The Oregon City Bridge, Part II

By Marcus H. von der Hofen

This is the second of two articles discussing the Oregon City Bridge. The first article, "The Oregon City Bridge, Part I," was published in the Fall 2012 issue of Shotcrete *and discussed the historical background of the bridge. This article covers the recently completed rehabilitation project.*

The Oregon City Arch Bridge Rehabilitation project was officially completed on October 31, 2012, by the Wildish Standard Paving Company. Dedication to quality and professionalism, along with a true partnering between owners, contractors, and suppliers, helped find ways to solve problems that could have easily turned the project into overwhelming confrontation and failure. This article is dedicated to those who pride themselves on working toward the best solutions.

Wildish was tasked with renovating a historic bridge that is 90 years old, replacing structurally deficient components and accurately replicating the details and architectural features of this Conde McCullough through-arch bridge. McCullough's signature detailing is evident in the arches, obelisk pylons with sconce light fixtures, ornate railings, and art deco piers. It is believed to be the only bridge of its kind in the entire United States—a through-deck steel arch covered with shotcrete that incorporates concrete spandrel columns, corbels, a sidewalk, deck approach spans, and a bridge rail (refer to Fig. 1).

The shotcrete covering had caused many a bridge expert to be deceived into thinking this was a structure made entirely of concrete. In all actuality, it is a steel structural arch design encased in shotcrete to protect it from the emissions from industries located in close proximity. Originally placed using the dry-mix method nearly a century before, the protective concrete would need to be removed and replaced to the original lines and grades (refer to Fig. 2 and 3).

One of the first questions to contemplate was: Should it be done wet or dry? Should it be both? Today's shotcrete technology offers efficient site batching of material in small amounts both wet and dry; state-of-the-art batch plants and testing facilities also allow ready mix producers to perform various adjustments and quality control that simply was not available 90 years ago. The project has areas that really lend themselves to either method. The bottom line in this case came down to what the personnel felt the most comfortable with. I don't find this reason brought up in the discussion very often, but it really should be part of the process. Many contract specifications are

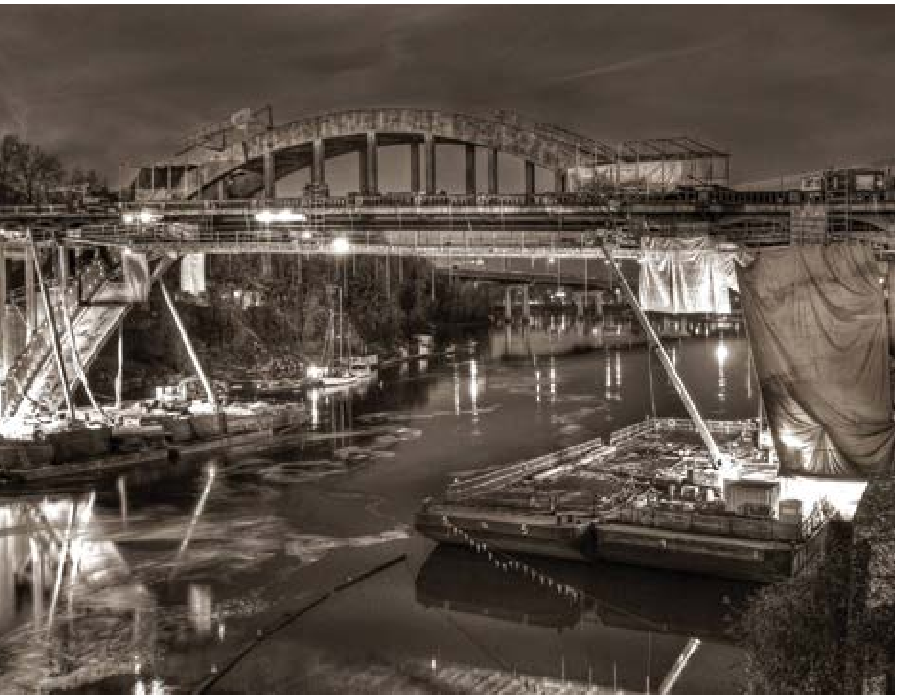


Fig. 1: Oregon City Bridge—multiple access methods

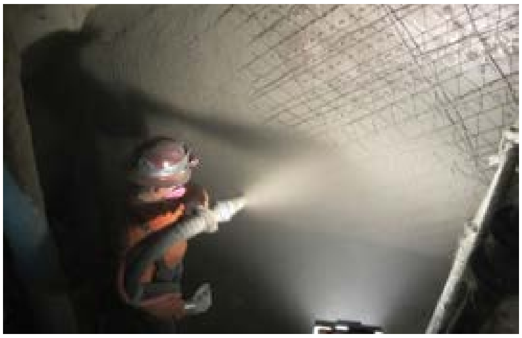


Fig. 2 and 3: Shotcrete placement inside the arches written making the choice, and I personally don't think that is the right answer. The fact is that many jobs can be done efficiently and correctly either way, so the choice should be left up to the qualifications of the contractor.

In this case, my personnel and I agreed that we could perform the job more effectively using the wet process. At first, I believed that we would do the project using both site-batched bagged material and ready mix. After initial testing, I became convinced that the ready mix supplier CEMEX, with whom I had a long working relationship, could lend invaluable expertise to the project. As it turned out, it was a good decision (or maybe just lucky) on my part, as their ability to provide extensive resources, quality information, and testing played a large part in the success of the project.

Initial trial batches based on the project specification seem to function reasonably well, but there were definitely some issues. The specification called for specific levels of 8% or less boiled absorption. The initial test came back at 7.6 to 7.9%, leaving little margin for variation. Secondly, there was a great deal of reluctance to allow a hydration stabilizer because it might affect the bond. The bond was specified at 150 psi (1 MPa) shotcrete-to-steel, but no data were available showing this was achievable. The specification required hydrodemolition of the existing shotcrete followed by an abrasive blast of the surface. This created some degree of ambiguity. Thus, it was decided that a surface preparation mockup test should be conducted.

The initial surface preparation test section was divided into three areas: one with a walnut shell blast, the second with a light sand blast, and the final area with just an air and water blast. The initial process was the belief that minimizing the removal of the existing material (steel surface and attached mesh) would be a good approach, and to then build the sections back up from there. The surface preparation tests had almost identical results from each of the three methods, with values ranging from 0 to 120 psi (0 to 0.83 MPa) with the majority being 0. After this initial test, it was obvious that more extensive testing would be required. Steel road plates were used to represent the bridge surface during the next test, which included a variety of differing parameters, including more extensive sand blasting, bonding agents, accelerators, hydration stabilizers, and different curing methods. In the end, a complete white blast of the steel surfaces proved to be the most effective with a multi course sandblast material. But even then, the results were still not very consistent. Sections would bond well and meet the specification and others would have no bond at all. Another effect that seemed to be creating the variability was the shrinkage and the

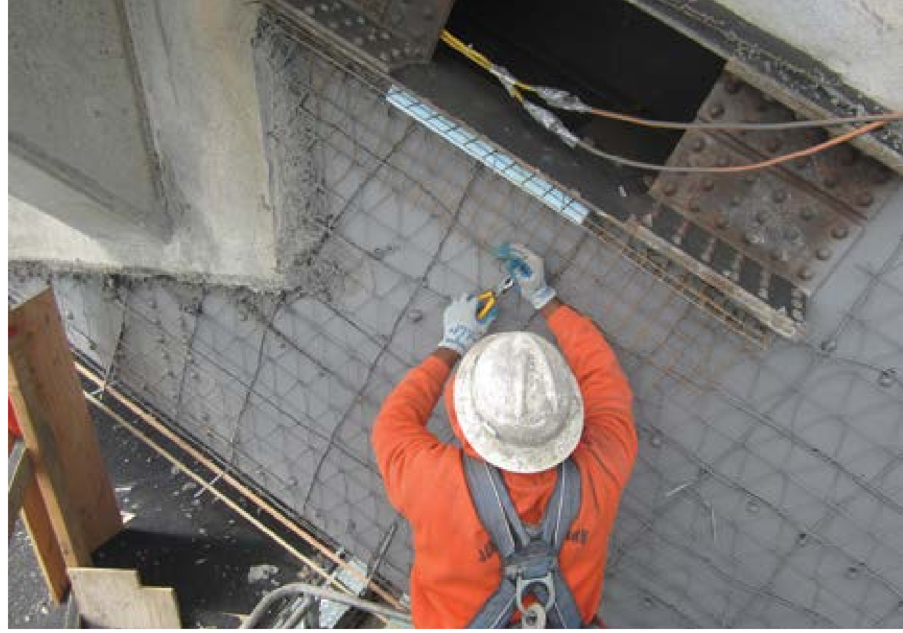
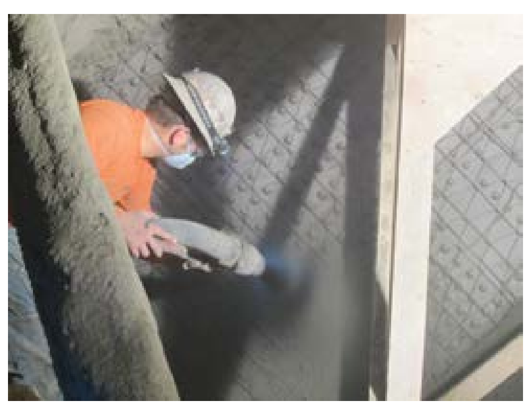


Fig. 4: Repairing mesh prior to shoot

Fig. 5: Positioning the equipment for the next shoot



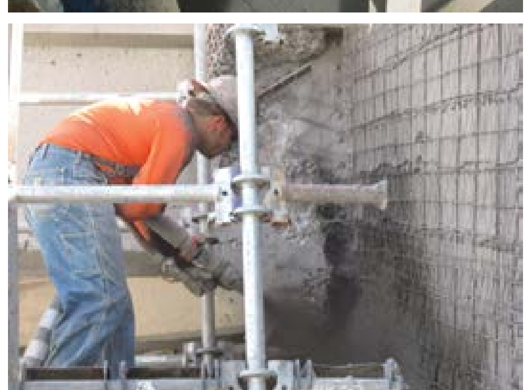


Fig. 6 and 7: Ever-changing shooting positions flexural properties of the shotcrete material. The specification called for minimum levels of silica fume and cement, but we decided we needed to rethink this.

This is typically where I've seen a great number of projects become dysfunctional. The focus changes from getting the job done correctly to minimizing the damage and protecting one's best interest. The parties become more adversarial than trying to work together to solve the problems and move forward. Fortunately, with this project, the Oregon Department of Transportation (ODOT) and its team stepped up not only financially but also (and more importantly) remained focused on finding the best solutions. I believe their role was instrumental in allowing both the contractors and suppliers the means to find the best answers in a timely manner. I think a statement made by a member of Wildish Standard Paving sums it up best:

"Our shotcrete applicator was committed to achieving the very best mix design that could be developed. From the original mix we reduced the silica fume content; used other supplemental cementitious material, including fly ash and added fiber; and a W R Grace retarder to slow the set time. After developing eight different trial batches for the project, they were able to identify a concrete mix that exceeded the requirements of the specifications, while offering better adhesion and more elasticity than originally specified. Were it not for their perseverance in obtaining the best possible product, the shotcrete applied to the bridge might have met the original project specification, but would not have been as durable over the years. From the original mix, which produced a 10 to 30 psi (0.07 to 0.21 MPa) bond pulloff strength, we increased to getting over 300 psi (2.1 MPa) with the final mix."

I would add, it was really the commitment of all the parties to achieve the best quality and durability that allowed this to take place (refer to Fig. 9).

As a result of the efforts by many, including Wildish Standard Paving, Johnson Western Gunite, CEMEX, and ODOT, the project team rehabilitated a beautiful historic landmark of the region in a safe and effective manner. Through working together toward a mutually desired end goal, I believe we produced a durable, serviceable, and aesthetically pleasing project that will be enjoyed by many generations to come. For information on the concrete mixture designs and specific test results, please contact ASA.

Fig. 8: Overhead finishing

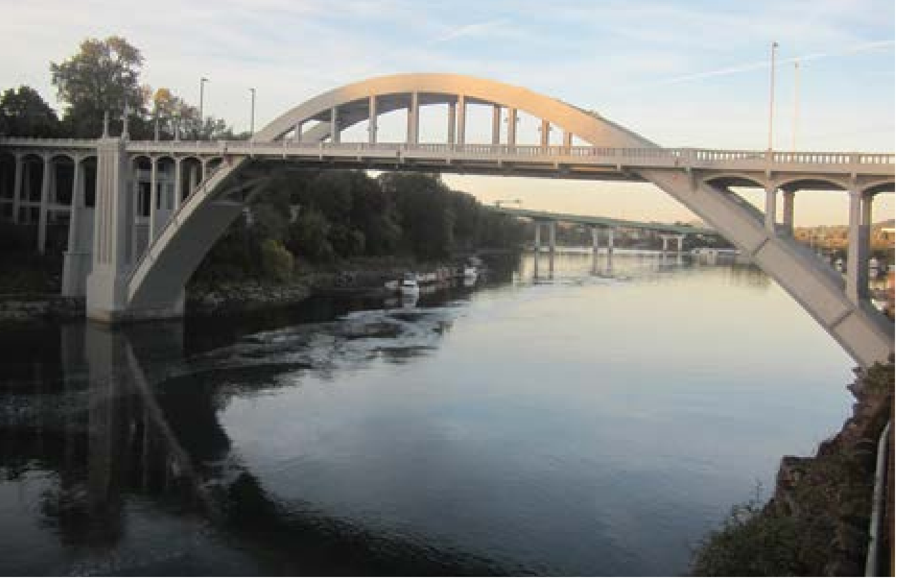


Fig. 9: The finished product

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