Behavior of Earthquake-Resistant Rectangular Walls with Mechanical Splices

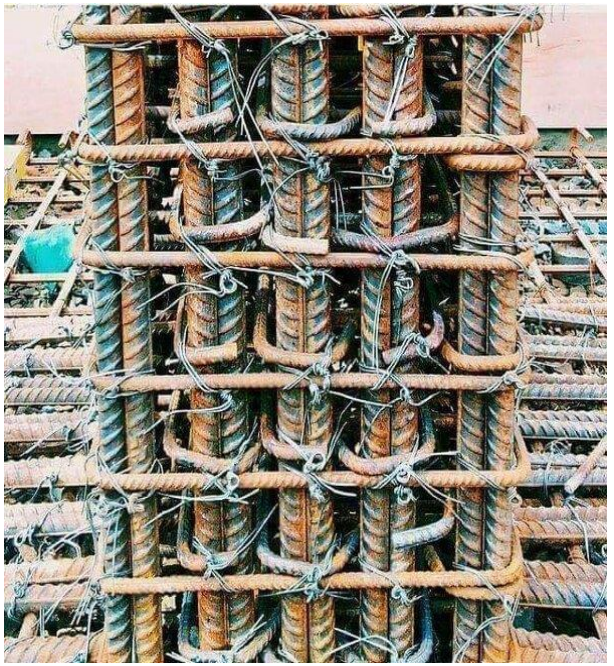
Utsav Neupane

Dr. Rémy Lequesne,
Dr. Andrés Lepage, Dr. David Darwin

The University of Kansas

Introduction

- Structures with large force and deformation demand
- Require high reinforcement
- Constructability an issue
- Made worse by lap splicing



Source: civil4m.com

Introduction

- Use large, high-strength bars (Grade 80,100)
- Use mechanical splices
- ACI Code Provision??

Fig: Bars with Mechanical Splices
Source: https://www.structuralguide.com

Code Provisions

Limitations

- Cannot use Type 1 mechanical splice at critical regions
- Type 2 mechanical splices limited to Grade 60 reinforcement in yielding regions
- Cannot use lap splice where yielding is expected [ACI 318-19]

Research Questions

- Can mechanical splices be safely used with Grade 100 reinforcement at critical regions?
- If yes, under what conditions?
- Does splice connection type affect wall behavior?
- Does splice length affect wall behavior?

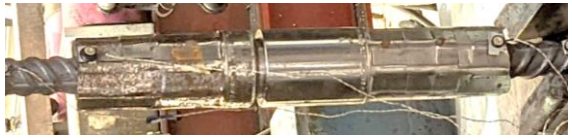
Our Work

- Use mechanical splices with a range of performance characteristics
- Use mechanical splices in critical regions
  - at base of wall or wall-footing interface
- Use large high-strength bars
  - No. 10
  - Grade 100
- Measure deformation capacity of wall – 3% (expected)

Test Matrix

Taper threaded coupler

Wall 1
A22 Standard Coupler
Length ~= 2.5-3d_b

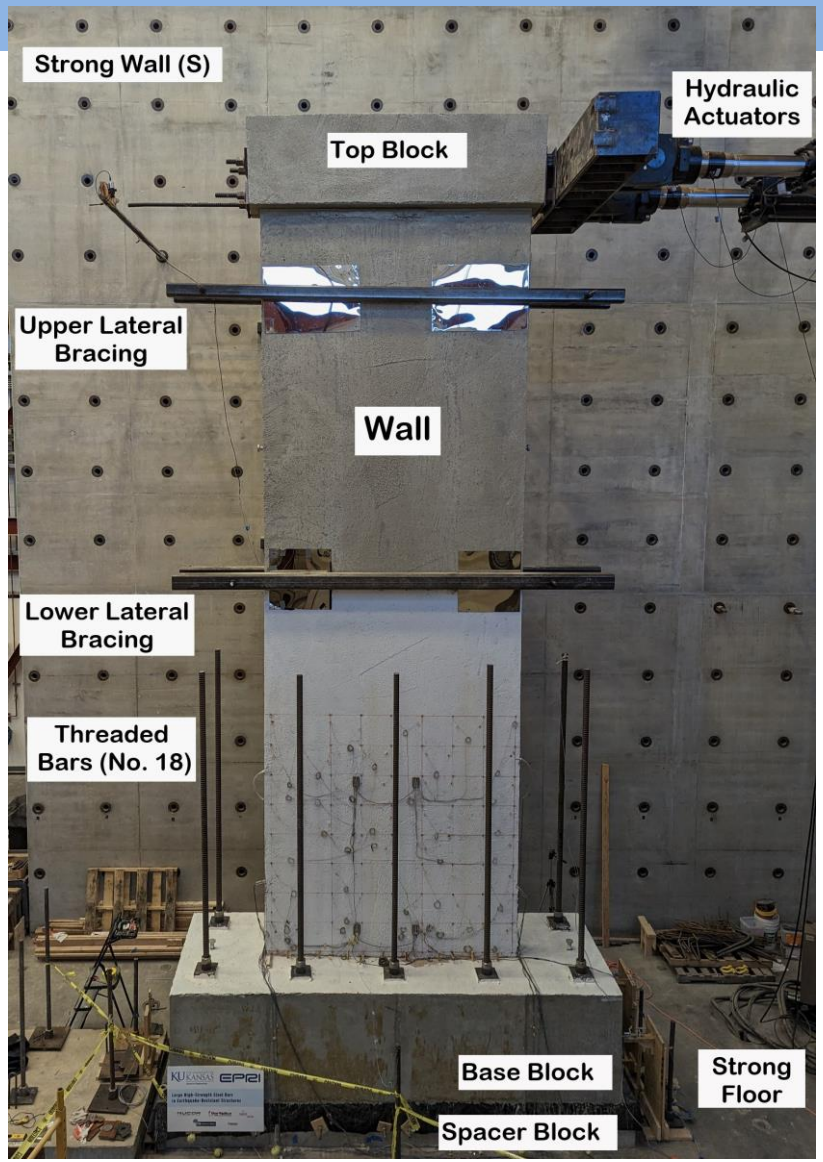


Swaged (threaded) coupler

Wall 2
GripTwist Coupler
Length ~= 11d_b

Shear-screwed coupler

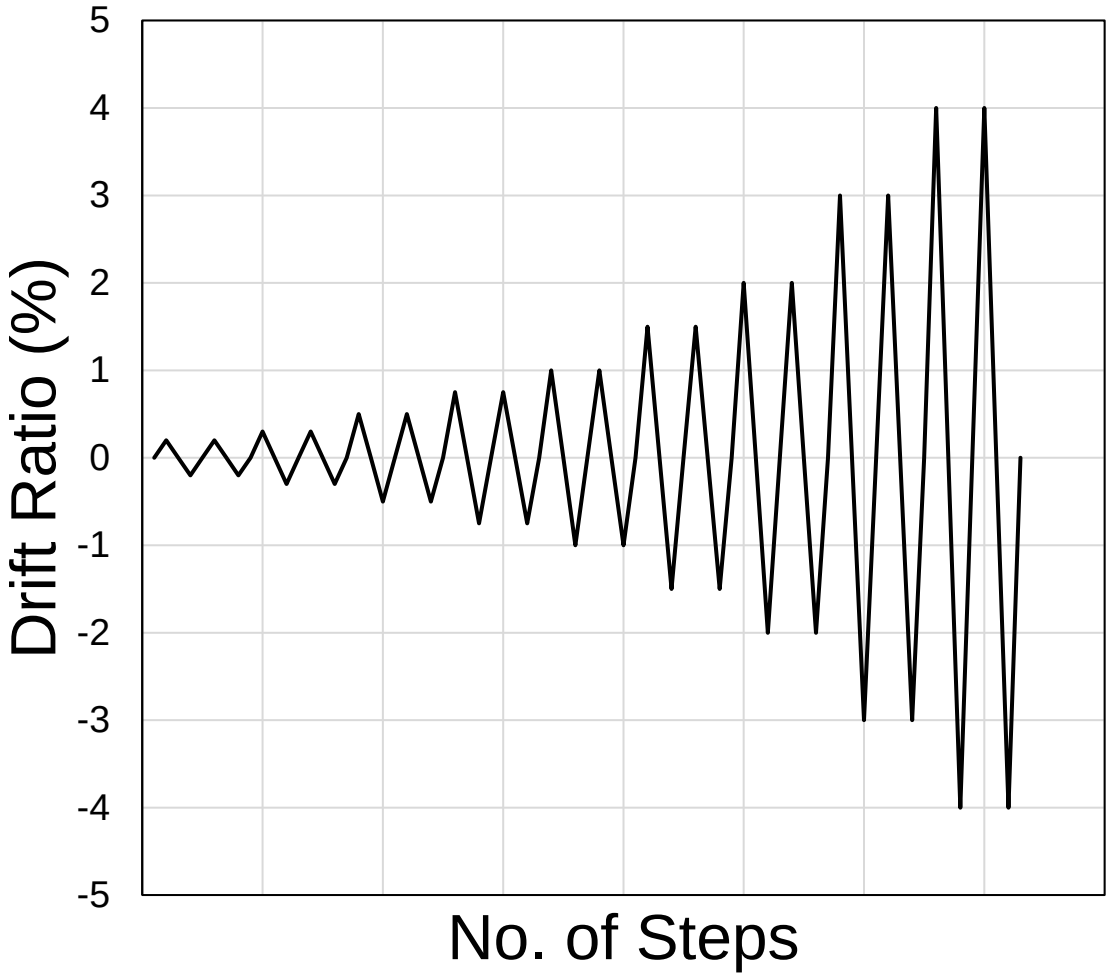
Wall 3
Zap Screwlok Coupler
Length ~= 15d_b


Strong Wall (S)
Hydraulic Actuators
Top Block
Upper Lateral Bracing
Wall
Lower Lateral Bracing
Threaded Bars (No. 18)
Base Block
Strong Floor
Spacer Block

Test Setup

Lifting of Wall

Loading Protocol



Results

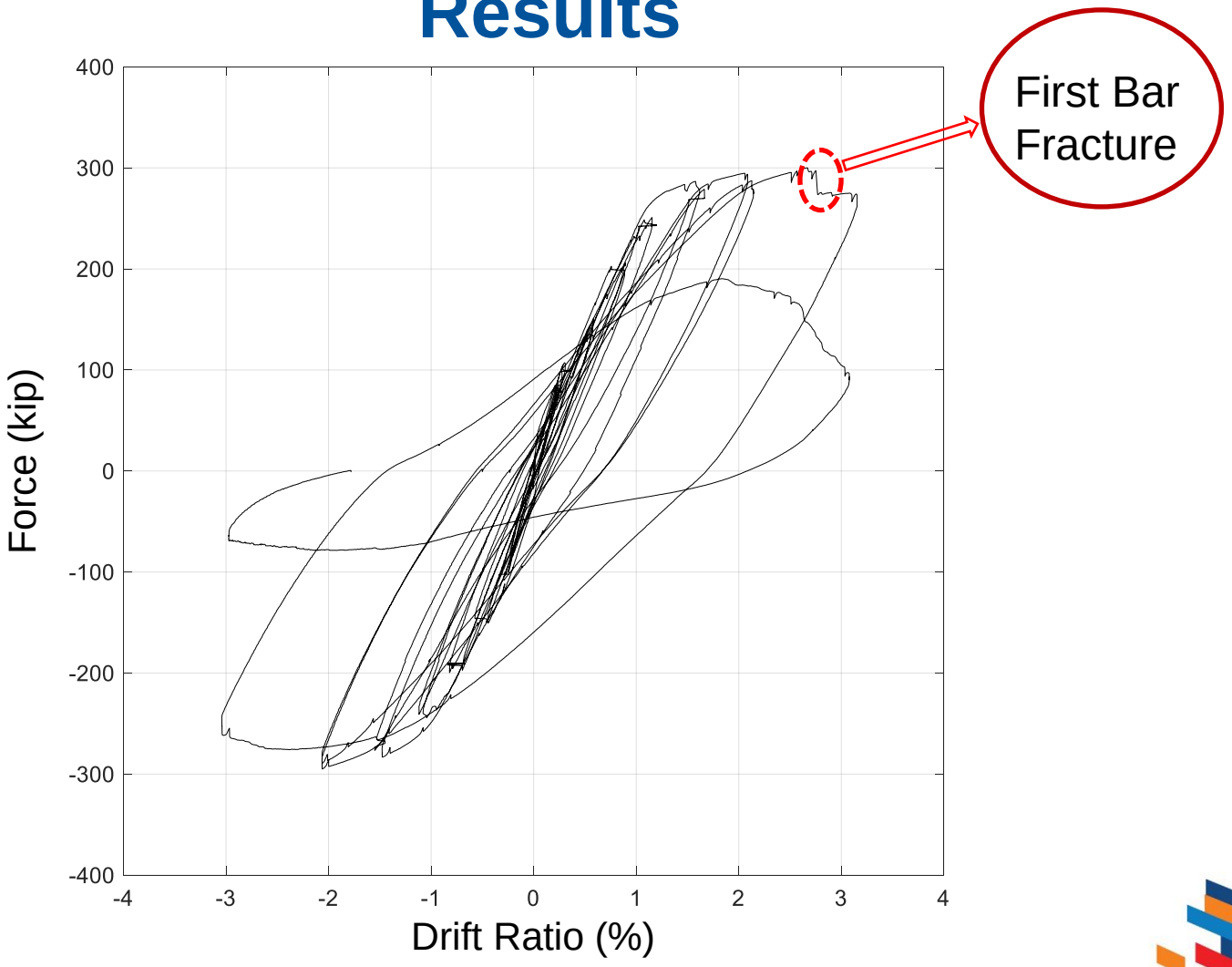
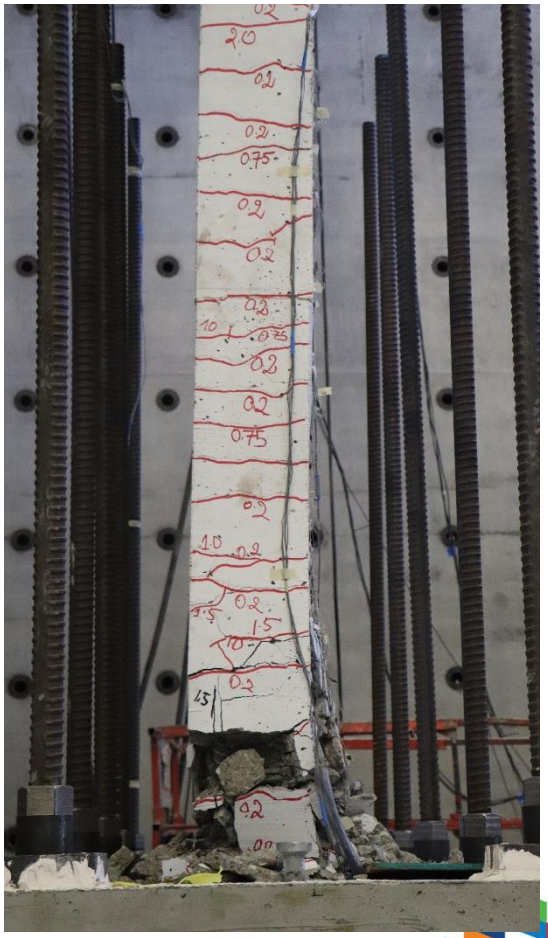


Fig: Force vs drift ratio (Wall 1)

Results

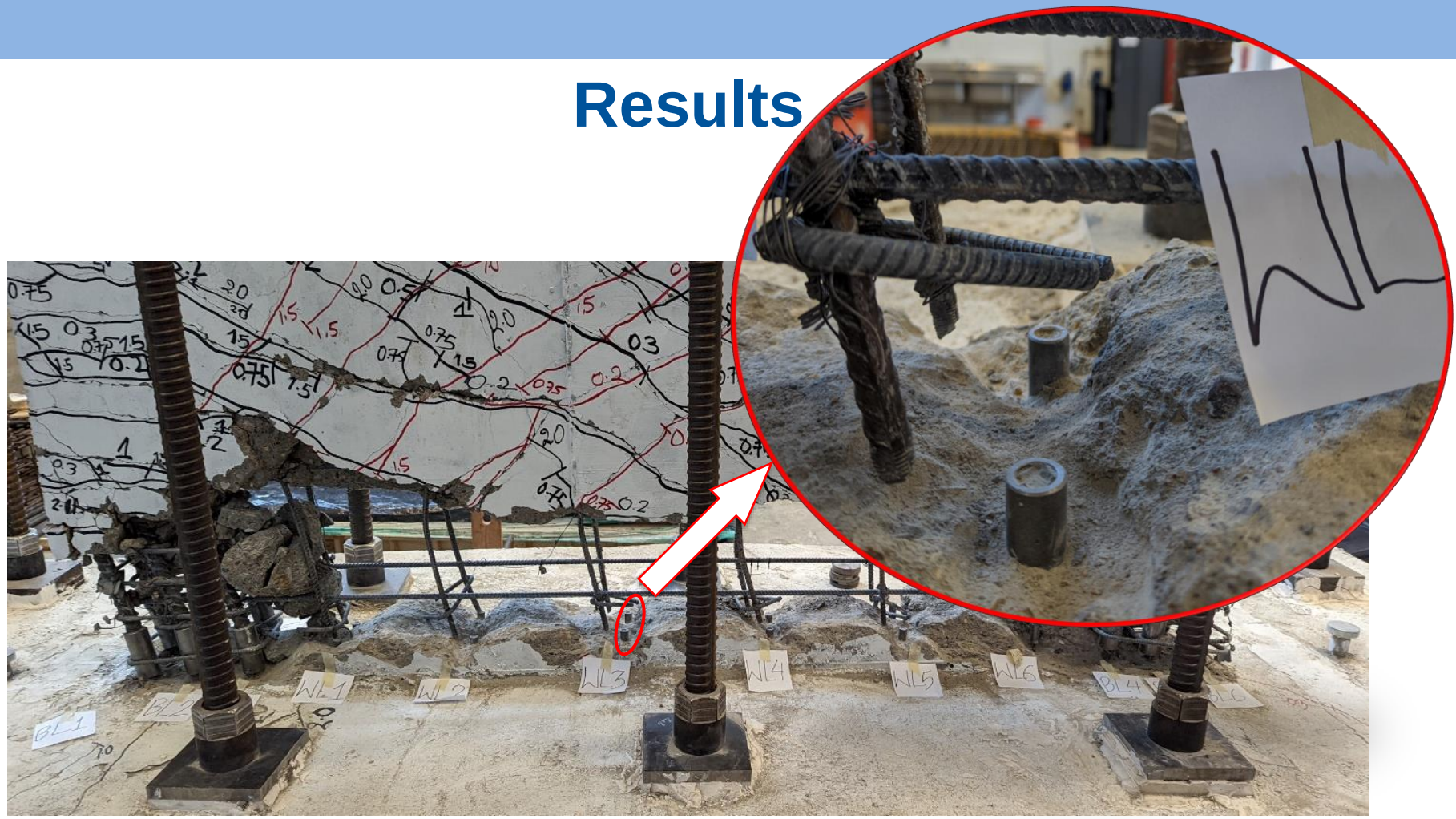
a) Front View



a) Side View

Condition of Wall 1 after Testing

Results



Condition of Wall 1 after Removal of Concrete

Results

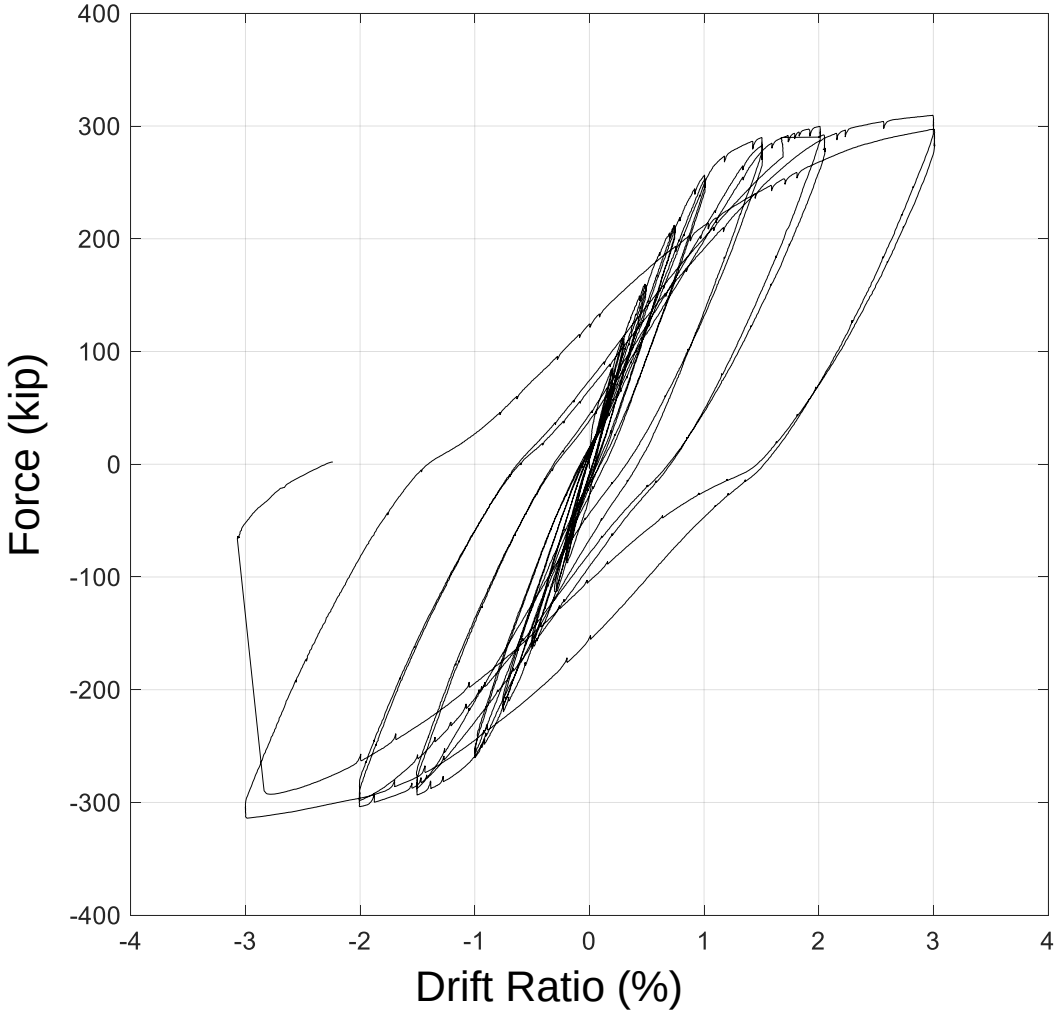
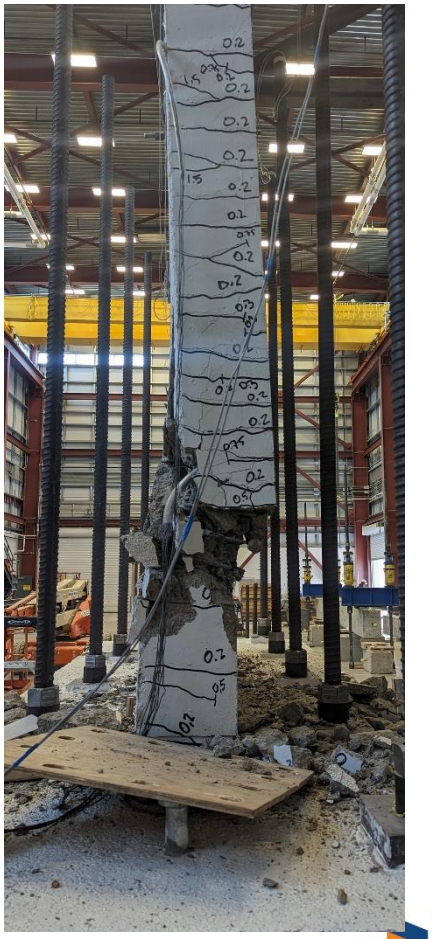


Fig: Force vs drift ratio (Wall 2)

Results

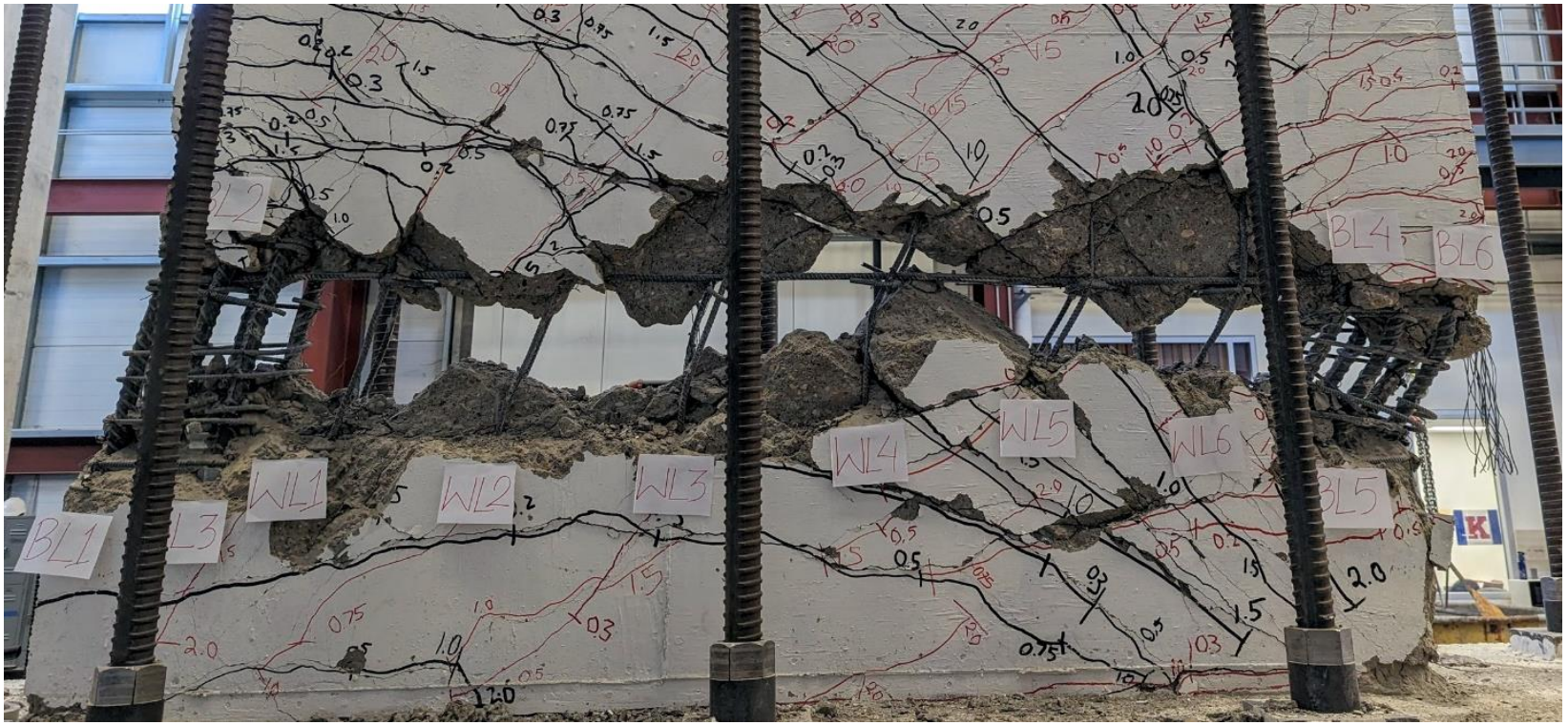
a) Front View



a) Side View

Condition of Wall 2 after Testing

Results



Condition of Wall 2 after Removal of Concrete

Preliminary Conclusions

- Walls with couplers that produce bar failure away from the splice in direct tension tests have a drift capacity similar to walls with continuous bars

Future Work

- Test the third wall

- Propose qualification requirements for use of couplers in special structural walls

Acknowledgement

- Thank you for listening

- Questions?