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Fire Fighting of a Tall Bulding: A Review

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ABSTRACT

The number of Fire accidents has been increased due to reckless building construction and nonconformities of different codes. So, at present urban cities have experienced many fire incidents. But insufficient equipment support and lack of public awareness are the main culprit of this situation to create more complex. This study will review the fire incidents throughout out the world and Bangladesh and also introduce the main components of firefighting systems of a tall building.

***Keywords*:** Fire accident, fire fighting systems and public awareness

1. INTRODUCTION

An obvious solution to the challenge of housing for growing urban populations is vertical living. So the concept of tall building structures is being popular day by day and solving many urbanization problems. But the improper design and arrangement, in this case, are causing deaths and other damages. Fire is one of the most important factors which must be considered in tall building design [1]. If the fire is not managed, this can be disastrous for human settlements. Statically records show that in the last 30 years, earthquake and fire cause most of the structural failure of Tall buildings. During this period, a large number of steel buildings are collapsed due to earthquake and fire incidents. Tall buildings are being constructed without maintaining the planning rules and regulations [2].

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In some cases, failure can occur to mitigate the fire hazards. It has been observed how preventive measures failed in smoke management in buildings like Cook County Building (USA) and Camberwell fire (UK) and modern buildings like TVCC, China, failed to stop the spreading of fire as the fire spreads 44 floors in around 15 minutes [3]. So, studies and researches on fire fighting system are becoming popular day by day. This paper discusses the background and importance of fire safety in the context of tall building structures. So, the proper knowledge of firefighting techniques should be acquired to meet the challenges of reducing the damages [4].

2. FIRE FIGHTING SYSTEM & THEIR COMPONENTS

2. 1. Fire Fighting System

Fire safety in high buildings has been a significant issue for architects for over 100 years. After 1970, a great awareness was tried to create worldwide for preventing fire hazard related problems. This article identifies the fire safety problems, the component of firefighting, the scenario of firefighting in high-rise apartment buildings, And discusses proper design parameters and codes to install fire protection infrastructures. And ways or techniques to reduce fire risk [5].

2. 2. Classification

Current fire protection strategy for a building often incorporates a combination of active and passive fire protection measures. Figure 1 shows the firefighting system classification.

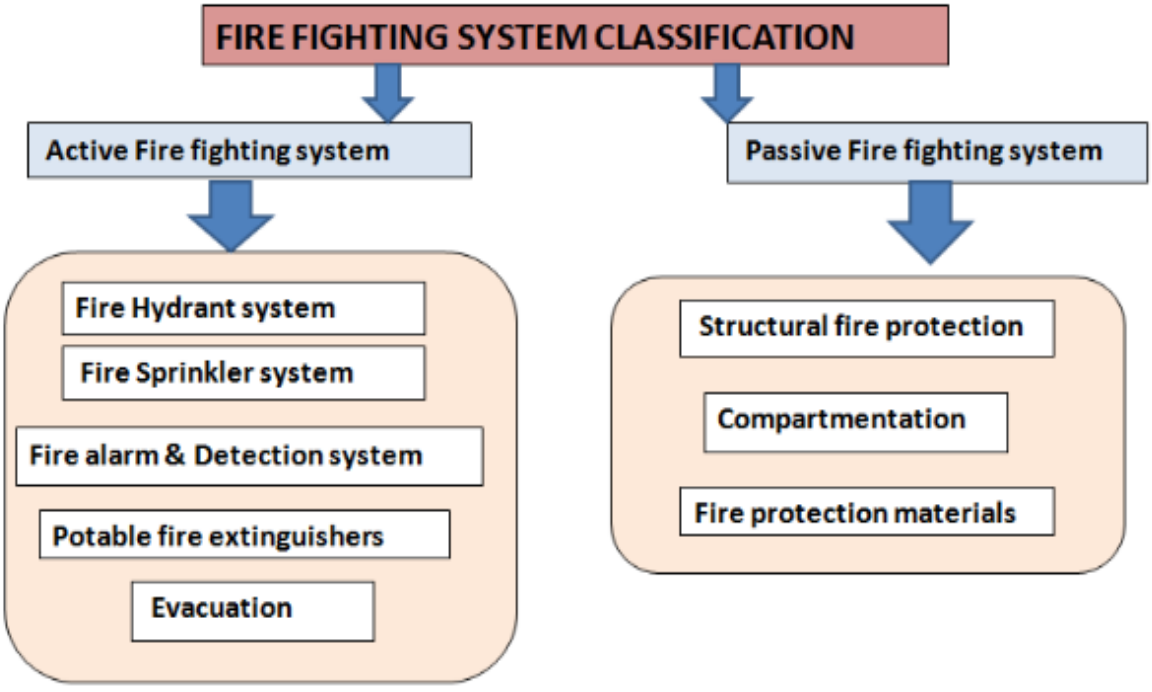

Figure 1. The firefighting system classification [6].

2. 3. Active Fire Fighting System

Active Fire Protection is an arrangement of systems that work efficiently against the fire of a structure with the help of some action which may be operated manually or automatically. The fire extinguisher is manually and the sprinkler is operated automatically [7]. So, when detectors find fire and smoke in a building, a fire/smoke alarm is on and alert people. Then the active fire protection system works to stop the fire or slow down the growth of fire so that the firefighter can reach the location. Once firefighters reach the location, they use fire extinguishers, fire hoses and others supporting tools to put out the fire [8]. The basic components of active firefighting system are listed below.

2. 4. Fire Hydrant System

Fire hydrant system is one kind of joint or point which creates a connection between water supply system. By using this a firefighter can control the water supply system in the fire incident. It is considered as a most active fire system to reduce fire rapidly. A sufficiently large water reservoir is the basic components of the fire hydrant system. So, the overall pictorial view of this large water reservoir is attached below [9]. Figure 2 shows the pictorial view of Fire Hydrant System.

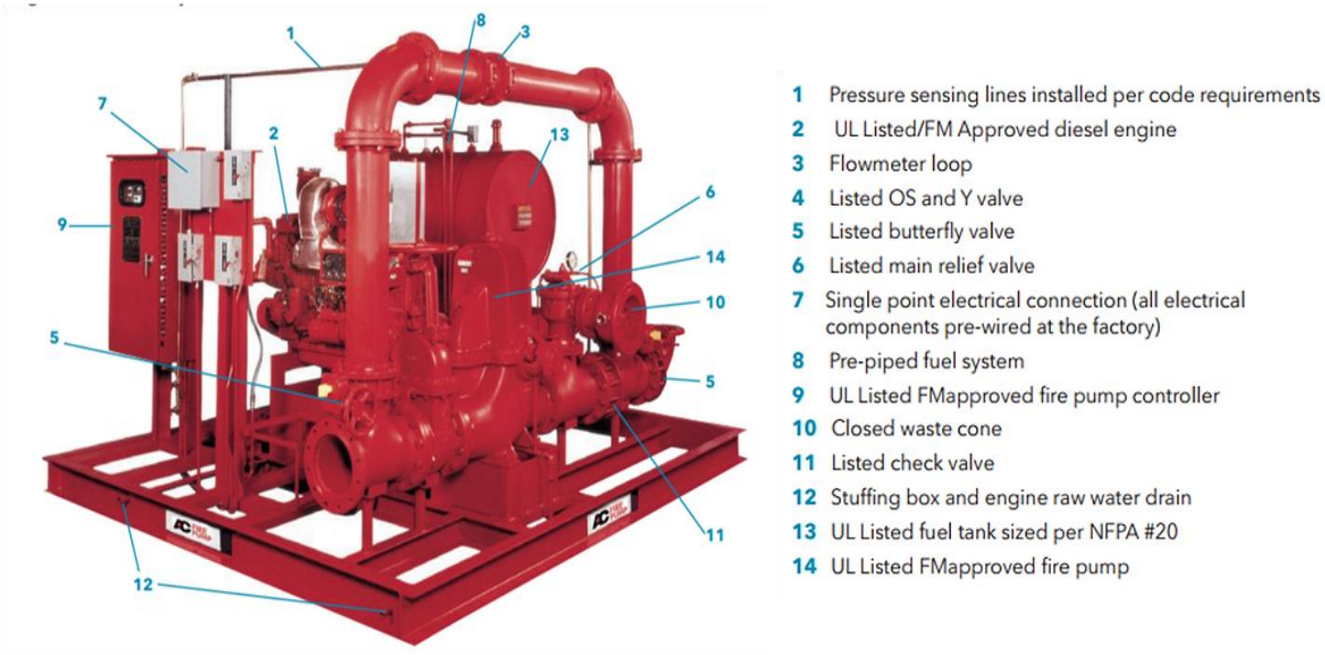

Figure 2. Fire pump **(**Fire Hydrant System) [WIKIPEDIA].

2. 5. Fire Hose System

The fire hose system is such a kind of system where large vertical pipes are attached in the residential or commercial building which is connected with a hose where water is kept in high pressure. And at the time of fire incident, the hose releases the water at a great speed. In hose standpipe, if water is always kept then this system is called a wet riser system [10].

But if the hose standpipe is not filled with water, but connects to the water supply system to supply water at any time then this system is called a dry riser system [11].

And in a dry riser system, the sprinkler head is attached at the top of this system. Many distributed branches of pipes are considered between the sprinkler head and compressed water tank of this system [12]. At any kind of fire incident, the sprinkler head can release the distributed water accurately. And then the water is spread out quickly [13]. So, this is the effective mechanism of the fire hose system. Figure 3 shows the dry & a wet riser system.

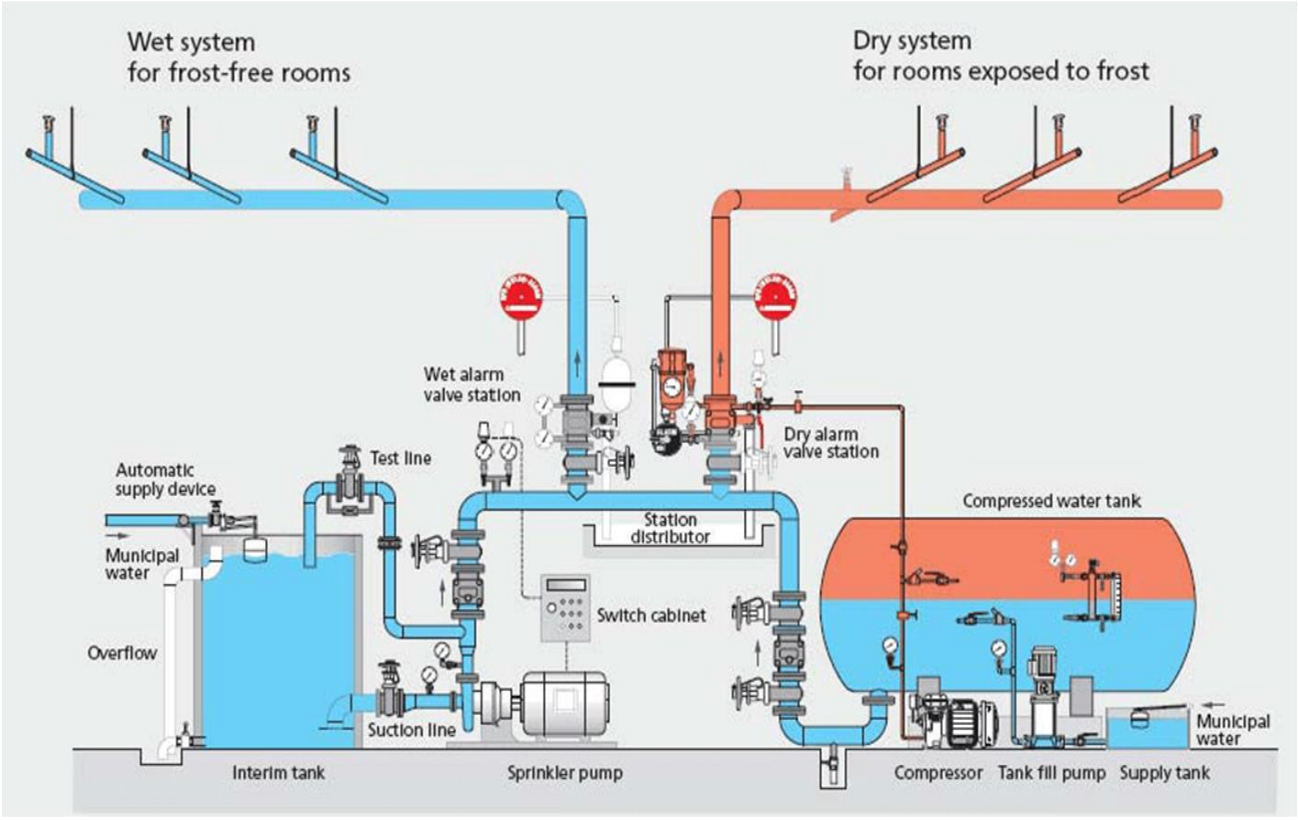

Figure 3. Dry & wet riser system [14].

Sophisticated components of the fire hose system are Hydrant valves, fire fighting hoses, Branch pipe with nozzles, Landing Valves, Hoses, Couplings, Hose Reels, Branch Pipes & Nozzles and Fire Brigade Connectors [15].

2. 6. Automatic Sprinkler System

Many water distribution pipes are connected to the automatic sprinkler system. The plug which is fusible is enclosed in sprinkler nozzle can be melted at a specific temperature. This temperature is absolutely large than normal room temperature. And then the nozzle of sprinkler releases the water to the source of fire [16]. Figure 4 denotes the pictorial view of the Automatic Sprinkler System. The basic components of sprinkler system are piping, sprinkle, fire alarm check valve, water motor gong, retard chamber, cut off valves, inspector's

test valve, retard chamber, cut off valves and inspector's test valve. Fire alarm & detection system also plays a vital role to create awareness for instantaneous fire [17].

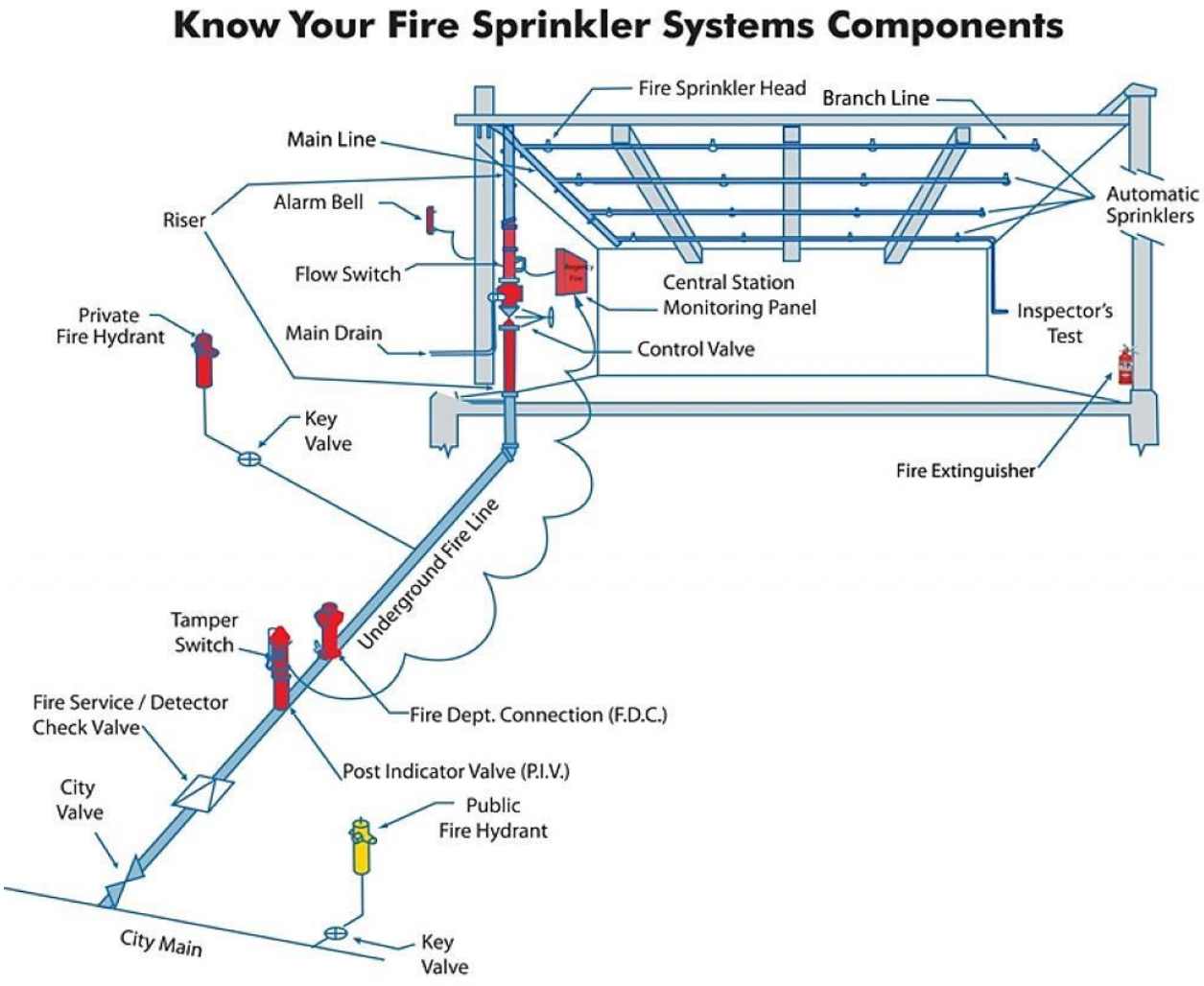

Figure 4. The pictorial view of the Automatic Sprinkler System [WIKIPEDIA].

2. 7. Fire extinguishers

Fire extinguishers are known as 'first attack' firefighting measure. It is used by the occupants inside the building before the firefighters arrive. So occupants must be known about the type of extinguisher and their use. Many large fires may be happened from small fire [18]. If proper fire resisting agents are used then this type of massive fire can be removed. The principal of fire extinguisher types currently available include:

Table 1. The principle fire extinguisher types

Extinguishing Agent	Principle Use
Water	Wood and paper fires - not electrical
Foam	Flammable liquid fires - not electrical
Carbon dioxide	Electrical Fires
Dry Chemical	Flammable liquids and electrical fires
Wet chemical	Fat fires or grease fire in kitchen - not electrical
Special Purpose	Various metal fires

2. 8. Travel distance

The plan of any building should set considering the small travel distance to the exit so that people can get out easily in case of a fire incident. So, travel distance is the time in which all occupants of the building can get out of the building in case of a fire incident. Lower the travel distance time, safer the building [19]. Figure 5 shows the short safe travel distance for fire safety.

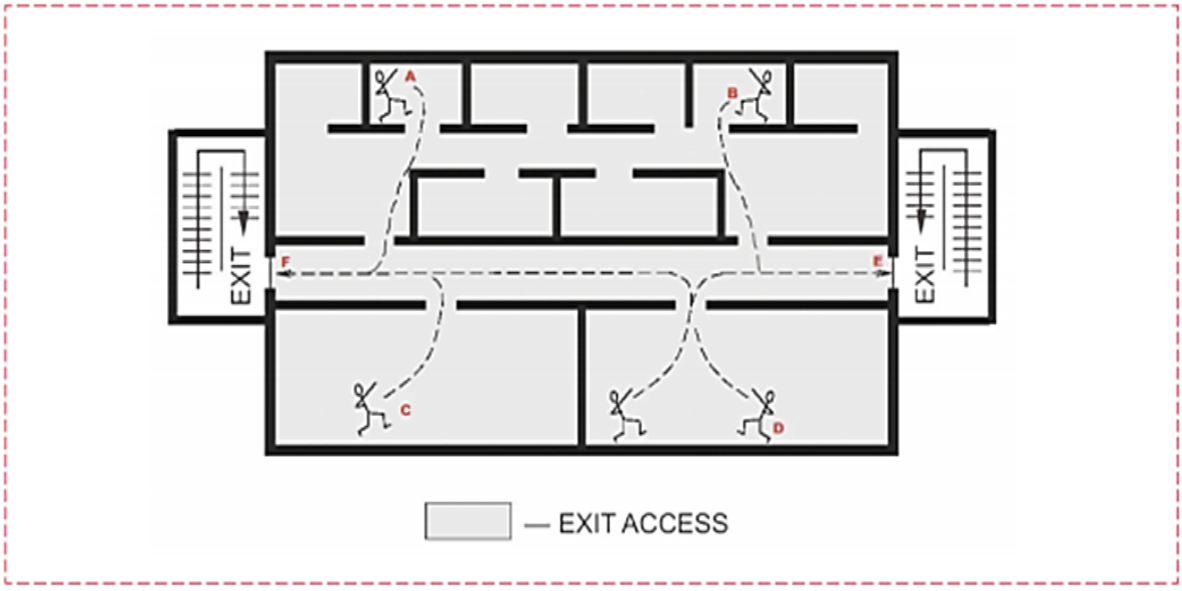

Figure 5. The short safe travel distance for fire safety [20].

2. 9. Escape chute system

The escape chute system is such a kind of system where anyone can safely exit through high strength synthetic fabric tube from the roof or upper floor of tall buildings in case of a

massive fire. One man can escape easily to use this. The main basic component of this fabric tube is kevler [21]. The structural rigidity, flexibility and elasticity of this synthetic tube is very high and it has good non-flammable properties. So, where it may be used in case of a criminal attack [22]. Figure 6 shows the escape chute system in Seoul, South Korea.

Figure 6. The escape chute system in Seoul, South Korea.

3. PASSIVE FIREFIGHTING SYSTEM

3. 1. Structural Fire Protection

The materials which increase the fire resistance of any element are called fireproofing materials. The intumescent is one of the fireproofing materials. At the contact with heat, intumescent swells up and acts as fire protective coatings. So, thinly coated intumescent is used as a structural fire protection system. At the time of heat contact, Intumescent's density decreases with the increase of its volume [23]. One kind of plaster which consists of gypsum-based cementitious materials can be a good solution for structural fire protection. The mineral wool wrap is one kind of good insulator to protect the structure from fire. Various fire protective cladding materials are used in the joint between steel girder and column to protect

them from fire [24]. Concrete, gypsum or masonry fire-rated floors, walls or ceilings work as fire barricades. Figure 7 shows the working mechanism of intumescent paint.

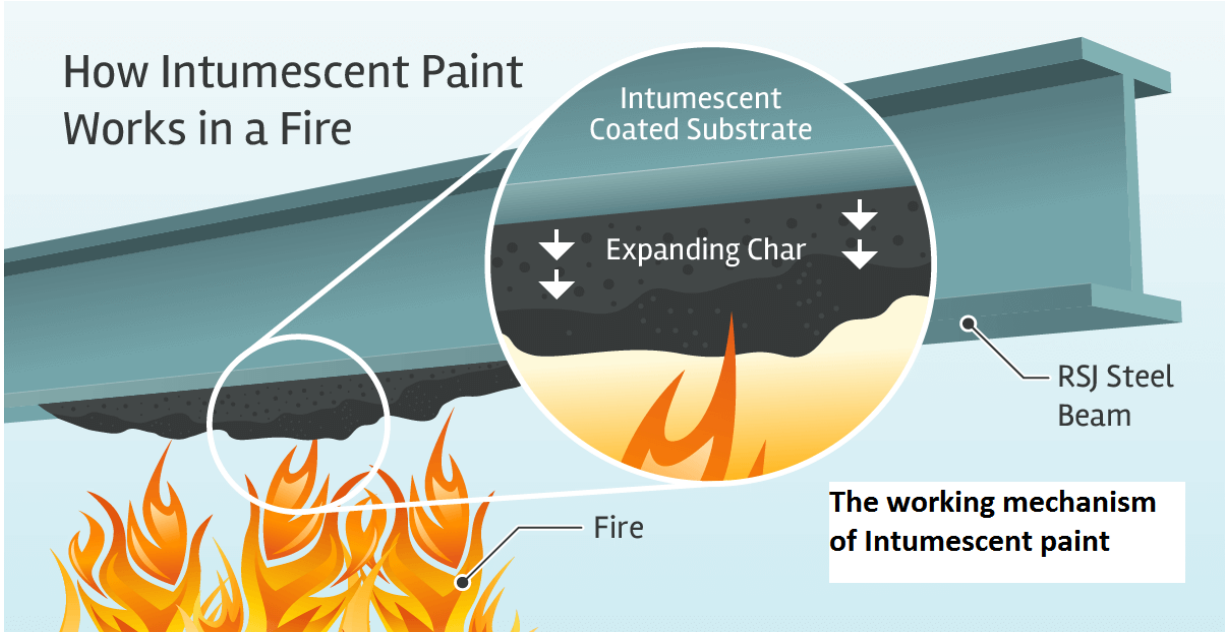

Figure 7. The working mechanism of intumescent paint [25].

3. 2. Fire Resistant Glass

The special intumescent coating is adopted on the surface of the glass. So, when temperature increases then both viscosity and density also increase of the glass surface which is the greatest hindrance for spreading out of the fire [26]. The mechanism of installation of this intumescent coating also uses on the surface of steel girders or columns. And for the cause of swelling property and chemical reaction of the connection of heat, this coating helps to protect this steel structure from fire [27].

4. EFFECT OF FIRE ON FLOOR OR BEAM SYSTEM

The effects of fire on the concrete, steel or timber structure are discussed in small proportion of their corresponding guidelines. So, fire effect related guidelines should be furnished for this corresponding structure.

1) Fire causes deformation of beams and columns and it may happen extra deflection of the slab.
2) At the effect of fire slab or beam may face downward deflection.
3) Fire causes column deformation which is considered as thermal deformation. This thermal deformation may increase the compressive force on this column.
4) The cause of the increased of the axial compressive force of column which creates the unstable condition of this structure.

5) Fire may reduce the modulus of elasticity and yield strength of steel.
6) Fire is liable to increase the thermal extension and the axial compressive force of the column. So, the combination of thermal deformation, dead and live load of slab and extra- axial compressive force may create the permanent downward deformation of the slab.
7) After the fire exhaustion, the column cools down and creates shortening according to its length.

Table 2 shows that some important fire-related incidents.

Table 2. Some important fire-related incidents.

Incidents	Causes	Damages
The Santana Row fire, USA (2002)	Under construction building with incomplete firefighting system. At first, the fire was seen in the roof, then it spread.	Around 500 million dollars [28].
Fire in a textile factory, Alexandria (2000)	The fire started in the middle of the storeroom of this building. This storage room situated in the lower portion of this building. And the fire spread out quickly. A few victims were escaped. After 9 hours, when the firefighters tried to control the fire, then the building collapsed.	Killing 27 people [29].
World Trade Center (WTC) (2001)	Two jet airliners attacked the World Trade Center (WTC). It collapsed due to the impact and generated fire. Both effects (damage and fire) were equally important.	As a result of the attacks on the towers, a total of 2,763 people died. Of the people who died in the towers, 2,192 were civilians, 343 were firefighters and 71 law enforcement officers. Aboard the two aeroplanes, 147 civilians and 10 hijackers also died [30].
Incidents	**Causes**	**Damages**
Fire at KTS Textile Industries in Chittagong, Bangladesh, February 23, 2006.	Caused by a short circuit, there were between 400 and 500 people in the factory. The main gate had been blocked to "prevent theft". There was no fire-fighting equipment, and no drills had ever been done.	61 deaths, about 100 injured [31].
Fire at Sportswear (Hameem Group), Dhaka, Bangladesh December 14, 2010.	Caused by a short circuit.	29 deads and 11 serious injuries [32].
Fire at Tazreen fashion factory, Dhaka, Bangladesh November 24, 2012.	Caused by a short circuit.	112 deads and 200 serious injuries [33].

So, Incendiarism, smoking, fireworks, open flames and faulty electrical wiring are the most common causes of fire [34-40].

5. CONCLUDING REMARKS

Though in recent years, there have been seen many great attempts to protect structures from the fire. So, it is high time to take additional measures to reduce fire-related damage. Many investigations or awareness should be required to protect any kind of sophisticated structures from fire.

6. FUTURE RECOMMENDATIONS

Many case studies were analyzed to detect the actual problem of fire damage. So, probable recommendations are attached according to corresponding case studies.

1) The alternative exit path which can be used only after the fire or any other hazards must not be enclosed to the building interior.
2) This alternative exit path should separate from building interior and having enough space so that people can use it safely.
3) Proper fire protected doors, windows, ceilings are installed at fire-vulnerable areas.
4) Handrails should be provided on the both sides of exit stairs so that people can exit safely.
5) The tank should be filled with water so that this could help to fight with fire.
6) Stair and special exit path should be free of storage.
7) To stop the spreading of fire, any kind of openings in the ceiling or floor should be sealed.
8) For ensuring fire safety construction, dining room should not be placed in the basement floor or dining room should be detached from working area or place.

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