Preventing combustion in construction

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Plastic materials are not only found in cladding systems, so understanding the composition of fixtures and fittings will enable better assessment of fire risk

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In 1973, the disastrous fire at the Summerland Centre in Douglas on the Isle of Man claimed 50 lives and seriously injured 80. Within minutes, a fire in a small kiosk had engulfed the building thanks to its highly flammable Oroglas transparent acrylic cladding. Yet although the Building Regulations were amended subsequently, it has taken the lives of the 72 Grenfell Tower victims to see proper attention being paid to plastics in external construction.

In the past year, we have focused on fire tests, in line with the methods set out in BR 135, and on the lamentable performance of many kinds of plastic-based insulation used in tandem with aluminium composite materials. However, fires in cladding systems are merely one example of the risks associated with the plastic materials and components that may be found virtually everywhere in modern construction and in the furnishings and equipment we use in our buildings.

It would be easy to assume that all plastics perform badly in a fire, but this is not necessarily the case. Many plastics contain fire-retardants that modify their behaviour; others contain polymers that burn at high temperatures and produce toxic gases. In its report to the Hackitt Review , however, the Association of British Insurers (ABI) claimed that the fires in most tests used wood as an ignition source, when fires in contemporary buildings usually involve around 20% plastic, resulting in a temperature increase of 100?C.

These findings were contested by the Building Research Establishment (BRE), but the fact remains that some plastics will contribute to the overall fire load of a building. Interestingly, the latest revision to Approved Document B (England) in November last year suggests that BR 135 tests are no longer acceptable for residential buildings that are in excess of 18m in height.

Chemical composition

Plastics are formed of naturally occurring organic materials, usually one or more polymeric substances. A polymer itself is usually composed of molecules called monomers that hook together and form long chains.

These are the basis of plastics that have three broad classifications: thermosets, thermoplastics and elastomers. Thermosets form their final shape by heating and cannot be softened without deformation; thermoplastics are moulded by heat and pressure and can usually be reformed by heating; and elastomers or synthetic rubbers can stretch and return to their shape but cannot be reheated and reformed.

Some of the monomers used in plastic manufacturing can be very hazardous; for example butadiene gas, which is used to make neoprene and other elastomers, is flammable and also thought to be a carcinogen. Yet once they are combined in completed products, many

monomers stabilise and do not present a danger in normal use ? a good job, because you are probably wearing some now.

The burning characteristics of plastics are extremely varied, and it would be unreasonable to class them all as hazardous in fire. Factors such as ignitability, flame spread, heat release and smoke opacity all need to be considered.

When plastics do burn they may produce toxic gases, including asphyxiants such as carbon monoxide and hydrogen cyanide, irritants and carbon dioxide. Above a volume of about 2%, the latter makes those who inhale it breathe faster, which in turn increases their exposure to other gases generated by fire.

Plastics in construction

One of the most commonly used construction materials is the uPVC found in windows, plumbing, cable insulation and various other fittings. This is very difficult to ignite, and performs far better in fire than some other plastics.

According to the British Plastics Federation (BPF), the temperature required to ignite rigid PVC is more than 150?C higher than that of timber. Unlike thermoplastics, it does not produce flaming droplets but tends to char into a carbonaceous structure that protects the material beneath.

However, uPVC is not suitable as a cavity barrier so care must be taken when replacing timber-framed windows with PVC ones. Concerns have been expressed, too, that in a fire the chlorine content of PVC reacts to form hydrogen chloride gas ? a toxic irritant ? but in reality fire victims are more likely to inhale lethal doses of carbon monoxide.

Thermoplastics and thermosets are often used in rigid insulation boards, both internally in floors and walls, and externally in roofs and insulation systems. They are efficient insulators, but are unlikely to satisfy requirements for non-combustibility or use in systems of limited combustibility. In contrast, the alternative stone-wool or mineral-fibre systems are less efficient, so thicker insulation layers are needed ? again, a potential problem in retrofits.

A group of thermoplastic materials often selected for strength and transparency are polycarbonates, either single or multiwall sheets of which are used for rooflights and glazing. The performance of such materials in fire depends on a variety of factors such as thickness and addition of fire-retardants. Testing systems vary throughout the world, and in the UK polycarbonate materials cannot be tested to BS 476 part 3 or BS EN 13501 part 5 because the material melts under the conditions used. The material is rated as normally flammable to the German DIN 4102 and DIN 13501 codes ? comparable to other materials such as wood, save that ignition behaviour depends on factors such as multi- or single-skin use.

Polymethyl methacrylate (PMMA), also known as acrylic or acrylic glass, is a transparent thermoplastic often used in sheet form as a shatter-resistant or lightweight alternative to glass, or a cheaper alternative to polycarbonate. Certain brands generate almost no smoke compared with many other plastics, and under normal circumstances combustion only gives rise to carbon dioxide and water. Being thermoplastic, though, PMMA melts in the event of a fire, with the flow depending on the grade of acrylic and the development of the fire.

During the Summerland fire the burning Oroglas melted, allowing more oxygen to enter the building and increase the intensity of the fire, while burning droplets contributed to fire spread

and injury. One should not assume that current formulations would behave in exactly the same way, but the ever-increasing use of plastics in furniture is a concern given that it is not generally covered by the Building Regulations. There are some regulations relating to flammability, but once a fire has started the use of such products may well create a highly toxic environment in a building very quickly.

The performance of plastic components can also be critical. For example, the ABI?s submission to the Hackitt Review considered the effects of plastic vents and ducts passing through a cladding system. In one test involving a section of wall, temperature readings indicated that such a vent was providing an almost instantaneous route for fire directly into the void between the wall and cladding, long before it would have taken the fire to break through the outside cladding panels. The existence of vents will make a big difference to the performance of other materials and forms of construction, and yet standard test methods do not model these.

In summary, while the manufacturing industries strive to improve the performance of plastics in fire, the ever-increasing use of such materials in construction will almost certainly contribute more and more to the fire load of a building. But this may well occur in a way that is not necessarily modelled in standard fire tests, which often concentrate on the materials themselves rather than their use in combination.

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Further information

- Related competenices include: Fire safety and Risk management
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