OUT-OF-PLANE INSTABILITY IN RECTANGULAR RC STRUCTURAL WALLS SUBJECT TO IN-PLANE LOADING

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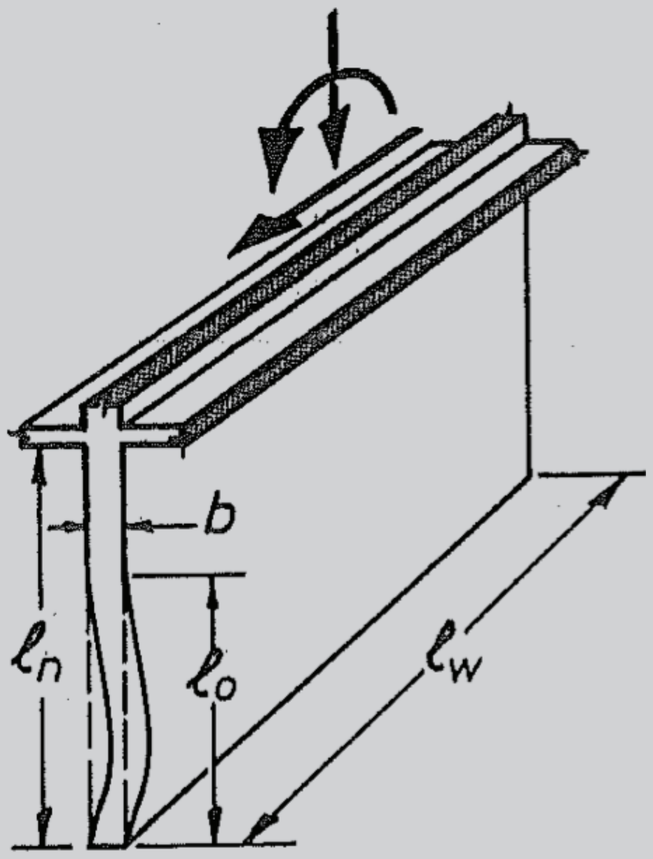
What is the problem?

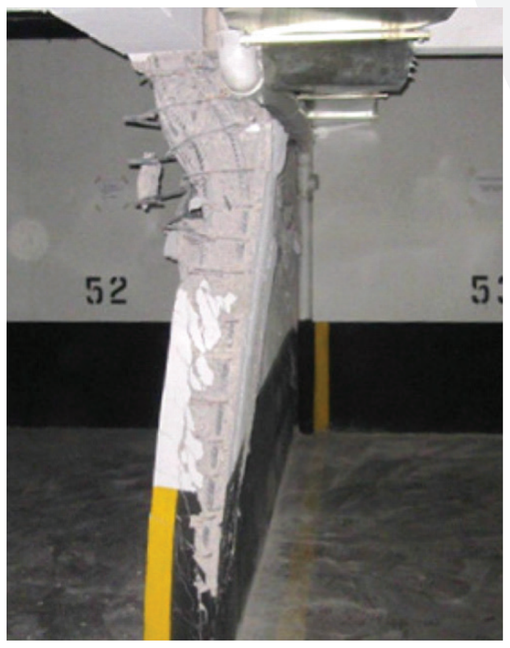
- Out-of-plane instability refers to the buckling of a portion of a wall section out-of-plane, as a result of in-plane actions.



Out-of-plane instability (Paulay and Priestley 1993)

- This mode of failure has been observed in several modern buildings in the 2010 Chile and 2011 Christchurch earthquakes, causing concerns over the existing design provisions of walls.
- The parameters controlling this mode of failure need to be identified and scrutinized, to provide design provisions that can prevent out-of-plane deformations of rectangular walls.

2011 Christchurch (Elwood 2013)

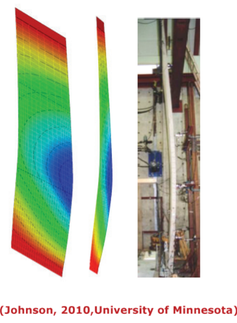


2010 Chile earthquake (Wallace 2012)

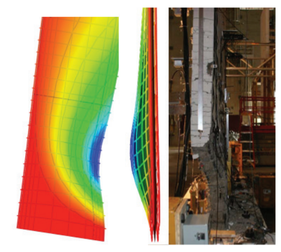
Research methodology

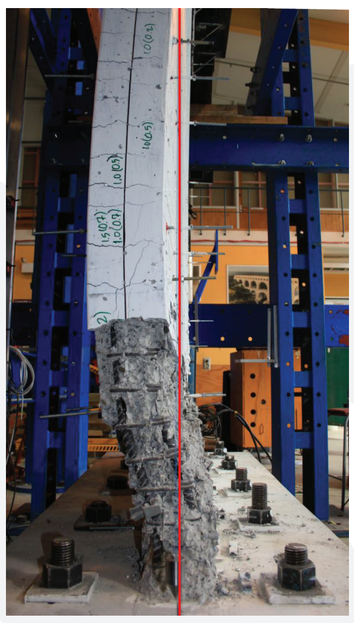
- Simulation of the common failure patterns of structural walls using finite element modelling (FEM)
- Verification of the FEM model against experimental observations of out-of-plane instability
- Blind-prediction of a wall test in which out-of-plane instability had occurred
- Identification of the parameters controlling out-of-plane instability of rectangular walls using the verified model and parametric studies
- Experimental investigation of the parameters
- Comprehensive parametric analysis based on numerical simulations and experimental observations.

Specimen3 (Beattie 2004, BRANZ)



RWN (Johnson, 2010,University of Minnesota)





Research outcomes

- Design provisions limiting the parameters that are known to be most influential on out-of-plane instability of rectangular walls
- Assessment charts proposing the probability of out-of-plane instability for a set of parameters.

How will these outcomes be used?

New design:

Some changes will be proposed to apply in the next revision of the NZS3101 following a very comprehensive parametric study using the verified numerical model and considering the experimental observations. According to the revised version of the NZS3101, the structural walls will need to satisfy specific limitations to be able to resist against out-of-plane instability failure.

Existing buildings:

Using the proposed assessment charts, the probability of out-of-plane instability in rectangular walls of existing New Zealand buildings can be evaluated.

What will be the benefits?

The structures with instability failure in walls are hardly repairable as a very abrupt loss of lateral load resistance is induced to the building by this mode of failure and can cause instability of the whole building.

The findings of this research will help prevent observations of out-of-plane instability in rectangular structural walls in future earthquakes and facilitate reparability of damaged wall buildings.

Publications

F. Dashti, R.P. Dhakal, S. Pampanin (2015) **"Numerical Modeling of Rectangular Reinforced Concrete Structural Walls"** Accepted for publication in the Journal of Structural Engineering, STENG-4262.

F. Dashti, R.P. Dhakal , S. Pampanin **"Simulation of out-of-plane instability in rectangular RC structural walls"** Second European Conference on Earthquake Engineering and Seismology, 25-29 August, 2014, Istanbul, Turkey.

F. Dashti, R.P. Dhakal , S. Pampanin **"Development of out-of-plane instability in rectangular RC structural walls"** The 2015 New Zealand Society for Earthquake Engineering Conference, 2015, Rotorua, New Zealand

Acknowledgments

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