SEISMIC ASSESSMENT AND DESIGN PHILOSOPHY OF REINFORCED CONCRETE WALLS IN AUSTRALIA

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THE FOCUS OF THIS RESEARCH IS TO ASSESS THE PERFORMANCE OF EXISTING REINFORCED CONCRETE (RC) WALL AND CORE BUILDINGS IN RESPONSE TO A RARE OR VERY RARE EARTHQUAKE EVENT IN AUSTRALIA. ULTIMATELY, FRAGILITY FUNCTIONS FOR DIFFERENT PERFORMANCE OBJECTIVES WILL BE DERIVED AND COST-EFFECTIVE DETAILING PROVISIONS WILL BE RECOMMENDED.

WHAT IS THE PROBLEM?

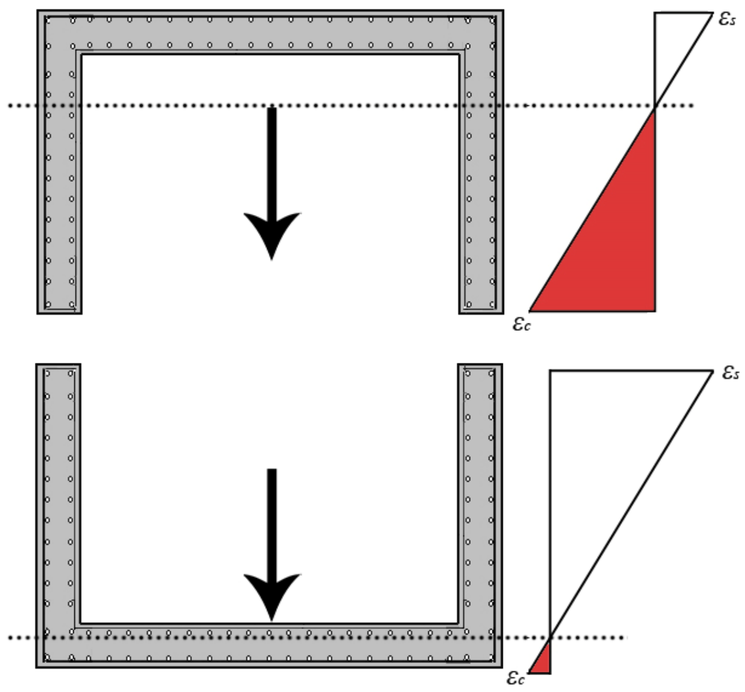
Some non-ductile reinforced concrete walls in buildings were observed to perform poorly in the 2011 Christchurch earthquake, with most of the lives lost from the event caused by the collapse of buildings that relied on these structural elements for lateral support. Reinforced concrete (RC) walls are widely used throughout the Australian building stock as the primary lateral support elements. It is possible that some of these structural elements would perform poorly in a very rare earthquake due to the low standard of detailing that is currently required in Australia, as well as the low earthquake return period that the Building Code of Australia stipulates for their design. The aim of this research has been to assess the seismic performance of reinforced concrete structural walls, both rectangular and C-shaped, in Australia, a region of low-to-moderate seismicity.

RESEARCH OUTCOMES TO DATE

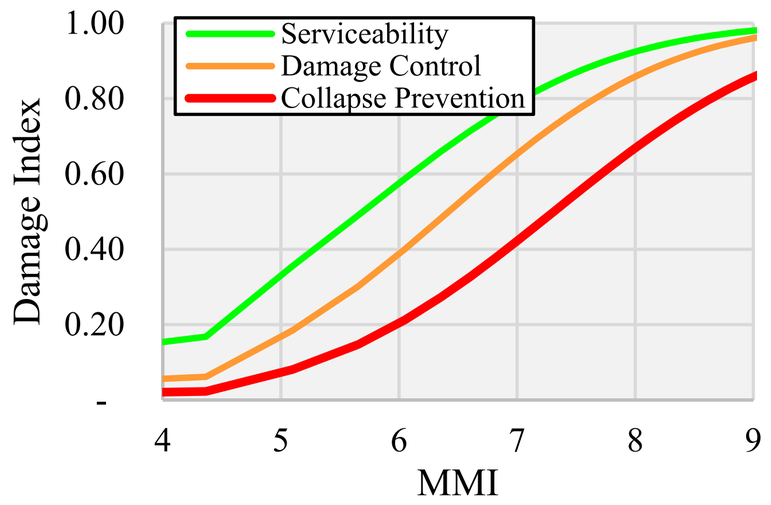
A study on the seismic hazard in Australia was conducted in an attempt to calculate the best estimate of the seismic demand. This included running Probabilistic Seismic Hazard Analyses (PSHA), evaluating Ground Motion Prediction Equations (GMPEs) for Australia and investigating the site response dependency on seismic intensity.

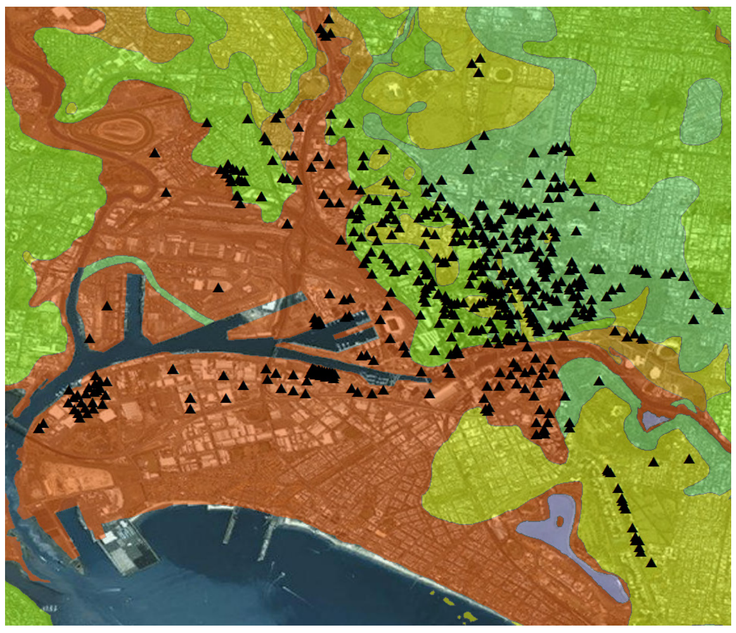
The displacement capacity of lightly reinforced and unconfined RC rectangular walls were investigated using VecTor2. A simple model was developed for estimating the amount of longitudinal reinforcement required to allow secondary cracking. This minimum was found to be generally higher than what is currently given in the Concrete Structures code AS 3600:2009.

RC C-shaped walls were also investigated using VecTor3. Poor performance was generally observed for these walls, particularly for bending about the minor axis with the web of the wall in tension (WiT). This poor performance was due to the wall boundaries being unconfined, which is commonly practiced in low-to-moderate seismic regions such as Australia. The figure below illustrates that non-rectangular walls, such as C-shaped, can be governed by large concrete strains depending on the direction of loading. Therefore, confinement in these regions are necessary such that the wall can achieve a ductile performance.



A program was written in MATLAB to investigate the Melbourne RC shear wall building stock. Fragility functions were derived from the progtam, which showed that these types of buildings were much more susceptible to collapse from large earthquake events than previously thought. The program also illustrated the different building damage distributions from 500-year and 2500-year return period earthquakes. It was estimated that 4% and 47% of buildings reached a Collapse Prevention performance level for the 500-year and 2500-year return period events respectively.





END-USER PERSPECTIVES

This PhD program is directed at a key issue we face in Australian cities, the presence of vulnerable reinforced concrete structures. This problem is exacerbated by the nature of Australia's intraplate seismicity that results in very severe ground shaking for longer return periods that can present problems for life safety. The research to date has confirmed the severity of very rare earthquakes. It has also progressed into examining the ability of poorly detailed wall structures to exhibit ductility. We look forward to this work extending and providing the metrics needed to understand the risk associated with these structures and how this can be reduced.

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