Ductility of RC Shear Wall Boundary Element in Compression

PEER Internship Program – Summer 2012

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1. Introduction and Background


Shear wall boundary element of Chile 2010

On February 27, 2010 a massive 8.8 moment magnitude earthquake struck just off the Chilean coastline, ranking it the 5th most energetic earthquake in the world. Although many building performed exceedingly well in this earthquake, wide spread damage was found in reinforced concrete shear walls, particularly in their boundary elements. The damage that was seen in these shear walls was not caused by shear effects however. Instead concrete spalling and rebar buckling was seen in most of the shear walls, caused from large compressive forces in the boundary elements. These failures were most likely due to lack of transverse reinforcement and slenderness, commonly seen in Chilean shear walls. The examination of the effects and damages seen in this earthquake raise questions about shear wall design and construction here in the United States. This test looks into the ductility of shear wall boundary elements under compression, designed according to current Californian code, in order to evaluate the quality of current design.

2. Objectives

Main Objective:

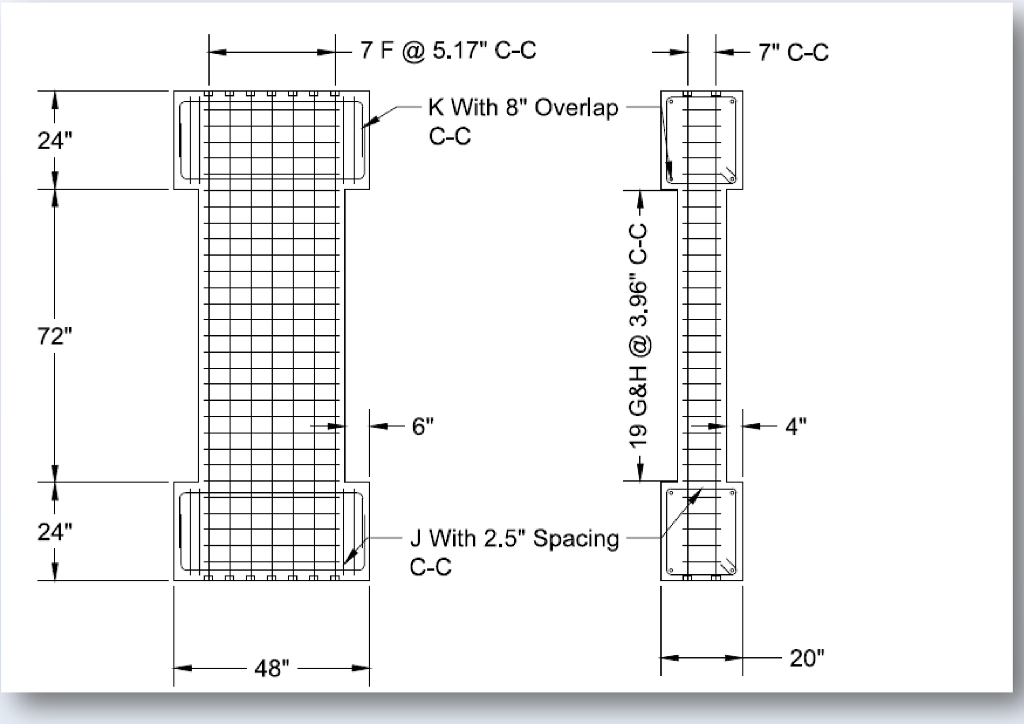
To examine the ductility of a concrete shear wall boundary element in compression.

Other Objectives:

To examine what effect transverse reinforcement and slenderness have on these specimen, and to examine the failure modes of the specimen

4. Specimen Layout

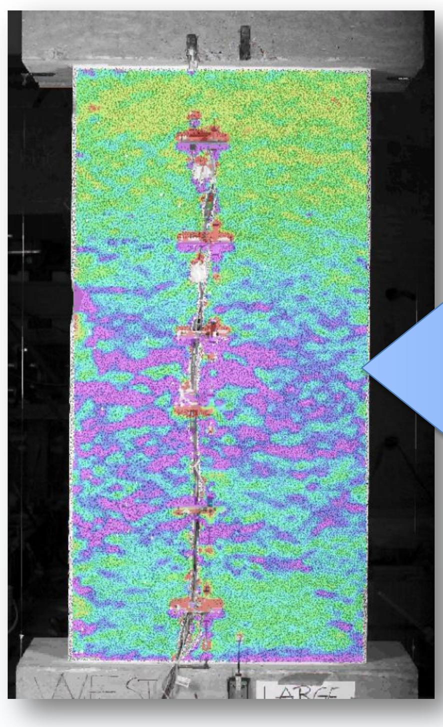
- 2 Specimens were constructed in Davis Hall and loaded in uniaxial compression till rupture at the Richmond Field Station in the 4 mil lb. capacity UTM.
- Each specimen was of the same dimensions but had different transverse reinforcement spacing of 3.96", according to current ACI code, and 2.61", a suggested requirement of future ACI code.



- Two other specimens of smaller dimensions were also constructed and tested in the same manner, these are being reported on by PEER intern, Andrew Lo.
- During construction, the large specimen with a 2.61" transverse spacing developed large cavities and honeycombs and was unable to be tested along with the others. This specimen will be reconstructed and tested at a later time.

5. Test Results

Shows specimen during testing right before rupture. Micro strain is measured using digital image correlation.



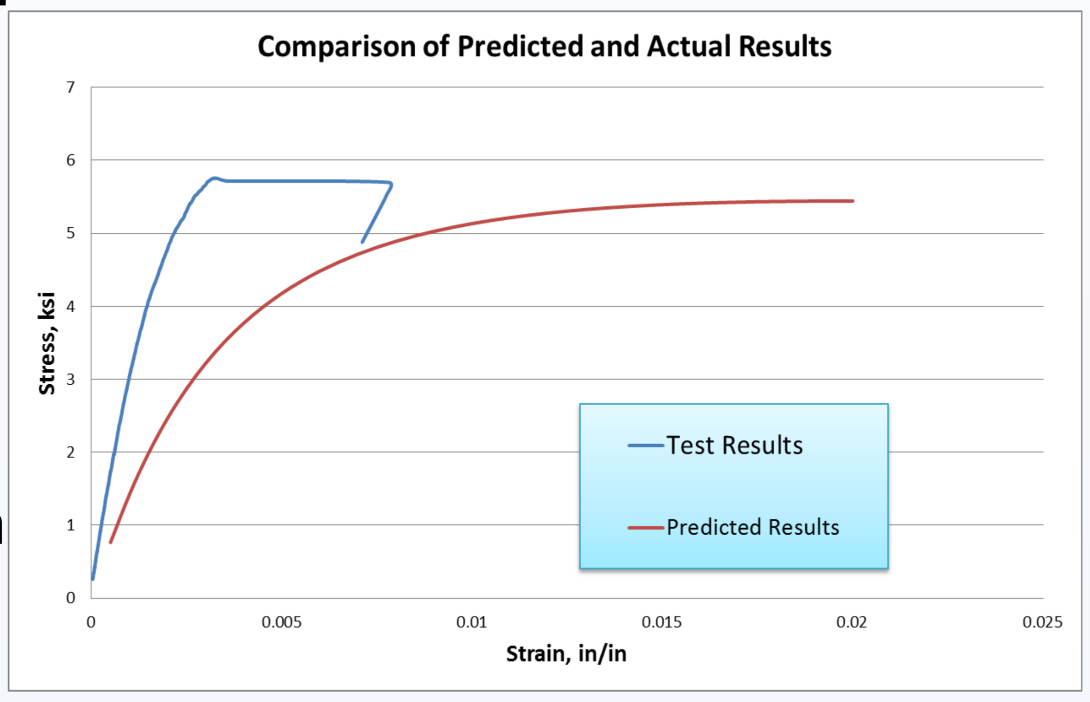

Rupture section of the specimen after testing.

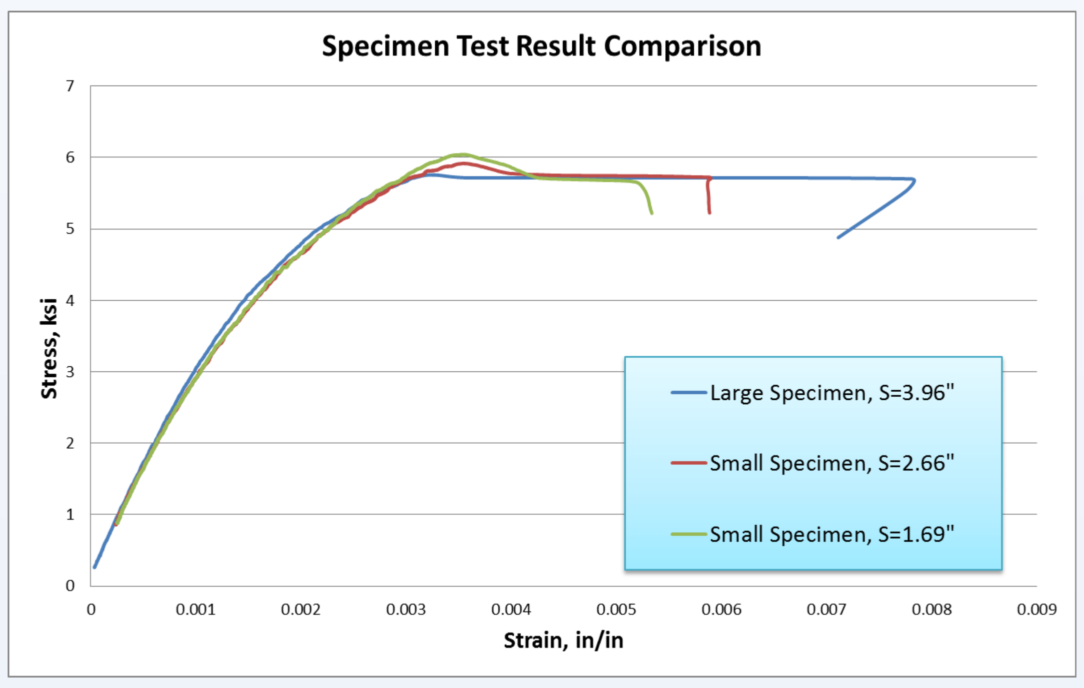
Failure Mechanism

Failure occurred do to concrete spalling in concentrated area, which led to a reduction in cross sectional area and increase of stress. This increased stress and lack of concrete cover led to yielding of the transverse reinforcement followed by buckling of the longitudinal reinforcement and finally failure of the whole specimen.

Stress-Strain Relationships

Even though the actual specimen had a higher ultimate stress than was predicted, it lost strength through yielding, thus producing a non-ductile failure. Little can be said about ductility gained through tighter transverse spacing. The tighter spacing in the smaller specimen showed no more ductility than the corresponding specimen with larger spacing. The larger specimen reached a higher strain before failure than the smaller sized specimens, most likely due to the increased width of the large specimen.





6. Conclusion

1) Specimen constructed to current ACI standard did not have a ductile response.
2) Tighter spacing of transverse reinforcement did not produce higher ductility in the smaller specimens.

7. Future Research

Along with previous research done by PEER interns in 2010, further testing will be performed on similar specimens with high strength longitudinal reinforcement, along with the testing of a full size shear wall under a six degree of freedom actuator system.

8. Acknowledgments

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