International Journal of Scientific Research in Civil Engineering
© 2022 | IJSRCE | Volume 6 | Issue 3 | ISSN : 2456-6667

Analysis of A Tall Structure Considering Two Different Type of Dampers Using Analysis Tool A Review

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Article Info
May-June-2022

Publication Issue :
Volume 6, Issue 3

Page Number : 71-81

Article History
Accepted : 05 May 2022
Published : 20 May 2022

ABSTRACT

Vibrations are one of the major environmental factors that act on buildings and mechanical structures, potentially reducing their lifetime. Current trends in construction industry demand taller and lighter structures with more flexibility, yet they have a quite low damping value. This increases failure possibilities and also create problems from serviceability point of view. Many building structure and bridges fall because of vibration, if frequency of excitation coincide with one of the natural frequency of system. Now-adays several techniques are available to minimize vibrations of a structure. Out of these, concept of using tuned mass damper is a recent trending innovation.

In this paper review of literature is present to examined the present condition of structure

Keywords: Vibration control, Tuned mass damper (TMD), High rise buildings, Structural design, Structural Analysis, Tuned Dampers.

I. INTRODUCTION

Structural passive control systems primarily include energy dissipation devices. Damping is an impact inside or upon an oscillatory framework that has the impact of lessening, limiting or keeping its oscillations. In physical frameworks, damping is created by procedures that separate the intensity put away in the oscillation. Seismic earthquake in the least complex terms can be characterized as Shaking and vibration at the outside of the earth coming about because of underground development along a flat plane. The vibrations created by the tremors are because of seismic waves. Seismic waves are the saddest one. The recent development in the application of passive energy absorption systems for seismic resistance of structure. Multi-storey scale model building structures are tested in shaking table, it subjected to controlled semi-active fluid damper control system. Viscous damper, visco-elastic damper and steel damper are the seismic effect of 8-story RC building seismic energy dissipation device application in China. High capacity friction dampers are installed in tall structures based on rotational friction concept. The frictional dampers are resists the seismic response in single-story structures. Based on complex damper theory to determine the seismic response by viscous damper. Seismic vibration can control to use fluid viscous dampers is desired to control the shock vibration. The mathematically modeling of viscous damper and dynamic analysis. The preservation and application of any structure are in this manner endangered with the expanding rise. According to the standard codes, a structure that can oppose the most elevated shaking that could happen in that specific zone can be called as a quake-safe structure. Be that as it may, the most effective method for planning a trembling safe structure is limit the passing's just as limit the decimation of the usefulness of the basic component. From the past and few present records, the world has encountered a number of destroying seismic earthquakes, causing in the number of increment the loss of individual because of basic crumple and extreme harms to structure.

Types of Seismic Dampers

Damper systems are designed and manufactured to protect structural integrities, control structural damages, and to prevent injuries to the residents by absorbing seismic energy and reducing deformations in the structure. Seismic dampers permit the structure to resist severe input energy and reduce harmful deflections, forces and accelerations to structures and occupants. There are several types of seismic dampers namely viscous damper, friction damper, yielding damper, magnetic damper, and tuned mass damper.

Viscous Dampers

In viscous dampers, seismic energy is absorbed by silicone-based fluid passing between piston-cylinder arrangement. Viscous dampers are used in high-rise buildings in seismic areas. It can operate over an ambient temperature ranging from 40°C to 70°C. Viscous damper reduces the vibrations induced by both strong wind and earthquake.

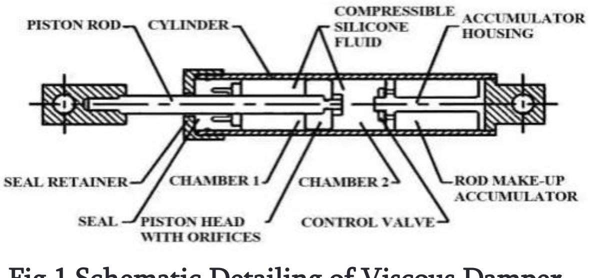

Fig 1 Schematic Detailing of Viscous Damper Components

Viscoelastic Dampers

Another type of damper is viscoelastic dampers that stretch an elastomer in combination with metal parts. This type of damper dissipates the building's mechanical energy by converting it into heat. Several factors such as ambient temperature and the loading frequency affect the performance and consequently the effectiveness of the damper system. Viscoelastic dampers have been successfully incorporated in a number of tall buildings as a viable energy dissipating system to suppress wind-and earthquake-induced motion of building structures.

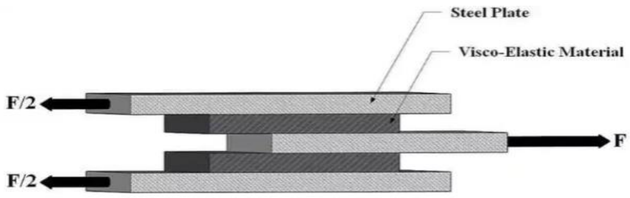

Fig 2 Viscoelastic Damper

Fig 3 Installed Viscoelastic Damper

Friction Dampers

Generally, a friction damper device consists of several steel plates sliding against each other in opposite directions. The steel plates are separated by shims of friction pad material. The damper dissipates energy by means of friction between the surfaces which are rubbing against each other. It is also possible to manufacture surfaces from materials other than steel.

Fig 4 Friction Damper

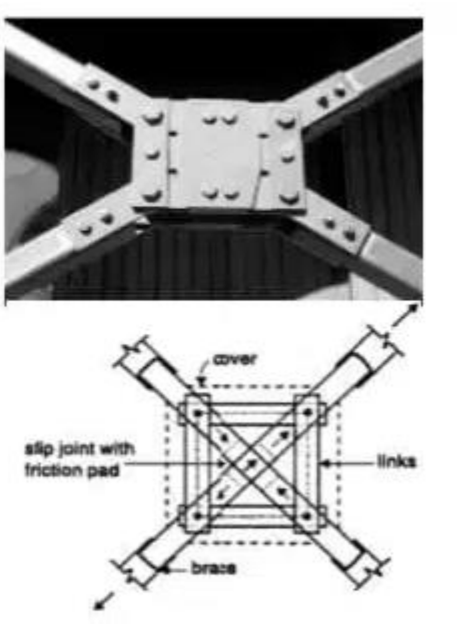

Fig 5 Friction Damper Working Mechanism

Tuned Mass Damper (TMD)

Tuned Mass Damper (TMD), also known as vibration absorbers or vibration dampers, is a passive control device mounted to a specific location in a structure so as to reduce the amplitude of vibration to an acceptable level whenever a strong lateral force such as an earthquake or high winds hit. The application of tuned mass damper can prevent discomfort, damage, or outright structural failure. They are frequently used in power transmission, automobiles and tall buildings.

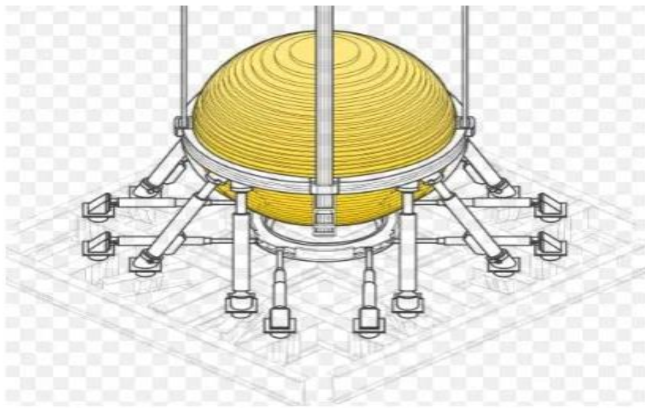

Fig 6 Tuned Mass Damper

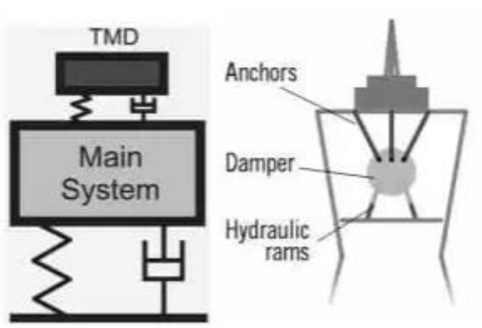

Fig 7 Working Mechanism of Tuned Mass Damper

Yielding Dampers

Yielding damper or metallic yielding energy dissipation device or passive energy dissipation device is manufactured from easily yielded metal or alloy material. It dissipates energy through its plastic deformation (yielding of the metallic device) which converts vibratory energy and consequently declines the damage to the primary structural elements. yielding dampers are economical, effective, and proved to be a good energy dissipator.

Fig 8 Metallic Yielding Damper Installed in Multistory Building

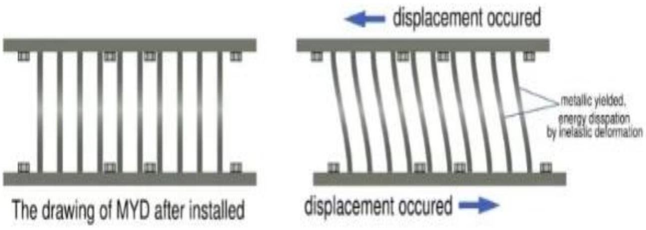

Fig 9 Working Mechanism of Yielding Damper

Magnetic Dampers

Magnetic Damper consists of two racks, two pinions, a copper disk and rare-earth magnets. This type of damper is neither expensive nor dependent on temperature. Magnetic damping is not strength that is why it is effective in dynamic vibration absorbers which require less damping.

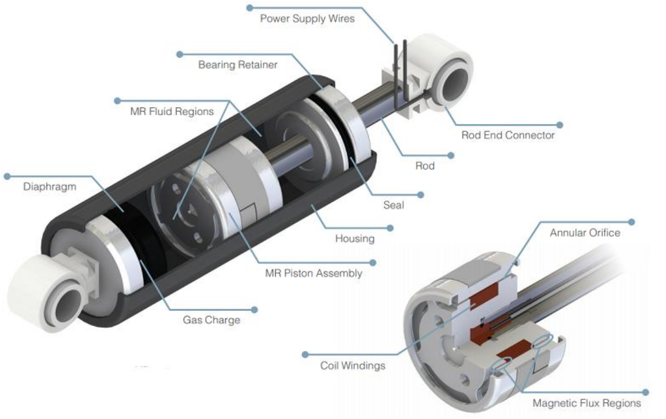

Fig 10 Magnetic Damper

II. LITERATURE REVIEW

Daniel C et al (2019) research paper conducted dynamic analysis for 5 Storey RC Structure with various seismic intensities using analytical application SAP 2000 for the purpose of modelling and analysis. Six ground acceleration for various intensities on MMI Scale to relate seismic response and seismic intensities.

The time history method for static and dynamic values, the scale factor fixed from the various Time histories the base shear obtained has decreased to the percentage of 50 for X-axis and 61.3 for Y-axis. The Roof displacement with VFD in X-axis decreased to a percentage of 50.65 and in Y-axis 51.35. There was a slight difference in the shear value when the damper was attached. When eventually introducing viscous dampers to the building, its behaviour was different under the earthquake force observed from the results.

Sunitha V et al (2019) research paper investigated the effectiveness of different bracing systems on the structural performance of buildings. 10 storied commercial RC building was designed and analyzed under lateral loading. The structural performance of the RC building was investigated using different types of bracing system such as crossed bracing, V-type bracing, and eccentric bracing and a comparative study were done on story displacement, story drift and storey shear.

Results stated that cross diagonally braced structure shows better structural performance among all the structures considered here under similar circumstances, and then compared with X bracing RC building with friction damper. Hence, the conclusion stated that the displacement of RC building with X Bracing and friction damper decreases by 63% compared to RC building with X bracing and story drift is decreased by 70%. Base shear also increases by 20% using building with X bracing and damper.

Yogesha A V and Dr. Jagadish G. Kori (2018) research paper was concerned with the comparative analysis of symmetrical and unsymmetrical building using different dampers like Fluid viscous and Visco-elastic dampers. Using codal provisions IS 1893 (Part I): 2002, the structures are analyzed by Equivalent static and Response spectrum method. The modeling and analysis was done with using software ETAB 2016, results that is seismic parameters such as displacement, storey drifts and storey shear was tabulated and comparative study of structure with and without dampers and combination of Fluid viscous and Visco-elastic dampers was performed.

Using fluid viscous dampers in equivalent static and response spectrum method of analysis the displacement, storey drift and Storey shear reduce 40 to 50 % in the both symmetrical and unsymmetrical building model as compared to building without dampers. Using the combination of two different dampers also reduces Displacement, storey drift and Storey shearup to 35 to 45 % in both symmetrical and unsymmetrical building as compare to building without damper. The performance of fluid viscous, visco-elastic and combination of two different dampers is much better for the tall buildings with slender design. Hence, results concluded that the fluid viscous dampers can be effectively used as one of the better alternatives for the conventional ductility based design methods of earthquake resistant design of structures.

Javed Shaikh and Girish Joshi (2016) research paper described the seismic and wind analysis of an R.C.C high rise structure with added viscoelastic dampers. The primary objective of the research was to perform quasi-static analysis according to response spectrum curves and wind analysis with and without the use of viscoelastic damper where the modeling of viscoelastic damper was done in ETABS software and results were valuated in terms of storey displacement, storey drift, storey acceleration and accessed the variation of placement of dampers affect the seismic response of the building.

Results stated that response of the structure can be greatly reduced by using viscoelastic dampers. Properties of dampers i.e stiffness and damping coefficient are highly sensitive to temperature changes but comparatively less sensitive to frequency change. The best suited position for damper placement is at the point of maximum inter-storey drift than at the point of maximum absolute displacement. The base shear of the structure reduces considerably by using viscoelastic dampers. Instead of providing dampers to all over the structure,one can obtain overall reduction in the displacement of the structure by providing dampers at point of maximum inter-storey drift.

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Jaggari Naveen et al (2018) in the research paper, an unsymmetrical structures of Z Shape and T Shapes of G+20 was analyzed with and without dampers by utilizing ETABS V9.7.4. with the three diverse soil (high, medium and free) quality conditions. The examination was considering Story Drift, Shear drive, Bending minute, Building torsion for between Buildings with and without dampers.

The computational modeling of the damper and structural analysis has indicated a rather efficient damping system and has also indicated its limitations. The device was easy to manufactures and implements its structure and above economical due to easy availability of material and easy replaced. By Response spectrum analysis for the G+20 Building by using dampers the value of Drift is more for the T Shape building than Z Shape building in both X and Y Directions. The value of story shear (Shear force, Bending moment, Building torsion) by Response spectrum analysis for G+5 building by using dampers has higher value for the Z Shape building than the T Shape Building. Seismic performance of building can be improved by providing energy dissipating device (damper), which absorb input energy during earthquake. After application of damper is much better when we provide same number of damper to bottom 5 stories. Frame is safer when damper is provided up to floor from base as compare with other arrangement. Due to drift reduction one can make the structure cost effective. Hence, results concluded that the buildings with friction dampers are more vulnerable compared to other buildings.

K. Sudheer kumar and Y.Vinod (2019) research paper dealt with the performance evaluation of various type of passive control devices for the selected RC frame structure. Time history analysis was carried out on a G+9 story RC framed structure with and without dampers by using sap 2000. Comparative study of various type of dampers was done on parameters like storey shear, storey drift, and absolute displacement. The design parameters have been designed as per IS 1893-2016 (part-1) Criteria for earthquake resistant design of structures in Zone III.

Result of the analysis revealed that maximum absolute displacement, storey shear, storey drift values are more in case of RC framed structure without damper as compared to RC framed structure with dampers.

S Shivarani and Dr V B Reddy Sudha (2021) in the research paper, RCC constructions of 10m, 20m, and 30m storeys was investigated. The buildings have a rectangular form and are 20x45 m2 in size, with a seismic zone of V. E-Tabs software was used to analyse structures. For modelling of RC framed structures, the loading calculations were done according to code regulations, namely IS:1893- 2002, IS:875(Part-III)-1987, and IS:456-2000. With and without dampers, the parameters of base shear, storey drifts, storey forces, and storey stiffness was further investigated. The primary objective of the research was to analyze the seismic behaviour of G+10, G+20, and G+30 earthquakes and compare the characteristics on structures without and with dampers in terms of displacement, storey drift, base responses, and storey stiffness with aim to reduce the response of the structure effectively using Fluid viscous dampers and providing it as most efficient in the stability of the structure.

Results stated that the installation of dampers, maximum storey displacements were reduced by up to 44%. With increasing height, storey displacement rises. By installing dampers, maximum storey drift has been reduced by up to 50%. With increasing height, storey drift rises. The use of dampers increased Storey stiffness by up to 13%. With increased height, overall stiffness diminishes.

Abdul Bari Sayyed et al (2020) the objective of the reserach paper was to design spring-mass vibration systems, measure the vibrations of that system and reduce the vibrations by applying the concept of Tuned mass damper. The report proposed a comparative analysis of passive vibration control system with un-damped system, on single degree of freedom structural frames subjected to external excitation. A combined unit of an accelerometer and an Arduino Uno R2 aided in measurement of vibrations and processes it in the form of acceleration vs. time graph.

The vibrations of a single degree of freedom system can be damped by converting it into two degree of freedom system and by comparison of the graphs between damped and undamped condition, it was concluded that when damper is attached to the primary system, the amplitude of vibration get reduced.

Rincy M. A and Shwetha Saju (2016) in the research paper, comparative analysis of structures with fixed base, structure with damper and structure with isolator was presented. Storey displacement, storey acceleration, modal time period, storey drift and performance point were analysed with the help of SAP 2000 V15.

Results stated that structures with isolators and damping devices perform good during seismic loading. In base-isolated structure storey drift and storey displacement are reduced at greater extent. The performance point of both base isolated structure and structure with is increased as compared to fixed base structure. In structure with viscous damper, storey drift, storey acceleration and storey displacement are reduced. Viscous damper have better control effect on displacement. Overall there was a significant reduction in values of storey displacement, storey drift, storey acceleration. Analytical results stated that the fundamental period was approximately doubled in the isolated structure.

Ubair Gul Khan and Mirza Aamir Baig (2020) research paper presented an outline of cutting-edge measures to lessen basic reaction of tall structures, including a conversation of assistant damping gadgets for moderating the seismic tremor and wind-initiated movement of structures. Latent tuned mass damper (TMD) is broadly used to control auxiliary vibration under wind load yet its viability to lessen tremor-initiated vibration is a developing procedure. An investigative examination was proposed to contemplate the adequacy of TMD to decrease auxiliary vibration in Tall Buildings. For this examination, a 60m tall structure having 15 stories with a square arrangement of 20x20m was proposed and the viability of single TMD to lessen basic vibrations, was analyzed for a variety of TMD mass proportion. Four numbers of identical models were created, first model is the base model (uncontrolled) and the remaining three models (controlled) have TMDs with mass ratios of 0.01, 0.02 and 0.04.

Results stated that the acceleration of the building in the fundamental mode is reduced by 17.67%, 23.72% and 28.83% for the mass ratios of 0.01, 0.02 and 0.04 respectively. The effective damping of the building in the fundamental mode is increased to 8.01%, 9.27% and 11.09% for the mass ratios of 0.01, 0.02 and 0.04 respectively. The maximum storey displacement of the building is reduced by 19.8%, 25.1% and 29.1% for the mass ratios of 0.01, 0.02 and 0.04 respectively. The effective damping of the building increases and the dynamic response of the building reduces as the mass ratio of the TMD is increased. The TMD becomes robust with increasing mass ratio. Hence an optimal mass ratio of the TMD can be found to reduce the building responses substantially there by giving a desired level of human comfort, safety and economy to the structure.

III. CONCLUSION

In literature review following outcomes has been observed:

1. It has been observed that authors in past analyzed structures using different analysis tool for different lateral load resisting members

2. In past researches authors generally adopted linear method
3. In past researchers studied the variation in terms of forces and moment.

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Cite this article as :

Jitesh Khatri, Dherendra Tiwari, Rakeh Patel, "Analysis of A Tall Structure Considering Two Different Type of Dampers Using Analysis Tool A Review ", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 6 Issue 3, pp. 72-82, May-June 2022.
URL : https://ijsrce.com/IJSRCE22639