

Shotcrete Nozzlemen: ASA Educates—ACI Certifies

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How do we distinguish the role of the American Shotcrete Association (ASA) and the American Concrete Institute (ACI) when it comes to *shotcrete nozzleman certification*? The answer lies in the title of this article. ASA educates whereas ACI certifies!

As with any other ACI certification program, examination sessions are conducted by local sponsoring groups (LSGs). Although most ACI certification programs are typically administered by local ACI chapters approved as LSGs, Shotcrete Nozzleman Certification programs require a higher degree of logistics, exceeding most ACI chapter resources. Arguably, the Shotcrete Nozzleman Certification program is the most demanding certification program available through ACI. Both physically and logistically, the program requires strong commitments from well-established LSGs. ASA's contribution as the first ACI LSG for nozzleman certification was instrumental to fully developing this ACI certification program^{1,2} and continues to contribute to its success, with over 1300 certificates currently valid. This article provides an overview of shotcrete nozzleman education and certification in North America with the most current updates from activities of both ASA and ACI committees.

American Shotcrete Association (ASA)

The American Shotcrete Association was founded in 1998 “to have the shotcrete process understood and used in every beneficial application” and “to encourage and promote the safe and beneficial use of the shotcrete process.”

With this in mind, the discussion over the importance of shotcrete nozzleman certification at the time, and the vehicle by which a certification program could be delivered, was debated by industry members everywhere and led to one of ASA's first industry tasks. A shotcrete nozzleman certification program was put together by ASA with the hope that ACI would fast track the completion

of the ACI shotcrete nozzleman certification program as part of its certification activities.

Members of ASA worked diligently to complete the development of the Shotcrete Nozzleman Certification program and launched the first shotcrete Training and Certification Session in 1999. This session also served to qualify future trainers and examiners and helped define what eventually became two separate entities: ASA's Education Program and the ACI Shotcrete Nozzleman Certification program.

ASA was the first LSG to administer the ACI written and performance examination starting in 2001 and has been actively promoting the program and certifying nozzlemen since that first session. ASA also provides a Shotcrete Education Session (classroom only) for nozzlemen taking the ACI Certification Examination and for those simply interested in learning correct nozzleman techniques (for example, owners, project supervisors, and foremen).

ASA's Shotcrete Nozzleman Education

The ASA Education Committee developed a series of Shotcrete Education Modules covering the key aspects necessary for successful shotcrete application. ASA's education modules are under continuous review and revision to update current construction practices and technology. The Education Module presentations are supplemented in the classroom with ACI CP-60(09), “Workbook for ACI Certification of Shotcrete Nozzlemen.”³ ACI CP-60 was developed and is maintained by ACI Committee C660, Shotcrete Nozzleman Certification, to provide reference study material for nozzleman certification candidates. The ASA Education Modules cover the full range of concrete/shotcrete-related technical material, including:

- Introduction to Shotcrete;
- History and Uses of Shotcrete;
- Shotcrete Materials and Properties;
- Shotcrete Mixture Designs;
- Quality Control/Quality Assurance;

- Shotcrete Equipment;
- Preparation for Shotcreting;
- Shotcrete Nozzling and Application Techniques;
- Shotcrete Finishing and Curing Procedures; and
- Safety.

ASA Education Sessions are conducted by ACI Examiners for Shotcrete Nozzlemen, who are approved and appointed by the ASA Board of Direction. This mandatory course for all new candidates seeking ACI Shotcrete Nozzleman Certification through ASA not only provides an excellent foundation to succeed on the written portion of the certification exam but also an excellent resource for all those who need to work with shotcrete in any capacity. The ASA Education Sessions have been offered in recent years at major trade shows such as World of Concrete and the Pool | Spa | Patio Expo. Participation in these sessions fulfills the ASA education requirement while providing valuable information to help you become a better nozzleman. Please see ASA's calendar for this year's courses: <http://shotcrete.org/pages/news-events/calendar.htm>.

Apart from ASA, there are currently only a handful of ACI-approved LSGs that offer ACI Shotcrete Nozzleman Certification. Information on these LSGs is available on the ACI website. The ACI Shotcrete Nozzleman Certification program has been operating successfully for the last 12 years. The program continues to gain recognition among federal, state, provincial, and private specifying authorities throughout North America. Adding to the popularity of specifying ACI nozzleman certification on shotcrete projects is the fact that there are now over 1300 ACI-certified shotcrete nozzlemen in North America.

ACI's Shotcrete Nozzleman Certification Program

For decades, the shotcrete industry has recognized the need for more stringent standards when it comes to shotcrete quality. In addition to good-quality, well-proportioned shotcrete mixtures, suitable well-maintained equipment, and an experienced shotcrete construction team, a qualified shotcrete nozzleman is a key element to successful shotcrete placement. ACI Committee C660 has delivered a credible and thorough program with strict policies, guidelines, and procedures that respond to the demands of the construction industry.

A select group of experienced and acknowledged shotcrete experts has been approved by ACI to act as Examiners for the certification program (refer to Examiner Requirements and Approval

Process in the following). Today, certification of a shotcrete nozzleman through this ACI program provides nozzlemen with not only improved knowledge and skills but also with international recognition as a craftsman.

Although no certification program can address all potential variables, the ACI Shotcrete Nozzleman Certification program is focused on specific key elements of the shotcrete process such as knowledge, skill, and ability. The ACI Certification Program requires a prerequisite of 500 hours of verified work experience as a nozzleman to attend the certification session.

In addition, to achieve certification from the ACI program, candidates must fulfill the following requirements⁴:

- Achieve a passing grade in the 90-minute written examination per process; and
- Successfully complete the following two-part performance evaluation:
 - Part I—Demonstrate knowledge of all the items covered in the performance checklist; and
 - Part II—Shoot a test panel with the method(s) and position(s) to be certified. The test panels are cored in five predetermined locations (through embedded reinforcing bars); these cores are evaluated as specified in the policies.

Note: Without the mandatory shotcrete education session ASA provides when they conduct ACI Shotcrete Nozzleman Certification, many nozzlemen would find these requirements difficult to achieve.

The certification program is available for both the dry- and wet-mix shotcrete processes and two shooting positions: vertical and overhead. All nozzlemen must qualify in the vertical shooting orientation and may elect to qualify in the overhead shooting orientation in either the dry- or wet-mix shotcrete process, or both. The ACI Shotcrete Nozzleman Certification is valid for a period of 5 years from the date of completion of all certification requirements.

Considering the difficulty in some areas for a nozzleman to acquire the 500-hour minimum experience prior to attending the certification session, ACI Committee C660 has been actively working on the concept of a “nozzleman-in-training.” A nozzleman-in-training would be allowed to gain experience hours while working under the direct supervision of an ACI-certified nozzleman at the job site. The formal procedures for acquiring a nozzleman-in-training level certification are still under development by ACI Committee C660; visit the ACI website for the most up-to-date policies in the upcoming months (www.concrete.org/certification/cert_ProgramPolicies.htm).

ACI's Certification Policies for Shotcrete Nozzlemen

ACI Committee C660's original mandate was to develop, maintain, and update programs for use in certification of persons performing as shotcrete nozzlemen. As the certification program grows, the program policies are continually updated to maintain the integrity of the program.

ACI Recertification Policy

One of the committee's objectives in maintaining the integrity of the program was to provide an incentive to contractors to recertify before certification expires. To avoid duplicating the expense of the original shotcrete certification program, the policies were updated to allow the shotcrete contractor to have recertification conducted without mandatory ASA training and related incidentals, such as the written examination. These changes were introduced as follows.

A candidate may renew certification (recertify) by successfully completing:

1. A structured oral interview with the Examiner.

The interview is in lieu of the written exam requirement imposed for initial certification and is designed to substantiate that the candidates have retained their knowledge of the safe and competent application of shotcrete and are made aware of any new developments in this area of concrete construction; and

2. A performance examination as per the current policies.

This recertification policy is available for those who are seeking recertification in the same process within 6 years of their previous ACI-issued certification. Nozzlemen must possess at least 1000 hours of work experience as a shotcrete nozzleman within the 2 years immediately prior to seeking recertification or possess an average of 500 hours per year of shotcrete nozzleman experience within the 5 years immediately prior to seeking recertification.

Most recertification sessions have been conducted at job sites where ACI examiners were able to travel to conduct recertification rather than asking a group of nozzlemen to travel to a single location. This has enabled recertification costs to be kept to a minimum.

ACI Examiner Requirements— Approval Process Policy

As the certification program grows, the need for more ACI-approved Examiners increases. Also, the program must be readily accessible to shotcrete nozzlemen throughout North America.

According to the recent updated policy, an Examiner must be approved for dry- and/or wet-

mix shotcrete with the assistance of a task group under the direction of ACI Committee C660. Qualifications must be submitted separately for the dry- and/or the wet-mix processes.

The requirements are described as follows:

- The Examiner shall be authorized by ACI to conduct nozzleman certification examinations for only the shotcrete process for which the Examiner is approved; and
- To be considered for approval as an Examiner and to maintain Examiner status, the applicant shall meet the following requirements:
 - A. Be knowledgeable about shotcrete and thoroughly familiar with the current applicable reference documents; and
 - B. Have a total of at least 5 years of documented experience in at least two of the following four categories:
 1. Testing, inspection, and quality control of shotcrete;
 2. Supervision of shotcrete construction work;
 3. Design of shotcrete structures; and
 4. Shotcrete nozzling.
 - C. Have sufficient experience to evaluate and judge the qualifications of shotcrete nozzleman applicants and conduct written and performance examinations. For each process, this experience must be (but is not limited to):
 - Knowledge of both vertical and overhead spraying; and
 - Knowledge and experience on more than one type of equipment (gun, pump, or nozzle).
 - D. Have participated to the satisfaction of the Examiners of Record in all phases of at least two ACI-sanctioned shotcrete nozzleman certification programs for the process in which approval is sought, with different Examiners of Record for each session. For the first session, the applicant must serve as proctor and Supplemental Examiner. For the second session, the applicant shall serve as a Proctor and Supplemental Examiner and conduct all phases of the session, including written examination; performance examination; and core grading, under the direct supervision of the Examiner of Record for both vertical and overhead;
 - E. Attain a passing grade on the written exam for each process sought; and
 - F. To maintain Examiner status, the Examiner must have conducted or assisted in at least three ACI-sanctioned shotcrete nozzleman certification programs in 5 years, if not actively participating in ACI Committee C660 activities.

Panel Affixation Specification Document

Shotcrete nozzleman certification for overhead shotcrete requires the use of standardized panels that are affixed overhead. ACI Committee C660 was asked to provide a specification document that would include general parameters for an apparatus or structure that would quantify the forces in hanging and shooting a panel to assist and provide guidance with on-site construction. A specification document was developed, accompanied by a sample drawing of a suitable apparatus that is typically used for overhead shotcrete nozzleman certification. The proposed apparatus is illustrated in Fig. 1.

Shotcrete Core Grades—Standard Certification Panel

Core grading shall apply only to cores extracted from the standardized test panel approved by ACI Committee C660. Grading of the cores is based on visual examination and measurements of defects. A total of five cores are graded using these criteria at specific locations.^{4,5} Deductions are made for various defects such as (but not limited to) sand lenses; porosity pockets; and random voids, especially voids around reinforcing bars.

A test panel is declared a failure if any single core exceeds core Grade No. 3 or if more than two of the five cores exceed core Grade No. 3. Averaging core grades is not permitted. Definitions of core Grades No. 1 to 5 are provided in the program policy⁵, and, more recently, in the new document “Shotcrete Core Grades for Use in the Evaluation of Cores during Shotcrete Nozzleman Certification according to CP60 (09).”²³ Sample photos of core Grades No. 1 and 5 are presented in Fig. 2.

A Message to Shotcrete Specifiers!

ACI Shotcrete Nozzleman Certification makes a difference. Although it does not guarantee perfection, it provides the specifier with the comfort that the nozzleman has demonstrated the basic knowledge and capabilities to properly apply shotcrete. However, the ACI-certified nozzleman is only one part of the shotcrete construction team. A contractor offering to place quality shotcrete must have specific knowledge, equipment, training, and hands-on experience of an entire shotcrete construction team—from company management to the entire field team—to truly be considered a shotcrete contractor. The identification and selection of a qualified shotcrete contractor is essential for quality shotcrete work on your project.

To ensure a quality shotcrete application on specific projects with demanding shotcrete placement (for example, deep sections and multiple

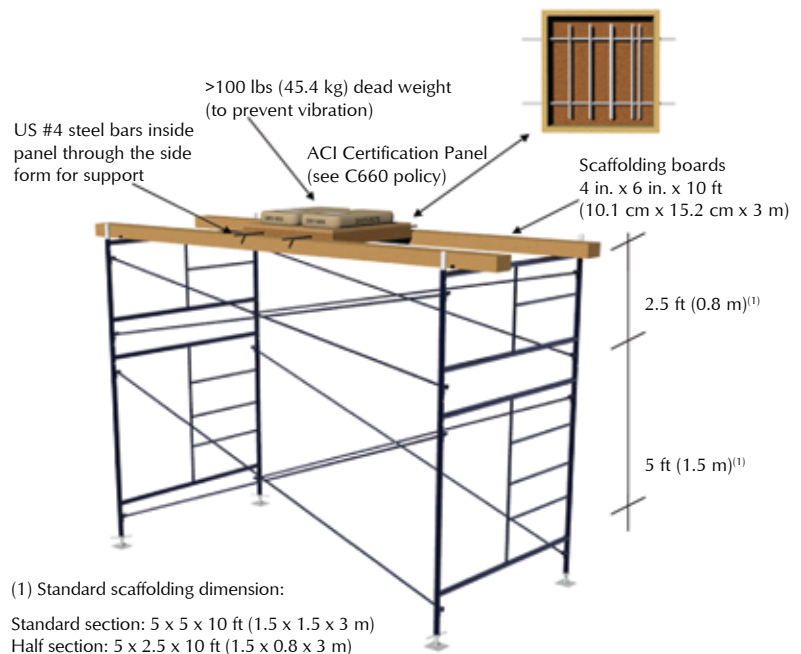


Fig. 1: Overhead standard set-up—ACI Shotcrete Nozzleman Certification

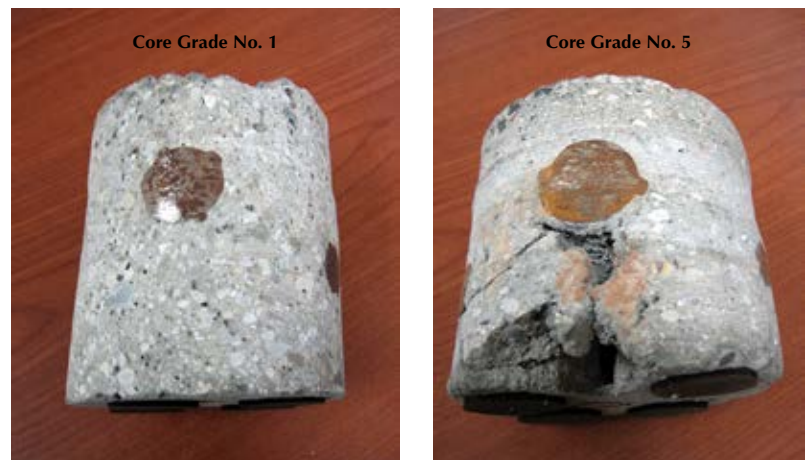


Fig. 2: Core Grades No. 1 and 5

layers of reinforcing), preconstruction qualification mockups that simulate job-site conditions may be desirable. To assist design professionals, owners, contractors, and other construction personnel in achieving desired quality, ACI 506R-05, “Guide to Shotcrete,”²⁶ has procedures for qualifying shotcrete nozzlemen where project requirements have features that dictate more than just ACI nozzleman certification.

Specifier, this ACI Shotcrete Nozzleman Certification program has been developed for you. Take advantage of the tool you have been given and specify ACI-certified shotcrete nozzlemen on your construction projects!

How Do I Get Certified?

To participate in an ACI Shotcrete Nozzleman Certification program, interested parties should first contact ASA. As an LSG, ASA will provide

a candidate with the necessary information on both ASA education and the ACI Shotcrete Nozzleman Certification program. They will then process the inquiry and contact ACI-approved examiners to coordinate the certification program. To request a quote for shotcrete nozzleman certification, go to: <https://www.shotcrete.org/pages/secured/CertificationQuote.aspx>.

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