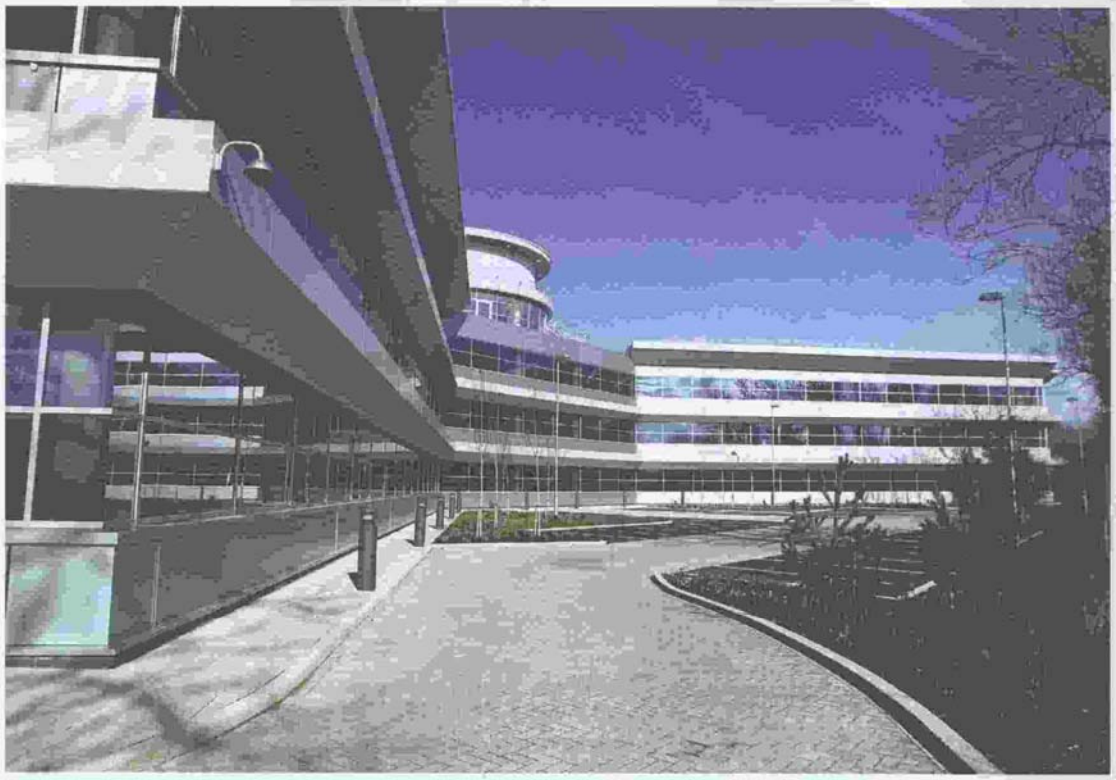
As modern buildings become more complex in design and use, there's more to consider when designing and building effective fire walls. **Gordon Cooke** guides us through the building blocks.



BUILDING YOUR FIRE WALL

Sandwich panels, such as these manufactured by Eurobond, can be highly suitable for large internal or external fire walls
EUROBOND LAMINATES

AS BUILDINGS BECOME MORE COMPLEX THERE'S A danger that the designers will not have the detailed knowledge to compile all the specifications needed. The following guidance is intended to fill the gap and act as a check list of design aspects to consider. Much of the guidance applies to fire walls, irrespective of their materials and method of construction.

A fire wall may be used internally for dividing the building into fire compartments, or used externally to provide safety against an external fire (accidental or malicious), or to reduce the fire hazard by radiation to adjoining property when located near a site boundary. As buildings get larger and fire walls are correspondingly higher, designers turn to prefabricated lightweight fire walls in order to limit foundation loads to an acceptable level. Steel faced sandwich panels can be an excellent application for high fire walls since they are lightweight, can be rapidly erected, have reasonable sound insulation, and can possess a high level of fire resistance – up to four hours if structural rock wool cores are used.

A fire safety strategy needs to consider the effect of a fire wall on life safety, property loss, business continuity, environmental pollution and preservation of heritage. Reference to the BSI PD 7974 documents on fire safety engineering may be helpful in developing a fire safety strategy for the building as a whole.

The fire wall should normally possess the

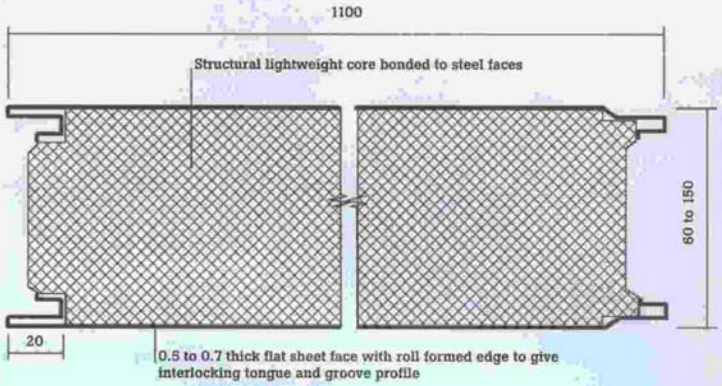
"A fire safety engineer may be able to advise on less stringent levels of fire resistance than those recommended in ADB"

required amount of fire resistance in terms of stability, integrity and insulation when exposed to the standard fire resistance exposure test on one side, ie ISO 834 time-temperature relation. The length of time needed may be decided by reference to Approved Document B 'Fire Safety' (ADB), by the insurer, or by a professionally qualified fire safety engineer who would need to be knowledgeable about the behaviour and severity of fires in buildings. In the case of an engineer, he or she may be able to advise on less stringent levels of fire resistance than those recommended in ADB. For protection from radiated fire from neighbouring buildings, for example, hazards can be calculated using configuration principles which underlie ADB and are illustrated in BRE Report 187. I myself have made several such calculations with some based on idealised flame shape and emissivity.

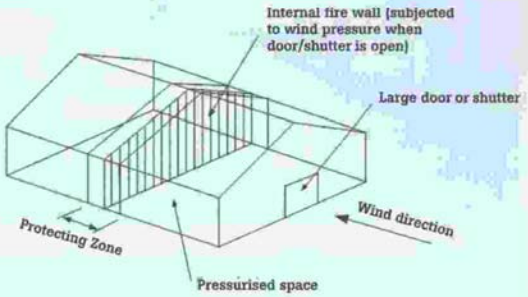
Protection zone

Depending on the strategic importance of the fire wall, it may be necessary to include a zone of fire protecting external wall and roof construction along either side, so that fire cannot bypass it. The junction at the perimeter of the fire wall needs good fire integrity to allow for any thermal deformation which can occur in a fire. This is especially necessary if a 'crown-fire' scenario (a fire that may start high up under the roof of a building and then spread laterally and downwards) is possible, such as in high rack storage facilities. It is accepted that the zone of roof cladding in the fire compartment will eventually collapse in a severe fire, but the zone of roof cladding on the other side of the fire wall should resist collapse and remain acting as a radiation shield. In addition, the materials used in the construction of this zone of wall and roof should not be capable of generating molten flaming droplets, which could ignite the building contents.

This protecting zone concept is now a recommendation in LPC design guidance, though the extent to which this is being followed in practice is not known. Rarely is enough attention paid to achieve effective fire stopping at this junction and very often, this protecting zone is not present because it costs too much or is inconvenient and has not been allowed for in the contract tender documents. As for ADB, the guidance (para 8.29) is inadequate because the 1.5m wide strip of construction recommended as a fire protecting roof zone either side of the fire wall is unlikely to remain in place in a severe fire, and the alternative option of a 375mm upstand of the fire wall above the roof is inadequate. But we must remember that the ADB guidance is principally concerned with the minimum standards for life safety, and that it is recognised that better protection is needed for property loss reduction.



Above: Cross section through a typical sandwich panel



Right: A protection zone around either side of the fire wall may be needed, especially in buildings such as high rack warehouses

"The materials used in the construction of the zone of wall and roof should not be capable of generating molten flaming droplets, which could ignite the building contents"

Sandwich panels with thermoplastic cores (for example, expanded polystyrene foam) that 'over-sail' the fire wall should incorporate a 300mm wide full-depth fire stop strip of material of limited combustibility immediately above the fire wall (note to para 8.30 in ADB). It is not clear if a charred core of polyisocyanurate plastic foam in steel faced sandwich panels which over-sail the fire wall would be an adequate fire stop at this important position.

The fire wall must not be seriously affected by deformations of the roof structure under the action of variable live loads in normal use (snow and/or wind), and in the fire condition where thermal distortions occur. In particular, the structural support of the fire wall must tolerate any excessive thermal bowing in long structural steel members, or suppressed longitudinal expansion which causes bowing. This is the responsibility of the building designer but it is sometimes conveniently

Rockspan panels used to provide a smooth appearance for an Asda superstore

overlooked.

The fire wall should not be susceptible to damage by the collapse of the adjoining roof construction in a fire, and the design should specifically address this important issue. Very careful consideration should also be given to the effect of collapse of high storage racking within a compartment; such racking is normally constructed with unprotected lightweight steel sections with little fire resistance, typically 10 –15 minutes. Such consideration should also be given to the lateral collapse of other contents, which could damage a fire wall during a fire. In some high value projects it may be necessary to design the fire wall as a free standing element i.e. as a cantilever, structurally isolated from the roof so that collapse of the roof in a fire cannot drag down the fire wall or otherwise damage it.

Squaring the security circle

The need for security in and around the building may also have implications for the design of a fire wall. Arsonists may resort to setting multiple fires (not usually covered in national fire protection guidance) or blast explosions may be initiated. Sandwich panels with rock wool cores have shown themselves able to resist fire transfer when exposed to severe fire on one side. In the photo, rockwool cored panels manufactured by Eurobond Laminates behaved very well in retaining panel joint integrity in the unexposed face, even though the exposed steel face expectantly delaminated and buckled. Access for people working in different fire compartments may require security features as part of the fire wall. But these will need to fail safe when a fire or other emergency occurs, so that people can escape from, and firefighters can enter the fire compartment. Again, this is the responsibility of the building designer.

Construction of a fire wall should ideally be accomplished with minimum dirt and no wet trades, something that is assured by using sandwich panels. It should be easily erected, with sandwich panels being erected by specialists with appropriate lifting equipment ensuring minimum hazards to safety.

Tall fire walls should be lightweight to avoid the use of piled foundations, so again sandwich panels are ideal in this respect. Large fire walls should take account of wind pressure acting either during installation or after completion of the building. Although the room temperature design of the sandwich panel fire wall may allow for the effect of wind pressure on the internal fire wall (acting through a large opening such as a shutter in the external wall), the forces imposed by wind during a fire need to be considered. It has to be remembered that on exposure to fire one face delaminates from the core, so the faces then behave as 'catenary' elements which cannot transmit bending movements. Implicit in this is a consideration of compounding probabilities: the probability of high wind occurring at the same time as fire, the wind being in an unfavourable direction, and a large door or shutter being open at the time of a fire. In a fire engineered approach, one solution might be to have the door or shutter closed automatically on detection of a fire, so that one element in this scenario can be avoided.

The fire wall should be robust in normal use and resist or be readily capable of repair after normal impacts, for example that by a fork lift truck, so that its fire resistance is not impaired. Equally, it should be reparable if damaged by a localised fire. This is not always easy with sandwich panels which have roll-formed tongue and groove joints.

Modifications

The construction of the fire wall should preferably be such that it is amenable to modification to allow for changes in working

procedures. For instance, it should be possible to reposition door openings and service penetrations during the life of the building, without reducing the fire resistance. Wherever possible, ducts which penetrate the fire wall should be avoided so as to prevent fire transfer should a fire damper fail to operate. Conveyors carrying goods which unavoidably penetrate the fire wall need very careful design to ensure the continuity of fire resistance in the plane of the fire wall. This may require special fire detection and actuation devices to automatically close the opening at a point where goods are not obstructing the closure.

Large penetrations of the fire wall, for example, by fire resisting fire doors/shutters, should be designed carefully to account for load redistribution around the openings where sandwich panels are cut. This would, of course, apply to any lightweight construction, not just sandwich panels. Support for fire doors and shutters should be designed so that the door or shutter is adequately supported after delamination of the fire exposed steel face of panels occurs. Where a high measure of fire resistance is required, this may be achieved using double fire doors spaced apart in a fire protecting lobby and in this case, it is essential that large doors and shutters are supported by supplementary protected steel framing. Fixing of doors and shutters to assemblies of lightweight sandwich panels that delaminate in fire needs special attention. Other points to note are:

- The extrapolation of fire resistance test results for larger-than-tested constructions should only be made by a suitably qualified fire safety engineer, and the calculations should have a rational basis and be transparent.
- If a sandwich panel wall has been tested for fire resistance with the panels in the horizontal orientation, great care is needed to assess the fire resistance when the panels are in the vertical orientation, and vice versa.
- Ideally the fire wall should be confirmed as 'fit for purpose' by the insurers.

Use can also be made of practical guidance already freely available. Some references are given in the panel below. The listing of performance needs given here does not cover any resulting from the Regulatory Reform (Fire Safety) Order 2005, as the Order only kicks in after completion of a building when it becomes occupied. However, when a fire risk assessment is needed for a building under the RRO, such a list will be useful.

Finally, it may not be possible to satisfy official prescriptive guidance on the design of a fire wall and a fire safety engineered approach may then be appropriate. Guidance on fire safety engineering is available in national and international standards.

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This large scale testing showed that Eurobond panels retained joint integrity in the unexposed face

"Arsonists may resort to setting multiple fires – a scenario not usually covered in national fire protection guidance – or blast explosions may be initiated"

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