

Bridge Engineering Education: Access and Excellence

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Never has there been a greater need for high-quality education and the development of bridge engineers. Labor trends indicate that the workforce is shrinking. At the same time, governing codes and specifications are becoming increasingly complex, and new tools and materials can enable more sophisticated bridge designs. Despite the need for a better-educated workforce, course offerings in bridge engineering have diminished over time as universities have been pressured to reduce undergraduate credit-hour requirements, which means graduate programs in structural engineering must increasingly focus on “the basics.” For these reasons, continuing education opportunities play an especially critical role in the education and development of bridge engineers. An important issue for the bridge engineering community is how members of our industry can improve opportunities to educationally prepare and sustain bridge engineers in successful practice.

At the University of Kansas, we’ve undertaken a project to address this challenge. The Federal Highway Administration is funding a research effort in which we are identifying gaps in bridge engineering education across higher and continuing education offerings and exploring innovative approaches for “bridging” educational gaps. This article focuses on the initial part of the research.

The research team started by analyzing higher education offerings, which entailed compiling a list of the 35 top-rated U.S. civil engineering programs (as ranked by *U.S. News and World Report*) and the 35 programs with the largest civil engineering graduating class sizes that offer at least one bridge engineering course at the undergraduate or graduate level. With the overlap between these

two groups, a total of 47 university programs were evaluated.

The team contacted faculty within the programs to request course syllabi for their bridge engineering courses. In total, we received more than 30 syllabi. The syllabi were analyzed to identify learning objectives, innovative educational techniques (essentially anything different than traditional lecture-based content delivery), and course content.

A similar exercise was undertaken to create a snapshot of continuing education offerings relevant to bridge engineers, including offerings from the National Highway Institute, the American Society of Civil Engineers, the American Institute of Steel Construction (AISC), the National Steel Bridge Alliance (NSBA), the Short Span Steel Bridge Alliance, the Precast/Prestressed Concrete Institute, the American Segmental Bridge Institute (ASBI), the National Precast Concrete Association, the American Concrete Institute, the Transportation Research Board, and University Transportation Centers (funded by the U.S. Department of Transportation). Our research team considered cost, delivery modality, and content, and looked for innovative educational techniques in the offerings.

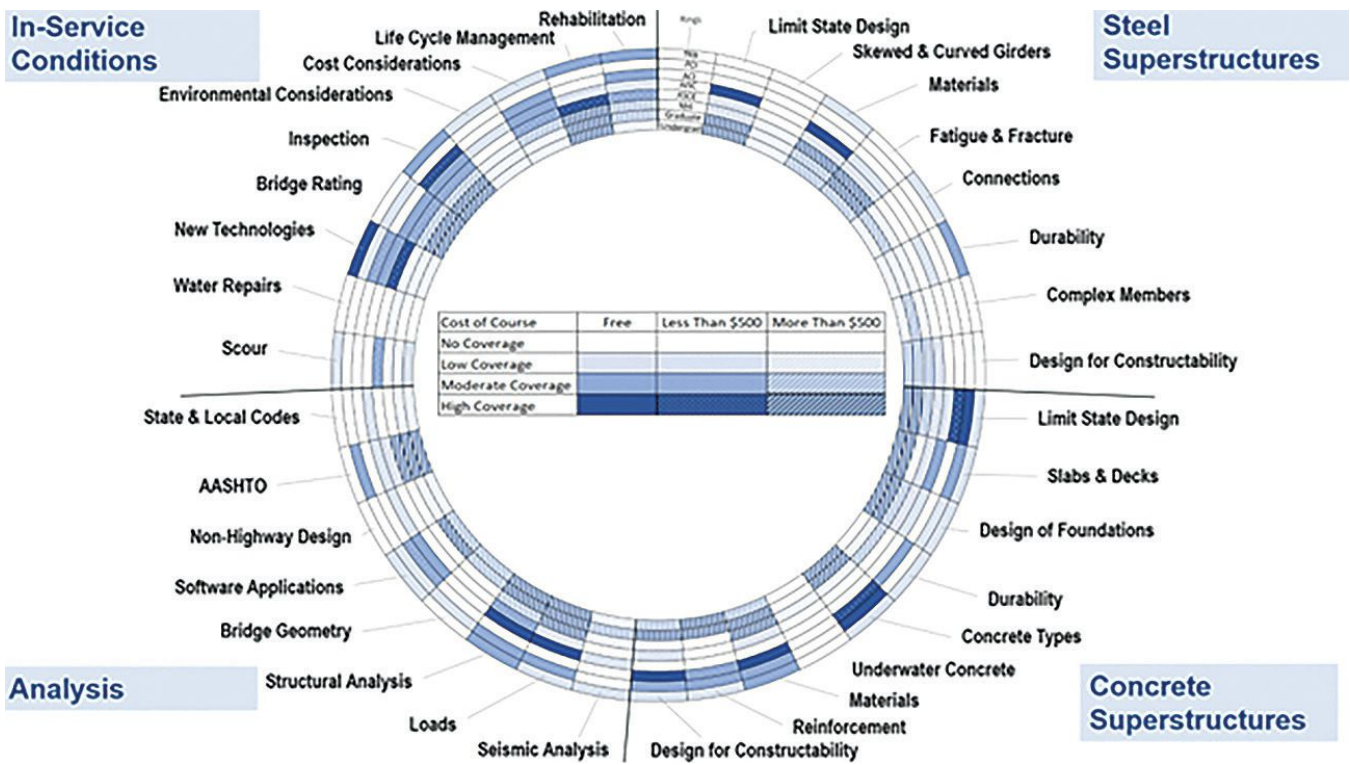
What did we find? Unsurprisingly, there was not much evidence of innovative educational approaches in bridge courses in higher or continuing education. However, there is a rich diversity of continuing education opportunities with a variety of topics covered. Based on our content analysis, we organized the higher and continuing education offerings into four main categories:

- Steel superstructures
- Concrete superstructures
- Analysis
- In-service conditions

These four categories emerged from the topical analysis of the syllabi. Bridge engineering courses are often specific to one material and almost always have specific analysis topics. We rated each educational offering according to its coverage level at a subtopic level, as well as by cost.

This process was useful to identify topics with educational gaps, and which content tended to be concentrated in high-cost offerings. Each occurrence of a subtopic within the syllabi was recorded and the percentage of course offerings that included a specific topic was used to categorize the coverage for that topic, with 0% considered as no coverage, between 0% and 15% as low coverage, between 15% and 30% as moderate coverage, and greater than 30% considered high coverage. Some examples of content areas with low availability include skewed and curved steel girders, steel connections, designing for constructability, underwater concrete, nonhighway bridge design, bridge geometry, seismic analysis, environmental conditions, underwater repairs, and scour.

To further explore what is and what is not working well with continuing education for bridge engineers, we developed and deployed a survey instrument with the help of ASBI, the National Concrete Bridge Council (NCBC), AISC, NSBA, American Association of State Highway and Transportation Organizations committees, and others. The survey was distributed broadly to bridge industry practitioners, and more than 240 responses were received. Most respondents have practiced in the bridge industry for more than 10 years, work primarily or entirely with highway bridges, and are designers.



To identify bridge engineering topics with educational gaps, the research team divided educational offerings into four main categories: steel superstructures, concrete superstructures, analysis, and in-service conditions. Each offering was rated based on coverage levels and cost.

The survey revealed that the bridge industry is highly engaged in professional continuing education, with 87% of respondents reporting more than three continuing education occasions per year on average. Most respondents sought out continuing education from sources such as conferences, committee service, workshops, short courses, and professional meetings, and indicated that it is relatively easy to participate in bridge engineering continuing education. The three biggest barriers to continuing education cited were time, travel, and cost. There was a good level of satisfaction with employer support for engaging in continuing education.

We asked specifically what gaps exist in current continuing education offerings and what should be changed about bridge engineering continuing education, and we garnered plentiful data in response. Survey respondents identified technical content gaps that were similar to those discovered through our review of higher education syllabi and continuing education offerings. However, respondents also highlighted a lack of training in leadership and teamwork skills as well as project and business management. Additionally, they emphasized a considerable gap in real-life, practical contexts, and expressed a

need for task-specific training, including the analysis of specific components and help understanding new specifications.

Respondents called for more courses facilitated by state and federal agencies, with a push for making these offerings more accessible online. There was a consistent demand for reducing course costs and improving availability across different regions to mitigate travel expenses and logistical barriers. Respondents also emphasized the importance of hands-on and field experiences. They recommended integrating field experiences into more continuing education programs, instead of relying solely on webinars and conference presentations. And, crucially, many respondents called for a structured educational pathway for young bridge engineers.

Our findings to date have set the stage to explore how the industry could expand access to educational opportunities, and how to make those opportunities as impactful as possible. As the team moves forward in this research, which we anticipate to be completed by the end of 2024, we are exploring innovative approaches for educating bridge engineers, and making recommendations to the Federal Highway Administration

for how those innovations could be incorporated into higher and continuing education offerings. Stay tuned for more! In the meantime, we invite you to continue to expand our dataset by responding to our survey on continuing education in the bridge industry: https://kusurvey.ca1.qualtrics.com/jfe/form/SV_8e7nqpUgZhUsf8W.

EDITOR'S NOTE

The American Association for State Highway and Transportation Officials (AASHTO) and the National Concrete Bridge Council (NCBC) have created a comprehensive resource catalog to aid concrete bridge practitioners in their design and construction endeavors, and enhance workforce development in the concrete bridge industry. Developed from the AASHTO/NCBC Collaboration Agreement, Resources for Concrete Bridge Design and Construction compiles essential resources from AASHTO, the Federal Highway Administration, and NCBC members. The publication is available to download for free at the AASHTO store: <https://store.transportation.org/Item/PublicationDetail?ID=5250>.