

## **SHOTCRETE NOZZLEMEN ASA TRAINS - ACI CERTIFIES**

*by Jean-François Dufour*

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 trains while ACI certifies!**

As with any other ACI certification programs, 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 Chapters' 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 Local Sponsoring Groups. The American Shotcrete Association's contribution as the first ACI Local Sponsoring Group was instrumental to the development of this ACI certification program [1,2] and continues to contribute to its success, with over 800 certified nozzlemen being certified since its debut in 2001.

This paper provides an overview of shotcrete nozzleman training 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 promote shotcrete with the *Vision Statement*; to have the shotcrete process understood and used in every beneficial application and the *Mission Statement*; 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 lead to one of ASA's first industry tasks. A shotcrete nozzleman certification program was developed by ASA with the hope that the American Concrete Institute would eventually develop an ACI shotcrete nozzleman certification program as part of its certification activities.

Members of the American Shotcrete Association worked diligently to develop a 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 Training program* requiring ASA Trainers and *ACI's Shotcrete Nozzleman Certification program* requiring ACI Examiners. As a result, ASA's Training and Certification program ran until 2001 when the ACI C660 Committee introduced the first ACI Shotcrete Nozzleman Certification program.

As mentioned in the first paragraph of this article, ASA now acts as a Local Sponsoring Group to administer the ACI examination. ASA also provides a Shotcrete Training School (both classroom and hands-on training) for nozzleman taking the ACI Certification Examination and for those simply interested in learning correct nozzleman techniques.

### **ASA's Shotcrete Nozzleman Training Schools**

The Education Committee of the American Shotcrete Association has developed a series of Educational Shotcrete Training Modules segmented to best suit the area in which shotcrete training takes place. This ASA training program consists of concrete/shotcrete related technical modules such as; introduction to shotcrete, history and uses of shotcrete, shotcrete materials and properties, shotcrete mix designs, quality control/quality assurance, shotcrete equipment, preparation for shotcreting, shotcrete nozzling and application techniques, shotcrete finishing and curing procedures, and safety. Modules for shotcrete for swimming pools and spas, and Underground Shotcrete are also available.

Shotcrete training would not be possible without an adequate number of ASA approved trainers. These trainers, all of whom are current ASA members, have been approved by the American Shotcrete Association's Education Task Group. To qualify as an ASA trainer, one must:

- be knowledgeable in shotcrete (both wet and dry-mix processes)
- have been in the field of shotcrete for a minimum of 5 years
- have attended at least one ASA-approved training session.

To ensure the successful completion of the session, ASA trainers are required to conduct both a classroom session and hands-on training and are responsible to provide the Host (shotcrete contractor in most cases) with a "to do list" before a training session takes place. Unlike ACI certification, it should be noted that ASA training does not require any pre-requisite, such as 500 hours of nozzling experience, for the training session to take place. Attending an ASA shotcrete nozzleman training school is a valuable tool for nozzlemen who wish to improve their knowledge and placement skills, and for others who want to learn more

about the latest in shotcrete technology and equipment. This program is also a valuable tool for those interested in becoming involved in the shotcrete industry.

Let's not forget that since 2001, ASA trains and ACI certifies. As a result, ASA shotcrete trainers can not conduct ACI shotcrete nozzleman certification examinations unless they are also ACI approved examiners.

In summary, two important points should be considered with respect to ASA shotcrete nozzleman training schools:

- 1) As a Local Sponsoring Group administering ACI certification examinations, ASA requires that shotcrete training provided by approved ASA trainers take place before ACI certification is offered.
- 2) ACI examination is the responsibility of ACI approved examiners, who may also be ASA approved trainers. (It should be noted that some ASA trainers are not necessarily ACI examiners and vice-versa).

There are currently two ACI approved Sponsoring Groups who are available to offer both ASA nozzleman training and ACI nozzleman certification. They are the American Shotcrete Association and Laval University in Quebec City, Canada. Information of both these LSG's is available by contacting ASA.

### **American Concrete Institute (ACI)**

In 1991 the American Concrete Institute ACI 506 Shotcrete Committee published ACI 506.3R-91 Guide to Certification of Shotcrete Nozzlemen. The Synopsis to this Guide stated: This is a guide for a means of certifying wet and dry-mix shotcrete nozzlemen for application of several but not all types of shotcrete. The certification procedure includes a learning and training period, a written/oral examination and a workmanship demonstration. This publication was, however, only a Guide and there was no organization in North America actually providing formal Certification of Shotcrete Nozzlemen to this Guide.

When the American Concrete Institute established the ACI C660 Committee for shotcrete nozzleman certification in 1997, ACI did not know at the time that the American Shotcrete Association was going to be instrumental in making the ASA program available as early as 1999. ACI C660's mandate was to develop, maintain, and update programs for use in certification of persons performing as shotcrete nozzleman. The precedence of the ASA program helped ACI accelerate this process.

Not only did the ACI C660 Committee achieve this objective in record time, but this ACI shotcrete nozzleman certification program has been operating successfully for the last 7 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 800 ACI certified shotcrete nozzleman in North America.

### **ACI's Shotcrete Nozzleman Certification Program**

As previously indicated, for years, 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 mixes and suitable well maintained equipment, qualified shotcrete nozzlemen are a key element to the success of this process. The ACI C660 Committee 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 (see Examiner Requirements and Approval Process in the Policies section below). 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, this ACI shotcrete nozzleman certification program is focused on specific key elements of the shotcrete process such as; knowledge, skills and abilities. Unlike the ASA shotcrete training program, the ACI certification program requires a pre-requisite of 500 hours of verified work experience as a nozzleman or nozzleman-in-training.

In addition, in order to achieve certification from the ACI program, candidates must fulfill the following requirements [3,4]:

- Achieve a passing grade in the 90-minute written examination per process
- Successfully complete the following two-part performance evaluation:
  - Part I – Demonstrate knowledge of all the items covered in the Performance Checklist
  - 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 reinforcing) and the cores are evaluated for “shotcrete core grade” as per ACI 506.2.

Note: Without the mandatory shotcrete training session (classroom and hands-on described above) set by ASA as ACI's Local Sponsoring Group, many nozzlemen would find these requirements difficult to achieve.

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

## **ACI's Certification Policies for Shotcrete Nozzleman**

ACI 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, our 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:

- Candidates may renew their 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.
  - 2) A performance examination as per the current Policies.

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

Many recertification sessions have been conducted on job sites where ACI examiners were able to travel to conduct re-certification rather than asking a

group of nozzlelemen to travel to a single location. This has enabled recertification costs to be kept to a minimum.

### ***ACI Examiner - Requirements and 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 nozzlelemen throughout North America.

According to the new updated policy, an examiner must be approved for dry-mix 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-mix and/or the wet-mix processes.

The new requirements are described as follows:

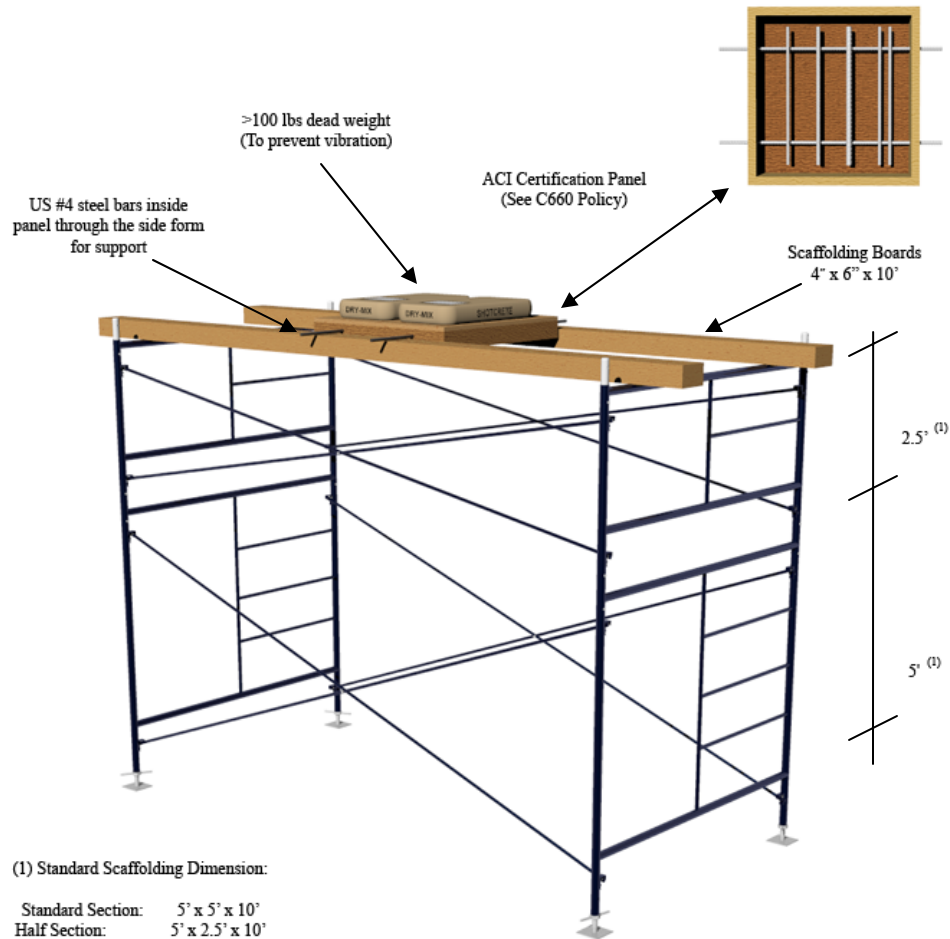
- The examiner shall be authorized by ACI to conduct nozzleman certification examinations for only the shotcrete process for which the examiner is approved.
- In order to be considered for approval as an examiner, and to maintain examiner status, the applicant shall meet the following requirements:
  - A) Be knowledgeable about shotcrete and thoroughly familiar with the current applicable reference documents.
  - B) Have a total of at least 5 years 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
    - 4) Shotcrete nozzling
  - C) Have sufficient experience to evaluate and judge the qualifications of shotcrete nozzleman applicants and conduct written and performance examinations.
  - D) Have, to the satisfaction of the examiners of record, participated in all phases of at least two ACI-sanctioned Nozzleman Certification programs for the process for 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 must serve as a proctor and supplemental examiner and also conduct all phases of the session including written examination, performance examination, and core grading, under direct supervision of the examiner of record.
  - E) Attain a passing grade on the written exam for each process sought.

- F) Have conducted or assisted in at least three ACI-sanctioned Nozzleman Certification programs in five 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. The ACI C660 Committee 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 with a sample drawing of a suitable apparatus that is typically used for overhead shotcrete nozzleman certification. The proposed apparatus is illustrated in Fig. 1.

## ACI SHOTCRETE NOZZLEMAN CERTIFICATION - OVERHEAD STANDARD SET-UP -



**Figure 1:** Overhead Standard Set-Up – ACI Shotcrete Nozzleman Certification

### ***Shotcrete Core Grades – Standard Certification Panel***

An appendix that addresses core grading was developed for the ACI 506.2 document by ACI 506 Committee in 1995. This core grading system was discontinued for use with structures in the field (because of problems relating to its misuse) and now applies only to the standardized test panel approved by ACI C660.

The nozzleman certification program is currently using the ACI 506.2 core grading appendix to quantitatively evaluate rebar encapsulation. 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]. Points are deducted for various defects, such as (but not limited to) sand lenses, porosity pockets, random voids, and especially voids around reinforcing bars.

A test panel with any single core grade exceeding core grade No. 3, or with more than two of the five cores having a core grade No. 3 is declared a failure. Averaging of core grades is not permitted. Definitions of core grades No. 1 to 5 are provided in the Program Policy [4]. Photos of grade No. 1 and No. 5 cores are presented in Fig. 2.



**Core Grade No. 1**



**Core Grade No. 5**

**Figure 2:** Grade Grades No. 1 and No. 5

### **New ACI Education Document – CCS-4**

The ACI education document, Shotcrete for the Craftsman (also known as CCS-4), has been revised and is awaiting publication.

The main purposes of this education document (CCS-4) are to help nozzlemen understand basic concrete and shotcrete technology, and illustrate how to properly place quality shotcrete. The Workbook document that is currently used by ACI C660 for Shotcrete Nozzlemanship Certification is the CP-60 (02) document, which is comprised of the following:

- Program Information
- CCS-1 (Concrete Craftsman Series 1)
- CCS-4 (Shotcrete for the Craftsman, Concrete Craftsman Series 4)
- Appendices

The ACI C660 Committee accepted the challenge to gather all literature pertaining to shotcrete from the CCS-1, National Spa and Pool Institute (NSPI), and other ACI documents to add to the original CCS-4 booklet that was originally developed by ACI 506 members Lars Balck, Steven Gebler, Merlyn Isaak, Dudley Morgan, and Phillip Seabrook. All of these documents contributed to the development of the new CCS-4 document.

This new education document (CCS-4), Shotcrete for the Craftsman will become part of the CP-60 Workbook and was prepared by the Chair and Secretary of ACI Committee C660 *Shotcrete Nozzleman Certification*. Peer review of the document was performed by the above mentioned original authors together with contributions by additional ACI C660 members who were all key in the improvement and support of this new document.

The new CCS-4 document will be published soon by ACI and introduced at an educational session at the ACI Fall Convention in St-Louis, MO in 2008. This event will be co-sponsored by ACI Committees E-703 and C660.

Following ACI publication, the program's written examination questions will also be reviewed and updated for future certification sessions. Very soon, this international certification program and its supporting literature (Workbooks, written examination, etc.) will also be available in three languages: English, Spanish and French.

*Note: Information in this workbook should be used as a guide to good practice. Publication ACI 506R, "Guide to Shotcrete", should also be consulted.*

### **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 knowledge and capabilities to properly apply shotcrete. To ensure a quality shotcrete application, preconstruction qualification mock-ups, simulating jobsite conditions, should be required on specific projects as needed (e.g. deep sections, multiple layers of reinforcing, etc.). In order to assist design professionals, owners, contractors and other construction personnel in achieving desired quality, there are procedures for qualifying shotcrete nozzlemen where project requirements may have special features that dictate more than just ACI certification. A new guide for pre-construction mockups for shotcrete projects is being developed by ACI 506. Preconstruction mock-ups should be used on projects where assurance is needed that the proposed applicators can provide the desired end product. These mock-ups can be quite costly and the need for them should be evaluated on a project by project basis. This guide should be available soon.

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 the American Shotcrete Association. As a Local Sponsoring Group, ASA will provide them with the necessary information on both the ASA training program and the ACI Nozzleman Certification program. They will then process the inquiry and contact ACI approved examiners to coordinate the certification program. To download an application for shotcrete nozzleman certification, go to: <http://www.shotcrete.org/ASAcertification.htm>

*The author would like to both recognize and thank all ACI C660 members for their dedication to the improvement of shotcrete practices throughout the industry, with special thanks to Merlyn Isaak who was C660 Chair during development and launch of the ACI Shotcrete Nozzleman Certification Program in 2001.*

### **References:**

- [1] Dufour, J-F., Shotcrete Corner: ACI Shotcrete Nozzleman Certification and the American Shotcrete Association, ASA Shotcrete Magazine, Volume 5, Number 4, Fall 2003, pp. 28-30.
- [2] Isaak, M., Certification vs. Qualification of Shotcrete Nozzlemen, ASA Shotcrete Magazine, Volume 4, Number 4, Fall 2002, pp. 40-42
- [3] Program Information, ACI C660 Shotcrete Nozzleman Certification
- [4] Certification Policies for Shotcrete Nozzlemen, ACI C660 Shotcrete Nozzleman Certification



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