Structural Engineering Education

From Hardy Cross' teachings to Dean Van Landuyt's arch bridge and a few additional thoughts

by Dr. Oguzhan Bayrak

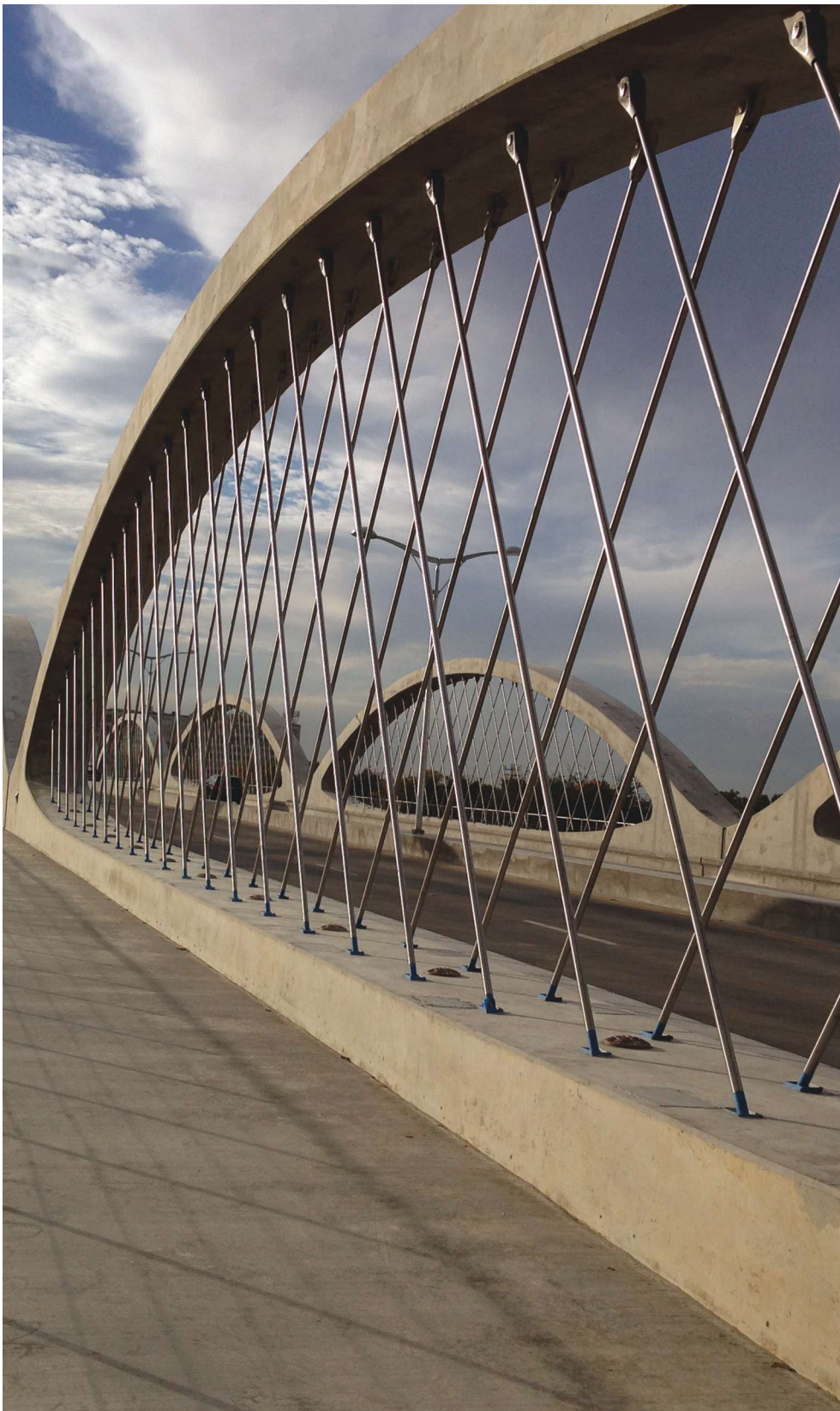
When I was first approached by the editor-in-chief of *ASPIRE*,™ William Nickas, I was presented with an important opportunity and a challenge to share my thoughts on educating bridge engineers for the twenty-first century. I accepted this responsibility because I view teaching as the most important part of my job at the University of Texas. In this context, teaching ranges from teaching formal classes on our main campus, to the teaching that takes place in the Phil M. Ferguson Structural Engineering Laboratory where I conduct research and teach graduate students.

With this new series, I will share my perspectives on educating structural engineers, drawing from lessons learned in research projects I have supervised. I will also provide an opportunity for students and bridge design professionals to voice their opinions with the goal of making bridge engineering an even more exciting profession for many. As a starting point, in this issue, I would like to share some thoughts that served me as guiding teaching principles over the years.

Educating Structural Engineers Is Not Simple

Examples of best structural engineering products exist at the intersection of structural form and function. The most daring structural forms are often not functional or at least not ideally functional. The most functional designs appear to be ordinary.

In my view, striking a balance between structural form and function can only be achieved through a successful combination of applied science principles that form the very foundation of structural engineering and the art of



West 7th Street Bridge in Fort Worth, Tex., the world's first precast network tied arch bridge
Photo: Hossein Yousefpour, the University of Texas at Austin.

hiding complex structural behavior in simple structural forms that make up a structure. Hence, by definition, "good" structural engineering exists between competing interests: structural form and function.

Let us take a look at the world's first precast concrete network arch bridge (the West 7th Street Bridge in Fort Worth, Tex.), shown in the photograph, as an example. This architectural marvel does a good job of hiding many complex behavioral problems in a neat and clean appearance to the casual observer.

Like the profession itself, the education of "structural engineers in the making" exists in between two competing factors: disciplined ways of thinking and a freedom to create. In the eyes of the students, there is a fine line between a well-organized series of lectures and overly regimented classes. As was stated by Hardy Cross in the early 20th century, student aversion to an overly regimented learning environment is rooted in the intellectual freedom needed to create.

As a result, as educators, we must try to balance the learning environment in our classes through highly organized lectures and more open-ended design assignments and projects.

Structural Engineers Must Think

For practicing engineers, the need to have the time to think may be at odds with highly constrained schedules and budgets. Nevertheless, structural engineers must find the time to organize and rationalize their thinking and consequently make decisions in their designs.

In my view, as structural engineering professors, we must think before our students. The importance of accommodating questions, both pertinent to the lecture and seemingly off-the-wall, cannot be over-emphasized. When addressing a question raised by one student, the rest of the class benefits by witnessing how the professor thinks, how he/she rationalizes and proves his/her point.

At times, providing multiple explanations to the same question is equally important to actively demonstrate how several rational solutions to the same problem exist. In essence, this teaching principle can also be referred to as leading by example; in this case, by thinking in class. As the students witness their professor provide rational explanations leading to good structural engineering solutions, they will develop similar habits in tackling complex, real-world structural engineering problems.

Structural Engineering Is an Applied Science

A good structural engineering professor should remember and remind his or her students the fact that structural engineering is not pure science. Often, conservative assumptions are made to simplify complex design processes and the focus is kept on the big picture. All structural designs should be simplified to the extent possible but they should not be overly simplified.

Let us use the example of the network arch shown in the photograph once again. It is important to recognize that the example given in the figure is the work product of a structural designer with three decades worth of experience (Dean Van Landuyt formerly of the Texas Department of Transportation [TxDOT]). Considering the unique features of this bridge, Van Landuyt decided to engage Ferguson Laboratory researchers at the conceptual design stage to identify and discuss several important aspects of structural behavior and ultimately simplified the design process to the extent possible. Further, Ferguson Laboratory researchers worked with the designer and contractor to ensure the safety and stability of this unique bridge during construction.

Conclusions

In my view, some of the most important traits of the structural engineering profession, and hence education, have been described in this article. A genuine appreciation of those concepts is absolutely essential to the education of the next generation of structural engineers and bridge engineers.

With this inaugural article, I wanted to share some of my thoughts and views on structural engineering and bridge engineering. More specifically, I have discussed the principles that have guided me as an educator and researcher in structural engineering. I hope you find this new series of articles interesting and valuable.