



Improving the resilience of buildings to severe wind events

Cyclone Testing Station is not funded by JCU:

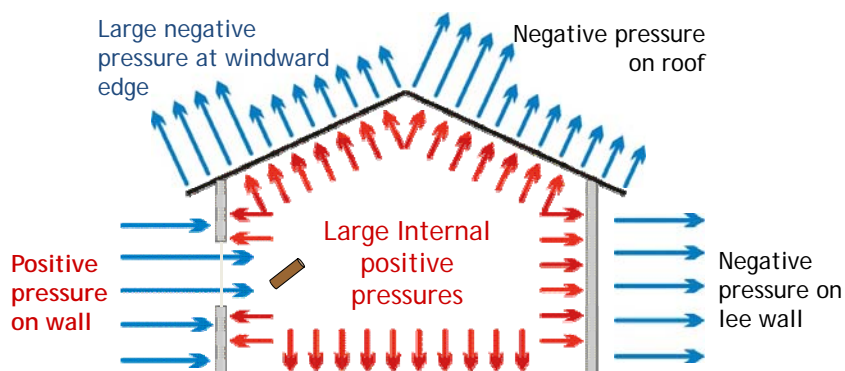
We get income via donations, research grants, risk assessments and product testing services.

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Wind loads on low rise buildings

If an opening forms in the external envelope of the building
e.g. a window is broken or a door blows in...



Housing design standard AS4055 requires that a dominant opening is assumed in the design.
(for cyclonic regions, C and D, only)



National Construction Code of Australia:

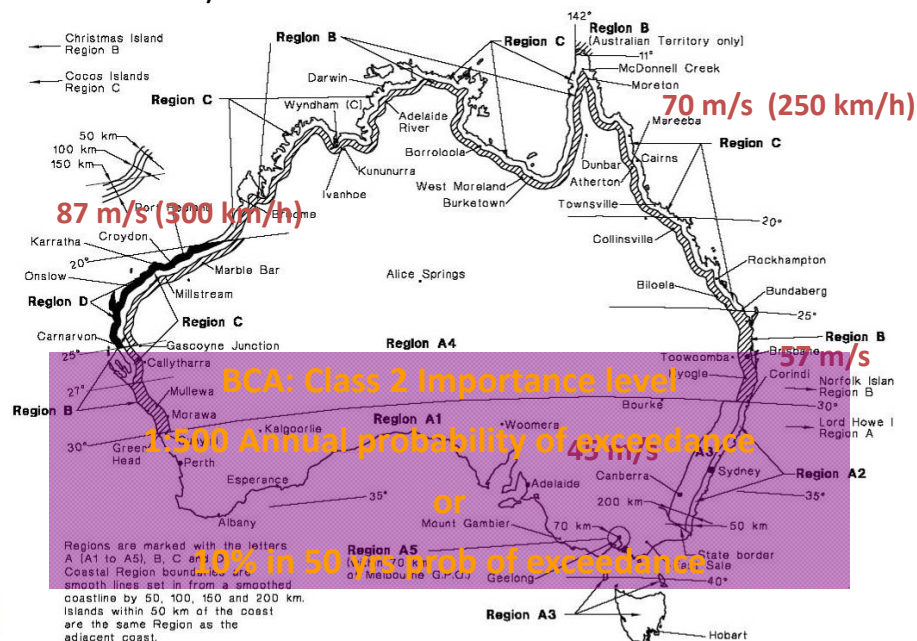


Structural objectives

- Safeguard people from injury caused by structural failure,
- Safeguard people from loss of amenity caused by structural behaviour,
- Protect other property from physical damage caused by structural failure, and
- Safeguard people from injury that may be caused by failure of, or impact with, glazing.



AS/NZS1170.2 Wind load standard



Tropical Cyclone Categories

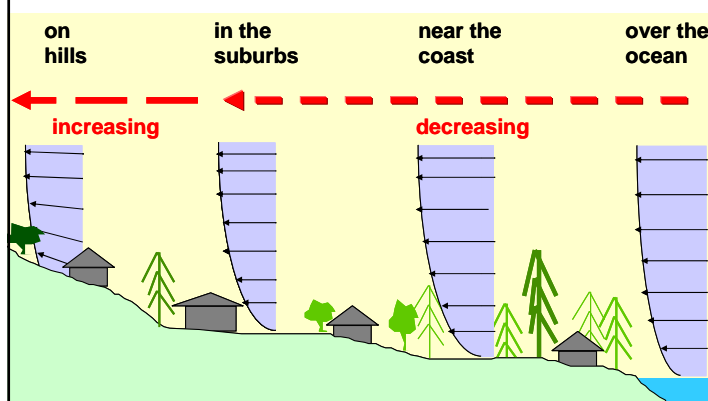
(Not the same as the Saffir-Simpson scale used in North America)

Cyclone Category	Gust Wind Speed (10 m height in open terrain)	
1	< 125 km/h	< 35 m/s
2	125 – 170 km/h	35 - 47 m/s
3	170 – 225 km/h	47 - 63 m/s
4	225 – 280 km/h	63 - 78 m/s
5	> 280 km/h	> 78 m/s

What is the wind speed?

Local Wind Field Parameters

- approach terrain category
- shielding
- topography
- height of building
- orientation of building



Why failures?

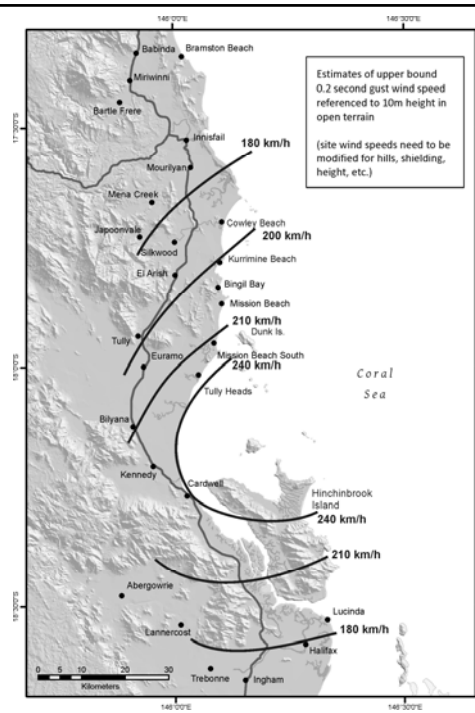
- Are our design standards appropriate?
- Was the design criteria (wind speed) exceeded?
- Correct implementation of design criteria?
- Appropriate materials?
- Adequate construction quality?



Estimated wind speeds

- Max gust speed estimated at 245 km/h
- (Design wind speed houses 250 km/h)
- Max gust ~90% design speed
Cardwell, Tully Heads, South Mission Beach
- Max gust ~80% design speed
Tully, Kurrimine Beach

Communities in these areas
subjected to Cat 3 to Cat 4 wind
speeds (mainland)



Post-80s housing (current construction)

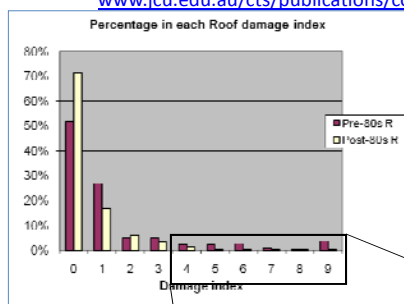


Pre-80s houses



Structural Damage Data

www.jcu.edu.au/cts/publications/content/technical-reports/jcu-078421.pdf/view

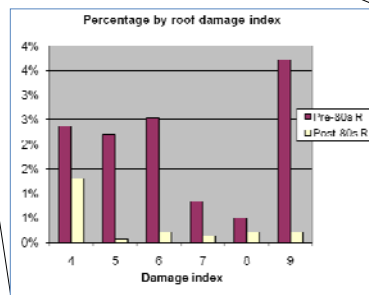


Post 80s (current construction)

- <3% major roof damage
- ~30% all roller doors damaged
- But many houses had water ingress

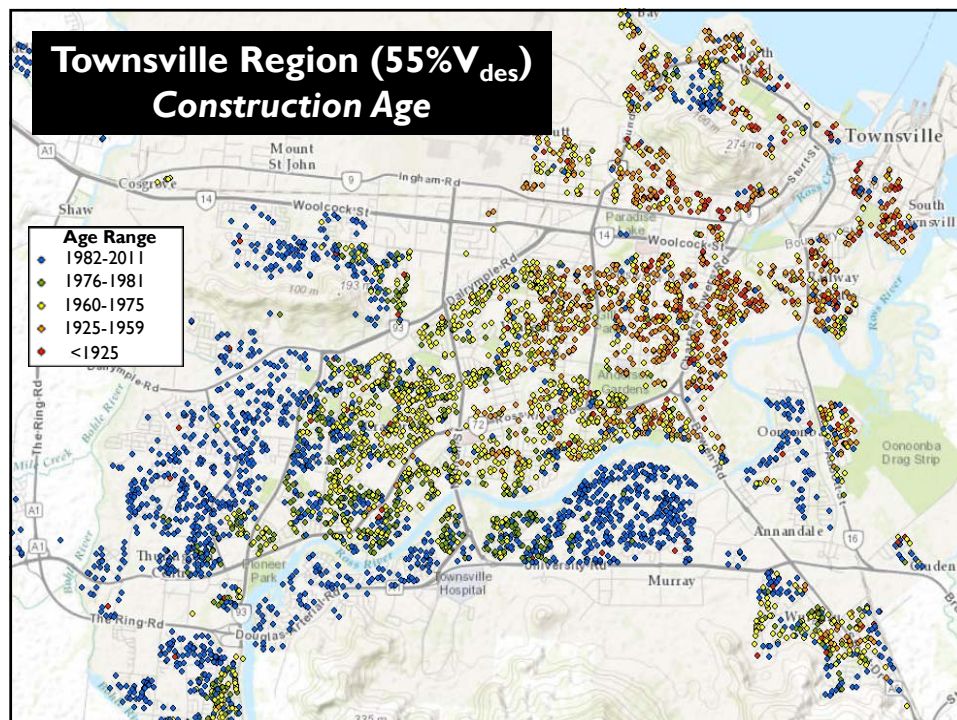
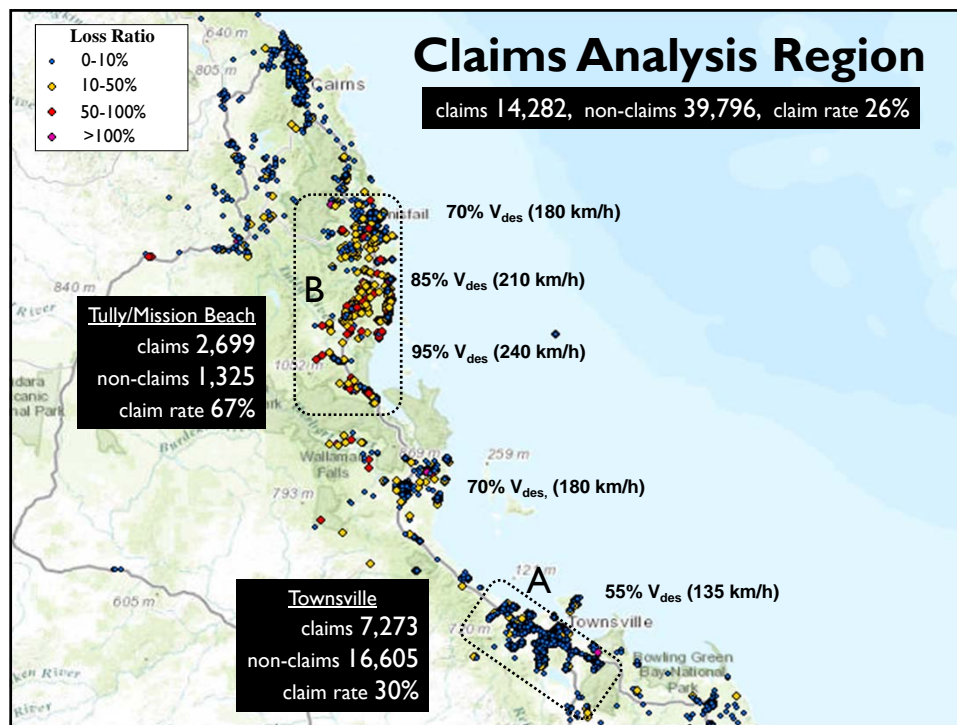
Pre 80s (older housing)

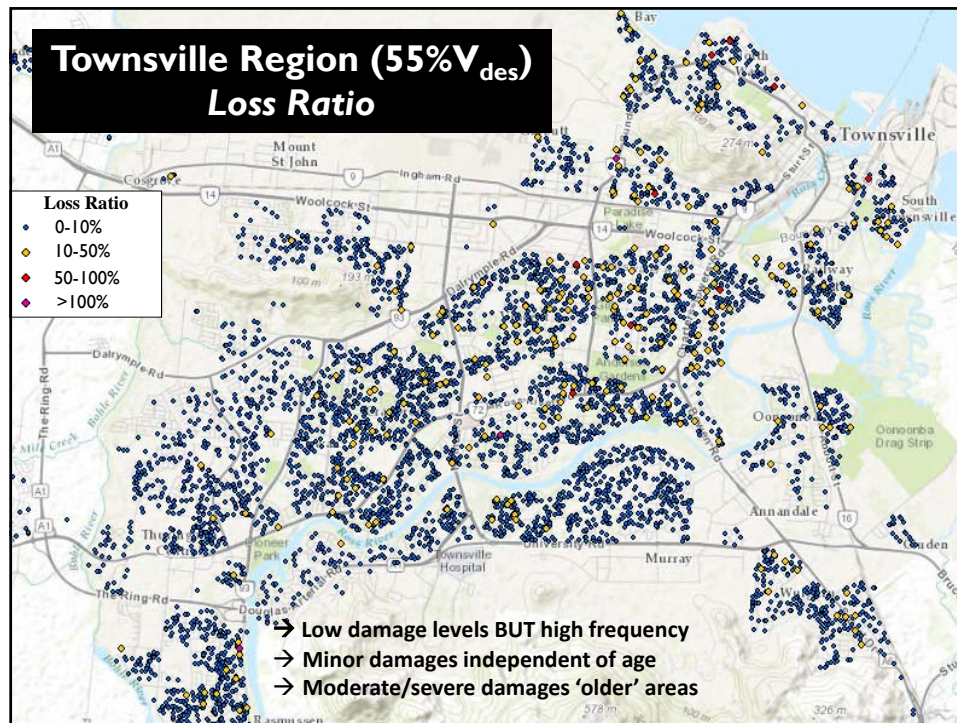
- >12% major roof damage
- ~2% damaged by large debris
- May have hidden damage



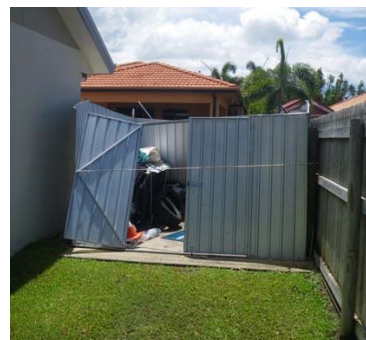
Lower levels of damage of "newer" housing similar pattern in other surveys (e.g. Cyclone Winifred Cyclone Vance, Cyclone Larry)

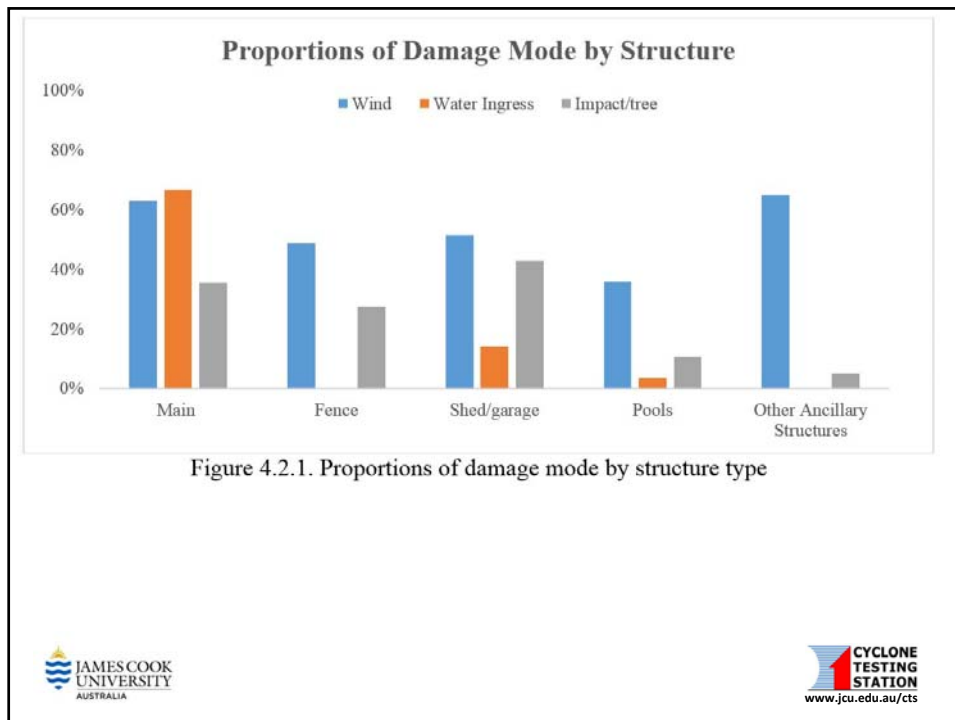
Lessons have been learnt since Cyclone Tracy!





Low claim ratio <0.1 Townsville region





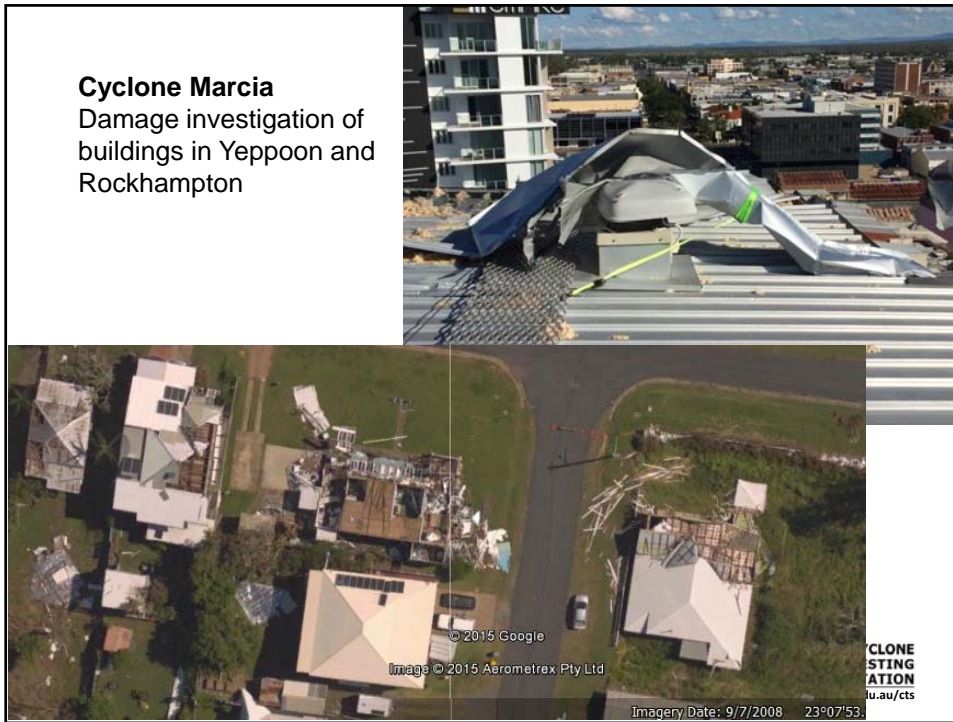
Reduce drivers of loss (and improve resilience of community)

Four mitigation options:

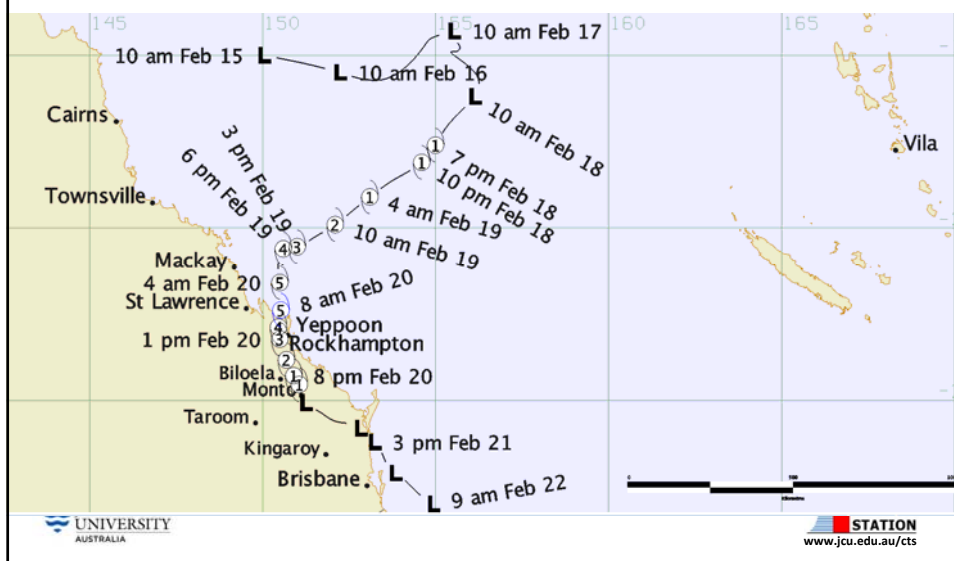
1. For older houses - Upgrading of roof structure (with focus on work occurring during typical renovations) (Examples in HB132.2 and on QBCC web site)
2. Opening protection (i.e. windows, doors, etc.) (applies to all house types and ages for helping to reduce water ingress)
3. Community education/preparedness/maintenance (applies to all house types and ages)
4. On-going builder/trades/engineering/manufacturer education for updates to codes and standards and practices

Cyclone Marcia

Damage investigation of buildings in Yeppoon and Rockhampton



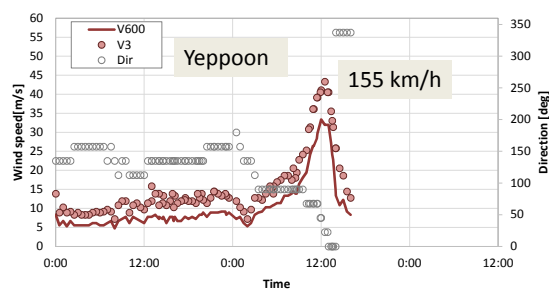
BoM Operational Track Map



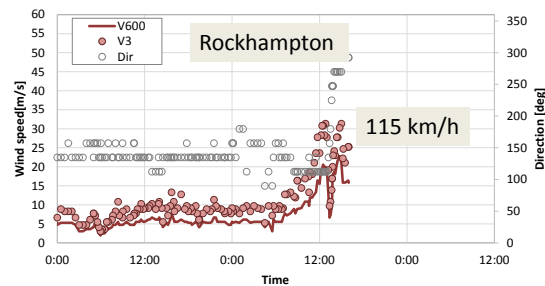




Estimating surface winds



This is
75% of design wind speed
and only
50% of design pressure
Therefore No Damage?!?





Queensland Building and Construction Commission inspections of housing

- In discussions with QBCC they consider that the cladding is a part of the structural system and that a “simple” re-roof does require certification which covers inclusion of appropriate batten to rafter connections and strapping of rafters to internal walls and top plates.
- They agree however that this is not a common outcome of a “re-roof”.

Queensland Building and Construction Commission

- "a number of homes" in Yeppoon and Rockhampton where roof replacements didn't meet cyclone standards
- contractors responsible for “dodgy roof installations”

Brisbane Times 4 March 2015

Webinars



<https://cyclonetestingstation.com.au/community-education>

Improving future for Pre-80s housing

- General information on upgrading structural performance in existing houses can be found in Standards Australia **Handbook HB 132.2** (and for repair **Timber Qld/QBCC**)
- Tie-downs up to date
 - Whenever roof is off – look deeper
- Roof space inspections should be undertaken to look for partial or hidden failures of connections within the roof.



Retirement village

- 57 total units,
- 43 metal (no observed wind damage),
- 14 tile (12 damaged)
- Tile damage was hip/ridge leading to water ingress issues



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TC Yasi - Progress on Recommendations: Codes and Standards

- Roof tile damage overrepresented compared with metal cladding
- AS 2050 Installation of roof tiles
 - Mechanical fixing requirements for ridge, hip and part tiles in cyclonic house classifications C2 and above (No change for C1?)
 - No longer allow flexible pointing as a fixing method
 - What about demonstrating compliance for cyclonic wind loading?
 - Performance of roof tile clips?



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Wind driven debris

- Small
 - Tiles
- Medium
 - Battens
 - Sheets
- Large
 - Roofs
 - Sheds
 - Big consequences



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Wind driven debris test



Australian Standard Test (AS/NZS1170.2):
4 kg 100 x 50 mm timber travelling at > 28 m/s (100 km/h) (Region C house)



Impact at mid-span -> less deformation







Near support -> more damage










Impact at mid-span -> less deformation







Near support -> more damage

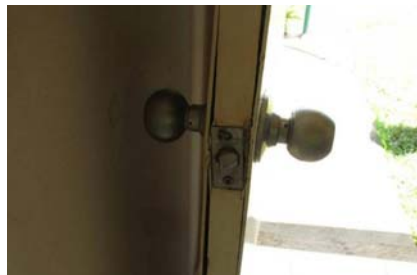


When selecting debris screens for window protection or cladding systems, make sure that the testing included at least impacts at centre span AND near an edge!!!

Windows and doors

- Doors and windows are part of the building envelope
- **MUST** be able to resist wind loads



Roller Doors



Required:

- Wind ratings for doors exist (Specification /certification)
- All forces on supports to be resisted including wind lock tensions

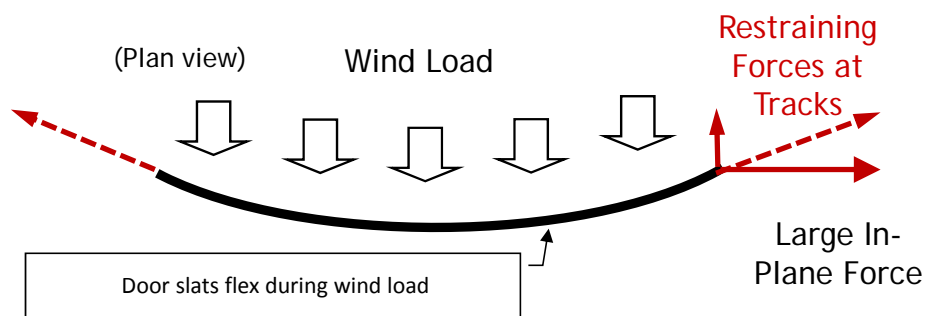


Roller Doors

Wind locks engage into tracks

Inwards (or outwards) deflection results in large in-plane forces in door skin

Large in-plane forces imposed upon the mullions and structure.



Appendix E of AS/NZS 4505 details methods for determining restraining forces for structure



Wind driven rain (WDR) ingress

In every cyclone or thunderstorm damage investigation report conducted by the CTS back to Cyclone Winifred mentions damage due to water ingress



- Extensive damage to Plasterboard linings
- Corrosion of framing elements
- Non structural elements
- Mold and bacteria
- Odour

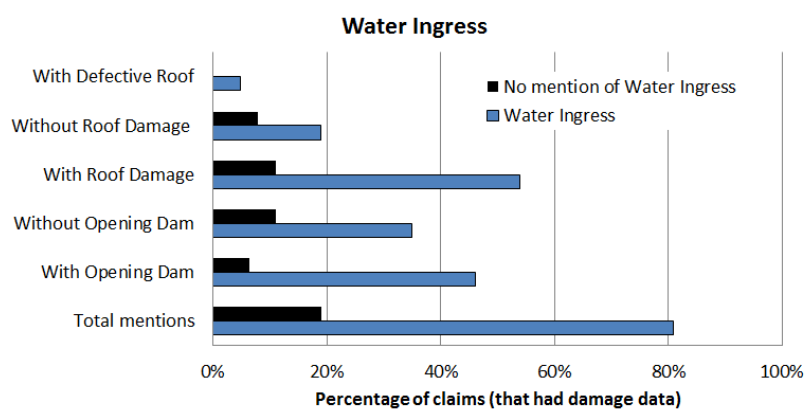
(slide from TC Larry CTS report)





Cyclone Olwyn
Exmouth gust wind speeds
estimated at 180 to 190 km/h

WDR Water ingress



Damage to modern engineered construction?



Internal damage from pressurised ceiling space



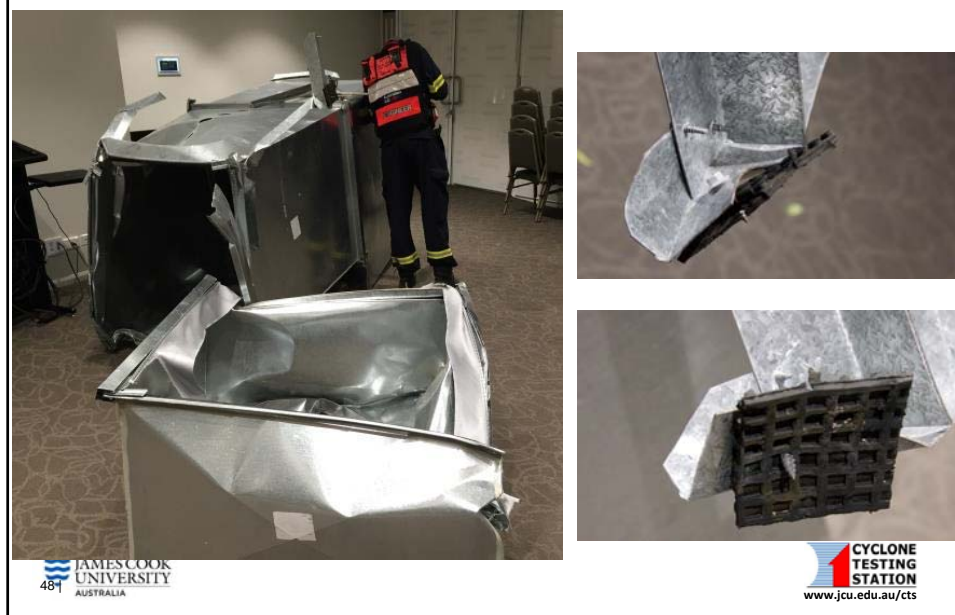
Roof top damage



A/C Ducting lost



Recovered a/c duct



Debris from modern buildings



Simple steps for improvement

- Take control & engineer all exposed elements incl:
 - Fascias
 - Flashings
 - Ceilings
 - Vents
 - A/C plant...
- Redundancy (prevention of progressive collapse)
- Durability consistent with design life
- Incorporate additional reserves when elements cannot be readily inspected or maintained

Recent house construction



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Structural load path - Truss tie down

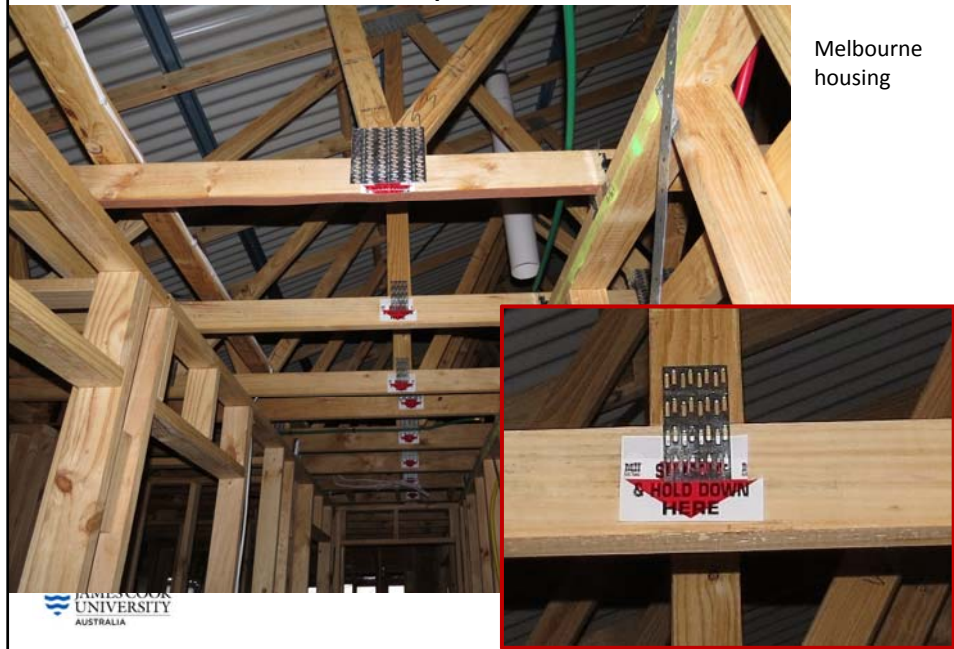


Brisbane
housing

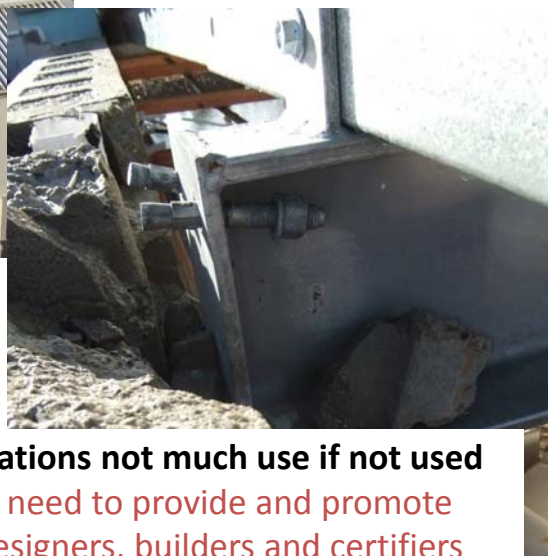
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Structural load path - Truss tie down



Edge distance?!?!?!?



All test data and Regulations not much use if not used
 Product manufacturers need to provide and promote
 installation guides to designers, builders and certifiers

MYTH

- Test Standards have a factor of safety to account for errors in construction
- **FALSE**
- Test Standards based on “Fabricated to manufacturers specifications” – i.e. “best practice”
- If there are build errors – the building is more **vulnerable** and not able to withstand design load

Lidcombe unit owners face \$2.6m storm damage bill after AIG insurance rejects claims

By [Mazze Ford](#)
Updated Fri at 7:58pm



PHOTO: AIG found the roof damage was caused by inadequate structure strength. (Supplied)

The owners of units inside a western Sydney apartment block that lost half of its roof during a storm in January have found out their insurer will not foot the multi-million-dollar repair bill.

Global insurance giant AIG initially told owners they would not be out of pocket, but after further investigation the company changed its position. AIG claimed the roof of the building, which was

RELATED STORY: Roof alteration had 'minimal impact' before storm damage, council says

MAP: Lidcombe 2141

Key points:

- Roof structure with adequate strength would not have lifted, report said

<http://www.abc.net.au/news/2016-04-08/lidcombe-unit-owners-face-storm-damage-bill-insurance-bid-fails/7312578>

To Conclude:

- The wind finds the weakest link.
- Failure of a single element can lead to the progressive failure of the structure.
- Our houses are where we shelter – they have to be secure.
- **But MUST evacuate if threat of Storm Tide**
- Continued education and awareness of the building community is required



CTS Benefactors



end