

Changing a Culture Takes Time

By Mark Croarkin

Changing a culture takes time. Missouri's reputation as a "Show Me" state stands true as MoDOT engineers had to be shown that shotcrete is a viable solution before they opened up their specifications.

On June 1, 2011, MoDOT partnered with Concrete Strategies (a St. Louis contractor) and BASF (material supplier) to host a shotcrete demonstration on the substructure of a bridge in Chesterfield, MO. Contractors, consultants, construction inspectors, bridge engineers, and many more observed a live demonstration of shotcrete. This event kindled positive conversations on shotcrete applications, which ultimately had to overcome decades of concerns derived from observations and opinions formed during an era filled with poor quality control, little to no specifications, and no nozzleman requirements.

In November of 2011, Dan Millette with Euclid held a shotcrete class for MoDOT in Chesterfield. As a representative of the American Shotcrete Association (ASA), and a former ACI nozzleman

examiner, Millette was an excellent source of information to help educate our group on the history of shotcrete, types of equipment, mixture information, safety practices, and much more. ASA has been extremely helpful and more than willing to hold education sessions like this for interested parties. I would strongly recommend that agencies interested in shotcrete take advantage of the expertise within ASA. After a demonstration, some education, and a few field trials here and there, the only thing left was to wait. It takes time to evaluate products, so time is what MoDOT needed to evaluate before allowing shotcrete placement on a more regular basis.

Shotcrete repairs are now fairly commonly allowed by Job Specific Provisions (JSP) in Missouri and many construction inspectors have become familiar with its use. While MoDOT relies heavily on ACI 506.2, "Specification for Shotcrete," each job may have additional considerations. Some portions of the job specifications tend to be enforced more strictly than others. The



Fig. 1: June 2011 Chesterfield, MO, demonstration

American Concrete Institute (ACI) or EFNARC (the European Federation of National Associations Representing producers and applicators of specialist building products for Concrete) nozzleman certification is a must. MoDOT recognizes that the experience in the art of placing shotcrete is critical to its success. While there is currently only a certified nozzleman requirement, the experience of the entire placement team contributes to the quality of the repair. If a large project was to allow the use of shotcrete, experience requirements for the contractor with similar projects would likely be required. An area not as strictly enforced has been moisture requirements of dry material, which typically require the use of a pre-dampener or a hydro-mix nozzle. To keep costs down on small applications, MoDOT has focused more on cracking issues and has left the application up to the nozzleman. We have had good performance with a few pre-bagged products that are prequalified for use on small quantity projects without requiring additional testing, although we always reserve the right to test.

While wet-mix placement methods have been used, dry-mix shotcrete or the old tradename “gunite” is typically the method of choice due to the small quantities being placed at a time. During the learning process, some MoDOT trials were in less than ideal environments, and shrinkage cracks appeared. While shrinkage cracks are not typically a long-term issue in a material that is so dense, they definitely catch the attention of bridge inspectors. Most trials that resulted in shrinkage cracks were sealed with 100% acrylic overcoats such as BASF’s Thorocoat to seal the cracks. Temperature, wind, time to finish, and curing methods are topics that are typically discussed now to avoid shrinkage issues.

The majority of shotcrete use in Missouri has been fairly small areas of substructure, deck, and superstructure repairs in locations exposed to high chlorides. The repair restores the area to protect other elements from the harmful chlorides used to melt snow. Shotcrete has the ability to produce a high-quality repair with minimal access to the location being repaired, which typically results in cost reductions. The specific characteristics that are so appealing to MoDOT engineers are cost savings, the low chloride permeability, and the high bond strength. Prepackaged products such as BASF Shotpatch 21-F, Euclid Chemical Eucoshot F, King Shotcrete MS-D1, and CTS Cement Low-P have been successful enough such that they are typically preapproved for small quantity use in Missouri. Numerous very-low, 28-day chloride permeability (around 300 coulombs) and pulloff strengths consistently exceeding hand patch or “form and pour” comparisons have made this decision easy.

While MoDOT has not had a large iconic project that makes headlines in trade magazines, they have made great strides in their knowledge and use of shotcrete over the last 5 years.



Fig. 2: Shotcrete repair under a bridge



Fig. 3: Proper curing is a critical part of shotcrete placement



Mark Croarkin graduated from the Missouri University of Science and Technology in 1997 and has been a licensed professional engineer since 2002. With the exception of 1 year of experience in private industry, Croarkin's career has been dedicated to MoDOT. His foundation started with Construction Inspection, but his experience includes working in six of MoDOT's seven geographically diverse districts in materials, construction, design build, bridge maintenance, and maintenance positions. Recently, Croarkin has been promoted to lead all of MoDOT's maintenance efforts as the St. Louis District Maintenance Engineer. From 2009-2016, Croarkin was responsible for the safety of all structures in the St. Louis region, as well as directing repair crews and prioritize contract repairs. His passion for finding better ways to maintain bridges earned him a reputation as a leader in innovation for the State of Missouri. This article describes his accounts of the road MoDOT took to allow shotcrete into the specifications.