ELASTIC WAVE ABSORPTION IN LASER-CUT ACOUSTIC METAMATERIAL PLATES

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ABSTRACT

This dissertation presents modeling techniques for design and analysis of laser-cut acoustic metamaterial plates (LCMPs) capable of acoustic/elastic vibration suppression. The conventional acoustic metamaterial plate (CMP) consists of a uniform isotropic plate with many small spring-mass-damper subsystems integrated at different locations acting as vibration absorbers. Both the single-stopband laser-cut acoustic metamaterial plate (SLCMP) and the multi-stopband laser-cut acoustic metamaterial plate (MLCMP) are proposed in this dissertation, with cutting periodic vibration absorbers consisting of one center mass and four surrounding beams into an isotropic plate for an SLCMP or two center masses and eight surrounding beams for an MLCMP. Modal analysis, dispersion analysis, frequency response analysis and transient analysis are conducted for LCMPs to investigate their dissipation characteristics. Factors that influence the stopbands characteristics such as the unit cells' resonant frequencies, damping coefficient and plate boundary conditions are also analyzed and discussed. Results show that for an LCMP with unit cells designed with one resonant frequency, a single stopband will occur at the unit cells' locally resonant frequency. Moreover, if each unit cell has two locally resonant frequencies, there are two stopbands. In addition, two stopbands for an MLCMP can be combined into one wider stopband by using a greater damping coefficient for the inside vibration absorbers when unit cells' two resonant frequencies are designed to be close to each other. Finally, it is found that boundary conditions applied to the LCMPs will not significantly affect the stopbands characteristics.