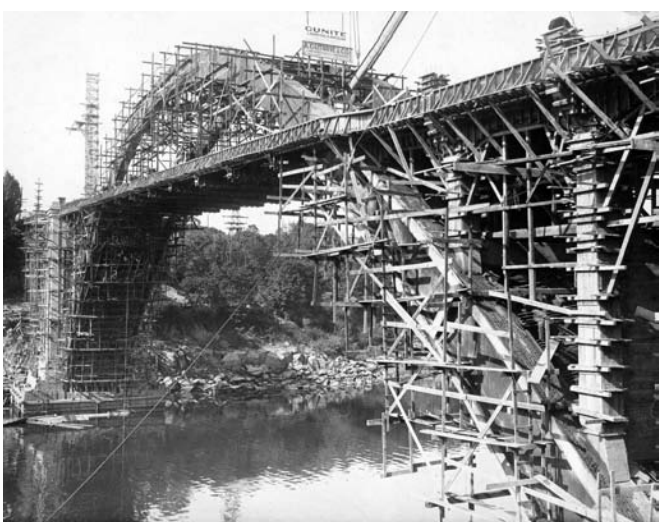
The Oregon City Bridge (Part I)

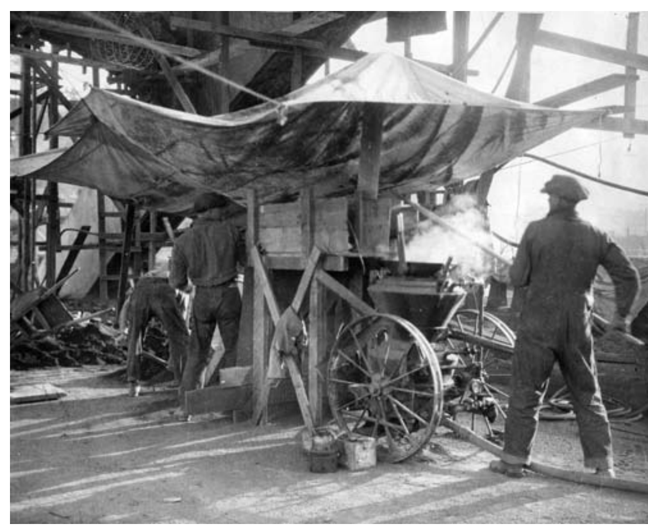
By Marcus H. von der Hofen

The Oregon City Bridge, which spans the Willamette River between Oregon City and West Linn, OR, served the community for nearly a century before recently getting a major overhaul. Originally completed in December 1922, this steel box girder arch bridge was—and still is—a beautiful landmark of the region. Designed under the direction of State Engineer Herbert Nunn, the plans of State Highway Engineer C. B. McCullough were adopted and carried out. A unique feature of the project was the encasement of the steel structure in what was then called "gunite" to protect it from the emissions of the paper mill located close-by.

The bridge is 900 ft (274 m) long, including the viaduct design approaches. The center section of the bridge measures a horizontal distance of 140 ft (43 m) with the supporting arches above built on a 160 ft (49 m) radius. The remaining 210 ft (64 m) of the center span are supported from below by the continuation of the arches on a 306 ft (93 m) radius. The box beam arches start with a section of 10 ft (3 m) deep at the base, reducing to a 6 ft (1.8 m) depth at the top with the width remaining the same throughout. This all supports a roadway deck 18 ft (5.5 m) across curb to curb with a sidewalk on each side and the added bonus of restrooms located at the piers under the sidewalk at



Oregon City Bridge during construction
Photo courtesy of the Oregon Department of Transportation



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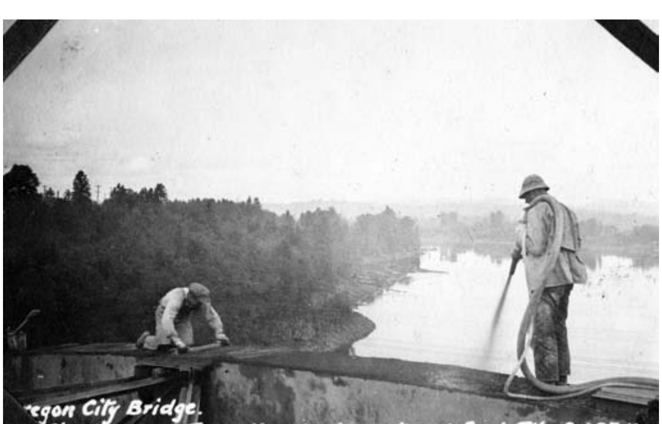

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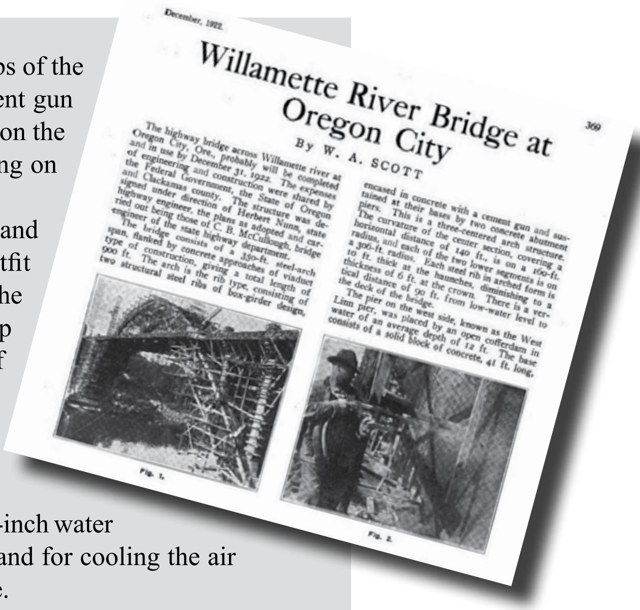
each end. All of this could have been yours in 1922 for a published cost of $300,000.[1] As of 2000, the bridge carried 12,800 vehicles per day, which represents only a 40% growth in traffic since 1953.

The bridge was built to replace an 1888 pedestrian suspension bridge. Workers used the old bridge to begin construction of the present bridge's box steel ribs.[2] Construction was made difficult by the great depth of the river at the bridge site and the water traffic during construction. Construction workers used the cables of the old bridge to support the arch during the assembly. Once the new arch was completed, the old suspension bridge was dismantled.[3]

During my research, I was able to track down an excellent article[4] written by W. A. Scott published in the December 1922 issue of *Engineering World* that gave a detailed account of some of the gunite operation. Scott wrote the following in his article[4]:


December, 1922. 369

Willamette River Bridge at Oregon City

By W. A. Scott

The highway bridge across Willamette river at Oregon City, Ore., probably will be completed and in use by December 31, 1922. The expenses of engineering and construction were shared by the Federal Government, the State of Oregon and Clackamas county. The structure was designed under direction of Herbert Nunn, state highway engineer, the plans as adopted and carried out being those of C. B. McCullough, bridge engineer of the state highway department.

The bridge consists of a 350-ft. steel-arch span, flanked by concrete approaches of viaduct type of construction, giving a total length of 900 ft. The arch is the rib type, consisting of two structural steel ribs of box-girder design, encased in concrete with a cement gun and sustained at their bases by two concrete abutment piers. This is a three-centered arch structure. The curvature of the center section, covering a horizontal distance of 140 ft., is on a 160-ft. radius, and each of the two lower segments is on a 306-ft. radius. Each steel rib in arched form is 10 ft. thick at the haunches, diminishing to a thickness of 6 ft. at the crown. There is a vertical distance of 90 ft. from low-water level to the deck of the bridge.

The pier on the west side, known as the West Linn pier, was placed by an open cofferdam in water of an average depth of 12 ft. The base consists of a solid block of concrete, 41 ft. long,

Fig. 1.

Fig. 2.

"A feature of special interest was the work of encasing the steel ribs of the arch with concrete, which was applied with a cement gun. The cement gun was used also in producing a concrete web, extending from rib to rib on the underside of the arch. The gunite web was backed by steel reinforcing on the steel struts and braces between the ribs.

The guniting was done under subcontract by Lanning & Hoggan and was directly supervised by A.C. Forrester, Civil Engineer. The outfit used was the N-1 type cement gun of the Cement Gun Co., Inc., and the necessary auxiliary equipment. The latter comprised a J. I. Case 45-hp tractor engine, an Ingersoll-Rand single stage air compressor of 325 cubic feet displacement. The air was conducted through 100 feet of 1-1/2 inch rubber hose to the cement gun on the east shore. A line of Pioneer Rubber Mills' 1-1/4 inch sand blast hose extended from the cement gun to the points of gunning, this distance varying from 100 to 450 feet laterally and to a maximum of 120 feet vertically. A 3/4-inch water line, connected to a city main, served to deliver water to the engine and for cooling the air compressor, as well as furnishing a supply to the 1 inch gunite nozzle.

The cement gun charge was made up in the ratio of 1 part cement to 3 parts washed river sand, the latter being graded from 1/2 inch down to fines. The moisture in the mixture was reduced by a railroad sand drier. However, this moisture reduction was varied some according to the humidity of the atmosphere. The volume of water coming in contact with the sand and cement in the gunite nozzle was so regulated by the operator as to produce concrete that would conform to standard practice—admitting water sufficient to hydrate the cement. In applying the gunite a distance of about 3 feet was maintained between the nozzle and the surface being gunited, the gunite being shot at a velocity of about 300 feet per second under an initial pressure of 60 pounds.

This work required 40,000 square feet of 2 inch guniting on the steel ribs; 1200 square feet of 6 inch gunite for the web on the underside of the arch; 800 square feet of 4 inches thick; 1200 square feet of 3 inches thick, and 2800 square feet varying from 6 inches down to 2. The 2 inch gunite coat over the steel ribs was shot against No. 28 U.S. Steel Co. wire mesh, fastened to steel rods, the latter being spot-welded to the steel structure. On this particular part it is figured that 75 square feet of gunite resulted from each cubic yard of sand used. The 6 inch gunite was applied to build up the concrete web between the steel ribs and this extended from the base of the arch up to the first panel. This web was continued higher up in 4 and 3 inch coats. All inside struts and braces below deck were wrapped with wire mesh and sheathed with gunite. Relative to applying the 2 inch gunite which constituted the major part of the job, it is stated that the work carried on at the rate of 500 square feet per day of 8 hours.

In the illustrations given herewith there is shown some of the scaffolding required in carrying through this unusual job of guniting. All the gunited surfaces were gaged by straight edge to a true plane, giving them a finished appearance. The efficiency of the cement gun and accessory equipment on this piece of work was demonstrated to the satisfaction of those assumed responsibility for the character and speed of construction. The aesthetic features of the bridge as they appear in the general view, will commend themselves to those who like to see a touch of the artistic imparted to a structure of severe utility."

(Note: 1 in. = 25 mm; 1 ft = 0.3 m; 1 ft^2 = 0.09 m^2; 1 lb = 0.45 kg)

During my first visit to inspect the bridge, I must say I was more than a little overwhelmed by the craftsmanship of this structure. It was and still is amazing to me. The quality of the gunite that these crews produced so long ago is impressive. Not that there weren't any problems, but for the most part, the gunite has held up incredibly well over the years. The finish, the consistency and, again, the overall craftsmanship produced by the crews must have made subcontractor Lanning & Hoggan immensely proud (and I hope some money). Most of the deficiencies I saw really didn't have anything to do with the gunite but were inherent to the design. It was amazing to see reinforcing steel mesh exposed in a hydrodemolition test area in the same condition as when it was placed on the bridge 90 years earlier.

As I walked the job, it became more and more amazing to me what these early shotcreters had accomplished nearly a century ago. Even with all the modern shotcreting tools we have today, duplicating the quality of the shotcrete work on this bridge would be a major challenge.

Oregon City Bridge during construction
Photo courtesy of the Oregon Department of Transportation

In April 2010, Wildish Contractors was awarded the contract for the rehabilitation of the Oregon City Bridge. Its goal was to upgrade the structure to regain the capacities it once had while keeping the original appearance of this historic icon. A great deal of work would be necessary to carry out this upgrade within the short time frame of only 2 years. The history behind the building of this bridge plays a large role in this two-part story of an old bridge becoming new again. Stay tuned in 2013 for the second half of this transforming story!

References

1. Wood, S., *The Portland Bridge Book*, Oregon Historical Society, Portland, OR, 2001, 140 pp.
2. Hadlow, R. W., *Elegant Arches, Soaring Spans: C.B. McCullough, Oregon's Master Bridge Builder*, Oregon State University Press, Corvallis, OR, 2001, pp. 51-53.
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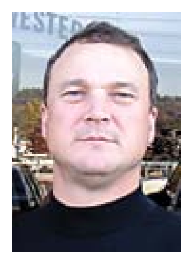

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