Hardening Building and Infrastructure Cluster

PROJECT A9: Cost-effective mitigation strategy development for building related earthquake risk

Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme
bnhcrc.com.au

Project Participants

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End Users:

WA DFES, York Shire Council, *ABCB, Standards Australia, EMA, State/Local Governments*

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 cost-effective Australia-specific retrofit solutions**
- **Develop decision-support and earthquake risk forecasting tools to support infrastructure managers**
- **Develop economic loss models that include business interruption and casualty costs**

End User Engagement

- WA Dept Fire & Emergency Services
- York Shire Council
- WA Dept Planning, Lands & Heritage
- Standards Australia – AS 3826
- Other indirect
  - EMA
  - State & local governments
  - Bldg Code of Australia

YORK MAIN STREET

Out-of-plane wall bending failures in Christchurch (42 fatalities in URM buildings)

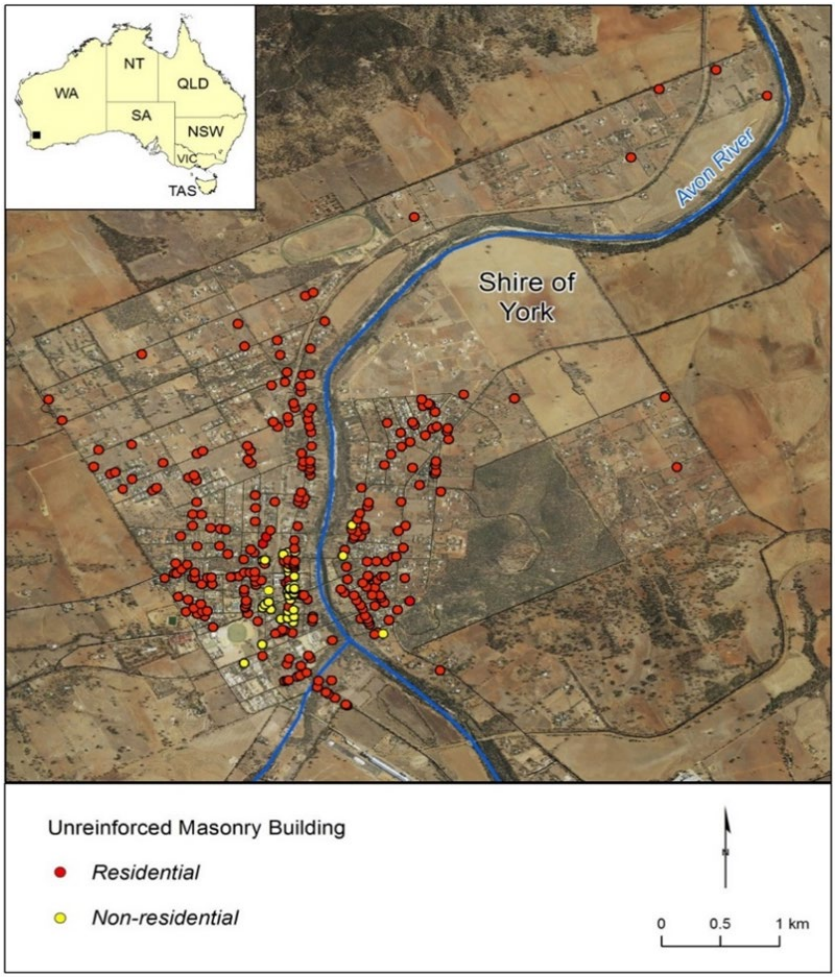
Some statistics

- 39 of the 42 fatalities associated with unreinforced masonry buildings were ***outside*** the building
- NZ law has existed for several decades requiring ‘Earthquake Prone’ building owners to strengthen or demolish it.
- However, it was up to ‘local authorities’ to enforce it.
- Often, cost-benefit arguments were used to ‘avoid’ strengthening

BUILDING SURVEY DATA CAPTURE INCLUDED:

(1463 BUILDINGS SURVEYED, 307 URM BUILDINGS IDENTIFIED)

- Building type and usage
- Building plan dimensions, # of storeys and storey heights
- Roof shape
- Presence/detail on chimneys, parapets, awnings/verandahs
- Presence/detail on existing retrofit
- Masonry wall material and bond pattern
- Separation with respect to adjacent buildings
- Presence of neighbour falling hazards



GENERIC BUILDING TYPOLOGIES

(a) Residential

(b) Pub

Falling Hazards: chimneys, gable end walls, parapets, out-of-plane wall failures

COMMERCIAL (ROW) BUILDINGS

(a) Single storey

Falling hazards: parapets, OOP wall failures in multi-storey bldgs.

(b) Two/three storey

2 STOREY INSTITUTIONAL BUILDINGS

(a) Isolated

(b) Row

Falling hazards: Parapets, chimneys, OOP wall failure

Damage & Economic Loss Modelling

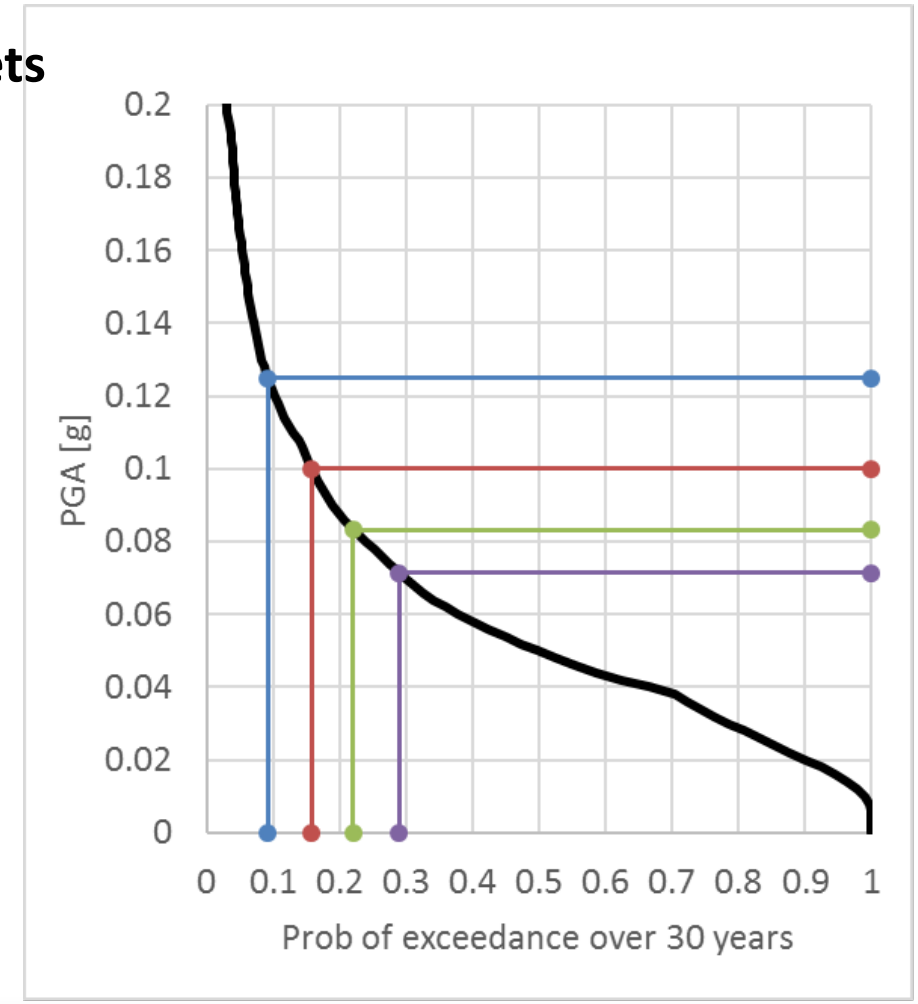
1. *Rank Vulnerability of Common Construction Types*
2. *Estimate Structural Drift for Various Magnitude Events*
3. *Develop Damage-Drift Relationships to Estimate Building Damage for unstrengthened and strengthened buildings*
4. *Develop Cost-Damage Relationships to Estimate Economic Impact* of Natural Hazard*

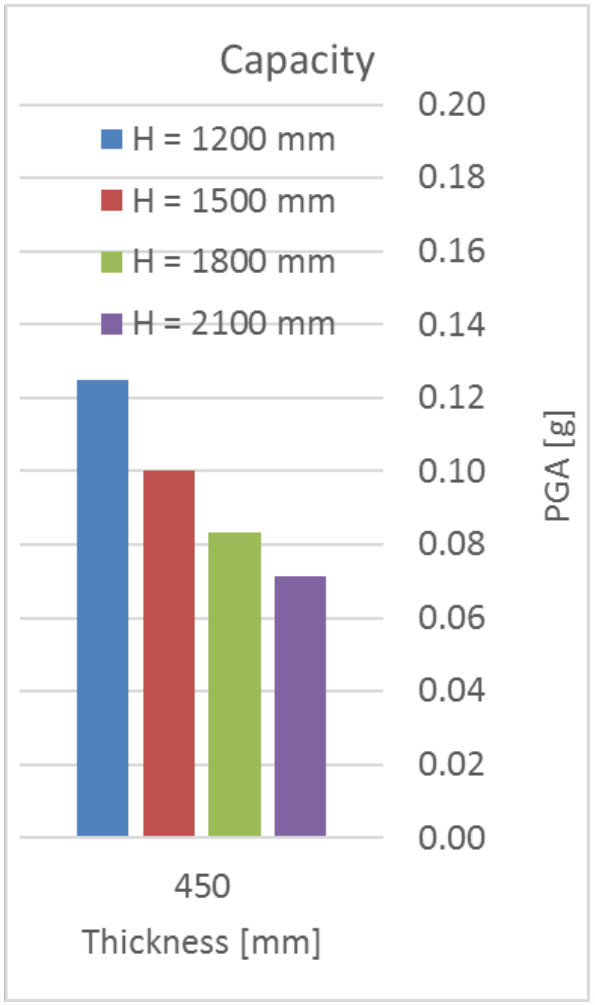
- *costs to include fatalities & injuries, business interruption at a precinct level*

1, 2 ‘done’; 3 & 4 in progress

PGA CAPACITIES AND PROBABILITY OF EXCEEDANCE OVER 30 YEAR TIME HORIZON

Parapets





2010 Kalgoorlie Earthquake

Parapet/awning damage in URM buildings in M5.0 earthquake

Closing Remarks

- WA DFES and York Shire Council end user engagement has been fantastic:
  - Community engagement has been good;
  - Seismically vulnerable buildings have been identified;
  - Seismic strengthening options being developed for typical York buildings;
  - DFES and York Shire successfully applied for a $250,000 NDRP 2019-21 grant to expand scope across all of WA;
- Much of the assessment and retrofit solutions being developed for York will have national application
- Update of AS 3826 “Earthquake strengthening of existing buildings”