Alternative ABC Connections Using UHPC

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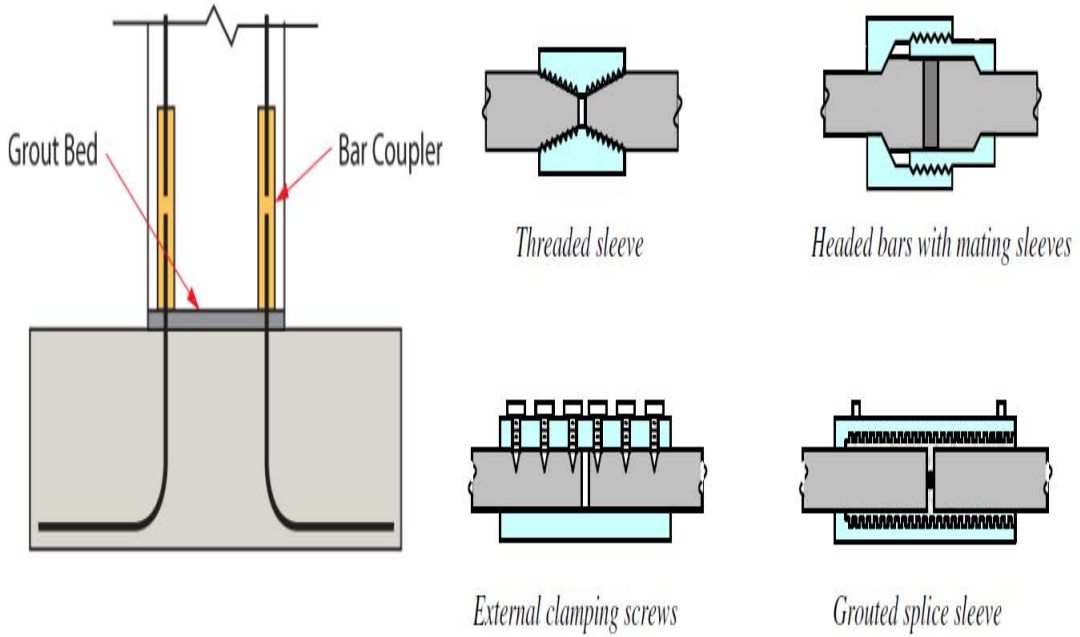
September 2017

Problem Statement

Currently all ABC Connections to connect cap beam to columns uses types of connections that penetrates into the cap beam, creating a very challenging detailing Requirements within the cap beam.

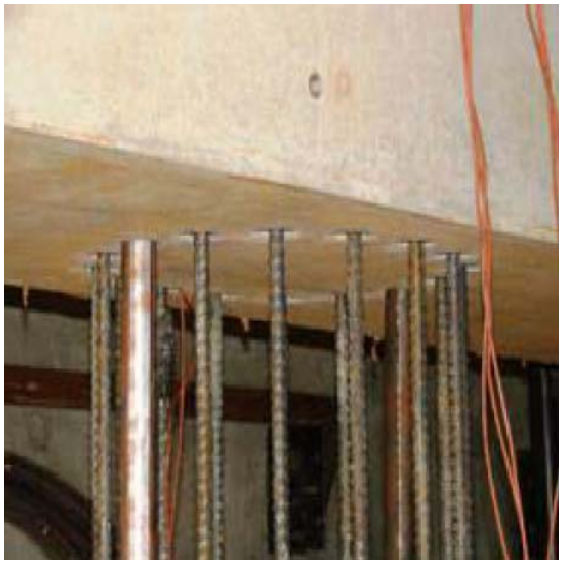
Background
Common Connections

Bar Couplers



Background
Common Connections

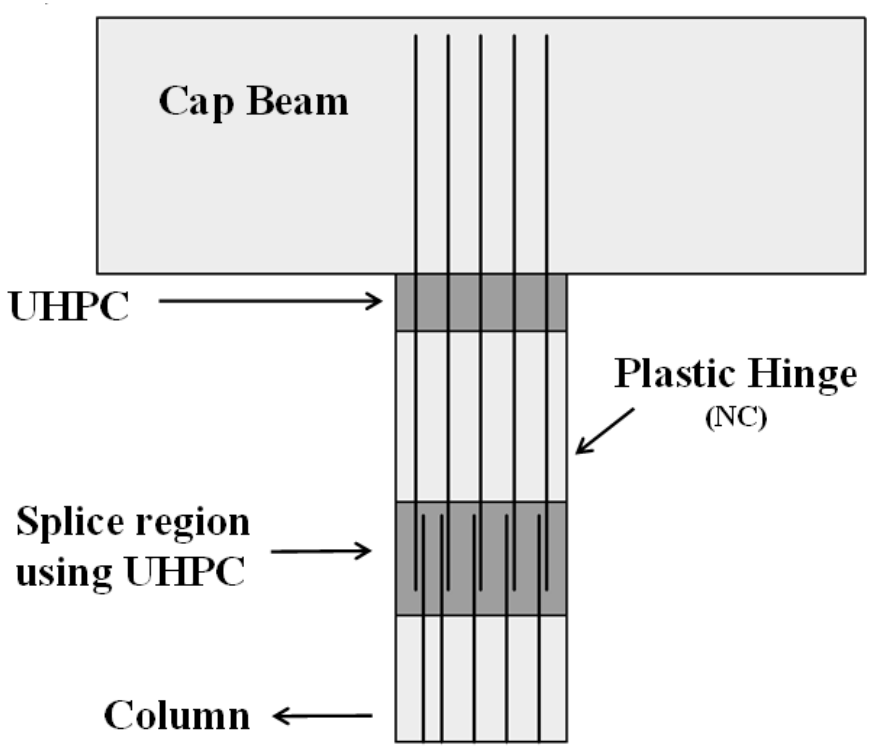
Grouted Ducts



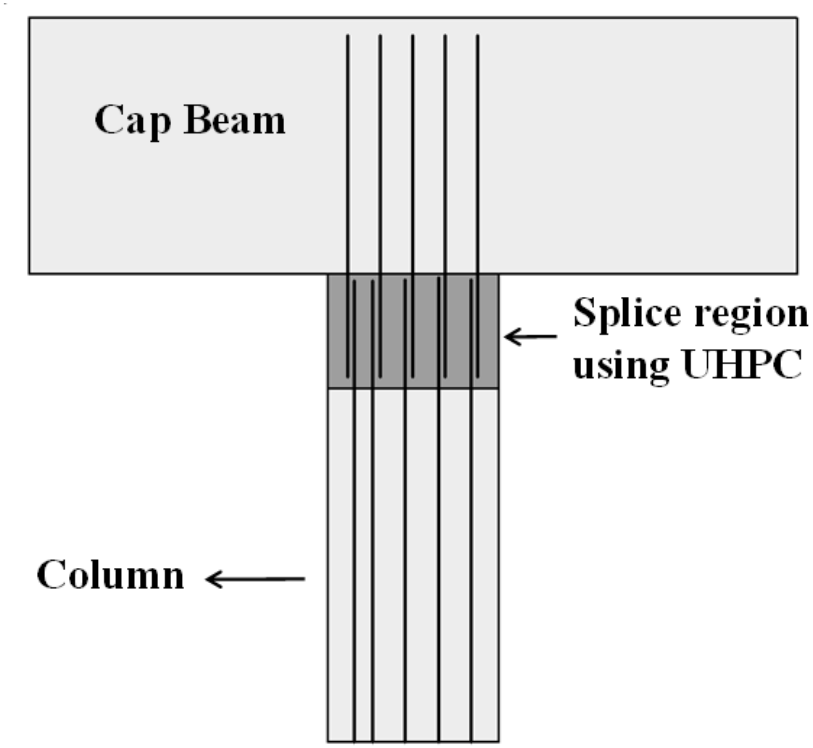
Background
Common Connections

Pocket Connections

Details of the Proposed Connection



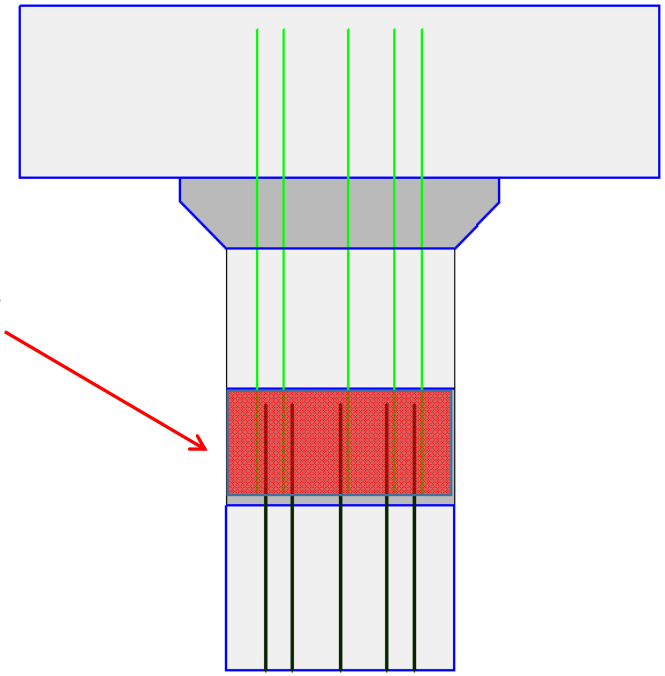
Seismic Detail

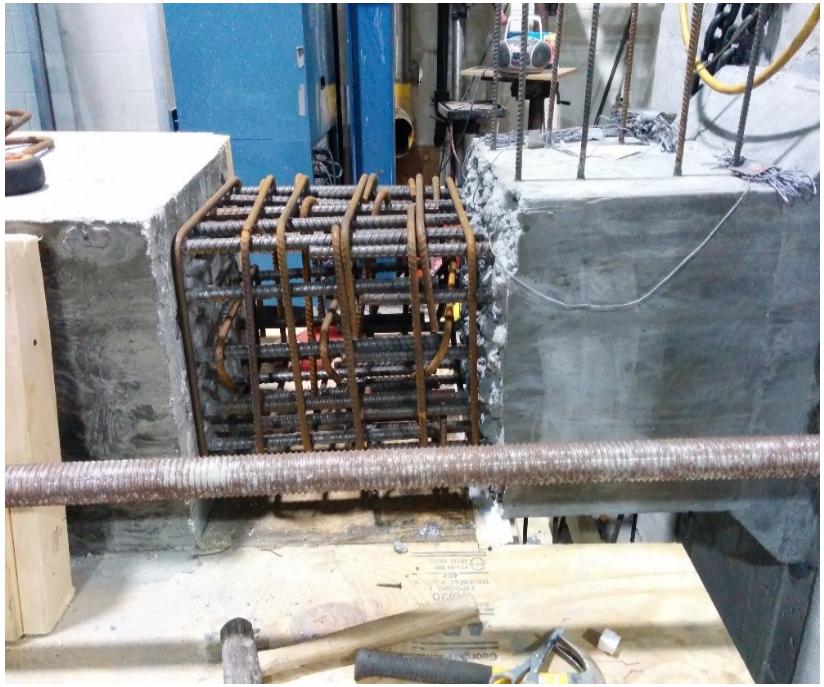


None-Seismic Detail

Advantages

✓Large Tolerances

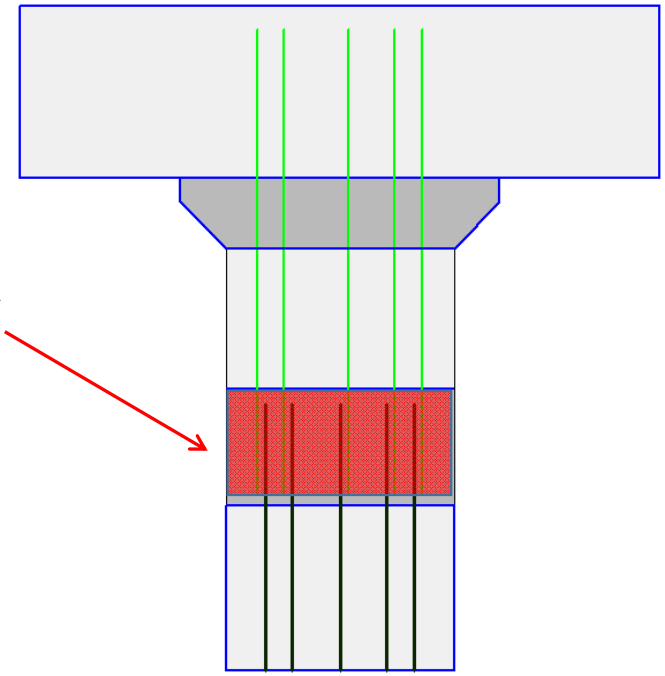


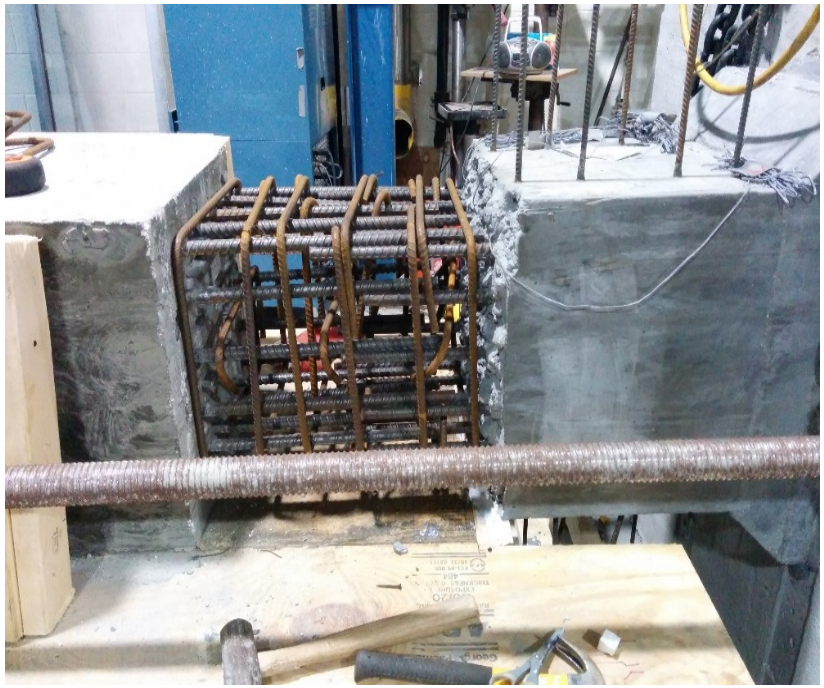


Advantages

✓Developing the reinforcement over short length

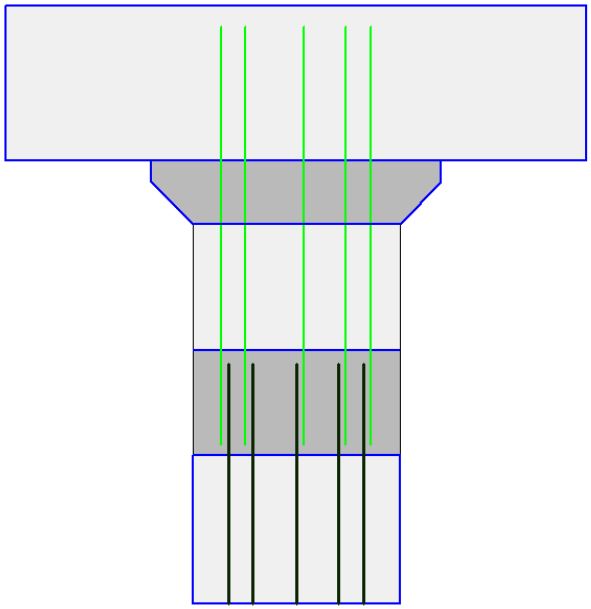
✓Minimal volume of concrete to be casted in the field



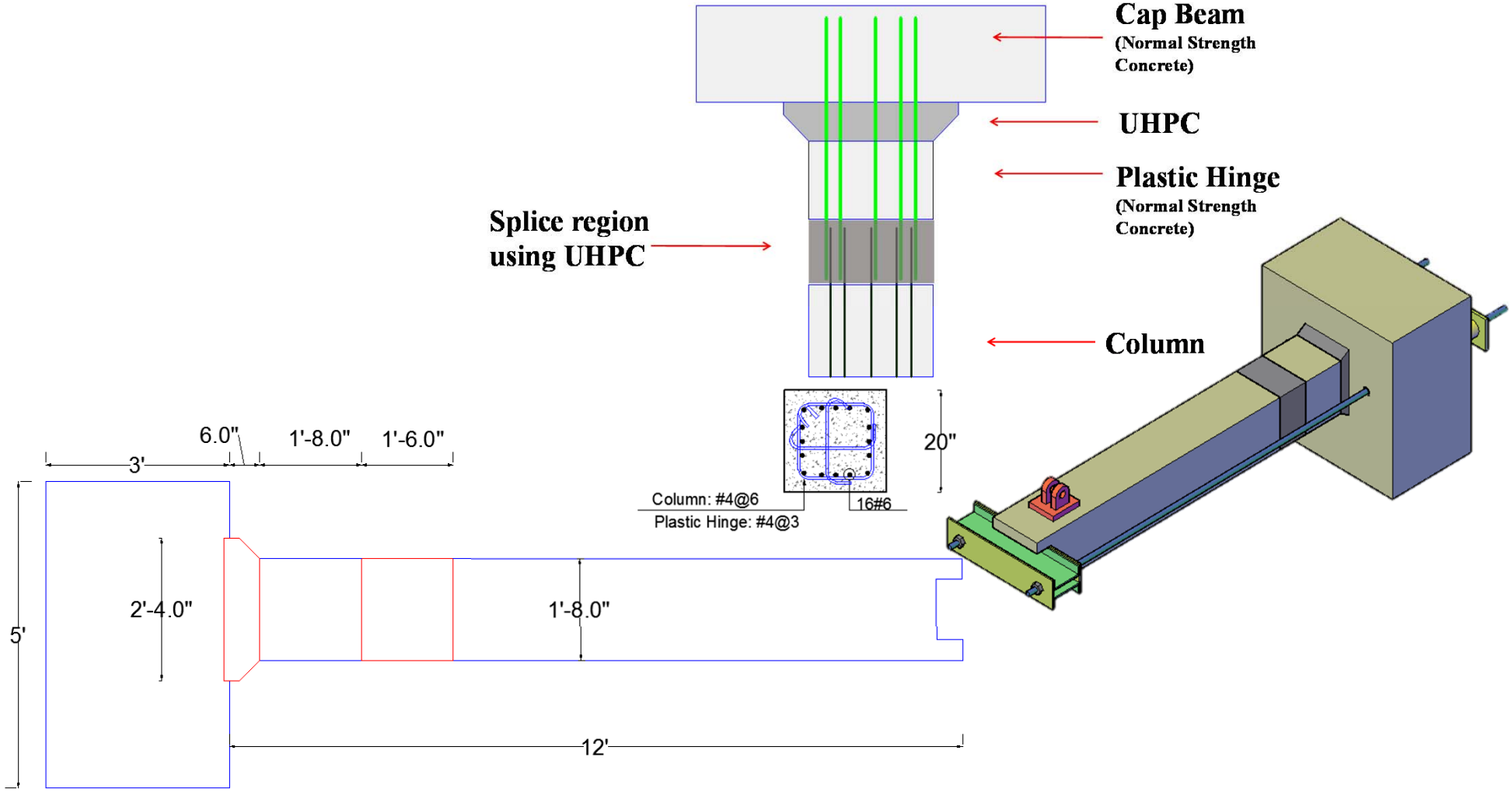


Advantages

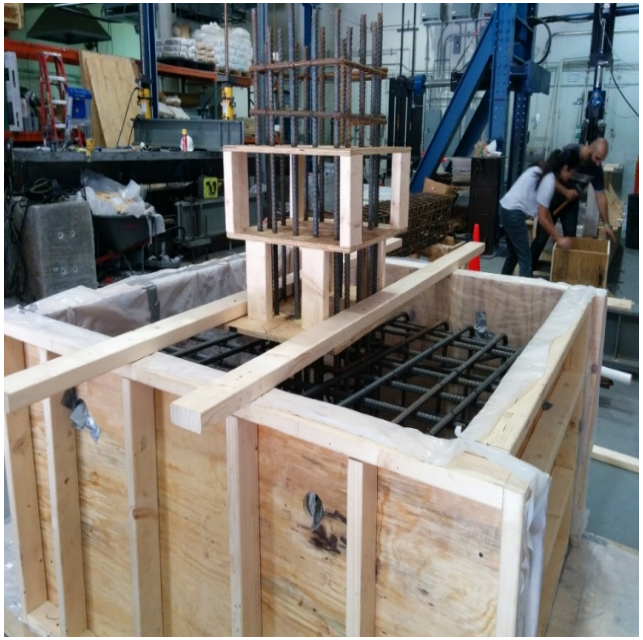
✓Eliminating the potential interferences with reinforcement in the cap beam



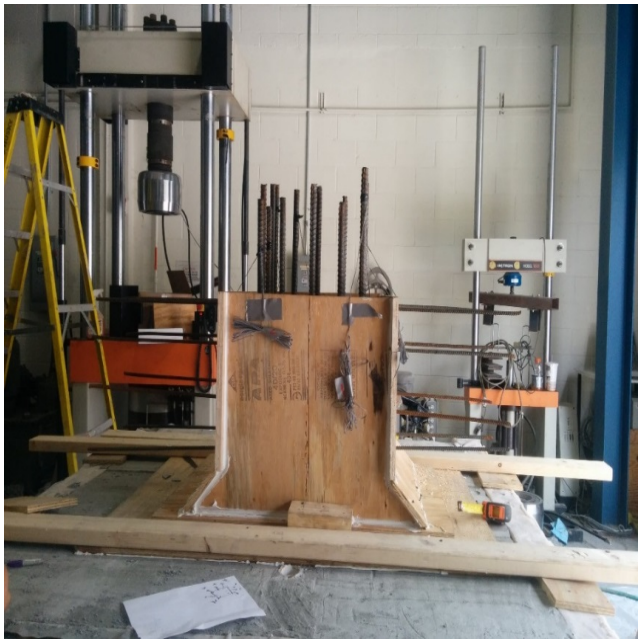
Details of the Feasibility Study



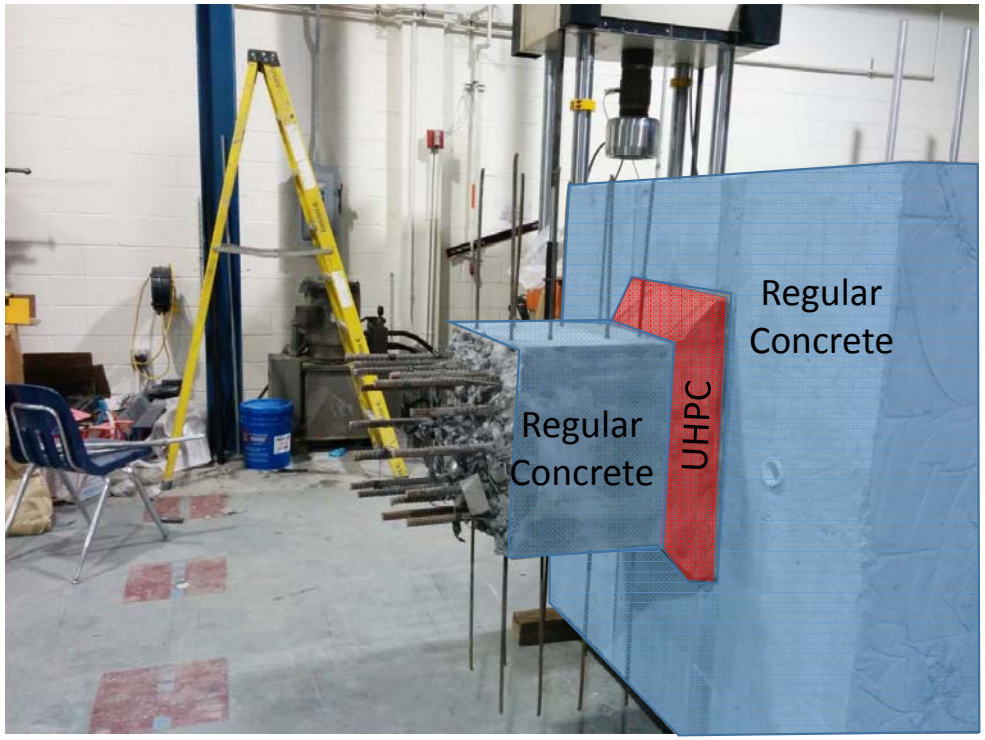
Construction of the Specimen



Construction of the Specimen

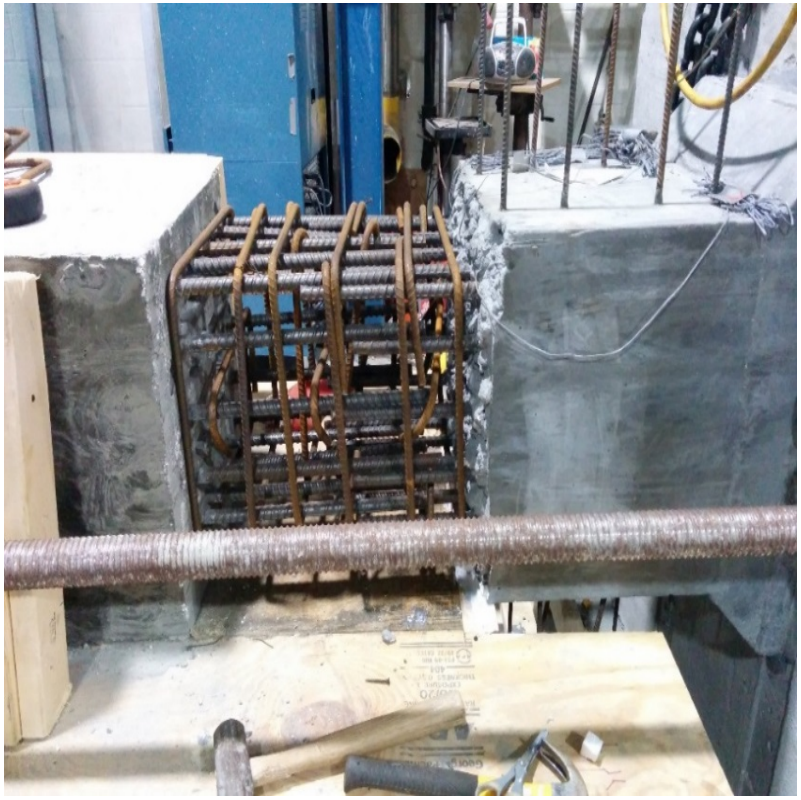


Construction of the Specimen
First Part

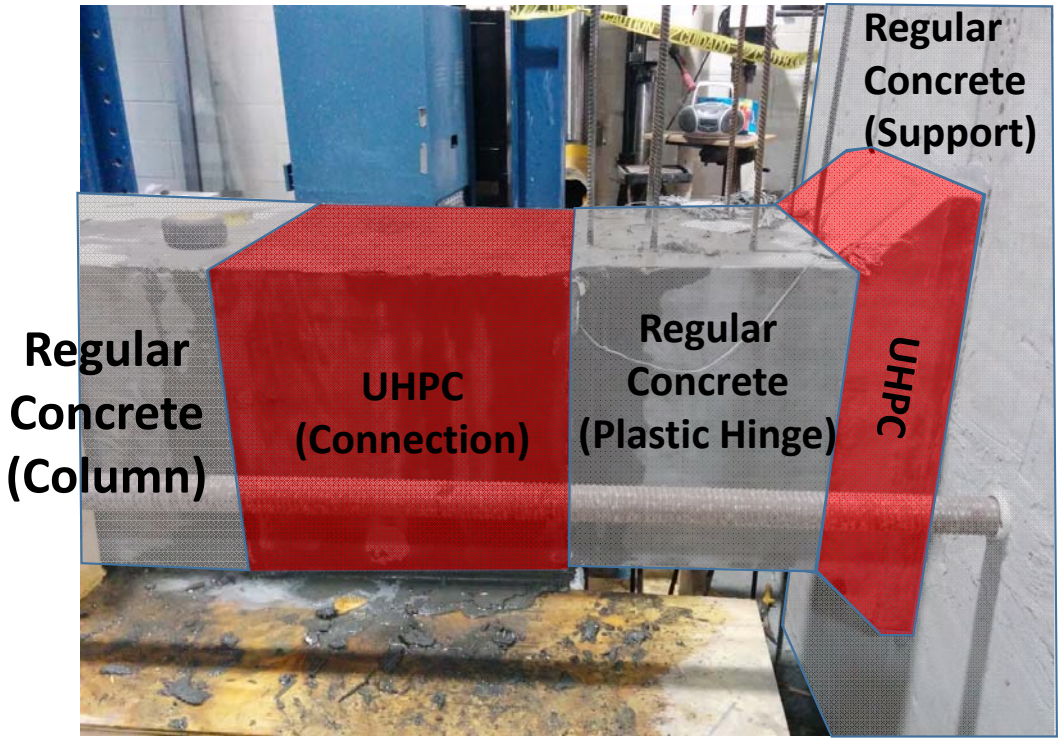


Construction of the Specimen

Joining Column to the First Part



Construction of the Specimen
Joining Column to the First Part



Testing the Specimen

Loading and Supports (Axial Load=200 Kip (10% P_u)

Results

Observations

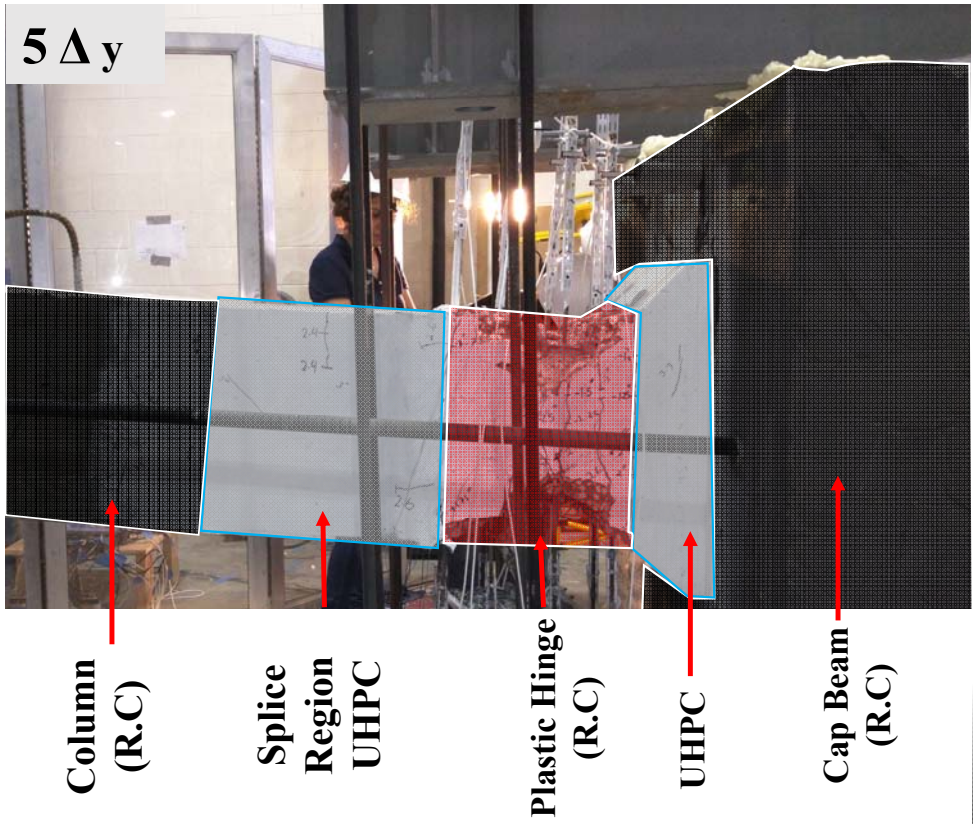
Results

Observations

Results

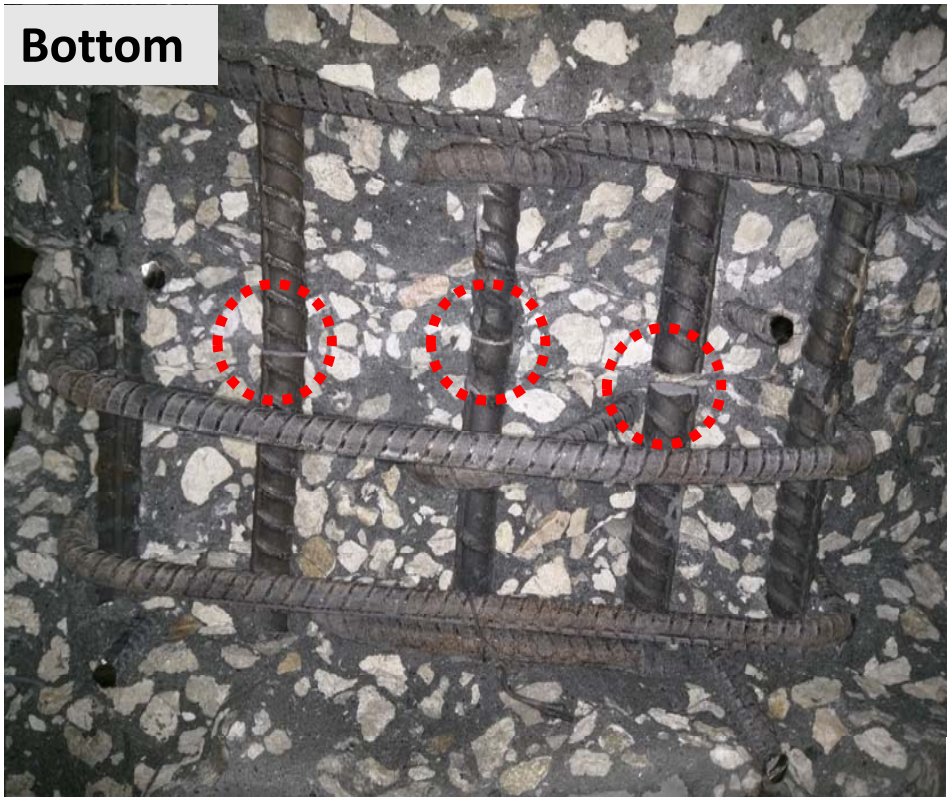
Observations

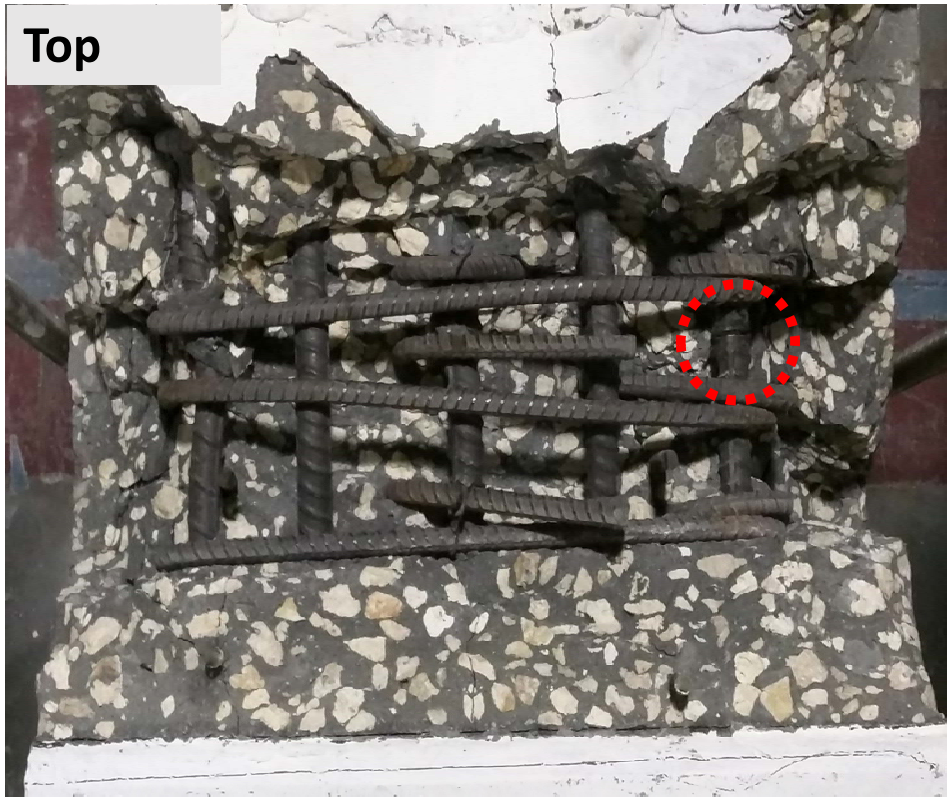
Results
Observations



Results

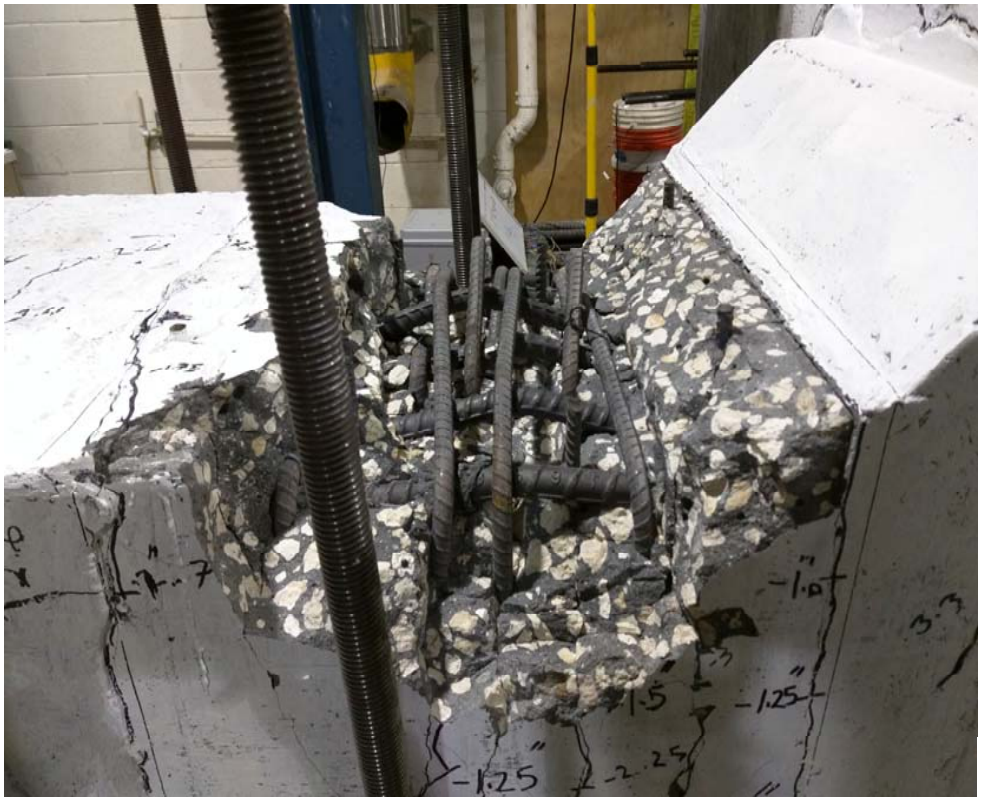
Observations





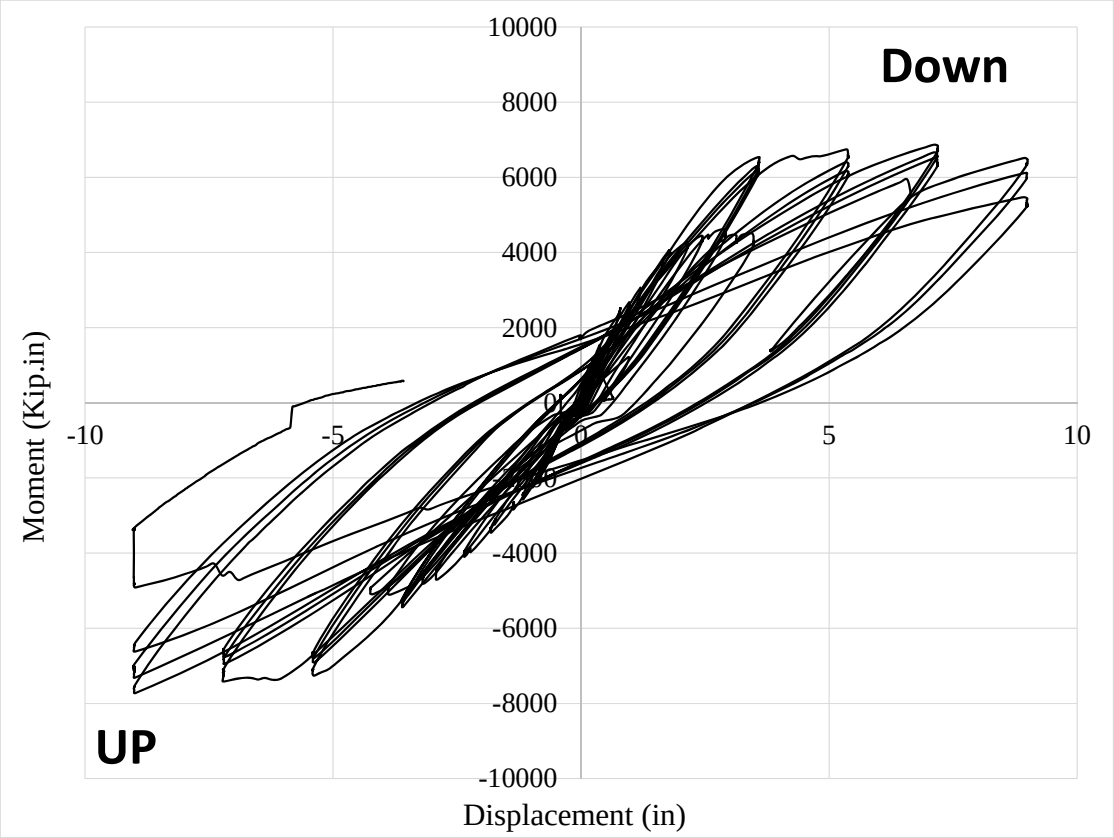
Results

Observations

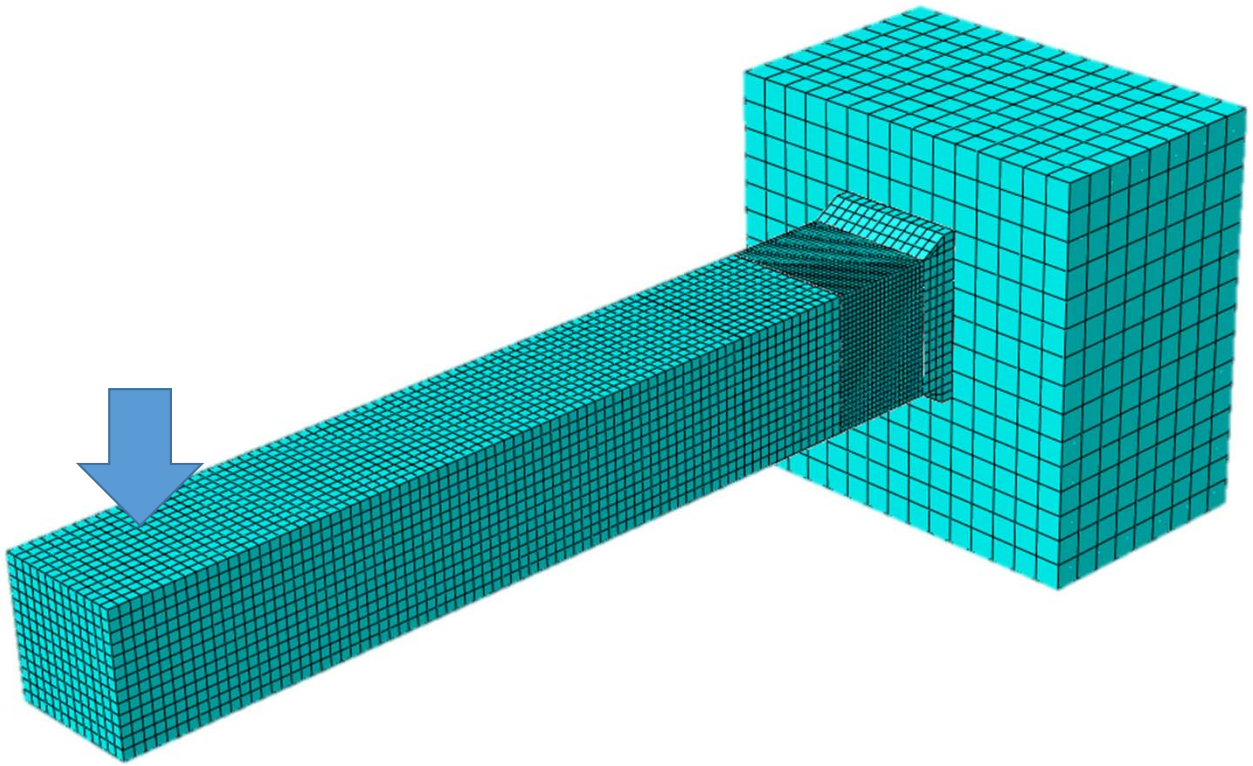


Results

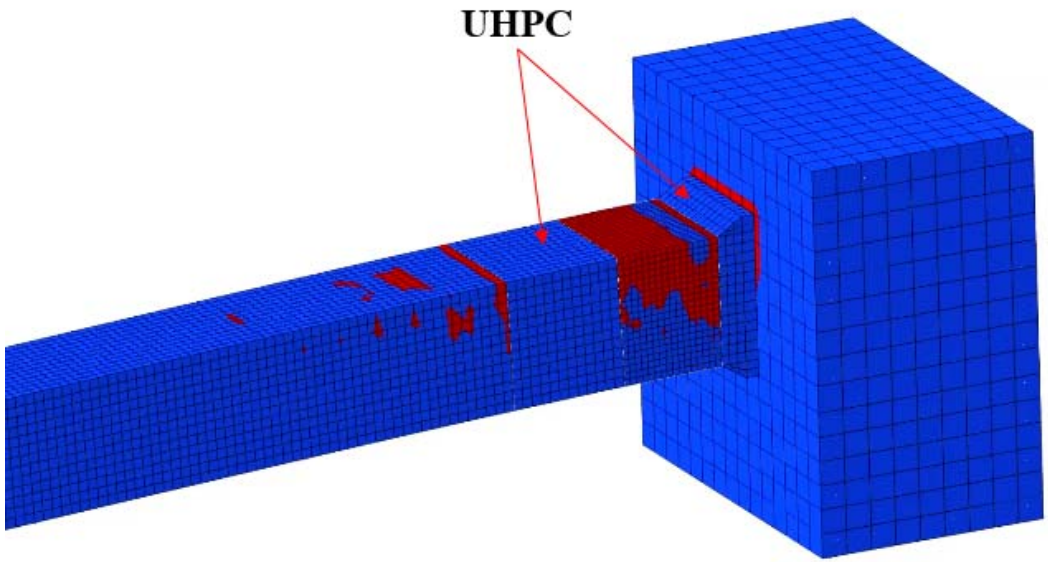
Moment-Displacement



Numerical Analysis

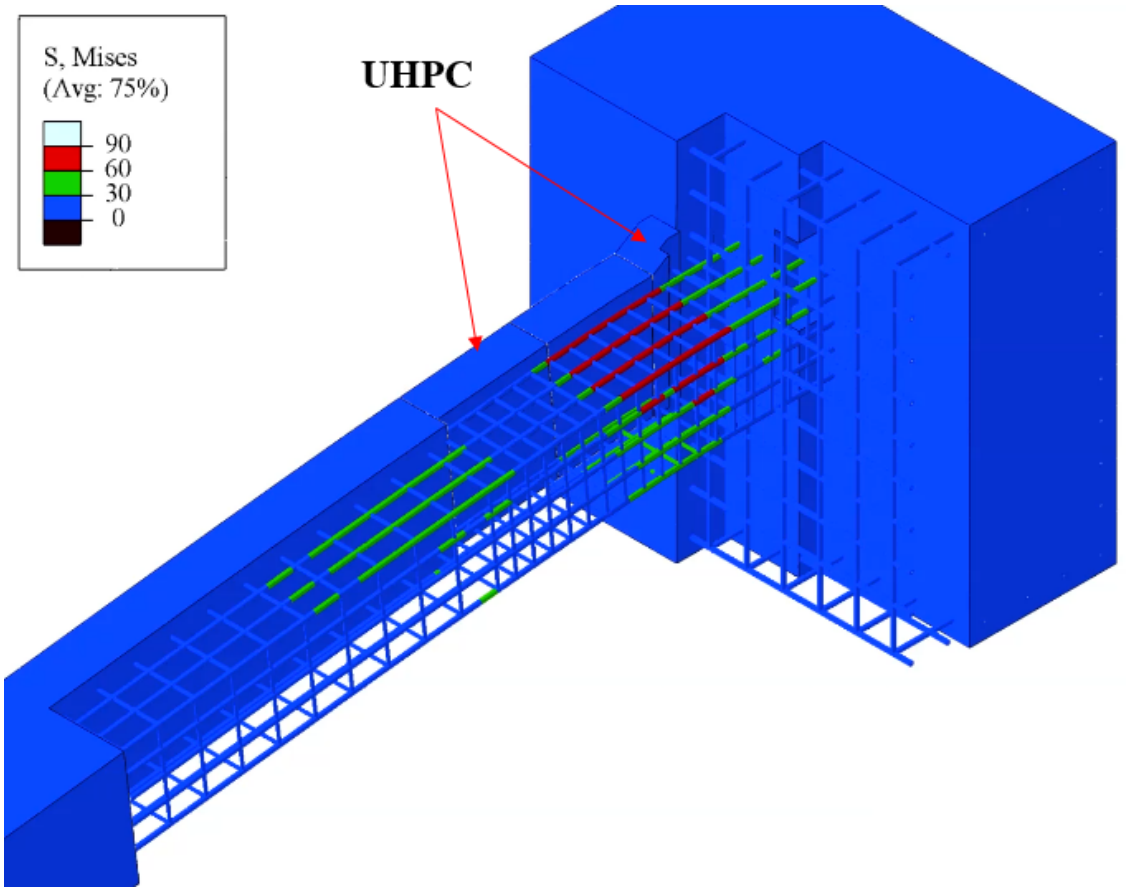


Numerical Analysis
Crack Formation



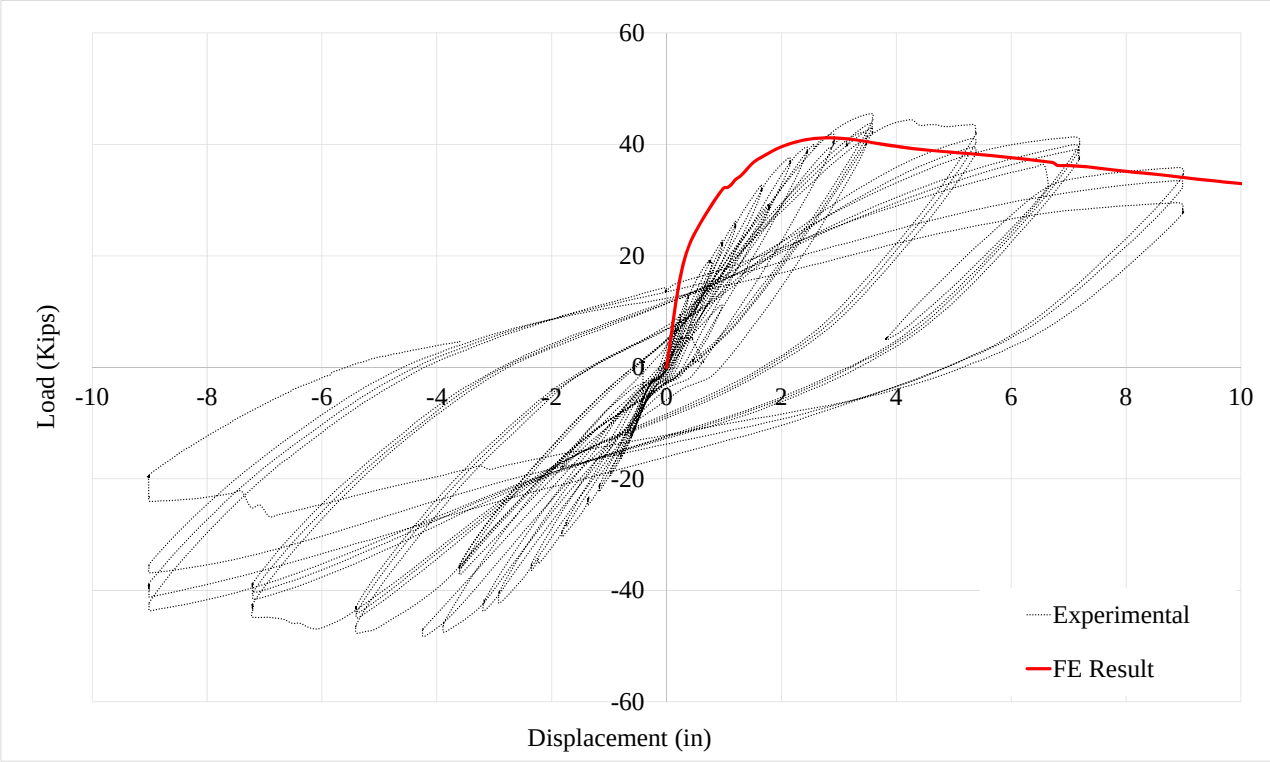
Numerical Analysis

Stress in Rebar



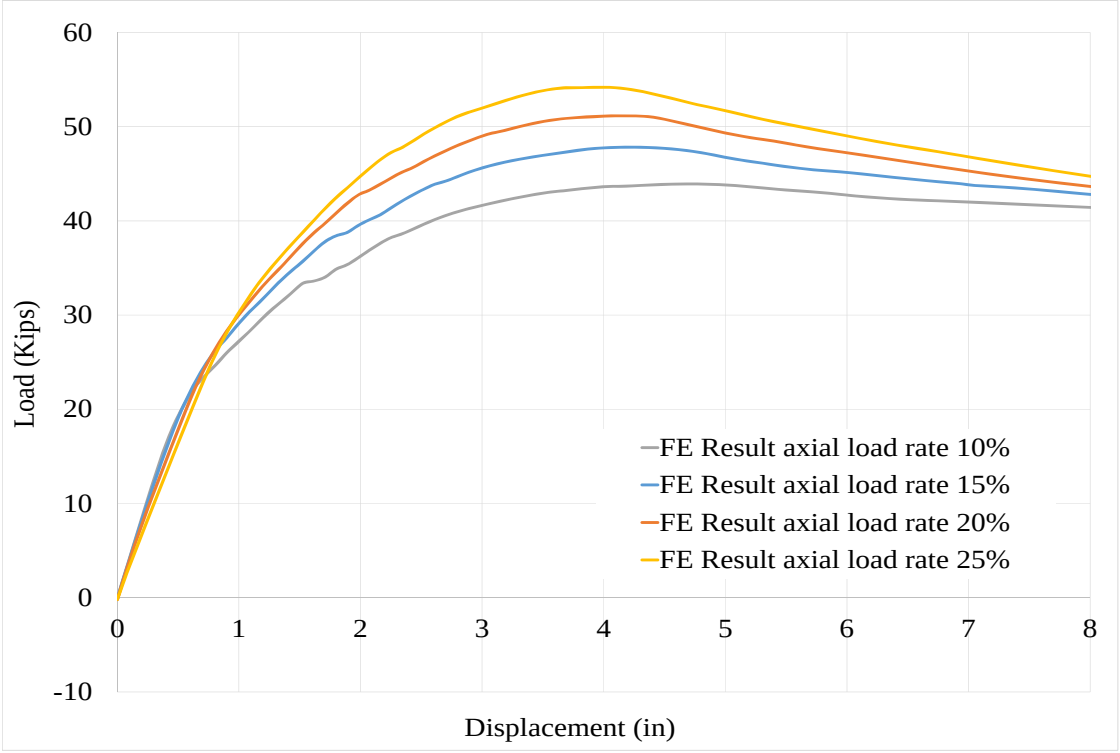
Numerical Analysis

Load-Displacement

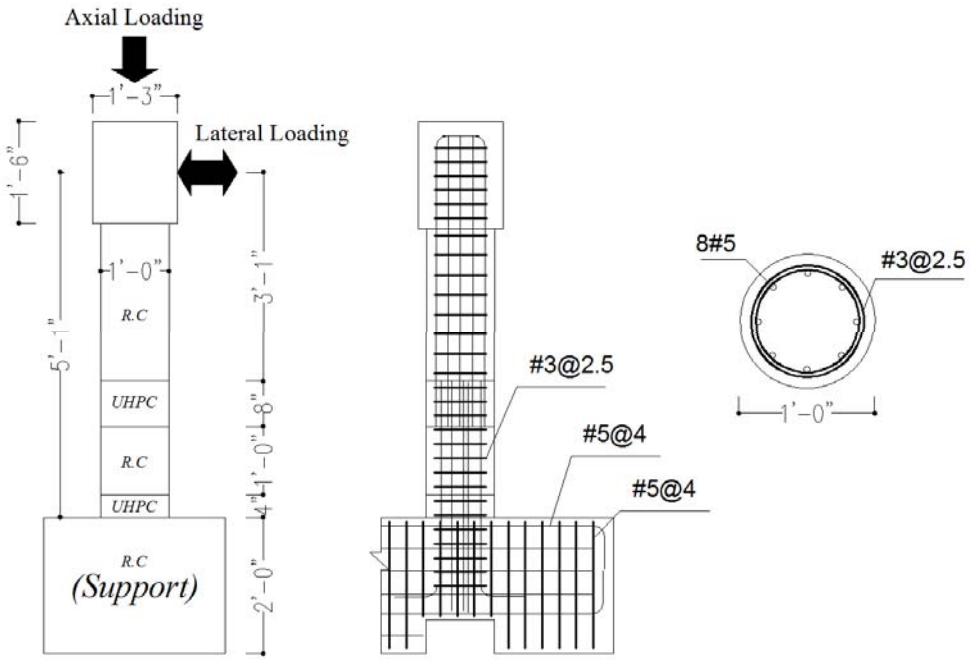


Numerical Analysis

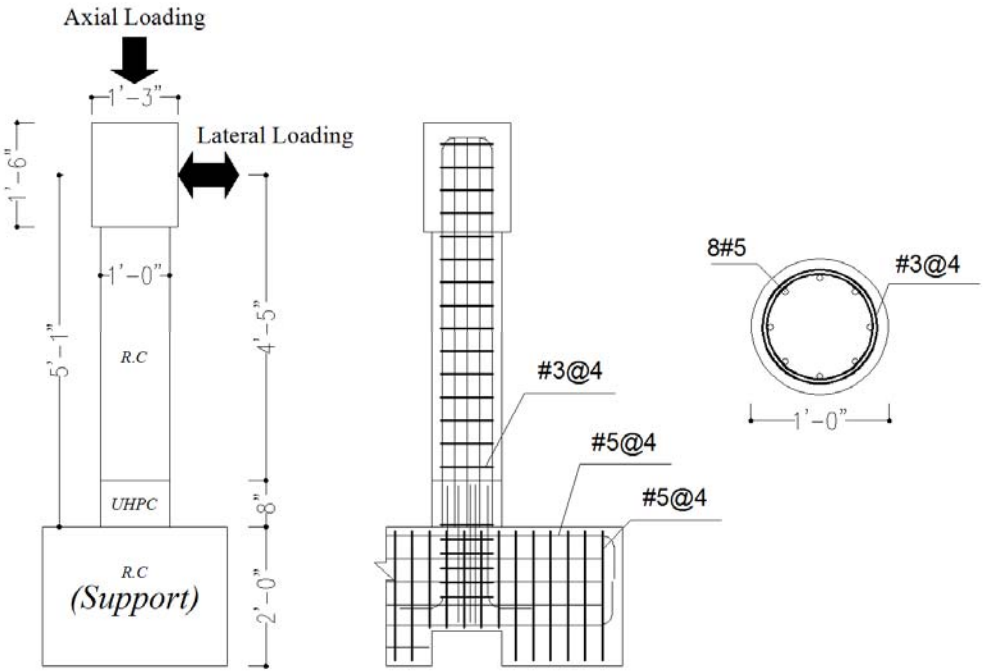
Load-Displacement



Test Specimen Dimension (Parametric Study)



Seismic Detail



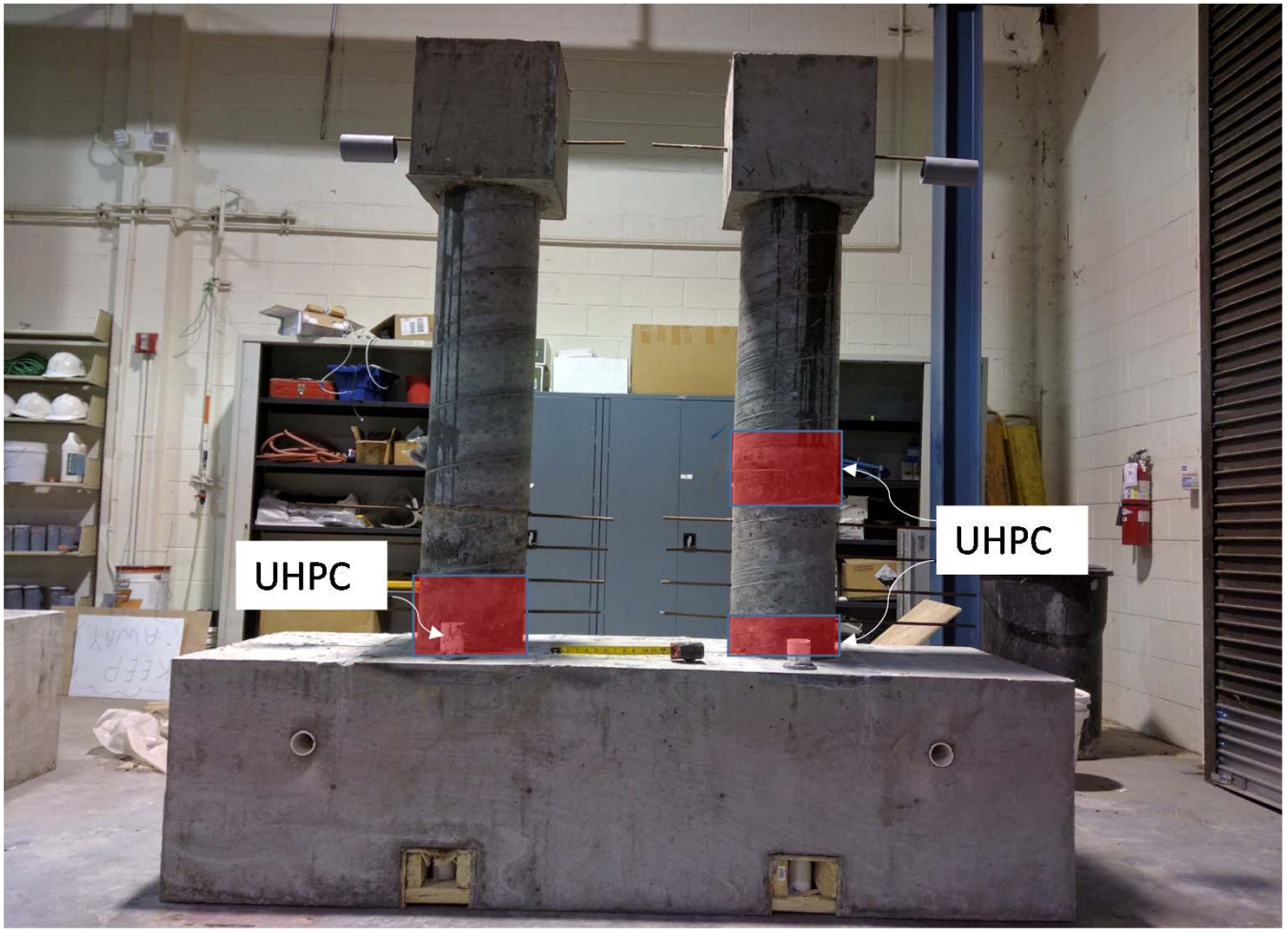
None-Seismic Detail

Test Specimens Detail

Specimen ID	Geometry detail	Transverse Reinforcement detail	Axial Load Ratio
S-2.5-2.5-10 (Reference)	seismic detail	#3@2.5 in. in plastic hinge and splice region	10%
S-4-0-10	seismic detail	#3@4 in. in plastic hinge and no strips splice region	10%
S-2.5-4-20	seismic detail	#3@2.5 in. in plastic hinge and one stirrups at splice region	20%
NS-2.5-0-10	non-seismic detail	#3@2.5 in. in plastic hinge and no stirrups at splice region	10%

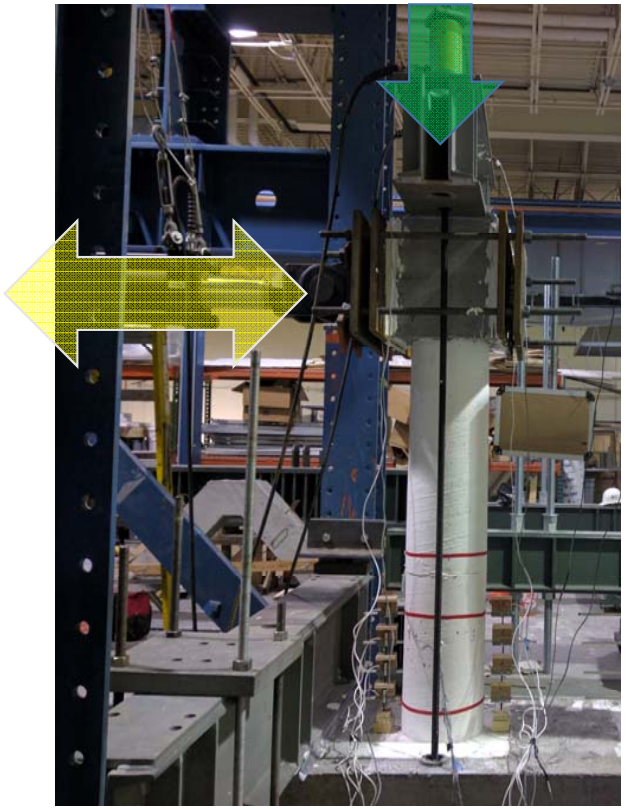
Construction of the Specimen

Construction of the Specimen

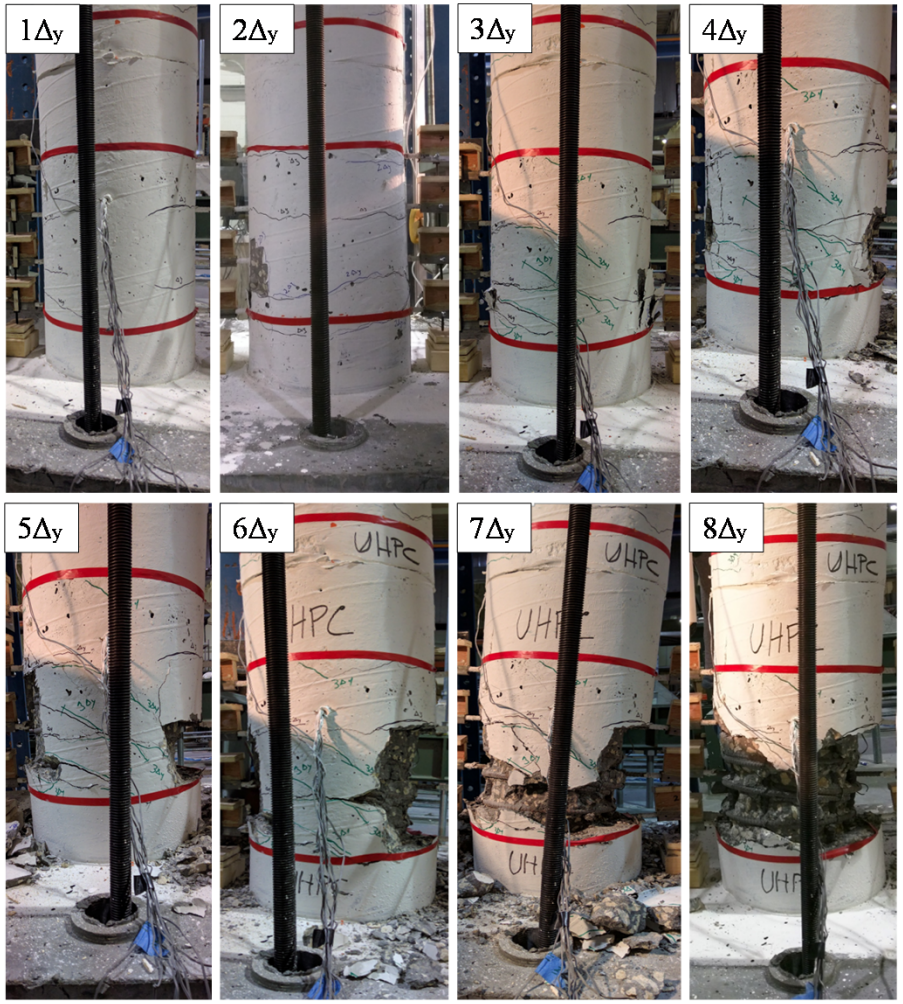


Testing the Specimen

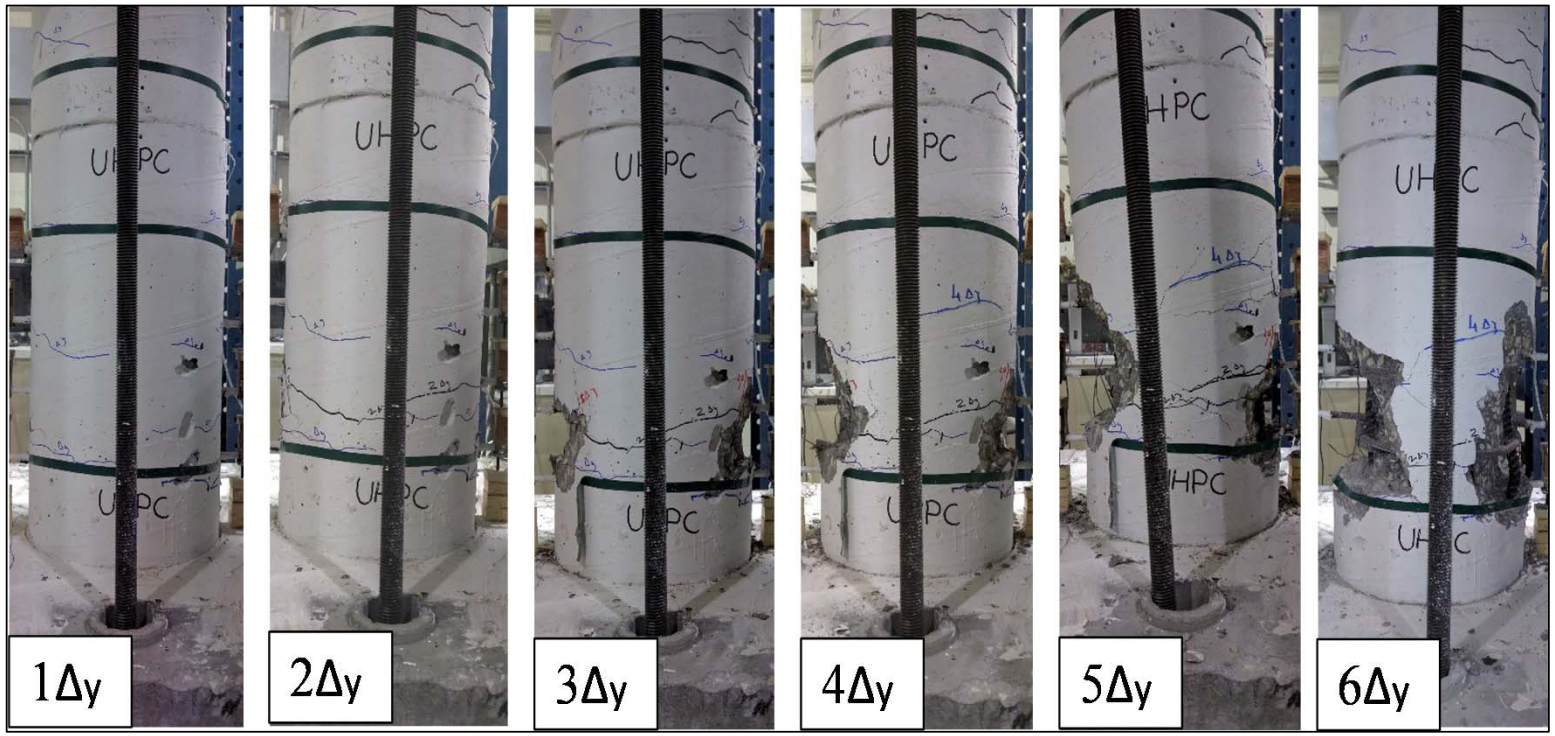
Loading and Supports (Axial Load=56 Kip (10% P_u)



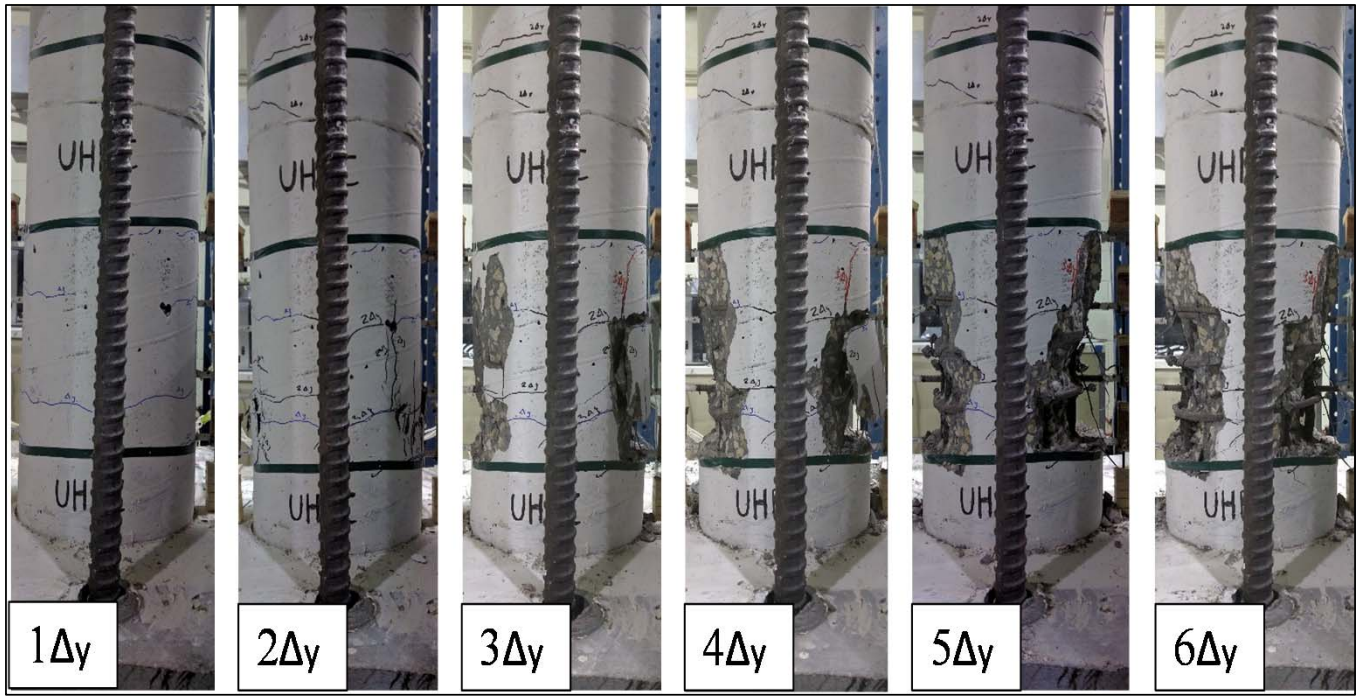
Specimen 1 (S-2.5-2.5-10) (Seismic Detail) Reference



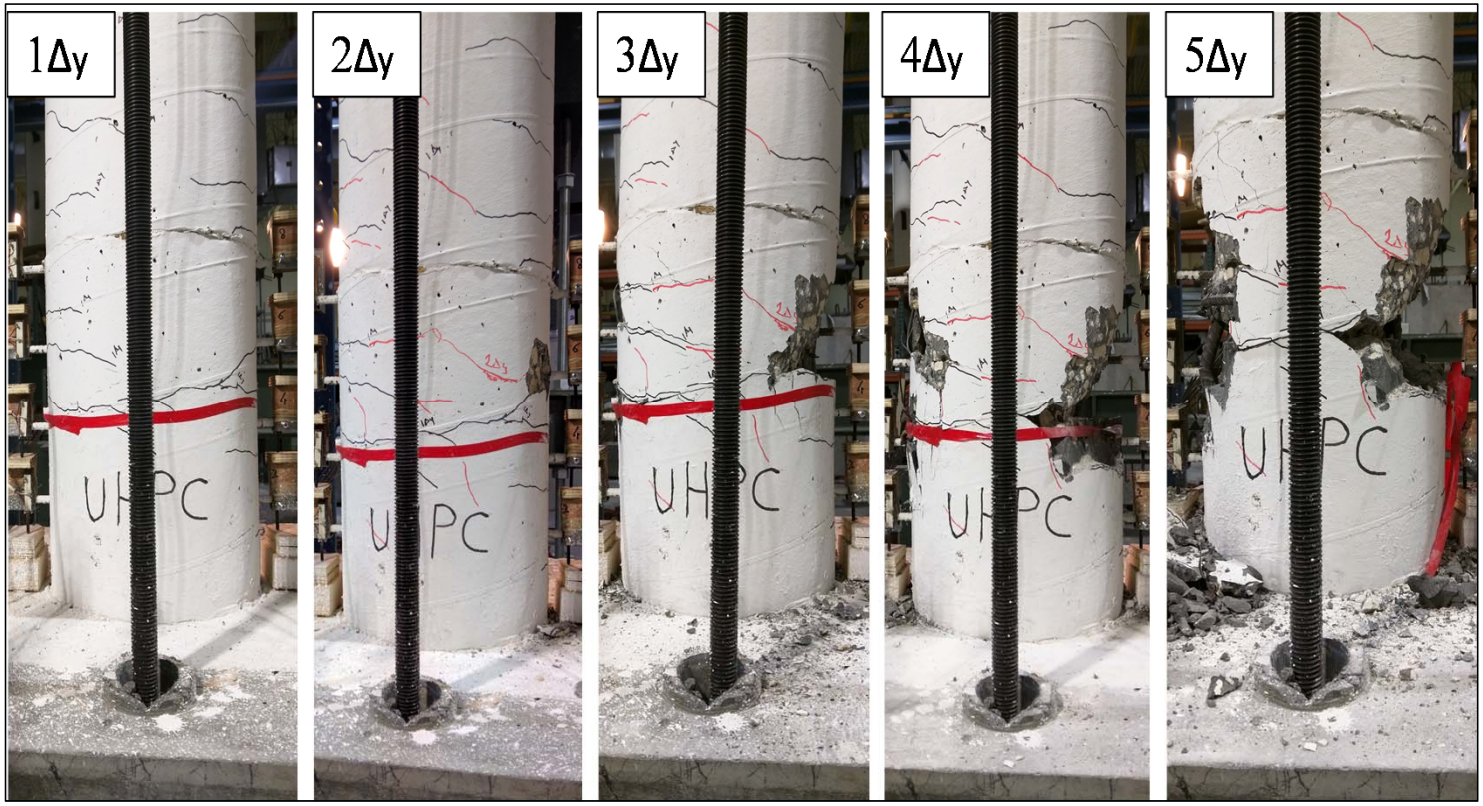
Specimen 2 (S-4-0-10) (Seismic Detail)



Specimen 3 (S-2.5-4-20) (Seismic Detail)

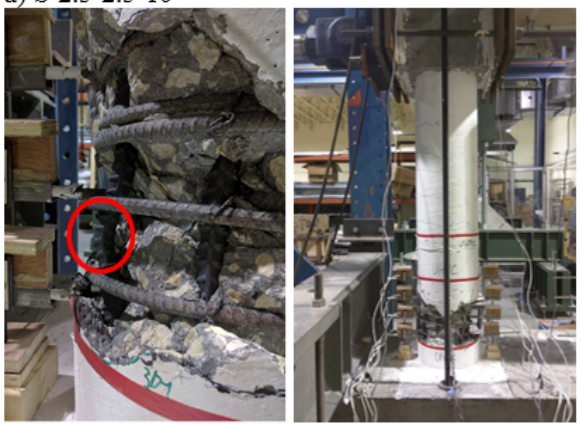


Specimen 4 (NS-2.5-0-10) (Non-Seismic Detail)



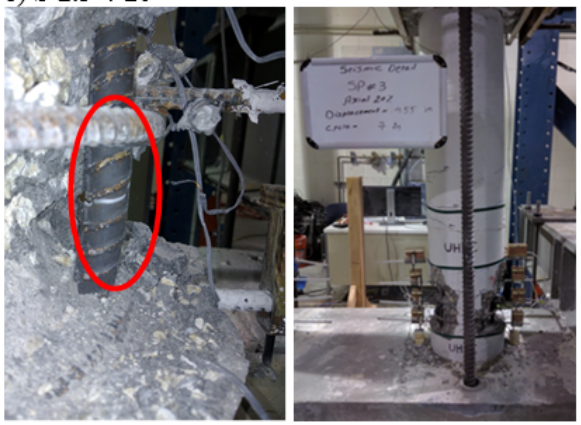
Results (Mode of failure)

a) S-2.5-2.5-10

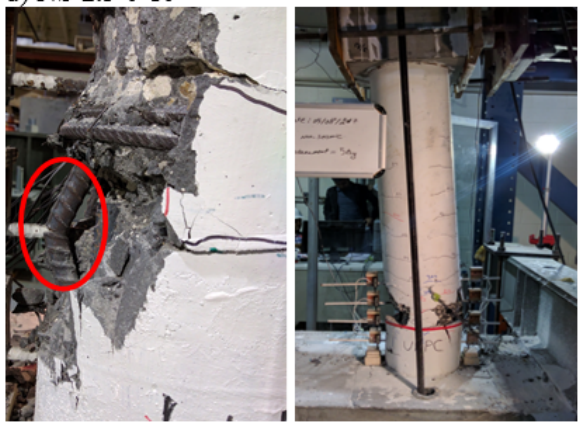


b) S-4-0-10

c) S-2.5-4-20

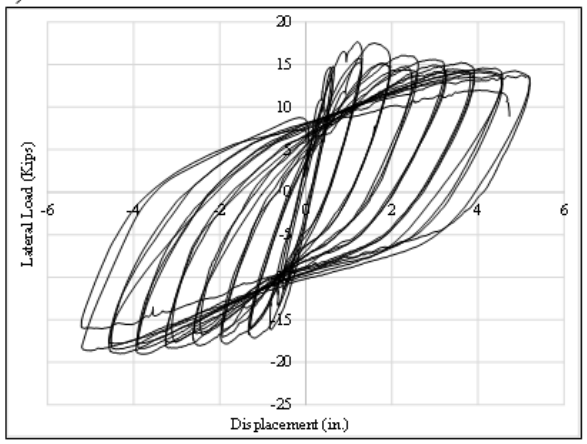


d) NS-2.5-0-10

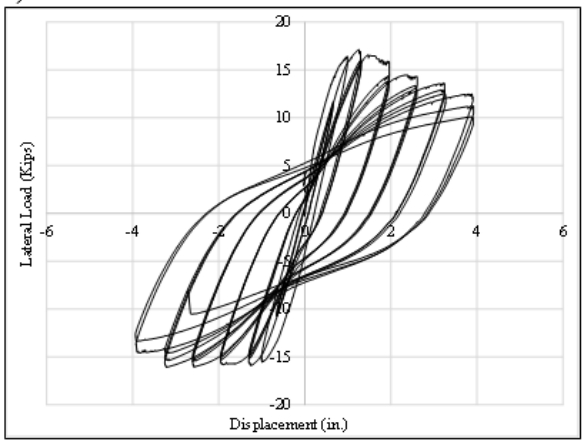


Results (Load-Displacement)

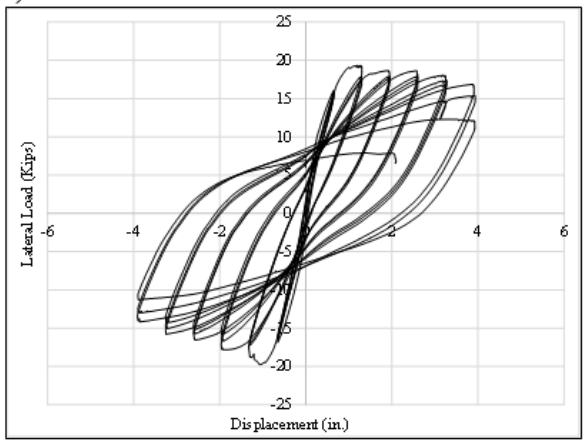
a) S-2.5-2.5-10



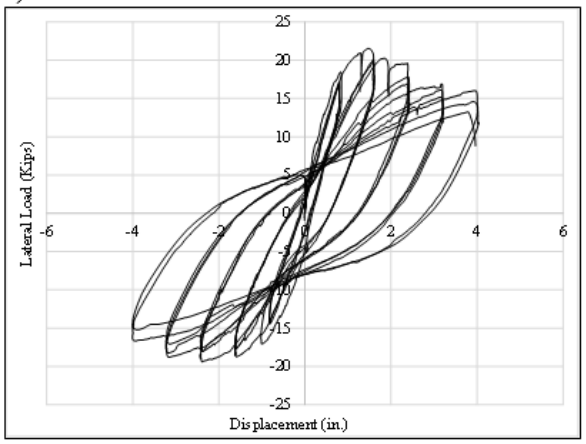
b) S-4-0-10



c) S-2.5-4-20

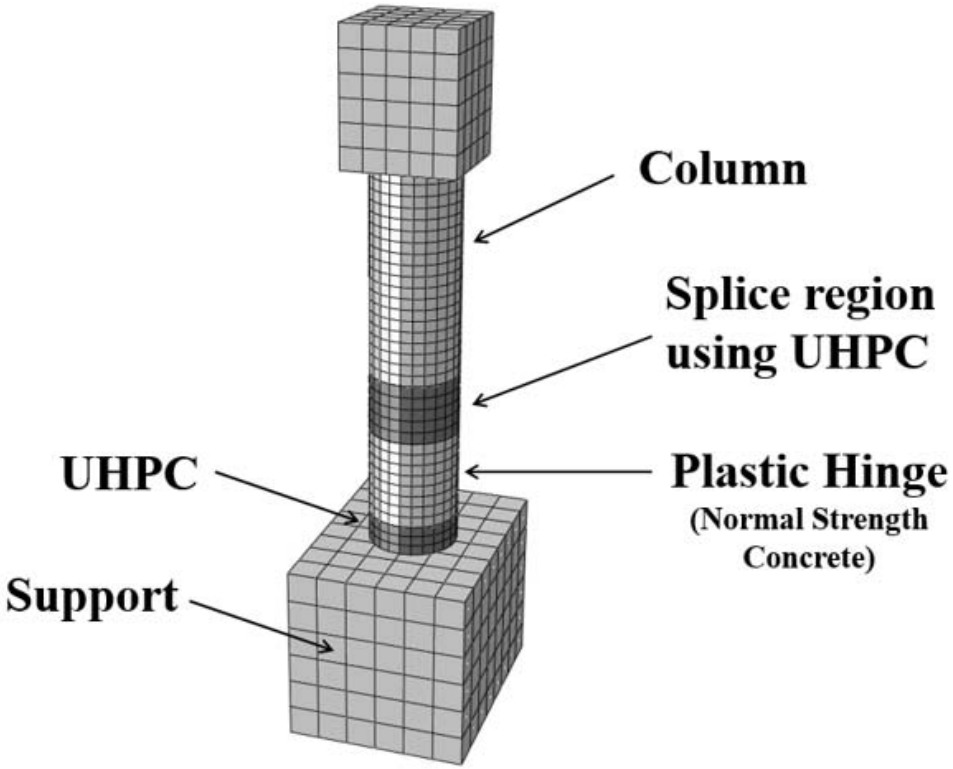


d) S-2.5-0-20

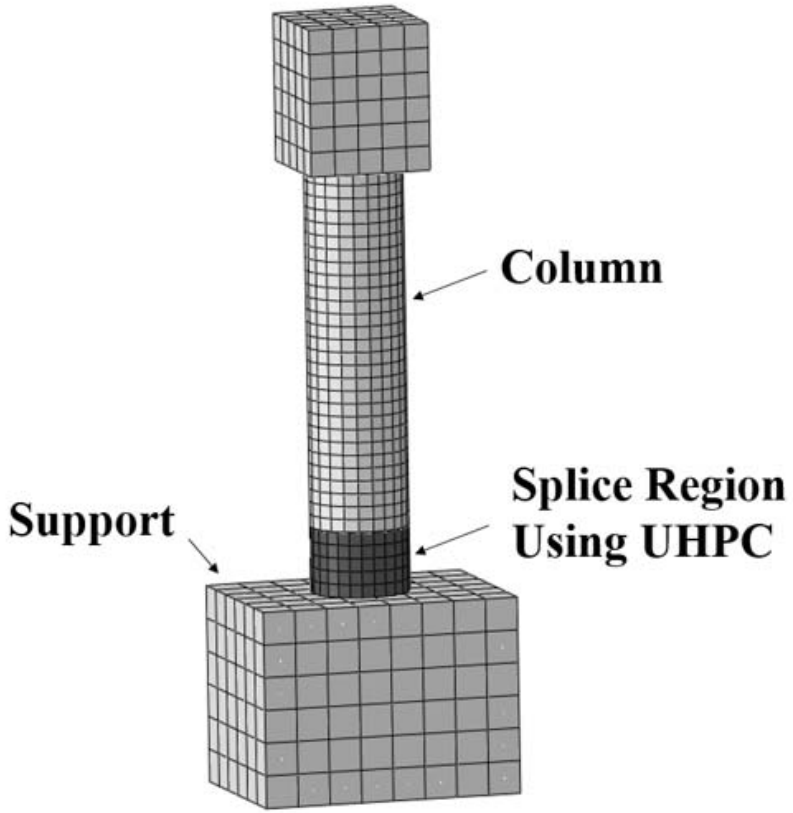


Specimen ID	Maximum drift	Displacement ductility
S-2.5-10	8.5 %	8
S-4-10	5.3 %	5
S-2.5-20	6.4%	6
NS-2.5-10	6.5%	5

Numerical Analysis



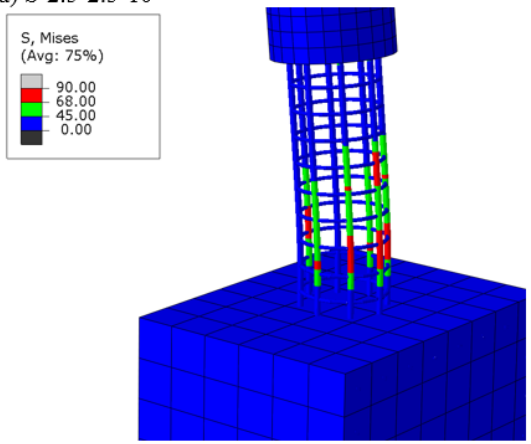
Seismic Detail



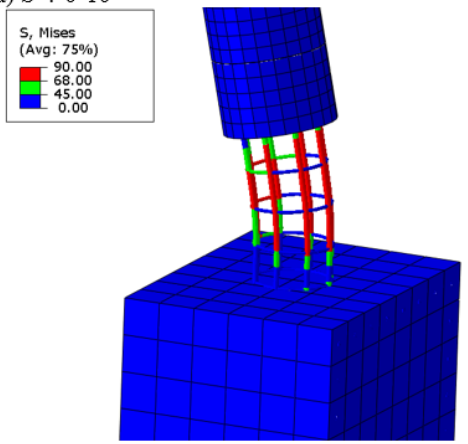
None-Seismic Detail

Numerical Analysis

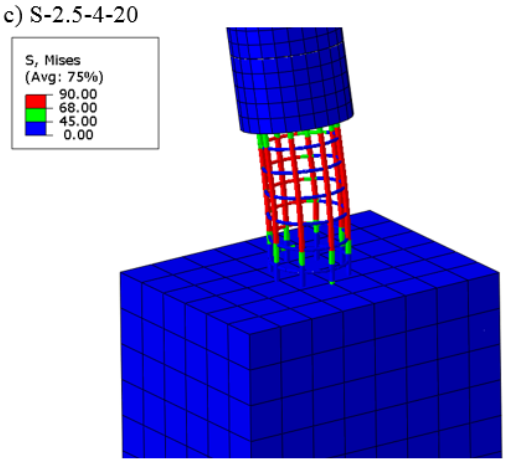
a) S-2.5-2.5-10



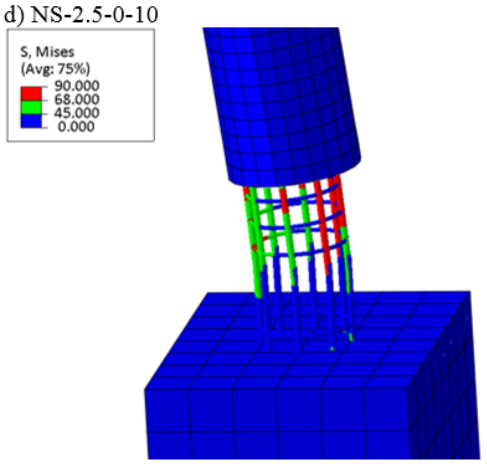
a) S-4-0-10



c) S-2.5-4-20

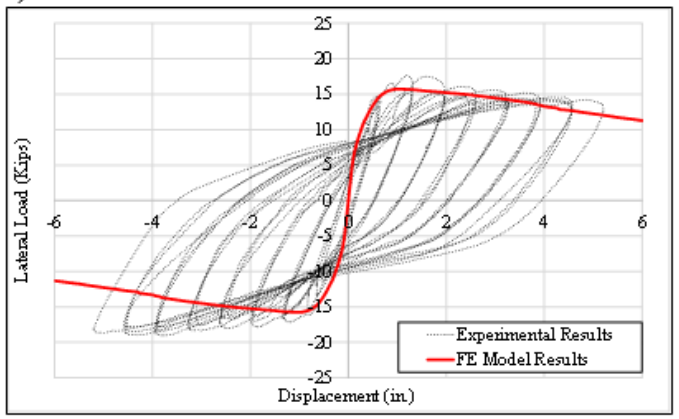


d) NS-2.5-0-10

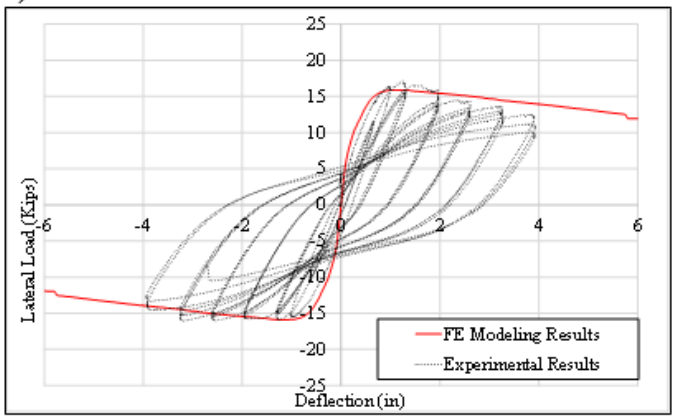


Numerical Analysis (Load-Displacement)

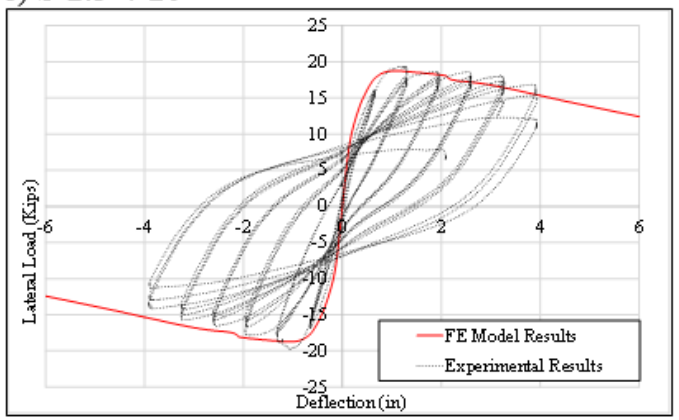
a) S-2.5-2.5-10



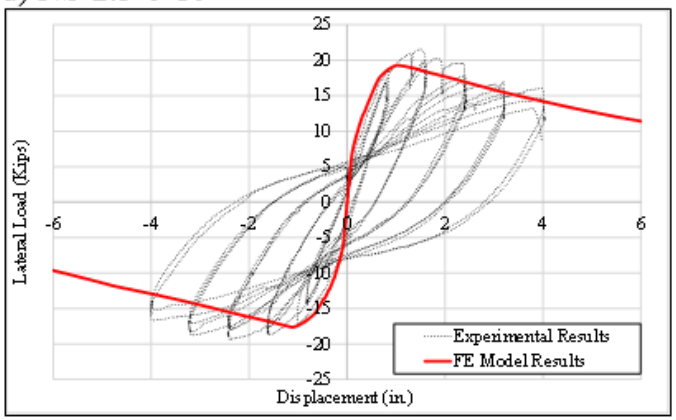
b) S-4-0-10



c) S-2.5-4-20



d) NS-2.5-0-10



Conclusion

- All of the specimens with seismic detail showed ductile behavior and the plastic hinge formed in the desired location.
- The main characteristic of the proposed connection is influenced by transverse rebar ratio. The distance between the stirrups plays a major role in preventing longitudinal bars buckling.
- No major crack was observed in the cap beam for the proposed seismic and non-seismic details. Therefore the non-seismic detail, with a seismic design consideration can be an alternative detail even for seismic regions.
- No significant damage was found in splice region even in the absence of the transverse reinforcement in this region.

Thank You!
Questions?