FIRE-RESISTANT GLAZING

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Fire is a life-threatening and destructive force, which if unchecked, can spread rapidly through a building. Every year, even in the UK alone, some 900 people are killed and 10,000 injured in fires which, if multiplied worldwide, gives an indication to the severity of damage by fire.

The purpose of fire resistant glazing is to provide protected areas for the containment of a fire within a building, and to provide safe escape routes for the evacuation of people. The requirement can also extend to the protection of adjoining buildings, the protection of equipment within a building, or the provision of safety zones for fire-fighting forces.

Architects and designers are increasingly looking for larger glazed screens and doors, to provide buildings with new aesthetic designs, plus more comfort and safety for the people who use them.

Glass is a very sophisticated and versatile product, on which building designers rely heavily for aesthetics, performance and protection. Specialist fire-resistant glasses, which are now readily available throughout the world, allow innovative architectural concepts to become a reality.

The requirements of building legislation are that buildings shall be subdivided into what are called 'fire compartments'. The objective of this compartmentalisation is to limit the maximum size of fire that can develop, by providing boundaries, both vertical and horizontal, which are able to withstand the effects of fire and, therefore, contain it.

Another requirement of the regulations, is that there shall be adequate means for escape from the building in the event of fire, and to contribute to this, corridors and stairways may be provided, which must be protected and preserved in the event of fire.

Fire-resistance is the ability of an element of construction, to perform its design function during its exposure to fire. When glazed openings are introduced, they must be provided with a means of closing the aperture and reinstating the fire resistance. For example; fire-resistant doors in openings provided for the passage of people, goods, etc., and by fire-resistant glazing in the case of openings for the provision and passage of light.

To fulfil these requirements, fire-resistant glazing systems have been developed, tested and approved according to the British Standard: **BS 476 : Part 22 – Methods of Determination of the Fire Resistance of Non-Loadbearing Elements of Construction**, for both integrity and insulation criteria. Although this is a British Standard specification it is accepted, within the industry, that the criteria used is a global reference, with slight variations allowed above or below the BS 476 temperature figures, dependant upon the country in which the testing is being undertaken.

Fire resistant glazing systems are now available in large panel sizes, offering valuable sound reduction properties as well as compliance with the safety requirements of the British Standard **BS 6206** for Impact Resistance.

We are dealing with a product which :-

(a) Must perform (based upon the success rate of successive & varied fire tests)
and
(b) Can save lives.

We can improve our understanding of fire-resistant glazing by learning more about the following :-

(1) Specimen testing
(2) Performance
(3) Time criteria
(4) Glass
(5) Framing
(6) Compatibility

Fire-resistant glazing is manufactured and installed by licensed and approved fabricators throughout the world. It is designed to provide an essential ingredient to the provision of fire safety in buildings.

Fire-resistance is evaluated by a standardised test – BS 476, part 22 – during which a full size representative specimen of the element of construction is subjected to a simulated fire. This is achieved using special large furnaces, which are able to expose the element in a manner representative of practice.

All fires are different; as a consequence of different combustible materials being involved, different ventilation conditions, different room geometry, etc. To be able to make meaningful comparisons between different designs, therefore, it is necessary to standardise the heating regime. This is therefore typified by controlled heating and pressure conditions in a furnace test. From commencement of the test, the furnace temperature is raised very quickly to in excess of 500^{o}c, within five minutes, to an excess of 700^{o}c within ten minutes, to around 850^{o}c at sixty minutes and onto approximately 1000^{o}c at 120 minutes.

The two performance requirements are 'Integrity' and 'Insulation'.

Integrity - is the ability of a separating element to remain solid, thereby preventing the passage of flame or hot gases, which may result in a lack of fire containment. Integrity also relates to the ability of a load-bearing element to remain stable, i.e. resist collapse.

Insulation - is the ability of a separating element to resist heat conduction from the fire-side to the non-fire side, thereby ensuring that there is no possibility of ignition of combustible material on or within the confines of the non-fire-side.

Fire-resistant glass and glazing systems are often referred to in two fire performance terms, i.e. 'insulated' or 'integrity-only'.

Fire-resistant glazing systems are clearly part of the fire separation process, and the fire test objective is to ensure that the incorporation of a given design of glazing system, into a wall or partition, does not impair the fire separation performance. The appropriate criteria are, therefore, integrity and insulation.
The test on the system is conducted in accordance with BS 476 : Part 22, and it should be remembered that the test is a test of the combined glass and steel system, not of an individual component. It is, therefore, not appropriate to test a pane of glass without it's appropriate framing system and glazing methodology. It is important to remember that the objective of providing fire-resistant glazing, into a wall or partition, is to maintain the fire separation capability of the wall or partition into which it is fixed. It is inappropriate, therefore, to fix a sixty minute fire-resistant glazed assembly into a wall which has thirty minutes fire integrity / resistance. It is a complete waste of time to fix fire-resistant glazing into a supporting construction that has no fire-resistance. The fire test includes an evaluation of the details of the connection of the glazing system to the supporting construction, since this may often be a source of weakness.

Fire-resistant glass and glazing systems are proved by, fire tests and subsequent assessments. These demonstrate the ability or inability to bring together a particular type of glass, with a given framing system, using a particular glazing methodology, and the suitability for use in a particular design of supporting construction.

BS 476: Part 22: 1987

Integrity

Failure is deemed to have occurred if:-

a) There is collapse of the specimen
b) There is sustained flaming of 10 seconds or more on the unexposed face
c) There is a loss of integrity, i.e. if a cotton pad can be ignited by emerging hot gases
d) If through gaps of greater than 6mm x 150mm or 25mm (in isolation) form within the specimen

Insulation

Failure occurs if:-

a) The mean (combined average) unexposed face temperature rise is greater than 140^{o}c
b) The maximum unexposed face temperature rise is greater than 180 ^{o}c
c) Integrity failure occurs

The most common time factors are :-

30 minutes
60 minutes
90 minutes
120 minutes

And these are expressed in tender documents (and the industry) as follows :-

30/0
60/0
90/0
120/0
30/30

60/60
90/90
120/120

The first figure is the integrity performance and the second figure is the insulation performance. For example, 60/0 means sixty minutes integrity only, and 120/120 refers to 120 minutes integrity and 120 minutes insulation.

Glass is the primary component within any fire-resistant glazed system. It probably makes up the largest area of the system and requires most care in its installation. It is the reason for using the system, i.e. to provide visibility but also fire-resistance.

The size of glass pane to be installed can have a significant bearing on the fire-resistance performance of the glass. Some types of glass can be installed into certain framing systems in greater glass pane sizes than other types. The size of glass pane that can be installed depends on the type of glass and the system into which it is being installed.

There are many types of fire-resistant glasses currently available in the world market and the range of products and sizes will continue to increase as the technology for combining quality glazing with fire-resistant performance develops.

The glasses currently available may be divided into two main groupings, namely integrity-only or insulated. A third group, which is some times referred to as 'partially insulated' or 'radiation control' glasses, satisfy the performance criteria for 'insulation' for part of the fire-resistance classification period only.

Un-insulated glasses provide integrity-only performance and are not intended to provide any level of insulation. There are four commonly available glass types, i.e.:-

- Embedded wired (wired reinforced annealed)
- Borosilicate and ceramic
- Modified toughened
- Reactive interlayer

Each of these glass types work in a quite different way and may be suitable only for a specific frame style, size and time period. It is important that you check with your licenced fabricator and installer to ensure that the glass can be supported with relevant and current test evidence.

Insulated glasses are of two basic types, i.e. laminated using intumescent interlayers, and toughened gel-filled units. Although they are manufactured using different materials, they are designed with the same objective, i.e. to provide a glass product which will remain cool on the face opposite the face exposed to the fire.

- Laminated glasses incorporate intumescent layers and are made up from clear float glass bonded together via the intumescent material layers. These layers expand when exposed to heat from a fire and provide a thick, insulating layer. In general, the greater the overall thickness of the glass, the greater the fire-resistance performance.

- Gel-filled insulated glasses comprise two layers of toughened float glass filled with a clear UV stable fire-resisting heat reactive gel, surrounded by a stainless steel spacer bar. In the

event of a fire, the clear gel interlayer reacts to the heat to form a barrier against the passage of flame and radiant heat through the glass.

Insulated glasses are commonly used to protect building evacuation routes, the vulnerable areas of adjacent buildings, or to prevent 'fire-spread' caused by radiant heat.

Framing systems are used to support the glass. The design is critical to the performance of the system. The appropriate framing must be chosen for the type of glass to be used and it must be compatible with the supporting construction into which it is fitted if the required fire-resistance performance is to be achieved.

The frame must provide the necessary design functions required by the glass in order to achieve the required level of fire-resistance. If the glass is incorrectly fitted into a frame, it may fail early in a fire. Additionally, the method of fixing the frame system to the supporting construction may be crucial to the performance of the system. The supporting construction itself must have compatible fire performance and it must also be adequate to support the glazing system.

Each glazing system has its particular requirements and is suitable for use with particular glasses and glazing compounds. They can be divided into five different categories:-

- Softwood
- Hardwood
- Uninsulated steel
- Insulated steel
- Aluminium-clad

Softwood frames

These can be used with insulated, uninsulated and partially- insulated glasses and may normally only be used to provide up to 30 minutes fire resistance.

Hardwood frames

Similar to softwood, but hardwood will char, i.e. erode by burning, and this will eventually result in a loss of material to support the glass. Hardwood, however, has a lower charring rate than softwood and can therefore be used for sixty minutes fire-resistant applications.

Uninsulated steel-based frames

This is the most common type of framing system currently used, but can only be used with integrity-only glasses. The heat transfer through the framing members to the non-fire-side means that the fire resistance performance criteria for insulation will not be satisfied. However, uninsulated steel frames can provide up to 240 minutes integrity-only fire-resistance performance.

Insulated steel frames

These tend to perform in a similar manner to uninsulated steel frames. However, their design incorporates specialist insulation materials, separating one side of the steel assembly from the

other and this reduces the transmission of heat and minimises the extent of distortion in the frame. They are always used with insulated glasses, which are capable of achieving up to 120 minutes for integrity and insulation.

Aluminium-clad frames

These should be considered similar to uninsulated steel frames as they are based on a steel core construction with aluminium as a purely cosmetic component.

Glazing in doorsets

Doorsets fall into two basic categories:-

- Timber
- Steel based

Each system can be treated in a similar way to that previously described for frames and the same principles will apply as they are, in effect, the same components but with different supporting structures.

The type of glass should always be the first consideration when installing a fire-resistant glazed system. It must be installed using the correct fixing details and procedures to achieve the required fire-resistance performance. This does not simply mean that, if the glass is installed securely under normal ambient conditions, the system will function as intended in a fire. If the beads are not fixed correctly, for example, the glass may slump, relatively early in a fire, as the glazing beads degrade. Since any system is only as strong as the weakest component, the fire-resistance performance will be compromised. All products and their precise installation requirements should be considered.

Each basic type of fire-resistant glass has its own particular installation requirements and they can differ significantly between systems; the requirements for one type cannot be assumed to apply to another.

The supporting construction to which the glazed system is to be fixed should be the first consideration before commencing any installation. It is the approved and licensed fabricator and installer's responsibility to ensure that the supporting construction is adequate to support the glazed system, i.e. the supporting construction has to be appropriate and suitable to accommodate the system to be installed.

Conclusions

- Many type of fire-resistant glazed products and systems are available – each with their particular requirements.
- Not all products are compatible.
- Always consult the local licensed fabricator to ensure the compatibility of the various products.
- Check the performance of the products and the systems.
- Remember that ill fitting may result in five minutes fire-resistance instead of sixty minutes.

Photographs

a. Schools (Corridors / canteen, safety)
b. Leisure and sports centres (Mezzanine, bar / restaurant, indoor playing area / courts)
c. Public and transport centres (Airports, railway terminals, bus depots).
d. Shopping centres (Glazed smoke curtains – BS 7346)
e. Cruise ships / oil rig platforms (A60, B15 & Hydrocarbon)
f. Curtain walling (External and anti-blast)

The need to design systems to meet fire test resistance for both internal and external use, is a requirement of the modern glazing systems supplier. In the case of curtain walling, the added facility of weather and wind resistance performance for external applications has to be considered. In all cases the systems must be dry-glazed, using fire resistant glazing gaskets, which are self draining and provide the equivalent weather performance standards of aluminium systems, but with the obvious advantage of being fire resistant.

It is now possible to use fire resistant glasses and systems from the façade right through to the core of the building. Fire resistant glass literally makes it possible to create an open design, based upon transparency, visibility and natural lighting, whilst meeting the exacting demands of fire protection compartmentalisation.

THERE IS NO SECOND PLACE IN FIRE-RESISTANT GLAZING. IT IS THEREFORE IMPERATIVE THAT, AS AN INDUSTRY, WE INSTALL THE RIGHT SYSTEM IN THE RIGHT PLACE.