GOING TO RECORD LENGTHS

by Brian Slagle, Janssen & Spaans Engineering Inc.

Kentucky project's 325-ft-long main span sets record for spliced, precast, prestressed, concrete girders

The Route 22 Bridge over the Kentucky River near Gratz, Ky., was initially planned as a steel structure, but officials at the Kentucky Transportation Cabinet allowed a concrete alternative to be designed. That option resulted in the creation of a spliced, post-tensioned, precast concrete girder bridge that features a 325-ft-long main span, the longest span of this type in the United States. It also produced a cost savings of more than $800,000.

The bridge was designed to replace the existing steel-girder structure, which will be demolished after the new bridge is in place. Upon release of the initial drawings, which featured a steel-plate girder design, engineers at a precasting firm asked if they could provide a precast concrete alternative for consideration.

Long Spans Required

The company realized that to span the river as required would necessitate long spans. But it knew it could produce the segments required, and it had access to special barge-loading facilities that would allow it to deliver the girders via the river.

The 325-ft length was necessary to span the river without changing the pier locations from the original design, which located them along the riverbank. Moving them closer to shorten the span lengths would have required placing a pier in the river, which would have caused encroachment on the waterway and environmental concerns.

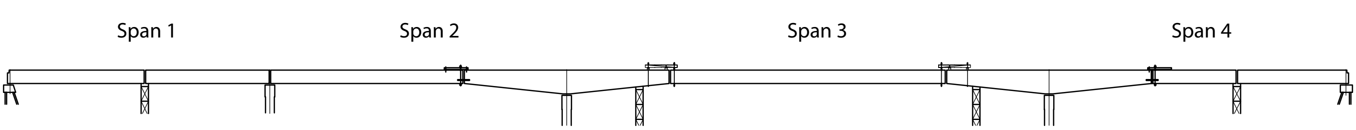
The bridge has four spans and four girder lines were used throughout the bridge. The center span features haunched bulb-tee pier segments varying from 9 ft deep to 16 ft deep. The haunched pier segments were each 138 ft long and weighed 169 tons. Between the two cantilevered pier segments, a 9-ft-deep drop-in girder, 185 ft long completed the 325-ft main span. Segments were joined with 1-ft-wide cast-in-place concrete closure joints.

Spliced Approach Spans

There are two approach spans on the west side with lengths of 175 ft and 200 ft and an approach span on the east side of 200 ft. The precast beams for the three approach spans consist of 9-ft-constant-depth, bulb-tee beams. Span 1 consists of two segments with lengths of 90 ft 9 in. and 84 ft 3 in. that were set on falsework at their splice. Span 2 comprised one end of the haunched pier segment and a drop-in girder segment, 131 ft long. Span 4 comprised two segments, 57 ft 6 in. and 73 ft 6 in. set on falsework with one end bearing on an end bent and the other supported with a strongback from the cantilevered end of the haunched pier segment. In all, eight girder segments were used in each beam line.

Materials Selection

The girder segments used concrete with a specified 28-day compressive strength of 7500 psi. All segments used normal weight concrete except for the main-span, drop-in girders, which used a



Schematic of the framing of the spans on the Route 22 Bridge over the Kentucky River near Gratz, Ky.

profile

ROUTE 22 BRIDGE OVER THE KENTUCKY RIVER / GRATZ, KENTUCKY

ENGINEER: Kentucky Transportation Cabinet, Lexington, Ky.

PRIME CONTRACTOR: Haydon Bridge Co., Springfield, Ky.

PRECASTER: Prestress Services Industries LLC, Lexington, Ky., a PCI-certified producer

PRECAST SPECIALTY ENGINEER: Janssen & Spaans Engineering Inc., Indianapolis, Ind.

ERECTION CONTRACTOR: C.J. Mahon Construction Co., Columbus, Ohio

Left: The new spliced precast, prestressed concrete girder bridge along Route 22 over the Kentucky River replaces a deteriorated steel structure that will be demolished once construction is completed. Photo: Aerial Innovations of Tennessee Inc.

Above: The precaster's loading pier allowed the heavy precast girders to be placed on specially designed barges, which delivered the components to the site. The 185-ft-long main-span, drop-in girders were always handled as braced pairs to address stability concerns. Photo: Prestress Services Industries LLC.

Locks along the waterway had to be repaired and modified to allow the girders to be barged to the site.

semi-lightweight mixture resulting in a unit weight of 125 lb/ft^3. This material reduced the weight and made the girders easier to maneuver to and from the barges during loading and erection. Standard grade 60, epoxy-coated reinforcement was used, along with Grade 270 ksi for the pretensioning and post-tensioning strands. Concrete compressive strengths required for the deck and pier concrete were 4000 psi and 3500 psi, respectively.

The three piers ranged from 33 ft to 66 ft in height, with the two piers on the east side set on piles, while the one on the west side, along the river bank, was set on spread footings due to the close proximity of sound bedrock.

Locks Created Challenges

Casting the segments posed no challenges, especially for the shorter spans, which are more typical in length. Transportation to the site proved more challenging than initially anticipated, however. The precaster had planned delivery with special barges, but a system of locks along the waterway created a problem. They were no longer operational, which the precaster knew would require repairs and modifications to at least one lock's entrance to accommodate the barges' widths.

Initially, the precaster speculated that, if delivery was scheduled during high-water in the spring, the water level would be high enough that the barges could float over the locks, saving time and money. The barges then would remain at the site until the next spring, when they could be transported back up the river at the high water mark again. That scenario created a risk factor, as a dry spring would have caused delays or last-minute adjustments.

Upon a closer examination of the locks, the precaster determined that the necessary repairs were not as extensive as originally expected. The repairs were made, and the barges were used to transport the girders. In the end, the river experienced flood-level conditions several times, requiring the contractor to adjust the work sequences and processes to maintain the project's schedule.

A strand jack was used to lift haunched pier segments from the barge to the pier seats. The jacks were later relocated and used to lift the drop-in girders for the main span. Photo: Haydon Bridge Co.

FOUR-SPAN, PRECAST, PRESTRESSED CONCRETE SPLICED-GIRDER BRIDGE / KENTUCKY TRANSPORTATION CABINET, OWNER

POST-TENSIONING CONTRACTOR: Dywidag Systems International-USA Inc., Bolingbrook, Ill.

BRIDGE DESCRIPTION: Four-span (175, 200, 325, and 200 ft—center to center of bearings) precast, prestressed concrete spliced-girder structure 909 ft long and 47 ft 4 in. wide, with cast-in-place concrete piers and composite concrete deck

BRIDGE CONSTRUCTION COST: $8.9 million

The new structure features a four-span concrete design that includes a 325-ft main span, the longest span for a precast girder bridge in the United States. The main span and east approach span are shown. Photo: Haydon Bridge Co.

The girders were transported to the site on barges during high-water levels in the spring, after the precaster had modified and repaired several locks along the route. Photo: Haydon Bridge Co.

Construction began with the end bents, piers, and temporary supports. Then the haunched pier segments were erected, followed by the main-span, drop-in segments. Once they were in place, the remaining girder segments were erected and the closures were cast.

No Cranes for Main Span

Because of the difficult riverside site, the biggest construction challenges came with the erection of the center span. The haunched pier segments and main-span, drop-in segments had to be erected without cranes. First, the contractor erected four structural towers around each riverbank pier. They supported two straddle beams above the piers that in turn supported a gantry beam on trolleys. The gantry housed strand jacks that were used to lift the pier segments. Once over the pier, the trolleys moved the segments laterally to their final position.

For erection of the main-span drop-in segments, a reverse strongback was attached to the free end of the cantilevered pier segment. A strand jack was placed at the end of the strongback and was used to lift the drop-in segments into place. Due to the length of the drop-in segments (185 ft), the contractor had to erect these as two braced pairs to address stability concerns. Each pair weighed 258 tons and each jack needed nine strands for the lift.

After removal of the temporary pier segment erection towers, a braced pair of main-span segments was lifted into place by strand jacks from the strongbacks mounted on the pier segments. The haunched bulb-tee pier segments vary from 9 ft deep to 16 ft deep. Photo: Haydon Bridge Co.

After all pieces were erected, the structure was post-tensioned over its full length in two stages. Stage one post-tensioning needed three tendons with fifteen 0.6-in.-diameter strands and was completed prior to the deck placement. Stage two post-tensioning was performed after the deck achieved strength and used one tendon with fifteen 0.6-in.-diameter strands. The final step following the stage two post-tensioning operations was to construct concrete barriers and install expansion joints at the end bents. Construction of the bridge began in early 2009 and was completed in the fall of 2010, on schedule.

A new national record for this type of concrete construction was established by evaluating the original steel plate girder plan, maintaining the pier locations, but otherwise completely value-engineering the substructure and superstructure. The result is a more durable bridge with a significant savings in cost.

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Temporary towers supported steel beams spanning over the piers that in turn supported a gantry with strand jacks to lift the pier segments and move them laterally into place. Photo: Haydon Bridge Co.

The haunched pier segments and main-span drop-in segments were erected without cranes.

Pier segments were equipped with strongbacks at their main-span ends. The strand jacks were moved to the strongbacks to raise the drop-in girders into final position. Falsework towers under the pier segments provided temporary support of the cantilevers during this operation. Photo: Haydon Bridge Co.