ENGINEERS
AUSTRALIA

# Australian Wind Design Codes for Construction in Cyclonic Areas

10 November 2021

Structures

# Housekeeping notes

- This webinar will start 2 minutes post advertised start time to ensure everyone has dialled in
- Participant cameras and audio are switched off, this has been done on purpose to ensure the presenters do not have any disruptions
- If you have issues with the audio or visual of the presentation, please contact the moderator via the Q&A section in the bottom right hand corner of your screen
- Q&A for the presenters will be live throughout the whole session, please submit your questions via the Q&A section in the bottom right hand corner of your screen. Questions will be answered at the end of the presentation.
- A recording of this session may be made available on Engineers Australia video viewing platform EA OnDemand post event – please allow at least ten business days.
- A post event survey will automatically pop up at the conclusion of the webinar, your feedback will be greatly appreciated.
- Your certificate of attendance for this webinar will be automatically generated and sent to you post event.

# Acknowledgement of Country

Engineers Australia acknowledges the traditional custodians of the country throughout Australia and recognises their continuing connection to land, waters and community.

We pay our respects to them and their cultures; and to elders past and present and emerging.

ENGINEERS
AUSTRALIA

# Australian Wind Design Codes for Construction in Cyclonic Areas

10 November 2021

Structures

ENGINEERS
AUSTRALIA

# Prof. Geoff Boughton

AM PhD MEngSci FIEAust CPEng RPEQ
Adjunct Associate Professor
James Cook University's Cyclone Testing Station

ENGINEERS
AUSTRALIA

# Peter Airey

HonFIEAust CPEng APEC Engineer IntPE (Aust) RPEQ
Managing Director
Airey Taylor Consulting Engineers and Scientists

# Australian wind codes for construction in cyclonic areas

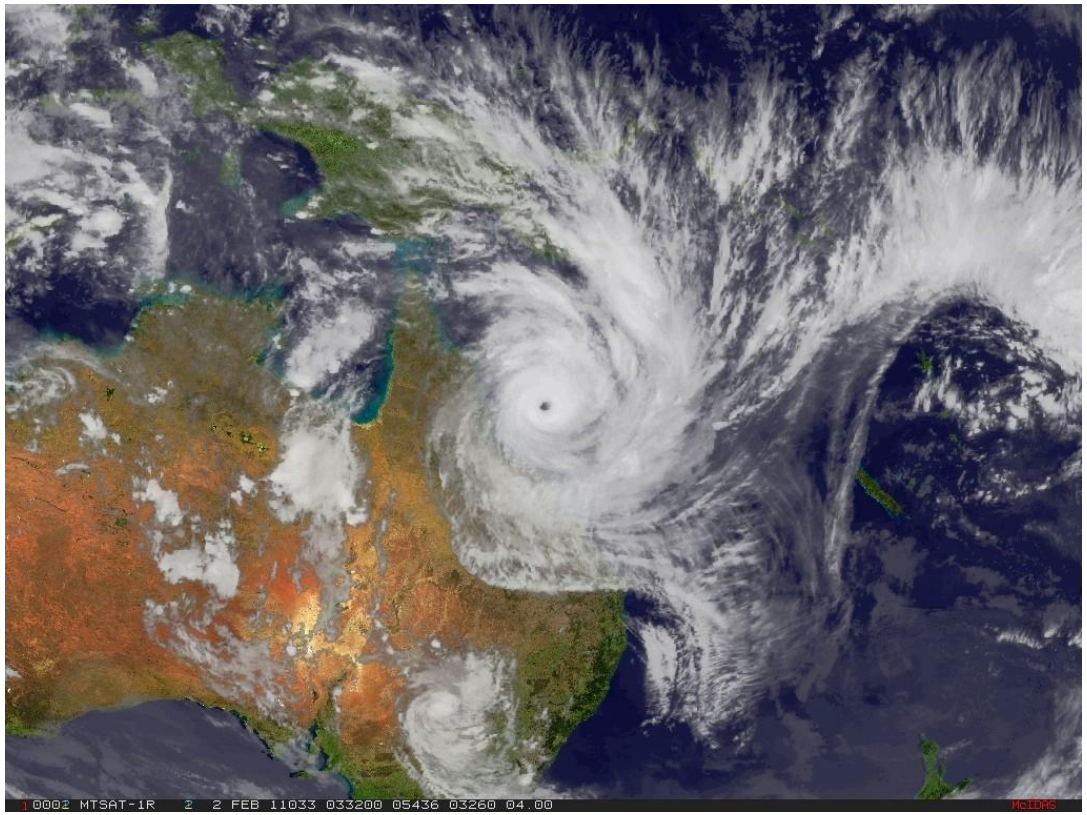
Understanding wind loads so that the standards make more sense

- Geoff on cyclones and cyclone wind damage
- Peter on design philosophies
- Geoff to finish up with design for resilience

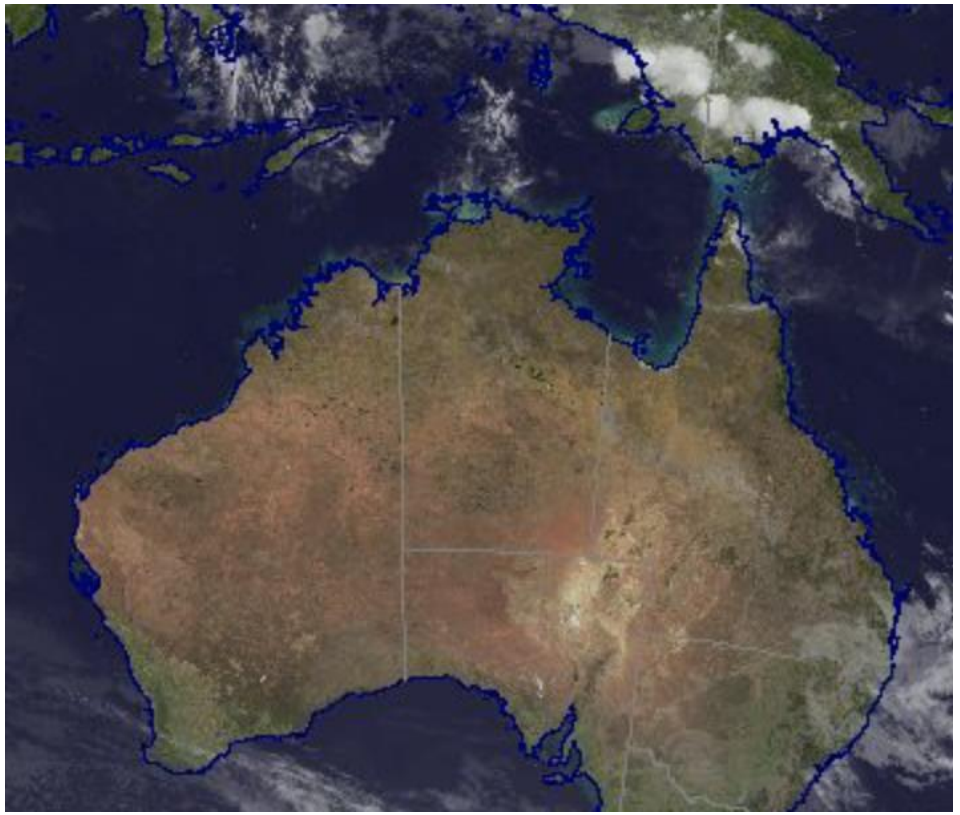
https://www.youtube.com/watch?v=DfJx830H9JA

# Are cyclones different?

- Tropical cyclone

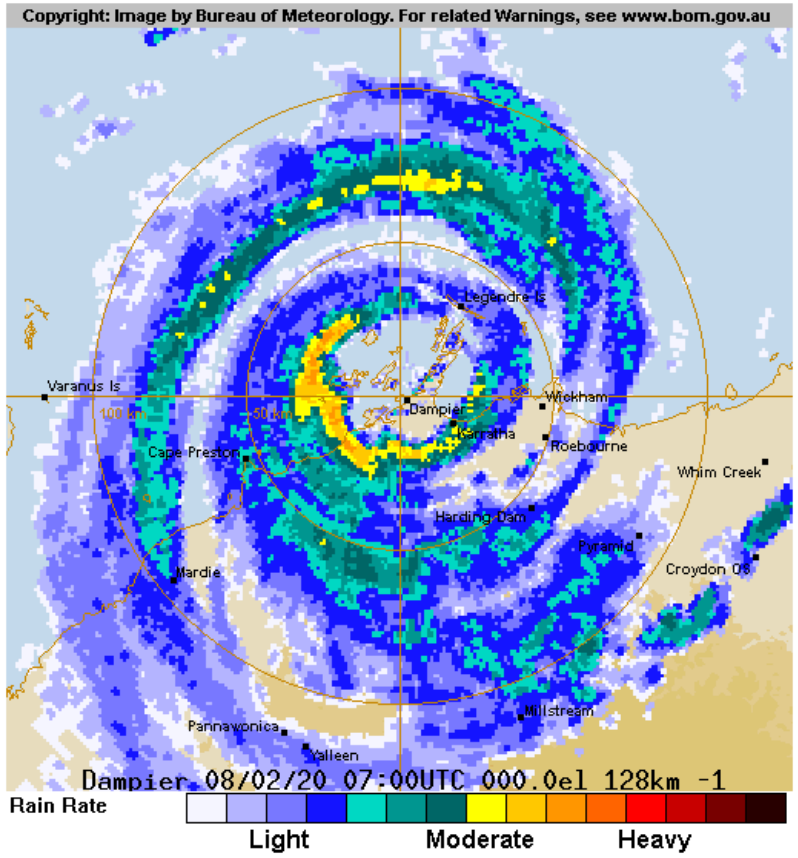



- Thunderstorm/cold front

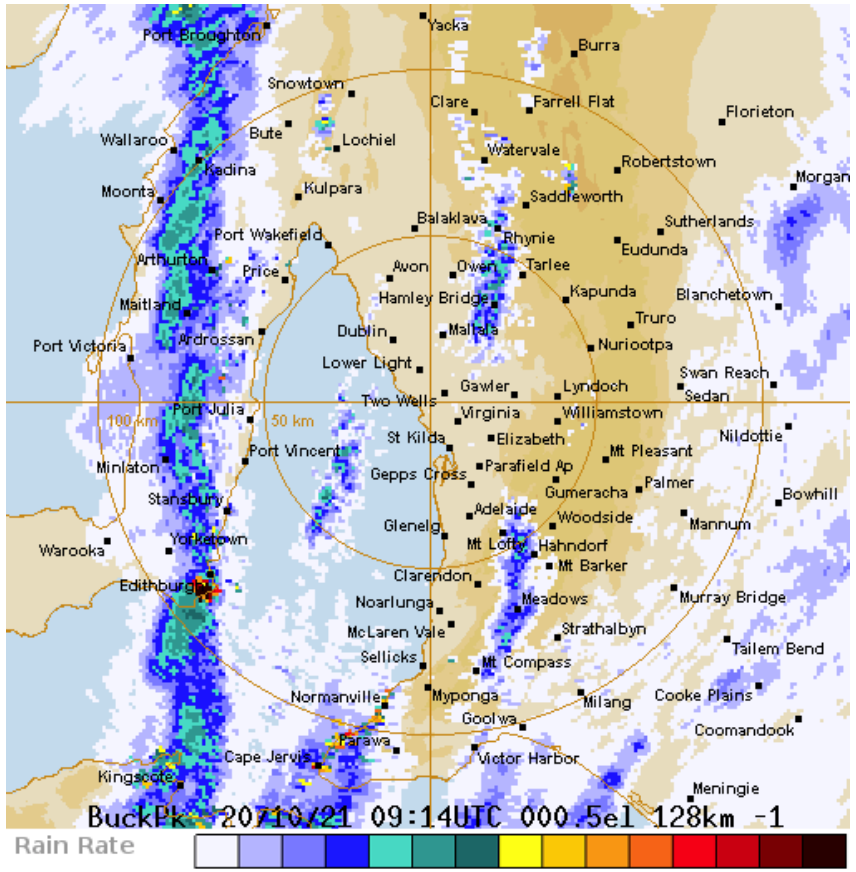


# Extent

- Tropical cyclone

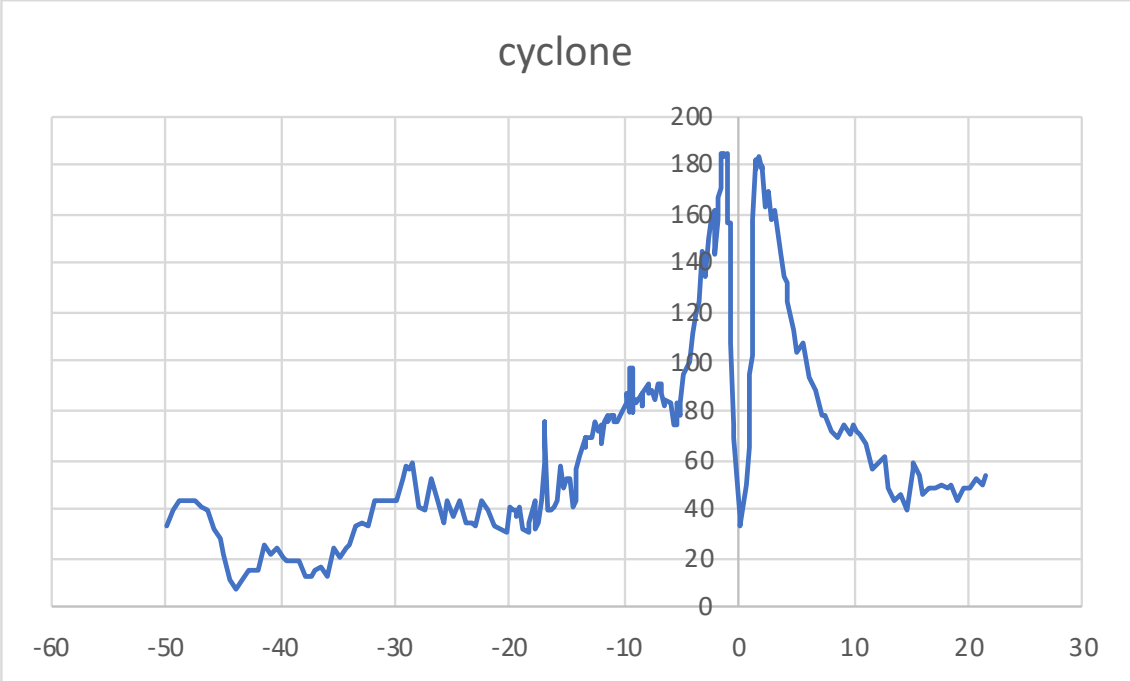



- Thunderstorm/cold front

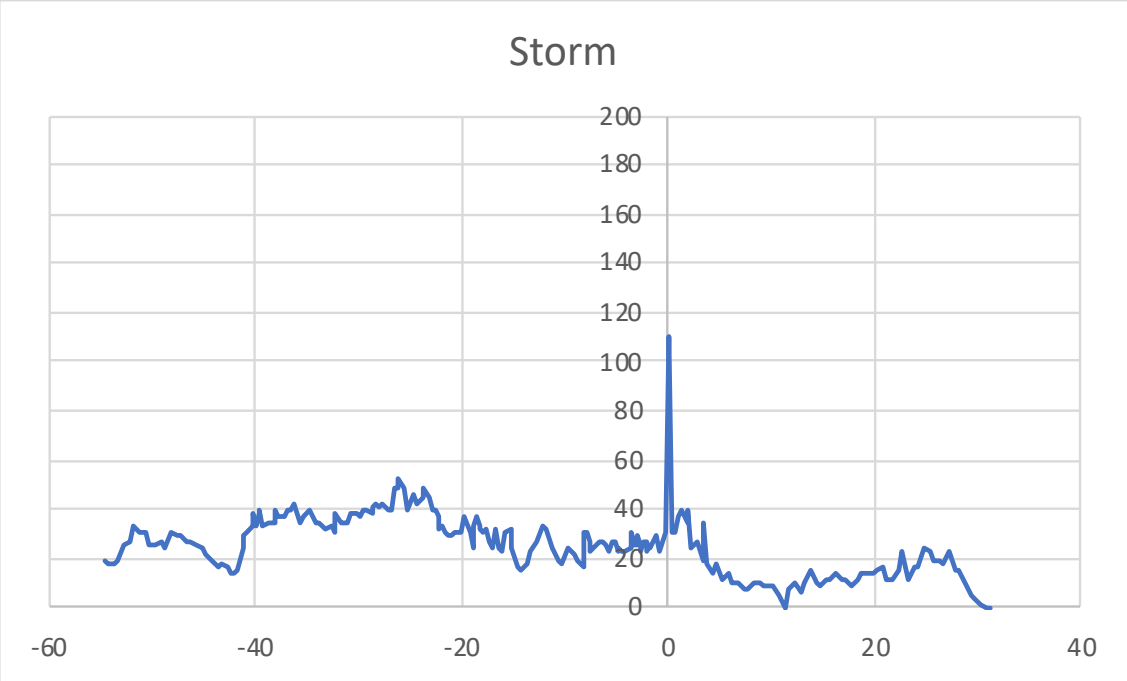


# Anemometers

- Tropical cyclone




- Thunderstorm/cold front



# Differences

**Tropical cyclone**

- Hours of strong gusts
- Wind-driven rain for hours, different directions
- Debris impacts before peak gusts

**Thunderstorm/cold front**

- One or two strong gusts
- Wind-driven rain for minutes
- Debris impacts after peak gusts

# Wind damage

- Tropical cyclone

- Thunderstorm/cold front

# Windborne Debris damage

- Tropical cyclone

- Thunderstorm/cold front

# Wind effects

**Tropical cyclone**

- Pressure on walls
- Uplift on roofs
- Internal pressure (major)

- Many gusts
- Widespread (whole towns)

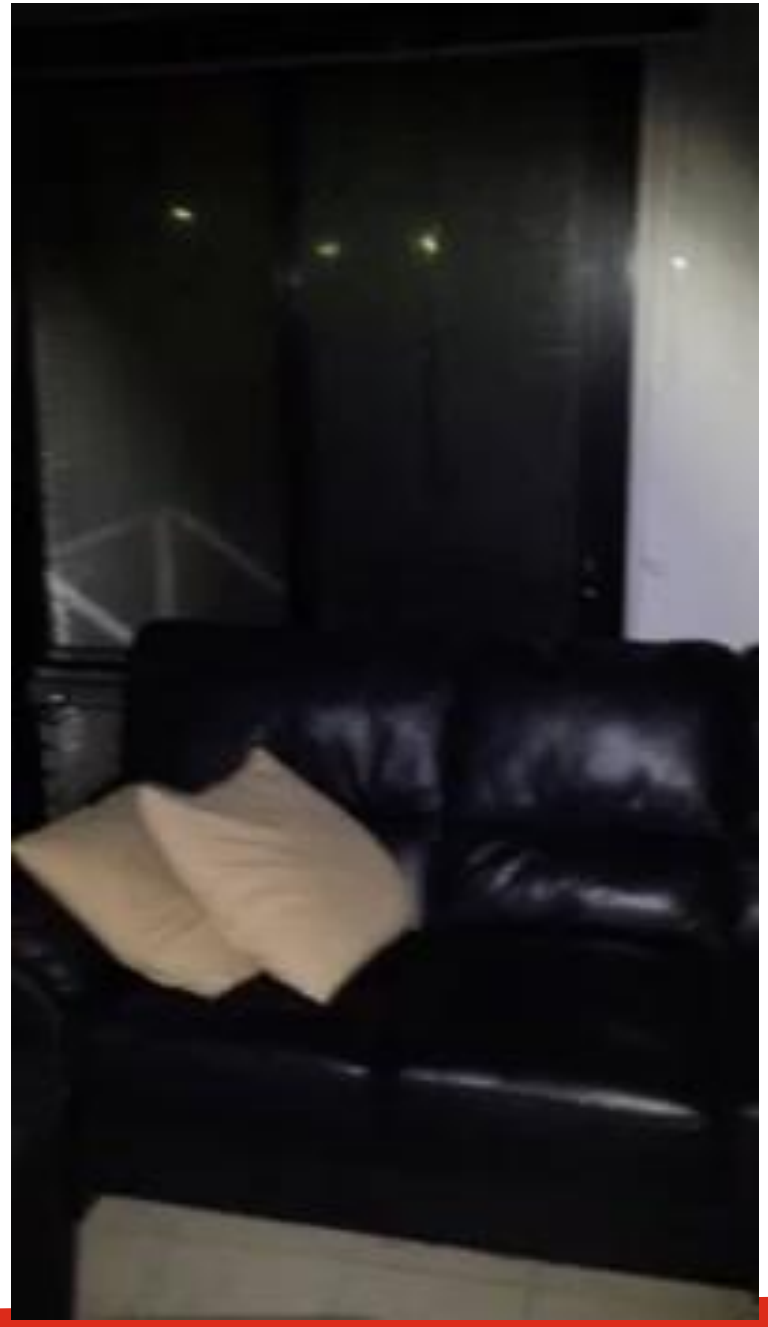
**Thunderstorm/cold front**

- Pressure on walls
- Uplift on roofs
- Internal pressure (minor)

- Few gusts
- Localised (several buildings)

# Water ingress

- Windward wall windows and doors
- Flashings



# Tropical cyclones

## Water ingress

- Windward wall windows and doors
- Flashings

## Debris impact

- Windward wall windows and doors
- Gutters and flashings

# Design for wind actions

## AS/NZS 1170.2

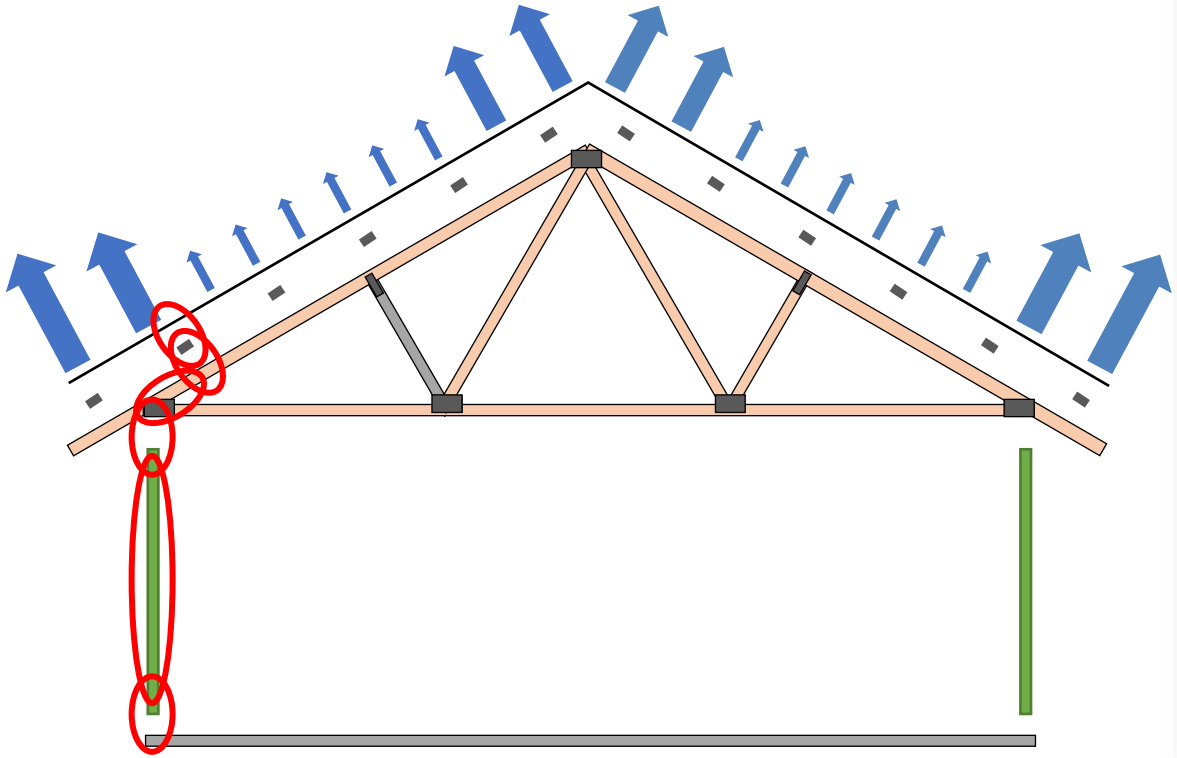

## AS 4055

# Design for wind actions

## Members

## Connections

# Tie-down chain



# Flashings

- Fixings
- Effectiveness

# Debris

# Why test for debris impact

- Life safety?
- Internal pressure?

- Protect?
- Reduce impact

# Robustness

## BP1.1 Structural reliability

(a) A building or structure, during construction and use, with appropriate degrees of reliability, must—

(i) perform adequately under all reasonably expected design actions; and

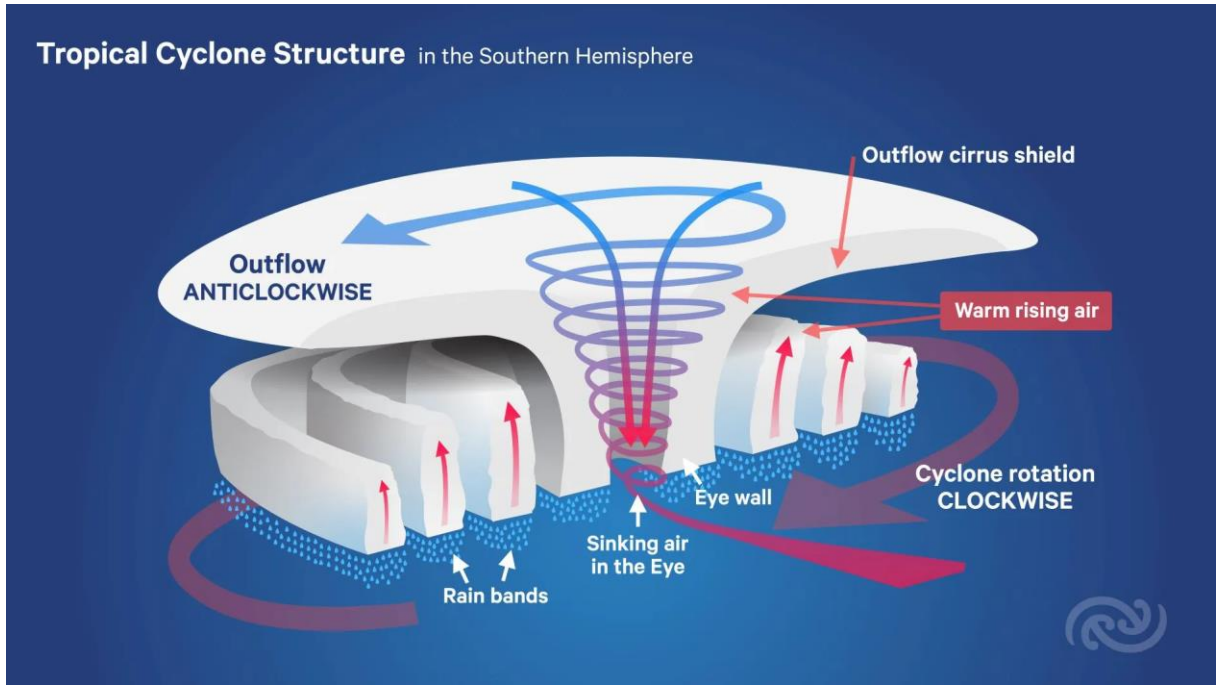
(ii) withstand extreme or frequently repeated design actions; and

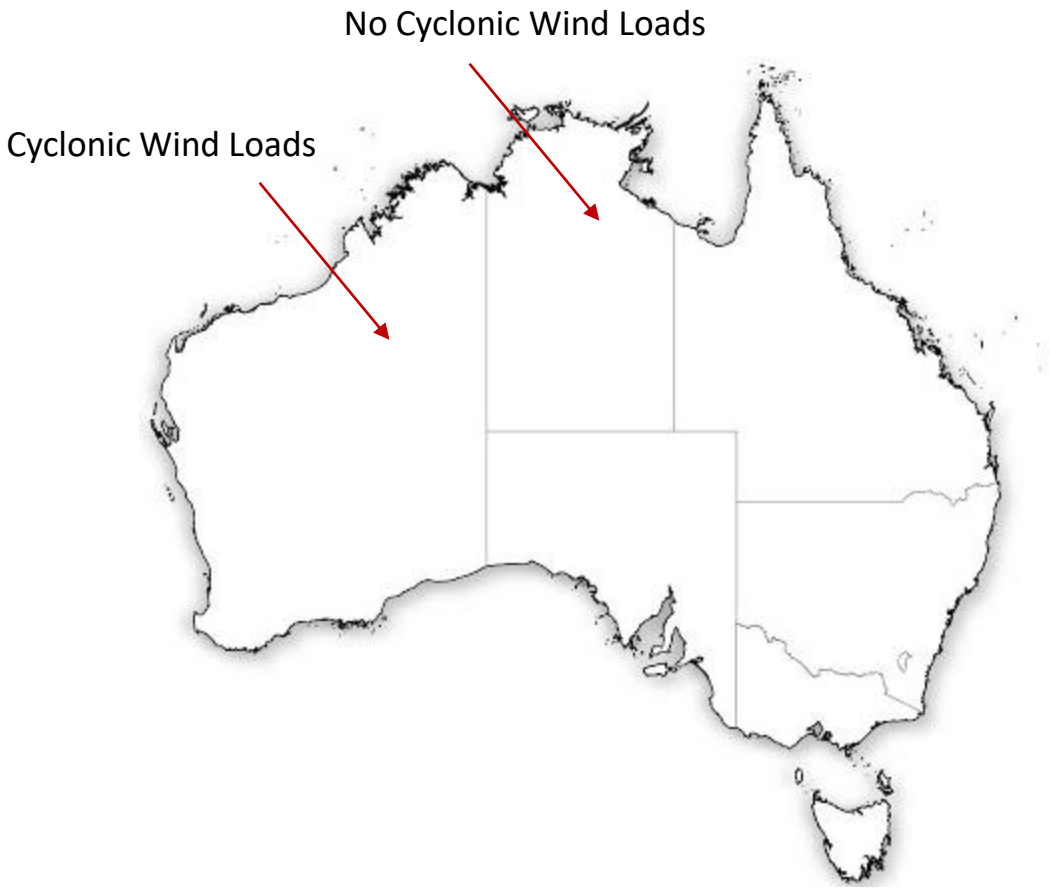
(iii) be designed to sustain local damage, with the structural system as a whole remaining stable and not being damaged to an extent disproportionate to the original local damage; and

(iv) avoid causing damage to *other properties*, by resisting the actions to which it may reasonably expect to be subjected.

# Robustness?

# Cyclonic Wind Loads design requirements used to stop at State Boundary in relevant Design Codes




airey taylor consulting
engineers
scientists

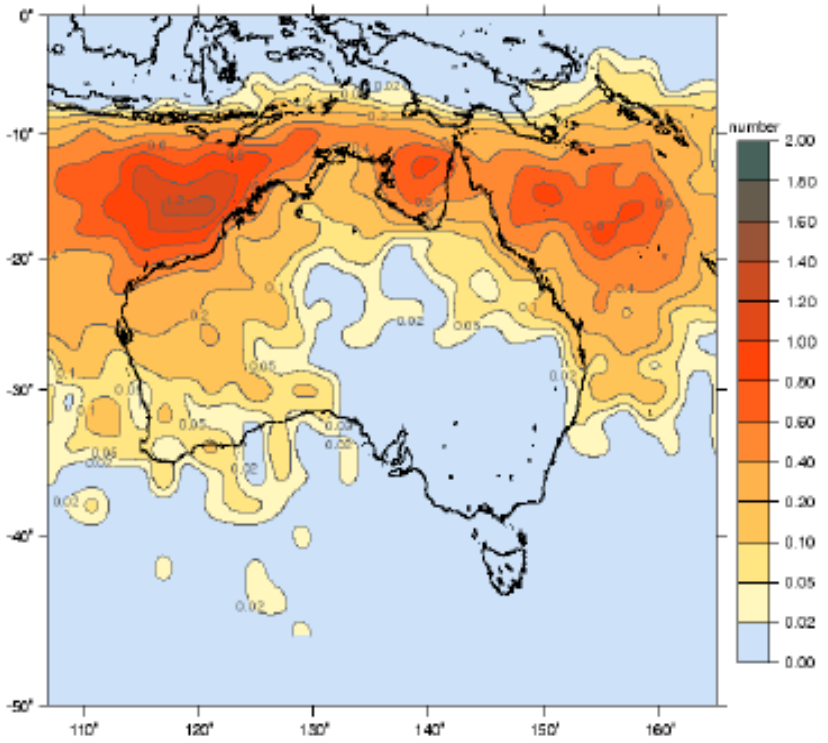
# Cyclone Tracy; 24 – 26 December, 1974

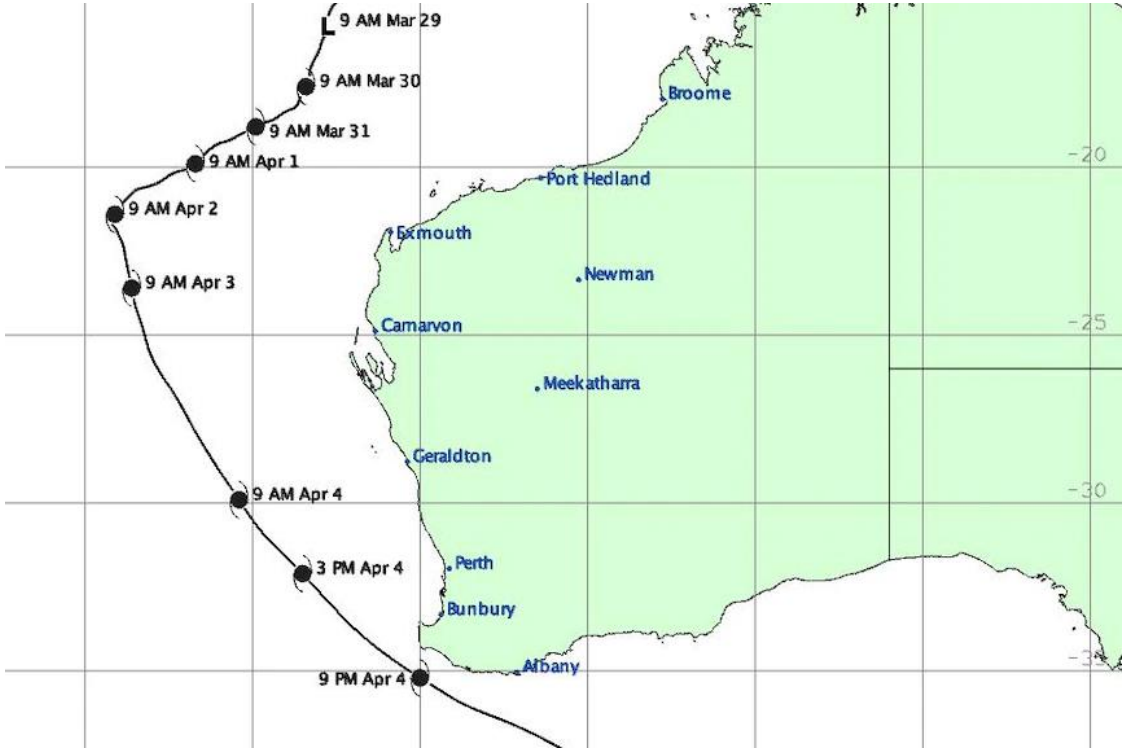
Territorian Hotel (rebranded as the Frontier Darwin; seen in 2019)


Photo : Laurie Gwynne

airey taylor consulting
engineers
scientists

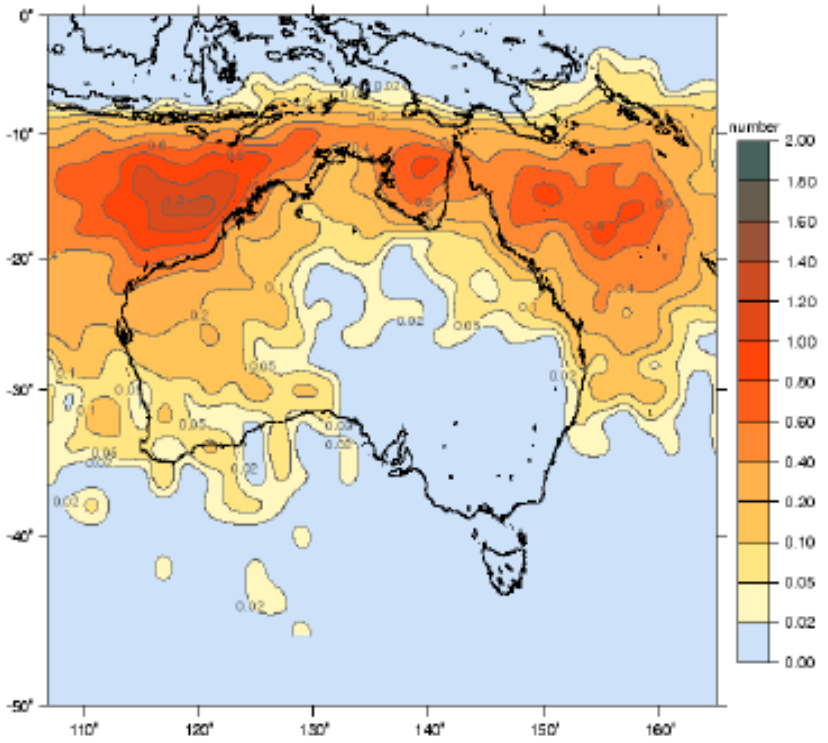
# Cyclone Alby, March-April 1978

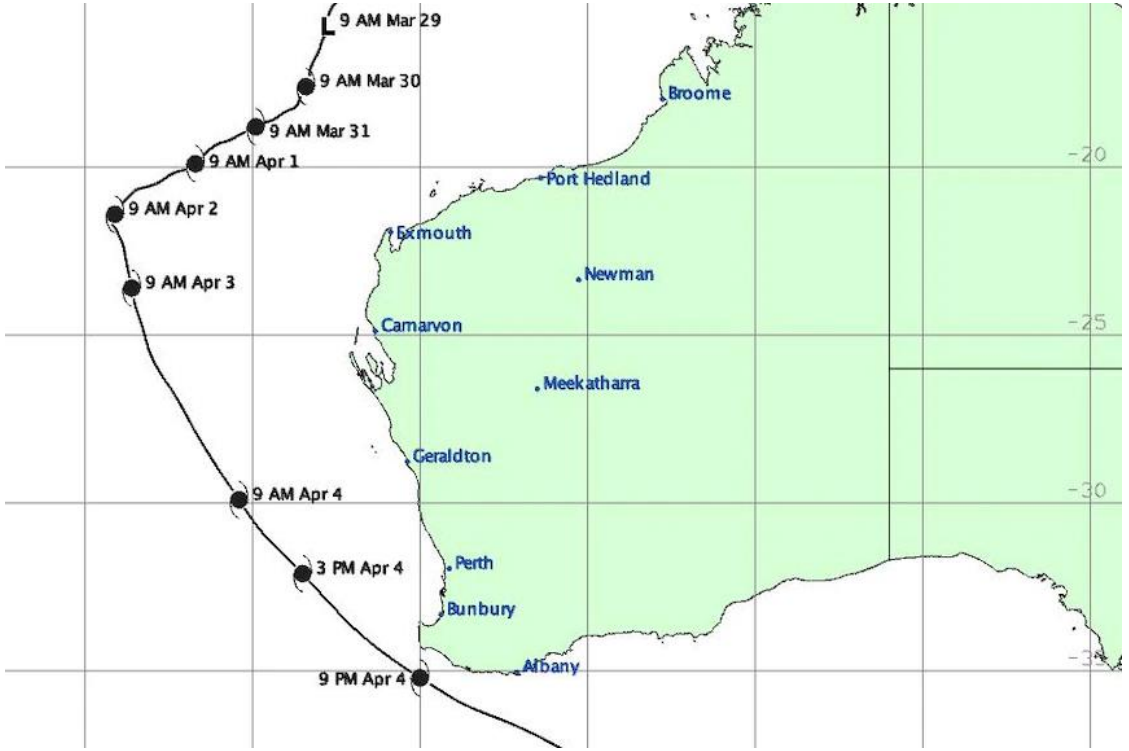



airey taylor consulting
engineers
scientists

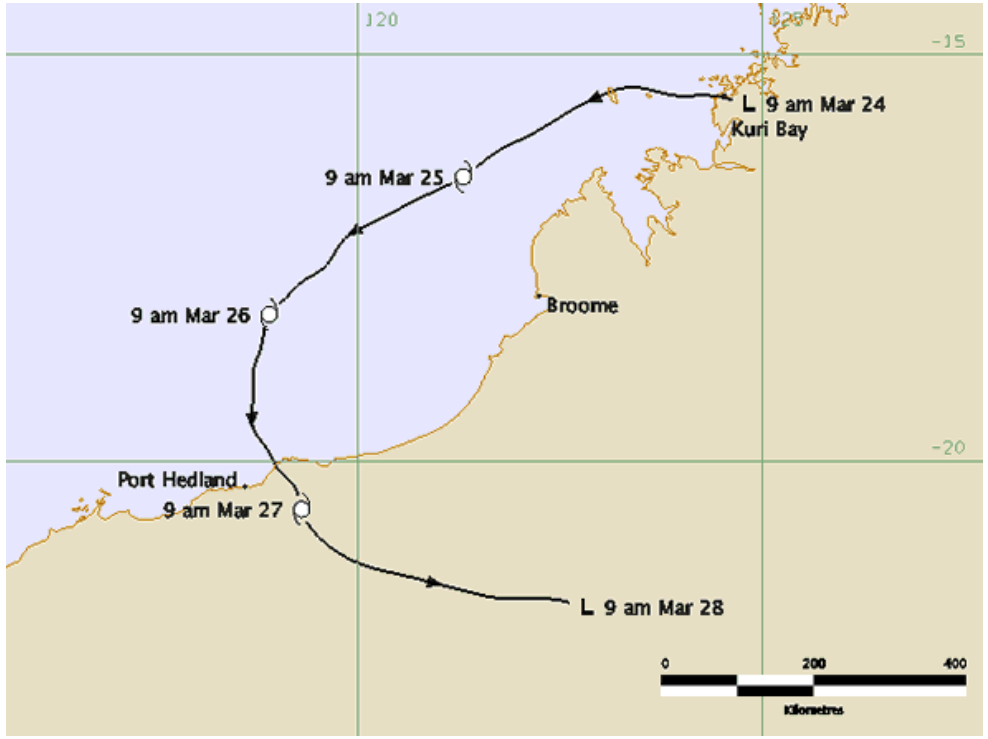
# Cyclone Alby, March-April 1978




airey taylor consulting
engineers
scientists

# Cyclone Leo, 24 – 28 March, 1977



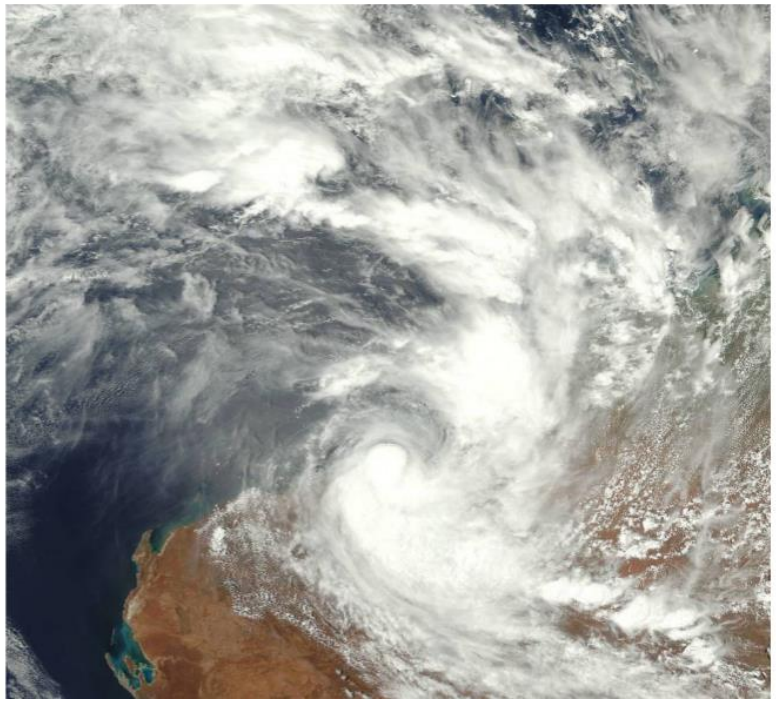

Australian Government
Bureau of Meteorology

DFES

Town of Port Hedland

**Cyclone Information**
**Be Aware and Be Prepared**

Town of Port Hedland Cyclone Information Booklet

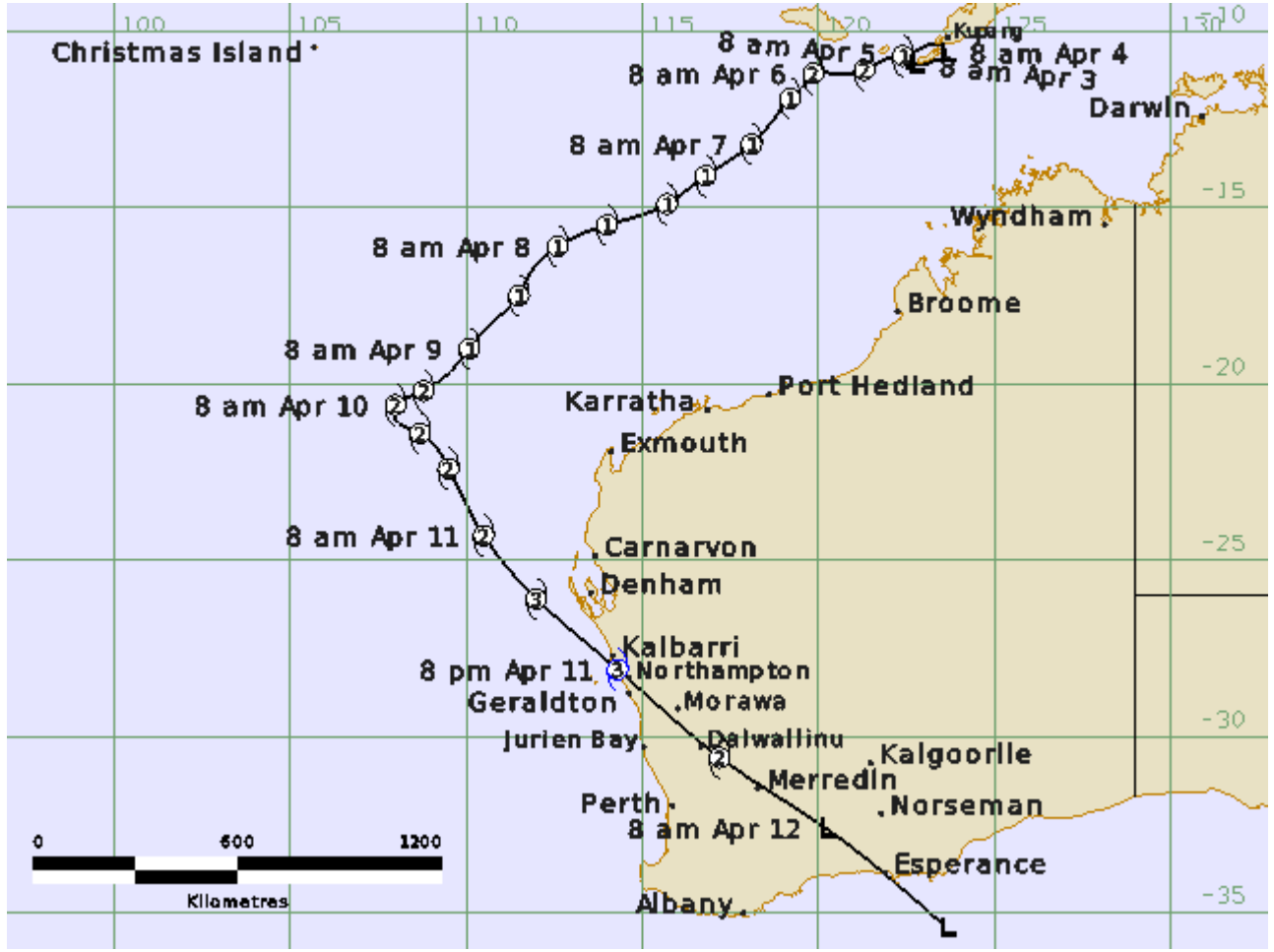


airey taylor consulting
engineers
scientists

ENGINEERS
AUSTRALIA

# Cyclone Seroja, 3 – 12 April 2021


ABC News, photo : Hugh Sando




airey taylor consulting
engineers
scientists

ENGINEERS
AUSTRALIA

# Full chain of effective responsibility

a) Structural Design

b) Peer review of Structural Design

c) Valid Approval Process prior to Construction

d) Check that Design intent fully implemented

e) Active Maintenance of Buildings after Construction

airey taylor consulting
engineers
scientists

ENGINEERS
AUSTRALIA

# As Engineers, we need a higher level of involvement

a) Design, then peer group review of that Design

b) Quality Assurance during Construction

c) Structural review process for buildings > 20 years in place

airey taylor consulting
engineers
scientists

# State Coroner report notes and recommendations, 2014

a) Failure to design proper anchors against wind loads
b) No vetting of application for building licence by Local Authority
c) On-site supervision did not ensure design implemented properly

*"..the Western Australian government consider introducing mandatory inspections to Wind Regions D & C to achieve greater construction compliance with the applicable Building Standards set our in the Building Regulation Act 2012"*

# State Coroner report notes and recommendations, 2014

a) Failure to design proper anchors against wind loads
b) No vetting of application for building licence by Local Authority
c) On-site supervision did not ensure design implemented properly

*"..the Western Australian government consider introducing mandatory inspections to Wind Regions D & C to achieve greater construction compliance with the applicable Building Standards set our in the Building Regulation Act 2012"*

# Have we improved?

# AS/NZS 1170.2

- Updated with new research and experience
- Re-examined after each major event
- Flexibility with building form and shape
- Non-discrete output (pressures)

# AS 4055

- Compatible with AS/NZS 1170.2
- Geometric limits important
- Simpler, faster – mix of conservative assumptions and non-conservative
- Discrete output – wind classifications (used to order products rated to same classifications)

# Cyclones load test communities

- TC Debbie – ~ 100% ultimate design wind load (C)
- TC Damien – 50% ultimate design wind load (D)
- TC Seroja – 65% ultimate design wind load (B)

# TC Debbie

# Wind classifications

**Housing AS 4055**

- Geometric limitations
- All directions
- Terrain
- Topography
- Shielding

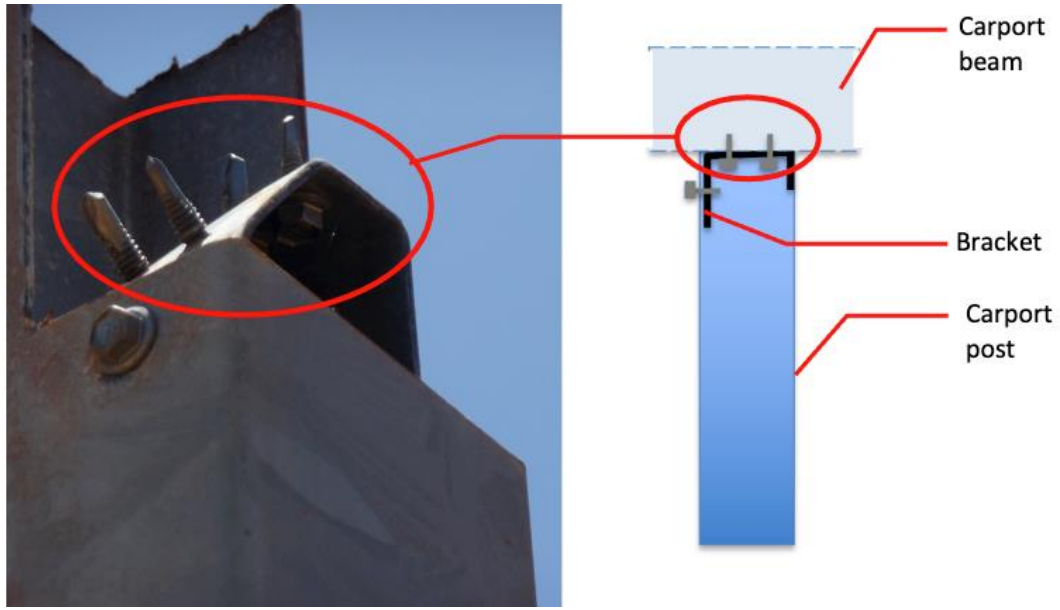
**AS/NZS 1170.2**

- 8 directions
- Terrain
- Topography
- Shielding

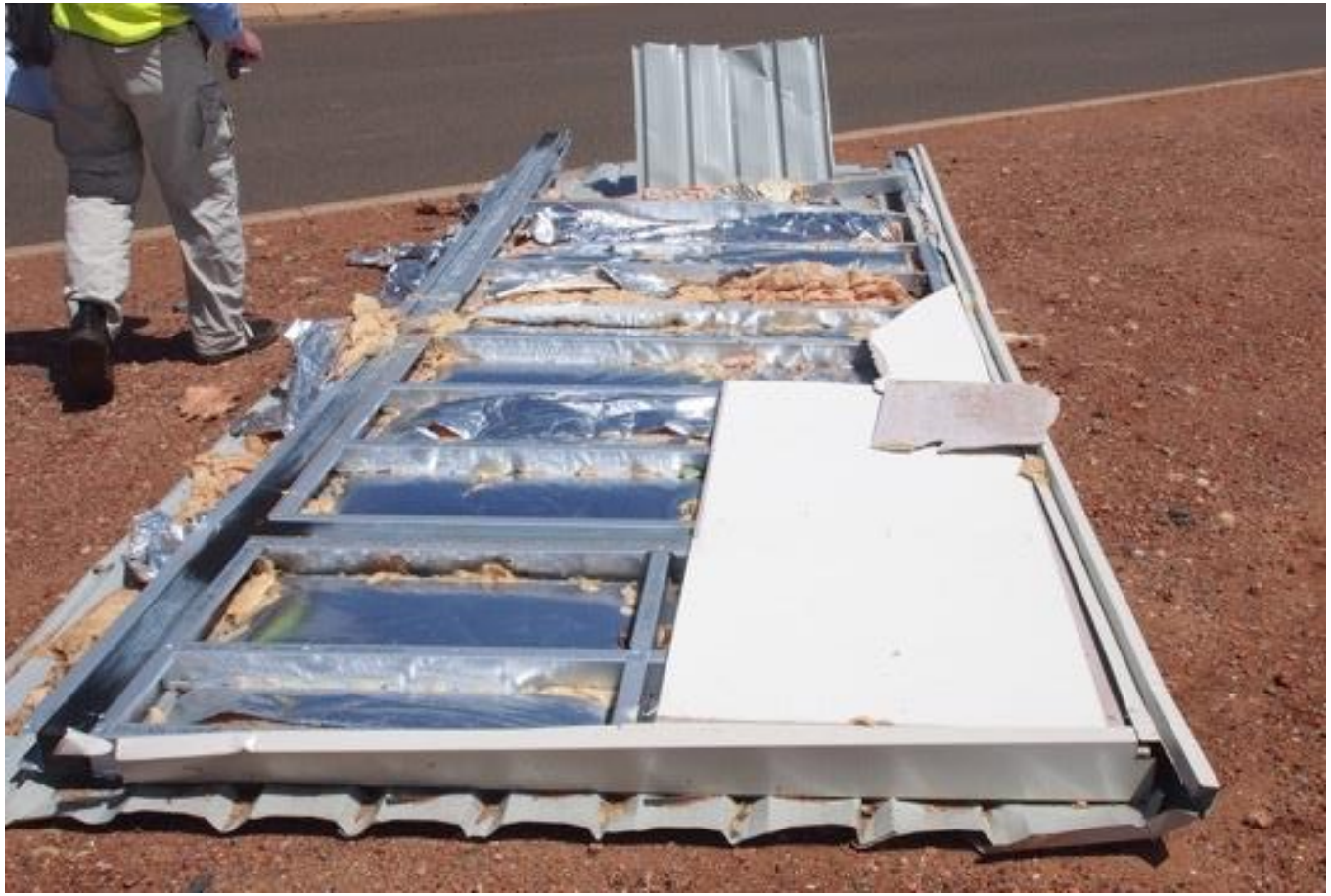
# Design to minimise water ingress

- Seals on windows and doors
- Water penetration tests
- Flashing details

# TC Damien




# Details, details, details



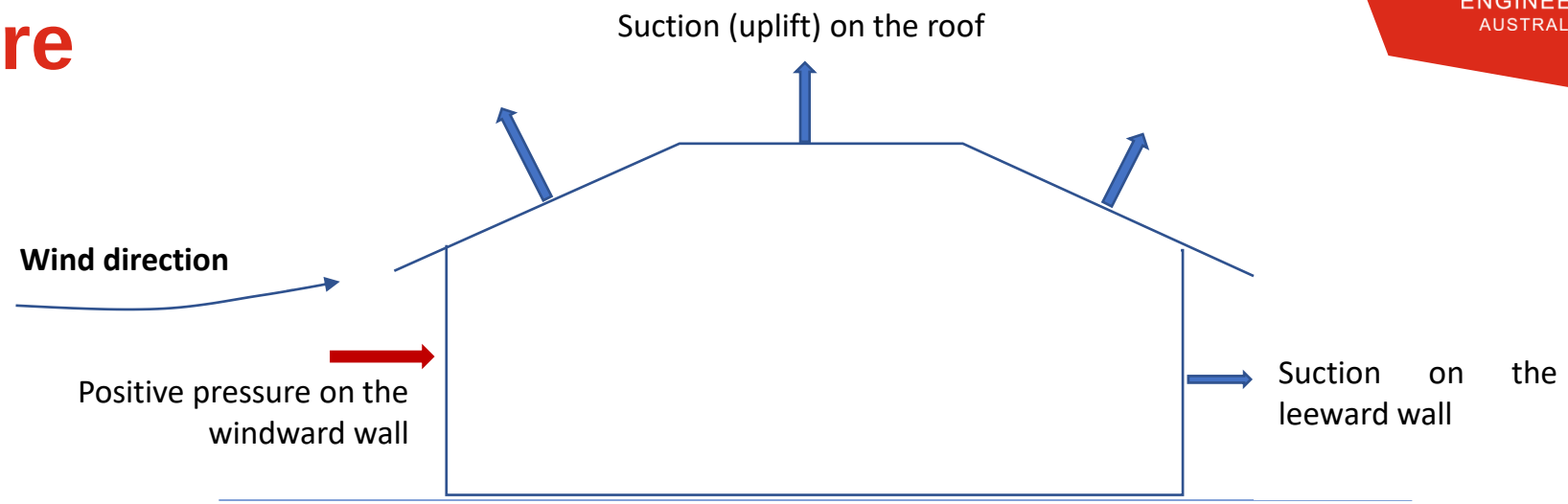
# Openings TC Debbie

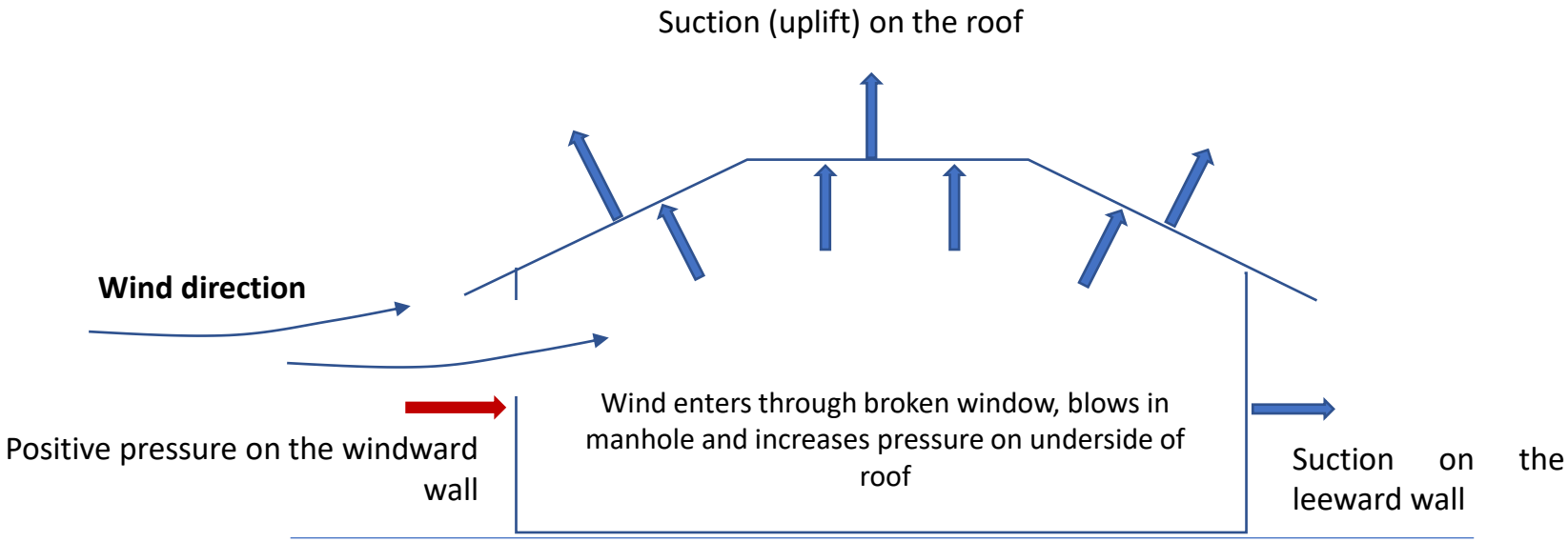
(Wind region C) Roofs OK

# Openings TC Seroja

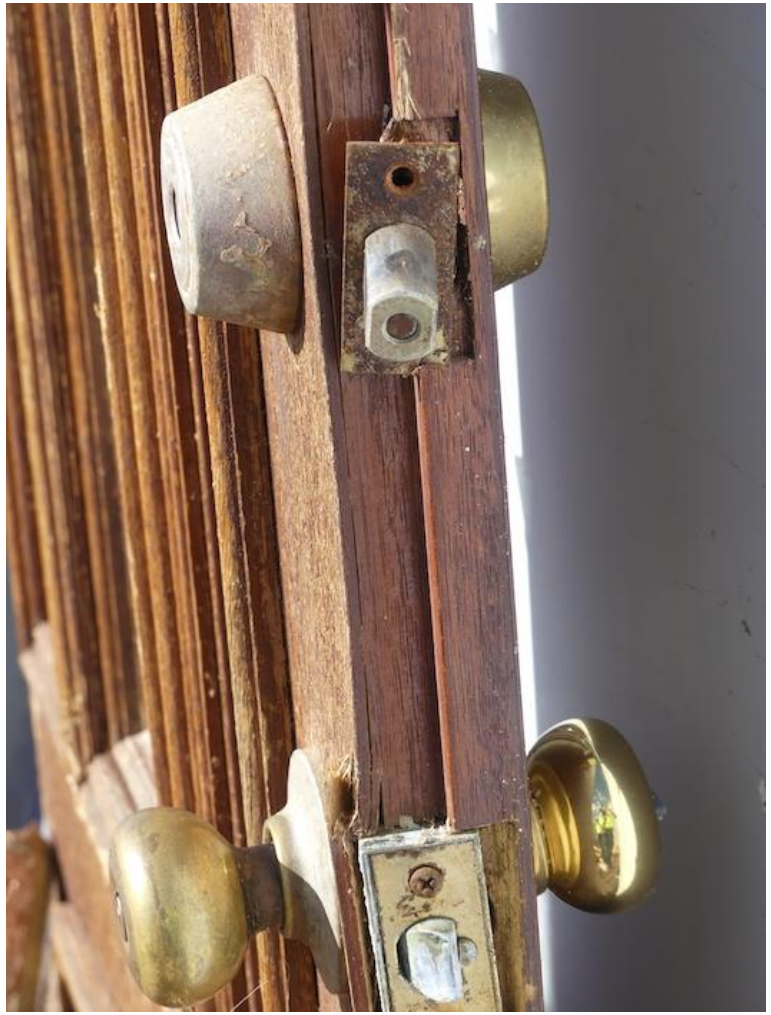
(Wind region B) Roofs not OK

# Internal pressure – cyclone areas



# Entrance doors



# Garage doors

# New wind standards


**AS/NZS 1170.2:2021 and AS 4055**

- No TC 1.5
- Climate change factor for cyclone areas
- Interpolation of $V_R$ within wind regions C and D
- Internal pressure includes $K_l$ for opening position and a volume factor

# AWES

- Research on wind actions
- Publications e.g. commentary
- Annual workshops
- Access to wind engineering community
  - https://www.youtube.com/watch?v=DfJx830H9JA
- CTS test methods for debris loadings

# Conclusions

- External combined with internal pressures
- Must assume high internal pressures to satisfy robustness requirements for cyclones
- Cyclones affect whole communities

- **Whole process MUST BE right**
  - Design – structure, cladding, weatherproofing
  - Approval
  - Construction – Inspection?
  - Maintenance and operation

- Climate change – more intense, further south?

- Community safety and resilience is dependent on engineers getting design and construction right

# Q&A

# Upcoming events


## Climate Smart Engineering Conference
16-17 November 2021

*Virtual Event*

Al Gore, Keynote Speaker

CSE will demonstrate the pivotal role of engineering in providing sustainable solutions, systems and efficiencies, which in turn provides the pathway by which business and government may avoid serious climate consequences.

ENGINEERS
AUSTRALIA

**engineersaustralia.org.au**

@EngAustralia

facebook.com/EngineersAustralia

engineersaustralia.org.au/linkedin