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Highlights

- The performance and robustness of different metabsorber configurations are compared.
- Numerical studies rely on the FEM method and energy quantities.
- Robustness is estimated with the Info-Gap method considering lack-of-knowledge.
- Numerical results are compared to experimental measurements for an airplane model.

Abstract Tuned Mass Dampers (TMD) are passive devices well-known to mitigate vibrations thanks to the principle of vibration absorption. They consist of a mass, a spring and a damper whose frequency is tuned to a critical frequency of a master structure in order to generate the expected energy transfer. As these devices require a very fine tuning to be efficient, Multi-frequency designs (Multiple Tuned Mass Dampers — MTMD) integrating several absorbers whose specific frequencies are distributed around the target resonance frequency have emerged to obtain good damping performances on a wide frequency band, even in the presence of uncertainties. The elastodynamic properties of these designs are classically estimated from lumped mass models that are a simplified representation of the 3D structures that will actually be used on a real application. In this context, the purpose of the paper is to design a metabsorber consisting in a set of 3D resonators, and to estimate numerically and experimentally the performance and the robustness in an uncertain context. The design approach relies on a dynamic analysis of the whole structure using the Finite Element Method that allows to considerate any topology for the absorbers. Epistemic uncertainties resulting from lack-of-knowledge on the target frequency are introduced, and the robustness of the metabsorber is estimated using the Info-Gap Theory that is a non-probabilistic approach for decision-making in such an uncertain context. Different frequency distributions in the metabsorber are compared to quantify the gain in performance and robustness that can be achieved changing the number of absorbers. The methodology is applied to the case of a simplified airplane model in order to control the third bending mode: numerical and experimental results show that even if the robustness improves when the number of different absorbers increases, very good results can be obtained by using a reduced number of absorbing elements in the metabsorber.

Keywords Absorption; Info-Gap theory; Lack-of-knowledge; Multiple tuned mass damper; Passive damping; Robustness.

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