6th International Conference on Advances in Experimental Structural Engineering
11th International Workshop on Advanced Smart Materials and Smart Structures Technology
August 1-2, 2015, University of Illinois, Urbana-Champaign, United States

Development and validation of an experimental blast simulation technique utilizing shake-table-produced ground motion

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ABSTRACT
In recent years, concerns over terrorism have made investigation of the effects of blasts on structures increasingly important; however, security, safety and financial concerns create large logistical challenges for engineers and researchers involved with the explosive blast testing of structures. As a consequence of these challenges, and the limited number of adequate facilities available for these tests, only a relatively small number of structural engineering research projects utilize explosive blast testing. In contrast to this, a large number of structural engineering research projects utilize excitations produced by shake tables, which are available at many universities, corporations, and government agencies. With the logistical challenges to explosive blast testing in mind, this work seeks to develop a technique for experimentally simulating the global response of structures subjected to blast using shake-table-produced ground motion. In this work, the limitations of such a technique are explored and a prototype ground motion for experimental blast simulation is proposed. After this, a methodology developed for shaping this prototype ground motion based on the evaluation of modal energy is presented. Additionally, validation of this technique is performed by comparing the results of a set of experimental studies performed on a large-scale nine-story structure. For this validation, explosive blast testing of the structure was performed at the US Army Corps of Engineers Engineer Research and Development Center Big Black Test Site near Vicksburg Mississippi and shake table testing of the same structure was performed at the US Army Corps of Engineers Construction Engineering Research Laboratory in Champaign Illinois. The results of this comparison shows that the technique utilizing shake-table-produced ground motion developed in this study can be used to accurately experimentally simulate the global response of a structure due to blast.

KEYWORDS: