Post-Tensioning Laboratory at the Concrete Bridge Engineering Institute

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As part of a series of articles on the Concrete Bridge Engineering Institute (CBEI), an article in the Winter 2023 issue of *ASPIRE*® explored the institute's Concrete Materials for Bridges program. That article also presented CBEI's collaborative efforts with the National Concrete Bridge Council (NCBC) and the support provided by NCBC members. This article describes the Post-Tensioning Laboratory (PT Laboratory) program, one of CBEI's three "pillars of learning."

Program Scope

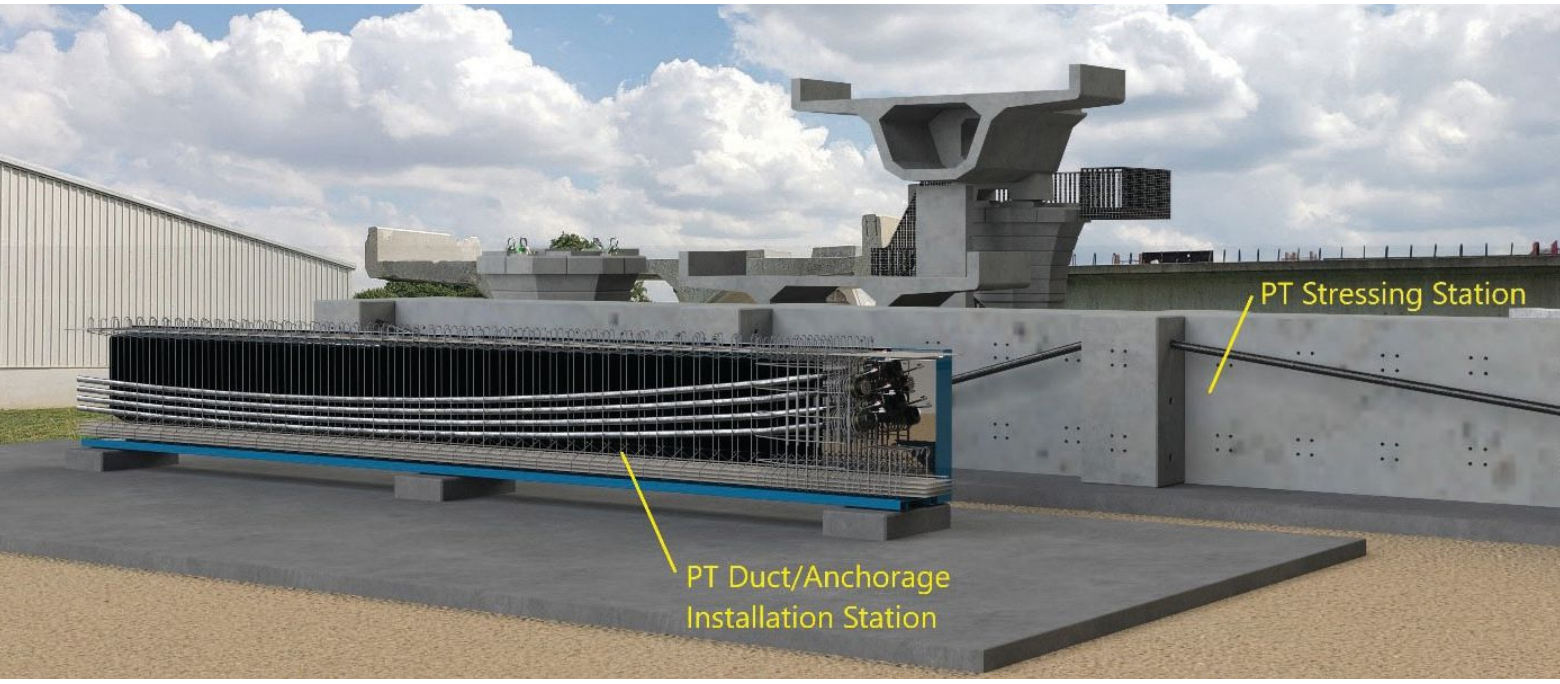
The PT Laboratory is scheduled to open in the fall of 2024. In addition to training and certification programs, it will offer technical services through formats ranging from workshops to one-on-one support for post-tensioning-related topics under the concrete solutions umbrella. The PT Laboratory, like the other CBEI programs, will be a hub for sharing information, standardizing procedures and relevant training programs, and facilitating implementation of new technologies.

Workforce-Development Goals

Many stakeholders in the construction industry have called for robust workforce-development programs that will attract workers and provide resources to train personnel in every facet of the industry. Additionally, it is recognized that post-tensioning installation in particular requires workers with a specialized technical skill set and a high standard of workmanship. To ensure that the intended durability of post-tensioned structures is achieved, it is crucial that workers who install and inspect post-tensioning receive intensive training informed by current industry standards and requirements.

In the United States, the need for qualified personnel and effective training programs has been recognized for decades. Programs such as those offered by the Post-Tensioning Institute (PTI) and the American Segmental Bridge Institute (ASBI) are required by owners around the country and have been instrumental in increasing the availablity of training offered in the industry. These robust programs have evolved with the changes in industry requirements over the last 20 years, and they have educated more than 2000 attendees.

Figure 1. Two of the Post-Tensioning Laboratory stations. All Figures and Photos: Concrete Bridge Engineering Institute.



Although the existing training programs have had a very positive impact, stakeholders have expressed that more hands-on training and "next-level" training for personnel would be an excellent complement to the existing programs and would further increase the effectiveness of training. The overarching goal for both existing training and the new offerings from the PT Laboratory is improved performance of post-tensioned structures. This goal can only be achieved if all individuals involved in planning, designing, and constructing post-tensioned structures can be uniformly educated and rigorously trained to address the expressed needs of the industry.

Target Audiences, Prerequisites, and Certification

The target audiences for the PT Laboratory training and certification programs are installation and inspection personnel directly involved in construction on project sites. Project managers, engineers, materials specifiers, and individuals who work in various other roles involved with bridge projects may also be interested in attending PT laboratory programs.

The post-tensioning courses at CBEI are intermediate and advanced courses. Most courses require the successful completion of the PTI Multistrand and Grouted PT Specialist Level 1 Certification workshop and the ASBI Grouting Certification training. These certifications and any other course-specific prerequisites are required so that attendees will already have a working understanding of post-tensioning concepts and will be prepared to focus primarily on hands-on exercises and demonstrations, while spending only a short time in the classroom.

The program will use demonstrations and hands-on exercises to teach the "whys" and "hows" of best practices. Attendees will participate in exercises on the correct approaches to post-tensioning, and they will examine lessons learned from scenarios in which things are done incorrectly. These experiences of "doing" and "seeing" are expected to accelerate the experience level of those involved in the program. By demonstrating a problem, such as a grout void, attendees will be exposed to a wide variety of situations that they may not otherwise encounter directly in the field for a substantial time. This program is designed to present as many of these problems as possible, show attendees how to avoid them, and provide troubleshooting information on how to approach them if encountered. For example, a failing pre-grout air test and the steps that are taken to remediate the issue before actual grouting of an element will be demonstrated.

Many of the PT Laboratory programs will include certification. The certification requirements of these programs will involve both written and hands-on practical exams. Demonstrating the ability to properly perform a given task or test is often a good indicator of competence.

To ensure that field personnel are equipped with an understanding of the latest industry requirements, owners may choose to establish requirements for certification, by this program or equivalent programs, in project specifications. Most certifications are valid for four years with renewal through a short program done either in-person or online, depending on the content. The renewals will primarily focus on any changes since the previous certification. Most of the certifications for the CBEI courses are anticipated to be part of the PTI and ASBI certifications, in addition to the programs PTI and ASBI currently deliver and administer.

Curriculum Development

The PT Laboratory courses are designed as modules that can be offered individually or grouped together in customized blocks. The overall curriculum includes both traditionally offered topics as well as new ones. While training will include some topics covered by existing PTI and ASBI certification courses, such as tensioning and grouting, the goal will be to complement the existing courses and avoid redundancy. Specific modules will be introduced for new procedures and materials as needed.

The following are a sampling of the initial certfification and learning modules planned:

- Installation
- Tensioning
- Grouting
- Finishing
- Protection Level 3 (PL3) monitorable tendons or electrically isolated tendons (EITs)
- Replaceable tendons
- Post-tensioning repairs
- Post-tensioning spliced-girder details
- Segmental post-tensioning details

A theme that will be emphasized throughout the modules is the importance of proper installation of the post-tensioning system for the overall durability of the structure. For example, the curriculum will emphasize that the initial installation of all materials—including the duct, anchorage, and grout vents—has a large impact on the success of the subsequent strand installation and tensioning, and duct-grouting operations. One module will be dedicated to finishing details, including the proper surface preparation and filling of blockouts, finishing of grout ports at the deck interface, proper installation of elastomeric coatings, and similar details that often represent a critical first line of protection for the post-tensioning system.

The initial modules for PL3 monitorable tendons or EITs and replaceable tendons will be one-day programs that will provide guidance for a visual and hands-on approach to the required details and equipment. The courses are designed to match the number of students with the available equipment and number of instructors to ensure appropriate access to the content.

The courses are planned to follow the guidance given in PTI/ASBI M50.3-19, *Specification for Multistrand and Grouted Post-Tensioning*,[1] and PTI M55.1-19, *Specification for Grouting of Post-Tensioned Structures*,[2] as well as manuals from the PTI certification programs.[3] (For detailed descriptions of PTI/ASBI M50.3-19 and PTI M55.1-19, see the Concrete Bridge Technology article in the Summer 2019 issue of *ASPIRE*.) The courses will also make use of references from owners and other industry groups, such as the Federal Highway Administration (FHWA)

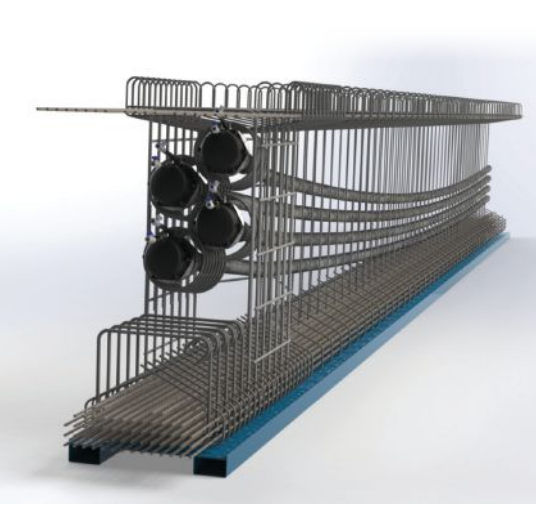


Figure 2. The Post-Tensioning Laboratory will have a duct/anchorage installation station with a "preconcrete" beam that has a reinforcing steel cage. Participants will witness demonstrations and experience hands-on activities such as installing post-tensioning components and learning proper placement of grout vents.

Figure 3 (above and on the right). Course participants in the Post-Tensioning Laboratory modules will be able to work with different types, brands, and sizes of post-tensioning systems, including both strand and post-tensioning bar systems.

publication *Replaceable Grouted External Post-Tensioned Tendons*.[4] Throughout the courses, the different tendon protection levels (PLs) will be referenced to acknowledge that different environments and structure types warrant different types of post-tensioning systems and procedures. PLs are a key concept presented in PTI/ASBI M50.3-19.

Two modules that are being developed based on input from stakeholders are the post-tensioning system inspector module and the grout testing module. The former module will provide inspector training and certification focused on understanding the requirements for certification and approval of a post-tensioning system per the PTI/ASBI M50.3-19 specification. The module will review the topics and issues encountered in the field, including defects, substitutions, material certifications, storage, and initial project qualification for a post-tensioning system. Upon completion, the attendee will be able to demonstrate through hands-on trials identification of conforming and nonconforming post-tensioning system components such as defects or substitutions. The module will also cover such topics as material certification quality control tests and traceability requirements, acceptance criteria for various components subject to corrosion or ultraviolet exposure, typical variances by type of structure and region, the various PLs, and a sample quarantine and disposition procedure for nonconforming parts.

The grout testing certification module will build on the information provided in the current ASBI Grouting Certification training. The CBEI certification will require the attendee to demonstrate, in the presence of a proctor with the testing equipment and grout, their competence in performing field grout quality control tests—such as wet density, modified flow cone, Schupack pressure bleed test, wick bleed test, sampling for a compressive-strength test, temperatures of mixed grout, ambient, water, and bag material, spot-checking bag weights and verifying expiration date, and chloride test—in accordance with the appropriate ASTM or PTI standards. The module will cover proper recording of the quality control information on a standard grout log. The module will also cover, primarily through demonstrations, potential causes of test values outside of the acceptable range and typical remediation measures.

Stations and Infrastructure

The PT Laboratory will be outfitted with infrastructure for efficient demonstrations and hands-on activities. Several stations will be arranged at the CBEI facility to focus on the various modules. The stations include an over-100-ft-long reaction beam for tendon-tensioning and duct-grouting operations (**Fig. 1**) and a companion "preconcrete" beam (**Fig. 2**) with a reinforcing steel cage for duct, anchorage, and grout vent placement operations. It will be possible to configure the reaction beam for different profiles and details, including replaceable tendons. The "preconcrete" beam at the duct/anchorage installation station will allow such activities as measuring support heights, viewing and remediating damaged ducts, maintaining proper angles and avoiding kinks at anchorage-to-duct transitions, proper placement of grout vents, and illustrating congestion at anchorage zones.

Stations specifically focused on grouting will include grout testing, grout inspection and remediation, and vacuum grouting. There will also be a station dedicated to finishing, including pourbacks, grout vent finishing, and elastomeric coatings; this station will be used for instruction focused on material installation, including proper surface preparation. Another station will be dedicated to inspection and nondestructive evaluation techniques. One station will be dedicated to post-tensioning systems and will include different types and sizes of post-tensioning systems, including both strand

Figure 4. Course participants will be required to identify conforming and nonconforming components of post-tensioning systems as part of the post-tensioning system inspector module.

and post-tensioning bar systems (**Fig. 3**). It will also include nonconforming and substituted parts that are used as part of the exercises during the post-tensioning system inspector module (**Fig. 4**).

While the PT Laboratory's infrastructure represents a significant tool, CBEI also aims to make as many of the modules as possible available in a mobile format. A train-the-trainer program is planned to disseminate the information as widely as possible. Other regional centers that could incorporate some of the larger infrastructure are being considered as part of strategy to expand the footprint of the training. Collectively, the training programs are intended to address the needs of the industry by educating and training all individuals vertically (from installers to engineers and designers) and horizontally (by establishing satellite training centers and opportunities all across the United States).

Conclusion

Plans for the PT Laboratory are ongoing under a current contract with FHWA. Articles in upcoming issues of *ASPIRE* will explore other CBEI technical programs, including the Bridge Deck Construction Inspection program, and provide status updates.

For more information about CBEI, please visit www.cbei.engr.utexas.edu.

References

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