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AN INSIGHT TO MUSEUMS FROM FIRE HAZARDS ASSESSMENT AND FIRE PROTECTION POINT OF VIEW

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A painting, a sculpture or even entire art collection in an art gallery is an invitation to pause and to observe a point of attraction and repose. The immediate encounter between a work of art and the eye that views it may bring a sudden deep rooted intimacy/attachment. A glance into certain master pieces of any museum room brings in a desire for their possession. The atmosphere of repose coupled with astronomical prices of these in six figures brings an element of danger. The hazards that threaten to diminish or destory the often quite intangible 'material value' of a work of art are of all kinds: exposure to light, fluctuations in temperature, humidity, dryness, insects, fire, flooding, theft, vandalism etc. Museums are vulnerable to the wide variety of common occurrences which are responsible for most of the fires. Careless smoking, malfunctioning of heating appliances, faulty wiring and incendiarism together with combustible materials and careless visitors are prime sources of fire occurrences. A fire broke out at Burg Trousmity in 1961 damaging major sections of buildings beyond repair inspite of best efforts of large number of fire fighters. Although with the painstaking efforts it would be possible to recreate outside appearance to the near original without consideration of cost, however it would not be possible to see again the masterpiece work of art. Further the chances of fire disasters increased considerably as arson has become a common social phenomenon almost everywhere in the world due to rise in terrorism and political instability in various countries. The paper covers possible fire hazards, analyses of data received from different museums and an approach towards better fire prevention and protection measures in museums.

INTRODUCTION

The word museum[1], derived, through Latin, from the Greek mouseion, "seat of the muses", was defined by Guillaume Bude in his Lexicon Graeco Latinum (1554) as "a place dedicated to the muses and to study", where one engages oneself in noble disciplines. Today the museum is an institution that assembles, studies and conserves objects representative of nature and man in order to set them before the public for the sake of information, education, and enjoyment.

MUSEUM COLLECTIONS AND HAZARDS

The general improvement in the standard of living achieved during past few decades has enabled affordable class to buy and put a masterpiece in his drawing room. It has therefore become a status symbol and one feels proud when the guests enquire about the price of the art piece. Since the demand is increasing, more and more of these are appearing in the market hence large number of people are getting acquainted and are interested in seeing a variety of collection. Hence they are attracted by museums where collections can be very wide.

The museums own collections can be textiles, vetebrate material, biological collection, ethnographical material, geological material, easel paintings, archival papers, prints, drawings, technology, scientific instruments, decorative art etc.

The art business, which is conducted largely on the art markets has experienced a boom in the last few decades that would have been unbelievable even at the beginning of the century. The buyers[2] may include Paul Getty Museum with a budget of almost $100 million per annum or a Japanese gallery owner who failing to procure the Miro came to London auction to buy Pie Mondrian composition for $ 1.25 million. Since very high profits are at stake to make one's eyes pop, very high risks are involved. The encounter between a work of art and the eye that views it, should be a sacred moment of intimacy. The

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force of attraction should not present any danger to a piece of art or to any museum room. All kinds of dangers are present to damage/destroy the work of art. These are levels of relative humidity, fluctuations in temperature, insects, fungi, micro organisms, dust, dirt, pollutant gases, vibrations, exposure to light, dryness, fire, earthquake, storm, burst pipes, flooding, damage in transit, theft, misappropriation, carelessness, vandalism etc. However, of all hazards, fire is the most serious one, as it can not only destroy/completely with rapid rate/all the archaeological materials, building structure (which may itself be a work of art) furnishings but can also cause irrepairable loss of lives of visitors and staff of the museum. Since annual fire damage in museums has been growing steadily throughout the world, hence appropriate measures should be designed and practised for its prevention and protection.

Museums

All over the world there are more than three thousand museums and art galleries. The USSR heads the list with more than 250 museums, UK and Italy each have more than 170, France and Germany each have about 150 museums and art galleries. Hungary, Romania and USA have more than 100 each. Apart from this there are many countries which have more than 50 museums and art galleries like Austria, Belgium, Bulgaria, Canada, Czechoslovakia, Germany, Japan, The Netherlands, Poland, Spain, Switzerland, Yugoslavia and India. We have tried to collect world wide information on building construction, type of exhibits, fire prevention and control measures and number and details of fire incidences. It is important to mention here that the questionnaire were addressed to the Directors of 150 museums, out of which 40 responded. Some of them are summarised in the Tables.

MUSEUM BUILDINGS AND CONSTRUCTION

Most of the museum buildings are either old buildings made available or new buildings specially designed and constructed for the purpose. Many historic buildings have been constructed using highly combustible materials and seldom have adequate means of egress by today's standards. Open stairways, absence of fire and smoke barriers, compartmentation and other fire protection measures may allow fire to develop and spread rapidly. The buildings specially designed for museums have the provision for different units like exhibition, laboratory, shop, office, class room space, lecture hall, storage space, kitchen and dining space, cloakroom and lavatory space, fumigation rooms and library. Depending on the type of units, the materials used for the construction are sometimes surfaced with wood with or without finish composite boards and plyboards. Panels bounded by wood strips are also in much use specially for false wall (to flush with case fronts). The gallery wall of wood, faced with fabric, is also common. The following materials are generally employed for exhibition spaces ; terrazzo, marble, slate, ceramic tile, several kinds of wood, linoleum and concrete. Asphalt tile flooring is used in exhibition rooms, in corridors and lobbies and in offices and other work places. Cork tiles and carpet are used in exhibition rooms and even in corridors, though their most common place is in library, reading rooms etc. due to their acoustic properties. Nearly all museums use linoleum in offices and curatorial space. Wooden floors over concrete floors are common in exhibition rooms, The use of some of these materials, enhances fire hazards and increase fire load. Therefore, the design of any museum and the type of materials used in its construction are important factors in enhancing the resistance of the building against complete burnout and in restricting the rapid spread of fire, smoke or fumes which may otherwise contribute to loss of lives and property and damage to pieces of art or art collection in totality.

FIRE PREVENTION AND CONTROL

Some of the major fire incidences in museums, which have been reported in the literature are :

1. Munich Crystal Palace on 6th June, 1931.
2. Schlob Jawgonberg Uber Der Jogst in 1963.
3. Bad Orb. (500 year old Church) 1983.

Further, chances of fire disasters have increased considerably as arson has become a fairly common phenomenon throughout the world due to rise in

terrorism and political instability in various countries. Blind faith in own religion coupled with disregard and hate for other religions is also a contributory factor towards increasing trend. Consequently public rath is more on the governmental property or on a particular item which can attract more attention. There can be different causes of fire varying from electrical appliances, wiring, short circuits, smoking, overheated materials, cutting and welding, exposure to neighbouring fire, mechanical sparks and lightning. To minimise occurrence of fire incidences and the losses incurred, better fire prevention and control measures should be adopted right from the design and construction stages of building to the final use.

Building Construction

Before the commencement of construction activity an independent water storage tank with adequate capacity should be provided and maintained at all times. Also the temporary building for construction of offices and storage should be located at safe distances and should be constructed to the maximum possible extent using noncombustible materials. During the construction of building gangways, the ground below the scaffolding should be kept free from combustible materials. Further free access should be available to permanent, temporary, portable first aid fire-fighting equipments, which should be maintained at all times. Complete plans of the museum, the location of fire-fighting equipment and of the surrounding areas must always be available near the entrance and at another suitable place.

Structural Elements and Construction Materials

The structural elements of the museum building should have adequate fire resistance rating depending on fire load, ventilation, window height etc. The openings in separating walls and floors, which are necessarily to be provided to allow cables, should be designed to contain fire. It will be advisable to use noncombustible materials as far as possible in museum building. It has also been observed that in most of the museums the material used for partitions or false walls, false ceilings, floors, roofs are of the composite boards, plywood, timber, plastics and fabrics. These materials should be treated either by surface coating or by chemical impregnation for fire rendering a degree of fire retardance of class I surface spread of flame rating. The materials, which can be used are fire retardant paints and chemicals. Further these can be segregated by putting noncombustible materials in between so that continuity for fire/flame spread is not maintained.

FIRE DETECTION

Early detection and warning system, in case of fire is not only important for the safety of visitors and staff but also for taking first aid fire-fighting measures and for early call of fire brigade before flash over conditions. A study by McGuire[3] of the circumstances surrounding 342 dwelling fire deaths in Ontario, Canada, indicated that the use of smoke detectors could have saved 41% lives.

However, if economy does not permit automatic detection system, manually operated fire alarm system should be provided. Fire detectors may respond to any one or other of the manifestations of combustion such as the generation of heat, smoke and flames. Various type of fire detectors are available for installation in buildings intended for different units and appropriate detectors should be chosen as no single detector is suitable for universal application.

FIRE EXTINGUISHMENT

No fire can develop into a big fire until it is allowed to grow. After detection of fire a very precious time is lost till fire brigade arrives. A lot of property losses can be saved by installation of extinguishing systems in museums. In the absence of sprinklers a fire will spread beyond its origin and the resultant damage can be extensive. Some of the illustrative example of museum fires in which the main factor for continuation of the spread of fire was absence of automatic sprinkler system, are home of Franklin D Roosevelt, National Historic site, Hyde Park, Ny, Jan 23, 1982; Museum of Modern Art, Rio de Janeiro, Brazil July 8, 1978; George Eastman House, Rochester, NY, May 29, 1978; San Diego Aerospace Museum, San Diego, Feb 22, 1978; Henry Ford Museum, Dearborn, Aug 9, 1970; Santa Bar-

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bara, Museum of Natural History, Santa Barbara CA, April 12, 1962.

The extinguishing systems, which are required for museums, are manually operated portable fire extinguishing equipment, fire hydrants, wet/dry riser with hydrants at each floor, and automatic fixed fire extinguishing systems. The extinguishing media may be water, carbon dioxide, halogenated hydrocarbon or dry powder depending upon the display in different galleries or other spaces such as chemical laboratory, library. But in choosing the particular type of extinguisher or system, one should be very particular about the type of displays or the type of units in the museum.

CONCLUSIONS

1. Planning for fire safety of museum shall also take into account the planning of integrated complex, segregation of the museum from other buildings by adequate space, planning of proper roads for heavy fire-fighting vehicle load and safety utility services.
2. Museums, incorporating noncombustible materials and Class I materials for well designed galleries, work places, liftwells, staircases and fire escapes, can provide inbuilt fire safety without sacrificing the architectural integrity or aesthetic appeal of the building.
3. All combustible materials should be stored in a separate building at safe distance from the main building of museum.
4. Laboratories, workshops etc. in the museum with inherent high fire hazards should have separate ventilation and air conditioning system.
5. Air conditioning, ventilation and heating shafts, which may result in spread of fire throughout the building, should be equipped with automatic dampers.
6. Obsolete electrical fittings in old buildings must be replaced and improvised electrical connections should never be used. Further the cables, as far as possible, should be laid in electrical conduits. Electrical installation should be checked at least six times in a year . Heater and hot plate, if used, must be placed on a noncombustible floor or plate and never be in the vicinity of combustible materials.
7. Smoking should be prohibited in exhibit areas, collection store rooms, workshops and laboratories are permitted only in designed safe areas.
8. Activities like welding, paint burning and even sealing of museum locks should only be done under the supervision of a guard equipped with a fire extinguisher.
9. At closing time each day the security staff should check to see that inner doors, especially fire resistant ones, are closed. It will be a good idea to provide automatic security system with fire detection system.
10. Since 500-1000 people per hour may visit the museum area such a crowd may cause panic and chaotic situation in the event of fire, hence a public address system should be provided in the museum so that in any unfortunate eventuality the public can be properly directed. Therefore, to evacuate the visitors from museums efficiently and quickly and to address people for safe refuge area, a public address system together with closed circuit T.V. arrangement placed in a control room must be provided covering galleries and each corner of the museum building. The closed circuit T.V., if can be made operational throughout 24 hours, may also prove operational against attempt of burglary or theft besides fire.
11. Suitable fire-fighting system should be installed, properly maintained and checked for use in emergency. Staff on duty should be trained for fire fighting operation.

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Table – Analyses of fire safety response data of questionnaire on museums

NAME OF MUSEUM	BUILDING DESCRIPTION			FIRE PREVENTION & CONTROL MEASURES			NO. / CAUSE OF FIRE
	PLAN AREA / m² /NO.OF STOREYS	FALSE CEILING	CONSTRUCTION	FIRE DE-TECTION	FIRE EXTI-NCTION / EX-TINGUISHERS	ESCAPE ROUTES / A / C & POWER CABLE DUCTS	
Aberdeen Art Gallery, U.K.	440 / Base + one	Lathe plaster with glass panels in centre	Outer walls -granite, Partitions of brick, Stair of marble brick & concrete	Heat Detectors	16CO_2, 4BCF 6x30 Hose reels	Three / Underground ducts with vertical shaft for power cables	N.A.
Royal Pavilion, U.K.	1858 / Tow	–	Timber & cast iron framing with stucco, Brick with stucco	Smoke detectors, automatic signalling to fire brigade	Portable appliances & water hoses	–	Two / Vandal
Livrust-kammaren, Sweden	4000 / Four	N.A.	Walls of Brick or rock, New concrete construction	Smoke detector Alarm bell	Fire extinguishers throughout the building	Exterior stairway to street / -	N.A.
Lahore Museum, Pakistan	- / Base + One	Thermocole sheets	Walls - Brick, Timber trussed roof, Brick & RCC floor new construction	–	Fire hydrants, fire extinguishers for electrical fires	- / N.A.	Some minor / Electri-cal
Colchester & Essex Museum U.K.	1115 / Tow	N.A.	Stone walls 12'6" thick. Modern roof of brick & concrete	Smoke detector in boiler houses & offices	Water & CO_2 extinguishers	- / N.A.	N.A.
Colonial, Dominion, National Museum, New Zealand	Various / Three	Gib boards with wooden framing	Reinforced concrete frame with brick partition & external stone	Electronic heat & smoke sensors	Mainly sprinkler system, 62 CO_2 & water extinguishers	Exterior stairways / Cables carried by metal conduit	Small fire / Electri-cal
Dunedin Public Art Gallery, New Zealand	3000 / Two	Timber frame and fibrous plaster	Double cavity brick wall, steel roof on timber frame, wooden stair and timber tiles	Evacuation on bells operated by battery	Hand held gas and foam sprayers	One steel exterior stairway / Galvanised iron ducts for A / C & power cables	N.A.
National Museum of Ireland, Ireland	- / One to four	–	Brick & mortar, new prestressed concrete, mosaic floor, stone face	Smoke detectors & alarms	Extinguishers	To be provided	N.A.
Zoologische Staat-ssammlurg, Germany	3500 / Two	N.A.	Concrete frame work, metal curtain wall	Fire alarm systems	Fire extinguisher in each room	Two interior stair cases	N.A.

NAME OF MUSEUM	BUILDING DESCRIPTION			FIRE PREVENTION & CONTROL MEASURES			NO. / CAUSE OF FIRE
	PLAN AREA / m^2 / /NO.OF STOREYS	FALSE CEILING	CONSTRUCTION	FIRE DE-TECTION	FIRE EXTI-NCTION / EX-TINGUISHERS	ESCAPE ROUTES / A / C & POWER CABLE DUCTS	
Seoul National University Museum, Korea	11140 / Base + two	–	Concrete	–	–	–	N.A.
Australian National Gallery, Australia	20,000 / Ten	Hard Plaster or concrete slabs	Reinforced concrete construction	Smoke detector in return air ducts, Computer controlled system to fire station	Sprinkler except for art gallery. BCF or CO_2 extinguisher Hose reel at max. 30m spacing	Interior fire and smoke isolated dampers in A / C ducts. Power cables in metal ducts in concrete	two / Over-heated materials
Victoria & Albert Museum, U.K.	13.5 Acres / Four	–	Steel & brick	106 fire electronic call points –	66 hoses, 240 water, 6 foam, 10 BCF, 52 CO_2 extinguishers, 18 fire blanket	4 exterior & 7 interior satairways	Two / Electrical cutting & welding
S.R. Guggenhem Museum, U.S.A.	- / Seven	Plaster on lath	Poured & sprayed concrete	Smoke detectors	Halogen and ABC extinguishers	110 galvanised metal risers	N.A.
Port Elizabeth Museum, South Africa	1500 / Three	N.A.	Brick, corrugated aluminium roof, Vinyl flooring	Electronic smoke detectors linked to city fire brigade	BCF fire extiguishers and hose reels	1 exterior and 3 interior staircase. Three external doorway / fresh air ducts	N.A.
Alands Museum, Finland	4600 / Two	Fire resistant materials	Brick walls, concrete roof & floor	Electronic smoke detectors	Fire extinguishers and fire hoses	According to Finnish building regulations	N.A.
Narodna Galerija Ljubljana	227742 / Two	–	Brick work	Infra-red & microwave sensors	Fire extinguishers	Side exits / A / C systems	–
Botanischer Garten, Munchen-Nymphenburg, F. Republic of Germany	7500 / One	N.A.	Glass houses	N.A.	N.A.	N.A.	N.A.
Museo Argentino De Ciencias Naturales e Instituto De Investigacion De Las Ciencias Naturales Argentina	12,000 / Five	N.A.	Masonry and RCC	None	CO_2 and Chemical powder extinguishers and water lines	Interior staircases	N.A.

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NAME OF MUSEUM	BUILDING DESCRIPTION			FIRE PREVENTION & CONTROL MEASURES			NO. / CAUSE OF FIRE
	PLAN AREA / m^2 / /NO.OF STOREYS	FALSE CEILING	CONSTRUCTION	FIRE DE-TECTION	FIRE EXTI-NCTION / EX-TINGUISHERS	ESCAPE ROUTES / A / C & POWER CABLE DUCTS	
Swaziland National Museum, Swaziland	- / Single	–	Roof is in timber structure	–	Hose pipe, CO_2 bottles, dry chemical extinguisher	Two / -	N.A.
Museum of Applied Arts Budapest, Hungary	7712 / Ground + Two	–	Brick walls, steel supported wooden roof structure	Smoke & heat sensors	Dust and halogen foam extinguish-ers, fire hydrants around the building	3 main staircases, 7 small, through several floors & linked by corridor system. Three fixed gang ladders stand out of the wall	N.A.
Museu Zoologicoda Universidade Coimbra, Portugal	1300 / Two	–	Solid stone walls 80 cm thick	–	Two fire extinguishers for each room	–	N.A.
Stellenbosh Museum, South Africa	Three buildings are 2 storey & 15 are single storey	Reed & soft plaster thatch, concreted & corrugated iron roofs	Brick & clay or mortar on wooden beoms	–	Automatic water & halogen sprinklers, manual halogen extinguishers	- / In archival store & main entrance	one / Exp. of neighb-ouring fire
The Adler Planetarium, U.S.A.	7432 / Basement + Two	Some metal & accustical tile	RCC	Smoke and heat detectors	Fire extinguishers and hoses	1 exterior, 8 interior staircases & 9 openlings / yes	N.A.
The National Museum of Korea	7226 / Five	–	Steel, concrete and granite building	Closed circuit T.V at central control room	Fire plug & fire extinguishers	6 interior staircases and 5 openings	N.A.
Cotchester & Essex. Museum U.K.	1115 / Two	–	Stone building, brick & concrete roof	Smoke detectors in offices, boiler house	Extinguishers, water & CO_2	Two interior stairways and two openings	–
Anthropol-ogische Staats Sammlung, F. Republic of Germany	449 / Two	N.A.	Brick structure raftered ceiling, wood work with copper coping	–	Fire extinguishers in each room	One interior staircase	N.A.
Salar Jung Museum, India	–	Gypsum boards	Brick Masonry and RCC	Smoke and heat detectors	Extinguishers, hydrants and high velocity water spray system	Interior staircases	Two / -