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SELF COMPACTING HYBRID FIBER REINFORCED COMPOSITES (SC-HyFRC) FOR BRIDGE COLUMNS

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Outline

I. Performance of SC-HyFRC

II. Brief Summary of Performance of SC-HyFRC bridge columns

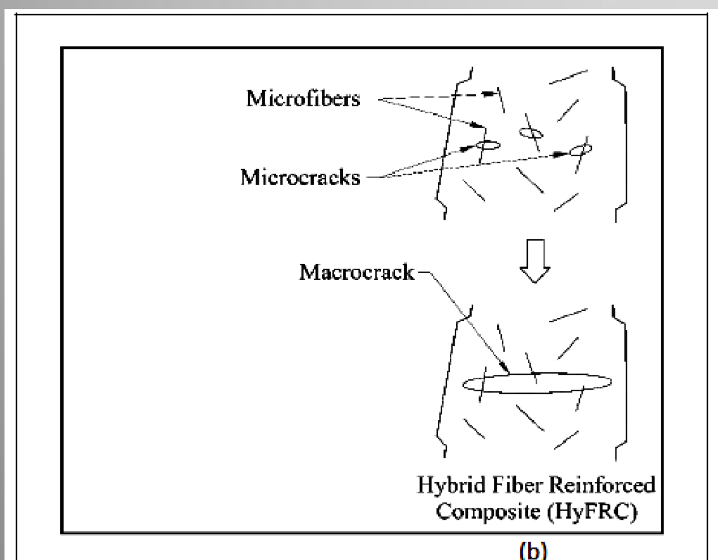
III. Proposed test specimen that utilizes a precast SC-HyFRC tube as permanent structural formwork for accelerated bridge construction

IV. Conclusion

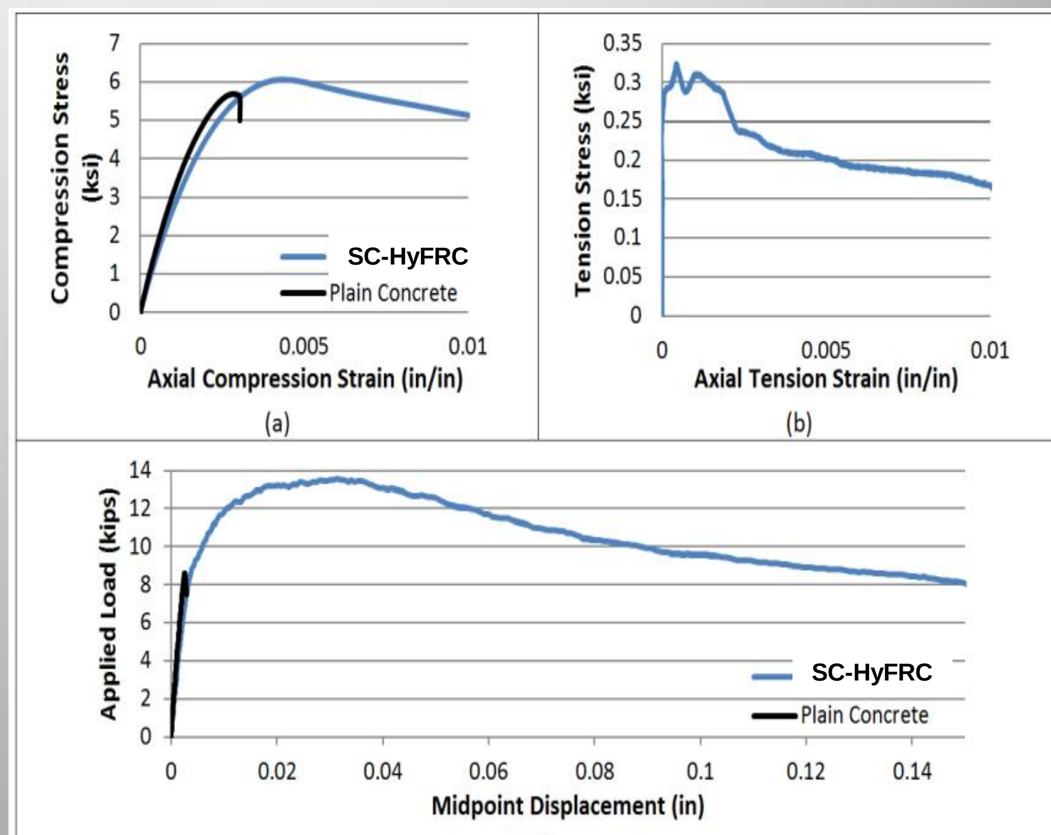
I) Performance of SC-HyFRC

Crack control in SC-HyFRC

Cracking controlled from micro-to macroscale through fiber hybridization



Mechanical properties of SC-HyFRC



SC-HyFRC provides crack control on multi-scale which results in high ductility in compression, tension & flexure, enhanced shear resistance, and high durability when exposed to environmental loading conditions such as Alkali silica reaction (ASR) and corrosion.

OBJECTIVES OF SC-HyFRC RESEARCH PROGRAM

(ASR) Environmental Damage *(Corrosion)*

Seismic Damage

- To ***enhance damage resistance*** of bridge columns subjected to both environmental and seismic loading conditions (*and hence reduce the need for repair after small to moderate earthquake events)*
- To ***minimize spalling, delay buckling of longitudinal reinforcing bars, and prevent crushing of concrete*** at the column/foundation interface

OBJECTIVES OF SC-HyFRC RESEARCH PROGRAM (cont.)

- To ***achieve high compaction***,
- To increase ease of flow of concrete around reinforcements ***without need for vibration***,
- To ***facilitate bridge construction***
- and ultimately ***enhance the sustainability and service life*** of bridge columns.

SC-HyFRC for Bridge Columns

Test Specimen #1: testing & analysis completed

(Utilizes SC-HyFRC in entire column; Specimen designed to rock at column/foundation interface)

Test Specimen #2: testing & analysis completed

(Utilizes SC-HyFRC in entire column; Specimen designed to form plastic hinge at base of column)

- **Submitted PEER report on test specimen #1 and #2 in July 2010;**
- **Results of test specimen #1 and #2 presented at PEER meeting in August 2010**

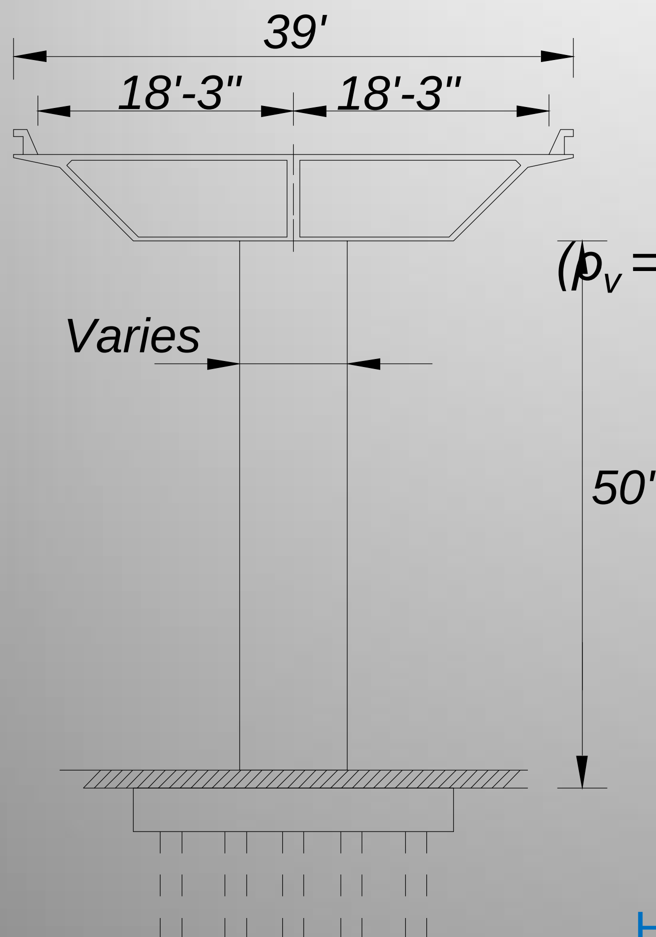
Test Specimen #3: to be tested in summer 2011

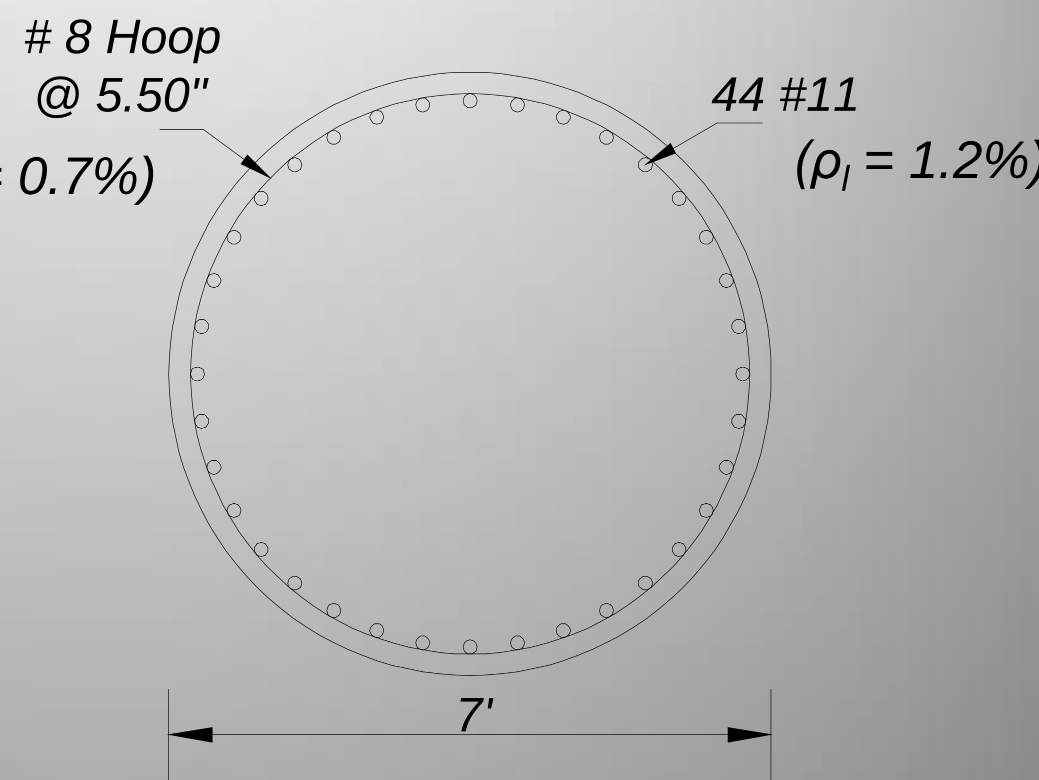
(Utilizes a precast SC-HyFRC tube as permanent structural formwork; specimen will be designed to rock at column/foundation interface with post-tensioning)

Specimen #1 and #2 were based on PROTOTYE COLUMN

(Ketchum et. al. 2004)

Aspect Ratio, H / D = 7





However, transverse reinforcing ratio in specimen #1 and #2 were reduced to 0.37% due to internal confinement capabilities of fibers

II) Brief Summary of Specimen #1 & #2 Test results

- Hi
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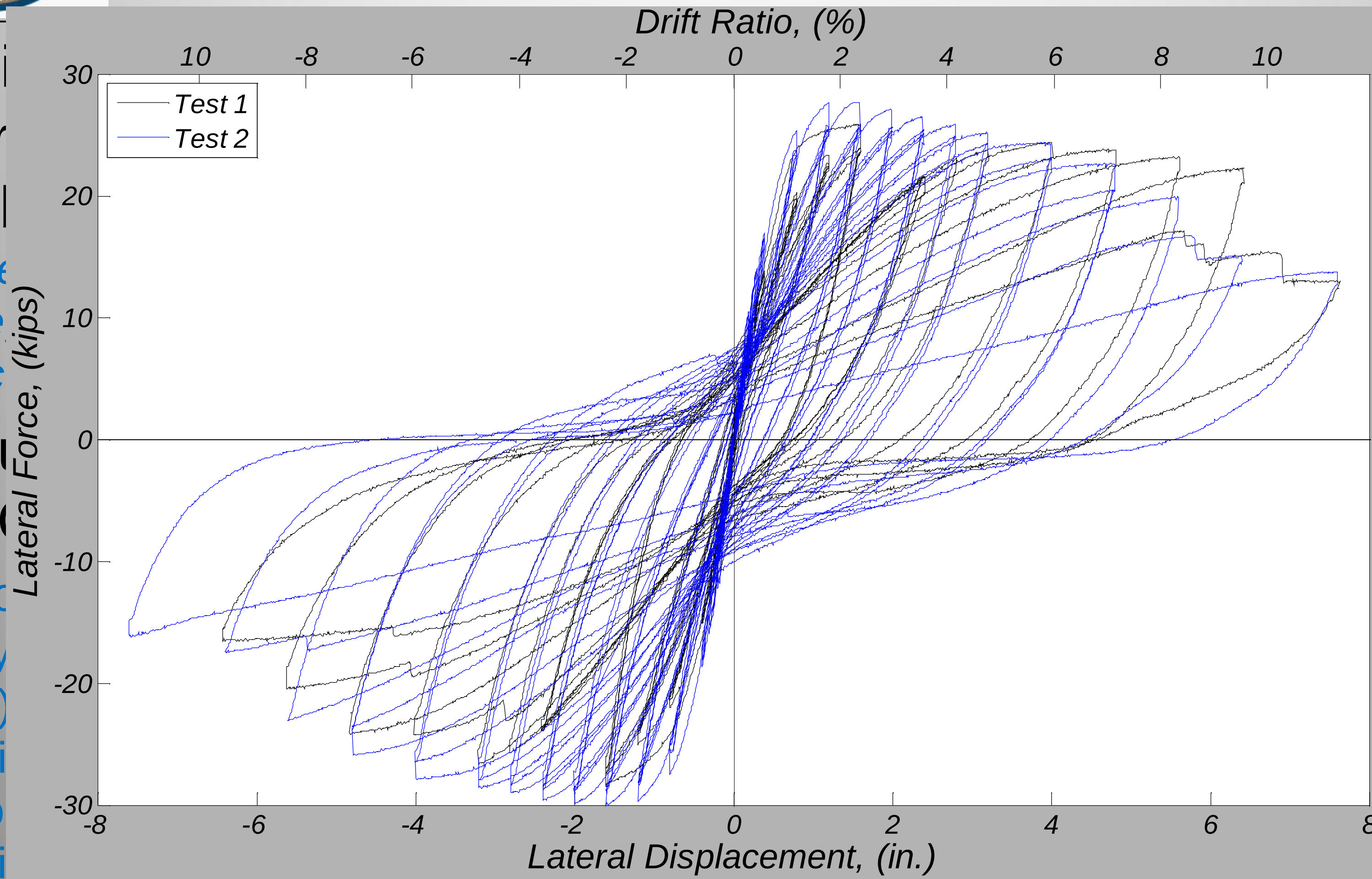
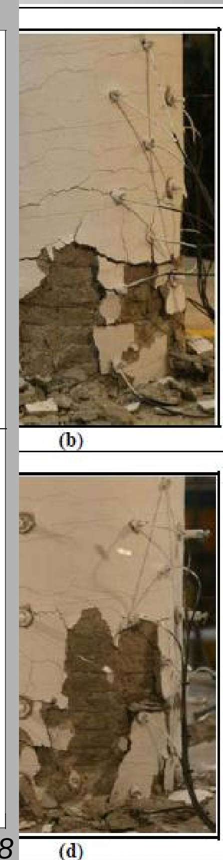
  vi
  De
  se
  ac




(b)
(d)

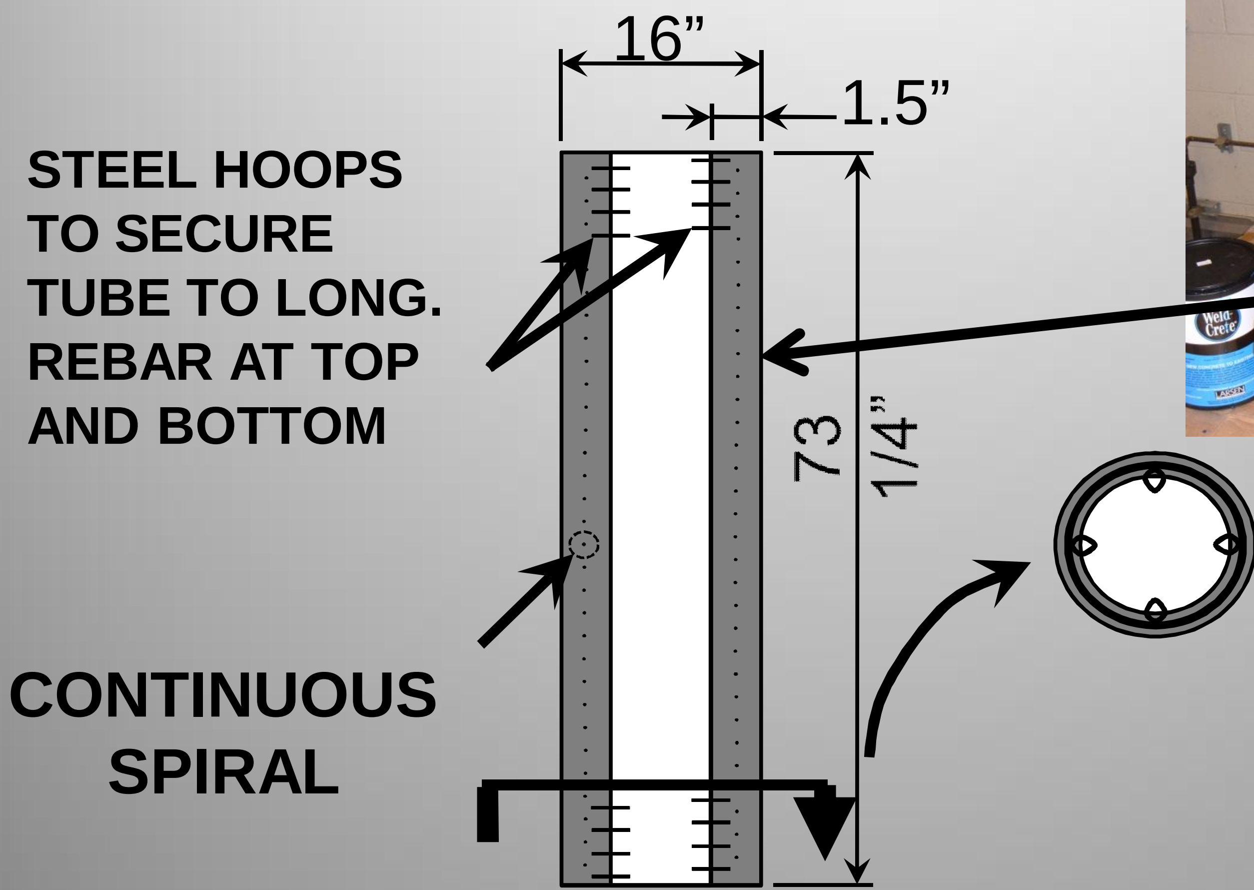
- Su
  SC
  No
  Hy
  (a)
  rei
  co
  dri
- Axial load carrying capacity retained up to large drift ratios

III) Specimen #3: Proposed Bridge column with pre-cast SC-HyFRC tube

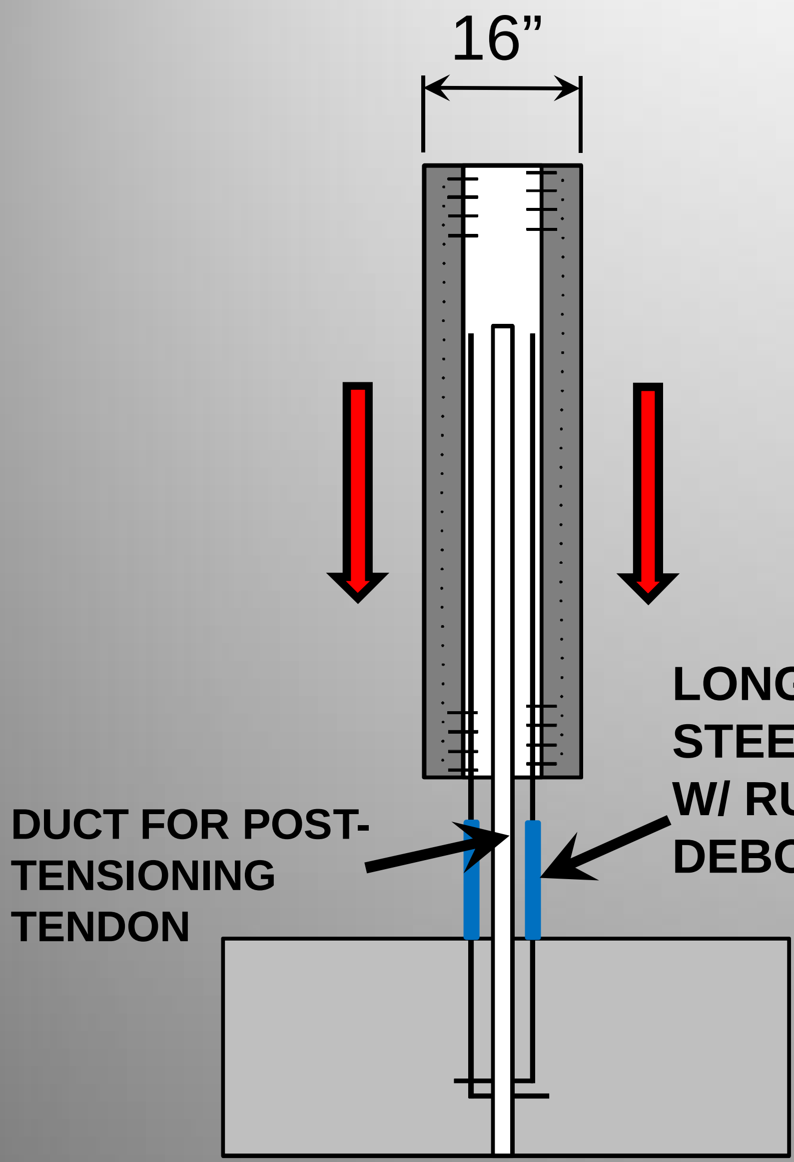
Objectives for using Pre-cast SC-HyFRC tube as *permanent structural formwork:*

- to enhance damage resistance and durability of bridge columns exposed to **both** environmental and seismic loading conditions.
- To promote *sustainable* bridge construction with *prolonged service life at reasonable cost.*
- To promote *Accelerate Bridge Construction* in seismic prone regions
  - i. Reduce time and labor in the field and reduce traffic delays and congestion,
  - ii. Reduce the weight and size of precast members for easy deployment and transportation,
  - iii. Reduce repair and maintenance cost due to enhanced damage resistance and seismic performance.

Test Specimen #3: Pre-cast SC-HyFRC tube as permanent formwork for bridge column

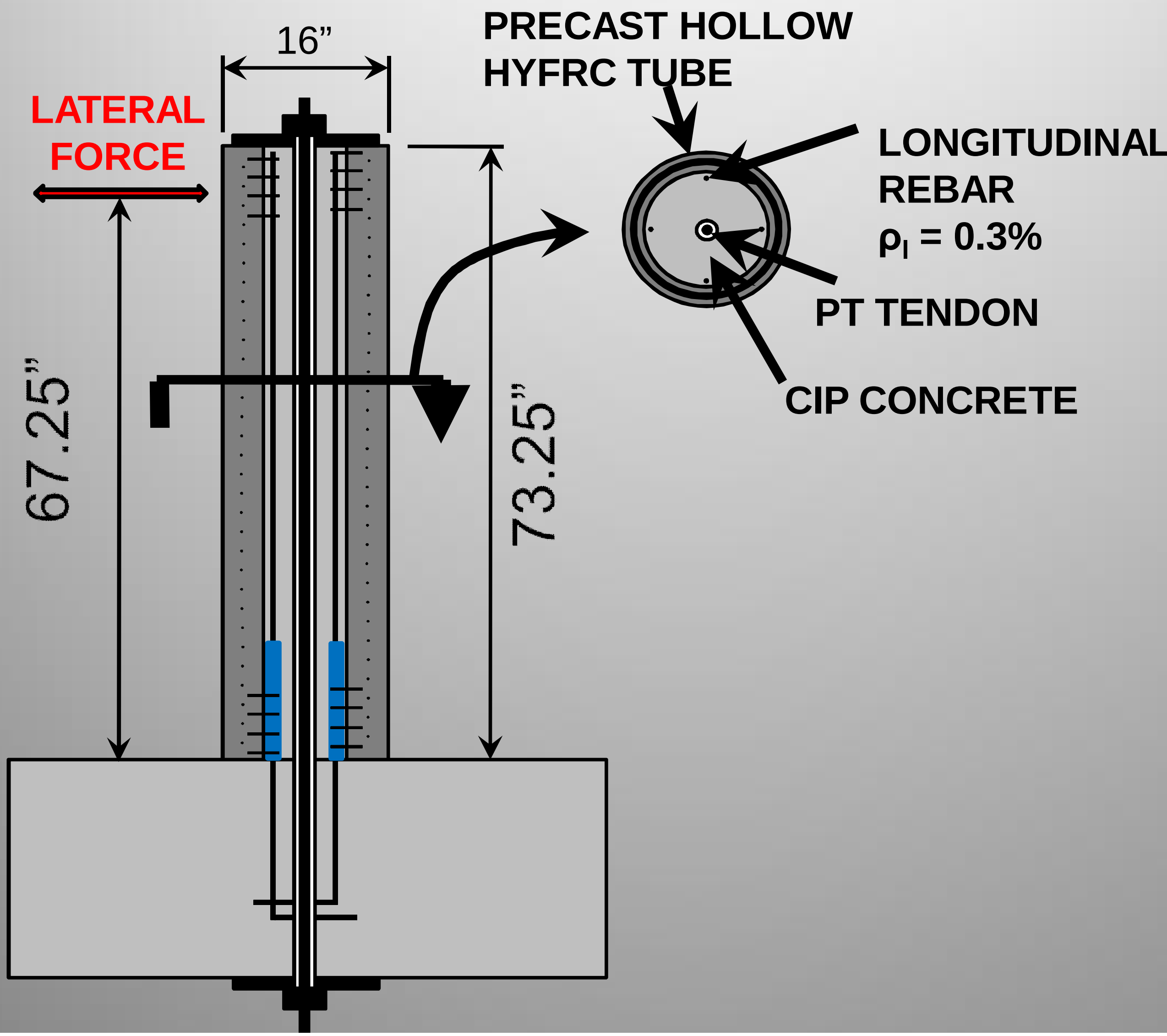


Specimen #3: Fabrication of unbonded post-tensioned specimen



Sliding of SC-HyFRC tube over pre-existing longitudinal reinforcing cage (shown here for small scale specimen)

Specimen #3: Testing of unbonded post-tensioned bridge column



Conclusion

Advantages of using SC-HyFRC for bridge columns:

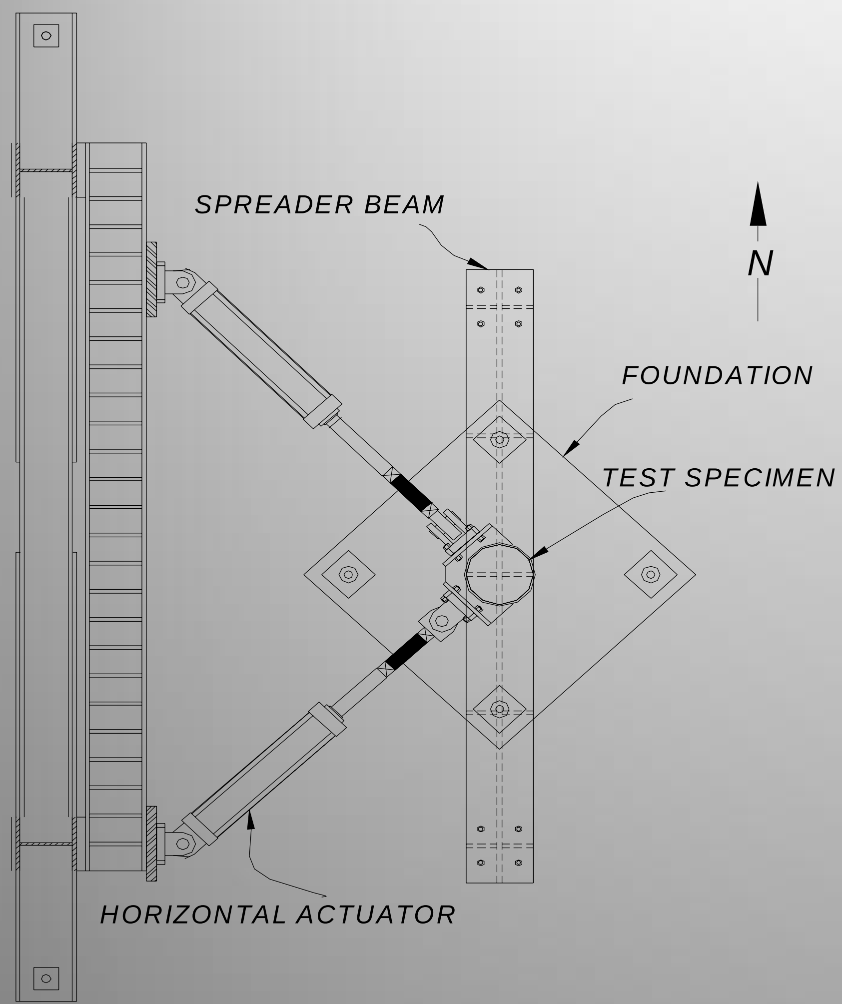
- Enhances the damage resistance and spalling resistance of bridge columns (and hence reduces the need for repair after small to moderate seismic events)
- High potential in delaying rebar buckling and rebar fracture in bridge columns and in retaining their axial load carrying capacity up to high drift ratios,
- Pre-cast SC-HyFRC tubes that serve as permanent structural formwork will not only promote accelerated bridge construction but also reduce repair cost and enhance the sustainability and service life of bridge columns in seismic prone regions at considerably lower cost.

EXPERIMENTAL SETUP

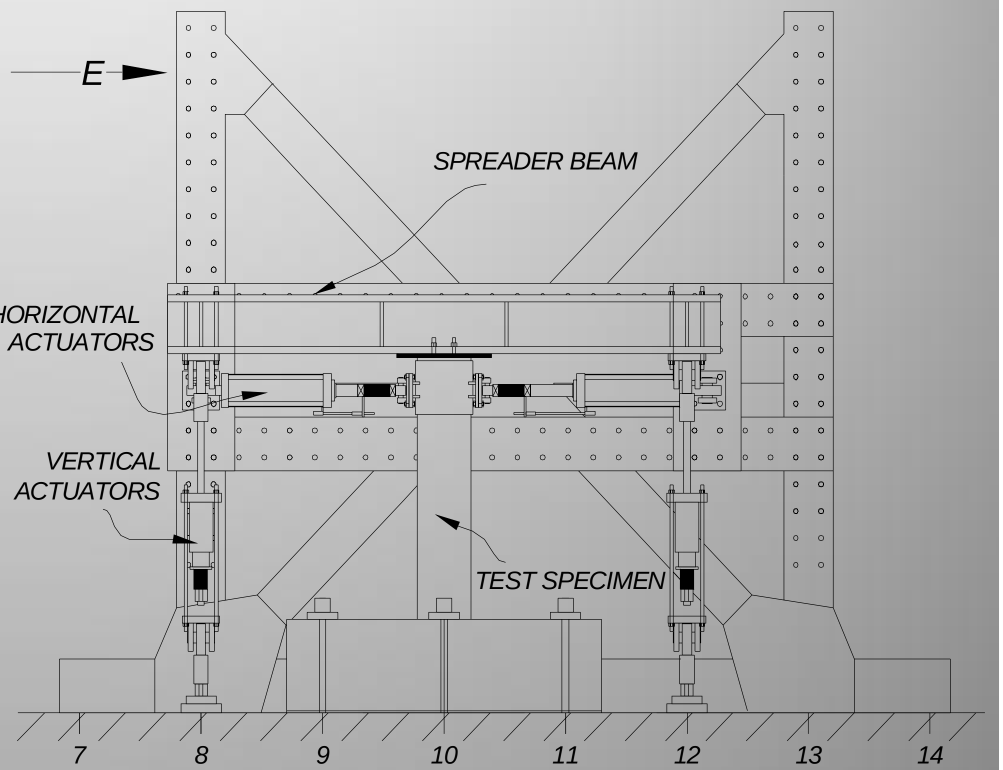
Global View of Test Setup at UCB Davis Hall

Thank you for your attention

EXPERIMENTAL SETUP at UCB



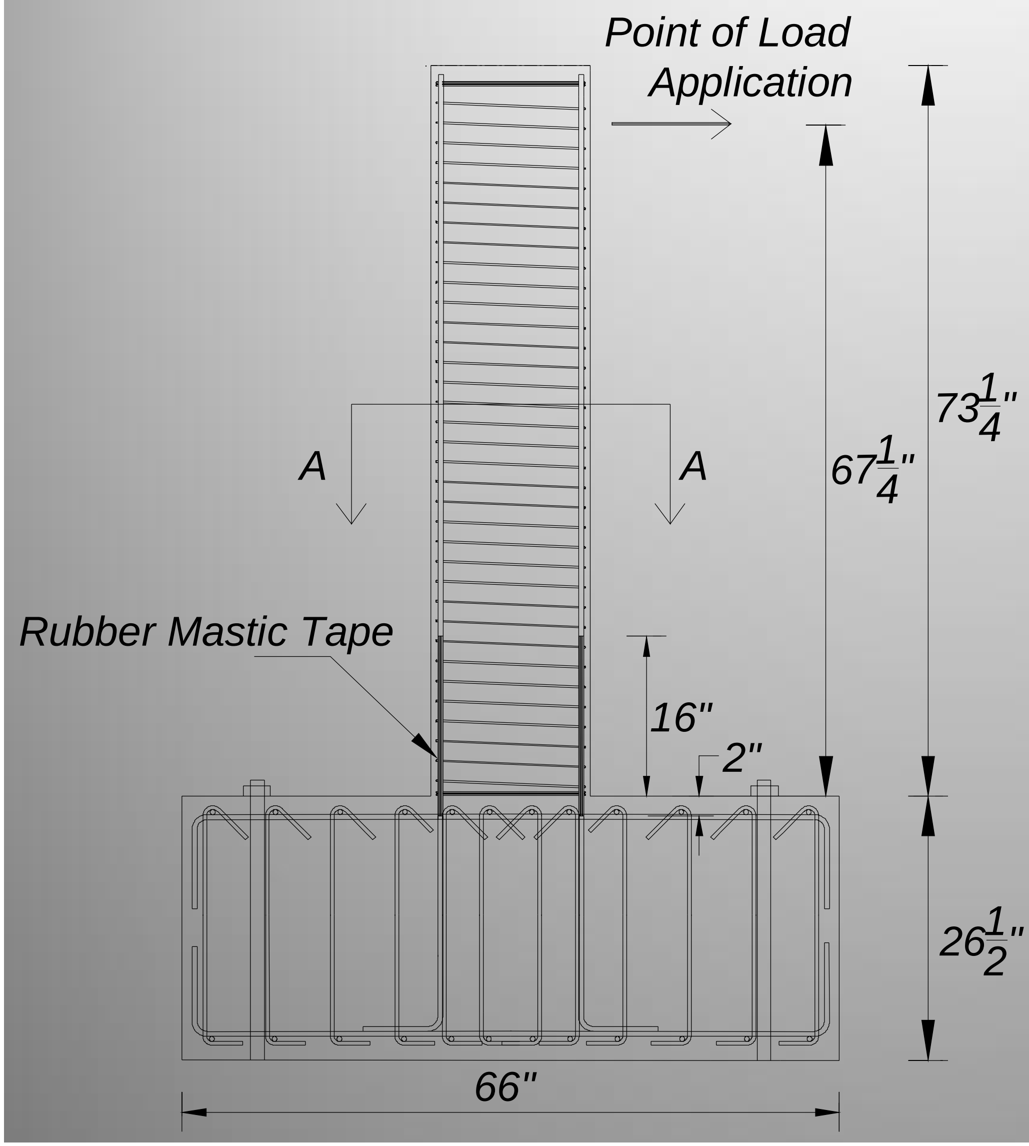
Plan View

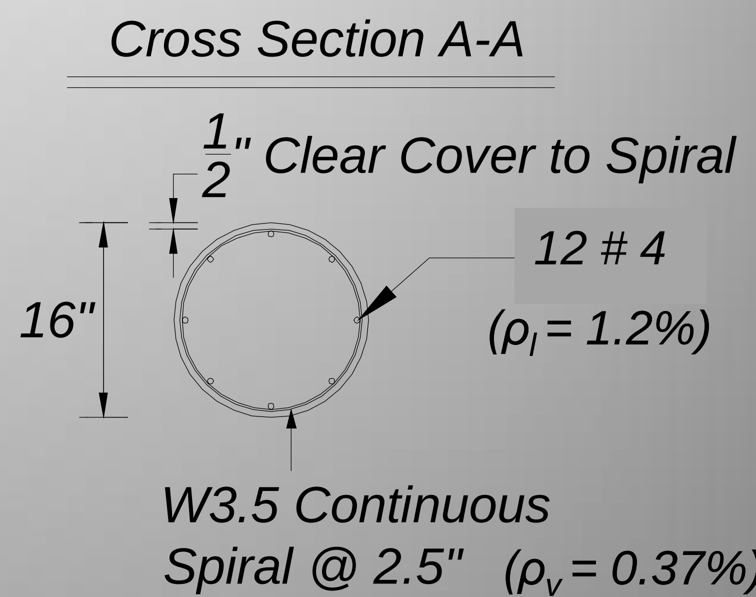


Elevation View

TEST SPECIMEN-1 (TS-1)

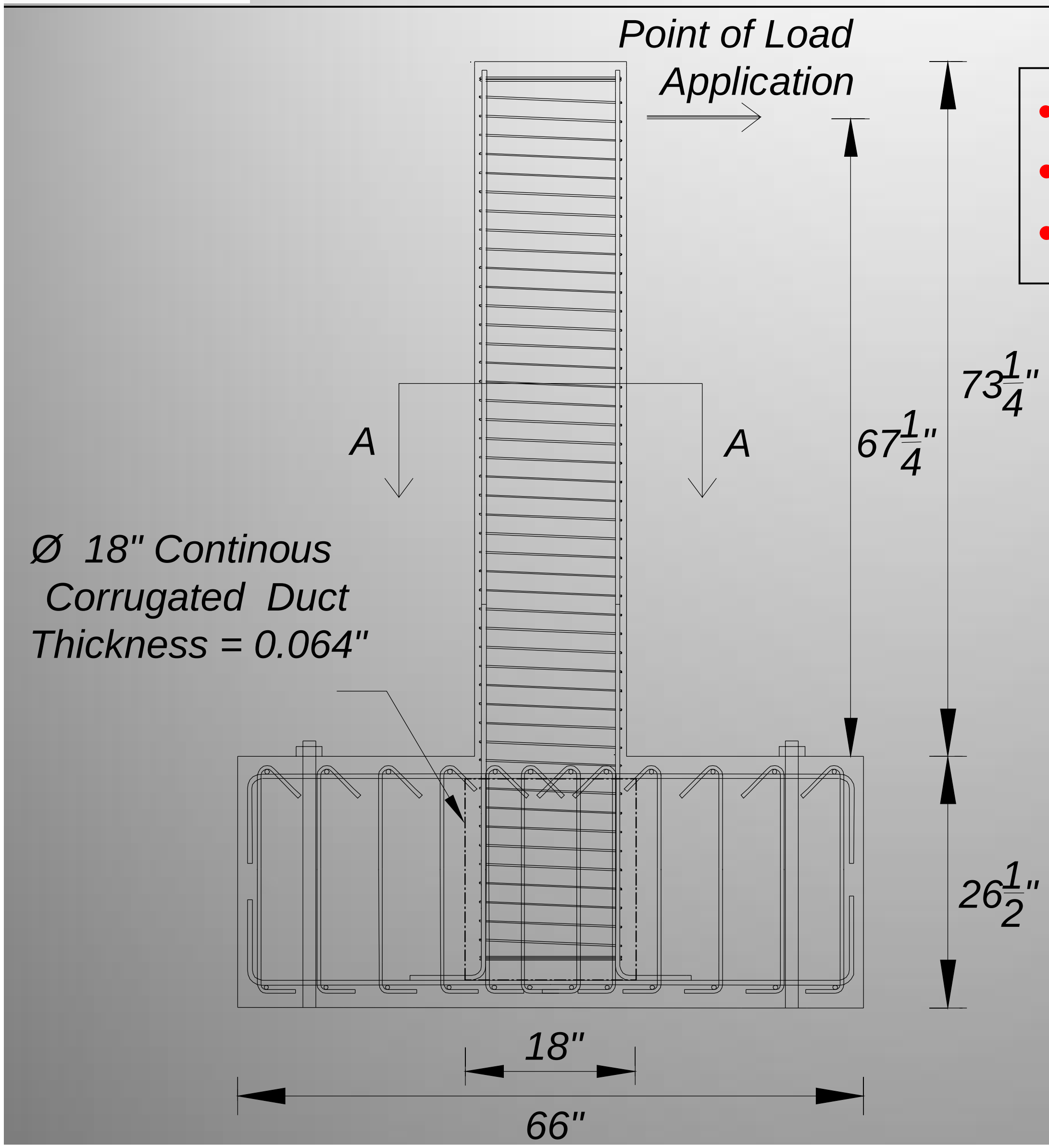
- 1:4.7 Scale Specimen
- Aspect Ratio, $H / D = 4$
- Axial Load Ratio, $N / f'_c A_g = 0.1$

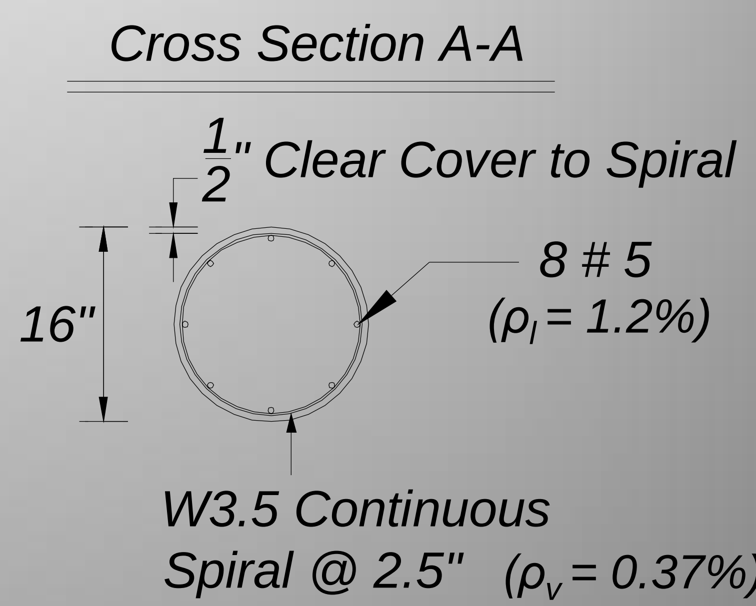




TEST SPECIMEN-2 (TS-2)

- 1:4.7 Scale Specimen
- Aspect Ratio, $H / D = 4$
- Axial Load Ratio, $N / f'_c A_g = 0.1$





Crushing and damage resistance of small scale column with SC-HyFRC tube vs. conventional concrete

Damage of small scale column with conventional concrete (transverse reinforcements fractured and long. rebar buckled)

Damage resistance of small scale column with 1.5” thick SC-HyFRC tube (damage was shallow and did not penetrate to the spiral or to the longitudinal rebar; no buckling or fracture of long. rebars even at high drift ratios)