Particle damping for vibration suppression of a clamped plate

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ABSTRACT

Particle damping is a cost-effective technique for vibration suppression. It involves the use of small metallic or plastic particles contained in a cavity of a primary mass. The damping effect results from the exchange of momentum during the impact of granular materials against the wall of the cavity. Owing to the simplicity of their construction, particle dampers have been widely used for structural damping applications in boring bars, printed circuit boards and double-layered ceilings.

Many experimental and analytical studies have demonstrated the effectiveness of particle dampers. In the experimental studies, the effects of the mass ratio, particle size, cavity dimensions and excitation level on the efficiency of the damping system was investigated. In the analytical studies, the discrete element method [1] and the direct simulation Monte Carlo approach were used to predict particle damping. Most previous theoretical analyses have focused on single-degree-of-freedom systems with particle dampers. Recently, some researchers have been studying the vibration characteristics of continuous structures with particle dampers [2]. However, these studies were limited to predicting the dynamic responses of a cantilever beam with particle dampers.

In this paper, analytical and experimental studies of the vibration suppression of a square plate with a particle damper are discussed. The primary objective of this work is to construct an analytical model to simulate the transient impact response of a plate with a particle damper. In the experimental approach, an acrylic resin plate with all sides clamped was used. The transient vibration of the plate caused by the impact of a steel ball was measured with a laser displacement sensor. It is shown that the particle size, material and cavity dimensions affect the damping efficiency. In the theoretical analysis, the simulation was performed by combining the finite element method with the discrete element method. The damping characteristics of the plate are given by the Rayleigh damping. Comparison between the experimental and analytical results shows that accurate estimates of the response of the plate can be obtained.

REFERENCES

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