Thunderstorm Downbursts

Although they are less well-known than tornadoes and hurricanes, thunderstorm downbursts are the source of the highest wind speeds experienced by buildings and other structures in many parts of the world [1]. An understanding of them, and the forces they exert on structures, is therefore important if building design codes are to accurately reflect the conditions which buildings must withstand - inaccurate codes may lead to costly over-engineering or, worse, unsafe buildings.

Downbursts are extreme wind events which occur when rising, warm air cools, becoming denser and falling under gravity to form a downward air current. When this downdraft reaches the ground the downward velocity is stalled, causing an increase in air pressure which forces the air radially outwards, forming the horizontal, downburst wind. It is estimated that this outward velocity can reach speeds of approximately 1.6 times the original downward velocity, leading to winds of level F3 [2] on the scale developed by Fujita for tornadoes:

> "F3 158-206mph [70-92ms-1], SEVERE DAMAGE
>
> Roofs and some walls torn off well-constructed houses; trains overturned; steel-framed hanger-warehouse type structures torn; heavy cars lifted off ground and thrown; most trees in forest uprooted, snapped, or levelled." [3]

The outflow is a highly non-stationary event (i.e. it produces a short-term increase in wind speed). Due to the short duration, with downbursts typically lasting less than 5 minutes, and near impossibility of predicting where and when a downburst will occur, measuring the forces on a building due to an actual, full-scale downburst is impractical. Researchers have therefore turned to small-scale, physical, laboratory-based simulations and numerical simulations using Computational Fluid Dynamics (CFD) to measure their effects. The project described on these pages uses a combination of physical and numerical modelling to investigate what happens to buildings subject to a downburst event.

References

[1] Chay MT, Letchford CW. Pressure distributions on a cube in a simulated thunderstorm downburst - Part A: stationary downburst observations. Journal of Wind Engineering and Industrial Aerodynamics. 2002;90:711-32.

[2] Fujita TT. Tornadoes and downbursts in the context of generalized planetary scales. Journal of the Atmospheric Sciences. 1981;38:1511-34.

[3] Fujita TT. Proposed characterization of tornadoes and hurricaines by area and intensity. University of Chicago. 1971.