Structural steel may be sound as steel, but once it reaches a temperature of a thousand degrees in a building fire, it collapses. That’s why passive fire protection such as spray-on fireproofing is used to maintain the integrity of a building during a fire. It buys people time to exit and firefighters to extinguish a blaze without the building collapsing around their ears. Unfortunately, two trends are undermining the use of passive fire protection, both driven by commercial rather than safety concerns.

Playing with Fire

The first trend concerns what is called “The Sprinkler Trade-off.” Sprinkler manufacturers, in an effort to reduce the cost barrier for owners, have presented the best-case scenario, based on a selective quoting of facts, for using sprinklers in place of, rather than in addition to, passive fire systems. The sprinkler lobby suggests that spray-applied fireproofing, intumescent coatings, fire dampers, fire doors and directing airflow are options that can be traded out or “up.”

As Leon Bablouzian, global product group manager for fire protection at W.R. Grace puts it, “passive fire protection features are either reduced or eliminated by the new IBC (International Building Code) and NFPA (National Fire Protection Association) codes as a result of increased leniency in allowing sprinkler trade-offs. Balanced fire protection, the proven method of using both active and passive systems, is being ignored in new construction primarily as a means of cost cutting.”

Kathleen Taraba is vice president of Rolling Plains Construction, Inc. in Colorado, as well as a member of AWCI’s Fire Safety Task Group, an industry group that has taken upon itself the task of reverting the trend away from passive fireproofing systems. She adds that “the increasing use of fire protection engineering firms to analyze the removal or reduction of passive systems is also a threat. One can cause numbers to say almost anything, but what performance statistics are they using to dictate that passive fireproofing can be reduced? The information collected in fire reports is not directed at the performance, or lack of performance, of fire-rated construction, so the data are difficult to find. But anecdotally, it is in plain view.

“Take the First Interstate fire in Los Angeles in 1988. Had the fireproofing not been performed, we would have experienced one of the greatest tragedies ever recorded in our country, far worse than the [Alfred P. Murrah] Federal Building in Oklahoma—the entire upper 30 or more floors would have toppled over onto neighboring buildings.”

While nobody has kept track of passive fire protection successes in protecting property and lives, statistics do exist that are of concern to owners and occupants of a building that relies only on sprinkler systems for fire control—the failure rate of sprinkler systems. Numbers from the

Sprinkler system failure caused this fire at a cardboard box warehouse in Cicero.
Federal Emergency Management Agency show 18.5 percent fail to perform in commercial fires. This figure does not even include those systems that did perform but were not effective. The absence of any passive fire protection in cases of complete failure or partial effectiveness of sprinkler systems can be disastrous.

Karl D. Houser, P.E., senior fire protection engineer, EBL Fire Engineering in Maryland and also a member of the FSTG, speaking not for the group but as an individual, adds that "when sprinklers do operate, suppression is achieved about 92 percent of the time. However, the codes give sprinkler systems credit as if they were 100 percent reliable."

It is of note that, while they are quick to promote successes of sprinkler systems, the NFPA quit tracking the failures of the systems in 1970. Vickie Lovell, president of Intercode, explains that "the way the NFPA and the U.S. Fire Administration [an entity of FEMA] gather and assemble available data now is primarily intended to demonstrate that buildings with sprinklers usually perform better in a fire than buildings without sprinklers. This point has been well made and is not being argued by anyone—sprinkler systems are acknowledged as vital in fire mitigation. The lack of other statistics and useful information, however, is conspicuous, especially information on sprinkler failures."

Houser adds: "The NFPA used to cite 13 major categories and about 45 conditions that led to sprinkler failure, but have since withdrawn the data, as I understand it, because of the way it was portraying sprinklers. Dr. John L. Bryan's book, Automatic Sprinkler and Standpipe Systems, references the NFPA's 1970 "Automatic Sprinkler Performance Tables," in which many of these sprinkler failure modes are identified. These conditions exist throughout our building inventory today. The recent recalls of the Omega sprinklers and suspicion cast on certain dry sprinklers are also alarming."

"The sprinkler industry is a trade association," summarizes Lovell, "that has marketed its product very effectively and aggressively. They use the term 'performance rating' without identifying what it means, thus leading us astray. Unfortunately, the sprinkler industry and its supporters have given all the credit to sprinklers for reducing property losses and loss of life. In reality, it has been an integrated package of many fire protection features that has produced improved results. Consequently, many designers have been induced into placing all their confidence in sprinklers and have traded off many other important passive features."

It is worth noting, also, that although nobody is arguing that sprinkler systems should not be used, they do have two key drawbacks that make them
less than the universal panacea their advocates would like them to appear. The first is that when a sprinkler goes off, it creates significant water damage. Second, approximately 10 times more people die of smoke inhalation than from burns in a building fire. Sprinklers create steam that displaces smoke into areas that otherwise would not be subject to it.

Sprinkler trade-offs have been written into the International Building Code in the absence of statistics to warrant such a move, but in the face of much anecdotal evidence indicating the risks of doing so. Houser points out that “Many of the large-loss fires in the United States reported in the NFPA’s Fire Journal are in sprinklered buildings.”

Edward Prendergast used to be the Chicago Fire Department’s chief of fire prevention and is now a forensic engineer for fire investigations. He provided the photos for this article and notes that “these pictures show buildings where sprinkler systems failed to perform satisfactorily and thus control a fire-usually from inaccurate design, inadequate water supply or a long-term deterioration of the system, such as the interior corrosion of pipes. The problem is building codes being structured on the basis that one will always have satisfactory performance of the systems, when in fact there will always be a certain percentage of the systems in which that does not prove to be true.”

Just as the silence speaks volumes when one asks a psychiatrist if he would be willing to receive the 480 volts of electricity that he passes through the brains of his electroconvulsive therapy victims, so would the following question when asked of owners of a building with reduced passive fire protection. “Do you feel secure about being in your building when a major fire breaks out, knowing that sprinkler systems do not function properly or at all in at least one-in-five fires? They shouldn’t be, according to Bablouzian: “Eliminating passive fire protection and relying solely on active fire protection removes redundancy in fire safety systems, compromising both life safety and property protection.”

Money Talks

One might think insurance companies should lower their rates for buildings that were built above and beyond the lowest common denominator called for in the codes, with both active and passive systems in place. It seems insurers are not obliging, but they are savvy at least to their own exposure. Houser states that
Taraba mentioned “a building owner who was required to install sprinklers and was told by the building department that he would receive a reduction in his coverage rates. When he contacted his insurance agent, he was told that, if anything, the coverage would rise as the cost of accidental discharge to the carrier would be higher than any savings realized as a fire deterrent.”

Looking for ways to revert the trend, Bablouzian suggests that “contractors raise the awareness of their local regulators to the current trends in codes and fire protection engineering. Eliminating redundancy from fire protection designs compromises both like and building safety. A balanced use of both active and passive fire protection systems has proven successful. Unduly increasing risk by dramatically reducing, or eliminating, either of these systems is difficult to justify.”

Restraining an Unrestrained Impulse

The second trend relates specifically to spray-on fireproofing and steel manufacturers, who want to halve the amount of fireproofing used on steel. The problem they are trying to solve is the price advantage their competitors, concrete companies, enjoy over steel. As passive fireproofing is a key element in the higher cost of steel, manufacturers are taking the shortcut of reducing the fireproofing thickness instead of addressing the real target and Achilles’ heel of the concrete alternative, which is that it takes several weeks to cure. As anyone who has been alive in the 20th century knows, time is money, and this is the point the steel folks should be accentuating with their customer—that steel goes up as fast as they can put it up.

But there is also a situation on the engineering side. A horizontal piece of structural steel that is held at both ends, to prevent it twisting when it becomes hot, is considered restrained. If not, it is considered unrestrained and requires significantly more passive fire protection to prevent it buckling as it reaches the 1,000-degree mark.

Some engineers are offering to value-engineer jobs for architectural firms in order to recategorize the jobs as thermally...
restrained in theory and so save money on passive fire protection. Needless to say, those in the passive fire protection business are not at all pleased with this approach, especially as the math on it is questionable. Papers are being written on both sides of the issue concerning what truly constitutes restrained and what does not.

Bablouzian explains that “there are no specific standards to determine what constitutes thermally restrained conditions in steel buildings. Scientists and engineers have yet to determine the restraint needed in building construction in order to withstand fire conditions. A thermal and structural analysis of a whole building under fire conditions needs to be conducted and reviewed jointly by experts in each field. The lack of such an evaluation leads to confusion in specification and bidding practices, leading potentially to inappropriate thickness application of spray-applied fire-resistive materials.”

Houser adds that “although restraint has been demonstrated in the laboratory, the full and complete mechanics of how one should apply the phenomenon have yet to be fully discussed and agreed upon by all parties in a balanced, standards-development venue without dissention. Generally, designers today are relegated to best guesses of structural reaction in many cases and may be misapplying restraint concepts.”

Taraba provides an example to illustrate the issue. “If you have an existing rated precast floor with an opening for an elevator shaft and then you want to remove the elevator to infill with beams and deck, you have a restrained condition. The precast construction restrains the steel from pushing away from itself when under fire. The reason for unrestrained designs is to provide enough insulation to hold the steel in place without physical restraints from other sources. The use of restrained bidding can be used by fireproofing contractors to come in low, leaving the general with an inadequate value. I’ve seen it happen time and time again that the GC will then go to the engineer to get hi somehow to stamp the drawings as restrained.”

When asked for comment, the American Iron and Steel Institute was unwilling to do so in a forum over which it has no control. Hank Martin, AISI’s director of construction, codes and standards, finally offered these words: “I would challenge anyone’s expertise claiming that something isn’t thermally restrained. When a professional engineer chooses to submit data to a local authority, that’s an issue between those two parties. The code has always allowed alternate solutions to prescriptive requirements. That’s what engineers do for a living, not only in fireproofing but structural engineering.”

That may be so, but the issue goes beyond those two parties when their calculations are not borne out in practice. Bablouzian uses two fires to illustrate the wisdom, or lack of it, in using sleight of hand to justify re-categorizing unrestrained steel as restrained.

“The Philadelphia Meridian Plaza is a good example illustrating the difference between restrained and unrestrained assemblies. On the Meridian Plaza, beams were protected using restrained ratings
(for example, a thickness based on a load-bearing capacity of say two hours and thermally protected for only one hour). The beams failed badly in the fire and the building was a complete loss to its owners and the city. In contrast, the Los Angeles Interstate Building used unrestrained assembly and beam ratings (which means it has a thickness based on a load-bearing capacity of say two hours and thermally protected for the full rating, or two hours). The building suffered no structural loss in the fire and the property was fully functional within months.”

Don’t Throw Up Your Hands

“At this point,” suggests Houser, “education is one of the best tools for the fire protection industry. Perhaps through development and refinement of restraint concepts, designers, installers and code officials can agree on areas where restraint is probable— and improbable—and methodologies that one should insist upon when reviewing engineering calculations that purport to prove restraint. It is a difficult task, with some related to structural mechanics and some to the wide variety of structural systems and connections that are available. There is also the time and resources required to assemble dedicated individuals to develop an excellent and thoroughly comprehensive document on the analysis of restraint.”

Taraba suggests that “a Request for Information be prepared prior to each bid, asking the question, ‘Is this project considered to be thermally unrestrained?’ Then send a copy of the code requirements. Both 97 UBC and the 2000 IBC require jobs to use unrestrained thickness unless otherwise noted by the structural engineer. With the RFI going out prior to bid, GCs would establish a base-

line that is more difficult to play games with.”

Bablouzian concurs, insisting that, “contractors should always submit fireproofing thickness and designs assuming unrestrained ratings and use thickness for beams based on beam ratings equal to the assembly ratings.”

“The pendulum is swinging too far toward absolute and total reliance on fire sprinkler systems,” complains Houser. “Sprinkler systems are vital to fire protection, but they are mechanical systems subject to mechanical failure and inappropriate human intervention. The unrelenting devastation that fire causes makes it seem unreasonable to put all of one’s fire-protection eggs in one basket. Working
together, passive and active fire protection provide the minimum necessary fire protection that people deserve and should expect.”

Taraba’s view is more strident: “The increased usage of multiple trade-offs (one sprinkler system can now be traded for more than one passive one) and reduced fire-rated construction can only result in catastrophic losses of both property and life in the future. We use redundant systems for everything but dealing with the threat of fire: We use generators in case of power outages, air bags in case the safety belt is not adequate, life jackets in case the lifeboat sinks. We are abandoning this redundancy in fire control solely to save owners money.”

“The point of this debate is life safety,” Bablouzian concludes. “Faced with the choice of using a proven system for protecting lives—the combined use of active and passive fire protection—or a system that has not yet been proven, the decision should be pretty clear. Until the alternative systems are proven, people should err on the side of safety.”

Fire protection contractors familiar with the story know that lives, as well as their own businesses, are in the balance. In line with Bablouzian’s earlier suggestion and the FSTG’s program to create a presentation for contractors to use, they can help revert the trend by attending local building official meetings and going over the issues with the officials who approve the plans that architects submit. They can do the same at architect meetings such as the ones held by the Construction Specifications Institute. When the FSTG’s presentation is released, contractors can use that as a tool to convince building officials and architects that erring on the side of responsible safety is preferable to catering to impulses toward short-sighted personal gain.

When it comes to choosing between your money and your life, it seems there are those who don’t have a problem taking both, if it only involves fiddling with a few numbers and facts. It’s up to the majority to bring about a responsible approach to the issues and to permit action when all the facts are in.

About the Author
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