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SCIENTIFIC AND TECHNICAL COMMITTEE

Fact sheet on:

Fire and the Construction Products Directive Why are Gypsum Products so effective in Fire?

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Principles of Fire Protection

1. Fire Growth

The choice of material for walls and ceilings can significantly affect the spread of fire and its rate of growth, even though they are not likely to be the materials first ignited. The specification of linings is particularly important in circulation spaces where surfaces may offer the main means by which fire spreads and where rapid spread is most likely to prevent occupants from escaping.

Two properties of lining materials that influence fire spread are the ignitability (the energy needed for ignition) and the energy production when burning.

Compartmentation

The spread of fire within a building can be restricted by subdividing it into compartments separated from one another by walls, ceilings and/or floors of fire resisting constructions based on Gypsum boards. The objective is two fold:

- To prevent rapid fire spread which could trap occupants in the building.
- To reduce the risks of fires becoming large, on the basis that large fires are more dangerous- not only to occupants and fire personnel-, but also to people in the vicinity of the building.

The appropriate degree of sub-division depends on:

- The fire loading of the building, which affects the potential for fires and their severity, as well as the ease of evacuation.
- The height to the floor of the top storey in the building, which is an indication of the ease of evacuation and the ability of the fire service to intervene effectively.

3. Structural Fire Precautions

Premature failure of the structure can be prevented by the provision of gypsum based encasements for load bearing elements to have minimum period of fire resistance to failure of load bearing capacity. The purpose in providing the structure with fire resistance is threefold:

- To minimise the risk to the occupants, some of whom may have to remain in the building for some time (particularly if the building is large), while evacuation proceeds.
- To reduce the risk to fire fighters engaged on search or rescue operations.
- To reduce the danger to people in the vicinity of the building who might be hurt by falling debris or because of the impact of the collapsing structure of the building.

4. Fire Limit State

In structural design terms, fire is considered to be an accidental limit state, i.e., an accidental occurrence, and one for which the structure must not collapse.

It is unlikely that the loads assumed in the structural design of buildings will actually be present during a fire. Many structural members are over-designed under normal conditions and therefore, the proportion of their load carrying capacity that is actually utilised at the fire limit state is significantly less than 0.5. This parameter is known as the load ratio.

Typically, structural members that are designed to be fully stressed under normal conditions would be subject to a load ratio of 0.5 to 0.6 under fire conditions.

European Test Standards

The Construction Products Directive (CPD)[1] within European legislation is designed to enable free trade across Europe in construction products. To enable free trade, harmonized test standards for technical performance are required. The area of technical performance most affected by this requirement is fire performance. This can be split into two main parameters:

- Reaction to fire
- Resistance to fire

1. Resistance to Fire[2]

The methods currently used across Europe are similar but the severity of furnaces varies due to factors such as different fuel sources and furnace geometry. A new European fire resistance test standard is now available. The schedule for moving over from existing National test standards to the EN test standards is dependant on the Building Regulations of the individual countries.

Classification of fire performance following a European fire resistance test is expressed in terms of specific criteria, or their combination under the influence of fire e.g. R - load bearing capacity, E - integrity and I - insulation. Additional performance parameters e.g. C - self closing, S - smoke leakage, may also be used.

2. Reaction to fire[3]

The European Classification Systems (Euroclass), devised for the classification of reaction to fire, is part of the ongoing harmonisation of European standards. Similarly to the adoption of European fire resistance test standards, the schedule for use of the Euroclass system as a basis

[1] Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the member States relating to construction products (89/106/EEC)
[2] Commission Decision of 3 May 2000 implementing Council Directive 89/106/EEC as regards the classification of the resistance to fire performance of construction products, construction works or part thereof (2000/367/EC)
[3] Commission Decision of 8 February 2000 implementing Council Directive 89/106/EEC as regards the classification of the reaction to fire performance of construction products (2000/147/EC)

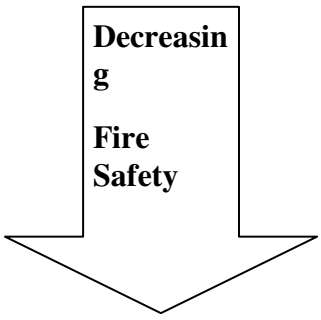
for assessing the suitability of a product for a particular end use is dependent on the national building regulations.

The background of the harmonization process lies on the Commission Decision 94/611/EC implementing Article 20 of Directive 89/106/EEC on construction products [4]in the field of fire safety. The Euroclass decision includes a classification system for building products based on their reaction-to-fire performance. It additionally defines the test methods according to which construction products shall be categorised. In the Euroclass system, floor coverings and other surface linings are considered separately[5].

Reaction to fire has traditionally been assessed using at least 30 different national standards across Europe. Not only is the Euroclass system new, but it includes new tests designed to better evaluate the reaction of building products to fire.

Indicative performance description and fire scenarios for Euroclasses excluding floorings

Class	Performance description	Fire scenario in room/corner test
A1	Non combustible	
A2	No contribution to fire	No flashover
B	Very Limited contribution to fire	No flashover
C	Limited contribution to fire	No flashover at 100kW
D	Acceptable contribution to fire	No flashover before 2 min at 100kW
E	Easy flammable	Flashover before 2 min
F	No performance determined or very easily flammable requirements	Products not tested or failure to ignition test



Euroclasses predict the performance of construction products in end-use conditions, in a real fire more accurately than the 30 above-mentioned standards. Gypsum products are intrinsically fire safe products and generally fall into the higher Euroclass classifications.

The Euroclass test methodology is built around the Single Burning Item (SBI)[6] test method which is an intermediate scale test to evaluate the rate of fire growth from a waste paper basket fire positioned in the corner of a room. Other tests used in the classification system are the non-combustibility test, bomb calorimeter and direct small flame impingement test.

Plasterboard is subject to a classification without further test (CWFT) Commission decision[7]. Essentially this means that any type of plasterboard is classified A2 (material of limited combustibility) as long as the paper grammage of the liner does not exceed 220g per m2, or class B if paper grammage is between 220 and 320, provided in both cases that the core is classified as A1. Under conditions other than covered by the above mentioned commission decision, the product need to be tested.

"Classified without further testing" (CWFT) corresponds to the following definition:

[4] Commission Decision of 9 September 1994 implementing Article 20 of Directive 89/106/EEC on construction products (94/611/EC). Official Journal of the European Communities No L 241. 16.9.1994. Pp. 25-29.

[5] The detailed European classification system for the reaction to fire performance is specified in EN 13501-1. Two sub systems are included, one for construction products excluding floorings, e.g. wall and ceiling surface linings, and another similar system for floorings. Both classification systems are based on fire testing according to EN fire test methods.

[6] Commission Decision of 3 July 1998 concerning the test of the Single Burning Item (SBI) referred to in Decision 94/611/EC implementing article 20 of Council Directive 89/106/EEC on construction products (98/457/EC

[7] Commission Decision of 5 October 2006 amending decision 2003/43/EC establishing the classes of reaction-to-fire for certain construction products as regards gypsum plasterboards (2006/673/EC)

"Products which have been proven to be stable in a given European class (on the basis of testing to the appropriate EN test methods), within the scope of their variability in manufacture allowed by the product specification (harmonised standard or ETA), and when evaluated for the influence of other possible variations, that may occur outside the scope of the specification, which may have an impact on their fire performance.[8]"

Why Gypsum is so effective in Fire

Gypsum plasters and plasterboards provide good fire protection in buildings due to the unique behaviour of gypsum when exposed to fire. Pure gypsum (**$CaSO_4.2H_2O$**) contains nearly 21% chemically combined water of crystallisation, and about 79% calcium sulphate, which is inert below a temperature of 1200°C.

When gypsum protected elements are exposed to fire, the chemically combined water is gradually released in the form of water vapour. If sufficiently high temperature is maintained, eventually all the water of crystallisation will be expelled. The process of dehydrating gypsum by heat is known as "calcination". This condition is caused in general use if the board or gypsum finish is continuously exposed to high temperatures. It commences at the surface exposed to the fire and proceeds gradually through the gypsum layer i.e. the thickness of the gypsum plaster covering the core of the plasterboard.

The covering of the calcined gypsum formed on the exposed faces adheres tenaciously to the uncalcined material and serves to retard the calcination process, which becomes progressively slower as the thickness of calcined material increases. While the process continues, the temperature directly behind the plane of calcination is only slightly higher then that of boiling water (100°C). Therefore, until all the water of crystallisation has been liberated, the temperature of materials adjacent to, or in contact with, the unexposed side will not exceed 100°C. This temperature is well below that at which materials used in building will ignite and far below the critical temperature for structural components. Once the gypsum layer is completely calcined, the residue (calcium sulphate) continues to act as an insulating layer for as long as it remains intact. The inclusion of glass fibres and shrinkage inhibitors within the gypsum core of certain plasterboards improves the cohesive properties and fire integrity performance. This enables a much higher fire protection to be achieved compared to standard wallboards.

Gypsum is a powerful fire retardant element in the construction sector due to its non-combustibility and ability to delay the spread of fire up to 4 hours – according to the number of plasterboards in the corresponding system.

[8] European Commission : rules related to the classification without further testing