Latourell Creek Bridge
Spanning Latourell Creek on the Columbia River Highway
Latourell
Multnomah County
Oregon

HAER OR-24

HAER
ORE,
26-LATO,
1-

PHOTOGRAPHS
WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
U.S. Department of the Interior
Washington, DC 20013-7127

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

HAER OR-24

Latourell Creek Bridge
Spanning Latourell Creek on the Columbia River Highway
Latourell
Multnomah County
Oregon

Jet Lowe, Photographer, Summer 1990

OR-24-1	Perspective view from northeast
OR-24-2	View of roadway from west
OR-24-3	View of towers and main span from southeast
OR-24-4	View of main span from south
OR-24-5	Detail, underside of deck from eastern abutment
OR-24-6	Perspective view of reinforced concrete and formwork from eastern abutment

HAER
ORE,
26-LATO,
1-

HISTORIC AMERICAN ENGINEERING RECORD

LATOURELL CREEK BRIDGE
HAER OR-24

Location:	Spanning Latourell Creek on the Columbia River Highway, Latourell vicinity, Multnomah County, Oregon UTM: Bridal Veil, Oregon Quad. 10/561125/5042925
Date of Construction:	1914
Structural Type:	Reinforced-concrete braced-spandrel deck arch
Engineer:	Samuel C. Lancaster, Consulting Engineer/Assistant Highway Engineer K.P. Billner, Resident Designer
Builder:	Pacific Bridge Company, Portland, Oregon
Owner:	Oregon Department of Transportation
Use:	Vehicular and pedestrian bridge
Significance:	Latourell Creek Bridge is a three-span reinforced concrete braced-spandrel deck arch. The braced spandrel framing is usually found only in steel deck arch construction, and is unique to this structure. At the time of its construction it was one of the lightest concrete bridges, relative to its dimensions, in the country. This bridge established the essential form of the concrete arch that would be used in Oregon and other sections of the United States.
Project Information:	Documentation of the Latourell Creek 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:	See also HAER OR-56, Columbia River Highway Bridges.

HISTORY

The Columbia River has been an important transportation route ever since Captain Gray discovered it in 1792. Early pioneers arriving in the Oregon country transported their families and possessions down the river on barges supplied by the Hudson Bay Company. In 1856 the first wagon road, with 20 percent grades and switchbacks, was completed from Bonneville to the Cascade Locks. This treacherous route allowed for overland travel for the pioneers. The Oregon state legislature appropriated $50,000 for a wagon road from the mouth of the Columbia River to The Dalles in October, 1872. This road served its purpose well until completion of the Oregon Railway and Navigation Company line in 1882. Railroad construction destroyed parts of the 1872 wagon road making the railroad the primary means of transportation a long the Columbia River until the first decades of the twentieth century.

The Good Roads Movement in Oregon was supported by a constitutional amendment that granted the power to counties to issue bonds for the construction of permanent roads. Additional support followed for a unified highway system thanks to participation by some of Portland's business elite. Henry Wemme and Simon Benson crusaded for construction of a high class road along the banks of the Columbia River between the years 1910-1912.

With the arrival of Samual Hill to Oregon in 1907 the tide began to turn for the construction of the Columbia River Highway. Hill was an active proponent of the good roads movement in Washington state. After a great deal of promotion and politicking, and personal financial investment by Sam Hill, the Oregon legislature established the highway department and commission in 1913.

Upon Hill's recommendation, the State Highway Commission hired Major Henry Bowlby as the first State Highway Engineer. Samual Lancaster was appointed Assistant State Highway Engineer for Multnomah County, and Consulting Engineer for the Columbia River Highway. Both of these men had traveled with Sam Hill to Europe to study highway and bridge development there. Noted bridge engineer Charles H. Purcell was hired as a third member of Hill's hand-picked engineering team. K.P. Billner became Assistant Bridge Engineer to Charles Purcell. Lancaster was assigned the task of laying out the highway through Multnomah county to Hood River county. Portland millionaire John B. Yeon volunteered his services as roadmaster and supervised the construction and work crews.

Samual Lancaster, with bridge engineers C.H. Purcell, K.P. Billner and L.W. Metzger, worked out the designs for the numerous bridges along the Columbia River Highway. They designed each bridge to conform to the unique topography that existed at the construction sites. These structures were designed to be light, graceful and durable as well as innovative in their construction technique for the period. The following passage helps to illustrate Lancaster's devotion to his work on the Columbia River Highway. "Lancaster had a great and deep love for the beauty of the Cascades and the Columbia, and had a talent bordering on inspiration for solving difficult engineering problems.[1]

Latourell Creek Bridge is one of eight deck arches built on the Columbia River Highway between 1913 and 1921. This structure crosses the stream below Latourell Falls. Originally, visitors could view the falls from the bridge, but an overgrowth of vegetation presently obscures the view. Joseph Latourell was a prominent citizen in the area and the falls were named for him. "Rooster Rock post office was established in May, 1876. Joseph Latourell became postmaster in August, 1876 and the name was changed to Latourell Falls in August, 1887.[2] The bridge is now located in the 220-acre Guy W. Talbot State Park, which was given to the state of Oregon in early 1929 by the Talbot family.

This bridge was designed by K.P. Billner who was the "first American engineer to break entirely with tradition and treat the concrete arch as a distinct kind of structure comparable in its behavior to the elastic ribs of steel"[3] that had become popular in the late nineteenth century. Historian Carl Condit believes that the Oregon State Highway department played a leading role in the development of American concrete bridges, with their earliest contributions found on the Columbia River Highway.

DESIGN AND DESCRIPTION

The total length of the bridge is 316' and the width is 25', including the 17-foot roadway and two 3-foot cantilevered sidewalk. This is a three-span reinforced concrete braced-spandrel deck arch bridge, with three 80-foot parabolic rib arches and two girder approach spans that are 30' and 40'. The arches are open spandrel with vertical columns and diagonal members. Two 20-inch square arch ribs carry each span. They are reinforced by eight longitudinal 1-inch square bars and No. 0000 hooping, 18" in diameter, with a 2-inch pitch.

This rib reinforcing technique represents an early departure from Joseph Melan's outmoded technique of using parallel metal I-beams embedded in concrete.[4] At the turn of the century, the Melan system of reinforcing was popular for concrete arches, although the more efficient methods of bar reinforcing introduced by Ransone in 1889, were beginning to gain new attention. By 1910, the main line of evolution was moving away from massive construction, with its echoes of the masonry tradition, toward the flattened parabolic curves of narrow ribs, slender spandrel posts, and minimal piers that scientific reinforcing was to make possible.[5]

The deck load and superimposed load is carried to the arch rings on vertical columns placed at 10-foot centers. To insure against bending moments from partial loading in the arch ribs, diagonal members were erected between the junction points of the arch ribs and the vertical columns; and the deck and the columns. These diagonal members are subject to alternating compressive and tensile stresses. Special care was employed in the construction of the junction points. The reinforcing bars of the diagonals are hooked around the longitudinal reinforcement of the arch ribs and also around the longitudinal reinforcement of the girders which form the edges of the deck. Where it was impossible to hook the bars to one another as described, special dowels were inserted in the hooks. The joints received a rigid inspection during the erection of the bridge.[6]

The main piers are 97' high from stream bed to deck. The concrete above ground amounted to 560 cubic yards, making this one of the lightest concrete bridges, relative to its dimensions, in the country. If the traditional ideas of construction had been followed a bridge with the same strength would have contained 1,200 cu.yd. of concrete. Because of this innovation, there was a savings of $12,000 in concrete, with a moderate increase in the cost of false work.

A light bridge was important at this sight because of difficulty in securing a firm foundation. The underlying bedrock is covered with a layer of silt and boulders to an average depth of 25 feet on the western shore. On the east side of the creek, there is a deposit of drift sand 50 feet deep. At the east end, the bridge the bridge piers descend 56 feet into the ground.[7] The cost of building abutments and piers for a heavier type of bridge would have been considerable with these foundation conditions to contend with. Safety factors are as high on this bridge as any on the highway.[8] At each end of the bridge, there are two girders which carry a set of columns and struts which support the roadway. Precast concrete railings include balustrades with arched openings, caps and posts.[9] Curved brackets support the railing and impressions of the narrow lath false work that was used in forming them can be seen.

Latourell Creek Bridge is the only braced-spandrel concrete arch on the State Highway System. Its spare, clean and economical shape results in a lightness of structure akin to that found in steel. The braced-spandrel framing is usually found only in steel deck arch construction. The X-braced towers carry the comparison to steel even further.[10]

The west abutment and two central column bents are placed directly on bedrock. The east abutment rests on four columns, two 4' square, and two 5' square. The average depth of these columns is 45 feet from the underside of the abutment to rock. The tops of the five foot columns are connected to the bases of the 4-foot columns by inclined struts. The thrust from the arches is transmitted down to the rock foundation.

The false work was erected with a tower at each end of the bridge and an aerial cable-way stretched between. All of the forms were constructed and braced before the pouring of the concrete superstructure began. The main columns were poured in 8-foot sections and allowed to solidify for a few hours between the pourings. The arch ribs were poured simultaneously, starting at the spring line and moving towards the crown. The deck contains 250 cubic yards of concrete and was poured in a continuous operation lasting twenty hours. The men worked from 7 A.M. one day to 3 A.M. the next--only a few of them stopping at one time for food. The maximum settlement during the pouring of the arches was ⅜". The deck was poured after the arches had set for twelve days. No settlement took place while the deck was being poured or after. The false work was struck six weeks after the pouring of the arches.

Wind stresses on the deck and balustrades were taken care of by the rigid deck construction and transmitted to the large abutments. The wind stresses on the bowstrings, webbing and supports were taken up by diagonal counter braces. Tension stresses were provided for by the hooks on the steel bars which grip the rods of the connecting members. The concrete was not intended to take tension stresses. The heavyweight of the east abutment was calculated to give a horizontal reaction equal to the maximum thrust of the bow strings. Expansion joints were not installed because of the elastic, light, springy design and the heavy reinforcements. Temperature stresses were not a major consideration because this bridge was built in an area where temperature is uniform with few variations. The horizontal reaction caused by impact[11] was assumed to reach a limit of 30 tons. The unit stress in the deck from a reaction of 30 tons was 25 lbs. per square inch. The concrete piles carry 30 tons each.[12]

Billner intended that this bridge be one of the lightest concrete structures of its dimensions in this country. He explains the method of construction in a 1915 article in <u>Engineering and Contracting:</u>

> The thrust of the arches are transmitted to the rock foundations by inclined struts, which connect the tops of the 5-foot columns with the bottoms of the 4-foot ones. The vertical columns, which carry the weight of the deck and its superimposed load to the arch wings, have a section of 14x12 ins. and are reinforced with four 3/4 in. round rods and with No.7 wire stays spaced 24 ins. on centers. To provide against bending movements in the arch ribs due to partial loadings 12x12 in. diagonal members are inserted in each panel. These members are reinforced with four 7/8 in. round rods and with No. 7 stays spaced 12 ins. on centers. Special care was used in the construction of the end connections of these diagonal members, their reinforcing bars being hooked around both the longitudinal reinforcement of the arch ribs and that of the girders. Where it was impossible to provide connections of this kind, special dowels were inserted in the hooks. The springing points of the arches are restrained by making the main columns serve as beams, by means of double reinforcement.[13]

Reinforcing for this bridge was innovative and moving away from the heavily reinforced bridges of the period.

Bridge analysis in the summer of 1990 revealed the presence of electrical conduit in the railing piers. Billners correspondence explained: "Regarding electric conduits or iron pipes for electrification of the bridge at Latourell, I do not know the difference in price of regular conduit and that of pipe but the conduit would be preferable because of the large quantities of steel in the bridge." The conduit was installed but the lamp standards were never put in place.

The paving of the bridges was performed by the Warren Construction Company. They specified in 1915:

> All concrete floors to be swept as clean as possible and apply over same a thin coating of asphaltic cement not to exceed one-half gallon per square yard, and on this paint coat there shall then be spread the bitulithic wearing surface mixture, the same as that called for by the Multnomah County specification for other work on the Columbia River Highway, the pavement to be 18 feet in width with 3½ inch crown in the center and gradually tapered to 2 inches at the gutter line. In the laying of bridge pavement additional fussy work was involved since the bridge floors needed to be crowned which was slow work, also requiring special tamping at the gutter line.[14]

Today the bridge has a slight crown to the deck, so it must be assumed that the surfacing work was performed by the Warren Construction Company even though early specifications called for no crown in the pouring of the deck.

In 1915 Samuel Lancaster wrote this description of the bridge:

> The falls at Latourell can be seen from the bridge pouring their shining waters over the wall of basalt cliff, where the rock is formed into pentagonal shapes which hang down like icicles. The Giant's Causeway of the Irish Coast is well known, but it offers no better example of rock crystallization. The roadway forms a suitable frame to the beautiful picture and adds a charm to the landscape.[15]

Today the trees are much taller and conceal a considerable amount on the highway and bridge, creating a forested effect that contrast with Lancaster's original design intent for a tame and cultivated European landscape along this highway. This bridge established the essential form of the concrete arch that would be used in Oregon and other sections of the United States.

REPAIR AND MAINTENANCE

Maintenance records from the Oregon State Highway Department reveal that little maintenance was need on the bridge until the 1930's when it became necessary to repair broken hand rail spindles and damaged curbs on the pedestrian walks. Late 1930's maintenance records explain that the brush in the vicinity of the bridge needed to be cleared. 1950's maintenance records mention that spalling was occurring to the spindles on this bridge. By 1969, serious spalling was evident on the spindles caused by moisture penetration and expansion of the reinforcing bar. Replacement of the spindles in kind in the early 1980's. The original precast spindles were made by William P. Vrooman of Salem, Oregon.[16]

ENDNOTES

1. Alice Benson, Simon Benson: North West Lumber King (Portland: Binfords & Mort, 1971), p.115.

2. Lewis A. McArthur, Oregon Geographic News, Fifth edition (Portland: Western Imprints, Oregon Historical Society Press, 1982), p.435.

3. Carl Condit, American Building (Chicago and London: University of Chicago Press, 1968), p.253.

4. David Plowden, Bridges: The Spans of North America (New York: The Viking Press, 1974), p.298.

5. Condit, p.251.

6. State of Oregon, First Annual Report of the Highway Engineer for the Period Ending November 30, 1914 (Salem, Oregon: State Printing Department, 1914), p.187.

7. Alfred Reese, "A Unique Reinforced-Concrete Bridge," Engineering Record, v.70, no.18.

8. State of Oregon, First Annual Report, 1914, p.186.

9. Engineering News, 10 December 1914, p.1147.

10. Louis F. Pierce, Esthetics in Oregon Bridges: McCullough to Date, p.5.

11. Impact: a dynamic increment of stress equivalent in magnitude to the difference between the stresses produced by a static load when the quiescent and by a load moving in a straight line.

12. K.P. Billner, "Calculations for Bowstring Bridge at Latourell Falls, 1914," (Roadmasters Collection, Oregon Historical Society, Portland Oregon.) The structure was designed for the following stresses: maximum compressive stress in concrete (ribs with hoops), 750 psi.; direct compressive stress in spandrel columns, 500 psi.; compressive stress where concrete is subject to bending, 650 psi.; tension in steel, 16,000 psi.

13. K.P. Billner, "Bridges," Engineering and Contracting, 10 February 1915, p.122.

14. Warren Construction Co., Letter to H. Nunn, 5 August 1915, Columbia River Highway Bridges File, Roadmasters Collection, Oregon Historical Society, Portland, Oregon.

15. Samual C. Lancaster, The Columbia: America's Great Highway (Portland: Press of Kilham Stationary and Printing Co., 1915), pp.59-60.

16. ODOT Bridge Section Maintenance Files, "Latourell Creek Bridge, #4527".