MASONRY DOES NOT BURN

Can we afford relaxed fire protection in new building codes?

BY STEPHEN S. SZOKE, PE

Recently, passive fire protection provisions in new building codes based on the International Code Council's *International Building Code* (IBC) have been relaxed, as a result of requiring, in many cases, mandatory sprinklers for many occupancy uses. As efforts to further relax fire safety provisions continue in model building codes, the International Code Council (ICC) has formed an ad hoc committee to assist in resolving opposing views on height in stories and feet and total floor area requirements for buildings.

Controversy ensues

A segment of the building community, supported by the cement-based product industries, is encouraging more stringent building height and area requirements. For example, the Masonry Alliance for Codes and Standards (MACS) supports eliminating sprinkler trade-offs and restoring fire protection provisions to those that are consistent with the requirements of the legacy codes, as does the Alliance for Fire and Smoke Containment and Control (AFSCC) which represents manufacturers of fire stopping materials, fire doors and other components and systems vital to effective compartmentation. There is also support from building code officials, fire marshals and fire services personnel.

Opposing more stringent provisions for passive fire protection are groups that encourage maximum affordability to provide housing and places of business with a primary concern of being able to build the least costly structures. Proponents of further relaxation in the passive fire protection provisions of the model building code, including the complete elimination of the height and area table, are builders, developers, building owners and architects. Also, further relaxation of passive fire protection provisions has been encouraged by federal, state and local government entities that favor maximum affordability. This view is also supported by some building code officials, fire marshals and fire services personnel.

While not all builders, developers, building owners and architects design and build buildings to minimum provisions of building codes, increasing competition creates a trend where this can become the norm. More often than not, affordability is being interpreted as the lowest initial cost. This is not a true measure of the ability to afford housing or to economically provide places of work.

Improve codes for life safety

Addressed here are three concepts followed by recommendations for the development of improved building codes for life safety, property protection, welfare of the general public and safety for emergency responders. First is a

[above] View looking along the length of the building. There were two CMU exit stair enclosures on the extreme ends of the building. The CMU elevator hoistway was near the center. Despite the fact that there were no doors installed yet, the exit stair enclosures suffered only minor damage that was repaired. While the engineer that investigated the damaged elevator hoistway determined that it could be reused with some repairs, the contractor decided that it would be cheaper to tear it down and rebuild it rather than repair it.

Fire-Resistance Rating Requirements for Bearing Walls (hours)

	TYPE I		TYPE II		TYPE III		TYPE V	
Bearing Walls	A	B	A	B	A	B	A	B
Exterior	3	2	1	0	2	2	1	0
Interior	3	2	1	0	1	0	1	0
Interior, Supporting Roof Only	2	1	1	0	1	0	1	0

Table 1.

Comparison 2006 IBC and 1999 NBC of the Story Height and Total Building Area Limits for Type V Construction

Occupancy	No. of Stories with Sprinklers	Total Area with Sprinklers IBC	NBC	IBC/NBC
TYPE VA CONSTRUCTION – 1-HOUR FIRE-RESISTANCE RATING FOR BEARING WALLS				
Office Building, NFPA 13 Sprinklers	4	202,500	201,960	1.00
Assisted Living, NFPA 13 Sprinklers	4	118,125	117,810	1.00
Hotel/Motel or Apartment				
NFPA 13 Sprinklers	4	135,000	134,640	1.00
NFPA 13R Sprinklers	4	84,000	93,840	0.90
TYPE VB CONSTRUCTION – 0-HR FIRE-RESISTANCE RATING FOR BEARING WALLS				
Office Building, NFPA 13 Sprinklers	3	101,250	71,280	1.42
Assisted Living, NFPA 13 Sprinklers	3	50,625	41,580	1.22
Hotel/Motel or Apartment				
NFPA 13 Sprinklers	3	78,750	47,520	1.66
NFPA 13R Sprinklers	3	36,750	33,120	1.11

Table 2

discussion of building height and area requirements with a comparison of provisions in one of the legacy codes with the current requirements of the 2006 IBC. Second is a discussion of the need for combined active and passive protection for fire protection within buildings. Third is a discussion on initial costs and affordability. These discussions are followed by suggestions for influencing state and local building codes.

Building size

The height and area tables in building codes have been the historic basis for construction of buildings to provide passive fire protection. The maximum area per floor and the number of stories in a building are based on occupancy use, type of construction, presence of sprinklers and amount of qualifying open space around the perimeter of the structure. Limitations were developed to contain fire to a size that could be extinguished promptly and safely by fire services, provide for life safety of occupants and to protect the building and adjacent structures.

Fire-resistance ratings for bearing walls in various types of construction are shown in Table 1. These minimum requirements are applicable where there is a fire separation of at least 30'. Higher ratings may be required if fire separation distances are less than 30'.

The type of construction specifies whether non-combustible materials are required for structural elements of a building and gives the required fire resistance rating of these various elements. In Types I and II construction, structural elements are generally required to be of non-combustible materials such as concrete, masonry, structural steel frame and cold-formed steel stud construction. In Type V construction, structural elements are permitted to be any materials allowed by the code. Wood frame construction is Type V, as is a building with exterior walls of cold-formed steel studs with structural wood panel sheathing. Type III construction requires that exterior walls be of any non-combustible construction or fire-retardant treated wood within two-hour rated wall assemblies, and allows any type of construction material permitted by the code for interior loadbearing and non-loading walls, floors and roofs. Within Types I, II, III and V construction, there are two subcategories designated A and B; the difference being the required fire resistance of structural elements. Type IV construction, not shown in Table 1, is construction utilizing heavy timber members (columns, beams, floor decking) of a size sufficient to provide a minimum of one hour of fire resistance.

Type of construction combined with the presence of fire sprinklers, open space and occupancy use are the basis for determining the allowable area per story of a building, height in feet and number of stories, and maximum area considering all stories.

Table 2 shows the increase in total building area permitted for Type VB (wood frame) office buildings, assisted living facilities and hotels, motels and apartment buildings. The areas are provided for sprinkler systems conforming to both National Fire Protection Association *Standard for the Installation of Sprinkler Systems* (NFPA 13) and *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and including Four Stories in Height* (NFPA 13R). While being limited to residential occupancies and four stories, NFPA 13R does not require sprinklers in concealed spaces, such as attics, even if constructed of combustible materials. With the use of sprinkler systems complying with NFPA 13, Type VB unprotected wood frame office buildings can be built 42% larger than permitted by the National Building Code (NBC). Wood frame assisted living facilities can be built 22% larger. These are very large buildings without any minimum requirements for fire-resistance ratings, many of which rely solely on fire sprinklers for life safety, property protection, welfare of the general public and safety for emergency responders. Wood frame hotel, motel and apartment buildings can be 66% larger than permitted by the NBC.

THE OPERATIONAL RELIABILITY OF SPRINKLERS IS ONLY ABOUT 84%.

Sprinklers vs passive protection

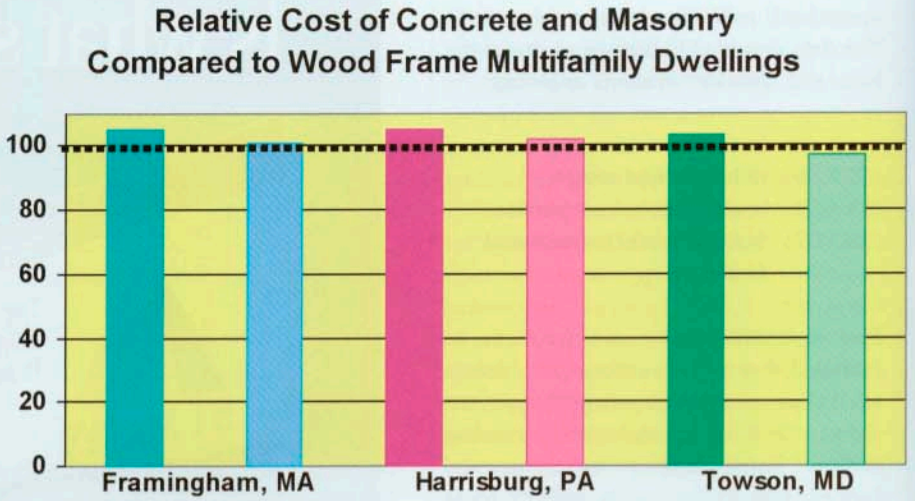
There are two types of protection against the spread of fire in buildings: automatic fire suppression systems (fire sprinklers) and passive fire protection, which includes non-combustible construction such as masonry. While masonry does not burn, the fire sprinkler industry has leveraged its way into the building codes on "operational reliability," the ability of fire sprinkler systems to perform in laboratory test conditions. Operational reliability for most sprinkler systems is reported as being 98% to 99%. Performance reliability, the ability of a fire sprinkler system to suppress a fire large enough to activate the sprinkler system, is not as good. Data collected in the United States Fire Administration (USFA), National Fire Incident Reporting Systems (NFIRS) and reported by the National Fire Protection Association "U.S. Experience with Sprinklers" advises that the

operational reliability is only about 84%. The data provided in the report shows the failure of sprinkler systems as being:

12.4%	**in apartments**
17.3%	**in hotels and motels**
20.45%	**in educational properties**
20.0%	**in healthcare/correctional facilities**

Fire sprinklers may not perform as intended due to installation error, design mistakes, manufacturing/equipment defects, lack of maintenance, exceeding design limits and/or environmental factors. Installation errors include loose solder in pipes that clog sprinkler heads and incorrect sprinkler head types or ratings for the design hazard. Design mistakes may be related to overestimating the adequacy of the water supply or adequate number or placement of sprinkler heads. Manufacturing or equipment defects do occur. During the 1990–1998 federal investigations regarding the Omega Fire Sprinkler settlement and recall, the Consumer Products Safety Commission was informed of 20 fires in which Omega sprinklers did not function. Maintenance criteria for sprinkler systems are well defined in industry standards but routine inspection and testing are not always in compliance with requirements. Sprinkler systems may also fail due to environmental conditions such as major natural disasters — earthquakes and hurricanes. Other disasters on a smaller scale but equally disruptive to water supplies include: flooding, explosions, high wind events and frozen water lines, including pipes within buildings. Fire sprinklers may also be rendered inoperable during normal maintenance of community water supply systems or when breaks in water mains occur. Arson resistance is also jeopardized when sprinklers are used as the sole fire protection in lieu of combined passive and active fire protection as a knowledgeable arsonist will disable sprinkler systems prior to setting the fire.

Fire sprinklers should not be an alternative to passive fire protection. Rather, the two systems should be considered as complimenting each other.



Should one fail to do its job, the other is still available to perform its intended function. When fire sprinklers are properly designed, installed and operate they often can suppress the fire or provide adequate control for evacuation and/or for the fire services personnel to arrive and extinguish the fire.

Passive fire protection may also fail in a building fire. In some instances openings made for items to penetrate fire rated walls are not properly sealed. This tends to be most common in retrofits for plumbing, mechanical, electrical and other building service systems. Fire doors may sometimes be propped open which may result in passive fire protection systems failing to perform to expectations.

While data on the performance of passive fire protection is not readily available or reported in a similar fashion as the performance of fire sprinklers in the NFPA report, studies have been performed in the U.K. and Australia. In the U.K., masonry passive fire protection has been reported to confine fires 81% of the time even though openings were reported to be fixed open 29% of the time. An Australian report showed that masonry construction provided fire containment 95% of the time when there were no openings and 90% of the time when there were openings.

While this is superior performance to active fire protection, passive fire protection is not foolproof. For this reason, the masonry industry does not oppose the mandatory use of fire sprinklers in most building occupancies covered by the ICC, IBC or the NFPA *Building Construction and Safety Code* (NFPA 5000). However, reductions in the amount and frequency of passive fire protection when fire sprinklers are present (commonly referred to as sprinkler trade-offs) should be eliminated in building codes to assure adequate life safety, property protection, welfare of the general public and safety to emergency responders. For more information visit: www.cement.org/codes/tech_fire_sprinkler.asp.

Affordability

The concept of affordability in building code development tends to focus on the initial cost of construction without consideration of the benefits of long-term durability, low maintenance, thermal mass, long life expectancy, low insurance costs, low sound transmission, high resale value and other benefits inherent in most masonry construction.

In addition, initial cost information is usually based on information that is not a true comparison for similar construction type. For example, the ICC annually publishes building valuation data in its *Building Safety Journal*. Data provides square foot construction costs for various construction types. In the August 2006 edition of the journal, Type IA (non-combustible fire rated) office and multifamily residential buildings were

shown to cost about 40% more than Type VA (which includes combustible one-fire rated) construction. Unfortunately, the comparisons are generalized and inappropriately applied to concrete and masonry construction versus wood frame construction. What is not considered is that Type VA construction is limited to four stories in height (with sprinklers); whereas, the height of Type IA construction is not limited. Cost comparisons reported include everything from site and foundation work to the roof structure and covering but does not include cost of the land.

Low-, mid- and high-rise construction are included in Type I construction. Type V is limited to four or five stories or less. Construction methods are not the same. The amount and size of cranes and scaffolding are different for mid and high-rise construction versus low-rise construction. Mid- and high-rise construction may require pile foundations where low-rise construction may be designed with simple mat foundations. There are considerable differences in size, type and costs for water supplies, HVAC, elevators and other mechanical equipment in mid and high-rise construction versus low-rise construction. Also, mid- and high-rise construction tend to require more robust structural elements than low-rise construction. It is clearly inappropriate to assume the published cost per square foot of construction is applicable to similar size buildings of Type I versus Type V construction for the same occupancy use.

This data from the ICC Building Safety Journal has been used to oppose improvements to passive fire protection provisions of building codes proposed by the cement-based products industry. The opponents used the data to make claims that concrete and masonry construction are too expensive and are counter to efforts for affordable housing and places to work. To respond to these erroneous comparisons, the Fire Safe Construction Advisory Councils (FSCAC) in the Northeast engaged the services of John C. Haas Associates, a design firm in PA, to determine costs of comparable multi-family

residential structures constructed using two-hour non-combustible concrete and masonry construction versus wood frame.

For the first three locations studied, initial cost for concrete and masonry construction did not exceed 5% more than the initial cost for wood frame. In one of the three locations, cost of concrete and masonry construction was shown to be 3% less than wood frame. Since initial studies were performed in 2004, studies have been conducted for more than 30 other locations, all showing similar results demonstrating that the initial cost difference between Type I and Type V construction for similar building size and occupancy is not nearly as significant as suggested by a cursory review of the ICC building cost data. For more information, see the article *Optimizing Your Construction and Initial Costs* under Fire Safety at www. cement.org/codes.

Strategies for influencing improved building codes

The masonry position on fire protection is likely to remain the minority view in the development of model building codes. While the industry will continue to challenge the continued erosion of the passive fire protection provisions, the IBC and NFPA 5000 are model codes for states and local jurisdictions to consider in developing a building code, i.e. law, that is appropriate for specific jurisdictions. The model codes represent minimum requirements and may not adequately consider local resources, climate, topography or geology.

Our industry, which has historically focused on educating and influencing design professionals, builders and owners, encourages construction that provides superior fire safety compared to the minimum construction provisions permitted by building codes. We may not have placed enough emphasis on educating the building code officials, building code administrators, fire marshals and fire services. This important audience continues to receive misinformation about passive versus active fire protection, the reliability of fire sprinklers and the concepts of affordability and initial costs. People influencing state and

local building codes need to be better informed so they can make appropriate decisions for their communities.

While some efforts by individual cement-based product industry groups have proven to be effective, it seems that the best success results when industry groups in a particular state or region work together and share implementation and benefits of programs designed to influence state and local building codes. This can be done through alliances such as FSCAC. The benefits of these alliances is that local members:

1) tend to see the real impact of sprinkler trade-offs on the low-rise and mid-rise office, apartments, hotels, motels and assisted living facilities
2) are constituents in the jurisdiction and have a better opportunity to influence regulators and legislators involved in the development of building codes
3) have more access to and can thus more readily develop relationships with building code officials, building code administrations, fire marshals and fire service personnel.

We need these individuals to be better educated so they can enact and enforce improved building codes at the state and local level and support proposed changes intended to improve the national model building codes.

National industry organizations and alliances will continue to focus their efforts on the national model building codes and to provide support for regional, state and local programs designed to influence state and local building codes. Many resources, such as industry statistics that are particularly valuable when talking to elected and appointed officials, are now available on the PCA website: www.cement.org/codes/state_local_codes.asp.

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