

Infrastructure Focus and Close Relationships Work in

Pennsylvania



by Tom Macioce, Pennsylvania Department of Transportation



The historic 70-ft-long Big Chickies Bridge over Big Chiques Creek in Lancaster, Pa., was replaced with a precast concrete tied-through-arch bridge that replicated the appearance of the original while upgrading the design to current loading, flooding, sight, and safety requirements.



Pennsylvania has a long history of building precast, prestressed concrete bridges, going back to the first structures to use that concept beginning in the late 1940s. Today, a high percentage of the state's bridges continue to be constructed from prestressed concrete. That total has jumped substantially in recent years, led by the passionate support for infrastructure improvements directed by Governor Edward G. Rendell.

The Keystone State has a large number of bridges, but a high percentage of them are less than 100 ft long, owing to the state's rugged terrain and many streams and rivers. Some of them also have deteriorated from long service and a gap that was growing between the need for maintenance and the capabilities to fund that work. Most projects fall into the category of "Bridge Rehabilitation or Replacement," which encompasses everything from repairs to the existing structure to building a completely new bridge. The other categories of projects comprise "Bridge Preservation" and "Bridge Maintenance."

Funding for bridge projects took a dramatic leap in 2008 with Governor Rendell's Rebuild Pennsylvania initiative. Bridges benefit from those efforts through the Accelerated Bridge Program (ABP) portion. The goal is to repair or replace 1145 structurally deficient bridges over a 3-year period. The Pennsylvania Department of Transportation (PennDOT) exceeded its first-year goal of 411 bridges by opening bids on 470 contracts by June 30, 2009.

In addition to the ABP bridges, PennDOT is working toward awarding contracts to fix 105 structurally deficient bridges with federal money from the American Recovery and Reinvestment Act (ARRA). Contract spending for bridges also has been rising, from \$259 million in 2002 to \$787 million in 2008. For fiscal year 2009, thanks to these additional funding sources, contract spending is expected to reach nearly \$1 billion.

In fact, the state has finally turned the corner on the backlog of bridge maintenance needs. In March, for the first time in memory, the number of structurally deficient bridges in the state declined, from 6034 to 5911. As of last

September, the number had been lowered further to 5846.

Concrete Bridges Dominate

Most of the bridges—as many as 90%—will be constructed using concrete materials. Prestressed concrete I-beams and box beams are the most common solutions, primarily because of the excellence of precast concrete fabricators in the area who can supply the necessary components on a fast response and competitive basis.

Many projects in Pennsylvania have presented challenges to designers and fabricators alike. Even small projects can create unique designs. A typical example is the Big Chickies No. 2 Bridge on Auction Road (T-875) over Big Chiques Creek in Lancaster, Pa. The historic concrete tied-arch bridge had degraded, lowering the maximum allowable load. Maintaining the aesthetics and contextual sensitivity for the 1920s structure, while upgrading to meet new loading, flooding, sight, and safety constraints, were key concerns. These were exacerbated by the need to widen the

bridge to two full lanes and ensure the arches could withstand the increases in deck torque and flexure.

The new 70-ft-long bridge features precast concrete, tied-through arches and a cast-in-place concrete deck to replicate the appearance of the original bridge. The precast concrete arches were erected in a single night, minimizing disruptions to traffic and speeding construction. No temporary formwork or scaffolding was needed in the creek, saving additional time and money. In production, close tolerances were needed to ensure the enormous amount of reinforcement and post-tensioning steel would fit the forms and meet clearance and cover requirements.

The project proved so distinctive that it was named a co-winner of the award for Best Bridge with Spans Less than 75 ft in the Precast/Prestressed Concrete Institute's 2009 Design Awards Competition.

Prestressed concrete is the common solution, primarily because of the excellence of the precast concrete fabricators.

Long Concrete History

Pennsylvania has been at the forefront of advances in prestressed concrete technology for a long time. The nation's first major precast, prestressed concrete bridge, the Walnut Lane Bridge in Fairmont Park in Philadelphia, included a 160-ft-long main span and two 74-ft end spans, and used concrete with a compressive strength of 5400 psi. It was also one of the earliest structures ever to use large-scale precast concrete components and high-performance concrete. That milestone drew engineers and scientists who were interested in this concept,

to Pennsylvania. That in turn ensured manufacturers would construct facilities here, creating a long-term foundation. Pennsylvania-German engineers in PennDOT's offices also encouraged the use of precast, prestressed concrete and developed standards to make it efficient and cost competitive.

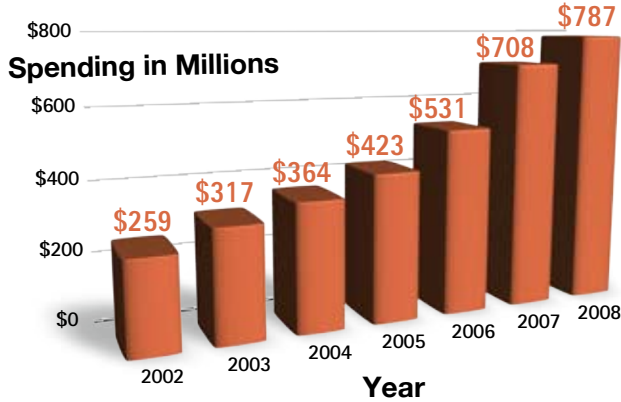
That evolution has been enhanced by regional associations that work closely with PennDOT to produce better practices on an on-going basis. The Prestressed Concrete Committee for Economic Fabrication (PCEF) consists of representatives of the Federal



The first major prestressed concrete bridge in America was constructed in Pennsylvania in 1950. Using concepts devised by Professor Gustave Magnel of the University of Ghent in Belgium, the Walnut Lane Bridge in Philadelphia features a 160-ft-long main span and two 74-ft-long end spans.

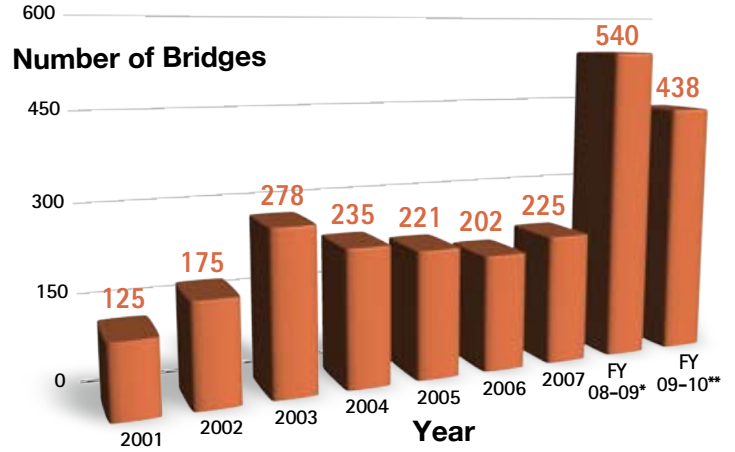


BRIDGE CONTRACT SPENDING



Contract spending for bridge construction in Pennsylvania has grown steadily since 2002.

PROJECT DELIVERY



* 470 ABP Bridges and 70 ARRA bridges
 ** 403 ABP Bridges and 35 ARRA bridges
 Source: PennDOT 2009

Highway Administration, regional DOT officials, engineering firms, academics, and concrete fabricators from New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, and Virginia. They work to find consensus on standardized designs and ideas to aid economical production of materials, such as quality-control guidelines, and more efficient bulb-tee girder shapes.

PennDOT also works closely with the Prestressed Concrete Association of Pennsylvania (PCAP), led for many years by executive director Hank Bonstedt. That group has spear-headed

a variety of initiatives in conjunction with PennDOT to standardize precast components and create efficiencies in the designs produced by the state. (For more on their contributions, see the sidebar.)

PCAP worked with PennDOT recently to standardize the design of precast concrete bulb-tee beams to create efficiencies that will save design, fabrication, and construction time. One result of that work can be seen in the 8th Street Bridge in Luzerne County, which is now under construction. The 1319-ft-long bridge

features 10 spans, with five girders per span. The project replaces the existing bridge, which was structurally deficient. The design-build project is planned for opening in summer 2010.

Another larger project, recently completed, that incorporated prestressed concrete I-girders is the Tioga River Bridge on Route 15 between Route 287 and the New York Border in Tioga County. The \$26.9-million project includes four twin prestressed concrete I-beam bridges with three single-span bridges and one 11-span structure. The bridges were the “missing link”



The Tioga River Bridge on Route 15 features twin, 11-span structures constructed with precast, prestressed concrete I-beams. The \$26.9-million project connects two key roadways to speed traffic flow and accessibility in Lawrenceville, Pa.



tying together the construction between Route 287 at Tioga and Route 49 in Lawrenceville. The twin 11-span bridges cross the Tioga River and the Wellsboro-Corning Railroad, while the single-span bridges cross a farm lane, a new township road, and a wildlife area. More than 21,000 yd³ of concrete and 2.64 million lb of steel reinforcement were used in the project.

Contractor Alternate, Design-Build Aid Process

The use of a contractor-alternate design bidding process, as well as design-build approaches, have aided PennDOT's construction techniques in significant ways. For each project, bid documents include an option that the contractor may submit an alternative bridge design to be considered. In addition, about 25% of bridge projects in the state are bid as design-build projects.

Fewer projects are taking advantage of the contractor-alternate option today, however, as PennDOT designers have learned from past projects, and incorporate those efficiencies into subsequent designs where applicable. This additional input ensures that designs continue to evolve and provide continuous improvements that feature the latest and best techniques.

One benefit of design-build and contractor-alternate approaches is that the savings are built into the project from the beginning. With value engineering after the project is let, the savings are split between the state and the contractor. This approach allows funds to be reallocated to other vitally needed projects and add greater value for Pennsylvania's residents.

The close cooperation that PennDOT garners with industry associations and designers ensures that it remains on the cutting edge in bridge designs. Those new ideas are incorporated into the thinking for each new bridge going forward. Combined with the new commitment to infrastructure construction spearheaded by the state and its long heritage with the material, Pennsylvania's position as a major state for concrete bridges will remain intact.

Tom Macioce is chief bridge engineer with the Pennsylvania Department of Transportation in Harrisburg, Pa.

For more information on Pennsylvania's bridges, visit www.dot.state.pa.us.

PCAP Teams with PennDOT

by Hank Bonstedt, PCAP

The Prestressed Concrete Association of Pennsylvania (PCAP) has a long and proud history of working closely with officials at the Pennsylvania Department of Transportation (PennDOT). That relationship has paid off with several key design techniques that have increased efficiency and reduced costs for construction projects. Key initiatives with which PCAP has worked with PennDOT in recent years have included:

- A new "Pennsylvania" precast concrete bulb-tee I-girder design that creates a more efficient section for design, fabrication, and erection.
- The elimination of corrugated cardboard voids in box beams, replacing them with expanded polystyrene foam. This provides for more durable, consistent, and economical fabrication.
- Self-consolidating concrete standards that ensure the material's best capabilities are achieved. Its benefits include easy workability and a better finish, making it easier to cast complex components while achieving an aesthetically pleasing finish.
- New standards for spliced girder designs, with the goal of creating economical methods to transport lighter weight components to the jobsite while retaining the material's long-span capabilities. Delivering segments that can be connected at the site facilitates transportation access and allows spans to extend from 165 ft in the past to 225 ft today, eliminating piers that add time and material costs. This work has made precast concrete more competitive with steel and provided an alternate option for longer lengths.

PCAP is committed to working with PennDOT to achieve continuous improvements in the design, fabrication, transportation, and erection of precast, prestressed concrete bridge components. These various initiatives build on each other to ensure bridges can be aesthetically pleasing and cost efficient while reaching the 100-year service life that owners want to achieve.

To learn more about PCAP's work and to see some of the design initiatives, case studies, educational programs, and other resources available to designers, visit www.pcap.org.

Hank Bonstedt is executive director of the Prestressed Concrete Association of Pennsylvania, Allentown, Pa.



The 1319-ft-long 8th Street Bridge in Luzerne County, Pa., will feature 10 spans of precast, prestressed concrete bulb-tee girders. The project, to open summer 2010, replaces a deteriorated structure on the site.