8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

A PERFORMANCE OF OPTIMUM FRICTION TUNED MASS DAMPER CONNECTED TO MULTI-DEGREE OF FREEDOM STRUCTURES

Boshra BESHARATIAN
Research Assistant, University of Isfahan, Isfahan, Iran
besharatian_boshra@yahoo.com

Hossien TAJMIR RIAHI
Assistant Professor, University of Isfahan, Isfahan, Iran
tajmir@eng.ui.ac.ir

Keywords: Tuned mass friction damper, Multi-degree of freedom, Passive control, Seismic analysis, Particle swarm optimization algorithm

Present study investigates the performance and optimum parameters of friction tuned mass damper (FTMD) as a passive control device. This is done for multi-degree-of-freedom (MDOF) structures equipped with this damper and subjected to ground motion excitation. FTMD consists of mass, stiffness and friction mechanism created through contact surface between FTMD mass and the main structure. FTMD is a modified version of tuned mass damper (TMD) in which friction mechanism provides proper capacity of energy absorption in it. Therefore some benefits such as simplicity of implementation, low cost and easy-to-change condition are added to this damper. The best performance of structures equipped with this damper is obtained when optimum parameters of FTMD are used for its design. Therefore in this study, optimum parameters of FTMD for a range of MDOF structures with different periods up to 4.0 seconds and different number of stories are calculated. To do so, particle swarm optimization (PSO) algorithm is considered as an efficient algorithm which has been used in similar investigations. PSO is a time saving algorithm which needs less memory in its process. With respect to each certain story number, three different structures are designed with three different periods equal to 0.1, 0.15 and 0.2 of number of stories. Stiffness distribution in height of structures is considered as a linear function which is close to real structure stiffness distribution. Essential parameters of FTMD are mass damper ratio (μ), frequency ratio (f) and friction coefficient (R_f) that are defined as ratio of damper mass to main mass, ratio of damper frequency to main structure frequency and ratio of friction force between contact surface of damper and main structure to damper weight, respectively. Objective function in optimization problem is defined as maximum displacement of main structure as a factor which directly affects on safety and integrity of structures. To reach a general conclusion, systems are investigated under a set of 20 SAC project ground motion records. This set has 10% in 50 years of risk level and its average spectral acceleration corresponds well to the ASCE07 design spectrum. Figure 1 shows present study results in comparison with Pisal (2015) study under the same FTMD parameters which shows good agreement between these studies. Studying convergence of the optimization process shows that PSO is a suitable algorithm in finding optimum FTMD parameters. In addition, optimum FTMD reduces main structure response properly.

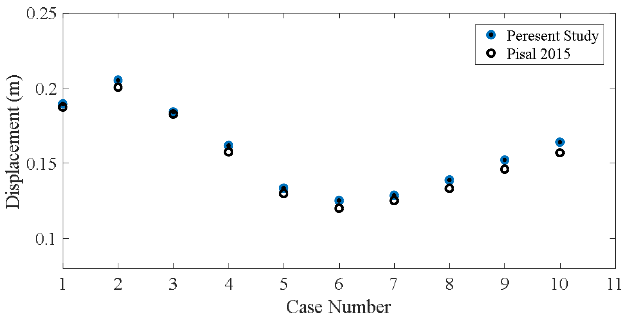

Figure 1. Roof displacement of a 5-story structure equipped with different FTMD systems under Kobe earthquake excitation.

Figure 2 shows roof displacement response of 3-story structures with different periods. This figure shows that optimum reduction is dependent on period of structures. Average amount of this reduction for different structures under SAC records is about 30% which is considerable. Optimum FTMD parameters vary with respect to main structure characteristics and mass ratio which is pre-selected similar to other studies because its optimum value is so high and non-practical. For flexible main structures, effectiveness of FTMD on reducing structural responses is higher.

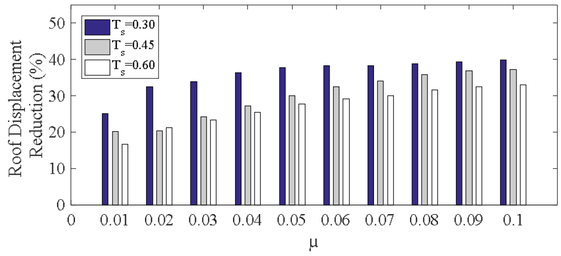

Figure 2. Effects of optimum FTMD on 3-story structure responses.

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