Tropical Cyclone Larry

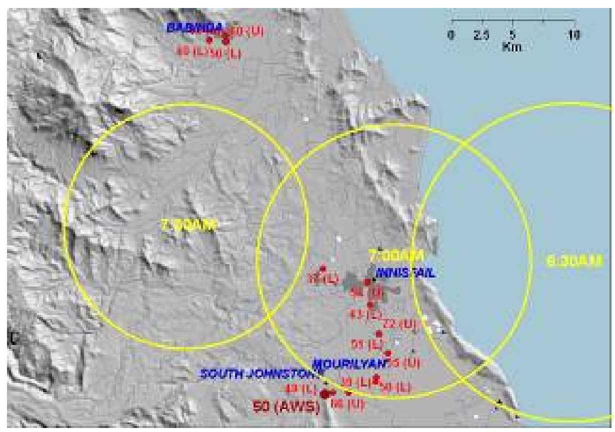
Tropical Cyclone Larry crossed the North Queensland coast in the early morning of Monday 20th March 2006 and caused severe damage to infrastructure and crops in the Innisfail region. Wind damage was reported by the media well into the Atherton Tablelands and flooding was reported in the Innisfail area, the Tablelands and into the Gulf country.

The cyclone caused significant community disruption within the affected area. Lifelines (e.g. power, phones, roads) were severely disrupted. It took weeks to restore communications and power, with some properties un-connected for months. It is anticipated that the rebuilding will take well over a year. At the end of September it was reported that there were still 1000 tarped houses, awaiting repair or demolition.

The Bureau of Meteorology forecast Cyclone Larry as an extremely destructive Category 5 cyclone prior to it crossing the coast about 10km ESE of Innisfail. The cyclone then travelled in a WNW track overland at a fast forward speed of about 30 kph with the 25 km diameter eye passing over Innisfail. If the cyclone did not have such a fast, forward movement it is likely that structural damage levels, wind driven debris and water ingress would have been far worse for a slower moving system. This reduced duration of intense winds also minimised the potential for fatigue failure of metal cladding, fixings and battens.

Estimates of peak winds were determined by calculating wind loads required to cause failure of simple structures such as signs or hoardings. Reliable estimates of wind speeds across the region are required in order to assess the performance of buildings and standards. In particular, it is necessary to determine the relationship of the estimated wind speed to the current design wind speed. These engineering wind speed estimates also plays an important part in the meteorological post mortem of the event.

Simple structures (e.g. road-signs) were used to estimate upper and lower bounds of peak gust wind speeds at different locations in the study area. Undamaged sign posts give an upper bound to the wind speed as the signs resisted the wind loads, while bent posts give a lower bound to wind speed as they failed during the event.



The maximum gust wind speeds (referenced to flat open country at a height of 10 m) across the study area were estimated to range from 50 m/s to 65 m/s.

This estimate of peak winds in open terrain correlates with the Bureau of Meteorology's reanalysis of Cyclone Larry at landfall. Their reviews of data suggest that TC Larry was a Category 4 system when it crossed the coast.

If Cyclone Larry had been a Cat 5 system when it crossed the coast, damage from the winds would have been much worse. Wind pressure is proportional to wind velocity squared. That is, a small increase in wind speed gives a larger increase in wind loads!

The wind loading standard AS/NZS 1170.2 gives a strength limit state design wind speed of nearly 70 m/s referenced at 10 m height in open terrain, for the cyclonic regions of North Queensland. The damage investigation estimated the peak wind speeds to be less than this design value. This implies that structures designed to the wind loading standard should be structurally adequate for the wind forces generated during Cyclone Larry.

Housing constructed since the mid 1980s performed well, structurally. This is to be expected due to the contemporary housing having a regional design wind speed greater than the event wind speed. The main source of structural damage to newer construction was from wind driven debris. For a small number of cases, poor detailing led to loss of structural elements. In general, garage doors performed poorly leading to water ingress, internal pressurization and subsequent damage. The loss of flashings, guttering vents and soffits also contributed to water ingress, which on occasion resulted in the collapse of the ceiling. Such collapse could lead to structural problems if the ceiling is relied upon to provide diaphragm action to link bracing walls.

Increase in wind speeds due to speed up over steep topography did cause increase in damage to buildings. This was more apparent in the older housing. However there were a few cases of damage to contemporary houses, where the construction details were inadequate for the site topography. This highlights the need for each building site to have the topographic wind speed modifiers (AS/NZS1170.2, or AS4055) correctly specified.

Also, in assessing the topographic and terrain effects in tropical cyclone areas, the sheltering effects of vegetation should be ignored. This is because it invariably is denuded by winds less than the design wind velocity.

Most commercial and light industrial buildings surveyed had some form of damage including water ingress, loss of flashings, roller door failures, cladding loss, and in some cases, structural frame failure. Apparent poor detailing of structural connections contributed to failure of some structures. A street side assessment of cold formed industrial sheds showed that approximately 30% of these engineered structures suffered loss of cladding through to complete collapse. This is at wind loads less than the region's design wind speed where structural failures should not be expected. For 60% of industrial sheds surveyed, that had roller doors were fitted, the roller doors had failed. Designers need to assume that a dominant opening (such as roller door failure) will occur, causing a large internal pressure. Poor construction practice and minimal maintenance lead to failure from corrosion of cladding and frame elements. The failure of such engineered structures, at wind speeds less than the regions design wind speed is a cause for concern.

Overall, the buildings performed well for the wind speeds endured. This reflects achievements since

Cyclone Tracy. Where failures from wind forces were observed they were associated with older buildings that had not been upgraded, corrosion of fixings, or incorrect construction practice on newer structures. Adequate maintenance and properly designed and detailed modifications must be performed to ensure that our houses and buildings can provide us shelter.

Summary and Recommendations:

- Most contemporary housing performed well as it should have, as the estimated wind speeds of 50 to 65 m/s were less than the regions design wind speed of 70 m/s. However the poor performance of roller doors, guttering, soffits, awnings, etc led to water ingress and wind driven debris damage.
- Failures associated with degradation (rot, corrosion) of framing members and connections were observed. Therefore specify and use appropriate materials suitable for the site exposure conditions and undertake regular inspection and ongoing maintenance, especially the structural components.
- Majority of failures in older housing occurred at the roof batten to rafter joints. - Ensure strength upgrades are completed on all structural components of the wind load resistance system. This includes the batten to rafter and rafter to top plate connections.
- Significant damage was caused by water ingress, even when there was no failure of the building windows or doors. - Use water resilient internal linings, if practical.
- A significant number of sheds suffered structural damage. The failure of engineered structures, at wind speeds less than the regions design wind speed is a cause for concern. Continuing education of designers and manufacturers in wind loading details is required.

The CTS gratefully acknowledges Qld Dept of Public Works, ABCB, Timber Qld, IAG and Bluescope Steel for supporting the CTS damage investigations. We are also extremely grateful to all the residents who generously assisted this study by volunteering information, answering questions and inviting the authors into their houses to inspect damage.

The 96 page CTS report TS51 'Tropical Cyclone Larry - Damage to buildings in the Innisfail area' can be downloaded from the ABCB research publications web site;
http://www.abcb.gov.au/

Wind Workshop – Glowing reports

The CTS Wind Engineering Workshop held on 24-25 August 2006, was a popular event with 40 attendees. travelling from across Australia, NZ and the US. The presenters, John Holmes, Geoff Boughton, John Ginger, Bruce Harper, Yukio Tamura, David Henderson and Cam Leitch, covered a wide range of topics.

According to feedback from the participants, some of the highlights were Geoff's presentation on the lessons learnt from Cyclone Larry, Prof Tamura's dramatic animations of the dynamic response of structures from winds, and the demonstrations of the CTS aircannon and airbox test chambers graphically showing the power of the wind. (The meals also rated highly on the feedback sheets.)

Staff Changes

David Henderson has resigned from being the CTS Manager. However David is not travelling too far as he has been accepted as the PhD student working on the Station's ARC research grant examining cyclonic wind induced fatigue loading of the building envelope. David is still part of the Station and will also be representing the CTS on Standards committees, and the like.

The CTS Manager's position has been advertised and Cam Leitch is the Acting Manager until the position is filled.

As part of the Station's expansion, Peter Kim started in July. Peter supervises commercial testing and assists with consultancy work and research. He is an engineering graduate of UWO and previously worked at the RWDI wind tunnel facility.

Andrew Grice, a JCU graduate engineer, who has been with the CTS since the start of this year following his work experience, is leaving us to go see the world on a working holiday. First stop is the snow at Whistler.