Risk Aversion

By Stan R. Caldwell, P.E., SECB

The public generally takes the safety of the structures around them for granted, and for good reason. A landmark study by Robert E. Melchers in 1987 compared the annual risk of death due to a variety of activities. He found that smoking is a high-risk activity, with about 1,000 deaths/million smokers/year. Automobile travel is a moderate-risk activity, with about 210 deaths/million motorists/year. Swimming is similar, with about 175 deaths/million swimmers/year. Air travel is a surprisingly low-risk activity, with about 24 deaths/million flyers/year. Structural failures, however, cause only about 0.12 deaths/million users/year. The public freely accepts the risks inherent in automobile and air travel, and most accept the risks inherent in swimming. Those risks are 200 to 1,750 times greater than the risks associated with structural failures. That begs the question: Are structures too safe?

Structural engineers can claim most of the credit for safe structures. During their years in college, students are taught that a structural failure is never an acceptable outcome. They learn that the consequences of structural engineering mistakes can be severe. For example, when a medical doctor makes a mistake, a single patient might be injured or killed. In contrast, when a structural engineer makes a mistake, hundreds of people might be injured or killed. Also, a structural engineering mistake might cause enormous economic loss and environmental damage.

As structural engineers enter the profession, the importance of avoiding mistakes is repeatedly stressed by their employers and professional liability insurers. They learn the dangers that lurk in their contracts, their construction documents, their field work, and their emails and other project records. At some point, they learn the financial realities of their profession. Based on revenues, structural engineers have the highest claims of all engineering disciplines. The average individual claims against structural engineers are about three times greater than those of any other engineering discipline.

With these concerns firmly established in the minds of all practitioners, the structural engineering profession has become very averse to risk. This approach has certainly served the public very well, as evidenced by the statistics noted above. However, risk aversion is now threatening the prosperity, and perhaps even the future, of the profession.

A century ago, many structural engineers worked as master builders. You probably know some of their names: Gustave Eiffel, John Roebling, Othmar Ammann, James Eads, Eugene Freyssinet. It is a long list. They took responsibility for most aspects of their projects, including planning, design, financing, construction, and maintenance. Eventually, due in part to liability concerns, structural engineers began to limit their responsibilities. Today, many limit their services to investigation, design, and construction observation. Some also decline certain types of projects that are perceived to be a high liability, such as condominiums.

For decades, structural engineers have accepted (or created) an environment that is driven by increasingly prescriptive codes and standards. To avoid risk, few engineers intentionally venture beyond the many requirements stated in these documents. Consequently, they now are sometimes viewed by the public as mathematical technicians who meticulously follow detailed "recipes" to produce adequate designs. They are no longer seen as valued professionals. In this environment, structural engineers have mostly forfeited their ability to exercise professional engineering judgment, which is the very essence of their professional engineering licensure.

Continuing on the current path will lock most structural engineers into a supporting role in a shrinking profession bound by prescriptive design requirements. This will be a profession with diminished stature, one that will be less rewarding to practitioners, and one that will be less appealing to the bright students of the future. As the pressures of automation and globalization are added to this environment, the profession will certainly face marginalization and might eventually face obsolescence.

To ensure their future, structural engineers must find new paths outside their current comfort zones. They must learn to actively manage the technical and business risks on all of their projects. This will require mastering new tools and, importantly, having the discipline to use them daily. If fully understood and actively managed, risk can be a powerful asset. To become more creative and innovative, and thereby to be able to offer more value to their clients, structural engineers must be willing to accept reasonable risk.

Also, structural engineers must once again make professional engineering judgment the primary reason why structural engineers are valuable and why creative people aspire to be structural engineers. This means cautiously going beyond the prescriptive requirements of current codes and standards, and making design decisions based on knowledge and experience. One path is to develop special expertise in a niche area, such as the rehabilitation of old structures, where codes and standards might not readily apply. Another path and a broader one is to embrace performance-based design. While not for the faint of heart, and while not appropriate for every project, this is rapidly becoming a popular method of venturing beyond the requirements of current codes and standards.

In summary, the profession of structural engineering has evolved into one that is overly risk averse and overly prescriptive. Change is required if the profession is to thrive in the future. Two paths forward are niche specialization and performance-based design. These are likely not the only paths. It is evident, however, that the status quo does not lead anywhere that most structural engineers want to go.▪

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