Large Damage Bills (to buildings) From Cyclones Can Be Reduced By Small Actions

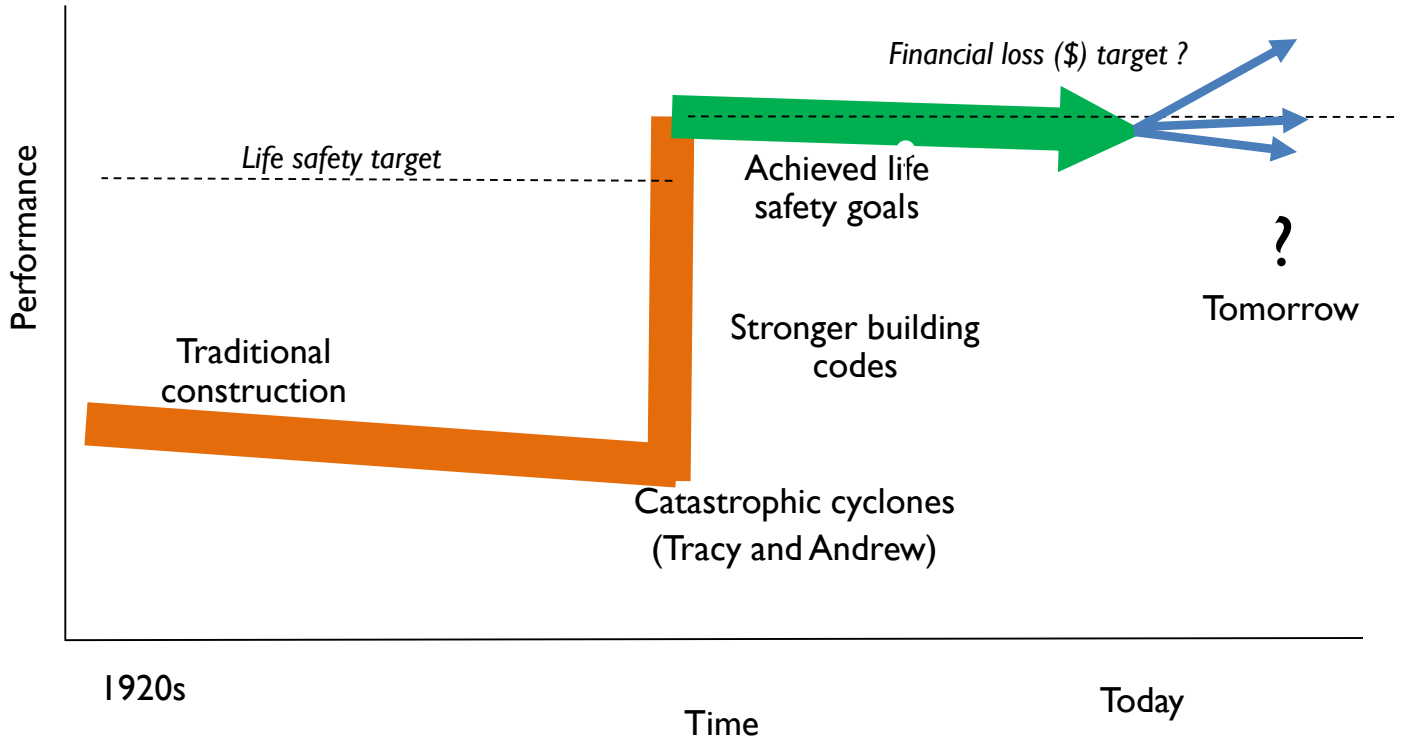
- Peak gust estimated 243 km/h (71 Fatalities)
- 70-90% of housing destroyed
- Engineered structures performed better

- Peak gust estimated 281 km/h (65 Fatalities)
- >63,000 homes destroyed

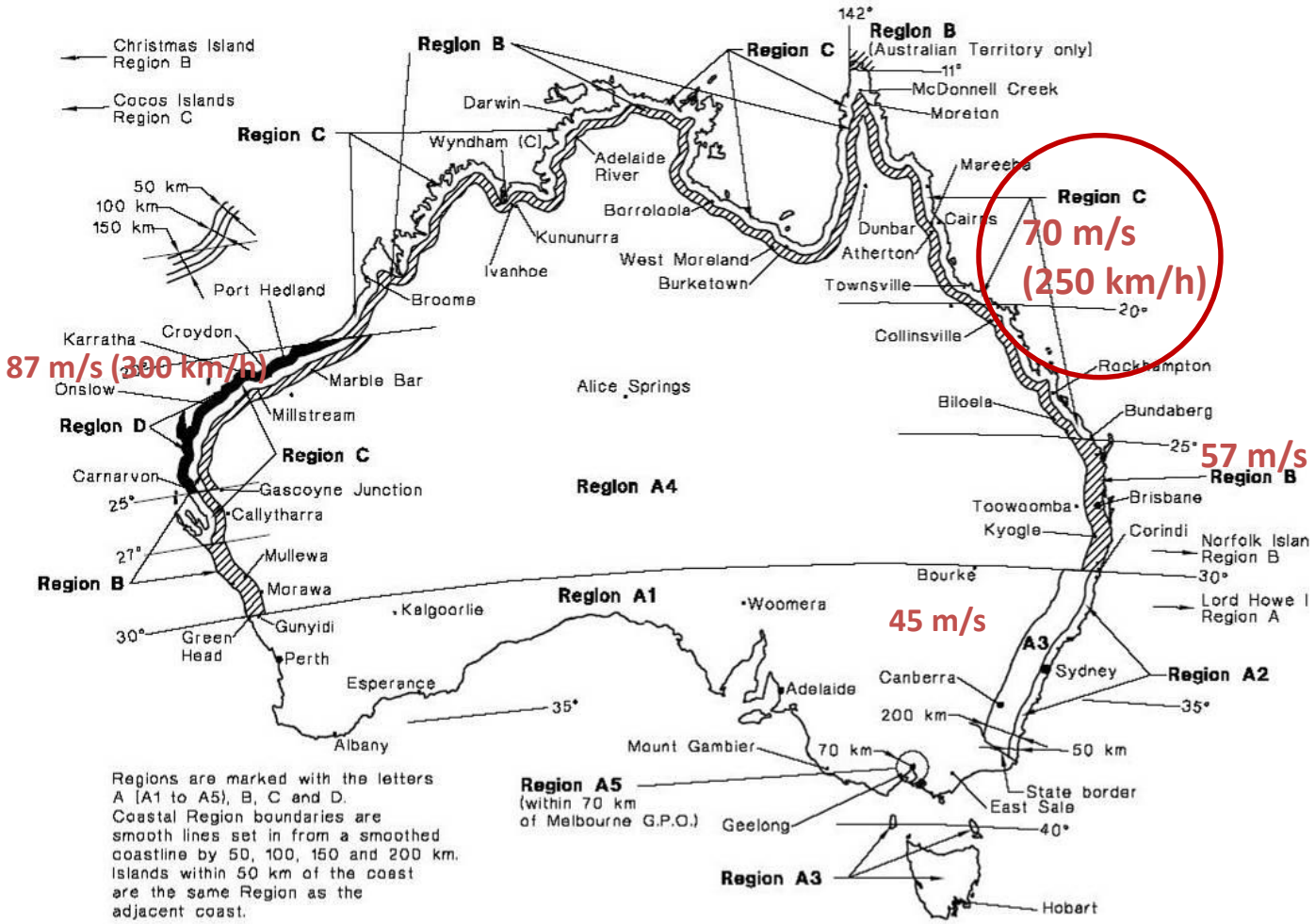
Queensland Home Building Code (1982)

Florida Building Code (2002)

Housing Performance



AS/NZS 1170.2



NCC Structural Tenents

- 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

Minimum design standards

NCC: Class 2 Importance level

10% in 50 yrs prob of exceedance

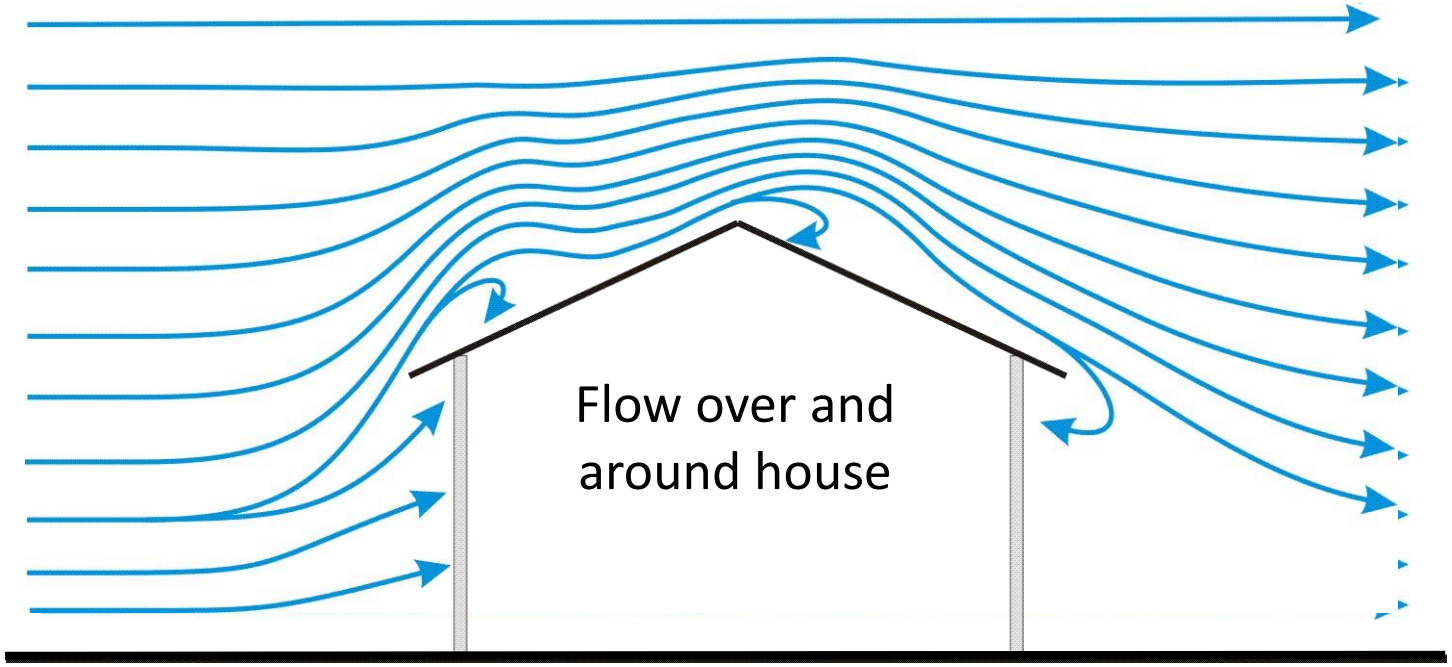
(1:500 Annual probability of exceedance)

JAMES COOK UNIVERSITY AUSTRALIA

CYCLONE TESTING STATION
www.jcu.edu.au/cts

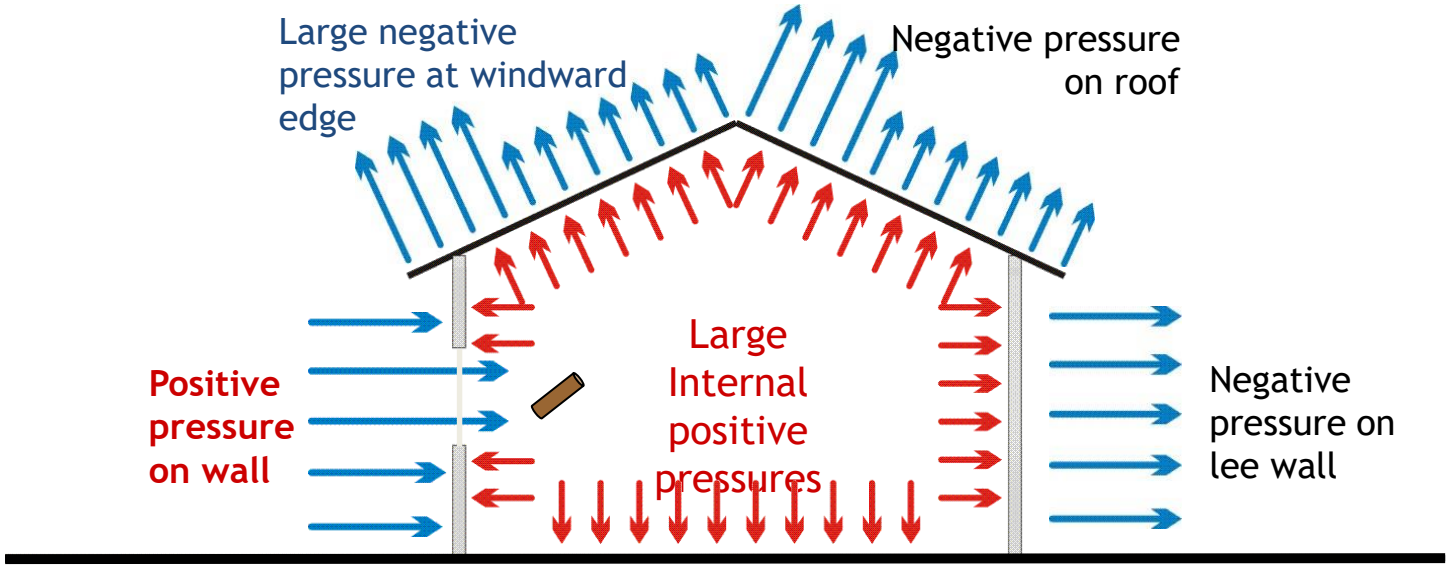
Wind Loads on Houses

Consider the forces caused by pressures induced by wind passing over structure



Wind loads on low rise buildings

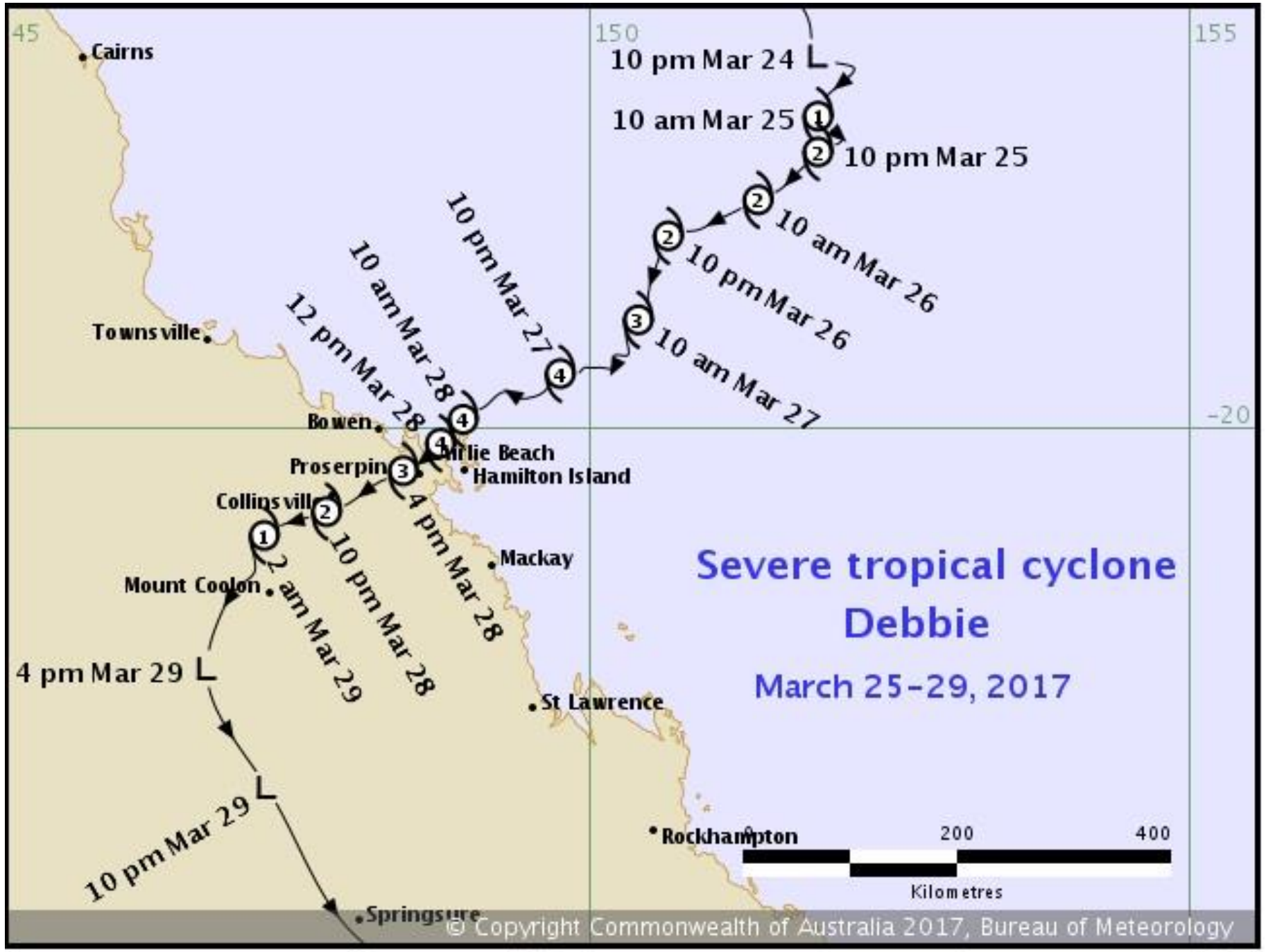
If an opening forms in the external envelope of the building e.g. a window is broken or a door blows in…



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

Tropical Cyclone Debbie
Damage to buildings in the Whitsunday Region

https://www.jcu.edu.au/cyclone-testing-station/publications



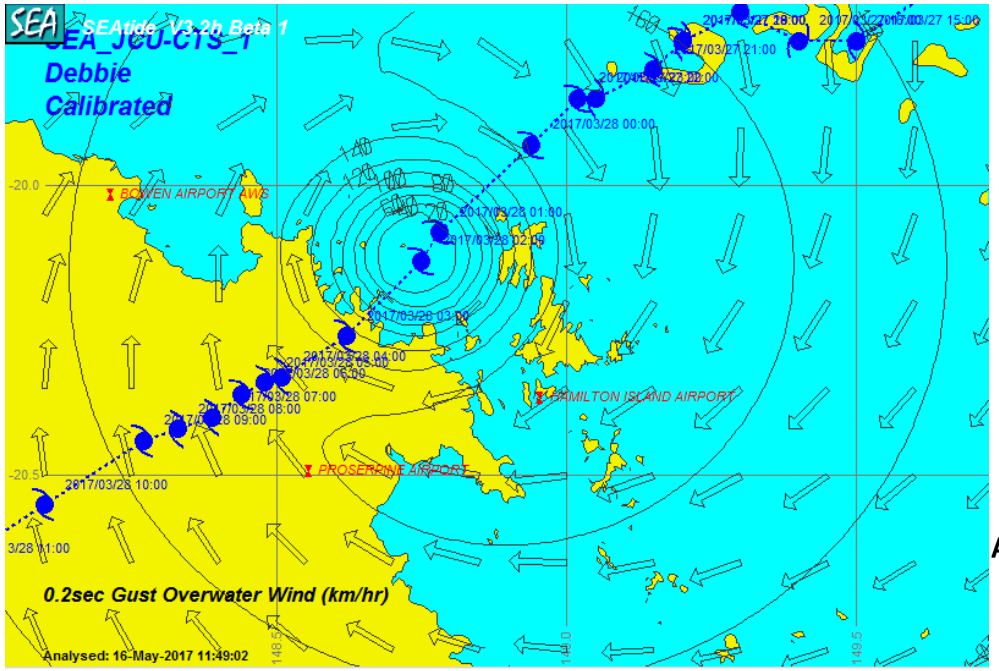
JAMES COOK UNIVERSITY AUSTRALIA

CYCLONE TESTING STATION
www.jcu.edu.au/cts

Why do damage surveys?

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

Investigation commenced 29/3 and included the communities of;
Bowen, Proserpine, Airlie Beach, Hamilton Island, Shute Harbour, Hideaway Bay, Dingo Beach, Wilson Beach and Conway Beach



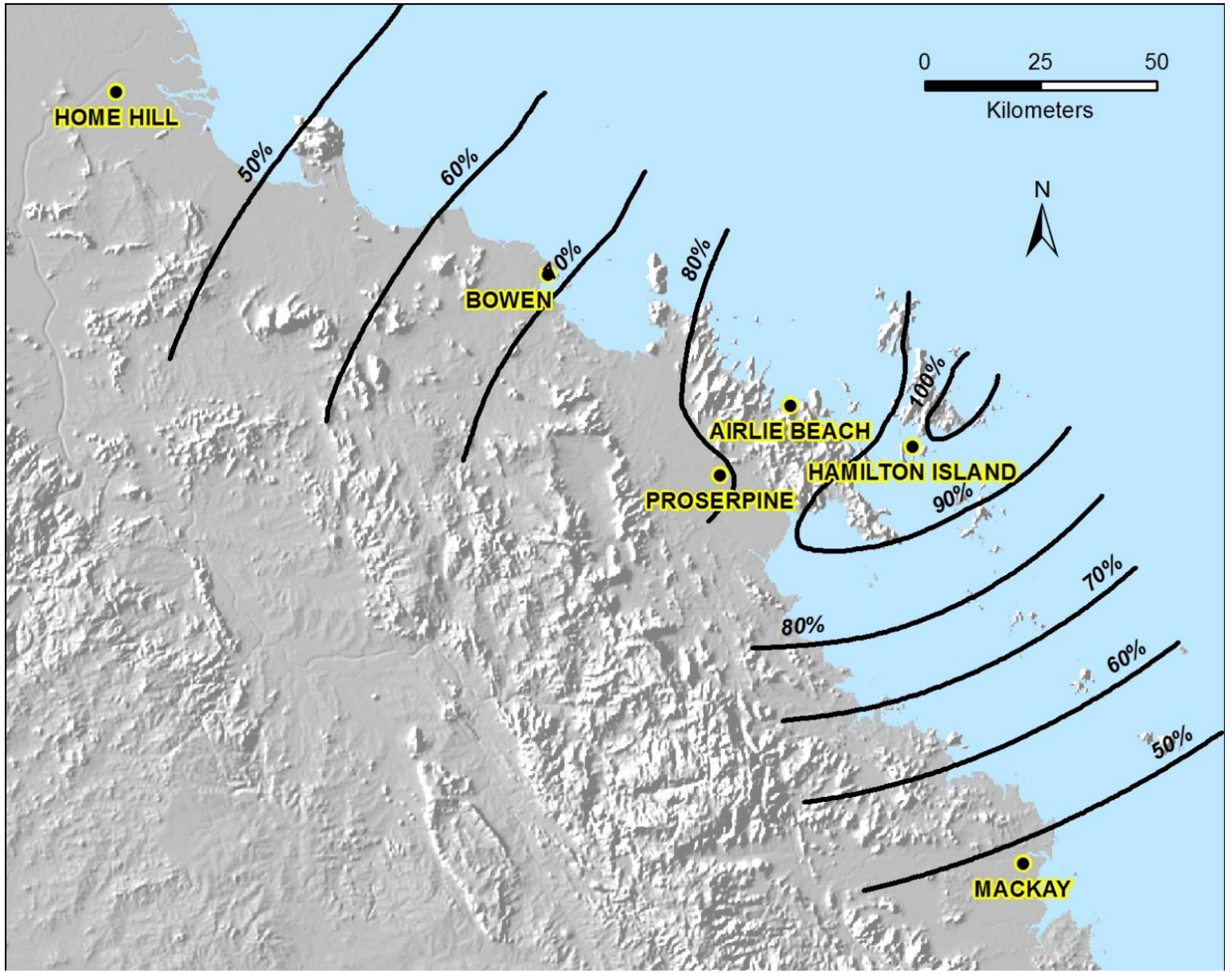
Adjusted anemometer data as a percentage of V_{500}

	$\hat{u}_{3,600,tower}$ [m/s]	$\hat{u}_{3,600,open}$ @ 10m [m/s]	$\hat{u}_{0.2,600,open}$ @ 10m [m/s]	% V_{500}
BoM AWS (z = 10 m)				
Bowen Airport	41.1	41.5	47.6	69
Proserpine	45.8	47.2	53.5	77
Hamilton Island	73.1	57.3	67.1	97
Mackay Met. Office	26.4	24.0	26.6	38
Mackay Airport	27.2	27.9	31.5	45

SWIRLnet Tower (z = 3.2 m)	Location	$\hat{u}_{3,600,tower}$ @ 3.2m [m/s]	$\hat{u}_{3,600,open}$ @ 10m [m/s]	$\hat{u}_{0.2,600,open}$ @ 10m [m/s]	% V_{500}
1	North Ayr	16.5	20.6	22.4	32
2	North Bowen	30.3	37.9	41.9	61
3	South Ayr	15.4	19.5	21.3	31
4	Home Hill	17.7	21.2	23.7	34
5	South Bowen	34.9	42.6	47.6	69
6	Proserpine	27.0	36.4	49.6	72

JAMES COOK UNIVERSITY AUSTRALIA

CYCLONE TESTING STATION
www.jcu.edu.au/cts

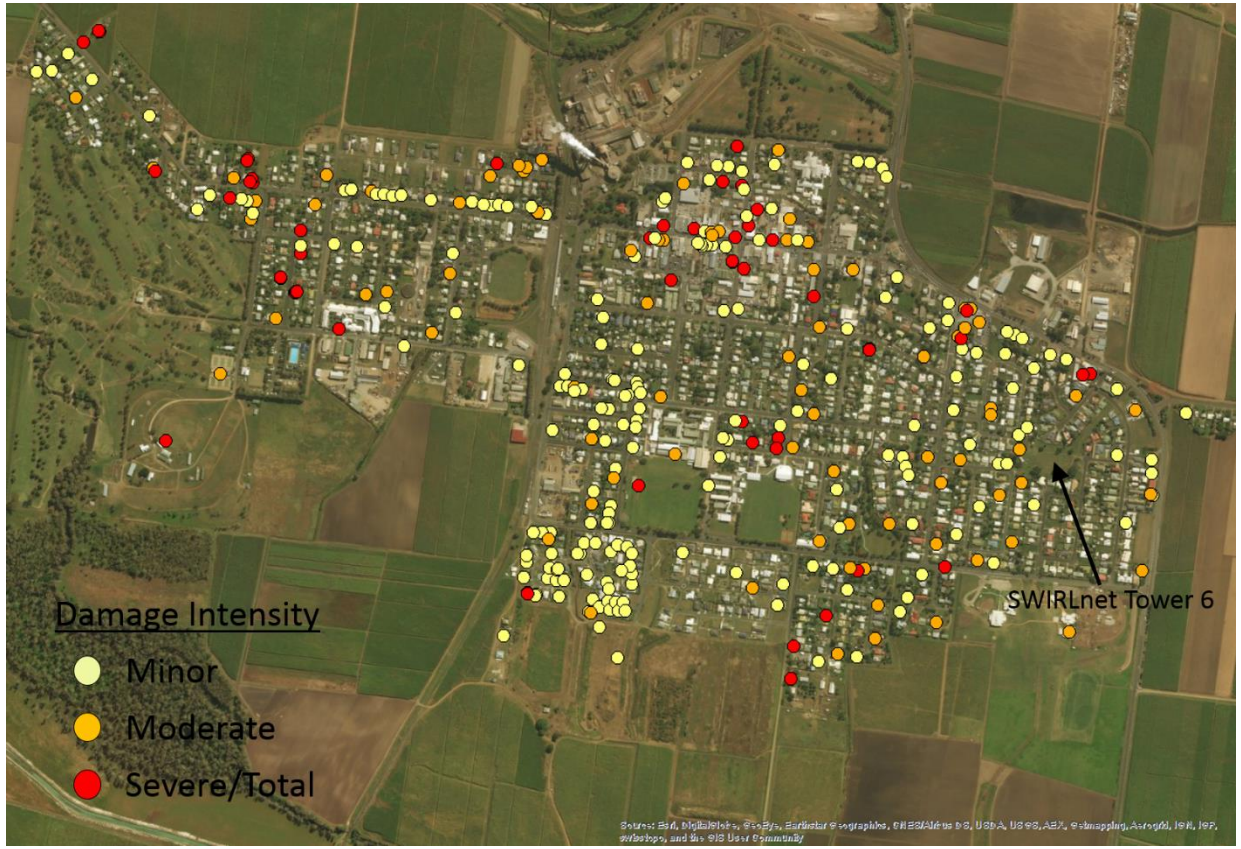


Estimate of wind speed as a % of Design (V_{500})

(referenced to 10 m height in open terrain)

Wind at specific buildings will be influenced by surrounding hills/shielding/exposure

QFES and F&R NSW - RDA damage survey points for Proserpine



Majority of properties - No observed damage

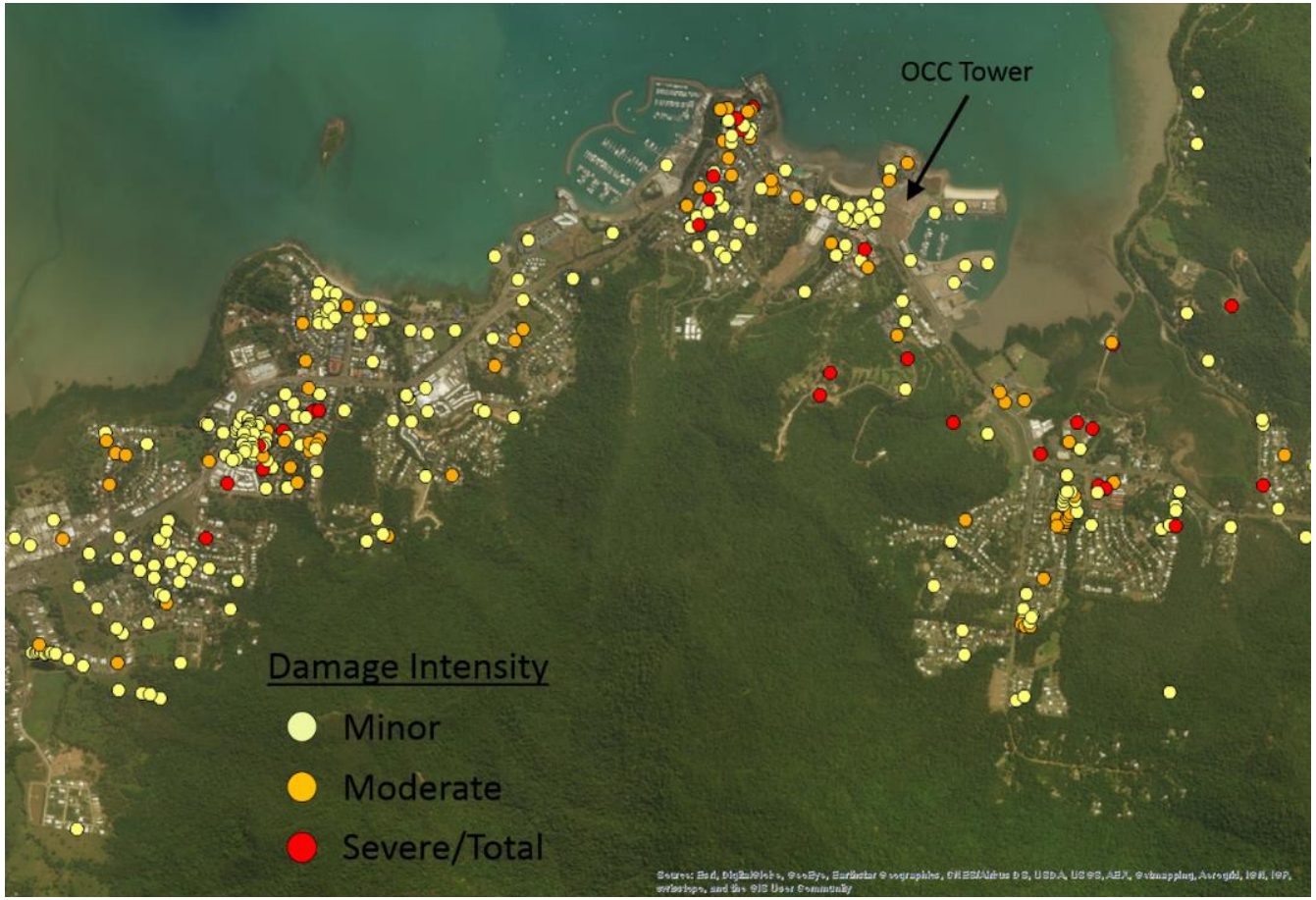
- CTS Webinars https://cyclonetestingstation.com.au/community-education
- QBCC has repair checklists and guides for rebuilding after cyclones: http://www.qbcc.qld.gov.au/home-maintenance/rebuilding-after-natural-disaster
- Standards Australia Handbook **HB 132.2** for upgrading structural performance in existing houses


15
14


13

Rust, rot and termites

QFES - RDA damage survey points for Cannonvale and Airlie Beach



Roof structure damage to contemporary (engineered) construction in Airlie and Hamilton Island

Loss of cladding elements from <u>Engineered</u> buildings

CYCLONE TESTING STATION
www.jcu.edu.au/cts

From insurance data → Can be $1000/m for repair (includes interiors)
(but < $5/m if build it correct the first time)

Changes to cladding Standard to include to minimum requirements of material, strength, thickness and fastener spacings for all flashings for cyclonic regions

From insurance data → Can be $1000/m for repair (includes interiors)
(but < $5/m if build it correct the first time)

Revisions to AS1562.1 for minimum requirements for fixings of attachments

JAMES COOK UNIVERSITY AUSTRALIA

CYCLONE TESTING STATION

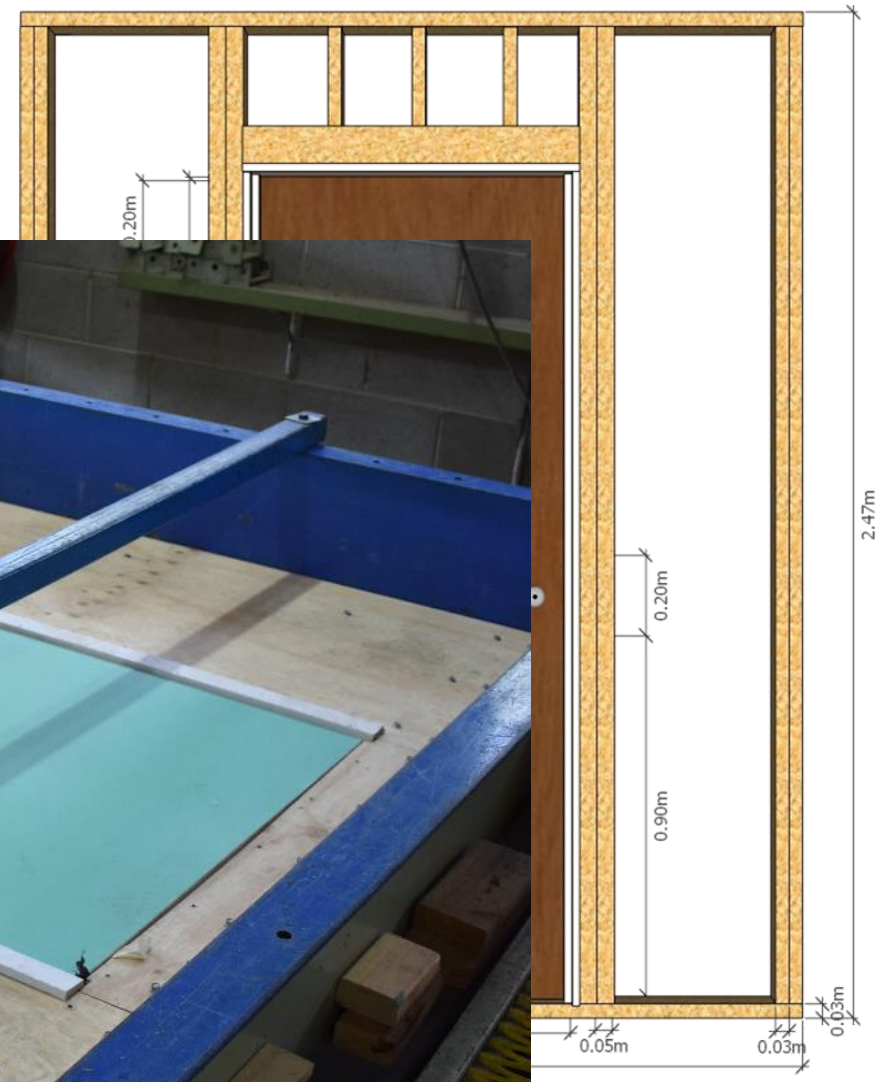
www.jcu.edu.au/cts

Windows and doors

- **Doors and windows are part of the building envelope**
- **But rare for designers to consider wind loading**

Full-scale Testing

Full-scale tests were conducted in the Cyclone Testing Station's air-box to determine the capacity of generic timber door system arrangements and likely failure modes.



ing in the air-box.

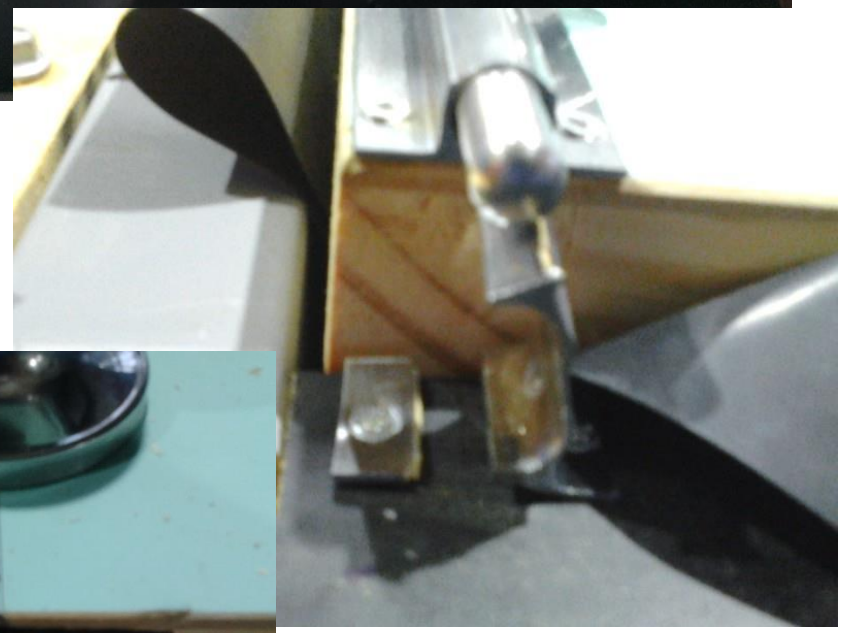
Test rig in air-box.

Air-box Video: Test 1

Testing so far…

- ~~Budget 35mm hollow core externally rated doors~~
- ~~Budget locksets~~
- ~~Prefab finger jointed pine jambs~~
- ✓ Prefab steel jambs
- ✓ Mid-range price for 35mm solid core doors
- ✓ Mid-range entrance lockset
- ✓ Mid-range price 40 mm hollow core external doors

- Tested for ramp and cyclic loading (yet to test under simulated wind load for cyclonic trace)
- Have not yet tested “solid” timber jambs
- **Have only tested new products!!!!**



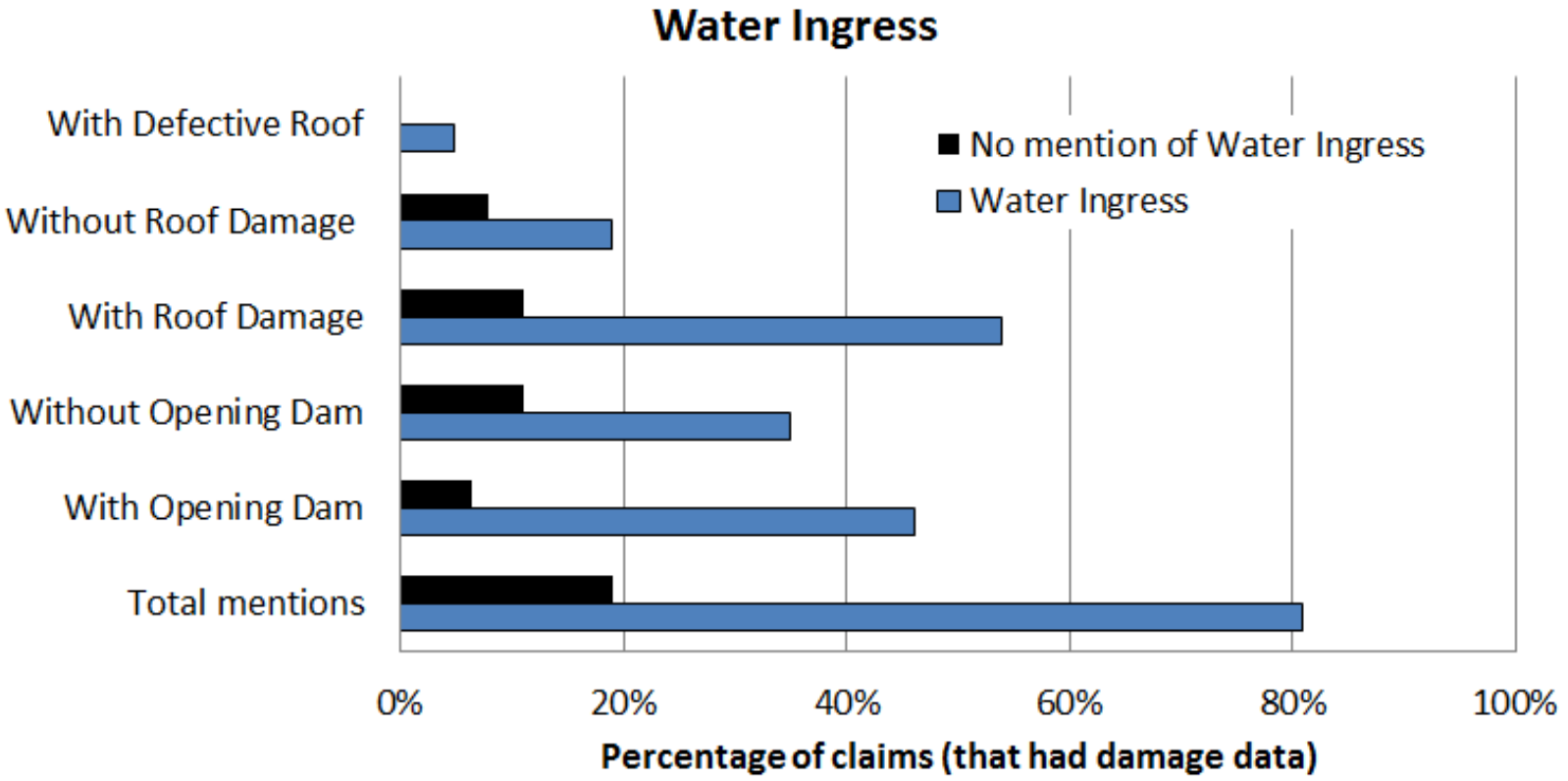
Wind driven rain (WDR) ingress

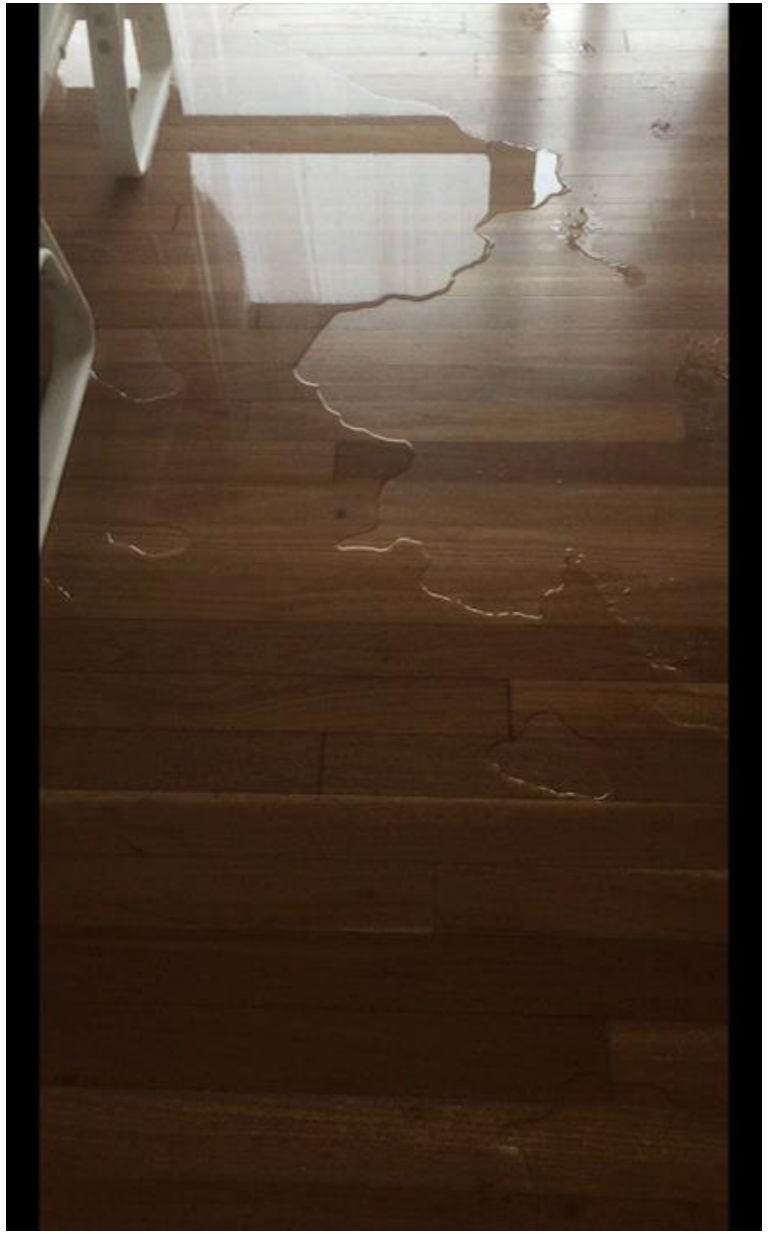
In every cyclone or thunderstorm damage investigation report conducted by the CTS back to Cyclone Winifred mentions damage due to water ingress

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

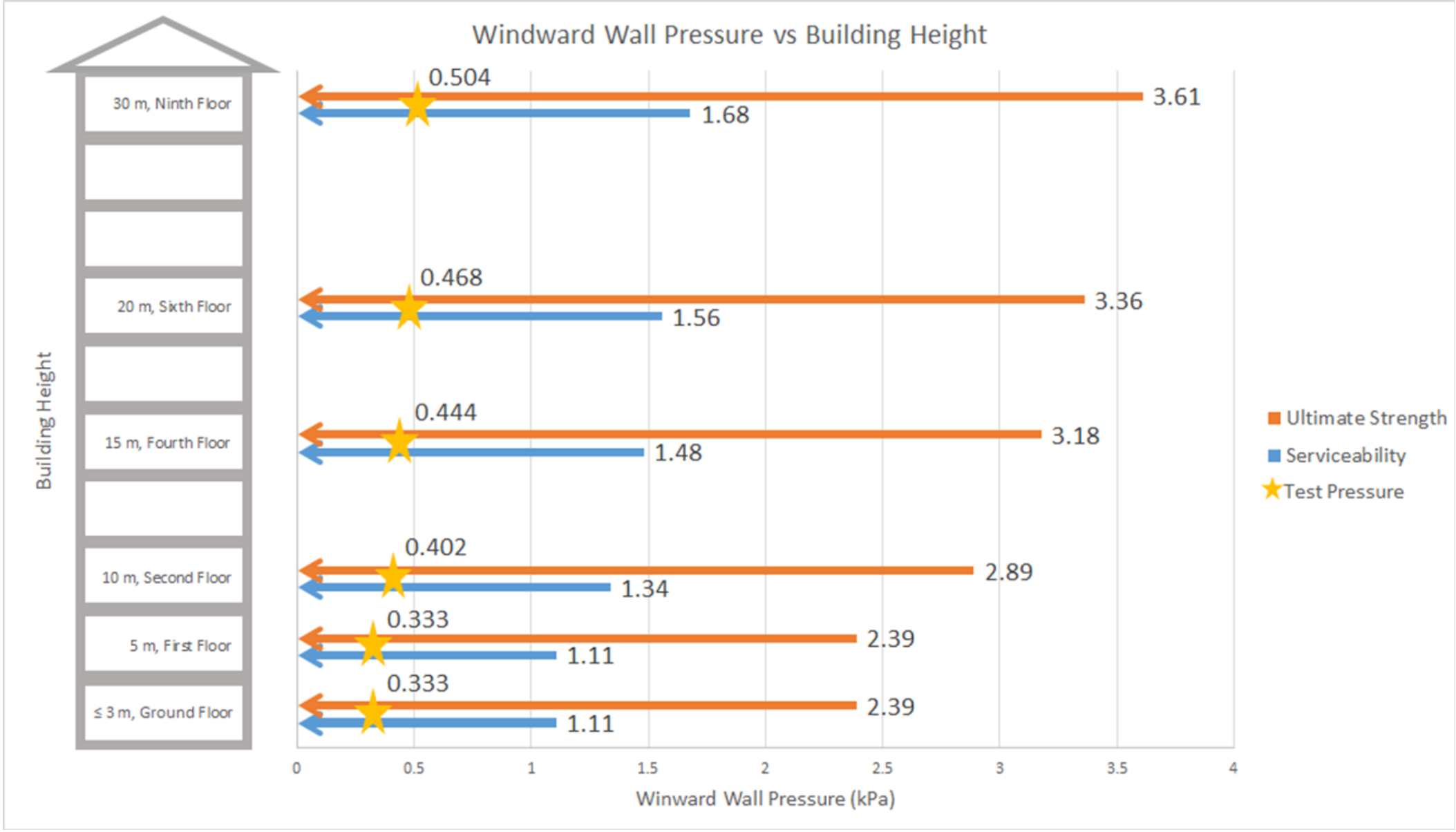
CYCLONE TESTING STATION
www.jcu.edu.au/cts

WDR Water ingress



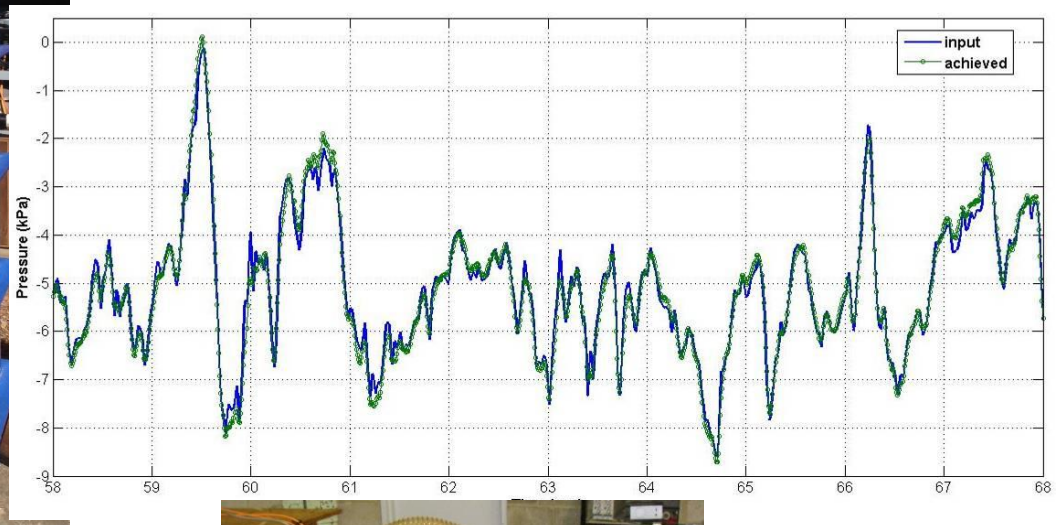


But don’t need a hole in roof to let the water in



Relationship between ultimate strength design pressure, serviceability design pressure and the test pressure for the Australian Standard water penetration test (AS20147)

Investigate WDRWI from applying a windward wall fluctuating pressure as opposed to static pressure from the standard



Research supported by Suncorp, IAG and BNHCRC

JAMES COOK UNIVERSITY AUSTRALIA

CYCLONE TESTING STATION
www.jcu.edu.au/cts

C2 Rated Sliding Door

1200Pa Max. gust applied over a 3min trace

- Bad building performance can turn a storm into a DISASTER
- **Good building performance can make a potential disaster not even newsworthy!**

Need research to inform Codes to help us deliver cost effective standards and materials…

But importantly,

Need paths for encouraging all aspects of design and construction to implement it!

Reduce drivers of loss (and improve resilience of community)

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 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

Storm tide damage from TC Debbie and TC Yasi

CTS supporters