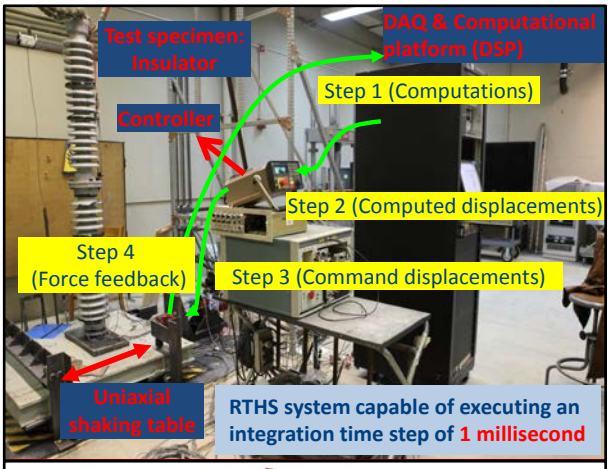
Hybrid Simulation: Fundamentals, Recent Developments and Links to Analytical Simulation and Performance Based Earthquake Engineering

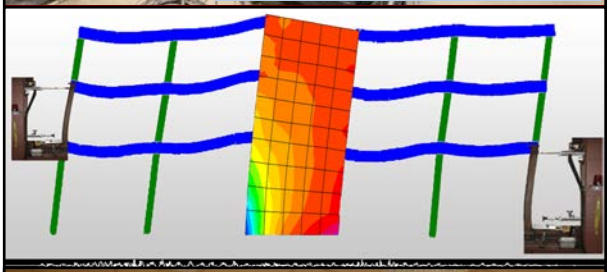
by Mehmet Selim Günay, Ph.D.
University of California, Berkeley

Date:	January 14th, 2014 (Tuesday), 15:00-16:00
Place:	Earthquake Engineering and Disaster Management Institute, Prof. Dr. Remzi Ülker Conference Hall, Istanbul Technical University

Abstract

Hybrid simulation, also known as **pseudo-dynamic testing**, is a method for examining the seismic response of structures by using a hybrid model composed of both physical and numerical substructures. Because of the unique feature of the method to combine physical testing with analytical simulations, it provides an opportunity to investigate the seismic response of structures in an efficient and economically feasible manner. It is this feature of the method which made it gain widespread use in recent years.





This presentation starts with a brief introduction of NEES (**Network of Earthquake Engineering Simulation**) and the nees@berkeley testing facility. This introduction is followed by background information on hybrid simulation: the theory behind the method, benefits of the method and a brief overview of the previous research related to various aspects of the method, namely substructuring, integration methods, simulation errors and geographically distributed hybrid simulation.

Subsequently, the presentation covers three recent developments, which are aimed towards broadening the application range of real-time hybrid simulation (RTHS). First of these developments is a standalone RTHS system which can accommodate integration time steps as small as 1 milisecond. Second development is the use of an efficient equation solver in RTHS which decreases computation time. The third development is the novel use of a three-variable control (TVC) for RTHS on a shaking table configuration. Application of these developments in

testing porcelain and polymer composite insulator posts of high voltage electrical switches are presented. Links which extend the hybrid simulation experience to analytical simulation are also discussed during this part.

Finally, the presentation is concluded with an application, where the hybrid simulation results are employed in the context of Pacific Earthquake Engineering Research Center's (PEER) Performance Based Earthquake Engineering (PBEE) methodology. PEER's PBEE methodology is a second generation PBEE method that considers the effects of earthquake hazard on the society in a rigorous probabilistic manner. The method covers all the aspects related to the earthquake hazard; namely earthquake intensity, ground motion characteristics, structural response, physical damage, and economic and human losses.