International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

A Review on Fire Protection: Architect's Role during Construction of Buildings

H. Chinna Saidulu

Head, Department of Architecture, School of Planning and Architecture, Jawaharlal Nehru Architecture and Fine Arts University, Hyderabad-28

Abstract: ***Main aim of this research is to review the fire protection with the architect's role during building construction. For new buildings, management of fire safety should be planned by the architects at the designing stage of fire safety provisions using the engineering approach. The main aim of this research is to analyze role of architects during building construction for fire protection. Further, this study uses the secondary data collection methods. Architects are played an effective role in constructing the building towards fire protection. Some of them are hazard control, system of lightening protection and specification of material are also detailed in the prior literature review. In future, this work can be detailed by collecting the primary source through quantitative approach and conducting suitable statistical analysis on the collected data.***

Keywords: fire safety, architect's role, hazard control, system of lightening protection, specification of material, efficiency of fire safety practices

1. Introduction

Human interests in fire safety dated back from the employment and discovery of fire. The obvious benefits of numerous friendly heat energy usages are often overshadowed by the enormous destructive fire power. Fire is also considered as the potentially life altering threat in public building and this has further created worse situation in many aspects. The fire safety codes of the existing buildings are for protecting against the accidental fires (Chow, 2006). Long evacuation time, direct rescue by the ground applications from the building exterior, direct water application by the firefighting jets, lack of implementing the firefighting techniques like water application, fire ventilation and others are some of the fire safety problems for super tall buildings. In fact, the high heat has released by the new architectural features such as glass constructions causing severe damages to the buildings (Wood et al, 2004). Building maintenance plan, staff training plan, fire prevention plan and fire action plan are some of the plans associated with the fire safety management creates a significant impact on the building construction. Most of the architects are developing the new and leading edge creative curtain wall designs to avoid the fire spread in the buildings (O'Connor, 2008 and Simon, 2012).

The developing and implementing the fire safety management program have the capability to reduce the property insurance premiums and impact the organizational profitability in a higher level (Chow, 2001). Apart from these, the architects have played a significant role in controlling hazard, managing smoking, deliveries and storage, heat producing and warming appliances during construction (International Cooperation, n.d). In some cases, the firefighting systems are installed by the architects to meet the legislative requirements. Further, it helps to achieve the risk reduction for the resilience purpose of business. Regular inspection by the architects has to be carried out for ensuring the proper management of fire safety in an effective manner. So the present study attempts to investigate the architect's role in designing the fire safety mechanism during the building construction.

2. Literature Review

2.1.1 The Architect's role in designing the fire safety mechanisms during the construction of a building:

a) Hazard Control:
In the site of building construction, the noncommercial appliances of cooking like toasters, ovens and microwaves are potential hazards. Architects should have ensured that they are in proper conditions of working and it has not imposed fire hazards (Obi, 2015). Human safeties, spread hazard prevention, accessing the assurance of fire-fighters are some of the requirements dealt by the architects during the building construction (Chow, 2003). At the same time, the architects may never face the structural collapse during the fire and also they have lacking experience in dealing with the fire hazards (Licht, n.d). In fact, the changes to the building codes have driven by architects and others focused on reducing the costs of the construction.

The codes and standards for the built environment have studied by Cote and Grant (n.d). Most of the architects have started to accumulate the information about the fire hazards in the construction of buildings and in the manufacturing process. In fact, the requirement contained in the codes of building have generally based on the materials with the known property, the hazards presented by the various occupancies and the lessons learned from past experiences such as fire and natural disasters. On the other hand, the code of fire prevention includes the fire hazards information in a building and it is usually regulated by the fire official (Darshan et al, 2016). Fire threatens the human life. The architects have played an effective role to design buildings which are capable of protecting the people and their property against the fire hazards. According to Mydin et al (2014), the main electrical

installation and equipment should be inspected occasionally depending on the situation of the building. The authors have pointed out that most of the buildings have not practiced good housekeeping to prevent the fire hazards and maintain the safety standards. In this sense, the material subject to the combustion like oil, paints and mops are obvious hazards.

b) System of lightning protection:

According to Hung (2003), sprinkler system with the unique characteristics of large internal open space have given the adverse effects and it has further essential to ensure the safety of fire and occupants lives with safeguard. Appropriate fire protection system has to be installed by the architects by using attentive design consideration in advance. Omahanna, Basiru and Tinufa (2016) studied the role of design and construction in mitigating fire disasters in Nigeria. The technical interpretation of building with fire safety is to convey the building's fire resistant in terms of hours when subjected to known intensity.

The basis of conventional lightening protection technology has studied by Tobias et al (2001). The components of lightening protection system have received equal attention in the demonstration of their effectiveness. Most of the architects have used the standards of modern lightening protection in order to avoid the fire hazards.

Quiter et al (2012) provides the guidelines for designing the fire safety in very tall buildings. The authors pointed out that the ratings of fire protection and safety factors for structural transfer has evaluated for the adequacy. The architects have used the lightening protection system in the tallest building to prevent the fire in which it consists of protecting steel structural members, upgrading the curtain wall and the automatic sprinkler. Life safety, protection of property, mission continuity and the protection of an environment are the four types of goals identified the desired fire safety performance of the building.

According to Whitepaper (2016), blunt rod lightning protection system has played an effective role preventing the fire in the building. In fact, the blunt rod has remained the safest and most effective means of protecting structures from the fire risks and damage due to the lightning. Zipsee (1994) investigated the advantage and disadvantage of lightning protection systems. The architects have used the lightening protection system to safeguard the persons and property from exposure to lightning. In fact, this system has used the early streamer emission air terminal under several considerations and development.

c) Specification of Material:

A study done by Park (2014) examined the development of a holistic approach to integrate fire safety performance with the building design. The architect's mission starts with given building design features. In fact, the material specification has provided the potential for the collaboration between the fire engineers and architects. The use of rated materials has helped to stop the fire spread in the buildings. Most of the architects have used the rated materials to prevent the risk of fire. Fire protection for structural steel in high-rise buildings has studied by Goode (2004). Fire resistive materials have used by the architects to limit the fire during the construction. Advancements in materials have created the significant impact on the construction industry. There are different methods to achieve the ratings of the fire including directly applied materials which insulate the steel, protection of membrane, block radiation, discharge water and circulate water for structure cooling and others (Chow, 2001). The architects have used the application of insulating materials and this is also considered as the most common means of protecting the structures from fire hazards.

Moreover, the plastic materials with low fire resistance can easily be degraded and this has also used by the architects to construct the wall and roof of the building (Ebenehi, 2016).Insulating board systems have created the significant impact in the application of fire prevention. Aesthetics, steel preparation, installation and quality control are some of the advantage of insulating board systems used during construction to prevent the fire hazards. Architects have considered the materials, system of building and consistent building with the owner's budget. Low quality materials are negatively influenced the building and causes fire hazards whereas the high quality materials are created the significant influence during the building construction (O'Connor, 2012). Combination walls are constructed by the architects due to its fire resistance capacity and durability. The technical specifications provided by the architect have continually updated to eliminate materials which are potential health hazards to construction workers. In fact, the local, national and inter-national codes of building have tried to reduce the fire and smoking hazards in a successful manner (Merritt and Ricketts, 2000).

2.1.2 Review on the efficiency of all the fire safety practices

The study done by Yeung (2007) examined the fire safety legislation in Hong Kong. Several legislations have played an effective role to control the danger from the fire in most of the buildings. Separation of fire and the distance requirements between the buildings have aimed to prevent the spread of fires. In fact the regulation on content flammability and the explosive handling have aimed to keep the fire hazard under the usage of building control (Canovan, 1988 and Walters & Hastings, 1998). The building ordinance (BO) is developed to address some of the key areas such as passive fire protection, active fire protection and the aspects of fire safety management.

According to Newscience (2012), industrial hygiene practices related to the firefighter protective equipment has created the significant impact on the building construction. Some of the fire safety practice has played an efficient role to reduce the firefighter death and injury. Better fire prediction and the techniques of prevention have reduced the accident in the higher level. It was discovered that the new construction materials usage have led to fire propagation , rapid changes in

dynamics of fire and occupants and firefighter with the shorter escape times.

Gordon (2016) studied the efficiency of fire protection systems in major public buildings. Fire hydrant, means of escape, warning system, directional sign in buildings, escape stairs, firefighting equipment and fire detector system are some of the measures for fire prevention played a significant role in reducing the numerous accidents. Apart from these, the firefighting equipments, warning system when fire is detected, employee's nomination for firefighting duties, adequate training, training records availability and the emergency services are some of the variables related to the efficiency of the fire protection systems (Rasbash, 2004). In fact, the operation and maintenance of fire equipment, conducting inspection, taking work precautions and inspection and taking periodic pest control practices are some of the attributes of fire safety management. In contrary, the lack of knowledge on how to use the system of available protection has compounded the inefficiencies.

Wahab (2015) has evaluated the fire management practices in selected restaurant buildings in Nigeria. Dry chemical extinguisher, halon and foam extinguisher, wet chemicals and fire blankets are some of the facilities of firefighting played a vital role in reducing the severe causes in the buildings. According to Hadjisophocleeous and Benichou (n.d), fire prevention practices have made the occupants aware of the proper habits, safe storage procedures of hazardous materials especially flammable materials and procedures for the disposal of safe waste particularly hazardous waste. Moreover, an integral part of the fire safety manual is pointed as the program for providing the occupants with the training and information. Establishment of clear communication lines, responsibilities and accountability are some of the main elements for a successful implementation of fire safety practices. Additionally, the maintenance of fire safety systems are considered as another element of fire safety practices created an impact on the building construction.

Srinivasan and Thirunavukarasu (2015) investigated the usage of GSM Technology in the measurements of fire safety. Management responsibilities, staff-training, routine precautions, fire warning systems, emergency lighting, fostering the efficient working environment, fire safety and security personnel, evacuation management and extension and alterations are some of the practices of fire safety management play a critical role in providing the prevention of fire in the building. The authors have proposed the integration of GSM approach in the fire safety measurements. This has the capability to reduce the manual work involved in the process of fire extinguisher. Key less safety system, robust application with advanced safety and allowance of extensive fire bloom are some of the advantages of using this system to deal with the fire safety provisions. In addition to these, the program of fire safety management has developed in an organized fashion (Bachanan, 1999). Analyzing facilities and fire hazards, develop and implement life safety, fire suppression, reports and record keeping, fire prevention and evaluating effectiveness are some of the sequences in an action plan for developing the fire safety management program.

Siddiqui et al (2014) studied the assessment of fire prevention and protection measures in the buildings of Dehradun city. In particular, the audit of fire safety acts as the effective tool for assessing the standards of the fire safety in an organization. Further, it helps the people to identify the areas for improvement and evolving an action plan. The measurement of passive protection of fire has applied to enhance the capacity of fire resistant of construction material. The plan of fire safety has proposed before laying out the foundation of many organizations (Ansah, 2003). Moreover, the new technologies in fire prevention have introduced to reduce the risks associated with the fire. Fire safety inspections have carried out in every management to prevent the fire and this has appreciated the need for fire safety measures in an efficient manner.

3. Discussion

Table 1: The Architect's role in designing the fire safety mechanisms during building construction

S.NO	Role of Architect in designing the fire safety mechanisms during building construction		
	Hazard Control	Lightening Protection System	Specification of Material
1	Architects have played a significant role to reduce the potential hazards caused by non-commercial cooking appliances (Obi, 2015)	Appropriate fire protection system towards lightning has to be installed by the architects to attain the effective measures. Omahanna, Basiru and Tinufa (2016)	Most of the architects have used the rated materials to prevent the risk of fire. (Park, 2014)
2	Fire risk assessment should be effectively handled by the architects to control the hazards (Mydin et al, 2014)	The architects have used the lighting protection system to limit the fire hazards when compared to other installation (Zipse, 1994)	The architects have used the application of insulating materials which is also considered as the most common means of protecting the structures from fire hazards. (Goode, 2004)
3	Architects have used the fire prevention codes to serve the built environment (Cote and Grant, 2001)	Blunt rod lightening protection technology has used by the architects in the tallest building to protect structures from the risk of fire and damages due to lightning. (Whitepaper, 2016)	Insulating board systems has used by the architects and it has created the significant impact in the application of fire prevention. (Ebenehi, 2016).
4	Most of the architects have used the concrete in the face of the fire hazards more when compared to the alternative	Lightning protection system has created the positive impact in building construction in order to address to the environmental issues in a	Architects have used the high quality materials to overcome the fire hazards during the building construction

	materials. (Darshan et al, 2016)	successful manner (Quiter et al, 2012)	(O'Connor, 2012)
5	Architects have used the fire engineering approach to prevent hazards successfully (Chow, 2003)	The components of lightening protection system have received equal attention in the demonstration of their effectiveness (Tobias et al, 2001)	Architects have adopted the codes of buildings on specification of materials to reduce the fire hazards (Merritt and Ricketts, 2000).

The Table 1 depicts the analysis of architect's role in designing the fire safety mechanisms during building construction.

The architects play an important role in some of the aspects such as structural elements in a buildings, good site layout, service provision in design, well and dry risers, and designs of walls, columns and beams. Additionally, the architect's role is therefore to address the escape routes incorporation, specification of right materials for doors, staircases and floors during his design. In this sense, most of the architects have adopted several codes of buildings on the materials specification to prevent the severe fire hazards. The architect has required to bring together all relevant information in form of byelaws, practice codes and regulations pertaining to the fire safety of buildings. In particular, the architect has the capability to address the issues pertaining to the potentials of detection and notification in and around the building. Architects need to communicate with the fire professional across the world to update their knowledge in the management of fire safety in building construction.

4. Conclusion:

This research has reviewed some of the roles of architects for fire safety while constructing the building. The study, hereby recommends that in order to achieve the practices of efficient fire management, its proper design from the design stage should be carried out. Also, the installation, use and maintenance of firefighting facilities should be done according to the specification of manufacturers. It was also predicted that the appreciable number of personnel had knowledge in handling the facilities of installed fire-fighting and underwent periodical training in a successful manner. Applying appropriate coatings for fire protection to give a longer period of fire resistance should be also applied to prevent the accidental fires during the building construction. At last, different buildings have different layout and occupants characteristics, therefore, the scheme of fire safety management need to be building-specific to reduce the severe damages.

References

[1] Ansah P. M. (2003) Fire Safety Guide, the McMillan Press Ltd.
[2] Bird S N et al (2013), Development of a Fixed Firefighting System Selection Tool for Improved Outcomes, Journal of Information Technology in Construction, Vol-18, pp 353-371.
[3] Buchanan A H (1999), "Implementation of performance based fire codes", Fire Safety Journal, Vol. 32, No. 4, pp. 377-383.
[4] P. Canovan (1988), "Legislation on fire safety; Limits and achievements", Interflam, pp. 209-212.
[5] Chow W K (2001), Review on Fire Safety Management and Application to Hong Kong, International Journal of Engineering Performance Based Fire Codes, 3 (1), pp 52-58.
[6] Chow W K (2003), Fire Safety Engineering and Potential Application of Fire Models, International Journal on Engineering Performance Based Fire Codes, 5 (4), pp 92-102.
[7] Chow W K (2006), Fire Safety Provisions For Supertall Buildings, International Journal on Architectural Science, 7 (2), pp 57-60.
[8] Cote A E and Grant C C (2001), Codes and Standards for the Built Environment, Safety in the Built Environment.
[9] Darshan et al (2016), A Critical Review on Fire Resistance Structures, International Journal of Current Engineering and Scientific Research, 3 (3).
[10] Ebenehi, I.Y. ... et al., 2016. Fire safety education and training I architecture: an exploratory study. IN: Proceedings of joint international conference - 21st Century Human Habitat: Issues, Sustainability and Development, Federal University of Technology Akure, Nigeria, 21-24 March 2016.
[11] Goode M G (2004), Fire Protection of Structural Steel in High-Rise Buildings, Buildings and Fire Research Laboratory, Maryland.
[12] Gordon A K (2016), The Efficiency of Fire Protection Systems in Major Public Buildings in Ghana: A Case Study of Selected Major Public Buildings in the Sunyani Municipality, Ghana, International Journal of Innovative Research and Development, 5 (9).
[13] Hadjisophocleeous G V and Benichou N (n.d), Fire Safety Design Guidelines for Federal Buildings, Retrieved on 26 December 2016 from http://www.cfaa.ca/Files/flash/EDUC/FIRE%20ALARM%20ARTICLES%20AND%20RESEARCH/FIRE%20SAFETY%20DESIGN%20GUIDELINES%20FOR%20FEDERAL%20BUILDINGS%20pg65%20a4409.2.pdf
[14] Hung W Y (2003), Architectural Aspects of Atrium, International Journal on Engineering Performance-Based Fire Codes, 5 (4), pp 131-137.
[15] International Corporation (2011), Improving Fire Safety in Buildings, Retrieved from http://www.kenken.go.jp/english/contents/topics/japan-journal/pdf/jj2011aug_09-11.pdf
[16] Licht R (n.d), The Impact of Building Code Changes on Fire Service Safety, Retrieved on 26 December 2016 from http://www.firesafenorthamerica.org/wp-

content/reports/The_Impact_of_Building_Code_Changes_on_Fire_Service_Safety.pdf
[17] Merritt F S and Ricketts J T (2000), Building Design and Construction Handbook, R.R.Donnelley and Sons Company.
[18] Mydin M A O et al (2014), Evaluation of Imminent Fire Hazards of Inheritance Ancestral Temple and Mansion in Georgetown, Penang, E3S Web of Conferences, Vol-3.
[19] Newscience (2012), Fire Safety: Overview, New Science Fire Safety Journal, Vol-1.
[20] Obi A N I (2015), Fire Protection: Architect's Role During Construction of Buildings, Civil and Environmental Research, 7 (7).
[21] Obi A N I (2015), Fire Protection Measures in Buildings: The Architect's Design Role, Civil and Environmental Research, 7 (7).
[22] O'Connor H (2012), Architectural Services During Construction, Perkins+Will Research Journal, 4 (1).
[23] O'Connor D J (2008), Building Façade or Fire Safety Façade?, CTBUH Journal, Issue:1
[24] Omahanna S et al (2016), The Role of Design and Construction in Mitigating Fire Disasters in Housing in Nigeria, Journal of Good Governance and Sustainable Development in Africa, 3(1), pp 73-84.
[25] Park H (2014), Development of a Holistic Approach to Integrate Fire Safety Performance with Building Design, Retrieved from: https://web.wpi.edu/Pubs/ETD/Available/etd-012414-110344/unrestricted/HPark.pdf
[26] Quiter J et al (2012), Guidelines for Designing Fire Safety in Very Tall Buildings, Society of Fire Protection Engineers.
[27] Rasbash D.J (2004), Evaluation of Fire Safety, John Willey and Sons, West Sussex, England.
[28] Siddiqui N A et al (2014), Assessment of Fire Prevention and Protection Measures in Group "C" Buildings of Dehradun City, International Journal of Occupational Health and Safety, Fire and Environment- Allied Science, 1 (1), pp 17-19.
[29] Simon (2012), An investigation into the fire safety management of historic buildings. Sheffield Hallam University Built Environment Research Transactions, 4 (1), 24-37.
[30] Srinivasan J and Thirunavukarasu M (2015), A Study on the Usage of GSM Technology in Fire Safety Measurements, International Journal of Emerging Technology in Computer Science and Electronics, 12 (4).
[31] Tobias J M et al (2001), The Basis of Conventional Lightning Protection Technology, Retrieved from: http://www.lightning-risk.org/pdfs/TheBasisofConventionalLightningProtection.pdf
[32] M. Walters and E.M. Hastings (1988), "Fire safety legislation in Hong Kong", Facilities, Vol. 10, No. 9/10, pp. 246-253.
[33] Wahab A B (2015), Evaluation Of Fire Management Practices In Selected Restaurant Buildings In Osogbo, Nigeria, Journal of Multidisciplinary Engineering Science and Technology, 2 (9).
[34] White Paper (2016), Blunt Rod Lightening Protection Advantages over Non Conventional Approaches, DEHN, Inc, Germany.
[35] Wood A et al (2004), Immediate Action in Providing Fire Safety in Cities with Dense High rise Buildings: The Possibility of Incorporating Skybridges, Shenyang-Hong Kong Joint Symposium on Health Building in Urban Environments' 2004.
[36] Yeung C H (2007), Review of Fire Safety Legislation in Hong Kong, International Journal on Engineering Performance Based Fire Codes, 9 (4), pp 177-182.
[37] Zipse D W (1994), Lightening Protection Systems: Advantages and Disadvantages, IEEE Transactions on Industry Applications, 30 (5).