

# Mitigation of Seismic Response of Multistoried RCC Building Using Passive Tuned Mass Damper

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**ABSTRACT:** The issue of mitigating the response of structures due to seismic loads has drawn the interest of many researchers in recent years. The concept of structural control is now widely accepted and has been frequently applied in construction. Among the numerous passive control methods available, the tuned mass damper (TMD) is one of the simplest and most reliable. It is applicable not only in new constructions, but also in existing ones. Due to its simplicity and reliability, the device is also used to suppress undesirable high vibration levels in machinery. The mechanism involved in mitigating the vibration consists in the transfer of the vibration energy to the TMD, which dissipates it by damping. A widespread application of TMDs is found in high-rise buildings in order to reduce the oscillating effect of seismic loads.

A high-performance design can be efficiently obtained by controlling the vibration level through the adoption of an enhanced TMD strategy. In order to increase the efficiency of a TMD, it is necessary to define its optimum mechanical parameters (tuning frequency, damping ratio and mass ratio). Many researchers have investigated the characteristics of tuned mass damper systems and several design formulae have been proposed to optimize parameters at different levels of oscillation.

In the present work, study the performance of tuned mass damper system in multi-storeyed RCC building. Two models of building G+10 storey and G+8 storey are considered. Nonlinear time history analysis carried out using El Centro earthquake record. Building is analysing with and without TMD for different mass ratio varying from 0.01 to 0.05. Compared different parameter such as displacement, drift, max bending moment, max base shear for building with and without TMD.

**KEYWORDS:** Affiliation, character, format, modeling, solar, zeal (Not more than seven keywords reflecting the contents of the manuscript. Arrange key words in alphabetical order, separated by commas).

## I. INTRODUCTION

With the rapid economic development and advanced technology, civil structures such as high-rise buildings, towers and long span bridges are designed with an additional flexibility, which lead to an increase in their susceptibility to external excitation. Therefore, these flexible structures are susceptible to be exposed to excessive levels of vibration under the actions of a strong wind or earthquake. To protect such civil structures from significant damage, the response reduction of civil structures during dynamic loads such as severe earthquakes and strong winds has become an important topic in structural engineering. An earthquake is a natural phenomenon associated with violent shaking of the ground. They are vibrations of the earth's surface caused by sudden movements of earth crust mostly due to tectonic movements. Since earthquake forces are random in nature and unpredictable, the engineering tools needs to be sharpened for analyzing structures under the action of these forces. Earthquake loads are to be carefully modelled so as to assess the real behavior of structure with a clear understanding that damage is expected but it should be regulated. A different storey building such as 10th, 12th, 14th, 16th, 18th, and 21th storey building is selected which is subjected to

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dynamic loading earthquake. Under the increasing urban population density, scarcity of land and housing shortfalls, there is necessity of high-rise buildings.

### II. LITERATURE REVIEW

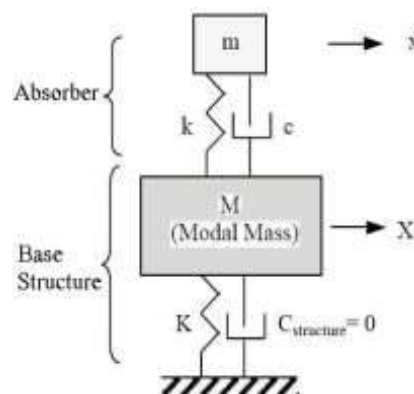
- Zahrai and Ghannadi [1] presented the effectiveness of Tuned Mass Dampers (TMDs) in controlling building structures under earthquake.
  - It was observed that TMD effective in reducing maximum displacement in MRF buildings by as much as 32.2% in the Tabas earthquake an 45.3% in the El Centro earthquake.
  - The maximum displacement results of a respon Sespectrum analysis for the uncontrolled and controlled case in the El Centro earthquake, in an 8-story structure, were 25.70cm and 14.59cm.

#### 2. Mane And Murudi

- Mane and Murudi presented 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.
- 3. Roofoei and Shamsi
  - In this study the procedure suggested considers amplification of static eccentricity as well as accidental eccentricity. The proposed approach is applicable to orthogonal as well as no orthogonal unsymmetrical buildings and accounts for all possible dentitions of center of rigidity.

### III. MATERIALS AND METHODS

**Tuned Mass Damper:-** A tuned mass damper (TMD) is a device consisting of a mass, a spring, and a damper that is attached to a structure in order to reduce the dynamic response of the structure. The frequency of the damper is tuned to a particular structural frequency so that frequency is excited, the damper will resonate out of phase with the structural motion. Energy is dissipated by the damper inertia force acting on the structure. The Tuned Mass Damper (TMD) concept was first applied by Frahm in 1909 (Frahm, 1909) to reduce the rolling motion of ships as well as ship hull vibrations. A theory for the TMD was presented later in the paper by Ormondroyd and Den Hartog (1928), followed by a detailed discussion of optimal tuning and damping parameters in Den Hartog's book on mechanical vibrations (1940). The natural frequency of the TMD is tuned in resonance with the fundamental mode of the primary structure, so that a large amount of the structural vibrating energy is transferred to the TMD and then dissipated by the damping as the primary structure is subjected to external disturbances. Consequently, the safety and habitability of the structure are greatly enhanced. From the field vibration measurements, it has been proved that a TMD is an effective and feasible system to use in structural vibration control against high earthquake loads, as shown in Figure



A schematic representation of damped vibration absorber suggested by Den Hartog

#### IV. RESULTS AND DISCUSSION

##### 4.1 Storey Displacement

Figure 4.1 shows the maximum displacement time histories of structures with and without TMD under the Bhuj earthquake. It demonstrates that the maximum displacement of the top storey without TMD is 35.4 mm and that of with TMD is 21.9 mm in an 10<sup>th</sup> storey structure. In comparison with an 10<sup>th</sup> storey structure, in a 12<sup>th</sup> storey structure, the maximum displacement of the top storey without TMD is 42.9 mm and that of with TMD is 27.3 mm. Whereas, in a 21 storey structure the maximum displacement of the top storey without TMD 76.8 mm and that of with TMD is 53.4 mm. Also the Top storey displacement values with and without TMD as well as the top stories displacement reductions were obtained after analysis.

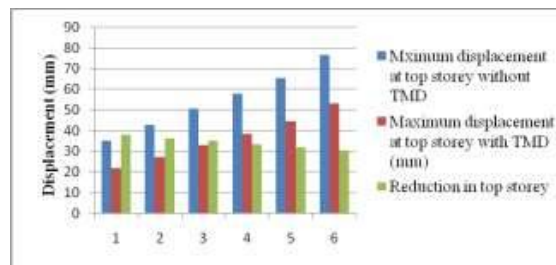


Fig. 4.1: Maximum storey displacement reduction with TMD structure.

#### V. CONCLUSION

The seismic behaviour of 10<sup>th</sup>, 12<sup>th</sup>, 14<sup>th</sup>, 16<sup>th</sup>, 18<sup>th</sup>, and 21<sup>st</sup> storey building with tuned mass damper and without tuned mass damper was investigated. TMD is effective in reducing displacement and acceleration and, thereby, can be used for structures under earthquake. This study is aimed as tuned mass dampers in reducing structural (storey drift, storey displacement and base shear) of seismically excited 10<sup>th</sup>, 18<sup>th</sup>, and 21<sup>th</sup> storey building.

1. It has been found that the TMDs can be successfully used to control vibration of the structure.

2. For the regular building frame, 5% TMD is found to effectively reduce top storey displacement. The reduction of 10<sup>th</sup> storey building is 38.13, reduction of 12<sup>th</sup> top storey building is 36.36, reduction of 14<sup>th</sup> top storey building is 35.16, reduction of 16<sup>th</sup>, 12<sup>th</sup> top storey building is 33.34, reduction of 18<sup>th</sup> top storey building is 31.96, and reduction of 21<sup>st</sup> top storey building is 30.46. And base shear by about 2%.

3. Therefore, the TMD should be placed at top floor for best control of the first mode.

4. For the regular building, TMD with damping exponent (n) value 0.2 is found to be better than TMD with damping exponent value 0.5.

5. From analysis it can be seen that it is necessary to properly implement and construct a damper in any high rise building situated in earthquake prone areas.

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