Fire Safe Interior Surface Finishes : A Selection Guide

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Abstract

The main focus of this article was to mitigate the fire hazards occurring from the internal furnishing materials widely used in buildings. To enhance the safety of life and property inside buildings, internal material selection guide characteristics were developed. The internal furnishing materials used in the buildings were initially characterized as non-combustible and combustible materials based on the ignitability properties of materials as per Indian Standard, IS: 3808 – 1979. The combustible materials were further classified as Class 1 – 4 based on the surface spread of the flame (SSF) as per British standard BS 476 : Part 7. With these specifications and standard test methods, the internal furnishing materials such as gypsum board, rock wool slab, deodar wood, Polyvinylchloride structural foam, Phenol formaldehyde foam, particleboard, rice husk board, and particleboard, etc. were characterized. Recommendations were prepared on their usage of the materials for selection and application at a suitable location, with respect to ceiling height, and any fire-retardant treatment. These internal furnishing materials selections/recommendations guide will help to improve fire safety in buildings.

Keywords : **Classification, combustibility, fire hazards, interior finishes, surface spread of flame (SSF)**

NOMENCLATURE

BS	British Standard	*ASTM*	American Society for Material and Material
NC	Non–Combustibility	*ISO*	International Standard Organization
IS	Indian standard	*EUROPIES*	European Standard
PUF	Polyurethane Foam	*XLPE*	Cross-linked poly ethylene
SSF	Surface Spread of Flame	*FRP*	Fiber- reinforced Plastic
PVC	Polyvinyl chloride		

I. INTRODUCTION

The objective of fire safety is to minimize human loss and property damage caused by fire accidents in buildings. Fire damage in buildings is due to internal combustible materials used in practice. To mitigate the fire hazards, the internal furnishing materials need to be characterized [1]. These days there is a rapidly developing mindfulness among architects and engineers on the dangers to human safety caused by fire outbreaks when they plan, design, and construct buildings [2]. The combustible materials of the encompassing region were

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the main cause of fire spread when a fire breaks out. The spread of fire may cause loss of human lives and the whole structure. So, the fire load has to be reduced, that is, minimize the use of combustible materials in buildings and check them on schedule.

Guidelines have been laid for the prohibition on use of flammable materials in high–rise buildings [3]. The outlaw implies that combustible materials would not be considered for use on the outer wall of structure over 18m such as clinics, hostels in schools, and in residential care premises [4]. The guidelines should be followed in the norms and regulations of India which are important for planners and designers while designing buildings [5].

CSIR-Central Building Research Institute (CSIR-CBRI), the fire research group is one of the leading agencies for the purpose of approval of materials. The owner or his agent shall obtain prior approval for the use of any new, alternate, or corresponding material in the building. Determination of fire behavior of the material is needed before the use of a material. Fire behavior or characteristics are very important criteria to know the performance of materials during a fire. A material or product can contribute to a fire hazard by either initiating the fire or by its behavior in a fire [6]. The first type of contribution was referred to as ignition hazard while the second part was called fire growth hazard. The fire research group is equipped with different facilities to carry out the following characteristics, that is, non-combustibility [7], ignitability, maximum specific optical smoke density [8], surface spread of flame [9], toxicity [10], fire propagation index [11]. These are the most important characteristics of building materials in terms of fire hazards. These tests provide the data/result to assess the behavior of the product in terms of fire hazards. These results help architects and builders to identify fire-safe materials for use in different situations. To determine these characteristics, fire research group follows the standards of BS/IS/ASTM/ EUROPIES/ISO for these facilities.

II. SURFACE INTERIOR FINISHES MATERIAL CHARACTERIZATION

A. Non-Combustible Material Characterization

In building design, it was useful to know whether the material to be used in the building was combustible or not. Non-combustibility is the property of a material to withstand high temperatures without ignition. The method of determination of non-combustibility of materials was specified in the Indian Standard, IS 3808 – 1979 [7]. Materials which were expected not to contribute significantly to a fire can be identified. The non-combustible materials can be considered safe materials from a fire safety point of view and can be used in any situation within a building. The use of all non-combustible materials within a building may only be an ideal solution. In practical situations, combustible materials may also be required to be used. Since these materials burn and contribute to a fire, it was necessary to know how these materials were expected to perform in case of a fire. Selection of materials for use in different situations within a building from combustible materials was done on the basis of their other fire properties.

B. Combustible Material Characterization

The materials identified as combustible by the test method IS : 3808 – 1979 were also used as surface interior finishes. These internal combustible materials have their tendency to spread flames over their surfaces. These materials can permit flames to travel over their surfaces to distances away from the initial outbreak. Other materials within the interior can also get successively involved in a fire resulting in the spread of fire to different locations within a building. This property assumes considerable significance where continuous surfaces of materials were available such as wall linings, false ceiling, insulation in air conditioning ducts, etc. To prohibit fire, it was necessary to avoid materials based on the surface spread of flame classification (SSF).

The characterization of materials for SSF was determined using the apparatus described in British Standard, BS 476 : Part 7 [9]. The test method will perform for the sample size of 900 (L) × 270 (W) mm for a maximum thickness of 50 mm. The classification methodology was based on the flame spread traveled distance on the specimen surface for a duration of 10 minutes. Based on the extent and the rate of fire increase observed, the material was classified as Class 1 – 4 in descending order of merit. Thus, a selection of materials can be made on their surface spread of flame classification. Receptiveness to fire of various kinds of wall surfaces was assessed by the rate of propagation of the fire on the surface of the specimen. The materials

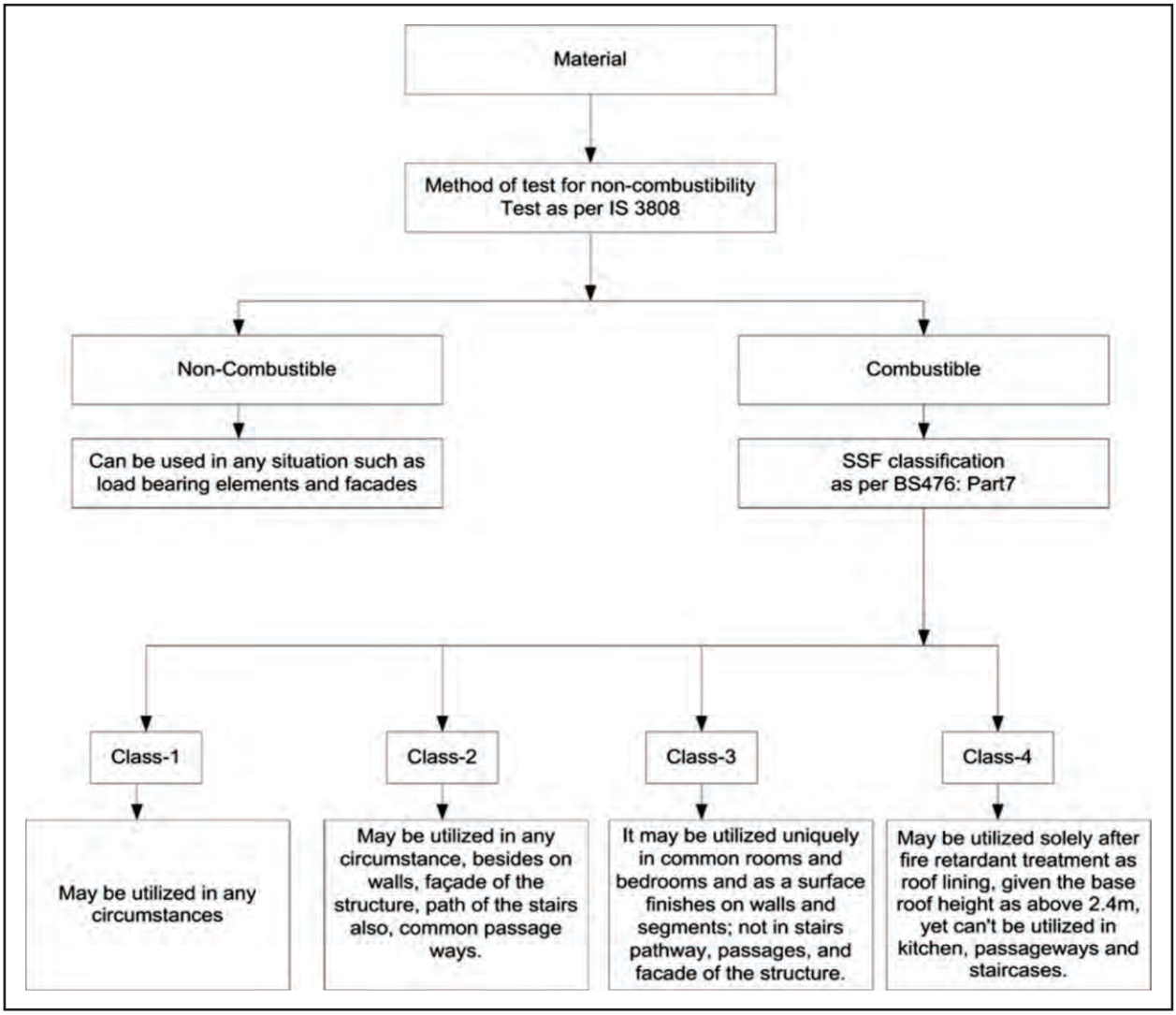

Fig. 1. Fire Safe Surface Interior Finishes Materials Selection Guide

were divided into classes as follows based on the rate of fire spread on their surfaces.

- **Class 1 :** Spread of flame up 165 mm
- **Class 2 :** Spread of flame up 215 mm
- **Class 3 :** Spread of flame up 265 mm
- **Class 4 :** Beyond the class three limits, i.e. 265.

The maximum permitted tolerance limit for the above classification was +25 mm only in all classes 1 – 4. The fire-safe interior surface finishes materials selection guide criteria are shown in Fig. 1.

The classification of surface finish material with respect to fire was done as given below :

- **Class 1 :** Fire–safe material may be used in any circumstances.
- **Class 2 :** Can be used in any circumstances, apart from on walls, façade of the construction, stairways, and common passageways.
- **Class 3 :** Can be used only in the common room, bedrooms (not allowed in accommodation on the ceiling) and only as a liner to concrete walls and partitions; not on stairways, common pathways, and facade of the structure.
- **Class 4 :** The furnishing material which does not have any fire retardant treatment may be used after fire retardant treatment on the ceiling which is atleast upto

TABLE I.

SURFACE INTERIOR FINISHES MATERIAL CHARACTERIZATION AS PER IS : 3808 & Bs476 : PART 7

Combustible or Non-Combustible test method for surface interior finishes as per IS:3808 - 1979				
Non-Combustible	**Classification of the SSF of products as per BS 476 : P 7**			
	Class-4	**Class-3**	**Class-2**	**Class-1**
Gypsum board	Rigid PUF (polyurethane)	Rice Husk Particle Board	Anotone Slab	Phenol-Formaldehyde Foam
Bison panel mineral fibre board	Kail Wood	Wood chip particle board 12 mm thick	Wood chip particle board 18 mm thick	PVC Structural Foam
Asbestos cement board	Deodar Wood	FR-PUF 10 mm thick	Red Mud Plastic Sheet	Wood-Wool Board Composite panel
Ceramic wool board	Fibre Board 12 mm thick	Medium Density Particle Board	FRP	FR-PUF Sandwich panel
Mineral wool board	Low- Density Particle Board	Plywood	XLPE- Foam	GRG & Ceramic Wool Board
Glass-reinforced gypsum board	--	Paper surface Gypsum Board	--	–
Calcium silicate board	--	--	--	–
Cement board	--	--	--	–
Rock wool slab	--	--	--	–

2.4 m in height. The material of Class 4 can't be applied in kitchens, common pathways, and stairways. A few materials consist of bitumen and help in adding up to risk due to increase in fire, release of opaque smoke during combustion, and are to be avoided from use and can't be used for the making of roof of the building where the is duct used for air to go back inside air–conditioned premises.

The detailed classification of surface interior finishes material characterization is given in Table I. When frames, walls, divider, and floors are covered with flammable materials, the exposed side of the surface should also comply with suitable class of fire safe materials. This lets the fire spread slowly on the surface, which allows the occupants to escape safely from the building.

III. CONCLUSION

Surface interior finishes were characterized as combustible and noncombustible materials. The combustible materials were further classified based on the flame spread on the surface. Location and restrictions on usages of classified materials were discussed. Further evaluation is needed for these materials for their toxicity and smoke generation during a fire.

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