ABSTRACT: If current population and accommodation trends continue, Australian cities will, in the future, have noticeable numbers of apartment buildings over 60 storeys high. With an aging population it follows that a significant proportion of those occupying these buildings will be senior citizens, many of whom will have some form of disability. For these occupants a fire emergency in a high rise building presents a serious problem. Currently lifts cannot be used for evacuation and going down 60 storeys in a fire isolated staircase would be physically impossible for many. Therefore, for many, the temptation to remain in one’s unit will be very strong. With an awareness of this behaviour trend in older residents, many researchers have, in recent years, explored the possible wider use of lifts in a fire emergency. So far the use of lifts for evacuation has been approved for a small number of buildings but wide acceptance of this solution is still to be achieved. This paper concludes that even in high-rise apartment buildings where lifts are approved for evacuation, architects should design the building with alternative evacuation routes and provide suitable safe refuge areas for those who cannot use the stairs when the lifts are unavailable.

Keywords: lifts, refuge floors, fire evacuation, tall buildings.

1. INTRODUCTION

With the increasing height of apartment buildings in most major urban areas, serious doubts have been raised about the use of the fire isolated stairs as the only method of evacuation in a fire emergency. This concern is reinforced by a noticeable percentage of the building occupants who are aged, some with a physical disability and others who are obese. The aging of the population will become more noticeable in the future and a considerable proportion of this aged population will move from their single dwellings to unit accommodation because of their inability to continue to maintain their houses and gardens. To cater for this demographic shift in occupants in tall unit buildings consideration is now being given to the possible use of lifts as an alternative egress method to the standard fire-isolated stairs. However lifts being a mechanical item are not ‘foolproof’ in all situations. Fire isolated stairs in high rise buildings, provided the pressurisation works and the fire doors are not pegged open have a very high level of safety. Obviously for lifts to be as an alternative means of escape adequate redundancies are needed to provide the building occupants with the required confidence to rely on the lifts in an emergency.

2. CURRENT SITUATION

Under the Building Code of Australia (BCA) at present the use of lifts in a fire situation is not permitted unless special approval is given. This is because lifts currently do not have the same safety record as fire isolated stairwells. As a result many countries including Australia have had a long history of cautioning the building occupants against the use of lifts in a fire. If building occupants are inadequately trained for a fire emergency, they can become stressed, impatient and then may over crowd a lift causing it to remain indefinitely on a floor (Kuligowski 2003). This situation would be fatal for the occupants if that floor is the fire floor. Traditionally fire isolated stairs have been considered the only safe exit route in a multi-storey building. However, people do not intuitively understand tall multi-storey buildings. Being on the 60th floor of a building is like being in a long building where the exits are about two to three football fields away. Such a distance is daunting but going down stairs for such a distance is physically harder especially for older persons.

Over the years there have been a considerable number of evacuation studies regarding travel in corridors and on stairs. The London Transport Board report in 1985 (Lathrop 1997) showed that the walking speed of persons in level passageways decreased as the density of persons increased. Regarding stairs Pauls (1995) and Hakonen, Susi and Siikonen (2003) reported that occupant speed on stairs first increased with increasing density but at higher densities it decreased. Nelson and MacLennan (1995) found that the movement speed on stairs is governed by the riser and going dimensions of the stairs together with the density of occupants on the stairs. Studies have also shown that there is a significant reduction in walking speeds for persons over 65 years of age (Lathrop 1997). With an increasing percentage of aged persons in apartment buildings this will become a significant factor. Depending upon the width of the stairs, the speed on the stairs can be influenced by the slowest moving person and/or if an occupant were to trip...
and fall on the stairs. Another slowing factor if the stairs are not wide, is fire officers going up the stairs to the fire while building occupants are still coming down.

3. APARTMENT BUILDING OCCUPANTS

Like many other developed countries Australia will progressively have an increasing aging population. At the same time there is a need to restrict the urban spread of the population centres in Australia by increasing the densities of these centres by encouraging the construction of multi-storey apartment buildings. From 1981 to 2001 the population in high-rise apartments in Australia rose from approximately 129,000 in 1981 to around 334,000 in 2001 of which 13% were aged 65 years or older (ABS 2004). Based on current trends the percentage of aged occupants in high rise apartment buildings can be expected to increase.

A certain percentage of these aged occupants are financially able to spend a noticeable time travelling in various parts of the country and overseas. Under these circumstances building fire training for them can be problematic. Another complication is that it is well known that a number of occupants pretend not to be home when a fire drill is undertaken. Nevertheless it is essential that the manager of apartment buildings ensure that all building occupants are fully aware of the fire evacuation procedures for the building because apartment buildings where people sleep are inherently more dangerous than buildings where people work during the day.

Investigations by Proulx (1999) found that elderly occupants and those with a disability remained in their apartment units waiting to be rescued. This presented a problem for the fire fighters to determine if the unit occupants were in the unit. Remaining in a unit does provide a limited level of protection provided the fire integrity of the fire wall enclosure had not been breached during alteration work and the building fire is extinguished early before structural damage occurs to the building.

Many countries including Australia have adopted anti-discrimination laws that require equal accessibility to buildings by all people. By providing equal access to all occupants it follows that all should have equal egress (Proulx & Pineau 1996). Unfortunately, this is not the case in all situations when one considers the egress provisions for able bodied persons with those with a disability. An able bodied person normally does not need any assistance to use the stairs to exit the building in an emergency. Under the present situation persons who cannot use the stairs are allowed to use the non-fire rated lifts only if the fire officers consider the lifts safe to be used. If the lifts are no longer safe then that person is required to remain on a landing in the fire-isolated stairs until resecured by fire officers. Normally in an office building when there is an emergency the floor warden or assistant will inform the building warden or control room of the situation and will remain with the person in the stairs until the fire officers arrive. When a fire occurs in an apartment building at night the floor warden may not be in the building. The persons who cannot use the stairs will themselves have to contact whoever in charge of the fire situation and then wait on a landing in the stairs. Although the waiting period may be short it is very easy for that person to become stressed and agitated. Proulx & Pineau (1996) have pointed out that there is a range of disabilities such as mobility-impaired, visually-impaired, auditory-impaired and mentally-impaired occupants. It follows that the evacuation plan should cater for all occupants by providing equal egress arrangements and if necessary, safe refuge areas for some or all occupants. Another group of building occupants are visitors and short term occupants who may not be aware of the evacuation procedures. Their immediate reaction to a fire emergency will most likely be to evacuate the building the way they came in, that is, use the lifts. It was found in the study of Australian shopping centres that the public exited a shopping centre in an emergency the way they came into the centre (Bennetts 1999).

4. USE OF LIFTS FOR EVACUATION

The increasing height of buildings plus the accessibility of these buildings by aged and disability persons has encouraged the reassessment of the ban on the use of lifts in a fire. Lift evacuation involves less physical effort; is quicker; and can be used by the elderly and disabled (Kuligowski 2003; Johnson 2009; Sikkonen & Hakonen 2003). Sorsa, Hakonen, Susi and Sikkonen (2007) also found that in tall buildings the use of stairs decreased at the higher levels and this stairs aspect was supported by investigations by Heyes (2009).

The main development supporting the use of lifts has been the improvement in the reliability of the lifts and the facilities to enable lifts to withstand the effects of smoke, heat and water (Kuligowski & Bukowski 2004). Lifts can now be supplied with waterproof components (Bukowski 2003). The exclusion of water from the lift shafts can be assisted by designing the lift lobby with fire rated doors, drains outside the lobby area and a raised sloping lobby floor to keep the sprinkler water out of the lobby. Protection of the lift shafts from smoke and heat can be achieved by enclosing the lift shafts and lift lobby in a fire rated compartment (Claiborne & Wahl 1972; Smith 2000; Sharma, He & Mahendran 2008). These lifts would require the provision of secure power and the number of lifts that can be completed with emergency power could influence the number of lifts available for evacuation. In the event that the lifts cannot be used then Smith (2000) recommends that a fire isolated stairs be located next to the lift lobby so that occupants can exit the lift lobby to the stairs without going onto the fire or smoke filled floor. The stairs can also be used by those who are unwilling to wait for delayed lifts.

The Metropolitan Fire & Emergency Services Board of Melbourne produced in 2010 a guideline document for the use of lifts for evacuation. Some of the significant aspects of this document are for the building to be fully sprinklered;
sufficient lifts be provided for evacuation of occupants as well as fire fighter access; reliable communications within the lifts; emergency management plan to take into consideration human behaviour; and appropriate signage and education of building occupants.

5. REFUGE AREA OF FLOOR

In certain situations disabled or aged persons may require the provision of a refuge or safe area which is a place where people can wait to be rescued by fire officers (Cheng, Lam, Lo & Liang 2007). The simplest version of a refuge area is a wide landing at each floor level inside a fire isolated stairs. In Hong Kong a refuge floor is required every 25 storeys. This is to enable those exiting by stairs to be provided with a safe area where they can wait to be rescued or to rest before proceeding further down the stairs. Although the Hong Kong regulations only require a refuge floor to be open on two opposite sides, there is a smoke retention problem on the floor with only two open sides when the wind is at right angle to the open sides (Cheng, Lam, Lo & Liang 2007). It is assumed that this smoke problem can be overcome with openings on four sides. In Burj Dubai (Tower of Dubai) areas of refuge were also provided where people exiting down the stairs could rest and be given evacuation instructions (Weismantle, Smith & Sheriff 2007).

6. CONCLUSIONS

It is anticipated that in time the anti-discrimination laws will require buildings to be designed to provide equal egress for all building occupants. Remembering that there would most likely be a significant proportion of occupants in a high-rise apartment building with some form of disability, it follows that to achieve equitable egress for all occupants the building lift system should be designed for egress use in an emergency. Naturally there would need to be a procedure to ensure that these lifts are adequately maintained. The lift core should be designed with fire rated lift shafts and lift lobbies and the lift lobby be designed to keep sprinkler water out of the lift shafts. This will require an innovative design solution for the fire rated door system if the traditional aesthetics of open and inviting lift lobbies is to be achieved when the building is not in a fire mode. Next to the lift lobby should be located a fire isolated stairs to be the alternative exit when the lifts cannot be used. These stairs should have a refuge area at each floor level. A key element in this system is good communications. This is to ensure that everyone knows what is happening; the availability of lifts; and if possible indicates the lift waiting time to be expected at each floor. Associated with the use of the lifts consideration should be given in the design of the unit floors to keep the travel distance from each unit to the lift lobby as short as possible to allow for slow moving elderly occupants who may delay leaving their units.

In very tall apartment buildings consideration should be given to the possible inclusion of a refuge floor for those coming down the stairs where they can rest before proceeding further down the stairs. This is considered to be important in an apartment building where a significant proportion of the occupants are aged but not disabled. Some may prefer to use the stairs but after going a number of floors may need a rest. It is acknowledged that a refuge floor portion of the occupants are aged but not disabled. Some may prefer to use the stairs but after going a number of floors may need a rest. It is acknowledged that a refuge floor

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