Fire safety of facades

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Fire safety of facades

The fire in Grenfell Tower in London in 2017 that caused 72 deaths, really increased the focus on fire safety, particularly fire safety of façades in high rise buildings.
An independent review of the building regulations in the UK was carried out, several desktop studies have been conducted and there has been a great deal of focus on building materials used, leading to a ban on combustible cladding.
This has ultimately led to a greater focus on fire protection of façades around the world.

Modern ventilated rainscreen cladding systems have become one of the preferred choices around the world for high-rise structures, providing design flexibility as well as weather protection.
A free flow of air behind the cladding is very important to keep the cavity dry, but this also makes the façade one of the most vulnerable elements of a building in case of a fire.
The rainscreen cladding is the outer protective layer over the structural skeleton framework, with the primary function of protecting the interior from water intrusion, wind and other weather elements.
Simply put, a ventilated façade is an assembly comprising an outer protective wall, a ventilated cavity and an inner construction.

Fire resistance is an integral part of the building envelope.

A façade must neither propagate fire, nor allow fire or heat travel from one area to another(compartmentation) and it should remain structurally intact for a reasonable amount of time when exposed to fire.
That ultimately means that the separating function between fire cells must be maintained, spread of flame within the wall must be limited, risk of spread of flame along the surface of the building façade should be limited and the risk of injuries to persons resulting from materials falling from the building façade must be limited.
There are several factors to consider, such as the use of combustible materials, fire stopping in the cavities and air gaps and penetrations in the construction.
Since façade cover large areas and fire can spread very quickly, active systems like outside sprinklers or other suppression systems are ineffective and expensive. Therefore, the fire safety should mainly be safeguarded by passive systems without any mechanical moving parts, detectors or activation. These products should also be constructed with the life span of the construction in mind.

Moholt student appartments - photo Ivan Brodey

Treet - photo David Valldeby

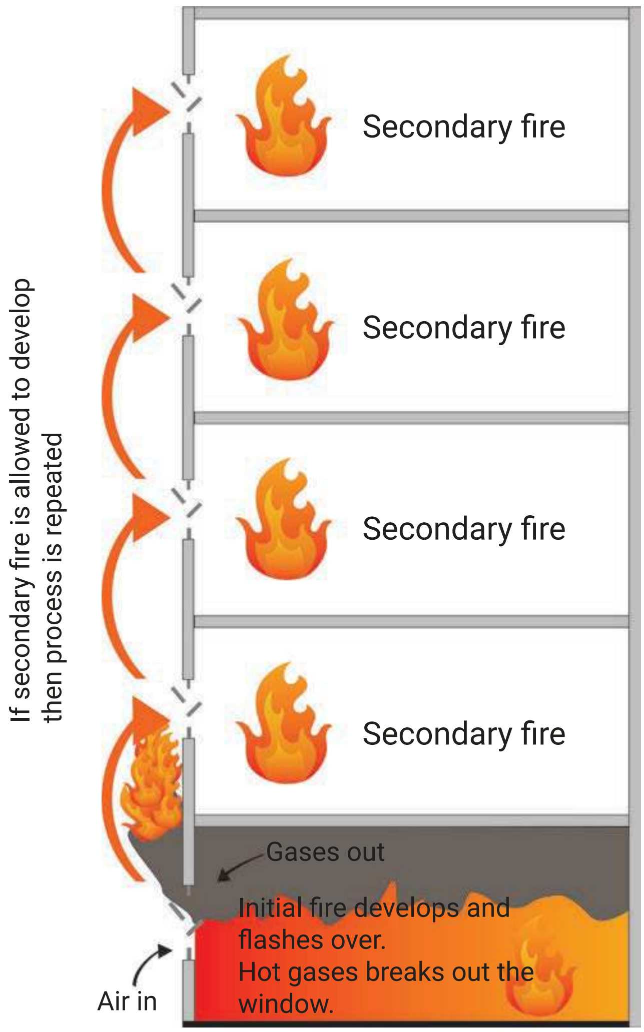
Typical scenarios of fire spread in facades

Spread of an external fire onto combustible façade by flaming or embers coming from a neighbouring burning building or other external source of fire.

An internal fire that has started inside a building, that spreads through openings in the façade (windows, doors etc.) onto higher or lower floors.

Why are fire in cavities and air gaps in facades so dangerous?

Due to the “chimney effect”, fire in the air gap behind cladding can spread very quickly.
As the oxygen in the air gap is utilised, the fire seeks more oxygen and moves rapidly upwards.
Fire spreading only on the outside of cladding is often not that critical, while fire that spreads in the air gap behind the cladding **can travel 5-10 times faster in the same time frame** due to rapid buoyancy of hot air in the air gap, compared to fire on the outside. **Speed up to 8 meters per minute have been measured**. Since the fire is hidden behind the cladding, it is very hard for fire fighters to extinguish it.
A flashover in a room may cause fire to break out of a window and the flames and hot gasses escaping through a window opening are sufficient to cause the re-entry of the fire in the room above the storey of fire origin. When this mechanism of fire spread occurs, it has the potential to repeat through the same mechanism to every floor above it. Therefore, this is referred to as the “**Leap-Frog”**-Effect.
And even if the cavity itself is fully non-combustible, the extended length of flames created in the “chimney” still allows the flames to reach the next floor level, where windows and other wall penetrations will allow the fire to re-enter the building and maintain the spread of fire.



Leap-Frog effect

How do we reduce the risk of fire spreading in ventilated facades?

Use of

Non-combustible materials

Fires that have started and spread in buildings through combustible materials on façades are not all that common, but they can have considerable consequences both in terms of property damage and casualties.
So, a properly designed and executed façade system with non-combustible cladding materials, and a working cavity compartmentation, will decrease the risk of fatal consequences.

Two examples of the opposite are the Grenfell Tower in London in 2017 with aluminium composite panels with a combustible 100% PE core, and the Cultural Television Center Tower in Beijing in 2009, where the whole tower was in flames within 20 minutes because of the combination of titanium-zinc alloy panels, with extruded polystyrene (XPS) filling and the lack of fire barriers in the air gap.

Use of
Non-combustible materials

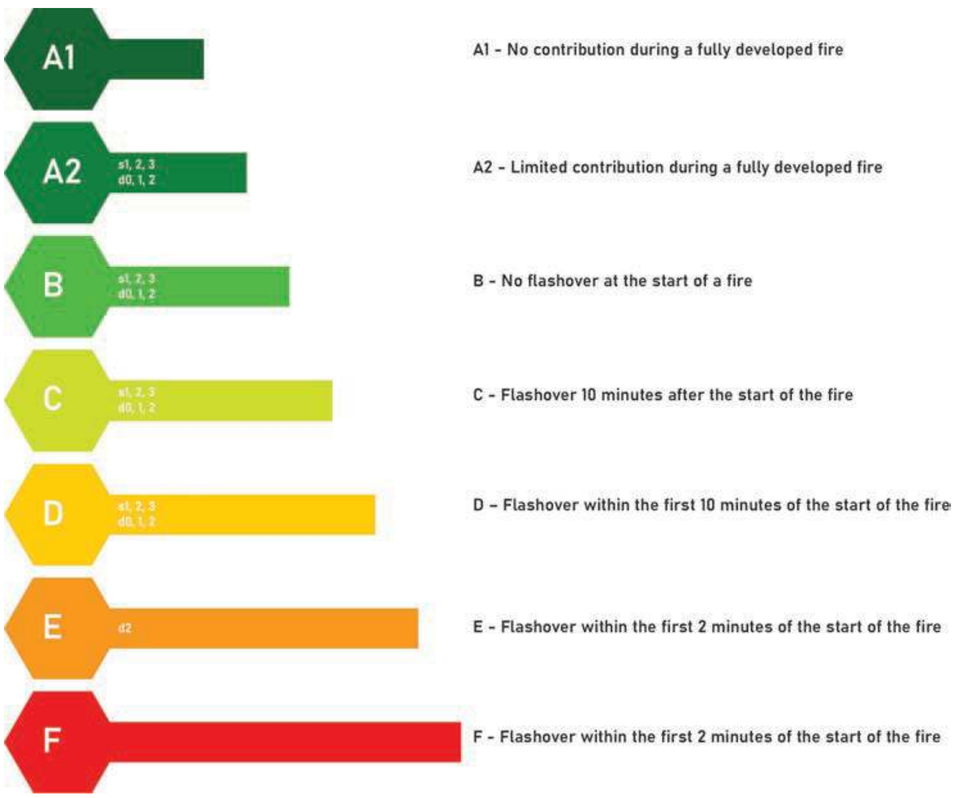
Most construction products like **cladding materials and insulation** are classified under the **European classification for reaction to fire** which is divided into seven principal classes, A1, A2, B, C, D, E and F with the following additions:

- class s for smoke production (s1 and s2 for floor coverings; s1, s2 and s3 for other construction products)
- class d for flaming droplets and particles (d0, d1 and d2 for all products except floor coverings).

For products for which the reaction to fire has not been evaluated, the letters 'NPD' (no performance determined) are used.

The Euro class system

- Compares ignitability, flame spread, heat release, smoke production and tendency for producing flaming droplets/particles, etc.
- Is accepted by all European Union States (mandatory where there is a harmonised product standard).
- **Includes seven classification levels, from A1 to F**
- **Products achieving A1 and A2 classification are defined as non-combustible.**



Use of

Non-combustible materials

The first letter indicates a classification based on combustibility and contribution to fire: A1 and A2 are non-combustible, B till D go from very limited to medium contribution to fire and E and F go from high contribution to easily flammable.

The ‘s’ part relates to the total smoke propagation/emission level. The values range from 1 (absent/weak) to 3 (high):

s1 = a little or no smoke
s2 = quite a lot of smoke
s3 = substantial smoke

The ‘d’ part indicates the ‘flaming droplets and particles’ during the first 10 minutes of exposure. The index is:
d0 = none
d1 = some
d2 = quite a lot

In the EU, the fire testing and classification standards for construction products have been harmonised for more than a decade under the Construction Products Directive, and subsequently the Construction Products Regulation. These standards have been implemented in all EU Member States.

However, whilst fire testing and classification methods for individual products are harmonised in the EU, building **regulations for an overall structure - including fire safety requirements** – are the responsibility of each individual EU Member State. In other words, Member States determine their own fire safety level and use a mix of products that – used together – correspond to that level.

Member States determine their safety level and some countries have no requirements for individual products used in the façade system, focusing only on the performance of the entire system. However, they do not have a fire-safety test for façades based on real-life, large-scale situations. Some countries allow the use of products not fulfilling the product requirement if the entire system passes a national large-scale test.
The other countries have strict requirements for the combustibility of the products used in the façade, from limited combustibility (B s3, d0) to Non-combustible (A2 s1, d0).

Source: **Fire Safe Europe**

But what if we only use non-combustible materials?

Even if the cavity itself is fully non-combustible, the extended length of flames created in the cavity still allows the flames to reach the next floor level, where windows and other wall penetrations will allow the fire to re-enter the building and maintain the spread of fire.

Therefore, the use of cavity barriers able to withstand direct flame impingement can be crucial to stop the fire from spreading, also in façades with only non-combustible materials .

Use of

Cavity Barriers

To prevent vertical fire spread in the façade, some kind of fire stopping needs to be installed.
One of the main challenges is ensuring that the breathability of the building is balanced with the ability to prevent the passage of smoke and fire through the cavities.

The most effective way is to use non-combustible cavity barriers that are mechanically fixed on the façade wall so that, in case of fire, the expanding material does not fall off.

These barriers will allow the cavity to be maintained under normal circumstances but seal the cavity in the event of a fire.

The cavity barriers need to be installed continuously, so if a fire breaks out there is no pathway for the fire to pass.

Cavity barriers are pieces of fire-stopping material that are installed in building cavities, horizontally at each floor and vertically at wall level with the purpose to stop or restrict the spread of flames and heat within the cavity.
This kind of compartmentation is essential to stop fire from spreading to large parts of a building.

The products can be labelled solid cavity barriers or ventilating cavity barriers. Here, we will only deal with ventilating barriers. Furthermore, we can divide them into **"open state" cavity barriers** and **"open state fire resistance rated" cavity barriers**, where the latter do not let flames or heat pass the barrier at any time. More on this later.

For products like cavity barriers used for compartmentation, elements must be resistant to fire in terms of their ability to perform the necessary structural and (fire) separation functions.

Use of

Cavity Barriers

Resistance to fire

The resistance to fire is the ability of a construction element to maintain its fire stability, integrity and thermal insulation for a certain period of time.

Fire integrity (E) is the ability of a construction element with a separating function, that is exposed to fire on one side only, to prevent the transmission of fire to the unexposed side as a result of the passage of flames and hot gases.

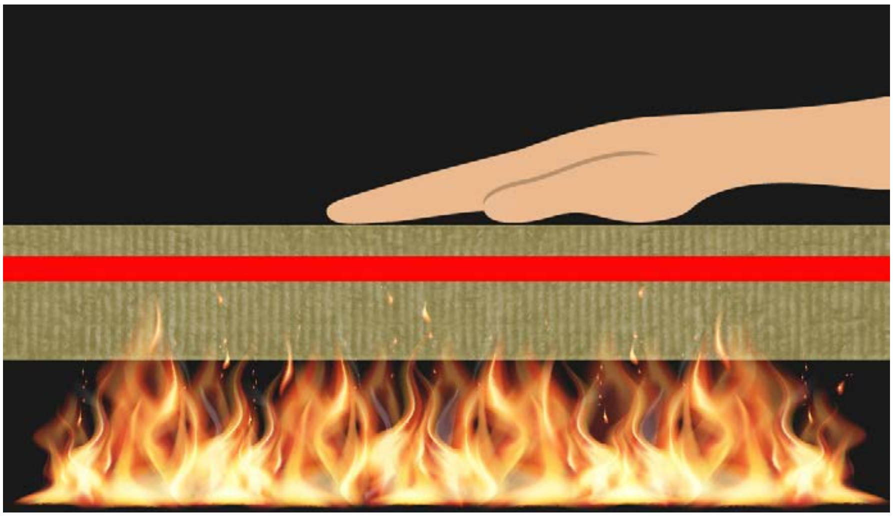
Thermal insulation (I) is the ability of a construction element with a separating function to withstand fire exposure on one side only, without the transmission of fire as a result of a significant transfer of heat from the exposed side to the unexposed side.

We distinguish between **reaction to fire and resistance to fire**.
While the European classification for reaction to fire describes the combustibility characteristic of building materials, resistance to fire describes the period for which a particular construction can resist exposure to a specified fire load, whilst maintaining its form and function.

Minimum requirement for cavity barriers should be an EI rating for at least 30 minutes.

Integrity E:
No flames passing to unexposed side during the certified period.

Insulation I:
Temperature shall never increase more than 140°C on average at unexposed side during the certified period.



Use of
Cavity Barriers

So how do ventilated cavity barriers work?

One of the most important parts of a cavity barrier is a material called intumescent: a substance that swells as a result of heat exposure, leading to an increase in volume.
Intumescent materials are most typically utilised within construction products to maintain or reinstate the fire resistance of buildings. For example, within walls, floors, and ceilings.
In a fire, a correctly installed intumescent product will swell and completely close off the gap or cavity and block further spread of fire in the construction.
Correct use of cavity barriers should restrict fire in the air gap so that the only fire strain is from the outside, instead of both sides of the cladding. This will keep the temperature and the fire load on the facade much lower, and greatly reduce the risk of fire spreading to the next compartment.

Selecting your cavity barrier.

When selecting your cavity barrier, there are a number of requirements you should consider.

The product should:

- Have a integrity and insulation rating.
- Maintain air gap and vertical ventilation as in open state.
- Provide full closure.
- Although the test standard does not test for closure of the air gap until 5 minutes into the test, **the product should not let flames pass at any time**.
- Withstand direct flame impingement.
- Keep embers from entering the air gap.
- Be mechanically fixed so it won't fall out during a fire.
- Not smoulder during a fire.
- Stop burning droplets from spreading fire downwards in the construction.
- Maintain performance for the life span of the building.
- Have an openly available product documentation and be tested according to a relevant test standard.
- Preferably be third-party tested, by means of a full-scale façade test, for example by cladding producers.

Use of

Cavity Barriers

The point about not letting flames pass at any time and withstanding direct flame impingement is really important when we consider the chimney effect and the speed at which a fire can spread in an air gap.
Remember how we spoke about fire spreading at up to 8 meters per minute?
If a cavity barrier takes up to several minutes to close, the fire can spread far from its origin before the cavity is closed for further spreading.
As fires escalate at great speed, such as observed at Grenfell, there is no time for the intumescent material to expand and seal. If the combustible decor cladding at the Grenfell Tower had been changed to a non-combustible variety, it still might not have prevented the furious upward spread of the fire.

That is where the terms “open state” cavity barriers and “open state fire resistance rated” cavity barriers come into the picture.
Where your traditional “open state” cavity barrier, be it the plastic wrapped version or the one in combination with a mineral wool slab, needs time to expand, there is a version that also includes a flame arresting element that will keep flames and heat from entering the air gap for the entire time between the start of a fire, and the intumescent becoming expanded. Hence the term ”open state” and “open state fire resistance rated” cavity barriers.

The joint **report by the ABI, FPA and RISC Authority** in UK following the fire at Grenfell Tower also addressed this problem with the British façade test BS8414, as shown in the **pictures taken from the “Cladding approvals” report**.

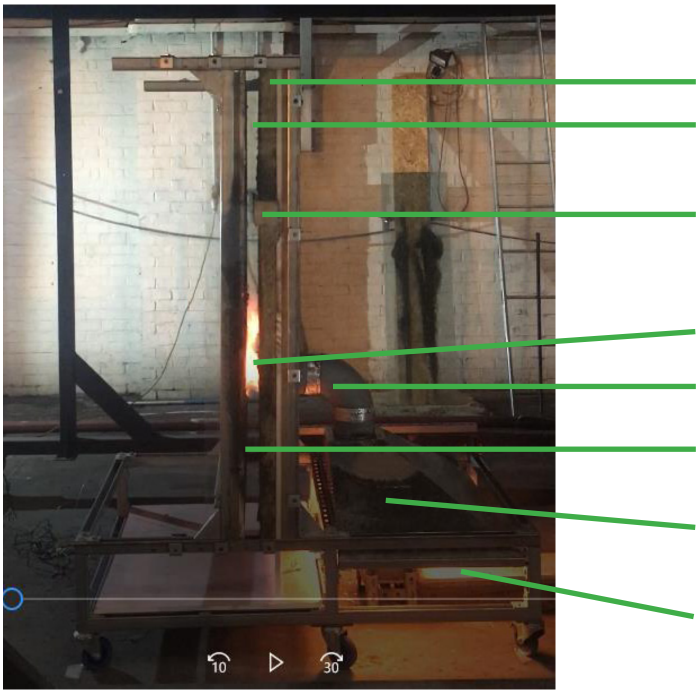


Figure 34 - Cavity barrier test rig

Use of

Cavity Barriers

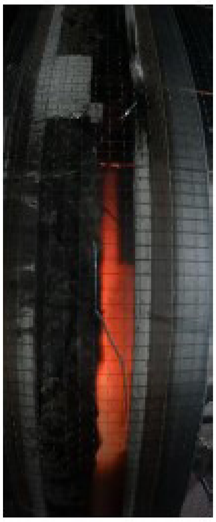
Flames 1st emerge from vent t=0s

Flames reach cavity barrier t=5s

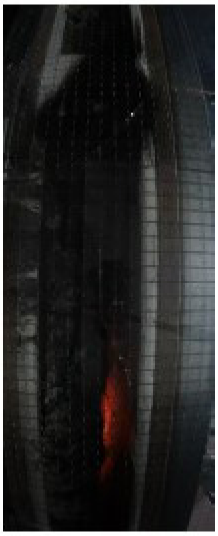
Flames passing cavity barrier t=13s

Test of “open state” cavity barriers showing that flames pass the barrier already 13 seconds after ignition.

Flames 1st emerge from vent t=0s



Flames reach cavity barrier t=60s



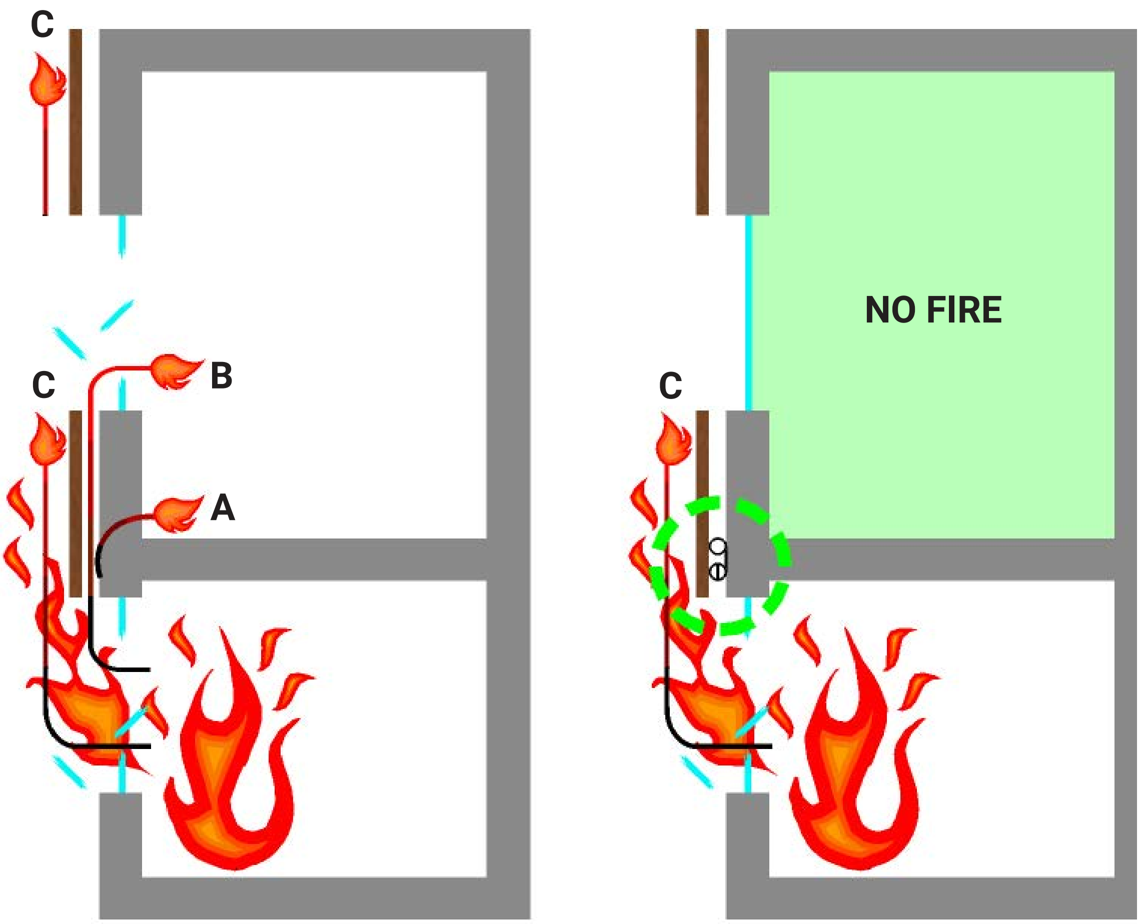
Flames do not pass barrier

Test of “open state fire resistance rated” cavity barriers showing that flames do not pass the barrier.
Test specimen is Firebreather cavity barrier from Securo.

Use of

Cavity Barriers

What makes the Firebreather cavity barrier from Securo your best choice for passive fire safe venting of your façade?



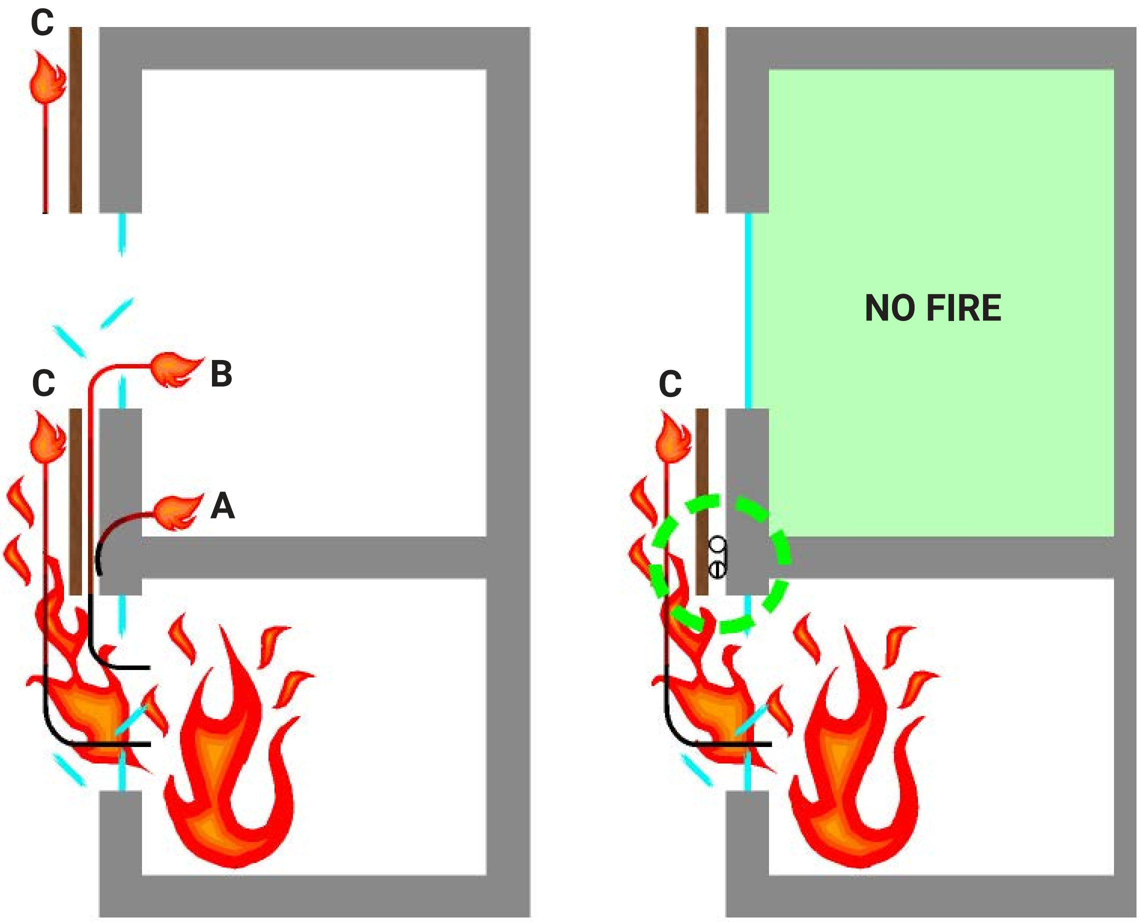
- No bypassing of fire compartments via perimeter wall-deck joint **(A)**
- No bypassing fire compartments via air gaps and breaking window **(B)**
- Limit fire spread on façade as required to pass façade tests **(C)**
- Block flames in the open state (trad. CBs allow flames to pass first 5 min)*
- No smouldering during fire (FBH keeps in place)
- No PVC or plastic that can form burning droplets spreading downward fires.
- Block ember attacks
- Block birds, rodents and insects (more than 2 mm)

* The **Firebreather cavity barrier** is the only cavity barrier in the market with instant fire stop. While all other products need up to several minutes to expand and close of the cavity, the Firebreather product will keep flames from entering the proteced area at any time. Knowing the speed at which a fire can spread in a cavity, this is an essential attribute for a cavitity barrier.

Use of

Cavity Barriers

What makes the Firebreather cavity barrier from Securo your best choice for passive fire safe venting of your façade?



As the FBH prevents any concealed fire in the cavity, the only way for fire to spread is on the panels' outer surfaces **(C)**. Flames **(C)** are no longer supported by the torch **(B)** emanating from vent opening at top of air gap so its capability of leap frogging to next panel is significantly reduced.

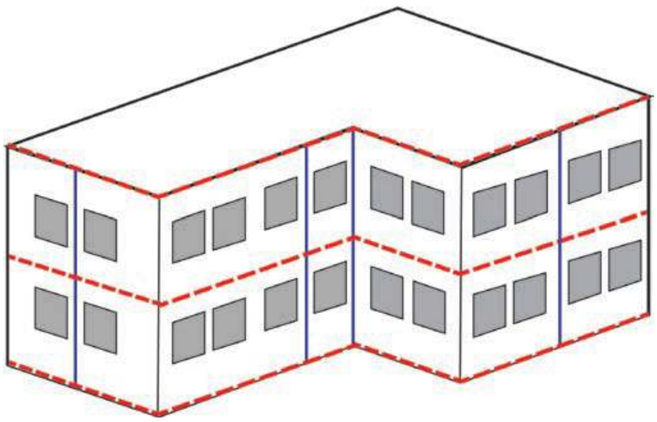
Since there is no concealed fire, burn-through from the outer face (single side) takes much more time.

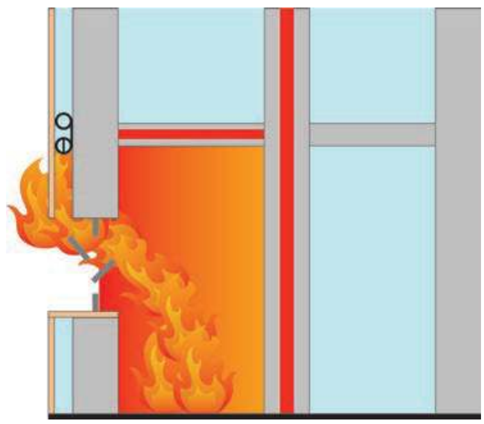
No hidden internal fire also means effective firefighting, even if the firemen arrive late.

Use of

Cavity compartmentation

A properly constructed façade and correctly installed cavity barriers should lead to **a working cavity compartmentation in the façade**, which ensures that fire cannot spread rapidly between compartments, relying on the integrity of its structures not being compromised. The use of horizontal cavity barriers installed at each floor level will prevent fire from spreading from the place of origin to storeys above.





Ventilated cavity barriers

Solid fire stop

What is the concept of cavity compartmentation?

Just like fire compartments inside a building, cavity fire compartments prevent fire from entering or spreading to others. The volume of a cavity compartment is confined by the cladding panels, cavity barriers and windscreen or exposed insulation. Cavity compartments are designed to limit the extent of hidden fire in a façade to an area where fire can self-extinguish, or firemen can easily access it by external attack through cladding panels, or by penetrating the insulating wall from the inside in high-rise structures.

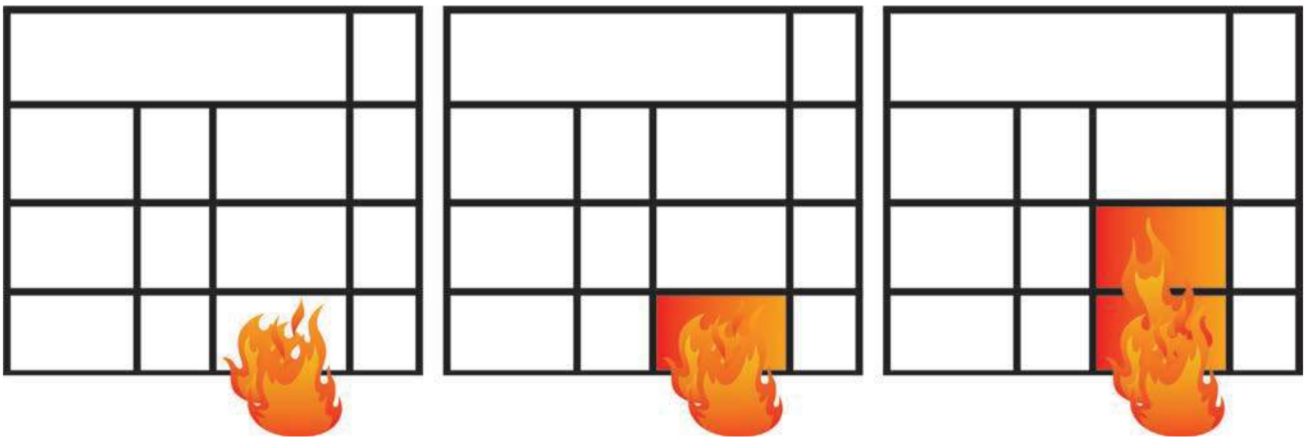
What is the role of barriers in cavity compartmentation?

Cavity barriers prevent fire from entering the cavity of rainscreens and from bypassing fire separating elements like floors. A cavity can be as large as the wall itself, so it is most often sub-divided into cavity compartments. A cavity compartment usually coincides with the extent of fire compartmentation of rooms inside. **It is cavity barriers that make cavity compartmentation possible**. Typically 25 or 50mm deep only, they cover the cross section of a fire compartment inside. Cavity compartments can be fairly small, or span vertically from bottom sill to top of wall, depending on the fire strategy. They typically cover from 10 m2 up to a few hundred m2.

Use of

Cavity compartmentation

Working principle of 30 minutes external wall cavity compartmentation



0 - 30 min: External fire

At 60 min: Hidden fire contained within cavity compartment 1

At 90 min: Hidden fire contained within cavity compartment 1 and 2

INTERVENTION TIME <30 MIN: **External originating fire only**
(or internal fire breaking out of window)

INTERVENTION TIME <60 MIN: **Hidden fire in cavity compartment 1 only**

INTERVENTION TIME <90 MIN: **Hidden fire in cavity compartment 1 and 2 only**

Source Geir Jensen

Test standards

Fire safety for façades starts at the design stage. Along with the other technical disciplines, the architect should ensure that the design aesthetic intent is met, with the required technical performance.

The use of recognised products and technologies is very important. These products and technologies are usually developed with the help of extensive research and testing.
Each individual component used in the façade system should be tested to ensure its reaction to fire, and for separating products like cavity barriers, their resistance to fire. For cavity barriers this can, for instance, be in compliance with EN 1366-4 for linear joints.

The correct testing, certification of installation and build-up of a system are very important, so the entire façade system should also undergo a large scale fire test, such as SP105, BS 8414, Lepir2, NFPA 285, DIN 4102 or similar.

Product test

The Firebreather cavity barriers are tested according to **EN 1366-4**.
This European Standard specifies a method for determining the fire resistance of linear joint seals based on their intended end use and is used in conjunction with EN 1363-1.

Thermocouples are placed directly on the steel mesh and on both sides of the cavity barrier.
For the duration of the test, no flames can pass the barrier and the temperature shall not increase more than 140°C on average, or 180°C at one single thermocouple, to comply the integrity and insulation criteria.

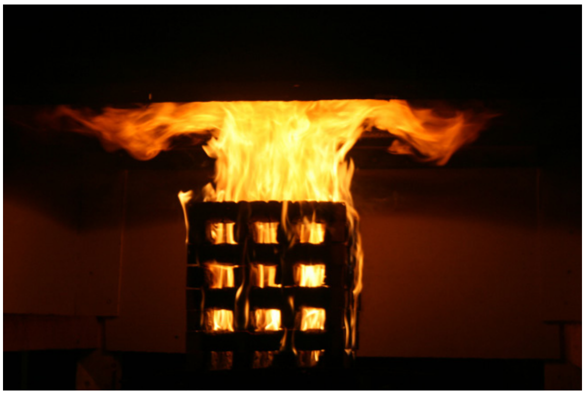
The Firebreather cavity barrier has a fire rating of EI90 for the full duration of the test, including the first 5 minutes. In addition, no flames will pass in a sudden flame exposure test like the ASTM 2912.

Test standards

Product test

ASTM 2912

This fire-test-response standard assesses the ability of non-mechanical fire dampers used in vented construction, in their open state, to limit the passage of hot gases, radiation, and flames during a prescribed fire test exposure. **The fire exposure condition in this test method comprises sudden, direct flame impingement**, which produces these hot gases, radiation, and flames.



Sudden direct flame impingement.

In the absence of a European normative reference for the test of direct and sudden flame contact or hot gases, the French guide for timber construction and spread of fire in façades also references the ASTM 2912 test standard.

EN 1364-6 - Fire resistance tests for non-loadbearing elements - Cavity Barriers.

The European Committee for Standardization (CEN) is working on a new test standard for cavity barriers.
This testing approach specifies a method for determining the fire resistance of cavity barriers and is to be used in conjunction with EN 1363-1.

The standard is applicable to non-loadbearing, vertically or horizontally oriented, closed and open cavity barriers, which are used to provide fire separation to non-compartmented or ventilated spaces. Cavity barriers are designed to provide fire separating performance and the test method is therefore based on the standard room fire exposure in EN 1363-1. Open cavity barrier specimens are installed for testing in one of two ways, to simulate slow or sudden exposure in use.

Test standards

Large scale facade test

Fire behaviour of façades has been a topic with growing focus, especially after the Grenfell Tower fire. Nevertheless, understanding such façade fires is very complex as it concerns a combination of many products such as insulation, cladding, cavity barriers, etc. and system parameters like mounting and fixing, and singularities such as window frames as an example.

The complete system can only be properly assessed with fire tests at a sufficient scale.
Façade designers need to know the fire properties of all the materials being used and their key reaction to fire, like ignitability, combustibility, flame spread, and reactions of droplets and smoke. This knowledge is then used to design a complete system that must not fail when a fire occurs.

There are a lot of different large scale façade tests available, at least 12 in Europe alone, all with different attributes like wall geometry, ventilation openings, temperature, heat flux distribution and quantity of fuel, type of fire exposure (wood, heptane, propane), use of window openings and measuring criteria like temperature limits, flame spread, falling parts, etc.

There have been attempts for harmonisation of façade test standards, but the number of test methods has however increased.
The European Commission has started its own initiative to harmonise the methodology and classification of façade fire spread.
The end result of this should be a harmonised system of façade fire performance testing and classification, based on a test that reflects real safety risks.
There is no reason why this work should be limited to some parts of the world when the problem of façade fire performance and its evaluation is global.

The Firebreather cavity barrier has been included in numerous third party large scale façade tests like SP 105, Lepir2 and BS 8414.

SP 105 test - Sweden.

Lepir 2 test - France.

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Protecting people

Securo produces fire-resistant vents based on the renowned Firebreather™ technology.

”Protecting people” is more than just a slogan for us at Securo. It is something we strive to achieve in our everyday life by offering the most secure products on the market and by continuously working for safer regulations, both nationally and internationally.

It is satisfying for everyone working here to know that the results of our work are socially beneficial and give people better security.

The Firebreather™ technology gives us the only products in the market that offer continuous fire resistance while still enabling ventilation.

Securo strives to be characterized as Professional, Innovative and Responsible.

Firebreather™ technology (FB) is a patented concept for the development of passive ventilation grilles and cavity barriers with the unique feature of blocking the spread of flames, heat and embers instantly in case of fire.

FB Firebreather™
by Securo

By
Tronn Røtvoll

Sales Manager
Securo AS