Characterization of Reinforced High Performance Fiber-Reinforced Concrete Composites for Bridge Columns

Sarah L. Billington[1], Claudia Ostertag[2], Daniel M. Moreno[3], Gabe Jen[4], Will Trono[4]

Research is being conducted to develop robust analytical models and design guidelines to facilitate the implementation into practice of reinforced, high performance fiber-reinforced concrete (HPFRC) subjected to cyclic tension, compression and confinement. Currently no guidelines exist for modeling and designing with ductile HPFRC materials when reinforced with mild steel with the exception of a recently adopted option of using steel fiber HPFRC in place of minimum shear reinforcement in ACI-318 (2008). A unique strain compatibility between the HPFRC and the mild steel results in better strain distribution in the steel in tension, controlled damage under sustained cyclic loading and higher ductility levels at relatively large deformations. In addition, minimal damage and spalling has been observed with low reinforcing ratios of confinement for compression members. The objective of this research is to understand and characterize the interaction between the reinforcement and the HPFRC, in particular HPFRC materials with varying properties, through experimental testing to proper develop appropriate models for structural performance predictions.

Two different ductile HPFRC mix designs, hybrid fiber concrete referred to as HyFRC and Engineered Cementitious Composites referred to as ECC, are under investigation, both of which have been studied experimentally in large-scale for bridge applications at PEER and elsewhere. These two materials represent well the range of unique properties and characteristics of many ductile HPFRC materials. Large-scale tension-stiffening tests and confined compression tests are being conducted. Results to date indicate that reinforced ECC and HyFRC maintain strain capacity beyond strains at which they fail if tested unreinforced. In addition, high confinement ratios are not needed with self-compacting HyFRC materials, as they do not exhibit severe damage localization at failure.

[1] Associate Professor, Dept. of Civil and Environmental Eng., Stanford University, Stanford, CA
[2] Professor, Dept. of Civil and Environmental Eng., University of California at Berkeley, Berkeley, CA
[3] Graduate Research Assistant, Dept. of Civil and Environmental Eng., Stanford University, Stanford, CA
[4] Graduate Research Assistant, Dept. of Civil and Environmental Eng., University of California at Berkeley, Berkeley, CA