TRADA
wood information

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SECTION 4 SHEET 11
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Timber and wood-based sheet materials in fire

Timber and its board products are remarkably predictable in their behaviour when exposed to fire conditions. Even though no two accidental fires are alike in terms of temperature and rate of development, to understand the complex phenomenon of fires, it is important to distinguish two main stages:

1. Ignition and fire growth

2. The fully developed fire

The behaviour of a material in the first stage is termed its *reaction to fire.* A fully developed fire is the material's contribution to the *'fire resistance* of an element of building structure'.

A third stage, that of fire decay, is recognised in theoretical studies of fire behaviour. However, it is not really relevant to conditions in the UK where most fires are extinguished - usually before they become fully developed.

REACTION TO FIRE

It is convenient to break down the reaction of materials to the early stage of fire development into components, although these are rather arbitrary and often connected with a particular method of test :

- Non-combustibility
- Ignitability
- Surface spread of flame
- Rate of heat release

Non-combustibility

The term non-combustible is often taken to mean that a material will not burn. This is incorrect and it is equally untrue that materials classified as non-combustible by British Standards are necessarily fire-safe. BS 476: Part 4: 1984,' Non-combustibility test for materials ' and its equivalent ISO Standard 1182 determine the reaction of a small sample of material to temperatures of 750 °C, which is about the level that would probably be developed during the first stages of a fire.

Timber and its derivatives, even when treated with flame retardants, are classified as combustible. Although it is only a very crude indication of a material's likely behaviour in a fire, Building Codes do control use in certain situations on the basis of classification by this test.

BS 476 Part 11: 1982 ' Method for assessing the heat emission from building materials' is also based on placing the material in a temperature of 750°C. The standard, like others in this series specifies the test procedure but does not lay down acceptance criteria.

Ignitability

Timber and wood-based materials in thicknesses used in building are classified as not easily ignitable by the test laid down in BS 476: Part 5: 1979 'Ignitability test for materials'. This requires a panel to be exposed to a small source of ignition for a short period of time and classifies it on the basis of flame spread and sustained flaming. Ignition is a very complex phenomenon depending on the amount and type of heating and the length of time of exposure.

Timber will ignite after a relatively short period (in minutes rather than hours) when subjected to temperatures of about 270 ^{0}C, as long as a pilot flame is present to ignite the gases given off during the 'cooking' process. If no pilot flame is present, spontaneous ignition will occur at temperatures of about 500 ^{0}C. Prolonged heating at temperatures below the ignition temperature will result in progressive loss of strength and deterioration but normally without ignition.

Surface spread of flame

BS 476: Part 7: 1987' Method for classification of the surface spread of flame for materials' defines the property in four categories. These are based on the rate and extent of travel of a flame front across a 885 mm long test panel, exposed at one end to a radiant heating panel and a pilot flame. Because the test involves horizontal spread on a vertical surface, it is not an accurate simulation of behaviour in a real fire where flame spread is vertical but it does give a relative ranking of materials of the types used or linings.

Timber, plywood, particle board and hardboard fall into Class 3 surface spread of flame as long as their nominal density is at least 400 kg/m^{3}. Species below this density and fibre insulating board are inherently Class 4. However all may be upgraded to Class 1 surface spread of flame by impregnation treatments, surface coatings, incorporation of chemicals during manufacture or combinations of these. Separate Wood Information Sheets deal with such treatments and products, (see references).

The inherent Class 3 rating of wood products enables them to be used in buildings without special flame retardant treatments. The scope is greater when they have been upgraded to Class 1. The BRE Fire Research Station publication ' Results of surface spread of flame tests on building products' states that oil-based or polymer paint on a natural timber surface provides a Class 3 flame spread rating. However some coatings, such as nitrocellulose lacquer can downgrade a substrate.

Rate of heat release

The rate at which heat is released from buildng components involved in a fire can be significant where the amount of fuel contributed by the contents is small, eg in corridors. Normally the contents contribute most fuel to the fire (as well as being the material first ignited)and overshadow the contribution of the structure. A means of measuring approximately the rate of heat release is specified in BS 476 : Part 6: 1989 ' Fire propagation test for materials'. The Class O category of lining materials is defined in approved document B to the England and Wales Building Regulations on the basis of this test and that for surface spread of flame.

Normal timbers and wood-based sheet materials fall far below the levels set for Class O but with certain specialised products and/or treatments it is possible to achieve the required performance. These can be used in the most demanding situations open to combustible materials. The TRADA WI sheets referred to above include Class O products and treatments.

FIRE RESISTANCE

Fire resistance is defined as the ability of an element to carry on performing a building function in spite of being exposed to a fully developed fire. It is thus a property of the elements of building construction, not materials. In consequence, to state that 12 mm plywood has x minutes fire resistance is incorrect. It may contribute x minutes to the fire resistance of a load-bearing stud wall but several things, particularly its support and fixings, can alter this contribution.

The appropriate tests for fire resistance are contained in BS 476: Parts 20-24 : 1987 Test methods and criteria for the fire resistance of elements of building construction and ISO Standard 834, the two being essentially harmonised. Test methods have been defined for most common elements - walls, floors, doors, glazing, beams, columns, etc.

Structural elements are required to maintain their load-bearing capability for the appropriate period and separating elements must resist the passage of fire or excessive heat. The principle is one of maintenance of structural stability and containment of the fire until fire fighting is successful.

The keyword for timber's performance in fire resistance is predictability. Although it burns, this occurs at a predictable speed known as the charring rate. The thermal insulation properties of timber are such that the timber just a few millimetres inside the burning zone is only warm. This is in contrast to high thermal conductivity materials such as metals, which heat up more uniformly giving rise to problems of expansion and loss of strength over the whole section.

Different timbers char at varying rates, largely as a function of their density with the higher density timbers charring more slowly. For structural timbers listed in BS 5268 Part 2 this rate of depletion is taken as 20 mm in 30 minutes from each exposed face. Certain of the denser hardwoods (>650kg/m^{3})used for structural purposes merit rates of 15 mm in 30 minutes, eg, keruing, teak, greenheart, jarrah. Timbers of lower density will char more quickly eg Western red cedar is quoted as 25mm in 30 minutes.

The rate of charring is little affected by the severity of the fire, so for an hour's exposure, the depletions are 40 mm for more structural timbers and 30 mm for the denser hardwoods. This enables the fire resistance of timber elements to be calculated, whereas for less predictable materials it is necessary to rely on testing of constructions. The predictive method is published in BS 5268 Part 4. 'Fire resistance of timber structures ', Section 4.1:1978 'Method of calculating the fire resistance of timber members ' and Section 4.2:1990 ' Recommendations for calculating fire resistance of timber stud walls and joisted floor constructions '.

Constructions which fall outside the parameters of the standard will still require testing. Some interpretation of test results is often possible to cater for minor variations in construction, loading levels etc. Proprietary constructions will usually be tested on a sponsored basis for the manufacturer who should be consulted for the test results and appro-

priate certification. Fire doors, which are often constructed using timber because of its stability under extreme temperature conditions, are in this category. They are covered in a separate WI Sheet Technology of fire resisting doorsets.

SMOKE PRODUCTION

Burning materials produce smoke at all stages of a fire so that this aspect of fire behaviour does not fit into the chronological scheme of fire development already considered.

Currently there is no British building standard for measuring the smoke producing potential of materials. Several aspects of smoke production are important. For example the density of smoke, causing impaired visibility, is of importance because difficulty in finding exits gives rise to panic in a fire, particularly in unfamiliar surroundings.

Without a standard method of test, generalisation is difficult but timber and wood-based materials produce more smoke under smouldering conditions than when flaming freely. However, they tend to produce less smoke than most of the plastics, some of which produce copious dense smoke.

Smoke from burning timber is toxic in that it contains little oxygen and may have a fairly high proportion of carbon monoxide. However, the toxic constituents of smoke from certain plastics, eg hydrogen chloride, are largely absent from most wood products. The toxicity of wood smoke seems to be the norm by which other smokes are judged, but, again, the absence of an accepted test method hampers generalisation. Timber products treated with chemicals may have their smoke producing properties modified and more research is needed in this area when the testing problems have been resolved. However, smoke produced by building contents - furniture, upholstery, curtains, carpets, etc - is usually of overriding significance, particularly in the critical early stages of fire development.

References

FISHER R.W. and ROGOWSKI B.F.W. Results of surface spread of flame tests on building products. Building Research Establishment Report. London HMSO 1976.

BRITISH STANDARDS

British Standards Institution, London

BS 476 Fire tests on building materials and structures

Part 4: 1984 Non-combustibility test for materials

Part 5: 1979 Ignitability test for materials

Part 6: 1989 Method of test for fire propagation for products

Part 7: 1987 Method for classification of the surface spread of flame for products

Part 11: 1988 Method for assessing the heat emission from building materials

Part 20: 1987 Method for determination of the fire resistance of elements of construction (general principles)

Part 21: 1987 Methods for determination of the fire resistance of loadbearing elements of construction

Part 22: 1987 Methods for determination of the fire resistance of non- loadbearing elements of construction

Part 23: 1987 Methods for determination of the contribution of components to the fire resistance of a structure

BS 5268 Structural use of timber

Part 2: 1991 Code of practice for permissible stress design, materials and workmanship

Part 4 Fire resistance of timber structures

Section 4:1:1978 Method of calculating fire resistance of timber members

Section 4:2:1989 Recommendations for calculating fire resistance of timber stud walls and joisted floor constructions

TRADA WOOD INFORMATION SHEETS

Prices and a full list of publications are available on request

1- 13 Technology of fire resisting doorsets

1 - 32 Fire resisting doorsets by upgradiing

2/3 - 3 Flame retardant treatments for timber

2/3 -7 Low flame spread wood based board products

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