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Study on Tuned Mass Damper Use in High-Rise Building

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Abstract: Current styles in the construction industry demand tall and light buildings, which are also flexible and low-cost. This increases the chances of failure and problems from the point of view of usability. Many modern methods are available to reduce structural vibration, with many vibration control strategies, the idea of using the new TMD. This study was conducted to study the efficacy of using TMD in controlling structural movement. Initially a numerical algorithm was developed to investigate the response of a shear structure containing TMD. Next another numerical algorithm was developed to investigate the response of an independent 2D model programmed with TMD. Three slow loading methods used. The first was a sinusoidal upload, the second was in line with the corresponding timeline according to IS-1894 (Part -1): 2002 with 5% erosion (PGA = 1g) and the third was 1940 El Centro Earthquake Record (PGA) = 0.313g). From research it has been found that TMD can be used effectively to control building vibrations. TMD worked best when the softness of the structure was low. Gradually increase the magnitude of the effects of TMD on the gradual decline in the response to structural migration.
Keywords: Harmonic absorber, viscous damper, crankshaft torsional damper, kinetic energy,

I. INTRODUCTION

A tuned mass damper, also known as a harmonic absorber, is a device mounted structures to reduce the amplitude of mechanical vibrations. Their application can prevent discomfort, damage, or outright structural failure. They are frequently used in power transmission automobiles, and buildings. TMD consists of a lightweight, spring, and viscous damper, or pendulum mass and viscous damper, attached to a large structure. The formal geometry of TMD as shown in the figure. Another alternative to the standard rendering weight is the cable-backed size, where the set length determines the auxiliary working length; this is known as the pendulum tuned mass damper (PTMD). Properly designed, that is, when the auxiliary parameters are properly selected, TMD is effective in reducing structural response and improving internal compliance. In addition to its widespread use, standard TMD designs have several major drawbacks. Specifically the effectiveness of any idle TMD depends on the frequency of the selected structural mode (e.g. Clark 1988, Chang et al. 2010, and Setareh 2002). This frequency is usually achieved using one of two methods (Roffel et al. 2011). The first is to show the structure of the structure. The precise size and durability of a building can be measured by its construction drawings and the harmonic modes of building structure are improved. This approach is called prediction (Roffel et al. 2011). However, the major drawback is that the model only provides structural response limitations, and differences in structural and actual (as constructed) structural properties can significantly reduce the performance of TMDs (Roffel et al. 2011).

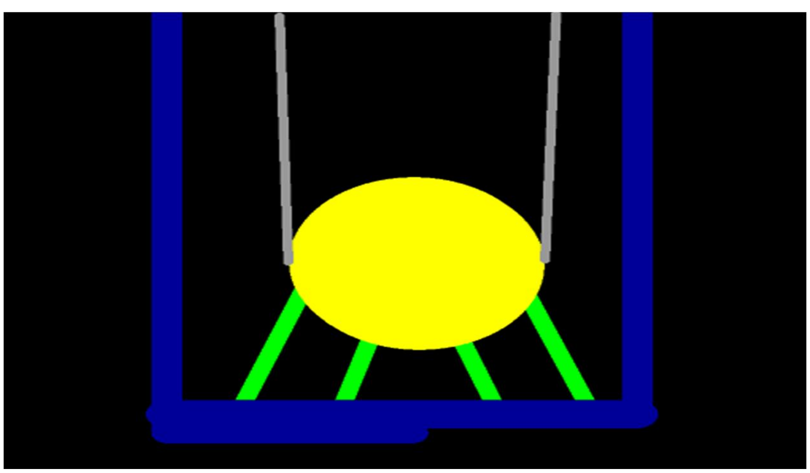

Fig . An animation showing the movement of a skyscraper versus the mass damper shown in green are the hydraulic cylinders used to damp the motion of the skyscraper.

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II. CONTENT

The tuned weight tuner is stable against violent movements caused by harmonic vibrations. The adjusted damper reduces the vibration of the system by half the relative weight so that the larger vibrations are less powerful. In other words, the operating system is being sought to remove the major mode away from the annoying frequency of stress, or to add a heavy or expensive weight pull to relieve it directly.

A final example is the crankshaft torsional damper. Mass damper is often used with a frictional or hydraulic component that converts kinetic mechanical energy into heat, such as a shock absorber.

The tuned mass damper system is a building control tool that is used to reduce the height of vibration and mechanical engineering in buildings and equipment systems. Their use in buildings is primarily to prevent discomfort to the occupants of the building and, in some cases, to increase the life of fatigue (Kareem et al. 2007). There are many different types of TMD programs. The simplest topology is the idle TMD containing a weight, spring, and a dividing power device such as a damper (Conner 2003). When the TMD is immersed near the mode of interest formation, the TMD will re-emerge outside the phase and structure, and the vibrating force that will emerge will be removed by the damper in the environment as heat. Selection of the TMD system parameters to match the frequency of the damper and the natural frequency of the connecting structure is the ‘tuning’ function of the TMD system. Therefore, by properly adjusting the TMD to the basic entertainment modes of the attached structure, TMD to the basic recreational modes of the attached structure, the TMD damper will emit a large amount of vibration of the structure.

Frahm in 1909 uses the concept of TMD to reduce the movement of ships and vessels. Further the concept of TMD was represented on paper by Ormondroyd and Den Hartog (1928), and a detailed discussion of good order and parameter reduction by Den Hartog on the book vibration book (1940). The first concept was to work on the wireless SDOF system aimed at reducing sinusoidal power. By many researchers Counseling in SDOF fluid systems has been investigated. Active control devices operate with an external power supply. Therefore, this works better than idle control devices.

There is a problem like the demand for excess power and sufficient control forces experienced by current technologies in the context of building control against inevitable earthquakes and need to be overcome. A new form of control such as slower control devices, which is a combination of idle and active control

All vibrating structures weaken due to internal stress, brushing, cracking, plastic defects, and so on; when the maximum dissipation force becomes smaller the vibration amplitudes. Some buildings have a very small 1% order removal of critical suspension and as a result experience significant vibration amplitudes and even moderately strong earthquakes. Energy efficiency distribution methods are very effective in lowering vibration amplitudes. Many different methods have been used to increase water removal and many more have been suggested.

Passive waste disposal systems use many building materials and metals to increase flexibility, durability and strength, and can be used to reduce environmental hazards and rehabilitate old or damaged buildings. In recent years, efforts have been made to improve the concept of power distribution or to add additional technologies to operating technology and many of these resources have been incorporated into international frameworks (Soong and Constantinou 1994) and (Soong and Dargush 1997).

In general, they are characterized by the ability to increase the power distribution in the building systems in which they are installed. This can be achieved by converting kinetic energy to heat, or by transferring energy between vibration modes. The first method involves devices that work on terms such as conflicting slides, metal delivery, and phase conversion to metals, conversion of viscoelastic solids or liquids, and liquid pre-installation. The latest method incorporates additional oscillators, which act as powerful vibration vibrators.

III. TYPES OF PASSIVE CONTROL DEVICES

A. *Metallic Yield Dampers*

For the dissipation of energy the metallic yield damper is to be used the input in structure from an earthquake is through inelastic deformation of metals. It is use in structure to absorb a large portion of the seismic energy with the conceptual and experimental work of Kelly et al. (1972) and Skinner et al. (1975).

Various of devices considered included, flexural beams, torsional and V-strip energy dissipaters. These devices use mild steel plates with triangular or hourglass shapes so that yielding is spread almost uniformly throughout the material. X-shaped plate damper and stiffness (ADAS) device is shown in figure.

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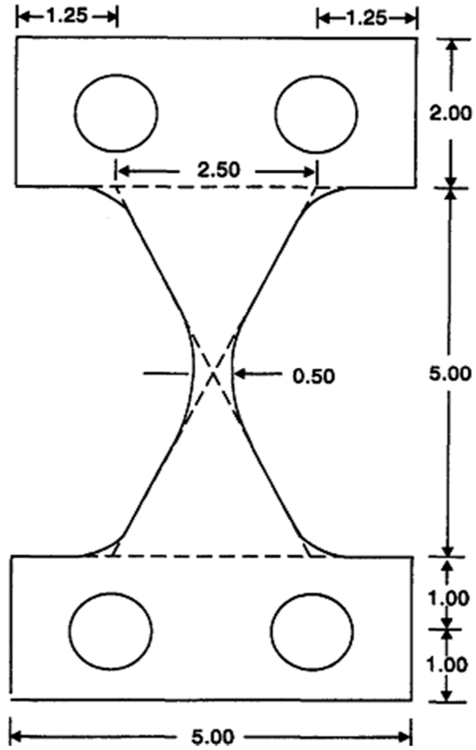

Figure . X-shaped ADAS device

B. Friction Dampers

Friction provides an excellent method of power dissipation, and has been used for many years on car brakes to extract kinetic energy for movement. In order to improve the lubricants, it is important to reduce the incidence of slipperiness to avoid introducing high frequency stimuli. In addition, compatible materials should be used to maintain a consistent conflict of impact with the intended life of the device. For the friction principle the pall device damper is utilize, which can be installed in a structure in an X-braced frame as illustrated in the figure (Palland Marsh 1982).

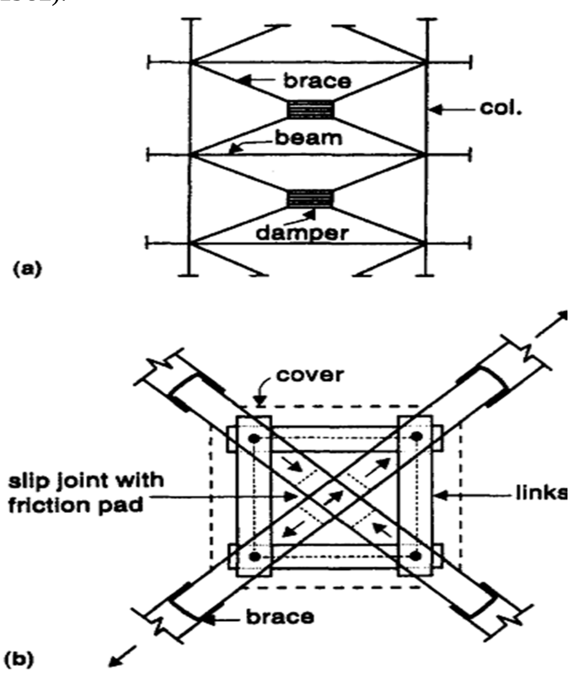

Fig . Pall Friction Damper

C. Viscoelastic Dampers

It is very helpful to get input on the use of air conditioning and earthquakes. While the metallic and contrasting metals described are intended for the use of heat exchanger. The use of viscoelastic damper began in engineering buildings in 1969 when about 10,000 were installed in all two towers of the World Trade Center in New York to reduce wind-induced vibrations. On the basis of further studies the robust performance of viscoelastic dampers has been made, and the results show that due to the wide range of seismic strength levels they indicate that they can also be used effectively to reduce structural reaction. The viscoelastic materials used in the construction of civil engineering are common materials with glass or copolymers. The standard viscoelastic mold, manufactured by 3M Company Inc., is shown in figure. It consists of viscoelastic layers composed of steel plates.

D. Tuned Mass Dampers

The concept of tuned mass damper (TMD) dates back to 1940 by Den Hartog (mechanical vibration). It is similar to a second spring with a well-marked spring and a bit of damping, providing frequency depending on the hysteresis which increases the dump in the original structure. More recently, numbers and tests have been performed on TMD performance to reduce seismic response to structures (for example, Villa Verde (1994)). The effectiveness of such a program in reducing air pollution and vibration of the building.

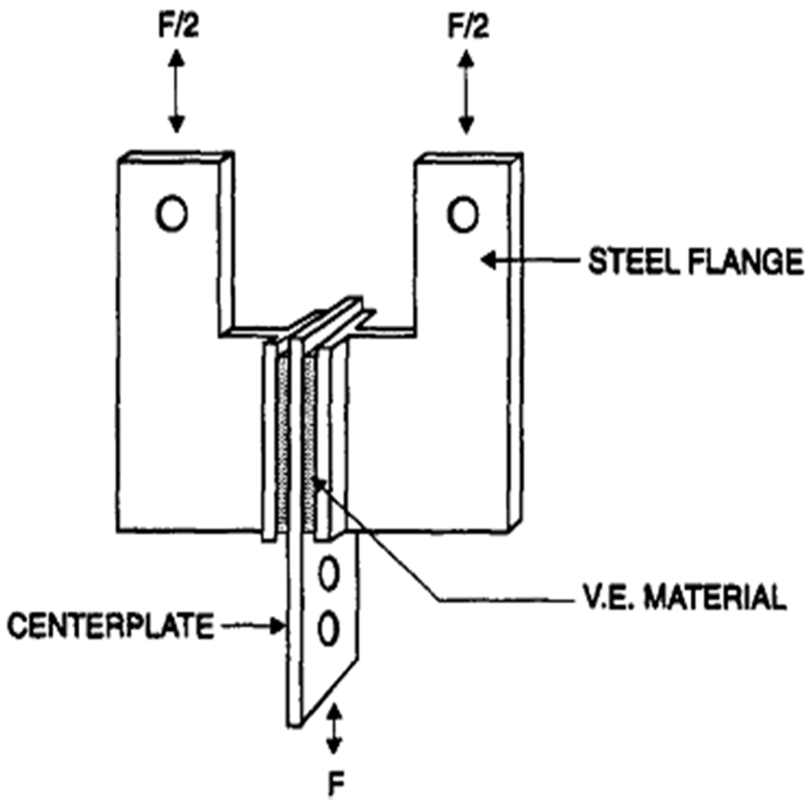

Fig . Viscoelastic damper

IV. CLASSIFICATION OF CONTROL METHODS

A. Active Control

In an active control system an external power source will be used to control the actuators to power the building in the prescribed manner. These types of energy can be used to add and distribute energy to a building. In an active response control system, the signals sent to the control actuators are the function of the response system of the sensory system (optical, mechanical, electrical, chemical, etc.).

B. Passive Control

This system does not require an external power source. This devices impart forces that are developed in response to the motion of the structure. Total energy (Structure plus passive device) cannot increase, hence inherently stable.

C. Hybrid Control

It can implies the combined use of active and passive control systems**.** For an example, near the top of the structure a structure equipped with distributed viscoelastic damping supplemented with an active mass damper, or a base isolated structure with actuators actively controlled to enhance performance.

D. Semi-active Control

It is a type of control system that works. The Semi control device requires less external power than an active control device. Inactive control devices do not add operating power to the system system (including the building and control actuators), so there is a fixed stability limit for guaranteed output. Invisible control devices are often viewed as uncontrollable control devices.

E. Practical Implementations

Large number of TMD implants in a high-rise building around the world. The first building at the Center point Tower in Sydney, Australia, where TMD was installed. Behind the two buildings in the United States with TMDs one is the Citicorp Center in New York City and the other is the John Hancock Tower in Boston. The height of the Citicorp Center is 279m and there is a basic time of 6.5s with a natural gravity of 1% next to each axis. The TMD located at 63 sites in the building weighs 366Mg, about 2% of the active weight of the first mode, and was 250 times larger than any sample that was present at the time of installation. The model is designed to be bi-axially resonant in the period structure with a flexible operating time, with the use of the flexible line from 8 to 14%, and the relative motion, the damper is expected to reduce the height of the structure by 50%.

F. Condition Assessment of an in-service TMD

A small work has been published in the full-scale performance appraisal service on the TMD service. Failure to accurately calculate the performance improvement of the same historical period of interest is a natural deficit in the full scale measurement study of TMD-constructed structures. And it is unlikely that estimates will be available in the event of a TMD movement design event, as collecting this data could bring residents comfort and potential damage to the building. The full functionality of TMDs is allowed for long periods of time and for all various events. Therefore, much of the work in the study of the ability of TMDs to reduce air-induced vibrations has been on numerical models that enjoy harmonic input or white noise. The study using air attraction which has been limited and has shown air modeling in the ways listed above often exceeds their effectiveness. Therefore, there is a need to accurately compare the response of a TMD-constructed structure to the same design event .A few studies have equipped airway models with TMD and tested their effectiveness [88, 104], but there are scale issues associated with it that way.

V. CONCLUSION

In current time of construction field demand for higher and light structures, which are having quite low damping value and also more flexible. Due this the possibilities of failure increases and also problem in serviceability point of view. Now manier techniques are today to minimize the effect like as vibration of structure. The concept of TMD is generate to minimize these effect. On this we study about TMD concept how to be control vibration of structure. A numerical algorithm was develop to model the multistory MDOF building frame structure as shear building with a TMD. There is three loading condition are applied at base of the structure. The loads are (i) sinusoidal loading and (ii) corresponding to compatible time history as per spectra of IS-1894(Part -1):2002 for 5% damping at rocky soil and (iii) 1940 El Centro Earthquake record (PGA = 0.313g).

The following conclusion can be made from this study:

1) TMD can be used to successfully control the effect of vibration of the structure.
2) TMD is more effective for the structure in reducing the displacement response with low damping ratio (2%). But, it less effective for structures displacement response with high damping ratio (5%).
3) Two earthquake loading are applied, (i) corresponding to compatible time history as per spectra of IS-1894(Part -1):2002 for 5% damping at rocky soil and (ii) the 1940 El Centro Earthquake it has been found that increasing the mass ratio of the TMD decreases the displacement response of the structure.

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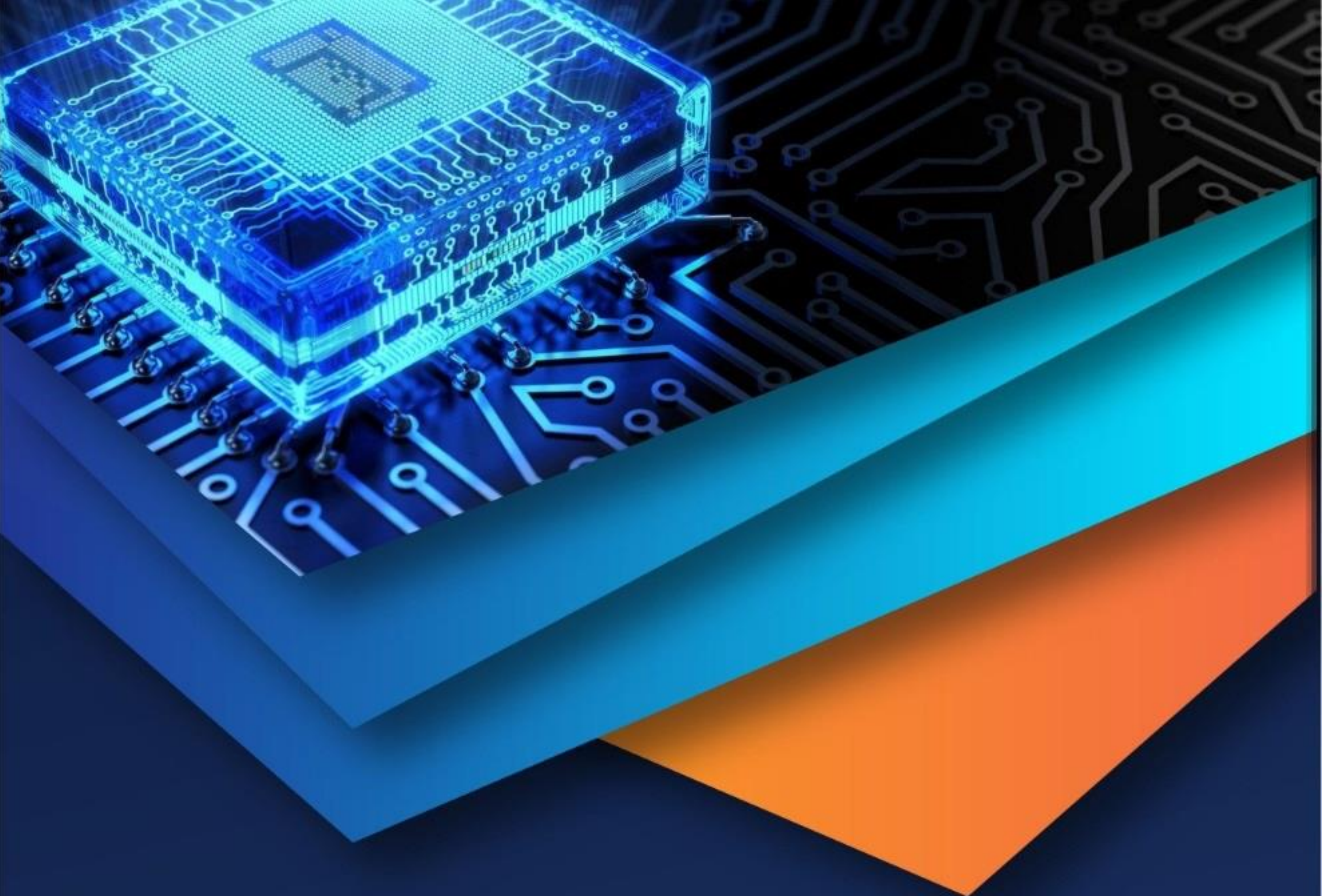

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