# PARAMETRIC STUDY ON OPTIMUM DETERMINATION OF DOUBLE TUNNED MASS DAMPER (DTMD) CHARACTERISTICS FOR MOMENT – RESISTING STEEL FRAMES UNDER SEISMIC LOADING

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In the recent years, energy dissipation and reducing the response of structures against dynamic loads such as earthquake and wind are of topics of interest to researchers. Passive control approach is one of the most studied and utilized control methods, in which, its advantages over other methods are the low cost of implementation and ongoing maintenance while providing a reliable permanent exploitation. Tuned mass damper is one of the passive control methods and in this study its optimal properties are being to be determined via a parametric investigation.

Although this problem is a well-studied one, the properties of the TMDs is adjusted based on the linear behavior of the structure, wherein, in most of the earthquakes, structures experience nonlinear behavior. This fact would change the frequency setting, causing a non-optimal performance of the control system and could even cause an increase in the structural response.

The aim of this study is to utilize a Double Tuned Mass Damper (DTMD) for controlling the structure response considering its nonlinear behavior during far field earthquakes through a comprehensive parametric study. The idea of using DTMD instead of TMD was first proposed by Li and Han (Han and Li, 2006). DTMDs comprise a larger mass damper and a smaller damper, which is for more efficient and robust mass damper to reduce unwanted vibrations of structures against earthquakes (Li and Zhu, 2006).

In this paper, two 5 and 10 stories structures with intermediate moment-resisting frames under far field earthquakes are assumed. Dampers are located on the roof floor and seven far fields seismic records are applied to the structure and over 500 time history analyses have been done employing OpenSees software. Maximum average responses of the structures under these earthquakes have been extracted and parameters such as displacement, velocity, acceleration and drift of the stories as well as the base shear are obtained to gain optimum properties by trial and error method. The parameter for optimization which is obtained from each record and then average of them is expressed as criterion for optimization is calculated as follows:

Performance percentage of damper:

$$(\text{Max uncontrolled response} - \text{Max controlled response}) \div \text{Max uncontrolled response} \times 100$$

The results reveal the better performance of the DTMD in comparison with TMD in mitigating the seismic displacement response of the structure. An example of a 5-story & 10-story building with roof displacement time history graph with DTMD, with TMD and with no damper structure can be seen in Fig 1. As the figure shows the displacement response with DTMD is less than TMD, e.g the best performance of DTMD in this research reduces 19.7 percentage in displacement of roof in 5-story while TMD reduces 17.4 percentage in displacement of roof at its best status. These numbers in 10-story is 22.3 for DTMD and 17.2 for TMD. Another result of this research is the more effectiveness of DTMD in 10 stories vis a vis 5 strory building that has been studied. For another parameters (acceleration, velocity & base shear) there are not a certain result for it, for some specification of damper it decreases the response and for some other does not.

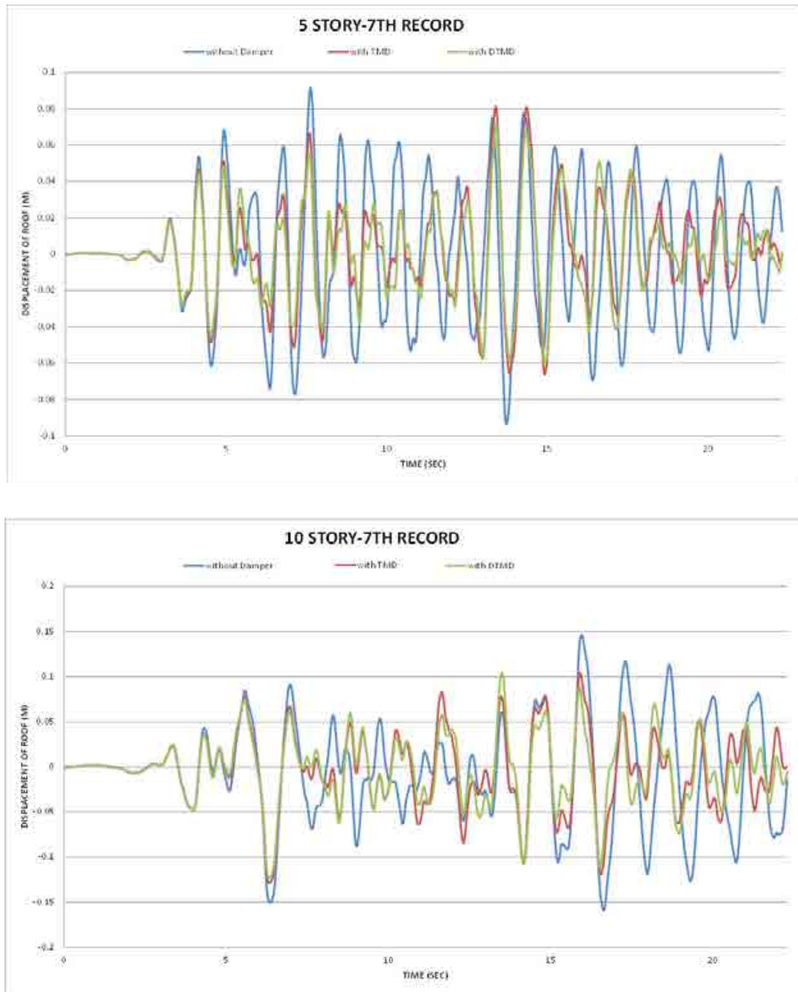


Figure 1. Time history displacement of roof with DTMD, TMD and without damper – 5 story & 10 story

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