FOREST & WOOD PRODUCTS
Research & Development Corporation

National Timber Development Program

NTDP
Technical Report
Issue 4, December 2003

Building with timber in bushfire-prone areas

AS3959 – Construction of buildings in bushfire prone areas

Australian Standard AS3959 only applies to houses built in areas identified as being bushfire-prone by government authorities in each State.

It outlines the most effective means for addressing the threats to houses posed by radiant heat, flame contact or the showers of burning debris which precede or follow the passing of bushfires.

Within the designated bushfire-prone areas, house sites are assessed and placed into low, medium, high or extreme bushfire attack categories.

This is based on the nature of the surrounding vegetation, the distance between the house site and that vegetation, and the slope of the land.

AS3959 specifies the additional construction requirements for houses located in the medium and high bushfire attack categories. It covers flooring systems, supports, external walls, windows, doors, vents, roofs, eaves, fascias, guttering, verandas, decks and service pipes.

Independent of the other features of the site, houses will only be included in the extreme bushfire attack category if they are to be located within 15 metres of the surrounding forest, woodlands or tall shrubby vegetation. AS3959 does not apply to houses built in the extreme bushfire attack category.

"Although there is no 'one size fits all' strategy to bushfire risk reduction, there is a range of building maintenance and design measures that can be taken to reduce the likelihood of damage suffered through ember showers, radiant heat and direct flame.

However, it appears that appropriate building maintenance is not performed and despite the existence of national building standards, buildings are nevertheless, not located and constructed to minimise the risks associated with bushfires. It also appears that the community as a whole is not aware of the ways in which it can contribute to minimising the loss of lives and properties in the event of a bushfire."

– from A Nation Charred: Inquiry into the recent Australian bushfires October 2003. House of Representatives Select Committee on the Recent Australian Bushfires.

Introduction

Periodic bushfires are a fact of life across much of Australia. On occasion, the fires will enter suburban areas and the ensuing loss of life and damage to housing can be tragic. How can we ensure that houses are made as fire-resistant as possible, without going to the extremes of building concrete bunkers and losing the amenities we value?

This technical report explains which features of a house are least resistant to advancing fire, and why, and gives information on how to minimise the susceptibility of a house to bushfire attack.

Adequate house protection in bushfire-prone areas can be provided by following the Australian Standard, AS3959. (Photo courtesy of Paul Harr, architect.)

It also lists which timbers are most fire-resistant, and explains the scientific research that shows that timber can be used in bushfire-prone homes without compromising asset or personal safety.

Timber in homes has been targeted as a fire risk. It need not be. In fact, windows are the most vulnerable part of a house exposed to bushfire attack. (CSIRO, Building Innovation & Construction Technology, Number 11, February 2000).

Adequate house protection can be provided by following the Australian Standard, AS3959 – Construction of buildings in bushfire prone areas. Some elementary design considerations, such as ensuring that suitable window thickness and window protection is combined with closure of eaves, and keeping shrubs and trees well away from residences, have been demonstrated as the means for minimising the threat of bushfire attack.

Timber use in house construction

Each year, Australians consume 6.5 million tonnes of timber products in construction, extension and renovation activities. The major portion of that timber is used to provide the structural elements and decorative features of our new homes.

Based on current design approaches, most houses are brick veneer with a frame made from softwood timber, structural elements made from hardwood timbers or engineered softwood timber products, and decorative hardwood features such as decking and flooring.

Most importantly, the recommended use of sustainably derived, greenhouse-friendly timber building products in bushfire prone areas, will not compromise fire safety or raise the threat of house destruction during bushfires.

How houses burn

Central to fire-safe design is the issue of how bushfires enter houses. The vulnerability of a house during a bushfire depends mainly on the ability of the fire to get into the house. There is little evidence that the fire front destroys houses as it passes.

CSIRO research emphasises that the majority of houses survive the passage of the fire front, only to burn down during the next few hours as wind-borne debris lodges in, or close by, the building and ignites flammable material.

Of course, almost any building can be destroyed if it has direct contact with flames and extremely high radiant temperatures for long enough. In Australian bushfire conditions, however, (which are usually very windy), these extremes occur only during the brief interval when the firewall passes through.

Many houses can withstand these extreme conditions for a few minutes, and may be left charred but intact. Only the outer few millimetres of the external cladding or timber building elements are usually damaged. Showers of burning debris, on the other hand, may attack a building for some time before the arrival of the fire front, as well as during the fire attack and for hours afterwards.

Research has shown that houses burn from the inside out. Stopping embers from getting in is the key. Clearly then, apart from sensible initial siting and appropriate landscaping, bushfire protection is first and foremost a matter of preventing burning debris from causing ignition in, on or around the house.

Protection may be provided by cleaning up ignition sources around the garden; keeping gutters clear of dry leaves; or dealing with embers as they fall.

The main external factor increasing the vulnerability of a house to bushfire is not timber constructions such as decks or pergolas, but rather, the close proximity of vegetation.

(Photos courtesy of Paul Harr, architect.)

Building in bushfire prone areas

Building design is a key element in preventing ember entry and subsequent ignition. Timber can be safely used in many situations, provided it is the right sort of timber, correctly sited, and within a suitably designed building.

Australian Standard AS3959 covers the construction of buildings in bushfire-prone areas. The standard was amended in 2000 and again in 2001. It has recently been reviewed, and a new draft standard is awaiting final approval. It includes any area that can support a bushfire, or that is likely to be subject to bushfire attack. Clearly that excludes most central urban areas and many, but not all, suburban areas.

The Standard lists the necessary requirements when designing for, or building in, the bushfire-prone areas of Australia. Buildings designed and constructed according to the Standard will be better at withstanding burning debris, radiant heat or flame contact from a bushfire. (Of course, in sufficiently severe conditions, virtually any building will succumb, but a building specially constructed for bushfire areas is likely to survive longer than one not incorporating the features listed in the Standard.)

The Standard applies only to buildings. There are other bushfire protection methods that involve planning, siting and landscaping.

Bushfire entry points to buildings

The heat and wind from the passage of the fire front, and/or fast-moving embers, can often cause windows to shatter. Burning embers can then enter the house, and curtains near the window are an obvious ignition point. Embers may also land in gutters, igniting accumulated dry debris such as dead leaves, or on any part of the building where the design allows accumulation of wind-borne material. This can be roof gulleys, open eaves, or on the ground in narrow corners.

The wind and the fall of hot debris may crack or remove roof tiles, opening another entry point into an area that is dry and that may contain readily combustible material (insulation). Even ventilation holes and weep holes can be entry points for embers. Wherever possible, they should be covered by fine metal mesh. Vegetation close to or overhanging a house may also trap embers and ignite, making eventual entry of the fire into the house more likely.

The CSIRO concluded that, in the Canberra bushfires of January 2003, most homes were lost because of ember attack:

'*Ember attack was the principal cause of house loss in Duffy. Radiation and flames from adjacent houses was a secondary cause of damage. But radiation and flames from the fire front did not play a significant role. Gardens that were heavily mulched, had dry lawns or loose plant debris caused problems.*' (CoResearch No. 395, April 2003.)

What about timber?

Research consistently shows that houses affected by bushfires, burn from the inside-out. A report by Warrington Fire Research Australia[1] confirms CSIRO findings that even if houses or their external features were made from wood, destruction did not result from the fire front itself igniting the timber. Rather, it is from ember entry into the house, which then started burning the flammable furniture, materials and fixtures.

The Report found that the main external factor increasing the vulnerability of a house was not timber constructions such as decks or pergolas, but rather, the close proximity of vegetation. If the vegetation was of a type that continued to burn after the passage of the fire front, then it was quite likely that it would provide a continuing source of embers. Those embers would accumulate around timber elements, under open eaves or enter through broken windows, and eventually cause ignition.

AS3959 specifies that timber used for construction in bushfire-prone areas should not burn readily. In many parts of the world, fire resistance can be achieved by the use of a chemical fire-retardant to treat the timbers. In Australia, there is currently no producer of fire retardant-treated timber that is approved for use in houses. It should be noted that 'treated timber' does not mean treated with a fire retardant. It usually refers to wood that has been treated with chemicals to inhibit attack by fungi and termites.

Fortunately, there are two effective solutions in Australia for minimising the impacts of fires, based around the use of timber. Within the internal framing of houses, there are no additional safety concerns or fire hazard risks associated with the use of softwood timber products, particularly where they are protected by lining materials that meet the deemed-to-satisfy provisions for fire resistance.

(Footnotes)

[1] Bushfire Investigations – Warrimoo, Valley Heights and Yellow Rock, Lower Blue Mountains, NSW, 2001-02.

Suitable window thickness and window protection, combined with closure of eaves and keeping shrubs and trees well away from the residence, will help minimise the susceptibility of a house to bushfire attack. (Photo courtesy of Paul Harr, architect.)

Research has shown that timber protected by standard lining materials, such as gyprock, will not be affected by fire until the temperature of the actual timber framing itself reaches 300^{o}C.

The choice of the right timber can help keep house construction costs down while ensuring that acceptable fire safety standards are either met or exceeded.

Research shows that the combustion of timber contributes relatively little to the total fire load when a timber-framed house burns.

For external and exposed applications, Australia has a range of high-density native hardwood timbers with considerable natural fire resistance. Seven timbers are sufficiently fire retarding to meet Australian Standard AS3959, and so can be used in bush-fire prone areas without any treatment. They are:

Blackbutt
Kwila (Merbau)
Red iron bark
River red gum
Silvertop ash
Spotted gum
Turpentine.

Timber-framed housing in bushfire prone areas

The other question concerns the safety and suitability of timber framing, which is common in many Australian brick veneer homes. Research has shown that timber protected by standard lining materials, such as gyprock, will not be affected by fire until the temperature of the actual timber framing itself reaches 300^{o}C. The lining materials, therefore, considerably lengthen the time it takes for the timber framing to ignite and reduces the chances of timber framing elements catching alight.

But if the structural timber elements burn in a fire, how serious is it? Research shows that the combustion of timber contributes relatively little to the total fire load when a timber-framed house burns. Analysis of the ignition of a six-storey timber-framed building showed that structural timber contributed only a limited proportion of the total fire load. (Warrington Fire Research, Project 20633, April 2003.)

Additional information demonstrating that timber use does not compromise fire safety is available in National Timber Development Program Newsletter No.6 (available at www.timber.org.au).

Essentially, Australia does not need fire retardant-treated timber products if we protect softwood structural timbers with appropriate cladding and lining materials or use the right sort of native timbers. By avoiding the need to treat timber with a fire retardant, the choice of the right timber can help keep house construction costs down while ensuring that acceptable fire safety standards are either met or exceeded.

Multi-storey constructions are less likely to be located in bushfire-prone areas. Even so, fire-resistant timber can still help to reduce the effects of 'normal' fires. By building with fire-rated timber, protected by appropriate lining materials, it is possible to prevent fires from spreading.

Multi-storey and multi-residential constructions

Multi-storey constructions are less likely to be located in bushfire-prone areas. Even so, fire-resistant timber can still help to reduce the effects of 'normal' fires. For example, a fire in a multi-residential softwood timber-framed building in Queensland (August 2002), had a severe impact on the complex.

When fire-fighters arrived, flames were already coming out through broken windows. One of the few parts of the building that did not need to be completely re-built was the separating wall between adjoining units. This was a timber-framed wall that survived because it was constructed with fire-rated timber, protected by appropriate lining materials that effectively prevented the fire from spreading.

Details of Design

A summary of the considerable volume of research about how bushfires attack homes and how houses burn, has led to the understanding that what counts most is house siting and design. For example, options to reduce the risk of embers getting underneath a house, are to ensure that it is fully enclosed below the floor level or to build on a reinforced concrete slab.

Where the site is on a slope, the bottom of a slope is safer than the top, and slopes facing east are generally safer than slopes facing north, northwest or west.

Leave a firebreak between nearby vegetation and the house. Fit any vents with spark-proof metal screens. Have a simple roof (avoiding roof valleys and skylights). Design a house to minimise external nooks and crannies, corners and spaces, in which debris or embers can accumulate. Consider external shutters for windows – an important point of entry for fires. And, finally, keep the gutters clear, and the garden green and free of debris.

Although they may sound trivial, it is these details that are crucial in terms of providing fire resistance – no matter what the house is built from. Knowing this, we can still build beautiful houses, using functional and attractive timber, which at least comply with Australia's fire safety requirements.

It is possible – and indeed desirable – to improve the bushfire performance of houses in Australia. The good news is that it's possible to do it without building concrete bunkers.

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The Report found that the main external factor increasing the vulnerability of a house was not timber constructions such as decks or pergolas, but rather, the close proximity of vegetation.

(Photo courtesy of Paul Harr, architect.)

From *A Nation Charred: Inquiry into the recent Australian bushfires* October 2003. House of Representatives Select Committee on the Recent Australian Bushfires —

"The Committee concluded that the recent Australian bushfires demonstrated a general lack of community awareness about the active role that it can play in reducing the severity of the impact of bushfires." To limit radiant heat exposure, flame contact or the impact of embers, it would be most effective to minimise the amount of combustible material around a property. Quite importantly, it is possible that the risk of bushfire attack may change over time and, as governments have reduced the capacity for landholders to remove hazardous trees, numerous properties may be ill-prepared to deal with the threats of bushfire attack. Table 7.4 of the report outlines the steps that individuals could take when preparing their property against the threat of bushfires.

In terms of housing design and construction, the Building Code of Australia contains technical provisions which incorporate Australian Standards such as AS3959. This standard applies to those zones designated as being Bushfire Prone by Governments and indicates the process for determining the level of bushfire attack risk within those zones. Compliance with these laws is based on interpretation and administration by the building and development authorities in each State and Territory. As a result, there is no consistent means for applying AS3959 across the country. Similarly, there are inconsistencies in the way that areas are identified as being bushfire prone, with great uncertainty over what should happen at the urban-rural interface.

Native vegetation retention policies are making it difficult to protect homes, given the importance of maintaining some prominent separation distances between dwellings and vegetation. However, an appropriate development control plan prepared by councils may be of assistance to home owners and builders. The Blue Mountains City Council plan, Building in Bushfire Prone Areas, provides the means for assessing bushfire risk at each site and sets out the minimum acceptable building and landscaping standards. Every residential property built to those standards has withstood the impact of bushfires, so far. A key concept of the development plan is to minimise radiant heat or flame contact through hazard reduction. This planning approach needs to be balanced against costs forced onto homeowners. In some cases, compliance with the Development Control Plan may increase the cost of building by up to $30,000 per home.

The Committee recognised that the AS3959 concentrated on building construction and design in bushfire prone areas. Two key recommendations from the report suggested that this standard could be improved to better protect lives and property:

Recommendation 47

"The Committee recommends that the Standards Australia incorporate building maintenance into AS3959-1999: Construction of buildings in Bushfire Prone Areas, perhaps renaming it as AS3959-1999: Construction and maintenance of buildings in Bushfire Prone Areas."

Recommendation 50

When considering the scope of AS3959, it "should include extending its scope to cover existing buildings and those that are not in areas declared as bushfire prone, yet still on the urban-rural interface and therefore, potentially at risk."