iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** V **Month of publication:** May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5400

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

Dynamic analysis of R.C. Frame Building Using Energy Dissipation Devices: A Review

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Abstract: In present days, the tall buildings are built more flexible and light in weight. This is having low damping. The buildings vibrate under earthquake vibration become uncomfortable for people. The new techniques for improving the earthquake resistance of building are also by energy dissipation device systems. These systems can be divided as Active, Passive, Semi Active and hybrid system. A passive energy dissipation devices used in building to improve the seismic response during the earthquake. The simplest energy dissipation devices are viscous fluid damper and tuned mass damper are installed in many tall building existing in earthquake prone area.
Keyword: TMD, VFD, Stiffness, Non Linear Time History, Etabs Software Packages.

I. INTRODUCTION

The Earthquake Results from the movements of tectonic plates these movements also energy released is transmitted through earth in the form of wave. These waves arrived at various instant of time having different amplitude and different level of energy. A Passive device which imparts the forces that are developed in response to the motion of the structure by absorbing some of the input energy. Therefore no external power source is required to add energy to the structure system. Base isolation, tuned mass damper (TMD), tuned liquid damper (TLD), metallic yield dampers, viscous fluid dampers are some of the example of passive energy control devices. Etabs is structural analysis programming software. With the help of Etabs building frame has been analysed for seismic loads without damper and with TMD and VFD damper Linear as well as nonlinear time history analysis has been done.

II. TUNED MASS DAMPER (TMD)

Tuned mass damper are passive devices which provided at the top of the building consist of addition mass is attached on it and tuned frequency of structure. It is suspended at the Top of building and are tuned to one fundamental first mode frequency. The dampers Also Overcome the inertia of mass due To presence of tuned mass damper. They Required the Large spaced at top of the building therefore single TMD or multiple small TMD is Installed along the height of building is effectively control the res--ponse of structure.

III. VISCOUS FLUID DAMPER (VFD)

Viscous fluid dampers is one of the damping devices that often used in aerospace and military ion and recently been adopted for structure application. A viscous fluid damper generally consists of a piston in the dampers housing filled with a compound silicon or oil. 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. Resulting these damper increases the damping without increasing structure stiffness and the overall damping will achieved effetely without frequency tuning.

IV. LITERATURE REVIEW

A number of works have been presented on the tuned mass dampers and viscous fluid damper. In this review paper some literature in brief is Presented by different Scholars and researchers.

Warburton (1982) has shown that when determining optimum parameters for an absorber which minimizes the vibration response of a complex system, the latter may be treated as an equivalent single degree-of-freedom system if its natural frequencies are well separated. Emphasis was on minimizing the displacement response when the excitation was a harmonic force. In the present paper sample expressions for optimum absorber parameters are derived for UN damped one degree-of-freedom main system for harmonic and white noise random excitations with force and frame acceleration as input and minimization of various response parameter. These expressions can be used to obtain optimum parameters for absorbers attached to complex systems provided that optimization is with respect to an absolute, rather than are elative, quantity. The requirement that the natural frequencies should be well separated is investigated numerically for the different cases. The effect of damping in the main system on optimum absorber parameters is investigated also.

Constantinou(1993) This paper presents the results of an experimental study of the seismic response of buildings with supplemental fluid damping devices. The experimental results demonstrate that the addition of fluid dampers to the tested steel model structure resulted in reductions of inter-story drifts, floor accelerations and story shear forces by factors of two to three in comparison with the response of the same structure without the dampers.

Igusa (1994) This Paper examines multiple tuned mass dampers (TMD's) with natural frequencies distributed over frequency range. An integral form for the impedance is developed by asymptotic techniques. The result is used to analyses the vibration control capabilities of multiple TMD's for structure subjected to wide - band input. Calculus of variation used to optimize the design of the TMD's with constrain on the total mass. It is found that multiple TMD's can be more effective and more robust than a single TMD with equal total mass.

Abe(1995) analytical results are developed for vibration control of structure with one or more Tuned mass Dampers (TMDs) The input is a harmonic load with a range of possible frequencies. The control objective is to reduce the maximum amplitude of the structural response. Perturbation theory is used with three sets of small parameters. The ratio of TMD of structural modal masses and the damping of the system. And the differences between the structural model masses, the damping of the shown analytically that for structures with widely spaced natural frequencies, the response can be approximated accurately by the response of the well-known single mode structure/TMD system.

Shimazu (1995) through surveying the real state of implementation of mass damper system in building. The effect of these system were clarified based on various recorded values in actual building against both winds and earthquake the effects are discussed in relation with the natural periods of building equipped with mass damper systems , the mass weight ratio to building weight. Wind force levels and earthquake ground motion levels.

Joshi (1996) The parameters of multiple tuned mass dampers "MTMD for suppressing the dynamic response of a base excited structure in a specie mode is investigated The base excitation is modeled as a stationary white noise random process. the criterion selected for optimality is the minimization of the root mean square " displacement of the main structure. The parameters of MTMD that are optimized include the damping ratio the tuning frequency ration and the frequency bandwidth of the MTMD system the optimum parameters of the MTMD system and corresponding effectiveness are obtained for different damping ratios of the main structure and mass ratios of the MTMD system in addition the effectiveness of an optimally designed MTMD system is compared with the of an optimum single tuned mass damper it is shown that the optimally designed MTMD system is more effective for vibration control than the single tuned mass damper .

Jangid (1999) investigated the optimum parameters of multiple tuned mass Dampers (MTMD) for an undammed system under harmonic bass excitation using a numerical searching technique. The criteria used for the optimality was the minimization of steady-stare displacement response of the main system.

Durgesh C. Rai (2000) this work deals with future trends in earthquake-resistant design of structures. It is fairly well accepted that earthquakes will continue to occur and cause disasters if we are not prepared. Assessing earthquake risk and improving engineering strategies to mitigate damages are the only options before us. Geologists, seismologists and engineers are continuing their efforts to meet the requirements of improved zoning maps, reliable databases of earthquake processes and their effects; better understanding of site characteristics and development of earthquake resistant design (EQRD).

Park (2001) numreically evaluated the performance of multiple damper with uniformly and linearly distributed masses, under harmonic excitation. A linearly elastic single degree of freedom system with damper ratio 0.01; and the total mass ratio of the MMD system 0.01 was taken. An algorithm was developed to identify the optimum tuning of the individual dampers. Which evaluate the performance by Effectiveness, robustness and redundancy? It was concluded that the uniformly distributed system is effective in reducing the peak dynamic magnification factor also slightly more reliable when an individual damper fails. The linearly distributed system is also more reliable when an individual damper fails/ the linearly distributed system is also more robust under mistuning. It was also found that the 11and 21 mass system is optimum for both configurations (uniformly and linearly distributes masses) for harmonic excitation and the EI Centro earthquake simulation respectively.

Yang(2002) Passive energy dissipation devices (EDDs), such as viscous dampers, viscoelastic dampers, etc., have been used to effectively reduce the dynamic response of civil infrastructures, such as buildings and bridges, subject to earthquakes and strong winds. The design of these passive energy dissipation devices (EDDs) involves the determination of the optimal locations and the corresponding capacities. In this paper, we present two optimal design methodologies for passive EDDs based on active control theories, including H_∞ and H_2 performances, respectively. The optimal design methodologies presented are capable of determining the optimal locations and the corresponding capacities of EDDs. Emphasis is placed on the application of linear matrix inequality (LMI) for the effective design of passive EDDs using the popular MATLAB toolboxes. One important advantage of the proposed approaches is that the computation of the structural response is not needed in the design process.

Chen (2003) Studied the performance o f MTMD system and compared the result with the TMD systems numerically as well as through shake table tests on a ¼- scale three-story building structure under the white noise excitation (the scaled 1940 ElCEntro earthquake and the scaled 1952 Taft earthquake). Experimental results showed that the multiple damper systems are better than a single tuned mass damper in reducing the floor accelerations. It was also found that the numerical and experimental results are in good agreement to validate the dynamic properties of the structure.

P.P. Diotallevi1, L. Landi2 and A. Dellavalle (2004) A simplified design method for SDF and MDF systems equipped with non-linear viscous dampers is proposed in this paper. It is known that the response of non-linear viscous dampers is proportional to a fractional power-law of the velocity, whose exponent ranges between 0.1 and 1. The response of these systems is usually investigated by evaluating the supplemental damping ratio due to the non-linear dampers under elastic conditions. The damping ratio of the first mode has been evaluated by using the iterative procedure and the direct procedure described before. the maximum displacements of the top level are shown. They are compared with the ones obtained by using the Fast Non Linear Analysis implemented in SAP2000 NL, where the frames still have an elastic behavior, but they are equipped with non-linear dampers.

Mohan M. Murudi1 (2004) Tuned Mass Damper (TMD) has been found to be most effective for controlling the structural responses for harmonic and wind excitations. In the present paper, the effectiveness of TMD in controlling the seismic response of structures and the influence of various ground motion parameters on the seismic effectiveness of TMD have been investigated. The structure considered is an idealized single-degree-of-freedom (SDOF) structure characterized by its natural period of vibration and damping ratio. Various structures subjected to different actual recorded earthquake ground motions and artificially generated ground motions are considered. It is observed that TMD is effective in controlling earthquake response of lightly damped structures, both for actual recorded and artificially generated earthquake ground motions. The effectiveness of TMD for a given structure depends on the frequency content, bandwidth and duration of strong motion; however the seismic effectiveness of TMD is not affected by the intensity of ground motion.

Wang (2005) Investigated the influence of soil- structures interaction (SSS) Effect on the robustness of multiple tuned mass dampers (MIDI) for vibration control of irregular buildings modeled as torsion ally coupled structures (single building) due ground motions by an efficient model analysis ne. The performance index of MTMD was established based on the foundation – induced building floor motions with and without the installation of MTMD’s It was concluded from numerical verifications that the increase in height – base ratio of and irregular building and the decrease on relative stiffness of soil to 18 structure generally amplify both SSI and MTMD detuning effect, mainly for a building with highly torsion ally coupled effect. Also detuning effect can be reduced with roper increase of the frequency spacing of the optimal MTMDs. Result also showed that if the SSI effect is significant, the MTMD is more effective.

Hoang (2005) Development a new method to design multiple tuned mas dampers (multiple TMDs) to reduce excessive vibration structure using a numerical optimizer that follows the Davidon-Fletcer-Powell Algorithm which can Handle large number of design multiple TMDs for SDOF lumped mass structures subject to wide-Band excitation. It showed that the optimally designed multiple TMDs have distributed natural frequencies and distinct damping ratios at low damping level

Li (2006) Studied the effectiveness of multiple tuned mass dampers (MTMD) with identical stiffness and damping coefficient but different mass to reduce translational and torsional responses for two-degree- of-freedom (2DOF) structure (which represents the dynamic characteristic of a general asymmetric structure) using numerical simulation. The 2DOF structure was a modeled as a 2DOF system of an asymmetric structure with prevalent translational and torsional responses under earthquake excitations using the mode reduced order method. From the tudy it was concluded that MTMD is capable of reducing the torsional response of the torsion ally flexible structures and the translational and torsional responses of the torsion ally stiff structures.

Haskell (2007) the application of VFD devices as part of seismic energy dissipation systems for buildings and bridges has been experimentally and analytically studied. The study included component testing over a range of temperatures, modeling of devices, shake table testing of 1-story building models, 3- story building models and a bridge model, development of alternate testing methods, analytical prediction of response and development of simplified analysis procedures. Experimental results demonstrate a significant improvement of the energy dissipation capability of the structures to which the devices are attached. This resulted in substantial drift reductions and under certain conditions in reduction of inertia forces.

Zuo (2009) Studies the characteristics and optimization of a new type of TMD system, in wich multiple TMDs are connected in series to the main structure. The parameters of spring stiffness and damping coefficients were optimized for mitigation of random and harmonic vibration.

Patil (2010) The seismic Waves cause by an earthquake sway structures like E.S.R. tanks, brides, buildings in various ways depending on the frequency and direction of ground motion and the height of the structure. In order to rescue the sway of structure, It is important to place large dampers into their design to interrupt the frequency. Various parameters like mass ration, damping ration and stiffness of structure are considered. THE objective of research paper is to prove that, the use multiple tuned mass dampers rather than single tuned mass damper (STMD) can reduce the responses of the structure.

Debbarma (2012) the performance of multiple tuned mass dampers to mitigate the seismic vibration of structure considering real time history data is investigated in this paper. The multiple tuned mass dampers (MTMD) are distributed at each story. For Comparatively study, structure. This study is conducted for a fixed mass ratio (5%) and fixed damping Ratio (5%) of structure. Numerical study is performed to evaluate the effectiveness of MTMDs and overall system performed. The displacement acceleration base shear and story drift are obtained for both combined system (Structure with MTMD and structure with STMD) for all earth quakes. The same responses are also obtained for without damper system. From obtained result, the MTMD system is more effective reducing the seismic response of system with compare to STMD system.

Vajreshwari Umachagi et.al (2013) presents study on applications of dampers for vibration control. The review includes different types of dampers like metallic dampers, viscoelastic dampers, frictional dampers etc. it concludes that use of seismic control systems has increased but choosing best damper and installing it into a building is very important for reducing vibration in structures when subjected to seismic loading. The controlling devices reduce damage significantly by increasing the structural safety, serviceability and prevent the building from collapse during the earthquake.

Raheel Kazi, P. V. Muley et.al (2014) this paper presents the comparative analysis on the seismic performance of building structural systems having passive damping devices-viscoelastic damper. Dynamic behavior of the structure for wind and earthquake loading with respect to response spectrum analysis is carried out. Changes in the responses of displacement, velocity, acceleration and drift for the damped structure are demonstrated illustrating the efficiency of dampers. And result carried out for the respective directions of wind and earthquake forces against displacement, drift, velocity and acceleration. When combination of various loading was considered

Alireza Heysami (2014) in these paper investigates types of dampers and their performance during earthquake. And the results show that no only dampers have an acceptable seismic behavior against lateral forces such as wind and earthquake forces. In seismic structures upgrading, one of the lateral force reduction caused by the earthquake is use of dampers. Dampers are classified based on their performance of friction, metal (flowing), viscous, viscoelastic; shape memory alloys (SMA) and mass dampers. Among the advantages of using dampers we can infer to high energy absorbance, easy to install and replace them as well as coordination to other structure members.

Gulshan (2015) the focus of this review paper is on Structural control of two parallel building structure coupled with nonlinear viscous dampers. This Research concluded that nonlinear viscous fluid dampers possess the capacity of reducing peak damper force demand at large structural velocities while still provide sufficient supplemental Damping.

Balakrishna (2016) Passive energy dissipation devices are used in 6 storied Regular building is proposed to be analysed using SAP2000 v14 with viscous damper (VFD), with Tuned Mass Dampers (TMD) and without any damping device. Tuned Mass Dampers with varying mass ratios of 2%, 3% and 5% was applied. Time History Analysis was carried out by applying the Bhuj (2001) intensity of earthquake. Similarly, VFDs with damping exponent values of 0.5 and 0.75 of required stiffness was input to the structure and analysis was done. Non-Linear Time History Analysis (NLTHA) was carried out. A comparative study was done. Finally, recommendations for the future research in the field of applying TMD is on an experimental model using shaking table to validate the results of using TMD in reducing both displacements and shear forces in the high rise buildings. TMDs need to be designed for each earthquake ground motion data mathematical equation for the VFD, so that standard VFDs can be used efficiently to reduce the overall displacement of the building.

Muhemmad (2016) several techniques are available to reduce wind and earthquake induced structural vibration. Shear wall is an already existing technique and commonly used. Passive tuned mass damper (TMD) is widely used to control structural vibration under wind load but its effectiveness to reduce earthquake induced vibration is an emerging technique. Tuned Mass Damper (TMD) is the most effective for controlling the structural responses for harmonic and wind excitations. This paper is to study the comparison of shear wall and TMD for reducing vibration of tall buildings due to wind and earthquake loading by using SAP2000 software. Shear walls and Tuned Mass Dampers are assigned in the structure alternatively.

Rujata S. Meshram (2016) This study alternative TMD, The water tank are provided at the top of the building. An attempt has been made to study the feasibility of utilizing the water tank in the resist seismic force.in these analytical investigation of symmetric and asymmetric, building with the water tank and the without water tank. The building were studying under four conditions, namely without tank, Empty tank, half-filled tank and fully filled tank.

Khemraj S. Deore (2017) This study made to the effectiveness of using TMD for controlling vibration of structure. A practical plan analysis and in which calculate max. Deflection, story drift, Base shear, Natural Frequency and fundamental time period of building. From the study result found that by using TMD the Gradual Decrement in displacement, story drift and fundamental period of structure.

Anil Kumar (2017) The aim of this Research work is analysis the feasibility of implementing water tank as passive TMD and finding the optimum level of the water tank would reduce peak response of the structure subjected to Seismic force. In these study the story drift, Base Shear, Time Period, Story Displacement calculated and result obtained were compared.

V. CONCLUSION

These presented review appears the different energy dissipation device have a great importance in controlling the response of the structure during the earthquake. The TMD helps in deceasing the displacement, drift, base shear and first mode frequency of the structure. But the problem with TMD is required specific design for every structure depending on the mass and the stiffness of structure. And they also required to the proper method to construct weak story above the structure of required stiffness, although the VFD is easily available of different masses and damping and VFD helps in reducing the overall displacement and response on structure.

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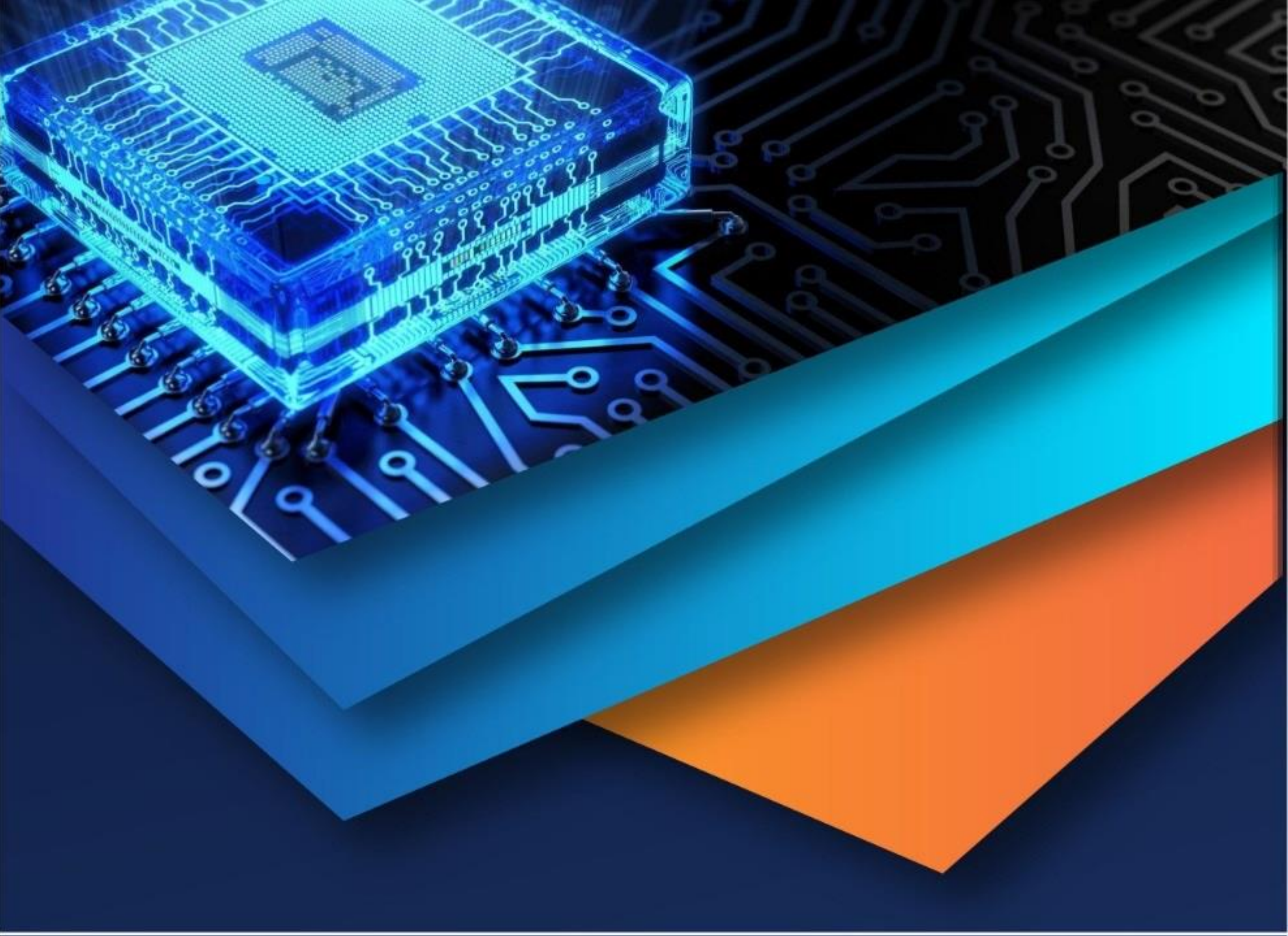

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