Accelerated Bridge CONSTRUCTION

by Mary Lou Ralls

Accelerated bridge construction includes both the replacement of existing bridges and the construction of new bridges. Innovative design and construction methods and high performance materials are used to reduce the typical bridge construction timeline without sacrificing bridge quality. The goal of accelerated bridge construction is to open a cost-effective, long-lasting bridge to traffic with increased safety and reduced traffic disruption in a shortened construction period.

Delivering projects quickly to improve safety and reduce congestion is now the priority on many of today's bridge construction projects across the country. This trend is increasing. Improved safety is needed to avoid injury to construction crews in the work zone and to motorists as they move through the growing number of work zones. Reduced congestion is needed to provide reliable travel times for motorists and emergency response teams and to avoid negative economic impact to surrounding businesses. Rapid delivery of both emergency and planned bridge construction projects ensures that people and goods continue to be efficiently and effectively moved across cities, counties, regions, states, and bordering countries.

In addition to delivering bridge projects more quickly, the need exists to deliver bridges that last longer. Almost a quarter of the nation's 595,000 publicly owned vehicular bridges are currently structurally deficient or functionally obsolete[1] at a time when the average age of the bridge inventory is approaching its design life. This state of the nation's bridges requires bridge professionals to pursue design and construction materials and methods that extend the service life of bridges to 100 years and that reduce maintenance requirements during this extended life.[2] To obtain longer life with improved performance, bridge owners increasingly specify the use of high performance materials, including conventional strength and high strength, high performance concrete, as the standard for accelerated bridge construction projects.

Accelerated bridge construction encompasses the entire process from planning through construction. Planning and preconstruction activities may include:

- early meetings between the owner, contractors not bidding on the project, and suppliers to discuss possible innovations;
- right-of-way acquisition and utility relocations before advertisement of the project;
- early environmental clearance and permitting;
- innovative contracting strategies such as A+B bidding, lane rental, and incentive/disincentive clauses in the contract documents;
- electronic shop drawing submittal and approval process;
- procurement of prefabricated products, such as prestressed concrete girders before advertisement of the project;
- stockpiling of standardized components.

Design activities may include prefabrication of bridge components or the entire bridge. In addition, geotechnical engineering enhancements, such as mechanically stabilized earth walls instead of conventional cantilever retaining walls, may be included. Reinforced or lightweight backfills may also be used.

Construction activities may include allowing contractors to adopt innovative ideas, use innovative equipment, and perform concurrent on-site engineering operations. Innovative equipment includes self-propelled modular transporters (SPMTs) to move the entire bridge into place. Concurrent operations can include building abutments and intermediate supports simultaneously.

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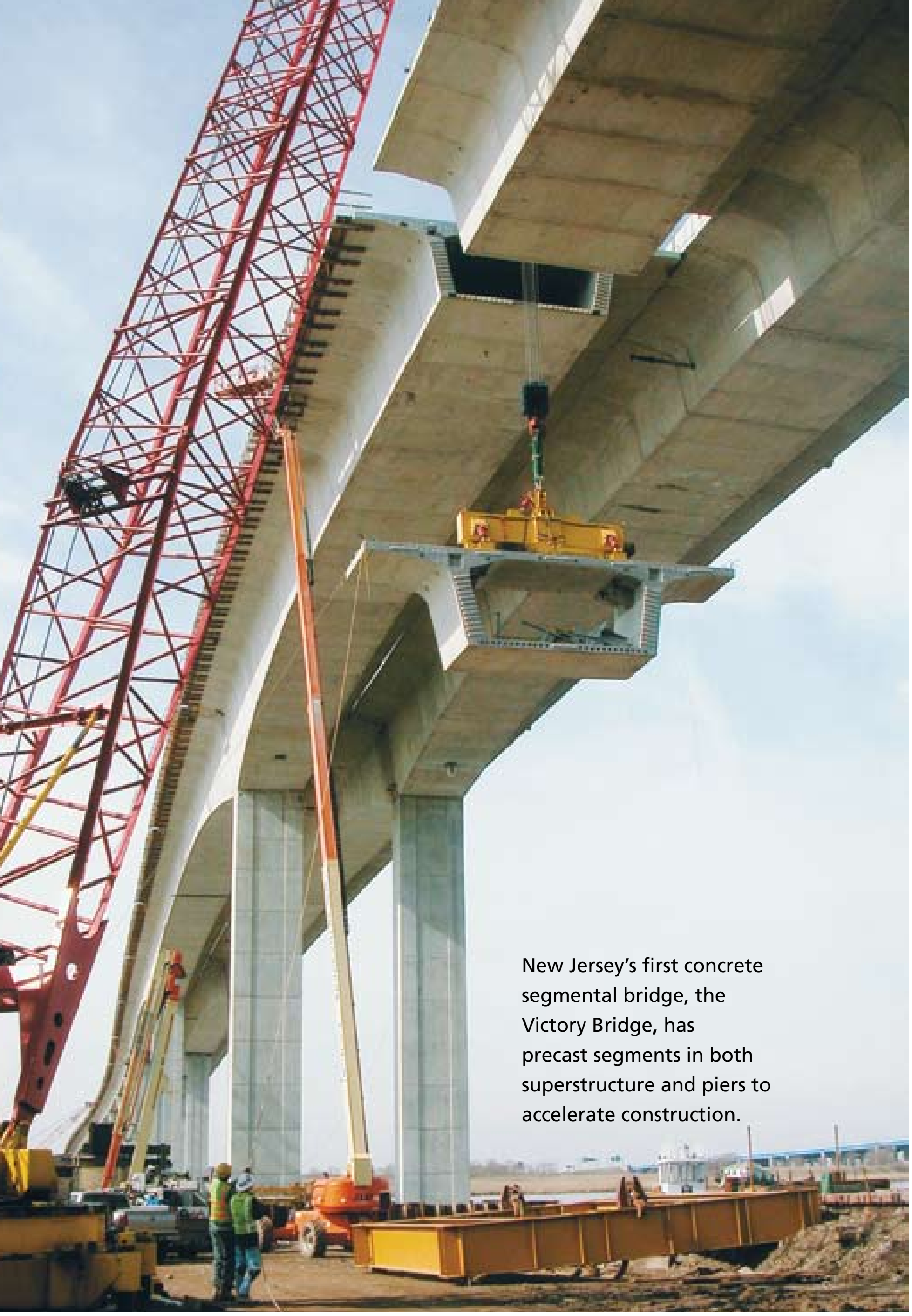
Bridge prefabrication is an accelerated bridge construction method in which the bridge components or the entire bridge are built in an off-site or nearby controlled environment. This helps achieve quality construction. The components or entire bridge are then moved to the final bridge location for rapid installation. A decision-making framework to assist owners in determining whether prefabricated bridges will provide benefits for their specific project is available on the Federal Highway Administration (FHWA) website.[3]

Because of the success of accelerated bridge construction projects to date, the FHWA has increased its support efforts and resources to further advance the development of these systems into more conventional practice nationwide. Aspects of accelerated construction may be included in any concrete



New Jersey's first concrete segmental bridge, the Victory Bridge, has precast segments in both superstructure and piers to accelerate construction.

Photos Far Left
1. Colorado's totally precast single-span bridge, the State Highway 86 Bridge over Mitchell Gulch, was installed over a weekend in 46 hours.

2. Each span of Florida's Graves Avenue Bridge over I-4 was installed in a few hours using self-propelled modular transporters.

3. Collapsed spans on the I-10 bridge. Photo courtesy of HPC Bridge Views, No. 44.

bridge project, whether cast-in-place, reinforced concrete; cast-in-place, post-tensioned concrete; precast, reinforced concrete; precast, pretensioned concrete; or precast, post-tensioned concrete. Most bridge projects have components of more than one concrete bridge technology. The determination of the most appropriate technologies depends on project time requirements, site constraints, and availability of the technology and the related expertise. Examples of accelerated bridge construction projects in each concrete technology are described below. Both emergency replacement projects and planned rapid construction projects are included.

Cast-in-Place, Reinforced Concrete Bridges

Cast-in-place, reinforced concrete may be the most expedient technology for some emergency construction projects. An example is the Hall Street Bridge over I-70 emergency replacement project near Hays, Kansas, described in the Winter 2007 issue of *ASPIRE*.™ [4] In this project, the 45-ft-long section of the 76-ft-long bridge span that was damaged by an over-height load was replaced with the same cast-in-place box section design as the original structure, allowing the bridge to be reopened in less than six months.

Cast-in-Place, Post-Tensioned Concrete Bridges

Cast-in-place, post-tensioned concrete is used in the substructures of some bridge projects that are accelerated in other ways as described in the introduction. This concrete bridge technology is not typically used for bridge superstructures on accelerated construction projects because of the extended time in traffic required for the sequential on-site construction processes of erecting formwork for the superstructure, placing steel cages and post-tensioning ducts, placing the concrete, curing the concrete before post-tensioning, and removing formwork.

Approximately 85 percent of California's bridge inventory currently consists of cast-in-place, post-tensioned, concrete box girder bridges. California uses incentive/disincentive clauses developed from lane mile rental rates and other factors, as well as A+B bidding on selected projects. These acceleration techniques were first used shortly after the 1994 Northridge Earthquake for cast-in-place, post-tensioned concrete bridges. A+B bidding has been successful in accelerating construction projects for both precast and cast-in-place, post-tensioned projects.

Precast, Reinforced Concrete Bridges

Precast, reinforced concrete is used for abutments and pier caps on an increasing number of bridges that require an accelerated construction schedule.

A deck girder with railing attached at the precast plant is lowered into position on State Highway 86 Bridge over Mitchell Gulch.

An example with precast abutments is the Colorado Department of Transportation's State Highway 86 Bridge over Mitchell Gulch replacement project.[5] In 2002, the original 40-ft-long, 26-ft-wide, two-span deteriorated timber bridge was replaced with a 40-ft-long, 43-ft-wide single-span precast, pretensioned concrete slab superstructure and totally precast reinforced concrete abutments. Prior to the bridge closure, steel H piles were driven just outside the existing roadway width. The 44-ft-wide precast abutments and 23-ft-long precast wingwalls with embedded steel plates were erected by crane and welded to the steel H piles and to each other. This was followed by placement of flowable backfill. The contractor initiated the field change to precast concrete construction to shorten the on-site construction time and to reduce the construction crew's exposure to traffic in the work zone. The use of precast abutments allowed the bridge to be constructed over a weekend, and opened 46 hours after closure.

A bent cap example is the Texas Department of Transportation's State Highway 66 Bridge over Lake Ray Hubbard replacement project.[6] In 2003, the narrow two-lane bridge was replaced with a pair of bridges. The 4360-ft-long, 40-ft-wide eastbound bridge includes 43 identical precast, reinforced concrete caps on cast-in-place columns. The contractor initiated the field change from the planned cast-in-place caps to improve the construction crew's safety while working over water and adjacent to high-voltage transmission lines. The change to precast caps also saved nine months on the construction schedule.

Precast, Pretensioned Concrete Bridges

Examples abound for rapidly constructed precast, pretensioned concrete bridges. For example, since the Northridge earthquake, Caltrans has moved more toward employing precast, pretensioned concrete girder superstructures in emergency situations to reduce potential jobsite delays and allow concurrent construction activities. Two recent Caltrans' examples are the emergency replacement of the Russian River Bridge on State Route 128 in Sonoma County and 12 bridges on I-40 in the Mojave Desert. Current research related to seismic concerns will likely further advance the use of precast members for accelerated bridge construction in California.

The conventional precast, prestressed concrete bridge consists of superstructures with pretensioned concrete beams and cast-in-place decks, a technology that has been used extensively in the United States since the 1950s. At the other extreme is an accelerated bridge construction technology that cuts on-site construction

Completed section of Graves Avenue Bridge over I-4.

Following Hurricane Katrina, self-propelled modular transporters and barges were used to realign I-10 spans on Lake Pontchartrain in record time.
Photo courtesy of Mammoet.

time to a small fraction of conventional construction time: the use of SPMTs to quickly remove or install entire bridges.

In early 2006, the Florida Department of Transportation demonstrated the use of SPMTs to remove two 71-ft-long, 30-ft-wide spans of the Graves Avenue Bridge that crossed I-4 northeast of Orlando, Florida. Each removal required less than one half hour.[7] Six months later, following the widening of I-4 and the construction of two 143-ft-long, 59-ft-wide spans in a nearby staging area, the SPMTs were again used to install the new spans. Each new span consisted of eight 78-in.-deep Florida pretensioned concrete bulb-tee beams with an 8-in.-thick reinforced concrete deck, and weighed 1300 tons. The interstate was closed for only a few hours for the installation of each span. Use of the SPMTs reduced the Graves Avenue closure from 12 months to eight months and reduced the I-4 lane closures from 32 nights to four nights. Total delay-related user cost savings was estimated to be $2.2 million.

Emergency construction can also be streamlined with the use of conventional precast, pretensioned concrete girder bridge spans in combination with innovative contracting strategies and innovative construction equipment. This was demonstrated in both the rehabilitation of the I-10 bridges across Escambia Bay in Florida following Hurricane Ivan in 2004[8] and the rehabilitation of the I-10 bridges across Lake Pontchartrain in Louisiana following Hurricane Katrina in 2005.[9] Significant incentives/disincentives encouraged innovation. Modular transporters, cranes, and barges were used on both projects to quickly re-open the bridges to traffic.

This issue of *ASPIRE* includes three articles on precast, pretensioned concrete projects: the Mill Street Bridge over the Lamprey River in Epping, New Hampshire; the CSX Transportation heavy freight railway bridge across Bay St. Louis in Mississippi; and an Iowa precast concrete approach slab project.

Precast, Post-Tensioned Concrete Bridges

Full-depth bridge decks, girders, segmental superstructures, and substructures may be constructed of precast, post-tensioned concrete to accelerate construction. Several examples are described below.

In 1998, the National Park Service's bridges over Dead Run and Turkey Run on the George Washington Memorial Parkway were rehabilitated with new full-depth precast post-tensioned concrete deck panels.[10] The decks were replaced at the rate of one span per weekend, with no weekday impact to commuters traveling between the states of Virginia and Maryland and Washington, D.C. The bridge was closed on Friday evening. The existing deck was saw cut into transverse sections that included the barriers. The old sections were removed and the new panels placed. Longitudinal post-tensioning strands were stressed after all panels in the span were in place. The areas beneath the panels above the

Completed Victory Bridge.
Photo courtesy of FIGG

steel girders were then grouted, and the bridge was re-opened to traffic by early Monday morning.

Precast concrete segmental construction originated in France in the early 1960s and was introduced in the United States in the late 1970s. It is now a well-established bridge technology that offers aesthetic long-span concrete bridges on an accelerated construction timeline relative to conventional construction.

The New Jersey Department of Transportation's Victory Bridge on State Route 35 is New Jersey's first segmental concrete box girder bridge. The twin parallel superstructures are constructed of match-cast segments and have a main span of 440 ft. The piers are precast concrete box segments that were each assembled in one day. In June 2004, the first 3971-ft-long structure was opened to traffic 15 months after the notice to proceed; the second structure was completed nine months later.[11]

In 2005, Florida's 5-mile-long Lee Roy Selmon Crosstown Expressway expansion, owned by the Tampa Hillsborough Expressway Authority, was completed. The 60-ft-wide precast concrete, segmental bridge includes over 3000 segments and was constructed within a 40-ft-wide median on an active expressway in two years.[12]

This issue of *ASPIRE* includes an article on the new Susquehanna River Bridge, Pennsylvania's first vehicular concrete segmental bridge.

More Projects Planned

Numerous accelerated concrete bridge construction projects have been completed to date, saving motorists countless hours of travel time that would otherwise have been spent in construction-related traffic jams. These projects consist of both cast-in-place bridges and precast bridges, with both reinforced concrete and prestressed concrete. Many more such projects are planned as bridge owners deliver projects more quickly to improve safety and reduce congestion.

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