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# Optimum multiple tuned mass dampers for seismic retrofit of existing reinforced concrete moment resisting frames

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**Abstract**

The interest in the application of multiple tuned mass dampers (MTMD) as a useful passive control method is pervasive throughout the structural engineering over the last decades. Tuning the dampers to the fundamental period of the structure can improve the seismic behavior of the structure due to energy absorption enhancement of the system. In seismic retrofit, the performance levels of the structure in the different levels of earthquake are determined based on some parameters such as the relative displacement of the roof or the plastic hinges rotation capacity of the structural system. Since attaching MTMD to the structure can improve these seismic responses of the structure significantly, we propose an optimum MTMD to improve the performance levels of the structure. The obtained results from nonlinear dynamic time history analyses show that attaching MTMD to the structure can be a powerful method for the structurally retrofitting.

**Keywords: Tuned mass damper, seismic retrofit, Performance level, Nonlinear dynamic time history analyses, Optimization.**

## 1. Introduction

As structure-related sciences for better understanding the actual behavior of structures developed, new ways are found for reinforcing and retrofitting the existing structures. In general, retrofitting is required not only for repairing and reconstructing a structure when it sustains collapse/failure, but also for various other reasons including the following: 1) a structure designed in compliance with an older construction code fails to satisfy the requirements of a newer code, 2) Failure of an existing structure to meet the new construction requirements in case of a change in occupancy of the structure. An optimum retrofit design must be economical and practical and at the same time, impose minimal modification on the structure architecturally. Using multiple tuned mass dampers (MTMD) for retrofitting buildings is a new practical method in most cases which requires minimal space due to the small size of the dampers deployed, and hence, imposes the least amount of damage to the building, thus reducing architectural modifications. A MTMD consists of several individual tuned mass dampers (TMD) installed at different locations on the structure through various methods. The MTMD is among the simplest and most reliable passive control methods, comprising a concentrated mass, a spring, and a shock absorber which can be displaced only horizontally (i.e., has a single degree of freedom).

The idea of using TMDs in structural applications was first presented by Frahm (1909) in the form of dynamic vibration shock absorbers. Den Hartog conducted the first studies on damped and undamped dynamic