CENTRAL BUILDING RESEARCH INSTITUTE, INDIA.

BUILDING RESEARCH NOTE 74

FIRE PROPAGATION INDEX OF LINING MATERIALS

Introduction

One of the prime factors governing the growth and spread of fire inside buildings is the nature of the combustible lining materials used. Such lining materials, once ignited. can continue to burn and contribute to the growth of fire. The rate at which the fire build-up takes place in an enclosure is dependent upon the behaviour of these materials apart from its design, ventilation available and thermal characteristics of its construction materials.

The user or the designer has a wide range of lining materials to choose from. These materials are different from each other not only on functional and aesthetic considerations, but also with regard to their chemical composition and chemical and physical properties. A proper selection of lining materials, therefore. is of utmost importance in order to maintain a desirad level of fire safety in buildings. It is essential to use only those lining materials which comply with the building regulations and codes.

The performance in a given fire situation of various lining materials varies and some materials are relatively more hazardous than others. To distinguish between the likely fire behaviour of the lining materials, standard fire tests are employed. These standard test methods enable the relative fire performance of the materials to be determined and hence offer a means of selection of the lining materials.

Fire Propagation Test Apparatus (Ref. 1 : Fire test on building materials and structures. Part 6. Fire Propagation Test for Materials. British Standard 476 : Part 6 : 1981) is one of the salient apparatuses for the assessment of fire behaviour of materials. it is used for determining the tendency of the lining materials to contribute to the growth of fire.

In this Building Research Note, results of the Fire Propagation Test on some of the lining materials evaluated at the Central Building Research Institute are summarised. A brief description of the standard test method employed is also given.

The Fire Propagation Test

The Fire Propagation Test provides a comparative measure of the contribution to the growth of fire by an essentially flat material, composite or assembly. The result is expressed in terms of a Fire Propagation Index. The higher the Fire Propagation Index, the greater is the influence of the product on accelerating the growth of a fire.

Fire Propagation Test Apparatus

A photographic view of the Fire Propagation Test Apparatus is shown in Figure 1. The apparatus essentially consists of a rectangular combustion chamber of which the specimen holder forms one vertical side. A burner issuing a row of small flames near the base of the specimen and two pencil type electric heating elements provide the external heat flux to the specimen during the test. A chimney and cowl arrangement is fitted on top of the combustion chamber through which the combustion products are allowed to escape. Thermocouples for measurement of temperature of combustion products are fitted in the annular space between the chimney and the cowl.

Specimens

Specimens of the test should be of following dimensions : length 225 mm, breadth 225mm, and of normal thickness upto a maximum of 50 mm.

A minimum of three specimens are normally required for a test, but it may be necessary to conduct the test on more specimens if there are large variations between the behaviour of the specimens arising due their softening, melting or disintegration which would be reflected in the data obtained.

Fire Propagation Test Procedure

In accordance with the standard procedure, a calibration run is conducted with a non-combustible board of specified properties and the time-temperature data is used for obtaining the calibration curve. The calibration curve is an indication of the external heat incident on the specimen of the material and is required to be within the specified limits.

Another experimental run is conducted with the specimen in place of the calibration board keeping the gas flow rate to the burner and power supply to the radiant heaters same as that for the calibration run. The time-temperature data now obtained for the lining material is also recorded.

The test is continued for a duration of twenty minutes.

Fire Propagation Index

The differences between the values of the temperature recorded for the material and those obtained during the calibration run are used for the computation of a Fire Propagation Index.

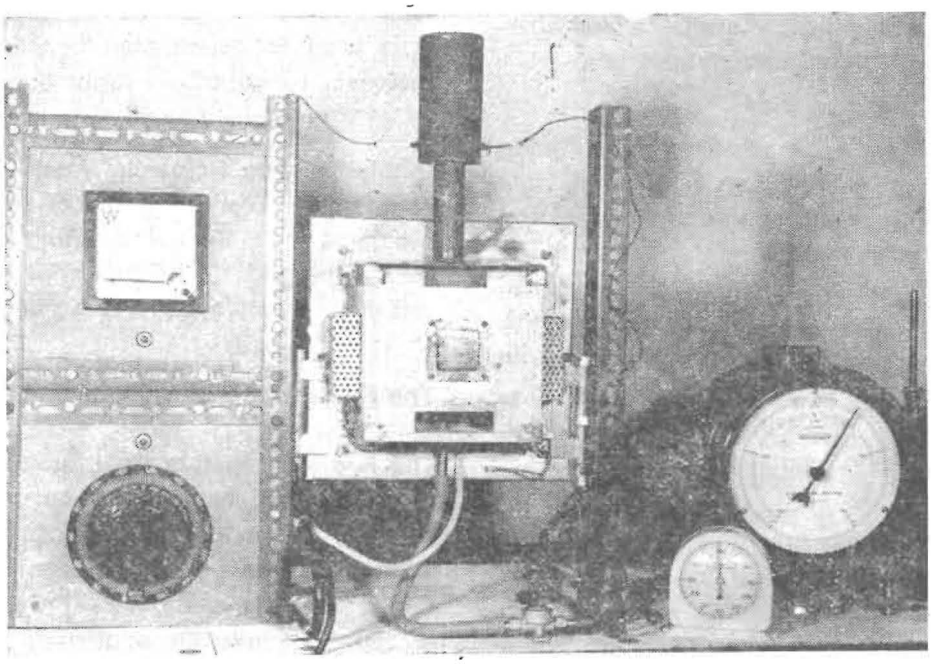

Fig. 1. Fire Propagation Test Apparatus

The time-temperature data for the entire duration of test of 20 minutes is considered to comprise of :

1. the time-temperature data for first three minutes,
2. the time-temperature data for the fourth to the tenth minute, and
3. the time-temperature data for the twelfh to the twentieth minute.

Three sub-indices i_1, i_2 and i_3 are computed from these three sets of data. The index of overall performance also known as the Fire Propagation Index is the sum of the three sub-indices.

Fire Propagation Index, $I = i_1 + i_2 + i_3$

Fire Propagation Index of Lining Materials

The Fire Propagation Index of common materials such as timbers, boards, decorative laminates and some plastics are tabulated in Table 1. The values of the sub-indices and the Fire Propagation Index for a particular material have been arrived at on the basis of data obtained mostly for a few types in each category, and are therefore considered representative for the class of materials. For example, the data on timbers are for *Teakwood, Deodarwood, Sheeshamwood, Chirwood, Kailwood,* and *Mangowood.* Similarly, the values reported for decorative laminates are for nine different types. A range, and not a single value, is given where the variation has been found to be large.

Table 1. Representative Values of Fire Propagation Index of Materials

Material	Thickness mm	Density kg/cu.m	sub-indices $i_1 \neq$	i_2	i_3	Fire Propagation Index I*
Timber, Teakwood	12	550	13	17	4	34
Timber, Deodarwood	12	600	17	16	3	36
Timber, Sheeshamwood	12	700	8	16	4	28
Timber, Chirwood	12	650	20	17	4	41
Timber, Kailwood	12	500	17	20	5	42
Timber, Mangowood	12	600	15	18	5	38
Plywood, general purpose	3–12	650–800	8–11	13–16	2–4	24–31
Fibreboard	12	300	26–34	18–20	3–5	48–53
Fibre hardboard	6	960	8	14	5	27
Particle board, insulation grade	12	400	15–25	14–17	3–4	35–44
Particle board, medium density	18	830	13	15	4	32
Wood wool building slab	25	650	3	2	1	6
Coir cement sheet	10	1800	3	1	1	5
Decorative laminates	2–3	1500	3–8	6–10	2–3	10–20
Expanded polystyrene	25	15	7	2	1	10
Rubberised coir	25	145	25	16	2	43
Phenol formaldehyde foam slab	25	35	5	4	2	11
Polyethylene foam	10	60	6	5	1	12
Polyurethane foam slab, rigid	25	55	21	9	2	32
Polyurethane foam slab, flexible	50	85	21	12	1	34

* Higher is the value of I, more hazardous is the lining material.

$\neq$ Higher the value of i_1 of any lining material, more easily ignitable and more rapid burning it would be.

Interpretation of Results

The Fire Propagation Index of materials can be used to identify the likely fire hazard of lining materials in terms of their tendency to contribute to the growth of fire inside buildings. A material of a higher Fire Propagation Index can be considered to have a tendency to contribute more towards the growth of fire than the one of a lower Fire Propagation Index. Out of the three sub-indices i_1, i_2 and i_3, the sub-index i_1, which pertains to the first three minutes of the test when the specimen is exposed to flames from the gas burners only, is relatively more important and is also taken into account while making a comparative assessment of fire hazard of different materials.

Conclusions

The lining materials available for different applications and occupancies can be fairly large. For making a proper choice of a material from the fire safety point of view, the Fire Propagation Index of these materials can serve as a useful guide. The value of the Fire Propagation Index to be considered, for any particular product or a material, should be the specific one determined for that particular product or material. However, the representative value of the Fire Propagation Index included here can be used as a preliminary indication of the likely performance of a material of the particular category.

The facilities for evaluation of the Fire Propagation Index of materials is available at this Institute and has been extended to manufacturers of building materials and users.

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