PI 658

HAER INVENTORY

Historic American Engineering Record
Department of the Interior, Washington, D.C.

1. SITE I.D. NO

2 INDUSTRIAL CLASSIFICATION: Bridges, Trestles, and Aqueducts | 7 | 5 | 8 | 5

BEAM: reinforced concrete

3 PRIORITY: 1

4 DANGER OF DEMOLITION? (SPECIFY THREAT) ☐ YES ☐ NO ☒ UNKNOWN

5 DATE: 1936/66

6 GOVT SOURCE OF THREAT — OWNER — ADMIN

7 OWNER ADMIN: State Department of Transportation

8 NAME(S) OF STRUCTURE: Purdy Bridge

9 OWNER'S ADDRESS:
Department of Transportation
Highway Administration Building
Olympia, Washington 98504

10 STATE: W A — COUNTY: 0 5 3 — COUNTY NAME: Pierce — CITY VICINITY: Purdy — CONG DIST: 0 3

STATE — COUNTY — COUNTY NAME — CITY VICINITY — CONG DIST

11 SITE ADDRESS (STREET & NO.)
crossing: Henderson Bay
13.6 East Mason County

12 EXISTING SURVEYS: ☐ NR ☐ NHL ☐ HABS ☐ HAER–I ☐ HAER ☐ NPS ☐ CL6 ☐ CONF ☐ STATE ☐ COUNTY ☐ LOCAL ☐ OTHER

13 SPECIAL FEATURES (DESCRIBE BELOW): ☐ INTERIOR INTACT ☐ EXTERIOR INTACT ☐ ENVIRONS INTACT

14 UTM ZONE: 1 0 — EASTING: 5 2 8 1 4 0 — NORTHING: 5 2 4 8 6 8 0 — SIGN — SCALE: ☒ 1:24 ☐ 1:62.5 ☐ OTHER — QUAD NAME: Burley, Washington

UTM ZONE — EASTING — NORTHING — SIGN — SCALE: ☐ 1:24 ☐ 1:62.5 ☐ OTHER — QUAD NAME

15 CONDITION: 70 ☐ EXCELLENT 71 ☐ GOOD 72 ☐ FAIR 73 ☐ DETERIORATED 74 ☐ RUINS 75 ☐ UNEXPOSED 76 ☐ ALTERED 82 ☐ DESTROYED 85 ☐ DEMOLISHED

16 INVENTORIED BY: Lisa Soderberg — AFFILIATION: HAER/Washington State Bridge Inventory — DATE: March 1979

17 DESCRIPTION AND BACKGROUND HISTORY, INCLUDING CONSTRUCTION DATE(S), HISTORICAL DATE(S), PHYSICAL DIMENSIONS, MATERIALS, EXTANT EQUIPMENT, AND IMPORTANT BUILDERS, ENGINEERS, ETC.

The Purdy Bridge is a 550 foot continuous box girder. Constructed under the supervision of Pierce County engineers in 1936, it is one of a handful that were designed and built in Pierce and King Counties during the 1930's. Although the hollow-box concrete girder was economical and used extensively throughout Europe, there are few American examples. In his book, American Building Art, Carl Condit asserts that the Purdy Bridge is the "nearest American rival to Freyssinet's girder spans." At the time that it was built, its 190 foot central span was the longest single span among concrete girder forms. The bridge also includes two additional 140 foot girder spans and two 40 foot cantilever ends, extending beyond the concrete box piers. It provides a 2 lane roadway, 20 feet wide, curb to curb.

Other designs in concrete also were considered by Pierce County engineers prior to the selection of the hollow-box girder design. Solid web girders had proven successful and economical in other situations. However, the enormous dead weight of a 190 foot solid web girder below the roadway level eliminated the feasibility of using such a design

(CONT OVER)

18 ORIGINAL USE: vehicular — PRESENT USE: vehicular — ADAPTIVE USE:

19 REFERENCES – HISTORICAL REFERENCES, PERSONAL CONTACTS AND/OR OTHER

State Department of Transportation files.
Carl Condit, American Building Art, 2 Vols., (New York, 1960) 2:209.
F.R. Easterday, "Concrete Box-Girders of Record Span," Engineering News-Record, 3 March 1938, pp. 339-342.

(CONT OVER)

20 URBAN AREA 50,000 POP OR MORE? ☐ YES ☒ NO

21 HCRS REGION: N W

22 PUBLIC ACCESSIBILITY: ☐ YES LIMITED ☒ YES UNLIMITED ☐ NO ☐ UNKNOWN

23 EDITOR — INDEXER

24 LOCATED IN AN HISTORIC DISTRICT? ☐ YES ☒ NO — NAME — DISTRICT I.D. NO

84

Description (continued)
to span Henderson Bay. If the half-through girder type which extended above the roadway level were used, it would be necessary to build it with considerable depth, and consequently lose all the benefits of flange action that are available in the road slab.

"Hollow-box girders, on the other hand," stated a contemporary article in Engineering News-Record, "are of minimum section and weight, make use of the full roadway slab as a compression flange for positive bending, can easily be given adequate section for negative bending, afford ample space for tension reinforcement, and if braced with transverse internal diaphragms have the strongest section that can be made with a given quantity of material."

In the Purdy Bridge, the concrete was poured around a hollowed steel box girder of which the roadway slab forms the top flange. The box girder is 15 feet wide, and 7 feet deep at the crown, increasing to 14 feet at the piers. It is composed of three webs, and a bottom slab which is 6 inches thick in the tension zone, and of greater thickness in the compression zone, as stresses require. At approximately 20 foot intervals, 8 inch transverse diaphragms brace and interconnect all longitudinally extending parts.

The pier shafts which are also of cellular construction, are flush with the outer sides of the deck box-girder. The shells and webs are 16 inches thick. A minimum cover of 3 inches of the Class A concrete encase the steel pier shafts to protect them from the corroding forces of the saltwater. Small openings through the diaphragms of the box girder allow the water to drain through the pier shaft to an outlet above the footings.

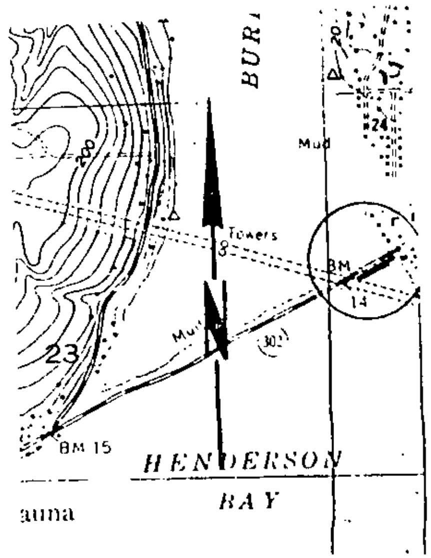
The long, 190 foot middle section was designed as a simple suspended beam, completely separated from the rest of the structure. The suspended span is seated on shelves at the end sections of the 190 foot span which are continuous with the deck structure of the two continuous 140 foot spans, and the two 40 foot cantilever spans. The ends of the suspended section that bear upon the shelf are locked in laterally by 15 inch solid concrete sections at the ends of the shelf. Although the engineers believed that the entire deck structure probably could have been made continuous from end to end, it was explained that in "deference to convention," expansion joints were put at each end of the 100 foot mid section in the 190 foot span.

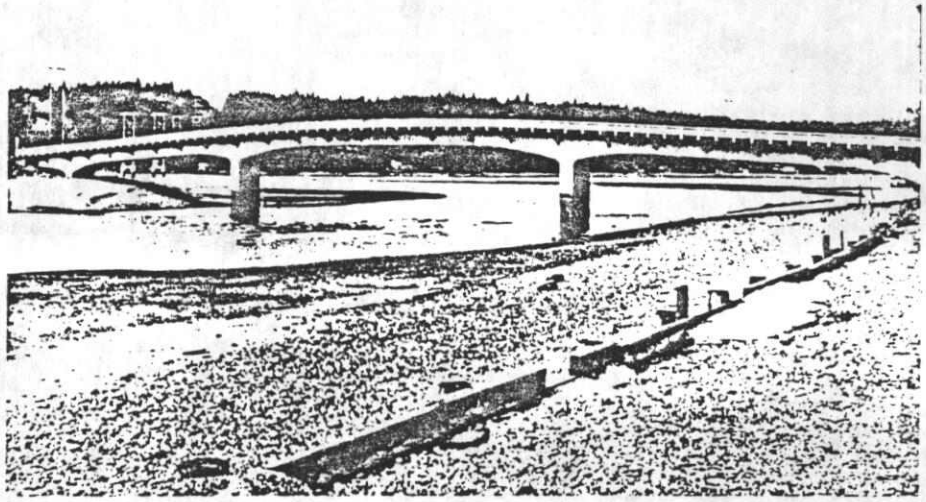
One of the major advantages to the hollow-box girder design, was its low cost. The total cost of the bridge was $62,000 or approximately $5.64 per square foot of net roadway width. Throughout bridge construction, cost factors dictated the bridge's form. Due to the commerical use of the upper portion of Henderson Bay, an 18 foot clearance at high tide was required by the War Department. It was recognized that pier construction must be carried down to a depth of 20 feet, because of the strong tidal currents, and the potential scour risks. However, construction would be costly. Although new piers for the channel span would have to be provided, it was reasoned that if a minimum number of additional piers were constructed in deep water, the cost of the bridge would be reduced. The overriding cost considerations of the hollow-box concrete girder with only two deep water piers created a distilled concrete form that was visually powerful in its organic structural simplicity.

The Purdy Bridge was built by Pierce County under the supervision of the county engineer, Mr. Forest R. Easterday. Mr. W.H. Craft was resident engineer in charge of construction. The concrete work was completed by the Portland Dredging Company. The detailed design was prepared by W.H. Witt Company of Seattle. However, the major design features and layout of the bridge were suggested by Homer M. Hadley, regional structural engineer of the Portland Cement Association. The Purdy Bridge, which is significant as an early and rare American example of hollow-box concrete girder, is one of several unique concrete bridge designs of cellular construction conceived and carried out by Mr. Hadley throughout Washington during his lifetime.

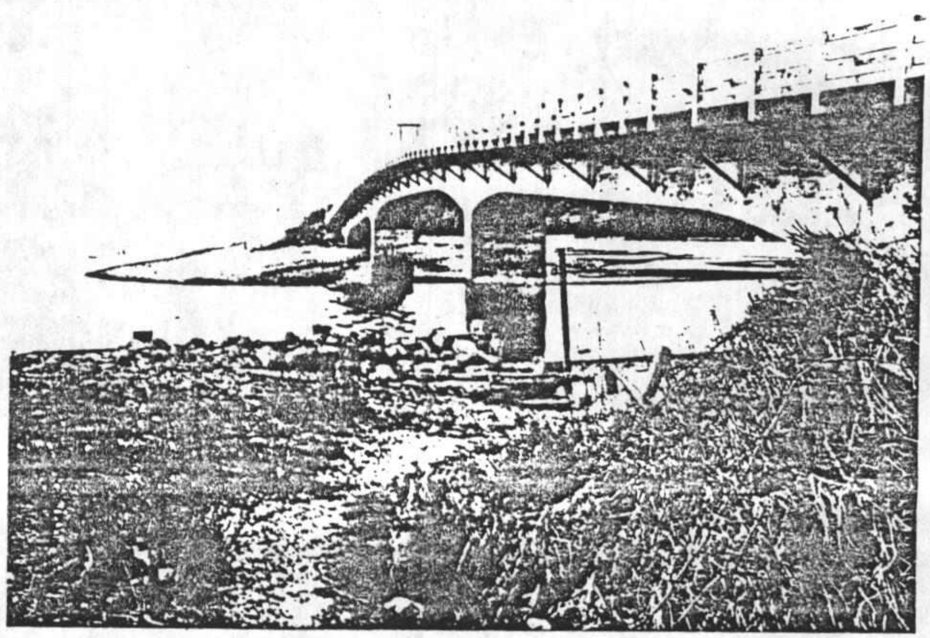
GPO 937 842

25. Photos and Sketch Map of Location

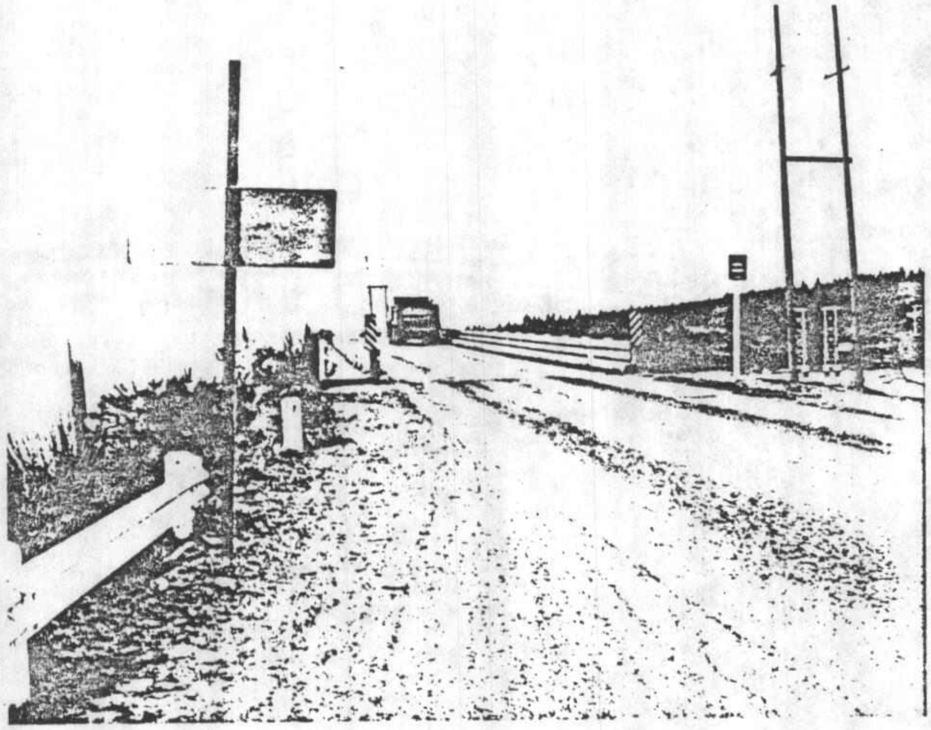




Purdy Bridge

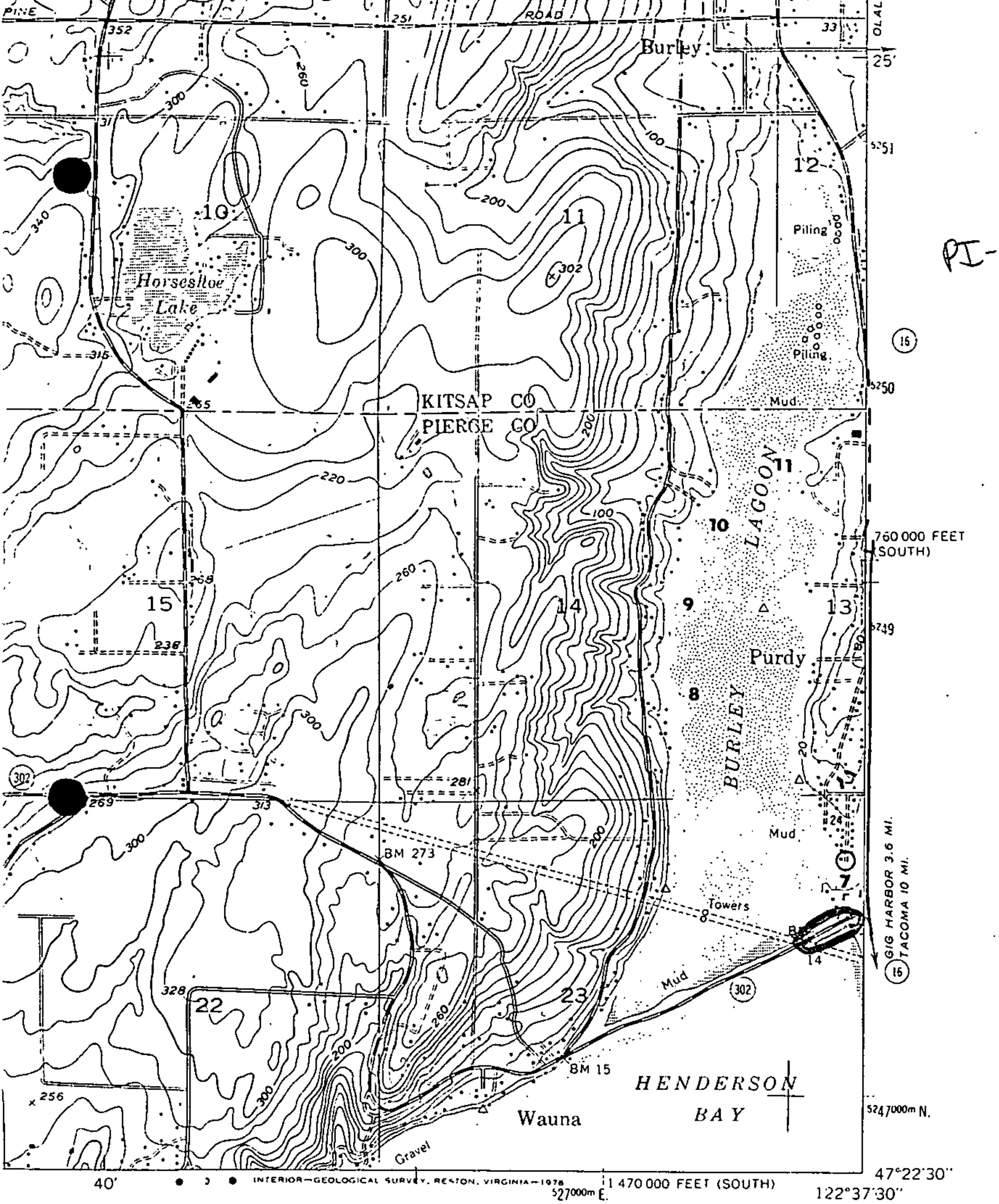


Purdy Bridge



Purdy Bridge

PI-658



1 MILE

7000 FEET

METER

ROAD CLASSIFICATION

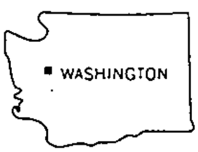
Heavy-duty

Light-duty

Medium-duty

Unimproved dirt

State Route



QUADRANGLE LOCATION

VIRGINIA 22092

QUEST

BURLEY, WASH.

N 4722.5—W 12237.5/7.5

1953

PHOTOREVISED 1968 AND 1973

AMS 1478 I NW—SERIES V891

25. Photos and Sketch Map of Location

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27
2
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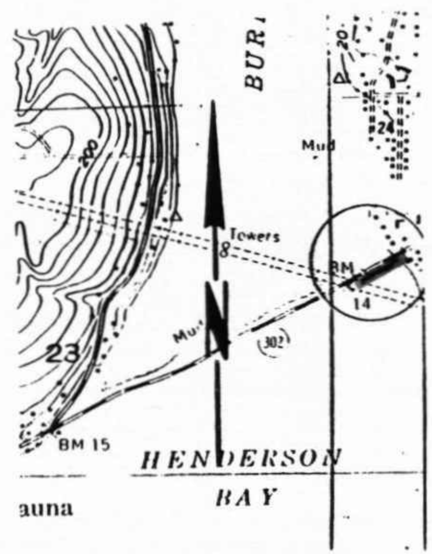

Historic Register Report

Historic Name: Purdy Bridge

Address: Spans Henderson Bay
City: Purdy
County: Pierce

Download nomination form

Historic Use: Transportation
Style: None
Built: 1936
Architect:
Builder:

Smithsonian Number: 45PI00658
Date Listed: 7/16/1982
Listing Status: WHR/NR
Classification: STR
Resource Count: 1
Area of Significance: Engineering
Level of Significance: Local
Listing Criteria: A, C

Statement of Significance

Photos

PURDY BRIDGE
(Purdy Spit Bridge)
State Route 302 spanning the strait between
Henderson Bay and Burley Lagoon
Purdy vicinity
Pierce County
Washington

HAER No. WA-101

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

PHOTOGRAPHS

HISTORIC AMERICAN ENGINEERING RECORD
NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

HAER
WASH
27-PUR.V
1-

HISTORIC AMERICAN ENGINEERING RECORD

PURDY BRIDGE
(Purdy Spit Bridge)

HAER No. WA-101

Location:	State Route 302 spanning the strait between Henderson Bay and Burley Lagoon, Purdy Vicinity, Pierce County, Washington, beginning at mile point 19.22.
	UTM: 10/528080/5247650 10/528240/5247730
	Quad: Burley, Washington
Date of Construction:	1936
Engineer:	Homer M. Hadley, Portland Cement Association. The W. H. Witt Company of Seattle did the detailed drawings.
Fabricator:	Built by the Portland Dredging Company of Portland, Oregon under the supervision of Pierce County Engineering Department.
Owner:	Built for Pierce Co. Bought by the Washington Department of Highways, since 1977 the Washington State Department of Transportation, Olympia, Washington.
Present Use:	Vehicular and pedestrian traffic.
Significance:	An example of a reinforced-concrete box-girder bridge, which was common in Europe but rare in the United States. It was considered the longest of its kind when built. It has been placed on the National Register of Historic Places.
Historian:	Wm. Michael Lawrence, August 1993

History of the Bridge

The Puget Sound area is replete with varied coastlines and numerous inlets, bays, and coves. One very picturesque example is the junction between Henderson Bay and Burley Lagoon, through which the Purdy Creek flows at low tides. On the west side, a narrow 2000' long extension of the pebbly beach, Purdy Spit, cuts across the mouth of Burley Lagoon, reducing it to a 500' wide channel. The spit points like a finger towards the town of Purdy, on the east side, platted in 1885 and named after pioneer Tacoma grocer Ernest R. Purdy who furnished lumber for the first school in the area.[1]

Since 1892 a bridge has spanned the waters between the town and the spit. When Pierce County built a wooden structure supported by timber piles, with a swing span at the channel in 1892.[2] Another bridge replaced this one in 1905, but a few years later the swift tidal currents, which can reach 10 miles per hour, washed away some of the piling and it collapsed. The difficulties involved discouraged any contractor from repairing it, obliging the county commissioners to use what their records called day labor, to replace it.[3] To complicate matters, the bridge spanned a navigable waterway, under the jurisdiction of the United States Department of War. After receiving complaints from ship owners, U.S. Army Engineer Ricksecket ordered the county to tear down a temporary bridge they built while repairing the 1905 structure.[4]

In 1919 and 1920, the county had the road approaching the spit widened and again rebuilt the bridge, this time with a steel swing span. The work was complicated by a lawsuit instigated by nearby property-owners.[5] Problems plaguing these bridges' construction factored into the design of the most recent bridge built in 1936.

Homer M. Hadley, regional structural engineer for the Portland Cement Association, reportedly suggested the design for the latetst structure, a reinforced-concrete box girder, with the W. H. Witt Company of Seattle preparing drawings.[6] Hadley is also credited with other Pierce County bridges from the period, including the another reinforced-concrete box girder, the McMillin Bridge (HAER No. WA-73).

Homer Hadley is remembered today as an innovator in the engineering profession, responsible for novel bridge designs. The surviving county records, unfortunately, provide little information about the degree of his involvement in this project or the involvement of the W. H. Witt Company. They do show that he was involved in the selection of another member of the design and construction team, resident engineer W. H. Craft. Hadley received a letter of recommendation for him, dated 30 June 1936.[7] He was also consulted during the project, when Craft suggested modifying the design.[8] This suggests Hadley was involved, at least as a consultant, in all phases of the project.

Design and Description

In a 1938 *Engineering News-Record* article discussing reinforced-concrete bridges, Pierce County Engineer Forrest R. Easterday discussed the new Purdy Bridge, which was built as a reinforced-concrete box-girder. The type was rather common in Europe at the time, but not in the United States, where concrete arch bridges or reinforced -concrete girders were more the fashion. Easterday gave several reasons for the design. The strong currents, caused by tidal variations of as much as 17', was one factor. Another was the U.S. War Department's requirement of a 18' clearance for the channel at high tide. As piers carried down to 20' below mean tide would be costly and because of the risk of scour due to the currents, he reasoned, fewer piers in deep water would be less costly. In addition, he believed that large piers would resist exposure of the concrete to saltwater. Finally, he suggested that "symmetry of spans and grades with good proportions in the main members would go far toward giving a pleasing appearance."[9]

The history of the Purdy Bridge would not be complete without a brief discussion of the other box-girder bridges built about this time in Pierce County and Washington. Pierce County built several others at this time, the Buckley overpass (1936), the Eatonville bridge (1936), and the Gehring Road bridge (1936). Homer Hadley and the W. H. Witt Company designed the first two.

The City of Aberdeen also built a box-girder, the Sixth Street bridge (1937), also with the W.H. Witt Co. doing the detailed design with assistance from Hadley's organization, the Portland Cement Association. He may have been involved. Yakima County built a box girder in 1939, also using the services of Hadley and the W. H. Witt Co. The Washington State Highway Department's first attempt at the new structural type was the Naches River bridge (1938) across the Yakima River. Going further afield, the first concrete box-girder built by the California Division of Highways was the Eel River Bridge in Mendocino County (1938).

It was with some justification that Homer Hadley could write in a 1938 *Western Construction* article that "Of late years there has been a great vogue for rigid-frame bridges,"[10] rigid frame bridges being those in which the deck was integral with the structure below, a definition which includes box-girders. And his was not the only article in the engineering and construction journals discussing this new bridge type, for several authors praised the bridges for their low cost and simple design, as well as their clean, graceful lines.[11]

The Purdy Bridge appears in many of articles concerning such bridges, considered noteworthy because its central span was considered the longest box-girder in the country. Carl C. Condit, in his pioneering work, would declare that "The nearest American rival to Freyssinet's girder spans [in Europe] is the continuous highway bridge over Henderson Bay at Purdy, Washington. . . This structure rates one of the few box-girder bridges in the United States and has the longest single span among concrete-girder forms."[12] The reinforce-box girder would not be widely used in America. The Purdy Bridge and others of this type are unique in the history of bridge building in America.

The engineers decided that the box girder would be most economical for such long spans. Solid web girders below the roadway were "automatically eliminated" by their dead weight. Half-through types would be very deep. Box-girders, which could use the roadway slab as a compression flange, had ample space for tension reinforcement in the bottom, and could easily be braced laterally with internal diaphragms. The webs could be very thin. The exterior surfaces would be smooth plans with a minimum number of corners, resisting the effects of weather.[13]

The designers made these decisions sometime before August 1935. That is the earliest date for any of the drawings that survive.[14] The engineers prepared more detailed drawings for the bridge, dated November 1935.[15] The contractor for this project was the Portland Dredging Company of Oregon, who was awarded the project after submitting a low bid of $69,068.95.[16]

It seems that a few obstacles stood in the way of the project. The construction of the new bridge would require reconfiguring the right-of-way slightly, and for this the county needed a small parcel of the land to the northwest of the bridge. The landowner, Hans Pederson, did not act quickly enough to satisfy the county engineer, so on 10 July 1936, Easterday wrote a letter, accompanied by a waiver and an offer of $50.00, asking Pederson to sign the document so that the county attorney would not have to take action to condemn the land.[17] Easterday did not wait for a reply, but immediately sent another letter to the county attorney's office, requesting that he begin such action, to avoid any delay of the project, as the contract was to be awarded 20 July 1936.[18] This issue resurfaced a short time later, for on 25 August, Easterday sent another letter to the landowner, informing him that they would have to rewrite the deed, as the engineers had changed the right of way again.[19]

The county was not so aggressive in dealing with another problem, that of getting permission from the War Department to replace the existing bridge. The county sent an application, dated 28 July 1936, to the Corp of Engineers' office in Seattle.[20] The process involved submitting drawings with a profile of the bridge and the bottom of the bay. The War Department formally granted the permit on the 24 August 1936.[21] On 31 August Easterday sent a letter to the Army Corp of Engineers' Seattle office, acknowledging receipt of the document and informing it that the starting date for the project was 29 August 1936--just five days after the permission was granted.[22]

The county also had to apply for a permit to build a temporary construction trestle alongside the new bridge. The application, accompanied by 2 sheets of drawings for the preliminary design of this structure, is dated 19 August 1936.[23] The Army Corps of Engineers granted the permit on 3 September and informed the county that the work had to be completed by 31 December 1939.[24]

Some drawings for the Purdy Bridge survive, which, along with Forrest R. Easterday's 1938 *Engineering News-Record* article, make it possible to describe and analyze the bridge. In elevation, the form of the Purdy Bridge is that of a arc at its deck, 550' long from end to end. The grade of the deck is 5.8 percent at each end. It consists of five spans supported by four piers laid out symmetrically. The ends of the bridge cantilever beyond the outermost piers, 40' beyond the pier centerlines. The spans from an outer pier to the next one is 140', from one pier centerline to the other. The central span, over the channel, is 190' long, measured at the pier centerlines.[25]

These box-girder spans are rectangular in section, being 15' wide and 7' deep at the center of each span, increasing to 14' deep at the piers. The top, which serves as the deck, cantilevers out beyond the sides of the box, for an overall width of 22'. The roadway between the curbs at the edges is 20' wide. The deck, which is 6-1/2" thick, may be considered the top flange of the box girder.[26]

The sides of the box-girder and a wall down its middle are the webs. Each is 8" thick at the center of the spans and 10" thick near the piers, as shear stresses require. Lateral bulkheads or diaphragms, 8" thick and spaced at 20', brace the three walls. The bottom slab of the girder is 6" thick in tension zones and thicker in the compression zones.[27]

The 190' central span of the bridge is not continuous. Expansion joints, 45' from the centerlines of the two inner piers, separates the middle 100' from the rest of the span. The surfaces on either side of each joint interlock with each other, with a protrusion from the middle section extending into and resting on a shelf built into the other side.[28] The bearing surfaces consist of two metal plates separated by asbestos packing. The interlocking joint is invisible from the outside except for straight lines that appear like ordinary joints. Technically, the middle section is a simple beam supported by shelves in the ends of two cantilevers. The engineers believed that the entire bridge could have been a continuous structure. "In deference to convention, however, expansion joints were put at each end of the 100-ft. mid section in the 190-foot span."[29] The detail could not be cast with removable wooden forms. The endforms, which remain embedded in the concrete on either side of the joint, are of sheet metal braced by angle iron.[30]

The piers are also hollow and rectangular in section, 15' x 6', with the narrower sides being flush with the faces of the girder. Like the box girder above, each is divided within by a central wall. This and the exterior walls are each 1'-4" thick. The piers rest on massive concrete footings. The outermost footings are 30' by 10'-6" in plan and 6' deep. The innermost are 30' x 12' in plan and 12' deep. These rest directly on "firm compacted gravel closely filled with sand." As already indicated, the engineers found that piles could be dispensed with in this bridge.[31]

The work apparently did start soon, considering the dates of surviving shop drawings by the contractors. There were drawings for the proposed falsework (6, 7, & 11 October 1936)[32], cofferdams to protect formwork for the footings (11 October 1936)[33], and the pier forms (2 & 3 November 1936).[34] By 19 October Resident Engineer Craft could report that the whaling for pier No. 2 was in place and discuss the pumping out of the coffer dams for pier Nos. 2 & 4.[35]

All piers in the Purdy Bridge bear directly on firm compacted gravel closely filled with sand.[36] The engineers had planned to drive piles to support the end piers, but decided against it in late October, after finding that the soil was firm enough.[37] Work on the project continued at least until January; for on 12 January 1937 the W. H. Witt Co. informed Easterday they were sending prints of the drawings to the county engineer and the job site.[38]

The difficulties of the site required special construction methods. The contractor built a construction trestle alongside the alignment for the new bridge, carrying an 8-gauge railroad track on which rolled a crane. The workmen used it to drive and pull sheetpiling for the cofferdams at piers 2 and 3, to lift construction materials in place, and to lift a bottom-gate bucket used for concrete pours. A small mixer on caterpillar treads also operated from this trestle.[39]

The formwork was lined with plywood and was removed after the pours except for that supporting the deck from inside the box girder. The concrete was poured as follows: footings, pier shafts, the girder except for the middle 100' of the midspan, than the middle part. The top slab of each part of the girder was poured separately from the deck on top. The middle section was poured separately because it was a simple beam separated from the rest of the bridge by interlocking expansion joints.[40]

The box-girder bottom, exterior walls, and diaphragms were to be of one continuous pour, except for the suspended portion in the middle span, starting at the end of the bridge and proceeding upgrade and inward. This did not quite happen when the workmen poured the west part of the bridge. A very heavy rain interrupted the operation when they reached a point 25' east of the western-most pier. The pour had to be resumed at a later date.[41]

On 16 June 1937, an official of the state highway department, which was financing the project, informed the county engineer of their concern that this would weaken the bridge and requested a load test.[42] The test consisted of a box filled with sand and gravel, weighing 115 tons, left on the deck for 12 hours. The engineers took extensometer reading across the line between the two pours. They indicated zero movement. This test was completed on 12 August.[43]

As the cells within this structure can collect moisture within, there are small holes through the diaphragms which permits water to drain into the piers. The water then escapes through openings at the base of the pier shafts. The reinforcement being near the outer surface, is protected by a minimum of 3" of concrete cover. Shear keys in the cold construction joints between the different pours serve to lock the piers, box girders, and deck together.

The bridge is a combination of beam and cantilevers, continuous with each other, and a simple beam supported by cantilevers. The action of the forces is rather complex. Easterday, in his article, indicated that the bottom slab of the box-girder is 6" thick in the tension zones and thicker in the compression zones, as stresses require. Easterday wrote that two-inch-square bars were used for the main tension steel because they "gave concentration of reinforcing close to the webs," which he believed "was preferred by engineers who checked the plans for the concrete box-girder bridge."[44] Construction drawings indicate that the thickness of the slabs and the location of the 2"-square bars constantly changes throughout the length of the bridge, to counteract the complex behavior of the forces in this structure, which is so simple in its outward appearance.

Numerous stirrups in the webs of the box-girder guard against shear stresses in the webs. When the pour of one of the girders was interrupted by heavy rain, the irregular surface of the concrete sloped from bottom to top a distance of 10', in a line almost perpendicular across the stirrups. The designers were confident that the stirrups and the irregular surface would hold this and the next pour together without any need for special precautions such as shear keys or additional reinforcing across the joint. The success of a loading test, insisted on by the state highway department, vindicated their confidence in the design.[45] The overall form of the bridge is a pleasing one, a sweeping curve with clean planar surfaces and curved haunches where the undersides of the box girder meets the piers.

Repair and Maintenance

The Purdy Bridge has changed little since its construction in 1936. The state highway department authorized posting of signs prohibiting people from fishing from the bridge in 1946, probably due to increasing traffic as more and more people moved into the Olympic Peninsula. The department replaced the timber railing in 1959 and 1960, at a total cost of $ 2,915.37. The addition of a timber sidewalk supported by angle brackets on the south side in 1966, at a cost of 11,241.95, altered the appearance of the bridge slightly.[46] The scouring action of the tides has eroded away some of the concrete on the piers.

Data Limitations

There were few limitations other than a general lack of newspaper coverage of this project which might have indicated what the public reception was. This should not be surprising, as the bridge was built in a rural area, next to a small town, rather than a major urban center. Helpful sources included the newspaper files at the Tacoma Public Library and the bridge file at the Pierce County Public Works Department in Tacoma. Some working drawings survive at the Public Works Department as well. Easterday's article on the Purdy Bridge provided valuable information about its design and construction. Several articles in professional journals discuss the bridge and other box-girders built in Washington in the mid to late 1940s, making it possible to place the bridge in its context.

Project Information

This project is part of the Historic American Engineering Record (HAER), National Park Service. It is a long-range program to document historically significant engineering and industrial works in the United States. The Washington State Historic Bridges Recording Project was co-sponsored in 1993 by HAER, the Washington State Department of Transportation (WSDOT), and the Washington State Office of Archeology & Historic Preservation. Fieldwork, measured drawings, historical reports, and photographs were prepared under the general direction of Robert J. Kapsch, Ph.D., Chief, HABS/HAER; Eric N. DeLony, Chief and Principal Architect, HAER; and Dean Herrin, Ph.D., HAER Staff Historian.

The recording team consisted of Karl W. Stumpf, Supervisory Architect (University of Illinois at Urbana-Champaign); Robert W. Hadlow, Ph.D., Supervisory Historian (Washington State University); Vivian Chi (University of Maryland); Erin M. Doherty (Miami University), Catherine I. Kudlik (The Catholic University of America), and Wolfgang G. Mayr (U.S./International Council on Monuments and Sites/Technical University of Vienna), Architectural Technicians; Jonathan Clarke (ICOMOS/Ironbridge Institute, England) and Wm. Michael Lawrence (University of Illinois at Urbana-Champaign), Historians; and Jet Lowe (Washington, D.C.), HAER Photographer.

APPENDIX

Box-girders in Washington State

The Purdy Bridge was one of several box-girder bridges built in Pierce County, Washington, and elsewhere during the latter half of the 1930s. Some were design by Homer Hadley, regional engineer for the Portland Cement Co., with the W. H. Witt Co. of Seattle producing the detailed drawings. Not one of them is identical with any other.

The Eatonville Cutoff bridge (1936), built over the Marshall River in Pierce County, was 162′ long and consisted of three-spans, supported by two piers. The central span was 106′ long at the pier centerlines and the two endspans cantilevered 28′ beyond the centerlines. Unlike the Purdy Bridge, it was straight. In section, it was similar to the Purdy Bridge, except the girder was 4′ instead of 7′ deep. Major features and layout were by Homer Hadley and the detailed design was by the W. H. Witt and Co.[47]

The Buckley Overpass (1937), built over the Northern Pacific Railway for Pierce County, had four spans varying from 40′ to 50′ in length and short cantilevers at each end, supported on five pairs of columns. The deck was the same width as that of the Purdy Bridge, 22′, but the section below the deck is quite different. It consists of two box girders, with the top of the girders being integral with the deck. Each was 4′ wide and 3′ high, the heighth including the thickness the deck. The cavities within the girders were octagonal in section, formed by "banana crates" of wood which were left inside the pours. As with the Purdy and Eatonville bridges, Homer Hadley suggested the layout and major features, and the W. H. Witt Co. prepared the drawings.[48]

The Gehring Road Bridge (1938) over a ravine south of the Puyallup River near Tacoma was another Pierce County project. It was 264′ long with a central span of 90′, side spans of 70′, and end cantilevers of 17′ in length. The roadway was 20′ wide with two 2′-6" sidewalks. There were two individual box girders integral with the deck, each 4′ wide, 5′ deep, and 7′ apart. As with the Buckley Overpass, the girders were supported by pairs of columns. The forms were left inside the box-girders in all of these structures except for the Purdy Bridge.[49]

Yakima County built a box-girder over the Yakima River in 1938. It was 600′ long, with four 130′ spans and 40′ cantilevers at each end supported on five piers. The deck was 31′ wide and the box girder, which consisted of three cells side-by-side, was 21′ wide and 6′ deep, including the thickness of the deck slab. The connections between the box-girder and piers was quite different than the other bridges. The girder was fixed to the central pier and rested on rollers at the other supports. It cost $77,521, less than the $81,500 estimated for a steel through truss. The low cost of the box-girder was an important consideration as the county could not afford the bridge without applying for a federal Public Works Administration grant. Homer Hadley made "valuable suggestions" for this design and the W. H. Witt Co. prepared the detailed plans.[50]

The City of Aberdeen built a box-girder as well, the Sixth Street Bridge (1937). This 172' structure consisted of four 73' spans and two 26' cantilevered end-spans resting on five bents. The deck was 42' wide and was carried by four box-girders, each 4' wide and 3' 5" high. The interior of these rectangular girders were octagonal in section, being formed up with "banana crates" left inside the concrete. The bents supporting this bridge consisted of pairs of piers, set under the outermost girders. Mesnager hinges in the end-bents, joints at which the reinforcing converged near the center of the section, allowed the engineers to dispense with expansion joints in the girders. Members of the Portland Cement Association staff, Hadley's organization, gave "considerable helpful assistance" and the W. H. Witt Company prepared the detailed design.[51]

The first box-girder bridge built by the Washington Department of Highways was the Naches River bridge (1938), 20 miles west of Yakima. This was 305' long, with three spans of 72, 73, and 100' and two cantilevers 25' and 35' long. The deck did not cantilever as dramatically as in the other bridges, being 29'-8" wide supported by a box girder below that was 23'-8" wide. The girder was 3' deep and consisted of five cells, side by side.[52]

The first such structure designed by the California Division of Highways was the Eel River Bridge (1938) in Mendocino County. The total length was 320', with a 95' center span, 84'-6" side spans, and 28' cantilever end-spans, supported by four piers. The deck was 22'-8" wide and the box girder was 15' wide by 4' deep. The girder and the piers were hollowed out, each by pairs of cells that were rectangles with truncated corners in section.[53] Within a few years, engineers in Washington built several of these structures. Authors of numerous articles written about these box-girders were unanimous about the virtues of the bridge type: low cost when compared with steel trusses, a continuity which eliminated the need for numerous expansion joints, economy of design because the reduction in the amount of concrete needed, the reduction of the exterior to simple planes with fewer corners which were less susceptible to weathering, especially with decks cantilevering beyond the box-girder on either side; the minimal depth of the structure which maximized

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ENDNOTES

[1] Gary Fuller Reese, *Origin of Geographic Names of Tacoma/Pierce County Washington* (Tacoma: Tacoma Public Library, 10 June 1974): 78.

[2] "Purdy Bridge Finished--Travel Opens by the New Route--A Contract Lot," *Tacoma Daily Ledger*, 26 December 1892, 3; The collapse of part of its falsework killed one of the workmen. See "Ole Peterson's Death--Caused by His Own Carelessness in Trying to Hold a Falling Timber," *Tacoma Daily Ledger*, 26 December 1892, 3.

[3] "New Bridge at Purdy is Nearing Completion--County Constructs a Durable Center Pier for the Draw" and "A. U. Mills' Statement Anent Purdy Bridge, *Tacoma Daily Ledger*, 1 November 1908, 5.

[4] "County Must Move Temporary Bridge," *Tacoma Daily Ledger*, 9 February 1908, 13.

[5] "Wauna-Gig Harbor Road Under Way," *Tacoma Daily Ledger*, 22 August 1920, C-3.

[6] Forrest R. Easterday, "Concrete Box-Girders of Record Span," *Engineering News-Record* 120 (3 March 1938): 342.

[7] Glenn B. Woodruff, State of California Department of Public Works, to Homer M. Hadley, Regional Structural Engineer, Portland Cement Association. Copy in the Purdy Bridge File, Department of Public Works, Pierce County, Tacoma, WA.

[8] Forrest R. Easterday, Pierce County Engineer, to Homer Hadley, 18 July 1937, Purdy Bridge File.

[9] Easterday, "Concrete Box-Girders of Record Span," 339-42.

[10] Homer Hadley, "A Discussion of Concrete Bridge Construction Trends," *Western Construction News* 13 (June 1938): 221.

[11] For a more detailed discussion of these bridges, see Appendix.

[12] Carl C. Condit, *American Building Art*, vol. 2, (New York: Oxford Press, 1960), 209.

[13] Easterday, "Concrete Box-Girders of Record Span," 339 and figure 3.

[14] Office of the Pierce Co. Engineer, "Bridge No. 24221-A, Secondary Road Project 51, August 1935, held by Department of Public Works, Pierce, County, Tacoma, WA.

[15] Ibid.

[16] Pierce County, table of lowest bids, not dated, in Purdy Bridge File.

[17] Forrest R. Easterday, Pierce County Engineer, to Hans Pederson, 10 July 1936, in Purdy Bridge File.

[18] Forrest R. Easterday, Pierce County Engineer, to J. E. Belcher, Deputy County Attorney, 10 July 1936, in Purdy Bridge File.

[19] Forrest R. Easterday, Pierce County Engineer, to Hans Pederson, 25 August 1936, in Purdy Bridge File.

[20] Application by Pierce County to the War Department for Construction of a New Bridge, 28 July 1936, in Purdy Bridge File.

[21] U.S. Corp of Engineers, permit for the construction of a new bridge at Purdy Spit, 24 August 1936, in Purdy Bridge File.

[22] Forrest R. Easterday, Pierce County Engineer, to the Army Corps of Engineers, Seattle Office, 31 August 1936, in Purdy Bridge File.

[23] Pierce County Engineering Department, application to Army Corps of Engineers, Seattle Office, for construction of a temporary trestle, 19 August 1936, in Purdy Bridge File.

[24] U.S. Army Corps of Engineers, permit for temporary falsework and trestle, 3 September 1936, in Purdy Bridge File; Easterday certified the completion of the contract on 15 September. The final cost was $71,511.62. See Pierce County Engineering Department, Certification of completion of the Purdy Bridge, 29 September 1937, and Tabulation of the final cost of the Purdy Bridge, 27 October 1937, in Purdy Bridge File.

[25] See Easterday, "Concrete Box-Girders of Record Span," figure 2.

[26] Ibid., figure 3.

[27] Ibid.

[28] Ibid., figure 5.

[29] Ibid., 340.

[30] Ibid.

[31] Ibid., figure 3.

[32] Portland Dredging Company, "Proposed Falsework for Purdy Bridge No. 24221-A," 6, 7, & 11 October 1936, in Purdy Bridge File.

[33] Portland Dredging Company, "Proposed Cofferdams for Purdy Bridge No. 24221-A," 11 October 1936, in Purdy Bridge File.

[34] Portland Dredging Company, "Proposed Pier Forms for Purdy Bridge No. 24221-A," 2, 3, 26 November and 7 December 1936, in Purdy Bridge File.

[35] W. H. Craft, Resident Engineer, to Forrest R. Easterday, Pierce County Engineer, 19 October 1936, in Purdy Bridge File.

[36] Easterday, "Concrete Box-Girders of Record Span," 340.

[37] W. H. Craft, Resident Engineer, to Forrest R. Easterday, 27 October 1936, in Purdy Bridge File.

[38] George Runciman, President of W. H. Witt Co., to Forrest R. Easterday, 12 June 1937, in Purdy Bridge File.

[39] Easterday, "Concrete Box-Girders of Record Span," 341.

[40] Ibid.

[41] Ibid.

[42] O. R. Elwell, State Highway Department, to Forrest R. Easterday, Pierce County Engineer, 16 June 1937, in Purdy Bridge File.

[43] Forrest R. Easterday, Pierce County Engineer, to C. Hamilton, Washington State Highway Department, 17 August 1936, in Purdy Bridge File.

[44] Easterday, "Concrete Box-Girders of Record Span," 340.

[45] Ibid., 341-42; the illustrations in the Easterday article depict many of its details and dimensions. This information was verified by an examination of surviving drawings noted as: Office of the Pierce Co. Engineer, "Bridge No. 24221, Secondary Road Project 51," November 1935, in Purdy Bridge File.

[46] "Purdy Bridge, No. 302/105," Bridge Inspection Reports and Correspondence in Correspondence Files, Bridge Condition Unit, Washington State Department of Transportation.

[47] Forrest R. Easterday, "Novel Hollow-box Concrete Girders on County Highway Bridges," *Western Construction News* 11 (April 1936): 105-08.

[48] Ibid., 107-08.

[49] Forrest R. Easterday, "County Finds Concrete Box Girder Bridges Economical," *Pacific Builder and Engineer* 13 (7 January 1938): 38-40. The article also discusses the Eatonville bridge and the Buckley overpass.

[50] Lloyd F. Fairbrook, "A Low-Cost Bridge for Yakima County," *Pacific Builder and Engineer* 45 (2 September 1939): 33-35.

[51] S. C. Watkins, "Hollow Girder Design Used For Bridge at Aberdeen," *Western Construction News* 12 (November 1937): 405-52.

[52] Clark E. Eldridge, "First Box-girder Bridge For Washington Highway," *Western Construction News* 13 (December 1938): 443-44.

[53] "Box-girder Bridge Used on Federal Aid Road," *Western Construction News* 13 (September 1938): 330-31.