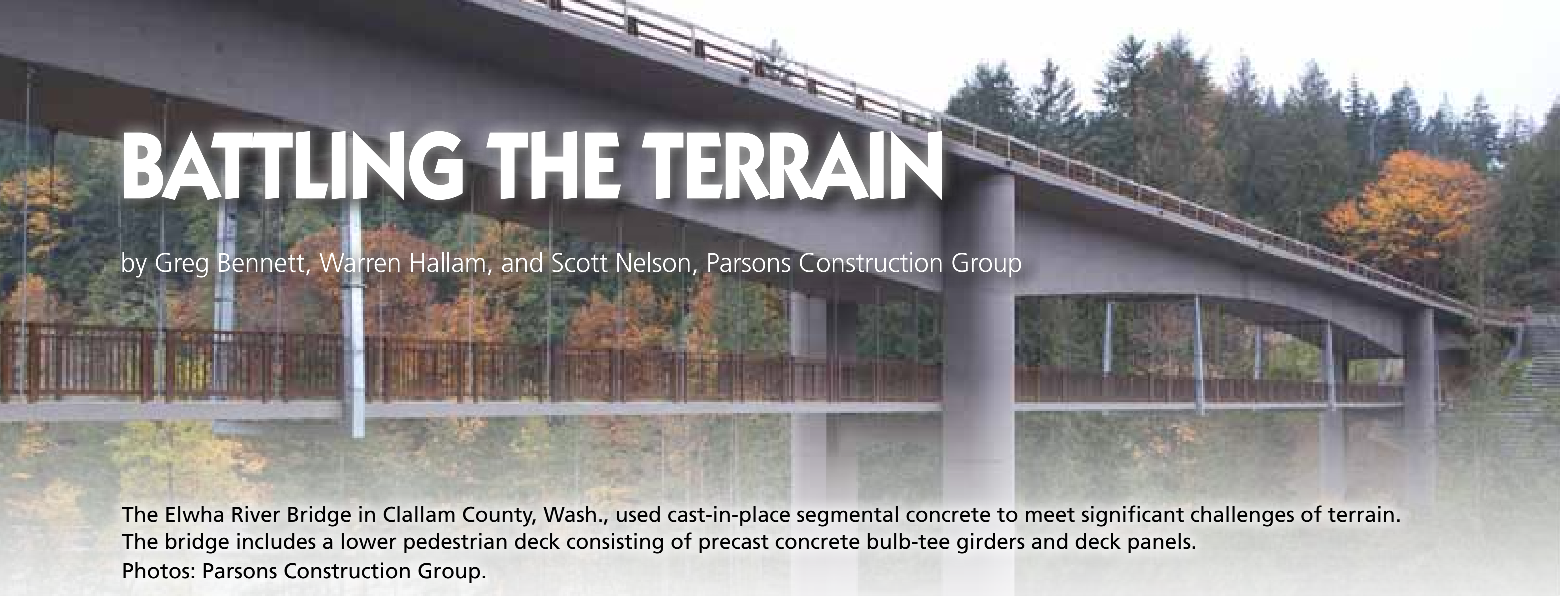
BATTLING THE TERRAIN

by Greg Bennett, Warren Hallam, and Scott Nelson, Parsons Construction Group



The Elwha River Bridge in Clallam County, Wash., used cast-in-place segmental concrete to meet significant challenges of terrain. The bridge includes a lower pedestrian deck consisting of precast concrete bulb-tee girders and deck panels. Photos: Parsons Construction Group.

Constructing the new Elwha River Bridge in Washington State required confronting steep, rocky banks, as well as flooding and environmental restraints

Replacing the deteriorated Elwha River Bridge in Clallam County, Wash., with a new segmental cast-in-place concrete design gave rise to a variety of challenges to ensure the project balanced the needs of the local community, historic-preservation groups, and the tribal jurisdictions. Foremost was the need to overcome severe terrain and other natural obstacles. Another constraint included suspending a pedestrian deck beneath the superstructure. These site-specific challenges required a tremendous effort even before construction of the bridge could be addressed.

The $19.7-million structure replaced a 1914 steel-truss bridge closed to traffic in 2007 because of advanced deterioration. Listed on the National Register of Historic Places, the one-lane Elwha River structure had been downgraded to load-restricted after serious structural deficiencies were found in 1992. In 2003, the county hired BergerABAM Engineers to begin the design process. Bids submitted exceeded the original budget and an innovative combination of funding sources was needed before construction could proceed.

Design of the replacement bridge included a main vehicular structure and a separate pedestrian and bicycle deck. The main structure is 589 ft long and features cast-in-place concrete box girders built using the balanced cantilever and cast-on-falsework construction methods. The cantilever technique minimized disturbances to sensitive environmental areas along the river.

Access Proved Difficult

The terrain surrounding the remote site posed considerable challenges. Access to Pier 3 on the east bank required construction of a 2-mile-long access road that utilized an old railroad right-of-way. Access to Pier 2 on the west bank proved to be one of the most difficult aspects of the project. Situated on a rocky knoll approximately 50 vertical ft down a steep embankment from the existing west abutment, it was bounded to the north and east by vertical drop-offs and to the south by an existing crib wall of unknown stability that retained a previous landslide area.

Contract documents were silent about access means. As a result, Parsons had to design-build a ramp and work pad. Environmental constraints prohibited blasting, so specialized rock-grinding equipment was used in addition to conventional excavation methods. A provision to facilitate continuous access required a split-ramp design.

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profile

ELWHA RIVER BRIDGE / CLALLAM COUNTY, WASHINGTON

DESIGN ENGINEER: BergerABAM Engineers, Seattle, Wash.

CONSTRUCTION ENGINEER: International Bridge Technologies, San Diego, Calif.

TRAVELER ENGINEER: John Parkin & Associates, Vancouver, Wash.

FASLEWORK ENGINEER: VAK Engineering, Beaverton, Ore.

PRIME CONTRACTOR: Parsons Construction Group, Sumner, Wash.

PRECASTER (PEDESTRIAN BRIDGE): Concrete Technology, Tacoma, Wash., a PCI-certified plant

The pedestrian bridge features 56 precast concrete deck segments below the main bridge and four deck bulb-tee approach girders along the river bank to transition to the Olympic Discovery Trail.

Substructure Design

With bridge demolition complete, work commenced on the substructure, which consisted of four piers. Piers 1 and 4 served as abutments and included pile caps supported by 4-ft-diameter drilled shafts ranging in depth from 21 ft to 35 ft. The Pier 4 cap was a stepped design to accommodate the sloping terrain. Piers 2 and 3 featured twin columns connected at mid-height by a stabilizing arch tie beam and supported below by 10-ft-diameter drilled shafts with depths of 59 ft and 80 ft, respectively.

A record-setting flood on December 3, 2007, briefly delayed the start of work at Pier 3. With the waters receded and cleanup complete, work proceeded with installing the drilled shafts. A 3-meter oscillator was used to drill at the interior piers and conventional drill rigs at Piers 1 and 4.

Construction of the above ground portion of the work began with the columns at Pier 3. They rose 70 ft from a base elevation near river level. Logistical concerns, along with splicing constraints for reinforcing steel, presented challenges during preplanning and construction stages. The steel cages were constructed full length (95 ft) on the ground and then placed via two-crane picks. A 100-kip shoring tower was placed between the columns to support the formwork and steel cages.

Superstructure Design

The superstructure comprises four main sections: Pier 1 segments, Pier 2 cantilevers, Pier 3 cantilevers, and six segments in Span 3 including Pier 4. The first and fourth sections were placed using the cast-on-falsework method. The two cantilever sections, other than the pier tables, were placed with a form traveler system.

Work on the superstructure began with the Pier 3 pier table. Steel forms were employed and placed on a work deck supported by 100-kip shoring towers. The pier tables were designed and built one-half segment out of balance to accommodate the subsequent traveler construction sequence. Overall dimensions are 30 ft 8 in. long and 31 ft 4 in. wide at the bridge deck with a depth of 15 ft at the centerline.

The pairs of cantilevers from Piers 2 and 3 include 15 segments each and extend 127 ft 6 in. from each of the piers. Typical segments were 14 ft 8 in. long. A final half-length segment included in each provides balance prior to placement of closure segments. Initial launches were difficult due to interference between the traveler system and external columns alongside the box's exterior.

At the same time, crews were working on the 78-ft-long cast-on-falsework section of Span 3. Initial plans called for placement of six separate segments. To simplify the work, site management opted to cast the entire span in three placements. The first closure segment was placed to connect Pier 3 cantilever and the cast-on-falsework section of Span 3. The two sides were aligned using a combination of the traveler system and steel beams set over the web walls and locked in place.

When it was no longer possible to pump concrete to the eastern heading of the Pier 2 cantilever from the excavated laydown area, Parsons worked with the design and construction engineers for approval to place the pump and concrete trucks near the end of the completed Pier 3 cantilever and reach across with the concrete pump boom.

Another challenge came with the superelevated, 185-ft-radius horizontal curve on the west end of the cantilever. A tight radius by form-traveler standards, it required altering the rear tie-down method and modifying the typical sleeve pattern for the connection rods.

Pedestrian Bridge Added

With the superstructure substantially complete, work began on the pedestrian bridge, which serves as the Elwha River's crossing for the Olympic Discovery Trail. The bridge is divided into two sections.

CAST-IN-PLACE CONCRETE BOX GIRDER BRIDGE WITH A SUSPENDED PEDESTRIAN BRIDGE THAT USED PRECAST FLAT PANELS AND PRECAST CONCRETE BULB-TEE GIRDER APPROACHES / CLALLAM COUNTY, WASH., OWNER

CONCRETE SUPPLIER: Fred Hill Materials, Sequim, Wash.

BRIDGE DESCRIPTION: Cast-in-place concrete box-girder bridge built using the balanced cantilever and cast-on-falsework methods, consisting of three spans: 133 ft, 255 ft, and 201 ft

POST-TENSIONING MATERIALS SUPPLIER: Dywidag Systems Inc., Long Beach, Calif.

BRIDGE CONSTRUCTION COST: $16.4 million

Cast-in-place concrete for the Pier 2 cantilever was pumped from the Pier 3 cantilever.

Throughout the work, safety was a key focus.

Section A consists of precast concrete panels suspended from the main superstructure where it spans the river. Section B, which runs perpendicular to the main structure, consists of four precast concrete deck bulb-tee girders on each side supported by drilled shafts, pile caps, and columns.

Section A comprises 56 precast concrete deck panels 8 ft long, 15 ft wide, and 10 in. deep connected to the main soffit above with steel rods and intermediate brace frames. The original joint design included 16 grout-injected reinforcement bar couplers at each panel. Concerns regarding constructability and schedule prompted Parsons to work with the design engineer to develop an alternative design using mechanical couplers to cut the number in half. Four intermediate brace frames consisting of 14 in. by 14 in. steel tube sections provide additional lateral support.

To place the precast segments, Parsons used an erection buggy. The top section included transverse steel beams supported by truck dollies and extending just beyond the width of the deck. The bottom section was a steel-beam-cradle assembly that carried a single precast panel. The two sections were connected via vertical steel cables, with hydraulic drums used to raise and lower the cradle. Once in place, crews positioned on the previously set panel made the joint connection with reinforcement couplers and welded tabs. A two-man crew in a 125-ft extension manlift made the clevis-pin connection at the bridge soffit.

Throughout the work, safety was a key focus, owing to the complexity of the project and the number of new and unknown factors involved. The construction team prided itself on its consistent reinforcement of a culture of safety, including emphasizing the need to plan each day's activities and identify specific hazards. This was an exceptional feat for a crew that began the project unfamiliar with balanced-cantilever procedures.

The efforts paid off with an attractive and efficient bridge that provides safe passage for hikers and a long-lasting structure for vehicles. The official opening took place on September 25, 2009, and nearly 200 spectators participated in the ceremonies. Among the event's highlights was a blessing from the Lower Elwha Clallam tribal leaders before the first cars crossed the river.

Greg Bennett and Warren Hallam are senior construction managers, and Scott Nelson is senior project engineer with Parsons Construction Group in Sumner, Wash.

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After the Pier 3 cantilevers were complete, cranes were used to break the form travelers into 21 segments, which were transported across the river and reassembled so the segments for Pier 2 could be constructed.