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A comparison of the common types of nonlinear energy sinks

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Abstract: Real life dynamical structures are subjected to different sources of excitations such as earthquakes, blasts, collisions, fluid-structure interaction, impacts, etc. that may induce high vibration levels and increase the risk of system failure. Hence, linear vibrations absorbers have been employed to protect such dynamical structures from collapse. However, these are only effective at a specified primary structure natural frequencies and their performance significantly deteriorates as the frequency changes. The newly proposed vibration absorbers, usually referred to as Nonlinear Energy Sinks (NESs) incorporate the essential nonlinear property that enables efficient and rapid vibration mitigation for wide frequency-energy domain. Consequently, many types of NESs have been proposed in literature and those are classified by the method of nonlinearly attaching the NES to the associated floor of the primary structure into stiffness-based, rotary-based and impact-based NESs. This paper presents a numerical investigation in which the most common NES types: cubic-stiffness NES, rotary NES, double-sided and single-sided vibro-impact (SSVI) NESs, are optimized, discussed and compared for energy transfer and dissipation for an impulsive excitation into a large-scale nine-story dynamical structure. The system description and governing equations of each coupled system are given first followed by a numerical optimization to maximize energy transfer and dissipation. It is found that an optimized SSVI NES gives the best performance to achieve highly efficient targeted energy transfer (TET).

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