EQUAL OPPORTUNITY IN EVACUATIONS IN FUTURE TALL BUILDINGS

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Abstract

The future tall buildings belongs to building owners who see the need to adopt new solutions to provide equal access as well as equal egress for building occupants and their visitors. Such solutions would give the people with physical disabilities the same ability that able-bodied people have for vertical exits during emergency evacuation. Following the World Trade Centre Plaza incidents in New York City, it has become evident that even though tall buildings are designed for the 'defend in place' strategy, people must still be able to evacuate quickly in case of extreme emergency. Currently, the stairway is the only way out of a tall building during evacuation. In an ageing community, the general population in a high rise has approximately 30 per cent of building occupants with some degree of disadvantage regarding the use of stairs to get down to the ground. The lack of emergency egress provision for this segment of society in the event of high rise evacuation continues to be an ethical issue.

Keywords: Equal access, equal egress, evacuation, tall building, ageing community, people with physical disabilities

1. Introduction

Historically Building Regulations in most countries have focused on the provision of equal access rather than equal egress as most tall buildings are designed for 'defend in place' strategy. All major codes for high rise buildings have provisions for accessible elevators, which is a vital aspect of accessible means of egress to those with disabilities. If the elevator fails, the building have got the protected stairways as a means of managed access/egress, and has not been designed to ensure that people with physical disabilities in the premises has equal opportunity to get out of the building quickly. But if the worst happens when a mass evacuation takes place and there is no alternative means of getting the mobility impaired down quickly with minimum assistance then the consequences can be very serious. When the building is faced with imminent danger from an unusual source, such as a terrorist threat, the ability to totally evacuate all the occupants in the quickest possible time can be very critical.

The World Trade Centre Plaza incidents in New York City certainly heightened everyone's attention regarding evacuations from high rises. In the September 11, 2001 tragedy, it was reported that thousands of WTC building occupants managed to see their way down the ventilated stairwells to successfully exit the buildings before the towers collapsed. People who survived the tragedy took about 35 to 50 seconds per floor to get out of the WTC Towers. In that evacuation, two people helped a woman in a wheel chair from the 68th floor into an evacuation chair; took turn carrying her down the stairs and took them more than an hour to reach the ground. There were also many people used elevators to get down when it was still running. Yet, the fatality figures were high. Had the event not been in the early office hours, more casualties would have resulted. It leave us all with some soul searching in respect to trying to visualize the many fire and rescue workers risked their lives to the rescue and what it must have been like for those trying to escape but have no ability of walking down stairs unassisted.

Experiences at the WTC disasters show that, in any kind of survival situations, people would take risks in attempting to get out of the building quick; such as using elevators to get down fast if, it still running. This evident makes it necessary to explore the quickest possible ways to empty the total building population in

the shortest possible time in the event of the worst conceivable scenario that could happen to a tall structure. As the speed of egress could be an essential factor of life and death, an important question is how to get everyone including those with physical disabilities down quickly and with minimum assistance in the absence of egress elevators?

In the aftermath of the WTC incidents, professionals from the building and fire community recognized that many improvements could be made to the current emergency egress requirement. This paper takes a careful look at the life-safety issues for evacuation of persons with disabilities in high-rise buildings. It discusses the need to provide a means of quick egress for these people in the absence of egress elevators to be considered as a means of emergency egress requirements in the building planning process and must be incorporated in the design. In addition, the paper produce some useful information addressing possible solutions, such as accessible means of egress designed into the structure which enabled evacuation access to everyone including the people with physical disabilities.

2. Ethical Issues

Current building designs may not be 'unsafe' in terms of evacuation of people with disabilities. There is a requirement within the building codes and fire precaution legislation to provide "places of safety" within buildings for people with physical disabilities to stay in temporary refuge areas during a fire evacuation until the fire has been eliminated or rescue arrives. However, this exposes the true risk to this group of people as to what the effects will look like in the event of a major fire evacuation or other critical happening include tornadoes, earthquake, terrorist threats, and even extended power outages that may require partial or total building evacuations.

It is important to realize that in the context of situational disabilities in the event of high rise evacuation, a significant proportion of population include the elderly, disabled and the able-bodied person might find himself or herself cannot walk down many flight of steps unassisted (Proulx, 1966). Yet, the only choice for them is to get down the stairs if elevators unavailable. This egress process is slow and tedious, putting them and their assistance at the greatest risk in the event of a major emergency. Clearly it is not enough in opting for one means of escape that cannot be used by all in a total evacuation. After a bomb hoax at the Petronas Twin Towers in Kuala Lumpur which resulted in a total evacuation of the building, it was reported that six people fainted during the evacuation, those sickly and expecting took elevators down (The Straits Times, pp 6, Sept 13 2001). This incident goes to show how true those who have never considered themselves as having a disability could fall into the context of situational disabilities requiring emergency assistance in such situations.

There are ethical questions that need to be addressed when faced with high rise emergencies involving people with disabilities in the absence of egress elevators, considering the egress time for person with disabilities could be as much as four times longer than an able-bodied youth (Pearson and Joost, 1983). Is it justifiable for someone with a disability who need to be assisted to use the stairs, thus slowing the evacuation of dozens or even hundreds of other people? Or should he or she wait to be the last one to get out? If he or she to wait, who is he or she waiting for? And who is going to be back for him or her after everyone else gets out? Is it justifiable for rescue workers who would have to put themselves at risk of injury to climb to the rescue because there are no means of emergency egress for the special needs people to get down with minimum assistance? If stair travel is taxing and potentially dangerous for the elderly and the disabled, this segment of society would definitely benefit from more mindful egress design, making emergency egress in future tall buildings more user-friendly for the safe evacuation of the people with disabilities in the worst conceivable scenario.

3. Evacuation Plan

As with any tall structures, protecting the building and its occupants, as well as keeping business interruption to a minimum, were key elements in its fire safety designs and fire protection systems. Most high rise buildings have design features for phased evacuation of occupants on, above, and below the fire floor, with progressive extensions to the evacuated area if the fire risk persists, and have not been designed

to allow a full extreme emergency evacuation. But if there is a catastrophic event, the building management will have to evacuate the entire building at once.

The speed at which the total building population can be emptied is dependent upon the evacuation plan, the building design and its safety features in the stairways, the occupants evacuation abilities and on the ability of others to help the disabled down the stairs. The time taken to evacuate a tall building during a fire drill cannot fully determine how long it will take to evacuate the structure under actual emergency situations. For example, people would normally take immediate action to evacuate only if smoke, fire, or other emergency conditions is evident. The standard option of evacuating the building quickly may not be available if the normal means of egress, such as elevators, are not working and one or more stairways are impassable because of smoke, heat or flames. In addition, firefighters will need to walk up the same stairways for fire suppression operations and rescue, thereby slowing the downward flow of evacuation process.

Many fire services deemed that it is the responsibility of the fire safety manager (FSM) of the building management to ensure safe evacuation of all occupants within his high rise non-residential buildings, prior to the arrival of the fire brigade. The FSM has to incorporate into his fire emergency plan procedures to take proper care and bring any persons with physical disabilities if they exist within his buildings down to ground level quickly and safely, if a full-scale evacuation is required. Fortunately, rare occurrence of major hazards in high rise buildings means that more often than not, the real-life experience of evacuating people with disabilities under urgent circumstances is not tasted. But when they do occur, the prompt evacuation of these people may be totally reliant upon the effectiveness of the building design, the level of preparedness in building emergency response planning and evacuation procedures.

4. Evacuation Strategies For The Disabled People

A safe strategy would be to consider an early opportunity at the initial fire alarm stage, to relocate or evacuate those who require assistance before other occupants of the same area. Gather them to an area of refuge to wait for emergency response staffs to assist them to the ground through manual means, if necessary (Klote, Nelson, Deal, Levin, 1992). A difficult part of moving the disabled people down the stairways involves the capabilities of other able-bodied evacuees, they have to know the right techniques of lifting and carrying the disabled in a safe manner down the stairs. Yet, an evacuation strategy should not rely on rescue by the fire brigade. Hence, it is very necessary for FSM to feel comfortable with the provision of egress facilities available within the building or more measures are needed, as the building management holds the responsibility to deal with safe evacuation of all mobility impaired people. If, in the event of an incident where these systems fail, then upon the arrival of the fire fighters they would take over the search and rescue operations of all those left behind.

Fire authorities worldwide have long recognized the difficulties for evacuating people from high-rise buildings, especially elderly and disabled people in extreme emergency situations. Some fire services approve the use of fireman elevator for the evacuation of people with mobility impairments, while others deemed that it creates a conflict of interest as to what a fireman's role should be. Strakosch (1996) notes that a fire elevator is meant for firemen to move their equipment and themselves quickly up to the location of fire to fight it and for rescue people but not for evacuation. Some fire services have even allowed the "trained building management staff" to operate the fire elevator prior to the arrival of the fire-brigade, while the industry feel more comfortable with such elevator under the control of firefighters (not civilians) during an emergency. Some deem it unsafe because of the following risk factors that are worth considering:

(i) In the context of situational disability and the ageing population, a significant portion of the building population in a high rise might find themselves cannot walk down many flights of steps unassisted in an emergency evacuation. If there is only one fire elevator, it will take time to transport all the mobility impairment people at different floors in a possible scenario.

(ii) Another concern is the difficulty of controlling other able-bodied people from using a fire elevator when they know that is a quicker means of getting them down to the ground in a fire situation.

(iii) Is the fire elevator designed to withstand extreme fire condition to support the whole elevator system during fire evacuation? In this regard such a fire elevator would be costly.

(iv) Or is it just an elevator that has “Fire Emergency Operation” (FEO) device or “an override switch” build into it to revert to the fire services when they arrive on site to activate the elevator during emergency operation? However, such a fire elevator is less costly to install but is the elevator safe for use in fire conditions?

(v) Emergency power for fire elevator is not foolproof and can be cut automatically and immediately if, water is sensed nearby or if the power cables is affected by the heat of a fire. There have been reports that elevators jammed in the shafts and leave the cab stranded with people trapped between floors.

The Building Codes by The National Fire Protection Association, NFPA 101 and NFPA 5000, both have provisions for egress elevators, although currently, these provisions only apply to air traffic control towers, which have special evacuation needs. Although National Institute of Standards and Technology (NIST) has conducted research into egress elevators for about 10 years, no such elevators are currently manufactured for evacuation purposes yet. The idea for using evacuation elevators is one potential aspect of emergency egress for those with disabilities (Klote, Levin, Groner, 1995). It is feasible if, these elevators are designed and protected for use in extreme fire conditions with considerations given to protection of elevator vestibules with fire rated separations and the reliability and integrity of power supplies to the system, as demonstrated in BS5588 Part 8:1988. However, several factors arisen from this approach has yet to be given consideration:

(i) The availability of a pool of staff would need to be trained and appointed as evacuation elevator operators. The problem that has been anticipated is that not every organizational structure and workplace has a pool of trained staff to be made available at all times to perform this task and problems may arise when the pool of the staff is unavailable during emergencies.

(ii) The whole evacuation method needs proper management, so it is not a free for all with disabled people or normal people racing to see who captures the elevator first.

(iii) The need of refuge areas like the elevator lobbies where the disabled people wait until the evacuation elevator operator comes to rescue them to safety. There should be a procedure to ensure that the operator knows the priority for collection at floors and not to miss any.

(iv) Alternative provisions should be made even if the evacuation elevators are available. An alternative plan must be designed to cater for elevator failure; in practice it is a plan in the absence of egress elevators.

(v) If the egress elevator fails, the protected stairways will be used as a means of managed access/egress. The difficulty of moving the disabled people down the stairways would require the provision of alternative means of getting them down more quickly and safely as in the alternative plan.

(vi) The provision of evacuation elevators in buildings can be quite expensive.

Clearly in the absence of egress elevators, complementary means of escape or emergency egress facilities should be made available within the building for special evacuation needs of people with mobility impairments to get them down more quickly. But what system and measures is the best model that can be adopted internationally?

5. Emergency Egress Facilities For People With Disabilities

The mobility limitations of people with disabilities in the engagement of egress activities can be separated into two groups, namely the semi-ambulant and the non-ambulant, depending on the extent to which they can walk. It is found that in general, semi-ambulant persons can move faster without any direct assistance

(Shields, 1993). The greatest concern is usually that of the egress of non-ambulant people or those who requires the use of wheelchairs, as noted by Proulx (1966). It is almost impossible for these people to escape via stairs without any assistance or alternate vertical escape mean. Physically fit co-workers would have to be trained on the proper lifting and carrying techniques to assist non-ambulatory persons down the stairs.

In the search for suitable measures to meet the emergency egress needs of persons with disabilities, a considerable amount of good work addressing the various options has been produced in recent years. A number of unique vertical escape devices have been developed for helping people with disabilities evacuate high rise buildings if, the elevator is not available and stairs not an option. Among of these devices include stairway chairs and escape chutes of different variations, are the available hardware solutions that the author has knowledge of when writing this paper. But if current fire regulations do not require buildings to provide egress facilities to aid evacuation or rescue purposes, should it be used? Nevertheless, building owners in many countries have provided these hardware solutions to enhance safety in meeting their evacuation requirement

5.1 Stairway Chairs

There are several types of stairway chairs for evacuation of mobility impaired available in the market, with varying in features and prices. These devices enabling helpers moving the disabled down stairs much easily although not necessary quicker. A team of emergency response staff should be physically fit and trained to use the chairs properly with frequent practice in drills to ensure that they operate the stairway chairs to move those mobility-impaired people down the stairs safely (Proulx, 1996; Harrowell and Peace, 1993). Generally, such chairs are designed which require one or two persons to operate. For maximum safety, it is desirable to have two to four persons to handle the stairway chair when heading down long flight of stairs, rotating positions as necessary during high rise evacuation. The problem anticipated is that not every organizations and workplace has a pool of staff available at all times who can perform this task and problems may arise when the pool of the helpers is unavailable during emergencies. People who act as helper may not be properly trained and tendency for risking themselves in the moving process. In addition, the chair might not be effective in moving the evacuee if that disabled person happens to be heavier or bigger-sized than the helpers. Nonetheless, it is still an option worth considering rather than having no provision of any hardware solution at all.

5.2 Escape Chute

The use of escape chute is a potential means of life saving during emergency egress for all people include those with difficulties or has no ability to use stairs. The concept of escape chute was developed hundred years ago. Since then, with the advancement in technology and innovation, several versions of escape chute are being developed and patented worldwide that permits evacuation from high rise structures during life threatening emergencies. A study on why chutes are not commonly installed in buildings suggests the lack of knowledge of professionals in the building community about using such systems as a means of quick egress alternative to the staircases (Oluwoye, 1992). Further, there are currently no standards for the design and construction of escape chutes or similar devices, nor mandatory requirement for placing them in structures for aiding rescue or evacuation purposes.

For example, escape chute varies in price and safety features, materials and systems, and few have been tested by the fire academy. Some chutes are made of different layers of fire resistant fabrics, while others are from fire retardant fabric, or of heavy-duty nylon tubular net. There are vertical gravity descend type, spiral descend type, and sloping-sliding descend type. Most systems are of free fall type with no or little possibilities of self-controlling descend speed or aids to control speed of one's descend. There is one system that uses braking coat spuncell in allowing users to self-control his/her own speed of descend and it also allow assistance from the ground to control the user's speed of descend. With frequent practice in drills, evacuee will even feel safer descending down the long chute than negotiating the long flight of stairs during mass evacuation in emergencies.

Most installations are of permanently fixed in one location served as emergency exits. There is single-entry type mounted on the rooftop, balcony of corridor, and window, allows occupants gain access to the chute on that floor. The multi-entry type allows occupants gain access to the chute at each floor where several levels can be simultaneously evacuated. The portable type used by the fire brigades for height rescue operations.

The evacuation and rescue of an individual or individuals from a blazing multi-floor building that has inadequate means of escape pose unique problems and challenges to the fire services. In correcting egress deficiencies of old buildings, where it is not possible to provide additional fire exit stairs or increase the size of existing stairways in its structure, in many ways, escape chute is recognized by fire authorities as a practical alternative to fire escape stairs. It is a permanent and reusable preparedness hardware solution to aid vertical escape from a structure, in the quickest timeframe possible, while maintaining safety and in meeting the minimum requirements in means of escape.

5.3 Accessible Emergency Egress Design

The accessible emergency egress designed into the structure is a means of escape that provides quick egress usability for all people include those who have difficulty or no ability to walk down stairs, making buildings egressible to everyone. This egress design is a unique and integral part of the protected stairwell shaft constructed in accordance to international fire code that provides protection from fire effects for managed access/egress. At the core of the enhanced stairwell, it needs only a minimum of 1.2 sqm area for the installation of the multiple escape chute system as illustrated in figure 1. The stairway has enough space for accommodate the expected counter-flow of fire and rescue workers attempting to go up as occupants flee from the building.

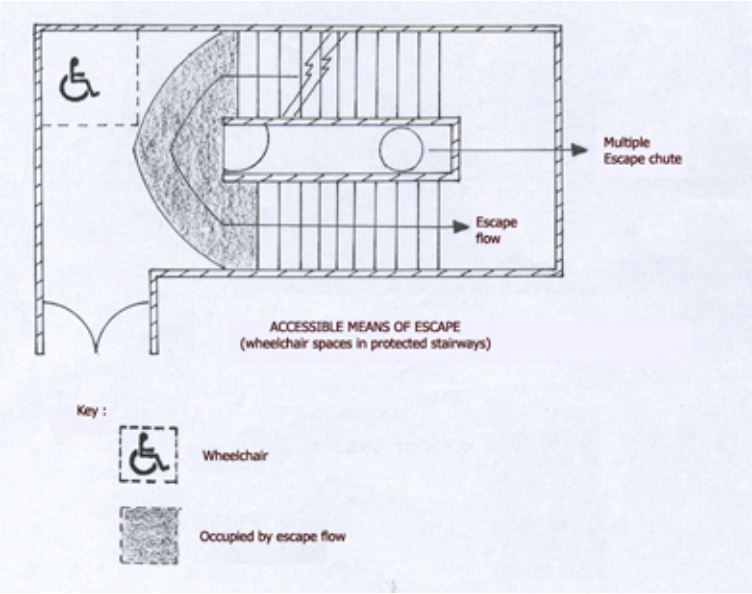
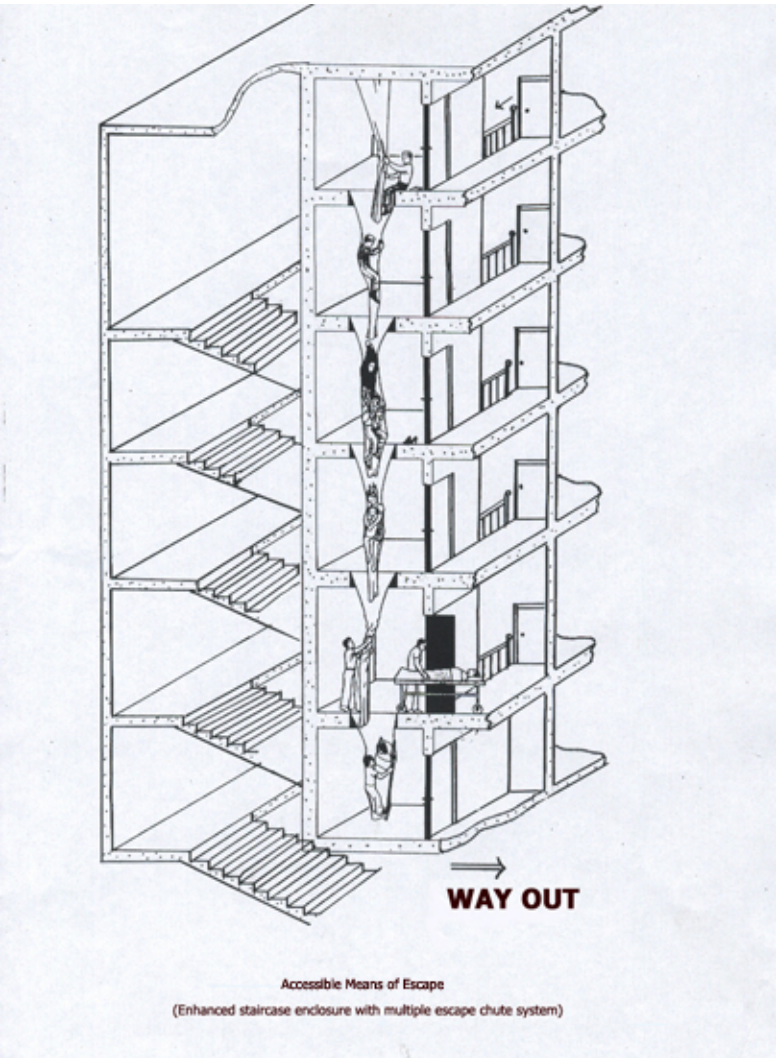


Figure 1 Accessible Means of Escape

The multiple escape chute system incorporated inside the enhanced stair enclosure consists of a series of small chute rooms at each floor in a vertical shaft as illustrated in figure 2. The chute is permanently available at each level inside the vertical shaft; one segment of chute per floor, from the highest floor to the ground floor on the same vertical line, entrance doors to the chute rooms, the exit door from the chute room to the level of exit discharge. There is no length and height constraint for incorporating the multiple escape chute facility in the egress design of tall structure. This system needs no power supply, no stairs and works on the principle of gravity regardless of body size and weight, based on the stress and friction method in providing a smooth and controlled descends. The chute is straightforward to use, requires minimal training and allows disabled or injured on stretcher and unconscious people to be safely and effectively brought to ground quickly. For maximum safety, it is desirable to have at least one person at the



ground to twist to control the speed of descend, and to guide the evacuees out of the chute quickly during the evacuation process.

Figure 2 Accessible Means of Escape

When fire occurs, mobility impaired persons will have to make their way, assisted or unassisted, and take temporary refuge inside the protected stairway enclosure while waiting for rescue. They can either choose to use the chute inside the stairwell to the ground floor quickly and relatively safely or to be assisted down the stairs. This approach does not only maximize the escape potential of people with disabilities but also the rescue workers, who would not have to put themselves at risking climbing up to rescue them. This evacuation system simultaneously grants occupants their right to evacuate while giving priority to firefighters to focus on fire suppression. In addition, the combine used of escape chute and stairways would increase the speed of egress and would take much lesser time to complete a mass evacuation. It was reported that the average speed for an evacuee descending down the chute was about 2.5 metres per second in a simulated drill. The evacuation rate of one person every two seconds, capable of conveying up to 30 persons per minute from any story to safety under high-risk emergency.

Conclusions

In the future, tall buildings will belong to a building community who see the need to provide equal access and egress into the structure as different people have different capabilities and limitations to access and egress a building. Even though high rise buildings are designed with fire safety provisions that will take care of the safety of the disabled during a fire emergency, clearly the means of getting them down would inevitably be different from that expected of the normal persons.

When exploring solutions of providing emergency egress for all, there is much scope for future studies on a ‘universally accepted’ accessible means of egress designed into the structure. Its objective is to provide a

means of getting everyone including people with disabilities to the ground more quickly in the absence of egress elevators. Further, more studies would be needed on the usage of evacuation elevators, escape chute as alternate means of quick egress to staircase, and stairway chairs, for evacuation of mobility impaired in extreme emergency situations. Also, the legal implications from non-provision of adequate means of emergency egress for the disabled in the event of a major evacuation, as well as the legal implications from such usage to overcome the disability discrimination aspects.

As the global population ages and the rights of the disabled have now been established in the Disability Discrimination Act, the government and its agencies could play more active roles in the promotions and campaigns to encourage building owners to build more access and egress-friendly buildings for people with disabilities. The government and public buildings need to 'lead the way' before some, if not all the private building owners would seriously consider moving beyond the current minimum requirement in means of escape as prescribed in the Building/Fire Code. While technology and innovation may provide the answer to equal opportunity in evacuation, but, it is the development of codes and standards that make future tall building conducive for access and egress to everyone, making evacuation less hazards for the disabled, high rise evacuation quicker and relatively safer.

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