

SECTION 033713 - SHOTCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wet-mix shotcrete.

B. Related Requirements:

1. Section 033712 "Exhibit Rockwork" for additional requirements regarding finished appearance of exhibit rockwork/shotcrete installation.
2. Section 071616 "Crystalline Waterproofing" for waterproofing/protection requirements for shotcrete formed pools.

1.2 DEFINITIONS

- A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
- B. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with shotcrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for shotcrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Shotcrete Installer.
 - e. Exhibit Rockwork Contractor.
2. Review methods and procedures related to shotcrete, but not limited to, the following:
 - a. Qualification data, equipment, and facilities needed to make progress and avoid delays.
 - b. Shotcrete finishes and finishing.
 - c. Cold- and hot-weather shotcreting procedures.
 - d. Curing procedures
 - e. Construction joints.
 - f. Forms and form-removal limitations.
 - g. Reinforcement accessory installation.

- h. Shotcrete repair procedures.
 - i. Protection of shotcrete.
- 3. Before submitting design mixtures, review each shotcrete design mixture and examine procedures for ensuring quality of shotcrete materials.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
- B. Design Mixtures: For each shotcrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Shop Drawings: For shotcrete installation.
 - 1. Include layout plans, elevations, sections, and support and anchor details
 - a. Layout plans shall identify all shotcrete by indicated exhibit rockwork categories and locations/types of all required footings/foundations.
 - 2. Detail fabrication, bending, and placing of reinforcement; number and location of splices; and special reinforcement required for openings through shotcrete structures.
 - 3. Detail formwork fabrication, assembly, and support.
 - 4. Indicate locations of proposed construction joints.
- D. Delegated Design Submittal: For shotcrete structural reinforcing indicated to comply with performance requirements and design criteria, including analysis signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.
- C. Material Certificates: For each of the following:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials.
 - 4. Steel reinforcement and accessories.
 - 5. Curing compounds.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer, subcontracted to the Exhibit Rockwork Contractor, employing nozzle operators for Project, each of whom is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical Position as appropriate to the required shotcrete work.
- B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
- C. Standard: Comply with ACI 506.2, "Specification for Shotcrete," unless otherwise indicated.
- D. Shotcrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design shotcrete mixtures.
- E. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups for each finish required and for each design mixture, shooting orientation, and nozzle operator.
 - 2. Build mockups in the location and of the size indicated on Drawings.
 - 3. Demonstrate curing and protecting of shotcrete, finishes, and joints, as applicable.
 - 4. It is intended that the configuration, texturing and coloring for exposed shotcrete be executed under the detailed direction of the Architect, until such time as satisfactory examples of the desired character have been developed. Notify the Architect at least 72- hours before beginning placement of first example of each type of shotcrete to be exposed and schedule time when the Architect can observe and direct the finishing work as it is executed.
 - 5. In presence of Architect, damage part of the exposed-face surface for each color and finish and demonstrate materials and techniques proposed for repair of holes and surface blemishes to match adjacent undamaged surfaces.
 - 6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waste, Rebound and Extra Material Required for Realistic Natural Simulations: Past experience in similar zoo projects indicates that up to 25% extra concrete material (above what appears on the Drawings) is or may be required to create realistic, natural simulations of the items to be provided.

1.8 FIELD CONDITIONS

- A. Protection of Property: Take note of requirements for protection of trees and soil as specified. Do not discharge cement-bearing water onto the ground on site. Account for all debris generated by operations and remove from site regularly, especially small bits of reinforcement and hardware.

B. Surveying:

1. Provide surveying as frequently as is required to accurately locate features as detailed on drawings. Confirm location, elevations and profiles of work by optical or laser survey immediately before and after placement of each contiguous surface.
2. Tolerance for location of any point defined on the drawings in one tenth of one foot in both horizontal and vertical dimensions.

PART 2 - PRODUCTS

2.1 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Plain-Steel Wire: ASTM A1064/A1064M, as drawn.
- C. Welded Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire, furnished in flat sheet.
- D. Mesh Screening (wire cloth): Galvanized, unpainted 2" x 2" x 14 gauge, square mesh, plain weave.
- E. Metal Lath: ASTM-F 1267 galvanized, unpainted.
- F. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place; manufactured according to CRSI's "Manual of Standard Practice" and as follows:
 1. For uncoated reinforcement, use all-plastic bar supports.
- G. Reinforcing Anchors: ASTM A36/A36M, unheaded rods or ASTM A307, Grade A, hex-head bolts; carbon steel; and carbon-steel nuts.
 1. Finish: Plain, uncoated.

2.2 SHOTCRETE MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type III. Use only one brand and type of cement for Project.
- B. Normal-Weight Aggregates: ASTM C33/C33M, from a single source, and as follows:
 1. Combined Aggregate Size: ACI 506R or ASTM C1436, Grading No. 1 sieve analysis.
 2. Deleterious Substances: As specified for fine aggregate according to ASTM C33/C33M.
- C. Water: Potable, complying with ASTM C94/C94M, and free from deleterious materials that may affect color stability, setting, or strength of shotcrete.

- D. Ground Wire: High-strength steel wire, 0.8 to 1.0 mm in diameter.
- E. Admixtures: ASTM C1141/C1141M, Class A (liquid) or Class B (nonliquid), but limited to the following admixture materials. Provide admixtures for shotcrete that contain no more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.
 - 1. Accelerating Admixture, Conventional: ASTM C494/C494M, Type C or Type E.
 - 2. Coloring Admixture: ASTM C979/C979M, synthetic mineral-oxide pigment or colored, water-reducing admixture, free of carbon black; color stable, nonfading, and resistant to lime and other alkalis.
 - 3. Air-Entraining Admixture: As limited in "Shotcrete Mixtures" Article.

2.3 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry, or cotton mats.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Curing Compound: ASTM C309, Type 1, Class B; clear, waterborne, membrane-forming curing compound.

2.4 SHOTCRETE MIXTURES

- A. Source Limitations for Shotcrete: Obtain each color, size, type, and variety of shotcrete material and shotcrete mixture from single manufacturer with resources to provide shotcrete of consistent quality in appearance and physical properties.
- B. Design Mixtures: Prepare design mixtures for each type and strength of shotcrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 506.2.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixture or field test data, or both.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
- E. Coloring Admixture: Add coloring admixture to shotcrete mixture according to manufacturer's written instructions and to result in hardened shotcrete color consistent with approved mockup.
- F. Design-Mixture Adjustments: Subject to compliance with requirements, shotcrete design-mixture adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

G. Shotcrete Mixture: Proportion mixture to provide shotcrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi.
2. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight wet-mix shotcrete having an air content before pumping of 7 percent with a tolerance of plus or minus 1-1/2 percent.
3. Color: As indicated by manufacturer's designation.
4. Color of Finish Coat: As approved by Architect, subject to sample review, to match reference images on Drawings.

2.5 SHOTCRETE EQUIPMENT

- A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.
- B. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

2.6 BATCHING AND MIXING

- A. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C94/C94M and furnish batch ticket information.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Earth Substrates: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces to saturated, surface-dry condition before shotcreting.

3.2 INSTALLATION, GENERAL

- A. Coordinate design of reinforcing, excavation, preparation, accessories, shotcrete mixtures, and other items with requirements of Section 033712 "Exhibit Rockwork", exhibit rockwork theming (photographs/illustrations), and the Exhibit Rockwork Contractor.

3.3 EXCAVATION, SUBDRAINAGE, AND BACKFILL

- A. The Exhibit Rockwork Contractor must coordinate the excavation, dewatering, shoring and maintenance of all excavation, subdrainage, wall drainage and aggregate for shotcrete features up to the shotcrete subgrade with the General Contractor.
- B. The Exhibit Rockwork Contractor shall be responsible for all additional backforming and backfilling required for shotcrete work as a result of over-excavation. It is the Exhibit Rockwork Contractor's responsibility to avoid such over excavation and to coordinate

with the General Contractor to facilitate excavation as close to final subgrade as possible.

- C. The Exhibit Rockwork Contractor must accept the subgrade in written form for each individual exhibit or portion of an exhibit and submit such approval, in writing, to the Architect. If the Exhibit Rockwork Contractor does not accept the subgrade, the Exhibit Rockwork Contractor must notify the Architect in writing immediately. Additional excavation and/or compaction of subgrade required by Exhibit Rockwork Contractor to reach acceptable level must be performed by General Contractor at no additional cost to the Owner.
- D. Following the acceptance of the subgrade by the Exhibit Rockwork Contractor, the Exhibit Rockwork Contractor shall be responsible for the following at no additional cost to the Owner:
 - 1. All additional subgrade adjustment and reinstallation of drainage systems and sleeves required for his work.
 - 2. All maintenance required to maintain the accepted subgrade, with the exception of any dewatering device which shall be the responsibility of the Site Contractor
- E. All backfill behind, around, within and on top of the shotcrete features to complete the rock simulation work to the satisfaction of the Architect shall be the responsibility of the General Contractor in coordination with the Exhibit Rockwork Contractor

3.4 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.
- C. Securely embed reinforcing anchors into existing substrates, located as required.
- D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports, bolsters, chairs, spacers, and other devices as required to maintain minimum concrete cover.
- E. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.
- F. Install welded wire reinforcement in largest practical sheets on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- G. Minimum Standards: The following minimal steel placement standards are supplemental to any steel reinforcement notes shown on the Drawings.
 - 1. No. 3 reinforcing bars shall be placed on 10" centers both ways as the minimum acceptable amount of bar reinforcing and shall be continuous around corners. The spacing shall remain the same but the bar size will increase where, in the opinion of the Delegated Design Engineer, it is deemed necessary. A No. 4 bar acting as a key rod shall be placed at intersections of all plan surfaces.

2. Tack weld or wire bars where they contact or cross each other. The bars must form a rigid framework. All bars are to lap thirty (30) diameters at splices. However, a lap of 4" will be allowed if one continuous fillet weld of 3" in length is used to tie or weld the bars together at the splice. Touch up bars at welds.
 3. Reinforcing bars shall be placed and bent around circles and curves, openings, corners, and angles to conform with the Drawings. Bends are to be permanently shaped, not sprung into place. Particular attention shall be made to follow the outline of the stratified rock formations to eliminate excess non reinforced rockwork outcroppings
 4. The tie bars and tie anchors which are exposed to air and which do NOT come in contact with any backfill material shall be given a protective asphalt coating of at least one heavy coat or Rustoleum, or equal.
 5. Tie bars and tie anchors which come in contact with backfill material shall be encased with a coating of shotcrete. Steel shall be covered by a minimum of 1" of shotcrete.
 6. Additional #4 bars shall be used diagonally across corners of all openings, and wherever shotcrete formations act as beams additional #5 bars shall be placed at points of maximum stress, i.e., one in top and one in bottom extending 12" into supports. Additional #4 bars shall be integrated into the steel framework if such steel is necessary to provide a stable structure.
 7. The mesh shall be placed on steel reinforcing on side opposite the backup material and shall be securely wired to the reinforcing bars at not less than 20" intervals in both directions. Mesh shall lap at least 2" at adjacent ends.
 8. Place reinforcing for pools and slabs uniformly 1 ½" to 2" from the bottom of shotcrete slabs.
- H. Where artificial rockwork is to be constructed, use the backup construction described below or provide the Architect with an alternate construction system for approval.
1. Construct an armature of metal lath on the unexposed side of the shotcrete structure as the backup construction material behind the steel reinforcing bars to which the shotcrete is applied.
 2. Metal lath shall be bent to conform approximately to the welded and steel reinforcing frame and shall be held away from the nearest bars a minimum distance of 2" min. In order to facilitate the installation of metal lath the Contractor may increase the thickness of the shotcrete to do away with matching exactly the steel reinforcing outline. However, all variances from the steel outline must be approved by the Exhibit Designer.
 3. Metal lath shall be fastened to the reinforcing bars by means of tie wires or anchor spacers. Ties or spaces shall be spaced not more than 10" on center in all directions. Space lath away from reinforcing rods such that reinforcing rods will be in the center of the finished structure. There must be a 2" minimum thickness of concrete between reinforcing bars and lath.

3.5 JOINTS

- A. General: Illustrate proposed locations of joints on Shop Drawings to be approved by Architect.
- B. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints unless otherwise indicated.

- C. Contraction Joints: Construct contraction joints in shotcrete using saw cuts 1/8-inch-wide by one-third of slab depth or joint-filler strips 1/4-inch- wide by one-third of shotcrete depth unless otherwise indicated.
1. After shotcrete has cured, remove strip inserts and clean groove of loose debris.
 2. Space joints horizontally and vertically, Illustrate proposed locations of joints on Shop Drawings to be approved by Architect.
 3. Tool edges round on each side of strip inserts if floated or troweled finishes are required.
 4. Where shooting over an existing substrate joint, align new shotcrete joint with existing joint.

3.6 ALIGNMENT CONTROL

- A. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

3.7 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.8 APPLICATION

- A. Apply shotcrete applied by wet-mix process and according to ACI 506.2.
- B. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
- C. Moisten wood forms immediately before placing shotcrete where form coatings are not used.
- D. Apply wet-mix shotcrete materials within 90 minutes after batching.
- E. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.
1. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
 2. Remove and dispose of cuttings during the trimming or rodding process to prevent unconsolidated material from falling onto lower reinforcement.
- F. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray, and prevent buildup against front face during shotcreting.
- G. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.

- H. Do not permit shotcrete to sag, slough, or dislodge.
- I. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
- J. Do not disturb shotcrete surfaces before beginning finishing operations.
- K. Remove ground wires or other alignment-control devices after shotcrete placement.
- L. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
- M. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117, increased by a factor of two.
- N. Cold-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 306.1 and as follows. Protect shotcrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. Discontinue shotcreting when ambient temperature is 40 deg F and falling.
 - 2. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F and no more than 90 deg F.
 - 3. Do not use frozen materials or materials containing ice or snow.
 - 4. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
 - 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
- O. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 305.1 when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
 - 1. Cool ingredients before mixing to maintain, at time of placement, shotcrete temperature below 90 deg F for wet mix.
 - 2. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F before shotcreting.

3.9 SURFACE FINISHES

- A. General: Finish shotcrete according to descriptions in ACI 506R.
- B. Finish-Coat with Final Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply shotcrete finish coat, 1/4 to 1 inch thick, using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 sieve, and apply finish matching approved mockup and in compliance with provisions of Section 033712 "Exhibit Rockwork".
 - 1. Wherever a flash coat is to be applied to a concrete surface, the concrete surface shall be roughened texture within minimum 2" thickness.
 - 2. The finish form, color and texture of the finish surface must meet with the approval and be completed to the satisfaction of the Architect, which approval, when given, must be in writing.

3.10 CURING

- A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
- B. Begin curing immediately after placing and finishing but not before free water, if any, has disappeared from shotcrete surface.
- C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
 - 1. Curing Compound: Apply uniformly in continuous operation by power spray according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Apply curing compound to natural gun and flash-coat finishes at rate of 1 gal./100 sq. ft..
- D. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

3.11 FORM REMOVAL

- A. Forms not supporting weight of shotcrete may be removed after curing for 24 consecutive hours at not less than 50 deg F, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.
 - 1. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Air Content: ASTM C173/C173M, volumetric method or ASTM C231/C231M, pressure method; one test for each compressive-strength test for each mixture of air-entrained, wet-mix shotcrete measured before pumping.
- C. Shotcrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of compressive-strength specimens.
- D. Test Panels: Make a test panel, reinforced as in structure, for each shotcrete mixture and

for each workday or for every 50 cu. yd. of shotcrete placed, whichever is less. Produce test panels with dimensions of 24 by 24 inches minimum and of average thickness of shotcrete, but not less than 4-1/2 inches. Testing agency will obtain sets of test specimens from each test panel.

1. Compressive Strength Testing: One set of three unreinforced specimens. Test each set of unreinforced specimens for compressive strength according to construction testing requirements in ACI 506.2.
 2. Visual Core Grading: One set of three reinforced specimens. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.
- E. Strength of shotcrete will be considered satisfactory according to the following:
1. Specimen Cores: Mean compressive strength of each set of three unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
- F. Shotcrete will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.13 REPAIRS

- A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.
1. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs.
 2. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders.
 3. Dampen surfaces and apply new shotcrete. Match adjacent color and finish.

3.14 CLEANING

- A. Immediately remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.
- B. Do not bury reinforcing, wire, formwork, rebound, chips, or other material within the exhibit area.

END OF SECTION 033713