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COST-EFFECTIVE MITIGATION STRATEGY DEVELOPMENT FOR BUILDING RELATED EARTHQUAKE RISK

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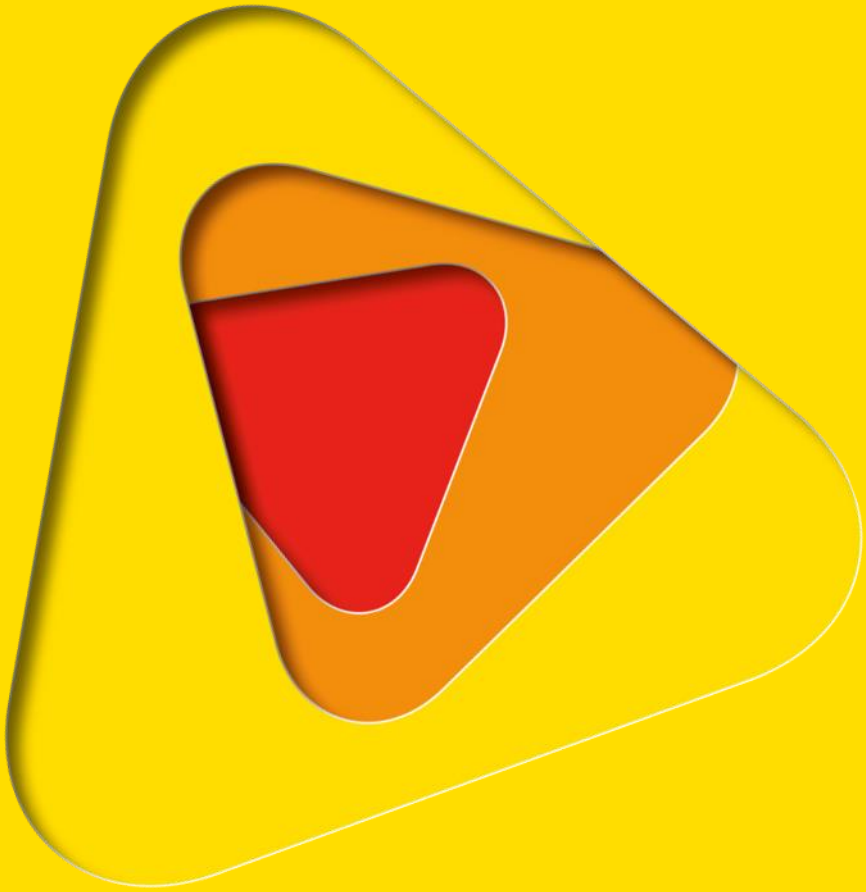
Bushfire and Natural Hazards CRC

Annual Report 2014



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The Elevator Pitch:

The seismic risk posed by earthquakes to buildings in our major cities in Australia is significant with the world insurance market rating a modest magnitude 6 earthquake occurring in Sydney to be in the world's top 10 of financial risks. A major reason for this is that Australia has not designed buildings for earthquake-induced forces until 1995 so that a large portion of our building stock is seismically vulnerable. As demonstrated in Christchurch New Zealand in 2010-11, a magnitude 6 earthquake can have a devastating impact on a city and country (damage build estimated at ~ 20% national GDP!) even though buildings have been designed for earthquakes for many decades.

This project will sift through the data that is available from the Christchurch experience to establish what earthquake retrofit techniques worked and what didn't as a starting point in developing a 'menu' of economically feasible seismic retrofit techniques that could be used in Australian cities. This information will then be fed into a 'decision support tool' being developed in project A7 that will be used by end users to develop consistent national policies for the application of seismic design of new buildings and retrofit of existing buildings.

Introduction

This project arose out of the on-going research efforts by the group involving structural engineering academics at the Universities of Adelaide, Melbourne and Swinburne with Geoscience Australia experts all working towards seismic risk reduction in Australia. Most of the research team are actively involved in the revision to the Australian Earthquake Loads standard (AS1170.4) as well as being members of the Australian Earthquake Engineering Society which is a Technical Society of Engineers Australia. The devastating impact of the 2010 – 11 earthquakes in the Christchurch region on the New Zealand economy and society has further motivated this group to contribute to this CRC's aims of risk reduction for all natural hazards in Australia.

The Project

The project will address the need for an evidence base to inform decision making on the mitigation of the risk posed by the most vulnerable Australian buildings subject to earthquakes. While the focus of this project is on buildings, many of the project outputs will also be relevant for other Australian infrastructure such as bridges, roads and ports, while at the same time complementing other 'Natural Hazards' CRC project proposals for severe wind and flood. Earthquake hazard has only been recognised in the design of Australian buildings since 1995. This failure has resulted in the presence of many buildings that represent a high risk to property, life and economic activity. These buildings also contribute to most of the post-disaster emergency management logistics and community recovery needs following major earthquakes. This vulnerability was in evidence in the Newcastle Earthquake of 1989, the Kalgoorlie Earthquake of 2010 and with similar building types in the Christchurch earthquake. With an overall building replacement rate of 2% nationally the legacy of vulnerable building persists in all cities and predominates in most business districts of lower

growth regional centres. The two most vulnerable building types that contribute disproportionately to community risk are unreinforced masonry and low ductility reinforced concrete frames. The damage to these will not only lead to direct repair costs but also to injuries and disruption to economic activity. This research project will draw upon and extend existing research and capability within both academia and government to develop information that will inform policy, business and private individuals on their decisions concerning reducing vulnerability. It will also draw upon New Zealand initiatives that make use of local planning as an instrument for effecting mitigation. Findings from the New Zealand Royal Commission on the Christchurch earthquake will also be used and opportunities for insurance industry linkages will be explored such as with the Insurance Council of Australia Building Resilience Rating Tool development by the consultant Edge Environment (http://buildingresilience.org.au/). The latter aims, in part, to provide metrics to support insurance premium incentives but does not presently include earthquake.

What's been happening in our project:

- Workshops of researchers and end users was held over 3 days in Adelaide (18-20 March 2014) where research group leaders presented to all CRC members and end users an overview of their research topics after which two days of discussions and workshops took place to consolidate potential project linkages and streamline activities where possible duplications were identified. Importantly, end user feedback and recommendations on project aims, methods and proposed end-outputs were incorporated into project work plans in the final session of the workshop.
- Recruiting – we have appointed in April/May two post-doctoral researchers (0.6FTE each) to work on our project: Dr Elisa Lumantarna (Melbourne/Swinburne) and Dr Wade Lucas (Adelaide). Several PhD projects on earthquake resilience related research have been submitted to, approved, and are now posted on the BNH CRC's website. Further recruitment is ongoing.
- Quarterly (2nd) reports were just completed detailing what the current state of the art is w/r classification of typical Australian building types and seismic retrofit/strengthening techniques.

Publication list (most in this list were in progress prior to CRC existence):

- Ryan Hoult, Helen Goldsworthy, Elisa Lumantarna (submitted) , "Spectral Shape Factors for Low-to-Moderate Seismic Regions," Journal of Soil Dynamics and Earthquake Engineering.
- Lumantarna, E., Lam, N.T.L, Tsang, H. H., Wilson, J., Gad, E., Goldsworthy, H. (2014). "State of the Art Review of Methodologies for Vulnerability Assessment of Multistorey Buildings," Australian Earthquake Engineering Society 2014 Conference, Nov 21-23, Lorne, Victoria.
- Setiawan, B., Jaksa, M. B., Griffith, M. C. and Love, D. (2015). Shear Wave Velocity Profile and Site Response Analysis of Adelaide's Regolith. *Proc. 16th European Conf. on Soil Mechanics and Geotechnical Engineering*, Edinburgh, September 13–17. (Abstract accepted: 20 May 2014.)
- Ozbakkaloglu, T., and Idris, Y. (2014). "Seismic behavior of FRP-high-strength concrete-steel double skin tubular columns." *Journal of Structural Engineering*, ASCE. 140(6), 04014019
- Idris, Y., and Ozbakkaloglu, T. (2013). "Seismic behavior of high-strength concrete-filled FRP tube columns." *Journal of Composites for Construction,* ASCE. 17(6), 04013013.
- Wibowo, A., Wilson, J.L., Lam, N.T.K. and Gad, E.F. (2014), "Drift Performance of Lightly Reinforced Concrete Columns", Engineering Structures. Vol. 59, pp. 522-535

- Wibowo, A., Wilson, J.L., Lam, N.T.K. and Gad, E.F. (2014), "Drift Capacity of Lightly Reinforced Concrete Columns", Australian Journal of Structural Engineering. Vol. 15, no. 2 (2014), p. 131-150
- Wibowo, A., Wilson, J.L., Lam, N.T.K. and Gad, E.F. (2013), "Seismic performance of lightly
- reinforced structural walls for design purposes", Magazine of Concrete Research. 65: 809-828
- Sivanerupan S., Wilson, J.L., Gad, E.F. & Lam, N.T.K. (2014), "In-plane drift capacity of contemporary point fixed glass façade systems". Journal of Architectural Engineering. 20(1), 04013002

List of current integrated project team members:

Researchers

University of Adelaide: Prof M Griffith (Project Leader), Prof M Jaksa, Assoc Prof AH Sheikh, Dr C Wu, Dr MMS Ali, Dr T Ozbakkaloglu, Dr A Ng, Dr P Visintin

University of Melbourne: Assoc Prof NTK Lam, Assoc Prof H Goldsworthy

Swinburne University: Prof J Wilson, Prof E Gad

Geoscience Australia: Mr M Edwards, Dr H Ryu, Mr V Juskevics

Students

- No new PhD students (yet).
- Existing PhD students conducting work on related/relevant topics include:

  Adelaide:
  - Yasuto Nakamura: Improved seismic assessment technique for URM buildings
  - Bambang Setiawan: Quantifying the Seismic and Site Amplification Characteristics of Adelaide's Regolith
  - Yunita Idris: FRP retrofit of non-ductile RC columns

  Melbourne:
  - Ryan Hoult
  - Anita Amirsardari
  - Mehair Yacoubian
  - Shanker Dhakal
  - Alireza Mehdipanah

  Swinburne:
  - Scott Menegon

End users

Matt Hayne (ACT, Geoscience Australia), Ralph Smith (WA), Shane Turner (SA, DPTEI)