Central Fire Brigades Advisory Council
Scottish Central Fire Brigades Advisory Council
Joint Committee on Fire Research

Fire Safety of Sandwich Panels

Summary Report

by J Harwood and B Hume

Research Report Number 76

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BACKGROUND

At the meeting of the Joint Fire Safety Committee of the CFBAC in autumn 1995, the Fire Brigades Union expressed concern about the use of large insulated sandwich panels (LISPs) following the fire in September 1993 at the Sun Valley Poultry Ltd chicken processing plant in Hereford in which two firefighters lost their lives. FRDG agreed to consider as a matter of urgency what research could be carried out and as a result, the Fire Research Station were commissioned to carry out a short research project for FRDG to determine the extent of the problem and what could be done about it.

The safety of firefighters in buildings containing sandwich panels is the main concern although building occupants may also be at risk. Other factors are the possibility of large property losses and environmental pollution.

WHAT ARE LISPS?

Sandwich panels take many forms but concern is centred around those with metal skins, and with "fillings" made of one of the following materials:

- expanded polystyrene
- polyurethane
- mineral fibre (also known as mineral wool)

As the filling material may be combustible there is a potential fire safety problem which needs to be considered.

The panels are usually between 50mm and 200mm thick.

WHERE ARE LISPS USED?

LISPs have been used for many years for the external envelope of buildings and are rarely involved in fire. LISPs have also been widely used in cold stores where reliable temperature control is achieved with the polymer-filled types.

However, LISPs have also been used as internal partitions or linings, in particular by the food processing industry. The use of LISPs has also been reported in hospitals and retail premises.

EXISTING GUIDANCE AND REGULATIONS

Different sectors within the industry manufacturing, selling or using the various types of panel are well aware of the concerns and have prepared fire safety guidance, or are actively preparing guidance, which includes advice for users of sandwich panels.

There are also concerns from the insurance industry that fires in buildings containing sandwich panels often result in the loss of the building. Consequently the Loss Prevention Council has introduced fire performance criteria for panels. Also, the International Standards Organisation (ISO) is seeking to develop a large scale fire test for sandwich panels.

Currently the only fire safety requirement imposed on sandwich panels is that under the Building

Regulations Approved Document B where internal linings are required to meet defined classes in the surface spread of flame test. ("Internal linings" as defined in this document means the materials lining any partition, wall, ceiling or other internal structure.) Approved Document B is currently being reviewed and the need to impose further controls on the use of combustible core sandwich panels is under consideration.

As a first step in the project, a questionnaire on the subject of sandwich panels was sent to all fire brigades by the Fire Service Inspectorate in October 1995. The questionnaire asked brigades for the following information:

- a list by use of the numbers of premises in their area which contained sandwich panels;
- the numbers of premises they considered the panels to create potential fire safety problems;
- any specific fire safety or operational procedural steps they have taken regarding premises in which sandwich panels are used;
- details of any fires in premises containing this type of panel.

ANALYSIS OF BRIGADE RESPONSES

The Fire Research Station (FRS) began their work for the Home Office by studying the responses by brigades to the Home Office questionnaire. The responses of 37 brigades were used of which four were Welsh and one was Scottish. In the case of the fire incidents reported, FRS fire investigation reports were used to supplement the information from the brigades.

Twenty two brigades were actively seeking premises with sandwich panels by various means. The most common approach was to ask local stations to report on premises within their area.

The usual practice in brigades, once a premise had been identified as containing or possibly containing sandwich panels, was to carry out a fire safety inspection.

INVESTIGATION OF FIRE INCIDENTS

A total of 21 fire incidents involving sandwich panels were considered, based on reports supplied with the responses to the questionnaire, FRS telephone contacts and FRS visits to fire incidents.

Although both cold store and food processing plants are generally perceived as being of high risk, only two incidents involved purely cold storage buildings. Twelve of the incidents studied involved food processing plants and a further five incidents were in factory buildings.

Fire brigades suspect that small fires are not uncommon in food processing plants and are routinely extinguished by staff. However, if staff are not present when a fire starts, or the fire is hidden or the cause is not routine, it is then more likely to develop and spread into the sandwich panels, with the possible loss of the factory.

All the fires that involved sandwich panels produced large quantities of black smoke. In many cases firefighters needed to use breathing apparatus while working around the outside perimeter of the building. In one case eight spectators in a nearby water park were taken to hospital suffering from smoke inhalation.

In eight incidents the fire brigade was unable to carry out firefighting within the building and in another three they were forced to retreat from the building.

Two firefighters died in Hereford, trapped by the collapse of panels, but they are the only fatalities reported. However, other brigades also report panels collapsing as they retreated out of the building or fought the fire from the entrances.

In all cases investigated, the occupants had left the building safely before the fire had developed sufficiently to put them at risk.

SITE VISITS

In the second phase of their work, FRS visited six selected working buildings to identify fire safety problems associated with sandwich panels and to

carry out a fire load audit. These sites included five cold stores and one vegetable processing factory.
Five of these visits were arranged for the FRS team by the Secretariat of the Cold Storage and Distribution Federation; the other visit was arranged by the West Midlands Fire Service.

The findings of the site visits included the following:

- Fire loadings, apart from the panels, included storage and packing materials such as wooden pallets, cardboard boxes, plastic bags and polyethylene film.
- Mechanical damage to the panels was observed, exposing the polymer filling. This was often caused by fork lift trucks.
- Penetration of panels by cabling was another possible site for ignition.
- Food safety tends to take precedence over fire safety.
- There were varying approaches to staff fire safety training: in one case only supervisors received training while in another there were regular evacuation exercises and all new staff received training.
- In some buildings fire exits were blocked by goods on pallets.

LABORATORY TESTS

In the third phase of their work, FRS explored the fire behaviour of a range of panels by a series of laboratory studies. Fire tests were carried out on metal-skinned panels with the following fillings:

- expanded polystyrene,
- fire-retarded polyurethane,
- mineral fibre,
- PVC-coated panel with polystyrene filling.

The tests comprised cone-calorimeter tests on 10cm square samples of panel and tests on larger samples.

Cone Calorimeter Tests

Cone-calorimeter tests were carried out to determine ignitability and rate of heat release. Panel samples were mounted horizontally and exposed to a radiant heat source. The polystyrene-filled panels ignited more rapidly than polyurethane-filled panels when the metal skin was exposed, but the reverse was the case when the filling was exposed. The panel samples with mineral fibre filling did not ignite in any of the tests although some light smoke was emitted on initial exposure. A further sample of PVC-coated panel with polystyrene backing was tested and this sample produced the greatest amount of heat and smoke.

Fire Tests on Larger Samples

Fire tests were carried out on larger samples to provide some indications of the way sandwich panels may be ignited and how they burn. Tests were carried out on panel samples positioned both horizontally to represent part of a ceiling, and vertically to represent part of a wall. Each of the four panel types listed above were used. The dimensions of the samples tested ranged from 0.85m x 1m to 2.75m x 1.2m. In some tests two jointed panels were used.

Photo 1. Polystyrene Jointed Panel Test

Thermal imaging and video recordings were made to show the progress of the fire through the material. Two tests were carried out using the FRS large calorimeter so that the fire products could be collected and measurements made of the heat release rate, and the smoke and gas production. Ignition sources used were a burning taper, a blow torch and a 30 kiloWatt gas burner.

The following observations were made from these tests:

1. None of the panels or the panel fillings can be ignited readily with either a taper or a blowlamp but under more intense heating the polystyrene panels may sustain a fire depending on the geometry. If the molten polystyrene is able to flow away from the heat then the fire will diminish and go out. If the polystyrene is contained, for example, by the skin of the panel, then the fire may sustain itself.

2. The fire-retardant treatment for polyurethane (for the samples tested) appeared to be effective. The mineral fibre filling was clearly non-combustible.

3. Different jointing systems allow delamination to occur in different ways. Simple "push fit" joints allow ready delamination whereas bolted joints may provide some structural stability.

4. Combustible fillings will ignite despite the protection of the metal skin where the level of radiant heating is sufficiently high. Filling which is exposed, through damage or penetrations, will speed this process.

5. Fire can spread vertically through a polystyrene panel at around 1.5 cm per second but spread through horizontal panels may be slower.The findings of this study support those from fire statistics, namely that the risks associated with sandwich panels are primarily in fire fighting. While there may be circumstances in which members of the public or workers in a building are put at risk directly from a burning sandwich panel, the evidence here is that, if panels are the item first ignited, development will be fairly slow and contained and that panels will only contribute to an already large and dangerous fire.

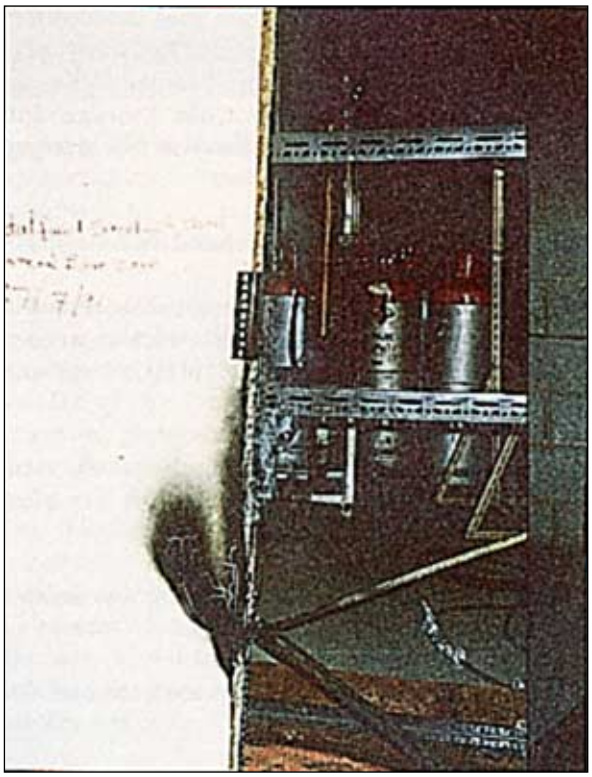

Photo 2. Mineral wool panel test

Photo 3. Vertical Panel Test

Photo 4. Horizontal Panel Test

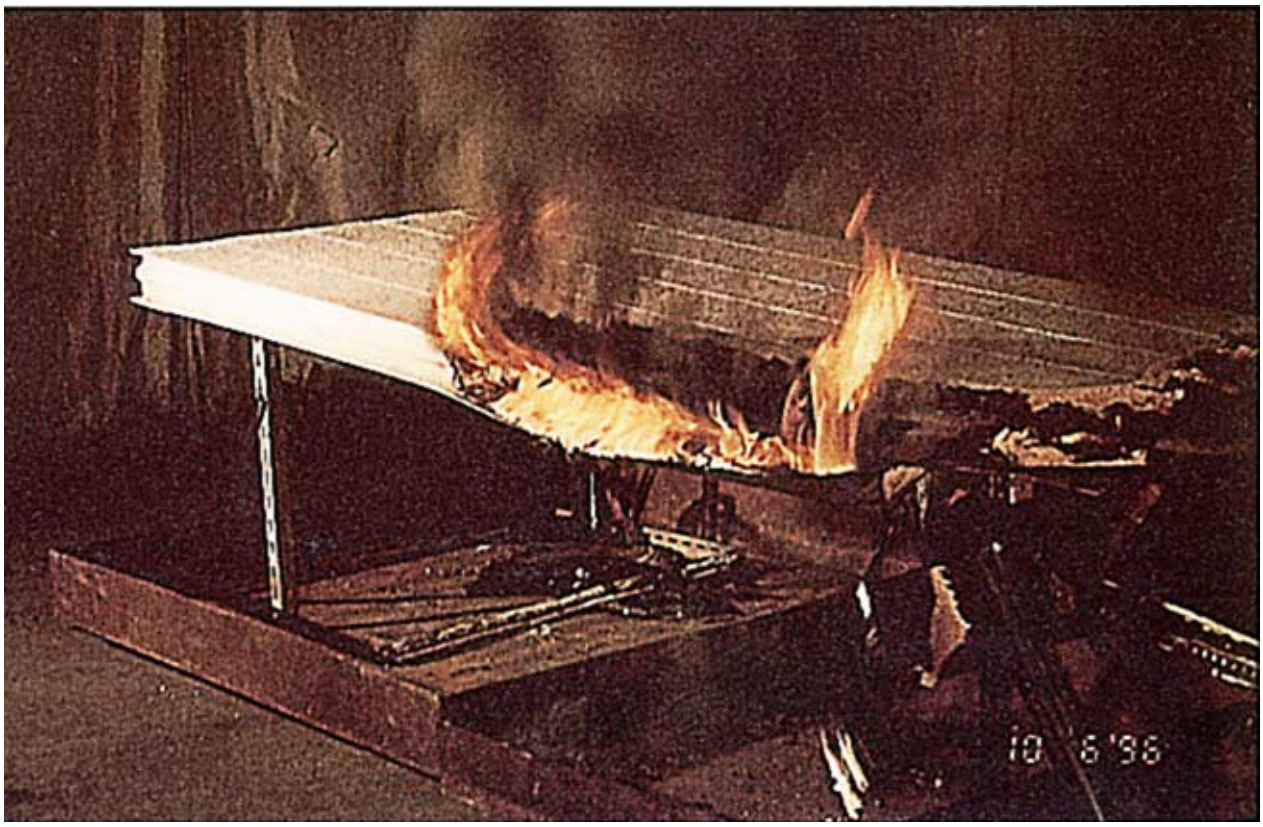

Photo 5. Horizontal Polystyrene Panel Test

CONCLUSIONS

1. The findings of this study support those from fire statistics, namely that the risks associated with sandwich panels are primarily in fire fighting. While there may be circumstances in which members of the public or workers in a building are put at risk directly from a burning sandwich panel, the evidence here is that, if panels are the item first ignited, development will be fairly slow and contained and that panels will only contribute to an already large and dangerous fire.

2. Different types of sandwich panel burn in different ways. Mineral fibre panels are non-combustible, and developments in the formulations of some types of polymeric cores will limit fire growth. However, there are many existing buildings that contain the older types of product.

3. Large quantities of black smoke are produced, making working difficult for firefighters outside the building as well as inside. In addition, there may be ammonia released from damaged refrigeration plant. There are also a number of pollution risks from fires involving sandwich panels.

4. For fire fighting there are evident risks. The fuel in the panels will contribute to the fire development, and the fire can spread quickly and unseen, both within the panels and within the voids behind and above the panels. As there is no fire resistance requirement for the fixings of these panels this can lead to sudden delamination or collapse of the panels. In addition, the nature of the panels themselves, which are intended to provide a watertight surface for hygiene purposes, makes it extremely difficult for firefighters to get fire fighting water onto such fires.

5. Fire fighters need to be aware of the unusual fire behaviour of sandwich panels, in particular the risk of sudden delamination, which is dangerous in itself, since large thin metal sheets may fall from a considerable height, and can accelerate subsequent fire spread.

6. There is some difficulty in identifying the different types of panel once they are in place and the core hidden. It would be useful to the fire service, and to building owners, if there were some means of identifying the different types of panel once they were in place, for instance by labelling.

7. There is a need for good fire safety management and housekeeping in these buildings. FRS staff have observed blocked exits and stacked combustibles. The nature of fires involving sandwich panels is such that well rehearsed evacuation plans are essential.

FURTHER INFORMATION

For further information on this project contact:

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