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PROTECTION OF FIREFIGHTERS UNDER THE BUILDING CODES

The fire service needs to speak up about what protections it needs and expects from the codes if those needs are to be met.

This article was written before the tragic events of September 11. The collapse of the World Trade Center towers and the deaths of more than 300 firefighters bring new focus to the issues discussed herein. Fire department standard operating procedures for high-rise incidents all include interior operations based on an assumption that the codes provide buildings that will stand for at least several hours. In tall buildings, this is not an option since all operations must be performed from the interior. While we can take some comfort from the fact that this is the first incident of fire induced collapse of a tall building, we must determine the cause(s) and modify the codes so that it does not happen again.

Historically in the United States and in many other countries, the building codes have been silent on the subject of firefighter protection. This issue has surfaced as performance-based codes based on explicit statements of objectives have replaced largely prescriptive codes. In several countries, this has been the topic of lively debate. This paper is intended to raise the major issues and to focus the debate in the hope of achieving some level of international consensus.

The stated goals of most building codes include public health, safety, and welfare and may include historical and cultural preservation, conservation of resources, and protection of the environment. Few building codes, such as the Building Standard Law of Japan, make explicit statements about the protection of firefighters in the performance of their duties.[1] This is not to say that any nation is indifferent to firefighter safety, but most say that prescriptive requirements for fire resistance and height and area limitations are there in part to limit the risk during firefighting operations. It is frequently pointed out that firefighters are equipped with protective gear and are highly trained to recognize the hazards and the need to pull back when the risk is too great.

Unfortunately, the experience in the United States has been that many injuries and fatalities involve structural failures that give no warning, sudden changes in fire severity often related to an instantaneous change in ventilation, or heroism related to the rescue of citizens or other firefighters. It is likely that other countries share a similar experience.

STRUCTURAL INTEGRITY

Clearly, the primary issue for firefighter safety is structural integrity, not only the prevention of total or partial structural collapse onto firefighters but also maintaining the integrity of roofs and floors so that individuals do not fall through into fire below. Failures of roofs and floors have resulted in several firefighter fatalities over the past few years.[2].[3] Although these have occurred in commercial properties where structural fire resistance requirements are applied in the codes, there is an ongoing issue concerning lightweight roof trusses used in residential construction where there are no fire resistance requirements. Recent work by the National Institute of Standards and Technology (NIST) with the Phoenix Fire Department demonstrated times to roof collapse of less than 20 minutes from the time of ignition for common residential truss roof construction. Further, there were no advance indications of the impending collapse.

The codes typically require one- or two-hour fire resistance for building structural elements, roofs and floors, exit access corridors, and shaft enclosures (including stairwells). Since this far exceeds the time needed for egress for buildings except for high-rises, it is frequently argued that the extra time is provided so the firefighters can safely perform their operational duties. This should at least be enough time to search for remaining occupants and to perform an initial attack. If this attack is not successful, there should be enough time for the firefighters to pull back to a safe area.

There are several problems with this argument. First, this may not be enough time. In heavy smoke conditions, search operations can take a long time because the firefighters are crawling on their hands and knees and feeling around as they move. People with disabilities often require much longer times for egress assistance. If there is any possibility of civilians being left in the building or if firefighters are in trouble, the search operation will continue well past the point when the firefighter's training says it is time to leave.

Second, fireground activities are often interdependent for safety. Suppression operations often cannot be terminated during search or ventilation activities without endangering those firefighters. Thus, pullbacks must be coordinated and often cannot be carried out quickly.

Third, these fire resistance times are measured under standard furnace conditions and cannot be related to actual performance in fires. Times to failure may be longer or shorter and, since there often are no other advance signs of failure, the situation often goes bad very quickly.

In summary, firefighters cannot determine in advance the time needed for safe operations and often do not have the choice to pull back even if their training tells them that such is necessary for their own safety. Times provided by the codes are benchmarks and do not necessarily reflect safe intervals in actual fire incidents. Failures can occur quickly and without warning, so firefighters will often not know when they are in danger.

AUTOMATIC SPRINKLERS

Fire sprinklers have long been used to protect property, but their crucial role in firefighter safety has only recently been highlighted in the code-change process. Fire sprinklers are designed to extinguish or control the fire until it is manually extinguished by the fire department. Fire sprinklers help to prevent fire spread and sufficiently limit exposure to building elements to prevent total collapse. Fire sprinklers may limit the need for search operations beyond the immediate fire area at least initially, reducing the demand for fire service resources.

For these reasons, the U.S. fire service, on firefighter safety grounds, has strongly advocated that codes require fire sprinklers in nearly all occupancies. The city of Louis-ville, Kentucky, demonstrated the need for a retrofit, high-rise sprinkler ordinance by running a drill response to a downtown high-rise office.[4] The fire department showed that even though it had units on the scene in four minutes, it took nearly 12 minutes-two minutes after the predicted time to flashover on the floor of origin-before it had a crew on the fire floor ready to apply water. It argued successfully that once flashover had occurred, the risk to any remaining occupants and to the firefighters was unacceptable. The ordinance was passed. Thus, code requirements for automatic sprinkler protection represent provisions for protecting firefighters, benefiting building occupants, and protecting property.

OBJECTIVES OF PERFORMANCE CODES

In the above cited examples, any protection provided for firefighters by provisions in prescriptive codes are implied to be for that purpose, because these codes do not make their intent explicit and even members of the drafting committees disagree about the intent. The situation with the new generation of performance codes is different, since they contain objective statements that make the intent clear. Most of the performance codes developed in the world today explicitly treat protection of firefighters.

One of the more interesting topics of discussion in the development of performance codes was that concerning the level of protection the codes should provide for firefighters. Here, there seems to be two opinions. One is that firefighters are highly trained and well-equipped professionals who can take care of themselves; thus, they need no special protection from the codes. The other argues that these heroes risk their lives on a daily basis to protect the lives and property of the public and they deserve all the protection the codes can provide.

A recent interpretation of the New Zealand performance code by the Building Industry Authority (BIA), the government body that promulgates the building code, relates to this issue.[5] The Authority held

" ...the objective to safeguard life in section 6(2) of the code can be taken to refer to the life of anyone likely to be in or about the building in the course of its intended use, which includes firefighters and people with disabilities. The term "intended use" includes activities taken in response to fire. The classified uses specified in the code include, for each classified use, activities taken in response to fire. The building regulations, therefore, require a building to achieve the performance requirements specified in the Building Code for activities taken in response to fire. The relevant performance requirements are:

"Clause C3.3.9 requiring fire safety systems to facilitate the needs of fire service personnel to control the spread of fire. The term "fire safety systems" includes building elements required to have some fire resistance.

"Clause C4.3.1 requiring such fire resistance to be appropriate to the function of allowing fire service personnel adequate time to undertake firefighting operations.

"The Authority therefore concluded that, unless some other compensating provision is made, the building elements concerned must have fire resistance ratings appropriate for the protection of firefighters, whether they are performing rescue operations or protecting the building. That did not necessarily mean that the ratings must be those specified in the acceptable solution."

As this often lively debate progressed in the United States, there evolved a position in the middle-that is, firefighters are highly trained, and their training and experience tell them when they are in danger. But the codes need to provide protection for firefighters in the situations where they cannot or will not exercise that choice to protect themselves-that is, when they are involved in search and rescue operations and when the building size or configuration precludes an exterior attack. This recognizes the fact that firefighters will not abandon civilians or other firefighters at risk and, except in extreme situations, they will not pull back and let the building burn down. But it further presumes that firefighters will recognize the danger and pull back to fight the fire from outside where the risk to the firefighters is high and no civilians are at risk.

RECOGNIZING THE DANGER

Today, incident commanders know enough not to put people on residential, lightweight truss roofs and not to position people or equipment near unreinforced masonry walls. But most dangers of structural collapse in fire are difficult to recognize. Two Fire Department of New York firefighters were killed and four were injured in 1998 when they fell through a floor in a three-story, mixed-use building with commercial properties on the ground floor and apartments above. While they were looking for an occupant on the second floor, the rear floor suddenly collapsed, dropping the firefighters into the inferno below.

Structural issues with residential construction go well beyond lightweight truss roofs. Modern residential construction increasingly employs engineered lumber products-floor joists are wooden I-beams, and plywood has been replaced by oriented strand board or particleboard. Historically, residential construction has few fire resistance requirements; they are generally limited to rated partitions to attached garages and around furnaces and separation walls in attached dwellings. Most code officials agree that this is not because fire resistance was considered unnecessary but because construction materials and methods commonly found in dwellings had some inherent fire resistance that was sufficient to allow for occupant egress.

The introduction of these engineered products was driven by the increasing difficulty and attendant cost of obtaining dimensional lumber of sufficient length for structural elements. These engineered products were actually stronger, allowing longer, unsupported spans; some made the installation of services and utilities easier. Since there were no fire resistance requirements, this factor was not an impediment to their introduction and use. We may assume certain fire resistance from certain types of residential construction-for example, 20 minutes is expected from a half-inch gypsum board wall on wood studs 16 inches on center. When the studs are replaced by an engineered stud, we do not know if there is any effect on fire resistance.

In Canada, the National Research Council's Institute for Research in Construction has undertaken a research project to quantify the degree of fire resistance implied by the older codes so that these levels can be incorporated into the performance codes (which the Canadians refer to as objective-based codes). The results of this work should have impact on the U.S. codes as well.

FINDING THEIR WAY TO SAFETY

Another issue highlighted by the tragedy in Worcester, Massachusetts, that claimed six firefighters was that of their finding their way in search operations.[6] When a suppression team needs to retreat in a hurry, it simply follows the hose out. But in a search situation, the firefighters are often working with little or no visibility and no guide out other than trying to remember how they came in. It is easy to get disoriented, particularly with a complex interior arrangement. Complicating the case in Worcester was that this warehouse had no windows that could provide a reference to the exterior.

Building codes require exit marking to guide occupants to safety. Perhaps the codes need to consider marking the means of egress for the safety of firefighters conducting searches. This might involve low-level path marking similar to that being used in Europe. This would certainly be consistent with the U.S. performance code concept that the codes need to protect firefighters conducting search operations.

Although the new codes include the objective to protect firefighters during search and rescue operations and interior attack, the associated functional requirements are limited to structural safety and tenability (assuming protective clothing and breathing apparatus) during these activities. There may be other issues that the codes should address with regard to firefighter safety. These may include egress marking, provision of equipment to assist in the evacuation of people with disabilities, equipment to track firefighters in the building, and standardized real-time information displays for incident management.[7]

FIRE SERVICE INPUT NEEDED

The United States as well as many other countries is in the process of developing new sets of building and fire codes. Many are performance-based codes that specify outcomes and objectives rather than prescribing specific solutions. These new codes are raising questions about what society really expects from buildings and the intent of individual provisions found in the current codes. It is crucial that all affected parties contribute their thoughts and make their needs understood.

The fire service needs to speak up about what protections it needs and expects from the codes if those needs are to be met. Firefighters can do this directly by proposing specific language or provisions to the developing codes or indirectly by making their needs known to the code-developing organizations. Every such organization is anxious to ensure that its code meets the needs of the fire service, but they can't do this if they don't know what those needs are.

This is also a time of considerable change in the U.S. codes development process. The three model codes groups that have produced the current codes have combined their activities to develop a single set of coordinated model codes. These are known as the International Codes (or the I-Codes) produced by the International Codes Council (ICC) of Alexandria, Virginia. Its building and fire codes are known as the International Building CodeT and the International Fire CodeT. These model codes are revised on an approximate 18-month cycle, and public proposals for changes to the codes can be submitted at certain times. Proposals must follow a specific format and include specific, suggested language and substantiation for the proposed change. Information on schedules and proposal forms can be found on the ICC web site: http://www.intlcode.org/.

The National Fire Protection Association (NFPA), publisher of the National Electrical CodeT and the Life Safety CodeT (among approximately 300 codes and standards) is also developing a consensus codes set that includes a building code (NFPA 5000) and a fire code (NFPA 1 will be merged with the Uniform Fire CodeT). NFPA codes and standards are usually revised on a three-year cycle with public proposal and public comment periods open at specific times during that cycle. Proposals and comments must follow a very similar format, and information on schedules for specific NFPA documents and blank forms are available on the NFPA Web site: http://www.nfpa.org/.

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