Fire and facades

A number of serious building fires have triggered significant public concern over the safety of façade materials. Andy Dean, of Exova Warringtonfire, discusses the issues involved, how the industry might respond, and raises questions for the future

Spacing buildings apart to prevent the spread of fire is not a new idea – it can be traced back to the Great Fire of London in 1666, when the streets were narrow and wooden buildings close together. This allowed flames and heat from one building to set fire to others across the street.

It is said that one of the strategies used by King Charles II to stop the fire spreading was to demolish perfectly good buildings to create 'fire breaks'.

This principle is still widely used today, with building codes all over the world stipulating that buildings must be spaced apart to prevent a fire in one building spreading to others.

The advent of high-tech fire resistant façades is a relatively new development and means fire rated buildings can be placed much closer together.

Most buildings don't need such high specification façade materials because they are appropriately spaced. This level of fire rating is also extremely expensive and not economically viable for ordinary buildings.

Many codes do not require the façade to be fire-rated if other systems are used, such as internal sprinkler systems or perimeter firestopping.

Understanding 'fire resistance' and 'reaction-to-fire'

Firstly, it is important to understand the difference between 'reaction-to-fire' and 'fire resistance'.

Reaction-to-fire mainly deals with materials: if they burn (combustibility); how easily they burn (ignitability and flame spread); and what happens when they burn (smoke development and resulting toxicity).

Reaction-to-fire focuses on the response of materials during the development of a fire, so, for example, concrete, paper, wood, plastic and paint will each register very different reaction-to-fire performances. The result is often a material classification that is used by designers to ensure the right material is in the right place with the aim of preventing a fire from starting, or limiting its spread.

Fire resistance, on the other hand, mainly addresses building systems (such as walls, floors, ceilings, and doors) and their compartmentation abilities – for instance, when a fire is fully developed in a space or room, how long will it take for that fire to burn through a system into an adjacent space? Fire resistance performance is always measured in terms of 'time' and is used by designers to make sure potential fire spread from one compartment to another is quantified. This is an important consideration when designing a building because it will enable people to get out in time, as well as limiting damage to property.

Why perimeter firestopping is crucial

Whether or not the façade of the building has a fire resistance capability, it must also perform in at least two other important fire-related ways. Firstly, the materials used have to limit flame spread – and it is lamentably apparent that some of the materials used on the buildings in the recent fires were not suitable.

Secondly, where ‘compartmentation’ is required by the fire safety strategy, the gap between the façade and the building (typically at the floors), must be sealed to limit fire spread between rooms. This is called ‘perimeter firestopping’. It is extremely important, but can become ineffective if the materials used in the façade enable the fire to bypass this seal.

When looking into the flame spread characteristics of a façade, it is important to evaluate the materials used in its manufacture. In particular, the combustibility, ignitability and spread of flame across the surface must be evaluated.

Some test methods traditionally used to determine a material’s fire-related performance may not be appropriate for some façade materials. For example, the ASTM E84 (‘Steiner Tunnel’) and EN ISO 13823 (the single burning item or SBI) tests that are used as part of the classification systems in key international regions are not, in isolation, sufficient to prove adequate performance. The reason for this is that these tests are often not aggressive enough, in terms of flame and heat, to challenge the material effectively.

For example, a common material used in façades is ACP, or aluminium composite panelling, which falls into the genre of metal composite materials (MCM). Non-fire rated versions of ACP often comprise a 2-5mm core of low density polyethylene (LDPE) sandwiched between two layers of aluminium (generally 0.5mm thick on each side). The LDPE typically burns ferociously once lit, but the fire has to get through the aluminium before it can ignite the core. The two tests cited above will often not penetrate the skin and therefore never ‘release the dragon’ inside – as a real life building fire might.

The need for more thorough testing techniques

The answer to concerns over testing these types of systems is a more aggressive fire test. NFPA 285 or BS 8414 are two such tests. These are performed on full-scale mock-ups with the wall system containing the material fixed to a test wall two storeys high.

The tests simulate a fully developed fire, either adjacent to the wall or breaking out from a window. The heat release from these tests is sufficient to properly test the façade and evaluate its performance in spread-of-fire terms.

Turning to fire compartmentation at the perimeter firestopping, it is important to consider a number of issues. The idea of this system is to stop elements of a fully developed fire travelling vertically between floors, through the gap between the floor slab and the façade. It is essential to keep in mind that this is not just a ‘smoke seal’. It is generally expected that the perimeter firestopping should have the same fire resistance performance as the slab which it abuts.

A question of fire safety

A frequent question is: “So what happens when the glass of the façade breaks (which it generally will do in a few minutes after flashover) and the aluminium of the façade melts (which it will do some time shortly afterwards)?”

This is a pertinent question, but does not remove the need to ensure that the integrity of the firestopping remains intact once any façade system failure starts to occur. If the longevity and performance of the perimeter fire stop depends on the resilience of the façade nearby, then this resilience must be made intrinsic to the design.

The firestopping and the façade at this location must act as a system in the case of a fire. This may require the selection of more durable materials that are not going to break or melt once the fire starts such as fire rated glass or steel framing or panelling. An alternative – and common – solution is to protect the façade area adjacent to the fire stop so it is insulated from the fire and retains its integrity for a specified length of time.

Tests such as ASTM E2307 or EN 1364 (parts 3 or 4 depending on whether the façade is fire-rated or not) are examples of test methods that can effectively evaluate the firestopping.

Testing, testing, testing

As implied above, the way to establish the reaction-to-fire, or fire resistance characteristics of a material or system, is to test its performance. Testing is performed in specialised laboratories, using both small-scale and large-scale furnaces specifically designed for the purpose.

Another important element in the testing process is the durability of a material. Many specifications and regional mandatory requirements (including European ones) stipulate that the durability of systems and materials is established alongside fire and other performance criteria.

For instance, it would be unsatisfactory to have a fire door with hinges that deteriorate after only a few years, allowing gaps to open between the door and the frame such that the original fire resistance properties of the door become ineffective.

Key issues of façade design

A well-thought-out fire safety strategy and façade design are critical. Making the whole façade fire resistant is usually not necessary, provided that the intended function and performance of the materials is understood in relation to both reaction-to-fire and fire resistance.

Appropriate testing of the materials used in the façade and the perimeter firestopping systems are two key aspects of ensuring that the façade system and its interface with the building performs adequately in a fire.

A fire safety strategy – the main points

Any fire performance component used in a building should function as part of the the building's fire safety strategy. This is a written plan that explains the design philosophy of the building in the case of a fire.

It sets out the codes and standards in the design; the rationale of the design; escape routes; alarm and warning systems; requirements for compartmentation and fire protection to prevent building collapse; occupancy type and number of people; provisions to help fire fighting operations; and any limitations on the use of the building.

All large or complex buildings should have a fire safety strategy and the associated report is an essential document for the owner, the design team, regulatory authorities, fire fighters and first responders, along with the operator of the building.

The fundamental principles of fire control are prevention and containment. Materials should be selected to minimise the chance of a fire developing. Systems should be designed so that if a fire does develop, it can be contained to the greatest extent possible. Containment is intended to provide occupants with enough time to escape, limit fire spread and minimise damage.