RESILIENCE & MITIGATION THROUGH HARDENING THE BUILT ENVIRONMENT (BUILDINGS & INFRASTRUCTURE)

A9: Cost-effective mitigation strategy for Earthquake Risk
A10: Cost-effective mitigation strategy for Flood Prone Buildings
B7: Improving the resilience of existing housing to severe wind events

Professor Michael Griffith
School of Civil, Environmental & Mining Engineering, The University of Adelaide
A9: COST EFFECTIVE MITIGATION STRATEGY FOR BUILDING-RELATED EARTHQUAKE RISK

Project Participants

Univ of Adelaide: MC Griffith, M Jaksa, AH Sheikh, C Wu, MMS Ali, T Ozbakkaloglu, A Ng & P Visintin
Univ of Melbourne: NTK Lam, H Goldsworthy
Swinburne University: JL Wilson, E Gad
Geoscience Australia: M Edwards, H Ryu, C Collins
**Aim:** to develop evidence base to inform decision making for earthquake risk mitigation

- Establish seismic vulnerability classes for representative building types in Australia
- Survey existing retrofit techniques for known performance in recent earthquakes
- Develop new cost-effective Australia-specific retrofit techniques
- Develop decision-support and earthquake risk forecasting tools to support infrastructure managers
- Develop economic loss models for business interruption and casualty costs
AERIAL VIEW OF CHRISTCHURCH SECONDS AFTER THE 22 FEBRUARY 2011 EARTHQUAKE
Lessons from Christchurch

Christchurch corner shops

Adelaide corner shops

Christchurch theatre

Adelaide arcade
Out-of-plane wall bending failures in Christchurch (42 fatalities in URM buildings)
PGC – 18 fatalities

CTV – 115 fatalities
DAMAGE LEVELS FOR DIFFERENT LEVELS OF RETROFIT

Percentage of buildings

Damage level

- insignificant
- moderate
- heavy
- major
- destroyed

Damage level categories:
- %NBS > 100
- 67 ≤ %NBS < 100
- 33 ≤ %NBS < 67
- %NBS < 33
- All
- No retrofit

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Expected Outputs:

- A cost-benefit analysis methodology for key retrofit options at both the building and regional levels

- Information and models to enable planning authorities to develop policies and legislation, backed up by substantiated economic benefits
A10: COST-EFFECTIVE STRATEGY DEVELOPMENT FOR FLOOD PRONE BUILDINGS

Project Participants

Geoscience Australia: T Maqsood, Ken Dale, Martin Wehner
Aim: mitigate risk posed by urban development in flood prone areas

Specific Objectives

• Develop an evidence base to inform decision making on risk mitigation strategies for flood prone buildings

• Develop cost-benefit analysis methodology for key mitigation options at the building level

• Build on existing work on flood susceptibility of typical Australian building materials and construction
Photos of flood damage to residential buildings after the 2011 Queensland Floods
B7: Improving the Resilience of Existing Housing to Severe Wind Events

Project Participants
Cyclone Testing Station- James Cook University: J Ginger, D Henderson, J Holmes, G Boughton
Geoscience Australia: M Edwards, M Wehner

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AIMS - OBJECTIVES

Improve structural performance of Pre-80s houses

- Develop cost-effective strategies for mitigating damage to housing from severe windstorms across Australia to aid policy formulation in government and industry.

- Provide guidelines detailing various options and benefits to homeowners and the building community for retrofitting typical at risk older houses in Australian communities.
• Traditional process – evolved from holding roof up not tying it down
• Many elements, closely spaced
• There is load sharing
• So no easily defined Load path
• They are where we shelter – so have to be secure
DAMAGE DATA – CYCLONE YASI

**Post 80s (current construction)**
- <3% major roof damage
- ~30% all roller doors damaged
- But many houses had water ingress

**Pre 80s (older housing)**
- >12% major roof damage
- ~2% damaged by large debris
- May have hidden damage

Lower levels of damage of “newer” housing similar pattern in other surveys (e.g. Cyclone Winifred Cyclone Vance, Cyclone Larry)

Lessons have been learnt since Cyclone Tracy!
PRE-80S HOUSES
Wind Loads on Houses

Large internal pressures....If an opening forms in the external envelope of the building e.g. a window is broken or a door blows in.
### Some common housing types – Cyclonic region

<table>
<thead>
<tr>
<th>Built During</th>
<th>Example of geometry and features</th>
<th>Generalised features</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1920s</td>
<td><img src="image" alt="House" /></td>
<td>Hip roof, reduced rafter spans, central core, exposed studs, on stumps (low and high)</td>
</tr>
<tr>
<td>1920 – 1950s</td>
<td><img src="image" alt="House" /></td>
<td>Hip and gable, VJ lining, reduced rafter spans, on stumps (low and high)</td>
</tr>
<tr>
<td>1960s – 1970s</td>
<td><img src="image" alt="House" /></td>
<td>Gable low pitch, vermin proof flooring (studs not mortise and tenon into bearers), panel cladding, on stumps</td>
</tr>
<tr>
<td>&gt; early 1980s</td>
<td><img src="image" alt="House" /></td>
<td>Reinforced masonry block, hip and gable, large truss spans, medium roof pitch, slab on ground</td>
</tr>
</tbody>
</table>
## Classification of House Types – All regions

<table>
<thead>
<tr>
<th>Jurisdiction / Wind Region</th>
<th>Age</th>
<th>Roof Material</th>
<th>Roof Structure</th>
<th>Wall Material</th>
<th>Wall Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld, NT, WA Cyclonic</td>
<td>Pre-1911</td>
<td>Tile</td>
<td>Timber rafter &amp; Timber battens</td>
<td>Timber</td>
<td>Timber Frame</td>
</tr>
<tr>
<td></td>
<td>1911-1940s</td>
<td>Metal</td>
<td>Tiles &amp; Timber battens</td>
<td>Fiber</td>
<td>Masonry Block</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td></td>
<td>Cement</td>
<td></td>
</tr>
<tr>
<td>Qld, NT, Non-cyclonic</td>
<td>1940-1960s</td>
<td></td>
<td></td>
<td>Brick</td>
<td>Brick</td>
</tr>
<tr>
<td>NSW, VIC ACT,</td>
<td></td>
<td></td>
<td></td>
<td>Veneer</td>
<td></td>
</tr>
<tr>
<td>WA- Cyclonic</td>
<td></td>
<td></td>
<td></td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>WA- Non-cyclonic</td>
<td>1960-1980s</td>
<td></td>
<td></td>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

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Wind Regions – AS/NZS 1170.2

Cyclonic – C & D
Non cyclonic – A & B