The Non-Combustibility of Concrete Facades

Findings of a fire test carried out on precast concrete cladding by the Fire Protection Association.

mpa UK Concrete

In August 2021, MPA Precast conducted a successful BS 8414 fire test on a single skin precast concrete cladding system.

In this document UK Concrete sets out why Human safety should always be paramount and when designing buildings proper regard should be paid to the use of none combustible materials in order to protect building occupants.

The non-combustibility of concrete is proven and accepted without the need for testing. However, the UK Concrete Industry recognises the importance of proving the safety and particularly the non-combustible properties of concrete products.

Fighting the Fire Risk to Life and Property

In 2021, the fire and rescue services dealt with 145,000 fires in England alone, tragically including 243 fire-related fatalities.

We don't always want to think about threats like fires in our homes and workplaces, but as individuals and as a society we need to prepare for them.

It's therefore critical that we continue to step up the pursuit for greater safety within our built environment, making sure that the right approaches and non-combustible, A1 fire rated, materials are used, helping to protect against every fire in every conceivable situation.

Human safety should always be paramount and when designing buildings proper regard should be paid to the use of none combustible materials in order to protect building occupants.

Understanding and eliminating risk

While the best protection is prevention, if a fire does break out, concrete is a reliable material and a low-risk solution that can save lives and property:

- **Concrete is non-combustible – it does not burn, you cannot set it on fire**
- **Concrete does not add fuel to a fire**
- **Concrete does not emit any toxic fumes**
- **Concrete does not produce smoke**
- **Concrete has a slow rate of thermal conductivity, acting as a shield against heat**

In almost all cases concrete does not require any additional fire protection because of its own inherent resistance to fire – helping to look after the people in the area surrounding a fire, whether that's occupants, neighbours or emergency services. Conversely, once a structure or cladding element made of combustible materials such as timber becomes involved in a fire, it adds significant fuel. This not only increases the chances of the fire spreading but ultimately raises the potential of the building collapsing.

"The problem is that the low bar of 'evacuation before collapse' can lead to designs with little intrinsic resilience yet are legal and compliant."

RISC Authority

"The presence of combustible voids creates one of the greatest challenges for building safety and the insurer."

RISC Authority

In addition to adding to the fire burden, construction methods such as lightweight Modern Methods of Construction (MMC) solutions, also create voids formed of combustible materials. The ability of fire to travel between compartments and become inaccessible to fire fighters within these voids has huge ramifications for the insurance industry, making combustible MMC difficult to insure.

The voids formed of combustible materials and reignition potential of timber structures also creates safety concerns for fire services. In many cases resulting in the need for a building to be partly or completely demolished to fully extinguish the fire.

This risk has been recognised by groups including the National Fire Chiefs Council, whose operational guidance highlights some of the hazards present in timber structures – especially those still under construction – such as access and egress routes quickly becoming compromised. The insurance challenges presented by mass timber construction have also been emphasised in a recent report by the RISC Authority [1]. Currently little emphasis is put on the protection of property itself, with regulations focused only on the safe escape of its occupants. It's time to question whether this is adequate. For example, 60 to 80 per cent of businesses fail within 18 months of a serious fire – something that can have a far greater impact for insurers than the damage to the building itself.

Equally, losing personal possessions in a fire and spending time in temporary accommodation can significantly add to the trauma, with lasting repercussions on mental health. In short, the long-term cost of losing a building to fire can reach a long way beyond its initial aftermath.

Concrete protects against fire

Concrete has the highest A1 reaction to fire classification possible (in accordance with BS EN 13501-1:2018) [2]. This classification is achieved without the need for testing and is based on the proven non-combustible nature of concrete. Concrete therefore satisfies the most onerous requirements for material combustibility and can be used without test, as a facade material for all buildings. The permitted combustibility of the other components of the external wall will depend on the building the cladding is attached to.

Dedicated to Building Safety

Concrete's inherent non-combustible properties together with its A1 classification mean that conducting fire tests on concrete facades isn't a necessary part of building certification.

Nevertheless, with high profile tragedies such as Grenfell and the resultant high levels of scrutiny being placed on the cladding/facades sector, UK Concrete recognises the importance of proving the safety and particularly non-combustible properties of concrete products.

The test method (BS 8414-2:2020) [3] sets out a clear process of assessing the behaviour of non-load bearing external cladding, rain screen over cladding and external wall insulation systems when applied to the face of the building and exposed to an external fire.

The fire exposure is designed to be representative of an external fire source or a fully developed (post-flashover) fire in a room, venting through an opening such as a window aperture that exposes the cladding to the effects of external flames.

The test is assessed against the following criteria:

External fire spread: The temperature recorded at any external thermocouple at level 2 should not exceed 600˚C for a period of at least 30 seconds, within 15 minutes of the start time.

Internal fire spread: The temperature recorded at any internal thermocouple at level 2 should not exceed 600˚C for a period of at least 30 seconds, within 15 minutes of the start time.

Mechanical performance: No failure criteria are set for mechanical performance. However, ongoing system combustion following extinguishing of the ignition source is included in the test reports, together with details of any system collapse, spalling, delamination, flaming debris or pool fires. The nature of the mechanical performance should be considered as part of the overall risk assessment when specifying the system.

Full details of the BS 8414 test method are available at: https://www.thefpa.co.uk/fire-testing

The test and report cover the details as tested [see Our Fire Test (right)], however the MPA Precast test was carried out as a solution demonstration rather than a system certification exercise.

Our Fire Test

In August 2021, MPA Precast conducted a BS 8414 fire test on a single skin precast concrete cladding system.

The test set up is shown in Figure 1, involving a crib of wood set within an opening in the cladding.

Name of Test House
Fire Protection Association Ltd

Test House Address
London Road, Moreton-in-Marsh
Gloucestershire GL56 0RH

Test reference
103138.001

Date of Test
19/08/2021

Cavity Barriers
Siderise CW-FS 120

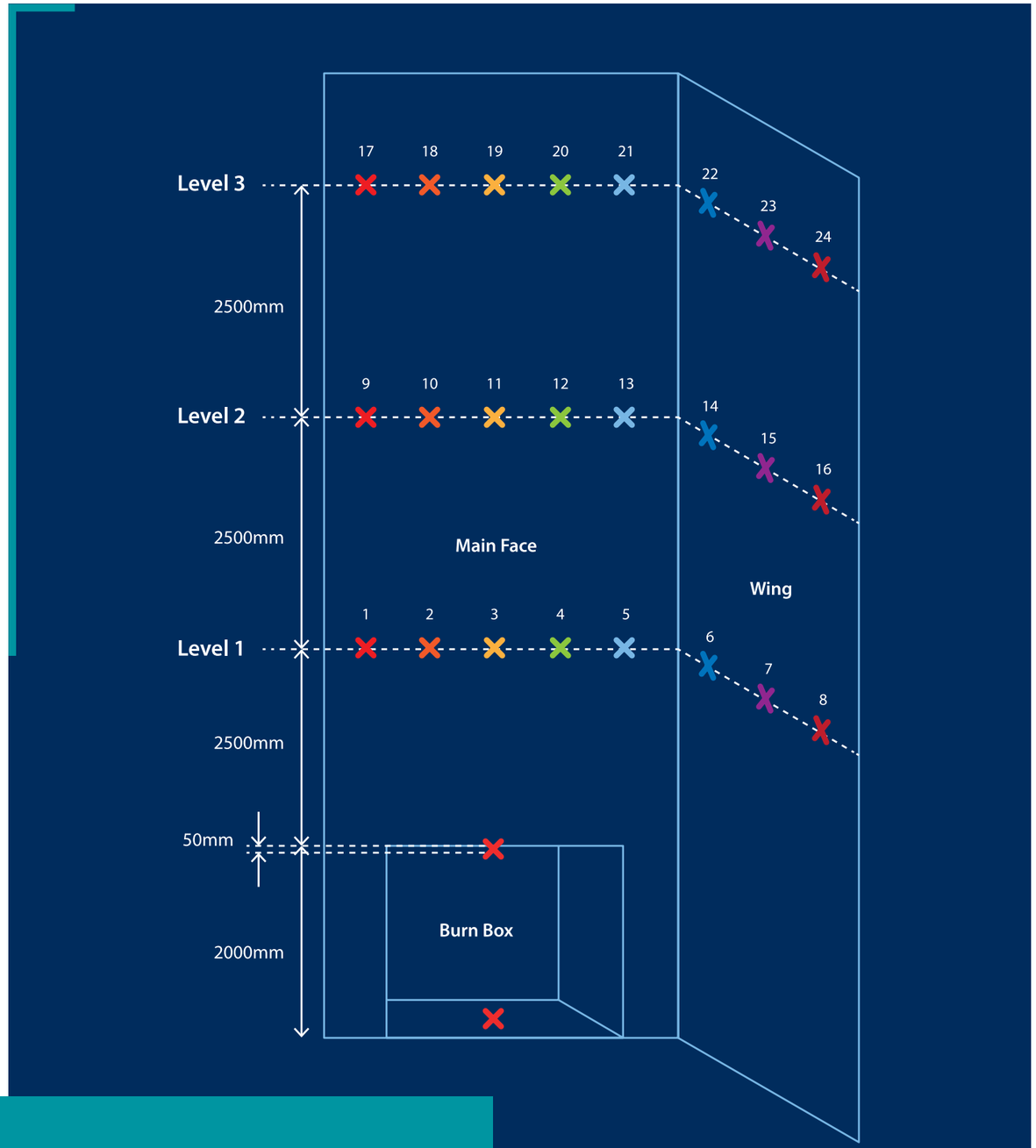
Insulation
150mm thick RW3 Rockwool – Foil face mineral wool insulation - VCL. A1 classified (to BS EN 13501-1).

Panel
150mm thick Min C32/40 wet cast concrete panels, traditionally reinforced to EC2 design and manufactured to BS8297.

Fixings
Vertical load from the panels applied into the structure using a combination of independent support and stacked to ground. Both being restrained back to structure to resist lateral loads. All fixings back to primary structure being of carbon steel or stainless steel, to EC3 design.

Sealants
Externally wet applied double mastic seal, for air and water tightness purposes, between panel-to-panel joints.

Figure 1 (right page).
Test Setup



Understanding the Results

✕ = Thermocouple monitoring locations

Fifteen Minutes into the Test

Test defining measurements are taken at levels **2 & 3**, 15 minutes into the test.

320 ˚C
External temperature at Thermocouple level 2 – number 11 is recorded at 320 ˚C

18 ˚C
Temperature behind the panels at Thermocouple level 2 – number 11 is recorded at 18 ˚C

The precast concrete façade system not only prevented external fire spread up the front of the panels but as demonstrated by the cool internal temperatures and lack of damage, also prevented fire spread into the cavity or insulation layers.

At 15 minutes the test looked like this (image left) – the flames coming solely from the timber crib.

The Fire Test Results

Understanding how important 15 minutes can be

- The Grenfell Tower fire is believed to have started shortly before 1am when a fridge on the seventh floor caught fire. First calls were placed at 12.54am and fire fighters arrived six minutes later, but by then block was well alight.
- Residents said it took just 15 minutes for Grenfell tower to become engulfed.
- Tests on a fire door recovered from Grenfell Tower showed it resisted the flames for only 15 minutes, the police have revealed.
- 15 minutes into the MPA Precast fire test, panels showed no signs of combustion or of fire spread and didn't transfer heat to the reverse.

BS 8414-2:2020 Test Results

Test criteria	Requirement met/not met
System tested to full duration	Requirement Met ✓
External fire spread	Requirement Met ✓
Internal fire spread	Requirement Met ✓

The full test report is available on the MPA Precast Website.

Figure 4.
Panels once the fire had been extinguished after 30 minutes

The Panels Post - Test

Upon completion of the test the concrete panels were still structurally sound, displaying only limited cosmetic damage to their surfaces.

Considering the ferocity and temperature of the fire which reached over 600 degrees centigrade, the fact that the damage sustained to the panels was only aesthetic and could be quickly repaired, is testament to their fire resistance performance.

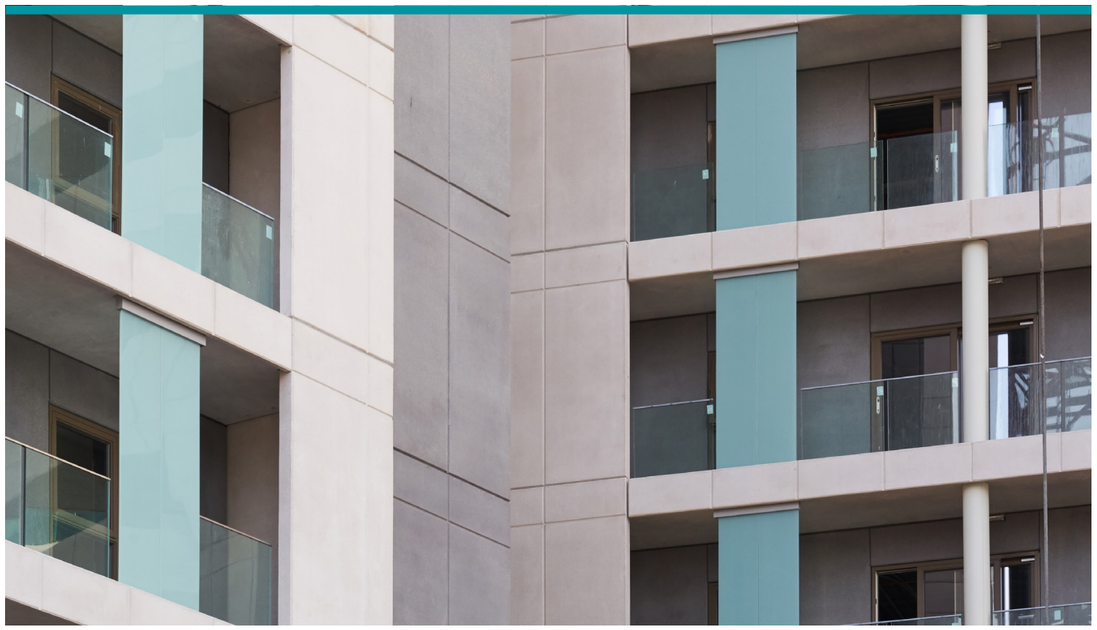
Summary

Despite there being no requirement in current building regulations or approved documents for non-combustible construction such as concrete to be fire tested, MPA Precast's successful full-scale fire test to the rigorous BS 8414 standard demonstrated categorically that the concrete cladding system met all requirements for external and internal fire spread.

Despite temperatures reaching over 600 degrees in front of the lower panels, where they were exposed to the burning wooden crib, behind the panels this barely climbed above a cool 18-degree ambient temperature.

The exercise highlighted the advantages of concrete's relatively low thermal conductivity – or heat transfer – which enables it to act as a fire shield not only between adjacent spaces, but also to protect itself from fire damage. Even when faced with searing temperatures over a prolonged period of time, the internal temperature of concrete remains relatively low. This allows the material to retain its structural integrity, thereby reducing the risk of catastrophic damage or collapse.

While the best protection is prevention, if a fire does break out, concrete is a reliable highly resilient material that can save lives and property. Life safety should be paramount in building design and construction. It is incumbent on both the regulators and the construction sector to design and build with the safest possible materials.



UK Concrete and Peace of Mind

Concrete is a strong and resilient material that can deliver peace of mind from threats like fire and flooding. Its resilience has been proven not just through laboratory testing but in real-life circumstances, providing reassurance about how it will perform to protect people, property, and communities in critical situations.

Did you know..?

- Climate change is challenging the way we design buildings. As our seasons continue to intensify with hotter summers, colder winters and more extreme weather events, we need to ensure what works today also works tomorrow. Concrete's resilience can help keep people safe and comfortable, for example from the increased risks of overheating buildings.
- Concrete is also inherently water resistant and its built-in flood resilience is key to coastal and river defence systems that protect our communities and critical national infrastructure. Its durability means that it is extremely well suited for these aggressive and exposed environments.
- Concrete's inherent water resistance also defends against the effects of escape of water, which is the greatest category of loss for residential buildings incurred by the insurance sector, greater than fire and security combined [1].
- The longevity of concrete allows a building's useful life to be extended; a key tenet of whole-life thinking and a circular economy. Concrete buildings also offer a level of flexibility not found in many other structural options, frequently enabling them to be repurposed to meet changing needs, greatly extending their useful lifespan.

References

- [1] Insurance Challenges of Massive and Mass Timber Construction, RISC Authority, 2022.
- [2] BS EN 13501-1:2018, Fire classification of construction products and building elements - Classification using data from reaction to fire tests, BSi, 2018.
- [3] BS 8414-2:2020, Fire performance of external cladding systems - Test method for non-loadbearing external cladding systems fixed to, and supported by, a structural steel frame, BSi, 2020.

Precast Concrete Cladding: Further reading

- Concrete and Fire Safety, MPA The Concrete Centre, 2019, https://www.concretecentre.com/Resources/Publications/Concrete-and-Fire-Safety.aspx
- Fire Performance: assessing concrete structures for reuse, MPA The Concrete Centre, 2022, https://www.concretecentre.com/Resources/Publications/Fire-Performance-assessing-concrete-structures-for.aspx
- Offsite Concrete Construction, MPA The Concrete Centre, 2019, https://www.concretecentre.com/Resources/Publications/Offsite-Concrete-Construction.aspx

UK Concrete is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and silica sand industries.

www.mineralproducts.org

UK Concrete would like to acknowledge the support of MPA Precast and its members in in the fire test and producing this document. www.mpaprecast.org

Follow us
Twitter | @thisisconcrete
LinkedIn | this-is-uk-concrete

MPA UK Concrete
Gillingham House
38-44 Gillingham Street
London SW1V 1HU

www.thisisukconcrete.co.uk
020 7963 8000