Lessons Learned from Bridge Collapse

By Brian J. Leshko, P.E.

In the medical profession, physicians routinely learn from medical mistakes through a process known as *Morbidity and Mortality Review*, which translates to Illness and Death Review. A tradition passed down through generations, physicians associated with specific cases present the background and findings from patients confronted with illness or death, which may or may not be caused by medical error. The process, which is usually guided by "what is said in the room stays in the room," allows frank discussion in order to educate others and improve patient care.

In our engineering profession, structural engineers can similarly benefit from the lessons learned following the tragic collapse of the I-35W Bridge in Minneapolis, MN, which resulted in the loss of 13 lives and injuries to 145 motorists. Design engineers and inspectors across the breadth of structural engineering should take note of the findings issued on November 14, 2008 by the National Transportation Safety Board (NTSB) from their Highway Accident Report, *Interstate 35W Collapse Over the Mississippi River*, Minneapolis, Minnesota, August 1, 2007, NTSB/HAR-08/03.

The NTSB has determined the probable cause of the collapse of the I-35W bridge in Minneapolis, Minnesota, was the inadequate load capacity, due to a design error by [the Design Firm], of the gusset plates at the U10 nodes, which failed under a combination of (1) substantial increases in the weight of the bridge, which resulted from previous modifications, and (2) the traffic and concentrated construction loads on the bridge on the day of the accident.

Contributing to the design error was the failure of [the Design Firm's] quality control procedures to ensure that the appropriate main truss gusset plate calculations were performed for the I-35W Bridge and the inadequate design review by federal and state transportation officials.

Also contributing was the generally accepted practice among federal and state transportation officials of giving inadequate attention to gusset plates during inspections for conditions of distortion, such as bowing, and of excluding gusset plates in load rating analysis.

Given the public release of the Report, the "what is said in the room stays in the room" philosophy has been breached; however, the ability to educate other engineers and inspectors, and improve the structural design and inspection processes, is retained. We can learn several lessons from this tragedy that can be used to ensure the safety of the traveling public.

…the NTSB made nine recommendations to the Federal Highway Administration [FHWA] and the American Association of State Highway and Transportation Officials [AASHTO] dealing with improving bridge design review procedures, bridge inspection procedures, bridge inspection, training and load rating evaluations.

The Board's full Report is available on the NTSB's website, **www.ntsb.gov**. Two of the nine recommendations (numbers 1 and 3) are identical, charging the FHWA and AASHTO to work together to mitigate the design error issue.

Develop and implement a bridge design quality assurance/quality control program, to be used by the States and other bridge owners, that includes procedures to detect and correct bridge design errors before the design plans are made final; and, at a minimum, provides a means for verifying that the appropriate design calculations have been performed, that the calculations are accurate, and that the specifications for the load-carrying members are adequate with regard to the expected service loads of the structure. (H-08-XX)

All structural engineers can take to heart the message of the aforementioned recommendation, regardless of what type of structure is being designed. The recommendation, as written above, can apply universally if the words that are underlined are omitted. The fact that this recommendation stems from the findings of an investigation into the collapse of a bridge does not preclude its use by all structural engineers. This is a wake-up call for all design engineers.

Design firms should perform a self-assessment to explore the effectiveness of their respective design quality assurance/quality control (QA/QC) program. QA/QC cannot be relegated to an afterthought in the overall design process. Effective measures must be established and enforced throughout the design process, starting at the 0% Review and scheduled at appropriate subsequent milestones (30%, 60%, 90%), to ensure the safety of the myriad of structures that are being built for and used by the public and private sector alike.

The most effective QC Review occurs when a senior structural engineer, not involved with the specific design project (and not the Project Manager), reviews the design process, specifications and calculations for appropriateness, completeness and accuracy. The time required for this QC Review must be negotiated up front and scheduled as part of the overall design process. Procedures must be in-place to ensure that any and all design errors are detected and corrected before the design plans are finalized. As an engineering profession, it behooves us to learn from this tragedy and satisfy the highest responsibility of the profession to 'hold paramount the safety, health and welfare of the public.'▪

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