluid dampers due to ground motion and damper characteristics” J. Construct. Steel Res., 63: 1102-1115.

[5] Chung- Hsin and L. Kuan-Hua, Lap-Loi, C., W. Lai-Yun, H. Hsu-Hui, C. 2009 “Optimal design theory of tuned-mass dampers with the irregular viscous damping” J. Earthquake Eng. Eng. Vibrat., 8: 41671-41674.

[6] Providakis, C.P., 2008. Effect of LRB isolators and supplemental viscous dampers on seismic isolated buildings under near-fault excitations. J. Eng. Struct., 30: 1187-1198.

[7] Huangsheng, S. and Linuo, C (2011). “Connecting Parameter Study on Adjacent Structures associate by Dampers,” Advanced Materials Research, 243-249, 3832-3838.[8] V. Sadeghi Balkanlou , M. Reza Bagerzadeh Karimi , Alaeddin Behravesh and B. Bagheri Azar (2013) “Evaluating results of Viscous Dampers on optimizing Seismic action of Structures” International Journal of Current Engineering and Technology ISSN 2277 -4106

[8] Sahana T S (2014) ad Raveesh R M “Effect of Tuned Mass Dampers on Multistorey RC Framed Structures” International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 3 Issue 8, August - 2014

[9] 9.Oliveto G. and Oliveto ND,Time domain identification of hybrid base isolation systems utilizing free vibration tests. Earthquake Engineering & Structural Dynamics. 2010;39(9):1015-38.

[10] Haskell G, Lee D. Fluid viscous damping as an replacement to base isolation. ASME-PUBLICATIONS-PVP. 1996;330:35-40.

[11] Lee D, Kim H, editors. Efficient seismic examination of high-rise buildings taking into account the basements2001: NZSEE Conference.

[12] Raheem SEA. Evaluation of Egyptian code presentation for seismic design of moment-resisting-frame multi-story buildings. International Journal of the Advanced Structural Engineering. 2013;5(1):1-18.

[13] Council NR. Preventing earthquake disasters: the grand challenge in earthquake engineering: a research plan for the Network for Earthquake Engineering Simulation (NEES): National Academies Press; 2003.

[14] Datta TK. Seismic examination of structures: John Wiley & Sons; 2010.

[15] Reinhorn AM., Viti S, Cimellaro GP, Retrofit of a hospital through strength depletion and build up damping. Smart Structures and Systems. 2006;2:339-55.

[16] Ribakov Y, Reinhorn AAM. Design of amplified structural damping utilizing optimal. Journal of Structural Engineering. 2003;129(10):1422-7.

[17] Madsen L. Improving the seismic response of structures by the utilize of dampers in shear walls. ME thesis, School of Civil Engineering, Queensland University of the Technology, Brisbane, Australia. (2001).

[18] Hisano K, Kuribayashi H, Saitou K, Nakano T, editors. The application sample of the hybrid damping system combined the hysteretic damper with viscous damper to highrise building. Proc 5th Inter Conf on Motion and Vibration Control, Australia; 2000.