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Experimental investigations into a passive auto-tuning mass damper

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ABSTRACT

A passive auto-tuning mass damper (PATMD) is a vibration control device that consists of a mass which is suspended in the top region of a structure and is forced into motion, due to inertia, when the structure is excited. A steel test structure is used to carry out the experimental investigation. The PATMD is connected to the structure to be controlled by a group of inelastic ropes and is free to move in any translational direction. It moves relative to the structure, utilising and dissipating large amounts of energy as it swings from side to side, and in this way, the vibrational energy of the structure is absorbed and consequently the vibrations of the structure are controlled.

First, the 'PATMD efficiency tests' are carried out, whereby the test model is subjected to translational, torsional and coupled free vibration tests, initially without the PATMD and then with the PATMD, in order to determine the damping effects of the PATMD. The test model is then subjected to forced harmonic vibration tests similar to those described above and the damping effects are again analysed. These tests aim to demonstrate the PATMD's effectiveness in controlling the translational vibration in two directions, torsional vibration and coupled vibration, under both free and forced excitation, without being tuned.

Secondly, a parameter study is carried out whereby the dynamic properties of the primary test model are varied whilst the PATMD is left unchanged. The free and forced vibration tests are repeated. Finally, the properties of the PATMD are varied whilst the primary model remains unaltered. Again, the tests described above are repeated, without any tuning of the system taking place.

The results of the 'PATMD efficiency tests' demonstrate its capability of providing significant control to translational, torsional and coupled vibrations of the structure without being tuned in any way. Furthermore, the parameter study demonstrates the PATMD's effectiveness under very different conditions of the system, without having undergone any tuning or specific adjustment. The tests reveal that the PATMD is robust, uncomplicated and versatile making it an ideal application for engineering structures.