# Lessons emerge from Cyclone Debbie aftermath

**The findings from the technical report into damage to buildings from Tropical Cyclone (TC) Debbie in northern Queensland released in late June reveal there are still issues associated with affixing flashings and cladding, loosened debris from garden sheds and steel fencing, but that roller doors meeting the revised standard prove more resilient.**

As such, the Report undertaken by the Cyclone Testing Station (CTS) at James Cook University has important lessons for those building with steel in cyclone-prone regions of Australia.

TC Debbie was a severe, slow moving tropical cyclone with a relatively wide sweep that crossed the Queensland coast south of Bowen on 28 March with wind gusts up to 263kph (as recorded on Hamilton Island).

The study area extended between Ayr and Proserpine and looked at both contemporary buildings constructed using current regulations (to determine whether their performance was appropriate for high wind speeds experienced) and older buildings (to determine the need for retrofitting and the effectiveness of past structural upgrades).

The CTS teams assessed the causes of damage to buildings from wind, wind-driven rainwater and storm surges. Generally, winds experienced in the subject of the study were found to be less than design wind speeds.

Overall, the study found that building envelopes are still not adequately designed to resist wind-driven rain, an issue consistently reported in every post-cyclone damage assessment conducted by the CTS for the past 40 years.

## Damage from debris

Whilst the study generally found little or no major structural damage to larger engineered sheds, many backyard sheds and garages that failed during TC Debbie contributed to wind-borne debris, increasing safety risks and damage to other buildings, so urges that they should also be designed and built to resist the site wind speed as per established ShedSafe industry guidelines.

Many cases were found with some older sheds and garages that incorporated frames failed in racking and some more recent sheds that used panel construction failing completely. A lack of capacity in the connections between the panels or in the connection with the ground generally contributed to the failures.

The second most common mode of damage was fencing as noted in the Rapid Damage Assessment data provided by Queensland Fire and Emergency Services and NSW Fire and Rescue.

There were two main modes of failure in sheet metal fences: failure of the steel posts and detachment of sheet panels from the frame. Sheet metal fences are also non-porous and more likely to become wind-borne debris due to their light weight and shape.

But whilst steel mesh fencing was also common throughout the study area, it generally performed well. The wind loads on steel mesh or grid fences are generally lower than the wind loads on other types of fences as they are very porous. The investigation did not find any steel mesh fences that failed under wind loads.

Due to its porosity, this fencing is the only type that has the potential to effectively resist wind forces. Composite fences with metal mesh infill also performed well under wind loads.

## Cladding and flashing fails

Whilst no cases were observed where portal frames (either hot-rolled or cold-formed) were harmed, the main damage was to claddings (particularly polycarbonate roof and wall sheeting) or flashing elements, large doors and cold-formed purlins and bridging elements.

Failure of cladding systems was initiated by loss of strength from corroded fasteners, evident with contemporary structures adjacent to marine environments. In other cases, damage of the roof-to-wall connection caused only partial roof loss. Such portions of roof that became detached included universal beam (UB) sections, cold rolled steel C-purlins, top hat battens, and roofing. The usual point of detachment was at the connection between the UB sections and concrete walls.

In contemporary construction where the cladding had separated from purlins or battens, the damage was usually near edges of walls or roofs. The failures observed involved systems that were not installed to appropriate specifications and in some cases, flashing damage may have contributed to the damage.

It also recommended that roof-to-wall connections need to be upgraded when roof tiles are replaced with metal sheeting. Metal sheeting is much lighter than tiles so the net uplift on a roof with metal cladding is much higher than that for a roof with tiles so tie-down connections between the roof structure and the walls need to have higher capacity.

The report urged that where possible, roof designs be simpler with fewer valley gutters and flashings to reduce the risk of rainwater ingress. Minimising roof penetrations such as vent pipes also decreases opportunities for wind-driven rain to enter buildings under or through flashings.

Previous investigations following severe wind events have found that flashings fastened with pop rivets have often detached from buildings. Flashings that were fastened with screws on all sides performed well. In a few buildings assessed during the investigation, loss of flashings contributed to partial loss of the adjacent roof sheeting.

The report recommended that AS 1562.1 (Standards Australia, 1992) should specify minimum requirements for flashings and their fixings to resist applied wind loads. HB39 currently recommends appropriate screws (not pop rivets) at a maximum of 600 mm centres and on horizontal and vertical faces of barge flashing.

## Gutted gutters

The Report also recommended the performance of guttering could be improved by increasing the number and stiffness of gutter brackets used to prevent loss of perimeter gutters and detailing roof drainage to minimise gutters being blocked by the large volumes of airborne leaf matter, often present during tropical cyclones.

For many buildings, relatively minor damage to gutters caused disproportionate damage to building linings and contents. Box gutters usually only have a drain at one end and strong winds can drive water pooled in the gutter to the opposite end to the drain where it piles up and overflows into the ceiling space.

Each end should have a spillway overflow so the overflows can't be blocked by detritus. The back edge of eaves gutters should be higher than the front so that they overflow to the outside of the building rather than into the eaves and ceiling space.

It also found that soffits made from adequately fastened resilient materials, such as steel sheeting or composite materials successfully resisted wind pressures and suffered only local damage under debris impact.

Less resilient materials were significantly damaged after relatively minor debris impacts so the Report suggests using linings such as steel sheet cladding to improve the resilience of soffits to water saturation and debris impact.

## Resilient roller doors

The performance of roller doors covered by the study strongly suggests newer ones built and installed to AS/NZS 4505:2012 are much more resilient to cyclone damage.

The poor performance of pre-2012 roller doors in this event indicates that many buildings are still vulnerable to large internal pressures. The most common failure mechanism for roller doors installed before 2012 was disengagement of the door from its tracks. Wind locks should not be retrofitted to existing roller doors unless the guides, supporting structure and walls of the building can carry the additional loads.

No failures of roller door curtains with wind locks were observed in this investigation. However, one roller door with wind locks tore the left guide from the building because the connections to the structure were inadequate to resist the catenary forces.

## Pre-1980s buildings

Inadequate tie-down details between battens and rafters or trusses and between the roof structure and walls caused many of the structural failures in buildings constructed before the 1980s. Connections between verandah beams and posts on some buildings with larger verandahs also failed.

The report recommended that inspection and maintenance of structural elements such as those within the roof space, verandah posts, house stumps and associated steel bolts, should be undertaken every seven to ten years (and shorter intervals for pest inspections).

Older housing also presented most of the failures of pierced-fixed metal cladding systems where the roofing had come off the house whilst still attached to the battens. The batten connection was of the old plain shank nail variety where the connection really needed to be a batten screw or nailed stap.

The full Report can be accessed via: www.jcu.edu.au/__data/assets/pdf_file/0009/461178/TC-Debbie-report.pdf