Concrete Materials for Bridges at the Concrete Bridge Engineering Institute

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The vision for the Concrete Bridge Engineering Institute's (CBEI's) Concrete Materials for Bridges course was described in the Winter 2023 issue of *ASPIRE*®. The first edition of that course, which took place January 2–3, 2024, received excellent feedback, and the upcoming course schedule has been released. This course is an important piece of the first pillar of CBEI's three-pillar concept.

Course Overview

The Concrete Materials for Bridges course covers a significant amount of information in a two-day, in-person format. The course is held at the CBEI facility within the University of Texas at Austin's J. J. Pickle Research Campus. The program begins with a Concrete 101 module, which provides a basic introduction to concrete and its consitutent components. It then delves into more detail on constituent materials—portland cements, supplementary cementitious materials, chemical admixtures, and aggregates—and their sources and interactive chemistry. After providing information on all the materials that make up concrete, the course shifts to focus on the fresh, hardened, and durability properties that are most relevant to bridge design, construction, and maintenance. The emphasis throughout the course is on potential durability issues that can affect bridge components and how to design for the intended service life.

The course highlights recent trends, such as the proliferation of portland-limestone cements and the ongoing shortage of fly ash, and explores new technologies, such as the use of ultra-high-performance concrete (UHPC) in accelerated bridge construction. Changes related to achieving sustainability goals are noted. Other important topics include concrete cracking, internal curing, alkali-silica reaction, sulfate attack, and delayed ettringite formation. The relevance of each of these durability issues to various bridge components is described, with an emphasis on how to build bridges that can meet or exceed their target design lives.

Hands-on Exercises and Tours

The Concrete Materials for Bridges course includes opportunities for hands-on interactions, including mixing small batches of concrete with various admixtures, touring the concrete outdoor exposure sites and the Concrete Materials Laboratory, and using the ConcreteWorks software in a small-group setting.

Various hands-on demonstrations were presented during the initial course, including demonstrations of the effects of various supplementary cementitious materials and chemical admixtures on heat generation, workability, and setting time (**Fig. 1**). A demonstration of the strength and ductility of UHPC was also given, culminating in the students "walking the plank" (**Fig. 2**).

Course participants also toured the outdoor durability exposure sites,

Figure 1. Participants in the Concrete Materials for Bridges course mix premeasured amounts of cementitious materials and water in a hands-on demonstration showing heat of hydration. All Photos: Concrete Bridge Engineering Institute.

Figure 2. A course participant "walks the plank" in a demonstration of the strength and ductility of ultra-high-performance concrete.

Figure 3. During a tour of concrete exposure sites, Dr. Thano Drimalas describes expansion measurements on specimens.

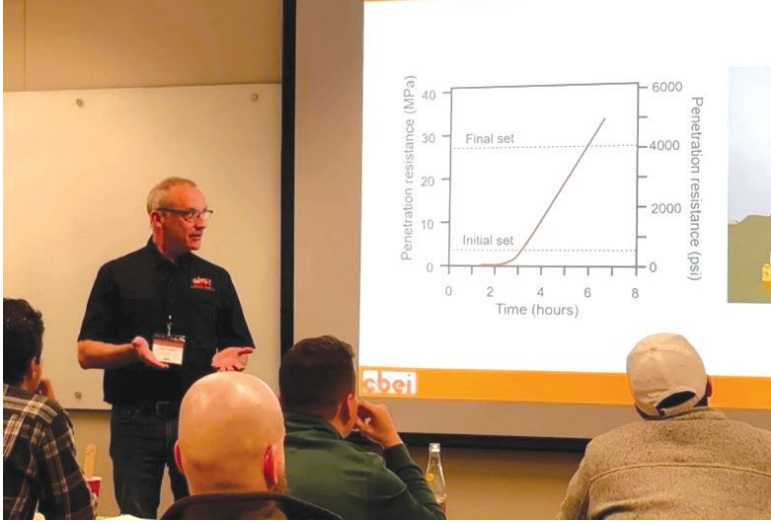

Figure 4. Dr. Kevin Folliard presents classroom instruction. Each participant receives a notebook with course slides and other pertinent information.

known as "The Cementary," and saw firsthand the detrimental impact of durability issues such as alkali-silica reaction, delayed ettrinite formation, and external sulfate attack (**Fig. 3**).

On the second day of the course, ConcreteWorks, a software program developed at the University of Texas at Austin with funding from the Texas Department of Transporation, was demonstrated to the class. Then, the participants broke into small groups to design the concrete mixture proportions for a bridge pier in a marine environment with the goal of achieving a 100-year service life. After completing their designs, the groups presented their approaches to the class, highlighting how they proposed to prevent thermal cracking, delayed ettringite formation, and chloride-induced corrosion. Because each group was given different constraints, such as being subjected to a shortage of supplementary cementitious materials, each team developed unique solutions to this challenging problem. Despite the intentionally challenging scenarios each group faced, they all successfully met the goals of the project.

Instructors and Students

Dr. Kevin Folliard (**Fig. 4**), Dr. Thano Drimalas (Fig 3), Dr. Racheal Lute (all from the University of Texas), and Anton Schindler (from Auburn University) are instructors for the course. Typically, two instructors are engaged per module, and each instructor has a wealth of research experience and industry knowledge.

The course is intended for a maximum of approximately 25 students per offering. The small class size facilitates interaction, questions, and group projects.

The course can benefit a wide range of participants, including those working in materials, structural design, inspection, and maintenance of bridges. The first class included participants from several state transportation agencies, as well as from the Federal Highway Administration (**Fig. 5**). Registration for future courses will be open to the general public as well as transportation agency participants.

CBEI Bridge Deck Construction Inspection

In addition to offering the Concrete Materials for Bridges training program, CBEI is focusing on the institute's second pillar, the Bridge Deck Construction Inspection program. This certification course is currently in development and scheduled to be available in early 2025. The course will use full-scale bridge components to illustrate the proper methods of bridge deck construction. Various construction and design defects will be incorporated within the training specimen to illustrate how they can be identified in the field before installation, and highlight their potential impact on durability. The Summer 2023 issue of *ASPIRE* provides more details of the Bridge Deck Construction Inspection Program.

For more information on CBEI and to register for courses, please visit CBEI's website: www.cbei.engr.utexas.edu.

Figure 5. Participants and instructors from the first offering of the Concrete Materials for Bridges course, held January 3–4, 2024.

The authors are all members of the Concrete Bridge Engineering Institute and colleagues at the University of Texas at Austin. Dr. Kevin Folliard is the Walter S. Bellows Centennial Professor in the Department of Civil Engineering; Dr. Thano Drimalas is a research associate; Dr. Racheal Lute is a research associate and lecturer; Dr. Oguzhan Bayrak is a Distinguished Teaching Professor, holder of the Cockrell Family Chair in Engineering #20, and director of the Concrete Bridge Engineering Institute; and Gregory Hunsicker is a research engineer.