

OPTIMIZATION OF RESONANT SUPPORTS FOR SIMULTANEOUS PLATE VIBRATION AND FORCE TRANSMISSION REDUCTION

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Abstract

Vibration isolation remains a challenge in many industrial sectors in order to reduce noise and vibrations, ensure the safety of workers, and achieve optimal functioning of machines. Passive isolators are particularly effective to reduce the force transmitted from a vibrating structure to its surrounding environment. The transmitted force through isolators can be minimized by either reducing their inherent stiffness or by strategically attaching them at a location where low structural deformation of the vibration source is observed. However, most methods ignore the influence of the isolator's dynamics on the vibration of the supported structure. Softening the supporting base might lead to an unacceptable increase of vibration levels. In this work, a rectangular flexible plate subjected to an harmonic force and supported by three isolators is used as a case study. An optimization method is presented to simultaneously minimize the transmitted force of the passive isolators and the vibration of the supported plate using a reduced order model. To achieve this, the supports are designed to have a structural resonance, so that they can act as tuned mass dampers. By summing and weighting the two objective functions, the cost function is minimized using a gradient-based algorithm. Modeled as ideal spring-mass-spring systems, the properties - stiffness, mass and damping - and the position of the isolators are optimized to minimize the displacement of the plate and the isolator's reaction force in a chosen frequency range containing multiple plate resonances. To ensure the structural integrity of the assembly, static constraints - minimum static stiffness and added mass - are considered. Their influence on the optimized isolator's properties and placement is studied.