Risk and REWARD

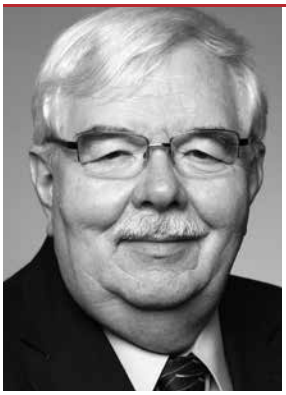
BY JOHN CROSS, PE

Material selection can have significant short- and long-term impacts on a building's insurance rates and resilience.

WHY ARE INSURANCE RATES DIFFERENT for similar buildings framed with different materials?

Because the risks and their associated costs vary depending upon the framing material being used. A lower rate is the result of an actuarial study reflecting a lower cost of repair or replacement for a given risk.

And guess what: The insurance rates for structural steel-framed buildings are less than those for comparable buildings framed in wood or concrete. For the same building in the same location constructed with different building materials, current insurance rates per $100 of value for Builder's Risk (a type of insurance that covers the building during construction) and All Risk (insurance that covers the building after occupancy) are lower for structural steel-framed construction than for wood or concrete. For example, the insurance rates for a building with a total insurable value of $100 million dollars that is not in a high-hazard flood or earthquake area will be in the following ranges (per $100 of value):



John Cross (cross@aisc.org) is an AISC vice president.

	Builder's Risk During Construction	All Risk After Occupancy
Wood	$0.22 – $0.27	$0.20 – $0.25
Concrete	$0.14 – $0.18	$0.13 – $0.16
Structural Steel	$0.08 – $0.12	$0.08 – $0.11

While these rates will change based on project location, risks associated with that location or special features, the general trend is the same. Insurance rates are 2.3 times higher for wood buildings—and 1.5 times higher for concrete buildings—than they are for structural steel buildings. This can translate to considerable savings over the life of a building. But the importance of lower insurance rates does not stop there.

Supplanting Sustainability

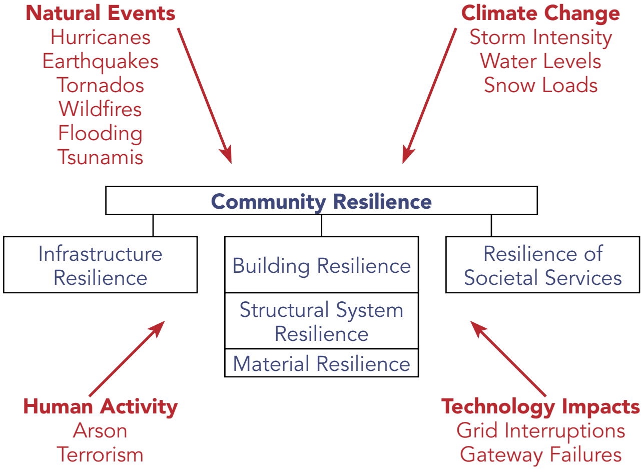
Discussions regarding the resilience of the built environment are slowly supplanting the past decade's focus on sustainability, and rating systems, codes and standards for green buildings are beginning to address resilience in their requirements. But what is resilience and what is the connection between insurance rates and resilience?

Resilience is the ability of an object or system to absorb and recover from an external shock.

While it's a simple concept, it has taken on an increased level of importance and a broader context for today's design and construction professional. And just like the early discussions of sustainability, resilience has triggered a debate between advocates of wood, concrete and structural steel regarding which material is the most resilient.

There is no universally accepted definition of resilience in the built environment. Discussions may focus on community resilience, infrastructure resilience, building resilience or the resilience of societal services. Even within a single category like building resilience, discussions may focus on the resilience of the building itself, the resilience of the structural frame or the resilience of the framing material. The topic can become even more complex when the scope of what is included in external shocks or events is discussed.

Natural events such as hurricanes, tornados, wildfires, earthquakes, flooding and tsunamis are generally included, yet not all of these events have the same likelihood of occurrence in every community. Events resulting from human activity, including arson and terrorism, also need to be considered. In some cases, technological events with no direct natural or human cause such as the faulting of an electric grid or the overloading of a communications gateway are included. And finally, the anticipation of future environmental events such as increased storm intensity, elevated water levels and increased snow loads driven by global climate change may also need to be taken into account. Clearly, any discussion of resilience is a multidimensional challenge combining discrete components, stressors, risk assessments and future trends.



With so many factors involved, how can the relative resilience of a building best be measured from the perspective of the selection of a framing material? It might seem that quantifying that risk and those damages would be difficult. It is not. Insurance companies regularly assess the loss records of buildings subject to both anticipated and extreme events. It is from those actuarial studies that insurance rates are set.

This is not a novel concept, as the advocates of resilient design and construction often compare the dollars invested in a building for increasing its ability to withstand and recover from an extreme event to purchasing a prepaid insurance policy on the building. For a given set of risks, a lower rate for Builder's Risk insurance during construction and All Risk insurance after occupancy means less damage and a lower cost of repair when extreme events occur.

Material Resilience

The material selection for a building's structural framing system impacts the resilience of the structure by reducing or raising the cost of the risk associated with the ability of the structure to absorb and recover from the stress of an extreme event. Of the materials used for structural framing systems, structural steel has demonstrated the greatest level of resiliency relative to extreme events. This is verified by significantly lower premiums in the current insurance market for structural steel framing systems when compared to concrete or wood. The reasons for these lower rates and greater resiliency are structural steel's inherent durability, strength, elasticity, non-combustibility and resistance to decomposition, as well as its ability to resist extreme loads, be rapidly repaired and adapt to changing structural requirements.

Structural steel is simply more resilient than wood or concrete. An AISC white paper, *The Impact of Material Selection on the Resilience of Buildings* (which can be found at **www.aisc.org/discover**), provides a detailed comparison of the resilient attributes of structural steel to those of wood and concrete.

Framing System Resilience

Structural framing systems can be designed to satisfy building code requirements using structural steel, concrete or wood. The central purpose of building code provisions is to provide short-term human survivability and safety in the event of an extreme event. The *International Building Code*, in Section 1604, even includes enhanced designed requirements and integrity checks for high-rise buildings in risk category III or IV. In those cases, structural integrity is evaluated independently—not in combination with other effects—and deformations are allowed as long as failure does not occur. The goal is to provide for the redistribution of loads in the event of damage. A competent structural engineer can accomplish this using structural steel, concrete or wood. But the question isn't whether those design goals can be accomplished using any of these materials but rather the efficiency of using a given material in the design, the cost of the system, the level of additional redundancy gained by the system and the ease and speed of repair if the system is damaged in an extreme event.

Keep in mind that a bunker-style solution, necessitating significantly increased material quantities, is not an efficient way to address the design requirements of high-risk buildings. And structural steel supports a multitude of design approaches and innovative systems that address the challenge of resilient design from a technical rather than an increased mass perspective. Steel provides multiple options for lateral load resistance in a highly ductile environment that allows adequate member deformation while still keeping access to critical services intact and operational. Using systems such as specially designed connections and buckling restrained braces as structural fuses can allow a structure to withstand an extreme event resulting from an earthquake, high winds or blast. If damage occurs to the structural system, these components (the "fuses") can be efficiently removed and replaced, thus returning the structure to full functionality in a short period of time without major structure demolition or extensive retrofit.

And unlike mix-dependent concrete or the variability of wood, structural steel performs in a structurally consistent and predictable manner. Redundant load paths, due to steel's natural ductility and reserve strength capacity, provide additional structural capacity and resistance.

Building Resilience

The resilience of a framing material and system contributes directly to the overall resilience of a building. Overall resilience involves assessing not only the level of damage and the cost of repairs but also the amount of time required to return the building to full functionality—which in turn is a function of the criticality of the services a building provides. Recovering to full functionality may require repairing the structural system, replacing structural components and temporarily removing portions the structural frame to gain access to other building service components that may need to be repaired or replaced.

Unlike concrete framing systems, which would typically require demolition and replacement, or wood systems, which face the challenge of replacing numerous structural members after a flood or fire, structural steel can be strengthened in place, structural members can be added and beams can be penetrated to allow the addition of other services. And this can be done using members that are readily available through a network of local steel service centers and fabricators.

Community Resilience

Community resilience is the ability of the community to withstand the stress of an extreme event, and is a combination of infrastructure, building and societal resilience. Selecting a structural framing material for a particular building with a specified level of serviceability may seem rather distant from the community as a whole. And it is. Yet building material selection does contribute to overall community recovery and performance. This is probably no more evident than in the area of waste management.

Extreme events that impact an entire community rather than just a single building generate significant amounts of waste, the majority of which is wood. While some wood waste is reused or recycled in the normal construction cycle, it is most likely that the wood waste resulting from an extreme event will not be suitable for reuse and will, in fact, be disposed of in a landfill. Burning or landfilling wood releases greenhouse gases into the atmosphere, and burning also generates particulate matter harmful to human health. In addition, wood and concrete waste requires sufficient landfill space to accommodate the increased flow of waste. Structural steel, on the other hand, is a fully recyclable material with an active resale market. It will not end up in landfills but rather be returned to steel mills for transformation into new steel products. In a nutshell, it will not become a burden as the community seeks to rebuild.

The Four R's

Resilience is often discussed in terms of the four R's: robustness, resourcefulness, recovery and redundancy. And structural steel buildings rank highly in each of those categories. It is not surprising that insurance rates for structural steel buildings are less than the rates for comparable wood and concrete framed buildings facing the same risk levels from extreme events. Steel's potential savings in repair costs and rapidity reduces the exposure of the insurance carrier, resulting in lower rates and overall more cost-effective and resilient buildings. ■