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Deep Tuned Sloshing Damper with Multiple Horizontal Baffles for Structural Vibration Control

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Abstract

In most of the real-life installations of tuned sloshing dampers (TSDs), small containers with shallow liquid depth ($d/B \leq 0.1$, where d = liquid depth and B = container dimension along excitation direction) have been used as higher d/B or B leads to reduced inherent damping of the TSD. A shallow-TSD system normally consists of a large number of small damper units to fulfill the requisite mass ratio. This may create maintenance issues and difficulty in using the damper liquid, generally water, during emergencies such as firefighting. Although one, or a few deep-TSDs ($d/B > 0.5$) with higher B, could cater to the required mass ratio, such TSDs have insignificant inherent damping. This leads to the inclusion of energy dissipating devices such as nets, and baffles in deep-TSDs. This article focuses on enhancing the energy dissipation in a deep-TSD by using multiple horizontal baffles to present deep-TSDs as a practical alternative to shallow-TSD systems. The deep-TSD with multiple horizontal baffles is represented through an equivalent mechanical model. The structure is modeled as a single-degree-of-freedom system. The equations of motion of the structure-damper system are developed. The performance of the deep-TSD with horizontal baffles is evaluated through a numerical study by considering an example structure-damper system under seismic excitations. The results indicate that the performance of the deep-TSD is significantly improved due to the installation of the horizontal baffles. Further, the effectiveness of the deep-TSD with multiple horizontal baffles is found to be comparable to that of a shallow-TSD system having an identical mass ratio.

Keywords: Deep tuned sloshing damper, Multiple horizontal baffles, Earthquake excitation, Structural vibration control