STA | STRUCTURAL TIMBER ASSOCIATION

Advice Note 7
Fire robustness part 1
Design concepts for the in-service life of the building

June 2021 (version 2)

Documents in the Advice Note series

This forms part of Advice Note 7 on structural timber building robustness against fire. Advice Note 7 comprises:

Part 1 - Design concepts for the in-service life of the building (this document)

Part 2 - Structural timber external wall compliance route for fire safety

Part 3 - Fire Safety Strategy (FSS)

Part 4 - Fire safety of façade systems for structural timber buildings

Part 5 - Design of escape distances during the construction process.

The June 2021 revision (v2) has been updated to reflect the change of content in Parts 2, 3 and 4 and has been updated to reflect current STA guidance.

Introduction

Purpose of the Advice Note

The use of timber as a current and sustainable construction material is well-known and documented. Detractors of timber structures point to the combustibility of the raw material. Look around any building, for example, a home, office and school and timber will be ever-present in furniture, doors and other second fix exposed items. Then consider the same emotion that drives detractors to call for timber structures to be questioned on the suitability of the construction material, on account of the possibility of the potential fire risk when it is fact that it is the contents of buildings that present a potential fire risk; contents that include many combustible items other than timber.

Structural timber buildings are designed to be robust against fire. The use of timber in the buildings structure has design principles that are tried and tested in the construction industry - and have demonstrated that timber structures can comply with the fire regulations of current Building Regulations across the United Kingdom.

This advice note provides generic information on the subject of robustness against fire and has been written to be of use to developers, end users, insurance companies, third party businesses and designers.

Building Regulation compliant

The regulations for fire safety do not differentiate between types of construction. Buildings using structural timber must meet the same fire safety standards as masonry or steel frame buildings. Most buildings are described in terms of fire resistance, which is presented in the statutory guidance documents that support designers in complying with the functional requirements of the Building Regulations. There is more to the building design than fire resistance but to support readers the following has been provided as an introduction.

The regulations are primarily focused on public health and safety. Fire regulations address issues such as:

- Means of escape (making sure people can get out of a burning building safely via stairs, emergency windows etc.) This is a function of the over building design and layout.
- Restriction of spread of fire internally and externally by direct flame travel and hot gases. This is a function of the surface spread of flame on exposed surfaces, fire stopping and cavity barriers.
- Load-bearing capacity, integrity (the ability of the structure of a burning building to stay intact long enough for occupants to escape safely) and insulation against fire spread through conduction. This is called fire resistance of the elements being considered - see basics of fire resistance for more information.

Statutory guidance documents, for example Approved Document B (England) and Technical Handbook (Scotland), prescribe a minimum time that all load bearing walls must resist fire (referred to as fire resistance). The following is a general guide but specific values should be determined from the building designer and regulations at the time of the build:

- Houses up to 3 storeys - 30 minutes
- Houses above 4 storeys - 60 minutes
- Schools (no sprinklers) - 60 minutes
- Duplex accommodation, up to 2 storeys - 30 minutes
- Blocks of apartments between 2-7 storeys and maximum 18m to the top floor level from the ground floor - 60 minutes
- Blocks of apartments of 8 storeys or more - 90 minutes
- All compartment walls and floors up to 7 storeys - 60 minutes

Building regulations and statutory guidance apply to completed buildings. See other STA documents relating to fire safety during construction and Site Safe.

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Basics of fire robustness

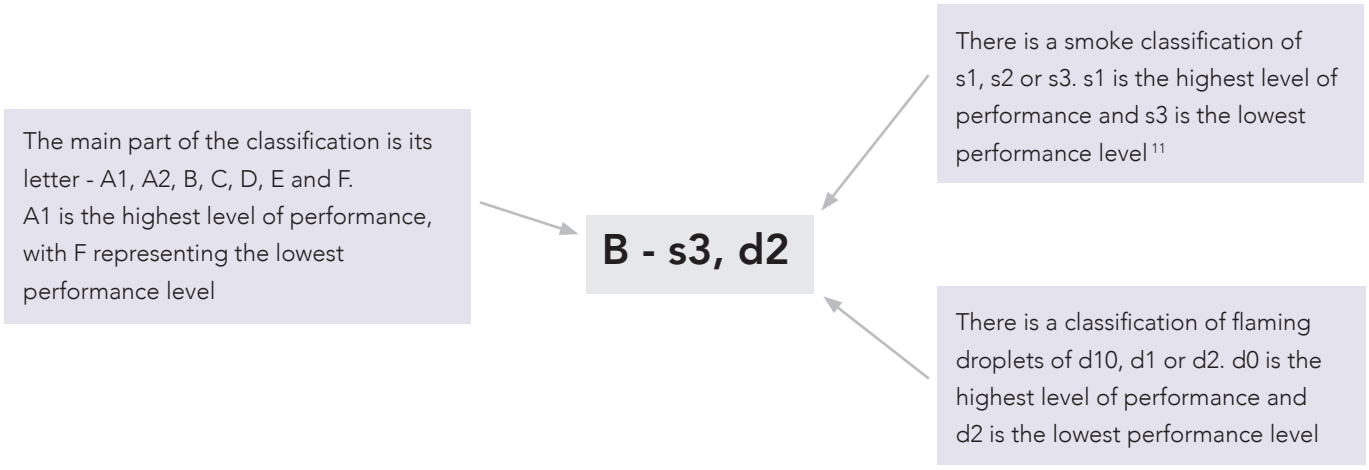
The robustness of buildings against fire is a key principle in the Building Regulations and statutory guidance. There are three elements to robustness, regardless of the materials used in the construction:

1) Reaction to fire to exposed materials
2) Fire resistance of the assembly e.g. wall or floor
3) Fire stopping and cavity barriers i.e. closing of gaps, wall to floor junctions, limiting closing of voids, and fire stopping service holes.

Reaction to fire

Reaction to fire is the ability to stop a fire getting bigger from an initial small fire, such as fire in a small waste bin. Timber itself will spread fire if left unprotected, so coatings or protection is used to ensure a suitable reaction to fire. Protections are typically plasterboard and coatings are typically flame retardant. European tests on the products provide the classification from A1 (no spread), on to A2, B C D and E, which is standard timber. In addition the amount of smoke and flaming droplets are given in a classification process.

A classification for a construction product is given in the following manor:



DESCRIPTION AND COMPARISON TO BRITISH CLASSIFICATIONS FOR REACTION TO FIRE	EUROCLASS	SMOKE CLASS	FLAMING DROPLETS
Non combustible - no contribution to a fire e.g. tested boards used in fire protection conditions	A1		
Limited combustibility - negligible contribution to a fire e.g. gypsum boards, mineral wool *	A2	s1-s3	D0-d2
Limited contribution to a fire, Class O e.g. gypsum boards with thin surface linings, cement-bonded particleboard, some flame retardant treated wood	B	s1-s3	D0-d2
Flame retardant treated wood, Class 1- some contribution to a fire	C	s1 - s3	D0-d2
Untreated wood products, Class 3 - contributes to a fire Density of 400kg/m^3. Plywood & OSB 9mm thick	D	s1-s3	D0-d2
Untreated wood products with a density of < 400 kg/m^3 - contributes to a fire Low density fibreboard. Plastic-based insulation.	E		
Untested products	F		

Table 1: Euro Class table for reaction to fire

* This comparison of materials is derived from the definition of materials of limited combustibility in approved document B of Building Regulations in England and Wales

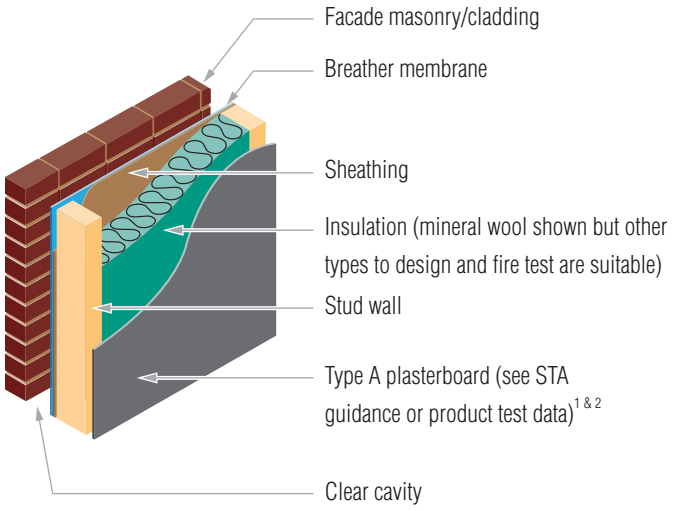
Building regulations on internal fire spread (linings) state a requirement to inhibit the spread of fire within the building. The internal linings shall:

- adequately resist the spread of flame over their surfaces; and
- have, if ignited, a rate of heat release or a rate of fire growth, which is reasonable in the circumstances.

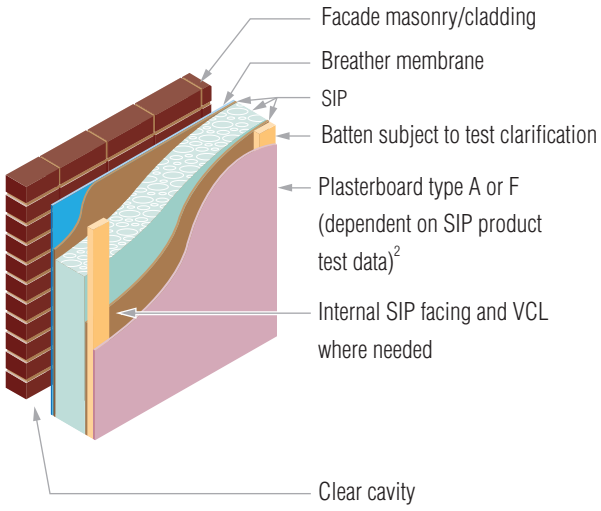
Requirements for internal fire spread will be meet if the spread of flame over the internal linings of the building is restricted by ensuring low rates of surface spread of flame. Or, in some cases, to have a low rate of heat release, so as to limit the contribution that the fabric of the building makes to fire growth.

Reaction to fire is a consideration where the timber structure is exposed. It is not a design issue where the timber is protected by an appropriate covering. The assembly detail which encloses the timber will require a reaction to fire classification.

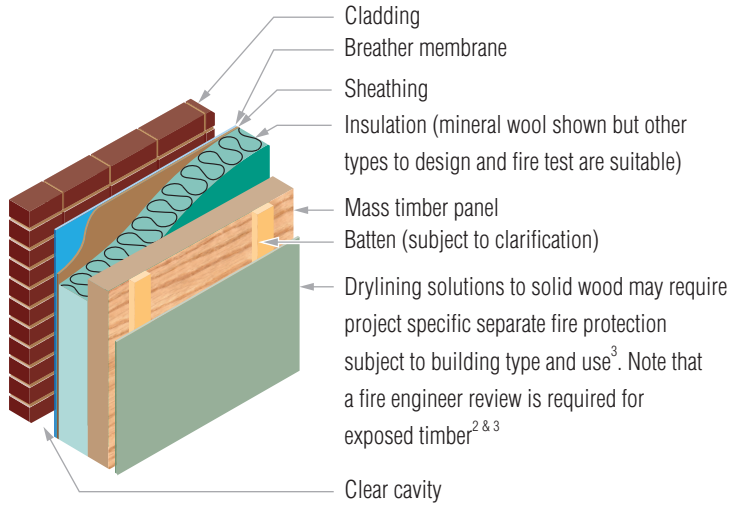
Exposed wood options provide resistance by virtue of the charring of the timber element, which can be incorporated into the design of the wood structure. The surface spread of flame over the exposed timber walls is protected either by a flame retardant, or a fire-engineering solution such as a suppression system (e.g. sprinklers).



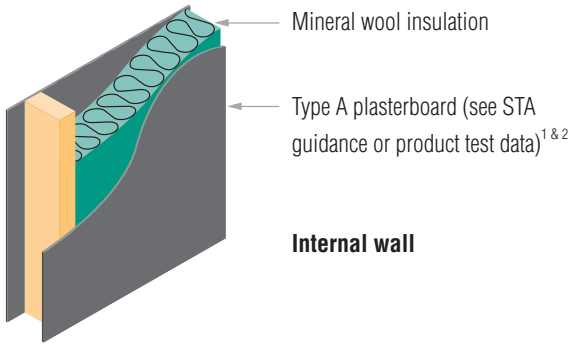
TIMBER FRAME PANELS



STRUCTURAL INSULATED PANELS (SIP)



MASS TIMBER PANEL



TIMBER FRAME INTERNAL WALL

Figure 1: Diagrammatic fire protection and solutions in timber structures - typical wall build ups for fire resistance

NOTES:

1 *Other product solutions are also possible with test data to Structural Timber Buildings Fire Safety in Use Guidance, volume 1 - pattern book systems*

2 *Number of layers/plasterboard is dependent on the project requirement. (Information may be in future STA publication Structural Timber Buildings Fire Safety in Use Guidance, volume 3)*

3 *Structural Timber Buildings Fire Safety in Use Guidance, volume 6 - mass timber buildings compliance route to B3 (England)*

Fire stopping cavity barriers

What is a cavity barrier?

A product that closes or subdivides a concealed cavity and inhibits the spread of fire across or into a cavity; inhibiting is to slow the spread of fire over a time period. See STA guidance or relevant Building Regulations for fire resistance requirements.

Fire stopping for elements of structure

Fire stopping is a product that closes a gap or imperfection in a fire resisting element of structure or compartment lining and has at least the same fire resistance as the function requirement in which it is located.

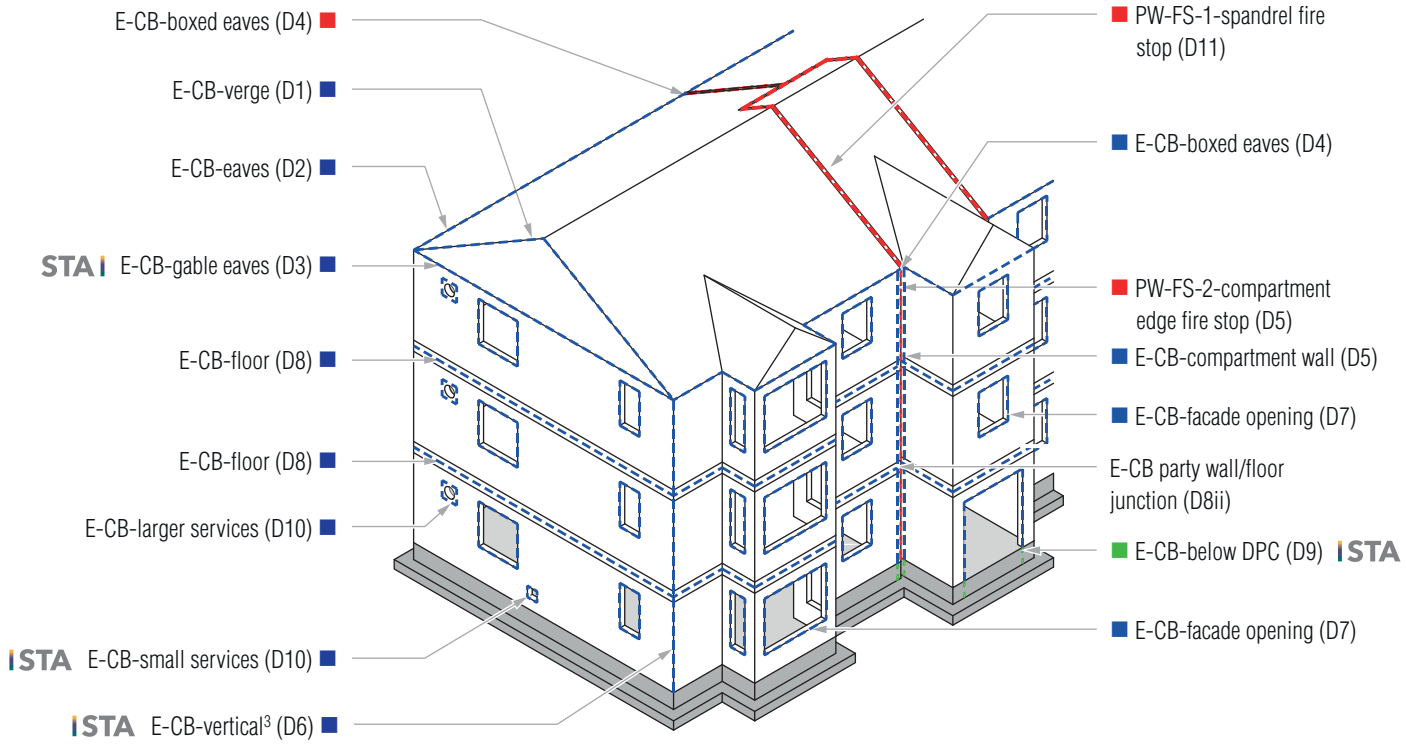
A cavity barrier is not fire stopping unless it is designed for that function. However, fire stopping can achieve cavity barrier functionality if it closes a cavity.

Additional information

The STA provides extensive documentation and support on fire stopping and cavity barriers. Below are excepts from the STA Structural Timber Buildings Fire Safety in Use Guidance, volume 2 - cavity barriers and fire stopping, which is available to download at www.structuraltimber.co.uk

(Extract from STA Structural Timber Buildings Fire Safety in Use Guidance, volume 2 - cavity barriers and fire stopping)

Locations for resilience; multi-occupancy



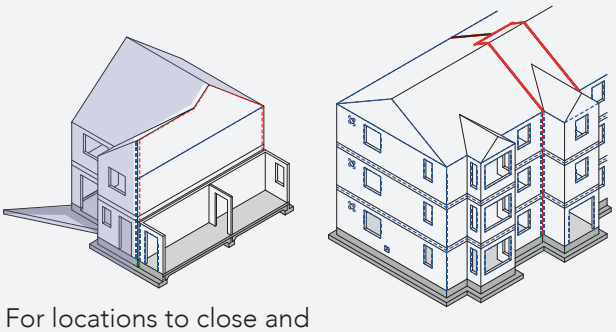
KEY TO CAVITY BARRIER AND FIRE STOPPING LOCATIONS

- Standard cavity barrier
- Fire stopping cavity barrier
- Below DPC cavity barrier
- STA Location not specific in guidance but is recommended as resilient practice by the STA

(Extract from STA Structural Timber Buildings Fire Safety in Use Guidance, volume 2 - cavity barriers and fire stopping)

Care points for designers

Relevant to any business undertaking this role within a project

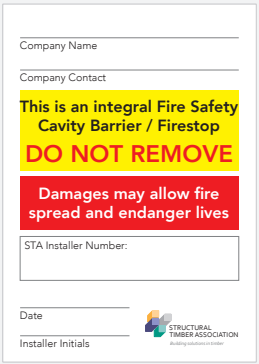
PROCESS	CARE POINTS	PHOTO / DIAGRAM / REFERENCE
1	Determine location of fire stopping and cavity barriers. Understand the difference	 For locations to close and divide a cavity see Part 3 of guidance
2	Provide details for each location Tolerance of the frame cladding is to be considered	Provide details taking account of tolerances and project details. See Part 4 of guidance for additional information
3	Provide specification cavity barrier types and fire stopping types	Select cavity barriers with appropriate compliance certification; test certificates from UKAS test authority Refer to manufacture's literature for tests to BS or EN standards and compliance for the actual application being designed. Check where appropriate, if construction element fulfilling another use will also provide the cavity barrier
4	Undertake the designer's checklist - see following page	Recommendation to incorporate as part of the company STA quality procedures for future checks
5	Tender details to include a sign off strategy for auditing the correct installation of cavity barriers and fire stopping	Recommendation to engage with an STA member company under STA Assure training and installation audit process for relevant cavity barriers and fire stopping installation

NOTES:

Fire safety information to be considered by the designer. For any building work there are legal requirements to provide summary fire compliance documents for to hand over to the principal designer who in turn passes it to the building "responsible person". Guidance required to be submitted of the fire-separating elements (which may be the cavity barriers) is the responsibility of the company who has agreed to take the design and install responsibility in the contract.

(Extract from STA Structural Timber Buildings Fire Safety in Use Guidance, volume 2 - cavity barriers and fire stopping)

Care points for installers/checkers

PROCESS	CARE POINTS	PHOTO / DIAGRAM / REFERENCE
1	Know why installing cavity barrier correctly is important: • Cavities can act as chimneys which can draw fire to spread beyond the original location • An effectively installed cavity barrier provides resistance to fire spread and slows the spread of fire • If cavity barriers are not installed correctly or removed and damaged, they will no longer be able to provide the resistance to fire spread which could endanger lives STA recommend using a trained installer who is provided with installer verification on the timber frame card upon completion1	 STA - cavity barrier installer card

[1] *The STA recommend that an installer adopt the training module and verification included within the Timber Frame Competency Award Scheme. Companies outside of the STA may still take the module as a demonstration of their competence to install cavity barriers.*

Facts on Fire

1. Structural timber buildings must comply with the functional requirements of the Building Regulations for which statutory guidance may be the most suitable for designers to follow.

3. The vast majority of injuries caused by dwelling fires in the UK are from gas/smoke inhalation and shock. Fortunately, the numbers of such injuries are reducing year on year on account of better fire-rated furniture, smoke alarms, fire awareness of owners and an increase in inspectors.

4. Most fatalities are caused by smoke from fires involving textiles, upholstery and furniture. Victims succumb to smoke long before the structural materials of the house is even involved in the fire.

(Extract from STA Structural Timber Buildings Fire Safety in Use Guidance, volume 2 - cavity barriers and fire stopping)

Fire damage to structures - all materials

Fire damage can occur in any/all types of building as all construction materials are vulnerable to fire:

- Brick and stone flakes and disintegrates. Rebuilding costs involve replacement - this is not considered in the design process and often protection such as plasterboard is required.
- Concrete can be subject to the violent phenomenon known as explosive spalling, which is hugely dangerous to firefighters and people trying to flee a building. Depth of concrete reinforcement and density is part of the design process. Plasterboard protection is often used as well.
- Steel can buckle in severe heat. The deformation of steel under heat is part of the design process. Plasterboard protection is often used here too.
- In the event of a fire, timber chars at a rate which is commonly taken as a set value in Codes and Guidance. The timber below the char surface has retained strength, though not immediately behind the charring as there is a reduced strength layer that has been affected by heat.

Every building material has its weaknesses when subjected to fire. Equally, each mainstream method of construction in the UK, including timber frame construction, has its specific strengths and benefits.

Timber and fire

In the event of a fire timber chars allowing the designer to determine section sizes, but the fire dynamics of the heat released from a fire over the surface of the timber must be considered in the context of the duration of fire and structural stability appropriate to the use and scale of the building. In addition, exposed timber is likely to require surface spread of flame treatments. Protection of the timbers is a suitable and practicable process to provide fire resistance to timber structures.

The fire safety of a building is far more complicated than whether the materials are combustible or not - the characteristics of the entire system must be taken into account.

The Structural Timber Association provides guidance for architects, builders, developers and building authorities on how to protect and maximise strengths - and how to use such materials in such a way that our buildings are safe, robust, durable and appropriate. Quality and knowledge within the construction company and product supply chain is important. The STA sets out quality levels for members to attain. Part of this is ensuring an understanding of designing to be robust against fire.

Building assessors, including mortgage lenders and insurers, accept that well-built timber frame homes are safe and reliable, providing, of course, that the quality of the build is appropriate.

To ensure quality appoint an STA member, who will adhere to STA Assure (see below) and will have access to technical updates and workshops to improve the quality of the build system.

STA Assure

Please note that timber frame systems performance declarations, only applies when supplied and/or erected by STA member companies, operating under the STA Assure Quality Scheme. They do not apply to non-member companies engaged in the supply and install of timber frames, regardless of any similarity of systems. For more information on the STA Assure quality scheme please go to https://www.structuraltimber.co.uk/members/why-use-an-sta-member

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