Background briefings on emerging issues for fire managers from AFAC and Bushfire CRC.

FIRE NOTE

ISSUE 70 NOVEMBER 2010

RESIDENTIAL BOUNDARY FENCES IN BUSHFIRES: HOW DO THEY PERFORM?

Testing of different types of fencing was conducted at the NSW Rural Fire Service Experimental Testing Site at Mogo on the south coast of NSW in 2005.

SUMMARY

The potential for residential fencing systems to act as a barrier against radiant heat, burning debris and flame impingement during bushfire is of the utmost importance to those whose homes rest in bushfire-prone regions. A 2005 testing project involving the Bushfire CRC and the CSIRO has revealed that different types of fencing can play an important part in defending homes against the threat of bushfire. Anecdotal evidence existed to suggest that steel fencing offerered greater protection to residential housing against bushfire than alternative materials because of its non-combustibility. The Bushfire CRC (with BlueScope Steel Limited and CSIRO Bushfire Research) set up a project to research and investigate the performance of residential boundary fencing systems through small and full-scale experiments looking at flame and ember propagation in fences, fences as barriers to radiant heat and flame, and toxic gas emissions from fencing systems. The full results of this research is being used by relevant agencies to influence how building codes and planning guides are developed, to provide advice to residents on the level of risk an individual property faces, and to help develop education programmes for local communities.

ABOUT THIS PROJECT

Project D1 Building and Occupant Protection was part of Bushfire CRC Program D: Protection of People and Property. Researchers involved in the project acknowledge the financial support of BlueScope Steel and collaboration with the NSW Rural Fire Service.

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BACKGROUND

The findings from post-bushfire investigations show the importance of design and building materials for houses exposed to bushfires in Australia. CSIRO research has shown that the majority of houses, including fencing systems, destroyed in bushfires usually survived the passage of a fire front, but burnt down during the following few hours due to fire spreading from ignition caused by burning debris (Leonard 2003; Blanchi *et al.* 2004; Ahern *et al.* 2004; Chen & McAneney 2004).

A survey and studies after the 2003 bushfires in Canberra, for instance, showed very high levels of house loss deep into the urban environment (Leonard 2003). Similarly with the 2009 Victorian bushfires (McAneney 2010). Destroyed homes showed strong clustering. Most houses were ignited by ember attack and/or house-to-house ignition. In fact, the post-bushfire investigation in Canberra showed that in 50% of cases, the bushfire attack

▲ Setting up timber fence for test burning.

mechanism was via embers, and in 35% it was via embers and some radiant heat from surrounding vegetation or other structures (Blanchi *et al*. 2004). Numerous studies have found that suppression activities by residents during and immediately after fires are important in saving homes – that human activity can significantly influence the survivability of structures.

In the case of the Canberra fires, residents who stayed in their homes to fight bushfires and spot fires before and after the passage of the fire front gave testimony to the specific protection offered by sheet steel boundary fencing systems to stay close to their homes to fight fires. With that in mind, it is proposed that fencing systems can offer protection to humans and homes during attack from bushfires and house-to-house ignition (similar to urban structural fires).

The Black Saturday Victorian bushfires of February 2009 have provided another opportunity to study the influences of fences on house survivability. The Bushfire CRC Task Force established immediately after Black Saturday has collected large volumes of relevant data that is pending analysis.

END USER STATEMENT

"This project has provided information that can be used in the development of planning and building codes, it offers practical, scientifically based information that fire agencies can provide to residents in bushfire prone areas to reduce their risk of bush fire attack."

– Lew Short, Group Manager Community Resilience NSW Rural Fire Service

BUSHFIRE CRC RESEARCH

The research aimed to observe, record, measure and compare the performance of commercial fencing systems made from pre-painted and metallic-coated sheet steel and timber (treated softwood and hardwood) when exposed to burning embers, radiant heat and flame attack. The objectives were to investigate:

- The performance of the most common commercial fencing systems made from pre-painted and metallic-coated sheet steel and timber (which are mostly used as residential boundary fencing in urban and urban rural interfaces).
- The potential for these fencing systems to act as protection for buildings against attack from radiant heat, burning debris and flame impingement during bushfires, and;
- Whether the behaviour of fencing systems contributes a risk to lives and homes.

The formal research testing involved:

- Small-scale flammability experiments, measuring the basic flammability of typical timber fencing materials (including the effect of ageing and weathering conditions).
- Toxic contaminant release experiments measuring gas and ash products from samples.
- Full-scale experiments (23 in total) on common timber and Colorbond steel fencing systems using a gas burner bushfire front simulator (including the effect on a simulated residential building and adjacent objects).

The research project was conducted in the NSW Rural Fire Service Experimental Testing Site at Mogo on the south coast of NSW in 2005.

▲ A steel fence after testing at the Mogo site.

RESEARCH OUTCOMES

SMALL-SCALE EXPERIMENTS

This investigation confirmed that Colorbond steel fencing panels do not ignite and contribute significant heat release during cone calorimeter exposure. Both pine and hardwood materials provide significant heat release under these exposures. The ranking of performance of these materials in descending order are: Colorbond steel (insignificant release), new hardwood, old hardwood, old pine and new pine.

Of particular interest was the effect moisture content had on the time to ignition for all these materials. In particular, the observation that a material exposed for six hours to 40 degreesC and 20% relative humidity had similar fire properties to the same material when conditioned at same temperature and relative humidity until moisture equilibrium was achieved. This highlights a significant point – that the fire behaviour of these specimens was influenced more by the surface moisture content rather than the average moisture content of the specimens, and hence the weather conditions on the day of fire impact will have a significant effect on the fire performance of timber elements.

TOXIC CONTAMINANT RELEASE

The major issue related to the combustion of Copper Chrome Arsenic (CCA)-treated pine is the release of significant levels of arsenic, as well as the high arsenic content in the timber ash (2.2% by weight). Arsenic can cause eye, throat and respiratory irritation, and is a confirmed human carcinogen. It is worth noting that the National Environmental Protection Measure provides health impact criteria for arsenic in soils in the range of 0.01-0.05%, and so the dispersion of CCA-treated pine ash could lead to site contamination, especially where large quantities of the material has been burnt. Analysis also showed that it could be harmful for a person to come into direct skin contact with the ash.

As for Colorbond steel, two human carcinogens (benzene and formaldehyde) were detected in the air toxicity experiments conducted on this material. While these gases were detected, the risks they present would depend on the levels of exposure to nearby occupants, which is unknown. In fact, evaluating the risks from these gases will depend on combustion conditions, the quantity of material burnt, the volume of combustion gases generated and its dispersion, and the degree to which site occupants are exposed to the gases.

LARGE-SCALE EXPERIMENTS

Colorbond steel

This had the best performance as it is a non-combustible material. It maintained structural integrity as a heat barrier under all experimental exposure conditions, and it did not spread flame laterally or contribute to fire intensity during exposure. The fencing reduced radiation levels within the fencing boundary to below 5 kW/m^2 immediately behind the fencing system during all radiation exposures, and reduced the radiant heat exposure on a structure nine metres from the fencing by at least a factor of two for the given fire size in the experiment.

Hardwood

Although combustible, closed paling hardwood fencing maintained a radiant heat barrier during radiation-only exposures, resulting in a reduction in heat received at the structure. In exposures where flame contact of the fencing occurred, flame emission from the fencing provided additional radiant heat exposure on the structure. Open paling hardwood fencing systems were partially effective in attenuating incident radiation

FURTHER READING

Ahern A., Aon Re Worldwide and Chladil M. (2004). *How Far do Bushfires Penetrate Urban Areas?* Tasmania Fire Service.

Blanchi, R., Leonard, J. and Maughan, D. (2004). *Towards New Information Tools for Understanding Bushfire Risk at the Urban Interface.* CSIRO Manufacturing & Infrastructure Technology, Bushfire Research, Bushfire CRC Research Project.

Chen, K. and McAneney, J. (2004). *Quantifying Bushfire Penetration Into Urban Areas in Australia.* Risk Frontiers–Natural Hazards Research Centre, Macquarie University, NSW, Australia, June.

Leonard, J. (2003). Bushfires in the ACT. Australian Institute of Building Surveyors 38th Annual State Conference.

McAneney, J and Chen, K. (2010) Bushfire Penetration Into Urban Areas in Australia: A Spatial Analysis, Bushfire CRC report for the 2009 Victorian Bushfires Royal Commission.

▲ **Researcher Justin Leonard examines a fence after burning test at the NSW Rural Fire Service Hot Fire Training Facility.**

when flames did not contact the fencing systems, however they provided little barrier during direct flame contact. Neither fencing configuration supported lateral flame spread to the extent that would expose the structure to direct flame contact. Under structural fire exposure conditions, the fencing quickly burnt away leaving no barrier to the impinging flames.

Treated pine

This had the worst performance, as its integrity under leaf litter attack resulted in ignition and extensive flame spread with the potential for loss of the adjacent structure. Its performance as a heat barrier was good until ignition of the fencing occurred, after which point additional heat impact was received by all elements behind the fencing. Significant risk of house loss occurred during all experimental exposures, either through thermal exposure or mechanical impact as the fencing collapsed onto the structure. Under structural fire exposure conditions, the fencing quickly burnt away leaving no barrier to the impinging flames and radiant heat.

FUTURE DIRECTIONS

The cone calorimeter experimental method used for toxic release does not assess the fire hazard of the materials – or products made from them – under actual fire conditions. The results, when used alone, should only be used for research and development, quality assurance or similar industrial needs. More extensive toxic release experiments could be conducted to simulate fencing exposure to bushfire for a quantitative risk assessment of: the toxic gases released during combustion of each fencing material; the impact of air emissions of arsenic; the exposure of site occupants to arsenic from the ash from CCA-treated pine, and; the contamination of building sites from arsenic.

Detailed analysis is needed of the fencing data collected by the Bushfire CRC Task Force after Black Saturday.

Fire Note is published jointly by the Bushfire Cooperative Research Centre (Bushfire CRC) and the Australasian Fire and Emergency Service Authorities Council (AFAC). This Fire Note is prepared from available research at the time of publication to encourage discussion and debate. The contents of the Fire Note do not necessarily represent the views, policies, practices or positions of any of the individual agencies or organisations who are stakeholders of the Bushfire CRC.

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AFAC is the peak representative body for fire, emergency services and land management agencies in the Australasia region. It was established in 1993 and has 26 full and 10 affiliate members.