

# Quality Control on the Injection Project

by John Trout

Deservedly, the resin injection process has more than a few skeptics. Specifiers have often been disappointed and embarrassed when assured results were not delivered. Specifications insisting upon years of experience, factory training, certifications, and licenses have not always helped.

Abundant guidance from contractors and resin suppliers has often larded specifications with procedural language calling out injection pressures, port spacing, porting devices, types of dispensers, frequency and nature of ratio checks, methods of installing the seal over the cracks, injection sequence, etc. This language has often discouraged the knowledgeable contractor who does not need guidance that often conflicts with techniques he prefers. Only the inexperienced, and probably therefore ill-qualified, have found such step-by-step guidance helpful.

For example, language requiring a minimum injection pressure will probably disqualify contractors favoring inflatable and spring capsule systems. Those use pressures of less than 10 psi (69 kPa) yet achieve very fine results on most applications through the use of an extended duration resin.

Another example is language calling for the initiation of injection at one end of the crack. This will frustrate contractors who find that better results and production are achieved by starting at the widest part of the crack. Other requirements such as drilling sockets for porting adapters, monitoring resin flow from port to port, etc., are also contrary to methods favored by many responsible contractors.

Knowledgeable contractors do not need guidance in selecting injection pressure, etc., anymore than a painting contractor must look to specifications to determine which type of tip or gun to use for spraying a particular coating. The specifier calls out little more than the results required and depends upon the painting contractor to have the skill and wherewithal to put them in place.

The same approach is a good one for injection. Call out, describe, or otherwise identify cracks to be injected. State the minimum crack width to be filled and to what depth. (As an example, requiring a contractor to fill cracks of greater than 0.003 in. (0.075 mm) to a depth of 8 in. (200 mm.) is reasonable). State that the injected resin shall be properly batched - i.e., with the correct ratio - and thoroughly mixed. Leave the details to the contractor.

Quality control is a four letter word: **C-O-R-E!** Simply state that cores are to be furnished throughout the project. Require the contractor to include one or two cores for each 100 ft (30 m) of injection with the understanding that cores will be taken from random locations as directed.

Do not use a unit price for cores. This can suggest they will not necessarily be required and may tempt a contractor to place a very high unit price on them to discourage their being taken. Include them! Leave no doubt about it! If additional cores are needed to verify re-injection necessitated by a poor earlier core, they should be at the contractor's expense. Such an approach will not add significantly to the project cost. A simple core drilling rig capable of delivering 2 in. (51 mm) diameter core is available to a contractor for less than \$2000. Unless difficult rigging gymnastics are needed, cores are taken without significant delays to the injection crew.

The cost of project supervision will be lower. Procedural specifications need to be frequently - if not constantly - monitored to assure compliance with pressures, ratio checks, sequence of injection, etc. The performance specification requires only a periodic visit by the owner's representative to observe cores and designate additional coring locations. The contractor is responsible for results, not merely procedural compliance. He has an incentive to perform with or without the presence of the owner's representative.

It is important to remove cores immediately after the project commences to become acquainted with the skill of the injection crew and the results available. If there is a problem, it is important to know about it, as soon as possible: it's called damage control. Get a grip on the problem quickly before it involves enough money to attract the lawyers. In some instances the contractor may be at fault; in others it may be discovered that the results needed are simply not available due to contamination within the cracks or some other factor.

Visually inspect the core on site for penetration and then demolish it to check for proper cure of the resin. If no breaks occur at the glue line, then the contractor gets paid.

The core requirement will not discourage the qualified and reputable contractor, only the ill-qualified. Skilled and reputable injection contractors are delighted to see specifications requiring cores since they know the ill-qualified will be discouraged. An inspector who does not see cores on his project usually does not know what results are being obtained. There are exceptions, but in most instances it is no less than a disservice to a client not to require cores to confirm that the results required are in fact in place.

Neither contractor nor inspector undertakes an industrial painting project without a mil gage. A core drilling unit is no less necessary on an injection project. If cores are required the contractor can only conclude that if the owner is concerned about the results he had better be also. Of course it works the other way around as well. Not every project lends itself to core verification. In some instances critical reinforcement could be endangered. In these cases - and especially where results are critical - contractor prequalification and site monitoring of the injection should be implemented.

Regarding contractor qualification, it is always nice to see a raft of color photos of the Grand Coulee Dam and other earlier projects, snazzy logos, messages from presidents, evidence of membership in numerous professional groups, a computer analysis of your project, certifications, licenses, and a litany of customers that reads like the Fortune 500. However, insist that at least two verifiable references for similar (identical is seldom necessary and may disqualify the qualified) projects carried out under current management and supervision be submitted with the bids. Request information regarding the contractor's projects and his performance. If possible, visit the earlier jobsite. If enthusiastic cooperation is lacking, the response is obvious. This is the only way to find a qualified contractor.

There are many responsible contractors entering the injection field in good faith and with every intention of performing with excellence. However, good intentions are no substitute for past performance on similar projects. An exception may be considered if the contractor has obtained personnel with verifiable job site successes.

Job site monitoring of injection need not be so obtrusive that the contractor feels harassed. It should include drilling of shallow (1/2 in. [12.5 mm]) holes between ports after injection to confirm the presence of cured material. Random samples of the injection resin should be taken during the course of the injection process - not at the beginning or end of the day. The resin sample should be dispensed at the prevailing job-site injection pressure and rate of flow.

Procedures and problems which suggest a poorly qualified contractor include numerous leaks at the porting adapters, setup or "cap" sealing the crack, frequently clogged injection lines (often an indication of ratio inaccuracy), uneven ratio consumption between resin components, use of manually retained resin line connections to ports (fatigue factor discourages duration and pressure), and the absence of occasional resin extrusion from micro fissures in the vicinity of the fault. Also, a poorly qualified contractor may be reluctant to continue injection on ports until refusal and may want to immediately move when resin bleeds from an adjacent port (this port-to-port mentality aborts injection prior to development of pressure within the fault).

The use of low injection pressures (less than 50 psi), which may not secure the results available also suggests a poorly qualified contractor. This anxiety does not apply where low pressure systems are being used with resins that have an extended pot life of perhaps 2 hours.

There is an infinite variety of jobsite conditions and projects that may justify exception to most of the preceding guidelines at one time or another. However, in nearly every instance, the performance specification is to be preferred to procedural language.