COLD-FORMED STEEL AND RESILIENCE

There has been an emerging awareness of the term “resilience” and its importance to the built environment. This has resulted in changes in our thinking on sustainability, building design, and preparedness protocol to natural or man-made disasters.
This paper will explore the concept of resiliency and relate it to a better understanding of the inherent properties of cold-formed steel framing. No building material better exemplifies resiliency.

RESILIENCY

There have been many published definitions of resiliency. The most comprehensive definition was developed in 2011 by the Department of Homeland Security (DHS) in partnership with the National Institute of Building Science (NIBS). Their document, High Performance Based Design for the Building Enclosure – A Resilience Application Project Report provides specific guidelines to follow in the design of resilience in exterior envelopes. It states resilience as “a function of Robustness, Resourcefulness and Recovery is a product of quality of function loss and the time to recover.”

RESILIENCE ATTRIBUTES

This same source clarifies “attributes” as “high-level properties that define a building in terms of the performance the building is to deliver.” These attributes fall into 5 categories: safety, security, energy conservation, environment, and durability. They become the fundamental requirements in meeting three types of conditions (demands) that a building must withstand. The three demands are natural hazards, man-made hazards, and environmental conditions. The resilience of a building corresponds directly to how well the five attributes enable the building to meet the three demands.

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Accepting the premise that the above five attributes establish a resilient structure, then by extension, the same attributes could also benchmark a building material. Following the direction provided by DHS and NIBS, cold-formed steel framing can be seen exhibiting inherent resiliency.

SAFETY and Cold-formed Steel

Cold-formed steel structures withstand the demands identified in the DHS/NIBS document, and then continue in operation after a major event. Characteristics such as lateral load resistance, strength-to-weight ratio, non-combustibility, and connection strength enable cold-formed steel to provide the needed resilience when subjected to the hazards identified in the DHS/NIBS definition of Safety. The hazards include: fire, high wind, seismic, and the deleterious effects of a flood.
As it relates to fire, the building codes recognize cold-formed steel as “non-combustible” and therefore make it eligible for use in Type I buildings where the fire-resistance standards are the most stringent. There are hundreds of fire resistive wall, floor-ceiling, and roof-

ceiling assemblies that use cold-formed steel members as the primary framing member.

The performance of a building during a high wind or seismic event starts with strong design. The American Iron and Steel Institute (AISI) has established a set of ANSI-accredited design standards for cold-formed steel that address all of the seismic categories and wind speeds up to 150 miles per hour. Steel is considered a ductile material because it has the ability to bend or stretch without breaking when a force is applied. Brittle materials like concrete or masonry units will fracture. Full scale shake table tests sponsored by the steel industry were run at the State University of New York in Buffalo. A shake table is a platform that is used to simulate ground motion such as an earthquake. The results of these tests exceeded expectations.

The Federal Energy Management Agency, FEMA, has recognized three key issues related to mitigating the ravages of a flood: flood duration, high velocity flow, and flood-borne debris. This also includes degradation of building materials. Steel is a good moisture-resistant choice for framing, making it resistant to the formation of mold - a major concern after floods.

SECURITY and Cold-formed Steel
DHS and NIBS look at blast resistance and ballistics as metrics for security. Cold-formed steel framing is one framing component in systems that perform well in both categories.

Recent research demonstrate that the overall stiffness and strength of steel stud walls can be significantly greater than the values currently indicated in available design guidelines and that steel stud walls can be utilized to resist blast threats using conventional construction methods that add little cost to traditional designs. (http://ascelibrary.org/doi/abs/10.1061/(ASCE)ST.1943-541X.0000760)

The DHS and NIBS definition of Security connects “ballistics” with a man-made event, such as a bomb or bullet, but the missile could also be a roof tile or a 2x4 wood stud turned into a projectile by a high wind event. Steel studs and steel sheathing products have been proven to provide a high level of resistance to penetration from large, blunt objects. Proprietary solutions have been developed using cold-formed steel to reduce threat from ballistics.

ENERGY CONSERVATION and Cold-formed Steel
The stringent requirements of the International Energy Conservation Code, IECC are met by four exterior wall systems that use cold-formed steel. The final exterior finishes are cement plaster, brick veneer, exterior Insulation Finish System, EIFS, and rain screen systems.

Cold-formed Steel and the ENVIRONMENT
This attribute for resilience explores a material’s impact on the environment and sustainability, an area where the steel industry has clear benefits. The Steel Recycling Institute, SRI reports that steel is recycled more than paper, plastic, glass, copper, lead and

aluminum combined. The World Steel Association states that world-wide, the steel industry has reduced energy consumption since the 1970's in the manufacture of steel by 50%. This directly relates to a reduction in greenhouse gas emissions. The U.S. Environmental Protection Agency, EPA documents that the North American Steel industry has reduced greenhouse gas emissions by 47%.

DURABILITY and Cold-formed steel

Long life is a primary attribute is a key component of resilience. It is important for structural materials to function where moisture from atmospheric conditions is present. Material that won't sustain significant damage from moisture or pests is essential.

Cold-formed steel has a corrosion resistant coating that effectively protects steel from water. With the proper coating, cold-formed steel will last hundreds of years, even under extreme conditions such as being near aggressive salt-laden waters.

Some materials absorb water in a flood situation. The Environmental Protection Agency, EPA has stated there is a window of 24-48 hours to effectively reduce the potential for mold propagation. That time window can be severely taxed if the building materials in the space absorb and hold moisture. Steel does not retain water and is inorganic, so it is not a food source for mold.

Approximately five billion dollars of damage occur each year due to termite infestations in the United States. Cold-formed steel can resist termites in nearly any climate or building type.

The strong relationship between sustainability and resilience requires that society consider how buildings may be used in the future. Cold-formed steel partitions can easily be removed, reused, and/or recycled during building modifications due to its light weight, fire-resistance, and flexibility. Unlike wood, steel does not increase fire risks when exposed during alterations to a building.

The use of cold-formed steel framing in building systems meets the requirements of resilience in the built environment as determined by FEMA, DHS, and NIBS. The material properties of steel incorporated steel members in systems design, assure resiliency and a sustainable future.

Click here to download a free copy of a publication on Cold-formed Steel and Resilience.