Parameter Optimization of Geometrically Nonlinear Tuned Mass Damper for Multi-directional Seismic Vibration Control

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ABSTRACT

A new type of mass damper is presented for passive seismic response control of building structures as well as long-span structures subjected to multi-component ground motions. The mass damper consists of a viscous damper and a mass connected by flexible springs. By utilizing the flexibility of springs and geometrical nonlinearity, the movement of the mass in multi-directions and the elongation of viscous damper are amplified, and the vibration energy of the mass is effectively absorbed by the viscous damper.

The effectiveness of the proposed mass damper, called MD-TMD, is demonstrated using a simplified single-mass model and a latticed roof model. The parameters consisting of stiffnesses of the springs, damping coefficient of the viscous damper and location of the mass are discretized into integer values. Approximate optimal values of parameters of the mass damper are first searched globally using a random selection of the discretized parameter values.

The objective function is the norm of response reductions in multi-directions, which is evaluated by carrying out a series of dynamic response analyses under seismic motions compatible to the design response acceleration spectrum. The parameters are further optimized using a heuristic approach called tabu search that is based on local search.

The properties of response reduction of the MD-TMD are compared with those of conventional tuned mass damper with the same total mass as the MD-TMD. It is shown that multi-directional responses are successfully reduced using the proposed model consisting of single mass and damper.