Bauhaus-Universität Weimar

Institute of Structural Engineering
Chair of Modelling and Simulation of Structures
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Numerical Models for the behaviour of Liquid Dampers in Analyses of Wind Response of Structures

Content of research

Flexible, slender and tall structures, such as high-rise buildings, bridges or chimneys are sensitive to dynamic wind excitations, therefore damages or fatigue may occur. Whilst prediction models for wind-induced response have become more reliable, building wind-sensitive structures has become more common. Vortex-induced vibrations are a nonlinear resonance problem that frequently leads to problems in flexible structures. For many of these the provision of additional damping is the only robust and practical method to control the dynamic problems. Liquid dampers have become an active research area as their applicability in structures increased due to their low maintenance costs and even double functionality, such that containers can be used for building water supply or firefighers. Tuned Liquid Dampers (TLD) are rigid tanks partially filled with a liquid, most of the cases water, whose function is to absorb the strutural dynamic vibrations through the effect of sloshing against the walls of the tank.
The project aims at developing numerical models to study the efficiency of liquid dampers with different configurations in the analysis of wind response of structures. To this purpose a Smoothed Particle Hydrodynamics (SPH) solver is used to study the behavior of liquid under various excitations, which will be further coupled numerically with a validated software for wind-structure interaction (AWind) in order to test the dampers efficiency and to apply to various projects. The numerical solver (DualSPHyisics) can be further validated with experiments by verifications at shaking table. The work will involve extensive validation studies based on data from past bridge and tower projects available, such that a practical modelling framework will be developed that can be used in the design of structures employing liquid dampers.

Collaboration

EPHYSLAB Environmental Physics Laboratory, University of Vigo, Spain (Dr. Alejandro J.C.Crespo, Dr. Jose M.Domínguez, Orlando García-Feal)

Softwares

AWind
DualSPHysics (https://dual.sphysics.org/)

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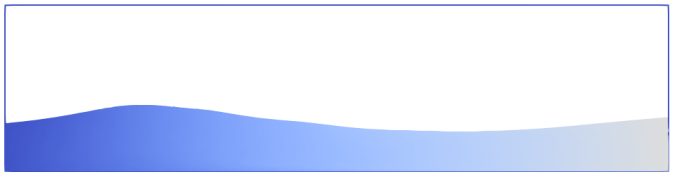
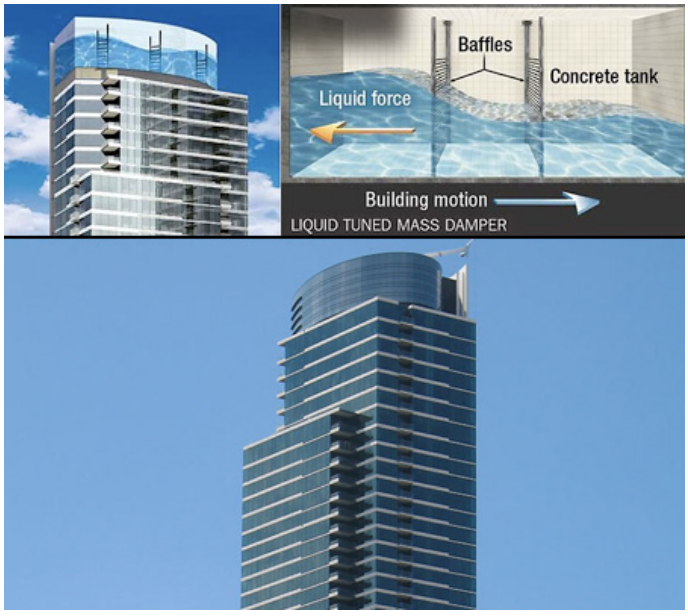
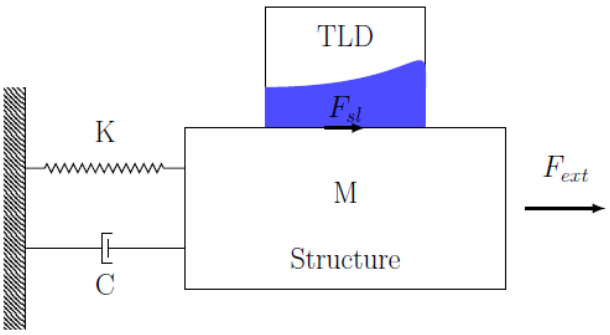


SPH solver for liquid behavior under horizontal excitation



Example of a Liquid Damper installed on a high-rise building (Source: http://www.techeblog.com/)



Equivalent mechanical model of spring-mass-dashpot with tuned liquid damper

Related publications

Vîlceanu V., Morgenthal G., Domínguez J.M., García-Feal O., Crespo A.J.C., Gómez-Gesteira M.: "Simulation of liquid sloshing dampers by coupling of SPH with structure dynamic analysis", Conference 2019 SPHERIC International Workshop, Exeter, England.