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Combined Strategy of Building Vibration Control by using Tuned Mass Damper and Base Isolator

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Abstract: ***Horizontal loading as a result of an earthquake is a dominant aspect which causes damage to the structure. The volume of damage is high in case of high-rise buildings. Many techniques are developed in recent years for resisting the structure from damage due to the earthquake. This present study deals with Base Isolation technique and Tuned Mass Damper for finding the inter-storey drift of a high-rise building. Base Isolation technique is used for partially absorbing the seismic energy. This Base Isolation technique can be used for new structures. Tuned Mass Damper is one the techniques for reducing the seismic effect on structures as it reduces the displacement causing from seismic energy. This research work deals with the performance evaluation of base-isolated structure along with Tuned Mass Damper using SAP2000.***

Index Terms: ***Acceleration, Base Isolators, Lateral displacement, Storey drift, Tuned Mass Damper.***

I. INTRODUCTION

Many buildings are affected by the seismic forces, so we need to control those seismic forces in some strategic techniques. The effective strategic techniques are BASE ISOLATION (BI) and TUNED MASS DAMPER (TMD). Nowadays the BI technique is commonly used in buildings by the affected earthquake-prone areas. The BI is a one of the techniques of an isolation system is rubber isolator. The rubber isolator acts as flexibility in the base of the structure and can absorb the bulk of the displacement of a given earthquake and it can extremely lower the fundamental frequency of the system. The TMD is also one of the techniques to control the vibrations of a building. Normally the TMD is placed on an upper floor and to absorb the given acceleration of an isolation system. The comparative system of a building vibration control for TMD and BI. In this paper deals with modeling and control of the building structure and also deals with the different types of techniques are overviewed, and then which technique is better to control the vibration of buildings [1].

The three types of mass dampers are TMD, Tuned Liquid Column Damper (TLCD), Liquid Column Vibration Absorber (LCVA); these three dampers the one of the dampers is used in this paper i.e. TMD [2]. In this paper the TMD to reduce the displacement on the base-isolated structure, the isolation is in a base of the structure and above superstructure is to fit a TMD. Mainly the isolation system to reduce the acceleration and to release the displacement, this displacement can be reduced by the TMD of a building [3]. In this paper BI and TMD combining both properties to control the vibration in buildings and also to mobilize the inter-storey drift of a building. In order to the seismic response of the isolation layer in reducing the effectiveness of the strategy [4].

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II. METHODOLOGY

A. Tuned Mass Damper

It is also known as a seismic damper or harmonic absorber. The mechanical vibrations of magnitude are mounted to minimize in structures. Their function involves prevention of discomfort, damage or outright structural failure. They are most commonly used in power transmission, automobiles, and buildings. The TMD is installed in the top of the building and can reduce the displacement of the building. Fig. 1 indicates the Tuned Mass Damper.

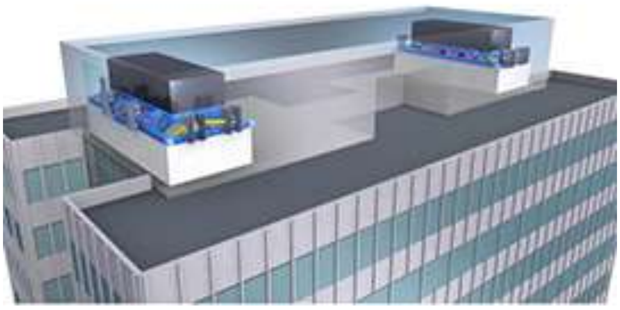

Fig. 1: Tuned Mass Damper

B. Base Isolation

It is defined as the separation between the superstructure and substructure of the buildings. It is also known as base isolation system. The base isolation system is to protect the structure against earthquake forces. The BI system is a passive vibration control of the structure. The BI of an element is to minimize the acceleration of a given earthquake force. The one of base isolation bearing is used in this paper i.e., rubber isolator.

***Rubber Isolator*:** It is one of the base isolated bearing and can act as flexibility of the base structure and ability to move but return to its original position. Fig. 2 indicates the rubber isolator.

C. Time History Analysis

An adequate time history resolve allows response of a structure up time during and after the function a load. The analysis in the prior zone occupied a static white-noise mechanism as a model for the ground acceleration. This is suitable since for this model the performance of TMD can be estimated with the least number of structure criterion and without concern any criterion that describe the input excitation. It is fundamental that the energy input into the structure be continuous so that there is the relocation of energy from the structure (the BI structure) into the secondary structure, the TMD. Fig. 3 indicates the plan of the structure.

Fig. 2: Rubber Isolator

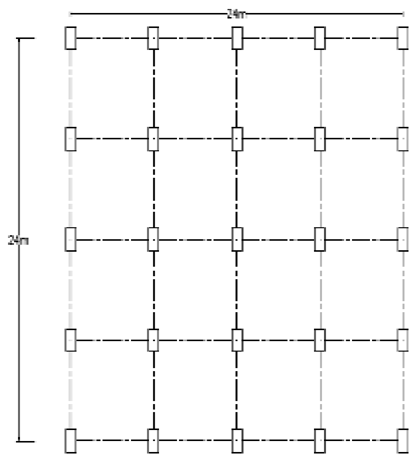

Fig. 3: Plan of the Structure

D. Seismic Linear Response For Tmd And Bi System Of Effectiveness

The effectiveness of control strategy to check with TMD’s is carried out for BI benchmark structures in numerical experimentation of dynamic linear response. The set of seven bi-directional recorded seismic inputs to describe the effect of control system and to study the special dynamic behavior of structure. The use of TMD's on BI is very effective in reducing seismic response i.e., isolated peak displacement control.

E. Building Structures Of Linear Control

***PID Control*:** In mainly the systems with one or two degrees of freedom (DOF) has been widely conducted for practical applications of the proportional-integral-derivative (PID). In multi-degree of freedom (MDOF) flexible structures which make them unsuitable for the application of vibration control and for the multivariable systems, its control algorithm becomes more complex. A simple proportional controller of a simulation is carried out for an ability to overcome the building displacement for wind excitation of a strong earthquake is found to be ineffective excitation.

H_α Control: In structural vibration control the H_α technique is of the widely used linear robust control scheme. The parametric variations and disturbances with respect to this technique are insensitive of makes a suitable for the MIMO type structural control systems.

Optimal Control: The minimization of a quadratic performance index termed as cost functions are based on optimal control algorithms while minimizing the control effort and maintaining the desired system state. The linear quadratic regulator is the most basic and commonly used optimal controller. The cost function that is to be minimized as for structural control application, the acceptable range of structure displacement and acceleration are to be considered.

F. Base Random Vibration Of Stationary To Subject Linear Elastic Tmd System

The civil and mechanical structures to enforced it has been generally is mostly preferred of passive structural control perception. The control devices of a structure are a one of the most reliable and simplest passive device of a TMD. The immense accuracy or safety and integrity due to its is mainly the inadmissible vibration overcome for a passive control device inefficient operation are mostly used as poised of mass, a spring and a damper. In high rise buildings and structures its mainly to deplete the energy over the damping of the TMD and vibration energy of the structure to the TMD is to relocation the inadmissible vibration of a structure of constricting mechanism. The proposed TMD would be used to minimize wind, earthquake or wave-indeed vibration.

G. Building Structures In Control

The lateral virtue of the building due to earthquakes or large winds, through a foreign control force to increase and to minimize the vibration of structural control system.

Time Delay: In different systems like data acquisition, data processing, control device, sophisticated control algorithms, or the sum of these effects is one of the main challenges in the structural control system is the time delay. The properties of building structures will affect the large mechanical control devices in control force caused by among these delays. The structural vibration control application for the inclusion of time-delay in the controller design provides a more realistic model.

H. Control Devices

The prevention of structural damages using devices in building of vibration control. The building structures of various control devices have been developed to ensure the safety of even when excessive vibration amplitudes occur due to earthquake or wind excitations. The control devices are isolators, dampers, and actuators are used to unwanted vibrations in a structure.

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Passive Devices: Passive devices are mainly used in structural control. The development of the structure to the control forces for its applies and action does not depend upon external power source of passive control device. The induced energy or amount of seismic is to consume a symbolic passive devices are TMD and BI that are installed on structures. The structure development with respect to the control device within a relative development The structure development with respect to the control device within a relative development by producing the energy is depleted.

I. Applications Of Vibration Control In Structures

The vibration control devices in building structures there have been several applications in the past few decades. In worldwide, many researchers have been investigated and implementation of vibration control devices in buildings and bridges. In around the world over 16000 buildings have been protected by using anti-seismic-system. In one of the widely implemented technique is seismic isolator of a passive control device. In Japan 18% of all earthquakes on the plant of the magnitude 7 or more and over 5000 building have been already protected by seismic isolators. In 1994 Northridge earthquake survived the world's first base isolated hospital without any damages.

J. Structural-Control Device Models

The structure of control devices is used to control the dynamics to the desired response. In a dynamic model of a structure, the control device is installed on it. In structure, the installation of control device will modify the parameters like natural frequency of changing the system model. The structural model is necessary to consider in the dynamics of the actuator.

K. The Selection Method Of An Proposed Earthquake Records

The earthquake records are according to ASCE 7-0.5 which has guidelines about using the design of isolation building. The maximum period 1.25 T_m and design period 0.5 T_D between response spectrums of the code specified to be more than 1.17 times of each pair earthquake records should be scaled to be that average SRSS response. The soil conditions and characteristics of ground motions are made as various response differences. The proposed earthquake records are:

1. The rare instrument earthquake record in Korea because it is difficult to use earthquake records for the time history analysis of base isolation building.
2. It is difficult to get the earthquake records consisted of the pair (2 components of horizontal direction) using available earthquake records of America and there are most severe earthquake records.
3. The soil condition between earthquake records and building location there are few code descriptions as using scaling method of earthquake records. The ground motion is related to the seismic response of the building.
4. There as earthquake records and soil types are the scaling can make differences of using earthquake records PGA (peak ground acceleration).
5. It needs the method selecting earthquake records with similar response characteristics in soil condition and design response spectrum of using time history analysis.
6. The response difference is very large between acceleration response in ground motion and design spectrum of El Centro earthquake record used generally by code.
7. Select the soil type of building as the same described earthquake records.
8. The scaling of earthquake records is set PGA (using 0.11g in this study).
9. Select design response spectra of within mean ± standard deviation in the response of earthquake records.
10. Select earthquake records are used to perform a time history analysis.
11. Set scaling appropriately and select more than 3 records in the time history earthquake records.

III. RESULTS AND DISCUSSIONS

Mass Ratios	TMD	BI (Rubber Isolator)
3%	K&C	C
5%	K&C	C
10%	K&C	C

Where K is stiffness and C is damping K= mw^2 and C= 2□mw. Where m is the mass of the structure and w is the natural frequency.

Mass Ratio: The ratio of mass of the TMD to mass of the structure.

The Fig. 4, 5 and 6 indicates the different mass ratios of 3%, 5% and 10% and also indicates the with and without of the Tuned Mass Damper and Base Isolator Rubber bearing.

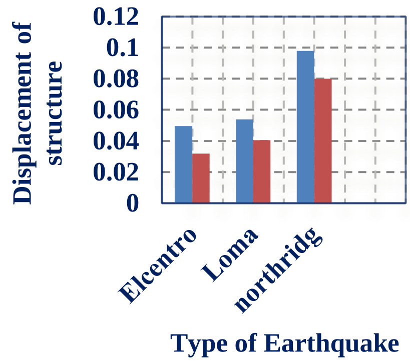

Fig. 4: Mass Ratio-3%

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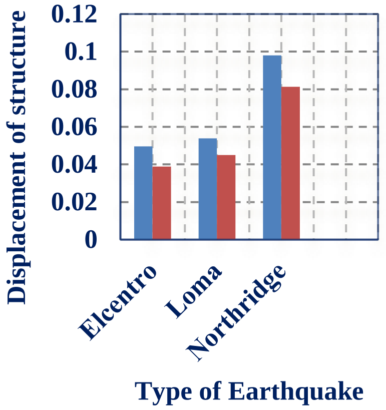

Fig. 5: Mass Ratio-5%

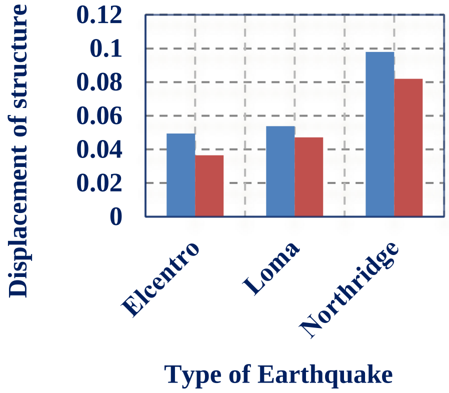

Fig. 6: Mass Ratio-10%

IV. CONCLUSION

In this paper, the combination of TMD and BI acts like a to minimize the linear seismic response of an earthquake vibration. Mainly the BI to reduce the vibration, acceleration and to release the displacement of a building. The TMD can be reducing the displacement of a building. The linear response of isolation devices to finding the inter-story drift of a building. The seismic displacement demand is lower than in the case of the isolation layer in reducing the seismic performance. The peak isolator displacement for 10% maximum reduction and the RMS base displacement for a 15% maximum reduction have been observed.

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