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 Numerical Simulation of Sub-structural Shaking Table Testing Framework Considering Soil/Fluid – Structure Coupling Effects

Ning Li*, Z.X. Li, Billie F. Spencer Jr

* *Presenting Author*

Corresponding Author: Ning Li
Contact Email: neallee@illinois.edu

ABSTRACT
For large scale structure shaking table experiments, especially for the oversea bridges, high-rise buildings, offshore structures and hydraulic structures, the coupled effects, such as soil and fluid – structure dynamic interaction (FSI/SSI) effects, need to be taken into account. A framework for shaking table testing method, which is developed based on substructure technique, is presented in this paper. The framework could be separated into three parts: the shaking table part, the structure/substructure numerical or physical part and the boundary condition part. In this paper, the uniaxial shaking table model with servo-hydraulic system is adopted for simplicity, which is implemented in Simulink. The test structure/substructure model is a numerical model of bridge pier which is implemented in OpenSees/OpenFresco. The frequency-dependent impedance function for FSI/SSI effect is expressed by Padé rational approximation firstly, and then the boundary condition for coupled dynamic effects is presented as recursive discrete filter which is implemented in Matlab. The connection between different parts is based on a low-time delay data transmitting technique. And each part of the test platform can be executed on different site distributed or on one site locally. A comprehensive study is made for soil- and fluid-structure interaction dynamic analysis. The linear and nonlinear seismic responses of the FSI/SSI systems in cases of considering or not considering interaction effects is illustrated. This paper proposes an efficient and simply achieved method for shaking table testing of large structural experiments taken into account the FSI/SSI effect, and the results of this research provide novel means to tackle coupled issues in hybrid simulation and tests.

KEYWORDS: *sub-structure method; soil-structure interaction; fluid-structure interaction; shaking table test; nonlinear seismic response*