International Journal of Civil Engineering Research.
ISSN 2278-3652 Volume 5, Number 3 (2014), pp. 255-260

http://www.ripublication.com/ijcer.htm

Evacuation Patterns in High-Rise Buildings

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Abstract

Buildings are built for function, beauty, fame, profit, commemoration, fun, economy and the hierarchy of motivation depending on the owner or developer. Safety has not been generally considered a critical factor. But in high-rise buildings, the cost in terms of human life in a natural disaster or man-made accident will be so high that life safety must become the foremost consideration, starting from the concept stage. Living and working at height are unavoidable in modern urban environment. Countries around the world are reaching higher and higher towards the heavens. The paper will discuss strategies implemented for ensuring safety of occupants in tall buildings under fire conditions. The life safety strategy must integrate key fire safety systems with building features. The possible use of vertical transportation for phased evacuation requires a combination of safe havens; innovative smoke management and sophisticated communication systems to ensure occupants under threat from fire are moved to safe locations within the building. The height of very tall buildings places great demand on time for occupant evacuation, fire fighting, search and rescue and preservation of the building. In considering fire protection measures for tall buildings, it has become evident that the safety of occupants and fire fighting personnel depends on the design of the building as a whole. A focus of the life safety strategy was to protect in place. High-rise building occupants near the fire would evacuate using the vertical transportation system; whilst occupants remote from the fire would remain protected within the structure. To facilitate this strategy, the fire must be kept small and the persons in the area of fire origin must be permitted to move safely within the structure. The key to the strategy was the design of an integrated fire safety system, with consideration to unique building features that influence fire and smoke spread throughout the building.

Keywords: Smoke resistant lift lobbies,Intelligent Smoke Detection, Phased Evacaution.

1. Introduction

1.1 What is 'high rise building'?

"A building whose height creates different conditions in the design, construction and use than those that exist in common buildings of a certain region and period".

High-rise buildings will serve better and longer if they are inspected and maintained at regular intervals. But these activities are not often considered at the design stage. For inspection and maintenance to be safe activities, anchors and accessories may be designed during design and implemented during construction, more simply and economically – and safely- than during each time the activity is to be carried out. Buildings are built for function, beauty, fame, profit, commemoration, fun, economy……, and the hierarchy of motivation depending on the owner or developer.

Safety has not been generally considered a critical factor. But in high-rise buildings, the cost in terms of human life in a natural disaster or man-made accident will be so high that life safety must become the foremost consideration, starting from the concept stage. Living and working at height are unavoidable in modern urban environment. Countries around the world are reaching higher and higher towards the heavens.

In many countries, concept of safety is still not part of the professional's imperative. There is also the deeply ingrained feeling myth that safety concerns will lead to greater cost and reduced productivity.

1.2 Pros and Cons of high-rise buildings

Pros:

- Only solution in scarce or expensive land situations
- More compact and integrated management
- Easier to provide and maintain services
- Symbolic of human and national aspirations

Cons

- Complex and expensive to design and build
- High density living makes high demands on services
- Higher psychological and social stresses
- More difficult to control risks and handle emergencies

Whether during or after construction, there will be occasions when:

- Accidents affect workers, or,
- Natural or man-made disasters affect residents.

These situations are especially critical in high-rise construction. Fires and explosions are common examples of such emergencies.

Good design and construction practice require that safety controls include appropriate rescue equipment and personnel trained in proper rescue procedures. These may include: First aid equipment, tripods and lifting equipment to shift workers from enclosed spaces, resuscitation equipment, fall rescue equipment, etc.

The paper will discuss strategies implemented for ensuring safety of occupants in tall buildings under fire conditions. The life safety strategy must integrate key fire safety systems with building features. The possible use of vertical transportation for phased evacuation requires a combination of safe havens; innovative smoke management and sophisticated communication systems to ensure occupants under threat from fire are moved to safe locations within the building.

The height of very tall buildings places great demand on time for occupant evacuation, fire fighting, search and rescue and preservation of the building. In considering fire protection measures for tall buildings, it has become evident that the safety of occupants and fire fighting personnel depends on the design of the building as a whole.

A focus of the life safety strategy was to protect in place. High-rise building occupants near the fire would evacuate using the vertical transportation system; whilst occupants remote from the fire would remain protected within the structure. To facilitate this strategy, the fire must be kept small and the persons in the area of fire origin must be permitted to move safely within the structure. The key to the strategy was the design of an integrated fire safety system, with consideration to unique building features that influence fire and smoke spread throughout the building.

2. Fire Development & Smoke Spread

The fire scenarios used within the quantitive fire and smoke analysis for the building were determined via a hazard analysis. Various fire scenarios were considered within the residential, office and public areas of the buildings to determine the fire risk based on ignition potential, frequency and consequence.

The considered “Design fires” can be categorized into three main groups smoldering fires, flaming fires and flashover fires. Smoldering fires are generally a poorly ventilated fire producing very little heat and thus not expected to spread beyond the object of fire origin.

3. Egress & People Movement

As building reach for the heavens, we cannot expect building occupants to evacuate using traditional “means of egress” via hundreds of flight of stairs. Egress down multiple flights of stairs is expected to slow down occupant evacuation, create queuing and bottle necks and cause injury.

4. Smoke Resistant Lift Lobbies

The provision of smoke resistant lift lobbies mitigate smoke spread via lift shafts which connect multiple compartments. Reducing the fire and smoke hazard allows

occupants on floors remote from the fire to stay in place. The lobby also provides a safe haven for occupants and fire fighting personnel using lifts during the evacuation of the fire floor.

The lobby needs to be of sufficient size to accommodate all people who may use the lifts in a fire emergency with the doors closed to prevent smoke. The lobby also needs to resist the spread of smoke and fire from the floor of lift shaft to maintain tenable conditions for the time required for evacuation or fire fighting search and rescue.

5. Intelligent Smoke Detection & Alarm Systems

Information is critical during a fire emergency. Data from equipments such as detectors, remote field devices and television or security cameras in lobbies would be valuable additional source of information to be used in a fire emergency.

6. Evacuation Procedures

High-rise buildings are required to have a Fire Safety and Evacuation Plan in accordance with IFC 404 and approved by the Fire Department prior to final occupancy.

Before any floor of the building can be occupied for use the following shall be completed:

- Permanent automatic sprinkler protection shall be installed on the occupied floor and all floors below.
- The permanent fire alarm system shall be installed on the occupied floor and all floors below.
- The elevator recall system shall be installed on all floors.
- The emergency generator shall be in service.
- The smoke control system shall be complete and functional.
- An approved evacuation and life safety plan shall be in place.

7. Phased Evacuation

In phased evacuation, occupants from the zone of fire origin may be moved to another area of the building that is protected from the fire zone. Phased evacuation is often associated with high-rise buildings.

Phased evacuation is initiated using multiple notification devices. Horn/speakers – voice alarms, in combination with strobe devices, are generally used to notify occupants of a phased building evacuation. Occupants on the floor of fire origin and the floor above and below are given a signal and message to evacuate and to re-enter four floors below their originating floor.

The following requirements must be met for phased evacuation to be considered in high-rise buildings:

1. Fire Resistive Construction: At a minimum, the building must be of fire-resistive construction. Additionally, the building must be provided with smoke or fire compartmentation. Most of the compartmentation is achieved through fire-resistive building construction.
2. Full Automatic Sprinkler Protection: The building must be fully protected with quick response automatic sprinklers. Sprinklers offer the ability to control a fire early in its growth, while also providing an effective means of initiating the occupant notification system.
3. Fire Alarm System: The fire alarm system must meet the requirements. Re-entry to occupied floors from the stairwell must be unobstructed, resulting in unlocked doors upon fire alarm signal.
4. Fire Safety management: Building management and occupant training play a critical role in evaluating phased evacuation capabilities.
5. If phased evacuation is to be used, it is imperative that fire zone boundaries are identical to occupant notification zone boundaries and smoke control zones. In other words, the entire fire zone must be single zone for occupant notification and protection, so that all occupants within the fire zone receive the same message and level of protection.

8. Conclusions

The direction of traffic should be related to the number of persons on each floor, the number of emergency stairwells available, and the number of floors directly exposed to the fire or emergency. There should be a positive means of directly notifying occupants to evacuate. Definite priority must be given to those floors directly involved and floor immediately adjacent to the emergency. Building control will determine the safest and most efficient means of evacuation, depending on the nature of the emergency and scope of damage. This decision should be made known to floor control personnel and those floors affected. Floor control personnel on the endangered floors should be notified first.

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