Reducing wind damage to buildings by improving internal pressure design

Mitchell Humphreys

Cyclone Testing Station, College of Science and Engineering, James Cook University, QLD

Destructive winds are inevitable around Australia and the world, thus our buildings must be prepared to withstand their damaging effects. A common and seemingly small failure of a door or window often contributes to the failure of the whole building due to wind entering, generating large internal pressures. These pressures can contribute to more than half of the total load on structural elements. This project will provide much needed information of the magnitude of these pressures with respect to building parameters to improve internal pressure design.

THE PROBLEM:

Current internal pressure design of buildings is based on limited wind tunnel tests and simplistic analysis, which has lead to a basic method for internal pressure design. Additionally some engineers have different interpretations of the given method due to misunderstandings, or are unconvinced by pressures given, leading to a range of internal pressures used by structural engineers, with the temptation to use lower internal pressures, leading to cheaper construction and potential for greater market share. Thus more information is needed to make informed decisions to improve these standards.

Shed in Tully post Cyclone Yasi, 2011

IMPORTANCE:

- If a building is considered to have no openings during design, (and low internal pressures are used), then a small open window may be the difference between having a roof over your head or not.
- Windows and doors are usually overlooked during design, leading to a higher probability of failure.
- Investigating buildings after wind storms highlights that an opening on the windward face significantly increases the whole buildings potential for failure.

The end user for the project, the QLD Department of Housing and Public Works believe "This research has the potential to increase our understanding of the impacts of wind loads on commercial buildings" and "anticipates that the data obtained from this research could be used to inform future Australian Standards for wind loading."

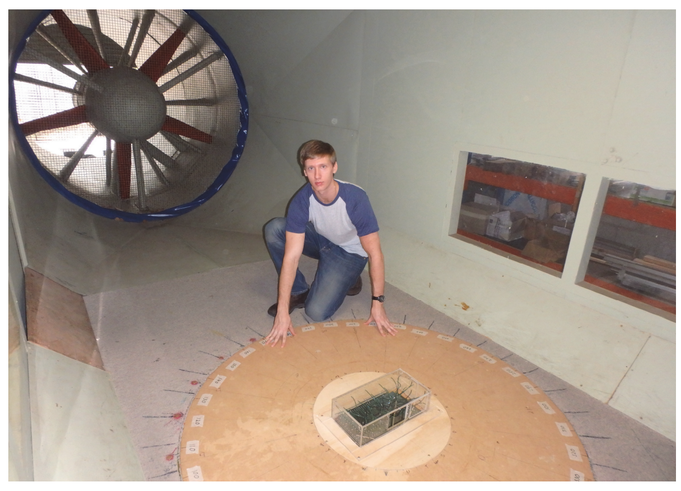
DATA COLLECTION:

Unique Full-Scale tests using State-of-the-Art Pressure Loading Actuators and actual atmospheric wind have been conducted on an idealized building as benchmarks for further tests on an actual full-scale industrial building and model-scale wind tunnel building.

The significance of this testing is that only a hand full of full-scale internal pressure studies have ever been conducted. Thus these results are critical to understanding the characteristics and mechanisms of internal pressure fluctuations.

Studies have shown internal pressures can be reduced if there is greater permeability around the building, (e.g. gaps around doors and windows, vents, etc.), a larger building volume, greater envelope flexibility, and if there is a breach in the envelope, smaller is better.

Testing using Pressure Loading Actuators



Wind Tunnel Test Setup

TAKE HOME MESSAGE:

- Full-scale findings show internal pressures are just as great as the external pressures even from a small opening in the envelope, if there is no background leakage.
- Ensure all external windows and doors are secured if there is potential for a severe storm.
- Investing in adequate locks and door jams for external doors will reduce your vulnerability.
- The outcomes of this project will better inform engineers to adequately design buildings and increase confidence in structural liability models.
- The optimization of building design will increase the resilience, survivability of communities and improve vulnerability modeling of all building stock around Australia, providing more reliable and potentially more affordable buildings for Australia.

For more information please contact Mitchell Humphreys at:
mitchell.humphreys@my.jcu.edu.au

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