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IMPROVING THE RESILIENCE OF EXISTING HOUSING TO SEVERE WIND EVENTS

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What is the Problem?
Damage investigations following severe wind storms have typically shown that Australian houses built prior to the mid-1980s do not offer the same level of performance and protection during windstorms as houses constructed to contemporary building standards. Some structural retrofitting methods for improving performance exist (e.g. Handbook HB132 published by Standards Australia in late 90s) for some forms of older housing but the take-up of these details appears limited. There is also evidence that retrofits are not being carried out for houses requiring major repairs following severe storm events, thus missing the opportunity to improve resilience of the house and the community. Additionally, damage surveys invariably reveal some failures due to loss of integrity of building components due to aging or durability issues such as corrosion, dry rot or insect attack. In fact, the damage survey after Cyclone Yasi showed substantial corrosion of roof elements in houses less than 10 year old.

Why is it Important?
Given that these older houses will represent the bulk of the housing stock for many decades, practical structural upgrading solutions based on the latest research could make a significant improvement to housing performance and to the economic and social well-being of the community. Hence the issues of retrofitting of older housing including economic feasibility, and obstacles on take-up etc. must be analysed. In addition, improving awareness of owners to the need for ongoing maintenance of houses as they age is also integral to the resilience of our communities.

How to solve it?
The primary objective of this project is to develop cost-effective strategies for mitigating damage to housing from severe windstorms across Australia. These evidence based strategies will be (a) tailored to both aid policy formulation and decision making in government and industry, and (b) provide guidelines detailing various options and benefits to homeowners and the building industry for retrofitting typical at risk older houses in Australian communities.

The uptake of the prescribed retrofit options given in the handbooks has not been effective as is evident by recurring severe wind damage to older houses. These details and methods will be reviewed to consider reasons for this. This project will incorporate latest findings on wind loads across roofs and load transfer mechanisms to improve the literature detailing general upgrading of structural connections in houses. Where appropriate, it will also include targeted structural upgrade details for more specific types of housing. This study will provide an opportunity to assess what amendments might be warranted to available information. The study will also consider the effectiveness of the current literature on upgrading of older houses and consider whether other mechanisms may be needed to support implementation. The involvement of stakeholders including organizations such as professional builders associations, insurers, ABCB and QBCC will be sought for input.

If initial findings from surveys and engagement with stakeholders show that the biggest impediment to upgrading is that the details in HB132 are all too expensive, excessive and in home owners eyes not aesthetic, then subsequent research should focus on development of new details. However, if the results showed that the details are acceptable, but that there is no incentive to apply them or there is lack of understanding of reasons for upgrading and maintenance, then research should focus on development of information to inform mitigation decisions including dedicated web based strategies to inform and educate home owners, designers and builders.

A major part of this study combines vulnerability assessments with cost benefit analysis. This work will include analysis from wind tunnel model studies and load tests, and construction and load testing of “upgraded” representative sections of house for both proof-testing and using resulting video material for education and guides.

Overview (Background and Introduction)
Extreme damage to housing resulted from the impact of Tropical Cyclone Tracy in December 1974, especially in the Northern suburbs of Darwin (Walker, 1975). Changes to design and building standards of houses were implemented for the reconstruction.
The Queensland Home Building Code (HBC) was introduced as legislation in 1982 with the realisation of the need to provide adequate strength in housing. By the mid 80s houses in the cyclone region of Queensland were being designed and built to these more stringent requirements.

Damage investigations, conducted by the Cyclone Testing Station (CTS) in NT, QLD and WA, from cyclones over the past fifteen years have shown that the majority of houses designed and constructed to current building regulations have performed well structurally by resisting the wind loads and remaining intact (Reardon et al, 1999; Henderson and Leitch, 2005; Henderson et al, 2006; 2010; Boughton et al 2011). However, these reports also detail failures of contemporary construction at wind speeds below design requirements. The poor performance of these structures resulted from design and construction failings or from degradation of elements such as corroded screws, nails and straps and decayed or insect attacked timber.

The wind field within a cyclone is a highly turbulent environment. The dynamic fluctuating winds that impact on the house subjects the building envelope (exterior skin) and structure to a multitude of spatially and temporally varying pressures. Generally, the design of the house structure uses the peak gust wind speed for determining the large positive and negative pressures acting on the house. The wind duration and temporally varying forces are important in assessing elements of the house envelope and frame, such as roofing, battens, and connections that may suffer degradation from load cycle fatigue.

During severe wind-storms positive pressures act on the windward wall and high suction pressures occur across the roof and especially at the leading edge. If there is a breach in the building envelope on the windward face, such as from broken window or failed door, the interior of the house is pressurised. These internal pressures act in concert with the external pressures greatly increasing the load on the house cladding elements and structure. Depending on the geometry of the building, the increase in internal pressure caused by this opening can double the load on the structure, thereby increasing the risk of failure, especially if the building has not been designed for the large internal pressures resulting from a dominant opening.

Houses are complex structures and do not lend themselves to simple design and analysis due to various load paths from multiple elements and connections with many building elements providing load sharing and in some cases redundancy. Different types of house construction will have varying degrees of resilience to wind loads. The Geoscience Australia NEXIS data-base is to be used to generate common housing forms for various regions around the country. Vulnerability models for these types of building systems are to be derived.

Objectives

This CRC research project has just commenced with the proposal that the overall project encompasses housing types across the country. The proposed work will;

- Categorise houses into types based on the building features that influence windstorm vulnerability, using survey data collected by Geoscience Australia and CTS-JCU. From these, a suite will be selected representing those contributing most to windstorm risk.
- Involve end-users and stakeholders to assess amendments and provide feedback on practicality and aesthetics of potential upgrading methods for a range of buildings. Strategies will be developed and costed for key house types.
- Vulnerability functions to be developed for each retrofit strategy, using survey data, author's vulnerability models and NEXIS. Case studies will be used to evaluate effectiveness in risk reduction. Economic assessment using the same case studies will be used to promote uptake of practical retrofit options.

PROJECT STATUS AT THE END OF 2013/2014

List of current project team members

Lead Researcher:	John Ginger (CTS at James Cook University)
Researchers:	David Henderson (CTS at JCU) Martin Wehner (Geoscience Australia) Mark Edwards (Geoscience Australia) John Holmes (Adjunct JCU and JDH Consulting) Geoff Boughton (Adjunct JCU and TimberEd)
Lead End Users:	Ralph Smith (DFES, WA) Leesa Carson (GA)
End Users:	Lindsay Walker (Dept HPW, QLD) Greg Howard (SAFMS, SA) Martine Woolfe (GA)

Recruitment:

Following lengthy advertising and recruitment process, we are delighted to be welcoming Post-Doc researcher Dr Daniel Smith who will be commencing in August. Daniel has completed his PhD at University of Florida where he investigated the performance of roof tiles to severe wind loads.

Project meetings held in 2013/2014:

- Hardening Buildings and Infrastructure Cluster meeting.
  Melbourne. 18 December 2013.
- BNHCRC Research Advisory Forum.
  Adelaide. 18-20 March 2014.

Reports issued in 2013/2014:

- Project management Plan
- 1st Quarterly Report (January 2014 - March 2014)
- 2nd Quarterly Report (April 2014 - June 2014)
- Annual Report 2014

Publications in 2013/2014:

- Paper (conference) – "Improving the resilience of existing housing to severe wind events" by Henderson D. and Ginger J., accepted for oral presentation for AFAC Conference, Sept 2014.
- Poster (conference) – submitted as requirement for BNHCRC at AFAC - "Improving the resilience of existing housing to severe wind events" by Henderson D. Wehner M. and Ginger J., for AFAC Conference, Sept 2014.
- Report – "Improving the Resilience of Existing Housing to Severe Wind Events: Preliminary Building Schema", by Edwards M. and Wehner M., Geoscience Australia

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