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?

Reinforced concrete (RC) walls and cores are used throughout Australia's building stock, with many structures relying on these elements to resist the primary lateral loads.

The underlying philosophy of the earthquake loading standard [AS 1170.4-2007] is to protect life by preventing building collapse whilst accepting that significant damage could occur under a rare, 500-year to 1000-year return period, earthquake event. As a consequence, most structures in Australia are designed for a 500-year(Importance Level 2) or 1000-year (Importance Level 3) return period earthquake event. However, as observed in Christchurch, it is the very rare earthquake event, with ground shaking reaching or exceeding the 2500-year return period event, that has the potential to cause major destruction in areas of low to moderate seismicity.

Further, due to the low standard of detailing required in the current material standards in Australia, it is anticipated that most of the RC walls and cores are "non-ductile". RC wall and core buildings are likely to be vulnerable to severe damage or collapse in a very rare earthquake event.

WHY IS IT IMPORTANT?

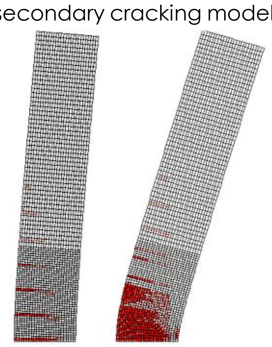
Although a rare occurrence, known active faults that have the potential to cause a moderate to large earthquake exist around many of the densely populated cities in Australia. It is only in the last 25 years that buildings have been designed with consideration for a 500-year or 1000-year return period earthquake event. Therefore, it is likely that many RC buildings in Australia will perform poorly in the event of an earthquake event that is larger than what is generally considered in design.

RESEARCH OUTCOMES TO DATE

A range of potentially applicable Ground Motion Prediction Equations (GMPEs) were assessed against data obtained for the Non-Cratonic eastern Australia region. The AUS5 earthquake recurrence model was used in a PSHA for the capital cities in Australia to reassess the earthquake hazard for a range of return periods. The earthquake hazard for most cities for return periods higher than 500-years was found to be larger than that obtained from AS1170.4-2007.

A study has been conducted to investigate the large dependency of the seismic amplification of different soil classes on the rigidity of the soil column and the intensity of the bedrock motions. Large discrepancies were found from the results when compared with the current spectral shapes given in AS1170.4-2007.

Lightly reinforced RC rectangular walls were investigated for the onset of secondary cracking, Many empirical equations were evaluated for their validity in predicting the plastic hinge length of lighted reinforced RC walls. A simple model was developed for estimating when the onset of secondary cracking would occur. The results were validated using the finite element modelling program VecTor2. A minimum longitudinal reinforcement ratio equation was also recommended based on the results of the secondary cracking model.



Left: RC wall with discrete crack, Right: RC wall with distributed crack

CURRENT AND FUTURE RESEARCH

- Seismic performance of non-ductile C-shaped walls
- Seismic performance of asymmetric RC buildings with RC frames
- Ductility of coupling beams used in low-to-moderate seismic regions
- Assessment of RC infrastructure in Melbourne/Adelaide
- Development of fragility functions for RC walls and cores
- Detailing recommendations

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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