

The 1,200-Ft. Cantilever Bridge at Longview, Wash.

Columbia River Crossing 50 Miles Below Portland, Ore., Completed as
Toll Structure After Many Legal Difficulties—Provides 1,100-Ft.
Channel With 195-Ft. Vertical Clearance

By CLIFFORD E. PAINE
Vice-President, Strauss Engineering Corp., Chicago, Ill.



FIG. 1—LAST MOVE OF THE TRAVELERS ERECTING THE 1,200-FT. CANTILEVER SPAN
OVER THE COLUMBIA RIVER AT LONGVIEW, WASH.

THE COLUMBIA RIVER Longview bridge, which was opened to traffic on March 29, spans the Columbia River at Longview, Wash., 50 miles below Portland, Ore. It is the longest cantilever structure in the United States, having a main span of 1,200 ft. and anchor arms 760 ft. long. In addition, its clearances above mean low water are unusual—185 ft. at the channel pier and 195 ft. at the center of the main span. A plan and elevation in Fig. 2 give dimensions and indicate the long approaches.

History of Project—Having failed in an effort to have the bridge built jointly by the states of Washington and Oregon, those most interested in the development of the district prevailed upon private interests to promote the enterprise, with the result that W. D. Comer and Wesley Vandercook were granted a franchise in February, 1925. The franchise, however, required that the plans be approved by the highway departments of the states of Washington and Oregon. The highway department of the State of Washington approved the plans. The highway department of the State of Oregon did not approve the plans and the Oregon Legislature passed a bill which restrained the highway department from approving them until they were first approved by the port of Portland. Before this obstacle could be overcome the franchise expired.

A second franchise was obtained by the promoters in January, 1927. Under this franchise, approval by the highway departments of the two states was eliminated and it was stipulated that the plans must be approved by the secretary of war, the secretary of commerce and the secretary of agriculture. After many hearings before the three secretaries and their representatives, a permit to construct the bridge was issued Nov. 3, 1927. The

permit stipulated a clear channel width of 1,000 ft. with a minimum vertical clearance of 185 ft. at the channel pier, 195 ft. at the center of the channel, and 155 ft. at the Longview pier-head line. It also stipulated that there should be only one pier between the channel and the Longview pier-head line. In order to meet this latter requirement it was necessary to utilize a main-channel span of 1,200 ft. and to adopt the unusual anchor-arm length of 760 ft.

Foundations

Conditions—Borings indicated a bed of gravel and sand extending more than 100 ft. below mean low water. Overlying this stratum of gravel and sand was a deposit of black basaltic sand of varying depth. The upper surface of the gravel bed was at El. 84.7 below datum on the Washington side (at pier 1, see Fig. 2), from which it sloped upward toward the Oregon side to El. —55 at pier 2, —42 at pier 3 and —32 at pier 4. The depth of water at piers 1, 2, 3 and 4 is approximately 35 ft. at mean low water stage. At a 17-ft. river stage the velocity of the current is 6 miles per hour.

Pier Design and Construction—Pier 1 is carried down to El. —50 where it is founded on piles (20 in. or more at the butt) driven to refusal with an average penetration of 30 ft. The footing is 24 ft. wide, 81 ft. long and 12 ft. deep. Two hundred and sixteen piles were used, and the direct load per pile from dead load plus live load is 22 tons.

From the top of the footing up to El. —2.0, pier 1 consists of two vertical shafts $11\frac{1}{2}$ ft. square connected by a solid diaphragm of concrete which varies uniformly from a thickness of $11\frac{1}{2}$ ft. at the bottom to 6 ft. at the top. Above El. —2.0 the two vertical shafts are extended

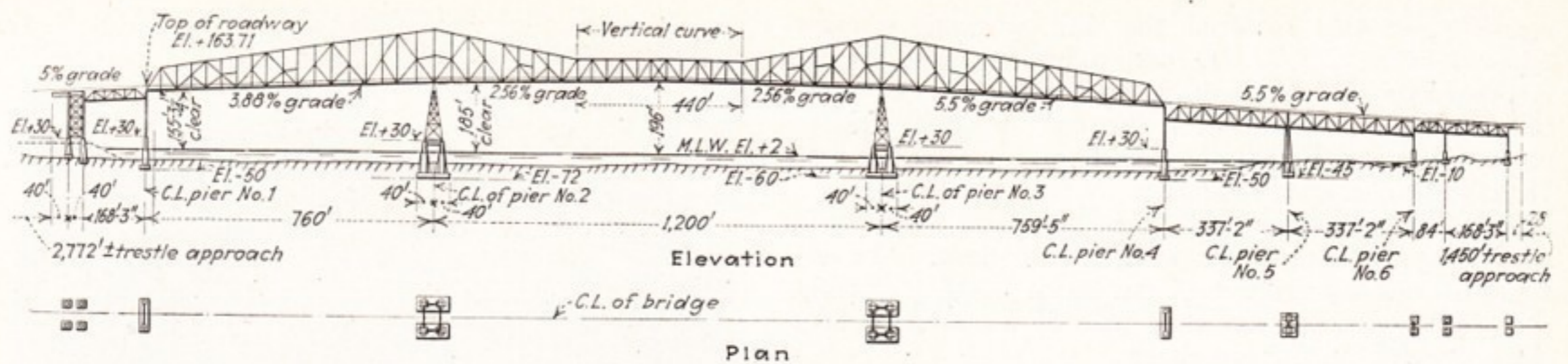


FIG. 2—PLAN AND ELEVATION OF COLUMBIA RIVER-LONGVIEW BRIDGE

upward to El. 30 and are connected at the top with a diaphragm 15 ft. deep and 4 ft. thick. Shafts and diaphragms are heavily reinforced.

For the construction of the portion of the pier below El. -2.0, a crib was built of 12x12-in. timbers tightly bolted together and calked. The inside dimensions of the crib conformed to the outside dimensions of the pier. The crib was built and all reinforcing steel was placed within it at the Pacific Bridge Co.'s dock at Portland, Ore. Excavation for the pier was accomplished by means of a clamshell bucket, after which piles were driven to grade. The crib was floated 50 miles down the river to the bridge site and sunk in place. All openings between the bottom edges of the crib and the excavated hole were carefully closed up with lagging.

A vertical bulkhead separated the crib into two halves, the bulkhead being shaped to provide proper keys for the joint. Concrete for half of the pier, from El. -50 to El. -2.0, was then poured in one continuous operation by means of two 10-in. tremies, which, with their hoppers, were supported directly on the crib. During pouring there was no movement of the tremies except the raising and lowering necessary to control the flow of concrete. As the concrete rose in the crib the shortening of tremies was effected by removing successive sections of the pipe at the upper ends. The upper portion of the pier (from -2.0 to 30.0) was placed in the usual manner.

Pier 4 is similar to pier 1 except that it is founded on the gravel bed with a unit-bearing pressure of less than 3 tons per square foot.

Pier 2 is also founded on gravel but at El. -72.0. It has two footings, each 39x84 ft. with the long dimension parallel to the axis of the bridge. The footings are 16 ft. deep and are spaced 70 ft. c. to c. Each footing carries two vertical shafts 45 ft. apart, having a cruciform section at the base of each arm, which is 33 ft. 4 in. long and 14 ft. wide. The section reduces uniformly to a square 14 ft. on a side which extends from El. -2.0 to 30.0. At the top all four shafts are connected by deep longitudinal and transverse diaphragms.

The method of construction of this pier was the same as for pier 1. Separate cribs were made for each footing

and a bulkhead was placed so that one shaft and half of one footing were poured as one unit. In this operation four tremies were used within the shaft. On one side of each shaft the crib was built to clear the shaft by 3 ft., and separate forms were provided for that face of the shaft. After completing the pier this well between the crib and the shaft was pumped out, the forms were removed and the surface of the concrete was inspected. Inspections made in this way in six wells on the several piers revealed in every case an excellent grade of concrete.

Pier 3 is similar to pier 2 except that the bottom of the footing is at El. -60.0. It is worthy of mention that although more than 20,000 cu.yd. of tremie concrete was placed, the work was so skillfully handled by the contractor that only once during the whole operation did a tremie lose its charge.

Superstructure

General Design—The bridge carries a 27-ft. roadway and two 3-ft. sidewalks. The trusses of the main bridge and of the 335-ft. approach spans are designed for a live load of 60 lb. per square foot plus impact. The trusses of the shorter deck spans are designed for a live load of 100 lb. per square foot plus impact. The floor system throughout is designed for a live load of two 20-ton trucks on the roadway, plus an impact allowance of 30 per cent.

Silicon steel is used for all main members in rocker bents, towers, trusses and main spans and 335-ft. side



FIG. 3—LONGVIEW BRIDGE PROVIDES 195-FT. VERTICAL CLEARANCE UNDER MAIN SPAN

Note the timber falsework supporting anchor arms,

spans. For this material the unit working stresses adopted were 24,000 lb. per sq.in. in tension, and 22,500-75 l/r lb. per sq.in. in compression. For ordinary structural carbon steel, the unit working stresses employed were 16,000 lb. per sq.in. in tension, and 15,000-50 l/r in compression.

The 760-ft. anchor arms were designed to be self-supporting as simple spans without floor deck. The design provided for erection of the entire 1,200-ft. channel span by the cantilever method with 85-ton stiff-leg derricks working on the top chords.

Erection—The deck truss spans and the anchor arms were erected on falsework and work on the anchor arms proceeded from the shore toward the main towers. Although the anchor arms had been designed as self-supporting spans so that falsework would be necessary for a minimum length of time, no advantage was taken of this, since river conditions were so favorable, and the anchor arms were not swung until after the cantilever arms were completed.

Since the shoes at the top of the main towers (Fig. 4) are fixed, it was necessary to shift the anchor arms in a longitudinal direction in order to make the pin connections between their bottom chords and the shoes. This movement was easily effected by a slight racking of the falsework. The suspended span was cantilevered out an equal distance from each side of the channel. Final closing was effected by means of 500-ton hydraulic jacks placed in the bottom and top chords at the connection of the cantilever arms and the suspended span.

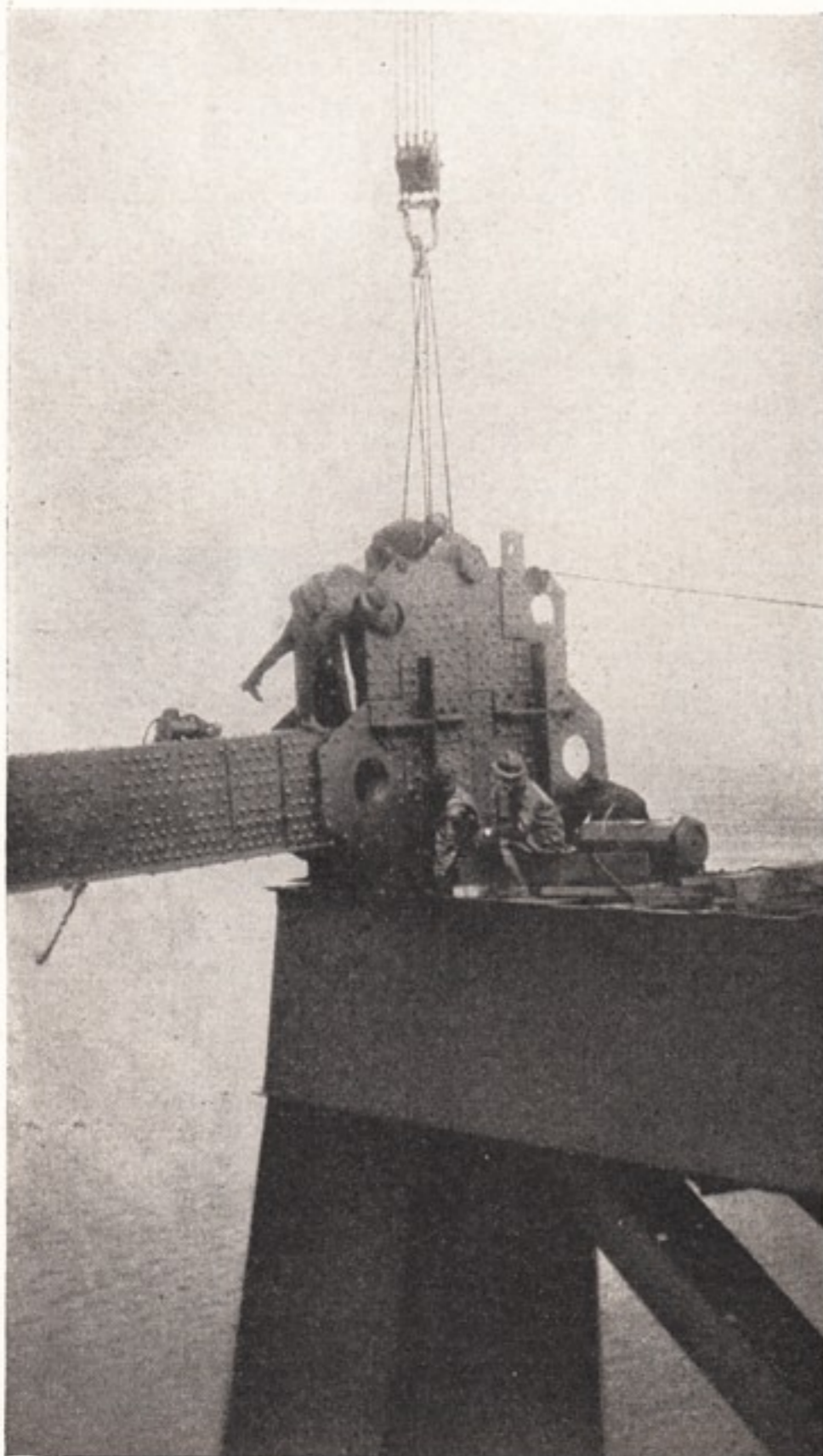


FIG. 4—SETTING MAIN SHOE ON TOP OF TOWER AT PIER 2

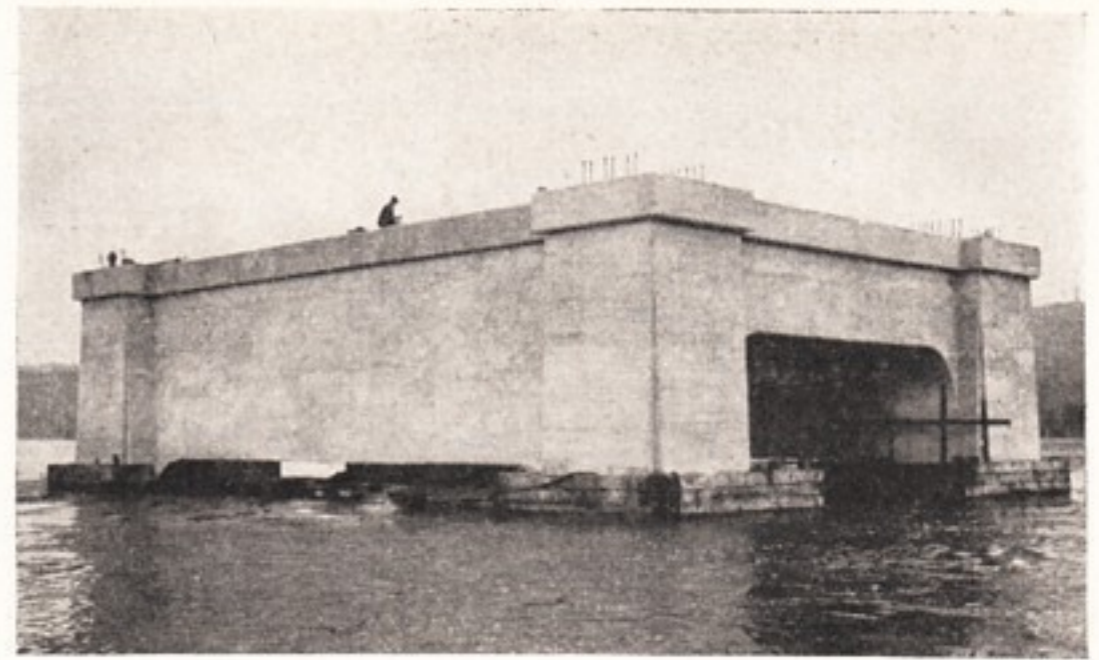


FIG. 3—MAIN CHANNEL PIER COMPLETED, LONGVIEW BRIDGE

Constructed by open crib with tremle-placed concrete

During erection of the suspended span, forms were placed on the anchor arms for the floor deck, and pouring of concrete was started. The floor slab has a total thickness of 6 $\frac{3}{4}$ in. and is a 1:1:2 mix of concrete using a lightweight volcanic rock for aggregate, which gave a unit weight of 120 lb. per cubic foot, and physical properties substantially equal to those obtained when using gravel aggregate.

Progress of the Work

General design plans for the project were started in October, 1928, field work began in November, and the bridge was opened to traffic on March 29, 1930—eighteen months after commencement of the general plans. More remarkable than the time record, however, is the record of building a structure of this magnitude without suffering a serious injury to any employee on the work. Approximately 25,000 cu.yd. of concrete and 12,800 tons of structural steel were required in the construction of the bridge.

The Bethlehem Steel Co. was general contractor. The Pacific Bridge Co. was subcontractor for the foundations and J. H. Pomeroy & Co. were subcontractors for steel erection. The Strauss Engineering Corp., as engineer for the Columbia River Longview Bridge Co., made the design and supervised the construction.

Experimental Highway to Be Constructed to Test Types of Low-Cost Surfacing

Construction of an experimental highway, with twenty half-mile lengths of various low-cost oil-treated surfaces, has recently been started under the joint supervision of the U. S. Bureau of Public Roads and the California Division of Highways. The same two organizations will maintain the 10-mile stretch for three years, keeping account of the construction and maintenance cost as well as the service obtained, with a view to obtaining accurate comparative cost data for the various types of surface used. Some sections will be sealed before winter and others will be sealed later, depending on their action under weather and traffic conditions. The test road is located in the mountains near the Nevada line, where the climate includes both severe winter conditions and warm, dry summers. Results of the test, according to the division of highways, should be of value not only to California but also to other states that look to the Bureau of Public Roads for this type of information.