Using BCSA Cement for Structural Concrete

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BCSA Cement in Structural Concrete

An ACI Standard

Building Code Requirements for Structural Concrete (ACI 318-19)

Structural Concrete Using Alternative Cements

A supplement to the commentary to ACI 318-19

by Roger J. Becker, Terence C. Holland, and Frank S. Malits

26.4—Concrete materials and mixture requirements

26.4.1 *Concrete materials*

26.4.1.1 *Cementitious materials*

(b) Alternative cements shall be permitted if approved by the licensed design professional and the building official. Approval shall be based upon test data documenting that the proposed concrete mixture made with the alternative cement meets the performance requirements for the application including structural, fire, and durability.

The following properties must be addressed:

- Axial, compressive, flexural, shear, and torsional strength;
- Ultimate strain and stress-strain relationship;
- Volume change properties (drying, thermal, creep, and shrinkage);
- Modulus of elasticity;
- Bond of reinforcement; and
- Strain compatibility of concrete and reinforcement.

BCSA Cement in Structural Concrete

- Past work at University of Oklahoma
  - Improved prestress losses
  - Good flexural strengths
  - Good bond to prestressing strands

Initial Practical Concerns

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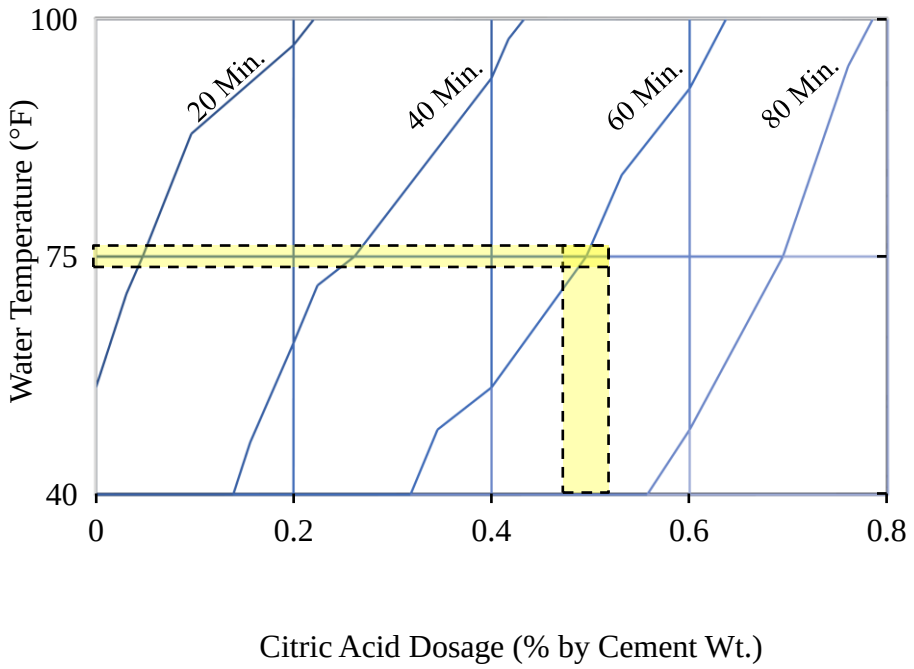
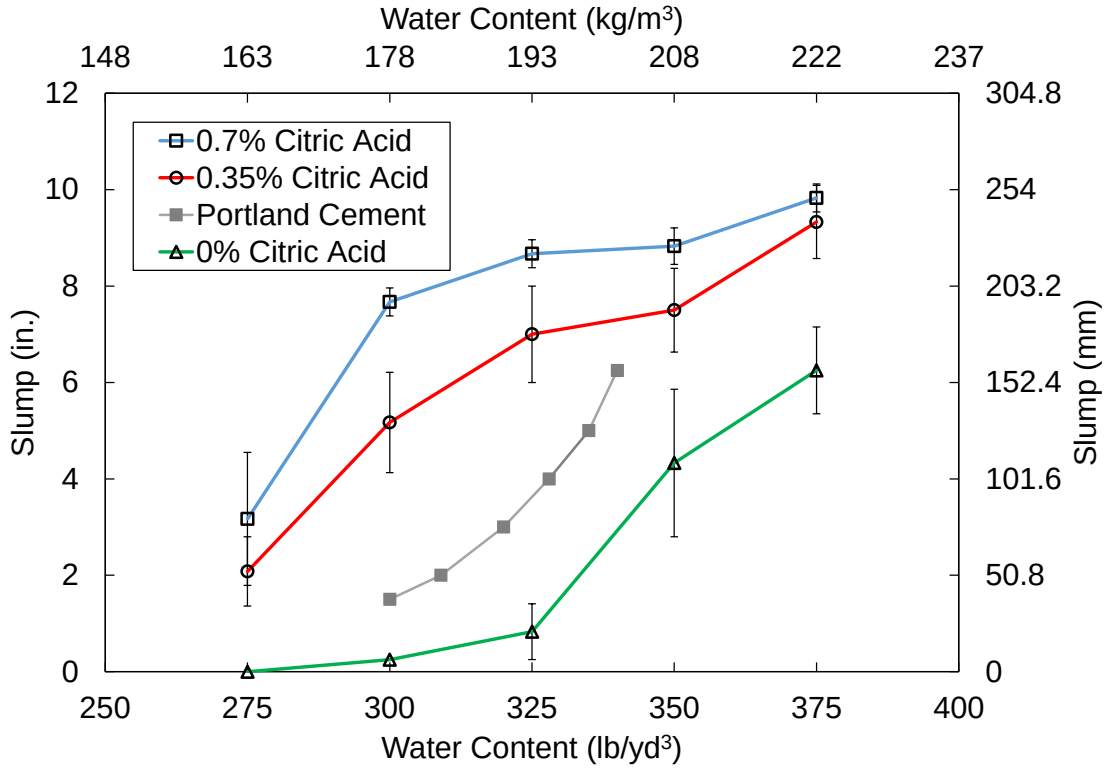
Setting Time of BCSA Cement
100 F Ambient Temp. Example

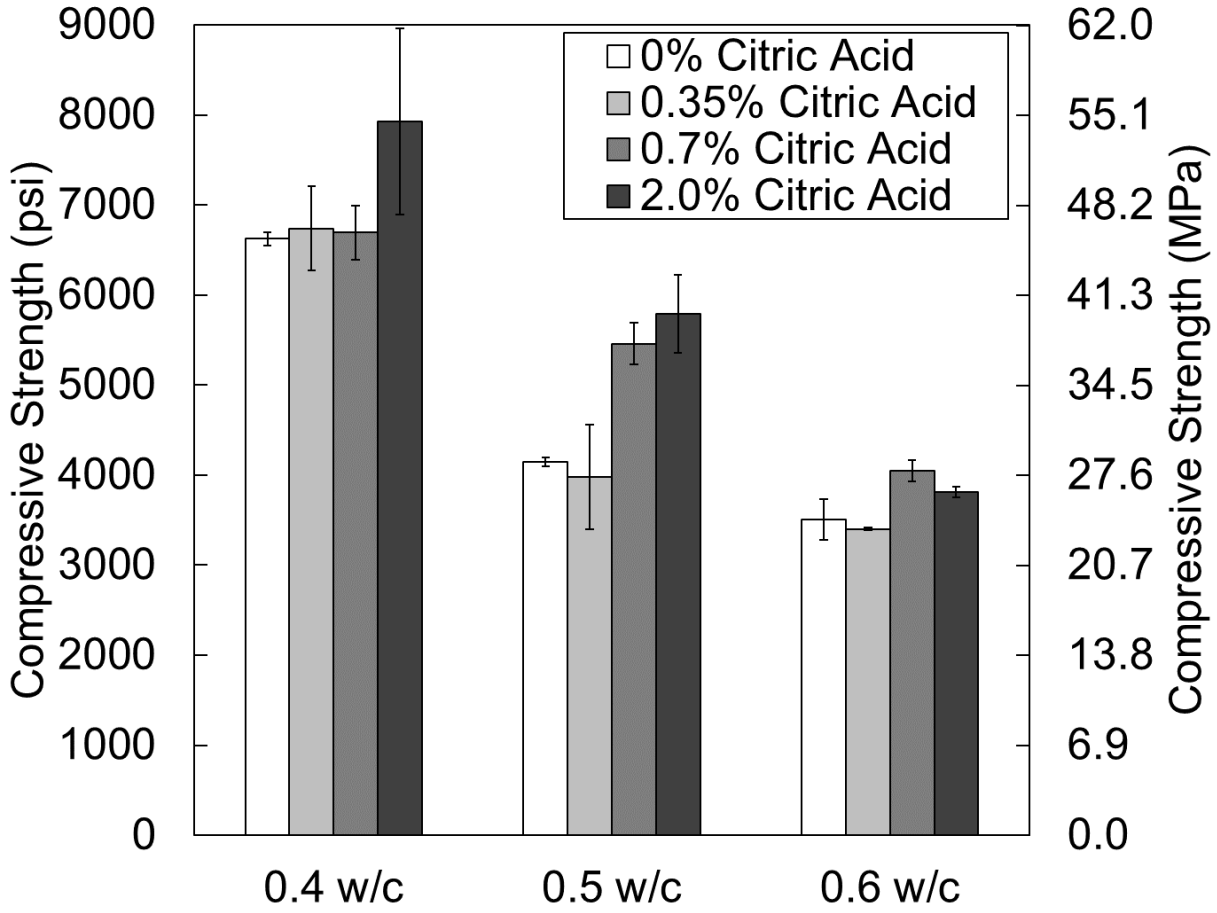


Slump and Water Content

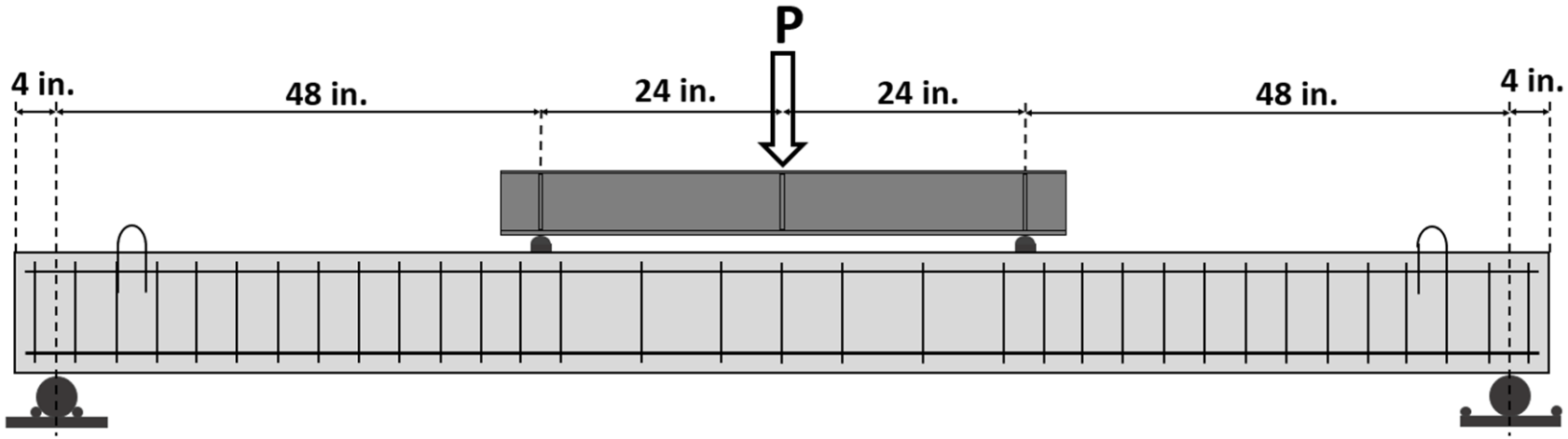


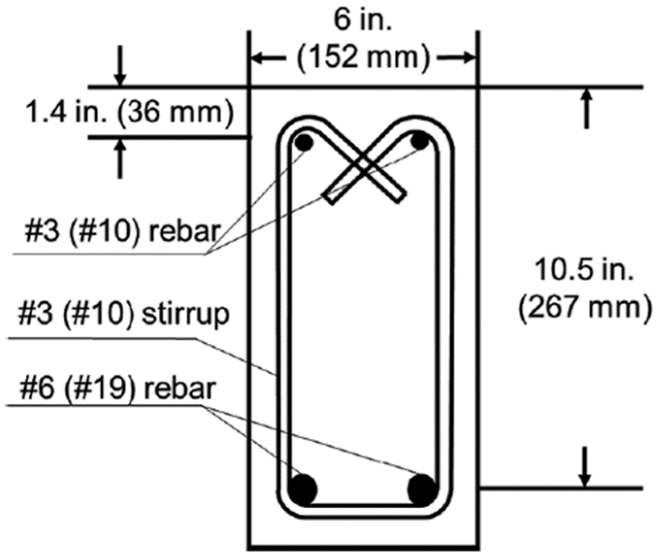
Initial Practical Concerns

- *w/c* – strength relationship similar to PC
  - 3 hour strength
  - 28 day strength



Flexural Strengths of BCSA Cement Concrete





- 12 reinforced concrete beams made with either PC or BCSA cement
  - 6 Tension Controlled
  - 6 Compression Controlled
- Tested at different ages

Cook, G.W., **Murray, C.D.**, "Early Age Performance of Reinforced Concrete Beams Made with BCSA Cement." *ACI Materials Journal* 117, no. 01 (2020).

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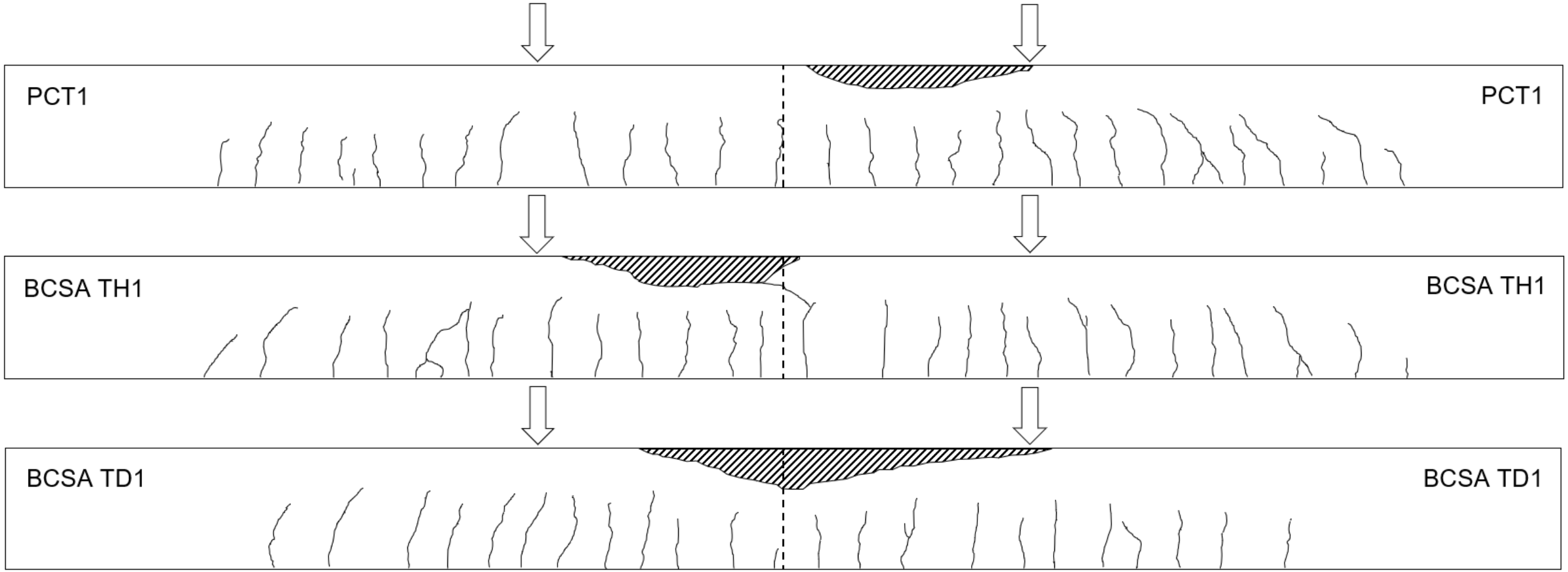

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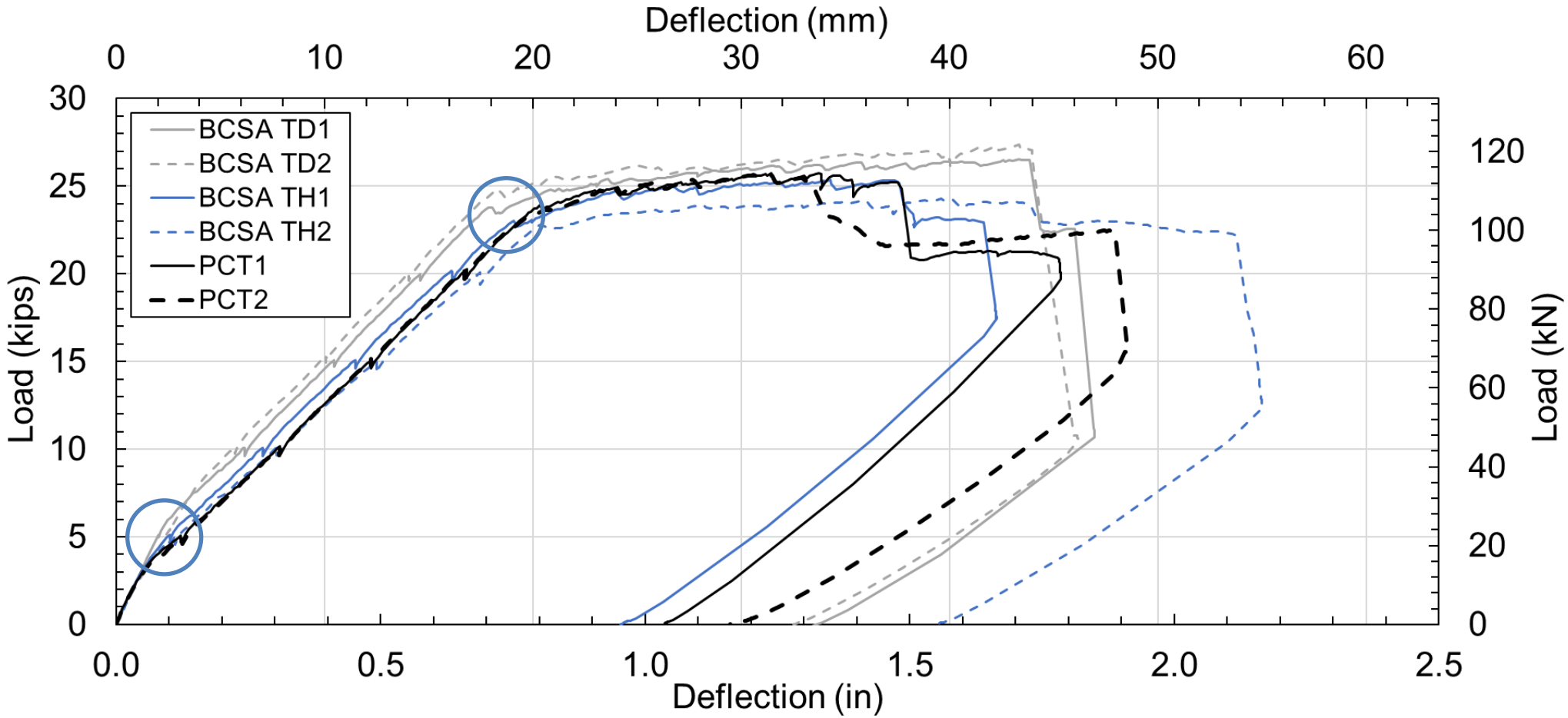
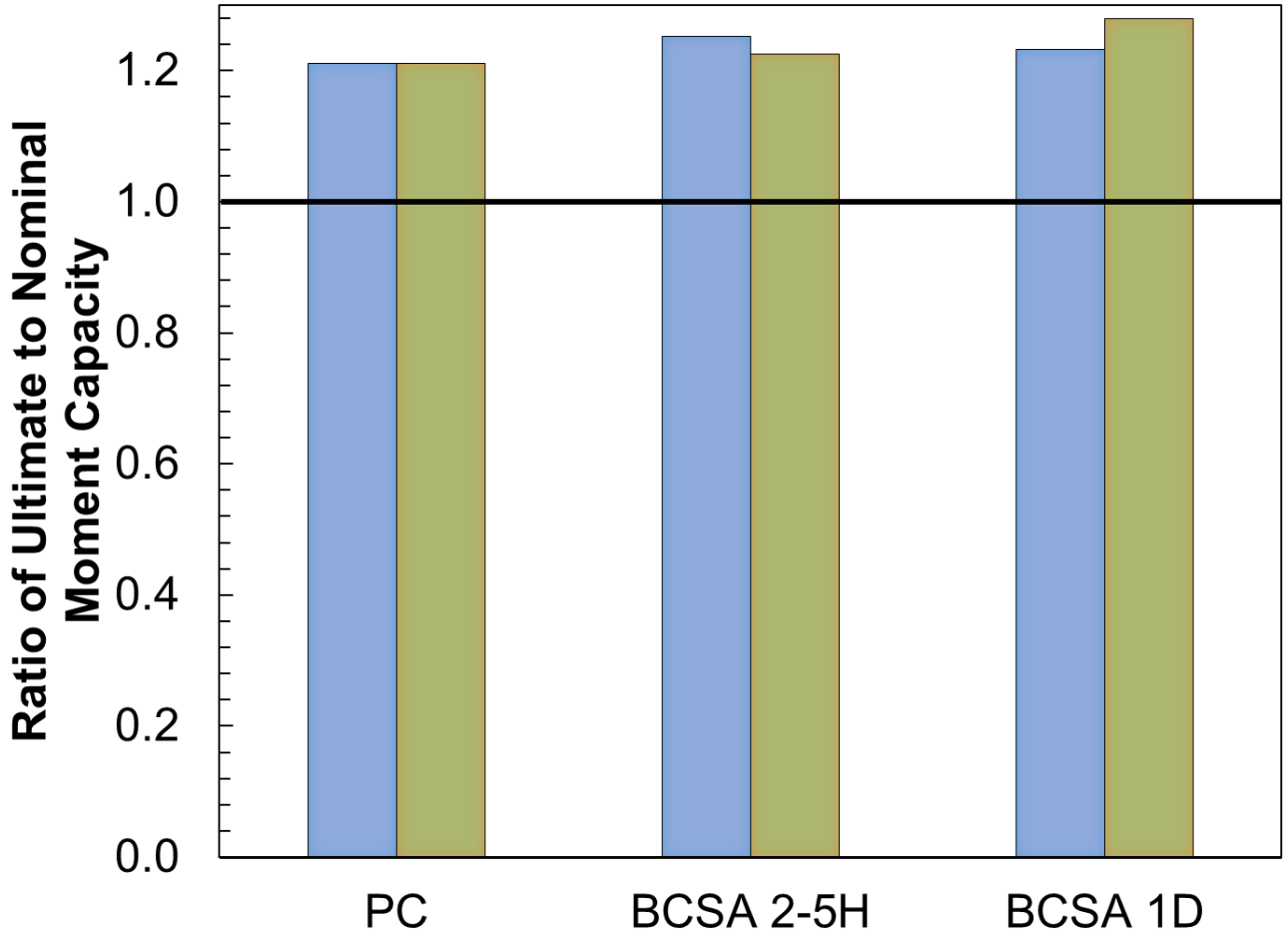


Flexural Strengths of BCSA Cement Concrete

$$\frac{Experimental\ Moment\ Capacity}{ACI\ Nominal\ Moment\ Capacity}$$



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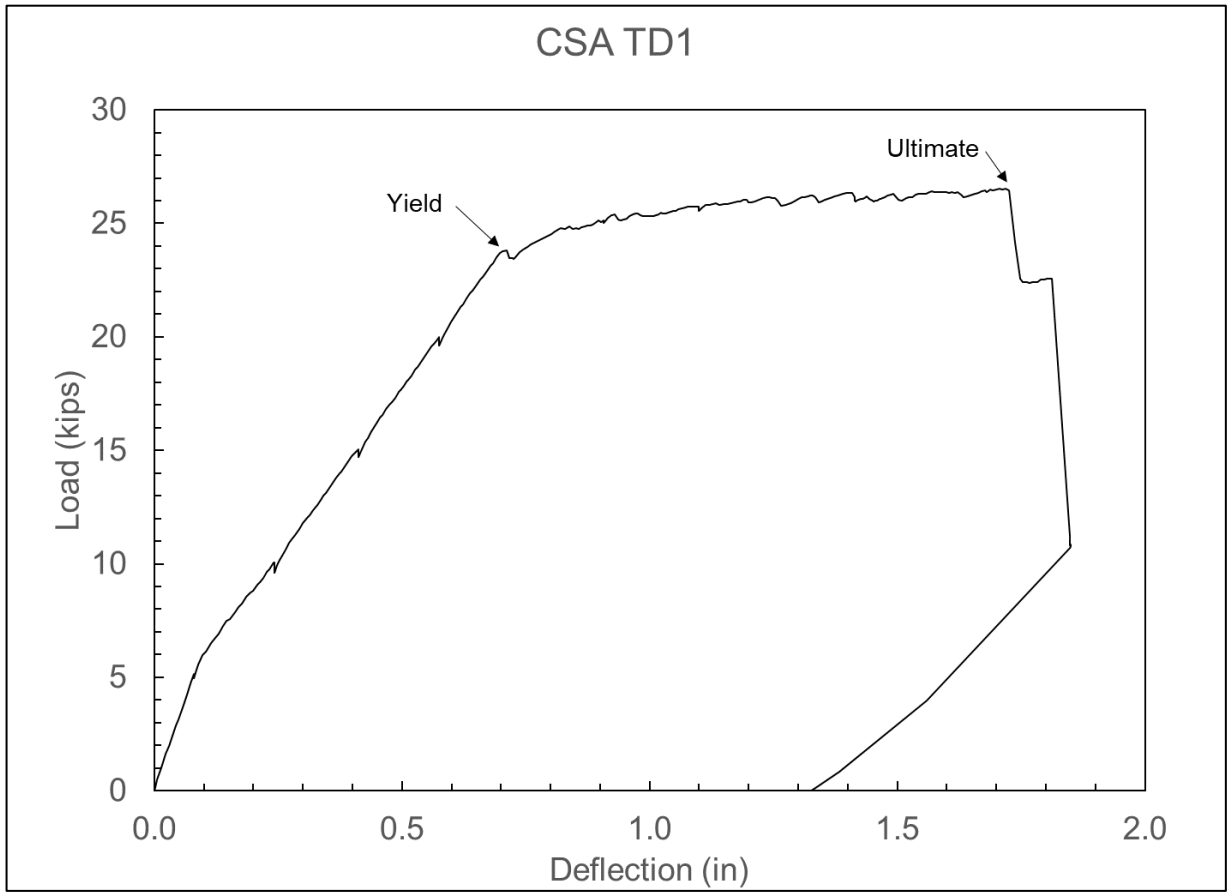
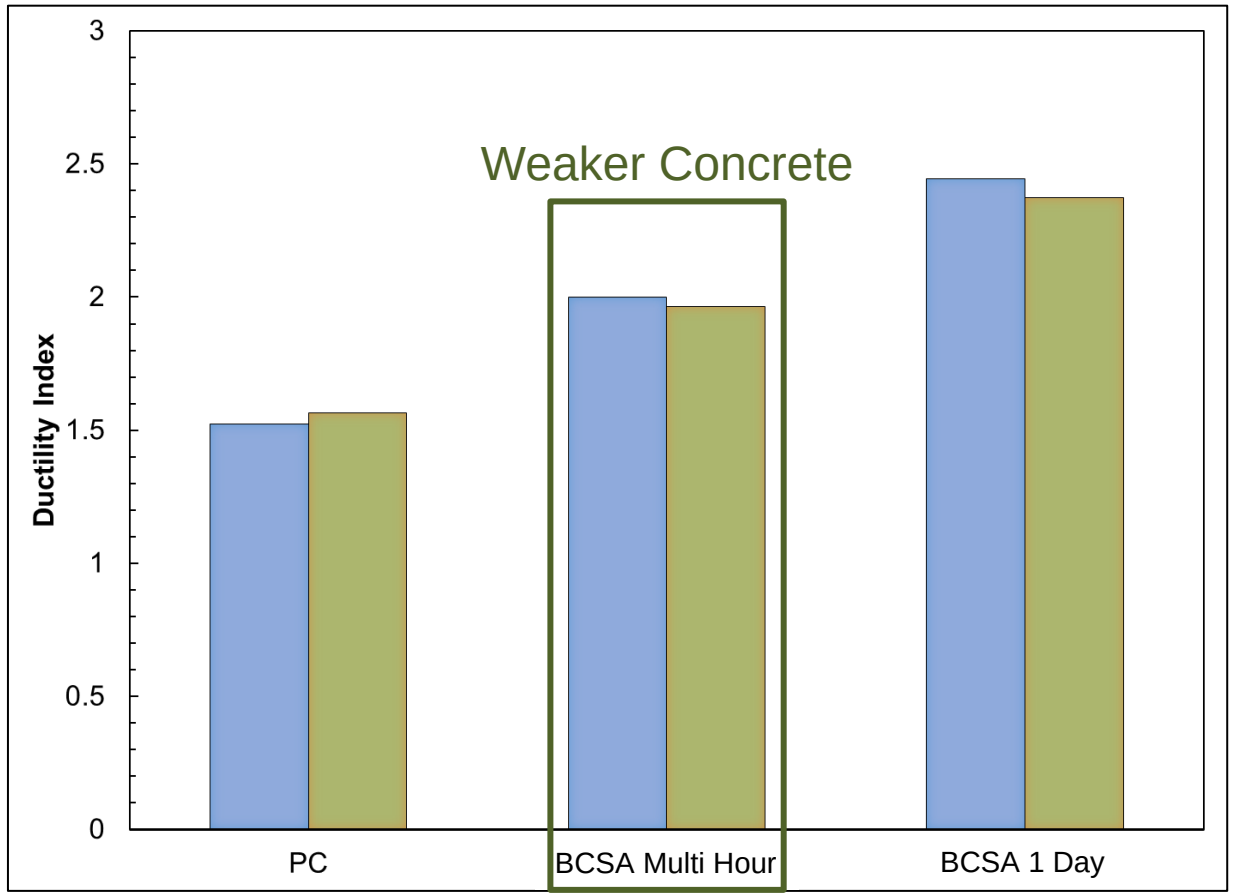
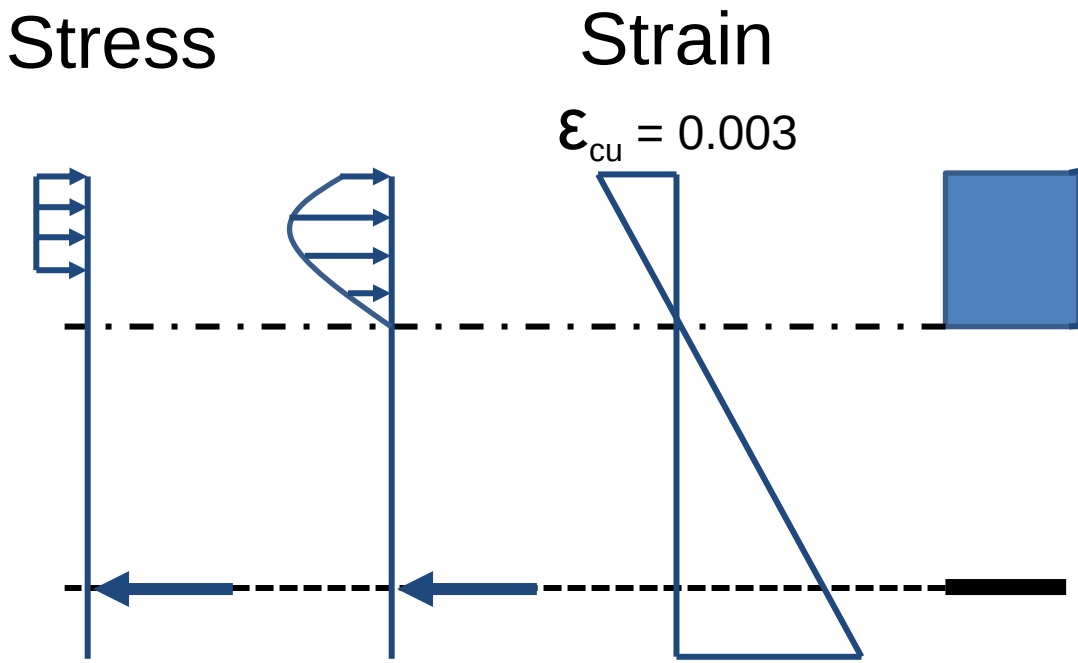
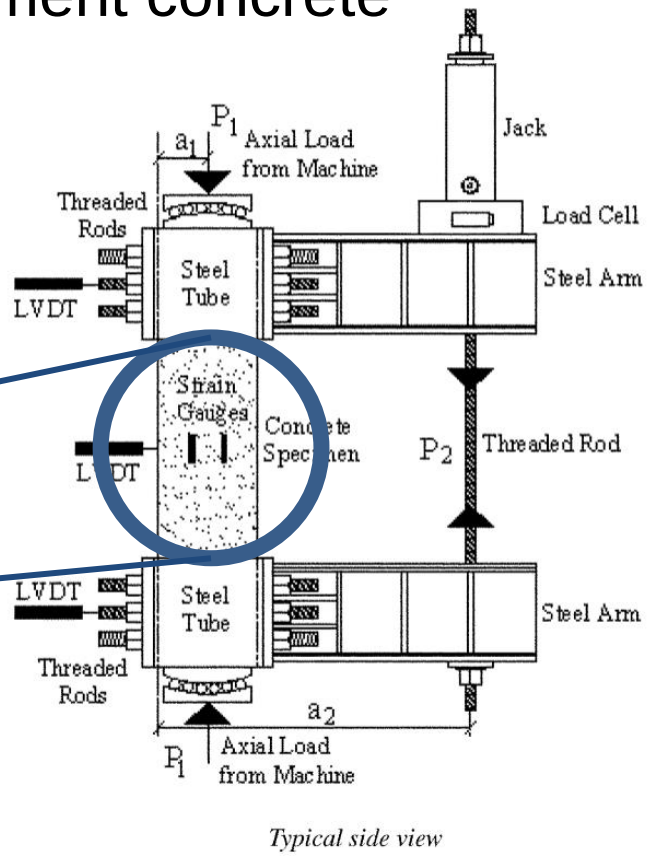




Current ACI CRC Study

Flexural stress-strain of BCSA cement concrete

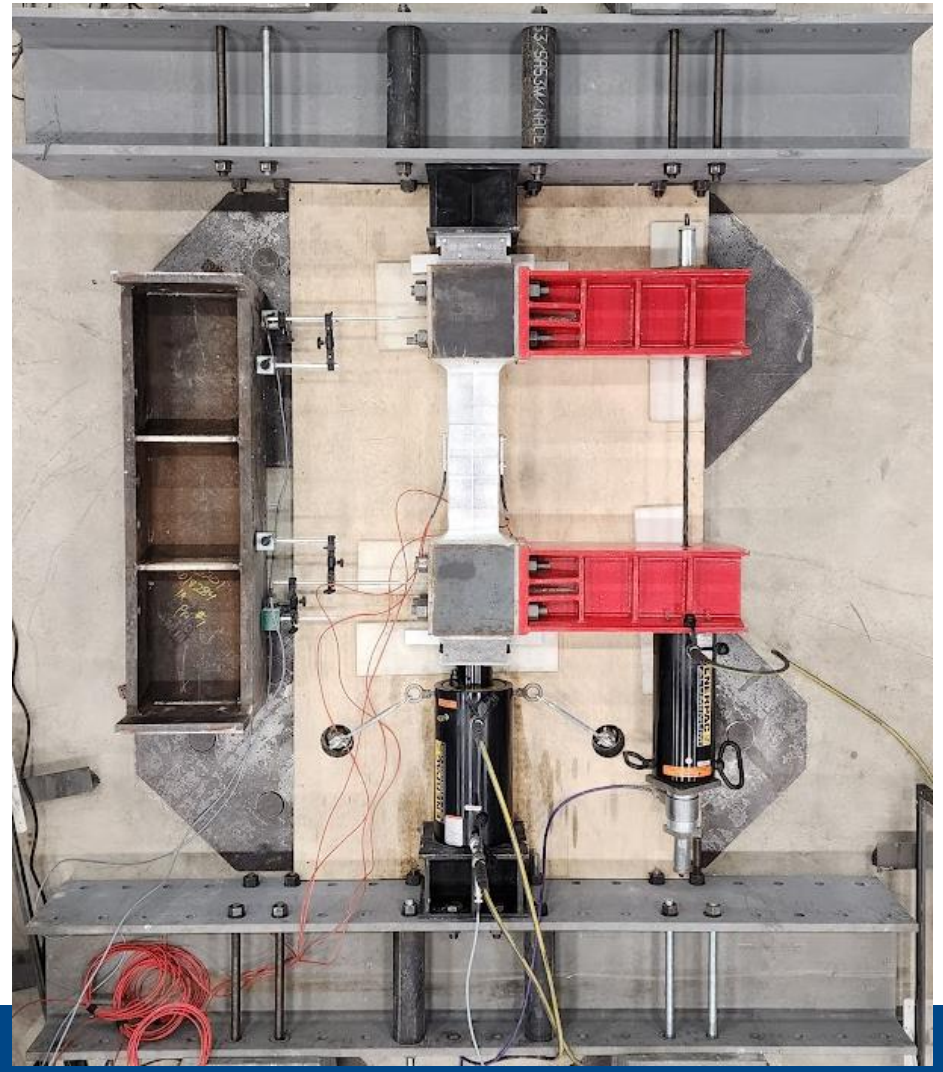


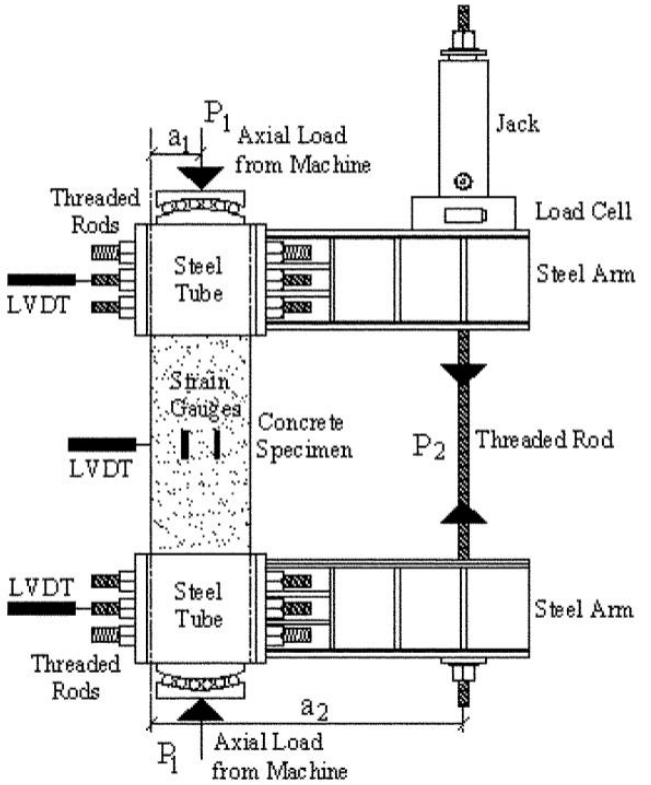


Typical side view

Mertol, H. C., Rizkalla, S., Zia, P., and Mirmiran, A." Characteristics of compressive stress distribution in high-strength concrete." *ACI Structural Journal*, Vol. 105, No. 5. 2008.

Current ACI CRC Study





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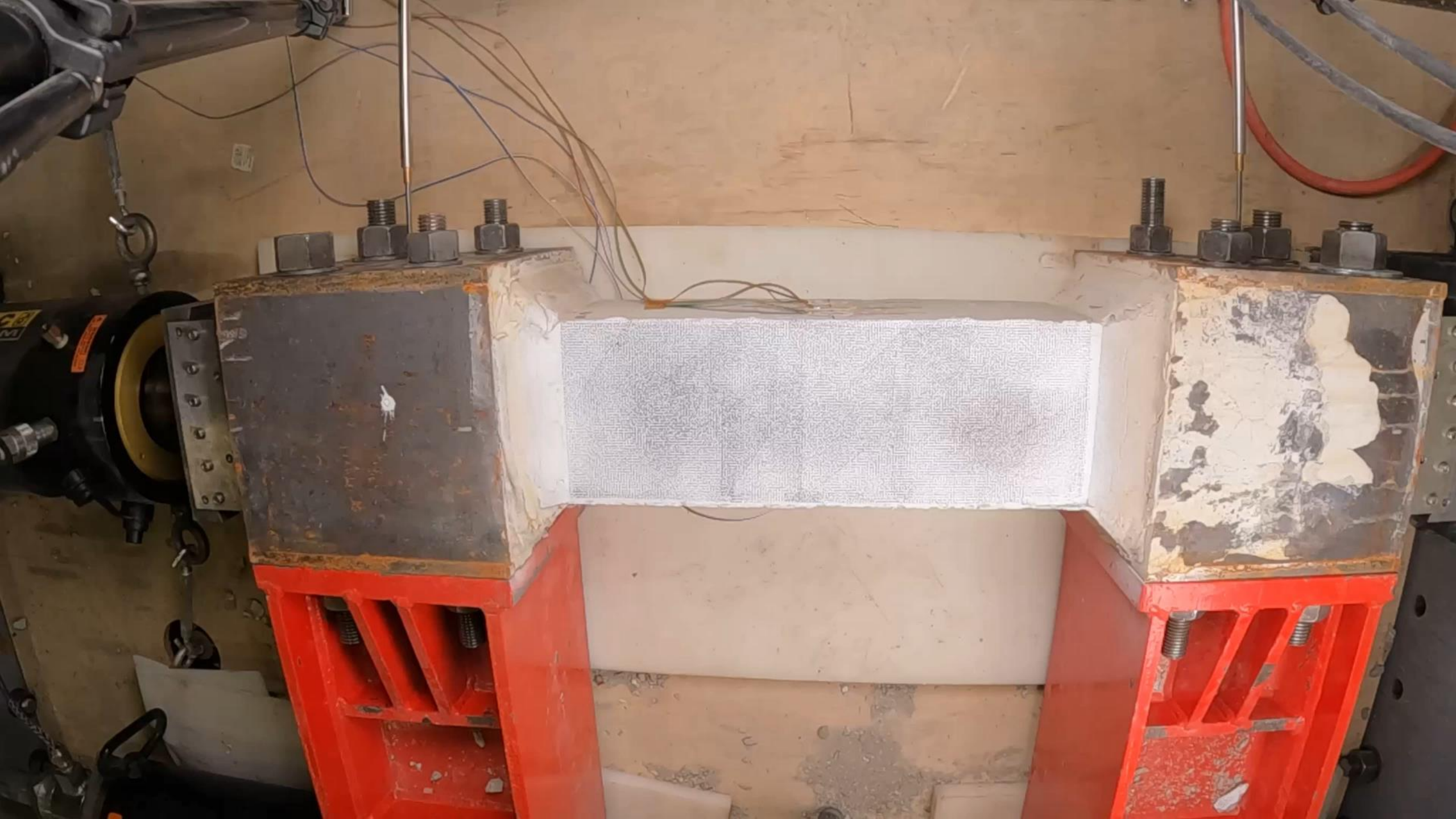
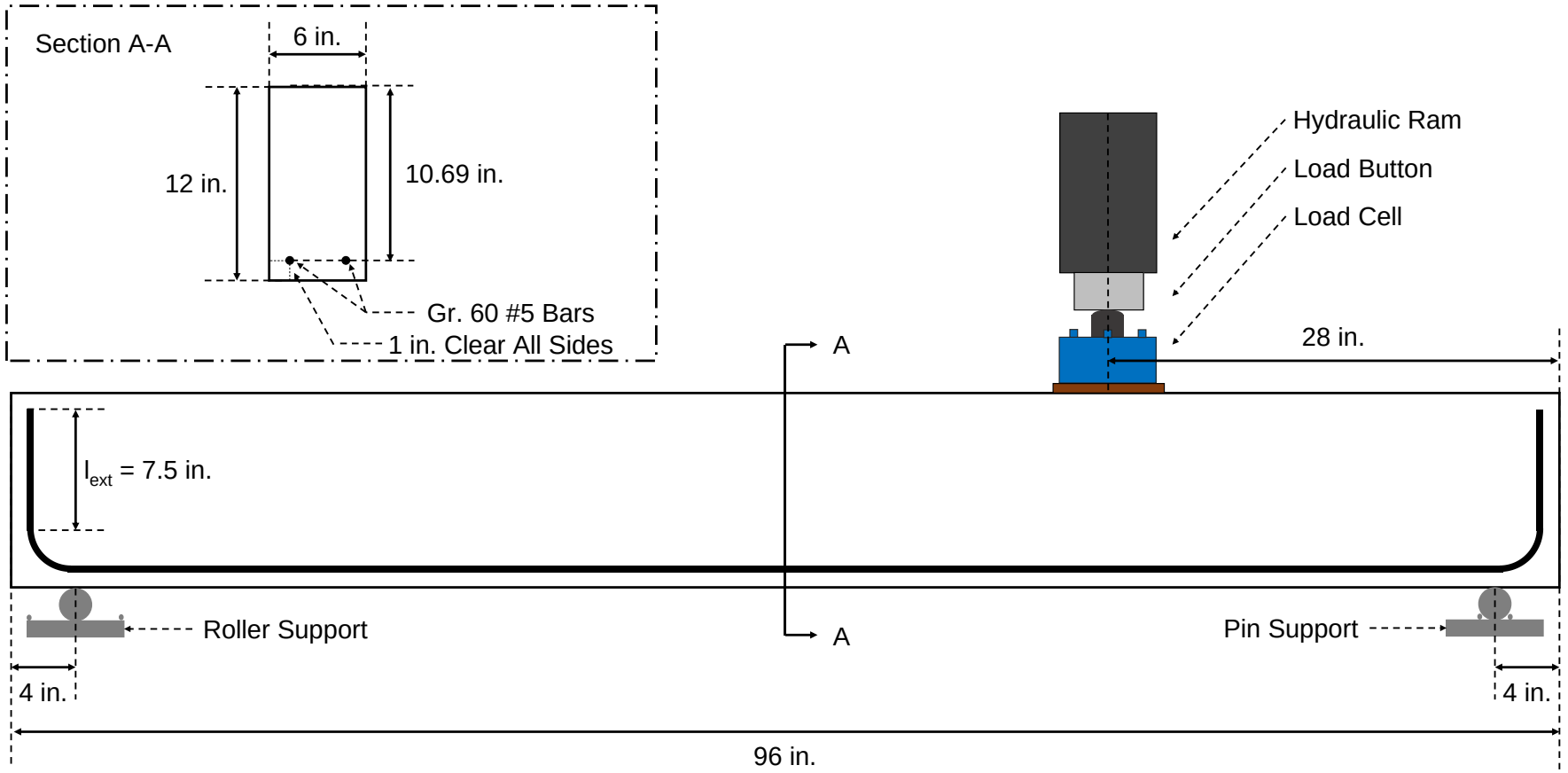


Shear Strength of BCSA Cement Concrete



Chesnut, C.W. and Murray, C.D. “Shear Capacity of Reinforced Concrete made with BCSA Cement.” *ACI Structural Journal* 120, no. 1 (2023).

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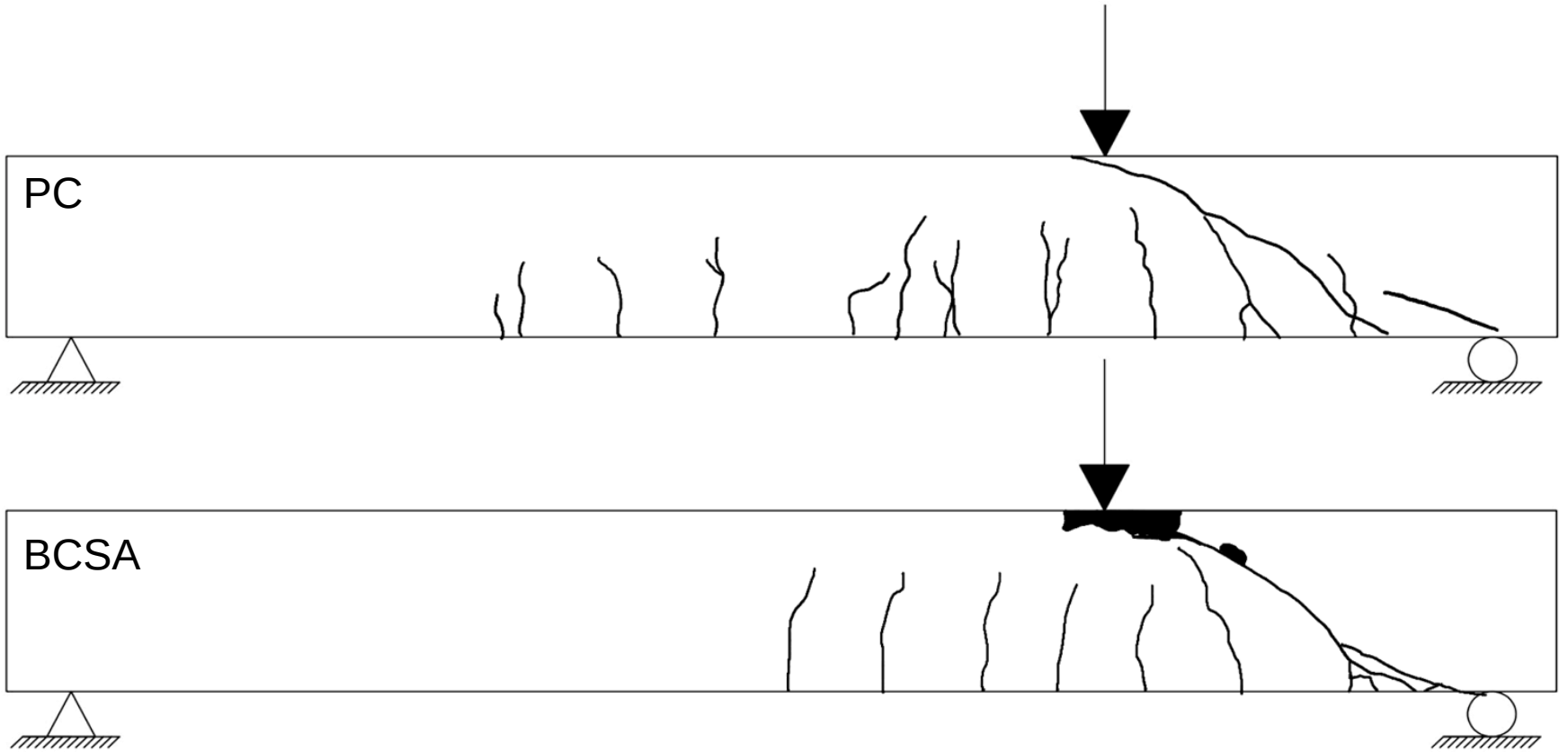

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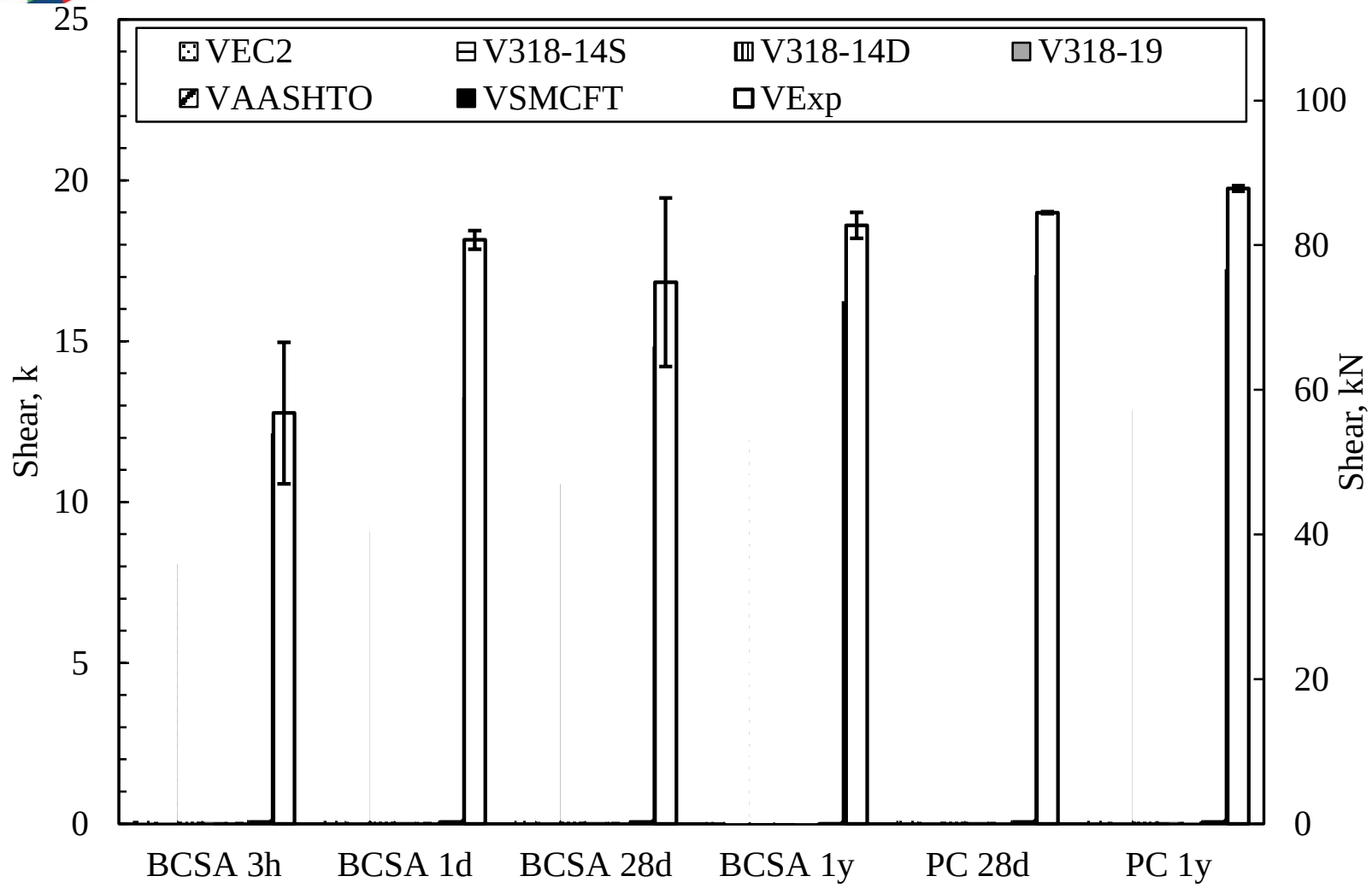

Conclusions

- Code procedures appear to be adequate for predicting BCSA concrete structural strengths
  - True for flexural and shear strengths
- Ongoing work investigating stress-strain relationships
- Unique mixture design considerations
  - But major benefit is similarities to PC

Questions?

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