Wind and Building Damage Issues:
Understanding the critical components

Geoffrey N Boughton, Director, Timber ED Services
Debbie J Falck, Engineering Assistant, Timber ED Services

Wind events have the potential to cause significant damage to the buildings and infrastructure of Australian towns and cities, affecting the lives and livelihoods of their inhabitants, and causing both direct and indirect costs for the community. All Australian communities must address the threat of potential wind damage.

The extent of damage to buildings in a severe wind event is largely dependent upon the age and condition of the building, and on the environment in which it is built (corrosion is more evident in coastal areas).

Much of the damage to recent buildings can be attributed to deficiencies in building design and construction.

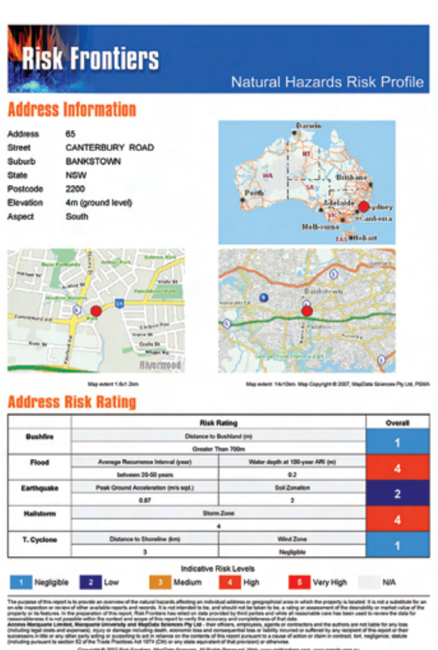
- Compliance with current building standards will ensure effective tie-down of roof structural elements, and prevent or resist full internal pressurization of buildings if and when a severe wind event occurs.
- The effects of topography should not be underestimated; buildings in elevated positions must be constructed with details that are capable of withstanding higher wind speeds than buildings on flat ground in the same area.

In older buildings damage is exacerbated by deterioration of the structure, whether by rot, corrosion or wear. If buildings have been subjected to high wind loads in the past (often the case for older buildings in cyclone-prone areas) then previous hidden damage can cause early onset of failure.

Resilience can be built into all structures. This is particularly important in buildings that have a post-disaster function.

- For new buildings, design to current standards with particular attention to topography of the site and to anchorage of all light-weight elements (including carports, pergolas and verandahs) will maximise performance under wind loads.
- Regular and competent maintenance of structural elements in all buildings will ensure that all elements have their intended capacity.
- After an event, detailed inspection must locate and repair any damage to ensure performance in future events.
- Reconstruction must be undertaken to current codes and standards and executed by builders and tradespeople with experience in local construction practices.

New product targets individual properties



Risk Frontiers are pleased to announce the release of two new on-line services – Street Address Hazard Profiles and accompanying Web services – that summarise natural hazard threats to individual Australian addresses.

Aimed at raising community awareness of natural hazards risk to property and life, these services provide "threat by peril" risk ratings for bushfire, earthquake, tropical cyclone, and, where available, riverine flood.

While no substitute for a property inspection, we expect these products to become a standard part of the due diligence in property transactions, assist mortgage providers and insurers make risk-informed decisions and help emergency managers more efficiently allocate and manage resources.

The products will be marketed and distributed by MapData Sciences, a company specialising in the provision of digital mapping data products and Web-based services. Individual Street Address Hazard Profiles can be accessed at www.mapds.com.au/solutions_risk_frontiers.aspx for $50 (excluding GST); institutional users can access the Risk Rating data via a web service under licence arrangements with MapData Sciences.

For more information contact MapData Sciences at 02 8436 2800 or email: info@mapds.com.au.

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An Updated Earthquake Loss Model for Australia

Paul Somerville, Risk Frontiers, Macquarie University

This Issue

- An Updated Earthquake Loss Model for Australia
- The Cost of Fire in Australia
- Post-event Claims Inflation (PECI)
- Wind and Building Damage Issues: Understanding the critical components

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QuakeAUS-2 is a new earthquake loss model for Australia that incorporates many enhancements that have been made possible by developments over the past decade. The earthquake potential of Australia is characterized by the spatial smoothing of historical seismicity in Australia. This approach has the advantages of simplicity and of avoiding uncertainty in the geological definitions of earthquake source zones that to date have formed the basis for characterizing earthquake potential in Australia. Figure 1 shows the number of earthquakes with magnitudes larger than 5 per 500 years throughout Australia that are forecast by the model. The amplification of ground motions by local soil conditions is taken into account using a soil site classification method that has been applied throughout Australia. It is assumed that there are regional differences in ground motion characteristics, with Western Australia having larger ground motions for a given earthquake magnitude and distance than the remaining regions of Australia. Losses are estimated from the instrumental ground motion values using the capacity spectrum method. The model has been tested against the losses from the 1968 Meckering and 1989 Newcastle earthquakes. The damage in Perth from the Meckering earthquake was low because the earthquake ruptured downdip and to the east, away from Perth. Other earthquakes in the region having different faulting characteristics could cause more damage in Perth. The damage pattern from the Newcastle earthquake cannot be explained using the published location of the event, but it can be explained if we allow for the uncertainty in its location, and place it on a fault that dips up to the southeast with a top edge that lies about 5 km below the ground and 5 km southwest of central Newcastle.

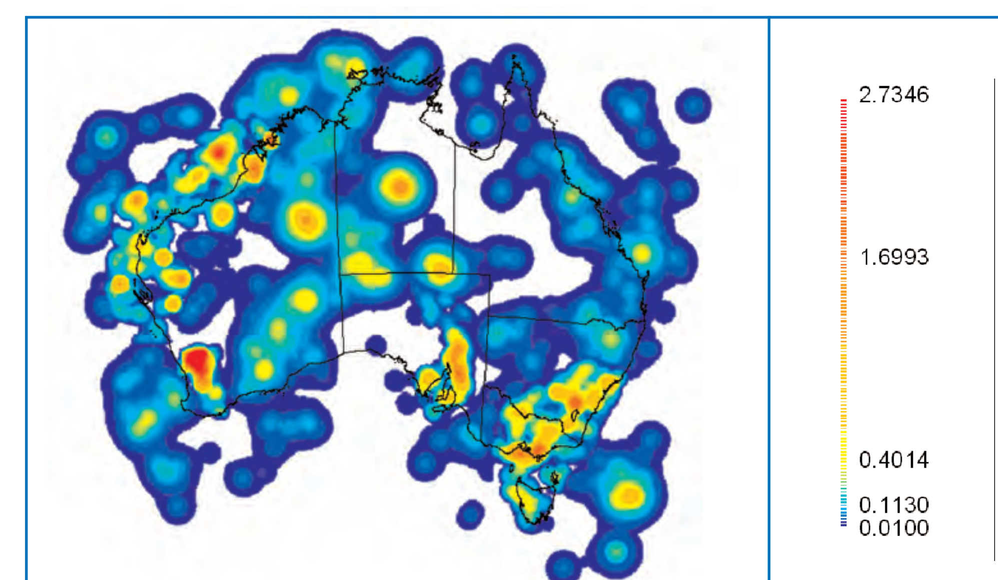

Figure 1: Number of events of Magnitude >5 per 500 years in each 10x10 km grid.

For further information please contact
Paul Somerville
Email: psomervi@els.mq.edu.au

The Cost of Fire in Australia

Brian Ashe, PhD student, Macquarie University

In Australia, fire is a significant hazard to people, property and the environment. Each year, fire is the cause of approximately 100 fatalities and approximately 3,000 injuries from structure fires. Over the last century, the loss of residential homes from bushfire averaged around 83 homes per year. The year-to-year variance about this mean figure is large ranging from no homes lost in 40% of years to 2,500 buildings in the Ash Wednesday bushfires, Victoria (1983), which also killed 75 people. In other Australian fires, the 1974/75 bushfires in the Northern Territory destroyed 117 million hectares; the Longford Gas explosion cost the Victorian economy a estimated $1,300 million; the Childers Hostel fire, Queensland, killed 15 people, and more recently the 2003 Canberra bushfires destroyed 500 properties, killed 4 people and cost $300 million.

While much debate takes place in Australia about fire, particularly bushfire, very little of this is informed by an understanding of its true cost to the nation. In fact, to our knowledge, no analysis of the total cost of fire to the national economy has been undertaken. In contrast to the situation in Australia, studies exploring the total cost of fire have been undertaken overseas. We briefly review these now.

For the first time, the total cost of fire in Australia has been estimated. This cost is approximately $8,500 million per annum or approximately 1.15% of the country's Gross Domestic Product (GDP). Comparable studies in the UK, USA, Canada and Denmark show that the costs in these countries range from 0.9% to 2% of GDP. 55% of the Australian total is allocated to 'costs in anticipation', 30% to the 'cost of response' and 15% to the 'cost as a consequence' of fire.

Is there an optimum philosophy to address the hazard of fire, or will the approach vary depending on country or region? One of our findings is that, compared to the other countries, the "cost of response" component in Australia and the USA is high in relation to the other cost categories. Is this a result of the fire hazard in both countries, for example large conflagrations such as bushfires / wildfires? Or is it a result of the Federal political systems, or a result of how the fire hazard has been historically managed? These questions remain unanswered and are areas of future research.

Having shown that the cost of fire prevention, management and response is a significant economic cost, it is natural to pose the question as to whether Australia receives value from this investment. Our study has provided the foundation from which questions of this type can begin to be addressed. While we cannot answer this type of question here, it is useful to reflect briefly on international differences in fire fatality rates as one example measure of outcomes. For the year 2000, the fatality rate in Australia was 0.6 per 100,000 population. Fatality rates for other selected countries were 1.6 for the USA, 1.2 for Canada, 1.1 for the UK and 1.6 for Denmark. The relatively low Australian fire fatality rate is potentially due to the significant allocation of resources and it would appear that this investment has been effective.

The results also show that Australia is investing approximately $7,200 million (or 85% of the total cost of fire) to manage a loss of approximately $1,300 million (or 15% of the total cost of fire), a result that raises questions as to the most effective and efficient investment of approximately $360 for every Australian.

For further information please contact
Brian Ashe
Email: bashe@bigpond.com

Post-event Claims Inflation (PECI)

John McAneney, Risk Frontiers, Macquarie University

The inflation in insurance claims payouts following a disaster (PECI) is an important variable contributing to the final market loss. In some cases, such as in the reconstruction of Darwin after Cyclone Tracy, it may approach 100% (George Walker, pers. com.); in other words, actual losses were double those anticipated on the basis of the pre-event repair and construction costs.

The situation with regard to the treatment of PECI in catastrophe loss models is confused: where fragility functions have been developed from actual claims experience, PECI may be already included implicitly; in other cases, where the equivalent curves are derived from engineering considerations, PECI is ignored. This ambiguity is unsatisfactory for model users.

Many factors contribute to PECI. One component, *demand surge,* is caused by the sudden increase in the demand for goods and services following a major disaster exceeding their supply; the result is rises in price. It may be possible to deal with demand surge by economic modelling; but this is not the case for a host of other variables contributing to PECI. These factors include: the magnitude of the event and the average loss ratio, remoteness of location, fraud on the part of builders and policy owners, contemporaneous strength of the construction industry (e.g., Figure 1), cost to bring badly-damaged non-code buildings up to code in Cyclone-impacted areas and the response of the government. The multivariate nature of the problem demands a stochastic description.

This brief represents a first attempt by Risk Frontiers at understanding this complex issue. Our approach is to break up Australian centres of population by *key* cities (State Capitals and a few other major centres of population) and *lesser* centres. For both key and lesser cities, we then develop overlapping matrices of the total market loss (TML) and average loss ratio by CRESTA zone using broad ranges of losses and some logical rules. These two categories of cities or towns and their matrix entries are then weighted by the historical pattern of industry losses normalised to 2006 values after adjusting for changes in population, wealth, inflation and building codes (Crompton and McAneney, 2007 (in review)). Interim *average* results as a function here of just a single dimension – Total Market Loss - are given below.

TML ($ Millions)	PECI Factor
<50	1.0
50 - 100	1.1
100 - 500	1.3
500 - 1500	1.5
>1500	1.6

Table 1: Interim average figures for Post-Event Claims Inflation for a given Total Market Loss range.

The PECI factor in Table 1 is the number by which the estimated company loss should be multiplied to gauge the likely inflated cost to insurers following an event loss. Its application in any particular circumstance requires understanding a company's market share in the affected region. In practice, it would be more convenient to include these adjustments together with their *associated uncertainty* within stochastic loss models as an additional random variable in the simulation of likely losses. However this would require modelling the market loss as well as the company portfolio. This would result in a different ranking of losses and probable maximum losses for different return periods.

For further information please contact:
John McAneney
Email: jmcanene@els.mq.edu.au

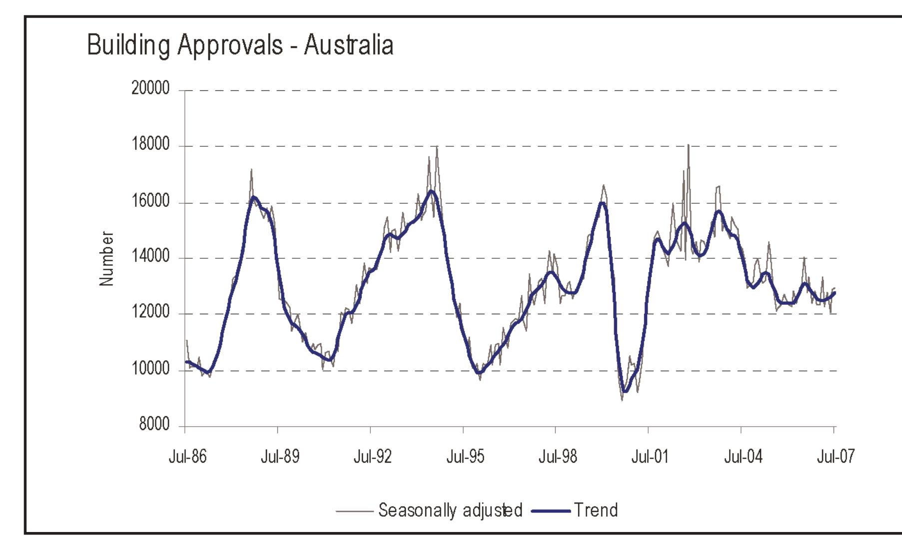

Figure 1: The cyclic behaviour of building approvals is one indication of changes in the buoyancy of the construction industry that at any time will affect the willingness of builders to relocate from major centres such as Sydney and Melbourne in order to contribute to the reconstruction of remote locations damaged by a natural disaster. (Source: Housing Industry Association, 2007.)