Safe from the start

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Through its experience of fire engineering Arup has identified common problems that can arise when safety is not considered comprehensively from the design stage onwards, as Nick Troth outlines

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The first concern in fire safety design and specification should be understanding material performance during fire. This is obviously topical, but Arup has considered it important for many years: the founder of Arup Fire Engineering was Prof. Margaret Law, a scientist who understood the significance of this knowledge and instilled it in our business.

The way a material?s fire performance is tested and then classified is not properly understood by designers, specifiers, contractors or approvers. There is confusion about the terminology, with different terms being used to describe the way materials behave in fire. A 'surface spread of flame test' and 'fire propagation test' are not the same; neither is a 'combustibility test' a 'fire resistance test'.

Better understanding of a material?s fire performance is required, and the profession must ensure the correct terminology is used and that what these terms signify is appreciated.

It is also important to understand exactly the configuration of a sample used in fire tests: we see fire-stopping products that have only ever been tested in a blockwork wall and never in a ceiling or plasterboard, but which are then still used in plasterboard ceilings. Product manufacturers should be much clearer on what tests their products have undergone, and what limitations their testing has.

New construction methods

Increasing pressure to reduce construction costs and time is seeing moves towards prefabrication, and non-traditional methods of construction are being brought to the marketplace.

Yet we find insufficient research is being undertaken into the fire performance of such systems, or the products used in them. One such example is cross-laminated timber: we have found that very few fire-stopping products made of this have been tested.

We also have experience in modular buildings where there has been insufficient attention to detail to ensure fire compartmentation and stopping. A significant issue with this type of construction is extensive voids. Careful attention is needed in the design and product selection for fire performance in modular buildings to ensure that fire and smoke spread is adequately controlled, and that products have been tested in this kind of lightweight construction. If not, there are significant challenges in demonstrating that an appropriate level of safety can be achieved.

Complex systems

As building systems become more complex, the fire system requirements also increase in complexity. There are often a considerable number of systems that need to interact in the event of a fire: the alarm and detection system may have many interfaces, and these can be linked to access control systems that unlock doors on escape routes, or to lifts, either to prevent or enable their use in a fire.

Some building users focus on minimising disruption in the event of a fire alarm, which may result in phased and zoned evacuation. What happens during a fire and the expectations of how these systems will react to that fire are not always clearly documented, however.

These must be considerations at the design stage. It is extremely important that the principles of the systems? function in any given fire scenario are then carried through into the specification, construction and commissioning stages.

Improved communication is also needed so end users clearly understand the systems, and know what they are expected to do and when. This is a basic requirement under Building Regulation 38 , but we encounter many buildings where it is not happening. It is important that emphasis is placed on proper commissioning at handover stage, and this should be overseen by the fire engineer to ensure the systems operate in line with the fire strategy requirements.

Occupancy restrictions

A fire strategy should not place onerous or unrealistic dependence on building fire safety management. Approved Document B section 0.13 is clear on this, but we still see an increased reliance on building management controls to support fire safety measures.

We often help occupants deal with constraints and limitations placed on them by the building designs they have inherited, too. Often these designs restrict occupants? ability to use the buildings; for instance, numbers can be limited by inadequate escape provisions.

There are also difficulties in dealing with evacuations of those who are mobility-impaired, if the design team has failed to account realistically for the possible number of occupants needing assisted escape.

Competent fire engineers need to ensure that the buildings they design are sustainable and sufficiently flexible. Wherever possible, end-user engagement should take place early enough during design to make certain that the fire strategy addresses the way they will occupy and operate the building. Where this is not possible, the fire strategy should be very clear on the limitations that it imposes on the end user.

Updating guidance

Fire safety guidance will always be playing catch-up in respect of new materials, technologies, construction techniques and society. When we are aware of issues, potential flaws or deficiencies in our guidance, a proactive process of amendment, clarification and updating is essential.

As an example, several current measures relating to external walls and firefighting provisions in Approved Document B are controlled by the reference to an 18m building or storey height.

This measurement originates with the fire brigade?s capability to fight a fire externally using a 60ft (18.3m) ladder, based on an old wheeled-ladder vehicle of the sort one might see in a 1950s movie. These have not been in use for more than 4 decades, but we still design to the height of the ladders carried on such vehicles.

Another example is in the previous version of BS 9999, which stated that a void in a building through a structural floor should be designed as an atrium. When this was published in 2008, it was questioned on the basis that Approved Document B only applied the same design measure for a void passing through compartment floors. It took until the 2017 edition of BS 9999 for the description of an atrium to be aligned with that of Approved Document B, and it now refers to compartment floors rather than structural floors. In the meantime, though, how many buildings were constructed in accordance with the earlier version of BS 9999 with provisions that may have been unnecessary?

Test standards and ductwork

Approved Document B refers test standards for fire-rated ductwork to BS 476?24: 1987 and BS EN 1366 , the former being superseded by the latter in 2014. The BS and EN standards use the same time?temperature curve, although the measurements differ, meaning that BS EN 1366 uses a higher temperature and more onerous test criteria.

There are also differences between fire-rated and smoke-extracting ductwork in the tests. Only rectangular smoke-extracting ductwork up to 1,250mm by 1,000mm in cross-section and circular ductwork of up to 1,000mm diameter can be tested to BS EN 1366.

Larger ductwork has to rely on an extended field of application assessment. The maximum sizes of fire-rated rather than smoke-extracting ductwork that can be tested under BS EN 1366 are up to 2,500mm by 1,500mm for rectangular configurations or 1,250mm diameter for circular. Again, there is no provision to test ductwork beyond these sizes.

Fire resistance specifications

Specifications and fire strategies often say a product should have 60 minutes? fire resistance, but this fails to identify the actual fire performance required.

Fire performance is made up of 3 qualities: stability, integrity and insulation. Table A1 in Appendix A of Approved Document B outlines these requirements clearly, setting out minimum provisions for each of the three qualities, along with the method of exposure. However, the table in Approved Document B is underused as a reference source.

As a result, there are projects where a contractor purchases fire-rated ductwork, for instance, but has not understood the full fire resistance requirements for it. The insulation criteria have often been missed, and for the ductwork then to fulfil this quality it needs additional fire-rated cladding, protection or wrapping to the outside, and invariably no space has been allocated for this.

Penetrations and stopping

Fire strategies usually require some form of compartmentation; that is, a fire-resisting element. For fire compartmentation to be effective, anything that penetrates it must be suitably protected. If fire-stopping is not considered during the design and specification phase, the contractor is only able to work with the substrate installed. Spacing around services is critical, but we have found on-site fire-stopping that has been installed where services are in such close proximity that its performance can no longer correspond to that under test conditions.

Design teams must start allowing realistic provisions that enable fire-stopping to be installed.

Received wisdom

The fire strategy should be the single point of reference that sets out how a safety measure is to perform during a fire. But this strategy is often implemented without proper consideration of what it requires. One reason for this seems to be that contractors, installers and so on are simply taking the approach they have done on other projects, without questioning whether this is this the right one or identifying whether improvements could be made.

A typical example of this is smoke control systems in common corridors or lobbies in single-staircase residential buildings. It is essential that these systems are installed, commissioned and maintained correctly, in accordance with the fire strategy?s requirements; but our experience is that we cannot always rely on the contractors ensuring this happens.

Total fire engineering

The final challenge ? one we continually face ? has also been raised in Dame Judith Hackitt?s review of the Building Regulations and fire safety : specifically, the lack of information transfer throughout the various project stages.

The fire strategy document should demonstrate the way in which regulatory compliance is to be achieved; advise the design team of the fire safety performance requirements of their design; tell the contractor what has to be fabricated, procured and built; and advise the client or end user about any limitations that the strategy imposes, and what they need to maintain throughout the life of the building.

There are key stages in the design and construction process where clear fire safety information needs to be passed from one party to another. Without such clear communication, the fire strategy may be misunderstood or misinterpreted in the design or specifications. One solution could be to increase the use of building information modelling in fire engineering. At the time of writing, it is not mandated that the fire safety strategy is incorporated into a building information model, and this is something the construction profession should address, because it would provide consistency across the design and construction process.

Building Regulation 38 mandates that relevant fire safety design and construction information is handed over to the relevant end users to help operate and maintain the building safely, though again our experience is that this is not being conducted properly. We would welcome building control surveyors being more active here.

For instance, the 'responsible person' is often handed either a RIBA Stage 4 fire strategy or a set of operation and maintenance manuals, an approach that doesn?t help the end user understand or manage fire safety in the building.

On many projects the role of the fire engineer ends at an early design stage, with clients not engaging them to check that what has been specified and installed meets the requirements of the fire strategy.

The fire strategy has to do much more than this. For a number of years, Arup has been advocating the concept of total fire engineering as a way of addressing this by involving the fire engineer throughout the design, construction and occupation of a building.

This would align with the golden thread for fire safety and the role of building safety manager in high-risk residential buildings recommended by Dame Judith (see pp.4?5 of this issue); with this in place, digital safety case files would be deployed, and there would be gateway approval points from inception to handover to management in use.

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Further information

- Related competencies include: Fire safety
- This feature is taken from the RICS Building control journal (November/December 2018)
- Related categories include: Building control , Fire and life safety and Health and safety