Session 63

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Testing of Structural Concrete Members Reinforced with a Carbon Fiber Grid

Topic Description

Structural concrete members reinforced with FRP flexural reinforcement behave in a non-ductile manner contrary to steel reinforced concrete members. In an effort to improve the ductility of FRP reinforced concrete members they were reinforced with a carbon fiber grid. The carbon fiber grid is used in a tubular configuration similar to spiral ties. The carbon fiber grid provides confinement to the concrete core which improves concrete ductility. That combined with a compression contolled design that results in a concrete crushing failure mode results in an improvement in the ductility of FRP reinforced concrete members. The confining effect of the carbon fiber grid was tested in different configurations and the results from such tests are presented.

Speaker Biography

Tony is a graduate research assistant at the department of Civil and Coastal Engineering at the Universtity of Florida.

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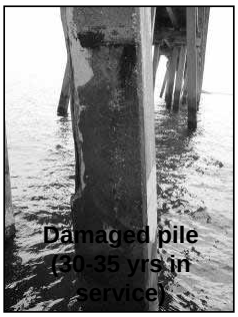
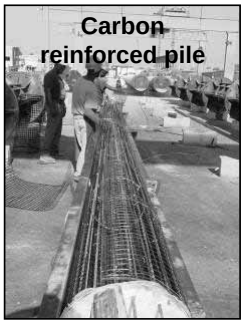
Overview

- Introduction
- CFRP composite grids
- Testing
  - Rectangular beams with grid tubes
  - Cast in place piles
  - Spun cast piles
- Conclusions

Introduction

- Corrosion of prestressing steel a problem for Florida
- Carbon FRP a possible solution
  - Carbon rebar (flexural reinf.)
  - Carbon fiber grid (confinement reinf.)



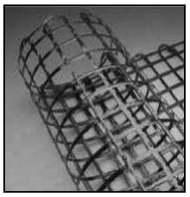


Why Carbon?

- Non-corrosive
- Unaffected by saltwater
- High strength
- CFRP grid
  - Easily formed into a tubular shape
  - Can be embedded in concrete

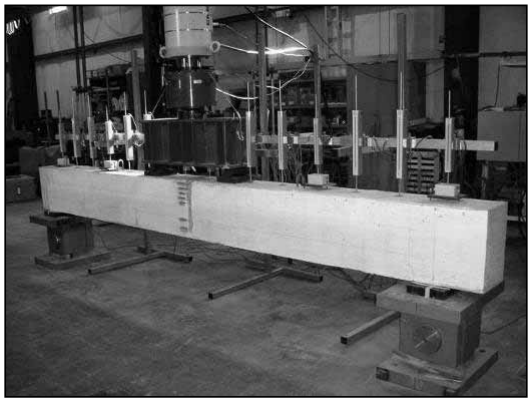
CFRP Grid

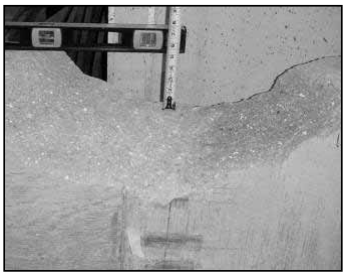
- Types
  - Heavy grid
  - Light grid
- Heavy grid
  - Used as reinforcement in slabs and bridge decks
- Light grid
  - Used to control cracks in concrete



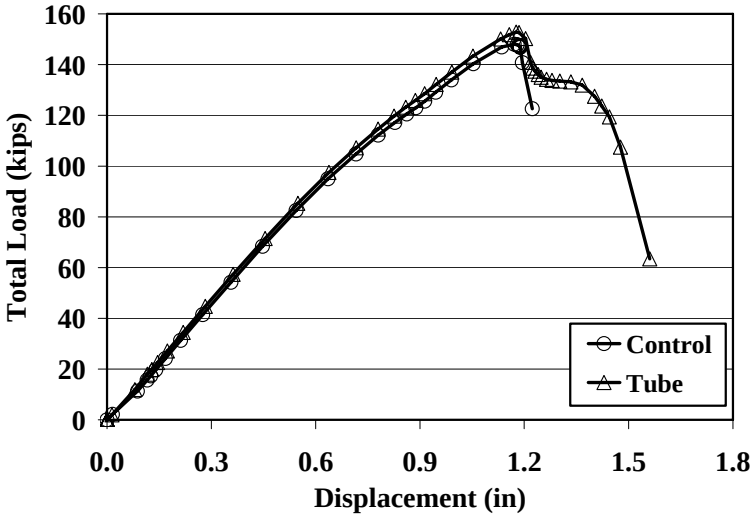
Rectangular Concrete Beams with CFRP Grid Tubes

Testing

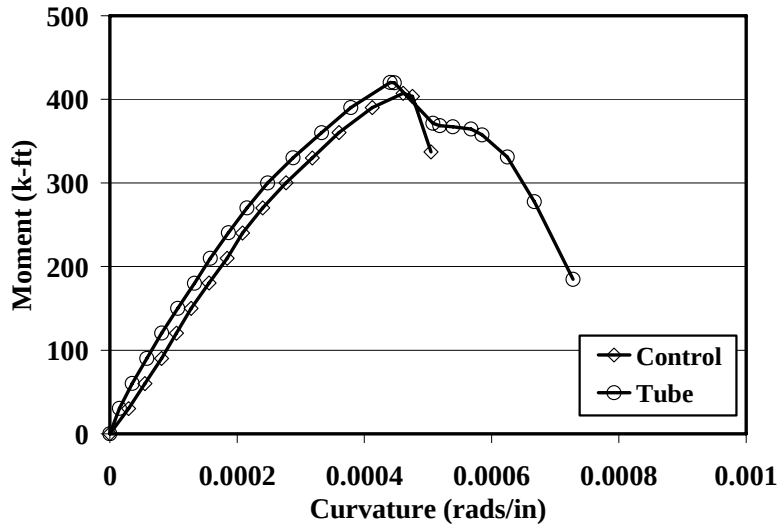




Results



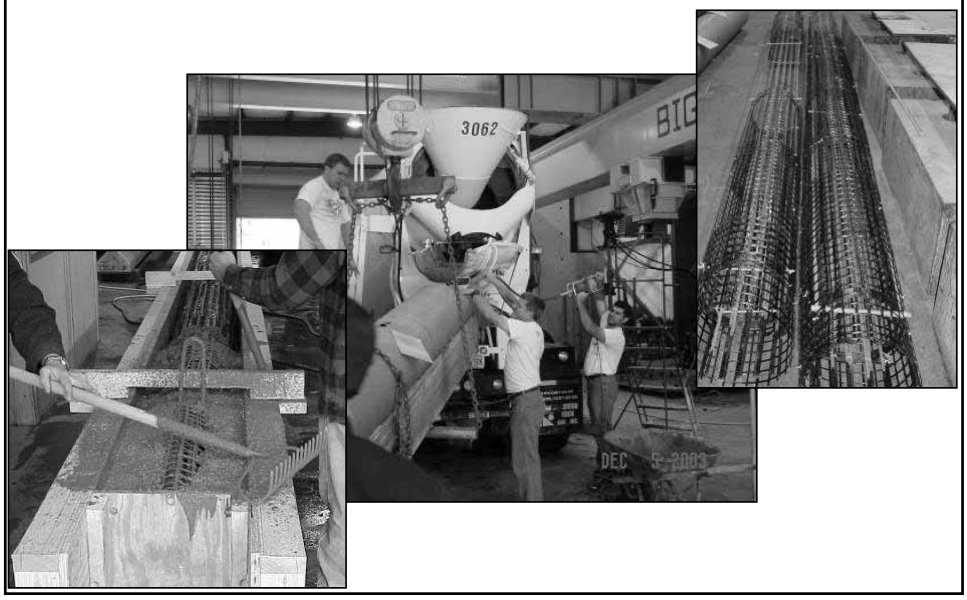
Results (Cont.)



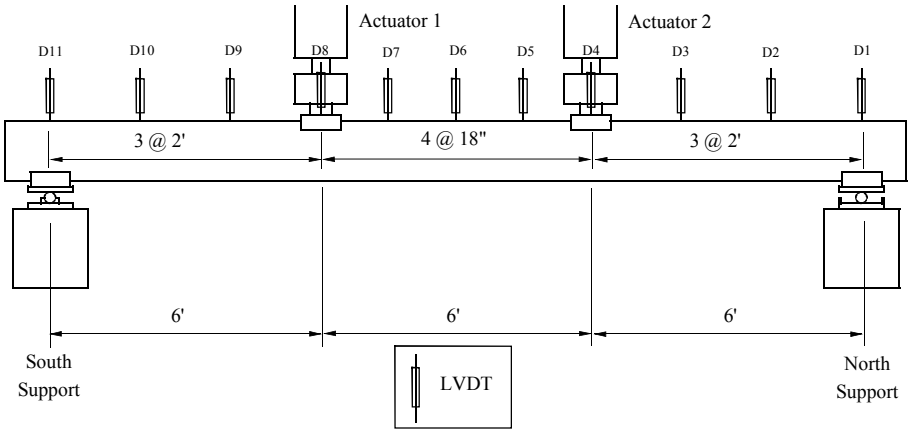
Ductility Factors

- Displacement ductility factors
  - Control = 1.33
  - Grid = 1.55
- Curvature ductility factors
  - Control = 1.52
  - Grid = 2.02
- Ductility improved 17% based on displacement and 33% based on curvature

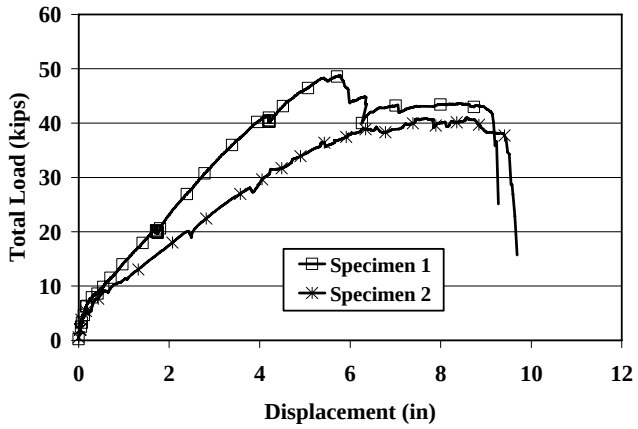
Cast in Place FRP Reinforced Piles



Testing

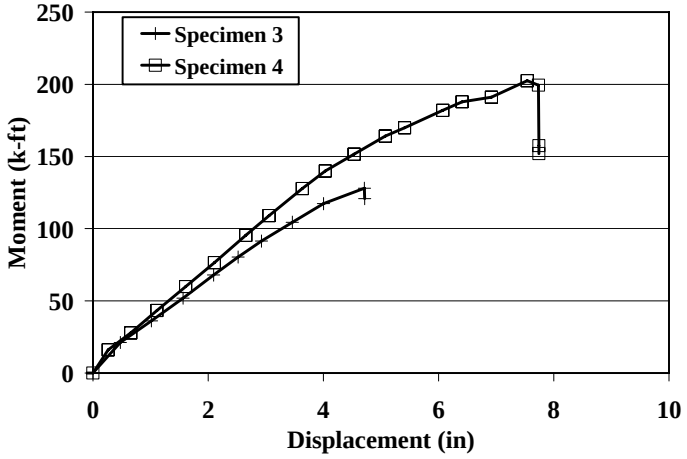


Results



Specimen 1: 16 in. square, Glass FRP rods, with CFRP grid
Specimen 2: 16 in. round, Glass FRP rods, with CFRP grid

Results (Cont.)



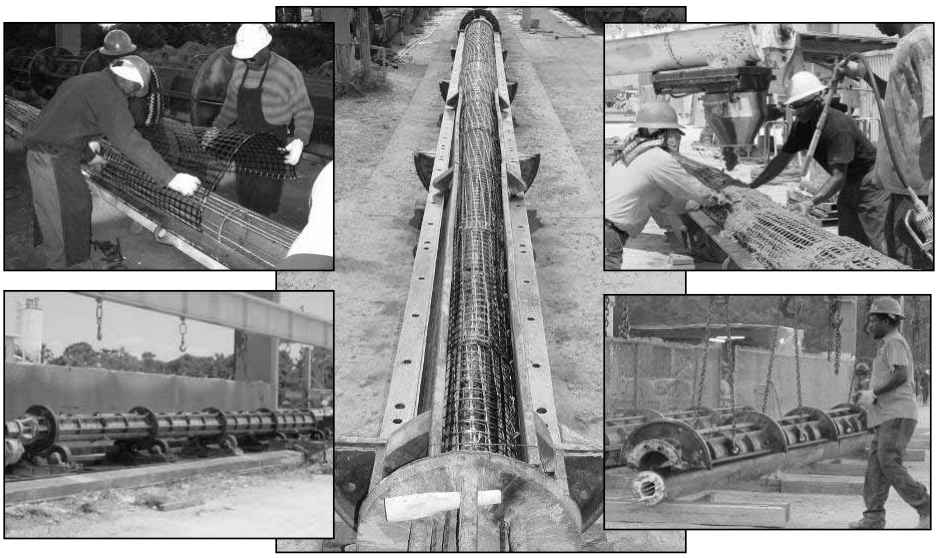
Specimen 3: 16 in. round, Carbon FRP rods, without CFRP grid
Specimen 4: 16 in. round, Carbon FRP rods, with CFRP grid

Ductility Factors

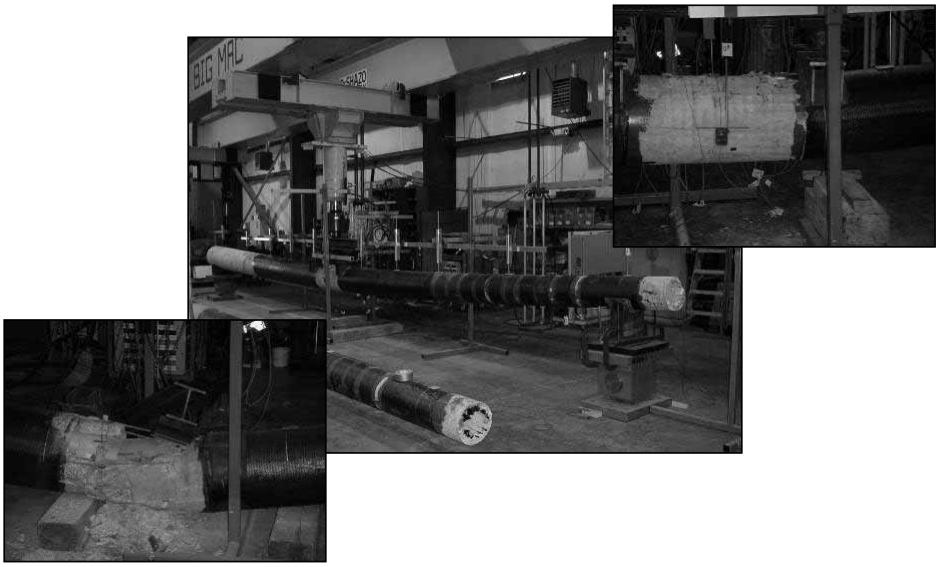
Specimen	μ_Φ	μ_Δ
1	2.60	2.20
2	2.00	2.10
3	1.20	1.10
4	2.00	1.90

- Grid piles have higher factors than control piles
- Displacement factor 72% higher
- Curvature factor 67% higher

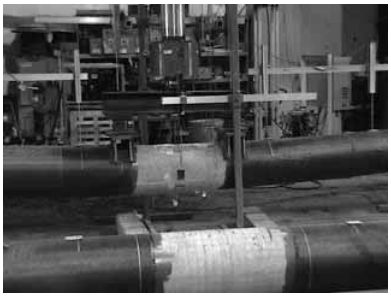
Spun Cast Piles

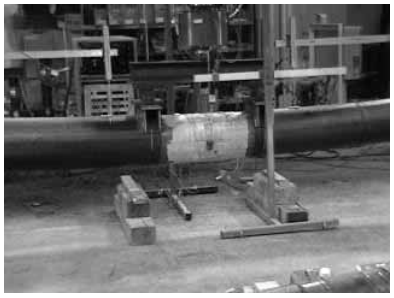


Spun Cast Pile Testing

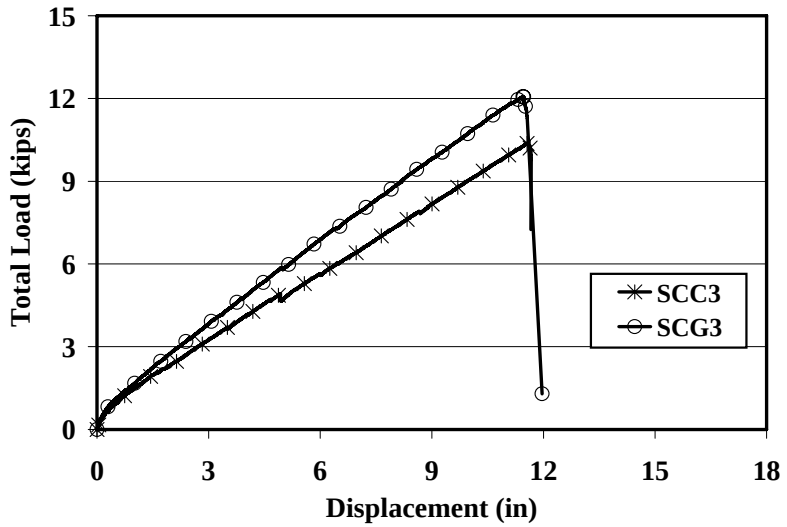


Results





Results (Cont.)



Ductility Factors

Specimen	μ_Φ	μ_Δ
SCC1	1.10	1.03
SCC2	1.13	1.09
SCC3	1.10	1.04
SCG1	1.26	1.18
SCG3	1.34	1.16

- Grid piles have higher factors than control piles
- Displacement factor 12% higher
- Curvature factor 22% higher

Conclusions

- CFRP grid provides confinement to concrete
- Strength increases due to the effect of the grid but the amount depends on the configuration.
- The ductility of grid piles was improved but is still lower than steel. Further improvement needed (more confinement).

Acknowledgements

- This project is sponsored by FDOT
- Steve Eudy who set up and ran the data acquisition systems, as well as Marc Ansley, Frank Cobb, Tony Johnston, Paul Tighe, and David Allen who helped prepare the specimens and the testing apparatus.
- TechFab for providing the Carbon FRP grid for the tests