PROJECT

South 200th Link Extension

Connecting communities through segmental bridge design

by Heather Yount and Bryant Helvey, PCL Civil Constructors Inc.

Installation of the last segments of the South 200th Link Extension. Photo: PCL Civil Constructors Inc.

As the first design-build light rail project for Sound Transit, the South 200th Link Extension lengthens the existing light rail system by 1.6 miles. The project extends the light rail from the Seattle-Tacoma International Airport south to the new Angle Lake Station at South 200th Street. The project comprises 1166 precast concrete segments, each weighing between 35 and 55 tons.

The project team used both balanced cantilever and span-by-span erection methods to assemble the units into an elevated guideway. The 10-ft-long segments were assembled into bridge spans with epoxy joints and 0.6-in.-diameter, post-tensioning strands in tendons stressed to 1000 kips.

The typical span-by-span unit is 27 ft wide and contains 13 segments, forming one span of guideway wide enough for two trains to pass side by side. The balanced cantilevers are up to 40 segments long (spanning 360 ft) and two segments wide, providing a 54-ft-wide structure that allows trains to switch tracks, and a third storage track between the two running tracks.

From Fast-Track to Precast

In choosing the design-build procurement method, Sound Transit and the design-build team were able to create efficiency in the design process by providing comprehensive design and construction services through a single point of contact. The design-build approach also allowed Sound Transit to fast-track the project by beginning construction before the total design was complete; thereby, reducing the schedule by nearly 6 months.

The term accelerated bridge construction (ABC) applies to a multitude of construction techniques, all used with the intention of reducing impacts to the environment, community, and traffic while positively affecting the project's budget and schedule. The practice of using precast concrete segments as opposed to the more traditional cast-in-place concrete superstructure is one way in which Sound Transit benefited from the use of ABC methods.

The use of precast concrete segments enabled the project team to minimize disruptions to vehicular traffic exiting the airport because the segments were manufactured and stored at an off-site casting yard until it was time to erect them. The simultaneous construction of the guideway's substructure

profile

SOUTH 200TH LINK EXTENSION / SEATTLE AND TACOMA, WASHINGTON

BRIDGE DESIGN ENGINEER: HDR Engineering Inc., Bellevue, Wash.

BRIDGE DESIGN SUB-CONSULTANT: International Bridge Technologies Inc., San Diego, Calif.

PRIME CONTRACTOR AND SEGMENT PRECASTER: PCL Civil Constructors Inc., Seattle, Wash.

POST-TENSIONING CONTRACTORS: PCL Civil Constructors Inc., Seattle, Wash., (superstructure) and Schwager-Davis Inc., San Jose, Calif. (substructure)

POST-TENSIONING SUPPLIER: Schwager-Davis Inc., San Jose, Calif., and Dywidag Systems International, Long Beach, Calif.

OTHER CONSULTANTS: KPFF Consulting Engineers, Seattle, Wash., station structural design

Crews prepare to launch the gantry to the next span. Photo: Roger Marble Photography.

Using an overhead gantry, the project team constructed an average of two spans per week. Precast concrete segmental construction allows project teams to maintain a fast pace, shorten the overall project schedule, reduce impacts on the community and other stakeholders, and create a safer work place. Photo: Roger Marble Photography.

components and the concrete segments resulted in a significant reduction to the overall project schedule when compared with more traditional cast-in-place bridge construction techniques. The contractor conducted an analysis of the cast-in-place concrete method versus the precast concrete segmental method and estimated that the precast segmental method reduced the project's schedule by 4 to 6 months.

The project team at the casting yard, located 30 miles from the main site, placed concrete for the bridge segments with a high-strength mixture that provided a concrete compressive strength of 6.5 ksi at 28 days. The mixture was designed to achieve 80% of the 28-day strength in just 12 hours to allow removal from the segment molds. A variety of segment bed forms were used for the bridge components, including four typical segment beds, a pier segment bed, a constant depth bed, and a variable-depth bed. The variable-depth bed cast segments between 8 and 16 ft deep, giving the balanced cantilevers their arched appearance.

The pier segments weighed up to 55 tons and transferred the structural load from the typical segments to the substructure. The pier segments contained the majority of the post-tensioning anchorages, access doors, and pintle bearings. The use of a casting yard helped the project to rapidly produce the segments for the superstructure and created a consistent, quality product after each concrete placement, which reduced the overall project cost.

Precast concrete segments enabled the project team to minimize disruptions to vehicular traffic exiting the airport.

SOUND TRANSIT, OWNER

OTHER MATERIAL SUPPLIERS: Deal Srl, Italy, precast concrete superstructure formwork and erection gantry; Gerdau Steel, Auburn, Wash., reinforcing steel; D.S. Brown Company, North Baltimore, Ohio, bridge bearings; R.J. Watson Inc., Alden, N.Y., bridge bearings; US Spec, Denver, Colo., post-tensioning grout

BRIDGE DESCRIPTION: A precast, post-tensioned concrete, segmental box girder bridge with 1.6 miles of double-track light rail, twin-track, and single-track box girders, with span lengths ranging from 99 to 363 ft

STRUCTURAL COMPONENTS: 66 cast-in-place concrete columns on drilled shafts; four double-leaf, long-span columns on spread footings; four cast-in-place concrete pier tables; 18 cast-in-place concrete pier caps; 1166 precast, post-tensioned concrete segments; 896 post-tensioning tendons; 1.98 million ft of 0.6-in.-diameter steel strand; 14,500 bags of post-tensioning grout

BRIDGE CONSTRUCTION COST: $172.8 million

The project team worked throughout the night to accelerate bridge construction over the roadway. This system allowed the team to complete a month or more's worth of work in one night. Photo: Francis Zera, Zera Photography.

The design-build team worked to develop a balanced cantilever solution that eliminated columns, significantly reducing the number of traffic detours, all while providing a more efficient and durable solution. Photo: PCL Civil Constructors Inc.

Reducing Impacts to Stakeholders

Design-build delivery and ABC methods benefit project owners and stakeholders by reducing project costs and overall construction duration, so it's only sensible that combining the two multiplies the benefits offered.

With more than 34 million passengers traveling through the Seattle-Tacoma International Airport each year, the project team carefully considered construction means and methods that would minimize impacts to airport operations. To reduce impacts to the airport's most heavily congested areas, balanced-cantilever spans were stretched to 360 ft between some piers, and ground-based track cranes were lifted onto the bridge to erect the structures, allowing the segments to be lifted in areas of limited space.

In one instance, the project team combined the balanced-cantilever and gantry erection methods at a temporary pier location, which allowed the team to erect the 210-ft span above the main airport traffic exit and keep the existing walkway open 16 hours per day. The team then removed the temporary support before Memorial Day 2015 so that pedestrians could access the airport's facilities unimpeded.

The project team used a self-launching overhead gantry to erect the precast concrete segments, a method that reduced ground disturbances and the number of road and lane closures. The use of this custom gantry also resulted in reduced ground stabilization and fewer trucks because each carried clean, completed bridge segments.

While this project offers many benefits to Sound Transit and community members in and around Seattle, the project team was met with the unique challenge of navigating around the "spaghetti bowl" that is Seattle-Tacoma International Airport's intertwining roadways. To mitigate this, the team suggested using a long-span, balanced-cantilever structures throughout this area instead of the typical span arrangement suggested in pre-bid documents. The solution eliminated the need for four piers and several straddle bents, which would have severely restricted future development in the area. The use of long-span, balanced-cantilever construction in this area also eliminated the need for additional construction phases, multiple detours, and accommodated the airport's plans for future expansion. The construction of the bridge is complete, and the project teams are working to finish the station and systems work. The new system is estimated to be fully functional as early as spring 2016.

Not only will these unique transportation solutions provide immediate benefits to the airport, but it is the nature of post-tensioned, precast, segmental bridges to provide long-term durability, possibly exceeding the 100-year design-life requirement.

A First Time for Everything

The South 200th Link Extension is a turnkey project for Sound Transit because nearly all aspects of the design-build project, from design to service operations, were delivered in one contract. "I have greatly appreciated the team's willingness to share lessons learned and collaborate," said Miles Haupt, Sound Transit's project director for South Link. "This project was a team effort, and we worked together to bring a more accessible light rail to the Seattle-Tacoma communities."

Heather Yount is a communications coordinator for PCL Civil Constructors Inc. in Denver, Colo., and Bryant Helvey is a superintendent for PCL Civil Constructors Inc. in Seattle, Wash.

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