A Load That's Hard to Bear

by David Siegel, National Society of Professional Engineers

EDITOR'S NOTE

This article is reprinted with permission from the Fall 2020 issue of PE *magazine, which is published by the National Society of Professional Engineers (NSPE). It is presented as the latest in an ongoing discussion in* ASPIRE® *about what we can learn regarding professionalism and ethics from the collapse of the Florida International University (FIU) pedestrian bridge and the subsequent National Transportation Safety Board (NTSB) investigation. The discussion began with the Editorial in the Winter 2020 issue of* ASPIRE*, which was then followed by a Perspective article in the Spring 2020 issue. That article included a reference to the NTSB Highway Accident Report, and following the article, the full text of NTSB Vice Chairman Bruce Landsberg's concurring statement regarding the collapse was printed. Other articles that have followed have provided references to enable readers to revisit the investigation and its findings and understand the reasoning behind this series of articles in* ASPIRE*. We hope that our readers continue to benefit from this discussion as we seek to better serve our communities and profession as engineers.*

For many professional engineers, the bridge collapse at Florida International University in 2018 is a failure that's still difficult to fully comprehend.

> *"On Thursday, March 15, 2018, about 1:46 p.m., a partially constructed pedestrian bridge crossing an eight-lane roadway in Miami, Florida, experienced a catastrophic structural failure in the nodal connection between truss members 11 and 12 and the bridge deck. The 174-foot-long bridge span fell about 18.5 feet onto SW 8th Street, which consists of four through travel lanes and one left-turn lane in the eastbound direction, and three through travel lanes in the westbound direction. Two of the westbound lanes below the north end of the bridge were closed to traffic at the time of the collapse; however, one westbound lane and all five eastbound lanes were open.*
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> *"Eight vehicles located below the bridge were fully or partially crushed. One bridge worker and five vehicle occupants died. Five bridge workers and five other people were injured."*
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> —National Transportation Safety Board (NTSB) Accident Report, ***Pedestrian Bridge Collapse Over SW 8th Street, Miami, Florida, March 15, 2018***

> *"Engineers, in the fulfillment of their professional duties, shall: (1) Hold paramount the safety, health, and welfare of the public."*
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> —National Society of Professional Engineers (NSPE), *Code of Ethics for Engineers*

Since March 15, 2018, the basic facts of the Florida International University bridge collapse have been assembled and widely reported. The analysis in the National Transportation Safety Board's accident report has spread far and wide, and there has been a profession-wide struggle to come to grips with the tragedy. That struggle can be seen in the many articles, webinars, seminars, online discussion boards, and chats among colleagues. The question that's typically asked, like a reflex: What can we learn so something like this never happens again?

Now, two-and-a-half years after the collapse, NSPE members, regardless of discipline, are still trying to make sense of the failure. Reading the NTSB report and other technical analyses don't necessarily make it easier. Professional engineers are obligated to hold paramount the safety, health, and welfare of the public. In this case, the obligation wasn't met.

"Screaming Loudly"

At NSPE's Virtual Professional Engineers Conference in August [2020], NTSB Chairman Robert Sumwalt summarized the investigation's findings. Three critical errors were identified: (1) the bridge was underdesigned, (2) the peer review was insufficient, and (3) there was a failure to close the bridge to traffic and workers.

The findings note that on the main span truss member 11/12 nodal region, there was visible cracking more than 40 times larger in width than generally accepted cracks for a reinforced concrete structure. Investigators said, based on interviews, that the cracking was the bridge talking to them. "I say the bridge wasn't talking, it was screaming," Sumwalt said. "It was screaming loudly that there was something desperately wrong with the design of this bridge and something needs to be done before people die."

He added: No matter where you sit in the project hierarchy—a new engineering school graduate, a construction manager without a four-year degree, or anywhere else—you can't stay silent. "If something doesn't look right, you have a professional and a moral obligation to wave the bullshit flag and say, 'You know what, I'm just not comfortable with this.'"

The Reaction

Those who listened to Sumwalt's presentation had different reactions and took away different lessons. Kathy French, PE, drew a comparison to the

Federal Energy Regulatory Commission's report on the February 2017 failure of the Oroville Dam spillway in California. The incident, brought on by heavy rains, forced the evacuation of more than 180,000 people living downstream. The vice president, environmental, at LS Power in Chesterfield, Mo., says the presentation reinforced a simple but challenging ethos. "Hubris and complacency cannot be allowed in engineering, and it is beholden on all of us in the profession to speak up when something looks or feels off or to foster in those we are managing or mentoring that they also have an obligation to speak up anytime something looks or feels off," she says. "No one is above having their plans or designs questioned."

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For Donna Riggs, PE, a software quality assurance engineer from Oak Ridge, Tenn., the main lesson was about the peer-review process. "I will invest significant effort into clear expectations whenever performing a peer review or when requesting one," she says.

The lessons of March 15, 2018, can be applied no matter your engineering discipline. Whether environmental, software, or any other, those lessons are at the heart of the professional engineer's great responsibilities.

"It's not just a civil engineering issue… it is a professional issue," says Susan Sprague, PE, FNSPE, chair of NSPE's Board of Ethical Review and a project manager with over 30 years of experience in public works, including bridge inspection, maintenance, and replacement.

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She finds many parts of the NSPE *Code of Ethics for Engineers* in the rubble of the collapse, foremost the obligation to hold paramount the public safety, health, and welfare. And, among others, "Engineers shall be guided in all their relations by the highest standards of honesty and integrity" and acknowledge their errors.

One particular Board of Ethical Review case makes Sprague realize that the outcome in Miami could have been different. The case, 98-9, is a simplified scenario of the well-known circumstances surrounding a potential disaster due to the design of the Citicorp Center in New York City.

The facts of the case are similar to the FIU bridge project. The story of the Citicorp Center building features an innovative design and a potentially life-threatening design calculation error that was missed by many engineers before and during construction. The difference, however, was that the Citicorp Center design error was recognized, remedial action was taken, and disaster was averted.

Although the technical details of the two cases are different, the professional issues are not. At the end of the day, professional engineers "want to be respected as professionals," Sprague says. "Regardless of the discipline, we all have the same code of ethics."

Breaking Strain

Discussion of the bridge collapse among Society members also took place in NSPE's online Open Forum. About a month after the NTSB released its final accident report in October 2019, Eric Tappert, PE, of Coopersburg, Pa., started the conversation. Like many members, Tappert wears the stainless steel ring of the Order of the Engineer on the little finger of his working hand. His posting to the Open Forum provided a link to the NTSB report and a link to Rudyard Kipling's poem, "Hymn of Breaking Strain."

Tappert volunteers his time to the Order of the Engineer in Pennsylvania, and he notes that the Kipling poem is always read during ceremonies. "The poem highlights the fundamental shortcomings of humans, as opposed to basic physics," he says. "It is these shortcomings that lead to ethical problems, bad design, and ultimately failures. The poem makes that clear, and the last verse gives us direction for the future."

Oh, veiled and secret Power
Whose paths we seek in vain,
Be with us in our hour
Of overthrow and pain;
That we—by which sure token
We know Thy ways are true—
In spite of being broken,
Because of being broken
May rise and build anew
Stand up and build anew.

The Order of the Engineer's roots are connected to the Canadian Ritual of the Calling of an Engineer, which started in 1925 and was written by Kipling. Coincidentally, myth holds that the iron used to make the ritual's original rings came from the wreckage of the Quebec Bridge, which collapsed during construction in 1907, killing 75 workers.

Other NSPE members shared their thoughts in the Open Forum, too. They saw the root cause in the project's organizational structure and contractual arrangements, and they noted the possible role of complacency. They also pointed to the Engineers' Creed pledge, "To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations," as well as the professional engineer's standing as a leader who accepts placing the public interest over corporate or personal interest.

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Joseph Englot, PE, of HNTB Corporation, asked whether a whistleblower law could better protect engineers and the public. As the company's national director of infrastructure security, he

would like to see a law stating that an engineer who observes a serious safety issue and reports it to the appropriate building department official or public owner-agency, regardless of signing a nondisclosure agreement, will not be subject to any penalty from a nondisclosure agreement.

In a later email exchange, he summarized his objective as a professional engineer in light of the bridge collapse: "To ensure that anything that I design must not risk public safety for any reason. In fact, that is why I have been educated and trained in my profession, to ensure that any product I help to develop is safe, as the first requirement." Once that product is determined safe, he adds, it can be optimized to reduce cost, increase service life, and improve performance.

Reflection

When the strain on the FIU bridge became more than it could bear, it collapsed in less than two seconds. Lost were the lives of an 18-year-old political science student at Florida International University, a 37-year-old worker on the bridge, a father and tower crane technician, a 60-year-old systems technician, and longtime partners who owned a party rental business.

For some professional engineers, the tragedy is still raw, and leaves unanswered questions. Could something like that happen on one of my projects? Kathy French, who has 16 years as a professional engineer, says Sumwalt's presentation "left me doing some serious reflection if I have been or become dismissive of my associates' questions or concerns and how to ensure I foster a challenging attitude in my team."

Sprague, whose resume includes decades of bridge project experience, also reflects on her personal experience. She asks, what would I do? What's my ultimate responsibility? What about the people I work with? What kinds of checks and balances do we have in our office? The answers are hard to come by. "Could something like this happen at my company?" she adds. "Or would we be humble enough to realize that something's not making sense and let's call for help?"

Professional engineers excel at solving technical problems, and in some ways, piecing together the forensic evidence from a failure and reaching a conclusion about what happened may be the easy part. But engineering is a human endeavor, and human behavior and decision-making are not as easy to understand.

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To reach better conclusions, perhaps asking the human questions in concert with the technical questions will shed a brighter light. "Engineers will never be perfect," says Tappert, "but we do need to understand our own failings so we can take steps to minimize their impact. That's why things like the FIU bridge failure need to be ethics lessons, and the technical stuff is only background for the people story."