Are our homes and buildings failing us?

Excessive damage and loss during cyclones

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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bushfire&natural HAZARDSCRC

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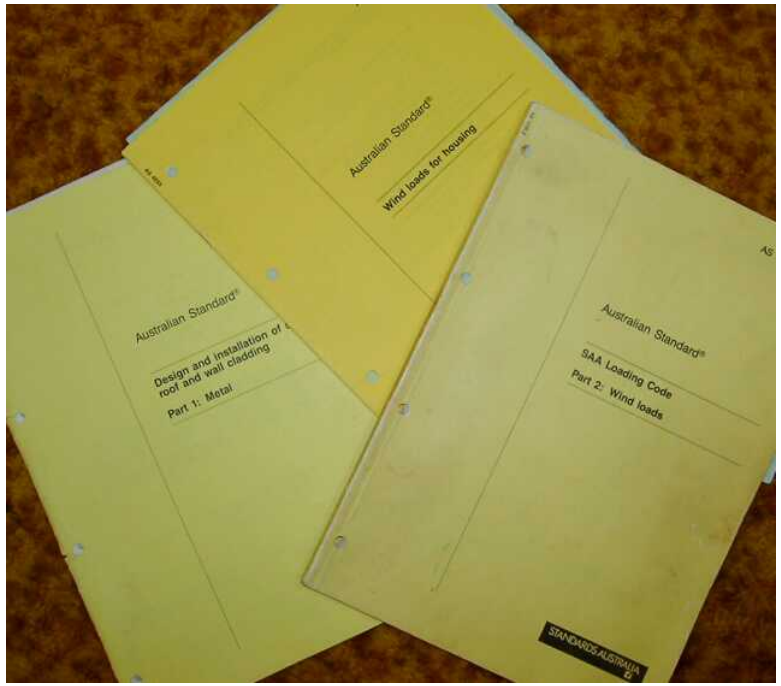
Building performance

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

Darwin - Cyclone Tracy

- Peak gust estimated 70 m/s (250 km/h Cat 4 event)
- Over 70% of houses suffered severe damage
- Some suburbs; 90% of houses destroyed
- In comparison, engineered structures performed well

The Station's work, along with people from CSIRO, Industry research labs and other Universities have all resulted in a Wealth of Standards and guides for designing and building houses to resist wind loads



Australian Building Standards:

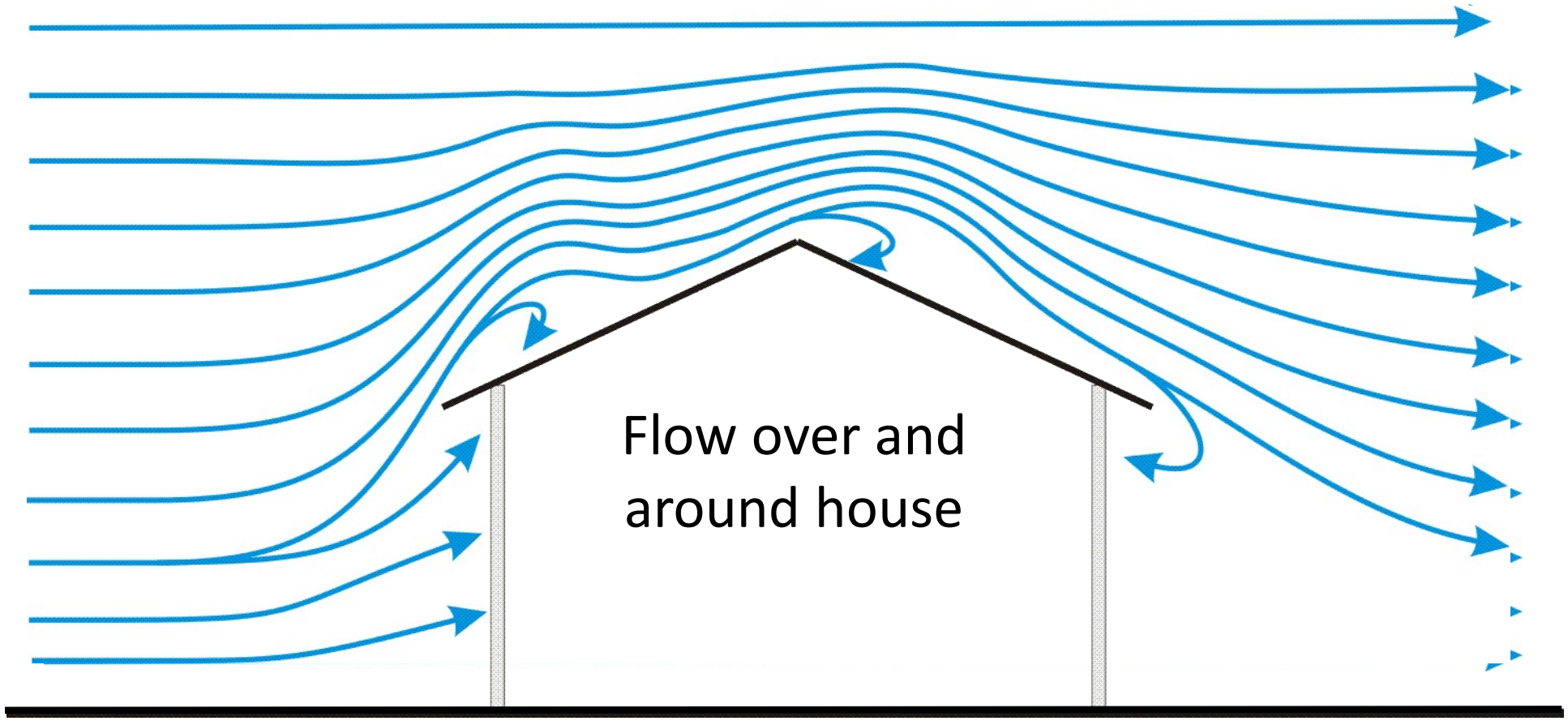
- AS1170.2 Wind loads
- AS4055 Wind loads on housing
- AS1562.1 Design and installation of metal cladding
- HB132 "Handbook on retrofitting older housing"
- AS1684 Timber Framing
- (and lots more)

Manufacturer Literature:

- Lots of Design Manuals for framing, block work, roofing, etc

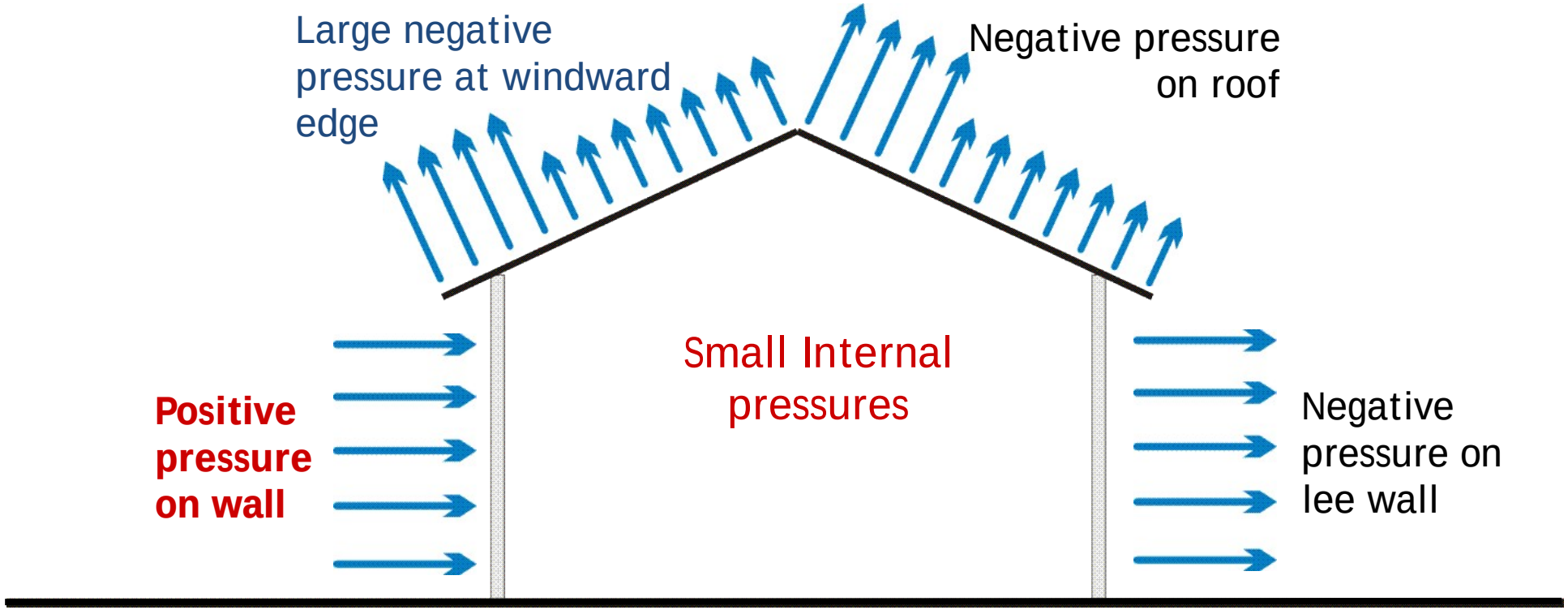
Wind Loads on Houses

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



Wind Loads on Houses

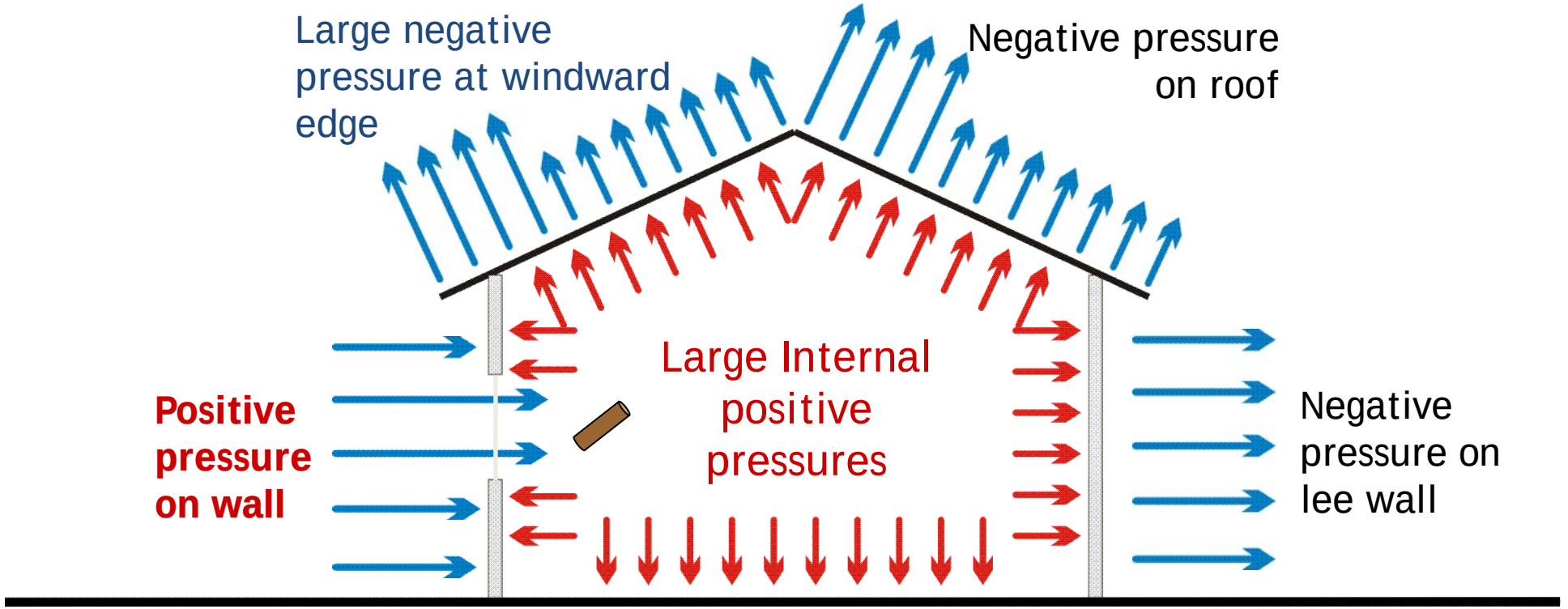
The house forces a change to the wind flow streamlines which causes pressure patterns on the house



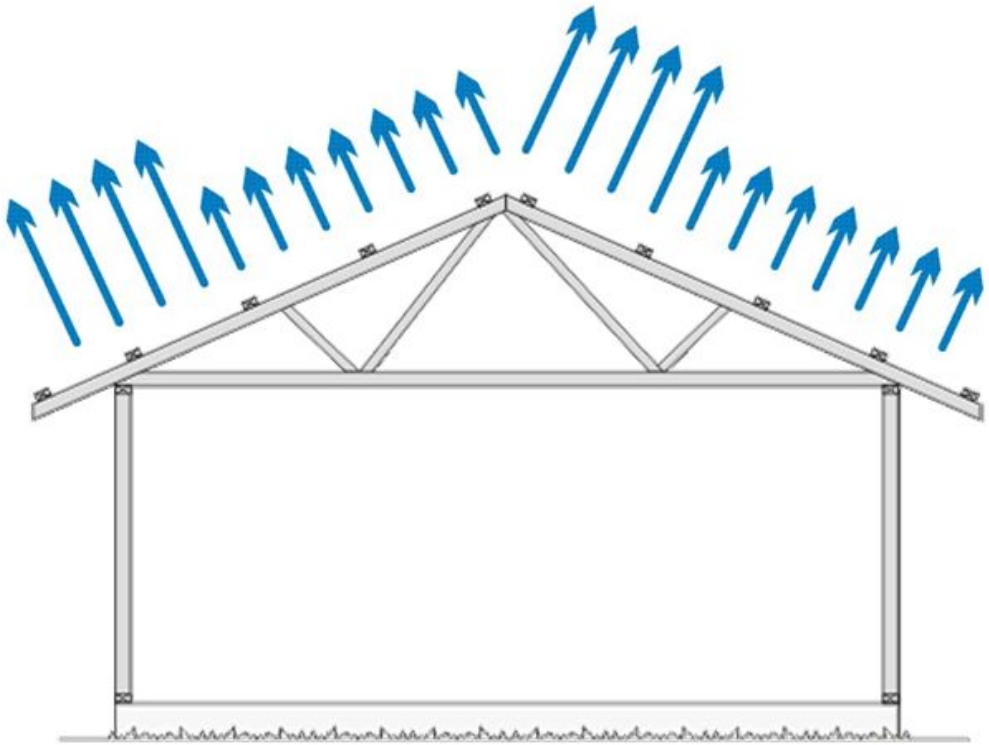
Wind loads on low rise buildings

If an opening forms in the external envelope of the building

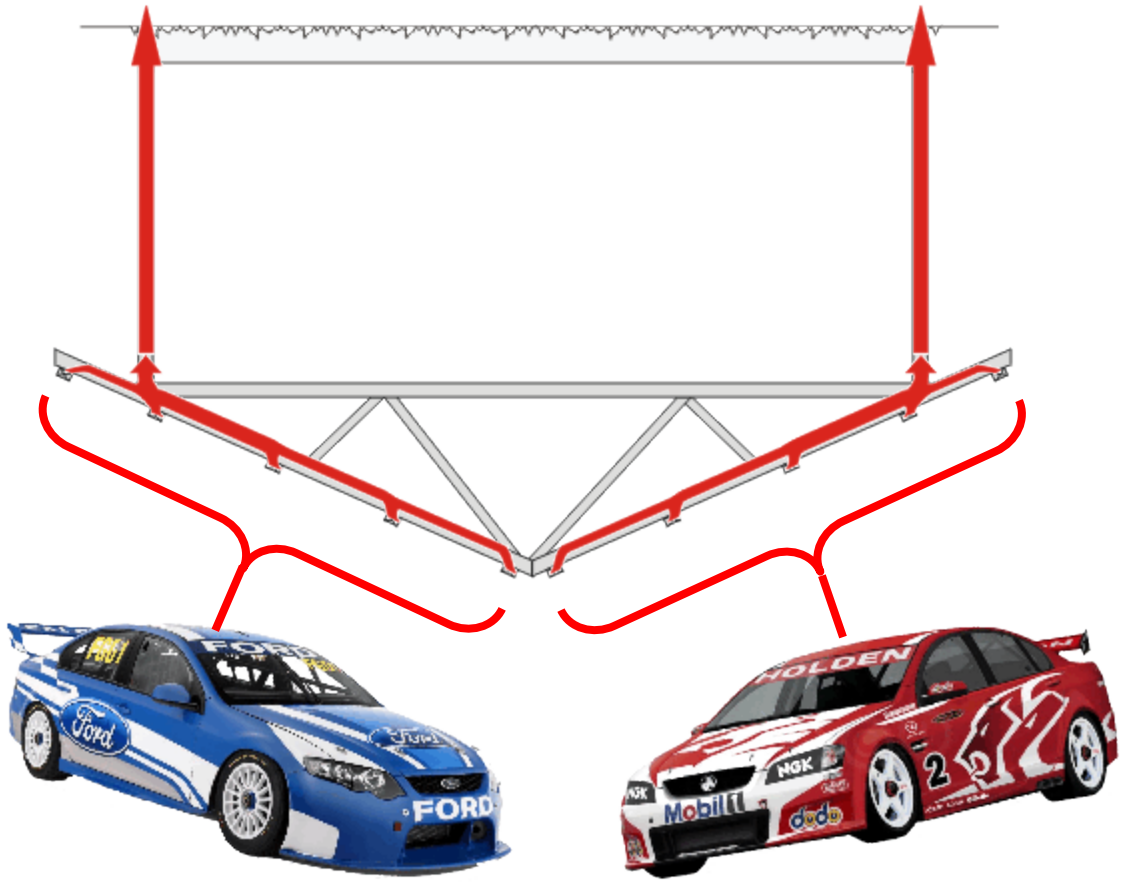
e.g. a window is broken or a door blows in…



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



Pressure acts over an area
Truss spacing ~900 mm
Roughly 1500kg per truss connection to wall

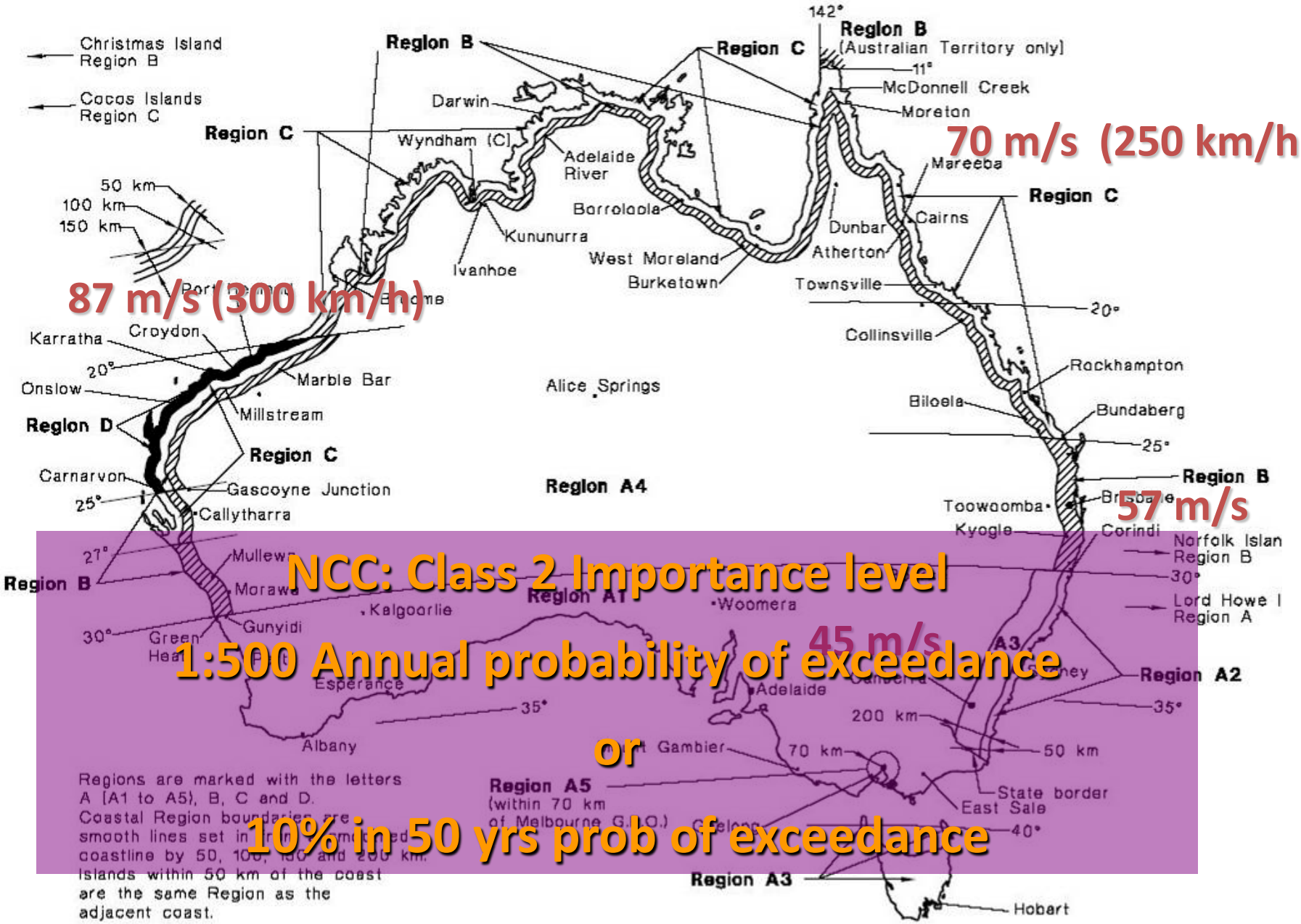

FORD
Ford
FORD
HOLDEN
NGK
Mobil 1
dodo
2

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



70 m/s (250 km/h)

87 m/s (300 km/h)

57 m/s

45 m/s

NCC: Class 2 Importance level

1:500 Annual probability of exceedance

or

10% in 50 yrs prob of exceedance

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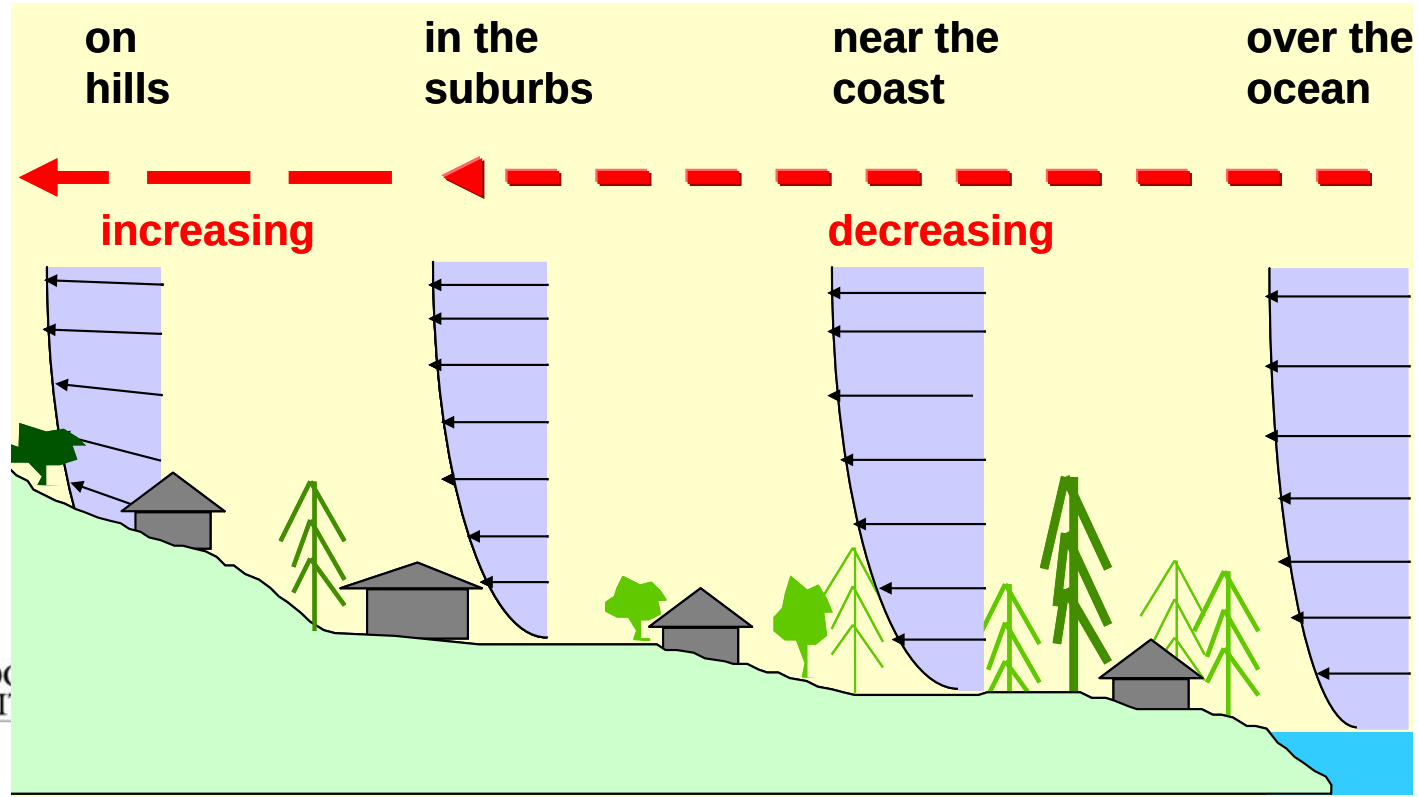
What is the wind speed?

Local Wind Field Parameters

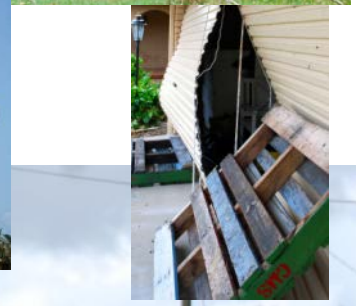
- approach terrain category
- shielding
- topography
- height of building
- orientation of building



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



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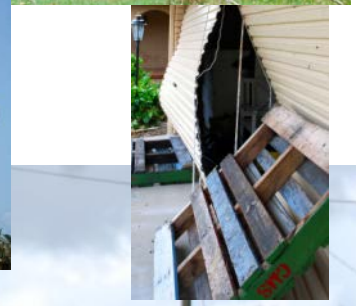
Why failures?

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



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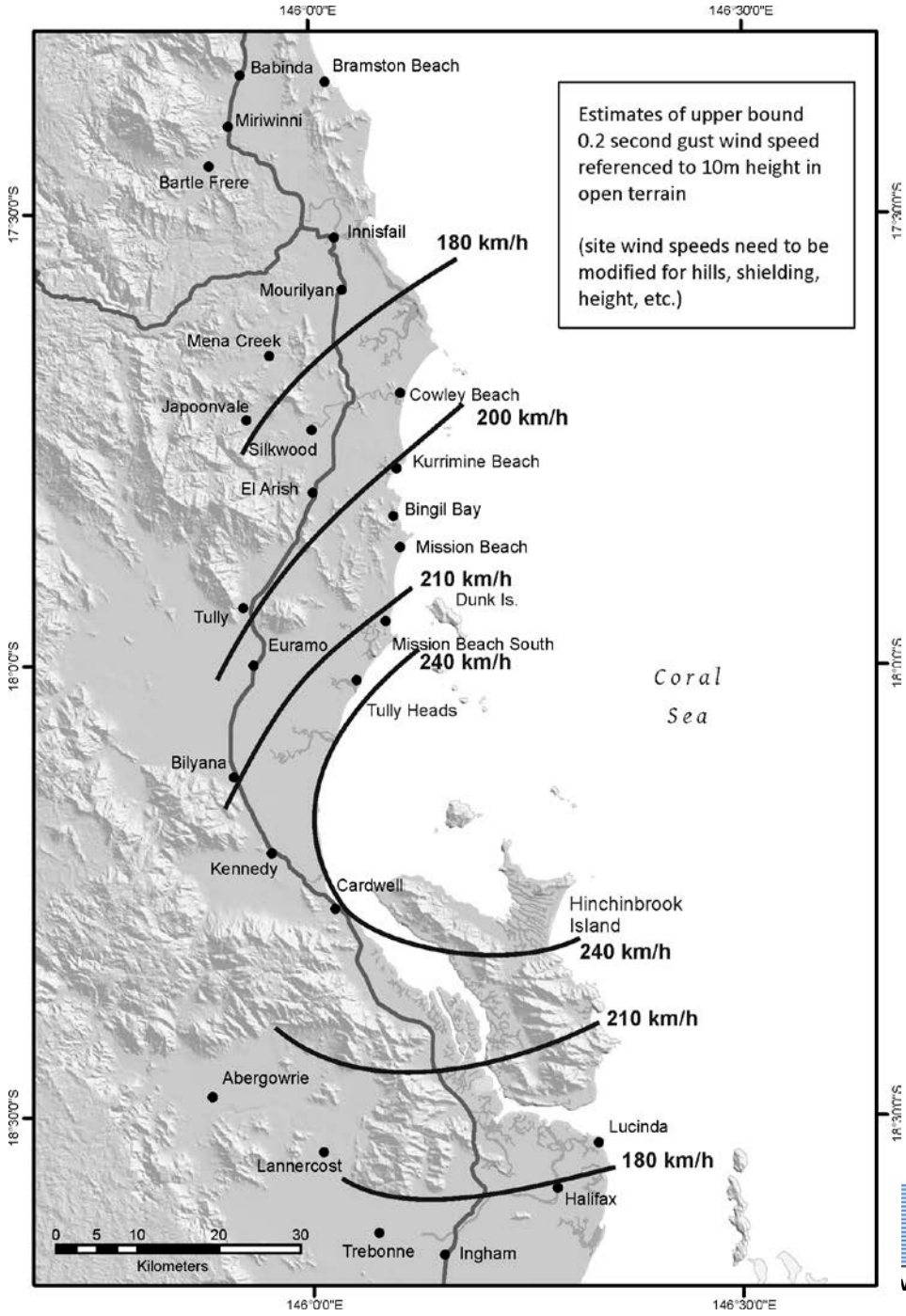
Estimated wind speeds

- 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)



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Post-80s housing (current construction)

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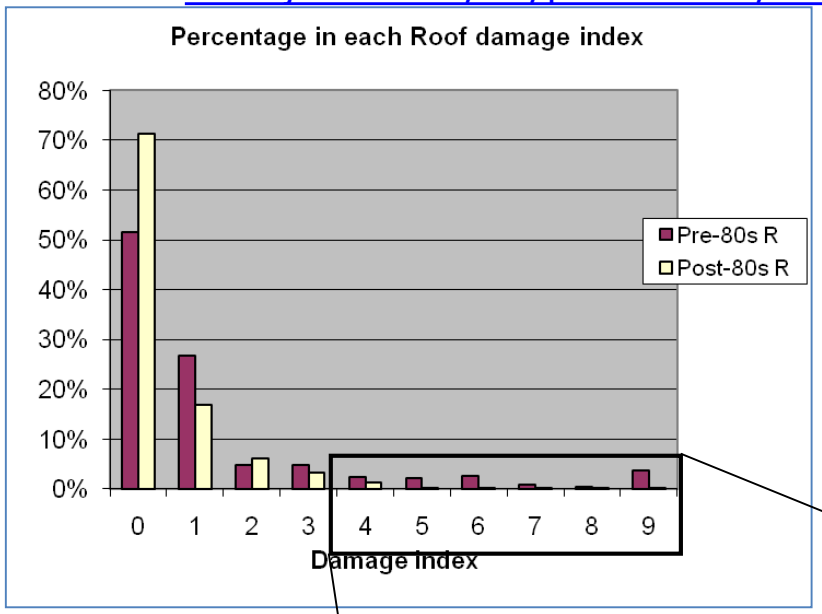
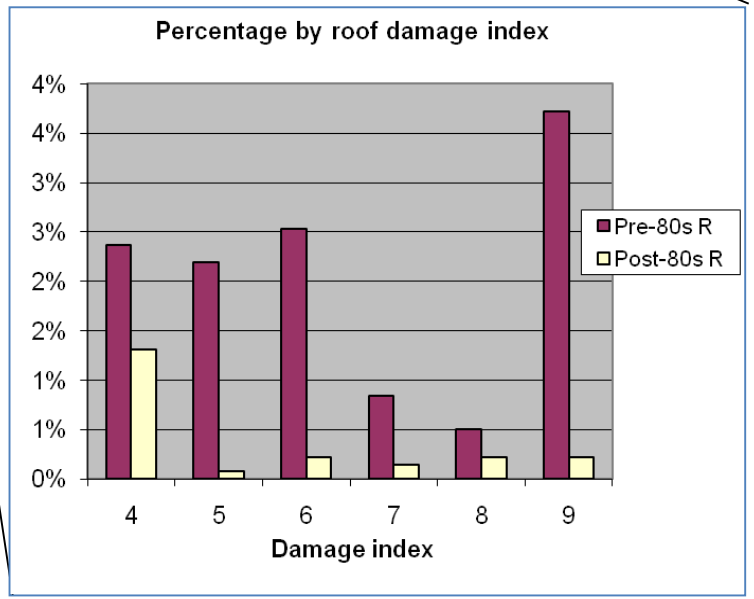
Pre-80s houses

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)

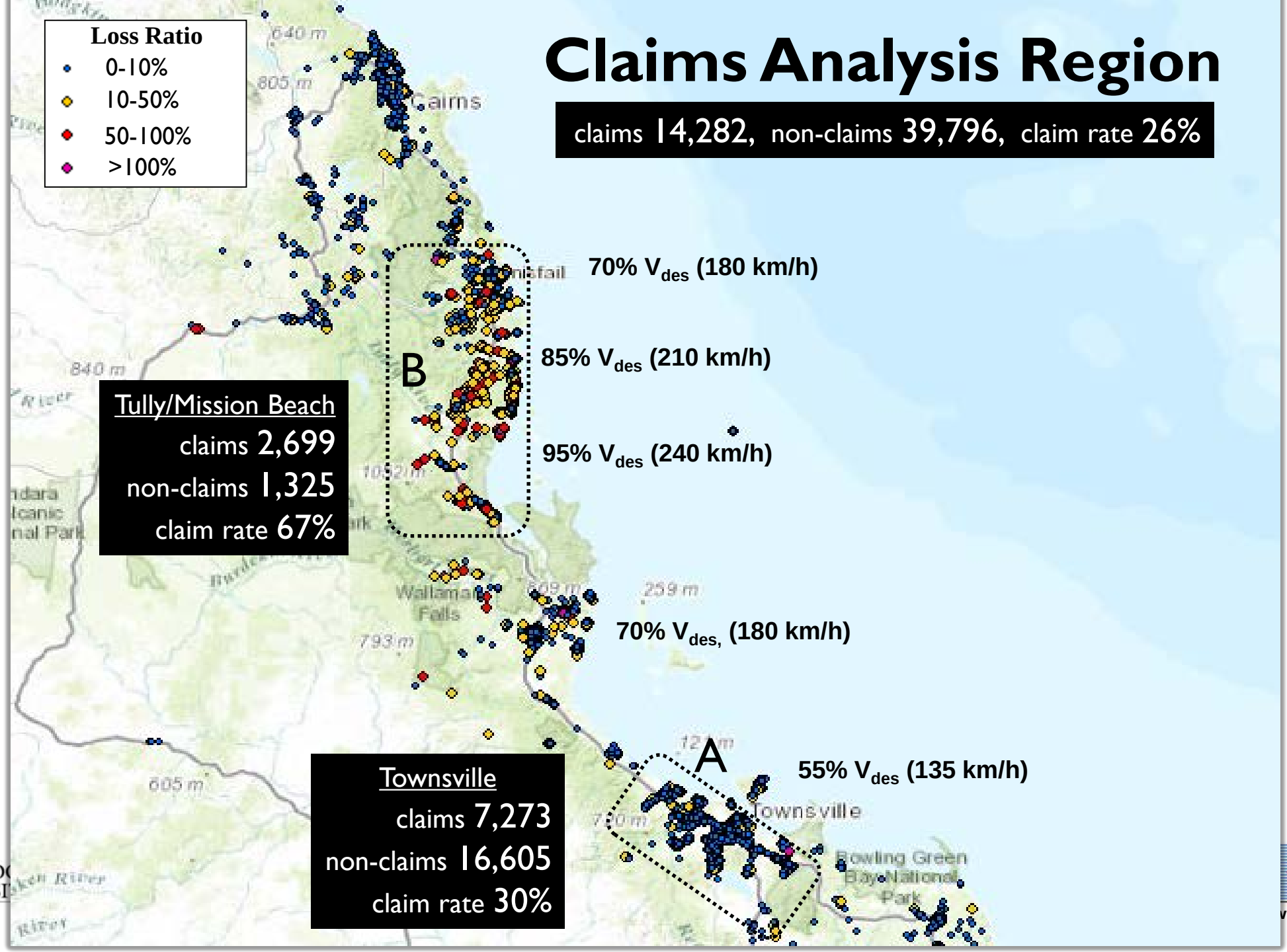
- >12% major roof damage
- ~2% damaged by large debris
- May have hidden damage

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!

Claims Analysis Region

claims 14,282, non-claims 39,796, claim rate 26%



Low claim ratio <0.1 Townsville region

Wind driven debris

Wind driven debris

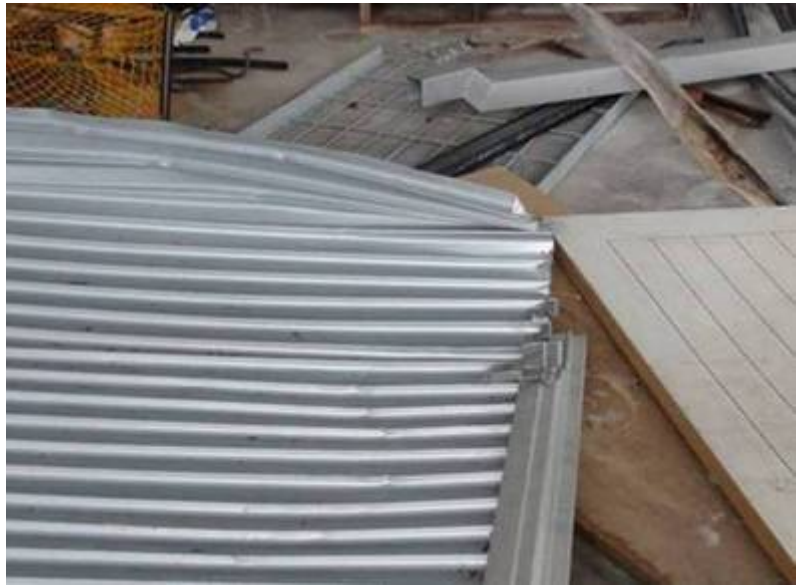
- Small
  - Tiles
- Medium
  - Battens
  - Sheets
- Large
  - Roofs
  - Sheds
  - Big consequences

Cyclone Vance 1999

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

Sheds?

(not just issues with doors)

- Design for dominant openings
- Detail all components
- Design for correct wind rating
- Construct correctly

Strata - Structural damage

Strata - Structural damage

Wind damage to building elements

- Windows and doors
- Garage doors
- Roofs
- Gutters
- Flashings

Water ingress

Wind driven rain water damage to building fabric from different points of entry during a cyclone

- Box gutters
- Valley gutters
- Perimeter gutters
- Windows
- Sliding doors
- Swinging doors
- Garage doors
- Flashings
- Thresholds and downpipes
- Walls
- Roof
- Machinery room

Does not include damage to contents, floor coverings

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

Standards

AS2047 Windows in buildings— Selection and installation.

TABLE 2.4

WATER PENETRATION RESISTANCE TEST PRESSURES

Window ratings	Water penetration resistance test pressure, Pa (see Note)	
	All windows except ajustable louvres	Adjustable louvre windows
N1	150	150
N2	150	150
N3, C1	150	150
N4, C2	200	200
N5, C3	300	200
N6, C4	450	200

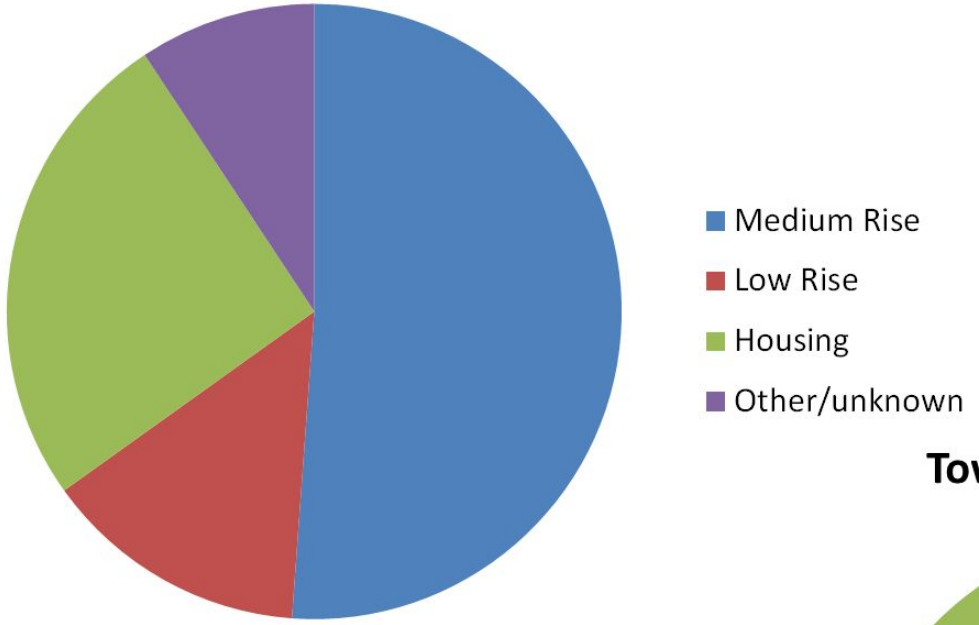
NOTE: Water penetration resistance test pressures are arbitrarily chosen, considering the method of test and shall be in positive direction only.

Due to low design (test) requirements for windows/doors water ingress and associated damage to house can be expected when heavy rain occurs with wind speeds greater than about 30 m/s.

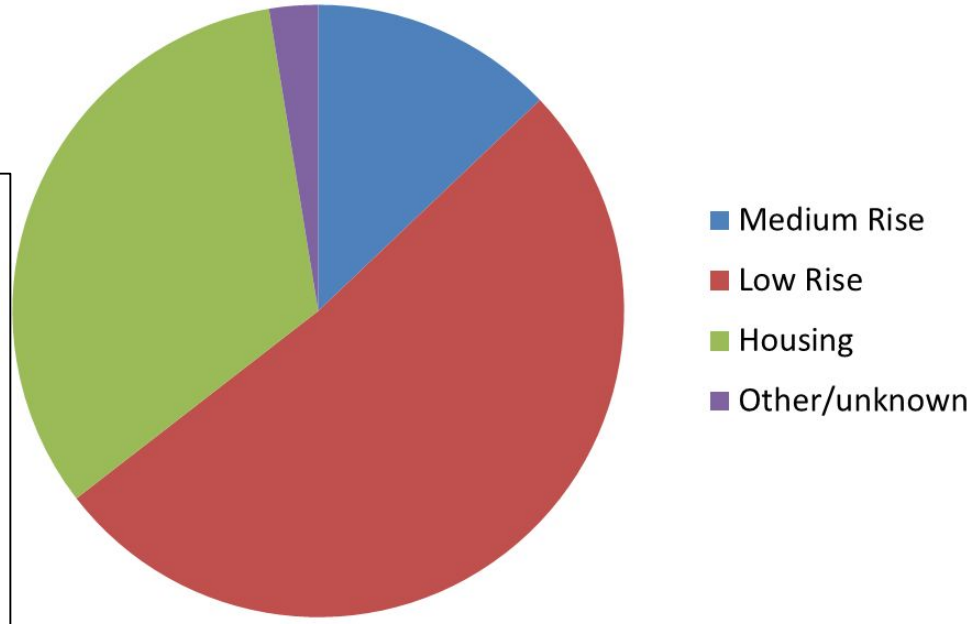
Policies, claims and ratio of claims to sum insured (SI) value

Region	Number of records	% of records with a claim from region	Average of (Claim / SI)	Standard deviation of (Claim / SI)
Townsville region	300	25%	3.5%	0.12
Ingham, Cardwell, Tully, Mission Beach, Innisfail	57	58%	20.7%	0.28
Cairns, Trinity Beach, Port Douglas	507	12%	0.5%	0.01

Townsville Claims - by building type



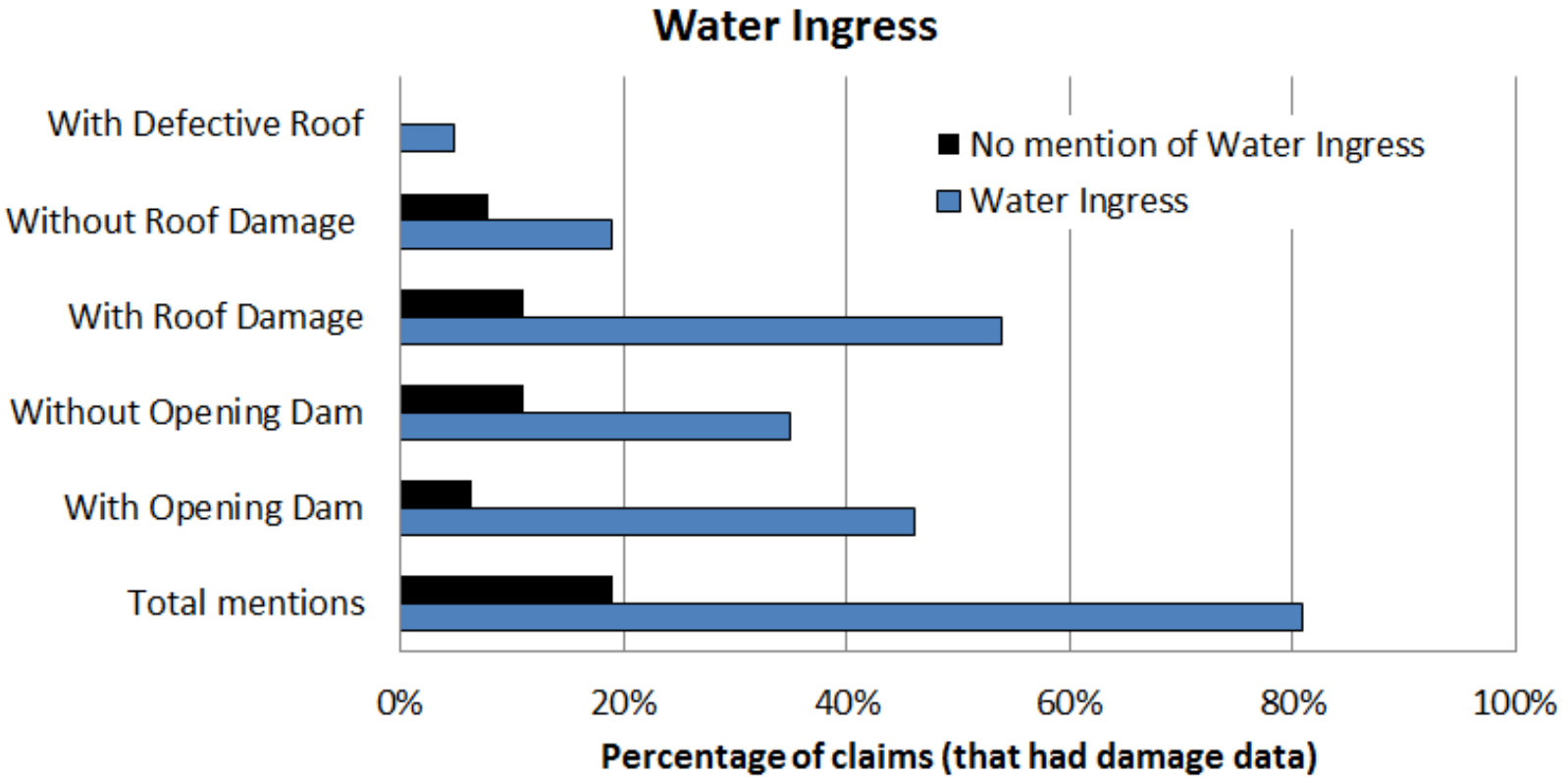
Townsville No Claims - by building type



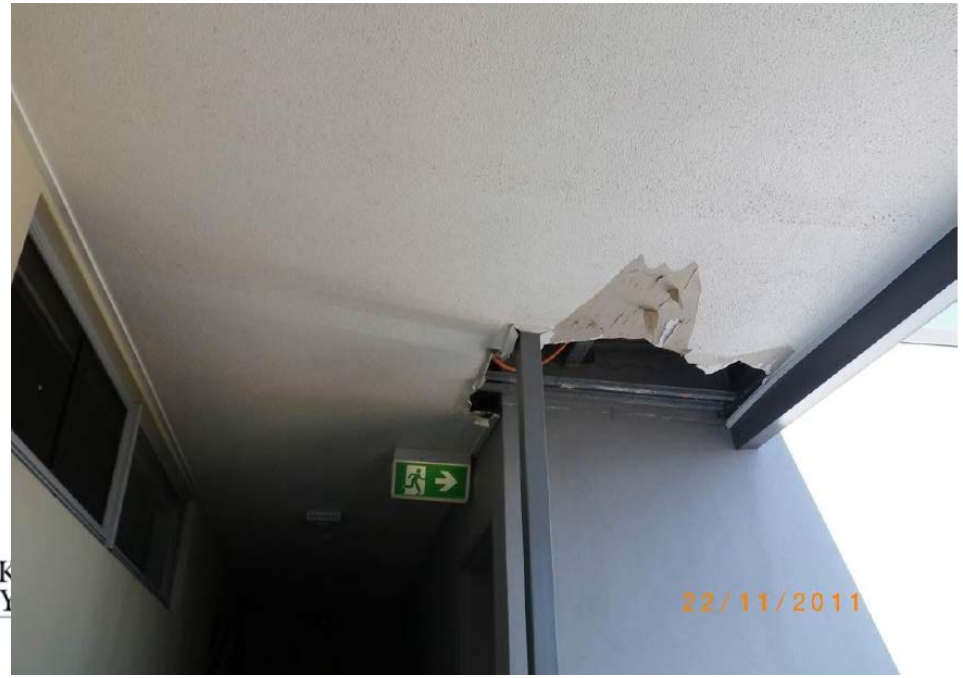
CTS report TS899:
www.insurancecouncil.com.au/assets/report/Independent%20strata%20study.pdf

CTS Report TS948
www.insurancecouncil.com.au/assets/media_release/2014/July%202014/100714%20Report%20JCU%20Engineering%20Inspection%20Scheme.pdf

WDR Water ingress

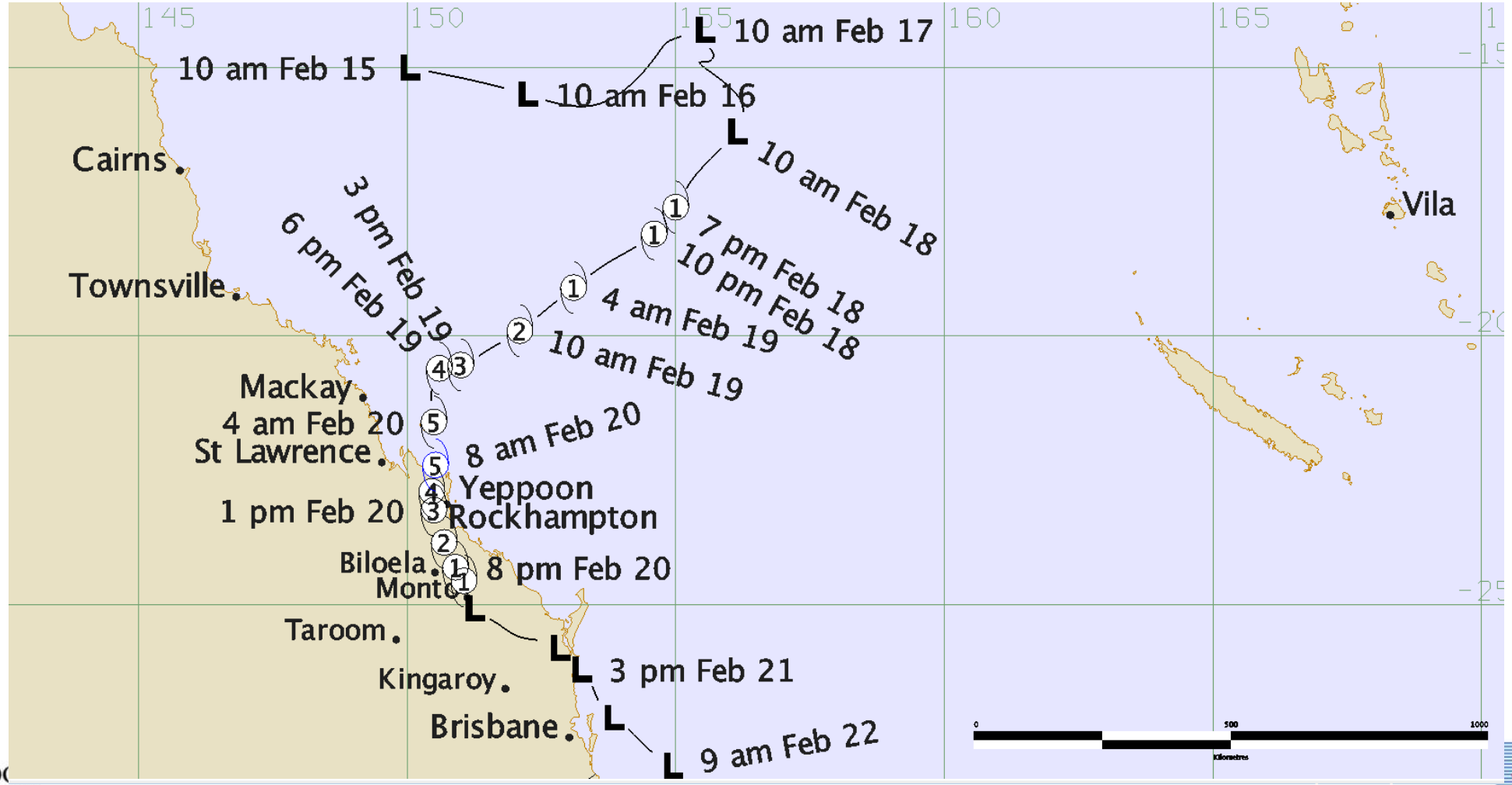


- Shade cloth shredded since not taken down prior to event
- (recurring feature in large strata or resorts is external kitchenettes, cupboards made from non-weather resistant materials)



Inadequate box gutters for roof area.
No overflow outlets for when over-capacity or when wind driven leaf litter is blocking down pipe.

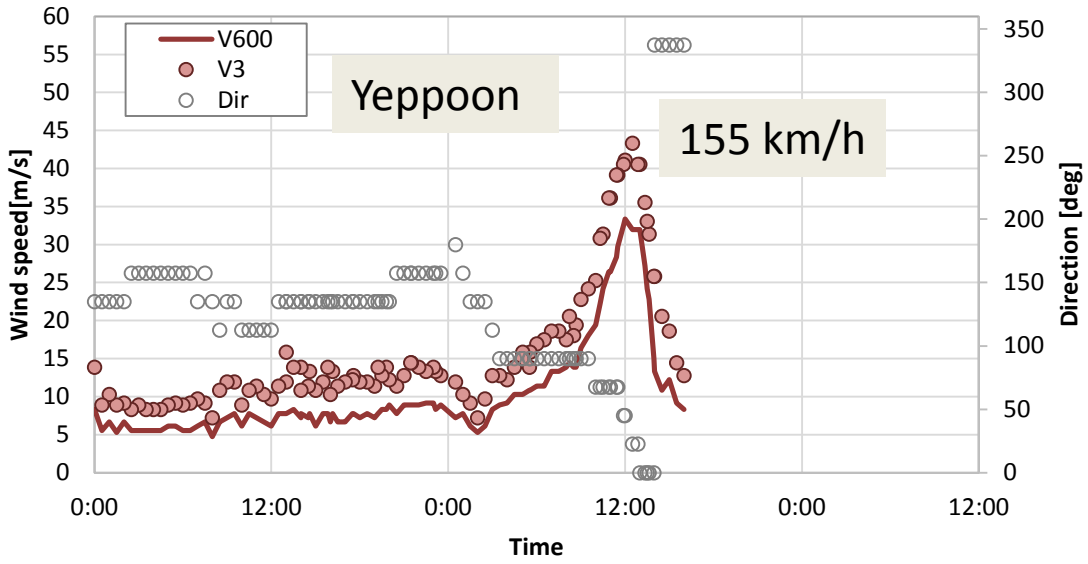
BoM Operational Track Map



Pearl Bay

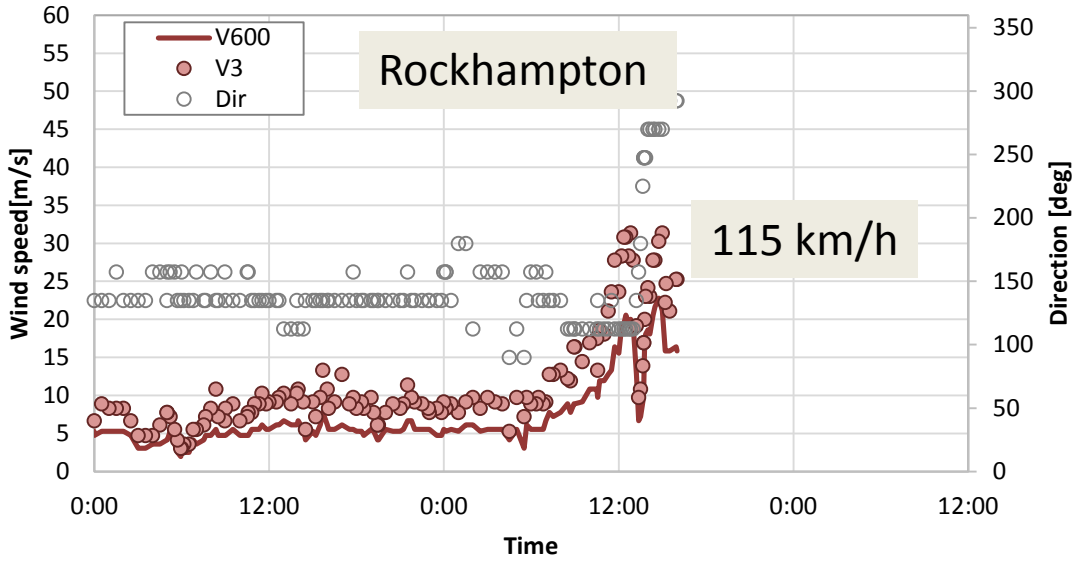
- **Photo: Bruce Gunn (BoM)**

Estimating surface winds



This is
75% of design wind speed
and only
50% of design pressure

Therefore No Damage!?!



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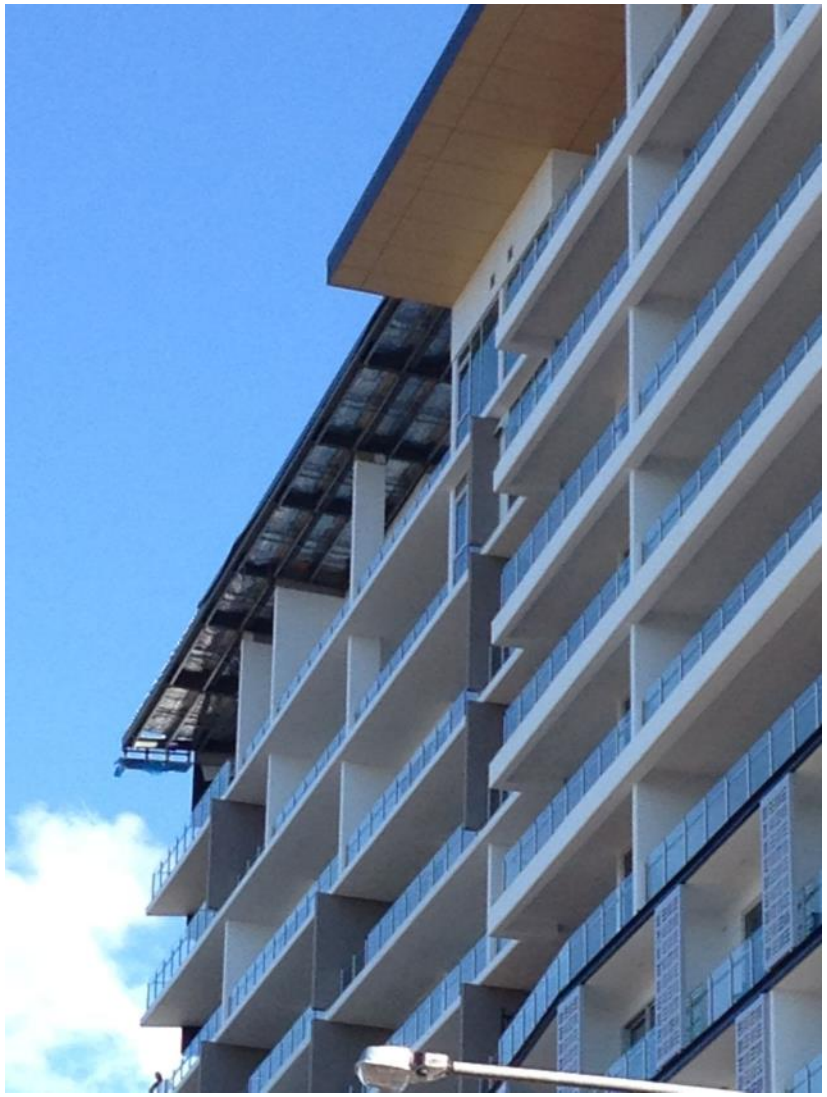
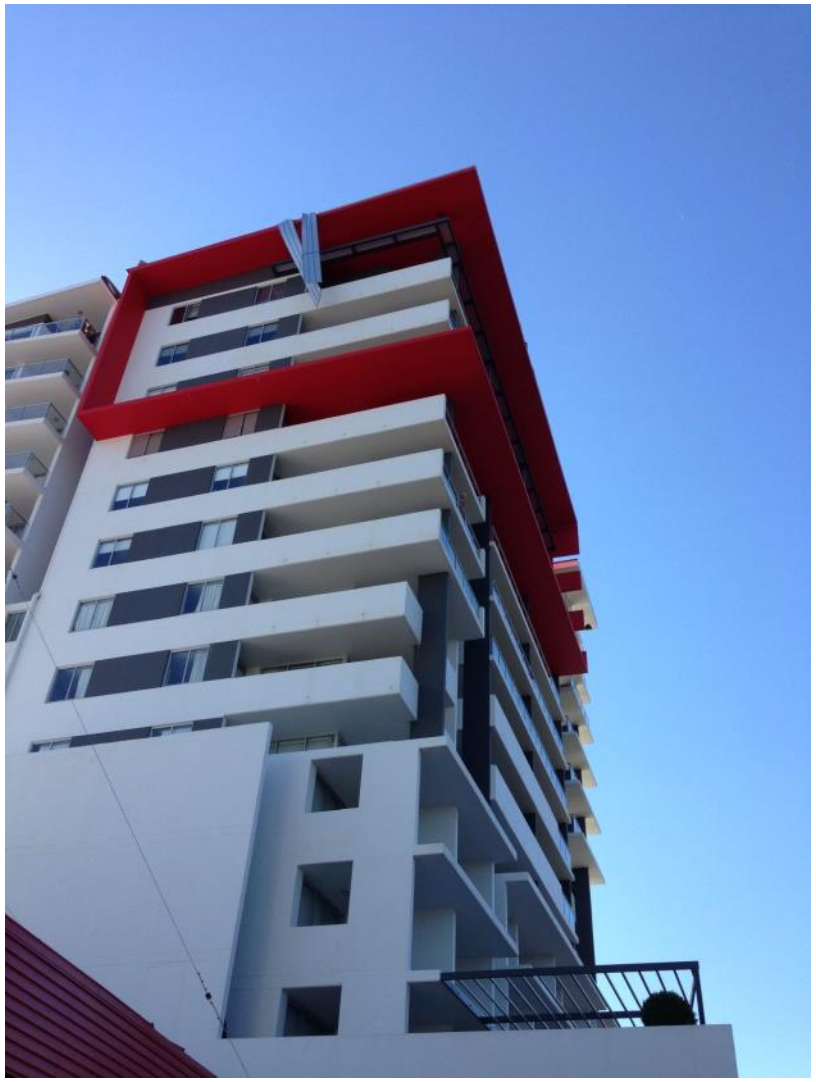
Queensland Building and Construction Commission inspections of housing

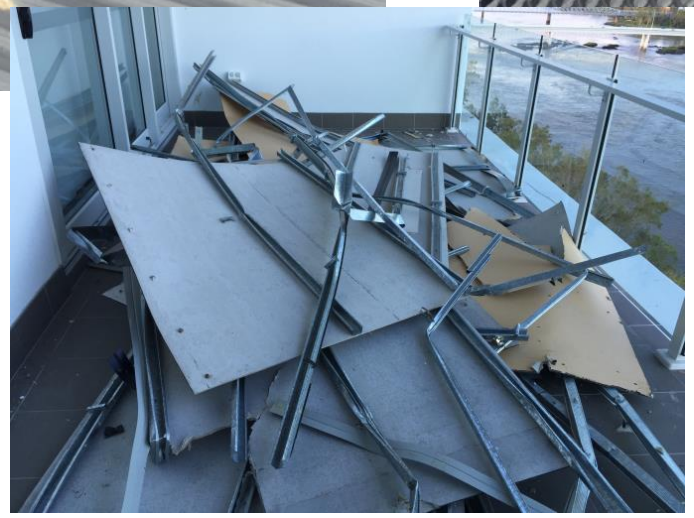
- In discussions with QBCC they consider that the cladding is a part of the structural system and that a “simple” re-roof does require certification which covers inclusion of appropriate batten to rafter connections and strapping of rafters to internal walls and top plates.
- They agree however that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

Damage to modern engineered construction?





Roof top damage



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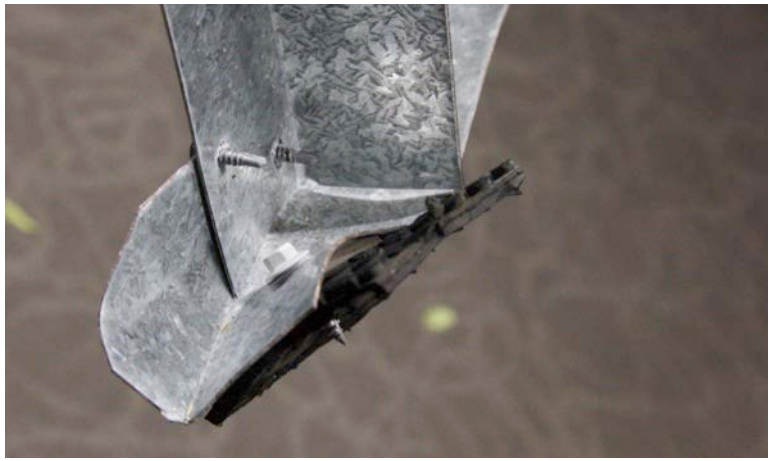
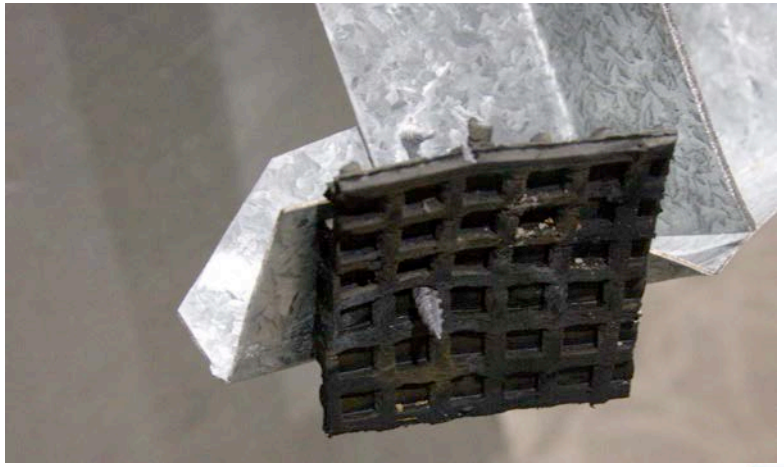
Internal damage from pressurised ceiling space

A/C Ducting lost

Recovered a/c duct





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Roslyn Bay and Yeppoon

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

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

Recent house construction

Structural load path - Truss tie down

Brisbane housing

Structural load path - Truss tie down

Melbourne housing

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

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Conclusions

- The wind finds the weakest link.
- Failure of a single element can lead to the progressive failure of the structure.
- Our homes are where we shelter – they have to be secure.
- But MUST evacuate if threat of Storm Tide
- For wind speeds less than the strength design wind speed, ancillary items have taken on increasing importance in claims costs.
  - Damage from wind driven rain ingress and the damage to ancillary components (e.g. air conditioners, shade cloth attachments, aerials and fences).
  - The failure of ancillary components has also led to damage to the main structure such as penetrations in cladding allowing further water ingress.
- New standard for water-resistance at ultimate wind speeds?
- Selection of more durable materials?
- Continued education and awareness of the building community is required

Webinars

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

CTS supporters

www.jcu.edu.au/cts

end