Low Damage Reinforced and Prestressed Concrete Elements for Resiliency

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Abstract

In addition to casualties and injuries, earthquakes may cause significant economic losses and disruption to civilian life. Recent earthquakes in New Zealand, Haiti, and Turkey showed that it may take businesses, cities and countries years to recover from these losses, rebuild structures and return to normal operations. Loss of structure operability amplifies the adverse effects of a hazard on the society, economy and the environment. Motivated by the urgent need for resiliency to extreme events and the need for infrastructure longevity, Dr. Okumus' research focuses on low seismic damage, serviceable, reinforced, prestressed and prefabricated concrete structures. Low damage is achieved through the controlled rocking of precast concrete systems, in which un-bonded post-tensioning is employed to connect members to each other or to foundation. Rocking systems can self-center after the removal of lateral loading and can eliminate large residual displacements associated with plastic hinging in traditional systems. This presentation will cover recent efforts by Dr. Okumus' group on the analysis and cyclic testing of innovative lateral load resisting elements for bridges and buildings. High performance materials such as an advanced cementitious composite called ultra-high performance concrete and high strength steel reinforcement are used selectively in regions that are prone to crushing, spalling and cracking damage in bridge piers. Hybrid use of emulative (of cast in place concrete) and non-emulative (rocking) connections were investigated to balance self-centering with energy dissipation. Cyclic flexural response of ultra-high performance concrete is evaluated as compared to the one of normal concrete. In addition to uses of rocking systems for new structures, applications of self-centering to resilient seismic retrofit of existing code-deficient shear walls are also considered for building structures, benefiting from the concept of selective weakening. The presentation will end with a discussion on how modularization of precast concrete can be utilized to create repairable, replaceable, sustainable shear walls that are also architecturally appealing. These systems utilize interlocking elements and can localize seismic damage in select elements for resilience. Finally, Dr. Okumus will provide information on the graduate program of University at Buffalo, including the MS degree at the Institute of Bridge Engineering and the application process for students interested in higher degrees.

Bio Sketch

Dr. Pinar Okumus is an Assistant Professor at the Department of Civil, Structural and Environmental Engineering at University at Buffalo (UB), the State University of New York. She joined the faculty of University at Buffalo in 2013, after obtaining her PhD and MS degrees from University of Wisconsin, Madison. She holds an BS degree from Middle East Technical University, Turkey. Her research is on understanding the fundamental structural behavior of reinforced and prestressed concrete structures under service and extreme loads. Her work has been funded by federal and state departments of transportation, the National Science Foundation of the US, and local bridge professional organizations. She was the recipient of the PCI George Nasser Award in 2013.