LATEST INTERNATIONAL DEVELOPMENTS IN PASSIVE FIRE PROTECTION

Presented by

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SUMMARY OF MR. OLLIVER MARX

Mr. Olliver Marx has several years experience of marketing building materials and in particular in the field of fire protection.

He is the General Manager of Promat Int'l (Asia Pacific) Ltd based in Manila.

He has addressed Fire Symposiums on the Principles of Passive Fire Protection and has been involved in the implementation of such systems on numerous projects in the Philippines.

LATEST INTERNATIONAL DEVELOPMENT IN PASSIVE FIRE PROTECTION

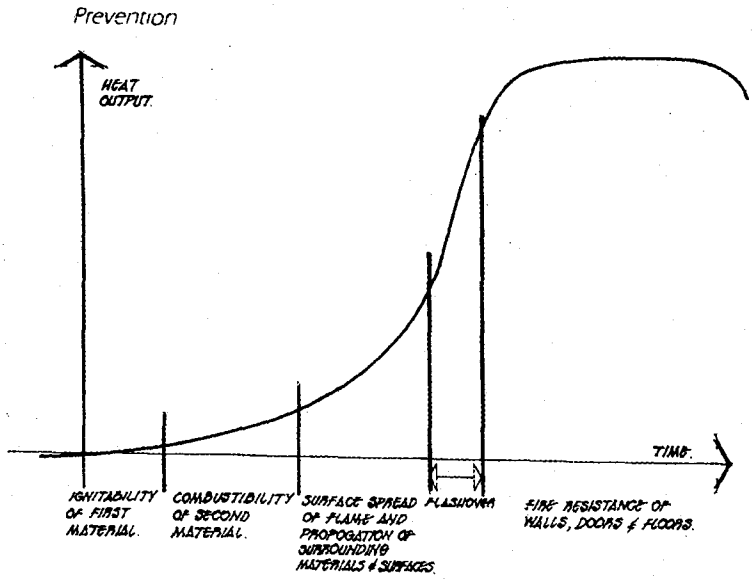
FIRE AND SMOKE START FROM A SMALL IGNITION SOURCE

An easy way to detect the role of Passive Fire Protection is to look at the development of fire from the first ignition source till the fully developed fire and to check the safety approaches used and how these are translated into regulating requirements.

MODEL OF FIRE DEVELOPMENT

STEP 1	**Start of fire with small ignition source**
STEP 2	**Spread of fire to the combustible content and/or exposed surfaces of the building materials within the room or origin**
STEP 3	**Windows break down and flash over eventually occurs**
STEP 4	**Hot gases and smoke are continuously produced**
STEP 5	**Through openings in walls and floors or through the damaged separating elements, the smoke and fire spread behind the room of origin through the whole building**
STEP 6	**In the meantime, high temperatures of the fully developed fire endanger the loadbearing capacity of the structural building elements.**
STEP 7	**Partial or total collapse of loadbearing elements occur**

FIRE AND SMOKE START FROM A SMALL IGNITION SOURCE (cont'd)



Building materials and fire growth

FIRE SAFETY CONCEPTS

The fire safety concept in buildings and other industrial premises applied on this simplified model is usually considered to be composed in five elements:-

(1) **To prevent the initial ignition;**

(2) **To restrict the growth and the spread of fire within the room of origin;**

(3) **To contain the fire within specific boundaries, the compartment and to ensure structure stability;**

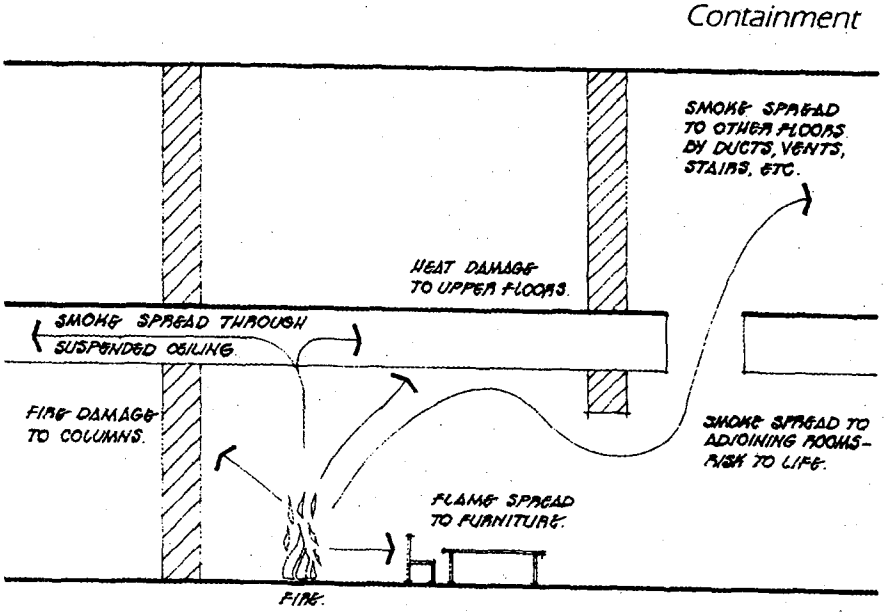
(4) **To provide safe means of escape for the occupants of the building;**

(5) **To control fire by automatic devices and/or fire fighting**

PASSIVE FIRE PROTECTION : AN ESSENTIAL PART OF FIRE SAFETY DESIGN IN CONSTRUCTION

The design of Active together with Passive Fire Protection measures in buildings will have to be carefully addressed at the planning stage.

Active systems such as smoke detectors or sprinklers will react at the early stage of the development of fire. However, those systems may not control the fire as a lot of variables such as ventilation or the size of the combustible content i.e. fire load in the room may influence the speed of the fire development.



Threats from heat and smoke

PASSIVE FIRE PROTECTION : AN ESSENTIAL PART OF FIRE SAFETY DESIGN IN CONSTRUCTION (cont'd)

Passive Fire Protection has a key role to play and will minimize the risk of fire hazard. The role of Passive Fire Protection can be defined as follows:-

ROLE OF PASSIVE FIRE PROTECTION

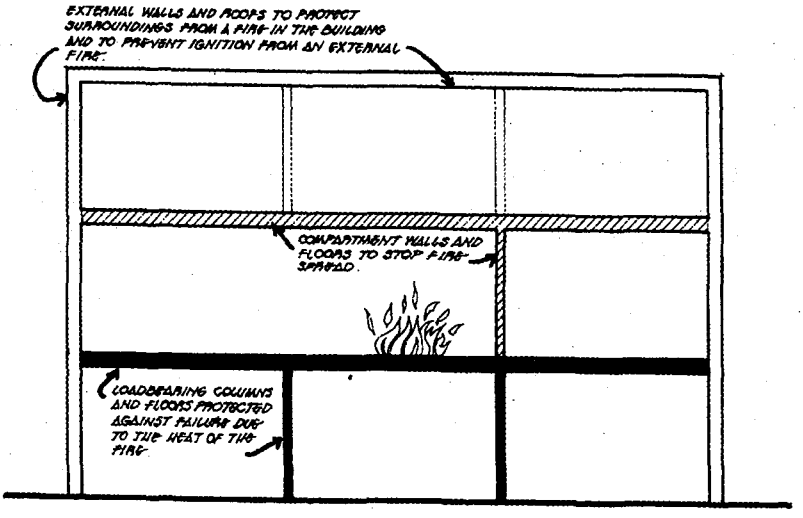
(1) **Providing *compartmentation* to a given building type in order to minimize the spread of fire and smoke**

(2) **Ensuring the *integrity* of compartments in case of fire by fire stopping any gap penetrating through those building sections**

(3) **Offering *heat insulated* solutions to eliminate possible self ignition of combustible materials by the transfer of heat through building elements**

(4) **Protecting against high temperatures *structural elements* from**

a) deformation and collapse in the case of steel structure
b) spalling concrete effects and derived heavy repair costs



Passive fire containment

PASSIVE FIRE PROTECTION : AN ESSENTIAL PART OF FIRE SAFETY DESIGN IN CONSTRUCTION (cont'd)

Consequently, the implementations of the Passive Fire Protection principles can achieve following outstanding benefits to the community, the developers, the occupants and the fire fighters:-

BENEFITS OF PASSIVE FIRE PROTECTION

(1) ***Minimize the cost*** **of property damages for the developer**

(2) ***Reduce insurance premiums*** **thanks to higher safety** ***standards***

(3) ***Contain smoke and flames*** **in a safe wall for a given fire resistance period**

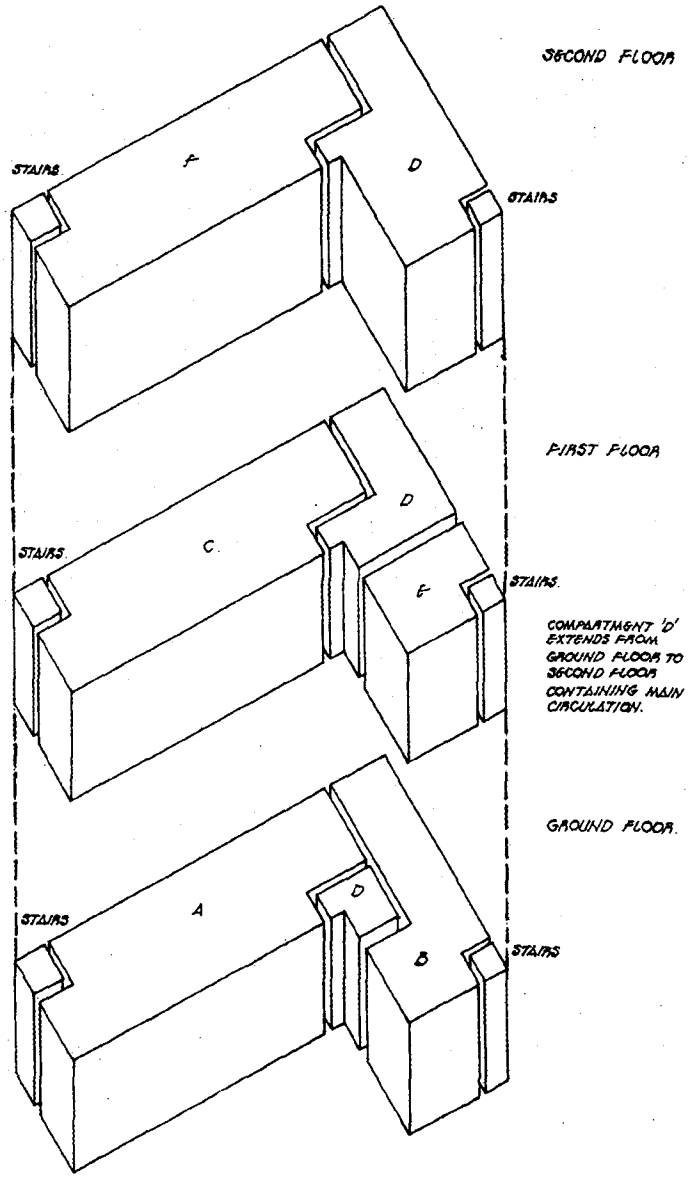
(4) ***Safe evacuation of building*** **occupants without being obstructed by smoke and flames**

(5) ***Provide sufficient time to fire fighters*** **to reach the site**

(6) ***Allow fire fighters to operate safely*** **in smoke free zones**

PASSIVE FIRE PROTECTION : AN ESSENTIAL PART OF FIRE SAFETY DESIGN IN CONSTRUCTION (cont'd)

Containment



Compartmentation of a building

BUILDING CODES REFER TO PERFORMANCE BASED STANDARDS TO IMPLEMENT EFFICIENT PASSIVE PROTECTION SYSTEMS

National building codes often prepared by the Fire Department in cooperation with the Ministry of Public Works will clearly indicate to the developers and the architects the minimum safety requirements. The codes will contain various aspects which can be summarized as follows:-

KEY ASPECTS COVERED BY BUILDING REGULATIONS

(1) **Means of escape**

(2) **Compartmentation**

(3) **Internal spread of fire**

(4) **External spread of fire**

(5) **Protection of the elements of structure**

(6) **Smoke control**

(7) **Active Fire Protection Systems**

(8) **Access of fire engines and fire fighters**

The building plans will have to comply with the building codes and will have to be approved by regulatory authorities. After the building completion a certificate of fitness will be released by competent authorities.

BUILDING CODES REFER TO PERFORMANCE BASED STANDARDS TO IMPLEMENT EFFICIENT PASSIVE PROTECTION SYSTEMS

The building code requires any building element and building materials in certain key areas of the building to be tested according to stringent test methods.

In the Asia Pacific region mostly British Standard will apply. Distinction between reaction and resistance to fire has to be clarified as it often leads to confusion.

4.1 Reaction to fire

Individual building materials have a different behaviour in fire. Their heat release, their degree of combustility, their spread of surface spread, their ignitability can be classified. The British Standard 476 Part 3 to 7 are concerned.

4.2 Resistance to fire

This notion will include:-

1) The capability of separating elements to stop the fire spread through the building

2) The capability of loadbearing elements to preserve their loadbearing capacity

Test methods to evaluate these properties of building components are similar over the world. The most commonly test standard in Asia are British Standard 476 Part 20 to 24.

4.3 Performance criteria of a building element

Performance based criteria as defined in BS476 Part 20 are used to assess the fire resistance of a building element. There are 3 main criteria:-

1) **Stability**
The ability of the building element to remain in place in a fire situation

BUILDING CODES REFER TO PERFORMANCE BASED STANDARDS TO IMPLEMENT EFFICIENT PASSIVE PROTECTION SYSTEMS (cont'd)

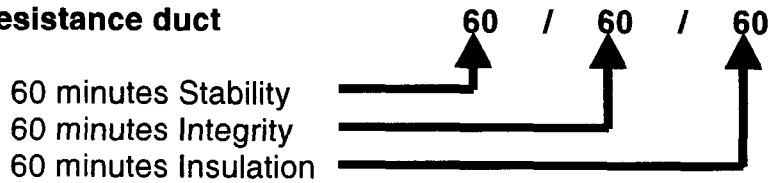
2) **Integrity**
The ability of the building element to stop the passage of flames and smoke

3) **Insulation**
The ability of the building element to prevent heat transfer from the fire side to the cold side. The maximum temperature of heat transfer is set up at 180°C according to most world standards.

Thus, building elements will be rated according to these 3 criteria. However, it is essential to indicate whether the element is insulated. An insulated building element has a specific role that should be well addressed in the building code. Insulated elements like partitions, doors and ceilings must be incorporated in escape routes. Thus, building occupants cannot be affected by heat transfer from fire behind such elements during the evacuation.

One common and very practical way of qualifying the fire resistance of a building component is as follows (case of a duct):-

Fire resistance duct **60 / 60 / 60**



A non-insulated duct which will be made of less building materials will be:-

Fire resistance duct **60 / 60 / -**

The specifier must therefore draw special attention to the performance requirements of the building components.

PROBLEMS AND COMPREHENSIVE SOLUTIONS TO PASSIVE FIRE PROTECTION

Various building components must proof their resistance to fire and only tested construction systems should be carefully selected by the specifier to achieve cost efficient results.

5.1 Structural Elements

Problems

Steel is a highly versatile building material which offers large design possibilities while enabling fast installation time. When exposed to fire, steel will loose its mechanical strength and risk of collapse of the structure of the building is greatly increase.

Careful attention should be drawn on the behaviour in fire of a given cross section of a steel profile. Indeed the smaller the cross section the lesser the fire resistance of the profile will be.

Solutions

Cladding and spray systems are by far the dominant solutions. Engineering calculations determine the thickness of material necessary to clad a given section for the target fire rated limit.

Experience shows that certain key criteria must be evaluated to decide about the choice of material:

a) **Thickness control :** The control of the thickness of material during the application requires special care and equipment to guarantee an efficient protection. Board cladding solve this problem as board thicknesses are factory controlled

b) **Adhesion :** Loss of adhesion of protection material can happen if the steel surface hasn't been properly cleaned prior to application or if a particular building area is subject to some vibrations. Loss of adhesion can be a great problem

5.2 Fire Rated Partitions

Problem

Fire originated from areas occupied with people such as hospitals or schools would instantly spread through doors, ceilings and partitions and penetrate into protected areas such as corridors or lobbies unless tested according to standards such as BS 476 applicable to non-loadbearing elements.

Solution

Heavy materials such as bricks and concrete can be a straight forward solution however they are architecturally limited. With raising labour cost the speed of installation has become an important element of decision

The choice of a light material like calcium silicate board can offer unique technical features such as:-

a) Easy to be penetrated with afterwards installed services fire stopped with approved tested systems

b) Running of various services within the wall cavity ensuring easier access for maintenance

c) Reduced dead load in case of high partitions

d) Fire ratings up to 6 hours

5.3 Fire Rated Ceiling Membranes

Problem 1

It is almost inevitable that services such as electrical cables, pipes, ventilation ducts, etc... will run through the plenum above the ceiling membrane. Concerns have been expressed in certain countries about the high fire load that those services represent.

Solution 1

Certain building codes such as Hong Kong or Germany will allow services passing through means of escape provided they are fire rated or enclosed by a fire rated ceiling membrane.

However, in such cases the insulation criteria is mandatory. This is because heat transfer from above or below the membrane impede safe evacuation. If fire comes from below unprotected services will become exposed to the blaze and fire will spread rapidly in the compartment.

Insulation criteria according to BS476 Part 20 is defined as a maximum temperature rise of 140°C on the average of the surface of the building element or 180°C at any point.

Problem 2

Maintenance openings in a shaft wall or in a ceiling are a very likely passage of fire and smoke if unprotected.

Solution 2

Fire rated access panels screw fixed or hinged and built in light weight systems or solid walls, also meet the insulation criterion.

5.4 Fire Barriers To Internal Spread Of Fire

Problem 1

Unprotected gaps between floor slabs and spandrel walls presents a passage of fire and smoke if unprotected.

Solution 1

Fire stopping made from board linings fixed to brackets at the edge of the floor slab combined with adequate fire rated sealants and insulation materials are a common method.

Problem 2

Similar problems occur in vertical shaft walls if protected with untested methods. Generally, concrete barriers may be unsafe due to the spalling effect from concrete in a fire.

Solution 2

For services running vertically in shaft walls horizontal fire services can be alternatively built using:-

a) Mineral wool combined with fire rated coatings

b) Fire rated pillows that enable retrofitted installation of new cables

c) Fire rated mortars

5.5 Smoke Extraction Ducting System

Problems

To perform efficiently smoke ducts must be able to handle hot gases that can reach temperatures over 500°C depending on the fire load. Key requirements are therefore:-

a) duct resistance to high temperatures

b) the ability of the duct to avoid the spread of fire to another compartment

c) the duct insulation performance to limit the heat transfer and possible ignition of combustible materials located in an adjacent area

Solutions

There are basically two major construction methods of fire rated ducts:-

First Method : Cladding a sheet metal duct with non-combustible board linings

Second Method: A self supported duct built with fire rated boards

5.6 Fire Stopping And Penetration Seals

Problems

A great number of services will inevitably penetrate compartment floors and walls. These services such as telecommunication cables, electrical cables, PVC or any other synthetic water pipe have poor fire resistance and will very quickly transfer heat and flames to the other side of the compartment.

Such penetrations will greatly affect the integrity of the compartment if Passive Fire Protection solutions are not implemented.

Such systems are tested to BS 476 Part 20 and more recently to the new European draft standard which has been specifically designed to cater for various types of penetrations.

Solutions

A variety of systems can be found on the market.

However, careful site inspections should verify if site conditions match the tested systems proposed.

The most common systems are:-

a) **Pipe Collars** fixed onto the element around plastic based pipes. These collars are made from an intumescent compound which expand at the early stage of a fire. The opening is sealed, flames and smoke will not pass through.

b) The integrity of a compartment concrete wall can be preserved with special **fire rated compression strips** applied in movement joints. These are cheap and efficient solutions.

c) **Fire rated sealants** whether acrylic or silicone based are ideal solutions to seal small joints up to 40mm wide or to seal any small gaps around penetrating cables or steel pipes.

d) **Fire rated mortar seal** is a better choice compared to cement grout which shrinks when exposed to fire. They are suitable for smaller openings up to 600 x 600mm.

e) As a permanent or temporary and efficient system **fire rated pillows** are designed to allow retrofitted service penetrations. This applies to telecommunication or computer cables that run below suspended floor systems, which must be protected when passing underneath a fire rated wall.

5.7 Cable Ducts

Problem 1

In the event of fire, it is vital to the safety of the building occupants that certain electrical systems are still functioning until they have effected their escape. Electrically operated active systems should be well protected.

Problem 2

If cable trays are exposed to fire, PVC made cable sheathing ignities and will emit toxic gases containing HCL. Some National Building codes (for example Germany) will require such cable trays passing through escape passages to be enclosed in a fire rated duct or bulkhead.

Problem 3

Halogen free cables or cable trays protected with coatings will have to comply with fire temperatures according to IEC 331 which defines temperature levels (750°C maximum) below the standard time temperature curve as defined in BS476 Part 20 and by ISO Standards.

PROBLEMS AND COMPREHESIVE SOLUTIONS TO PASSIVE FIRE PROTECTION (cont'd)

Solutions

Cable ducts made from non-combustible boards carrying non-fire rated cables provide an inexpensive solution to fire protection when compared to alternatives using fire rated cables.

Smoke and fire are contained in a small enclosure, and can also provide resistance to fire from outside, allowing continued operations of cables for essential services.

The only fire resistance standards applying for such systems is German DIN4102 Part 12. This standard will require cables to function for the duration of the heating period as defined and the temperature on the cable jackets does not exceed 150°C.

SUMMARY

Fire and smoke can from a small ignition source develop rapidly. Active systems in combination with Passive Fire Protection measures will offer highest safety standards to the building's developers and occupants.

Nevertheless, the fire growth is very unpredictable and it is therefore essential at the planning stage that tested solutions are well selected according to National codes and later on installed by qualified contractors to ensure optimum performance.

This demonstrates that Passive Fire Protection as safety measure cannot be neglected.

Recent fire cases all over the world still proof that fire can develop any time and any where even in countries of high safety standards.