

## PROJECT

# WORKING TOGETHER TO CREATE THE FUTURE

Sharing new technology through PCI Bridge TechnoQuests

by William Nickas, Precast/Prestressed Concrete Institute, and John Dick, J. Dick Precast Concrete Consultant

The cement and concrete industries have made remarkable advancements during the past 20 years or so. The precast concrete industry has greatly benefitted from these improved technologies, and has also contributed to advancing the construction industry.

A trade association or technical institute is often the entity called on to manage the change for an industry. It is relied upon to galvanize the industry's varied goals and objectives, since an industry serves many markets and clients. Through the work of the association, a focused message can be refined, presentations created, questions anticipated and answered, experienced professionals mobilized, and the technology broadcast to the end user.

A new bridge type is being offered to the design community. In a few areas, horizontally curved, precast concrete, trapezoidal box-girder bridges are being built economically with spans approaching 300 ft. They are competing very effectively on a first-cost basis against other alternative systems. Furthermore, these U-girders, as they are also known, feature outstanding aesthetic appeal and will result in exceptional long-term, low-cost performance.

This article focuses on the way the precast concrete industry, with the aid of the Precast/Prestressed Concrete Institute (PCI), has contributed to this advancement. PCI is educating its members concerning the new opportunity. It is an entirely new market for the precast, prestressed concrete industry. PCI has refined the technology, packaged it in drawings and descriptions,

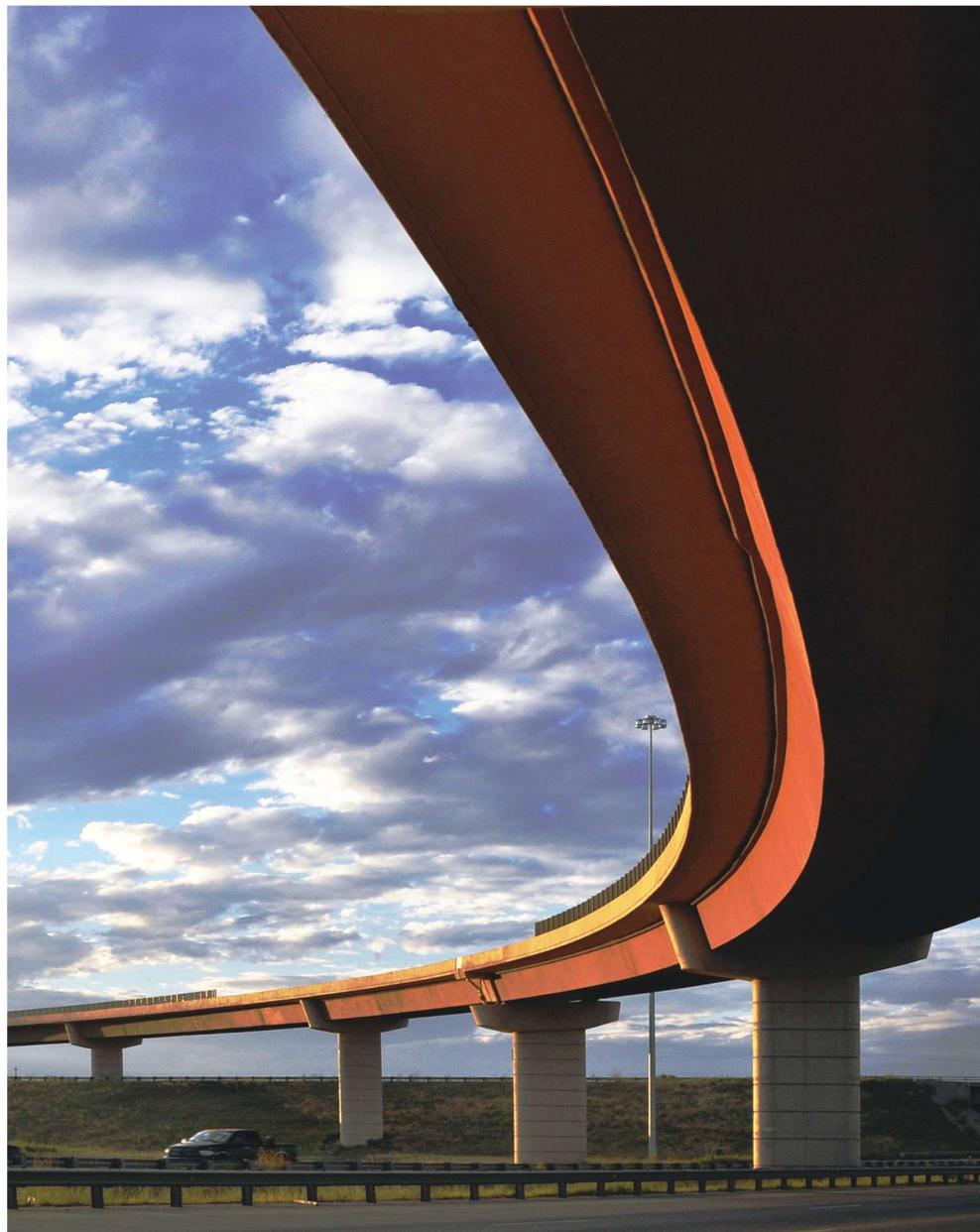
presented it to groups of end users, and is conducting on-site learning experiences called TechnoQuests.

### Exploring the Beginnings

The current work began in 1993 when PCI took note of a potential new market for the precast concrete industry. The idea resulted from a tour of a project underway in Denver, Colo. A horizontally curved girder was being precast on site because it was too large and heavy to cast in a plant and then transport.

After casting, the girder was lifted onto the piers. After that, the Colorado Department of Transportation (DOT) continued development of the concept.

They refined it to encourage production in established precast concrete manufacturing plants, a step considered important to compress schedules, reduce cost, and improve quality. It would take a decade; a Colorado prestressed concrete industry with vision; collaboration between the owner,



Flyover Ramp A at I-70 and SH58 was built in 2008, the sixth plant-produced curved U-girder bridge built in Colorado up to that time. Photo: Summit Engineering Group.

and contractors, specialty designers, as well as the precasters to refine the solution and make it cost-effective and constructable. PCI continued to stay abreast of developments, waiting for just the right timing to promote this system to a wider audience.

### Putting Wheels in Motion

In 2004, at a PCI Bridge Producers Committee meeting, a Denver precaster told the audience about the new project to fabricate horizontally curved precast concrete U-girders.

Following that meeting, articles were written and published, speakers invited to conferences, and committee work commenced. In 2005, through its Committee on Bridges, PCI established the Subcommittee on Curved Concrete Bridges. Their work, a state-of-the-art report, was published by PCI in 2012.

In 2010, several PCI-certified producer-member companies in Florida (specifically Coreslab Structures, Dura-Stress, Gate Precast, and Standard Concrete Products) pooled resources and teamed with the Summit Engineering Group and PCI to develop a set of 20 drawings for a family of "standard" U-girders. The package of standard plans included framing plans, erection details and sequences, splicing details, and typical reinforcement. The producers who spearheaded this effort are in PCI's "Zone 6" geographical region in the southeast United States. The plans are now referred to as the PCI "Zone 6 Concept Plans" and are available as PDF or CAD files. With the plans, a designer can estimate reinforcement and post-tensioning quantities, hauling weights, and erection sequences.

### Acceptance in Florida

As a result of PCI's work, the Florida DOT posted a notice on its Transportation Innovation website titled "Curved Precast Spliced U-Girder Bridges" in 2012. The site makes available for download a new set of the Zone 6 plans that were revised to reflect the specific Florida state policies and practices. The Florida DOT concluded that the girders offer lower fabrication times, faster construction, longer spans, and exceptional aesthetic appeal compared to conventional construction. The address of this website is <http://www.dot.state.fl.us/structures/innovation/UBEAM.shtm>.



The I-25 Trinidad (Colorado) Viaduct features haunched girders that provide 265-ft clear span over a rail yard. Photo: PCI.



Precast concrete lid slabs with deck overhang cantilevers are used with precast stay-in-place deck panels between girders on the I-25 Trinidad Viaduct. Girder lid slabs can become a composite part of the deck slab. Photo: PCI.

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Girder lid slabs are critical to the performance of girders, increasing the torsional stiffness 50 to 100 times. They can become a composite part of the deck slab. Here, the CFX project girders at the abutments are formed and ready for the cast-in-place concrete lid slabs. Photo: J. Dick Precast Concrete Consultant.



An innovative solution to provide space for post-tensioning is the girder “tongue”—an extension of the bottom flange that supports one end of the girder. Girder tongues support the girders on abutment of Ramp H, SR 416–Boggy Creek Interchange seen during TechnoQuest 2 Tour. Photo: J. Dick Precast Concrete Consultant.



Specialized casting forms capable of being configured to cast curved sections with variable radii. A steel casting form viewed during TechnoQuest 1. Precast lid slabs are visible in the background. Photo: PCI.

That was followed by Florida DOT Structures Design Bulletin 13-07 dated June 6, 2013, with the subject, “Spliced Pretensioned/Post-tensioned U-Girders.” This document contains specific requirements for the design and construction of these girders. The bulletin was reviewed and approved by FHWA. It can be viewed at: <http://www.dot.state.fl.us/structures/Bulletins/2013/StructuresDesignBulletin13-07.pdf>.

### PCI Bridge TechnoQuest 1

A TechnoQuest is an opportunity to learn from those with experience in a cutting-edge technology. It is conducted where attendees can view projects completed or under

construction. It includes presentations on those things that went well and others that could have been done differently and perhaps better.

In September 2012, PCI conducted the first bridge TechnoQuest in Denver, Colo. There were 18 attendees from the Texas DOT, the Texas precast concrete industry, what was then the Orlando Orange County (Florida) Expressway Authority—later to become the Central Florida Expressway Authority (CFX)—and six members of that agency’s consulting engineering firms. The presenters included an engineer from the Colorado DOT, three consulting engineers with experience in the region, two precast concrete producers who made curved U-girders in Colorado, and PCI. There were eight classroom sessions to teach the technology and the group toured two precast plants and six bridges.

Just before the TechnoQuest, the CFX had accepted bids on an interchange near the Orlando International Airport—the SR 417/Boggy Road Interchange. The project plans specified curved steel girders. Three of six contractors bid alternates with precast concrete curved U-girders. The contractors had indeed taken notice of presentations of the PCI Zone 6 plans and the Colorado bridges. All three concrete alternate bids were below the lowest bid on the contract documents. But it turned out all bids

were rejected because the project needed to be revised and rebid for other reasons. However, it was obvious the curved concrete girders needed to be taken seriously.

The realignment of the highways and the construction of the structures were split into separate contracts. As a result of the previous bidding and confidence gained from the Denver TechnoQuest, CFX redesigned three of the flyover ramps in precast concrete based on the PCI Zone 6 plans. The project was rebid in October 2013. This is the first time that a curved long-span structure in the United States had been designed and specified in precast concrete. All of the Colorado bridges had been design-build projects or contractor alternates.

### Production Technology Transfer

In November 2013, PCI conducted one of its regular series of production workshops. These are designed to provide exposure to regional production practices for precast concrete producers from all over the country. Because it was held in Denver and due to interest in Colorado’s curved U-girders, the group of some 150 plant personnel visited two U-girder production plants, some participants visited several completed bridges, and explored U-girder bridges then under construction in Trinidad, Colo.



Work in progress to preassemble a reinforcement cage with post-tensioning ducts during TechnoQuest 2 Tour of Dura-Stress Inc. plant in Lessburg, Fla. Inset: No. 9 bars headed at top and bottom to develop in shorter length. Photos: J. Dick Precast Concrete Consultant.

## PCI Bridge TechnoQuest 2

With the Florida SR 417 project well underway, PCI held its second bridge TechnoQuest in September 2014 in Orlando. This time over 80 engineers attended. Throughout two days, there were 14 classroom sessions featuring those who had experience with the CFX project and others with experience in previous work and there were several tours. The first tour was of the precast concrete manufacturing plant where nearly all of the plant processes were able to be seen. The group next toured the steel fabricator's plant that manufactured the unique steel forming system. The company explained how the form could be adjusted to cast girders with varying radii as small as 500 ft.

From there, everyone visited the jobsite and was able to get up onto and even into the U-girders that had been erected just a few days before. The owners, contractor, and designers were there to explain the construction and answer questions.

## Conclusion

The innovative Colorado DOT created a bold alternative to what was then a traditional method of construction. The industry's technical institute, PCI, envisioned a remarkable new opportunity and organized an effort to nationalize it for the benefit of owner agencies and the industry.

Through the development of plans, promotion in numerous venues, and technology transfer opportunities called TechnoQuests, curved, precast concrete U-girder bridges are being proven as attractive, cost-effective bridges in several new locations. 



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## EDITOR'S NOTE

*This article is a condensation of a much longer and more-detailed paper written by the same authors. The paper includes more information about how U-girder bridges are designed and constructed. Many of the questions raised by designers at the TechnoQuests and elsewhere about this unique structural system are answered in the full-length paper. There are more photographs and references to more information. The full-length paper has been posted on the ASPIRE™ website and can be viewed and downloaded by selecting the Resources button.*