Elastic wave transmission in a 1D elastic structure with an attached nonlinear autoparametric pendulum absorber

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Abstract

Autoparametric pendulum absorber is an effective device for vibration suppression and has been widely employed in various engineering applications. However, most studies on pendulum absorbers are based on discrete systems. In this paper, the dynamics of a pendulum absorber attached to continuous structures, such as rods and beams, is studied. This is motivated by the fact that numerous real mechanical components and structures can be modeled as rods and beams. First, the simplest case is considered: a single pendulum absorber attached to an elastic rod. The wave transmission and reflection at the pendulum attachment point are determined. Then performance of a single autoparametric absorber attached to a beam is studied. The governing equations of motions for the pendulum attached to the rod and the beam are derived using elastic wave theory. Subsequently, the response of the systems is analyzed using the method of varying amplitudes, and the results are validated numerically. Due to the energy transfer from the hosting structure into the motion of the pendulum, it is shown that the transmitted wave can be reduced considerably. The system parameters affecting the reduction of the transmitted wave are investigated, and a comparison is made between the effectiveness of the autoparametric pendulum absorber and that of the conventional linear mass-spring-damper absorber. It was found that the nonlinear pendulum absorber can exhibit a wider bandwidth and superior vibration transmission reduction performance compared to the linear absorber.

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