

EXPLORING BEHAVIOR OF THIN SHEAR WALL BOUNDARY ELEMENTS

PEER Internship Program – Summer 2012



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Objective

This project aims to explore the relationship between spacing of transverse reinforcement in shear wall boundary elements and its effect on concrete confinement, and subsequently, its effects on ductility and load capacity. Designs for specimen tested in this project are built to ACI 318-11, with the intention of recommending code amendments depending on the test results.

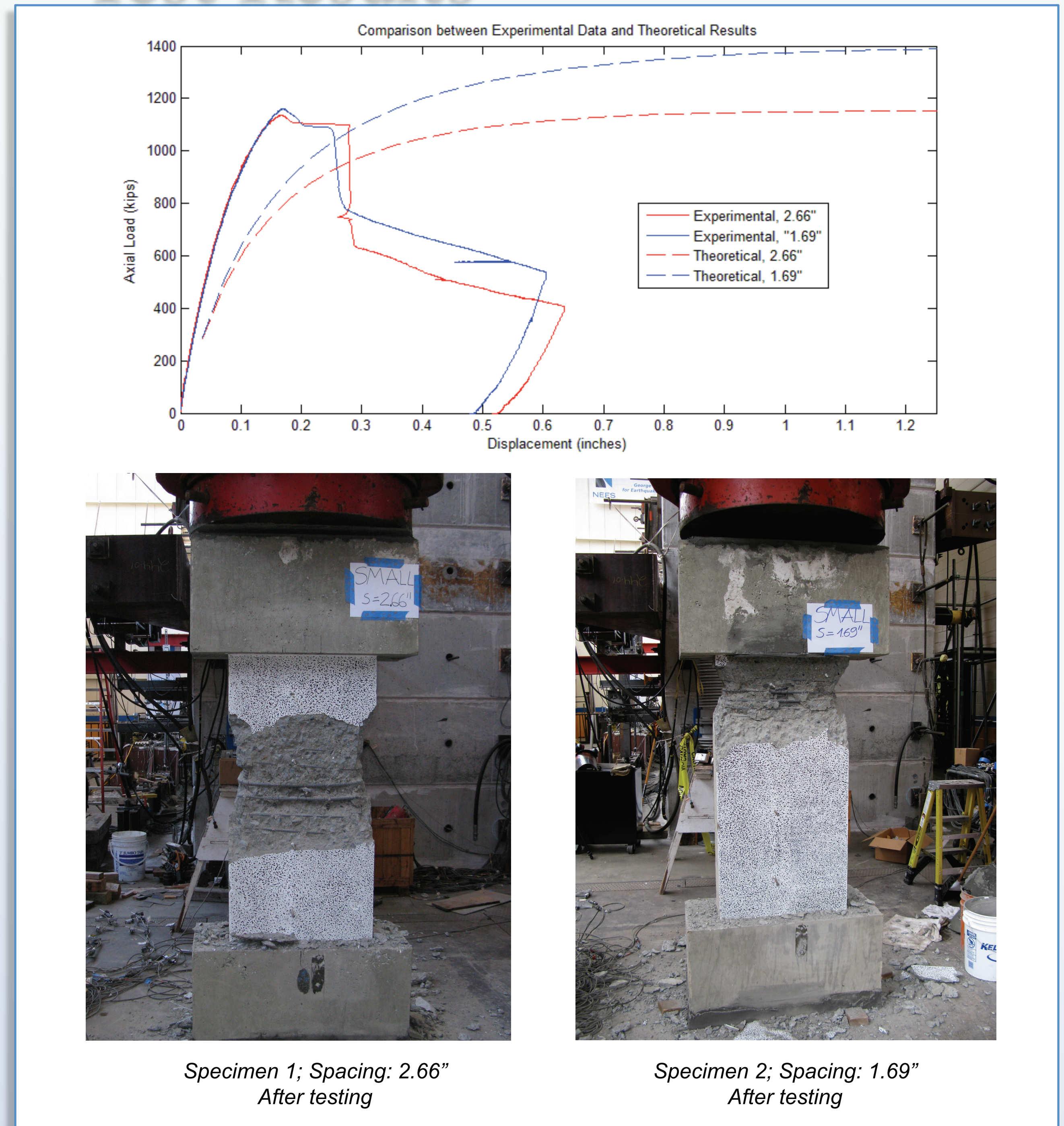
Background

In 2010, Chile experienced an earthquake of magnitude 8.8 off the coast of the Maule region, lasting about three minutes. This earthquake is ranked as the sixth largest to ever be recorded by a seismograph. The event warranted the Earthquake Engineering Research Institute (EERI) to send a team, led by Dr. Jack Moehle, to survey damage. The amount of catastrophic damage observed was significantly low, indicating strong seismic performance of the affected buildings. However, a large amount of crushing failures were observed in shear wall boundary elements. Factors suspected for these failures include the geometry of the buildings, the slenderness of the walls, and the lack of confining transverse reinforcement at these boundary elements. This project considers the third of these factors, the confining transverse reinforcement, and its subsequent effect on the load capacity and ductility of a shear wall boundary element.



Boundary Element Crushing Failure observed in Chile 2010 Earthquake

Test Results

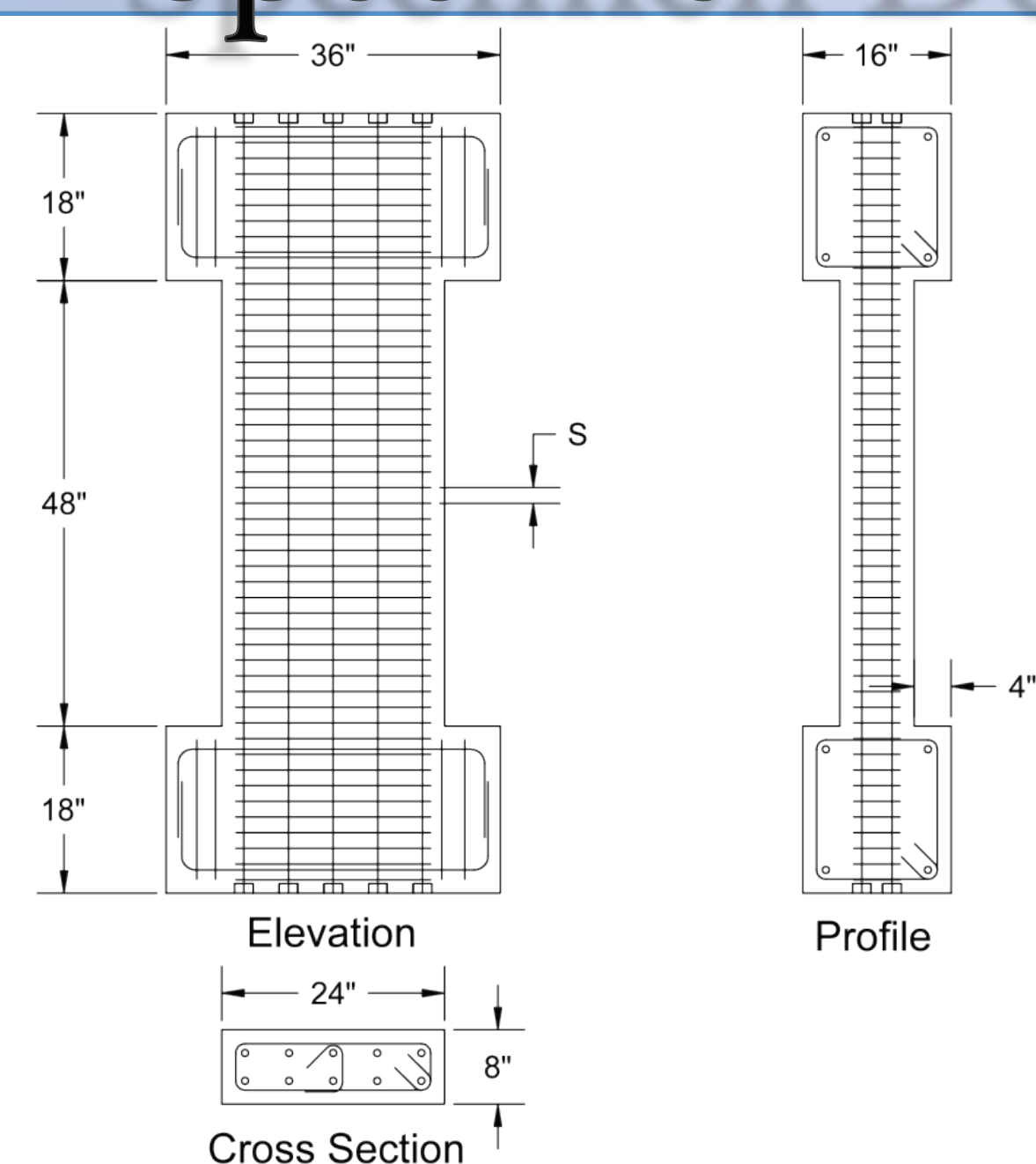


Specimen 1; Spacing: 2.66" After testing



Specimen 2; Spacing: 1.69" After testing

Specimen Design



- Tested in compression using 4 million pound press at Richmond Field Station
- Test Region: 48" x 24" x 8"
 - 1.5" clear cover
- Concrete block heads: 36" x 18" x 16"
 - Ensure development length for rebar is achieved
- Rebar at test region comprised of:
 - 10 #5 longitudinal headed rebar
 - #4 transverse at spacing S
 - #4 hook at spacing S
- Transverse spacing based on ACI 318-11 eq .21-4 and 21-5
 - Specimen 1: S = 2.66"
 - Specimen 2: S = 1.69"

Conclusion

Both specimen were designed with transverse reinforcement spacing that was expected to provide sufficient confinement, thereby leading to a ductile failure following the spalling of the full shear wall face. However, our experiment yielded a brittle response, with only isolated spalling occurring. Confinement in the spalled sections was not adequate in providing the expected increase in axial load capacity. Failure thus occurred when load capacity was lost due to the loss of concrete cross sectional area. Strain measured on Specimen 1 and 2 were 0.388% and 0.347%, respectively. This confirms the lack of ductility, as the specimen were expected to strain to 1.83% and 2.95%, respectively.

Results seem to imply that the decrease in transverse reinforcement spacing did little to alter the behavior of the boundary element at failure. The differences between the two specimen, in terms of load and displacement, were not significant enough to suggest that either spacing layout provided an increase in capacity or ductility.

In summary, neither specimen provided to be ductile, despite being designed so, and spacing layout did not affect the overall behavior of the boundary elements.

Further Questions

1. Would changing geometry of the boundary element, e.g. increased thickness or adding a flange, allow for ductility to be achieved?
2. What would be the affect of cyclic loading on the element overall capacity and ductility?

Acknowledgements

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