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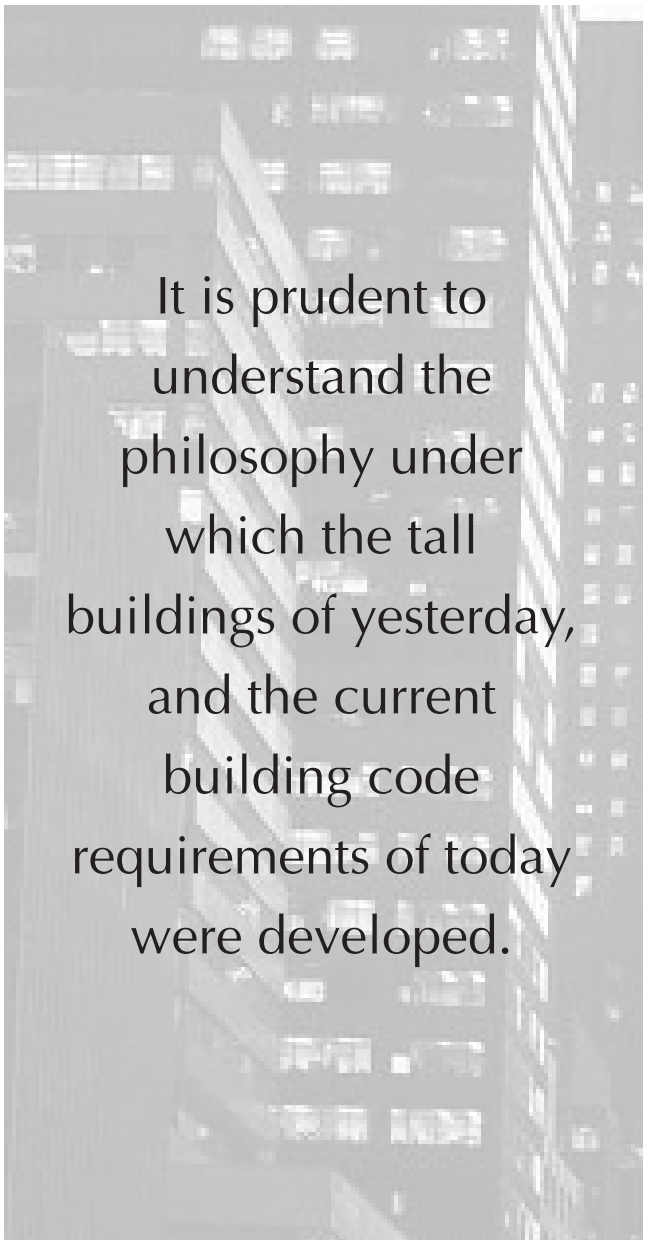
Educating the Public of Safety in Tall Buildings



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Since the terrorist attacks on September 11 to the twin towers of the World Trade Center, many questions have been asked, by both building designers and the general public, regarding what could have been done differently during the design or construction of the WTC to have changed the outcome of that day. What could have been done to increase the time for evacuating the buildings' occupants? To prevent the collapse of the Towers? And most importantly, what can now be done to minimize the impact of a similar event in the future?

Building technology will advance, identifying methods and materials that can be designed and incorporated into the construction of tall buildings of tomorrow to better resist the resulting collapse of the WTC. Many comparisons have been drawn between the hardened buildings of Europe and other nations who have dealt with terrorist attacks prior to 9/11. Such comparisons leave one with the question of why are buildings in the United States not built in a manner similar to those in Europe?

Societal fears and desires to prevent another catastrophic outcome from occurring will determine whether building owners and developers of the icon buildings of tomorrow will need to change how tall buildings are constructed to thwart terrorist attacks, ultimately increasing overall construction costs.. Another question is how far will architects and engineers need to go to design future buildings to be resistant to such attacks (i.e. what other, unforeseen assaults on our buildings must we plan for in order to minimize the impacts upon the building)?

Society will best answer this question in the demands placed on the market place in the form of available building stock that is better capable of resisting such attacks. But what do we, as the owners, developers and managers, as the consumers and society who will ultimately bear the costs, of the *existing* tall buildings do with the stock of buildings on hand? Must we spend significant amounts of dollars upgrading these *existing* buildings to better withstand impacts from airplanes used as weapons of destruction? How many other scenarios must we consider in retrofitting our existing buildings with protective features to mitigate the outcome of such attacks?

Several task groups, composed of prominent engineers and scientists, have spent significant amounts of time since last September studying the remains of the building skeleton from the WTC and have formulated theories about what specific events led to the collapse of the Towers. The task groups addressed everything from the type of hardware used to connect the steel floor joists to the perimeter load bearing elements to the brittleness of the gypsum based stair enclosure walls that reportedly disintegrated upon impact of the aircraft. Changes will be enacted in how future tall buildings, and other icon structures possibly targeted by terrorists are designed based on the evaluations and theories put forth by these task groups. Other design professionals, not specifically involved in the task groups, and journalist accounts have suggested the need for providing additional exiting capacity (increasing the number and/or width of stairs), providing slide-escapes that travel every ten floors, providing separate stairs for firefighter access up into the building, using elevators as part of the evacuation scheme, and the list goes on.

Some of these design enhancements will make clear improvements in the ability of occupants to evacuate a building and for the building to withstand an attack similar to WTC. Others changes mentioned are an overreaction to a perceived problem that occurred within the building. Journalists and the general public have asked numerous questions, specifically about the (perceived lack of) fire protection features of the WTC. Unfortunately, many journalists and the general public do not clearly understand the underlying philosophy of tall building occupant life safety protection.

It is prudent to understand the philosophy under which the tall buildings of yesterday, and the current building code requirements of today, were developed. That philosophy was one of "defend-in-place". The world-renowned engineers and architects that comprised the many various high-rise building task forces in the 1970's recognized the impracticality of attempting to evacuate an entire high-rise building for what was considered to be a common potential fire scenario. That fire scenario, up until September 11, 2001, considered most foreseeable, reasonable events that could threaten the occupants of our tall buildings.

The tall buildings of yesterday are, and continue to be made, "resistant" to the effects of fire. There are several examples of "successful" high-rise building fires in which the buildings endured significant fires, and stand today. The First Interstate Bank Building fire in Los Angeles in 1988 is such an example. Another is the One Meridian Plaza fire in Philadelphia that occurred in 1991. Both buildings are constructed of protected steel construction and neither of the locations in which these fires broke out was sprinkler protected. Both buildings endured significant fires that burned for hours, until much of the fuel for the fire was consumed or intervention from sprinkler systems several floors above began to cool the fire-engulfed areas, which allowed firefighters access to further control and eventually suppress the fires.

Evacuating an entire tall building was not a consideration. It was reasoned that evacuating the occupants of the 90th floor of a building was not prudent for a common fire event that may occur on the 20th floor, a fire event that, with properly designed and installed sprinklers, would be controlled or suppressed early in its development and would likely not impact those that are not near to the room of fire origin. So, exit systems were developed so that only a certain number of floors were to be evacuated, typically only relocated to a place of safety somewhere else in the building, located somewhere below the floor of fire origin. The exits were to be constructed to provide an atmosphere of protection from the rest of the building. That included enclosing the stairs in fire resistive construction. Over time, the use of increased air pressures in stairs relative to the adjacent floor spaces to limit the potential of smoke

migration into the stair became a standard design concept, and even a current code requirement.

Building communications systems were also addressed. Two different systems are usually included in most modern high rises (those constructed during and after the mid-1970's). One of those systems is a two-way system of communications for use by the fire department, since many of their radio systems operate sporadically in these steel and concrete monsters. The other system includes a building wide one-way communication system that allows either automatic or manual voice messages to be delivered to specific areas of the building, or throughout the building, if desired.

Another important feature of such buildings is the ability to provide emergency and stand-by power for such systems as emergency exit illumination, elevators, mechanical equipment for smoke management and stair pressurization systems, and fire detection and alarm system operation. In comparison studies of the evacuations of the WTC bombing in 1993, and the attacks on 9/11, one significant difference cited by evacuees which contributed to the relative success of the evacuation in 2001 was the improved exit stair illumination.

The owners and designers of future tall buildings will have many decisions to make regarding the design and construction of their buildings.

Many of the design and construction changes proffered by the task groups may have little cost impact in the grand scheme of constructing future tall buildings. However, some changes could have significant cost impacts upon the overall cost of tall building construction. Furthermore, other changes may have significant cost impacts on the operation of the building. One such example is the revenue lost from incorporating a dedicated firefighter stair into the structure. In general, firefighters use elevators to gain access to the floors directly below an incident, which were unavailable in the WTC. Using the elevators saves time and preserves the endurance of the firefighters. Other "cost" impacts that will be difficult to quantify include the loss of exterior glass in favor of hardened exterior concrete walls. Many studies have shown the value to productivity and overall health of being able to visualize the outside world.

As outlined in the television show on the WTC on NOVA, theories on the types of building materials that could have been used to harden the stair enclosures, and *perhaps* not have resulted in the obliteration of the envelope of protection surrounding the exit stairs were addressed. But what happened to these hardened materials when the third plane hit the Pentagon puts into question whether these hardened materials would have survived the impacts of the 9/11 attacks. Gypsum based fire rated wall assemblies pass the same fire tests to which concrete-based wall assemblies are subjected. In other words, a 2-hour fire rated wall is a 2-hour fire rated wall. The difference in the wall assemblies is their ability to resist external forces, such as impact from moving objects. The fire tests used to evaluate fire rated assemblies are not meant to evaluate impact resistance. These types of scenarios were not considered in the development of current high-rise features of protection.

The owners and designers of future tall buildings will have many decisions regarding the design and construction of their building. Some of those decisions will undoubtedly be made by societal demands. Perhaps companies will want to move into less prolific structures than those of similar stature as the WTC.

And others may even be made by future building code changes. Most building code changes are made as a direct result of lessons learned the hard way (i.e. documented failures of building features). One such example is the swing of doors in an assembly occupancy. It was determined in several assembly occupancy fires, including the Beverly Hills Supper Club fire (which actually occurred in Southgate, Kentucky), that doors swinging against the flow of egress was a primary contributor to a number of the many deaths experienced in this tragic loss.

If anything positive came of the two major incidents that occurred at the WTC, it is that prior preparation for and planning of emergency evacuation has significant improved ability of occupants of such tall buildings to deal with emergency events. The 1993 bombing ultimately showed that the occupants of the structure, and the building management and operations staff, were not well prepared for evacuating the structure. It showed that there is a general lack of knowledge among the general public for their surroundings, and a lack of understanding of the importance of fire safety features provided in these buildings. The WTC building management made improvements to the life safety systems, developed management plans for maintaining the systems and overall improved the ability of the occupants to deal with the events of the 2001 attacks. Imagine how bad the outcome could have been had building management not addressed the life safety systems nor developed emergency evacuation plans?

Unfortunately, it took the catastrophic outcome of the attacks on 9/11 to raise public awareness of their safety in these buildings and the value of both life safety systems and a well planned emergency evacuation plan.

All over the country, building managers are updating their evacuation plans, and becoming better prepared for emergencies, whether mandated by the local jurisdiction (such as recently occurred in Chicago) or not. Many, if not most or all, tall buildings are now practicing their evacuation plans. It is certainly advantageous to develop updated evacuation plans. But the occupants, and particularly the building staff, need to practice these plans. Evacuation plans will need to be continually revised to reflect the ever-changing environment of the building, and its occupants. One important consideration is the need for plans to reflect the availability of staff throughout the entire day, not just the primary occupancy periods.

The evacuation plans also need to consider occupant familiarity. Even though a high-rise hotel and a high-rise apartment or condominium are both residential occupancies, the occupants of the former are far less familiar with their surroundings than the occupants of the latter.

Although the collapse of the WTC is certainly considered a catastrophic failure, There were, in fact may successes observed in the events that unfolded that day. Deliberate considerations by task groups will identify many changes in the way we design and build such tall buildings, but we cannot allow overreactions to the failures to drive those changes. One of the most important lessons to be learned here is the need for educating the public about the fire safety features of the buildings they occupy and for practicing evacuation drills. Why else would we make our children practice them throughout grade school?

About the Author

Jeffrey E. Harper, P.E. is the Engineering Manager for the Chicago and Minneapolis offices of Rolf Jensen and Associates, Inc. (RJA). He began working with RJA in 1989. Mr. Harper received his first Bachelor of Science degree in Fire Science Management from Southern Illinois University in 1986 and another Bachelor of Science degree in Fire Protection Engineering from the University of Maryland in 1989. He is a registered Professional Engineer in three states.

Prior to and while attending the University of Maryland, Mr. Harper worked for over ten years in the field of firefighting and emergency medicine. Mr. Harper has worked for three fire departments and for a paramedic rescue department. In that capacity, he has had training and experience in tactics and strategies associated with fireground operations and fire suppression activities.