Shotcrete Facing for Rock/Soil Slope Stabilization

Qualifications of Contractor's Personnel

The shotcrete crew members shall have work experience conforming to Section 6-18.3(4), except that the nozzle operators and pumping equipment operators shall have placed a minimum of 100 cubic yards of shotcrete on a minimum of three projects of similar slope heights and orientations as in this project within the last five years.

All nozzle operators shall be qualified by test in accordance with Section 6-18.3(4).

Testing

Pre-production and production testing shall conform to Section 6-18.3(3) and the following additional requirements:

Fiber reinforcement shall be included in the shotcrete mix used for all pre-production and production testing.

The Contractor shall make at least two 12 inch square production test panels, where one section is defined as one day's placement. One additional 12 inch square production test panel shall be made whenever a nozzle operator or equipment is changed during the daily work period.

In addition to compressive strength testing, cores taken from the pre-production and production test panels will be tested for density, absorption and voids in accordance with ASTM C 642.

Absorption shall not exceed 8 percent and void content shall not exceed 17 percent.

Mix Design

Unless otherwise specified in the Plans, the fiber reinforced shotcrete used for rock/soil slope stabilization shall have a minimum compressive strength of 2,500 psi at seven days and 4,000 psi at 28 days.

Microsilica shall be included in the shotcrete mix, but shall not exceed 8 percent by mass of the mix.

The minimum steel fiber content in the shotcrete mix shall be 100 pounds per cubic yard. The minimum macro synthetic fiber content in the shotcrete mix shall be 10 pounds per cubic yard.

Surface Preparation

Immediately prior to shotcrete application, rock and soil surfaces within the section being shot shall be scaled of all loose material and be thoroughly cleaned by use of air or water jets or other means acceptable to the Engineer. Shotcrete shall not be placed on any surface which is frozen, spongy, or where there is free water. The surface receiving shotcrete shall be dampened not more than one hour prior to shotcrete application.
Alignment Control
Thickness control pins shall conform to Section 6-18.3(6) and shall be placed on a maximum five foot square grid pattern.

Drainage
Unless otherwise shown in the Plans, weep holes shall be provided throughout the shotcrete facing at 10-foot centers maximum, horizontal and vertical. The weep holes shall consist of 24-inch long, two inch diameter Schedule 40 PVC slotted drain pipe placed within predrilled holes and sloped to drain. The weep hole drains shall be installed prior to placement of the shotcrete facing. The weep hole drains shall extend one to three inches beyond the final finished surface of the shotcrete facing. During placement of the shotcrete facing, the exposed open ends of the weep hole drains shall be covered or plugged to prevent shotcrete intrusion. The Contractor shall remove the covers or plugs after completing shotcrete placement.

Prefabricated drainage mat, if shown in the Plans or specified by the Engineer, shall be placed on the slope face prior to placement of the shotcrete facing in accordance with Section 6-15.3(7) and the details shown in the Plans, and shall be secured to the slope face by methods acceptable to the Engineer to ensure permanent and full contact with the slope.

Anchor Bars
Unless otherwise shown in the Plans, steel reinforcing bar anchor bars shall be placed at approximately 10-foot centers maximum, horizontal and vertical. The bars shall be L shaped #5 bars with the short leg measuring 8 inches and the long leg 24 inches. The bars shall be placed in 1-1/4 inch diameter, 24-inch deep holes. The bars shall be set either with grout conforming to Section 9-20.3, or with Type II epoxy bonding agent conforming to Section 9-26.1, with the grade and class as recommended by the epoxy bonding agent manufacturer. The bars shall be placed such that the short leg of the L shaped bar points upward and is approximately 1-1/2 inches clear of the slope surface.

Mixing of Production Fiber Reinforced Shotcrete
Fiber reinforced shotcrete can be mixed by either a dry mix or wet mix process. If the dry mix process is selected, the fiber reinforcement used shall only be steel fibers. If the wet mix process is selected, the fiber reinforcement may be either steel fibers or macro synthetic fibers.

The method and equipment used for batch mixing shall be as submitted in accordance with Section 6-18.3(1). The frequency and procedure for equipment inspection, cleaning and maintenance shall be as recommended by the equipment manufacturer.

Dry Mix Process
The cement and aggregate shall be batched by weight. Pre-dampening shall be done prior to flow into the main hopper and immediately after flow out of the packaging in order to ensure that the premix will flow at a uniform rate (without slugs) through the main hopper, delivery hose and nozzle to form uniform shotcrete free of dry pockets. Pre-dampened cement and aggregate mix shall not be used if allowed to stand more than 90 minutes.
Wet Mix Process
The batching and mixing shall conform to ASTM C 94.

Batching and Mixing Fiber Reinforcement
If fiber addition takes place in the field after batching and mixing the shotcrete, the procedure used to add the fibers to the shotcrete mix shall be demonstrated by the Contractor for the Engineer's acceptance.

If fibers are added during the batching and mixing process, a screen having a mesh of 1.5 to 2.5 inches shall be used to prevent any fiber balls from entering the shotcrete line. Batching through a screen will not be required if the Contractor successfully demonstrates to the Engineer that fiber balls are not being formed.

Fibers shall not be added to the dry or wet mix at a rate faster than they can be blended with the other ingredients without forming balls or clumps. Bulk fibers showing a tendency to tangle together shall pass through a vibrating screen or be carefully sifted into the mix so that they enter the mix as individual elements and not as clumps.

Shotcrete Application
Shotcrete application shall conform to Section 6-18.3(7) and the following requirements:

Unless otherwise shown in the Plans, the minimum finished thickness of the shotcrete facing shall be four inches.

Shotcrete shall be applied from the lower portion of the area upwards to prevent rebound from accumulating on surfaces yet to be covered. Rebound, defined as shotcrete constituents that fail to adhere to the applied surface, shall not be worked into the finished shotcrete facing and shall not be salvaged or recycled for inclusion in later batches.

Shotcrete application shall be suspended if any of the following conditions are present:

1. High winds prevent proper application of the shotcrete.
2. The ambient temperature is, or is forecast to be, outside the temperature range of 40F to 90F during placement or initial curing.
3. Rain or seepage is washing cement out of the freshly placed shotcrete or is causing sloughs in the work.

Construction joints shall be tapered over a minimum distance of 12 inches to the thin edge. Square construction joints will not be permitted.

Shotcrete Finishing
Unless otherwise shown in the Plans or specified in the Special Provisions, the shotcrete facing shall be finished in accordance with Finish Alternative A in Section 6-18.3(8). Colorization, if required, shall conform to the requirements specified in Section 6-18.2 as supplemented in these Special Provisions.