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Evaluation and Planning of Multi-Storage Structures for Horizontal and Vertical Loading Controlling and Non-Controlling Dampers

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ABSTRACT:

Previous studies examined the use of response spectra for base isolation analysis The lack of technology and software analysis capabilities in ancient times made the designs unreliable and unsafe. These days, several nations use base isolation, and the building response that uses it works better in practice. You may optimise the building's cost and the response of a base-isolated structure is lower in amplitude. After extensive investigation, experts have come to the conclusion that in order to preserve lives and property, base isolation must be implemented in key seismic zones and isolators must be employed. The use of base isolation in building design is noticeably absent in Indian construction methods. Studying and researching base isolation under Indian constraints and settings must be motivated, it is advised at the conclusion.

Keywords: Single column, symmetrical, eccentric loads, Staad Pro

1. INTRODUCTION:

Mechanical engineering systems often use tuned mass dampers to manage vibrations. Recently, the principle of Tuned Mass Dampers has been used to lessen vibrations in many civil engineering projects, including skyscrapers. The next generation of tuned dampers and dynamic absorbers for controlling structural vibrations are tuned mass dampers and tuned absorbers. For linear applications, these devices' inertial, resilient, and dissipative components are mass, spring, and dashpot (or material damping). For rotational applications, they are equivalent to their rotary equivalents. These devices may range in size from a few grammes to several tonnes, depending on their intended use. For the purpose of reducing vibrations, other arrangements including pendulum absorbers/dampers and sloshing liquid absorbers/dampers have also been developed.

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A structure may have its dynamic response dampened by attaching tuned mass dampers to it. The damper is designed to resonate at a frequency that is out of phase with the structural motion when activated, in order to dampen vibrations at a certain structural frequency. Typically, a spring-dashpot system is used to connect the mass to the building. As relative motion occurs between the mass and the structure, the dashpot dissipates energy. An increase in the damping ratio reduces the stress or acceleration, and it is often safe to assume that structures have 5% critical damping.

Attached to a structure, a tuned mass damper uses a combination of a mass, a spring, and a damper to dampen down unwanted motion. In order to manage a building's accelerations, displacements, and internal stress factors during an earthquake, tuned mass control systems may be used. Importantly, the Tuned Mass Dampers must be mounted to the structure at a certain area. Large contemporary constructions may be controlled in several ways.

1. To lessen the impact of wind and vehicular (e.g., train) vibrations, tuned mass damper systems are extensively used. Low damping levels allow typical constructions, such as thin bridges, stacks, and tall, thin skyscrapers, to experience vibrations that are undesirable. The control effects of tuned mass dampers are comparable to those of increased damping. By adjusting the mass ratio, tuning frequency, and damping capabilities, the amplitude decrease may be substantial, reaching levels that are around 10% to 20% of what they would be without dampers. The factors for choosing the mass, stiffness, and damping ratio were diverse. In this case, a tuned mass system is installed on top of a multi-story structure.

2. LITERATURE SURVEY:

Den Hartog [7]. Fram first proposed the TMD idea in 1909 to lessen ship rolling motion and hull vibrations. Optimal tuning and damping settings are discussed in Den Hartog's book on mechanical vibrations [8], after which Ormondroyd presents a theory for the TMD later in the article. For a damp-free SDOF system excited by a sinusoidal force, the first hypothesis worked. Theoretical extensions to damped SDOF systems have been explored by scores of scholars.

Hrovat *et al*.[11]. An external power source is required for active control devices to function. Consequently, active control devices are superior. Unfortunately, there is no getting around the fact that existing technology in the field of structural control against earthquakes has issues including inadequate control-force capability and exorbitant power needs. The inherent stability and low power consumption of semi-active control devices, a novel control technique that combines the greatest

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aspects of active and passive control devices, have made them very appealing in recent times. The first SATMD-related publications date back to 1983, when the SATMD, a time-varying controlled damping transient model (TMD), was introduced. Using SATMD instead of TMD greatly improves the behaviour of a structure under the same circumstances. Since SATMD's control design is less reliant on related parameters, more options are available for their selection (e.g., mass ratios, frequency ratios, etc.).

Clark [2]. Clark put forward the idea of MTMDs, or multiple tuned mass dampers, along with an optimisation process. While TMD adjusted to a structure's fundamental frequency may significantly dampen its first mode response, it is more common for the higher modal responses to be only slightly muted or even increased. A doubly tuned mass damper (DTMD) was suggested, which consists of two masses connected in series to the structure, to circumvent the frequency-related limitations of TMDs. This allows for the use of multiple TMDs within a single structure, each tuned to a different dominant frequency. Several studies have examined the behaviour of MTMDs (Setareh 1994). To test how well DTMDs reduced responses, we looked at two loading conditions: harmonic stimulation and zero-mean white-noise random excitation. In terms of overall efficiency, analytical findings reveal that DTMDs outperform traditional single-mass TMDs across the board, but in terms of efficiency in the real world, they're just marginally better than TMDs throughout the 0.01-0.05 range.

Villaverde. There have been recent numerical and experimental investigations of the efficacy of TMDs in dampening seismic response of buildings (e.g., Villaverde, 1994). Using nine distinct types of earthquake data, three distinct buildings were examined: a two-story shear building in two dimensions, a one-story frame building in three dimensions, and a three-dimensional cable-stayed bridge. Results from both experiments and numerical simulations reveal that TMDs' efficacy in dampening the response of the same or different structures to the same earthquake varies greatly; in some instances, they perform admirably, while in others, they have little to no impact at all. The properties of the ground motion that stimulates the structure rely on the acquired decrease in response, according to this. Resonant ground movements cause a significant decrease in response, which decreases as the ground motion's dominant frequency moves further from the structure's native frequency, which the TMD is tuned to. In addition, TMDs don't work very well when subjected to seismic stress that mimics pulses.

Allen J. Clark [2]. Multiple passive TMDs for reducing earthquake induced building motion. In this paper a methodology for designing multiple

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tuned mass dampers for reducing building response motion has been discussed. The technique is based on extending Den Hartog work from a single degree of freedom to multiple degrees of freedom. Simplified linear mathematical models were excited by 1940 El Centro earthquake and significant motion reduction was achieved using the design technique.

K. C. S. Kwok *et al* [14]. Performance of tuned mass dampers under wind loads The performance of both passive and active tuned mass damper (TMD) systems can be readily assessed by parametric studies which have been the subject of numerous research.. Few experimental verifications of TMD theory have been carried out, particularly those involving active control, but the results of those experiments generally compared well with those obtained by parametric studies. Despite some serious design constraints, a number of passive and active tuned mass damper systems have been successfully installed in tall buildings and other structures to reduce the dynamic response due to wind and earthquakes.

T.Shimazu and H.Araki [26]. "Survey of actual effectiveness of mass damper systems installed in buildings". In this paper the real state of the implementation of mass damper systems, the effects of these systems were clarified based on various recorded values in actual buildings against both wind and earthquake. The effects are discussed in relation with the natural period of buildings equipped with mass damper systems, the mass weight ratios to building weight, wind force levels and earthquake ground motion levels.

Fahim Sadek *et al* [8]. A method of estimating the parameters of tuned mass dampers for seismic applications. In this paper the optimum parameters of TMD that result in considerable reduction in the response of structures to seismic loading has been presented. The criterion that has been used to obtain the optimum parameters is to select for a given mass ratio, the frequency and damping ratios that would result in equal and large modal damping in the first two modes of vibration. The parameters are used to compute the response of several single and multi-degree of freedom structures with TMDs to different earthquake excitations. The results show that the use of the proposed parameters reduces the displacement and acceleration responses significantly. The method can also be used for vibration control of tall buildings using the so-called ‗mega-substructure configuration', where substructures serve as vibration absorbers for the main structure.

G. W. Housner *et al* [9]. The three eras of structural control This paper aims to serve as a starting point for researchers and practitioners interested in evaluating the current state of civil engineering structure control and monitoring. It

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also connects structural control to other areas of control theory, highlighting similarities and differences, and suggesting areas where future research and application could be useful.

3. MATERIALS AND METHODOLOGY

The ETABS programme has been used to simulate a high-rise framed construction. Using dynamic analysis, we tracked the framed structure's displacements throughout time and measured their magnitudes at key points. Afterwards, an appropriate TMD system was developed. The TMD will add three to five percent to the building's overall weight. Separate analysis of the TMD revealed its natural frequency. Keeping the TMD as intended atop the building, the structure was reanalyzed utilising dynamic analysis. The findings were compared with those obtained without the TMD in terms of time period and displacement at the relevant areas, demonstrating the study's value.

The following are the procedures used in dynamic analysis:

1. Analysing the range of responses: This approach works for structures where modes other than the basic one have a substantial impact on the structure's response. Here, the overall response of a system with many degrees of freedom is calculated by superimposing the modal responses, where each modal response is derived from the spectral analysis of a system with a single degree of freedom. A response spectrum is often used with the approach.

2. A structure's pushover analysis is a static non-linear analysis that takes into account both constant vertical loads and rising lateral loads over time. The comparable static loads accurately depict the forces caused by earthquakes. Analysis of a structure's potential for early collapse and weakening yields a graphic of total base shear and roof displacement. By doing the analysis all the way to failure, we can find out the ductility capacity and collapse load.

3. Inelastic time history analysis: During the design earthquake motion, a building that is seismically weak will experience inelastic action. Spots of structural weakness and ductility demand are revealed by the inelastic time history analysis of the building subjected to strong motion earthquake. If you want to know how well a building is doing, this is the way to go.

Rectangular plan:

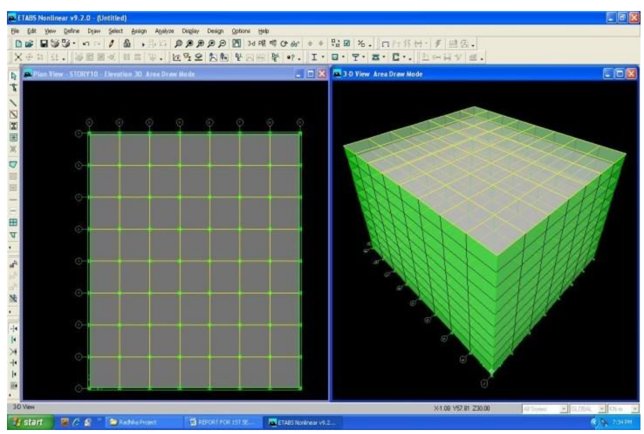

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Fig.1. Symmetrical building Plan without TMD.

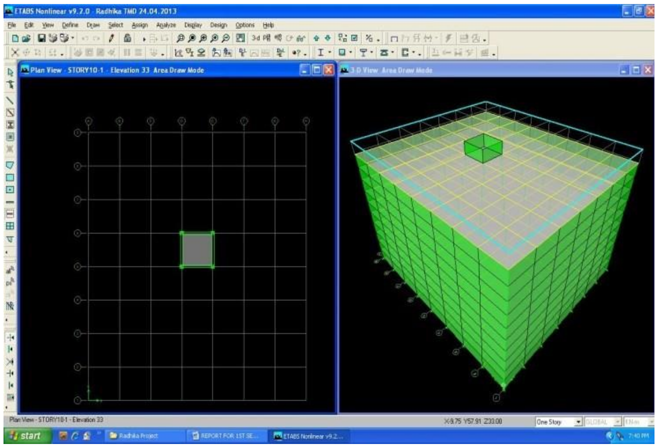

Fig .2. Symmetrical building plan with TMD.

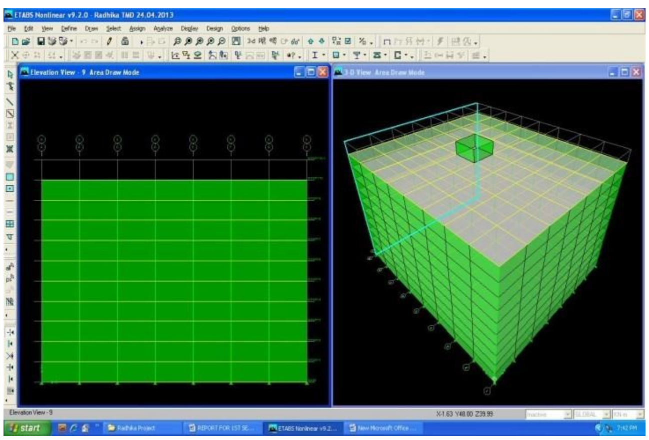

Fig.3. Shows elevation of symmetrical building.

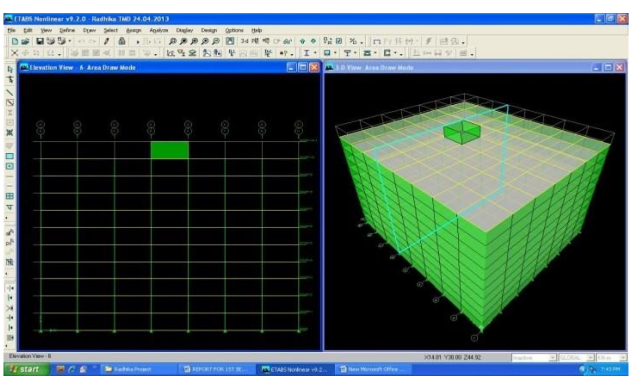

Fig.4. Shows elevation of symmetrical building.

L- Shape Building:

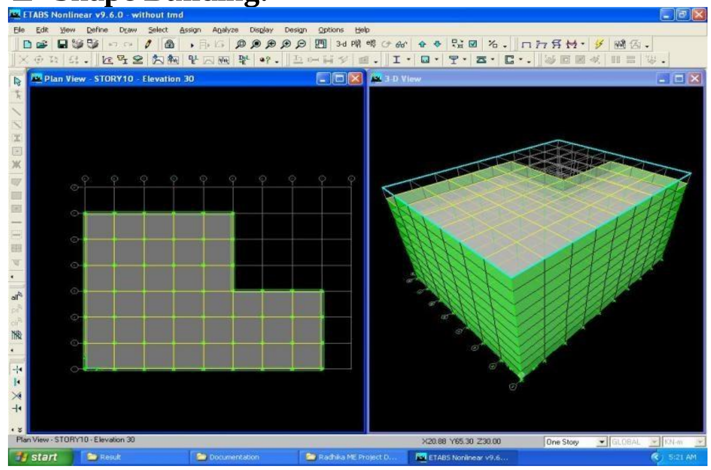

Fig.5. Unsymmetrical Building Plan without TMD.

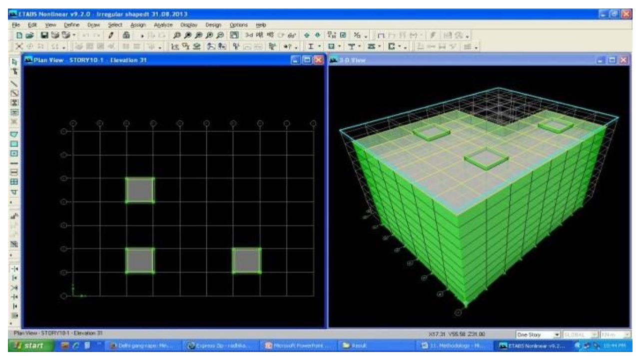

Fig.6. Unsymmetrical Building Plan with TMD.

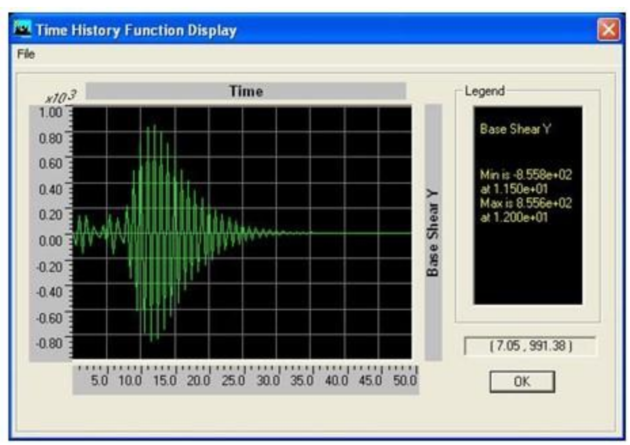

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Fig.7. The Graph Showing between Time Vs Base shear y (Without TMD).

Fig.8. The Graph Showing between Storey Number Vs Max displacements.

Based on the limited studies carried out it is observed that:

1) An efficient TMD mechanism is the steel damper installed in the building's upper columns.
2) The TMD made a noticeable contribution when the relevant column supports were hinged.
3) Roughly 4% to 5% of the total mass of the construction was used in the investigation.
4) The dimensions of the TMD's structural parts were chosen in such a way that the TMD's frequency is almost identical to the structure's frequency.
5) The research found that the ETABS programme may be used to construct an appropriate TMD for a certain building.

CONCLUSION

The results acquired from the ETABS software in accordance with IS: 1893:2002 (part-I) with 5% structural damping are used to draw the following conclusions.

1. The frequency of the Tuned Mass Dampers is almost in sync with the structure's fundamental mode while using 5% mass of the dampers. For that reason, tuned mass dampers always account for around 5% of total structural mass.
2. Tuned mass dampers, which are steel dampers, may reduce vibration amplitude by 51% for symmetrical buildings (page 50).

3. In a similar vein, steel dampers might reduce the vibration amplitude by 49% (page 58) for asymmetrical structures.
4. Using steel dampers, the value of the base shear may be reduced by 56% for symmetrical buildings (page 45 & 46).
6. Steel dampers may reduce the base shear value by 42% for asymmetrical buildings (page 54).

Scope of future work:

1. Further studies have to be carried out for different TMD’s. i.e Active, Semi active, etc.

2. The effect of TMD needs to be validated with experimental studies.

3. Further studies have to be carried out for finding the Stiffness Matrix and Mass Matrix of an element.

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REFERANCES

1. A.K. Chopra, Dynamics of structures: theory and applications to earthquake engineer, 3rd edition, prentice Hall, New Jersey.
2. Allen J. Clark. "Multiple Passive Mass tuned mass damper for reducing earthquake Induced Building motion".
3. Byung-Wan Jo, (2001) ―Structural vibration of tuned mass installed three span steel box bridge‖ *International journal of pressure vessels and piping" 78 pp* "667-675.
4. Chen Wai-fah. " Structural Engineering Hand book". CRC Press LLC, 1999.
5. Chi-Chang Lin, Jin-Min Ueng, Teng-Ching Huang, Seismic response reduction of irregular buildings using passive tuned mass dampers, Engineering Structures 22 (1999) 513-524.
6. Chouw Nawawi(2004) ― Behaviour of soil-structure system with tuned mass dampers during near-source earthquakes‖. *Thirteenth world conference on Earthquake Engineering paper no.1353*
7. Den Hortog's (1928). – Undamped dynamic vibration absorber- Mechanical Vibrations.
8. Fahim Sadek, (1997) ― A method of estimating the parameters of tuned mass dampers for seismic applications‖. *Earthquake Engineering and Structural Dynamics Vol.26 pp 617-635*
9. G. W, Housner (1996) ―Structural control: past, present, and future‖ *Journal of Engineering Mechanics, Vol.123, No.9, Paper No. 15617.*
10. Hartog, D. J. P. (1947). "Mechanical vibrations." McGraw-Hill, New York, N.Y. Anthony C. Webster "Application of Tuned Mass Damper to control vibrations of Composite floor systems.