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Testing times

Advances in fire safety design now include a significant element of risk assessment as a supplement, or an alternative, to prescriptive rules. There are major implications as a result.

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Product reliability and fitness for purpose become key considerations, and manufacturers have to give more consideration to the reproducibility of product performance in realistic and alternative fire scenarios. A risk-based approach requires confidence in product performance, linked to assurance on the reliability of product function. That requires more attention to the range and validity of furnace test data as evidence for product capability in fire.

Best practice principles

The successful application of fire-resistant glass is based on three core factors:

- the development of fire-resistant glass technologies with reliable and effective function, for use in the wide range of fire environments that may be possible;
- repeat furnace testing of fire-resistant glass, in as many different furnaces around the world as possible to demonstrate consistency of behaviour and effective fire protection function; and
- testing in as wide a variety of different glazed system applications and framing options as feasible to provide the maximum of specifier choice.

These best practice principles for fire-resistant glass need to be recognized and reinforced. Innovations in architecture and construction continue to set challenges, and fire safety is even more in the spotlight. Pilkington continues to be at the forefront of developments. Advances maintain reliable effective fire protection whilst expanding the variety and capability of applications. Fires in modern buildings can be intense and the course of fire growth characteristically unpredictable. The

underlying fire-resistant technology for glass products therefore has to be inherently safe and reliable, requiring a significant technical input.

Implications of risk

Risk-based approaches lead to focus on scope of application, product sensitivities, failure mechanisms and limits in fire. At issue are both the level and validation of product performance. Both are not easily satisfied by reference to a single passed fire test, least of all by an assessment that may be tenuously balanced on scanty test evidence.

Development of risk-based techniques calls for a greater focus on the depth and spread of test evidence, not less. Wider consideration of real fire conditions, in what could be a range of possible fire scenarios and a variety of fire safety objectives, is increasing in fire safety design. The uncertainties and risks of fire are well known. Deduction of expected performance in real fire conditions is a projection from test evidence involving an element of uncertainty. The further the claimed performance strays from the underlying test evidence, and the weaker that evidence is, then the greater are the potential uncertainties in predicting fire behaviour. The degree of uncertainty can effectively be minimized by increasing as much as possible the scope and range of available test evidence as a testament to product reliability, consistency and effectiveness.

Furnace testing

The prime purpose of a standard test is to allow product classification according to broad functional categories which are defined by prescriptive pass/fail criteria. A base of standard test evidence is essential. But, the prescriptive process is not ideally suited to provide the type of information required by a risk-based approach to design. The test evidence therefore needs to be as extensive as possible, to maximise the information content for the designer.

Assurance on repeatability and reproducibility of performance can best be provided by a demonstrated track record of testing – as many tests in as many different test furnaces and framing situations as possible, backed up by large scale tests and real fire experience. Such considerations can hardly be answered by a single test, or a limited scope of test evidence. In the approval process, test failures are not recorded, and no distinction is made between a product that just scrapes through by less than a minute and one that can achieve a safety margin of several minutes.

Test evidence is crucial, but the information should not be stretched beyond its point of applicability and relevance, at the risk of becoming misleading and unrepresentative. Scrutiny of the evidence should cover applicability, scope, relevance and validity. The designer also has to note the expected fire situation. There are some key points to be mindful of:

- Fire-resistant products should only be installed as part of an approved and tested fire-resistant system of matched components. There should be no short cuts, such as mixing and matching of components, or using a system based on incorrect test evidence. Different glasses made by different manufacturers should not be presumed to be equivalent..

- The product tested must always be representative of the routine product coming off the production line. And if that product changes, or varies, in a way that could compromise the submitted test evidence then controls must be put in place and the product re-tested.
- There are limitations on furnace test information. A proviso included in fire resistance test reports is that a test result only relates to the behaviour of the element of construction under the particular conditions of the standard classification test.
- Test reports remind users that the result applies only to the specimen as tested, also that the result is not intended to be the sole criteria for assessing potential fire performance of the element in use, nor to reflect actual behaviour in fires. Time in a standard test does not necessarily directly correlate with time in a fire, under fire conditions that may well vary significantly from those of the prescriptive test.
- The fire test evidence must be relevant and applicable to the application and the function of the fire-resistant glazed system. For example, a test report for overhead glazing is totally inadequate as evidence for a fire-resistant loadbearing glass floor (on the presumption that any horizontal glazing test will do).

Practical limits

Even relatively low levels of radiant heat can cause serious burns and smoking on the protected side, perhaps secondary ignition. Radiant heat absorption by a glass can also give high surface temperatures on the protected side, leading through convection to a high temperature environment on the protected side.

The UK's Building Research Establishment (BRE) guide safety limit for human tenability is 2.5 kW/sqm. That is within the range of insulation glass, but not integrity EW (limit 15 kW/sqm). There is a tendency to pass off the EW class, in some way, as a substitute for insulation. In practice, there is no comparison. The 15kW/sqm limit represents a high level of intolerable heat, and it is of questionable fire safety benefit.

Insulation on the other hand provides protection against all heat transfer, defined by precise temperature criteria. Insulation performance therefore effectively protects against the risk of serious burns, for enhanced life safety (especially for vulnerable groups) as well as benefits in providing containment and limiting fire spread.

Assessments

Assessments provide an opinion on performance were the product to be tested. Assessments are generally used to support minor variations in the product as originally tested They should not be used *in lieu* of fire tests, although this is a developing trend of suspect practice which requires careful scrutiny since the supporting test evidence can be tenuous. Assessments should be withdrawn when tests show the opinion to be mistaken.

If assessments are used to support a product claim, then it is absolutely important that they are based on valid and applicable primary test evidence which is owned by the assessment owner and approved for use. If specific test evidence of this validity is not referenced then the assessment should be dismissed. Above all, assessments must be carried out by properly accredited authorities with experience of testing and the fire-resistant glass in consideration (e.g. a notified body accredited to BS EN ISO/IEC 17025:2005, General criteria for the competence of testing and calibration laboratories).

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Fire resistance

Applicable fire resistance classes are either integrity (i.e. holding back flames and hot gases) or insulation (i.e. the limitation of heat transfer by all mechanisms, plus integrity). Integrity (EN classes E and EW) refers to the prime performance as a physical barrier to flames, fumes and hot gases. Insulation refers to the ability of the fire-resistant system to act both as a physical and a heat barrier (EN class EI). The insulation function is unambiguously evaluated by measuring the surface temperature of the test panel. Insulation effectively reduces the risk of dangerous heat transmission for the fire, by all transfer mechanisms.

The differences between the performance categories must not be blurred. For example, interpretation of the European EW class (integrity radiant heat) can be ambiguous. The EW radiant heat limit – less than 15 kW/sqm at a 1m distance – is not recognised by UK regulations. Radiation is determined by pane size, orientation and distance, as well as the intensity of the source fire. The level of radiant heat from a glass, even under standard test, therefore varies according to the situation. As a result, a single measurement cannot be taken as a characteristic material value.

Fire-resistant glass floors

The development of fire-resistant integral loaded glass floors is one of the best examples of the capability of intumescent fire-resistant glass based on co-operation between manufacturers and specialist systems developers.

Pilkington has worked closely with specialists

Pilkington Pyrostop, Pilkington Pyrodur, and Pilkington Pyrodur Plus are extensively tested fire-resistant glass types based on an established resilient intumescent interlayer technology. They are available in an extensive portfolio of framing systems, and are capable of fulfilling the range of fire safety demands from regulations and risk-based design. The record of use includes major buildings across the world in a range of challenging situations for glass. For more information on Pilkington call 01744 69 2000 or visit www.pilkington.co.uk/fireresistant

Glazeguard to develop a robust fully tested loadbearing fire-resistant glass floor system. Glazeguard's Triple-Lite™ Firefloor is at the forefront of transparent building design. It is the first fire-resistant glass floor system to attain the CE mark under standards EN 14449 (Glass in Building: laminated and laminated safety glass) and EN1365-2:2000, (Fire resistance tests for loadbearing elements – Part 2: Floors and Roofs). The test load has to be appropriate for the type of activity and occupancy characteristic. In the UK, guidance comes from standard BS 6399-1:1996, Loading for buildings – Part 1: Code of practice for dead and imposed loads.

Triple-Lite™ has shown fire resistance insulation and integrity for over one hour for both integrity and insulation when fully loaded under test fire conditions. The floor structure has demonstrated robust stability in several tests. Triple-Lite™ is available in individual panel areas 3m by 1m standard single panels for construction of glazed floor areas or glazed transit air bridges. Both timber and steel framing are approved. Major applications already include a range of situations. Major projects completed and in progress illustrate the value engineering benefit of a complete approach from design through to installation. Applications are in a wide range of diverse situations, including health care, commercial, education, and even domestic buildings (e.g. Rolls House, a commercial and court building in Fetter lane, London; United House, West St London, a commercial development; Dublin dental hospital; and private domestic installations in flats and houses).

The fire-resistant backbone of Triple-Lite™ is provided by Pilkington Pyrostop® 60-101, a well tried and tested insulation with integrity fire-resistant glass classified for 60 minutes. Not only does Pilkington Pyrostop® 60-101 have an extensive furnace test record around the world. It also has demonstrated fire performance in the major Center Parcs Elvedon Forest fire (2002) when the product had to survive severe fire exposure for more than seven hours – which it did comfortably, effectively stopping the fire in its tracks and protecting the heart of the site.

Fitness for purpose

The current widespread application of fire-resistant glass is fundamentally dependant on the application of best practice principles in furnace testing linked to systems development. Tragic headline fires involving fatalities serve to remind everybody of the risks and unpredictable nature of fire. The costs of fire are rising not falling. And the focus on fitness for purpose of products and constructions is accordingly getting sharper.

Against the background of fire risks, those principles of furnace testing need to be emphasized, rather than eroded. That is critical if the use of fire-resistant glazing is to keep in touch with advancing design. IFP