Rotating Fluid in Paraboloidal Tank Tuned Liquid Damper as an Effective Vibration Absorber

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In this study, I demonstrate the tuned liquid dampers (TLD) consist of paraboloidal tanks equipped with flow-guiding vanes, which can effectively mitigate the vibration of structure induced by external forces. The sloshing fluid in paraboloidal tanks can generate considerably less turbulences than the conventional cylindrical ones, which provide the higher effective mass ratios of fluid participating in sloshing absorption. In testing the performance of this TLD system, several tank curvatures, water fill-up levels, mass ratios of water to structure, and flow directions in tanks are carefully examined under three excitation amplitudes in the experiments. Damping coefficients are used to assess the overall performance of the TLD-structure system. Optimal vibration mitigation is finally obtained when the sloshing frequency of fluid is close to the natural frequency of structure. I find the breaking wave occurs on tank wall accompanied with the rotating fluid triggered at the resonant frequency of the TLD-structure system with high degree of coherence. Therefore, the rotating fluid in TLD can disperse the external vibration energy and generate anti-phase damping forces to mitigate the vibration. For effectively triggering the fluid to rotate in the desired directions, a streamlined flow-guiding vane is innovatively installed in each tank. Meanwhile, the fluid in pairs of TLD tanks have the opposite directions of rotation to prevent the generation of a net lateral force. The study illustrates that the paraboloidal tank TLD with flow-guiding vanes is indeed an effective device in mitigating the vibration of structure.

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