

1 **(August 3, 2015)**

2 **Shotcrete Facing for Rock/Soil Slope Stabilization**

3 **Qualifications of Contractor's Personnel**

4 The shotcrete crew members shall have work experience conforming to Section 6-  
5 18.3(4), except that the nozzle operators and pumping equipment operators shall  
6 have placed a minimum of 100 cubic yards of shotcrete on a minimum of three  
7 projects of similar slope heights and orientations as in this project within the last  
8 five years.

9  
10 All nozzle operators shall be qualified by test in accordance with Section 6-18.3(4).

11  
12 **Testing**

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

15  
16 Fiber reinforcement shall be included in the shotcrete mix used for all pre-  
17 production and production testing.

18  
19 The Contractor shall make at least two 12 inch square production test panels,  
20 where one section is defined as one day's placement. One additional 12 inch  
21 square production test panel shall be made whenever a nozzle operator or  
22 equipment is changed during the daily work period.

23  
24 In addition to compressive strength testing, cores taken from the pre-  
25 production and production test panels will be tested for density, absorption and  
26 voids in accordance with ASTM C 642.

27  
28 Absorption shall not exceed 8 percent and void content shall not exceed 17  
29 percent.

30  
31 **Mix Design**

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

35  
36 Microsilica shall be included in the shotcrete mix, but shall not exceed 8 percent by  
37 mass of the mix.

38  
39 The minimum steel fiber content in the shotcrete mix shall be 100 pounds per cubic  
40 yard. The minimum macro synthetic fiber content in the shotcrete mix shall be 10  
41 pounds per cubic yard.

42  
43 **Surface Preparation**

44 Immediately prior to shotcrete application, rock and soil surfaces within the section  
45 being shot shall be scaled of all loose material and be thoroughly cleaned by use of  
46 air or water jets or other means acceptable to the Engineer. Shotcrete shall not be  
47 placed on any surface which is frozen, spongy, or where there is free water. The  
48 surface receiving shotcrete shall be dampened not more than one hour prior to  
49 shotcrete application.

50

1                   **Alignment Control**

2                   Thickness control pins shall conform to Section 6-18.3(6) and shall be placed on a  
3                   maximum five foot square grid pattern.  
4

5                   **Drainage**

6                   Unless otherwise shown in the Plans, weep holes shall be provided throughout the  
7                   shotcrete facing at 10-foot centers maximum, horizontal and vertical. The weep  
8                   holes shall consist of 24-inch long, two inch diameter Schedule 40 PVC slotted  
9                   drain pipe placed within predrilled holes and sloped to drain. The weep hole drains  
10                  shall be installed prior to placement of the shotcrete facing. The weep hole drains  
11                  shall extend one to three inches beyond the final finished surface of the shotcrete  
12                  facing. During placement of the shotcrete facing, the exposed open ends of the  
13                  weep hole drains shall be covered or plugged to prevent shotcrete intrusion. The  
14                  Contractor shall remove the covers or plugs after completing shotcrete placement.  
15

16                 Prefabricated drainage mat, if shown in the Plans or specified by the Engineer,  
17                 shall be placed on the slope face prior to placement of the shotcrete facing in  
18                 accordance with Section 6-15.3(7) and the details shown in the Plans, and shall be  
19                 secured to the slope face by methods acceptable to the Engineer to ensure  
20                 permanent and full contact with the slope.  
21

22                 **Anchor Bars**

23                 Unless otherwise shown in the Plans, steel reinforcing bar anchor bars shall be  
24                 placed at approximately 10-foot centers maximum, horizontal and vertical. The  
25                 bars shall be L shaped #5 bars with the short leg measuring 8 inches and the long  
26                 leg 24 inches. The bars shall be placed in 1-1/4 inch diameter, 24-inch deep holes.  
27                 The bars shall be set either with grout conforming to Section 9-20.3, or with Type II  
28                 epoxy bonding agent conforming to Section 9-26.1, with the grade and class as  
29                 recommended by the epoxy bonding agent manufacturer. The bars shall be placed  
30                 such that the short leg of the L shaped bar points upward and is approximately 1-  
31                 1/2 inches clear of the slope surface.  
32

33                 **Mixing of Production Fiber Reinforced Shotcrete**

34                 Fiber reinforced shotcrete can be mixed by either a dry mix or wet mix process. If  
35                 the dry mix process is selected, the fiber reinforcement used shall only be steel  
36                 fibers. If the wet mix process is selected, the fiber reinforcement may be either  
37                 steel fibers or macro synthetic fibers.  
38

39                 The method and equipment used for batch mixing shall be as submitted in  
40                 accordance with Section 6-18.3(1). The frequency and procedure for equipment  
41                 inspection, cleaning and maintenance shall be as recommended by the equipment  
42                 manufacturer.  
43

44                         **Dry Mix Process**

45                         The cement and aggregate shall be batched by weight. Pre-dampening shall  
46                         be done prior to flow into the main hopper and immediately after flow out of the  
47                         packaging in order to ensure that the premix will flow at a uniform rate (without  
48                         slugs) through the main hopper, delivery hose and nozzle to form uniform  
49                         shotcrete free of dry pockets. Pre-dampened cement and aggregate mix shall  
50                         not be used if allowed to stand more than 90 minutes.  
51

1                   **Wet Mix Process**

2                   The batching and mixing shall conform to ASTM C 94.

3  
4                   **Batching and Mixing Fiber Reinforcement**

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

8  
9                   If fibers are added during the batching and mixing process, a screen having a  
10                  mesh of 1.5 to 2.5 inches shall be used to prevent any fiber balls from entering  
11                  the shotcrete line. Batching through a screen will not be required if the  
12                  Contractor successfully demonstrates to the Engineer that fiber balls are not  
13                  being formed.

14  
15                  Fibers shall not be added to the dry or wet mix at a rate faster than they can be  
16                  blended with the other ingredients without forming balls or clumps. Bulk fibers  
17                  showing a tendency to tangle together shall pass through a vibrating screen or  
18                  be carefully sifted into the mix so that they enter the mix as individual elements  
19                  and not as clumps.

20  
21                  **Shotcrete Application**

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

24  
25                         Unless otherwise shown in the Plans, the minimum finished thickness of the  
26                         shotcrete facing shall be four inches.

27  
28                         Shotcrete shall be applied from the lower portion of the area upwards to  
29                         prevent rebound from accumulating on surfaces yet to be covered. Rebound,  
30                         defined as shotcrete constituents that fail to adhere to the applied surface,  
31                         shall not be worked into the finished shotcrete facing and shall not be salvaged  
32                         or recycled for inclusion in later batches.

33  
34                         Shotcrete application shall be suspended if any of the following conditions are  
35                         present:

- 36  
37                                 1. High winds prevent proper application of the shotcrete.
- 38  
39                                 2. The ambient temperature is, or is forecast to be, outside the  
40                                 temperature range of 40F to 90F during placement or initial curing.
- 41  
42                                 3. Rain or seepage is washing cement out of the freshly placed  
43                                 shotcrete or is causing sloughs in the work.

44  
45                         Construction joints shall be tapered over a minimum distance of 12 inches to  
46                         the thin edge. Square construction joints will not be permitted.

47  
48                  **Shotcrete Finishing**

49                  Unless otherwise shown in the Plans or specified in the Special Provisions, the  
50                  shotcrete facing shall be finished in accordance with Finish Alternative A in Section  
51                  6-18.3(8). Colorization, if required, shall conform to the requirements specified in  
52                  Section 6-18.2 as supplemented in these Special Provisions.