TOWARDS FIRE SAFETY AND SECURITY IN GRILLS HOUSING: A REVIEW OF APPROACH.

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Abstract

Fire is one of the most deadly calamities that consume life and property within the glimpse of an eye. The manner, magnitude and period within which fire occurs vary, and dependant upon the circumstances that lead to such inferno. Residents seldom got trapped into such infernos for obvious reasons, and the situations worsen when access to rescue mission is minimal, thus making it rather impossible for victims and rescue effort to succeed. The use of grills (Doors and Windows) popularly known as Burglary proof grills in housing often serves as a strong barrier to effective rescue operation in emergency situation such as fire vis-a-vis the security protection it offers against intruders has been an issue of great concern to the scholars as well as professionals in the built environment. The need for well articulated and innovative building designs and materials in balancing the two can not be over emphasized. This paper aims at providing an insight into this contentious issue and providing an avenue for reviewing the strategies needed to adopt in designing and fitting grills in housing for enhanced optimum security and safety for the inhabitant and also serves as better alternative in emergency situations. This paper further highlight on the need to evolve the time adjustment model for both the rescuers and the trapped on high rise housing fires for grills fitted apartment.

Keywords: Fire Safety, Security, Grills, Housing

1. INTRODUCTION

Housing is a basic human need for shelter for human activities. It improves the well being of the people and contributes to economic development by integrating social factors into the economic system. It is a product of human enterprise and a key sector of the economy that is a pre-requisite to national socio-economic development. The housing sector plays a unique role in the development process. It is considered both a prerequisite for, and an objective of, development (Onibokun, 1983; United Nations, 1992; Salau, 1990). Housing should be free from all sort of criminal activities so as to accord the inhabitant the opportunity of realizing

the full potentialities of qualitative housing as enshrine within the united nation context of adequate housing.

However, in an effort to have personal safety and that of the property, residences are normally designed and fitted with burglary proof devices to act as a barrier to potential burglar especially in a high density low amenity residential neighborhood as a result of its higher degree of successiveness to crime and other social vices. These barriers are increasingly becoming a source of concern because of its resultant effect on emergency situation such as fire. Fire has claims a lot of lives and property some of which is as a result of non accessibility to the trapped victims. Most buildings with iron-grill windows are without the fire escape features they are supposed to have. Time and again, trapped occupants are seen crying out for help behind window grills of burning buildings while firemen and onlookers from the streets are powerless to rescue them.

The poor victims ultimately perish in the fire. The whole scene is emotion-wrenching. During the Dec. 19, 2010 fire that gutted a five-story pension house in Tuguegarao City, some of the 15 victims were reportedly trapped behind window grills (Philippine Daily Enquirer, 2011). Averages of 371,700 home structure fires per year during the five-year-period of 2006-2010 in the United States of America have been recorded. These fires caused an estimated average of 2,590 civilian deaths, 12,910 civilian injuries, and $7.2 billion in direct property damage per year. Almost three-quarters (71%) of the reported home structure fires and 84% of the fatal home fire injuries occurred in one- or two-family homes, including manufactured homes. The remainder occurred in apartments or other multi-family housing (Marty Ahrens, 2012). The increasingly challenging situation fire carnage poses to the overall survival of mankind is attracting global attention on the need to devise appropriate preventive as well as responsive approach. This is through both building designs, construction materials and other method needed to tame the magnitude of this inferno. For instance cooking equipment is the leading cause of home structure fires and home fire injuries. Smoking materials are still the leading cause of home fire deaths. Half of all home fire deaths result from incidents reported between 11:00 p.m. and 7:00 a.m. One-quarter (25%) of all home fire deaths were caused by fires that started in the bedroom; another quarter (24%) resulted from fires originating in the living room, family room, or den; and 15% were caused by fires starting in the kitchen. Almost two-thirds of home fire deaths resulted from fires in which no smoke alarms were present or in which smoke alarms were present but did not operate. Compared to other age groups, older adults were more likely to be killed by a home fire.

These estimates are based on data from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual fire department experience survey.

Fire resilience designs in form of fire engineering have been suggested to carter for the increasing fire incidences as against the conventional design which is prescriptive based approach. It was initially targeted for complex and specialized properties; nevertheless its significance to high rise housing estate has since being acknowledged. It is 'the use of engineering principles for the achievement of fire safety' (British Standards Institution, 2001, 2003). As an engineering discipline, fire safety engineering is relatively young, and it has been accepted as an alternative means of meeting the functional requirements of the UK building regulations (Great Britain, 1985a) since the publication of the 1985 edition of Approved Document B (Great Britain, 1985b). While fire engineering was originally the pioneering method of enabling the successful design of buildings such as airports and enclosed shopping centres, such practice is now commonplace. The new frontier for fire engineering design includes the design of very tall buildings (Wilkinson P. et al., 2012). Projects such as those described by Hannah, Daniels, and Russet (2003), Lam (2007) and Kennett (2007) demonstrate innovative designs incorporating the use of elevators for rapid evacuation of occupants during a fire, etc. Another area where fire engineering is beginning to make an impact relates to the sustainable construction agenda. Charters (2007) suggest that fire safety in buildings contributes to all aspects of sustainability and can help address the balance between protection of the environment and prudent use of natural resources.

While efforts are continuously being harnessed to improve on the resiliency of buildings to fire and the use of grills is in serious contention as to the degree of life threatening exposure in emergency situations. Personal security has equally being an issue to any housing development especially in the developing countries where fitting a grill is a necessity for security purposes. For example in Malaysia the issue of personal safety is an aspect of the national agenda that is very important and is, accordingly, given due emphasis in the 10th Malaysia Plan. Various strategies have been drawn up to shape a living environment and community that is safer, and therefore more attractive. The government is aware that the effect of crime has not only affected society adversely, it is also endangering the national economy. In view of this, the government has initiated various programmes towards reducing the crime rate and creating a living environment that is safer and more pleasant. The Hierarchy Theory of Maslow declares that the element of security as the second requirement

which is sought in life. The importance of security in life attains prominence once an individual has fulfilled his or her physiological needs, such as shelter, food, clothing and so forth (Maslow, 1954).

2. SAFETY AND BUILDING DESIGN

Residential fire disaster can ruin and destroy a whole family inspite of the causative circumstances and condition within which such fire originates. Figure 2.0 is a fire gutted house in Harlow, Essex United Kingdom that happens in November 2012 which has killed all but left only the surviving head of the family. The possibility of getting trapped by fire as a result of burglary grills should be given adequate attention in building design concept for its resultant effect on both the victims and their families. Figure 2.1 is a house in fire at Taman Pelangi Indah, Johor Baru, Malaysia in which the victim 'inset' was trapped "She ran upstairs to the master bedroom to escape but the doors to the balcony in the room were secured with padlocked grilles"(Lowyat.NET, 2012).

Design is an important and critical component of a building that plays significant role in shaping the performance out put of any structure. To be effective, safety in buildings needs to be integrated into the early stages of the design process. Construction documents should facilitate the understanding of building safety requirements by those involved in the design and construction of buildings. Safety errors in building design can be corrected much more easily at the design stage rather than on site or after completion (Al-Homoud, 2004). Implementing safety measures early in the design stage can reduce unnecessary hazards in buildings.

Accidents are often rationalized post hoc by blaming the victims' carelessness, but people ignore the efforts needed to determine genuine causes (Kalin, 1994). Furthermore, some tragic accidents and injuries happen when people deviate from well-known published requirements. For example, residents erect window barriers that prevent escape in case of fire. Critical time is lost by firefighters when looking for alternatives to windows blocked with steel barriers. Accidents usually occur not because people do not know how to prevent them, but because available knowledge is not applied properly (Brown, 1995). Building-related accident prevention steps start at the design stage. However, designers rarely take formal safety education or training, and they do not use the 'safety' resources applied by safety practitioners. Therefore, effort should not focus on motivating engineers to include

safety measures in their designs, but rather on methodologies available for their use (Main and Frantz, 1994).

The primary goal of fire safety is preserving life; life safety with no permanent damage to health. Thus, buildings must be designed so that in the event of fire, the occupants can remain in place safely, evacuate to another part of the building where it is relatively safe or totally evacuate the building without exposed to unhealthy, hazardous or untenable conditions. The life safety also concern with the life of fire fighter. Fire fighter is expected to assist in evacuation, rescue and prevent extensive uncontrolled spread of fire. Therefore appropriate fire resistance levels are needed to facilitate safe fire fighting for the purpose of controlling the fire and evacuation. The building must be able to resist progressive collapse both inside and outside the building during the time required for fighting the fire. Properties although not as important as lives, take an essential part of the well being of society. Property protections to a building include protection of the structure and the fabrics of the building and protection of the contents of the building. However properties protection will take social aspect such as protection from fire to adjacent buildings, interruption in business activity and public image.

3. FIRE SAFETY IN HOUSING

In most cases Fire in a residential housing often involves more than one unit. Many building occupants may be affected. Depending on the setting, layout plan, the housing compatibility and density, not withstanding the dense nature of apartment living allows for the spread of smoke, heat, and fire. Fire is always unexpected. Preparing for it should be paramount. Responding to a fire requires quick decisions and fast actions in a setting that can be loud, smoky, dark, and hot. Lives and property can be saved by being prepared before fire strikes. For instance; The Seattle Fire Code and Washington State Law establish fire safety regulations for multi-residential housing. These rules require property owners to develop a fire emergency guide for tenants. They also require that tenants be informed about the fire protection equipment in the building.

In Malaysia as reported by Zainudin et al., (undated) the Jabatan Bomba dan Penyelamat Malaysia statistical report for the year 2001, 62 deaths were reported due to incidents of fire. Incidents of fire reported were in housing, industrial, garages, offices and shops with

substantial loss of property worth in excess of RM 500 millions for the year 2001 in Malaysia.

Some of the characteristics of fire include:

- Fast: Once a fire begins to flame it can double in size every 30 seconds. At this rate, a room can become fully involved in minutes.
- Dark: Fire produce large amounts of thick, black smoke that obscures vision, causes nausea and may even lead to unconsciousness or death. Three out of four people who die in residential fires die from smoke inhalation.
- Hot: A fire can cause the temperature at ceiling level to reach excesses of 1200 degrees Fahrenheit, at just 5 feet it can be 800 degrees. At this temperature, the superheated air will burn your lungs.
- Unpredictable: Each fire is unique. Some may smolder for hours filling a room with smoke. Others will burn at exceedingly high temperatures, consuming everything with flames.

3.1 CAUSES OF FIRE IN HOUSING

The settle fire department reported an average of 150 residential fires in a year with a substantial loss in both life and property. These fires were normally caused as a result of an action or in action of the household or in other cases from other source. However, the following are the leading cause of home fires;

Cooking: In the United States, cooking is the leading cause of home fires. In Seattle, cooking causes more fires than any other source. Over a third of all fires in multi-residential buildings started in the kitchen. The majority of these fires began from food left unattended on the stove. The most common materials ignited are grease, oils, and flammable items such as plastic bags and paper products left on or near the stove. Cooking equipment is the leading cause of home structure fires and home fire injuries. Smoking materials are still the leading cause of home fire deaths (Marty Ahrens, 2012).

Heaters: are among the leading cause of fires in residential buildings especially in Europe and America. As would be expected, most heating-related fires occur during the winter months when heaters get turned on and the use of portable heaters and fireplaces increases.

Fires caused by furniture, bedding, and other materials placed too close to baseboard heaters and portable heaters are the most common types of heating-related residential fires.

Smoking: Residential Fires started by smoking materials cause more fatalities than any other type of fire. A report of home fires between 2001 and 2004 showed that smoking was the cause of 45% of all fatal apartment fires (USFA 2006).

Out door grills: Most grill fires occur during the summer months. The leading ignition factors in grill fires are mechanical failure or malfunction, combustibles placed too close to the heat, and cooking left on the grill unattended (USFA 2002).

Candle: The most common mistake people make when using candles is placing them near combustible materials (such as drapes, clothing, bedding). Most candle fires occur during the months of December and January.

Cloth driers: Each year, there are around 12,700 clothes dryer fires in residential buildings in the U.S. Failure to clean the lint screen is the leading factor contributing to clothes dryer fires in apartment buildings.

There are three important phases of actions in order to minimize fire hazards:

- Fire prevention,
- Fire protection, and
- Safety awareness and education.

Fire prevention requires that the building's layout, structure, materials, contents, equipment and systems must be designed, selected and maintained in such a way as to render them as free as possible from being causes of or aids to combustion. Fire prevention measures start at the design stage and must then be realized by making sure that construction complies with the approved safety measures. Completed buildings, therefore, should be checked for significant revisions or alterations in construction and/or occupancy that might affect safety. Fire protection involves fire detection, control and fighting. Fire protection necessitates the development and use of design methods for detecting and controlling fires to limit the probability of damage from fire, if one starts. A fire-detection system is an installation where detectors are connected to a control unit and where signals are transferred from each detector to the control unit. These devices include warning alarms for occupants, activated door-closing systems and fire-extinguishing systems. There are different types of fire/smoke detectors such as gas detectors, smoke detectors, flame detectors and heat detectors. Optimum fire protection depends on many factors, such as the size and complexity of the

building materials being handled, the accessibility for fire fighting, the potential for spread and escalation of fire, the potential for the exposure of people to injury or loss of life, and the effectiveness of fire-protection systems such as fire extinguishing systems, smoke control, and smoke- and heat-venting systems. Finally, occupants and users of buildings must be made aware of safety measures, fire prevention/protection methods and systems available in buildings, and continuous awareness or training programmes should be conducted for their education in matters related to fire safety.

4. FIRE SAFETY APPROACH

In Italy, current trends in fire safety are moving away from a reliance on prescriptive regulations in favor of an approach which sees fire as a risk to be considered in terms of its probability. This view calls for the development of alternative methods for fire prevention and protection capable of providing an "equivalent safety" level based on assessments of the actual risks applying in each individual case (Aiello, et al., 2002).

In Hong Kong Life safety in fire emergency is a major public concern, in particularly as a consequence of several big fires in old high-rise buildings over the past 10 years (K.H.Woo, 2006). The causes of fatal fire loss are mainly related to misuse of buildings, lack of proper maintenance of fire service installations, substandard building facilities, damaged smoke stop doors, obstruction of the means of escape and emergency exits (W.K.Chou et al., 1997; Wang and Lau, 2007). Although one of the remedial actions proposed for old buildings is to implement a proper fire safety management procedure, improvement work for fire safety measures in these buildings is still a must (Wang and Lau, 2007)

Currently in Malaysia, fire-resistance design philosophy is based on a prescriptive approach. The
behaviour of structures is evaluated based on the critical members subject to a standard ISO 834 fire where it is normally expressed in units of time. The required time for fire resistance is usually expressed in terms of multiples of 30 minutes: for example 30, 60, 90 minutes, related to ISO Standard fire.

Uniform Building by-Laws Malaysia adopted these standards and prescribe fire resistance time where members are not allowed to exceed their failure criteria. Regulation required certain elements of structure to have fire resistance depends upon such things as size, use of

building and function of the element. When exposed to fire, all commonly used structural materials lose some of their strength, for example, concrete can spall exposing reinforcement, timber sections deplete by charring and steel members eventually lose strength7. Therefore, according to prescriptive based structural materials has to be protected against fire for required time of fire resistance. Generally, prescriptive approaches are the results of regulation, insurance requirements, and industry practice or company procedures.

Increased understanding of fire and the development of fire safety engineering have opened up possibilities for a more flexible approach to fire resistance. Thus, the combination between performance based and prescriptive based will further enhance the reliability of Fire Safety Engineering. In practice, various safety factors were implemented in design of a building. Rationally, the probability of the building to face natural disaster such as fire and earthquake are unlikely to happen everyday. In reality there are buildings that are not exposed to any disaster throughout its entire life. Furthermore, protection based on standards rather than actual hazard is costly. Therefore, in rational approach to fire safety in building, all factors including the location, the used, available resources and the probability of disaster of the building had to be considered.

According to CIB W014 Fire Group, a rational system for fire safety of a building requires the safety objectives to be identified explicitly. Fire safety objectives identified for a specific project must also be the basis for the specification of the fire resistance property. Modern fire safety design of buildings takes into account both the buildings (materials, layout) and the occupants therein. A critical step in the design is to develop characteristic data for the design for example, what and who will be in the building when fire begins. Fire Safety Engineering had to be applied in design stage, occupancy stage and during fire stage, where all fire safety objectives and possibilities were considered. Fire resistant performance aspects can be divided into Fire Detection, Smoke Separation, Fire Separation and Structural Reliability. Fire detection is one of prescriptive based function that can be integrated in the fire safety engineering. Fire detection using smoke or heat detector will give an early warning to occupants and this will ensure speedy egress out of the harm. Fire detected in early stages is very important because it will ensure the prevention of fire. When the stage of fire is past the point of flashover, prevention as a prescriptive based will change to fire safety measures by combination performance and prescriptive based. Smoke separation will ensure that the

spread of smoke is prevented or restricted because smoke can move very quickly over large distanced in a building and fire separation will ensure that the fire including the smoke and heat cannot move or spread from Point A to Point B within specified time period. The prevention can be achieved in implemented the compartmentation in buildings by using fire resistance doors and walls. Structural reliability will ensure that the structural system of a building continues to operate effectively for the full duration of a fire or other actual environmental conditions encountered in the building.

The rational approach will ensure all the fire safety engineering objectives listed below accomplished:

• Building compartmentation and fire ratings for fire and smoke containment
• Probability analysis and risk assessments
• Occupant behavior in fire situations
• Fire detection and alarm systems for early detection of smoke and activation of alarms.
• Assessment of anticipated fire loads
• Smoke hazard management systems for control of smoke within the building
• Emergency warning systems for early warning to building occupants
• Active fire protection systems such as fire sprinklers for control of fire spread and products of combustion.
• Egress provisions, egress times and travel distances
• Fire Brigade access and fire fighting provisions.

5. GRILLS HOUSING AND SECURITY

Home of residence is one of our most valued possessions and in today's risky world guarding the home is our first priority. It is important to save our house from a misshape that might occur on account of fire, theft, burglary, intrusion etc. Today we have access to an array of electronic products and gadgets for personal and residential security which can alert us of the potential danger well in advance and also help us combat the threat to our safety (Bapat, 2011). The effectiveness of security system depends on the nature of the property and the management controls in place.

Grills in housing is a pre-fabricated materials normally made of metal in form of iron fitted on the door, window, balcony or stair ways in order to provide and enhance security and safety of a building especially against unauthorized intrusion. It has always been given adequate attention in building finishing of residential housing particularly in the developing

countries, and within a high density residential neighbourhood for its inherent exposure and susceptibility to security issues. It is consider as an item in housing security studies of low income residence for its continuous occurrence in a security evaluation strategies of housing. This is as attested by the study of Anuja Bapat, 2011 on the safety aspect of Co-operative Housing Societies in Kalyan Dombivli Muncipal Corporation- Maharashtra, India. The use of grills for doors, windows, and balcony has been captured in her studies to indicate how significant it is in housing security issues. In the study it was discovered that most of the housing do not have the required safety measures like: - Wing wise entrance grill, Grill for balcony, Main entrance gate among others (Bapat, 2011). It was further discovered that, the majority CHS have taken care of Wing wise entrance grill, Building terrace with door and proper lock system and Electric meter box properly guarded, as the part of safety measures. More so, some recurring housing security tips in order to reduce the chances of being burgled include:

Secure your home: Fit or upgrade window and door locks, install an alarm system etc. Keeping a home well maintained also makes it look more secure.

Keep property out of sight: Ensure that any property a burglar might be interested in isn't visible from the street.

Don't make it easy for burglars: Make sure that any equipment that could be used by a burglar to climb or break into your home, such as ladders or dustbins, are locked away.

Mark your property: Marking your property with the house number and postcode will make it easy to identify and therefore less valuable to a burglar.

Control that enters your home: If you live in a block of flats, student accommodation or a house in multiple occupation you should install an entry phone or other entry system as a way of controlling who can enter buildings.

Don't give burglars somewhere to hide: Make sure your home is visible to your neighbours. You can achieve this by pruning or removing shrubbery, trees or bushes or installing lighting. Remember, a burglar doesn't want to be seen!

Reduce opportunities for burglary: 80% of recorded burglaries are thought to be committed by opportunists. Ensure you always keep windows and doors locked and use any security measures you have even if you only go upstairs or outside for a short time. It only takes a moment for a burglar to enter your home through an unlocked door or window.

Make your property look occupied: If you leave your home empty leave a light on or even a television or radio. Timer switches can be use and will ensure that lights are on in your home even when you are away.

6. SECURED GRILLS AND FIRE SAFETY

Practically, buildings are adapted to demands of accessibility, but not to the same extent of emergency evacuation safety (Lena, et al., 2010).If windows have security bars, it is important that residents understand how to open them for evacuation. Serious incidents have occurred where people have been trapped and died in fires because the security bars were permanently fixed or did not have quick release devices.

Every resident should understand and practice how to properly operate locked or barred windows and doors. Locked or barred doors should operate quickly and easily. Windows and doors with security bars should have quick-release devices to allow them to be opened immediately in an emergency. If the security bars are permanently fixed or do not have quick release devices, they should be replaced or retrofitted with release devices which meet Fire Code requirements

Security bars can help keep a house safe and secured from burglars, it can equally trapped one in during emergency circumstances (NFPA, 2002). A fear of crime drives many people to install security bars and other devices on their windows and doors to prevent intruders from entering their homes. Often people take these security measures without considering fire safety or how they will escape their homes in the event of a fire. As a result of these bars, serious incidents have occurred where people have been trapped and died in fires. In 1993, two multiple-death incidents prompted closer attention to this apparently growing problem. Seven children died in a Detroit house fire and eight family members perished in Mississippi. More incidents followed. In October 1995, five children died in an Oakland fire blocked by a locked door and steel bars on the windows. Four children ages 6 through 12 were killed in an early morning house fire in Ybor City, Florida, February 1997. In April 1997, nine people died in a house fire in Palo Alto, California. A father of three died in a Boynton Beach, Florida, house fire in 1999. Also in 1999, a grandmother who initially escaped a fire went back in to rescue her two grandchildren (NFPA, 2002).

All three perished when burglar bars prevented their escape. In all of these incidents, security bars on windows and locked doors prevented escape from the fire and inhibited fire fighters' rescue attempts. In the United States most of the fires involving security bars occur in low-

income communities among people already at risk for both crime and fires, NFPA Center for High-Risk Outreach created the Home Security and Fire Safety Task Force to address this issue.

There are some model programs aimed at reaching these high-risk groups and reducing the number of injuries and deaths related to fires. One highlight is an outreach program sponsored by the Fort Lauderdale Fire and Rescue Department. A sidewalk survey was conducted to identify all the homes with security bars and a notice was sent to the residents informing them of the fire safety hazards along with names of a recommended installer who could provide retrofitting or new bars with release devices. Eight hundred properties were cited and 80 percent of them went before the Code Enforcement Board. Community block grant money was offered to help with the cost for low income residents. The program has been very successful and to date more than 400 homes are now in compliance with local codes. Another innovative program has been in place in Oakland, California. It is a cooperative agreement involving the Oakland Fire Department, State Farm Insurance and a local housing group. Funds are made available to local residents to retrofit or replace permanent security bars with ones having release devices. A public education campaign was also conducted to promote fire safety messages, which included presentations in schools, videos, brochures, and bus boards.

The Los Angeles Fire Department has recently begun an outreach program focusing on fire safety including the dangers of security bars. A series of successful community meetings have been held and a comprehensive brochure has been developed. Other efforts include the adoption of local ordinances or the passage of state laws requiring the use of some type of release device on windows and doors identified for emergency escape. The state of California has passed two laws - one requiring the use of releasable security bars on all escapes windows and the other requiring the labeling of all security bars with safety information. Texas and Mississippi also have security bar legislation.

Fire safety provision should be an integral part of design provision and guide lines such that the materials of construction should be of adequate resiliency. The design should accommodate issues of safety zones and evacuation procedures. However, in the event of an uncontrollable outbreak involving housing with grills, the following are ideal recommended rescue strategies:

- Use emergency release devices on barred windows and doors.

- Make sure everyone can operate release devices.
- Have working smoke alarms and test them monthly.
- Make an escape plan and practice fire drills in the home.

7. DISCUSSION

While discussing the observed literature gap in an effort to elicit a further research on the fire rescue mission in housing fitted with burglary grilles it is pertinent to give credit to those scientific researchers on fire safety. Howard Emmons is now regarded as the father of modern fire science. His efforts lead to the Fire Research and Safety Act of 1967 and the formation of the Fire Centre at the National Bureau of Standards. A similar process followed the war in the United Kingdom through the Fire Research Station at the Building Research Establishment (BRE) and in Japan through the Building Research Institute (BRI). Notable are the scientific contributions of Thomas and Kawagoe (Torero, 2006).

The post war efforts lead to dramatic progress in the understanding of fire and the recognition of the vulnerabilities inherent to prescriptive design of infrastructure. Scientifically based tools that quantify fire growth, its impact on buildings, fire detection, smoke management and suppression followed (Bard, 2004). These tools strengthen the believe that building design can include elements of performance. Thus performance-based design alternatives for fire have been subsequently included in many legal frameworks around the world (Custer, et al., 1997). Performance based design has the capability of enabling predictions of the behaviour of a building in the event of any particular scenario, therefore is ideally suited to lead to solutions that respond well to premeditated fires, resulting arson, war or terrorism.

Increasing research on fire safety is continuously focusing on the performance based design which thought to give the required optimum fire safety measures as well as comply with the existing regulations. However, regulations have not been developed to fully specify the design of unique and complex buildings such as high rise housing and even, in the event that they existed, they are of questionable effectiveness. Furthermore, if a scenario for instance of a large housing and with fitted doors/windows grills needs to be considered as a possible event during the life of the building, design on the basis of fire safety goals is a path that can be followed.

Nevertheless, Jose L. Torero, 2006 in his paper on the risk imposed by fire on buildings and how to address it, has made effort to high light on a frame work that describe the concept of performance based design in achieving fire safety goals.

He presented in the schematic behavior of a building in the event of a fire. It could be argued that the safety objective should be that the time to evacuation (t_e) at each compartment (i.e. room of origin, floor, and building) be much smaller than the time necessary to reach untenable conditions in the particular compartment (t_e). Characteristic values of t_e and t_f can be established for different levels of containment, room of origin, floor, building. Furthermore, it is necessary for the evacuation time to be much smaller than the time when structural integrity starts to be compromised (t_S). In summary:

$t_e << t_f$

$t_e << t_S$

It could be added to these goals that full structural collapse is an undesirable event, therefore:

$t_{S \to \infty}$

The frame work posited that safety times can be considered as a simplified statement, it is clear that it describes well the main goals of fire protection. With the objective of achieving these goals a number of safety strategies are put in place. These include those strategies that are meant to increase t_f which include active systems, such as sprinklers, or the intervention of the fire service. Success of these strategies can result in control or suppression of the fire. Passive protection such as thermal insulation of structural elements becomes part of the design with the purpose of increasing t_S. Finally, but most important, evacuation protocols and routes are designed to minimize t_e at all stages of the building. It is important to note that within the estimation of t_e the safe operations of the fire service need to be included (Torero, 2006). The question here now is how do you determine and interprets the safe operation of the fire service?

Though the emphasis on the model frame work is more of the behavior of buildings components on fire. The observed gap here is on the evacuation protocols which did not consider barrier element as posited by the model. The need to integrate barrier fitted structures into the model as it takes much longer time depending on the initial safety route

provision. Time allowance (t_a) need to be developed as a response effective model for access barrier building particularly in high rise residential apartment in order to attain the maximum rescue protocols for the inhabitant and the operators. This time allowance should be less than the time required to evacuate

$T_a \geq t_e$

It is equally important while determining evacuation time in relation to building fabrics, access and distance to safe zone from the onset of a fire should be well integrated into the frame work.

8. CONCLUSION

The use of grills in the housing deserve adequate attention and further research in the field of fire safety as there arises so many unanswered question particularly when victims got trapped within a locked, secured grills. It became obvious for loss of life as a result of inherent fire characteristics that instantly kill such as smoke. Housing is not confine to mere shelter or place of abode, but has to be adequate including optimum security provision against all the potential threat, facilities and accessibility to basic infrastructures and rescue protocols. The susceptibility of the low income housing makes it more vulnerable to crime, hence the high demand for security precautions at the construction stage necessitating the use of grills for doors, windows, balconies etc.

However, in an emergency situation such as fire, such grills stands as a barrier to rescue operation and causing significance loss of lives as recently the case in Jahot Baru as captured in fig. 2.10 and many reported cases above. The performance based fire safety approach does not seems to provide the reconciliatory frame work for this type of situation, thus the need for an improved research can not be over emphasized. Building on the proposed model frame work on the safety evacuation as proposed by Jose L. Torero, 2006, will be ideal in the body existing body of knowledge. Generally, the frame work model makes effort to identify the relation of time from the onset of an incidence (fire) to the required evacuation protocols vis-à-vis the structural components integrity. It is worth noting here that, in multi storey housing with a grills fitted apartments. We proposed that time allowance (ta) needed for adjustment on barrier fitted apartments for utmost evacuation success.

The integration of this concept is desirous from the design stage and performance measurement shall give an improved output. It is equally important especially in the

developing countries where for safety measures to develop and incorporate safety code, and the designers should be aware of the fire safety measures, also the need for the submission of safety drawings as highlighted by Al-Homoud et al., 2007 in Saudi Arabia.

Fire safety code should be developing into building design, such that, the escape reliability test and or simulation on housing with grills are incorporated. Best practice safety approach will require strict compliance to establish norms and ethics, including public enlightment, emergency escape design route. Fire safety ranking assessment should take cognizance of accessibility of evacuation protocols.

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