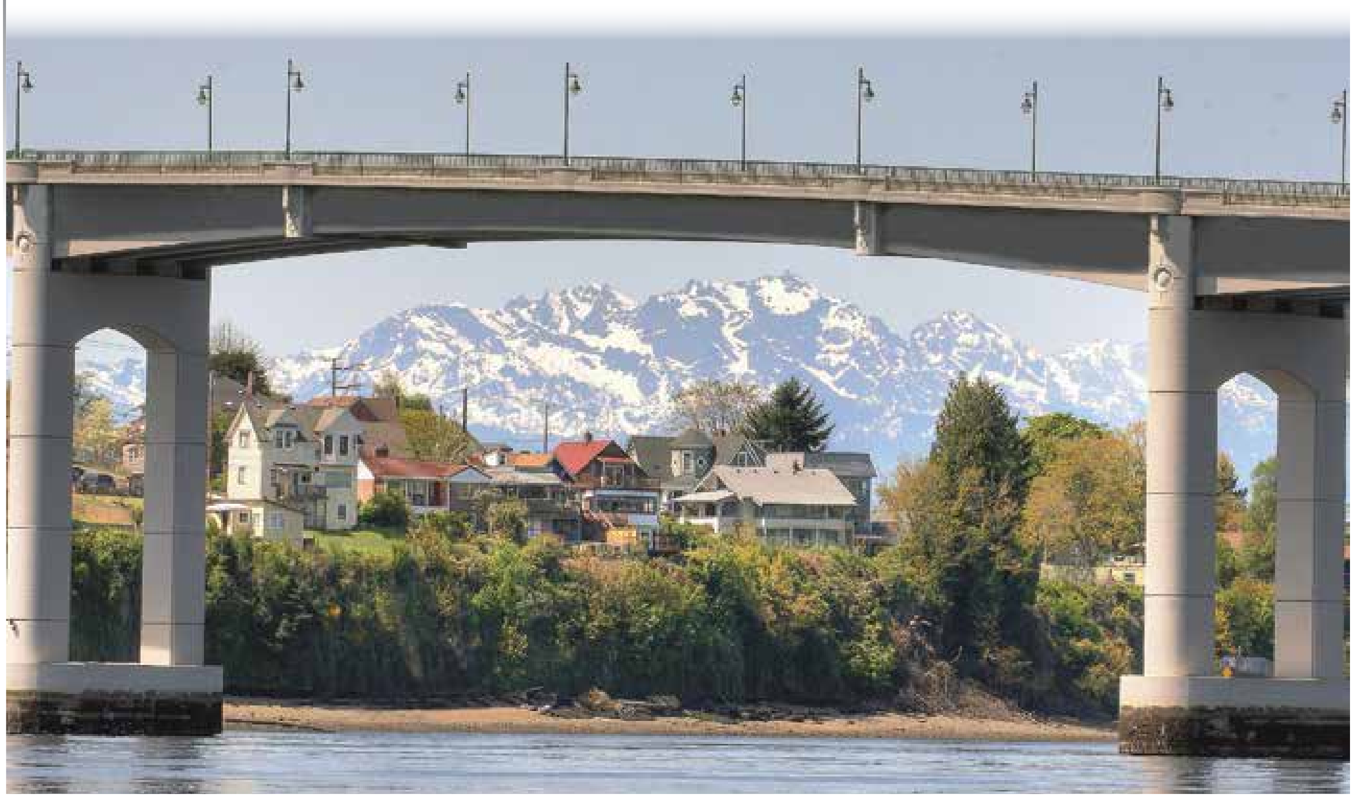
SR 303 Manette Bridge Replacement Project

A collaborative, interdisciplinary bridge design approach encourages community input

by Paul Kinderman and Eric Ferluga, Washington State Department of Transportation



Complete bridge with Olympic Mountains in the background. All photos: Washington State Department of Transportation.

The SR 303 Manette Bridge Replacement Project was built in the Naval Shipyard town of Bremerton, Wash. The project team took part in a collaborative, interdisciplinary design approach that involved all stakeholders and resulted in a new modern bridge that preserves and enhances the scenic and historic community.

This project replaced an 80-year-old bridge that was important to the city and neighborhoods in terms of transportation of goods and services and civic pride. Some of the greater challenges that needed to be addressed by the project team included the following:

- The existing bridge was to remain open during construction of the new bridge.
- The new bridge needed to be architecturally interesting and unique to satisfy the local community, yet economical to fit within the budget.
- The bridge foundation had to resist high seismic forces coupled with swift currents and large scour potential.
- The new bridge was to be constructed within 3 ft of the existing bridge to facilitate tie-in with existing roads.
- The bridge is not part of the state highway system, but state law had dictated that the state was responsible for the bridge's replacement.

Existing Bridge History

The Manette Bridge was originally built in 1930 across the Port Washington Narrows connecting the neighborhood of Manette with the rest of the city of

profile

SR 303 MANETTE BRIDGE REPLACEMENT / BREMERTON, WASH.

BRIDGE DESIGN ENGINEER: Washington State Department of Transportation Bridge and Structures Office, Tumwater, Wash.

GENERAL CONTRACTOR: Manson–Mowat, a Joint Venture, Seattle, Wash.

PRECASTER: Concrete Technology Corporation, Tacoma, Wash., a PCI-certified producer

POST-TENSIONING CONTRACTOR: Schwager Davis Inc., San Jose, Calif.

READY-MIX CONCRETE SUPPLIER: Kitsap Ready Mix, Poulsbo, Wash.

Bremerton. The main spans consisted of five steel trusses (four deck trusses and one thru truss) with approaches constructed of timber. In 1949, the timber approaches were replaced with steel girders.

Foundations supporting the truss spans were a combination of concrete seals and timber piles, and the approaches were founded on spread footings. The existing bridge was 1573 ft in length, with a 24-ft-wide roadway. The roadway width for the thru-truss span was 18 ft 4 in.

Originally, the existing bridge was part of the state highway system. However, state law (RCW 17.17.960 effective in 1991) decrees the following: "Although not part of the state highway system, the [Manette Bridge] shall remain the continuing responsibility of the Washington State Department of Transportation. Continuing responsibility includes all structural maintenance, repair, and replacement of the substructure, superstructure, and roadway deck. Local agencies are responsible for snow and ice control, sweeping, striping, lane marking, and channelization."

This law required state and city officials to coordinate closely with the project team during the planning, design, and construction phases.

The greatest structural issue with the existing bridge was the condition of the main span concrete piers. Testing of cores taken from the foundation starting in 1976 determined that the main cause of the deterioration in the concrete was due to alkali-silica reaction. Repairs to the bridge were completed in 1949, 1991, and 1996. These repairs attempted to encase the deterioration, but did not restore the capacity of the foundations.

The bridge was added to the replacement priority list in 1993 with a priority of 25, and had been waiting since then for funding. In 2007, the bridge had risen to a priority of 3, and funding of the $65 million was provided. In 2008, the bridge required posting below legal limits due to rusting and section loss in the floor stringers.

The Replacement Bridge

The replacement bridge is 1550 ft long, carrying two traffic lanes, two 5-ft-wide shoulders, and a 10.5-ft-wide bicycle/pedestrian path.

The new bridge is a seven-span, continuous, prestressed, post-tensioned spliced girder design, supported by two-column bents founded on drilled shafts. The superstructure consists of five 250-ft-long spans, with end spans of 140 and 160 ft.

The new bridge was constructed approximately 3 ft from the existing bridge while the existing bridge was kept open to traffic. The exception was on the west end, where the new bridge needed to overlap the existing bridge to facilitate tie-in with the existing road. This overlap meant the existing bridge had to be closed to traffic for a short duration before the new bridge was opened. This was accomplished with partial demolition of the existing bridge and creative construction of the new bridge. The Washington State Department of Transportation (WSDOT) made a commitment to the public that the closure duration would not be greater than 4.5 months.

Hammerhead precast, prestressed concrete girders.

Substructure

The bridge piers consist of an arched cross beam supported by two architectural columns that are founded on 12-ft-diameter drilled shafts. The column-shaft connection occurs at the water line and is encased in a shaft cap. The shaft cap consists of a precast concrete shell with reinforced concrete infill.

The precast concrete shell acted as a stay-in-place form that was sealed against water intrusion to facilitate placement of the infill concrete during varying tide conditions. At high tide, only a few feet of the shaft cap is visible. At low tide, the shaft cap is entirely out of the water by a few feet.

Aerial view of the complete bridge.

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: The bridge is 1550 ft long and 42 ft wide and consists of five 250-ft-long spans and two end spans of 160 and 140 ft. Pretensioned, precast, post-tensioned, parabolically haunched, spliced I-girders are supported by twin column bents on deep foundations.

STRUCTURAL COMPONENTS: Cast-in-place concrete deck; 52 precast, prestressed, variable-depth concrete I-girders including 24 hammerhead segments and 28 drop-in span segments; 8 by 10 ft cast-in-place architectural columns supported by pier tables; and 12-ft-diameter drilled shafts

BRIDGE CONSTRUCTION COST: $60 million

Structurally complete bridge with construction barges.

The construction contract contained two options for cross beam and column construction: a conventional cast-in-place option and an innovative precast concrete option. The contractor, who won the bid, elected to go with the cast-in-place concrete option.

The bridge is located in an area of high seismicity with close proximity to the Seattle Fault. In addition to the seismic forces, the bridge resists currents of 3.5 knots and a potential scour depth up to 20 ft. In order to resist these factors with only two shafts per pier, the superstructure was isolated from the substructure in the longitudinal direction with large elastomeric bearings.

Superstructure

The superstructure design utilizes a typical framing plan for continuous spliced girder bridges; hammerhead segments at the intermediate piers, drop-in segments spanning between the hammerhead segments, and drop in segments spanning between the end abutments and adjacent hammerhead segments. The bridge has four lines of girders spaced at 11 ft 7 in., except at the west end where the girders splayed to accommodate a right turn lane. The girders are spaced at 12 ft 5 in. at the west abutment.

Typically, continuous spliced girder bridges are post-tensioned several spans at a time or from expansion joint to expansion joint. This bridge was stressed span-by-span with unique opposing tendon anchorages centered over the piers in the hammerhead segments. This detail allowed most of the new bridge to be constructed while keeping the existing bridge open. Only the west abutment and first span of the new bridge needed to be constructed during the 4.5-month closure period.

Due to the architectural desire for a parabolic shape, custom I-girder sections that included a truly parabolic (not chorded) haunch were developed for both the hammerhead and drop-in segments. The custom segments, weighing up to 306,000 lb, varied in depth from 6 to 12.5 ft. At the time of construction, the precast concrete hammerhead segments were the heaviest ever produced by the precaster. The precast concrete girder segments were transported by barge from the fabricator along the Tacoma waterway to the bridge site in Bremerton.

The deck is mildly reinforced and placed after the girders are post-tensioned. The west end of the bridge contains an additional lane to facilitate right hand turns. This wider deck is supported by splayed girders and has a large overhang supported by a diaphragm, which extends beyond the exterior face of the girders. The deck contains overlooks at the piers and corbels at luminaire locations. All deck reinforcement is epoxy coated per WSDOT standards.

Specified minimum concrete compressive strengths for the superstructure girder segments were 6.0 ksi at release and 8.0 ksi at post-tensioning. The closure concrete (between girder segments) had a specified minimum compressive strength of 6.0 ksi at the time of post-tensioning.

Architecture

The bridge is set in a small town with an historic United States Naval shipyard. The look of the new bridge was driven by architectural details provided after lengthy public input. The main architectural feature is the parabolically haunched girders that make up the bridge superstructure.

Other details include compass rose motifs on the piers, which reference seafaring navigation. The deep green colored railing is chosen to recall the old replaced steel truss. The columns are classic forms rising outboard of the superstructure to embrace pedestrian overlooks. Girder closures are highly detailed with nautical themes and traditional looking brackets.

Bridge aesthetics were important for this bridge because the surrounding neighborhood had a strong sense that the existing bridge defined their community. They were adamant they did not want a typical highway bridge and strongly resisted chorded haunches like a nearby bridge. The budget for the replacement bridge did not allow for a truly signature bridge. The spliced, parabolically haunched precast concrete girders provided an aesthetically pleasing structure for a reasonable cost.

WSDOT practices the Federal Highway Administration's context-sensitive design process. In this project, the team took part in a collaborative, interdisciplinary approach that involved all stakeholders. In this approach, the community's desires are integrated early in the process leading to efficient project delivery.

Paul Kinderman is the state bridge and structures architect and Eric Ferluga is the senior bridge engineer, Washington State Department of Transportation in Olympia, Wash.

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