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Erdle, A., Smith, I., Weckendorf, J., Asiz, A.

Control of the dynamic performance of hybrid steel frame and cross laminated timber slab buildings
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Abstract
Distributed Tuned Liquid Damper (DTLD) systems for multi-storey building superstructures consist of arrays of partially filled liquid containers attached to the structural system and distributed amongst the storeys, to enhance the modal damping characteristics of substructures and entire structures. Work described here considerers DTLD systems as supplemental damping to hybrid superstructures that combine steel primary frameworks with Cross Laminated Timber (CLT), or other lightweight massive wood, slabs as an alternative to reinforced concrete slabs. The objective is to control lateral motions of building superstructures during normal and extreme loading events. Previous studies by the authors have shown that using CLT alone with steel frameworks is an effective way of reducing gravitational and lateral structural demands on steel frameworks, and for controlling lateral drift motions during normal or unusual loading events. Addition of DTLD systems is considered to further control dynamic motions without unacceptable amplification of lateral accelerations at above ground floor levels. The design of DTLD's is examined here with respect to their masses and sloshing frequencies, based on laboratory tests in which peak acceleration and damping characteristics of a scaled superstructure system fitted with rectangular box Tuned Liquid Dampers (TLD) were measured. Results collected to date indicate that using DTLD's is an effective method of controlling lateral motions in buildings with steel frameworks and massive wood slabs. Experiments showed that peak lateral acceleration of steel framework-and-wood slab superstructures is not sensitive to the mass of liquid in DTLD's, provided that the mass of the fluid in them is at least about 1 percent of the superstructure mass. In experiments, no strong sensitivity to the tuning accuracy of DTLD's was observed for control of motion attributable to the fundamental mode of vibration. However it may be required in practice to have DTLD arrays tuned to multiple response frequencies for overall control of lateral motions of buildings. Experiments also showed that damping of the system was increased with an increase in the mass of liquid and was not affected by the sloshing frequency. Further work will examine detailed aspects of the technical issues and how DTLD systems should be designed.

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