STEEL CONSTRUCTION
Fire Protection

STEEL for life

BCSA

■ Fire safety engineering
■ Fire protection for building safety
■ Meeting regulatory requirements

Steel for Life and the British Constructional Steelwork Association (BCSA) are working closely together to promote the effective use of structural steelwork. This collaborative effort ensures that advances in the knowledge of the constructional use of steel are shared with construction professionals.

Steel is, by a considerable margin, the most popular framing material for multi-storey buildings in the UK and has a long track record of delivering high quality and cost-effective structures with proven sustainability benefits. Steel can be naturally recycled and re-used continuously, and offers a wide range of additional advantages such as health and safety benefits, speed of construction, quality, efficiency, innovation, offsite manufacture and service and support.

The steel sector is renowned for keeping specifiers abreast of the latest advances in areas such as fire protection of structural steelwork and achieving buildings with the highest sustainability ratings. Recent publications have provided detailed guidance on Fire Protection and CE Marking and what it means for the construction sector. Guidance is provided on all relevant technical developments as quickly as is possible.

The sector's go to resource website – *www.steelconstruction.info* – is a free online encyclopedia for UK construction that shares a wealth of up-to-date, reliable information with the construction industry in one easily accessible place.

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Introduction
by Dr David Moore, Deputy Chief Executive Officer,
British Constructional Steelwork Association

Proven performance in real-world fires

Recognition of the importance of proper fire protection has never been higher, which is a welcome development. This intensified focus will give fire engineering a higher profile than ever before following the final Grenfell Inquiry Report that recommends it becomes a recognised profession with its own qualifications and is overseen by a new regulator. Companies highlighted in the report will be banned from government contracts, Prime Minister Keir Starmer told MPs following its publication, which itself will surely create a stronger focus on fire safety.

The general public and construction industry concern, as well as government and regulatory attention, will mean the safety of buildings in fires has to be proven from the earliest stage of construction. Choice of materials will be dictated to a greater extent than before on their ability to prove their safety.

The purpose of this publication is to remind architects, engineers and contractors of the exceptional performance of properly designed steel framed buildings in fires, and to outline how this is achieved, and how the benefits can be captured. Misconceptions may have arisen in the minds of some about how steel performs in real world fires, which should be dispelled when this brochure is read and understood.

There is a wealth of further detail about the proven performance of steel in fires and how fire engineering can help maximise building safety available on the free-to-use *steelconstruction.info* website. All the information that designers need to confirm how careful design, selection of appropriate coatings and adherence to regulations can produce safe buildings can be found there.

The constructional steelwork sector has been working closely with fire engineers for many years and looks forward to seeing their enhanced status if their skills gain the recognition they deserve with the creation of a new profession. We look forward to working with them and others along the supply chain to produce the safer built environment that the UK deserves.

November 2024

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Seismic shift in safety approach

Building safety has come under more intense scrutiny than ever before following the Grenfell Tower tragedy in 2017, where a fire resulted in the deaths of 72 people in one of the UK's worst fire related disasters. Since then, there has been a seismic shift in the UK's approach to building safety risk during the design, construction and occupation of new buildings in England, with a greater focus on those that are considered higher risk, which means above 18m.

Since the introduction of the Building Safety Act 2022, building owners and all parties along the supply chain should have a new awareness of their responsibilities for safety. Attention will likely, and rightly, focus on preventing the spread of fires. However, a key consideration will always be the ability of the structure to withstand fire, guaranteeing building occupants time to escape and giving fire fighters confidence in how long they can safely fight fires from inside buildings.

The steel-framed and BREEAM 'Outstanding' One Leadenhall, in the City of London, tops out at 35-storeys.

Steel performance proven in real-life fires

More is known about how structural steelwork behaves in a fire than any other construction material, largely thanks to its performance being proven through the Cardington series of full-scale fire tests, as well as analyses of steel's performance in major real-life fires. Steel emerged from these tests with a demonstrably exceptional and unique capability in fires. The Cardington tests are unparalleled.

The Cardington test results give building owners and engineers confidence in how structural steelwork performs in fires, along with certainty that modern techniques of finite element modelling and other, simpler tools accurately reflect how steel actually behaves in real fires.

Cardington fire tests

Investigations from actual fires, such as the one at Broadgate in 1991, suggest that the performance of complete structures is significantly better than that of the single elements from which fire resistance is usually assessed. Furthermore, there is general agreement that the structural contribution of composite flooring systems, comprising steel deck/composite floor slabs supported by a grillage of steel beams, is under-utilised in current fire design procedures.

The development of the Building Research Establishment's (BRE's) Large Building Test Facility at Cardington provided the UK construction industry with a unique opportunity to carry out full-scale fire tests on a complete steel-framed building designed and built to current UK practice. Consequently, in the early 1990s, a series of six compartment fire tests was conducted on a full-scale steel-framed building at Cardington.

The steel-framed building was designed and constructed to resemble a typical modern UK city-centre eight-storey office block. The building covered an area of 21m by 45m, with an overall height of 33m. It consisted of five 9m bays along the length of the building and across the width, there were three bays spaced at 6m, 9m and 6m. The building had three lift-shafts, one in the centre of the building and two placed at each end. The structure was designed as a braced frame with lateral restraints provided by cross-bracing around the three vertical access shafts. The beams were designed as simply supported, acting compositely (via shear studs) with the lightweight composite floor slab. The floor slab was 130mm deep and consisted of a steel trapezoidal profiled deck with lightweight concrete and an A142 anti-crack mesh. Throughout the structural design, the underlying philosophy was to obtain a structure that was buildable and at all stages of construction and erection reflected normal building practice in the UK rather than specialist research procedures.

The Cardington fire tests, conducted with the BRE, revealed the very high level of robustness of steel structures under various fire scenarios, even without fire protection. With the addition of either intumescent paint or other passive fire protection, steel surpasses all fire safety requirements, giving occupants time to safely exit buildings that more than complies with fire safety regulations.

Recognition of how real buildings react in fire and of how real fires behave has led to the realisation and acknowledgement that fire safety can be achieved by an analytical fire engineering approach. The steel construction sector carried out most of the research that led to the development of this approach, which has delivered benefits across the construction industry, although steel structures offer the greatest potential for improved solutions using the fire engineering approach.

Fire Safety Engineering

Determining the fire protection requirements for the structural steelwork of a building is a simple and straightforward process, consistent across all types of common buildings.

The procedure is clearly set out in BCSA documents, which provide reference aids for designers at all levels. There is a wealth of relevant information for structural engineers provided free at *www.steelconstruction.info*.

When properly designed in line with modern fire engineering approaches, a steel framed building gives owners and occupants the best assurance possible that the building will perform as it must

Steel framed building at Cardington - Fire test No.7

Steel framed building at Cardington - Fire test No.5

➤

➤ to ensure safe escape in the event of fire. No other framing material is able to demonstrate this from the results of intensive testing.

The Grenfell tragedy, together with the resulting Building Safety Act 2022 and the recent multi-storey car park fire in Luton, have highlighted the importance of fire protection strategies and how best to protect buildings in the event of fire.

Fire safety engineering is one method and combines a risk-based approach to determining the fire period with detailed finite element modelling to predict actual performance of the structure and the fire protection measures adopted in a fire. It is most commonly used on buildings where the prescriptive provisions given in: *Approved Document B - Buildings other than dwellings (England), Approved Document B - Buildings other than dwellinghouses (Wales), Technical Handbook - Non Domestic (Scotland)* and *Technical Booklet E - Fire Safety (Northern Ireland),* can be shown to be more demanding than necessary by analysis. Most of all tall and complex steel buildings in the UK now use fire engineering in their design.

Fire safety engineering analysis creates an integrated package of measures designed to achieve the maximum benefit from the available methods of preventing, controlling or limiting the consequences of fire. It may consider some or all of the following:

- Means of warning and escape.
- Internal fire spread.
- Structural response.
- External fire spread.
- Access and facilities for the fire service.

Designing for different types of fire

The procedure involves three distinct stages. First, determine the fire resistance period through Approved Documents, BS 9999 or specific sector requirements. Next, determine the section factor for the structural steelwork that is to be used.

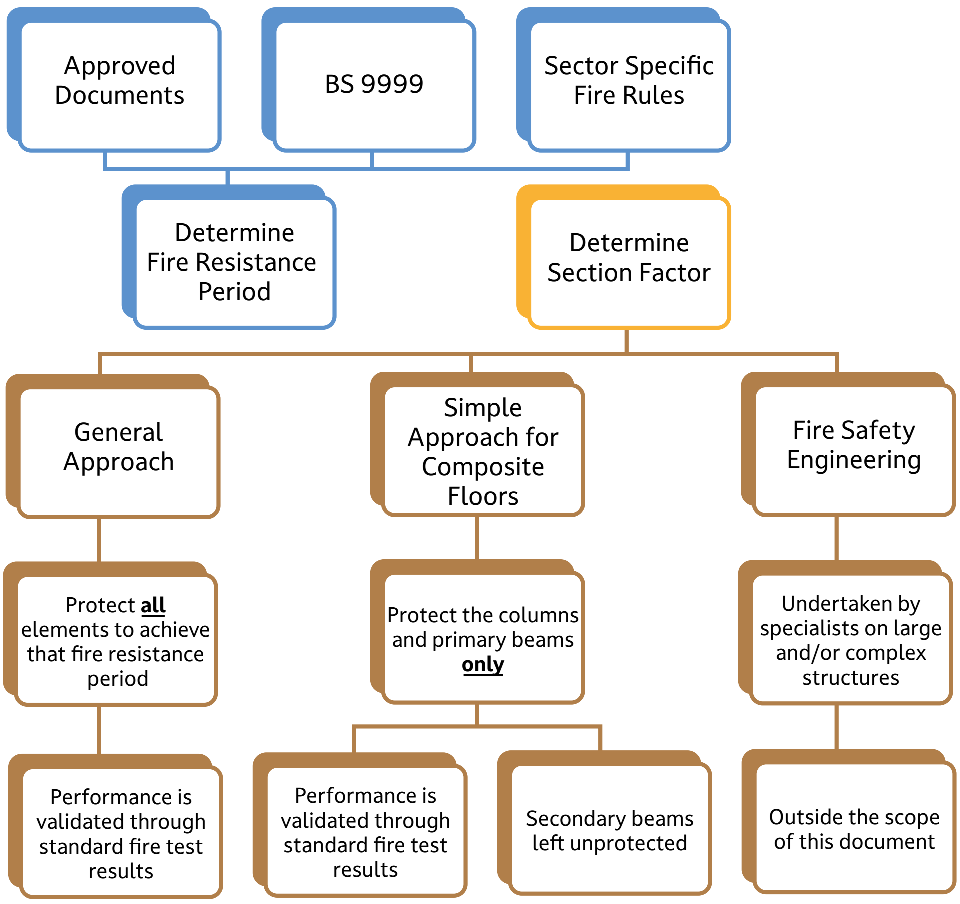
Then, the required fire resistance period can be provided through a general approach for all types of construction; a simple approach for composite floor construction; or by using fire safety engineering.

Determining the fire resistance period

The purpose of setting a fire resistance period is to ensure that in the event of a fire, the load-bearing capacity of the building will continue to function until all occupants have been able to escape.

The ability of a component or material to achieve the required fire resistance period is demonstrated by subjecting it to a standard fire test as defined in BS 476-20 or BS EN 1363-1.

However, the time-temperature relationship shown in the graph bears little relationship to what happens in most real fires. The graph suggests that the temperature in a standard fire rises quickly and then increases indefinitely. But in a real fire, once the combustible material has been consumed, the fire will decay and/or move. The



Designing for different types of fire.


The fifth of six redevelopment phases, I Broadgate is a new 14-storey office block, sat atop a three-level basement.

development of fire in a compartment is related to both the combustible material (the fire load) and ventilation, neither of which is considered in a standard fire test.

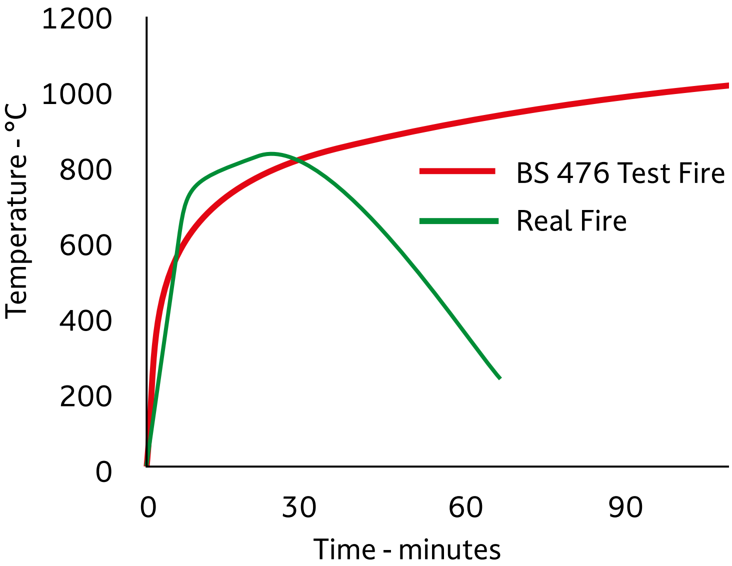
Fire resistance test results are expressed in terms of time to failure against one or more of three criteria for the product/element being considered. These performance criteria are:

- Load-bearing capacity (i.e. the ability to support the applied load and to resist collapse).
- Integrity (for example, the ability to resist the passage of flames/hot gases).
- Insulation (such as the ability to restrict the temperature rise on the unexposed face).

Some building elements require that all three criteria are met, others two and some only one. Structural columns are required to meet only the load-bearing capacity.

Structural floors between two fire compartments must meet all three criteria, and it is usually insulation, rather than structural criteria, which dictates the thickness of the slab.

As can be seen from the graph, there is no direct relationship between a standard test and a real fire. Fire resistance is not the length of time that a structure will survive in a real fire; it is simply a standard measure that is used to compare the performance of different designs in a consistent manner. It is therefore extremely unlikely that buildings with elements tested to 60 minutes fire resistance will collapse if subject to a 60 minutes duration real fire. ■



Comparison between a standard fire and a real fire.

Fire protection – a key to safe buildings

The entire supply chain involved in the design and construction of buildings has a responsibility to ensure that best practice and only suitable products are used to ensure safety. Nowhere is this more important than with fire protection.

Fire protection in buildings is primarily intended to give occupants time to escape before structural failure, as well as allow Fire and Rescue time to access a fire safely to extinguish it. In England, the minimum period of fire resistance varies depending on the purpose and height of the building. For open-sided car parks, the minimum period of fire resistance is 15 minutes; for offices over 30m high with sprinklers, it is 120 minutes.

Commonly used building materials lose their strength when exposed to fire. For example, concrete cracks and spalls; wood burns. Fire protection inhibits the failure of these construction materials for a predetermined period of time.

Steel structures are inherently robust in a fire, as all structural steel sections have some fire resistance, which increases with mass. Unprotected steelwork is usually accepted to have 15 minutes of fire resistance. With careful design, adherence to regulations, correct intumescent coating selection, steel structures are safe and reliable. However, the correct fire protection measures must be correctly installed, as research and experience show that bad practice in fire protection can lead to failure. It is crucial to follow the fire regulations, as well as the comprehensive, free advice provided by the constructional steelwork industry and product manufacturers, which will ensure fitness for purpose and success.

Steel starts to lose its strength above 400°C and at 550°C retains around 60% of its strength. However, experience of real-life fires has shown that steel with fire protection comfortably exceeds the current fire regulation requirements. The robust performance of steel in fire is tested, proven and backed by reliable data, to a sophisticated level that no alternative framing material can claim.

Fire protection systems

There are three types of fire protection systems used in buildings: *active*, *passive*, and *reactive*.

Active systems

These are designed to smother and extinguish the flame by means of water, foam, powder or inert gases. They can be effective in reducing the amount of oxygen available as a fuel and can act as a cooling agent. These systems can effectively eliminate a fire and can be fire suppression or fire extinguishing systems.

Passive systems

Passive fire protection systems feature materials that are inherently fire resistant so do not change their chemical state on heating, but provide fire protection via their physical or thermal insulating properties. These systems are more commonly used in areas of buildings that require little or no decoration. They are typically made from concrete, mineral fibre board, vermiculite cement, or cementitious boards.

Fire protection comprises of two types, Passive, such as boards and sprays, and Reactive, which refers to intumescent coatings. Boards are widely used for structural fire protection in the UK. They can be applied on unpainted steelwork and provide a clean, boxed appearance. Application is a dry process and so is less likely to disrupt other trades on-site, and as boards are factory-manufactured, thicknesses can be guaranteed.

Lightweight boards are typically 150-250kg/m³ and are not usually suitable for decorative finishes. They are cheaper than heavyweight equivalents and typically used where aesthetics are not important. Heavyweight boards are usually 700-950kg/m³ and will generally accept decorative finishes. Both types of board may be used in limited external conditions, but the advice of the manufacturer should be sought.

Cementitious sprayed protection, extensively used in the USA but less commonly in the UK, can be used to cover complex shapes and details. Costs do not rise significantly with increases in thickness, because much of the cost of application is labour and equipment. Some materials can also be used in external and hydrocarbon fire applications. The downsides are that sprays are not suitable for aesthetic purposes, and their application is a messy process as well as a wet trade, so may impact on other site operations.

Flexible blanket systems respond to the need for an easily applied fire-protection material that can be used on complex shapes and details, but where application is a dry trade. There are only a limited number of manufacturers of these products.

The introduction of lightweight, proprietary systems such as boards, sprays and thin-film intumescent coatings has led to a dramatic reduction in the use of concrete for fire protection. Blockwork encasement is also used occasionally. Concrete tends to be used where resistance to

Coated with intumescent paint for fire protection, exposed cellular beams provide an aesthetically-pleasing solution for service integration.

impact damage, abrasion and weather exposure are important, such as in warehouses, underground car parks, or external structures. Concrete's main disadvantage is the higher cost compared to lightweight systems, as its high thicknesses takes up valuable space around columns and add weight.

Intumescent paint is usually the preferred choice for fire protection of constructional steelwork in a wide range of locations including public spaces such as airports, offices, stadiums, shopping centres and other multi-rise buildings.

Reactive systems – intumescent coatings

The term "reactive" is used to describe intumescent coatings which undergo a chemical reaction when exposed to heat, so forming a carbonaceous foam char that provides fire protection of steel through the char's insulation properties. Intumescent paint is classified as both a reactive fire protection product as well as a protective coating.

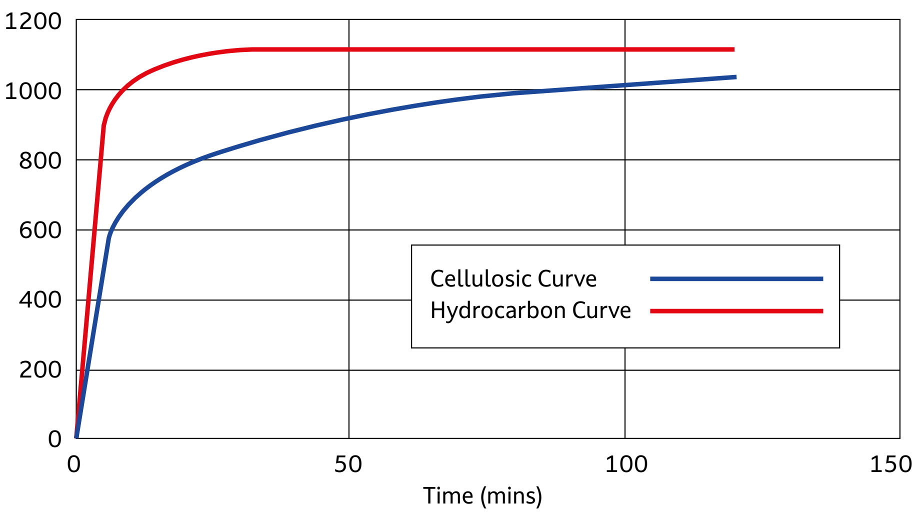
Intumescent paint can be used to provide fire protection for two different fire case scenarios, namely cellulosic and hydrocarbon fires.

What are cellulosic and hydrocarbon fires?

Cellulosic fires were originally defined as fires which were fuelled by cellulose containing materials. In the case of fire in a building, this is the heat energy resulting from burning wood, furniture, paper, cardboard, plastic, or anything else in the building that is combustible.

A hydrocarbon fire is fuelled by oil, petroleum or gas so generates much more heat than a cellulosic fire. As a result, the two fire test regimes are different and use different heat curves (rises in temperature v/s time) to evaluate intumescent products in the fire test laboratory.

As can be seen from the time/temperature curves, it takes much longer for a cellulosic fire to reach 1000°C than a hydrocarbon fire, some 70 minutes more, yet both curves show similar rates of gain up to 600°C. In the case of the civil construction market which uses steel frames, its buildings are only exposed to cellulosic fires. Cellulosic fires can spread rapidly in real life, as could sadly be seen at Grenfell Tower.



Comparison between a cellulosic and hydrocarbon fire.

Structural steel, section factor and fire engineering

The speed at which steel heats up is dependent on its weight or mass/metre length. In a fire, a heavy component takes longer to rise in temperature than a light component, which would heat up more quickly.

The important measure of this effect is called Section Factor, which in the UK is the heated perimeter over the cross-sectional area Hp/A or A/V in Europe, where A is the surface area per unit length and V is the volume per unit length. Heavy steel has a low section factor number and light steel a high number.

Section factor is used to calculate the dry film thickness (DFT) of the intumescent required. Light steel having a high section factor requires ➤

High and low section factors.

higher DFTs to provide more insulation. Conversely, heavy steel is intrinsically more fire resistant, so requires lower dry film thicknesses.

Longer fire resistance periods of 90' or 2 hours require progressively higher thicknesses of intumescent, which can lead to extended drying times and delay as well as extra cost.

As a result, Fire Engineers may decide to manipulate the DFT's by using steel with lower section factors, to reduce intumescent thickness. Fabricating plate girders with thicker bottom flanges is another way to improve fire resistance and use less intumescent.

Publication and use of intumescent fire test results and DFT's

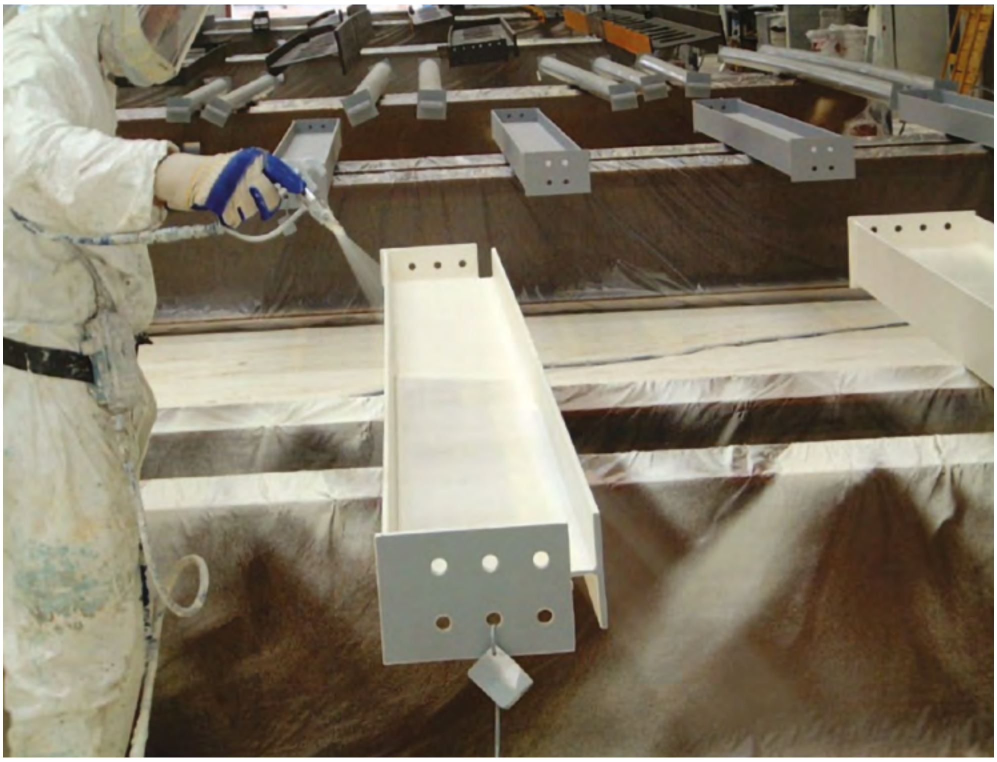
The performance of every intumescent product is established by carrying out comprehensive fire tests on a large range of short sections, beams, columns, and hollow sections at an accredited, independent fire test laboratory, such as Element Warrington Fire or BRE. Products provide fire resistance periods from 30', 60', 90' up to 2 hours.

Assessment of the fire test results must be carried out by a qualified, independent third-party fire engineer on behalf of an accredited third-party Certification Body; the processes of fire testing and assessment are separate but may be carried out in the same establishment.

The results (DFTs) for every intumescent product tested are then published on the Certification Body's website, so are freely available for public view and use by applicators.

The same data are provided by the paint manufacturers to their customers, very often using bespoke software to calculate the DFTs needed for every section. This software saves considerable time in bid preparation.

To guide the painters, most fabricators show the DFT needed for each piece of steel on their design drawings. DFTs will vary from section to section and even from web to flange on plate girders, so great care is needed by sprayers to avoid mistakes in applying the specified DFT.



Application of intumescent paint. Courtesy of Severfield

Popular Intumescent for cellulosic fires – thin and thick film

The two most common resins used for making intumescent paint are either water or solvent based, single pack acrylic and 2 pack polyamide cured epoxy. At this moment in time, acrylic makes up probably more than 80% of this specialised market globally, with water-based being used mainly on-site and not in-shop.

As acrylics provide the necessary fire protection at much lower thicknesses than epoxy, the market often refers to acrylic as "Thin-film" and epoxy as "Thick-film." It should be remembered that acrylic intumescent thicknesses are still very much higher than those needed for conventional protective coatings. Acrylic is generally applied at DFTs below 5mm but epoxy can be applied at DFT's as high as 15mm, hence the term thick-film.

As technology never stands still, new patented methyl-methacrylate (MMA) and hybrid polyurethane intumescent products have been launched in recent years. Their advantage is rapid cure so faster production, but their DFT's and costs tend to fall between those of thin and thick film intumescent. They are more durable than acrylic but not as durable as epoxy.

Acrylic intumescent and its uses

Acrylic intumescent is very easy to spray and build and it produces a good cosmetic finish. It is single pack (supplied in one can) and dries by solvent or water evaporation, so there is no chemical cure involved. In a fire, it forms a lighter, more friable, less dense char than epoxy intumescent but a much higher char thickness. 1mm of acrylic intumescent can generate some 70mm of char or more. Acrylic intumescent is also the cheapest in terms of raw material and application cost. It is simple, reliable, well proven technology which has worked well in real fires.

While it is applied like any other protective coating, its drying time is proportional to its thickness. At high thicknesses, as with 90' and 2 hour DFTs, it will stay soft and need much more time on the trestles when applied in-shop to avoid excessive handling damage. It is also thermoplastic, so will soften slightly in hot conditions.

It is important that specifiers note that as acrylic intumescent's active ingredients are moisture sensitive (hydrophilic), it is not very weather resistant, even with protective sealer coats applied. Most paint makers therefore limit its use to no more than ISO 12944:2 – C4 environments, namely "industrial and coastal areas with moderate salinity" for external steel and "chemical plants, swimming pools, coastal ship and repair yards" for internal steel.

Irrespective of the above ISO 12944 definitions, specification designers need to know that ponding or frequent wetting from rain, bad weather or condensation will lead to premature breakdown of an acrylic intumescent system, even with sealer coats applied.

It is not sufficiently durable for such environments and should not be used on external steel that is permanently exposed to the weather, such as car park perimeter steel.

Epoxy intumescent and its uses

Epoxy coatings are supplied in two packs, one of resin and one curing agent. Epoxy undergoes a chemical reaction to cure. While some four times more expensive than acrylic, epoxy intumescent is much more durable, being very tough and having low moisture uptake and excellent weather resistance. It has a successful track record of over 30 years on offshore projects, so is well proven in severe, wet marine environments, such as ISO 12944:2 – C5 and CX.

Cellulosic formulations of epoxy intumescent have better spray characteristics than the offshore versions so quite good cosmetic appearance can now be achieved. As a result of its excellent durability, epoxy should be specified for use in more aggressive environments, where steel is going to be exposed to the weather, frequent rain, wetting and condensation. Its toughness also helps it resist handling and erection damage.

On structures like car parks, where steel is subject to both internal and exposed environments, it is quite feasible and good practice to use an acrylic intumescent system on the internal steel and an epoxy system on the exposed perimeter steel to help mitigate cost.

The intumescent system – rules for primers and sealers

An acrylic intumescent system consists of a primer, intumescent and sealer coat, where improved weather resistance is needed. One or two sealer coats of either acrylic or acrylic urethane may be specified, depending on the durability and weather resistance required.

The primer and sealer must be compatible with the intumescent so must be fire tested together as a system. This is essential to evaluate stickability of intumescent char to the primer and to allow for any effect from the sealer coat chemistry on char formation.

There are some intumescent products on the market where their manufacturers claim no primer is required, as well as certain more benign environments where sealers can be omitted, such as in ISO 12944:2 – C1 dry, internal situations.

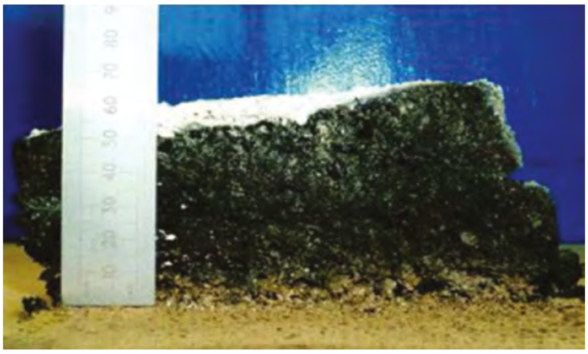
The specific primer and sealer used is included in the fire test assessment for that system, which is then approved. Deviating by using untested products is wrong and could lead to a reduction of fire resistance or even failure. An unapproved, untested system may well not be fit for purpose and should never be used. Ideally, primer, intumescent and sealer should also be bought from the same paint maker to create clear liability in the event of any subsequent failure.

Inter-coat adhesion can become problematic where high-build, shop applied epoxy primer is overcoated with intumescent some months later on-site, when the primer has fully cured and its surface may well have become contaminated during transport or storage and erection on site. Fast curing primers are even more prone to this problem when overcoated with water-based intumescent.

One key cause of failure

Acrylic intumescent systems are very reliable and provide long life when they are specified and used correctly.

However, failure of specification writers and engineers to diligently establish the likely environmental conditions at every stage of a project, from transport, site storage, through to construction and finally life in-service, has unfortunately caused a significant number of acrylic intumescent system failures due to its sensitivity to frequently wet conditions.



Acrylic Intumescent Char. Courtesy of Nullifire Ltd

Prolonged exposure to rain, ponding and condensation in unanticipated severe environments has resulted in premature breakdown, such as blistering, cracking, peeling and detachment from primer coats on too many projects over the years.

The most damaging environments are most likely during outdoor storage, construction on-site during winter months and before the building is protected by cladding. All too often, the specification writer only focussed on the building's exposure environment in-service, which is often benign.

A specification designer or engineer must carefully consider:

- The site location and its exposure environment.
- The time of year of the erection programme.
- How long coated steel will be stored in the open on site?
- How long the steel will be exposed to the weather during construction?
- Is there any exposed coated steel on the finished structure, such as the perimeter?
- Are there any aggressive micro-climates, like air conditioning outlets or boiler flues?

As a rule, it is always wise to specify the use of sealer coats over acrylic intumescent and for severe environments, specify the use of epoxy. The extra cost of epoxy intumescent is far less than the consequential costs resulting from premature failure, rectification, possible litigation, and the loss of client goodwill.

Finally, when in doubt, it is always wise to consult with the intumescent manufacturer's technical service staff to seek their advice and guidance, in writing. ■

Fire protection regulatory aspects

The Final Grenfell Tower Inquiry report was published on 4 September 2024 and made far-reaching recommendations for the construction industry and the regulatory system which are expected to bring about significant changes to the regulatory environment.

The government promised to respond to the final Grenfell Inquiry report within six months of publication, and indicated that there will be a wide ranging reform of the construction products regulatory regime.

Central to the new regime recommended by the Grenfell Report is the creation of a single Construction Regulator to oversee all aspects of building regulation, construction product regulation and fire safety law. Fire engineering is likely to become a recognised profession, overseen by an independent body, whose members will hold formal qualifications.

Reforms are likely to include attention being paid to Approved Document B, particularly as it relates to compartmentation of cladding and the stay put-strategies that were standard fire fighting practice at the time of the Grenfell Tower fire. The construction industry recognises that a major effort will have to be made to bring the regulatory environment up to the new standards.

Constructional steelwork has an enviable track record in providing solid evidence on how steel performs in real fires, which is unmatched by any other construction material. The performance of constructional steelwork was not called into question by the findings of the Grenfell Inquiry, but the sector has always promised never to allow complacency to creep into its approach to fire safety or any other safety related issues.

Building Safety Act 2022

Until a new regulatory regime comes into force, the existing approach will remain in place. Central to this is the Building Safety Act 2022 that created the Building Safety Regulator (BSR) to enforce a new, more stringent regulatory regime and also oversee the safety and performance of all buildings. The Act imposes competence requirements on the Principal Designer and Principal Contractor, and any other persons, and also imposes duties on those appointing them to ensure they meet the competence requirements. A new regulatory framework for construction products like cladding has been introduced.

The regulations

- Place a duty on those making appointments under these regulations, or permitting anyone to carry out work, to take reasonable steps to ensure they meet the competence requirements.
- Require the people who carry out any design or building work to have the relevant skills, knowledge, experience and behaviours, and/ or organisational capability to carry out work in the way that ensures compliance with Building regulations.
- Require the Principal Designer and Principal Contractor to have the relevant skills, knowledge, experience and behaviours, or organisational capability to carry out work and fulfil their duties under these Regulations.
- Where the Principal Designer and Principal Contractor is an organisation, require it to nominate a named individual who is competent to manage its functions as the Principal Designer or Principal Contractor.
- Require those carrying out design or building work to notify the relevant people when they are no longer competent for their roles or work arises for which they do not have the competence.

Gateways

Several Gateways were established for introduction of new measures introduced by the Building Safety Act.

Gateway One – Planning

From August 2021, any developer seeking planning permission for a high-rise building has to submit a comprehensive fire and structural safety report. This should make clear how the proposed design should meet the strict safety standards of the Building Safety Act.

Gateway Two – Pre-construction

From October 2023, replacing the building control 'deposit of plans' stage, this occurs prior to construction work. No building work can begin until the Building Safety Regulator confirms that the plans meet the demands of the building regulations. The Health and Safety Executive, who is the statutory consultee for HRB (Higher-Risk Building) planning applications, will review the Fire Statement and provide advice to the Local Authority on fire safety matters. The Local Authority is responsible for granting planning permission.

Gateway Three – Pre-occupation

Gateway Three occurs at the final completion stage of a higher-risk building, before a building can be occupied. The Building Safety Regulator will assess whether work has been completed in line with the building regulations. If it passes, then the

Photo: MrVlad/Shutterstock

building will be registered, and can be occupied. There is a proposed 12-week period for the Health & Safety Executive to approve the application for a Completion Certificate. It will be an offence to occupy a building without this certificate.

Other key measures include:

- A golden thread of information is now required for each higher-risk building.
- A safety case is now required for each higher-risk building.
- A Mandatory Occurrence Reporting system is now required for each higher risk building.
- Registration of New High-Rise Residential Buildings must now be registered before they are occupied.
- Amendments to the Regulatory Reform (Fire Safety) Order come into force.

Organisational Competence

For example, having appropriate management systems, processes, policies and resources to carry out their functions under these regulations, and ensuring that individuals who carry out the work for them have the appropriate skills, knowledge, experience and behaviours for their roles.

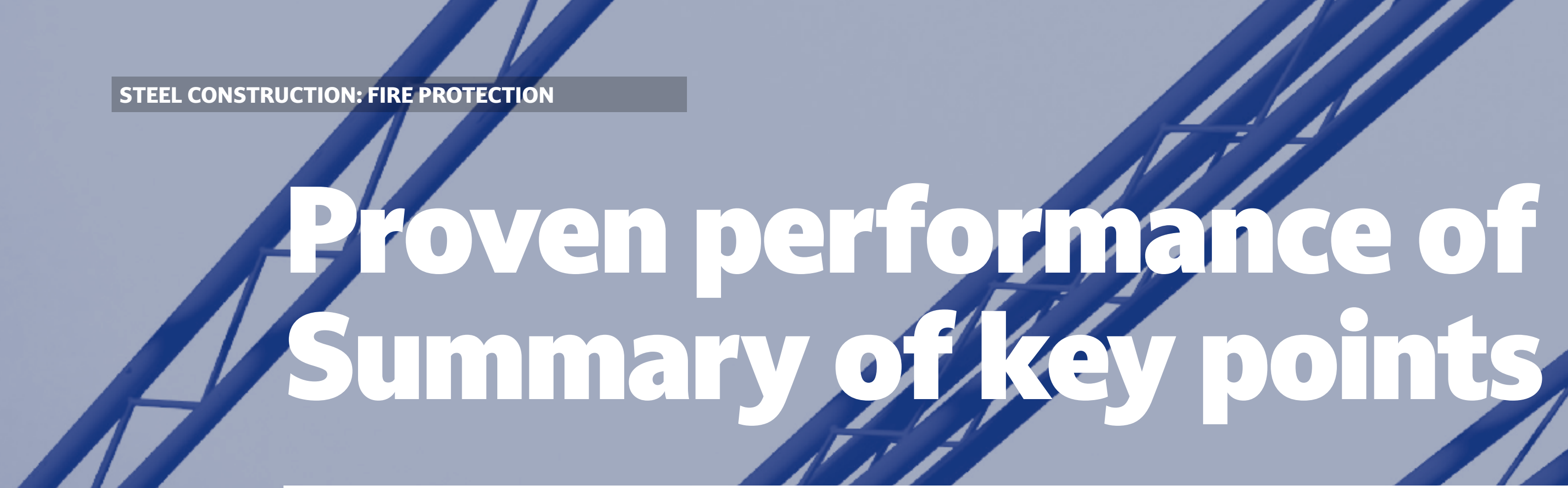
New competence requirements for contractors and others places fresh onus on clients of the construction industry to ask all suppliers to prove their competence and capability. The most assured way to demonstrate compliance with these regulations in relation to a steel framed building structure will be to use a steelwork contractor that is assessed under the Register of Qualified Steelwork Contractors (RQSC).

Previously, this widely respected route to proving competence was restricted to BCSA members. But post the Grenfell tragedy the BCSA has extended the ability to prove their competence to non-member steelwork contractors, part of a drive to ensure the entire steel construction sector can develop and prove competence under the new building safety regime.

BCSA has also updated, improved and simplified the RQSC – Buildings, and has also revised the 7th edition of the National Structural Steelwork Specification for Building Construction (NSSS) to introduce this new assessment scheme for steelwork contractors to demonstrate their competence and capability in the fabrication of structural steelwork.

Compliance with RQSC – Buildings will prove to clients that a steelwork contractor meets the competence requirements demanded by the new legislation. It will also give clients and insurance companies confidence that by selecting an RQSC – Buildings steelwork contractor they are choosing a company with the right competence, capability, and credentials to safely complete the project. ■

Published on 3rd April 2023, the 1st revision to the 7th Edition of the NSSS can be purchased from *www.bcsa.org.uk/nsss* and compliance with the RQSC – Buildings became mandatory from 2nd October 2023.



Proven performance of
Summary of key points

- More is known about the performance of structural steelwork in fire than any other construction material.
- This performance has been determined through a series of full-scale fire tests, which is unparalleled for other materials.
- Certainty in how structural steelwork performs in real fires is underpinned by finite element models as well as other simpler forecasting tools.
- Determining the fire protection requirements for the structural steelwork of a building is a simple and straightforward process, consistent across all common building types.
- The first step is to determine the fire resistance period that the structure is required to withstand in order to ensure adequate time for the building to be evacuated in the event of a fire.
- The fire resistance period is determined by use of either the prescriptive approach of Approved Documents or through the risk based approach set out in BS 9999. Reference should also be made to sector specific fire rules that may supplement the requirements of the other documents.
- The second step is to determine the section factor (A/V or Hp/A) of the structural steelwork specified, which is used to describe the heating rate of a member: lower numbers indicate stockier sections that are slower to heat than slender members with higher section factors.
- Section factors can be calculated but would normally be selected from the eBlue Book.
- The section factor will vary depending on the fire protection method (boarded or intumescent) and on exposure of the member to the fire (3 or 4 sided).
- The final step is to derive the fire protection requirement based on the required fire resistance period and section factor.
- Unprotected steelwork is usually deemed to have 15 minutes inherent fire resistance, but for higher fire resistance periods fire protection is usually required.
- A member exposed to fire on 4 sides will retain 60% of its strength at 550°c and a beam supporting a concrete floor will retain 60% of its strength at 620°c due to the heat sink effect of the concrete floor.

Photo: APHITHANA/Shutterstock

steel in fire:

- In both cases, the section factor should be used to determine the thickness of fire protection for that system from either manufacturer's literature or the ASFP's Yellow Book.
- Cellular beams can display complex failure mechanisms in fire. They are normally protected using intumescent coatings and care should be taken to ensure specification of an appropriate product by consulting both beam and coating manufacturers.

Fire protection

- In the UK, fire protection is typically provided by either intumescent coating or board.
- The two most common intumescent paints are water or solvent based, single pack acrylic and 2 pack polyamide cured expoxy.
- Acrylic makes up more than 80% of this market globally, with water-based being used mainly on-site and not in-shop.
- Acrylics provide the necessary fire protection at much lower thicknesses and are often referred to as 'thin-film' intumescent paints.
- To determine fire performance of a floor slab, manufacturer's design tables should be used.
- Increased fire resistance periods will typically result in an increase in the reinforcement that must be provided.
- The general approach is to fire protect all elements in a structure and demonstrate performance through standard fire test results; however, for composite floors, there is the option to use the simple modelling approach to leave secondary beams unprotected.
- The full-scale fire tests at Cardington, demonstrated that a composite steel floor plays a crucial role in providing enhanced fire resistance not apparent by tests on single isolated elements of construction.
- The Cardington fire tests showed that a composite floor slab will develop tensile membrane action, allowing the secondary beams to be left unprotected.
- Critical to this design approach is the position and amount of reinforcement provided. ■

Steel for Life
Steel for Life is a wholly owned subsidiary of BCSA, created in 2016, with funding provided by sponsors from the whole steel supply chain. The main purpose of Steel for Life is to communicate the advantages that steel offers to the construction sector. By working together as an integrated supply chain for the delivery of steel-framed solutions, the constructional steelwork sector will continue to innovate, educate specifiers and clients on the efficient use of steel, and market the significant benefits of steel in construction.

British Constructional Steelwork Association
BCSA is the national organisation for the steel construction industry: its Member companies undertake the design, fabrication and erection of steelwork for all forms of construction in building and civil engineering. Industry Members are those principal companies involved in the direct supply to all or some Members of components, materials or products. Stakeholder Members are clients, professional offices, educational establishments etc which support the development of national specifications, quality, fabrication and erection techniques, overall industry efficiency and good practice.

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