 ENGINEERS AUSTRALIA	PRACTICE NOTE NO: BL 1.2			Version: R2	May	2026
	Copyright © EA and EHA 2026			Author: F. Gamon, TSG Fire for EHNSW		
	Buildings and structures	Museum artefact	Operating object	Material specific	Intangible heritage	Sustainability
	Fire Safety for Heritage Buildings- Part 2 of 2- Understanding Fire Performance of Common Materials					

1. Introduction and background

This technical note (Part 2 of 2) discusses how the fire resistance of common building materials encountered when carrying out new works in heritage buildings is assessed and outlines strategies to achieve compliance with the current Building Code of Australia (BCA) and highlights some alternative pathways to retain heritage value without compromising life safety.

As identified in Part 1 of the Practice note, a critical success factor in achieving Fire Safety in Heritage Buildings is the early involvement of a **Fire Engineer** working collaboratively with heritage consultants, design professionals and building owners or operators.

2. Purpose

Understanding the fire resistance of common building materials and fire engineering solutions to improve heritage outcomes with respect to fire resistance levels.

3. Scope and applicability

This practice note is relevant to heritage consultants, architects, structural engineers, and building owners or operators seeking an understanding of how Fire Engineering solutions can help satisfy compliance to current Fire Safety requirements of older and heritage buildings constructed prior to the introduction of the Building Code of Australia (BCA), circa 1996.

4. Understanding fire resistance of common materials

Timber


Many heritage buildings incorporate timber structural components (roof trusses, columns, floor joists etc). Timber's primary fire behaviour is charring: the outer layer burns and forms a char, which acts as an insulator for the remaining wood. This means that sufficiently thick timber can maintain structural integrity for a considerable duration during a fire, as the uncharred core continues to carry load.

Heavy timber construction, commonly found in heritage public buildings like churches or old warehouses, can achieve an inherent Fire Resistance Level (FRL). However, timber floors are rarely capable of achieving the required FRL and typically need to be protected with fire-resistant materials such as fire-rated boards or a structural topping solution. Structural topping adds weight, which can exacerbate issues with structural capacity and fire resistance levels.

A fire engineering assessment should be able to determine whether the reduced FRL is acceptable for a credible fire scenario within the building. Also, an active suppression system might be able to be used to offset some of the required FRL via a Performance Solution approach.

Iron and Steel

Many heritage buildings feature exposed steel or cast iron components. Steel loses about 50% of its load-bearing capacity at 550 °C according to Eurocode 3, while cast iron shows similar vulnerability, losing half its strength at around 600 °C according to the research by A. Porter. Both materials expand roughly 60 mm over 10 m at these temperatures, creating internal stresses that can displace masonry or result in failure at connections. Detailed structural fire engineering analysis can highlight failure mechanisms, potentially changing the nature of the solutions available – e.g. replacement of rivets with high strength bolts may suffice instead of protecting the entire steel member with fire protective material.

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Cast iron's brittleness, combined with casting flaws, design deficiencies, and susceptibility to thermal shock from firefighting water, heightens its risk of failure in fire.

Boxing such members in fire-rated boards, such as gypsum, is a common *DtS solution*. Historically, many upgrades involved encasing iron or steel columns in concrete or brick to provide fire protection. If these measures remain in place, they typically offer excellent fire resistance. Encasing steel in concrete is possible but generally avoided due to its invasive nature, difficulty of removal, and the concealment of historic material. An alternative for hollow cast iron columns is to fill them with concrete and a reinforcing bar, increasing thermal mass and slowing temperature rise. This method preserves the external appearance while helping the column remain cooler and maintain load-bearing capacity for longer during a fire.

Intumescent paint can also be applied to exposed steel elements that need to remain visible. Thin-film intumescent coatings expand under heat to protect the steel during a fire. Depending on the product and applied thickness, these coatings can provide relatively high fire resistance, e.g. 120 minutes, while preserving intricate details such as fluted column capitals. However, the connection of secondary elements or attachments (e.g., handrails, hanging cables) may compromise the integrity of the fire protection by creating heat transfer paths to the protected elements. A fire engineering assessment is often required to evaluate these impacts and determine the extent of protection needed for secondary components.

Concrete

Many heritage buildings from the early 20th century onwards include reinforced concrete elements. In some cases, even older buildings were retrofitted with concrete during past renovations, for example, by inserting a new concrete slab into a 19th century masonry shell.

However, concrete in heritage buildings may well not perform to the same standard as modern concrete. Structural engineers often need to extract samples from heritage concrete to assess its current condition, identify deterioration mechanisms, and confirm the actual strength of the structure. And the performance in fire can vary significantly from area to area – e.g. across large floor plates.


The primary fire related concerns for concrete are spalling and the heating of reinforcement. Heritage concrete, particularly early mixes, may contain higher water content or certain stone aggregates that increase the likelihood of spalling under elevated temperatures.

One mitigation measure is to apply a protective layer. For instance, a cementitious fire spray can be applied to the underside of a concrete slab to prevent heating to the concrete and to effectively increase the cover to reinforcement.

As a result of changes to the standards (e.g. AS 3600:2018), designs that were previously considered to achieve one fire resistance level may no longer be considered able to achieve that standard of fire performance. This can result in a shortfall of FRL even if no change in use occurs. Fire engineering can often support retention of the existing structure without upgrade works, subject to calculations demonstrating adequate conditions.

Masonry and sandstone

Brickwork typically provides strong fire resistance, but maintaining its structural stability during a fire can be challenging. When exposed to high temperatures, one side of a brick wall heats up and expands, which may cause the wall to bow or even collapse if not properly supported. Older walls, especially heritage structures, often lack vertical reinforcement or secure ties to floors. Upgrading these walls might involve adding steel straps or through-wall anchors (such as ties or large screws with plates) at intervals to keep the wall securely connected to both itself and adjoining floors.

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Old lime mortar used in brickwork can crumble when exposed to high heat, allowing bricks to loosen. Repointing these areas with compatible mortar can help restore some strength. Additionally, any services passing through the wall must be properly fire-stopped using materials like fire collars or fire-resistant mortar to preserve the wall's integrity.

Thick stone walls, such as those made from sandstone or granite, also offer excellent fire separation and prevent fire spread. Still, stone can deteriorate under intense heat. Heritage stone elements, including columns and carvings, are at risk of losing strength or fracturing in a severe fire. Adding extra structural support can help reduce these risks.

5. References

Building Code of Australia (BCA)- part of the National Construction Code (NCC), setting national standards for the design, construction, and performance of buildings to ensure safety, health, accessibility, and sustainability.

British Standard BS EN 1993-1-2:2005, - Design of Steel Structures – Part 1-2: General rules – Structural fire design, British Standard Institute, 2006.

A. Porter, The Behaviour of structural cast iron in fire: A review of previous studies and new guidance on achieving a balance between improvements in fire protection and the conservation of historic structures, English Heritage Research

AS 3600:2018 Concrete Structures

Other EHA Practice Notes-references to be updated as they evolve

6. Definitions

Deemed-to-Satisfy Provisions (DtS)-Provisions which are deemed to satisfy the Performance Requirements of BCA/NCC.

Eurocodes-a set of European standards that provide harmonised rules for the structural and geotechnical design of buildings and infrastructure across the European Union.

Eurocode 3-European standard for the design of steel structures, covering safety, serviceability, durability, and **fire resistance** across a wide range of steel construction types.

Fire Engineer- Fire safety engineering deals with the protection of life, property, and environment through the application of engineering principles, rules and judgement to the phenomenon of fire, its physical effects and the reaction and behaviour of people to fire.

Fire Resistance Level (FRL)- The grading periods in minutes for the following criteria—structural adequacy; and integrity; and insulation and expressed in that order (-/-/-).

Performance Requirement- A requirement which states the level of performance which a Performance Solution or Deemed-to-Satisfy Solution must meet.

Performance Solution- A method of complying with the Performance Requirements other than by a Deemed-to-Satisfy Solution.