Upgrade of Universal Element Tester for Nuclear Energy Infrastructure Research

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ABSTRACT:

Nuclear containment structures are of great importance in containing radioactive material, protecting the nuclear system from weather and other external threats, and acting as a supporting structure for operational equipment. Realistic assessment of shear behavior of containment structures is a key to safe design and analysis of containment structures against internal pressure, earthquake action, and high local loads. The behavior of nuclear containment structures under shear, however, has not been studied thoroughly.

Previous studies concerning shear in reinforced concrete containment resulted in experimental equations for the prediction of the ultimate shear strength. Shear failure is particularly difficult to evaluate, and there is no generally recognized, reliable method of determining shear capacity of a reinforced concrete element in a complicated stress state. This difficulty of evaluation is due mainly to restrictions of experimental techniques and the difficulty of applying shear without interfering with the cracking behavior of specimens and the unlikeliness that large-scale dynamic tests can be done given the magnitude of forces involved.

A universal element tester, constructed from1986-1988 at the University of Houston, with in- and out-of-plane jacks and a servo-control system, can perform biaxial or triaxial tests on full-size concrete elements with load-control and strain-control loading modes. Two rational models, namely the softened membrane model for monotonic loading, and the cyclic softened membrane model for cyclic loading, have been developed to predict the behavior of reinforced concrete, pre-stressed concrete, and pre-stressed steel fiber concrete elements. For further studies of the behavior of reinforced concrete, prestressed concrete, steel plate concrete, and advanced materials used in nuclear power containments, however, an upgrade of the universal element tester must be done. The systems and functions that need to be renewed or added are: 1) Computer Control System and 2) Tele-participation Computer System.

With this upgrade, extensive studies on the shear behavior of nuclear containment structures can be carried out with full-size specimens and realistic boundary conditions. Results of the studies will have a profound effect on seismic design and analysis of nuclear containment structures. The upgrade will also enhance the teaching on nuclear containment structures, and faculty and students from the collaborative universities (Texas Southern University and Prairie View A&M University) will be beneficial.