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On the energy transfer mechanism of the single-sided vibro-impact nonlinear energy sink

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Abstract

In this paper, the vibration energy transfer mechanism of the single-sided vibro-impact (SSVI) nonlinear energy sink (NES) is studied. The concept of impact mode is proposed where the device velocities are decomposed into an energy free impact mode (EFIM) and an energy dissipation impact mode (EDIM). The impact modes are applied to the analysis of a single-degree-of-freedom (SDOF) vibration system with a SSVI NES. This analysis shows that the energy in the system can be redistributed between the different impact modes and that energy transferred from the EFIM to the EDIM is beneficial, because portions of the energy in the EDIM will be dissipated by impact, while the energy in the EFIM will not. More importantly, the mechanism of the SSVI NES to realize the local dissipation of energy is revealed. Furthermore, in order to better evaluate the energy dissipation performance of the SSVI NES, a new evaluation criterion called the vibro-impact vibration reduction (VVR) factor is proposed. Then, the relationship between the VVR factor and the energy free impact mode coefficient is investigated using the Hilbert transform. Finally, the effect of the SSVI NES parameters on the energy dissipation performance of the SSVI NES with various initial conditions is discussed, and a satisfactory region for the SSVI NES design, which is identified via numerical simulation, is proposed.

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