Testing of Ductile, High-Performance Fiber-reinforced Concrete for Future Model Development with Application to Bridge Columns

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Outline

• Objectives of the Research Program
• Research Tasks
• Accomplishments to Date
• Future Directions
Objectives

1. To conduct fundamental, small-scale experiments on reinforced, high-performance and deflection-hardening fiber-reinforced cement-based composites

2. To develop analytical models and design guidelines for these materials

Envisioned as a multi-year project. Year 1 (current) focuses on two tasks: confinement & tension stiffening of reinforced composites to begin model development.
Research Tasks for Current Project

Task I: Study effect of confinement on ductile fiber reinforced composites

Task II: Study tension stiffening effect of ductile fiber reinforced composites

Tensile Stress (MPa)

Tensile Strain

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<tr>
<th>Drift (%)</th>
<th>ECC-1</th>
<th>ECC-2</th>
<th>Reinf. Concrete</th>
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Applied Load (kN)
Accomplishments to Date

Task I:  Study effect of confinement on ductile composites
- Small scale testing of HyFRC, SC-HyFRC completed
- Initial ECC testing performed, to be completed in Fall 2010

Task II: Study tension stiffening effect on ductile composites
- Two experimental set-ups designed and manufactured
- Validation of set-ups on initial set of ECC specimens
- Completed dogbone testing of HyFRC materials
- Will complete ECC dogbone and all prism testing in Fall ‘10
Brief Summary of Results

Task I: Effect of confinement on fiber reinforced composites
• 48 confined 6”x12” cylinders in uniaxial compression with varying levels of passive confinement
• Plain concrete and HyFRC, Plain SCC and SC-HyFRC

Findings to date:
• High confinement ratio not needed with SC-HyFRC
• No damage localization in SC-HyFRC but observed with SCC
Task II: Tension stiffening effect reinforced composites

- Two experimental set-ups designed and manufactured; *Reinforced dogbones & reinforced prisms*
- Dogbone set-up validated (14 tests completed)
- Reinforced ECC & HyFRC maintain strain capacity well beyond strains at which they fail if tested unreinforced
- Analysis and modeling initiated using multiple material-level characterization tests
Remaining Work

On budget to complete current focus by Nov. 2010

1. Complete compression and tension stiffening tests
2. Complete initial analysis of characterization tests to use in modeling

Final joint report ready in Winter 2011
Future Directions

1. Develop modeling approaches with existing experimental data (additional tension/compression experiments likely needed)

2. Validate modeling on new flexural tests, column tests, and others’ bridge pier experiments

3. Longer-term: Bond/pull-out testing for bond-slip characterization