



**SECTION 03 31 01**  
**SCULPTED CONCRETE**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. CONTRACTOR shall furnish all labor, tools, and equipment for the construction of reinforced cast-in-place sculpted concrete (concrete and Shotcrete). Where “sculpted concrete” is called out on the DRAWINGS, it shall be up to the CONTRACTOR whether to use concrete and Shotcrete or just Shotcrete as necessary to conform to the lines, grades, thicknesses, and typical cross sections shown on the DRAWINGS. Sculpted concrete is to be finished to look like natural rock where exposed above ground.
- B. Work includes preparation of substrate surface, placing reinforcing steel, and placement and shaping of the top concrete or Shotcrete surface to look like natural sedimentary rock, and related items as shown or specified.
- C. This section includes basic finishing and curing methods, accessory control, and expansion and contraction joint devices.

**1.02 RELATED SECTIONS**

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 03 31 00, Structural Concrete.
  - 2. Section 03 11 00, Concrete Forming.
  - 3. Section 03 15 00, Construction Joints.
  - 4. Section 03 15 13, Waterstops.
  - 5. Section 03 21 00, Reinforcing Steel.
  - 6. Section 03 35 00, Concrete Finishing.
  - 7. Section 03 39 00, Concrete Curing.
  - 8. Section 07 92 00, Sealants.

**1.03 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. C33, Standard Specification for Concrete Aggregates.
    - b. C94/C94M, Standard Specification for Ready-Mixed Concrete.



- c. C150, Standard Specification for Portland Cement.
  - d. C260, Standard Specification for Air-entraining Admixtures for Concrete.
  - e. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
  - f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
  - g. C979, Standard Specification for Pigments for Integrally Colored Concrete.
  - h. C1059, Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
  - i. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
2. American Concrete Institute (ACI):
- a. 211, Standard Practice for Selecting Proportions for Concrete.
  - b. 301, Specifications for Structural Concrete.
  - c. 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
  - d. 305.1, Specification for Hot Weather Concreting.
  - e. 306.1, Specification for Cold Weather Concreting.
  - f. 309, Standard Practice for Consolidating Concrete.
  - g. 318, Building Code Requirements for Structural Concrete.
  - h. 504, Guide to Joint Sealants.
  - i. 506, Recommended Practice for Shotcreteing

#### 1.04 SUBMITTALS

- A. Provide product data on the following:
- 1. Ready-mixed concrete or Shotcrete mix designs.
  - 2. Fly ash.
  - 3. Admixtures (such as air-entraining and water-reducing admixtures).
  - 4. Form release agents.
  - 5. Bonding agents.
  - 6. Grout.



7. Concrete coloring pigment.
8. Data for proprietary materials and items including patching compounds, curing compounds, and other requested by the ENGINEER.
9. Contractor statement detailing previous sculpted concrete experience.
10. A sculpted concrete construction plan is to be submitted in writing to the ENGINEER for review 7 days prior to construction. The plan shall describe methods and equipment proposed for hauling, placing, curing, and protecting sculpted concrete as well as placement schedules indicating anticipated daily progress.
11. Shop drawings for sculpted concrete feature indicating sizes, spacing, locations, and quantities of reinforcing steel, bending and cutting schedules, splicing, supporting and spacing devices, and other accessories.
12. The CONTRACTOR shall construct a sample sculpted concrete panel measuring not less than 50 square feet. The sample panel shall represent the finished surface texturing, coloring, and etching of the sculpted concrete feature. The ENGINEER or other representatives of the OWNER shall observe and approve the sample panel prior to the construction of any sculpted concrete features.
13. Contractor shall submit to the ENGINEER for review and approval, all proposed texture mats to be utilized by the CONTRACTOR to achieve the most natural rock appearance and texture possible. If other methods of texturing will be performed, the contractor shall submit detailed descriptions of such methods for review.

#### 1.05 QUALITY ASSURANCE

- A. Structural Concrete as specified in Section 03 31 00, Structural Concrete, shall be used in the construction of the sculpted concrete feature unless Shotcrete is previously approved.
- B. Prior to placement of structural concrete for the sculpted concrete feature, the ENGINEER or other representatives of the OWNER must observe all reinforcing bar, forms, and surfaces receiving concrete. Prior to placing concrete CONTRACTOR must repair all discrepancies identified by ENGINEER or other representatives of the OWNER.
- C. OWNER's Direction:
  1. It is intended that the finished sculpted concrete feature simulate natural rock as shown on the DRAWINGS. OWNER's direction and aesthetic intentions are specified herein.
  2. To achieve the natural rock simulation, the CONTRACTOR shall coordinate fully with ENGINEER or other representatives of the OWNER. The ENGINEER or OWNER explicitly reserves the right to continuously monitor the WORK for aesthetic quality until the desired effects are achieved.



3. All WORK in this section shall be observed by the ENGINEER or other representatives of the OWNER. CONTRACTOR shall ensure a representative of the OWNER is onsite prior to placement of concrete.
  4. For sculpted concrete work, visits to other project sites (to view examples) may be required. Adequate notification of the intent to begin WORK on this item (minimum 24 hours) is required to ensure inspection and oversight by the ENGINEER and/or OWNER.
- D. The fabrication of artificial rockwork and placement, installation, and/or adjustment of finish details and sculptures shall be accomplished in such a manner as to appear as realistic as possible and “read right” to the trained eye. This element is artistic in nature and may require field adjustments to completed work to obtain the desired effect. The ENGINEER will decide questions of aesthetic effect. Minor changes or adjustments to in-place work shall be made at the CONTRACTOR’s expense.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Structural concrete delivery, storage, and handling shall be performed in accordance with Section 03 31 00, Structural Concrete.
- B. Ready-mixed Shotcrete shall comply with ASTM C94 except that it may be delivered to the Shotcrete equipment in the dry state if that equipment is capable of adding the water and mixing satisfactorily with the dry ingredients, or with ASTM C685, in which case the ingredients are delivered dry and proportioned and mixed at the site.
- C. Structural reinforcing steel delivery, storage, and handling shall be performed in accordance with Section 03 21 00, Reinforcing Steel.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Definition: Where “sculpted concrete” is called out on the plans, concrete or Shotcrete shall be used as necessary to meet the thickness, lines, and grades indicated on the plans.
- B. Concrete class:
  1. Concrete
    - a. Concrete shall meet the requirements of Class B concrete in accordance with section 601 of the Colorado Department of Transportation “Standard Specifications for Road and Bridge Construction”.
    - b. The concrete mix shall be made with AASHTO M 43 size No. 8 coarse aggregate.



<b>Sieve size U.S. Standard Square Mesh Sieves</b>	<b>ASHTO M 43 size No. 8 coarse aggregate Percent by Weight Passing</b>
¾"	-
½"	100
⅜"	85-100
No. 4	10-30
No. 8	0-10
No.16	0-5

2. Shotcrete

- a. Shotcrete shall be placed as a wet mixture of aggregate and Portland cement.
- b. The minimum 28-day compressive strength shall be 4500 psi.
- c. Coarse aggregates

1) AASHTO M 43 Size No. 8

<b>Sieve size U.S. Standard Square Mesh Sieves</b>	<b>ASHTO M 43 size No. 8 coarse aggregate Percent by Weight Passing</b>
¾"	-
½"	100
⅜"	85-100
No. 4	10-30
No. 8	0-10
No.16	0-5

d. Fine aggregates

- 1) AASHTO M6
- 2) ASTM C33

<b>Sieve size U.S. Standard Square Mesh Sieves</b>	<b>ASTM C33 Fine Aggregate Percent by Weight Passing</b>
¾"	-
½"	-
⅜"	100
No. 4	95-100
No. 8	80-100
No.30	50-85
No. 50	25-60
No. 100	2-10



- C. Use cement conforming to one of the following:
  - 1. Portland Cement conforming to ASTM C-150. Use only one brand of cement throughout the project.
  - 2. Blended hydraulic cement conforming to ASTM C-595 type IS, IS-A, IP, or IP-.
- D. Water shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances. For finished Shotcrete, use curing water that is free from elements that could cause staining.
- E. Submit for acceptance proportioning and test data from prior experience. If data from prior experience are not available or accepted, make and have tested specimens from three or more different mix proportions. Submit mix design containing recommended mix proportions and test results for acceptance of ready-mixed Shotcrete. Air entrainment shall be 5-8% prior to pumping.
- F. General: Structural concrete shall conform to Section 03 31 00, Structural Concrete. Structural reinforcing steel shall conform to Section 03 21 00, Reinforcing Steel.
- G. Concrete Pigment: Concrete coloring shall conform to ASTM C979.
- H. Fibermesh: Fibermesh shall not be allowed in sculpted concrete features unless written approval is provided by ENGINEER.
- I. Reinforcing Steel: reinforcing steel shall meet the requirements of section 03 21 00 Reinforcing Steel.

## 2.02 COMPRESSIVE STRENGTH

- A. Concrete compressive strength shall conform to Section 03 31 00, Structural Concrete.

## 2.03 SOURCE QUALITY CONTROL

- A. Batching, Mixing, Transporting Mixed Concrete; Mixed Concrete or Truck Mixers: Shall comply with Section 03 31 00, Structural Concrete.

## 2.04 ADMIXTURES

- A. Use of admixtures shall be permitted upon approval by the ENGINEER.

## 2.05 STAINING

- A. See section 09 91 00 of these specifications for information related to staining sculpted concrete.

# PART 3 EXECUTION

## 3.01 EQUIPMENT

- A. All Shotcrete shall be applied to the substrate surface via pneumatic-feed or positive displacement guns. All guns, air compressors, delivery hoses, and nozzles shall work



together to provide the appropriate Shotcrete product as determined acceptable by the ENGINEER. Failure to meet the desired product and strengths may result in rejection of equipment and/or methods employed by the CONTRACTOR at the discretion of the ENGINEER.

### 3.02 GENERAL

- A. "Sculpted concrete" shall be constructed with a single layer of concrete or Shotcrete. The CONTRACTOR is responsible for reviewing the DRAWINGS and deciding which application method will maintain the intended shape and grades. Any other application approach must be reviewed and approved by the ENGINEER.
- B. The "Test Section" shall be constructed first. This section will be inspected by the ENGINEER and OWNER. Once deemed acceptable and any necessary modifications to future work are discussed and agreed upon, the CONTRACTOR shall commence construction on other sculpted concrete. There is no specified sequence for the other areas.

### 3.03 PREPARATION

- A. Excavation to subgrade shall be carefully considered by the CONTRACTOR. Subgrade may be sloped uniformly, or stepped in accordance with the grading shown on the DRAWINGS as a means of reducing the concrete/Shotcrete quantity required. No adjustment in quantity shall be made for concrete/Shotcrete placed at thicknesses greater than the uniform layer shown on the DRAWINGS. The building of earthen steps on top of a sloping subgrade plane that has been compacted and approved is strictly prohibited. All concrete/Shotcrete necessary to achieve the layout shown on the DRAWINGS shall be included in the unit cost of the sculpted concrete.
- B. Prior to placing concrete, CONTRACTOR shall remove all debris and thoroughly dampen the surfaces that may be in contact with the concrete to be placed.
- C. CONTRACTOR shall examine the subgrade, and the conditions under which concrete reinforcement is to be placed, and correct conditions that would prevent the proper and timely completion of the work. The subgrade shall be free of water, unfrozen, mud, debris, or loose materials and have met compaction requirements as specific in section 31 23 00. CONTRACTOR shall not proceed with the work until unsatisfactory conditions have been corrected.

A Shotcrete flash coat may be applied over the top of the completed subgrade. The flash coat shall consist of a 1-inch layer of Shotcrete that will cap and protect the subgrade material during placement of reinforcing steel and prior to placement of sculpted concrete. The flash coat thickness can be counted towards the total required thickness of sculpted concrete if the following conditions are met: This requirement may be waived by OWNER or ENGINEER if CONTRACTOR can demonstrate it is not required and will not compromise the quality of the structure.

1. The thickness of the flash coat does not exceed 1.5 inches
2. The flash coat is power washed clean after steel placement is complete.



3. The flash coat Shotcrete does not excessively crack, break apart, and/or separate from the subgrade prior to placement of sculpted concrete. Determination of acceptance shall be performed by the ENGINEER.
- D. CONTRACTOR shall use compressed air from an air compressor to blow out construction debris and dirt at the bottom of members to be placed such as walls, beams, and columns, prior to final placement of forms that may obscure any joint. CONTRACTOR shall demonstrate to ENGINEER that all debris, such as concrete particles, saw dust, loose tie wire, bar tags, tape, trash, and dirt, have been thoroughly removed.
- E. All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed.
- F. No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms, and preparation of surfaces involved in the placing have been reviewed by ENGINEER.
- G. Concrete shall be placed when form surfaces that may be in contact with the concrete, reinforcement, embedded items or sub-base are greater than thirty-two degrees Fahrenheit (32°F). When the mean daily outdoor temperature is less than forty degrees Fahrenheit (40°F), the temperature of the concrete shall be maintained between fifty degrees Fahrenheit (50°F) and seventy degrees Fahrenheit (70°F) for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury as a result of concentration of heat. Combustion heaters shall not be used during the first twenty four (24) hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.
- H. Concrete shall not be placed against forms exposed to heating unless the temperature of the forms is first cooled to less than or equal to ninety degrees Fahrenheit ( $\leq 90^{\circ}\text{F}$ ).

#### 3.04 CONCRETE PLACEMENT

- A. Concrete shall be placed directly on approved subgrade in accordance with the requirements set for in Section 03 31 00.
- B. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.
- C. Concrete shall not be dropped more than five (5) feet unless confined by closed chutes or pipes. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and strain shall not be placed on the ends of projecting reinforcement.
- D. Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement.
- E. Concrete shall not be pumped through aluminum alloy pipe.





- F. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete.

### 3.05 SHOTCRETE PLACEMENT

- A. Place Shotcrete using suitable delivery equipment and procedures that will meet the requirements of this specification. Refer to ACI Standard 506-66, Recommended Practice for Shotcreting.
- B. Do not place Shotcrete if drying or stiffening of the mix takes place at any time prior to delivery to the nozzle. Do not use rebound or previously expended material in the Shotcrete mix.
- C. Remove over-spray or rebound prior to final set and before placement of Shotcrete material on such adjacent surfaces.
- D. Placement Techniques:
  - 1. Control thickness, method of support, air pressure, and/or water content of Shotcrete to preclude sagging or sloughing off. Discontinue Shotcreting or provide suitable means to screen the nozzle stream if wind or air currents cause separation of the nozzle stream during placement.
  - 2. Dampen absorptive substrate surfaces prior to placement of Shotcrete to facilitate bond and to reduce the possibility of shrinkage cracking developing from premature loss of the mixing water.
  - 3. Broom or scarify the surface of freshly placed Shotcrete to which, after hardening, additional layers of Shotcrete are to be bonded. Dampen surface just prior to application of succeeding layers.
  - 4. Provide a supply of clean dry air adequate for maintaining sufficient nozzle velocity for all parts of the Work, and if required, for simultaneous operation of a suitable blow pipe for clearing away rebound.
- E. Placement Around Reinforcement:
  - 1. Hold the nozzle at such a distance and angle to place material behind reinforcement before any material is allowed to accumulate on its face. In the dry-mix process additional waste may be added to the mix when encasing reinforcement to facilitate a smooth flow of material behind the bars.
  - 2. Do not place Shotcrete through more than one layer of reinforcing steel rods or mesh in one application unless demonstrated by pre-construction tests that steel is properly encased. Test to ascertain if any voids or sand pockets have developed around or behind reinforcement by probing with an awl or other pointed tool; by removal of randomly selected bars; or by coring or other suitable means.



### 3.06 COVER OF REINFORCEMENT

- A. Place concrete and/or Shotcrete to provide the 1 ½” (minimum) cover over all reinforcement.

### 3.07 LINE AND THICKNESS CONTROL

- A. Use adequate ground wires or other accepted means to establish the thickness, surface planes, and finish lines of the concrete/Shotcrete.
- B. No additional payment will be made for concrete volume or steel reinforcement placed in excess of amounts shown on the DRAWINGS, unless the ENGINEER agrees that conditions warrant such a change that go beyond the requirements set forth in Section 3.03(A) of this SPECIFICATION. If the CONTRACTOR prepares the subgrade in such a manner requiring additional concrete to meet design lines and grades without ENGINEER approval, the ENGINEER may require additional reinforcement steel at no additional charge to the OWNER.

### 3.08 CONSOLIDATION

- A. Concrete vibrators for consolidating concrete shall be two and one-half inch (2-1/2") diameter “high cycle” vibrators with a frequency under load of eight thousand (8,000) to ten thousand four hundred (10,400) vibrations per minute (vpm). Concrete vibrators of lesser capacity are unacceptable for use in any part of the construction. CONTRACTOR shall have at least one standby concrete vibrator ready for use for every two (2) concrete vibrators in use during a concrete placement.
- B. All concrete shall be thoroughly consolidated with internal vibrators as recommended in ACI 309 immediately after deposition. The concrete shall be thoroughly worked around the reinforcing steel, around embedded items, and into corners of forms. Vibration shall be supplemented by spading, rodding, or forking to eliminate all honeycomb and voids around embedded items.
- C. The vibrator shall be inserted vertically, allowing it to penetrate rapidly to the bottom of the lift and at least six (6) inches into the previous lift. The vibrator shall be held at the bottom of lift for five to fifteen (5 - 15) seconds. The vibrator shall be pulled up at a rate of about three (3) inches per second.
- D. The vibrator shall be inserted so that the fields of action overlap. The field of action is approximately eight (8) times the vibrator’s head diameter. Thus for a two and one-half (2-1/2) inch diameter vibrator, the spacing of each insertion shall be approximately twenty (20) inches.
- E. Vibration shall be stopped when the concrete surface takes a sheen and large air bubbles no longer escape.
- F. Do not use a vibrator to move concrete horizontally.

### 3.09 OPENINGS AND INSERTS

- A. Pipe sleeves, inserts for pipe connections, anchors, and forms for pipe holes shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. In the event that



openings are inadvertently omitted or improperly placed, ENGINEER may require the concrete to be cored at the proper location. Filling of improperly placed openings shall be done with expansive grout or dry pack or mortar applied with an accepted epoxy adhesive. The surfaces of the opening shall be roughened prior to filling.

### 3.10 EMBEDDED ITEMS

- A. At the time of concrete placement, embedded items shall be clean and free from mud, oil, and other coatings that may adversely affect bonding capacity. Aluminum embedments shall be coated with a bituminous material to prevent electrolytic action between the embedded item and reinforcing steel that results in concrete deterioration. Embedment items shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. Contact between embedded items and reinforcing steel or tendon ducts is unacceptable and is not permitted.

### 3.11 CONSTRUCTION JOINTS

- A. The location of all construction joints shall be subject to the acceptance of ENGINEER. The surface of all construction joints shall be thoroughly cleaned and all laitance and standing water removed. Clean aggregate shall be exposed by abrasive blast cleaning. Wire brushing and air water jets may be used while concrete is fresh provided results are equal to abrasive blast cleaning. Construction joints shall be keyed at right angle to the direction of shear. Except where otherwise shown on the DRAWINGS, keyways shall be at least one and one-half (1-1/2) inch in depth over at least twenty five percent (25%) of the area of the section.
- B. Construction joints shall not be allowed within a location where water is expected to flow over in the final constructed condition.
- C. Taper construction joints to a shallow edge form, about 1 inch thick, except where the joint will be subjected to compressive stress. In this case, use non-tapered joints and take special care to avoid or remove trapped rebound at the joint.
- D. The entire joint shall be thoroughly cleaned and wetted prior to the application of additional concrete/Shotcrete.
- E. Make joints perpendicular to the main reinforcement. Continue reinforcement across joints.
- F. Position construction and control joints to conform to the locations of natural occurring cracks and joints in the simulated rock and earth forms.

### 3.12 FINISHES

- A. CONTRACTOR will provide an expert(s) to perform texturing and shaping of the concrete/Shotcrete that is left exposed above ground.
- B. Finished product shall simulate natural rock as described in the SPECIFICATIONS and DRAWINGS. The CONTRACTOR shall achieve the desired appearance by 1) troweling the concrete/Shotcrete smooth, 2) cutting rock formation scars into the surface, and 3) texturing the entire surface using both texture mats and power



washing to achieve a natural rock finish. Alternative methods must be approved by ENGINEER.

- C. Extend texture layer a minimum of 3 feet below finished grade.
- D. If a trail section is included in the sculpted concrete a broom finish shall be applied to the trail surfaces shown on the DRAWINGS. Broom marks shall be perpendicular to the traveled direction. The broomed surface shall be smooth and void of sculpted concrete carvings.

### 3.13 CURING AND PROTECTION

#### A. Concrete:

- 1. Curing requirements specified in 03 39 00 Concrete Curing, shall be followed at all times.
- 2. The use of an evaporative retardant is required to assist in proper placement of concrete in accordance with Section 03 29 00, Concrete Curing. Apply two (2) times; after screeding and after the first floating operation. The retardant should be applied at a rate of one (1) gallon of sprayable solution per two hundred to four hundred (200 - 400) square feet by spraying with an industrial type sprayer. If the nozzle of the sprayer becomes plugged, CONTRACTOR shall clean or replace the nozzle. Under no circumstances shall the retardant be used except by spraying a mist with a nozzle. The retardant shall be applied in strict conformance with the manufacturer's recommendations and precautions. In no case shall the retardant be used as a finishing agent. The use of an evaporative retardant requires review and approval by ENGINEER.

#### B. Shotcrete:

- 1. Initial Curing
  - a. Following curing procedures of ACI Standard 308. Immediately after finishing, keep Shotcrete continuously moist for at least 24 hours. The methods and materials used for curing shall be approved by ENGINEER prior to placing Shotcrete.
- 2. Final Curing
  - a. Provide additional curing immediately following the initial curing and before the Shotcrete has dried. Use one of the following materials or methods:
    - 1) Continue the method used in initial curing.
    - 2) Materials conforming to "Specifications for Sheet Materials for Curing Concrete," (ASTM C171).
    - 3) Other moisture retaining coverings accepted upon approval by ENGINEER.

#### C. Duration and Temperature of Curing



1. Continue curing for the first 7 days after installation or for the first 3 days if high early strength is obtained. During the curing period, maintain Shotcrete or concrete above 40°F and in a moist condition as specified above. Prevent rapid drying at the end of the curing period

#### 3.14 REPAIR OF SURFACE DEFECTS

- A. Remove and replace concrete or Shotcrete, which lacks uniformity, exhibits segregation, honeycombing, or lamination, or which, contains any dry patches, slugs, voids or sand pockets. Remove and replace damaged in-place concrete or Shotcrete.
- B. Replace any concrete or Shotcrete which subsides after placement.

#### 3.15 FIELD QUALITY CONTROL

- A. CONTRACTOR shall assist OWNER or the concrete testing consultant as requested during the performance of quality control testing. Testing will be taken from the concrete truck.
- B. Test panels shall be shot for the Shotcrete. The panels should be 18" by 18" by 3" and shot at the same orientation as the majority of the structure. Panels shall be shot for every day of placement and every 25 CY of Shotcrete placed. All panels should be cured at the project site. Cores should be taken from the panel in accordance with ASTM C 42. Cores will be used to verify compressive strength. CONTRACTOR is to provide the panels for use in Shotcrete testing and have them available in the field prior to the start of Shotcrete. CONTRACTOR is to notify the ENGINEER 48 hours in advance of the start of Shotcrete operations.

**END OF SECTION**



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