Position Statement #1
ASA Board of Direction

american shotcrete association

Shotcrete Contractor and Crew Qualifications

Shotcreting is an efficient method for placing high-quality, durable concrete in a wide variety of concrete structures. Shotcrete has been successfully used in substantial projects for well over a century. As with cast-in-place concrete, the quality of the shotcrete placement is dependent on the quality of the materials, proper mixing and transport, substrate/subgrade preparation, the placing process, and protection until final strength is reached.

However, a comparison of the shotcrete process to the traditional "form-and-cast" process shows significant differences. Specifically, when using the shotcrete process:

- Formwork is eliminated or substantially reduced;
- It is necessary to identify the best shotcrete process (wet- or dry-mix) for the job;
- Special gunning equipment is required, including pumps, guns, hoses, nozzles, and admixture/water pumps;
- Knowledge is required to safely use and maintain the shotcrete equipment;
- A trained field crew that performs work totally unlike casting concrete in forms is required;
- Environmental conditions that are unsatisfactory for quality shotcreting must be identified;
- The shotcreter (formerly known as nozzleman) must be well-versed in shooting techniques, including proper air, water, and mixture flow;
- The crew must be prepared to properly finish, protect, and cure freshly placed shotcrete; and
- Knowledge of quality-control procedures specific to shotcrete is required.

Based on these factors, it is apparent that a contractor offering to place quality shotcrete must have specific knowledge, equipment, training, and hands-on experience of the entire construction team—from company management through the field crew—to truly be considered a Shotcrete Contractor.

ACI 506R-05, "Guide to Shotcrete," is a great primer on shotcrete design and application. ACI Committee 506, Shotcreting, is currently working on revisions to the "Guide to Shotcrete" and in the latest drafts has developed an expanded section covering shotcrete crew requirements. Those provisions are summarized herein to help establish field crew qualifications. The requirements for the contracting firm to be considered a quality Shotcrete Contractor are then presented. Taken together, a shotcrete team that meets or exceeds the crew and contractor requirements will be best qualified to provide a cost-effective, quality, and durable shotcrete application.

Field Crew Duties and Qualifications

(based on input from ACI 506 Subcommittee developing updates to 506R, "Guide to Shotcrete")

Composition and Crew Duties

The basic shotcrete crew may consist of a foreman, a shotcreter, a finisher or rodman, an assistant shotcreter, a wireman, a gun or pump operator, a mixer operator (if needed), and laborers.

Depending on the size and complexity of the project, some duties may be combined by having one person performing more than one operation. For example, the foreman could also function as the shotcreter; one person could perform as the rodman and finisher—also, an assistant can help the shotcreter by pulling the hose and operating the air-lance/blowpipe; and, where needed, the gun or pump operator and mixer functions could be combined with proper equipment and one person could perform the tasks. Larger, congested reinforced projects may require more than one shotcreter, air-lance operator, and several finishers. Where several crews are operating, a foreman, superintendent, or engineer may be required.

Shotcrete Foreman's Duties—The foreman plans, directs, organizes, and coordinates the work of each member of the shotcrete crew to obtain a safe and successful application. This includes safety of the work area and quality-control procedures. The foreman is responsible for the inspection and maintenance of equipment and ordering and expediting delivery of materials. The foreman sets the pace of the work, maintains crew morale, ensures good housekeeping, and acts as a liaison to either the general supervisor or to the owner's inspection team. The foreman is usually a veteran shotcreter, finisher/rodman, or pump/gun operator, and should be able to fill any of the positions if required.

Shotcreter's Duties—The shotcreter is a key person in a shotcrete operation and is responsible for applying the shotcrete and for bringing it to required line and grade in a workmanlike manner. The shotcreter's duties include coordinating the application with the foreman, finisher or rodman, and pump/gun operator. Before the shotcrete is installed, the shotcreter should ensure all areas to receive shotcrete are clean, sound, and free of loose material, and that anchors, reinforcement, and ground wires are properly placed and spaced.

In the dry process, the shotcreter controls the water content for hydration and ensures that the operating air pressure is uniform and will provide high velocity at impact for good consolidation. In the wet process, the shotcreter controls the air that increases or decreases the velocity to ensure proper placement, including proper encasement of the reinforcement.

The shotcreter provides leadership and direction for the shotcrete crew, which aids in the task of shooting high-quality shotcrete. The shotcreter is usually an accomplished finisher or rodman and gunman/pump operator.

Wireman's Duties—The wireman sets elevations and thicknesses for the shotcrete placement, which may include the top and face of the wall. Grades set by the wiremen are the lines the shotcreter and finishers will follow. The wireman may use many devices for setting grades, such as piano wire, fiberglass-metal rods, and plastic pipe.

Finisher/Rodman's Duties—The finisher rods or cuts the freshly placed shotcrete surface, bringing it to line and grade before final finishing. The finisher also locates and removes sand pockets, sags, and sloughs, and guides the shotcreter to low spots that require filling with additional shotcrete. Before the shotcrete takes final set, the finisher brooms and prepares the surface for final application.

Assistant Shotcreter's Duties (blowpipe/air lance control)—The assistant shotcreter helps the shotcreter by dragging the hose and performing other duties as directed by the shotcreter. The assistant shotcreter relays signals between the shotcreter and the gunman/pump operator, and may also relieve the shotcreter for short rest periods. The assistant shotcreter may operate the air lance, if one is required, to keep the areas in advance of the shotcrete free of rebound and overspray. The assistant shotcreter may be a shotcreter trainee and place shotcrete under the direct supervision of a certified shotcreter.

Gunman's Duties (dry-mix)—The gunman provides a constant flow of properly mixed dry-mix material to the shotcreter. The gunman operates and maintains a clean gun and assists in ensuring quality control. The gunman should be particularly attentive to the needs of the shotcreter and ensure that the mixture is properly prepared. The gunman generally oversees, controls, and coordinates the material mixing and delivery operation.

Pump Operator's Duties (wet-mix)—The pump operator regulates the pump to uniformly deliver the wet-mix shotcrete at the required rate. The pump operator is responsible for cleaning and maintaining the material hose and pump. The pump operator coordinates the delivery of shotcrete mixture and monitors the water content by observing or testing the slump of the mixture. The pump operator may change the delivery rate of the transit and concrete trucks, including staging the trucks at the pump. The pump operator is also responsible for the safety of the pump and delivery line.

Mixerman's Duties—The mixerman's duties include, where applicable, the proportioning and mixing of the shotcrete mixture materials, and maintaining and cleaning the mixing equipment. For field mixing, the mixerman is responsible for storage, care, and accessibility of the materials. The mixerman sees that the mixture is free of contaminated materials and debris and that the aggregates have the proper moisture content. The mixerman ensures a constant flow of shotcrete materials but is also careful not to mix more material than can be used within the specified time limits. The mixerman supervises the laborers who are supplying and loading the mixer.

Hose Tender's Duties—The hose tender's duties include moving tools, equipment, hoses, scaffolding, and materials. Hose tenders clean work areas, remove rebound and overspray, and provide support for the shotcrete application.

Project Engineer, Project Manager, or Superintendent—On large or complicated projects, a project engineer, project manager, or superintendent may be advisable. A shotcrete contractor usually employs engineers, project managers, or superintendents, but they may not be assigned full-time to a single project. The project engineer, project manager, or superintendent is responsible for the material selection, mixture proportioning, preconstruction testing, qualifications of the crew, equipment selection, project planning, scheduling, logistics, materials handling, quality control, sampling and testing coordinating, and troubleshooting technical problems during construction.

Crew Qualifications

General—The quality of a completed shotcrete application results from the combined skills and knowledge of the shotcrete crew. The foreman and crew should have performed satisfactory work in similar capacities for a specified period. The entire crew is responsible for the safety of each member and other's on any particular project.

Shotcrete Foreman—The foreman commonly has proficiency in all crew positions and is in charge of the crew and their safety procedures. The foreman typically has at least 2 years of experience in the placement of shotcrete.

Shotcreter—The shotcreter should be ACI certified (refer to ACI CP-60) and have completed at least one similar application as a shotcreter on a similar project for the shotcrete contractor. On congested reinforced projects, the shotcreter should also be able to demonstrate, by preconstruction testing, an ability to satisfactorily perform the required duties and to apply shotcrete as required by specifications.

Assistant Shotcreter/Shotcreter Trainee—The assistant shotcreter/shotcreter trainee should have 6 months of experience in a variety of shotcrete field operations that may include finishing, gun or pump operation, blowpipe/air lance control,

and hose tending, and should be able to demonstrate knowledge of proper shotcrete equipment setup (pump/gun, delivery hose, nozzle, air/water supply). When shooting, the assistant shotcreter/shotcreter trainee must be under the direction of an ACI Certified Shotcreter.

Blowpipe/Air Lance Control—This person should have experience in finishing shotcrete and have proven successful manipulation of the blowpipe on previous jobs as directed by an ACI Certified Shotcreter, shotcrete foreman, or superintendent.

Wireman—The wireman should have at least 1 year of experience in setting grades on projects with shotcrete applications.

Rodman and Finisher—The rodman and finisher must have shotcrete experience and care must be taken not to create sags and loss of bond. Previous work experience that provided acceptable results should qualify them in this position.

Gunman or Pump Operator—The gunman or pump operator should be familiar with and be able to operate the shotcrete delivery equipment, know the proper methods of material preparation and mixing, and be familiar with the chosen method of communication. The pump operator and gunman should preferably have at least 1 year of experience operating the intended equipment and be familiar with all manufacturers' safety guides and operations.

Mixerman—The mixerman should know and perform the proper methods of material preparation and mixing to consistently mix and maintain the required mixture proportions, including the proper water-cementitious material ratio (*w*/*cm*). The mixerman should have a minimum of 6 months running the specific (or similar) mixing equipment used on the project.

Project Engineer, Project Manager, or Superintendent—The project engineer, project manager, or superintendent should have at least 3 years of relevant field experience.

Shotcrete Contractor Qualifications

The uniquely different needs of the shotcrete field crew and equipment, when compared to that for conventional cast-in-place concrete work, require the support, commitment, and positive attitude of the entire contracting organization for successful execution of quality shotcrete projects. Successful shotcrete projects demand full corporate support in:

1. Establishing and enforcing safety and quality-control policies;
2. Purchasing and maintaining the proper equipment for each project's particular needs;
3. Committing to hire, train, and maintain the needed field personnel;
4. Handling the logistics of bidding, scheduling, and preconstruction requirements in a timely and efficient manner; and
5. Maintaining good client relationships, without which the shotcrete project may be less than successful.

The owner or specifier should always require an experienced and qualified shotcrete contractor team for executing quality shotcrete work. With this in mind, ASA has established the following guidelines for an owner or specifier to consider when selecting a shotcrete contractor qualified to undertake a project. Following these recommendations give the owner or specifier assurance that the entire shotcrete construction team (qualified contractor, ACI Certified Shotcreter, and experienced crew) have proven their knowledge and ability to consistently place quality concrete. It is highly recommended that the owner or specifier consider pre-qualifying shotcrete contractors using these guidelines prior to bid, or at a minimum have the information submitted with the bid.

1. Five years of experience as a licensed contractor.
2. Five shotcrete projects of similar size, scope, and shotcrete process used (dry- or wet-mix) successfully completed in those 5 years with proper documentation, including full contact information for owner/engineer/construction manager/general contractor, a project description, and the scope of work accomplished.
3. The ability to self-perform all shotcrete-related work and a minimum crew on hand and/or staff listed as part of the company (either employees or substitutes with a work history under current business name) consisting of the following minimum experienced field crew members:
    a. Shotcrete Foreman
    b. Shotcreter (at least one ACI Certified Shotcreter on the project)
    c. Dry-Mix Gunman or Wet-Mix Pump Operator
    d. Assistant Nozzlemen/Nozzlemen Trainees (blowpipe/air-lance controller)
    e. Finishers
    f. Mixerman
    g. Hose Tenders
4. Ownership of all necessary shotcrete-specific equipment (pumps, guns, and hoses) to accomplish the job based on the specific project needs. Shotcrete contractor must submit sizes and models for all shotcrete equipment to be used, including full equipment backup in case of equipment breakdown.
5. A certificate as a Business in Good Standing from the state that the company resides in.
6. A letter of bonding capacity from the bonding company or a letter of credit.
7. Company insurance in good standing, meeting all state minimum requirements, including, but not limited to, general liability and workers' compensation.
8. ASA Corporate Membership
9. Ability to demonstrate that company construction support staff (safety, general superintendent, project managers, and

Shotcrete Contractor Qualification Evaluation Checklist	
	Five years of experience as a licensed contractor
	Five shotcrete projects of similar size, scope, and shotcrete process (dry- or wet-mix), successfully completed in those 5 years with proper documentation
	Shotcrete Contractor self-performs all shotcrete-related work and has provided an experience listing of the minimum crew to be used on the project
	Owns all necessary shotcrete-specific equipment (pumps, guns, and hoses) to accomplish the job based on the specific project needs. Shotcrete Contractor has submitted sizes and models of all shotcrete equipment to be used—including full equipment backup in case of equipment breakdown
	Certificate as a Business in Good Standing or equivalent from the state that the company resides in
	Letter of bonding capacity from the bonding company or a letter of credit
	Company insurance in good standing and meeting all state minimum requirements (including, but not limited to, general liability and workers' compensation)
	Contractor is a Corporate Member of ASA
	Contractor documents that company construction support staff (for example, Safety, General Superintendent, Project Managers, and Construction Managers) have continuing educational session credits
	Physical office, shop, or other business address
	References (preferably including those from the five shotcrete projects of similar size, scope, and shotcrete process)
	Company Affiliations (for example, ASA, ACI, AGC, or ABC)
	Contractor has disclosed any criminal or fraudulent ruling for shotcrete work against former or current company owners in a 5-year period

construction managers) has educational session credits through an industry-appropriate continuing education program specifically addressing shotcrete design, construction, or administration (ACI certifications; ASA education sessions [including ASA Onsite Seminars]; seminars; or trade shows, such as World of Concrete, ACI conventions, and ASA meetings).

10. An office, shop, or business base (with an address).
11. References (including those from the five projects in Item #2).
12. Affiliations
13. Full disclosure of any criminal or fraudulent rulings for shotcrete work against former or current company owners in a 5-year period.

Summary

To consistently produce quality shotcrete work, the shotcrete contractor, key personnel, material, equipment, placement methods, curing, and protection all require proper training and qualification to handle your particular project. It must be stressed that any one of the elements alone cannot guarantee success, and poor performance or lack of shotcrete knowledge by any member of the crew can cause a substandard finished product.

Simply specifying the use of an ACI Certified Shotcreter WILL NOT guarantee successful shotcrete placement on a project. The ACI Shotcreter Certification program was designed to establish that the tested shotcreter is capable of shooting at an "entry" level. The shotcreter receives his certificate for each process and orientation if he succeeds in the written and the performance exam. It is plainly evident that the performance

exam is not representative of the shotcrete application experience needed to consistently and properly place shotcrete. The shotcrete construction market has a wide range of project needs from basic, lightly reinforced, thin shotcrete sections to complex and congested structural systems requiring substantially more experience and sophisticated techniques. The wide spectrum of construction practices, shotcrete processes, performance requirements, and geographic differences can impact shotcrete placement in many ways. No certification program can address all potential variables. The ACI Shotcreter Certification program simply verifies the certified shotcreter has basic shotcrete knowledge and has adequately shot a shallow, flat, relatively lightly reinforced test panel. This establishes that the shotcreter has the **potential** for doing a satisfactory job, once he has gained the experience required for a specific type of project.

Only by selecting a quality shotcrete construction team comprised of a qualified shotcrete contractor, a trained and experienced crew (including the ACI Certified Shotcreter), and the proper equipment and materials can you be reasonably assured your shotcrete project will produce the high-quality, durable concrete structures that shotcrete is capable of creating.

Shotcrete Field Team Qualification Checklist	
	Shotcrete Contractor has submitted names, positions, and experience of field team members as required for the project and generally including: 1. Project Engineer, Project Manager, or Superintendent 2. Shotcrete Foreman 3. Nozzleman (at least one ACI Certified Nozzleman on the project) 4. Gun or Pump Operator 5. Assistant Nozzlemen/Nozzlemen Trainee(s) 6. Wireman 7. Blowpipe/Air Lance Controller 8. Rodman or Finishers 9. Mixerman 10. Hose Tenders
	Project Engineer, Project Manager, or Superintendent—minimum 3 years of relevant experience
	Shotcrete Foreman—minimum 2 years of shotcrete experience
	Nozzleman—holds current ACI Nozzleman Certification appropriate for the work and has completed at least one similar application as a nozzleman on a similar project for the Shotcrete Contractor
	Gunman or Pump Operator—should have at least 1 year of experience operating the intended equipment and be familiar with all manufacturers' safety guides and operations
	Assistant Nozzleman/Nozzleman Trainee—should have 6 months of experience in various shotcrete field operations that may include finishing, gun or pump operation, blowpipe/air lance control, and hose tending. When shooting, must be under the direction of an ACI Certified Nozzleman
	Wireman—should have a minimum of 1 year of experience in setting grades and profiles on shotcrete work
	Blowpipe/Air Lance Controller—should have experience in finishing shotcrete and have proven successful manipulation of the blowpipe on previous jobs as directed by an ACI Certified Nozzleman, Shotcrete Foreman, or Superintendent
	Rodman or Finisher—has proven successful shotcrete finishing on previous shotcrete projects
	Mixerman—should have a minimum of 6 months of experience running the specific (or similar) mixing equipment in use on the project