Real-Time Hybrid Simulation of Large-Scale Steel Frame Building with Magneto-Rheological Dampers

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Abstract

Real-time hybrid simulation enables the efficient investigation of the dynamic response of various structural systems. In real-time hybrid simulation, the entire structural system is divided into two substructures, i.e., the analytical and experimental substructures. The structural component of interest is experimentally tested with a servo-hydraulic actuator system while the remaining structural parts whose behavior is well-understood are analytically modeled with a reliable finite element program. Compared to a shake table test, this arrangement of the experimental and analytical substructures is very economical and effective especially for testing large-scale structures.

In this presentation, the seismic performance of a 0.6-scale 3-story steel frame building with magneto-rheological (MR) dampers is investigated through real-time hybrid simulation. The experimental steel frame consists of the lateral force resisting system of the 3-story building along with the analytically modeled moment resisting frames (MRFs) and gravity frames. Large-scale MR dampers are placed in the experimental steel frame to control and mitigate the vibration of the building subjected to earthquake loads. Three large-capacity dynamic actuators at each floor level are used to impose the target floor displacements. An overview of the semi-active control of the MR dampers, performance-based design procedure, and the state-of-the-art algorithm for the multiple-actuator control is provided. Results from the real-time hybrid simulation are presented and discussed, and comparisons are made with nonlinear time history analysis results.

Biography

Dr. Yunbyeong Chae is currently a research scientist in the ATLSS Engineering Research Center at Lehigh University. He received his Ph.D. in structural engineering from Lehigh University in 2011. He received his Master of Science and Bachelor of Science from Seoul National University in South Korea in 2001 and 1999, respectively. Prior to his doctoral work, he was a structural engineer in GS Engineering and Construction from 2004-2006 and in Chungsuk Engineering from 2001-2004. His research interests include the innovative resilient structural systems, structural control, performance-based seismic design, and large-scale experimental studies. He has been significantly involved in several NEES (George E. Brown, Jr. Network for Earthquake Engineering Simulation) projects and has conducted a number of large-scale real-time hybrid simulations for structures with supplemental damping devices at the Lehigh NEES equipment site.