Air-coupled Ultrasonic Tomography for Internal Damage of Full-Scale Reinforced Concrete Moment Frame Components Subjected to Seismic Loadings

Hajin Choi1, John S. Popovics1, Guillermo Palacios2, Young-Jae Choi2, and Shih-Ho Chao2, 1Civil and Environmental Engineering, University of Illinois at Urbana-Champaign; 2Civil Engineering, University of Texas at Arlington

Full-scale reinforced concrete (RC) components are imaged using ultrasonic tomography before, during, and after simulated earthquake loads, up to a drift level of 1%, are applied. A total of five RC moment frame components, including three columns and two slab-beam-column sub-assemblages, are subjected to three different seismic loading protocols. Two advanced structural materials, ultra-high-performance fiber-reinforced concrete (UHP-FRC) and high-performance fiber-reinforced concrete (HPFRC) are used in one of the columns and one of the slab-beam-column sub-assemblages, respectively. The components contain embedded strain gauges that are used to establish accumulated damage at certain locations. Our hybrid air-coupled ultrasonic system is used to collect a large volume of through thickness ultrasonic data across the plastic hinge zone region of the components. The ultrasonic data sets are used to back-calculate wave velocity tomograms across the cross-section at the plastic hinge regions for each component. A comparison of ultrasonic and strain gauge data shows the great potential of using ultrasonic tomography to evaluate damage progression of RC structures both at global and local levels. The results also confirm that UHP-FRC and HPFRC behave differently from conventional reinforced concrete.