

Numerical Simulation of Tuned Liquid Damper Filled with Different Fluids by MPS Method

Xiao Wen, Xiang Chen, Decheng Wan*

State Key Laboratory of Ocean Engineering, School of Naval Architecture, Ocean and Civil Engineering, Shanghai Jiao Tong University, Collaborative Innovation Center for Advanced Ship and Deep-Sea Exploration, Shanghai 200240, China

*Corresponding author, E-mail: dcwan@sjtu.edu.cn

ABSTRACT

Tuned liquid damper (TLD) is a new kind of passive damper, which can be used in building structures and ships to damp unwanted oscillations. The damping characteristic of TLD depends on the sloshing of shallow depth liquid in a rigid rectangular tank. The liquid sloshing in TLD produces a periodic torque to counteract the external forces and dissipates large amounts of energy. However, due to the violent sloshing, the prediction of the motion of TLD has always been a challenge. In this paper, an in-house meshless solver MlParticle-SJTU, based on the modified MPS (moving particle semi-implicit) method, is employed to simulate the liquid sloshing in the TLD system. The aim of this paper is to compare the damping effectiveness of TLD with different fluids filled. Three kinds of fluids with experimental data are taken into consideration in this paper, differing largely in viscosity. First, the fully coupled angular motion of TLD filled with different fluids is simulated by the MPS method. Compared with the roll motion of empty tank, the damping effectiveness of TLD can be obtained. Then, the torque exerted by the fluid on the TLD and the energy dissipated due to sloshing are numerically calculated. For different fluids, the torque and energy dissipation vary greatly, offering us an insight into the mechanism of TLD. Finally, the results obtained by numerical method are compared with the experimental results, to indicate the advantages of the present modified MPS method.

Keywords: Meshless particle method; MPS; MlParticle-SJTU solver; Tuned liquid damper; Sloshing; Viscosity; Roll motion.