BUILDING RESEARCH NOTE 78

NON-COMBUSTIBILITY OF MATERIALS

Introduction

Fires result in considerable losses to life and property. A fire is a result of involvement of combustible materials which when ignited, release heat into the compartment, thereby raising the temperature of other materials at a distance. These materials also get heated up to their ignition temperatures and start burning. Different materials thus get involved successively. Thus a fire grows in size and spreads inside the building through combustible materials apart from hot gases and radiation.

The rate at which a fire grows is critical for the life and property losses and depends upon the type of the materials used. If the materials used are such that these do not get ignited easily, spread flames over their surfaces rapidly, generate significant heat as they burn, and produce sufficient quantities of smoke so as to affect visibility and thereby hamper escape, the fire would not grow very large and would not cause extensive damage.

One of the possibilities for ensuring fire safety in buildings is to use only those materials which do not burn at all. This is only an ideal solution. A more practical approach can be to select and use materials which do not contribute significantly to the growth of a fire inside buildings.

A wide variety of materials are available to users and designers which can be used for a particular situation within a building. Also, the functional and safety requirements vary from location to location inside a building. It is very important therefore that materials used are evaluated for their likely fire behaviour and only those found suitable are recommended for use. The assessment of 'reaction to fire' characteristics of materials is carried out using standard fire test facilities.

Identification of materials which do not possess a significant potential of contributing towards the growth of a fire is determined using the Non-combustibility Furnace. The method of carrying out the Non-combustibility test on materials is described in the Indian Standard, IS : 3808-1979.

In this Building Research Note, salient results of the standard Non-combustibility tests on building materials carried out at the Central Building Research Institute are summarised.

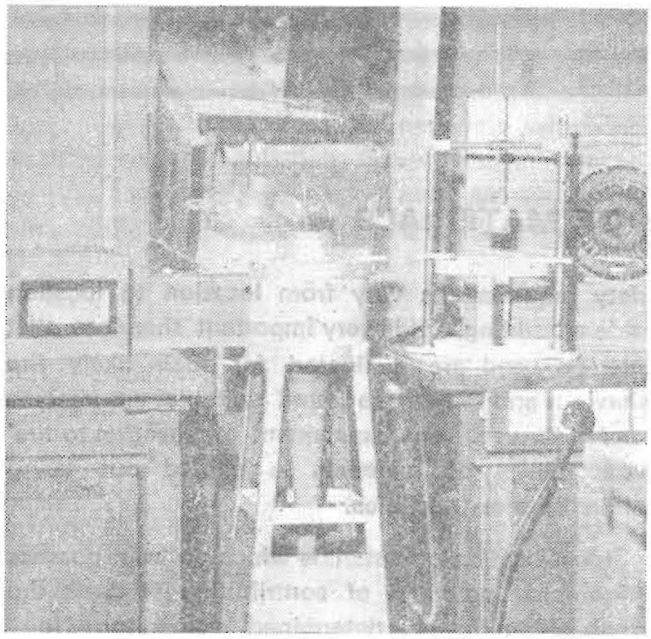
Non-combustibility Test

Non-combustibility of a material is determined to ascertain whether it will contribute directly to fire development or not. It is intended for selection of materials which, while not completely inert, produce only a limited amount of heat and flame when exposed to a temperature of approximately 750°C.

Non-combustibility Furnace

The Non-combustibility Furnace consists of a furnace tube which can be heated electrically and

is insulated from outside. The furnace provides a cylindrical space of 75mm dia. and 150mm height in which specimens of materials to be evaluated are positioned during experiments. An air flow stabiliser at the base and a draught shield at the top of the furnace tube are provided. Three thermocouples are used for monitoring temperatures at the surface and at a point in between the specimen and furnace wall.



Non-combustibility Furnace

Specimens

Representative specimens of a material are required in the following dimensions : dia. 45mm, height 50mm and of volume 80 cu. cm. Ten specimens are normally required for a test. Specimens of a material of thickness less than 50mm are made up in layers to obtain the specimen of 50mm total thickness.

Procedure

Prior to the test, the furnace is heated up to $750 \pm 10^{\circ}C$ as measured by the furnace thermocouple. The furnace is stabilised at this temperature for a specified period.

The specimen of a material, whose weight is already recorded, is placed in a specimen holder which is also provided with thermocouples for measuring temperature of the specimen on its surface and at its centre. The centre thermocouple is now inserted inside a cavity made in the middle of the specimen such that a good thermal contact is maintained between the specimen and the sensing tip of the centre thermocouple.

The specimen holder carrying the specimen and the thermocuples is inserted into the furnace environment in the test position such that the specimen is subjected uniformly to the heating conditions of the furnace.

During test, observations of temperature readings with time are recorded using a multi-channel temperature measurement device such as a data logger. Alternatively, a multi-channel multi-range recorder having a provision of range suppression is used. Observations of duration of sustained flaming, indicated by continuous presence of flaming inside the furnace for periods of more than 5 seconds, are also made. The duration of test is twenty minutes.

The specimen and its holder are taken out of the furnace, after the test is over. On cooling to the ambient temperature, the specimen is retrieved from the holder and weighed. Where char, ash or other debris breaks off and falls down the tube during test, it is recovered and considered as a part of the unconsumed specimen mass.

Computation of Results

From the data obtained during test, following results are computed :

a) the rise in temperatures recorded by the three thermocouples located at the centre, on the surface of the specimen and at a point within the space between the furnace wall and the specimen surface.

b) duration of sustained flaming, and

c) mass loss of specimen.

If these values are below the limits specified, the material is graded 'Non-combustible'. Otherwise, it is graded 'Combustible' in accordance with the standard method.

Non-combustibility Test Results

Non-combustibility test results for materials are summarised in the Table where the computed result for maximum rise in temperatures recorded by the furnace, surface-, and centre- thermocouples, duration of flaming and per cent weight loss are tabulated. Finally, the results are also expressed as the designation assigned to a material, indicating whether it is Non-combustible or Combustible. The results have been arrived at on the basis of data obtained for a few types of materials. Materials which are known to be combustible such as timber, plywood, particle board have also been included in addition to relatively inert materials for comparison. A range and not a single value has been given, where the variation has been found to be large.

Interpretation of Results :

Results summarised in the table are for a range of materials of different physical and chemical properties to those subjected to tests. However, the tabulated results illustrate the behavior of a variety of materials of a particular type. Where a higher temperature rise has been recorded for a material as compared to others of the same type, it indicates a higher maximum burning rate and liberation of heat by the material on exposure to the test conditions. Using these results, it is possible to identify materials which do not contribute significantly beyond a specified limit to the growth of fire.

Table Representative Values of the Non-combustibility Test Results for Materials.

Material	Thick-ness	Density	Maximum rise in temperature			Sust-ained flam-ing,s	Mass loss %	Des-ign-ation
			Furnace	Surface	Centre			
	mm	kg/cu.m	deg.C	deg.C	deg.C			
Calcium silicate sheet	6	900-1100	55-80	65-100	80-180	Nil	13-20	C
Calcium silicate sheet	6	1600	60	60	30	Nil	15	C
Calcium silicate block	50	300	50-70	35-105	20	Nil	15	C
Mineral fibre, resin bonded	25-50	50-140	2- 5	7- 22	10	Nil	3- 5	NC
Mineral fibre, resin bonded	25-50	30- 90	20-47	58-100	35-150	Nil	2- 6	C
Mineral fibre, resin bonded	50	170	—	133	55	Nil	2	C
Mineral fibre, resin bonded	50	380	35	—	57	Nil	11	C
Mineral fibre, resin bonded	50	555	60	137	—	Nil	13	C
Timber, Kailwood	12	500	390	325	180	350	98	C
Plywood	3	660	200	200	135	520	86	C
Particle board	12	400	230	215	140	220	97	C
Fibre board	12	250	225	190	125	230	99	C
Decorative laminate	2-3	1400-1600	150-325	190-310	150-445	636-850	55-80	C
Polyurethane foam, rigid	25	55	140	155	165	60	98	C
Polyurethane foam, flexible	50	100	175	190	170	180	83	C
Phenol formaldehyde foam	25	55	140	155	80	80	100	C
Rubberised coir	50	60	105	118	105	80	94	C
Expanded polystyrene	25	—	120	125	112	27	100	C
Composite panel, gypsum plaster core, paper surfaces	12-15	1100 WPA	65-110	—	160-240	Nil	25	C
Composite panel, polyurethane foam, paper surfaces	25	1.4 WPA	100	125	100	42	96	C
Phenol formaldehyde foam, laminated	48	3 WPA	170	185	130	120	99	C

WPA – Weight per unit area, kg/sq.m; C – Combustible; NC – Non-combustible.

The materials which do not exibit a rise of more than 50°C and sustained flaming for more than 5 seconds are classified, in accordance with the Indian Standard Method of Test, as Non-combustible. Materials which exibit a higher rise in temperatures or longer duration of sustained flaming, are designated as Combustible. One of the advantages of this test is that the material which are classified as Non-combustible need not be evaluated for other 'reaction to fire' characteristics such as ignitability, heat release, surface spread of flame classification and possibly specific optical density of smoke generated. On the other hand, it is imperative that for materials which are classified as Combustible, these above relevant 'reaction to fire' characteristics must be determined before being recommended for use in a building.

Conclusions

The Non-combustibility Test for materials provides a useful means of identification of materials which can be considered relatively safe from the fire safety point of view.

Materials which are designated as Non-combustble by the test, need not always be subjected to other 'reaction to fire' tests.

Materials which are designated Combustible must be evaluated for 'reaction to fire' tests such as Ignitability, Heat Release Rate, Surface Spread of Flame Classification and tendency to generate smoke and toxic combustion products. The facilities for determination of relevant 'reaction to fire' characteristics of materials have been provided at the Central Building Researh Institute, Roorkee and these are being extended to all users within the country.

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