SECTION 033713 - SHOTCRETE

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes shotcrete applied by wet-mix process.

1.2 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Design Mixtures: For each shotcrete mixture.
C. Shop Drawings: For support and anchor details; details of fabricating, bending, and placing reinforcement; and locations of proposed construction joints.
D. Samples: For each exposed product and for each color and finish specified.

1.4 INFORMATIONAL SUBMITTALS
A. Material certificates.

1.5 QUALITY CONTROL

PART 2 - PRODUCTS

2.1 REINFORCING MATERIALS
A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
C. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.


F. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.

2.2 SHOTCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III. Use only one brand and type of cement for Project.

1. Fly Ash: ASTM C 618, Class C or Class F.
2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or Grade 120.

B. Normal-Weight Aggregates: ASTM C 33, from a single source, and as follows:

1. Combined Aggregate Size: ACI 506R or ASTM C 1436, Grading [No. 1] [No. 2] sieve analysis.

C. Synthetic Fiber: [Monofilament] [or] [fibrillated] polypropylene fibers engineered and designed for use in shotcrete, complying with ASTM C 1116/C 1116M, Type III.

2.3 ADMIXTURES

A. General: ASTM C 1141, Class A (liquid), but limited to the following admixture materials. Provide admixtures for shotcrete that contain not more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.

2.4 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 C 171, polyethylene film or white burlap-polyethylene sheet.

C. Clear, [Waterborne] [Solvent-Borne], Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.5 SHOTCRETE MIXTURES, GENERAL

A. 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.
B. **Cementitious Materials:** Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. **Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.**

D. **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.

### 2.6 SHOTCRETE MIXTURES

A. **Shotcrete Mixture <Insert drawing designation>:** Proportion mixture to provide shotcrete with the following properties:

1. **Compressive Strength (28 Days):** [4000 psi] [3500 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] [8] <Insert number> percent with a tolerance of plus or minus 1-1/2 percent.
3. **Synthetic Fiber:** Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of [1.5 lb/cu. yd.] [5 lb/cu. yd.].
4. **Color:** As selected by Architect from manufacturer's full range.

### PART 3 - EXECUTION

### 3.1 STEEL REINFORCEMENT

A. **General:** 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.**

### 3.2 APPLICATION

A. **Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.**

B. **Apply shotcrete according to ACI 506.2.**

C. **Apply [dry-mix shotcrete materials within 45 minutes after predampening] [and] [wet-mix shotcrete materials within 90 minutes after batching].**

D. **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.

E. 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.

F. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.

G. Do not permit shotcrete to sag, slough, or dislodge.

H. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.

I. Do not disturb shotcrete surfaces before beginning finishing operations.

J. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117, increased by a factor of two.

K. Cold-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 306.1. Protect shotcrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

L. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to recommendations of ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete:

3.3 SURFACE FINISHES

A. General: Finish shotcrete according to descriptions in ACI 506R.

B. Natural Finishes:

1. Gun Finish: Natural undisturbed finish as sprayed.
2. Rod Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set. Do not push or float with flat part of trowel.
3. Broom Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set; followed by uniform brooming.

3.4 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.
Curing Exposed Surfaces: Cure shotcrete by one of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with water, continuous water-fog spray, water-saturated absorptive covers, or moisture-retaining covers. Lap and seal sides and ends of covers.

2. Curing Compound: Apply uniformly in continuous operation by power spray according to manufacturer's written instructions. Recote 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 finish or flash-coat shotcrete at rate of 1 gal./100 sq. ft.

3.5 REPAIRS

   A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets.

3.6 CLEANING

   A. Immediately remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 033713