Investigation of Crack Propagation in Composite Beams Using Fiber Reinforcement

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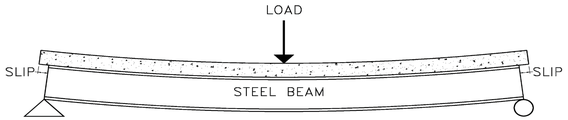
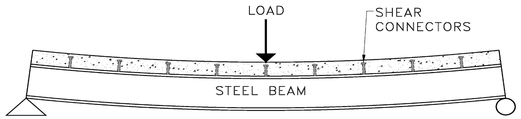
Objective

An experiment to test the effect of fiber reinforced concrete on the flexural behavior of composite beams will be done and compared to composite beams with steel mesh reinforcement.

Background



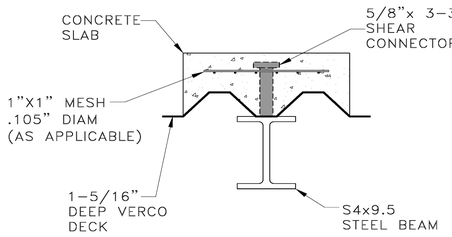
No Composite Action



Full Composite Action

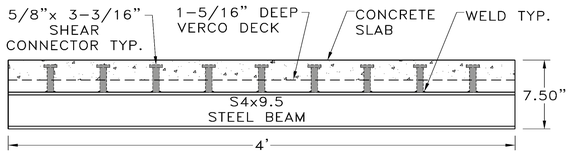
- Shear Connectors are used to connect the concrete slab to the steel beam. This allows the two components to deflect as one.
- Stresses in the concrete can lead to the development of cracking and crushing in the concrete slab.

Experiment



Composite Beam - Cross Section

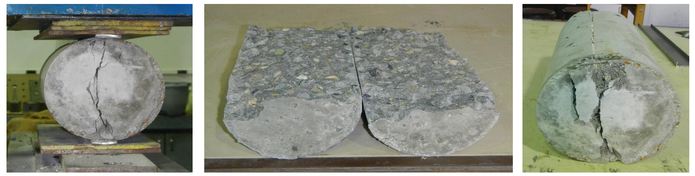
- Three types of specimens were tested under bending.
  - (6) composite beams with steel mesh reinforcement at various stud spacing.
  - (5) composite beams with steel fiber reinforcement at various stud spacing.
  - (1) composite beam with steel mesh and steel fiber reinforcement at various stud spacing.



Composite Beam - Side View

Experiment Continued…

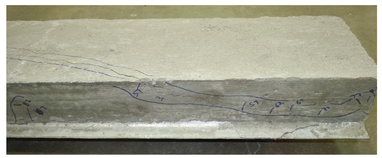
Compression Testing



Tensile Splitting Testing

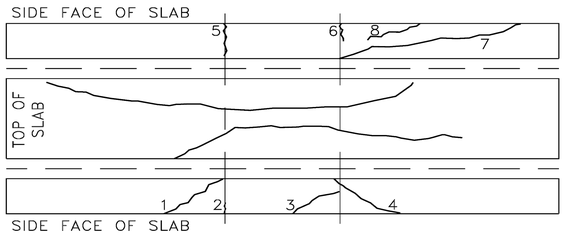
Loading of Specimen

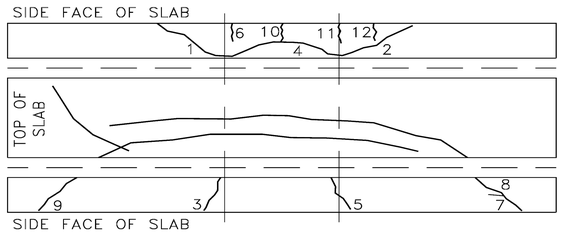
Specimen after Failure



Longitudinal Cracking & Shear Cracking

Results

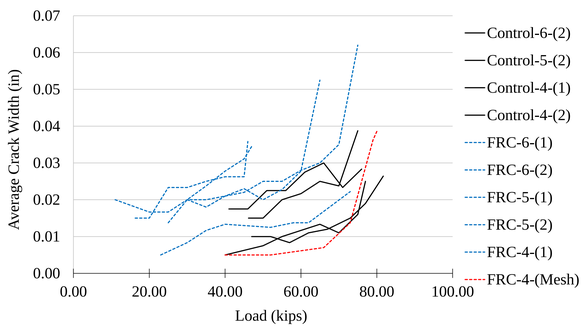




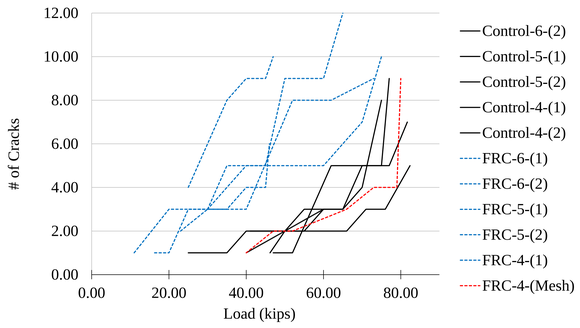
Typical Crack Propagations of Concrete Slab for Composite Beam

Typical failure came from shear cracks (1,4,7). Flexural cracks (2,5,6) contributed the least to failure.

Typical failure came from shear cracks (1,2,7,8,9). Flexural cracks (3,5,9,10,11,12) contributed the least to failure. The longitudinal cracks (cracks located at top of slab, contributed to the shear cracks (7,8,9).



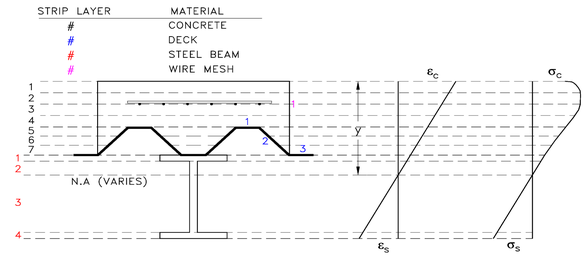
Average Crack Width Vs. Load



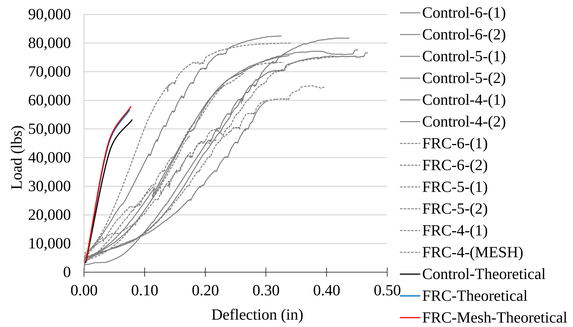
Average Crack Width Vs. Load

It can be observed that larger crack widths and the number of cracks first appear at lower loads for steel fiber reinforcement over steel mesh.

Results Continued…



Numerical Approach to Stress-Strain Distribution



Load Vs. Deflection

- Experimental values exceeded the theoretical values for composite beams acting under a bending load.
- Per unit volume, the specimens containing welded wire reinforcement performed better than the specimens solely containing steel fibers.
- Stud spacing did have an effect of the composite beams. The smaller the stud spacing the more strength the composite beam can hold.

Conclusion

- From this research, a good understanding of fiber reinforced concrete was sought. Thus, with more research, fiber reinforced concrete applied properly can be a benefit in composite beams
- Further research can still be done regarding fiber reinforced concrete in composite beams. The point of where the percent of volume needed to exceed the strength of the concrete composite beams with steel mesh reinforcement should be sought.

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