REAL TIME HYBRID DYNAMIC SIMULATION WITH SUBSTRUCTURE TECHNIQUES

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ABSTRACT

The development and implementation of a novel real time seismic response simulation method for large to full-scale structures, which involve the combined use of shake tables, dynamic actuators and computational engines is presented. With this technique, it is possible to test a substructure at full scale, or close to full scale, while the rest of the structure is simulated by computers. At the end of the synchronized analysis and testing it is possible to obtain realistic response of the entire system. The method was defined as *Real Time Dynamic Hybrid Simulation (RTDHS)*. The structure to be simulated is divided into one or more physical-experimental and computational substructures. Interface forces between the physical and computational substructures are imposed by actuators and the resulting displacements and velocities are fed back to the computational engine. The dynamic excitation, such as an earthquake ground motion, is applied to the physical substructure by shake tables. The unique aspect of the above hybrid simulation method is the force-based substructuring. Since the shake tables induce inertia forces in the experimental substructures, the actuators at the interfaces have to be operated in dynamic force control as well. The simulation method presented herein is more versatile than the existing seismic simulation methods.

The substructuring strategy related to RTDHS is presented focusing on the structural model condensation for real time simulation purpose and on interface force calculation. The numerical integration algorithm associated with the computational substructures is discussed along with the implementation of the computational engine. Issues related to the implementation of RTHDS are identified including force-controlled strategy in dynamic actuators and time delay compensations. A unique compensation controller is designed and experimentally verified. An example of a real-time hybrid test implementation, and results from this experiment are also presented.

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