

## Certification vs. Qualification of Shotcrete Nozzlemen

by Merlyn Isaak

**Certify:** To attest; to testify to in writing; vouch for; to endorse as meeting set standards or requirements.

**Qualify:** To limit or restrict, as by conditions or exceptions.

In 2000, ACI, in cooperation with ASA, established a formal certification program for certifying shotcrete nozzlemen. Prior to that date, ACI had a guideline document for certifying nozzlemen, but it was not being uniformly applied, it contained outdated features and applications, and it was not being universally accepted nor endorsed.

In the mid 1990s, ACI Committee 506, Shotcreting, started the ball rolling for a formal program and, in conjunction with ACI's Certification Programs Committee (CPC), went through the process of getting the Financial Advisory Committee (FAC) and ACI Board of Directors' approvals. CPC established Committee C 660, Shotcrete Nozzlemans Certification, for the specific purpose of formulating a formal certification program using the established strict procedures common to all other ACI certification programs. In addition to following standard protocols, the committee solicited input from ACI membership, shotcrete industry members (even prior to ASA's existence), and design professionals. To ensure credibility of the program and also to satisfy federal guidelines regarding fair employment, a survey of knowledge, skills, and abilities ("ksa's") required to be an employable nozzlemans was conducted. This information then was distilled into a job task outline that became the basis for all examination, reference, and performance material for the program. Simultaneously, the committee established minimum criteria for examiners.

The resultant program consists of a 90-min written examination (60 to 70 questions) and a two-part performance exam. Part I of the exam involves the verbal querying by an examiner (using a program's standard checklist) of the candidate to assess his or her knowledge of

equipment, safety, and procedures. Part II involves the candidate shooting a test panel that contains several sizes of reinforcing. Subsequently, the panel is cored in five predetermined locations (through reinforcing) and the cores are graded per ACI 506.3.

The program covers both wet- and dry-mix processes, and two positions: vertical (as for walls) and overhead. A prototype or "beta" test of the program was sponsored by ASA at Streetsboro, Ohio, in September 1999. This session served to qualify a first set of examiners as well as work out the bugs and refine the program.

As with all other ACI certification programs, examination sessions (written and performance) are conducted by local sponsoring groups (LSGs). For most ACI programs, chapters typically become LSGs (ACI headquarters' approval is required in accordance with formal rules). However, for doing a shotcrete nozzlemans certification session, the equipment, yard space, and manpower requirements exceed most chapters' resources. ASA chose, as part of its charter, to embrace the certification of nozzlemen. As such, they were the first LSG to be approved for administering this program. Because of their national membership base, they continue to sponsor most sessions; another organization, Laval University, in Quebec, Canada, which has a shotcrete-oriented part of its construction-related curriculum, has also qualified as an LSG. This attests to the international appeal of such a program.

### Status

Since its inception, as of this writing (August 2002), approximately 270 examinations have been administered. Having acted as an examiner, I can attest that the program is largely satisfying the basic objective—namely, to certify nozzlemen with

# Shotcrete Corner

basic knowledge, skills, and abilities. It has become obvious by the failure statistics that those who do not study the reference material (“knowledge”) or have inadequate experience (“skills and abilities”) fail those respective parts of the examination.

## CAVEAT!

The reason for the exclamation mark is that there are a lot of shotcrete applications that go way beyond “basic.” I could list numerous examples, but anyone who is interested in or involved in this industry knows what I mean. For just one example, at where I work (California), shotcrete is regularly used for seismic upgrades of structures. These applications often involve very large and congested reinforcing, in multiple layers, sometimes up to  $\pm 2$  ft in thickness. Needless to say, the “basic” minimally qualified nozzlemen would not be up to such a challenge. *Shotcrete* and other literature are full of other examples. This leads to the other key word in the title of this article: “**qualification.**”

## Qualification

As the definition at the beginning of this article states, “to limit or restrict, as by conditions or exceptions,” there are conditions where the basic certified nozzleman will not be able to satisfy the project requirements. Just because a nozzleman is certified does not mean he or she is *qualified* for every project.

We must keep in mind that the certification program, as currently structured, is “baselined” at 500 h of experience. It is not intended to instantly make him or her into the shotcrete equivalent of a master craftsman. Rather, we are ensuring only that he/she has the *basic* knowledge, skills, and abilities that a group of industry representatives believe are important. The test panel consists of a 30 in. square by 3-1/2 in. deep formed box with a grid of various-sized reinforcing bars spaced 6 in. apart (except two No. 4 bars at 1-1/2 in. apart to simulate a noncontact lap splice). So when conditions are more demanding, **qualification** may be necessary.

How is this additional qualification achieved, you ask? The two most common methods I am familiar with are referral (with documentation) from another successful project of similar or higher degree of difficulty, or shooting a mockup that simulates the most difficult aspect of the project at hand. With the referral method, it is important to ensure that the nozzleman being

qualified is the one who shot the referenced work, and that the referenced work is of a similar or higher degree of difficulty.

When referrals are not a possibility, about the only other alternative is a mockup. In our part of the world, we are still using the Uniform Building Code (UBC), which has a list of several conditions **requiring** a mockup.

In my practice, I have prepared a checklist of situations where I recommend a mockup (assuming referral is not possible) that goes beyond code requirements. The list includes:

- Wall or section thickness greater than 12 in.;
- Reinforcing spacing closer than 6 in. on center with two curtains of reinforcing;
- Reinforcing spacing closer than 4 in. on center with one curtain;
- Reinforcing larger than No. 8 (1 in. diameter);
- Contact lap splices for bars larger than No. 6;
- Use of rebar couplers for splices with less than 4 in. clear;
- Non-contact lap splices with less than 2 in. clear;
- Heavily reinforced boundary elements on shear walls;
- Heavily reinforced columns or pilasters being integrally combined with other elements; and
- Inside corners with heavy reinforcing.

In order for a mockup to accomplish its intended purpose, it must be large enough to allow the nozzleman to demonstrate his ability. Mockups that are too small only penalize the nozzleman, as they are more likely to trap rebound.

On large projects, or those lasting longer than 2 or 3 days of shooting, it is advisable to **qualify** two or more nozzlemen.

Evaluating the mockup can be done by coring and core grading per ACI 506.3. Note that core grading is not permitted for evaluating the in-place work of a project. So it is extraordinarily important to qualify the nozzlemen up front *before* the project starts!

Some advocate dissecting the mockup by saw-cutting at various locations to look for voids. The drawback to this method is the lack of acceptance/rejection criteria.

## Conclusion

I look at certification as a necessary first step for a nozzleman to establish himself/herself as a shotcrete craftsman. The alert reader may have deduced from the previous commentary that a nozzleman could conceivably be *qualified* for a project without being certified (unless there is a specification requirement for being certified).

# Shotcrete Corner

Currently, this is a weak link in industry practice, because without that nozzleman having gone through the certification process, there is no way of knowing what he/she **knows** (that is, the “knowledge” element of ksa’s).

Knowledge for this program includes such items as: concrete basics, the effects and consequences of hot and cold weather, admixtures, the importance of curing, the role of fibers, safety, and quality controls. Shotcrete is often expected to compete with or take the place of poured-in-place concrete; therefore, the resultant shotcrete must be of equivalent (or better) quality. This can be consistently achieved only if the nozzleman is completely “rounded out” with respect to *all* aspects of shotcrete construction. Eventually, as design professionals become aware of the

certification program and specify it, the weak link will be largely eliminated, and the shotcrete industry and project owners will benefit.



*ACI Fellow Merlyn Isaak, P.E., is a consulting civil/materials engineer in Los Gatos, California. He is past chairman of ACI’s Committee C 660, Shotcrete Nozzleman Certification, and is a member of ACI*

*Committee 506, Shotcreting. His experience includes over 35 years in quality control, testing, and inspection of construction materials.*