Hurricane-Damaged Span Replaced in 156 Days

by Stanley W. Woods

The 10,050-ft-long CSX Transportation railroad bridge in Bay St. Louis, Mississippi, connecting key transportation hubs, was reconstructed in only 156 days after Hurricane Katrina destroyed the original structure.

Precast concrete girders and close cooperation between designer, fabricators, and contractors ensure critical railroad bridge returns to service quickly

Executives at CSX Transportation needed a fast replacement when Hurricane Katrina destroyed the superstructure of their 10,050-ft-long railroad bridge across Bay St. Louis, Mississippi. Close communication and cooperation among the railroad officials, designer, fabricators, and contractors accomplished this task in only 156 days from the time of damage until it opened to traffic, beating the already tight schedule requested. A design featuring AASHTO Type IV precast, prestressed concrete beams contributed to this rapid reconstruction.

On August 29, 2005, the bridge superstructure was knocked out by one of the worst hurricanes in the nation's history. The key heavy-freight railway bridge carried 25 to 35 trains per day and served as the main corridor from New Orleans through Biloxi, Mississippi, to Mobile, Alabama. The 30-ft storm surge over-topped the entire length of the bridge, wrenching all but three of the 165 spans from the piers.

Miraculously, the 289-ft-long center swing-span truss weathered the waves, although there was track and operating system damage. Overall, about 75 miles of track and six other significant bridges were damaged on the line. These repairs were completed before the Bay St. Louis Bridge was opened, according to Gary Sease of CSX Transportation.

profile

CSX TRANSPORTATION RAILROAD BRIDGE / BAY ST. LOUIS, MISSISSIPPI

ENGINEER: STV/Ralph Whitehead Associates Inc., Jacksonville, Fla.

PRIME CONTRACTORS: Scott Bridge Co., Opelika, Ala., and Jordan Pile Driving, Inc., Mobile, Ala.

PRECASTERS: Sherman Prestressed Concrete, Pelham, Ala., and Madison Materials Co., Ridgeland, Miss., PCI-Certified Producers

BRIDGE DESCRIPTION: 10,050-ft precast concrete railroad bridge with ballasted deck

When the bridge was damaged, trains had to be detoured through Memphis, Tennessee; East St. Louis, Illinois; and Birmingham, Alabama, at an estimated detour cost for this primary east-west bridge of $1 million per day. "The railroad employees did an excellent job of rerouting trains so there was minimal delay to suppliers in the East," says Sease. Even so, the costs were heavy and access to the route needed to be restored quickly.

The damaged portion of the bridge comprised 162 spans, of which 160 were 60-ft-long ballast-deck precast, prestressed concrete box beams. The remaining two were 50-ft 6-in.-long steel open-deck approach spans adjacent to the swing-span truss. The original precast concrete box beams were cast with closed-end diaphragms.

When the incoming storm surge rose above the top of the boxes, air inside the boxes could not escape. The hydraulic force of the storm surge overcame both the strength of the anchor bolts and the weight of the box beams due to buoyancy. It sheared the boxes from their bearings, carried them away from the substructure, and eventually took them to the bottom of the bay. Immediately after the hurricane, underwater inspectors assessed the structural integrity of the existing piers and determined that they had suffered minimal damage and could be used in the reconstruction.

Six-Month Challenge

The owner immediately contacted two general contractors and an engineering firm to assess damage and propose reconstruction activities. The owner challenged the design and construction team to restore the critical line to service in only six months. It was decided not to replace the 39-year-old existing spans "in kind," since the original custom forms were no longer available and the fear still existed of a washout during future storms.

After the beams were erected, diaphragms, composite deck, and ballast curb were cast.

After conversations with local suppliers, the owner and designer replaced the original box beams with four precast, prestressed concrete AASHTO Type IV modified beams incorporating cast-in-place concrete diaphragms, composite deck, and ballast curbs. Two precasters were contracted to provide 640 precast concrete beams to complete the bridge reconstruction. The suppliers' familiarity with AASHTO beams and the availability of numerous Type IV forms ensured the proposed bridge beams could be mass-produced with minimal startup time. To maintain the original profile of the track, the top flange depth was reduced 2 in. so the overall depth would match the depth of the original box beam.

The superstructure's design and project plans were completed in only three weeks by STV/Ralph Whitehead Associates' Jacksonville, Florida, office. "Four designers worked 60 hours per week to complete the plans that quickly," says Nathan Porter of Whitehead. The original piers consisted of 54-in.-diameter prestressed concrete cylinder piles with a cast-in-place pier cap. To increase the lateral support of the beams on the piers, 2-in.-diameter by 2-ft 6-in.-long steel dowels were embedded 1 ft 6 in. into the existing pier caps at both ends of each beam to anchor them to the piers. In addition, steel-pipe and tubular sleeves were embedded in the beams to allow the steel dowels to project 1 ft into the bottom flanges. The tubular sleeves were incorporated in the design to permit longitudinal movement of the span at the expansion end.

The demanding schedule required the precasters to produce and deliver approximately 60 beams per week. "We had to scour the country for 10 sets of forms to create two beds with five beams each, because Alabama no longer uses AASHTO Type IV beams," notes Harold Bush of Sherman Prestressed Concrete in Pelham, Alabama. The company used regular work shifts but shifted some projects to produce the needed 10 beams per day with a design strength of 6 ksi and a release strength

AASHTO TYPE IV PRESTRESSED CONCRETE BEAMS WITH CAST-IN-PLACE SLAB / CSX TRANSPORTATION, OWNER

STRUCTURAL COMPONENTS: AASHTO Type IV precast concrete beams

BRIDGE CONSTRUCTION COST: $60 million

PRESTRESSED CONCRETE BEAM PACKAGE: $4.5 million

of 4.5 ksi. Madison Materials Co. in Ridgeland, Mississippi, also began beam production, with cooperation from Alabama and Mississippi Departments of Transportation to ensure rapid delivery to the job site. Both producers are certified under the Precast/Prestressed Concrete Institute's Plant Certification Program.

The first beam was cast on September 26, 2005, with the first shipment arriving on October 10, 2005. The final delivery took place almost exactly two months later, on December 12, 2005.

Meanwhile, the contractors made minor repairs to the cylinder piles and pier caps as well as to the swing-span truss. It needed to be rebalanced, and the destroyed track work needed replacing. Each pile cap was drilled for eight core holes, with each beam's anchor dowels held in place with epoxy adhesive. All the piers were surveyed to verify the span lengths, which were found to be consistent at 60 ft.

No Support Infrastructure

Complicating the construction was the fact that there was no support infrastructure remaining in place in the area, as Hurricane Katrina had devastated a vast area, points out Chuck Davis of Scott Bridge Co. Workers had to sleep in their trucks or tents during the first two weeks, until quarters could be provided. These ultimately arrived in the form of tour buses. Communication immediately after the storm could be conducted only via satellite telephones. All items required to run the project and support the workers were trucked in from out of the area.

Meals during those weeks were also hit and miss, Davis says. A mess hall was established on-site to serve 400 to 500 meals per day, with three local women preparing the meals. "Our behind-the-scenes supply-line planning and operations was key to getting this rebuild underway quickly," Davis says.

The two approaches were built simultaneously from the end abutments towards the swing-span truss. Scott Bridge worked on the west side and Jordan Pile Driving worked on the east side. "The two contractors raced to see who would reach the swing span first to set the final rail," Davis notes. Scott Bridge used 10 cranes of 100- to 250-ton capacity. The team worked 24 hours a day and used 20 light plants for night operations. With weather cooperating, there were few missed days.

Meanwhile, Jordan Pile Driving brought in its own equipment and worked primarily during the day, performing maintenance operations at night. Both contractors notified the other states in which they had projects so that other operations would stop there until this work was completed. The states were sympathetic with their request to bring workers to this job, smoothing the operation considerably, Davis adds. Because of the tight schedule, the contractors worked on a time and materials basis.

15 Beams Erected Daily

After the beams were delivered, they were loaded on barges and moved to the spans being erected. Beams were erected at an average rate of about 15 beams per day. Once the beams were set, stay-in-place metal forms were placed between the girders, and plywood forms were placed for the overhang soffits. The concrete deck and curbs were then placed. A pump truck was set on a sand causeway to supply concrete for the new superstructure. Replacement of the superstructure took only four months and was completed in early January 2006. The rock train arrived on January 14, 2006, when laying track and ballast operations began. The bridge was opened to rail freight traffic on February 1, 2006.

After the bridge reopened, Scott Bridge was the low bidder on a separate contract for removing the box beams from the bottom of the bay and began work immediately. Some of the beams weighed up to 250 tons, as water had filled the box voids. To hoist the beams, divers cleared muck up to 4 ft deep around the boxes and attached lifting slings. The beams were lifted out of the water with two 230-ton Manitowoc cranes, and the water was allowed to drain before moving to shore. Once on shore, the beams were crushed and the concrete was used to refurbish a man-made island. The prestressing strand and reinforcing bars were taken to a landfill, as they proved too difficult to recycle.

Once the structure was back in place, needed supplies and materials could be delivered to the communities destroyed by Hurricane Katrina. The project provides an excellent example of what close cooperation between owner, designer, and contractor can achieve when rapid reconstruction is needed. The use of the precast, prestressed concrete beams played a significant role in facilitating the rapid reconstruction of this vital railway asset in only 156 days, well below the hoped-for six-month deadline that the owners had originally set.

The AASHTO Type IV precast, prestressed concrete beams were erected at an average of 15 beams per day.

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