ABSTRACT

A Passive Auto-Tuning Mass Damper with Pulley connections (PATPD) is a vibration control device that consists of a box filled with silica sand on roller supports. The silica sand provides the mass of the damper. The PATPD is connected to the structure to be controlled by a group of ropes and pulleys; it is free to move in any translational direction. The pulleys and rope transfer a driving force to the damper, caused by the movement of the structure. The mass provides an inertial force which, in addition to the driving force of pulleys, dissipates energy providing the vibration control of the structure.

Firstly, the test model underwent ‘PATPD Efficiency tests’ where the model was subjected to free translational, torsional and coupled vibration both with and without damper. This procedure was then repeated for forced harmonic excitation and the control effect for both analysed. These tests aimed to demonstrate the effectiveness of the PATPD at controlling structural vibrations. The results indicate that the PATPD provided at least 99% reduction to first natural frequency Power Spectral Density (PSD) peak for all tests, with relatively minimal increases for others.

The model then underwent ‘Parameter Tests’ where the damper characteristics were changed and test procedure above repeated. These tests aimed to investigate the effect of the property changes of the PATPD on its ability to control free and forced vibration. The results indicate that (a) the PATPD provided significant reduction to first natural frequency PSD peak for all tests and (b) the properties of the PATPD affected the amount of control provided to the structure thus optimization of the PATPD could result in improved control effect.

The models’ ‘Dynamic Properties’ namely model mass and stiffness were changed and test procedure repeated. These tests aimed to demonstrate the auto-tuning or adaptivity of the PATPD in its ability to control free and forced vibration. The results indicate that for all tests performed the PATPD provided significant reduction to first natural frequency PSD peak for all tests, with relatively minimal increases for others. The PATPD worked over a wide frequency band and was able to adapt to frequency changes providing significant control effect.

Additional forced vibration tests under specific frequencies close to and far away from the models’ natural frequency demonstrates PATPD adaptability and efficiency. In addition tests under random excitation (as could be expected for earthquake loading) demonstrated PATPD positive control effect, adaptability and efficiency.