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Developments and Applications of Large-scale Real-time Hybrid Simulation to enable Advancements in Performance-based Earthquake Engineering

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ABSTRACT
Hybrid simulation is a technique that enables a complete structural system to be included in an experimental test. The development of new devices and ideas to improve the performance of systems has gained considerable interest among researchers as stakeholders have demanded a more resilience community to mitigate the effects of natural disasters. Because these devices and ideas typically possess load-rate dependent behavior, hybrid simulation is required to be performed in real-time in order to investigate the performance of systems that have these devices. This presentation will discuss accomplishments and new developments that have taken place at the Lehigh University NEES Equipment Site to enable large-scale real-time hybrid simulation to be utilized as a tool for seismic performance assessment. These developments include: unconditionally stable parametrically dissipative explicit integration algorithms for solution to the equations of motion; adaptive actuator control to achieve precise test specimen displacements during a real-time hybrid simulation; multi-grid computations to enable large computations to be performed quickly associated with real-time hybrid simulation; and, kinematic compensation for multi-directional real-time hybrid simulations. The implementation and applications of these developments will be then presented. A series of real-time hybrid simulations will be presented that illustrate thus use of these developments in experimentally assessing new ideas in earthquake hazard mitigation, enabling advancements in performance-based earthquake engineering to be achieved.

KEYWORDS: *Real time hybrid simulation, explicit integration algorithms, adaptive control, performance based earthquake engineering*