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PROSPECT OF MULTIPHASE HYBRID SIMULATION FOR DISASTER MITIGATION

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Abstract

Structural test on models have always played a significant role in structural engineering design, research and education. Particularly, experiments on reduced-scale models have always been important in understanding structural mechanics and structural engineering concepts, and rather full-size structures were sometimes used to assure the design concept and real safety of structures under various actions. Engineers, researchers and students may face a wide range of problems in planning, conducting, and interpreting an experimental study of structural behavior. For example, these are ranging from the theoretical similitude requirements to rather extensive discipline of stress analysis and instrumentations. Since structural models to predict structural behavior require measurement of strains, displacements and forces under prescribed conditions, the currently most-used techniques such as the electrical resistance strain gages and computers are perhaps the most important development in terms of providing variety of sensing devices, data acquisition of measurements and accurate control of loading.

Looking at civil engineering structures, the larger and more complex structural systems have been often constructed and even high performance structural materials and advanced construction technology are experimentally practiced at the present. Since such structural systems consist of many structural elements of different mechanical properties, the overall mechanical behavior of the structures up to their ultimate state depends on mainly the interaction among their structural elements. The remarkable development of computer and numerical analysis methods can make it possible to evaluate such an interaction of structural elements much easier than ever before. For example, a multi-CPU parallel computer with the speed of 33.86 PFLOPS and even faster was developed and more than ten millions of D.O.F. can be solved easily and visualized by using the Pre/Post data preparation technology as

well.

On the other hand, semi-analytical methods by means of combining analysis with experiment, so-called hybrid test, have been developed. They have been utilized particularly for the evaluation of nonlinear dynamic responses of structures, and are also referred as the pseudo-dynamic test. The advantage of pseudo-dynamic test is that the existing testing facilities can be utilized just like conducting static loading test, without specialized test systems such as shaking table. Its versatility was demonstrated in terms of substructure technique, digital actuator, real-time test, scale effect, rate effect, soil-structure interaction and error control. In addition, the on-line network testing using the Internet was also examined. The idea seems attractive particularly for pseudo-dynamic testing of complex structural systems with many components subjected to severe nonlinear behavior, which could otherwise require many sets of expensive structural testing facilities. This idea also leads the development of multi-phase hybrid system combining various kind of testing apparatus, simulators and computers by sharing the common data through the network for disaster prevention.

This presentation covers the prospect of feasible developments in testing and simulation for large structural systems with surrounding environment subjected to natural disasters. At first the seismic response analysis of vehicle-bridge interactive systems is presented; then the effective link to the drive simulator benefit from the comprehensive 3D visual and interactive attributes between drivers and vehicle dynamics is introduced as use of the man-machine interface. Secondly the practical use of supercomputer to the large scale simulation for civil infrastructures such as the serviceability assessment of urban road network against the near-fault earthquake, and the safety assessment of long-span bridges against the subduction-zone earthquake and tsunami is briefly discussed. Finally, the prospect of multiphase hybrid simulation with information technology for disaster mitigation is summarized