Bushfires

This fact sheet outlines essential design issues for buildings in bushfire prone locations. The potential for bushfires is an integral part of Australia's bushland. The functioning of that natural environment requires and accommodates fire. Buildings sited in this environment thus similarly need to cope with fire.

Bushfire is a fact of life in much of Australia.

Long hot summers dry out the vegetation. The vegetation holds oils and flammable fibre which, along with the fallen leaf and bark debris, create a substantial fuel load.

High temperatures, strong winds, airborne dust, and ignition sources from natural and human factors combined can then trigger and propagate fire.

Building sustainably emphasises certain preferred outcomes including the use of local materials with low embodied energy and with recycling and low toxicity attributes.

Meeting bushfire needs can call on different priorities: recycled timber often does not meet non-combustion rating requirements, fire resistant paint embodies toxins, steel and other non-combustible components have high embodied energy. Meeting the specifications for bushfire resistance can be at odds with some sustainability goals.

For intense bushfire prone places, bushfire resistance comes first in building construction decisions. In other locations, sustainable and bushfire resistant construction choices can mix.

MECHANISMS OF FIRE SPREAD

The Australian landscape has features that instigate and propagate wildfire.

Indigenous vegetation contains oils in timber and leaf that at higher temperatures form flammable vapour and feed flame. Vegetation debris such as bark, leaf and fallen limbs form base fuel loads which aid the spread of fire. Flammability arises also from detailed features such as leaf size and form.

Climatic factors that contribute to ignition and propagation of fire by drying out vegetation include:

> Long dry summers.

> Low rainfall.

> High temperature.

> Windy days.

Bushfire develops in stages from ignition through fire spread, growth, travel and changes in intensity. Bushfire resistance aims to:

> Prevent ignition.

> Minimise fire spread.

> Combat flame growth and intensity change.

The goal is to minimise destructive effects. The attention throughout is on minimisation of adverse impact on people and property.

Ignition

Ignition can be from natural and manmade causes.

> Natural ignition sources include lightning from summer storms striking ground features.

> Human instigated fire can begin from solar heat concentration onto manmade debris such as glass shards or bottles concentrating heat to ignition.

> Direct human ignition of vegetation is an on-going concern.

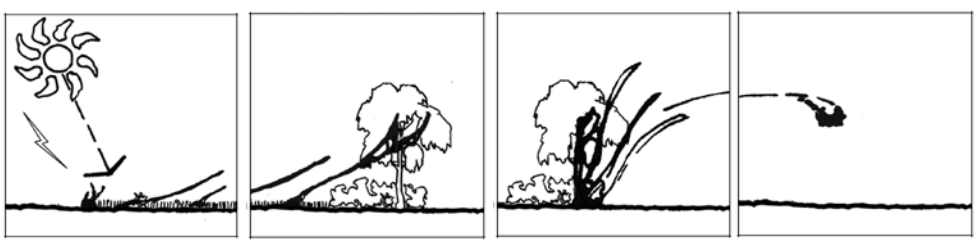
Fire progression

After ignition, the small initial fire travels through direct fuel load, principally ground debris.

> Ground slope and wind assist the spread of fire.

> Density of fuel load permits increasing fire intensity.

Fire Progression



As the fire enlarges, this permits flame spread through debris and vegetation, both in the understorey and canopy, giving the fire additional height and moving it toward intensification.

Fire grows by:

> Burning debris dispersal.

> Direct fire front heat radiation.

> Direct flame onto further vegetation.

Growth

Increasing fire intensity and growth then permits fire propagation through living vegetation from burning debris and direct flame, with the increased fuel load including vegetation oils boiled off and vegetation dried ahead of the fire front by direct radiation.

Development of intense fire front includes creation of individual fireballs of oils and embers propelled ahead of the main fire line advance. These fireballs permit spot fires separate from the fire front, causing either independent fires or accelerating the fire front advance.

Fire propagation

The speed of fire front advance is contributed to by the ambient weather, notably dry high temperatures and wind. See illustration below.

Ground level fire propagation is increased by changing ground slope and vegetation. Wind behind the firefront and upslope can accelerate fire spread, as can wind swirl around landform obstacles together with downslope and dry ground conditions.

The vertical spread of vegetation across the layers from grass to understorey and canopy enables fire to change in flame form and height, with independent fire travel at each level of this vegetation mix.

Design priorities

To deal with the fire behaviour outlined above, a design approach to bushfire resistance within the property focuses on:

> Preventing fire ignition sources.

> Avoiding fuel load that could contribute to spread or intensification.

> Creating fire barriers that permit safe movement for people and reduce fire advancement and propagation.

> Creating site surroundings and using construction elements that reduce fire load on buildings.

These are each expanded on in text and diagrams.

Site issues

The intensity of fire impact on buildings can be reduced by the features in the surrounding land area.

Reducing fire approach and intensity is contributed to by site development, its on-going maintenance, and fire fighting tasks on the day:

> Selection of high water bearing and fire resistant plant species.

> Long term wetting of ground, mulch, ground cover and plants with wastewater or garden water sources.

> Active fire fighting in the garden as well as on the building.

At time of fire approach, water delivery and spray to the garden similarly reduces fire intensity, in particular via airborne burning embers.

Water spray is delivered on ground and vegetation to retain a wetted condition, with reciprocating stand sprinklers creating a water droplet curtain to reduce fire approach intensity.

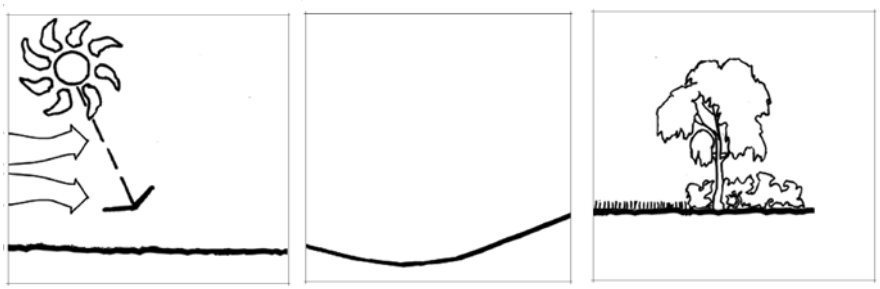
On-going maintenance is integral to such site development issues with on-going debris reduction, and ensuring serviceability of water delivery including stand pipes and sprinklers which need to be effective at time of fire. See illustration below.

Development for passive bushfire resistance can include creating changes in landform in the direction of potential fire approach. That type of mound can provide both shielding from direct radiant heat in the fire front, and deflect the core fire front flame or fire ball above the building form.

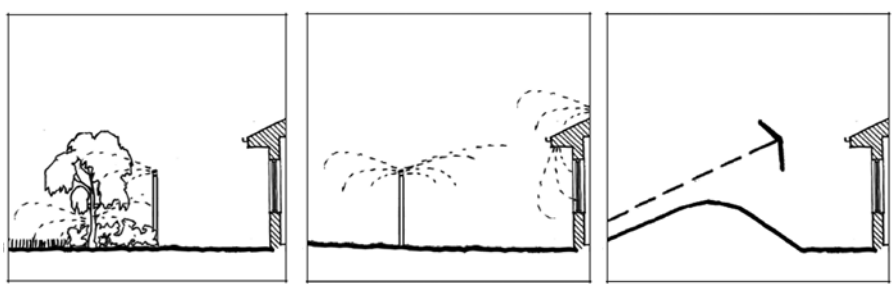
In the same way, the fundamental siting of the building in relation to natural landform and stands of vegetation determines the likely fire intensity at the building face.

Positioning below the crest of rising ground can reduce fire heat intensity on the building face compared with siting on the hill top. Siting behind existing dense vegetation can be a position where fire approach slows and fire front radiance is reduced. The positioning of wind break vegetation and out-building clusters can also contribute in this role.

Fire Propagation



Fire protect site



Landscape

While vegetation is often considered as contributing to fuel ignition source and fire spread fuel, in selected circumstances it can be part of fire barrier design.

Vegetation can form part of a fire barrier if it:

> Holds moisture throughout summer.

> Creates a continuous screen from understorey to canopy.

Water delivery and its capacity to be retained on surfaces can also contribute.

Plant criteria which reduce fire potential include:

> Leaves with moisture and mineral content, and low oil levels.

> Leaves with fine form and dispersed foliage density.

> Dispersed foliage clumps or clumps clear of the ground.

> Limited foliage volume.

> Low dead foliage content.

> Bark which is tight fitting and continuous rather than presenting recesses in which embers can lodgement.

> Plants that create debris with fine form and make a compact litter.

Approach paths to buildings

Occupants wanting to evacuate the property during bushfire need fire safe paths on the property. These are also essential for access into the property for fire fighting and to provide defensible spaces during fire fighting.

Attributes of paths and defensible spaces include:

> Pathway width, slope and surfaces able to be negotiated when conditions are bad and visibility is affected by smoke and flame.

> Paths that avoid going toward high fire intensity areas.

> Widths and turnarounds that accommodate the needs of fire fighting vehicles.

> Avoidance of adjacent and overhanging vegetation that might be a fire source or create barriers by collapsing across pathways.

Legislation

Development legislation includes minimum requirements for bushfire resistance of building construction. The Building Code of Australia (2.) sets performance goals (Part F2.3.4) and defines accepted standard construction (Part 3.7.4).

Requirements vary according to the location's assessed fire risk (medium, high, extreme). An individual building site is assessed according to Australian Standard 3959 (3.) that sets out assessment methods and bushfire resistant building elements.

Advice and formal assessment is performed by the approriate regional Country Fire Services or Country Fire Authority. For some locations, the state government provides mapping for the general bushfire prone category of various regions.

The following summarises thinking about fire resistance in building construction drawn from the sources above.

Building envelope

Beyond reducing fire intensity as described above, the building itself is built to be fire resistant. Detail construction to the building exterior seeks to avoid ember entry and combustion commencement through construction with non-combustible materials, surfaces and sealed construction junctions.

Complicated roof shapes generally offer more places for embers to lodge and make it more difficult to seal the roof. Keep roof forms simple.

Adjacent open structures (pergolas and decks) may contain combustible elements or ember traps. These building elements should be structurally separate from the building and not penetrate the building exterior.

In the building itself, common construction junctions need to be sealed against ember entry and flame access to the structure.

The junctions are:

> Roof ridge and flashings.

> End flutes of roof sheet at the gutter line.

> Eaves junctions to fascia and wall.

> Openings to cavities in walls and under suspended floor voids.

Openings are potential fire entry sources. Embers can enter through gaps in openable portions, and flame can enter through glass broken by fire radiant heat.

Construction to resist this includes:

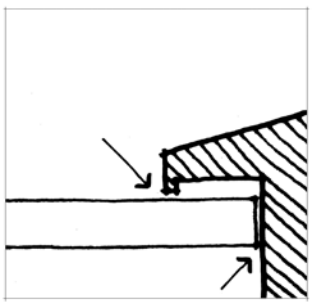
> Seals placed in junctions between frames and exterior claddings.

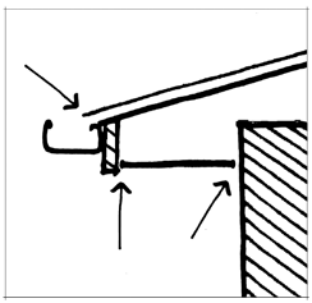
> Seals around frames in openable sashes.

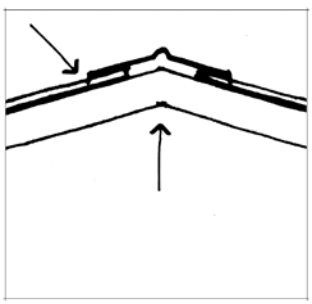
> Bronze mesh flyscreens covering openable sections of doors and windows.

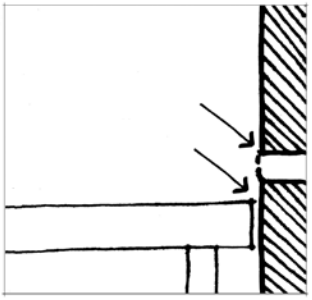
> Flyscreens covering open drainage and perps (open vertical joints for ventilation required by other legislation seeking to avoid damp and vermin in buildings) in walls.

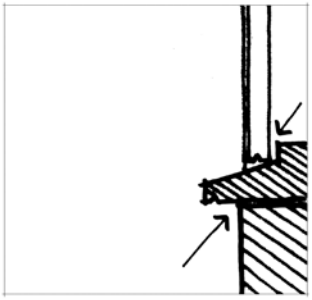
Non-combustible materials include sheet and masonry materials (steel, fibre cement, brick and stone). Manufacturers continue to evolve treatments to provide fire resistance to timbers but some paint coating options may contain

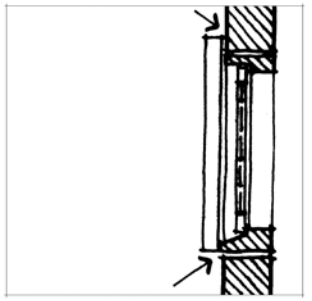

external structure seals


eave seals


roof ridge seals


vent seals


window seals


shutter screen seals

chemicals and combustion toxins. In some jurisdictions (South Australia) some dense timber species (turpentine, blackbutt) are accepted as adequate for use in some bushfire risk categories.

Improving fire resistance to glazing can include using toughened glass that is less prone to heat load breakage as it requires 450°C surface temperature to physically fail.

Further fire resistance can be achieved beyond minimum requirements with fixtures including shutters over openings either of non-combustible or fire rated construction.

Some fire entry points may be unexpected. Services ducts, conduits and pipes need to be non-combustible both where externally exposed and 300mm down into the ground.

Maintenance

Ageing and decay of materials, construction and finishes can reduce building resistance to fire.

Burning embers can lodge in the resulting cracks in surface and material depth of those external surfaces, giving a foothold for fire damage to the building exterior.

Movement of non-combustible linings away from structure and services can expose previously protected material that may then be prone to damage by fire, providing a fire path to the building interior.

Routine maintenance beyond debris removal includes repair to building surfaces and openings to maintain bushfire resistant performance:

> Fill cracks and gaps as these develop.

> Maintain exterior surface finishes intact.

> Remove ember lodgement and entry places.

> Maintain seals (ridge, eaves, flashings).

> Maintain flyscreens.

ADDITIONAL READING

Australian Building Codes Board (2007), *Building Code of Australia, Vol 2*, Part 3.7.4 Bushire Areas, AGPS, Canberra.

CSIRO
www.csiro.au/csiro/channel/ich49.html

Ramsay G and Rudolph L (2003), *Landscape and building design for bushfire areas*, CSIRO, Melbourne.

Schauble J (2004), *Australian Bushfire Safety Guide*, Harper Collins, Pymble, NSW.

Timber Development Association
www.timber.net.au/bushfire

Yates A et al (2002), 'Special conditions – gardening in fire-prone areas' in *Yates Garden Guide*, Angus and Robertson, Pymble, NSW.

Principal author:
Emilis Prelgauskas