Willamette River Bridge
Spanning Willamette River on Oswego Highway 3
Oregon City
Clackamas County
Oregon

HAER OR-31

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Historic American Engineering Record
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HISTORIC AMERICAN ENGINEERING RECORD

WILLAMETTE RIVER BRIDGE
HAER OR-31

Location:	Spanning Willamette River on the Oswego Highway, Oregon City, Clackamas County, Oregon UTM: Oregon City, Oregon Quad. 10/308207/5022720
Date of Construction:	1922
Structural Type:	Steel through arch encased in gunite
Engineer:	Conde B. McCullough, Oregon State Highway Department R.A. Furrow and C.P. Richards, Resident Engineers
Builder:	A. Guthrie & Co., Inc., Portland, Oregon
Owner:	Oregon Department of Transportation
Use:	Vehicular and pedestrian bridge
Significance:	The Willamette River Bridge (commonly called the Oregon City Arch Bridge) is 745' long with a 360-foot steel through arch of box-girder construction, encased in gunite. The gunite encasement was necessary to prevent corrosion from sulphur dioxide fumes from the paper mills south of the bridge. This is the only gunite-covered bridge in Oregon. The 1921-1922 Biennial Report of the Oregon State Highway Commission praised this bridge as being "the most artistic appearing large bridge in the State."
Project Information:	Documentation of the Willamette River Bridge is part of the Oregon Historic Bridge Recording Project, conducted during the summer of 1990 under the co-sponsorship of HABS/HAER and the Oregon Department of Transportation. Researched and written by Kenneth J. Guzowski, HAER Historian, 1990. Edited and transmitted by Lola Bennett, HAER Historian, 1992.
Related Documentation:	For more information on Conde B. McCullough, see HAER OR-54.

HISTORY

Oregon City was laid out and named in 1842 by Dr. John McLoughlin, of the Hudson Bay Company. Here he established his donation land claim in 1829. Prior to 1842 this area was referred to as Willamette Falls. The city grew as a political and trade center and the first paper mill was constructed on the banks of the river in 1867.[1]

West Linn is the successor to Linn City, which was established as Robins Nest by Robert Moore, a pioneer of 1840. Moore was prominent in organizing the provisional government of the state. In 1844 the legislature authorized him to operate a ferry between Oregon City and Robins Nest. In 1845 the legislature named the locality Linn City, for U.S. Senator Lewis F. Linn of Missouri.

Early on, local pioneers established transportation between these two communities. An expensive toll ferry operated until 1889. The first bridge to span this section of the Willamette River was constructed in 1887-1888. Population and industrial growth in the area mandated this construction. A suspension bridge was chosen because the depth of the Willamette River at this narrow crossing prohibited pier construction and a system of elaborate false work. At this site the river flows in a 100-foot channel and is bounded by high basaltic cliffs. The suspension bridge, with wooden support towers for the cables, was the primary crossing until 1922 when it was replaced by the Willamette River Bridge. The completed suspension bridge was considered a masterpiece in engineering and was the first true suspension bridge west of the Rocky Mountains.[2]

The 1913 Oregon laws creating the State Highway Department encouraged county courts to secure plans, specifications, and supervision for bridge construction from the State Bridge Department. During the 1918-1919 biennium, plans were developed for a new bridge that would replace the old suspension span. Increase in traffic by freight trucks and passenger vehicles made replacement a necessity.

The year 1917 began with a $6 million highway bond issue, plus other material financial assets. Labor restrictions had loosened up thanks to returning soldiers and building materials were more available. With these advantages the State Highway Commission began extending its road lines at a more rapid pace. At the same time, the Federal Aid Road Act of 1916 was coming into use. The number of motor vehicles in the state had increased from 11,857 to 48,632, and the demand for roads over which to operate them had become so great that a bond issue was authorized. The bond issue was ratified by popular vote.[3] The two-year stretch between November 30, 1918 and November 30, 1920 saw the highway commission flush both with money and motivation. In 1919 the legislature became even more generous than it had been in 1917 and increased the highway bonds by an additional $10 million. Additional revenue was appropriated by the imposition of a tax of one cent per gallon on all gasoline used in motor vehicles. Oregon became the first state to adopt the gasoline tax as a source of income for road building.

Federal aid for state highway construction became an important factor for many states, including Oregon. The total federal appropriations between 1916 and 1925 amounted to $540,000,000 for post roads and $47,000,000 for forest roads. Oregon received 1.5 percent of the post road funds and 9.7 percent of the forest road funds. With the passage of the 1921 appropriation came the plan for a connected system of roads for the whole nation, which became known as the "7-Percent System."

Concrete bridges on the main highways were designed for 20-ton truck limits. There were 318 bridges constructed in the 1921-1922 biennium, at a cost of $2,500,000. One aspect of the bridge work handled by the State Highway Commission was the furnishing of designs and the supervising of construction for bridges on county roads. This service was furnished to the counties without charge in compliance with a state law directing the Highway Commission to prepare designs for county bridges upon the request of County Courts. Altogether 169 drawings were prepared during 1921 and 1922 for structures having spans in excess of 20'. Drawings and specifications were also prepared for seventy-four structures with spans less than 20'.[4] The bridge department designed, planned and prepared specifications; supervised construction; checked final and monthly estimates; and attended to all other work pertaining to bridges. The department consisted of a general bridge office, a drafting office and a staff of field engineers and assistants.[5]

During the period 1921-1922 the routing of state highways through cities and towns was given considerable thought and study by the Highway Commission. The Commission chose the most direct routes, eliminating right-angle turns wherever possible and avoiding congested business districts. Additional considerations were given to the establishment of parks and camping sites. The Market Road Act provided large sums of money for the construction and improvement of secondary roads. During the 1920s federal aid for highways bacame a well-established governmental policy.[6]

DESIGN AND CONSTRUCTION

State Bridge Engineer Conde B. McCullough considered seven types of bridge designs for this location. A souvenir booklet explains some of the considerations for the chosen bridge design:

> A reinforced concrete arch would have met this condition better than any other, but had to be rejected because the depth of the channel and the navigation requirements precluded the use of falsework of the ordinary type, and suspended falsework proved too costly. A steel bridge, whether it be of the suspension, cantilever, simple truss or framed arch type, must be protected from atmospheric corrosion to be classed as truly permanent. Protection by paint is, at best, only temporary and involves heavy maintenance cost.[7]

The Willamette River Bridge is located downstream from the Oregon City and West Linn pulp and paper mills. As of 1922, the atmosphere was polluted with sulphurous anhydride (S02) emissions. McCullough realized that this atmosphere would be corrosive to a steel bridge and cause increased maintenance requirements, making an unprotected steel structure impractical for the location.

Two years of bridge study preceded the final design. A suspension span was dismissed because it was not rigid enough for the heavy truck traffic and the unprotected steel cables were subject to atmospheric corrosion. Cantilever, simple truss, and spandrel braced framed arch spans were considered unsuitable because of the prohibitive cost of devising a protective covering. The reinforced concrete arch had to be abandoned as a possibility cost of devising a protective covering. The reinforced concrete arch had to be abandoned as a possibility because the false work for such a structure would have blocked this heavily-used navigational channel. A steel arch rib with poured concrete encasement was abandoned after considerable thought because the concrete had to be poured in sections and allowed to set before positioning, therefore increasing the time in construction considerably.

The decision to use the steel rib arch with gunite encasement was the most advantageous solution because the old suspension bridge anchors, towers and main cables could be utilized for the erection of the massive steel arches.[8] The steel half-through arch design was deemed the most suitable for the site. The steel ribs of hollow box-girder construction encased in gunite allowed a considerable savings in material and simplified problems relating to the erection of the structure. Gunite is a mixture of sand and cement shot dry through a hose by compressed air, with water added at the nozzle. Once dry, gunite makes a dense, impervious concrete.

The erection schedule was worked out by the firm of Gerrick and Gerrick, of Seattle, Washington. Contract No. 414 was awarded to A. Guthrie and Company, Inc. of Portland, Oregon and St. Paul, Minnesota on June 29, 1921. The cost of construction was shared by the state, Clackamas county, and the cities of Oregon City and West Linn, with the state and county furnishing the bulk of the financing. McCullough explained that "the credit for the admirable solution of the many erection problems encountered is due to the excellent engineering staff maintained by the contractors' and sub-contractors' organizations, to A. Munster, their consulting engineer, and to R.A. Furrow and C.P. Richards, who were in charge of the construction work for the Oregon State Highway Dept."[9] Work began on the lower elevations immediately to take advantage of the low water period of the summer.

The Oregon bridge log of 1922 describes the bridge from west to east. The Willamette River Bridge has six 35-foot reinforced concrete deck girder spans, one 360-foot steel through arch, one 70-foot I-beam span, three 35-foot reinforced concrete deck girder spans, 85-foot retaining walls, 5'-8" sidewalks, with a concrete deck and wearing surface of 415 tons. Horizontal clearance is 17'-5" with a vertical clearance of 15'.

The arch ribs are closed box-girder sections braced at frequent intervals by radial diaphragms. Manhole openings are located in the rib sections at the crown and lower diaphragms, for ease of access for maintenance inspections. Each rib contains eighteen segments and the suspension cables of the old bridge were used to support the arch rib segments until all were erected and self-supporting. The last service of the old bridge was to assist its more massive and permanent successor into being.[10]

The arches were erected as three-hinged arch with the hinges placed after erection by through splices. The steel arches are clad with a layer of gunite, 1½" thick, which hides the riveting and bolting above the deck. The exterior of the steel frame was covered with a network of ⅜-inch round rods spaced 12" center-to-center both ways, and spot welded to each other and to the structural steel work at each intersection. This system provided anchorage for a layer of wire mesh that was laid over the entire surface and welded electrically. The floor beams and stringers are covered in the same way. The hangers, spandrel columns, and other minor parts are poured concrete. The ribs were fixed at crown and skewback, thereafter acting under live-load and the balance of the dead-load as fixed arch ribs. Below the deck the ribs are braced at each panel point by means of steel trusses that run the full depth of the rib. The individual truss members were encased in gunite and the entire system was converted into a solid girder by means of a gunite diaphragm shot against a temporary backwall. The gunite encasement was applied in two layers, the final layer being ¼" thick and applied to finish and smooth the surface. Between the years 1924-1932 cracks developed in the surface layer of gunite, but did not penetrate to the more substantial layer beneath.[11]

Three types of concrete finish appear on the exposed faces of this bridge. The gunite surfaces were screed to a true plane and finished by stippling with a brush. Concrete surfaces were rubbed smooth with carborundum stones after a sprinkling with water. A lather was worked up and brushed over to set up a smooth and even texture that is pale gray in color. All recessed panels are pebble-dashed, a masonry finishing process that chips the surface of the concrete exposing the pebble aggregate, giving a rough finish which contrasts aesthetically with the smooth and lighter portions of the bridge.

The foundations of the two main piers were constructed on solid basaltic rock. The east abutment was above water and the west was submerged in 8 feet of still water. The west abutment was concreted in the dry through the unwatering of a double wall puddle cofferdam. Core drillings were taken to a depth of 25' to 35' below the surface to disclose the presence of any seams or pockets in the foundation material. The drillings showed a uniform and continuous core. The base rock was blasted and 2 feet of rubble was removed to roughen the surface and remove any shattered or slightly seamed surface material before pouring the concrete abutments.[12]

The reinforced concrete piers are monolithic and battered ¼" per foot of height. They were constructed after the arch ribs were built and rest on the arch abutments. There are pebble-dashed panels recessed 2½" on all four sides of each pier. The piers terminate in a series of four horizontal bands of varying width. The railing detail is not executed in the tip band, but is articulated as a solid concrete parapet. The corners of the piers feature obelisk-shaped pylons, accentuating the verticality of the bridge. On the east and west sides of the piers cast concrete balconies remain below the deck, but construction drawings indicate that they were never accessible to the public. Windows are located in the north and south elevations of the piers.

The bridge railings have precast balustrades which take the form of squared, truncated columns with base and capital, forming a small arch between each balustrade. Approximately twenty-two balustrades lie between each post. Expansion joints were provided at the junction of rail and post, as well as at the curtain wall and spandrel columns. Concrete parapet caps appear to have been cast in place. The balustrades flair open on the west end of the bridge. Two obelisk pylons are mounted on pedestals at this end of the bridge, where the road deck begins. Historic photographs reveal that there were glass lanterns suspended from all twelve of the obelisk pylons, which are now removed. The Oregon City entrance does not flair but contains a pair of obelisk pylons mounted on pedestals ornamented with rectangular bush-hammered recesses.

An interesting feature of the bridge is that both piers were designed to accomodate elaborate public restroom facilities. The deck widens at the piers to make room for the stairways that descend to the restrooms. The bridge's location on a major tourist thoroughfare indicated the need for such accomodations. Unfortunately, due to vandalism, the restrooms have been closed to the public since 1937.

The road deck of the bridge is of steel I-beam construction with a 6-inch concrete slab, over which is laid 2" of paving. Twenty-six inches of the beam ends are encased with 11" of gunite 29" to the face of the curtain wall. The curbs are 4-inch slabs, while the base of the balustrades are hollow concrete tile laid end to end. The crown in roadway was originally 1½". Decorative brackets support the road deck. There are paired brackets above each spandrel column, with two brackets mounted on the curtain wall spans. The approaches to the main span are reinforced concrete beam and slab spans carried on tapered reinforced concrete columns which are on 35-foot centers. These compression spandrels below deck are cast with rectangular capitals at the point where curtain wall joins the columns. The curtain walls have two triangular panels and a central rectangular panel, all finished in pebble-dashed concrete.

The bridge dedication was held December 28, 1922 and ranks as the most elaborate of such ceremony ever held in Oregon. An estimated 10,000 people turned out for the dedication, including local and state dignitaries. A "wedding ceremony" was performed on the bridge to symbolize the uniting of West Linn and Oregon City. There were speeches and a parade as well as a band concert and two public dances after the crowning of Queen Harriet, on the Oregon City Court House steps. State Bridge Engineer Conde B. McCullough attended the dedication ceremonies.

REPAIR AND MAINTENANCE

Maintenance records for the Willamette River Bridge are extensive and pertain to the painting of the interiors of the main arches, as well as repairs to the manholes, diaphragms and comfort stations. In 1932 the electrical wiring was corroded and deemed unsafe so it was redone in its entirety, and new lighting fixtures were installed. In 1930 the bondex (a waterproof cement paint coming in numerous pastel colors) was chipping away, so the the bridge was sandblasted and repainted. As early as 1930 boys were climbing on the arch rings, thinking it was fun to sit at the crown of the arch. State Bridge Engineer Conde McCullough informed market road engineer, J.H. Scott that he should have "the police clamp down to scare a few of them." This apparently worked until the 1950s when the police had to clamp down again. Records indicate that the rivets were loose in the arches, which caused the gunite to crack and allow water penetration, resulting in corrosion to the steel arches.

In 1937 it was necessary to alter the east approach span to accommodate the routing of Highway 99E. After the viaduct was completed on the north side of the bridge, which raised the roadbed considerably, bent #4 was removed to allow for a greater clear span beneath this section of the bridge. After the removal of the bent, the curtain wall was squared up and four steel I-beams were installed to accommodate the span increase. The original spans of 35' and 45' were merged to create one 80-foot span. These beams are not covered with concrete.

In 1953 State Highway Engineer R.H. Baldock responded to the debate about building another parallel bridge at the site, which would carry one way traffic on each structure. He wrote:

> There is considerable congestion on the existing bridge, but this has been due, in the main, to the failure of city officials of Oregon City to adopt a recommended plan, including signalization, no parking limitations, and left-turn prohibitions. It is my recommendation that consideration for construction of a new bridge be deferred until the plan recommended has been tried out. I am satisfied that adoption of this plan would defer the necessity of constructing a new bridge for several years, as the traffic on the existing bridge is only 9,000 vehicles, which the bridge will adequately handle if proper provisions are made to accelerate the discharge at the bridge head in Oregon City.[13]

In the 1960s there was little maintenance performed on the bridge, other than minor repairs to the gunite. In 1970 maintenance records explain that the "bridge is very old and narrow so the value of extensive repairs is questionable." The opening of the I-205 bridge in the mid-1970s alleviated a good deal of the traffic on the Willamette River Bridge. During this period the bridge was cleaned, with attention placed on concrete repairs. The bridge was designed to carry a water line and telephone line concealed beneath the deck of the bridge. In 1985 it was proposed that an 18 inch sewer line be installed across the span. The Environmental Protection Agency objected to this alteration, as well as a proposed gas line. The bridge is now 68 years old and retains much of its original integrity. It is technologically significant as the only gunite bridge in Oregon.

Bridge Engineer Conde B. McCullough was extremely proud of this bridge. A November 23, 1922 letter from McCullough to Portland banker, J.C. Ainsworth, revealed his feelings: "I am pleased to send you under separate cover a group of photographs illustrating the work which has been done in Oregon and which believe, is not surpassed for quality by any bridge work in the United States." McCullough enclosed a marked copy of the Engineering News-Record containing an editorial on the bridge. He explained to Ainsworth: "I wish to call your attention to this editorial comment of which I am foolishly proud. I also want to state that I consider the erection of an arch as long as this without falsework, an engineering problem ten to one more difficult than any problem presented by the Portland bridges." This bridge was constructed to last for many years with excellent materials and craftsmanship. It was molded on bold, artistic lines, and fits well the beauty of the natural setting in which it lies. The total cost of the bridge was estimated at $270,000 with the state paying $70,000 and the county paying $200,000. According to the OSHC, Fifth Biennial Report, 1921-22, "It [Oregon City Bridge] is probably the most artistic appearing large bridge in the State." Pedestrians crossing the bridge can enjoy exceptional views up and down the river.

ENDNOTES

1. Lewis McArthur, Oregon Geographic Names, Fifth edition (Portland: Western Imprints, Oregon Historical Society Press, 1982), p.563.

2. "Oregon City Bridges Over the Willamette River," Willamette River Bridge File, CLAC-ARCH-312-1-22#357, Oregon Department of Transportation, p.1.

3. "Beginning with the Oregon Trail," Pacific Builder & Engineer, no. 83, 7 October 1977, p.71.

4. Oregon State Highway Commission, Fifth Biennial Report, 1921-1922, p.60.

5. Ibid., p.77.

6. Ibid., pp.18-23.

7. Carl Price Richards, "Design and Construction of the Bridges," Souvenir Program: Oregon City-West Linn Bridge, 12 September 1982.

8. C.B. McCullough, "Large Steel Arch Bridge Ribs Encased in Gunite," Engineering News-Record, no. 89, 2 November 1922, p.733.

9. C.B. McCullough, "Old Suspension Bridge Used in Erecting New Arch," Engineering News-Record, no. 89, 2 November 1922, p.733.

10. Eric Goranson, "City Span Made History In Its Time," Oregon Journal, 16 August 1966.

11. Oregon Department of Transportation, "Willamette River Bridge, File #357," Bridge Section Maintenance Files.

12. C.B. McCullough, "Old Suspension Bridge Used in Erecting New Arch," Engineering News-Record, no. 89, 2 November 1922, p.732.

13. R.H. Baldock, Letter to Oregon State Highway Commission, 23 April 1953, "Willamette River Bridge, File #357," Bridge Section Maintenance Files, Oregon Department of Transportation.

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