

locates and removes sand pockets, over-dry areas, sags, and sloughs, and guides the nozzle operator to low spots that require filling with shotcrete. After the shotcrete sets, the finisher or rodman brooms or prepares the surface for future application. Some applicators combine the duties of finisher or rodman and assistant nozzle operator on small projects.

4.2.4 Assistant nozzle operator's duties (blowpipe operator)—The assistant nozzle operator (nozzle operator helper) helps the nozzle operator by dragging the hose and performing other duties as directed by the nozzle operator. The assistant nozzle operator relays signals between the gun/pump operator and nozzle operator and may also relieve the nozzle operator for short rest periods. The assistant nozzle operator operates the blowpipe, if one is required, to keep the areas in advance of the shotcrete free of dust and rebound. The assistant nozzle operator may be an apprentice nozzle operator.

4.2.5 Gun operator's duties—The gun operator provides a constant flow of properly mixed dry-mix material to the nozzle operator. The gun operator operates and maintains a clean shotcrete machine and assists in ensuring quality control. The gun operator should be particularly attentive to the needs of the nozzle operator and ensure that the mixture is properly prepared. The gun operator generally oversees, controls, and coordinates the material mixing and delivery operation.

4.2.6 Pump operator's duties—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 concrete and monitors the water content by observing or testing the slump of the mixture.

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

4.2.8 Laborer's duties—The laborer's duties include moving equipment, hoses, scaffolding, and materials. Laborers clean work areas, remove rebound and overspray, and provide support for the shotcrete application.

4.2.9 Shotcrete engineer or superintendent—On large or complicated projects, a shotcrete engineer or superintendent may be advisable. A shotcrete contractor usually employs engineers, superintendents, or both, but they may not be assigned full-time to a single project. The shotcrete engineer 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. The shotcrete engineer or superintendent should have at least one year of relevant field experience.

4.3—Crew qualifications

4.3.1 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.

4.3.2 Foreman—The foreman normally has proficiency at all crew positions and is in charge of the crew. The foreman typically has at least one year of experience on shotcrete projects.

4.3.3 Nozzle operator—The nozzle operator should be certified (refer to ACI CP-60) and have completed at least one similar application as a nozzle operator on a similar project. The nozzle operator should also be able to demonstrate, by test, an ability to satisfactorily perform the required duties and to apply shotcrete as required by specifications.

4.3.4 Finisher or rodman—The finisher or rodman should have shotcreting experience; however, if his/her previous work experience provided acceptable results, this should qualify the finisher or rodman for the position.

4.3.5 Gun or pump operator—The gun 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 communication method in use. Preferably, the pump operator should have at least one year of experience as a gun or pump operator.

4.4—Communications

Communication plays a vital role during the shotcreting application. Because of many factors, such as the distance between the nozzle operator and gun or pump operator, objects obstructing their view of each other, and noise levels that prevent oral communication, the shotcrete crew should select an appropriate communication system.

4.4.1 Communication methods—Several methods of communications are used within the industry. A practical method is hand signals. With this method, the nozzle operator or assistant nozzle operator holds up one or two fingers in view of the gun or pump operator, indicating that the operator should regulate either the air pressure or material feed, respectively. Other signals may be used by individual companies and are normally customized to individual preference. Hand or other methods of communications, such as whistles, two-way radios, or voice-activated telephone, may also be used. Normal communication during shotcreting requires signals for raising and lowering the air pressure, starting, speeding up or slowing down the motor, and most important, a provision for shutting down the equipment in the event of a blockage or dangerous surge in pressure. Whatever method is selected, each crew member should understand the signals to ensure a safe and proper application (Section 3.8.5).