

## Chapter 8 Quality Assurance

### 8-1. General Considerations

a. Quality Assurance (QA) activities on a shotcrete project should be directed to obtaining compliance with the contract requirements. The quality of the materials used in the production of the shotcrete and of the in-place shotcrete are established during the design stage of the project and should have been clearly stated in the contract documents.

b. A memorandum entitled "Engineering Considerations and Instructions for Field Personnel" should be prepared by the designer in accordance with EM 1110-2-2000. This memorandum outlines the designer's intent and highlights the areas of special concern during construction. If any doubts exist by construction personnel as to the required quality, they should be resolved with the designer as early in the project as possible.

c. Qualified QA personnel with previous experience on shotcrete projects should be assigned to the project. ER 1180-1-6 should be followed in preparing a QA Plan. The following discussions pertain to technical aspects of shotcrete and should be incorporated into the plan.

### 8-2. Preproduction Phase

a. *Submittals.* Prior to start of production of shotcrete for any permanent work, the required material, equipment, and procedural submittals should be reviewed by the appropriate Corps of Engineers representatives to verify compliance with the contract requirements. On larger projects, government verification of cementitious materials properties should be considered.

b. *Mixture proportioning evaluation.* Test panels shot to verify the proposed mixture performance should be visually examined by QA personnel to confirm uniformity of the shotcrete. Specimens should be taken from the test panels to verify that the specified strength is being attained. The specimens may be taken by either QC or QA personnel, but strength testing should be performed by a Corps of Engineers division laboratory or the project laboratory.

c. *Nozzleman certification.* All nozzlemen shall be ACI certified. Test panels shot to evaluate a

nozzleman's qualifications should be thoroughly examined by a QA representative experienced in shotcrete work. Some panels should contain reinforcing or embedded items that will be included in the permanent work. Panels should be sawn into strips to allow examination of the interior portions of the panels. Panels should be homogeneous without lenses or pockets of aggregate and all reinforcing and embedded items should be completely encased in dense shotcrete. The quality of dry-mix shotcrete is particularly dependent on the skill of the nozzleman, because his ability to control the amount of water being added to the mixture and to shoot test panels to quality is essential.

d. *Shotcrete demonstration.* The same test panel evaluation to certify the nozzleman serves to approve the production and placement process.

### 8-3. Production Phase

An ongoing program of QA inspections and testing will be required to verify continued conformance with the contract requirements. Consistent materials, mixture proportions, and production methods are necessary for uniform in-place shotcrete.

#### a. *Submittals.*

(1) Manufacturer's certificate. Manufacturer's certified test results for the cementitious materials, admixtures, curing materials, reinforcement, and fibers should be reviewed to verify continued conformance with the contract requirements. Any changes in the appearance or performance of any of these materials should require additional verification by the supplier or testing by the QC laboratory.

(2) Test reports. Data from test reports must be reviewed to determine contract compliance and, more importantly, product performance. Consistent and vigilant review of data is the best method to spot trends in material quality that may later become a problem.

b. *Testing.* Depending on the size and criticality of the project, QA testing of materials and shotcrete may be required to verify compliance with contract requirements. These tests are in addition to QC tests. They will also serve to verify the ability of the QC laboratory to produce valid test data.

c. *Visual Inspection.* The quality of the shotcrete should be thoroughly evaluated by visual inspection. Surfaces should be inspected for uniformity, voids at the

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surfaces, varying finish conditions, dry conditions, seepage of water, cracking, and damaged sections.