9/11 in the Conversation about Disproportionate Collapse

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On this month's anniversary of the attack on 9/11, we remember the lives lost on that day and in the subsequent years while addressing the aftermath. We remember the shock and anger we felt when our world changed. We grapple with our role in preventing tragedies like that.

Structural engineers always have and always will put public safety at the highest priority. As a profession, we have been tenacious in our mission to find the best, cost-effective ways to protect lives and property from the forces that would destroy structures. While we have anticipated that wind and earthquakes could cause widespread damage, we have generally shied away from considering that some unforeseen threats could challenge our designs. To the extent that we expressly thought about those unforeseen threats, we might have reasoned that the general qualities of ductility and continuity would offer protection.

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9/11 changed that. Explosions, disproportionate collapse, general robustness, and resilience are very much in the conversation now.

But it did not start in 2001. Instead, the Ronan Point collapse in 1968 comes up in every conversation. That event sparked research by the pioneers of disproportionate collapse resistance – John Breen, Eric Burnett, Bruce Ellingwood, Edgar Leyendecker, William McGuire, and others – to contemplate unforeseen threats and keep structures erect when damaged. Their papers in the 1970s started serious discussions about serious issues.

Then came L'Ambiance Plaza, a building that collapsed entirely while under construction in Bridgeport in 1987. The profession took its next incremental steps toward addressing the problem of disproportionate collapse. But, like many of the most shocking failures through the years, this was a failure during construction rather than one while in service. We reasoned that it was a fluke, a one-off. We decided that design and construction processes needed to change rather than structural design.

Next was the 1995 bombing of the Alfred P. Murrah Federal Building in Oklahoma City. This event awakened American society to two facts: explosions are a real threat to structures, and people in this country will actually bomb structures to bring them down. Since then, we have needed to combat active, calculating, ever-changing enemies to structural performance in addition to the familiar natural, statistically quantifiable threats. That event started a serious discussion about blast resistance.

The world changed on September 11 when the Pentagon was undercut by an airplane, and the iconic 1,350-foot twin WTC1 and WTC2 towers in New York City were struck and collapsed, obliterating buildings for hundreds of feet in all directions and causing the nearby 47-story WTC7 tower to collapse a few hours later. All with unimaginable and unacceptable human, physical, and cultural tolls.

Except for WTC7, none of the structural failures on that day were the result of disproportionate collapse. In fact, the performance of WTC1, WTC2, and the Pentagon far exceeded what I would guess most structural engineers would have bet possible before 9/11. Thus, while many lives were tragically lost that day, many others were saved by the inherent robustness of those buildings.

Disproportionate collapse or not, the events of 9/11 truly moved the entire AEC industry to be proactive to directly consider the possibility of serious damage causing the unreasonable collapse of certain significant buildings.

Now we arrive at 2021, and the unthinkable collapse in the middle of the night of a high-rise condominium in Surfside. People in their beds, secure in the knowledge that their homes had stood for 40 years, were killed by a sudden, ghastly collapse. This happened in the United States. It really comes home now. It does not get more personal than this.

Undeniably, the profession and the world are different now than they were before Ronan Point, before L'Ambiance Plaza, before Oklahoma City, before 9/11, before Surfside, and before any of the other shocking and tragic failures along the way. We know this, and the structural engineering profession is doing more than just talking about things like disproportionate collapse, blast resistance, performance-based design, robustness, resilience, and life-cycle performance. We are a new profession facing new challenges, and we are working to conquer them.

SEI is leading in these efforts. In 2011, SEI issued the first edition of SEI/ASCE 59, *Blast Protection of Buildings*. SEI/ASCE 59 provides guidance for designing buildings to resist nearby explosions. The first revision is nearing completion and likely will be released early next year.

Also nearing completion is a new standard for mitigating disproportionate collapse potential, inspired by the series of unacceptable losses over the past decades. This new standard strives to be performance-based, giving guidance about risk assessments and the scope of the structural responses engineers should consider when contemplating resistance to collapse. It should be published early next year as well.

In addition to developing these new documents, SEI has formed committees to advocate for performance-based design, advance resilience, and study life-cycle performance. These critical initiatives should help the structural engineering profession respond to ever-changing societal and environmental demands.

Incremental steps are not enough. We cannot be watching the news about the next shocking, heart-wrenching loss without being able to say we are doing something about it. It is time to be proactive and directly acknowledge rare but high-impact events. One action you can take is to share a safety issue and knowledge to help create a safer built environment via Collaborative Reporting for Safer Structures US at **www.cross-us.org**. Then, sign up for the CROSS-US newsletter and access the reports and lessons learned.▪

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