

Real-Time Hybrid Simulation for a Tuned Liquid Column Damper Implementation

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Abstract : Real-time hybrid simulation (RTHS) is a modern cyber-physical technique used for the experimental evaluation of complex systems, that treats the system components with predictable behavior as a numerical substructure and the components that are difficult to model as an experimental substructure. Therefore it is an attractive method for evaluation of the response of civil structures under earthquake, wind and anthropic loads. Another practical application of RTHS is the evaluation of control systems, as these devices are often nonlinear and their characterization is an important step in the design of controllers with the desired performance. In this paper, the response of three-story shear frame controlled by a tuned liquid column damper (TLCD) and subject to base excitation is considered. Both passive and semi-active control strategies were implemented and are compared. While the passive TLCD achieved a reduction of 50% in the acceleration response of the main structure in comparison with the structure without control, the semi-active TLCD achieved a reduction of 70%, and was robust to variations in the dynamic properties of the main structure. In addition, a RTHS was implemented with the main structure modeled as a linear, time-invariant (LTI) system through a state space representation and the TLCD, with both control strategies, was evaluated on a shake table that reproduced the displacement of the virtual structure. Current assessment measures for RTHS were used to quantify the performance with parameters such as generalized amplitude, equivalent time delay between the target and measured displacement of the shake table, and energy error using the measured force, and prove that the RTHS described in this paper is an accurate method for the experimental evaluation of structural control systems.

Keywords : structural control, hybrid simulation, tuned liquid column damper, semi-active control strategy

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