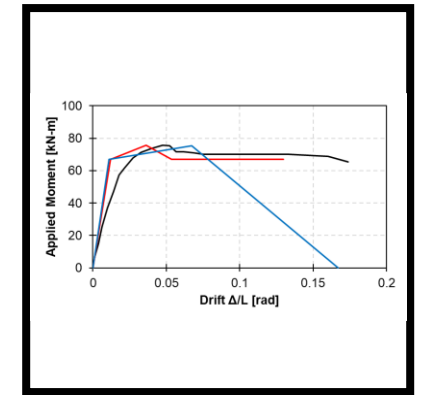
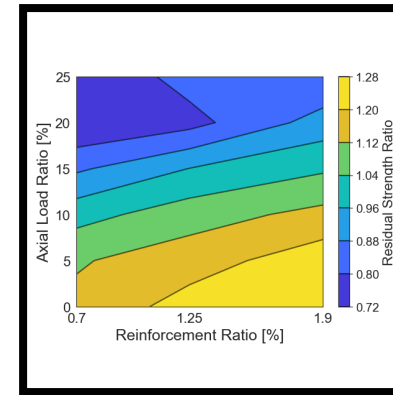
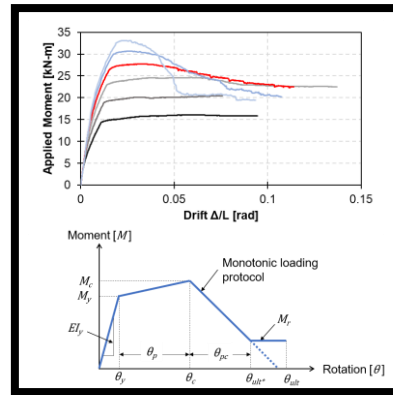
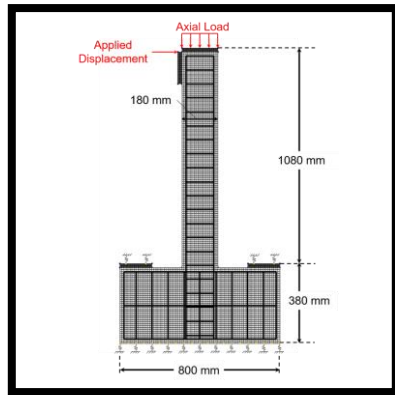


BEHAVIOR OF REINFORCED HPFRCC COLUMNS SUBJECTED TO VARYING AXIAL LOAD RATIOS



Joseph A. Almeida, Matthew J. Bandelt Ph.D. P.E.
J.A. Reif, Jr., Department of Civil and Environmental Engineering
New Jersey Institute of Technology

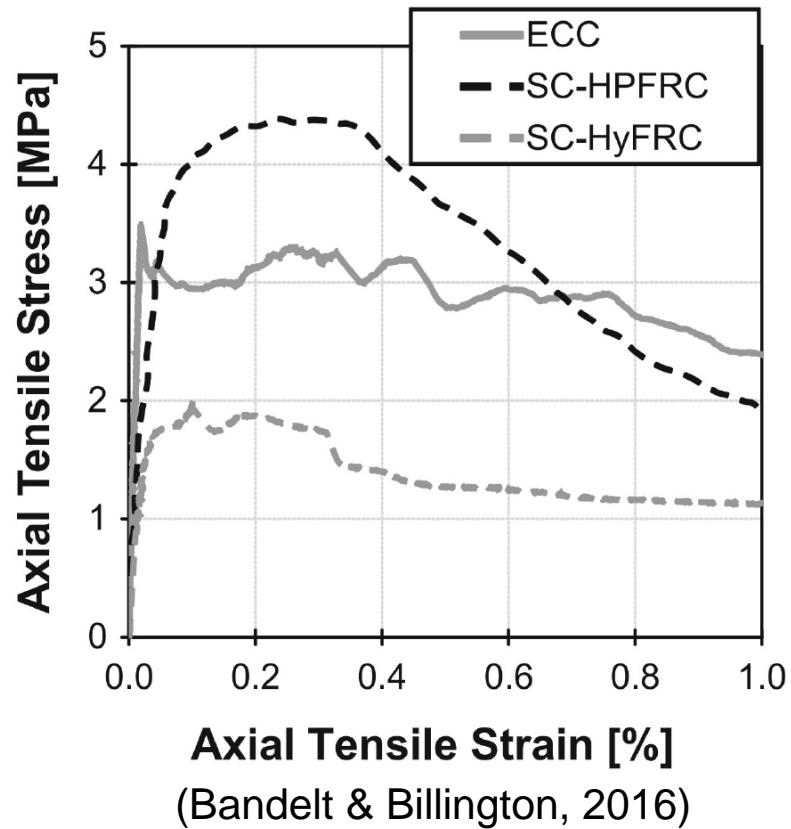


ACI Spring 2023 Convention
Research in Progress
San Francisco, CA
3 April 2023

HIGH PERFORMANCE FIBER REINFORCED CONCRETE

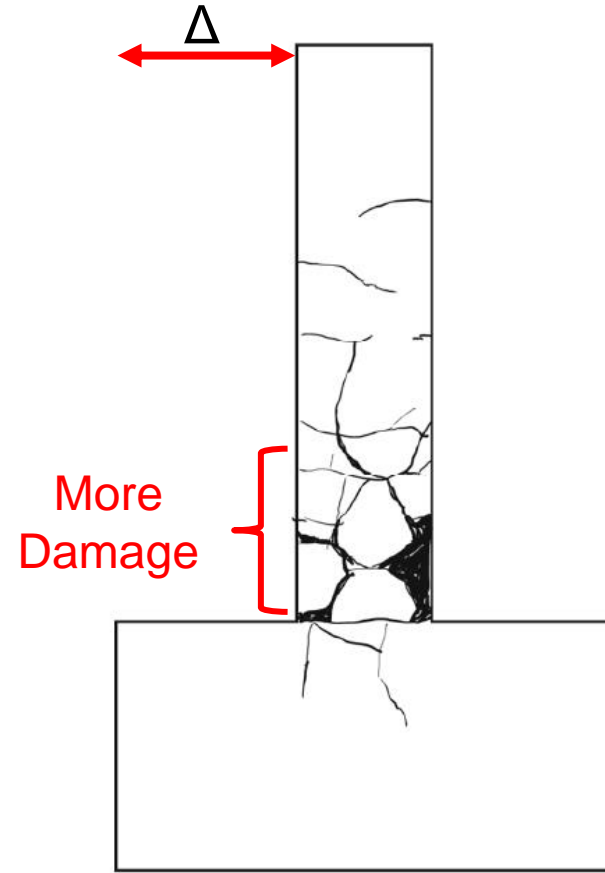
Material Level

Ductile Response In Tension

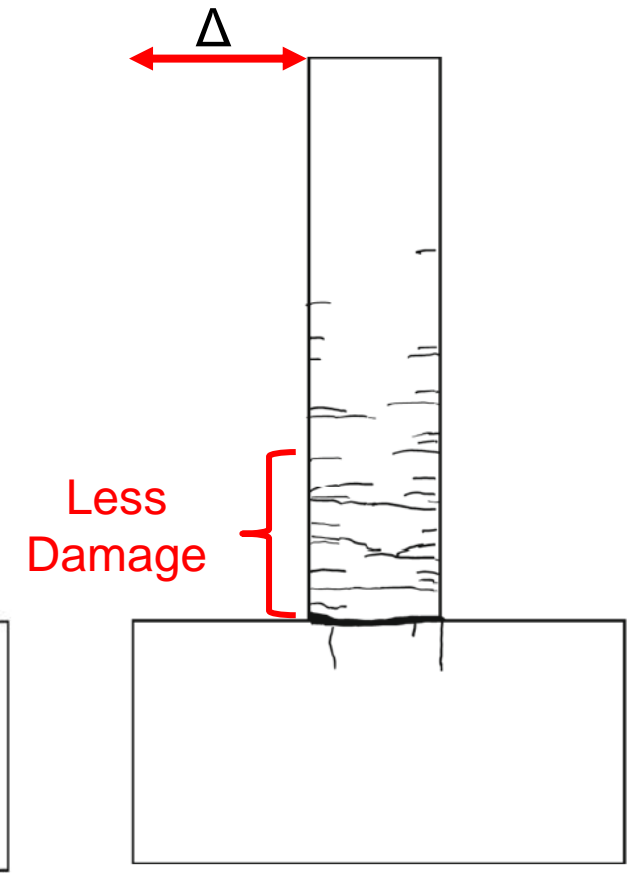


Component Level

Reinforced Concrete



Reinforced HPFRCC



(Frank et al., 2017)

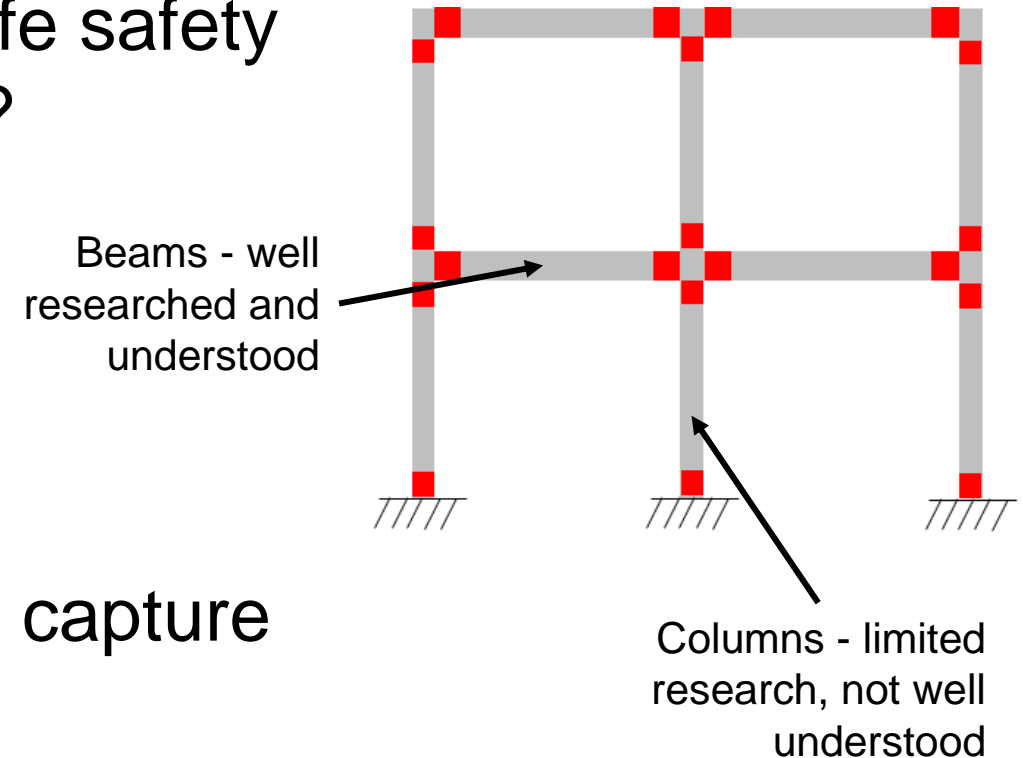
RESEARCH OBJECTIVES

Big Picture Question:

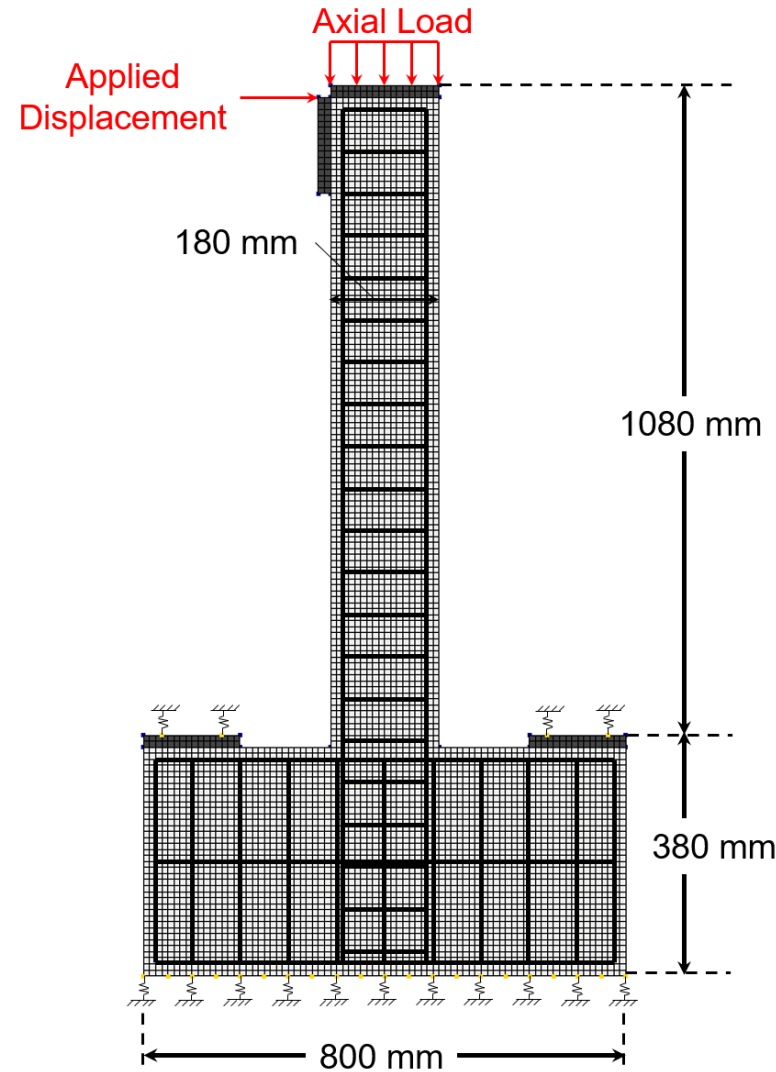
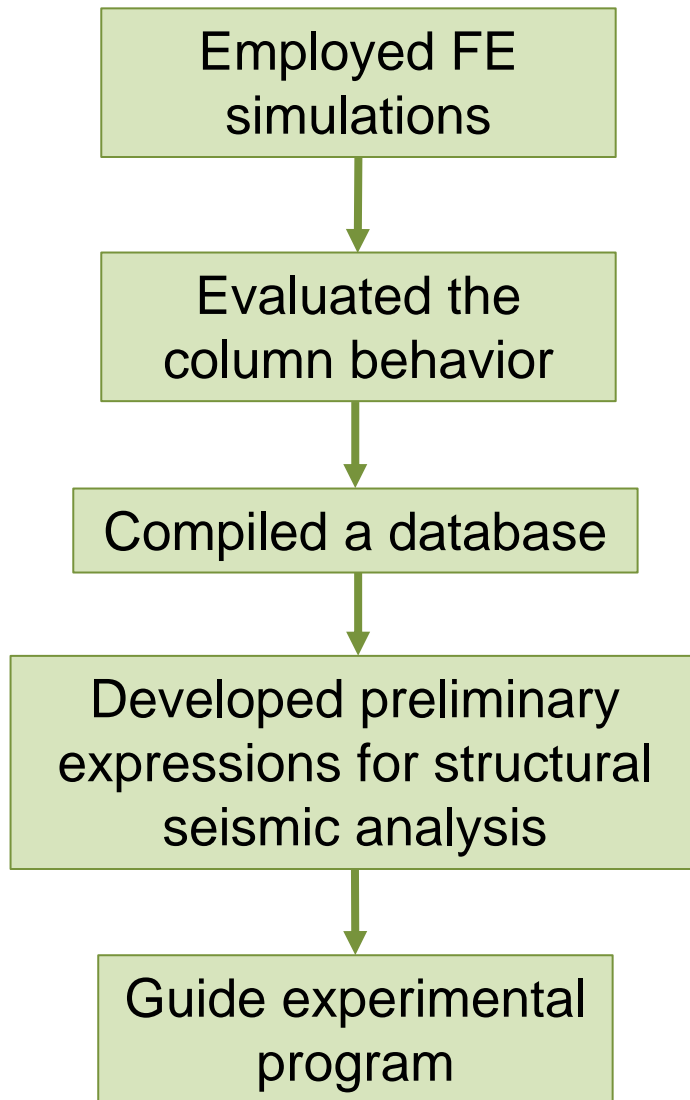
- What is the performance, cost, and life safety of HPFRCCs at the **structural level**?

In order to do so, we must:

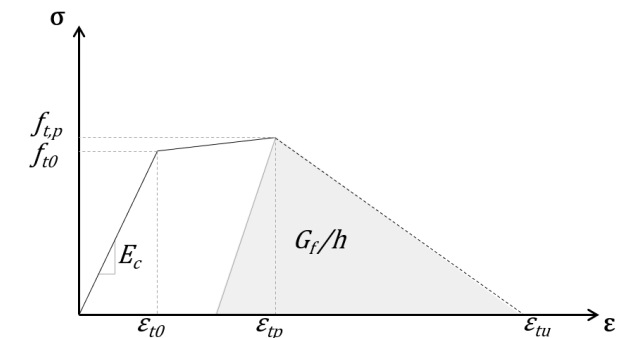
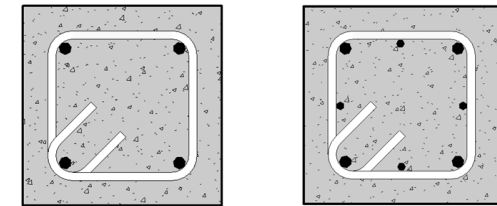
- Understand the behavior of columns
- Develop structural analysis tools that capture HPFRCC behavior



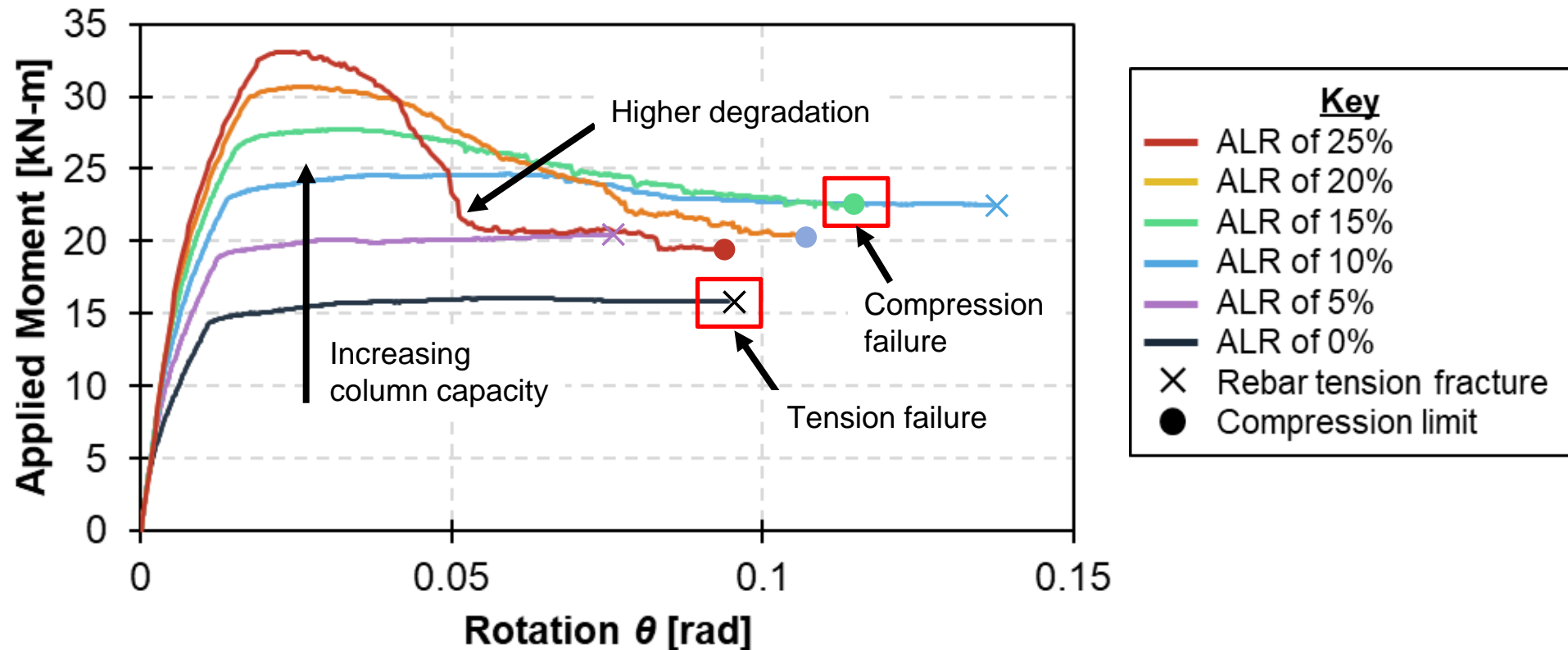
RESEARCH APPROACH AND SETUP



Varying Axial Load



COLUMN RESPONSE – MOMENT-ROTATION



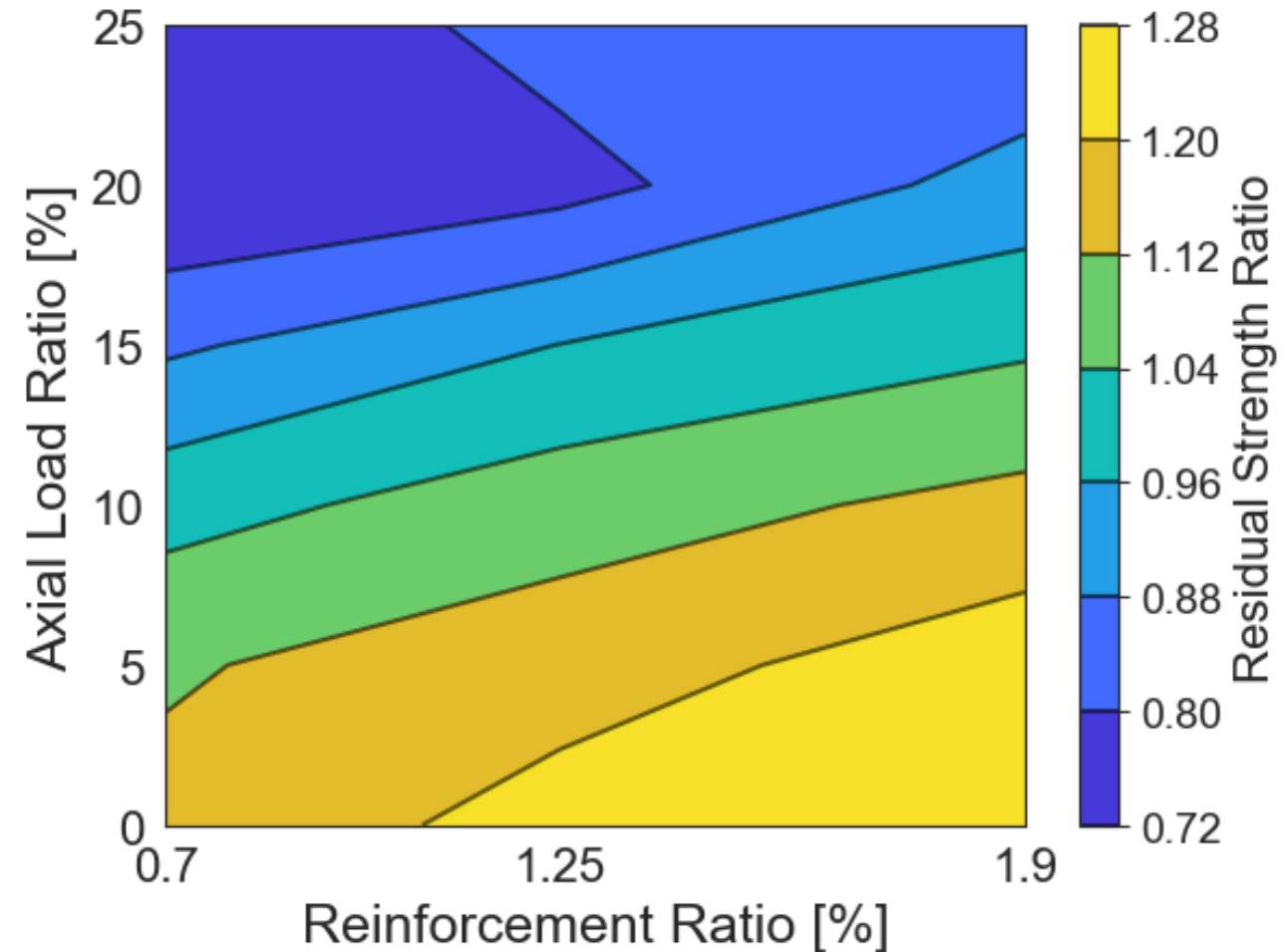
- Increasing axial load → Higher column capacity (Why? - tensile strains are relieved)
- Tension controlled below axial load ratio of 15%
- Increasing axial load → Higher degradation

STRENGTH DEGRADATION AND AXIAL LOAD

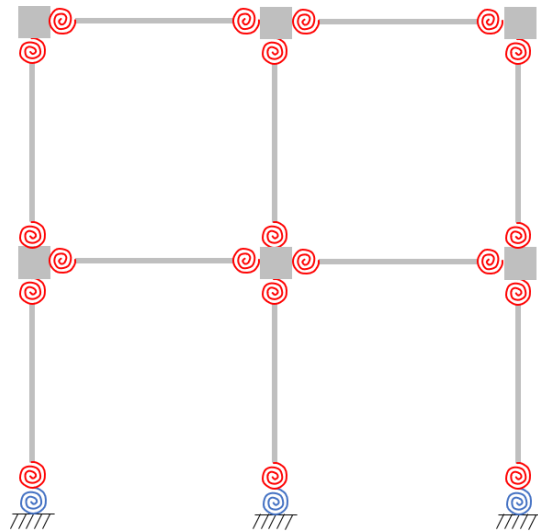
Residual Strength Ratio

$$\frac{M_r}{M_y} \begin{cases} \frac{M_r}{M_y} \text{ above } 1 \rightarrow \text{Strain hardening} \\ \frac{M_r}{M_y} \text{ below } 1 \rightarrow \text{Degradating} \end{cases}$$

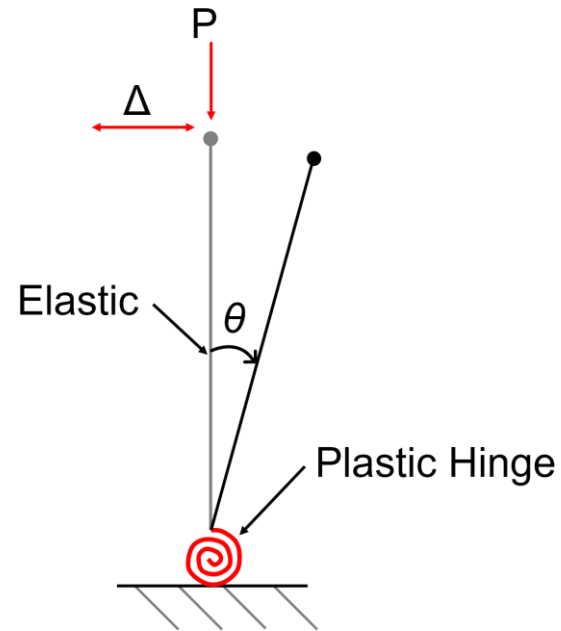
- Predominately a function of axial load
- Columns at high axial load still have 72% of load carrying capacity at failure



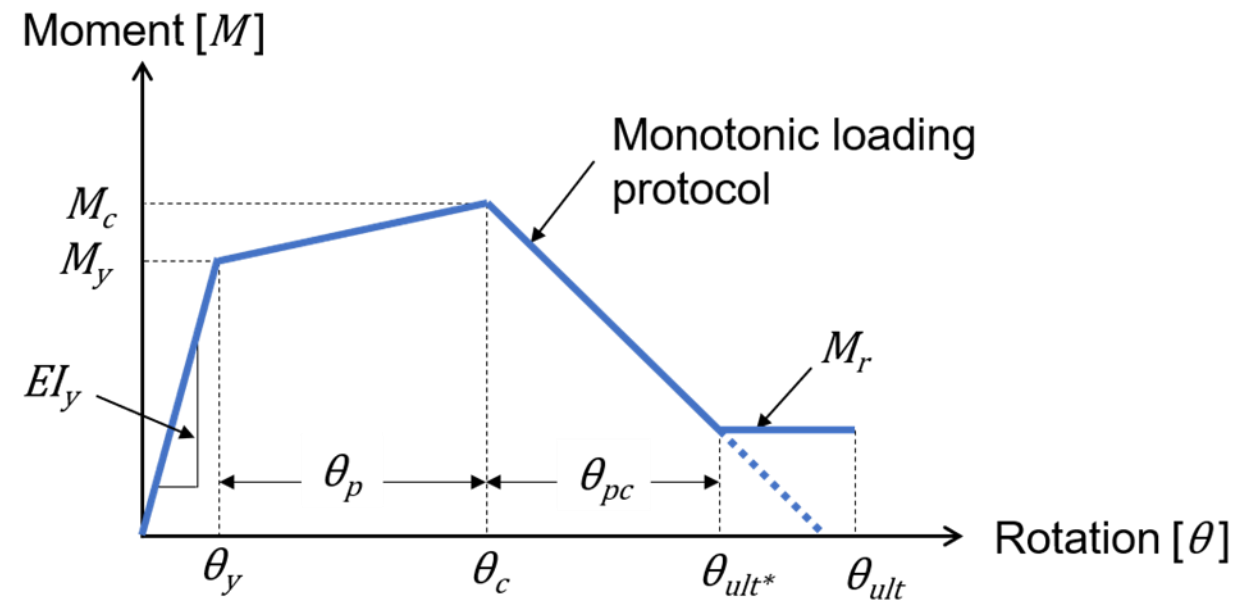
STRUCTURAL ANALYSIS



Structural Model



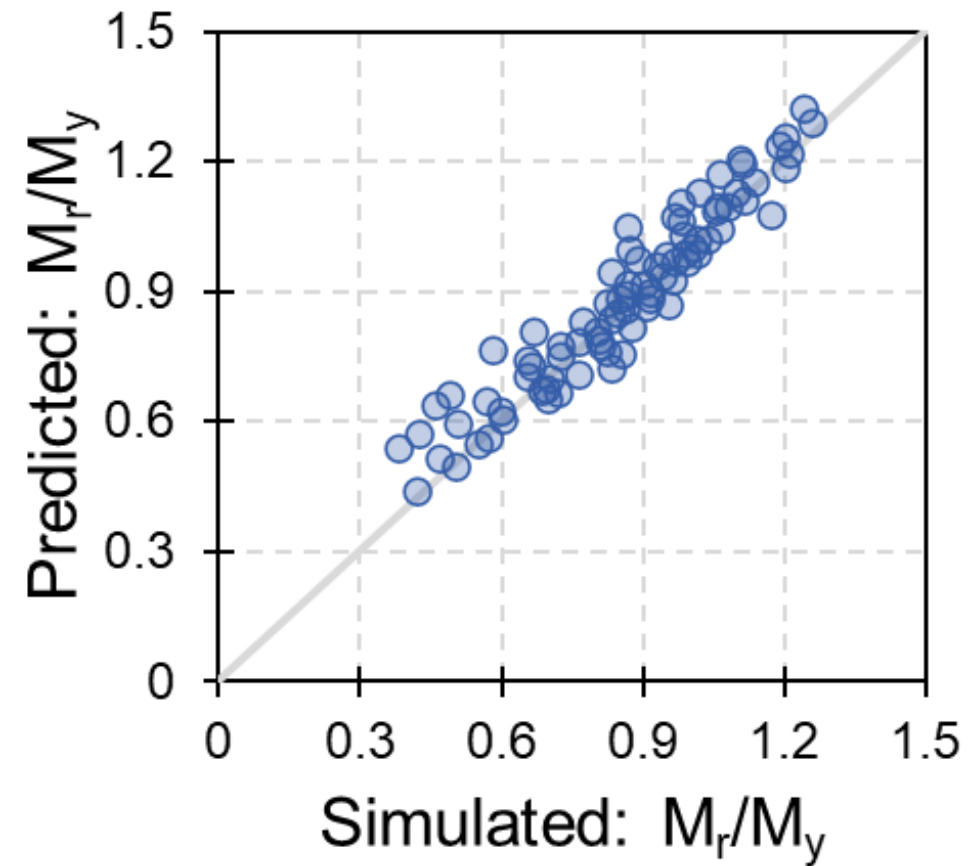
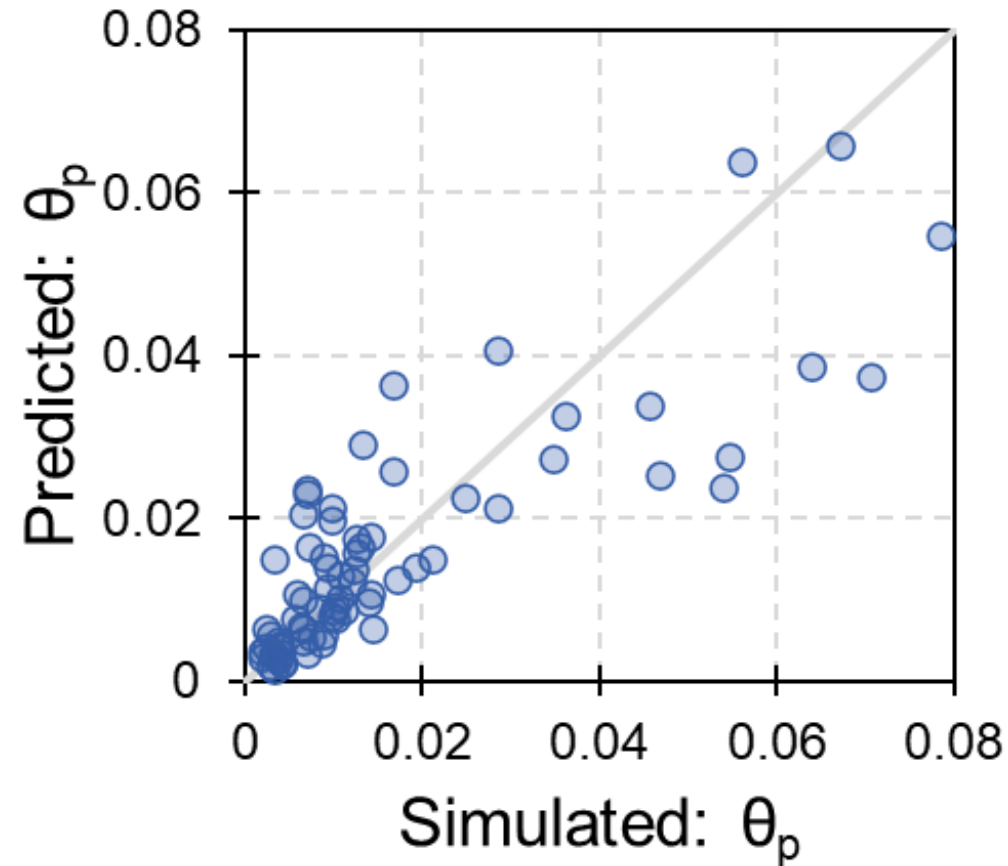
Modeled component



Plastic Hinge Response

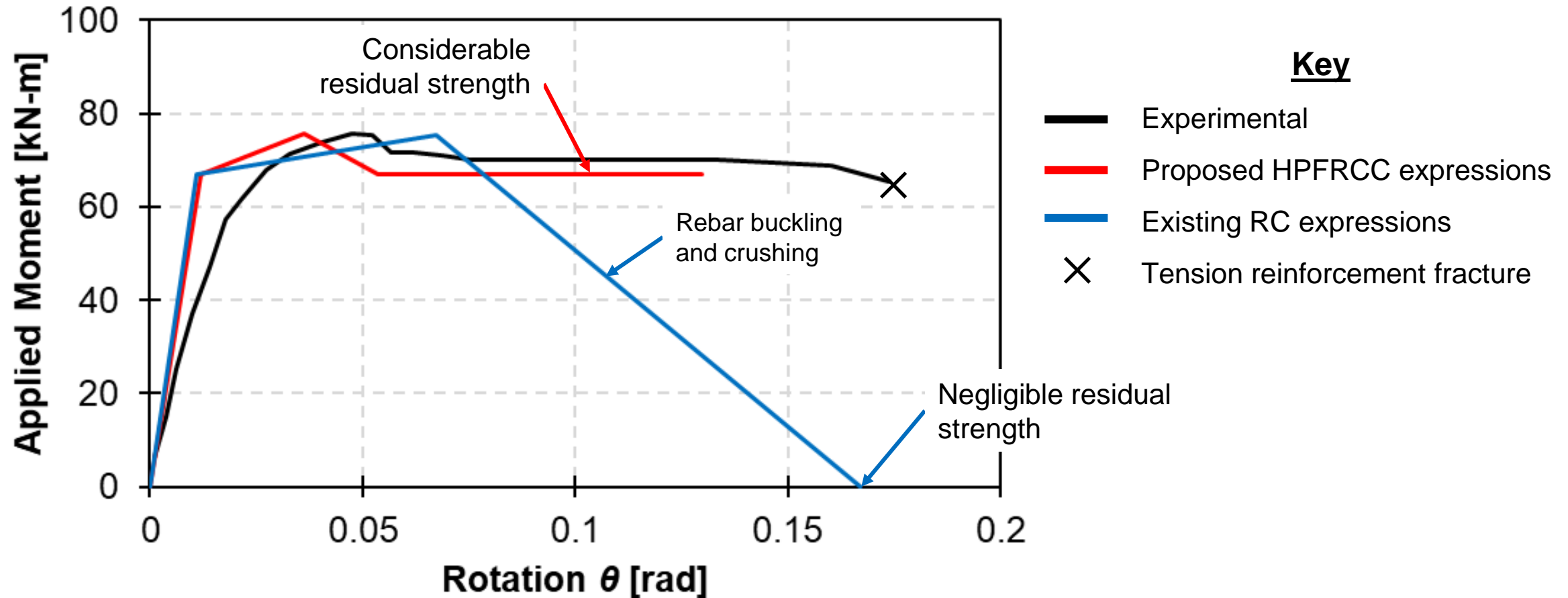
(Applied Technology Council, 2017)

PRELIMINARY SEISMIC ANALYSIS EXPRESSIONS



- Develop predictive expressions for key control points to predict column responses

PREDICTIONS AND COMPARISONS



- Proposed HPFRCC expressions reasonably capture HPFRCC column response
- Existing RC expressions do NOT capture HPFRCC column response

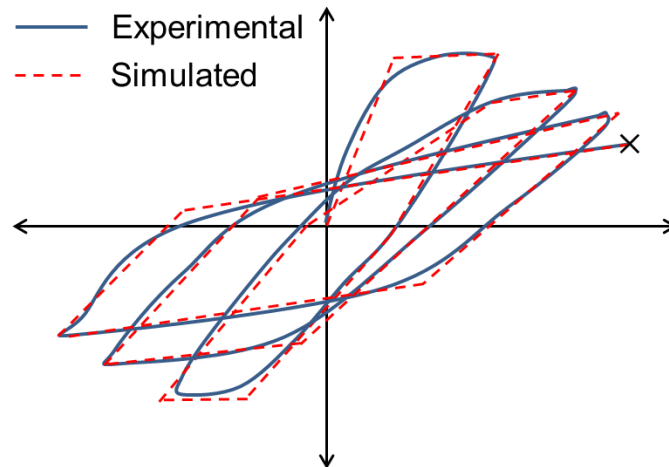
RESEARCH IN PROGRESS

WE ARE HERE

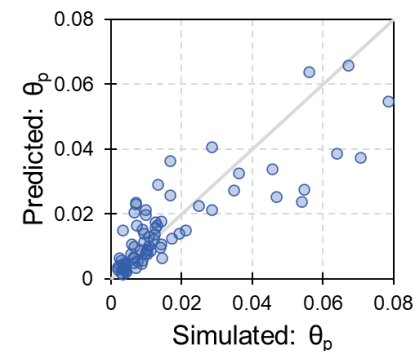
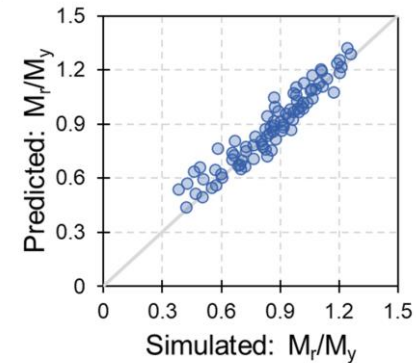
Use FE results to guide experimental program



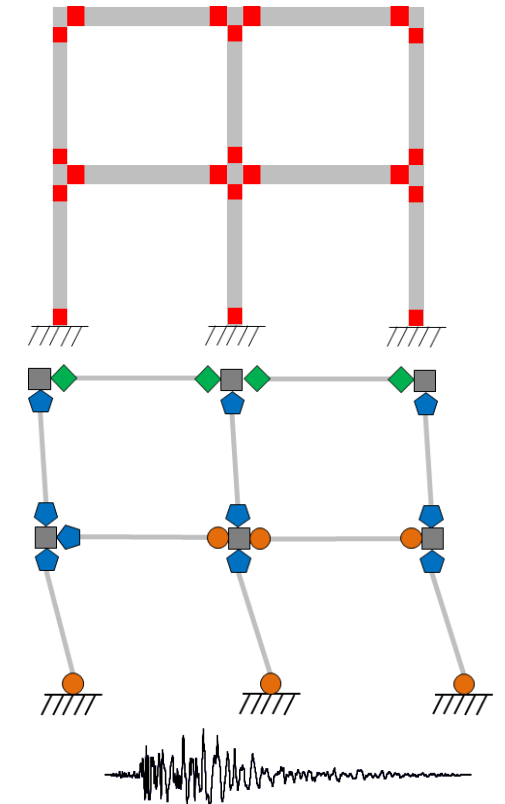
Directly validate and adjust FE models



Develop seismic analysis tools with experimental and numerical data



Evaluate HPFRCCs at the structural level



KEY TAKEAWAYS

- HPFRCC columns exhibit a ductile behavior even at relatively high axial loads.
- Existing RC column expressions do NOT adequately capture HPFRCC column response.

Big Picture:

- Accurate seismic models of structures allows for:
 - the evaluation of HPFRCC **structural** performance, cost, and life safety



THANK YOU!

ja558@njit.edu



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