FIELD DAMAGE SURVEY OF THE DUBBO, NSW, WINDSTORM OF 6TH JANUARY, 2001

BY JOHN STEHLE[1] AND DAVID HENDERSON[2]

At approximately 6:15pm local time on Saturday, 6th January 2001, a storm hit the rural city of Dubbo in New South Wales. The storm impacted heavily upon the eastern flank of the city, with estimated wind speeds of up to 140 km/h. High wind speeds, combined with heavy rainfall and hail, caused significant amounts of damage to residential and commercial structures and some key facilities. Estimates put the storm damage bill in the order of $100 million (Chris Henri, Insurance Council of Australia, personal communication, 2001). This paper presents an assessment of the impact of the storm upon the community. The survey demonstrated the utility of GIS-based data acquisition techniques. An aim of the survey was to improve severe storm risk assessment models using the data collected.

THE DUBBO STORM

The storm has been classified by the Bureau of Meteorology as a "storm microburst" with an intensity of approximately F1 on the Fujita Scale (Milton Speer, BoM – personal communication, 2001). This rating corresponds to a wind speed of between 120 and 180 km/h. However, the event was poorly recorded with regard to wind speed in the vicinity of the storm's destructive centre. The intensity rating has been based solely upon the observed damage.

The closest fully operational weather station at the time of the storm was located at the Dubbo airport, some 5 km to the North-West of the worst hit area of Dubbo. The wind speed, rainfall and temperature recorded at Dubbo airport are plotted in Figure 1 at time intervals of 20 minutes. A peak gust wind speed of 96 km/h, from the South South-East, was recorded at this weather station at 6.25 pm Eastern Daylight Saving Time. For the duration of the storm, which lasted about half an hour, approximately 6 mm of rainfall was recorded at Dubbo airport. Rainfall records obtained by the City of Dubbo measured between 37 and 45 mm in the vicinity of the worst affected area (Ray Tickle, Dubbo City Council - personal communication, 2001).

Due to a lack of wind speed data, an attempt was made to estimate the wind speed by considering the wind speed required to bend over street signs. Two parallel signs in Wheeler's Lane, within the worst affected area, were found to be suitable for such a calculation. Both signs faced the South, which was the predominant source of the wind direction, but only one sign was bent over in flexure (Figure 2). The other, stronger sign had not bent at all. By considering the estimated flexural strength and the measured geometry of the signs, the peak gust speed at 10 m height is estimated to have had a lower bound of 90 km/h and an upper bound of 150 km/h. Based on these calculations and estimates by local emergency response personnel and engineers, the peak gust wind speed is estimated to be in the order of 140 km/h, or 40 m/sec.

The ultimate limit state design wind speed (Vu) for Region A in the wind Loading Standard, AS1170.2-1989 (Standards Australia, 1989), is 50 m/s (180 km/h). We estimate that the peak gust wind speed of the storm did not exceed the ultimate limit state design wind speed specified in the standard.

[1] Australian Geological Survey Organisation – Cities Project, John.Stehle@agso.gov.au

[2] James Cook University – Cyclone Structural Testing Station, David.Henderson@jcu.edu.au

The Dubbo City Council specifies a permissible stress design limit for typical housing of W33 or W28 depending on location in relation to open terrain and shielding. This W33 nomenclature refers to a permissible stress design wind speed of 33 m/s at 8 m ridge height in terrain category 2.5, Region A. This permissible design wind speed of W33 is derived from the value of 50 m/s for Vu (10 m height in terrain category 2).

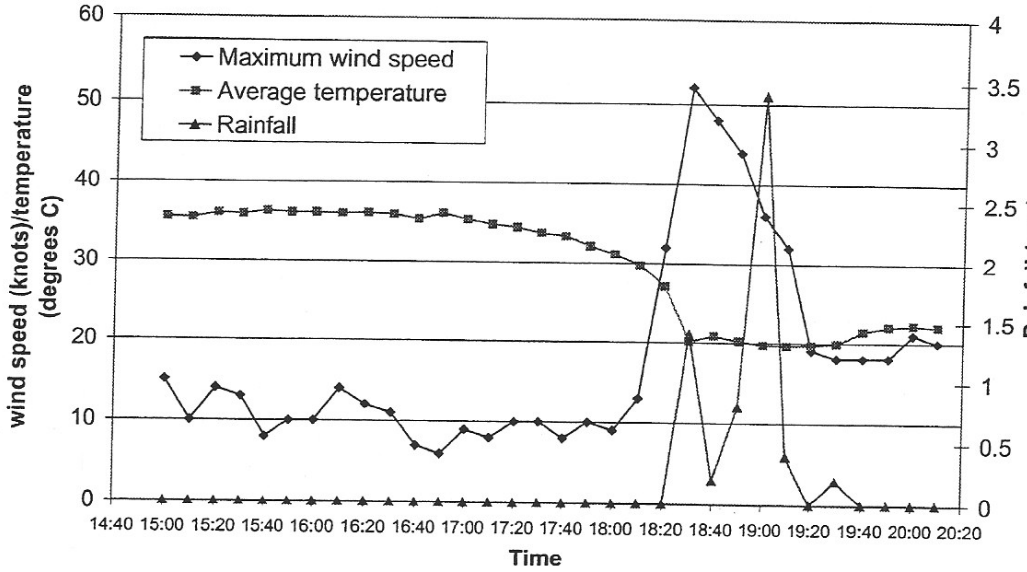

Figure 1: Weather data recorded at Dubbo airport AWS (Source: Bureau of Meteorology)

Figure 2: A bent over sign in Wheeler's Lane – obviously the speed limit was exceeded

The authors visited the affected area on the 11th and 12th of January. By this date clean-up operations were well under way, though few major repair works had been undertaken.

Structures were mainly damaged due to the direct force of the wind, the impact of wind blown-debris or by water ingress. Tile roofs were particularly vulnerable, as were roofs and leeward walls where the wind was able to develop internal pressure. Water damage was often consequential to wind and debris damage, although poor drainage was a significant problem in its own right for a number of buildings. Some examples of the damage observed are shown in Figure 3 to Figure 8.

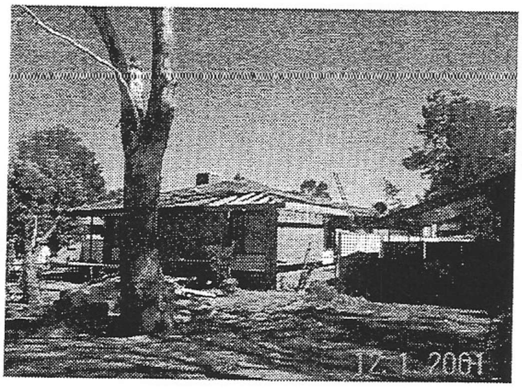

Figure 3: Debris damage to roof cladding and structure from fallen tree branch (Myall St)

Figure 5: Damage to tile roof due to wind suction at leading roof edges (Cunningham St)

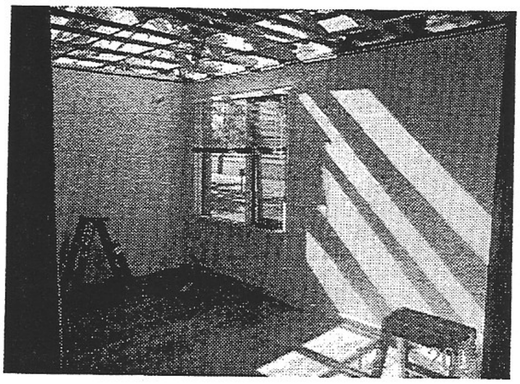

Figure 4: Internal water damage to house shown in Figure 3

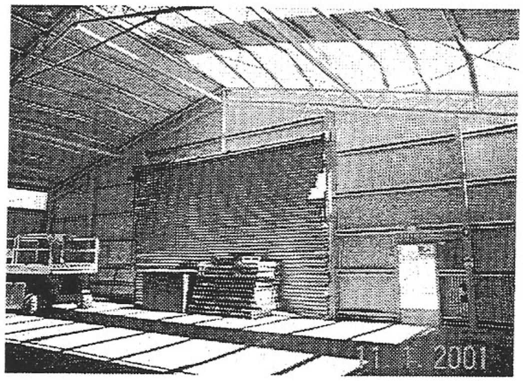

Figure 6: Debris damage to roller door allowed internal pressurisation and subsequent roof damage (Douglas Mawson Rd)

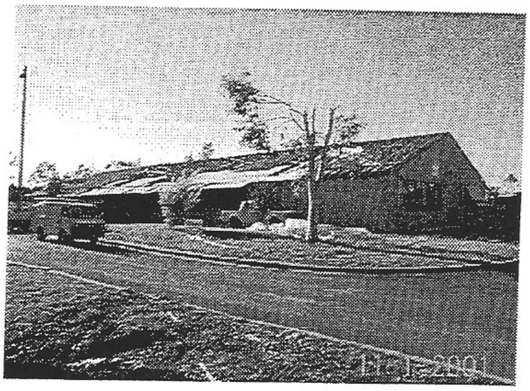

Figure 7: Complete damage to TAFE College building roof cladding (Myall St)

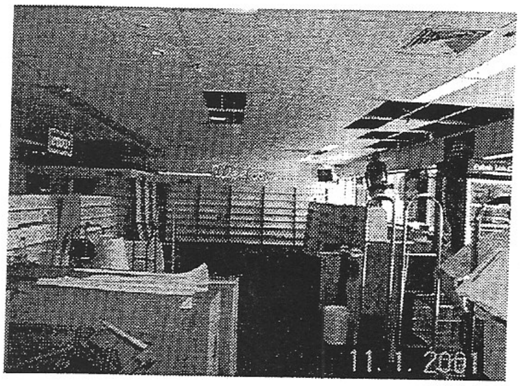

Figure 8: Internal water damage to Orana Mall shopping centre due to poor drainage

A survey of nearly all damaged buildings and an approximately uniform 1 in 20 sample of all residential buildings in East Dubbo was performed. Information on construction type, building age and size, and type of damage, was recorded on data acquisition systems with positioning determined using a GPS receiver, and was entered into GIS databases. A plot of the distribution of damage to roof cladding is shown in Figure 9. The damage state to each part of the building, eg, external wall cladding, roof cladding, windows, etc., was recorded as being either complete, extensive, moderate or slight . The damage states were estimated to relate approximately to a cost of repair of 100%, 50%, 10% and 2%, respectively, of the replacement value of the building component considered. Internal damage could not be assessed in most cases because the surveys were performed externally from the footpath.

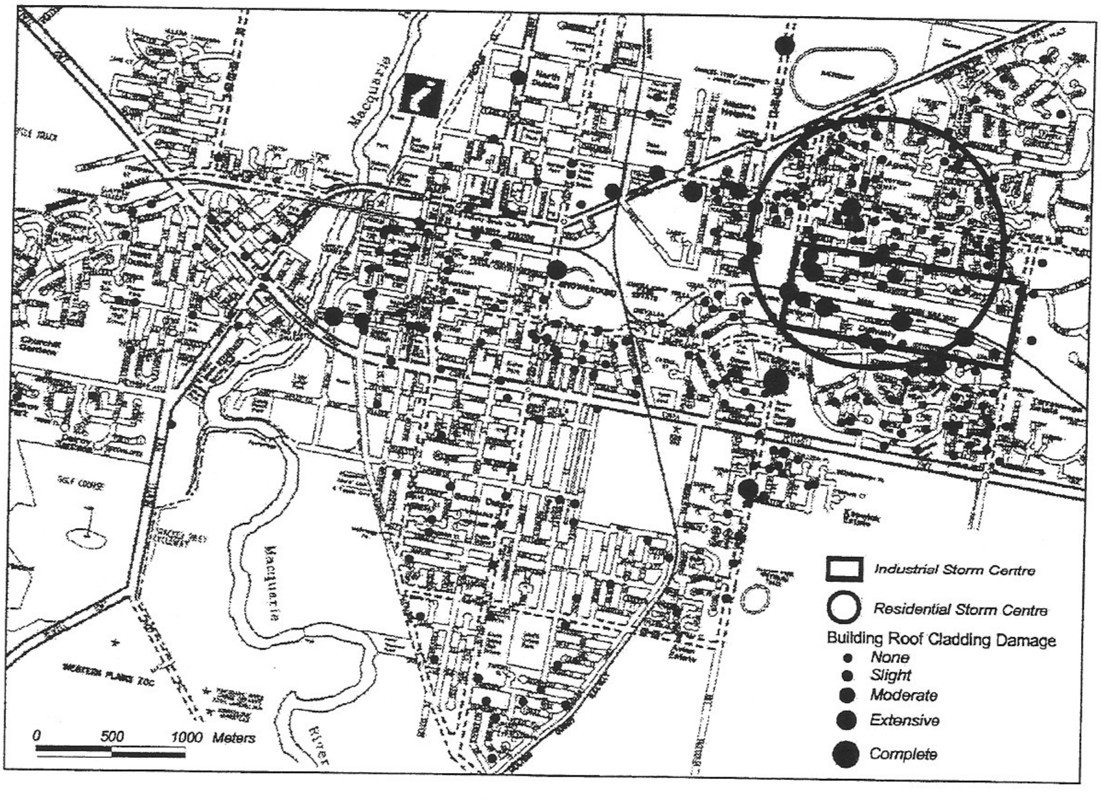

Figure 9: Distribution of damage to roof cladding

Some noteworthy comparisons have been generated with regard to residential and commercial construction. In the severely affected residential area (residential storm centre in Figure 9), approximately 5% of the 800 or so buildings with tile roofs had roof damage. This damage was approximately evenly divided between the slight and moderate damage states. Only one residential building with a metal roof was observed to have damage, even though such buildings make up approximately 13% or 120 buildings of the residential building stock (approximately 920 buildings in total) within the area considered. Hence, tile roofs on residential structures appear to be more vulnerable than metal roofs and there may be justification in improving performance standards for tile roofing. Failure of ancillary elements of housing, such as fences, garden sheds and awnings, added to the wind driven debris field causing further property losses.

Approximately 50% of the 40 or so industrial buildings in the most severely affected industrial area (industrial storm centre in Figure 9) suffered some damage. The damage was mostly to roof and wall cladding and to roller-doors, with the damage states ranging from slight to extensive. Overall, industrial buildings performed worse than residential structures. Modern, engineered construction failed at wind speeds estimated to be less than design speeds. This could be attributed to a lack of conservatism in engineering design practice. In particular, the assumption that buildings would remain nominally sealed is a risky one with the high incidence of window and roller door failures observed.

The field damage survey was successful in highlighting specific modes of failure. The survey also demonstrated the utility of GIS/GPS-based data acquisition systems. However, it was difficult to infer economic and social impacts from surveyed building damage, particularly when internal surveys were generally not performed. A report containing further detail is being prepared.

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