SECTION 32 13 16

ARCHITECTURAL CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Architectural Concrete Paving for areas as indicated on the Drawings including:
      a. Edge and face forming, reinforcing, the conveying, placement, consolidating, curing, polishing and top coating of exterior on-grade slabs.

B. Related Sections:
   1. Division 07 Section “Joint Sealers” for installation of caulking.
   2. Division 32 Section “Concrete Paving” for adjacent concrete paving.
   3. Division 32 Section “Underground Sprinklers” for coordination of irrigation sleeve installation.
   4. Division 32 Section “Planting” for coordination of plant material placement.

C. Requirements of Regulatory Agencies:
   1. Federal, State, and local laws and regulations governing this Work are hereby incorporated into and made part of this Section. When this Section calls for certain materials, workmanship, or a level of construction that exceeds the level of Federal, State, or local requirements, provisions of this Section take precedence.

D. Applicable Standards:
   1. Specifications and recommended practices of American Concrete Institute (ACI), American Society for Testing and Materials (ASTM), The International Code Council, and U.S. Patents referred to in this Specification with their individual designations are to be considered part of this Specification.

1.02 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other Pozzolans, and ground granulated blast-furnace slag.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
   1. Submit shop drawings for reinforcing steel and accessories in accordance with ACI standards.
   2. Paving Jointing and Pour Sequence Plan - submit prints indicating the following:
      a. Proposed layout of contraction, construction, and isolation joints. Clearly delineate the three different joint types.
b. Layout of paving and colors as indicated on Drawings. Give overall dimensions of each paving type.

c. Concrete pour sequence. Indicate sequence of paving pour installation.

C. Statement of Mix Design: Submit copy of Statement of Mix Design prepared by batch plant servicing Project for each load delivered to Project. Statement of Mix Design to contain following information:

1. Name, address, and telephone number of batch plant preparing statement of mix design.
2. Date of mix design.
3. Project location.
4. Contractor requesting load delivery.
5. Mix design number.
6. Integral color used.
7. Gradations for sand and aggregate.
8. Material weights, specific gravity, and absolute volumes.
9. Basis of testing, i.e. UBC 2605 D4 and Title 24 2604 D4.
11. PSI rating.
12. Signature of testing laboratory manager.
13. Signed stamp from registered Project structural engineer or architect.

D. Samples:

1. Submit samples showing specified gradation and anticipated color range of recycled glass aggregate to be seeded into the concrete surface. Package in transparent, clear, round container weighing approximately 10 pounds.
2. Submit 12-inch square samples no more than 3/4-inch thick showing proposed concrete mix, seeded aggregate, and proposed sheen for Architect’s preliminary approval. Following Architect’s preliminary approval, continue with the construction of the required mock-up.

E. Installer Qualifications: Submit Installers qualifications demonstrating compliance with specified requirements including letter or certification from manufacturer for acceptance as an approved Installer for the system to be provided. Include references for completed projects in the last five years including name and location of project; contact information for owner, architect and general contractor; size and type of project; overall project construction cost; cost of decorative concrete work; and date of completion.

F. Surface-Seeded Aggregate (extra stock):

1. One 1-pound sample of each aggregate specified.
2. One 1-pound sealed bag of each aggregate specified for use by Owner in future repairs of damaged Architectural Concrete Paving.

G. LEED Submittals:

1. General:
   a. Submit material cost breakdowns for all products used as part of this work, submitted in the format of the Material Tracking Worksheets, per Division 01 Section “Sustainable Design Requirements”.

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b. Submit additional materials information (e.g. recycled content, manufacturing location) to complete the information provided in the Material Tracking Worksheets where specified in this article or requested by the Architect.

c. Submit Letters of Certification, Product Cut Sheets, Material Safety Data Sheets, or other items to support the information provided in the Material Tracking Worksheets where requested by the Architect.

d. Submit Material Safety Data Sheets for all applicable products. If the MSDS does not show the product’s Volatile Organic Compound (VOC) content, this information must be provided through other published product literature from the manufacturer, or stated in a letter of certification (on the manufacturer’s letterhead) from the product manufacturer.

e. Recycled Content Materials: (Credit MR4).
   a. Submit product data or other published information indicating separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.
      1) Include information on Material Tracking Worksheets.

3. Local/Regional Materials: (Credit MR5).
   a. Submit location of manufacturing facility including name, address and distance between manufacturing facility and the project site. Provide manufacturer’s documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Also include material costs, excluding costs of installation.
      1) Include information on Material Tracking Worksheets.

4. VOC Content and Material Composition: (Credit EQ4).
   a. Submit product data and material safety data sheets (MSDS) for adhesives, sealants, paints, coatings and carpet products used on the interior of the building indicating chemical composition and VOC content of each product used. Highlight or circle applicable VOC content on submittal and indicate specified limit to be complied with.

1.04 QUALITY ASSURANCE

A. Installer Qualifications:
   1. An experienced installer who has completed decorative concrete floor finish work similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance. Installer must be acceptable to the manufacturer (certified in writing) of the decorative concrete floor finish system to be provided.
      a. Final approval of Installer to perform the work will be based on Installer’s ability to provide an acceptable mock-up. Architect reserves the right to require a different Installer be employed where Contractor’s selected installer cannot produce an acceptable mock-up in the sole judgment of the Architect.
2. Installers not listed herein must submit qualifications to the Architect for review and upon written approval of qualifications from the Architect must schedule visits to completed project(s) in the area prior to final approval. Acceptable installers include, but are not limited to, the following:

   a. Shawn Bullock
   b. 22285 East Alameda Avenue
   c. Aurora, Colorado 80018
   d. (720) 219-8628
   e. 
   f. Colorado Hardscapes, Inc.
   g. 8085 East Harvard Avenue
   h. Denver, Colorado 80231
   i. (303) 750-8200
   j. 
   k. Meidling Concrete Specialties
   l. 12411 East Empire Avenue
   m. Spokane Valley, Washington 99216
   n. (509) 924-7180
   o. 
   p. Rocky Mountain Construction
   q. 11470 Carisa Court
   r. Hayden, Idaho 83835
   s. (208) 772-8181
   t. 
   u. True North Polishing
   v. 3532 Northeast Austin Drive
   w. Lee Summit, Missouri 64064
   x. (401) 580-0867

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Standards:
   1. Conform to ACI and ASTM standards as specified in Division 32 Section “Concrete Paving” and applicable PCA standards.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Prepare slab-on-grade mock-up of not less than five, 4- by 4-foot areas which abut to one another to demonstrate differential between pours, typical joints, surface finish texture, color, slip resistance and standard of workmanship. Pour first section and following with the pouring of the second section 2 or 3 days later. Locate where acceptable to the Architect either outside of the building line or inside the building line.
where mock-up will remain uncovered and available for comparison throughout the construction period. Modify mock-ups or prepare additional mock-ups if directed by Architect to achieve approval of factors to be demonstrated in the mock-up. Demolish and remove mock-ups outside of the when directed by the Architect.

a. On one-quarter of each mock-up sample, finish the concrete surface by hand polishing methods and finish the balance with large field polishing method.

b. Testing of mock-up will be required to ensure compliance with the wet slip coefficient requirements specified and will be part of the determination as to whether the mock-up is acceptable or not.

E. Pre-Installation Conference:

1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:
   a. Concrete mixture design.
   b. Quality control of concrete materials and decorative concrete paving construction practices.
   c. Staging and sequencing.
   d. Protection of completed work.

2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Decorative concrete paving Installer.
   e. Manufacturer’s representative of decorative concrete paving system.

F. Slip Resistance: Provide a finish with a slip resistance of equal or greater than 0.65 when tested in accordance with ASTM F 489.

1.05 PROJECT CONDITIONS

A. Keep Work area clean, and in a safe and workmanlike condition so that rubbish, waste and debris do not interfere with work of other trades.

1.06 SITE INSPECTION

A. Verify conditions at site that affect work of this Section.

B. Take field measurements as required.

C. Report major discrepancies between Drawings and field dimensions to Owner's Authorized Representative prior to commencing work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store materials in a dry and protected location. Protect reinforcing steel and dowels from rusting, deformation, staining, and moisture damage.

B. Keep aggregate dry at all times prior to installation.
PART 2 - PRODUCTS

2.01 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
   1. Use flexible or uniformly curved forms for curves of a radius of 100 feet or less. Do not use notched and bent forms.
   2. Ensure that form lumber is new #2 or better grade wood. Do not use used form lumber.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.02 PORTLAND CEMENT

A. Type I, IA, II, IIA, III, IIIA, IV, and V cements, to conform to ASTM C150.

B. Use same brand of cement from single source throughout entire project.

2.03 WASHED CONCRETE SAND

A. Clean, hard, and durable washed concrete sand, conforming to ASTM C33.

B. Use same sand from single source throughout entire project.

2.04 COURSE AGGREGATE

A. Clean, hard, and durable coarse aggregate, conforming to ASTM C33.

B. Use same aggregate from single source throughout entire project.

2.05 SURFACE-SEEDED AGGREGATE

A. Decorative Aggregates:
   1. Concrete Aggregate: To meet the requirements of Division 32 Section “Concrete Paving” and to match the sample in the Architect’s office.
   2. Surface Seeding Aggregates – seven, as follows:
      a. (3) aggregates to be 100% recycled glass, as supplied by Colorado Hardscapes:
         1) Black Glass.
         2) Light Blue Glass.
         3) Blue Glass.
      b. (4) aggregates to be stone, as supplied by Colorado Hardscapes:
         1) Quartz No. 1.
         2) Crystal White.
         3) Texas Black.
         4) Texas Blue.
      c. 3. Seeding Rate: Maximum 10 ounces per square foot.
4. Predominant size will be No. 1, with approximately 5% of larger size seeded in.
5. Manufacturer shall match these colors or provide samples for review and approval by Architect.

2.06 WATER
A. Free from deleterious materials such as oils, acids, and organic matter.

2.07 ADMIXTURES
A. Air Entrainment Admixtures: Conforming to ASTM C260.
   1. Acceptable Manufacturers:
   B. Water Reducing Admixtures: Conforming to ASTM C494, Type A.
      1. Acceptable Manufacturers:
      1. Acceptable Manufacturers:
            1) “Eclipse” Shrinkage Reducing Admixture is a liquid admixture which dramatically reduces concrete shrinkage and curling due to drying.
         2. Application Rate: 1/2 lb./cy of mix.

2.08 READY MIXED CONCRETE
A. Batched, mixed and transported in accordance with ASTM C-94 "Specifications for Ready Mixed Concrete."

2.09 REINFORCING
A. Reinforcing Steel: Conforming to ASTM A615, clean and free of rust, dirt, grease or oils.
B. Tie Wire: 16-gauge plain cold-drawn steel conforming to ASTM A82, clean, and free of rust, dirt, grease or oils.
C. Supports for Reinforcement:
   1. Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars in place.
D. Polypropylene Fiber Reinforcement: 100% virgin multifilament polypropylene fibers, complying with ASTM C 1116 - Type III.
   1. Acceptable Manufacturers:
      c.
   2. Application Rate: 1/2 lb./cy of mix.
2.10 CONSTRUCTION JOINT DOWELS
   A. Construct Speed Dowel Construction joints at modules not larger than 20'-0" x 20'-0.”
   B. Dowel schedule to match rebar schedule and at a minimum spacing of 18-inches o.c.
   C. 1/2-inch-diameter Rebar, free of dirt, grease, and oils. Encase 50 percent of each dowel in a “Speed Dowel” plastic sleeve as manufactured by Greenstreak: www.greenstreak.com, to allow parallel lateral movement of each dowel.

2.11 FLY ASH
   A. ASTM C618 - Type F.

2.12 CURING AND SEALING MATERIALS
   A. Curing Paper: Non-staining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C 171.
   B. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
   C. Clear Acrylic Sealer: Manufacturer’s standard, waterborne, non-yellowing and UV-resistant, membrane-forming, matte-gloss, acrylic copolymer emulsion solution, manufactured for colored concrete, containing not less than 15 percent solids by volume.

2.13 CONCRETE MIXING
   A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.
      1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
      1. Subgrade to meet requirements of project’s soils report.
   B. Ensure that a minimum 2-inch layer of graded washed concrete sand or class 6 roadbase compacted to 95 percent relative compaction is placed over subgrade prior to placing concrete.
   C. Screed sand or roadbase to a smooth plane.
D. Ensure that utilities, including irrigation lines are buried and compacted below bottom of sand layer.

E. Keep sub grade damp prior to placing concrete.

3.02 FORMING

A. Installing contractor is responsible for design, engineering, and construction of form work.

B. Ensure that Work conforms to recommended practice for concrete form work (ACI 347), latest edition.

C. Do not exceed 20-feet by 20-feet in a formed construction area.

D. Perform form layout with digital electronic transit accuracy.

E. Allow forms to remain in place long enough to allow concrete to set properly. Remove forms when appropriate.

3.03 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, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

3.04 DESIGN OF MIXES AND PROPORTIONING

A. Proportion and mix of cement, aggregate, admixture, and water to attain required plasticity and strength in accordance with current edition of ACI Manual of Concrete Practice and PCA "Design and Control of Concrete Mixtures."

B. Concrete mixtures to be designed by an approved commercial testing laboratory, using approved materials to obtain specified minimum compressive strength.

C. Concrete Mix Criteria:
   1. Slump: 5-inch, with a 1/2-inch slump differential between successive batches. Obtain approval from Owner's Authorized Representative if slump is outside these parameters.
   2. Minimum PSI Rating at 28 days: 4,000.
3. Portland Cement: Gray and White in percentages as indicated.
   a. Gray (100% Standard Gray): 50% of area
   b. White (100% White Cement): 50% of area.
4. Cement quantity per yard of mix:
   b. Maximum: 7 sack.
5. Water/cement ratio: 0.50 maximum.
7. Coarse Aggregate: shall conform to ASTM C33.
8. Admixtures:
   a. Air entrainment: 5% to 7%.
   b. Shrinkage Reducing: Do not exceed 2% by weight of cement.
9. Fly Ash: Use only when seeding reactive aggregates such as glass and sea shells.
10. Non-Chloride Accelerators: Do not use corrosive accelerators such as calcium chloride.
11. Concrete Delivery: Use of concrete loads exceeding 90 minutes from time of batch plant must be approved by the Owner and Architect.
12. Ensure that batch plant guarantees single source supply for cement, sand, and aggregate for the entire project.

3.05 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.
H. Screed paving surface with a straightedge and strike off.
I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

K. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor’s option.
   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.06 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.07 SURFACE-SEEDED AGGREGATE INSTALLTION

A. Installation of surface-seeded aggregate must be performed only by an installer approved by manufacturer and in strict accordance with manufacturer’s installation requirements.

B. Seeding of Glass Aggregate:
   1. Hand seed glass aggregate into top surface of the decorative concrete slabs to produce a random but uniform pattern to match approved mock-up.
   2. Work aggregate into slab surface as required.
3.08 JOINTING

A. Refer to ACI 302 “Guide for Concrete Floor and Slab Construction” for work under this section.

B. Construction and Contraction Joints:
   1. Sawcut construction and contraction joints in locations indicated on Drawings.
   2. Perform jointing with a new diamond tip circular saw.
   6. Sawcut joints in a straight line with no overcutting.
   7. Use a hand tool to sawcut up to vertical edges such as walls, steps, curbs, and columns. No cutting into vertical surfaces will be allowed.

C. Isolation Joint Caulking:
   1. Install isolation joint caulking to be installed under Division 07 Section “Joint Sealers”.

3.09 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

F. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.
3.10 SEALING

A. Seal surface of paving using matte-finish acrylic sealer as recommended by manufacturer.

B. Follow sealer manufacturer’s printed directions when applying this product.

3.11 CONSTRUCTION WASTE MANAGEMENT (Credit MR2)

A. Manage construction waste in accordance with provisions of Division 01 Section “Construction Waste Management and Disposal”. Submit documentation to satisfy the requirements of that section.

END OF SECTION