EXPECTED FIRE RESISTING PERFORMANCE AND EVALUATION METHODS FOR BUILDING MATERIALS

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ABSTRUCTS

The living way has become more and more universal over the world. Modernized buildings and houses have been built in the similar ways according to the purpose of use of them except some traditional fanctions. Many efforts on establishment of international testing and evaluation methods have been made, but not so many of international standards have actually been established. What grade of fire performance is expected to building materials ? What are essential problems for establishing common standard testing and evaluation methods ? Discussion on probability of cooperative work on assessment of common standards will be made for a future work.

INTRODUCTION

Different culture has introduced different test methods for evaluation of building materials in fire. There exist so many test methods which classify materials in some fire rated grades in each country. However buildings and houses have been changing due to the improvement of living conditions. This causes a trend of uniform way of life through the world. The difference of test methods among countries have caused barriers for trades in these decades.
On the other hand, many test methods have been tried to develop and studied at the ISO/TC 92 in these decades. A few of them have already been adopted as International Standards. Most of them, however,seem to have been piled up as technical reports in the members countries. This may basically lack of consensus among administrative officers and researchers. An analytical study of estimating fire risk have been made.[1] It is expected to continue. Further study for development of new common test methods, therefore, will be expected to propose for classifying building materials and predicting fire growth with survey of social requirements.

PRACTICAL EVALUATION AND CHEMICAL/PHYSICAL PROPERTIMES

Many countries have their own requirement for fire performance of building materials in their fire codes.[2][3] The idea in each country involves the same purpose based on the following items;

1. Not to catch fire easily
2. Not to spread fire easily
3. Not to release heat and toxic gases

The purpose for fire safety is clear and simple, but complicated in practice.
The Japanese requirements for fire rated building materials are provided in the Details of Regulations of the Building Standard Law as "Restriction of Use of Interior Building Materials if they are used in "Specially Regulated Buildings in the Details of Regulation". Materials which may belong to furniture like curtains, carpets and thin materials for decoration etc., are not included in building materials. These are provided in the Fire Service Law in Japan.

Classification, for instance, in Japan is as follows:

① Non-combustible
② Semi-non-combustible
③ Fire retardant
④ Semi-fire retardant (for plastics)

by results of five test methods which are Non-combustible test, Surface test, Surface test with 3 holes through specimens, Box test and Toxicity test depending on the grades. These test methods are convenient for empirical classification, but may not give suitable data for prediction of fire growth for engineering treatment.
For fire safety in modernized buildings, a systematic evaluation methods which is based on engineering calculation is being introduced. But some kinds of current methods for evaluation of fire performance of building materials may still be required as specified test methods, because they are empirically easy to understand. Some materials, PVC sheet for instance, as shown in fig.1, give a small difference in ignitability with Polyethyren, but the former is commonly estimated as a material which is higher fire resisting than the latter. Ignitability does not always correspond to the propagation of flame. Some materials which are classified in a higher grade of fire rated materials by fire tests may be expected to be safer against fire. But, polycarbonate, for instance, which is classified into semi-fire-retardant may catch fire in some time and may release more heat from a unit weight than that of PMMA which is classified as "Combustible".

Further, non-combustibe and semi-non-combustible materials do not always stop fires as everybody knows. There is a tragic fire incident which caused 24 fatalites at an aged nursing home outskirt of Tokyo in 1987.[4] The building didn't break the fire regulations from the point of literature document. But the fire broke windows of non-wired glass which was estimated as parts of walls to be made of non-combustibles and got inside of rooms. The fire spread a room to another in succession. This is a bad example warning designers and building inspectors. That is "Catch not at the shadow and lose the substance". There may be so many examples like this. A big fire sometimes plays a trigger of revision of the current codes. But once it become regulation, then it may be difficult to remove in a rather short period, eventhough it does not meet practical way of life. A revision of a code may widely and seriously effect to the society.

ALTERENATING APRLICATION OF SPECIFIED CLASSIFICATION AND ENGINEERING METHODS

Many efforts have also been made for analyses of test data from the point of chemical and physical properties, but some materials, composit materials combined with plastics, may be difficult to be suitablly classified in current test methods(Table 2). Some materials, may not easily conduct a simplified test method. Because some of them which become swell, shrunk, melted etc, at elevated temperatures give different data between at real fire and at fires tests.
Rigid polyurethane and/or polystyrene with aluminium foil over the surface may have a

sort of fire rated grade, eventhough the latter is melt inside, but they are only fire resisting for a short period at an early stage of a fire. This kind of materials also have some trouble at tunnel test.

The difference of thickness of a material may give different fire resisting performance in practice, even though the composition is same.
More problems are implied in thiner materials like wallpaper which is widely used in the world. A simplified test method does not cover all materials to be suitablly classified in practical application. Some test results from heat release and surface test may give a contrary data which is shown in table 3.

Wallpaper do not show a rapid flame spread at a test, but if a room is involved in a fire, then wallpaper sometimes show a sudden combustion which leads flashover. This due to the chemical composition of wallpaper itself, lining materials and the glue in use. Contribution of furniture to fire must not be neglected, but restriction of more furniture to put in buildings may be difficult. Building materials will only be responsible in building fire.

Building materials may be too complicated to classify into some expected performance, but for a smoother trade and for a wider use of materials, essential discussion for development of common testing and evaluation methods may be needed. More and more materials which will be developed will change fire patterns for ever, but we must charange to improve testing and evaluation methods studying the following items.

- Survey of present problems for testing and evaluation methods.
- Survey and analyses of spreading fire in actual incidents.
- Essential study in practical use of materials.
- Development of test methods.
- Development of calculation methods.
- Social consensus to up-to-date target.

Reference

1) J. R. Hall: A Method for Estimating Fire Risk of Products in Buildings, 10th UJNR Panel on Fire Research and Safety, Tsukuba, 1988

2) R E H Read: International fire tests on structures, BRE information, IP 20/80, October 1980

3) R E H Read: International fire tests on building materials, BRE information, IP 21/80 October 1980

4) Tokyo Fire Department : Report of Shojuen Fire — An Asylum for the Aged, Japanese Association of Fire Science and Engineering, Vol.37 No.5 P 1 1987

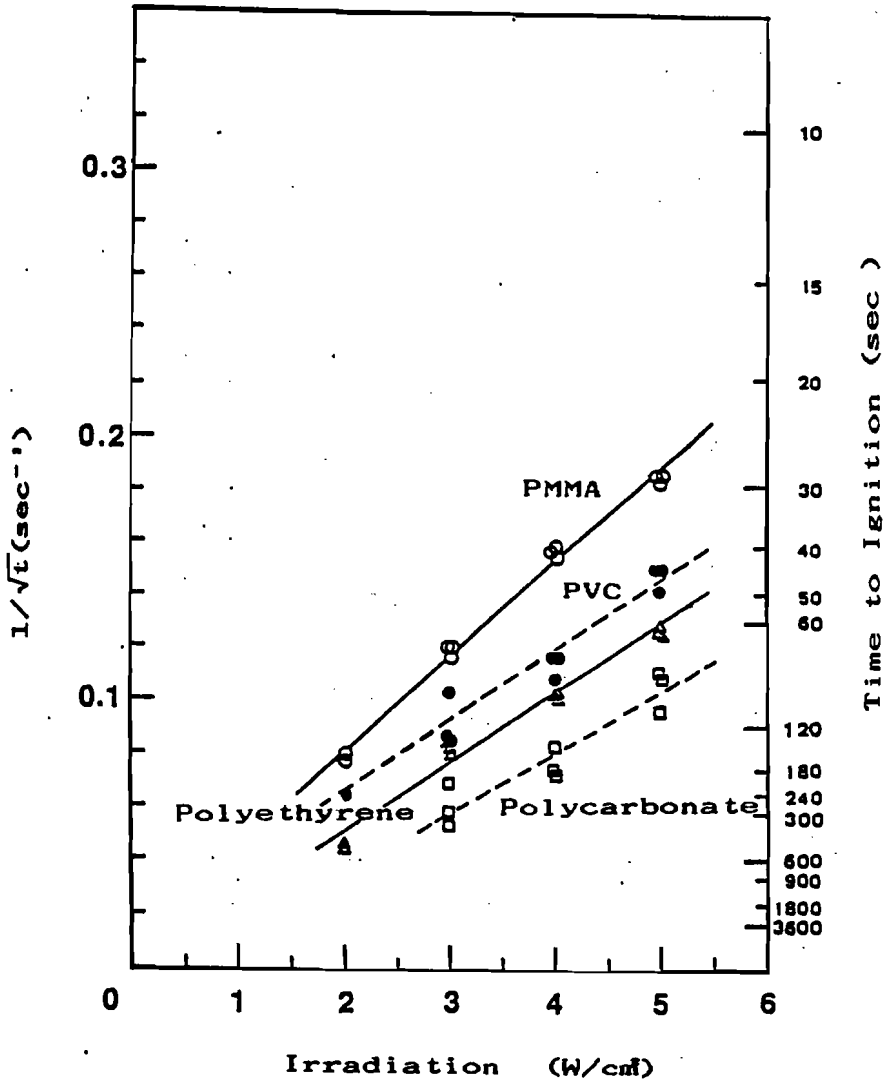

Fig.1 Relationship between Irradiation and Time to Ignition

Table 1 Typical Pattern of Burning Behavior at Real Fire and at Tests

Composition Materials	Characteristics in real Fire	Phenomena at surface test and box test
Paint / Concrete	Maltilayers by painting over painting in use burn and spread fire fast, but not large fire load	Fresh specimen do not release large amount of heat and smoke because of their thin layers at surface test, but sharp peeks of them arise at box test becouse of flashover
Metal surface (or thin inorganic materials) / Plastic insulation	Does not release severe heat at initial stage of fire but has potential of releasing more heat at elevated temperatures.	Heat and smoke are surpressed by the surface materials at tests.
Wall paper / Gypsum board	Combustion behavior changes due to the way of spreading glue for adhesson.	Flash over occurs at box test
Fire retarded treatment / Wood	To burn forming char due to incident energy. To reach flashover, if there are other fire load.	To burn giving proper amount of heat and smoke due to the mass and treated chemicals

Table 2 ISO Round Robin Test Result on Spread of Flame At BRI

No	Materials(Thickness)	No. / Phenomena	1	2	3	4	Remarks
1	Birch-faced plywood (9 mm)	Ignition(sec) Extinction(sec) Distance(mm)	29″ 13′40″ 610	29″ continued 765	27″ 14′00″ 765	30″ 21′42″ 710	Burnt steadily
2	FR plywood (4 mm)	Ignition(sec) Extinction(sec) Distance(mm)	23″ 4′32″ 420	18″ 4′47″ 450	24″ 2′20″ 420	32″ 21′42″ 710	Front flames of 2 ~ 3cm width were succeeded by the secondary flame 10~15cm apart
3	PMMA (3 mm)	Ignition(sec) Extinction(sec) Distance(mm)	20″ continued 765	21″ continued 765	26″ continued 765	18″ continued 765	Steadily burnt
4	Polystyrene cemented to non-combustible board (38+ 6mm)	Ignition(sec) Extinction(sec) Distance(mm)	2′43″ 8′41″ 430	2′51″ 8′28″ 410	3′22″ 8′56″ 450		Melted suddenly, then flame spread gradually
5	Isocyanurate foam faced with Aluminium foil (28 mm)	Ignition(sec) Extinction(sec) Distance(mm)	53″ – 0	10″ – 0	26″ – 0	3″ – 0 Impinging	Flame didn't spread, but existed at the pilot burner
6	PVC faced plasterboard (10 mm)	Ignition(sec) Extinction(sec) Distance(mm)	18″ 1′26″ 270	1′06″ 2′20″ 350	Non flaming 350 (Smoldering)	400 (Smoldering)	Flame spread by smoldering

Table 3. Material properties and classified grade

		Heat Released cal/g	O.I.	Saface Test
1	Acrylic Resin	6,265	18.8	Combustible
2	Polyethyrene	10,965	19.3	Combustible
3	PVC	4,315	26.5	Semi-fire-retardant
4	Polycarbonate	7,294	32	Semi-fire-retardant