FULL-SCALE EXPERIMENTAL VERIFICATION OF SEMIACTIVE CONTROL USING THE FAST HYBRID TEST SYSTEM AT CU NEES

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Structural control shows great potential for hazard mitigation in civil structures. Semiactive structural control provides supplemental damping to more efficiently dissipate the energy due to dynamic loads while increasing the safety and performance of the structure [1-2]. Semiactive control has typically been designed for and applied to linear structures. Civil structures, however, are typically designed to yield during extreme dynamic loading, thus behaving nonlinearly. Because semiactive control devices cannot inject mechanical energy into the controlled system, the resulting control strategies are inherently stable and well suited for application to structures with uncertainties and systems with the potential to behave nonlinearly. Additionally, the low power requirements of semiactive devices ensure that during extreme events, when external power may not be available, the semiactive device can continue to fully function using an alternate power source. Despite these advantages, semiactive control in the presence of nonlinear structural behavior has yet to be demonstrated experimentally.

Full-scale experimental dynamic testing of a nonlinear building model is a challenging task that can be addressed through hybrid testing. Additionally, the experimental examination of semiactive control devices that are highly rate dependant with significant nonlinear behavoir can be addressed through fast, or real-time, hybrid testing. The George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) [3] Fast Hybrid Test System at the University of Colorado at Boulder (CU FHT) [4] is being used to conduct real-time hybrid tests to experimentally verify semiactive control applied to a nonlinear structure. For the fast hybrid tests described here, the experimental components that are being examined and verified are three large-scale Magneto-Rheological (MR) dampers and the analytical component is a series of building models with potential nonlinear beam-column connections. The CU FHT facility houses one 1000 kN (220 kip) and two 500 kN (110 kip) MTS hydraulic actuators that are employed in the fast hybrid tests of three semiactive 200 kN MR fluid dampers. The use of semiactive control devices that are capable of providing large variations in stiffness and damping in milliseconds creates some interesting challenges for the stability and accuracy of fast hybrid testing.

This paper will discuss the experimental setup and challenges faced in conducting hybrid tests for the full-scale experimental verification of semiactive control strategies for buildings exhibiting nonlinear behavior during large seismic events.

[1] Spencer, B.F., Jr., and Sain, M.K. (1997). ”Controlling Buildings: A New Frontier in Feedback.” *IEEE Control Systems Magazine: Special Issue on Emerging Technologies* (Tariq Samad Guest Ed.), 17 (6), 19-35.
[2] Soong, T.T. and Spencer, B.F., Jr. (2002). ”Supplemental Energy Dissipation: State-of-the-Art and State-of-the-Practice.” *Engineering Structures*, 24, 243-259.
[3] http://www.nees.org/
[4] http://ceae.colorado.edu/NEES/

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