Improving the Resilience of Existing Housing to Severe Wind Events

Research advisory forum / **2018**

John Ginger, David Henderson, Daniel Smith: James Cook University

Martin Wehner, Hyuek Ryu, Mark Edwards: GeoScience Australia

End-User: Department of Housing & Public Works- Qld

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bushfire&natural HAZARDSCRC

Australian Government Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

CYCLONE TESTING STATION

Aims-Outcomes

- Identify Vulnerable House Types – Assess Vulnerability
- Propose Structural Retrofit
- Develop Software Package – VAWS
- Advice to Home owners on how to improve the resilience of their homes
- Insurance have a better understanding of the risk and the impact of retrofit on reducing that risk
- Community and government – reduced costs associated with response following windstorms –overall resilience of the community is increased at the individual house owner level

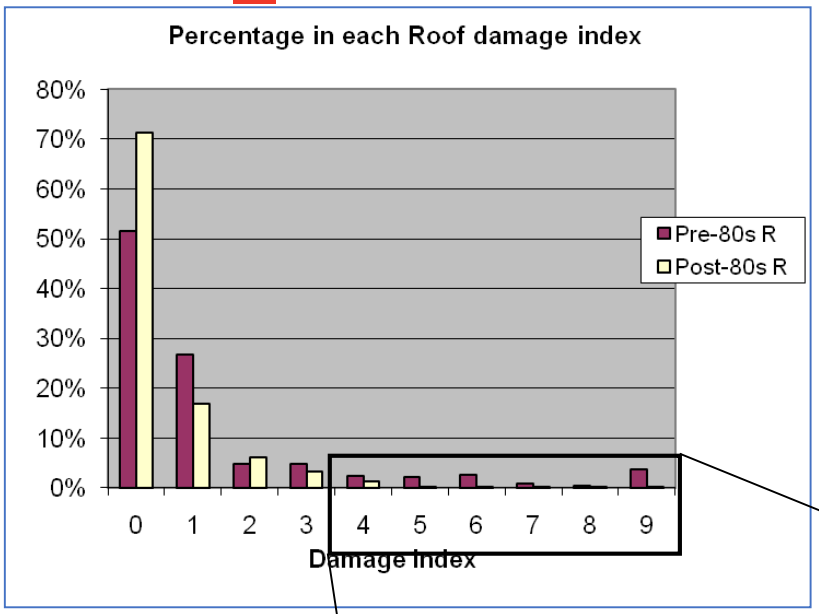
Damage Surveys – Cyclone Yasi

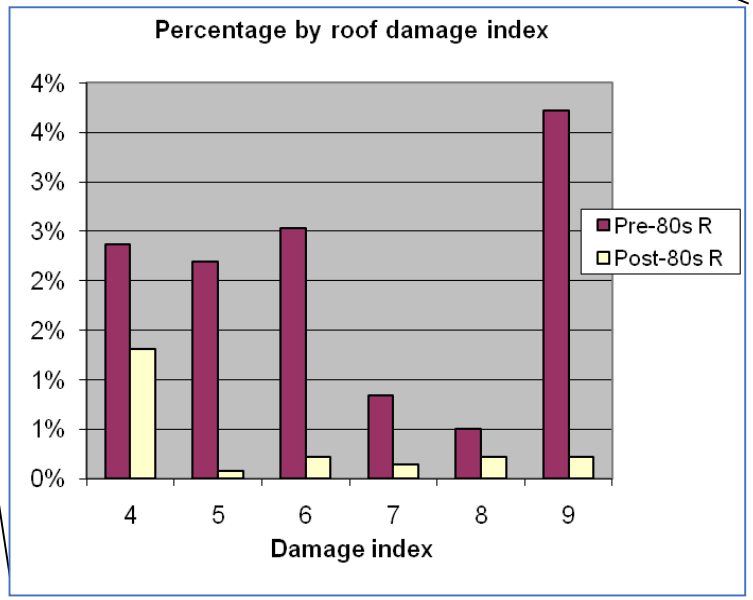
Pre-85 Houses

Damage Surveys – Cyclone Yasi

Post-85 Houses

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)

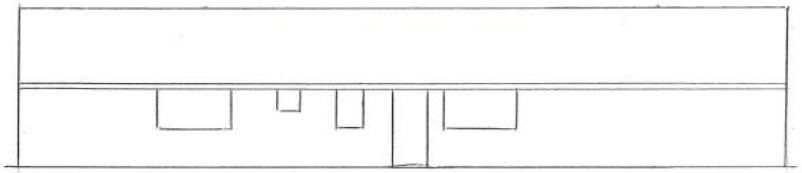
- >12% major roof damage
- ~2% damaged by large debris
- May have hidden damage

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

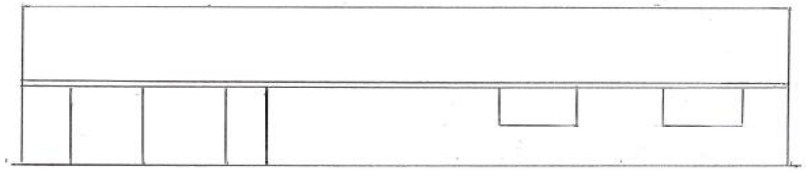
Lessons have been learnt since Cyclone Tracy!

House Types – Cyclone & Non Cyclone Regions

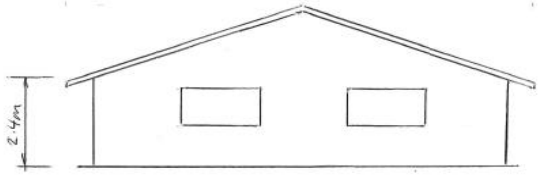
House Types



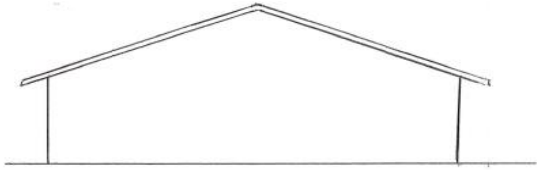
NORTH ELEVATION



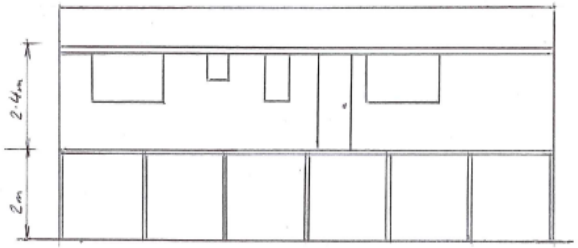
SOUTH ELEVATION



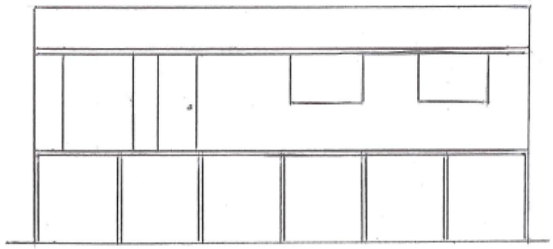
WEST ELEVATION



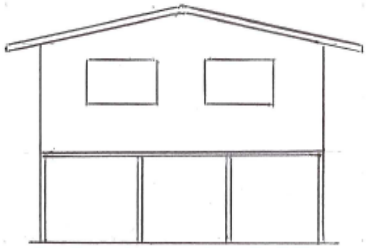
EAST ELEVATION



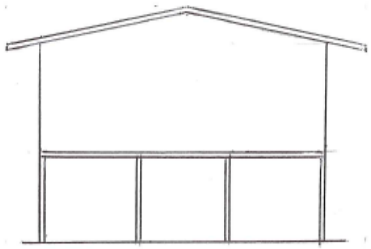
NORTH ELEVATION



SOUTH ELEVATION

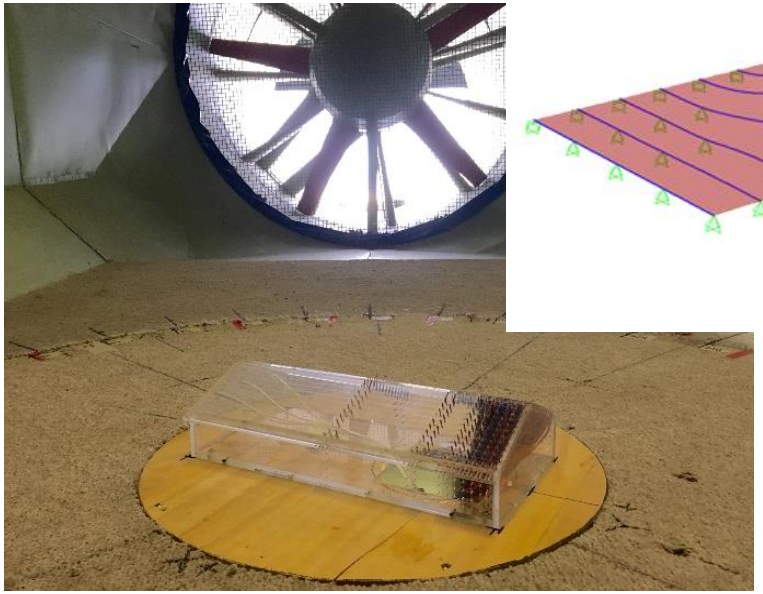


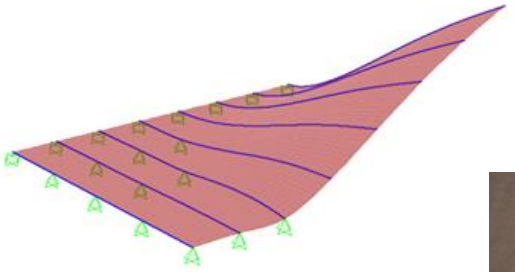
WEST ELEVATION

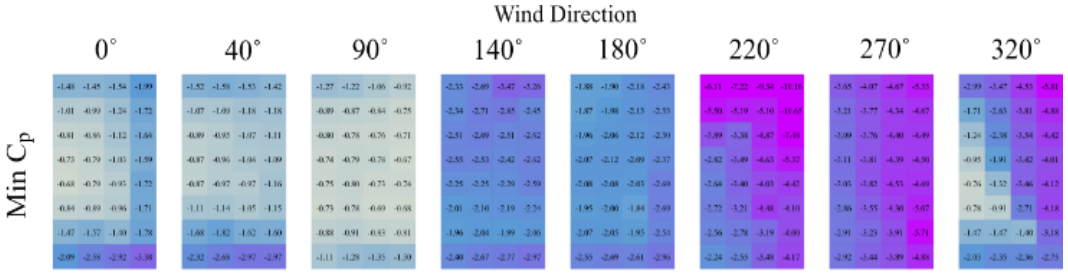


EAST ELEVATION

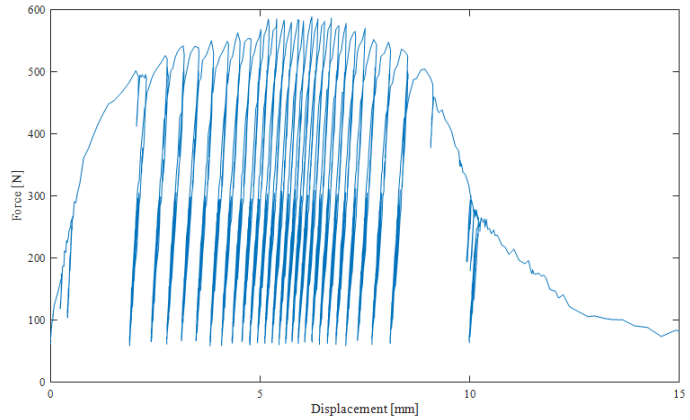
Wind tunnel Model Testing





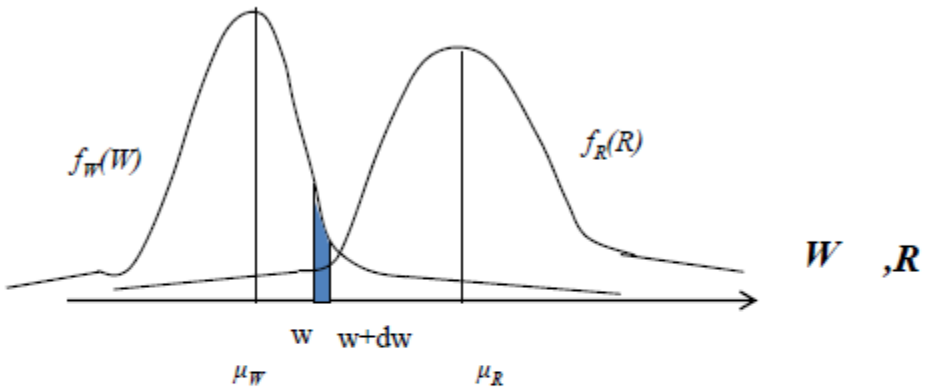


Testing Connections



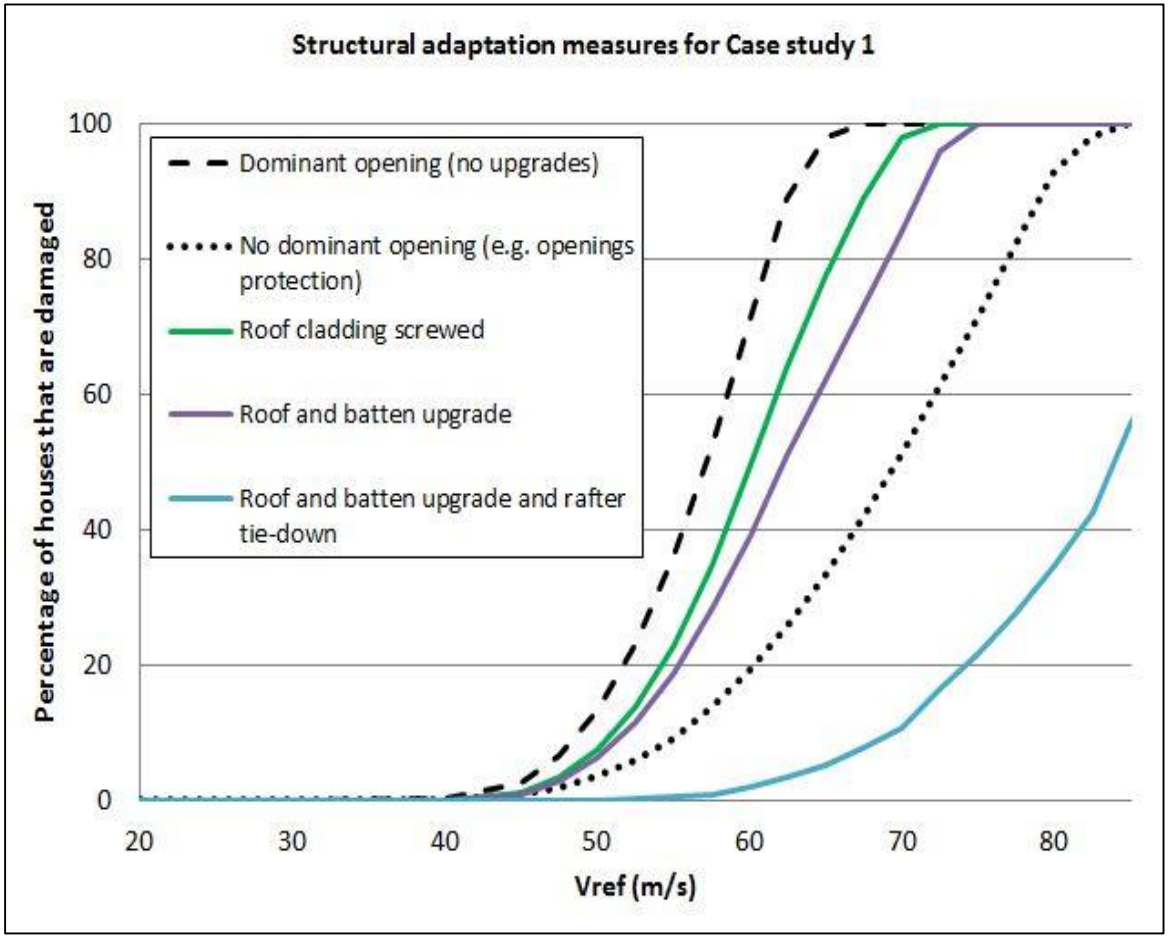
Mathematical Model

Probability of failure



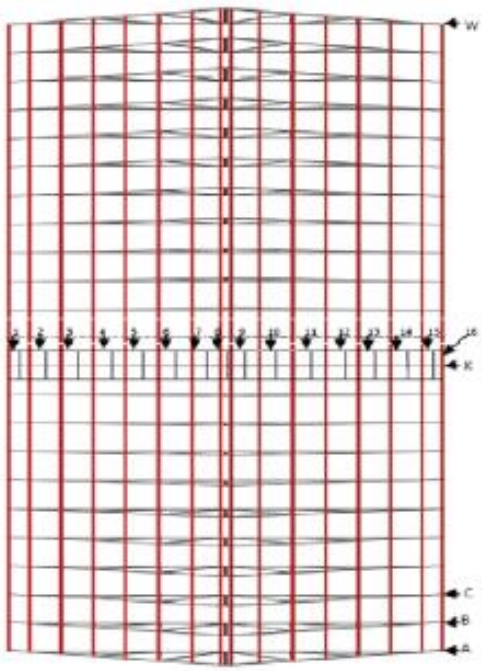
$$p_f = \int_{-\infty}^{\infty} F_R(W) f_W(W) dW$$

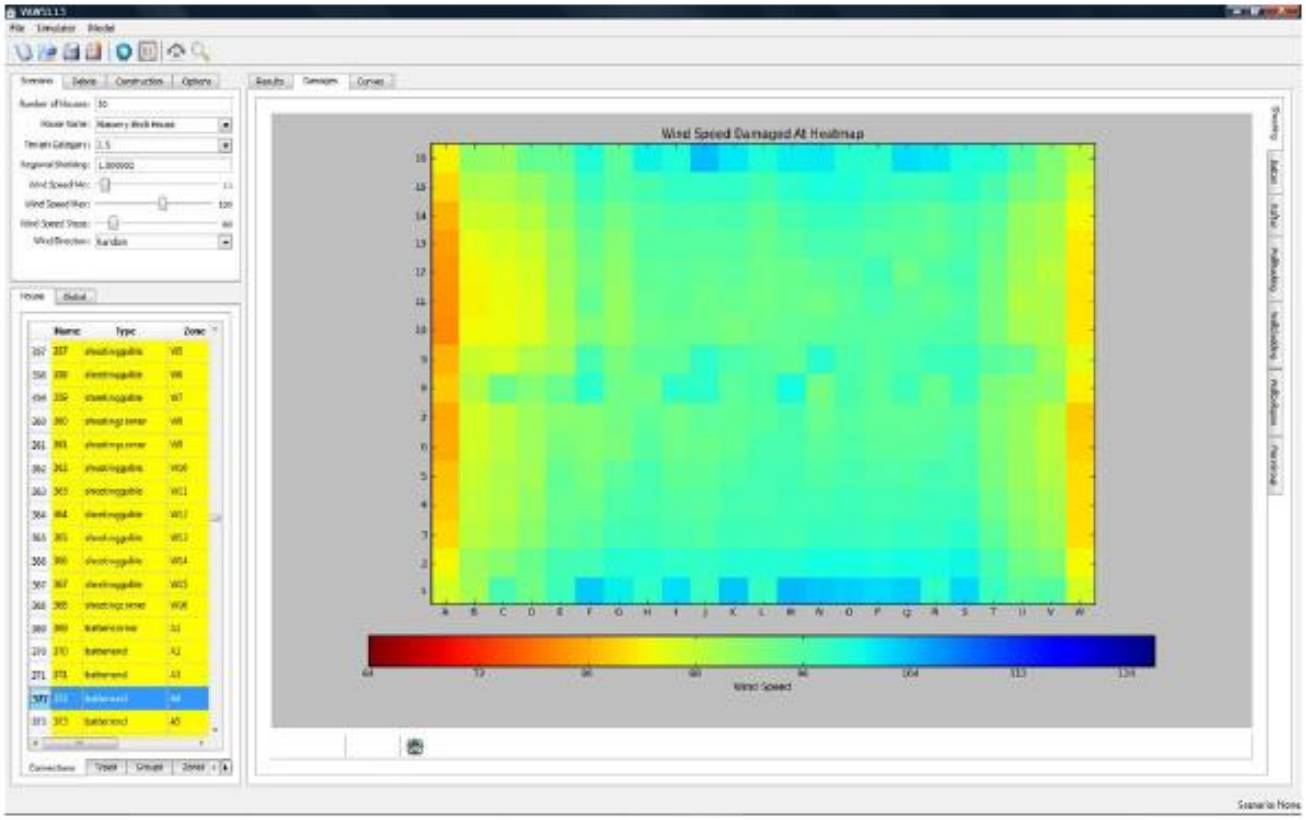
Damage Comparison



Failure of structural connections in older housing at wind speeds less than design

VAWS (*Vulnerability and Adaptation to Wind Simulation*)

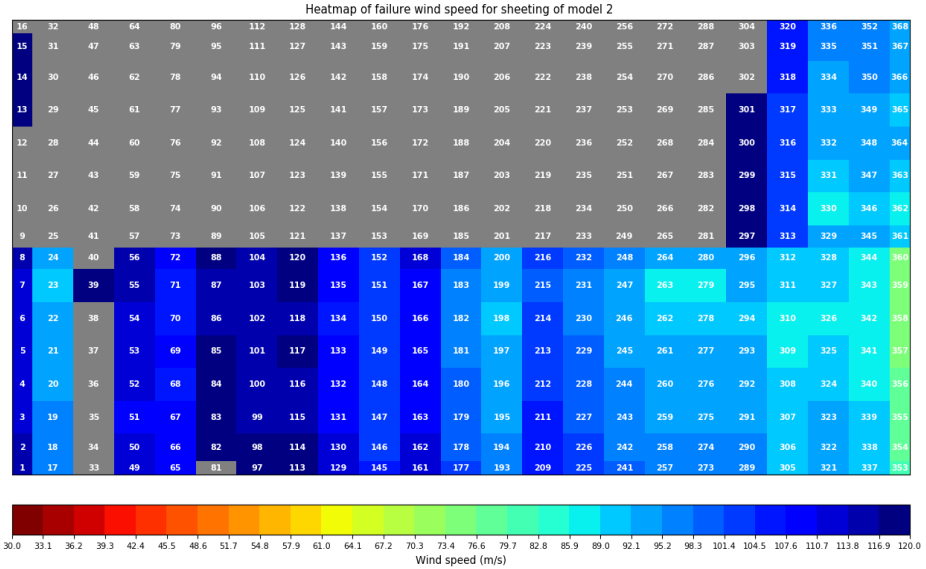




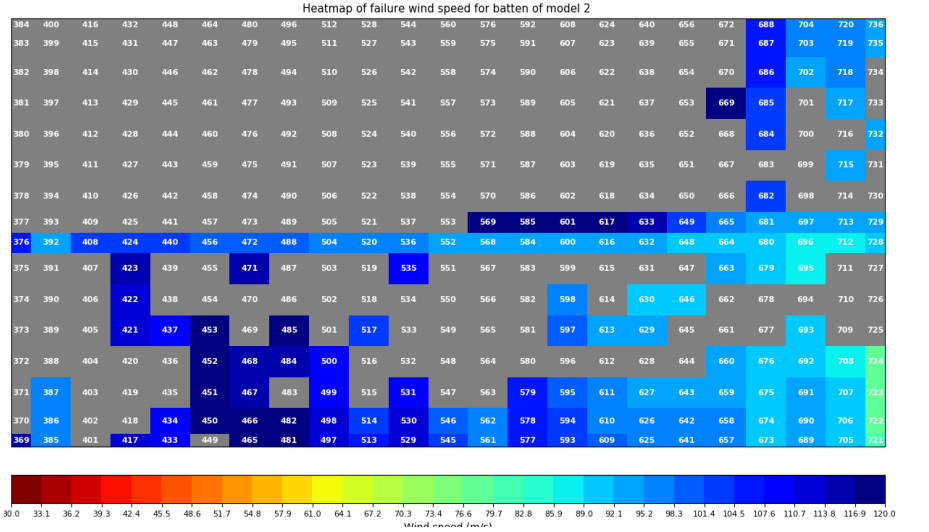
Software developed by GeoScience Australia in collaboration with CTS & JDH

VAWS

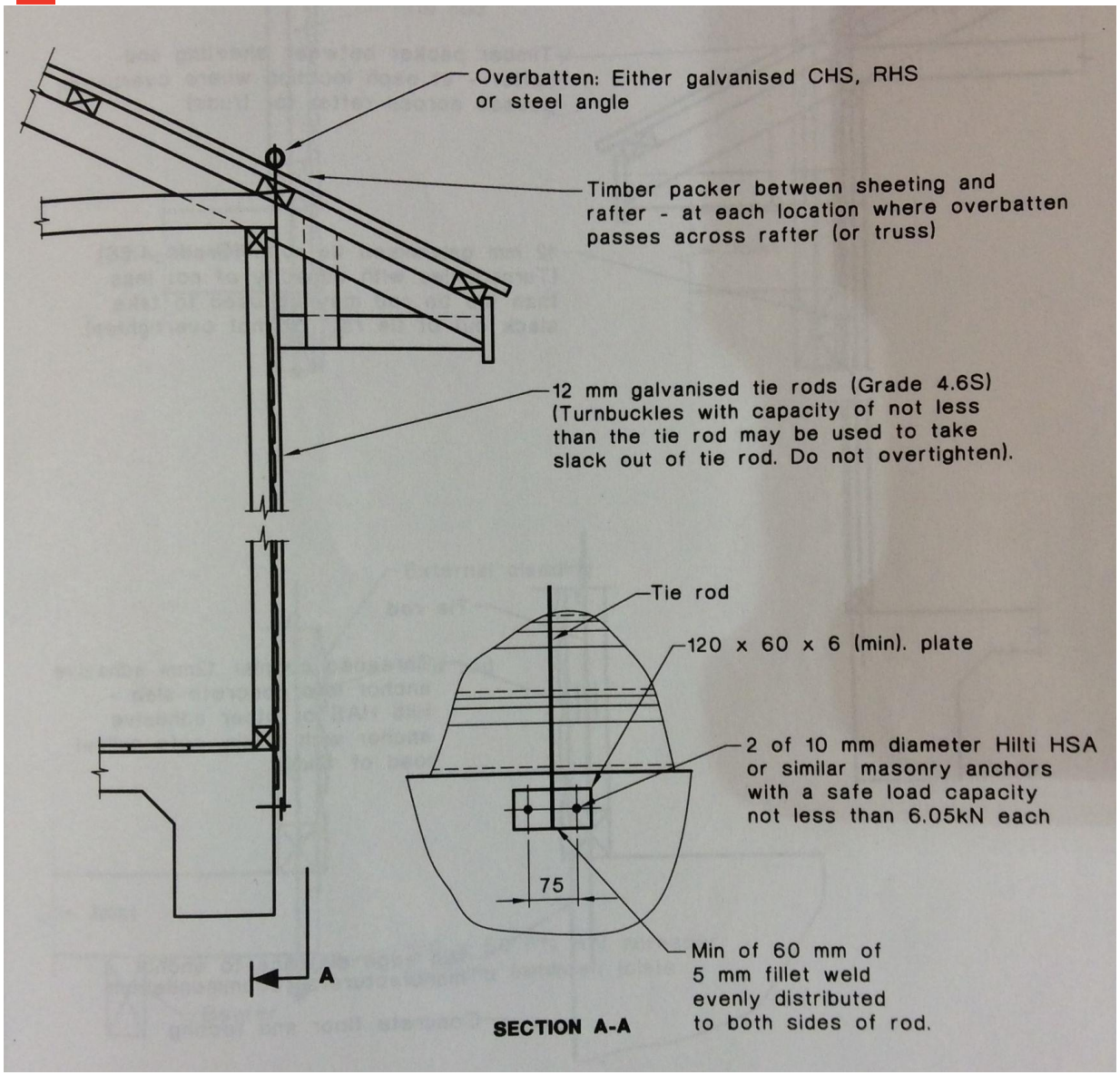
Example of gust wind speed at the failure of roof cladding fixings

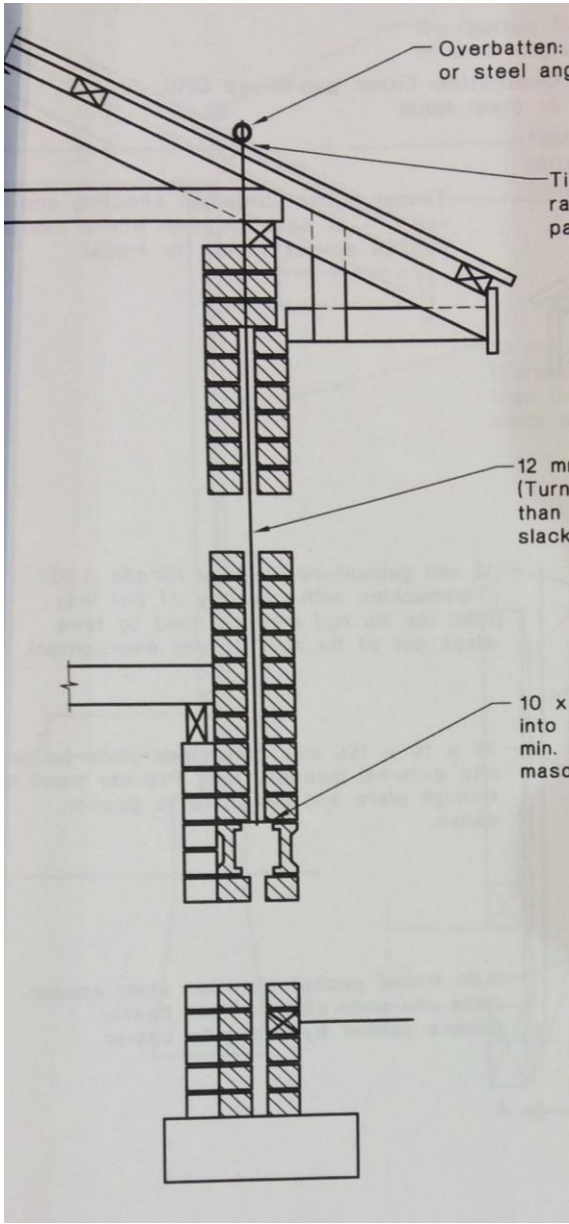


Example of gust wind speed at the failure of roof batten to truss connection



Retrofits– HB132





IS HB132 EFFECTIVE?

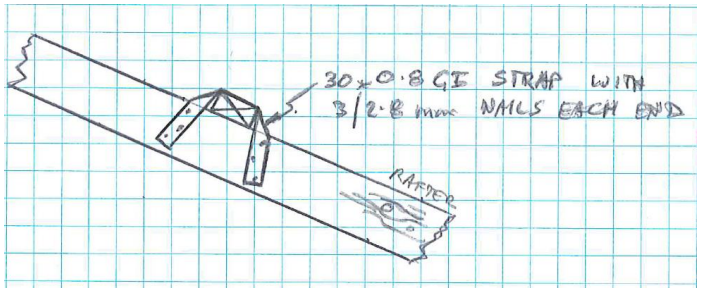
HB132 Over-batten

Cladding connection improved during reroof but…

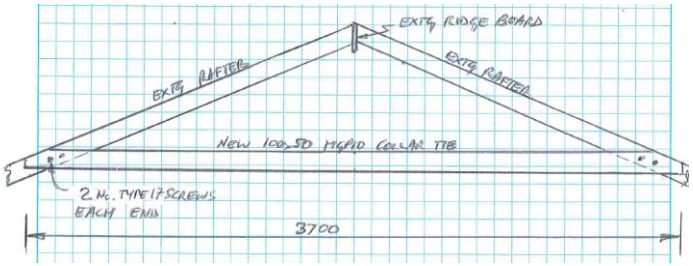
…moved failure to next link in chain – the batten / truss joint

Retrofits

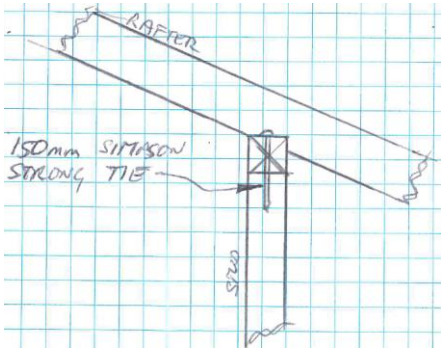
Strap each batten to rafter connection



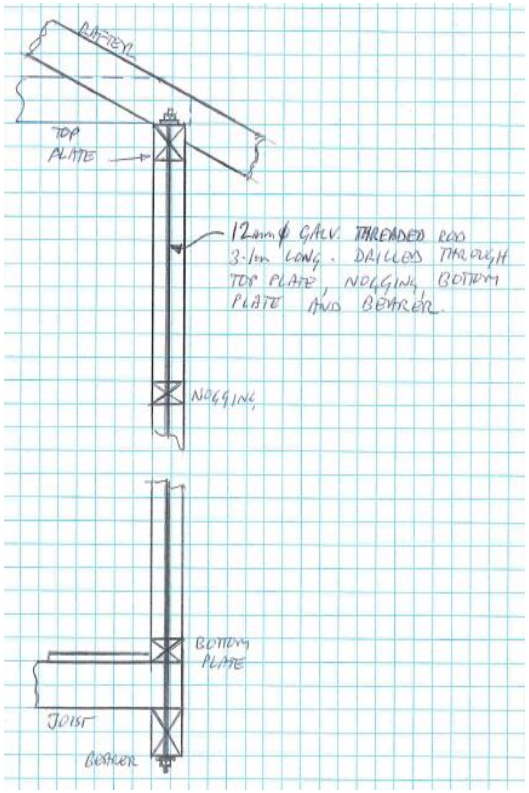
New collar ties



Top plate to stud connection



Wall cavity rods



Household Resilience Program

September 2018

Queensland Government

Mitigation options to be covered by the program include:

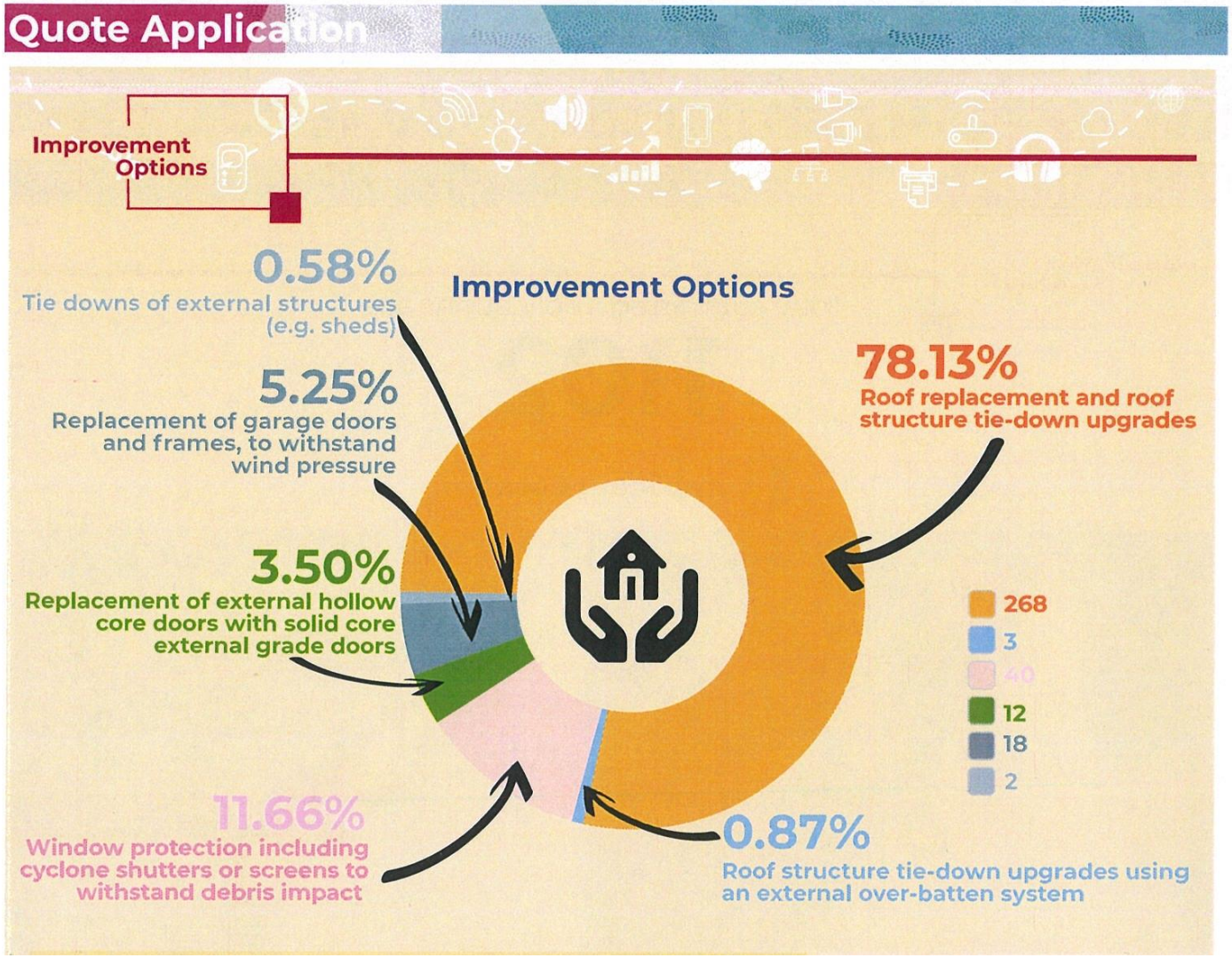
1. Roof replacement and roof structure tie-down upgrades (e.g. strapping of battens to rafters and rafters to top plates) to AS 1684.3:2010
2. Roof structure tie-down upgrades using an external over-batten system installed to: HB 132.2 Structural Upgrading of older Houses, Part 2: Cyclone Areas
3. Window protection including cyclone shutters or screens to withstand debris impact tests (AS/NZS 1170.2) and wind pressure tests to AS 4055 Wind Loads for Housing
4. Replacement of garage doors and frames, to withstand wind pressure tests from AS/NZS 4505 wind rated garage doors
5. Tie downs of external structures (e.g. sheds) to withstand wind loads from AS 4055 Wind loads for housing
6. Replacement of external hollow core doors with solid core external grade doors including upgrade of lockset and reinforce door frame

Roof replacement and roof structure tie-down upgrades

Upgrades and retrofitting to AS1684

Work certified to NCC reference documents

Household Resilience – Latest Statistics



Reduce drivers of loss (and increase resilience)

Mitigation needs:

1. For older houses - Upgrading of roof structure (with focus on work occurring during typical renovations) (Examples in HB132.2 and on QBCC web site)
2. Opening protection (i.e. windows, doors, etc.) (applies to all building types and ages for helping to reduce water ingress)
3. Community education to promote preparedness including maintenance (applies to all building types and ages)
4. On-going education for builders, trades, engineering/design, and product suppliers (re: Standards and practices)

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