STATE

Concrete Bridges in

Washington State

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The Selah Creek Fred G. Redmond Bridges on I-82 near Yakima opened in 1971.

Concrete is the material of choice for the majority of bridges in the State of Washington. Approximately 2600 out of 3000 bridges maintained by the Washington State Department of Transportation (WSDOT) have a main span type that consists of concrete. The oldest of these bridges dates back to the early 1900s.

The first known use of a precast, prestressed concrete girder bridge in Washington was in 1954 for a bridge over the Klickitat River on State Route 142. The center span of this three-span bridge is 90 ft and consists of four precast segments about 22 ft in length that were supported on falsework in place and then post-tensioned together. The contractor chose to install the girder in units, based on the lifting capacity of his crane. Technology and equipment have advanced since then to allow current bridges with spliced girders to have lengths in excess of 200 ft.

There are two major statewide transportation improvement programs underway. The first, known as the "Nickel" funding package, began in 2003 with a total budget of $3.9 billion to address primarily congestion and safety on 158 projects. The second, known as the "Transportation Partnership Account" began in 2005 with a total budget of $7.1 billion to address preservation and mobility on 274 projects. Concrete bridges will play a big part in these new programs.

Selah Creek Arches

The twin Selah Creek Fred G. Redmond Bridges on I-82 provide a connection south from Ellensburg to Yakima. They were the largest arch span bridges in the United States at 549.5 ft when they opened to traffic in 1971. The top of the arch span is 325 ft above the canyon and required falsework to be built from the valley below. The superstructure on each bridge consists of 17 spans of prestressed concrete girders that are 78.5 ft long. These two bridges are examples of the use of concrete for nearly 780 interstate bridges built between 1955 and 1975 that are now 30 to over 50 years old.

South 317th St HOV Access

In 2006, a bridge was opened over I-5 near Federal Way to provide direct access for buses and high occupancy vehicles from I-5. Bridge engineers decided to use precast, prestressed concrete trapezoidal tub girders 5 ft wide and 6 ft deep that were spliced together with post-tensioning. The bridge span is curved at the intersection with the access ramps to accommodate turning buses. The structure is 128 ft long with four spliced precast, trapezoidal tub girders, each consisting of 35-ft- and 88-ft-long segments. The segments were temporarily supported on falsework and then post-tensioned together. The bridge has 50-ft radius curves connecting to the ramp side. Curved edge beams frame into the diaphragm at a splice location and are supported on an abutment wall at the pier. This configuration of straight precast girders with curved edge beams is typically achieved with cast-in-place box girders. Trapezoidal girders were added to the WSDOT standards in 2004.

Precast trapezoidal tub girder.

The Methow River Bridge uses WSDOT's "Super Girder."

These girders have span lengths up to 140 ft, are considered for special bridge projects that need a low profile, and have been used in nine WSDOT bridges to date.

Transporting WSDOT's "Super Girder.

Methow River

The Methow River Bridge on State Route 20 in Okanogan County replaced a seven-span concrete T-beam bridge built in 1931. The old bridge had span lengths of 53 ft with several piers in the river. The new bridge, completed in September 2003, has two 180.5-ft-long spans that are 35 ft wide curb-to-curb with a total length of 360.8 ft. The bridge uses seven lines of 82.7-in.-deep precast, prestressed concrete WSDOT W83G "Super Girders" on 6.1 ft centers supporting a 7.9-in.-thick cast-in-place concrete deck. WSDOT introduced these deeper girders, commonly called "Super Girders" in 1999. The Methow River Bridge was their first application. There are three sizes of these girders designated WF74G, W83G, and W95G with the number equating to the approximate girder depth in inches. These "Super Girders" are capable of achieving span lengths up to 185 ft, based on a 200,000 lb weight limit for transporting the girders to the construction site. To date, WSDOT has used the W83G girders for eight bridges with the longest girder length being 180.75 ft.

The length and weight of the girders installed at Methow River required special planning for the 250-mile trip from the precasting plant in Tacoma. This trip took 9 to 13 hours. The introduction of new high performance concrete (HPC) mix designs allowed WSDOT bridge designers to develop these new "Super Girder" sizes. The Methow River girders used a specified 28-day concrete compressive strength of 10,000 psi with actual strengths ranging from 10,600 psi to 15,200 psi. The concrete mix proportions included 752 pcy of Type III cement and 50 pcy of silica fume, placed with a water-cementitious materials ratio of 0.27.

The SR 502 bridge over I-5 near Vancouver uses W83Gs with a girder length of 176 ft.

Twisp River

The Twisp River Bridge is also on State Route 20 less than 1 mile from the Methow River Bridge and is located in the town of Twisp. The new bridge was completed in 2001 and replaced a four-span, cast-in-place concrete T-beam bridge built in 1935. The Twisp and Methow Rivers are home to several endangered fish species. Environmental permit conditions limited the amount of time for construction below the normal high water mark during the months of July and August. WSDOT bridge engineers decided to use a new precast, prestressed concrete W95PTMG single-span girder that would be fabricated and delivered in three units, erected on temporary falsework bents, and post-tensioned together once the deck was placed. The span length is 197 ft and the girders are 7.9 ft deep. The girders used HPC with a 28-day compressive strength of 8000 psi. All post-tensioned anchorages were placed in a cast-in-place concrete end diaphragm. At the time, this was the longest precast, spliced concrete girder in WSDOT's inventory. This type of "Super Girder" was developed in 1996 through a joint effort between WSDOT and the Washington state precast, prestressed concrete industry.


Hood Canal floating bridge.


The Twisp River Bridge spliced "Super Girder."

Hood Canal Floating Bridge

The Hood Canal Bridge is the longest concrete floating bridge in the world over a saltwater tidal basin. The basin is up to 340 ft deep with a maximum tidal swing of 16.5 ft. On average, 15,000 cars per day use this bridge, which provides a vital link to the northern part of the Olympic Peninsula. The bridge was originally built in 1961. The west half sunk during a storm in 1979 and was replaced in 1982. WSDOT is currently in the middle of a $478 million rehabilitation project to replace the east half floating section along with both approaches, install new concrete floating anchors, and widen the west half superstructure. The project began in 2003 and is now about 73% complete. Further details of the bridge are provided in the article beginning on Page 16.

WSDOT also owns and maintains three other concrete floating bridges, the Evergreen Point Bridge on State Route 520, which is the world's longest, and the Homer Hadley and Lacey V. Murrow Bridges on I-90.

PGSuper™ Computer Program

WSDOT has developed an in-house computer program for engineers to design precast, prestressed concrete girders. It is available through a free download. (See Concrete Connections on Page 44 for details.) PGSuper is our precast, prestressed concrete girder design and analysis software. It can be used to design and to check designs in accordance with the AASHTO LRFD Bridge Design Specification and WSDOT criteria. The flexural design feature computes the number and configuration of prestressing strands and the minimum required concrete release strength. The shear design feature determines the number, size, and spacing of transverse reinforcement for vertical shear, horizontal shear, bursting, and strand confinement. Specification checking evaluates girders for compliance with strength, serviceability, and detailing criteria. Girders are evaluated for stresses and stability during handling and transportation. Temporary prestressing to control camber, improve stability, and reduce concrete release strengths may also be input. The program has been designed to allow for future expansion and updating as design criteria and user expectations change.

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For more information on Washington State bridges, visit www.wsdot.wa.gov/eesc/bridge.


Prestress girders rolled into position on the Hood Canal Bridge approaches.

American Coal Ash Association

The Romans used volcanic ash to build structures that we admire over 2000 years later. Engineers today can achieve the same high-strength endurance using coal combustion products (CCPs)—materials produced when we burn coal to generate electricity.

Though the material properties vary according to coal composition and power plant operating conditions, experts can advise on quality and determine the best mix design for almost any condition and project. Mix designs exceeding 40% fly ash have proven successful in many projects. Experts with first-hand experience may be located by contacting the American Coal Ash Association, an industry association devoted to educating designers, engineers, concrete professionals, regulatory officials, and others about CCPs' technical, environmental, and commercial advantages.

Fly ash concrete has been specified because of its high strength and durability for the John James Audubon Bridge near Baton Rouge, La. When complete, it will be longest cable-stayed bridge in North America.

The California Department of Transportation (Caltrans), a leader in fly ash concrete projects, required high volume fly ash mixes for the largest bridge project in its history—the San Francisco-Oakland Bay Bridge. Using innovative specifications and blending techniques, Caltrans was able to improve the workability, hardening, and permeability properties of the bridge's concrete. A number of engineering standards and specifications define CCP applications, thus ensuring high quality performance and products.

In addition to a myriad of core performance attributes in construction and industry, CCPs use can conserve natural resources, reduce greenhouse gas emissions, and eliminate the need for additional landfill space. For more information, contact ACAA at info@acaa-usa.org or call 720-870-7897.