SMA-based multi-modal adaptive TMDs: model and tests

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ABSTRACT

Shape memory alloys (SMA) are really promising materials in the field of vibration mitigation. Indeed, several articles investigating how to employ the special features of SMAs in order to design and build dampers and tuned mass dampers (TMD) are already available in the state of the art.

The special features of SMAs [1] enable to design adaptive TMDs, capable to change their dynamic features with the aim of maintaining the TMD tuned on the primary system (PS) to be damped in case of changes of the dynamic features of the PS itself (e.g. changes of the eigenfrequency due to temperature changes) [2,3]. The possibility to ensure the tuning between the TMD and the primary system allows to achieve an effective damping performance.

The adaptive TMDs based on SMAs described in the literature are usually mono-modal, meaning that they can damp a single eigenmode of the PS. Conversely, this paper proposes a new adaptive TMD able to change more than one eigenfrequency at the same time with a given level of independence. This allows to work on at least two eigenmodes of the PS at the same time, therefore realizing a multi-modal adaptive TMD.

This article explains that this multi-modal adaptive TMD relies on a specific layout made from a system of masses and SMA wires. More in detail, each mass is connected to the adjacent masses by SMA wires. The possibility to tune more than one eigenfrequency at the same time is yielded by heating and/or cooling the different SMA wires independently. This enables to change the axial force acting in the wires and, at the same time, also to change the geometry of the adaptive TMD. This double effect is proved to be suitable for developing multi-modal adaptive TMDs.

This article first explains the working principle of the adaptive TMD and its theoretical model. Then, experiments are described with the aim of proving the effectiveness of the proposed device. The set-up used for the experimental tests is made from a prototype made from two masses and three SMA wires.

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