The Bridge Design Academy at the California Department of Transportation

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At the California Department of Transportation (Caltrans), we are committed to developing new engineers to journey level as quickly as possible. How do we accomplish this? Through a combination of a rotation program and training.

The Transportation Engineer–Civil (TE-Civil) Rotation Program is mandatory for all newly hired, permanent, full-time TE-Civil employees. The objectives of the program are to enhance knowledge of engineering diversity within Caltrans and to develop essential engineering skills necessary for successful job performance. Within the Division of Engineering Services (DES), engineers can gain experience and develop relationships in three rotation assignments: bridge design, structure construction administration, and a supplemental assignment in another functional unit. These units are geotechnical engineering, materials engineering and testing, project management, design of ancillary structures, earthquake engineering, and bridge maintenance and inspections. The purpose of the bridge design and structure construction administration rotations is to provide an understanding of how a bridge is designed and constructed, and how to produce quality contract documents. Meanwhile, the purpose of the supplemental assignment is to expand the engineer's understanding of the other functional units and how they provide key design information and support to successfully deliver quality projects. The TE-Civil Rotation Program provides well-rounded knowledge.

A new engineer has a rotational status until they complete all rotation assignments, which usually occurs within the first five years. The first rotation assignment, also known as the probation period, is within the unit of the hiring supervisor and lasts 12 months. The second and third rotation assignments last 9 months each and are either in a bridge design section, structure construction administration section, or another DES functional unit that was not previously completed. Before rotating into a bridge design branch, the engineer is expected to complete the Bridge Design Academy. The academy is a key element of the bridge design rotation. The goal is to provide a successful and positive experience in the bridge design rotation by developing well-trained, competent, and proficient designers who can design bridges that meet code requirements and are safe for the traveling public. The Bridge Design Academy has been offered since the 1960s, when Caltrans used to be the Department of Public Works, Division of Highways.

The academy evolved over time and has been offered in different formats

Students, a few instructors, and two California Department of Transportation Deputy Division Chiefs at the Winter 2019 Bridge Design Academy. All Photos: Caltrans.

in different eras. In the first era, when engineers were transitioning from slide rules to calculators—from the 1960s to the late 1980s—the academy was a correspondence course. New engineers had homework assignments from the Caltrans *Manual of Bridge Design Practice* and other published guidance materials. The homework had to be done after work hours, mailed in if the engineer did not work in Sacramento, and graded. This course was self-paced and an informal requirement for promotion to Assistant Bridge Engineer.

The second era started in the early 1990s, when the Bridge Department carried out a mass hiring effort and saw the need to establish a mandatory 6-week academy, taught as a design course by specialists in an interactive, hands-on classroom setting. It covered the major topics in bridge design: layout and surveys, loads, reinforced concrete, prestressed (pretensioned and post-tensioned) concrete, steel, substructure, foundations, seismic concerns, detailing and plan sheets, earth-retaining systems, and quantities and estimates. This was a continuous, fully inclusive academy with homework assignments (mostly completed in class), team-building activities, a field trip to the Pomeroy precast, prestressed concrete plant, a capstone project, a graduation ceremony with attendance from management, a barbecue celebration, and much more. Because bridge design was not taught at many universities at the time, the Caltrans Bridge Design Academy became very popular, with more than 400 people on the waitlist, including engineers from both private companies and agencies such as the Federal Highway Administration and other departments of transportation. During this era, the academy was offered five times per year in Sacramento. Engineers traveled from other parts of the state and country to attend this well-regarded academy. In the early 2000s, personal computers were introduced, and the academy was extended to 8 weeks to include hands-on software training.

The third era started in 2009, when budget cuts resulted in limited training and travel opportunities. Caltrans did not want to stop offering the academy, so it collaborated with the California State University, Sacramento, to develop an online course. This was a self-paced, condensed version of the academy. However maintaining and updating the course became a challenge as the pace of technological obsolescence was greater than anticipated.

In 2019, DES management addressed the knowledge vacuum created by increased retirements and hiring of new staff by revamping the 8-week academy and offering it twice a year. This was the beginning of the fourth era. We realized we needed to bring back the classroom environment, with hands-on training and specialists as instructors. Parts of the online course became prerequisites, and we adjusted the length of the academy to 7 weeks, covering the previous bridge design topics as well as additional design, project delivery, and project engineering topics such as load ratings, maintenance design, environmental engineering, planning, accelerated bridge construction, quality and risk management, and internal and external customers. The last week is dedicated to the capstone project. The students are split into teams to evaluate bridge alternatives that would be most appropriate for specific site conditions. Then, each team presents its bridge-type recommendations to their classmates, instructors, and management. The objective of the capstone project is to foster collaboration and tie everything that was learned in the academy into a real-life bridge project.

Then COVID-19 came along in 2020. Classroom gatherings were prohibited, and we had to convert the in-person academy into a virtual academy. We tried to replicate a classroom environment by using online live instruction, with the same instructors and topics, but faced many challenges. The first challenge we had to overcome was getting familiar with an online conferencing platform. We used polling, breakout rooms, and conversations in the chat panel for a more interactive experience. The biggest challenge with the virtual environment was keeping the students engaged during the continuous 7-week course.

Now, we are starting a new era of the academy back in the classroom. In an effort to make improvements, we replaced the existing online course prerequisites (which were no longer supported because the software was obsolete) with PCI eLearning courses. These courses, some of which were sponsored by the U.S. Department of Transportation and balloted by PCI, were selected because they offer excellent learning materials related to bridge design. Created and reviewed by a team of subject matter experts, the courses provide at no cost a convenient and uniform process of training and review to the bridge design and construction community. The PCI courses have clear learning objectives, well-organized outlines, quizzes, lesson summaries, spoken and written narration, and many resources. Each course is followed by an exam that students must pass to receive course credit and a certificate.

To enroll in the Caltrans Bridge Design Academy, engineers must complete

PCI eLearning Courses Related to Bridges

The PCI eLearning Center offers courses that help bridge designers become more proficient. There are four series—Precast, Prestressed Bridge Girders; Bridge Geometry; Full-depth Precast Concrete Deck Panels; and Lateral Stability of Precast, Prestressed Concrete Bridge Girders—each with multiple courses.

The courses are based on the content of AASHTO LRFD and PCI publications. Although the courses are designed for an engineer with 5 or more years of experience, a less-experienced engineer will find the content very helpful for understanding concepts and methodologies.

The 10 PCI eLearning courses that engineers in the Caltrans Bridge Design Academy must complete are:

- Preliminary Precast, Prestressed Concrete Design (T110)
- Bridge Geometry—Fundamentals of Roadway Geometry (T505)
- Bridge Geometry—Working with Horizontal Alignments (T510)
- Bridge Geometry—Straight Bridges (T515)
- Basic Prestressed Concrete Design, Parts 1–6 (T100 series)

All courses on the PCI eLearning Center are offered at no cost. Go to https://oasis.pci.org/Public/Catalog/Home.aspx?tab=2.

10 PCI eLearning courses that cover preliminary precast, prestressed concrete design, bridge geometry, and basic prestressed concrete design. The goal is for the PCI courses to prepare the students for the rigors of the Bridge Design Academy. Caltrans offers other academies, such as the Resident Engineer Academy, Professional Engineer Academy, Project Management Academy, Survey Academy, and Environmental Academy; however, the Bridge Design Academy is the longest-running and probably the most rigorous program. So, completing the PCI courses is a great precursor to this academy.

No matter the circumstances or the format, the Caltrans Bridge Design Academy has benefited thousands of engineers. A recent student recalled, "My experience at the Bridge Design Academy felt like a once-in-a-lifetime opportunity to participate in a crash course in bridge design that most engineers covet taking. Having designed a couple of dozen bridges while working in the private sector, I have a solid background in bridge design, yet I still learned a lot from each class. Each design topic was followed by a class activity that reinforced the advanced lesson for each session. I enjoyed that the classes were taught by multiple practicing engineers. It was nice of them to take the time off their daily task to share and teach the skills of the trade. Developing a network with fellow students and getting to know most of the subject matter experts to collaborate with later when complex design issues arise also helped me as a designer."

As a former student myself, I can also say that the Bridge Design Academy was the best investment of my engineering career. The hands-on training I received and the network I formed set me up for a successful career and I am very grateful to have had that opportunity.

At Caltrans, we believe the employees are worth the time, cost, and effort of proper training. We offer many training opportunities that promote professional development, and we continuously seek to improve them as part of our quality management system. At the Bridge Design Academy, we evaluate the effectiveness of each course with pre- and post-course exams, and evaluations from each student. Feedback from the students is very valuable because it tells us what areas need improvement. As one of the current instructors at the academy, I can say that the course materials and agenda are revised every time the academy is offered, based on the feedback from the students.

Caltrans will continue to invest in developing a highly knowledgeable, experienced, and professional workforce, through the TE-Civil Rotation Program and specialized training.