



Investigation of Damage: Brisbane 27 Nov 2014 Severe Storm Event

Cyclone Testing Station, James Cook University

Korah Parackal, Matthew Mason, David Henderson, Daniel Smith and John Ginger



Cyclone Tracy:

- Peak gust estimated 250 km/h
- Some suburbs: 90% of houses destroyed
- In comparison, engineered structures performed well



- Testing of individual screws to whole houses
- Wind tunnel tests
- Vulnerability studies
- Damage investigations



The 27 November Brisbane Thunderstorm

- Severe hail and damaging winds
- \$1.3bn in damage – Mostly vehicles
- Media frequently reported wind speeds of 140 km/h

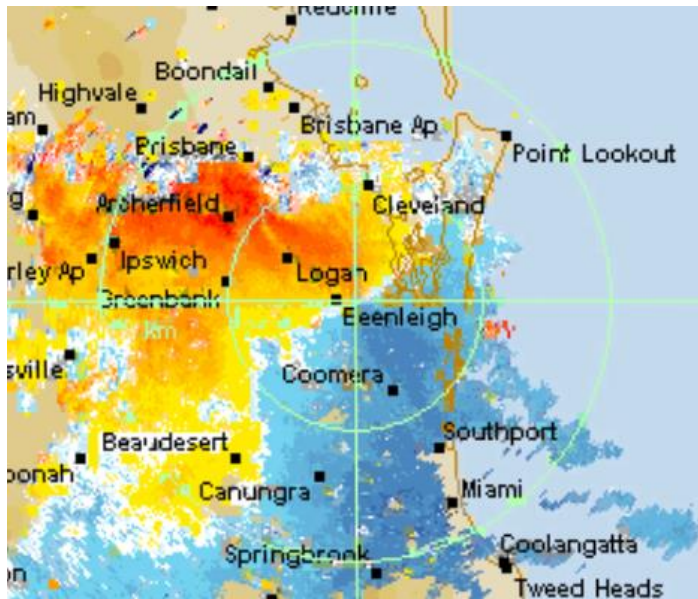


BoM



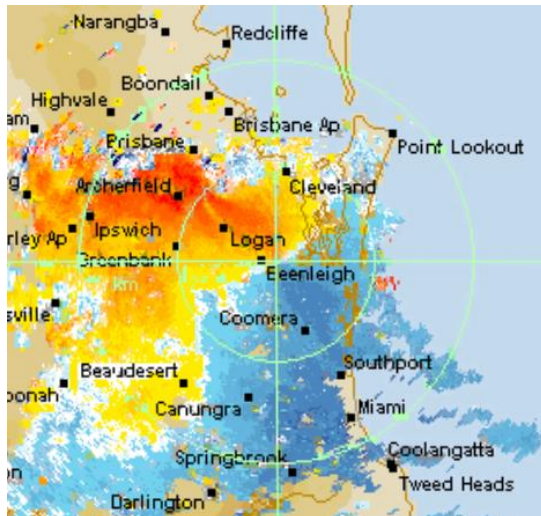
Brisbane Times

- Aims of investigation:
 - **Analysis of wind field:** what were wind speeds in affected suburbs?
 - **Damage assessment :** why did failures occur?



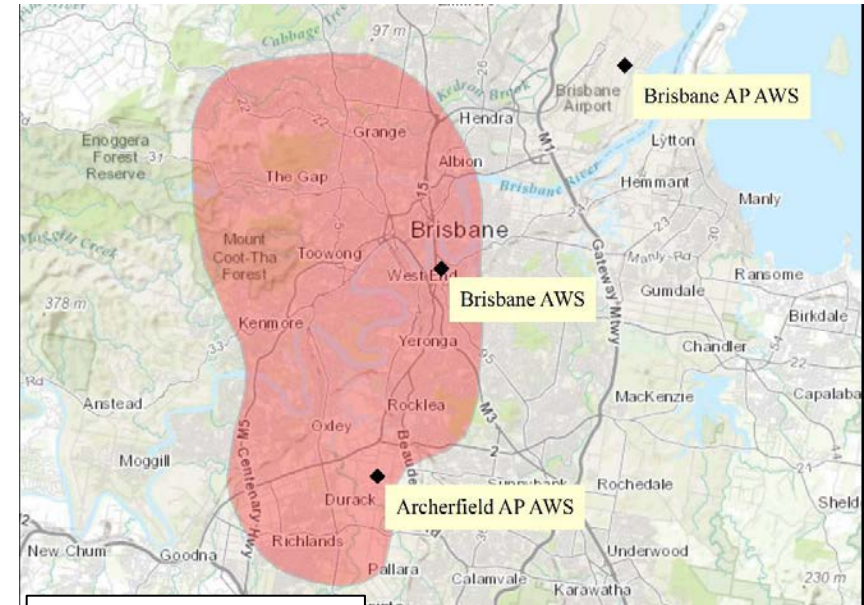
Analysis of Wind Field

- Based on: AWS data, Doppler Radar and field observations.
- 141km/h gust at Archerfield due to intensification of downdraft over the airport
- Wind speeds in most affected areas: 80km/h to 100km/h
= Less than design wind speeds



Doppler radar imagery

Diverging winds at Archerfield AP



High wind area

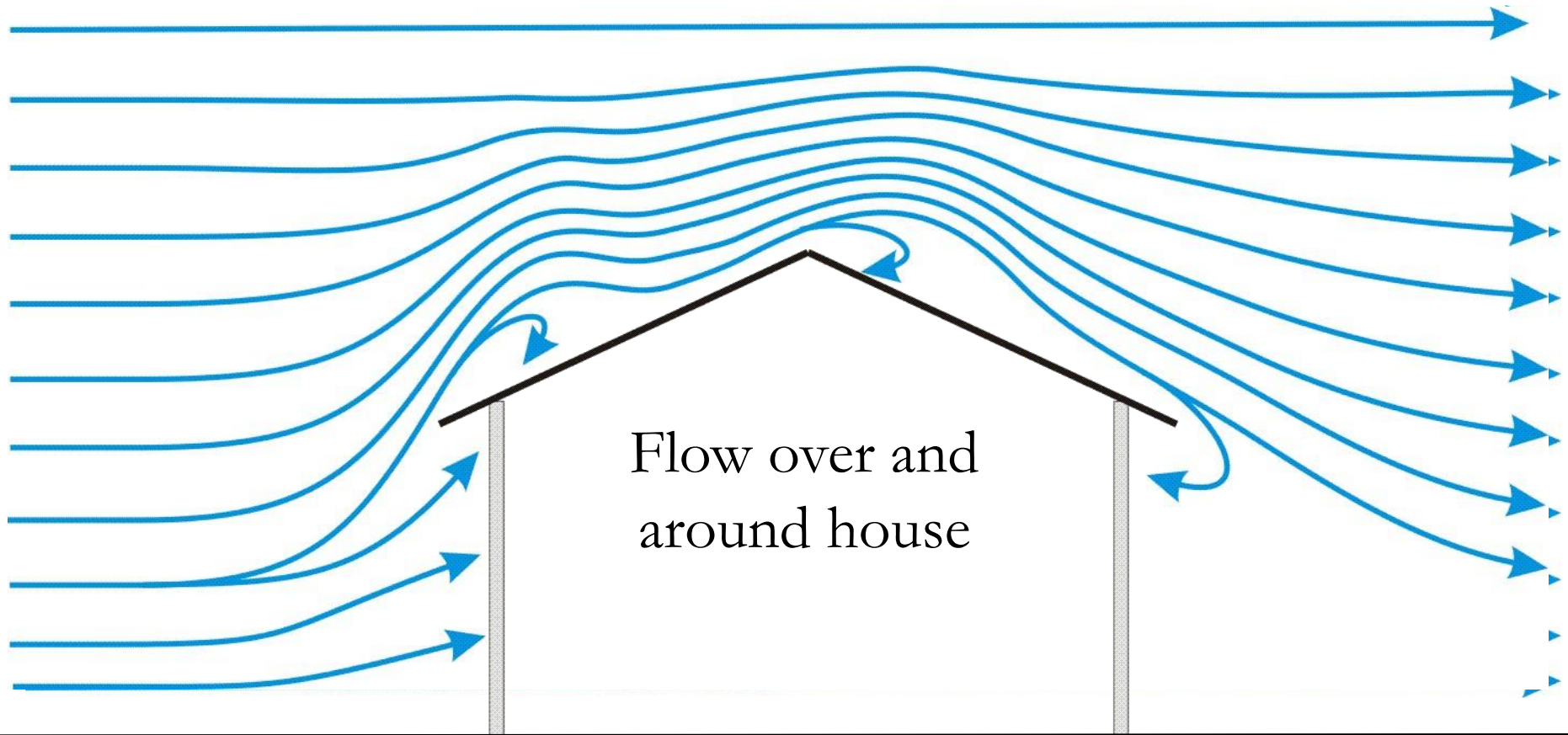
Structural Damage

- Several of these buildings had been renovated –Why did they fail?

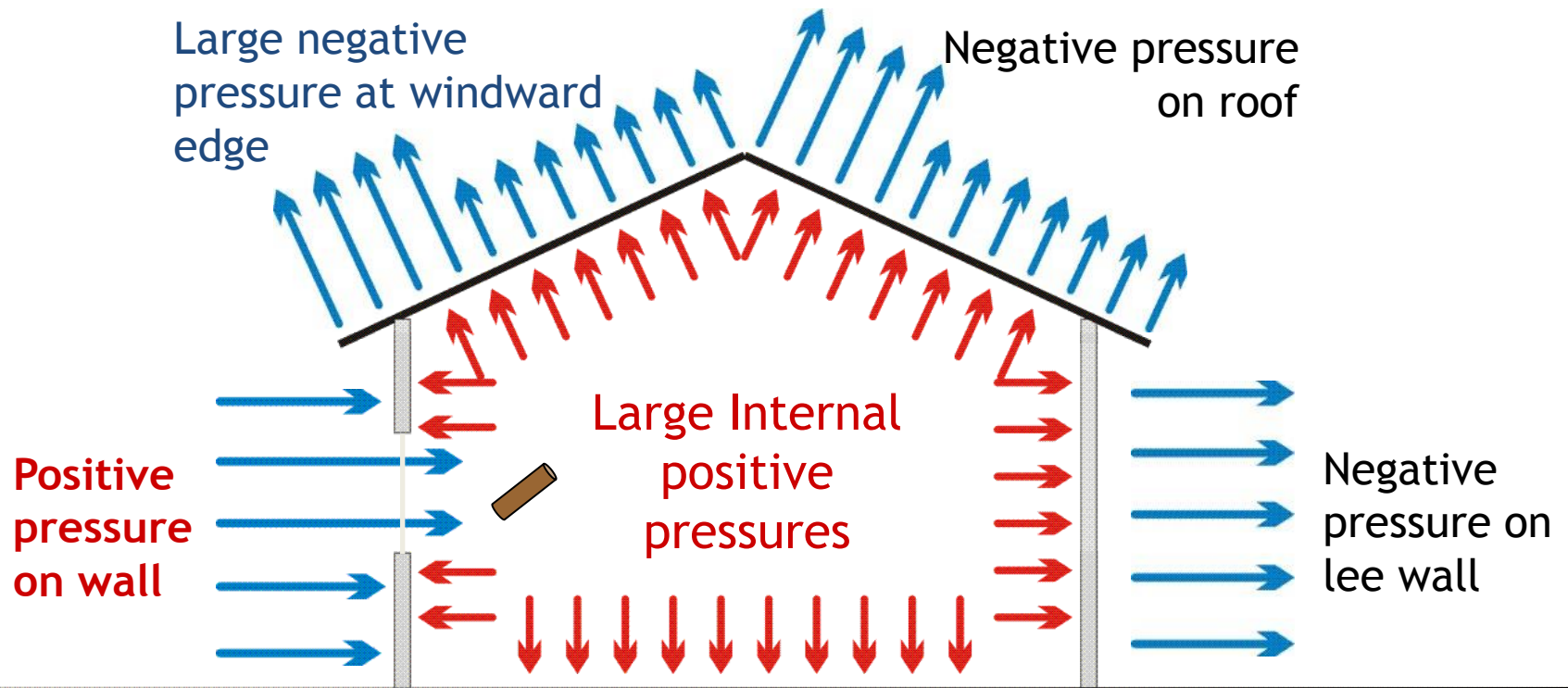


Wind Loads on Roofs

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

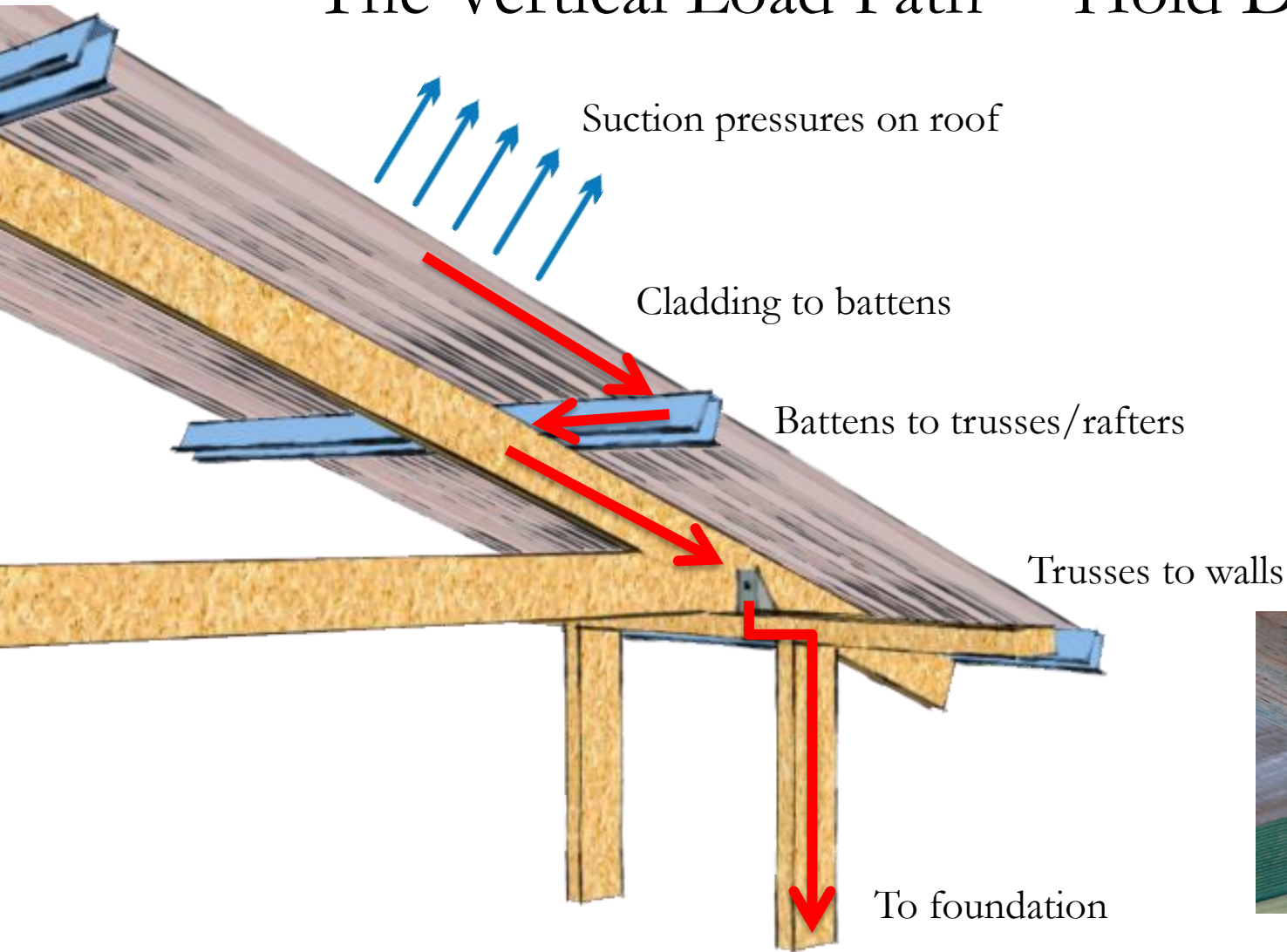


Wind Loads on Roofs



Housing design standard AS4055 requires design for a dominant opening for cyclonic regions only – not Brisbane

The Vertical Load Path – ‘Hold Down Chain’



The weakest link in the chain of connections = the point of failure

Loss of Cladding

Originally a tile roof, the new metal cladding was fastened to every 3rd batten



Loss of Cladding and Battens

Again, originally a tile roof. New metal cladding fastened to every 6th batten!



Loss of Entire Roof

Due to internal pressures and inadequate rafter tie-down

+ Inadequate rafter tie-down...



Window Broken by hail resulting in internal pressures



= entire roof torn away.



(a new roof is currently being installed)

Debris Damage



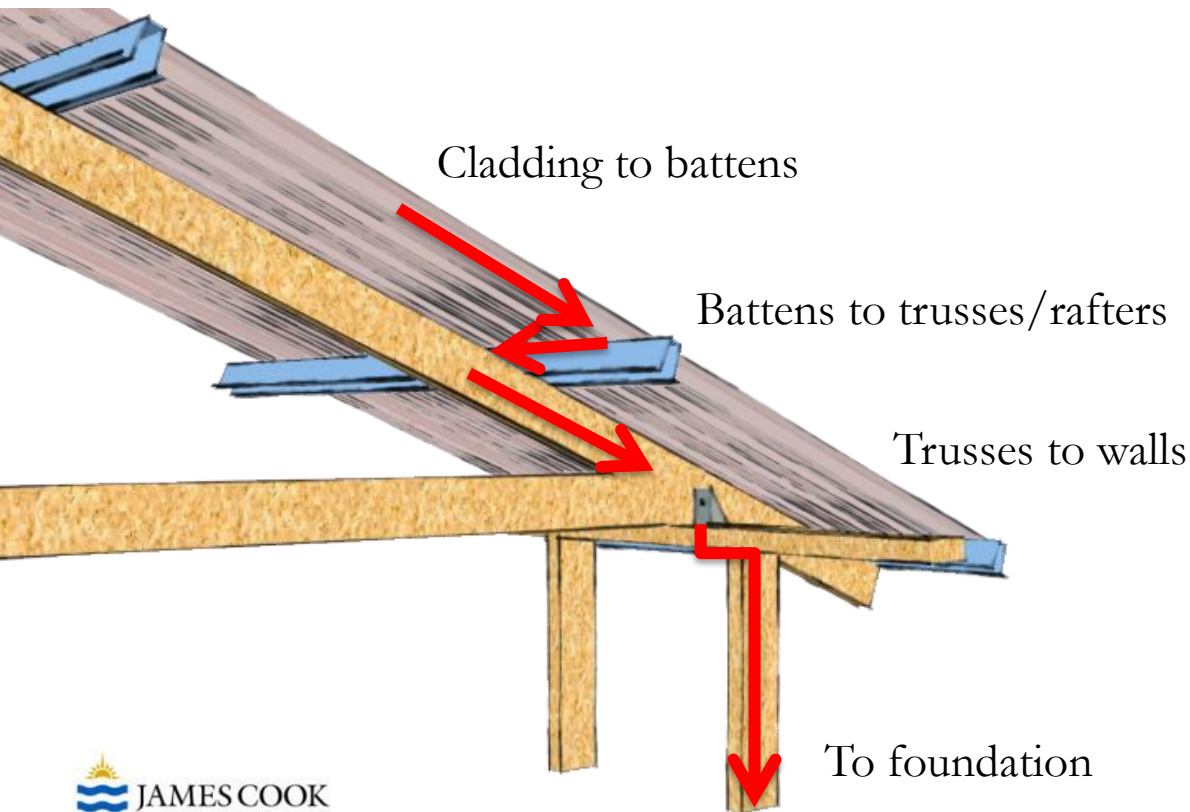
Hail Damage

- Most windows on southern side broken
- Significant horizontal component due to wind
- New windows performed better



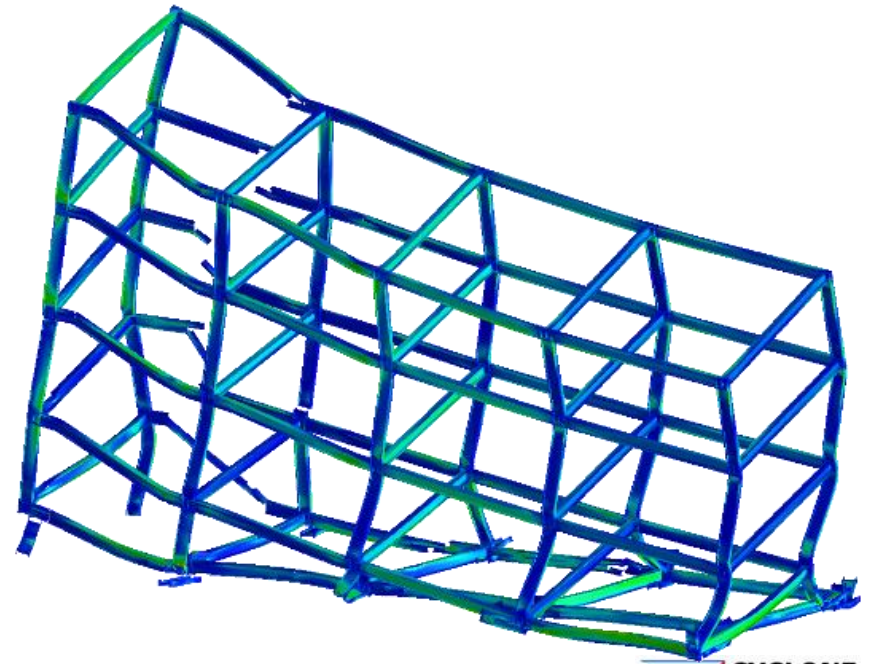
Summary:

The entire 'hold-down chain' must be considered during renovation work



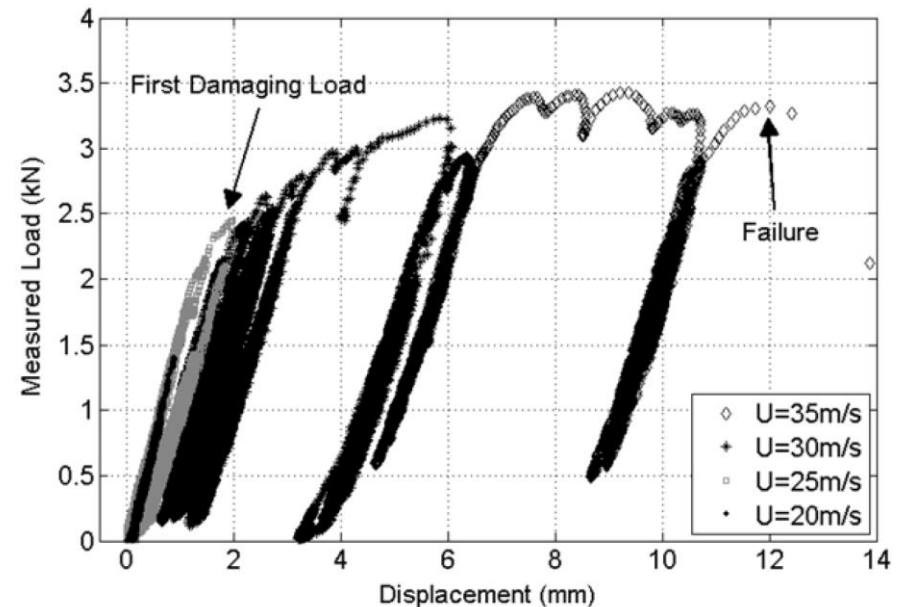
New Research – Cascading Failures

Investigating progressive failure mechanisms in roof systems using computer models



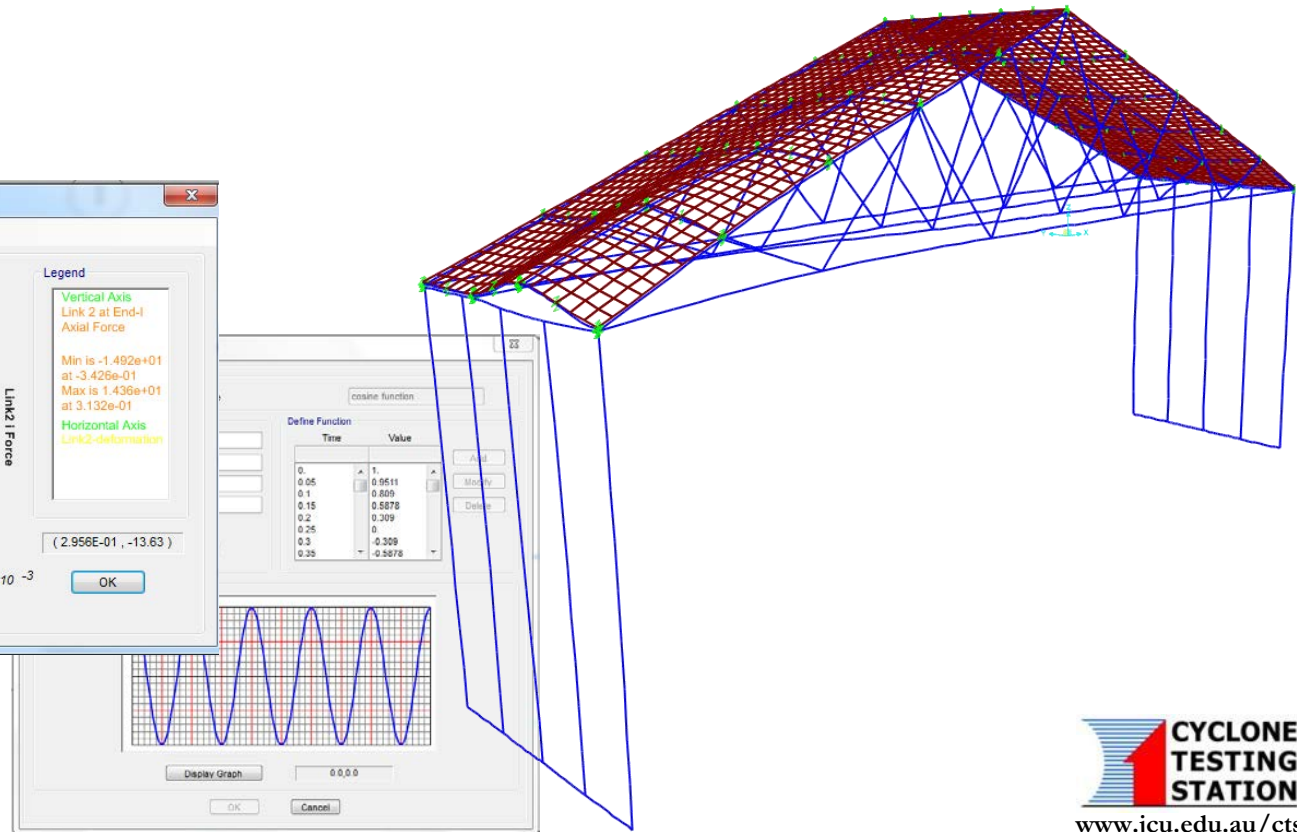
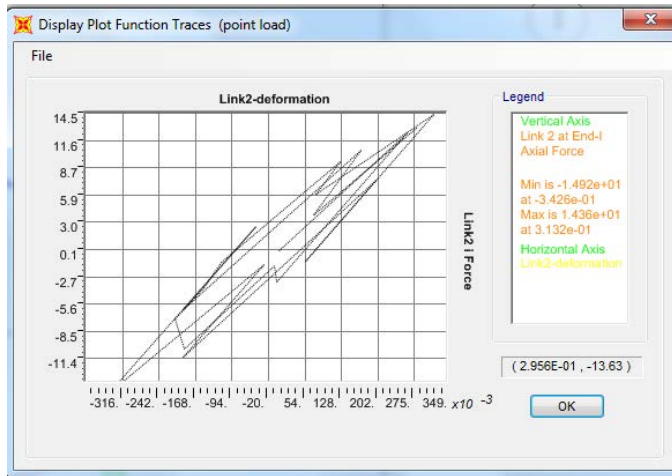
Methodology

1. Physical testing of individual connections to determine non-linear behaviour



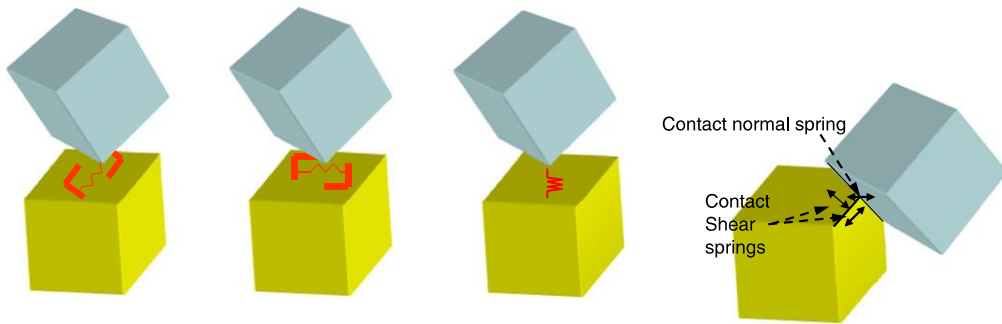
Methodology

2. Computer simulation to examine progressive failures

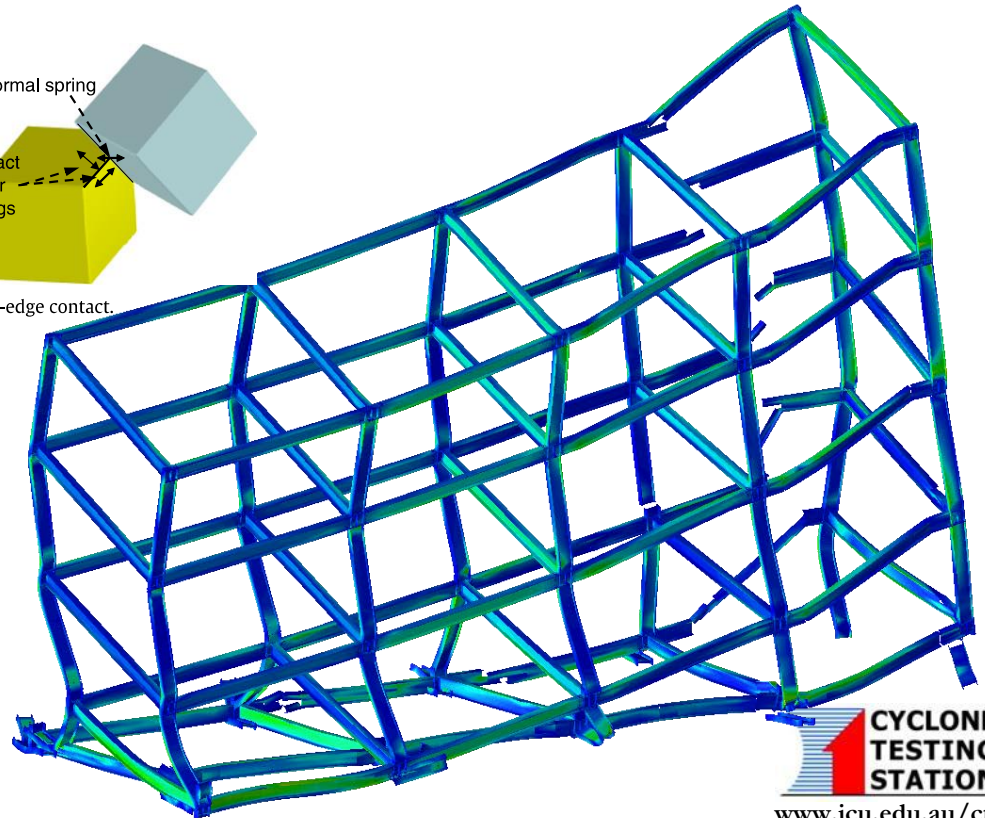


The Applied Element Method

A new method designed for problems with separation and collision of elements



(b) Edge-to-edge contact.



*Element Contact and Collision,
From Saleem et al. 2014*



Thank you

Useful Resources

qbcc
queensland building
and construction commission

TIMBER
QUEENSLAND
We build Queensland

Repair of sheet metal roofs in cyclonic areas

Guideline - February 2015

Build better.

Queensland Reconstruction Authority

OPERATION
QUEENSLAND

Planning for a stronger, more resilient North Queensland

Part 2
Wind resistant housing

CYCLONES... IS YOUR HOUSE READY?

A Homeowner's Guide

THIS GUIDE WAS PREPARED BY THE CYCLONE TESTING STATION WITH SUPPORT FROM
NORTHERN TERRITORY, QUEENSLAND AND WESTERN AUSTRALIAN GOVERNMENTS

Northern
Territory
Government

Queensland
Government
Department of
Infrastructure
and
Planning

Government of Western Australia
Department of Commerce
Building Commission

Cyclone
Testing
Station



Light Framed Structures are Complex

- Large number of members and connections
- Load-sharing and partial composite action
- Non-linear behavior of connections to extreme loads

