Experimental Study of a Nonlinear Energy Sink based on a Cantilever Beam under Special Boundary Conditions

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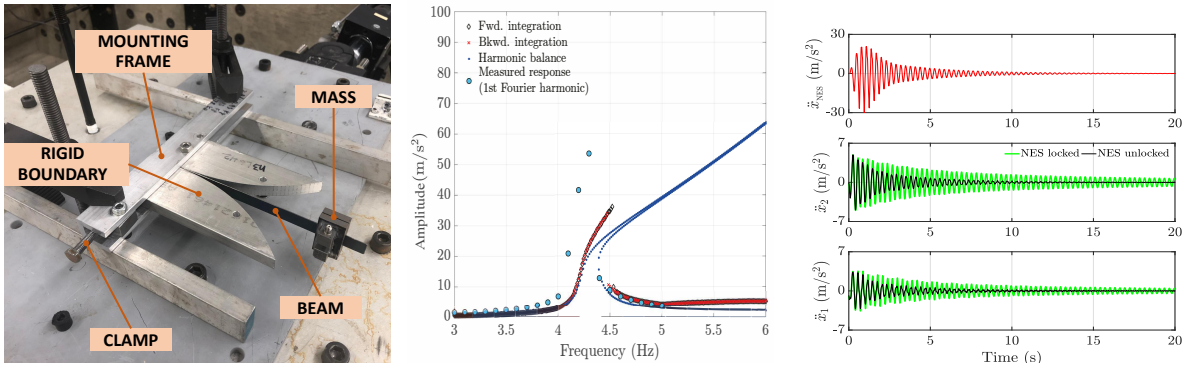
Abstract. The scope of this study is energy transfer from an impulsively base-excited lineal host structure towards a passive nonlinear damper (nonlinear energy sink, NES). An experimental verification of the reduction in response of the two-DOF host structure is conducted through several experiments conducted in the lab. Two specimens specially fabricated for this study are attached to a scaled shear structure under shake table excitation, and the responses of the system with the NES are compared to those without the NES. The observed attenuated responses both in the time and frequency domains confirm that these types of devices have great potential for vibration attenuation applications, with energy being transferred to the NES, and dissipated into higher modes of oscillation

Introduction

Vibratory energy in a structure, generated by base excitation events such as earthquakes, can be removed by attaching passive devices such as nonlinear energy sinks (NES). This class of devices have the capability of transferring irreversibly and locally dissipating energy through the rich dynamics of their nonlinear nature. In this paper, we extend the results presented in [1] on the analytical study of an NES device comprised of a cantilever beam whose lateral vibration is bounded by two rigid boundaries with specific shape. Previous studies focus primarily in the development of models aimed for energy harvesting applications [2, 3]. The focus here is to complement the developed models with a series of experimental observations of a fully functional host structure-NES system for energy pumping verification through existing and new assessment methods.



(a) (b) (c)

Figure 1: Experimental realization of an NES application on a 2-DOF linear specimen. (a) NES specimen; (b) frequency response of the beam nonlinear spring NES; (c) measured responses of the the host structure with and without the NES.

Results and discussion

A prototype fabricated from a cantilever beam with rigid lateral boundaries (Fig. 1(a)(a)) is evaluated as a suitable candidate for use as an NES. The observed behavior resembles that predicted by the semi analytical model developed in previous studies, with matching experimental behavior (Fig. 1(a)(b)). The observed dynamic response of the host structure with the NES active, shows a significant reduction in amplitude, when compared to the response with the NES inactive. This result, along with several other cases tested suggest that the device has great potentiality not only as an energy harvester, but also as an NES.

References

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