

Seismic Assessment of a Pre-Cast Recycled Concrete Block Arch System

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Abstract : This study aims to assess the seismic performance of arch and dome structural systems made from easy to assemble precast blocks of recycled concrete. These systems have been developed by Lock Block Ltd. Company from Vancouver, Canada, as an extension of their currently used retaining wall system. The characterization of the seismic behavior of these structures is performed by a combination of experimental static and dynamic testing, and analytical modeling. For the experimental testing, several tilt tests, as well as a program of shake table testing were undertaken using small scale arch models. A suite of earthquakes with different characteristics from important past events are chosen and scaled properly for the dynamic testing. Shake table testing applying the ground motions in just one direction (in the weak direction of the arch) and in the three directions were conducted and compared. The models were tested with increasing intensity until collapse occurred; which determines the failure level for each earthquake. Since the failure intensity varied with type of earthquake, a sensitivity analysis of the different parameters was performed, being impulses the dominant factor. For all cases, the arches exhibited the typical four-hinge failure mechanism, which was also shown in the analytical model. Experimental testing was also performed reinforcing the arches using a steel band over the structures anchored at both ends of the arch. The models were tested with different pretension levels. The bands were instrumented with strain gauges to measure the force produced by the shaking. These forces were used to develop engineering guidelines for the design of the reinforcement needed for these systems. In addition, an analytical discrete element model was created using 3DEC software. The blocks were designed as rigid blocks, assigning all the properties to the joints including also the contribution of the interlocking shear key between blocks. The model is calibrated to the experimental static tests and validated with the obtained results from the dynamic tests. Then the model can be used to scale up the results to the full scale structure and expanding it to different configurations and boundary conditions.

Keywords : arch, discrete element model, seismic assessment, shake-table testing

Conference Title : ICCSDEE 2016 : International Conference on Computational Structural Dynamics and Earthquake Engineering

Conference Location : Istanbul, Türkiye

Conference Dates : April 19-20, 2016