SECTION 321313

CONCRETE PAVEMENT

PART 1 - GENERAL

1.10 SUMMARY

A. The work of this Section involves providing integral colored cast in place concrete pavement including design mix, formwork, reinforcement, inserts, all necessary concrete materials, placement, mock-ups and samples, and finishing to match the color and finish of existing original units of similar type (after cleaning of same). The intent of this work is to match the existing exposed aggregate pavement on the bridges leading to the Tower Plaza.

B. The work of this Section also includes work for providing ADD ALTERNATE 1 - exposed aggregate cast-in-place concrete pavement.

C. Related Requirements:
1. Section 312200 "Grading, Filling and Compaction”

1.2 QUALITY ASSURANCE

A. Standards and Codes: Comply with the provisions of the following codes, specifications, standards and regulations:

1. ACI 318 "Building Code Requirements for Reinforced Concrete".
2. CRSI 59 "Recommended Practice for Placing Reinforcing Bars".
3. PCI "Design Manual for Architectural Precast Concrete".

B. Fabricator: Firms providing all concrete work including exposed aggregate cast concrete shall have a minimum of ten years’ experience in the production of same and must show successful completion of three similar projects to be considered qualified to complete the work of this Section.

C. Testing Requirements: Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Provide compressive strengths tests of at least four specimens from each batch of concrete prepared for use. Prepare cylinders in compliance with ASTM C172 and ASTM C31 for compressive strength testing. Test two specimens from each batch at 7 days, and two at 28 days.

2. Concrete from batches that fail to meet the specification requirements may not be incorporated in the work of this project and must be replaced by new material conforming to project requirements at no cost to the owner.

D. Visual Acceptance Criteria: When viewed from a distance of ten feet (10') in natural

daylight, exposed surfaces shall be within the range of aggregate exposure, aggregate color range/distribution and paste (cement) color and texture of cleaned original units of similar type. All exposed surfaces shall have a dense aggregate finish to match original materials and shall exhibit no holes, bug holes, voids or honeycombs. All edges and details shall be sharp and true without chips, cracks or other defects. Sections that fail to meet these standards, in the opinion of the Architect, shall not be incorporated into the work and shall be either repaired to meet the standards, or replaced with acceptable work, at no cost to the Owner.

1.3 INTENT

A. Base Scope - It is the intent of this specification to provide and install durable, weather resistant integrally colored non-slip concrete pavement. Color shall match the existing bridge materials and to be consistent with the design intent of the bridges.

The finish shall result in a surface that shows a uniform broom finish with a clean and straight jointing pattern with no deformations.

B. ADD ALTERNATE 1 - It is the intent of this specification to provide and install durable, weather resistant exposed aggregate concrete pavement to match the existing bridge materials and to be consistent with the design intent of the bridges. All new materials shall be of consistent cement paste color, matching to the original, and shall have aggregate type, gradation and exposure matching to existing weathered examples.

The finish shall result in a surface that shows a uniform smooth dense pattern of exposed gravel matching the original, is free of pockets, with firmly embedded aggregates and dust and laitence free.

1.4 SUBMITTALS

A. Product data for materials and items including reinforcement and forming accessories, admixtures, joint systems, curing compounds and others.
   1. Design mixes for each type of concrete. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
   2. Samples: samples of the following materials shall be submitted for approval, and approval obtained before materials are delivered to the site.
B. Colored admixture – Color samples – Submit color chip samples of manufacturers range of colors.
C. ADD ALTERNATE 1 - Special aggregates, for integral mix.
D. ADD ALTERNATE 1 - Special aggregates, for seeding.
E. Expansion joint materials.
F. Joint sealer color.
G. ADD ALTERNATE 1 - Exposed aggregate concrete samples: initial samples: (12" x 12" x 1”) samples of exposed aggregate concrete demonstrating a range of aggregate proportions (4 mixes). The architect will select the aggregate composition mix to be used for the selection samples from among the submitted initial samples. The aggregate composition mix selected by the architect may differ somewhat from the four initial samples.

a. Selection samples:
   1) 12” x 12” x 2” samples of exposed aggregate concrete for each mix.
   2) 12” x 12” x 2” samples of exposed aggregate colored concrete for each mix.

H. Contractor shall submit specified manufacturer's complete technical data sheets for the following:

I. Curing and sealing compound

A. Submit copies of all test reports per 1.2 C. verifying that all placed concrete meets the requirements of this specification.

B. Product Data: Submit manufacturer's product data and literature for all materials used in the production of the cast stone including all cements, aggregate, admixtures. Submit product data for all reinforcing, inserts, anchors and lifting devices.

C. Shop drawings:

1. Layout for pavement including profiles, dimensions, joining details, inserts, anchors and reinforcing placement.
2. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

E. ADD ALTERNATE 1 - Provide 1 quart samples of each type of coarse (exposed) and fine aggregates proposed for use.

F. Sustainable Design Submittals: As required by Contract requirements.

G. Submit concrete design mix proportions including aggregate, admixture, water content and full colorant identifying information and proportions.

H. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

I. joint sealants – Submit range of colors to be color-matched to the concrete.

1.5 MOCK-UPS

A. Provide mock-up installation providing three pavement sections from joint to joint complete; mock-up shall be at least 8' in length and the width of the pavement shown on the drawings. The Architect shall review the installation after finishing and drying (not less than seven days) for: confirmation of correct materials, color, finish, condition and cleanliness of materials, pattern, setting method, joint size and general workmanship. The Contractor shall be required to correct any deficiencies identified by the Architect before proceeding with the completion of work.

1.6 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M).

C. Colored Concrete Environmental Requirements
1) Schedule placement to minimize exposure to wind and hot sun before curing materials are applied.
2) Avoid placing concrete if rain, snow or frost is forecast within 24 hours. Protect fresh concrete from moisture and freezing.

D. Professional practices as described in ACI 305r hot weather concreting and 306r cold weather concreting should be followed.

E. Schedule delivery of concrete to provide consistent mix times from batching until discharge. Mix times shall meet manufacturer's written recommendations.

1.7 DELIVERY, STORAGE AND HANDLING

A. Ready-Mix concrete. Comply with ASTM C 94.

B. Normal delivery time shall not exceed 90 minutes from plant. Between 85 degrees F and 90 Degrees F reduce time to 75 minutes; above 90 degrees F delivery time shall not exceed 60 minutes.

C. All concrete shall be maintained at a temperature of 70 degrees F for 3 days after placement in forms or 50 degrees for 5 days. All concrete shall be kept continuously moist for a period of not less than 5 days.

D. Colored admixtures: comply with manufacturer's instructions. Deliver colored admixtures in original, unopened packaging. Store in dry conditions.

1.8 GUARANTEE

A. Provide written guarantee signed by the Contractor and Fabricator in a form acceptable to the Commonwealth (Owner) agreeing to repair, or remove and replace, and reinstall at no additional cost to the Owner, any precast unit that becomes defective within five years of the date of substantial completion. Defective units shall be defined to include those with unusual weathering, discoloration or color change, staining from reinforcement or attachments, spalling, cracking, loss of aggregate, scaling, exudation or other defects as determined by the Architect, or such other testing agency as designated by the Owner.

1.9 PERFORMANCE REQUIREMENTS

A. Minimum 28 day compressive strength, 4500 psi.

B. Water absorption by ASTM C97, not more than 6 % by weight on untreated material.

C. Reinforcement: All reinforcement shall have not less than 2 - 1/2 " of cover.

D. Slump: 1-1/2 inches to 3 inches.

E. Air entraining: 4%-8%.

F. Calcium Chloride shall not be added to the mix since it causes molting and surface discoloring.

D. Water: Clean, potable.

PART 2 - PRODUCTS

2.0 STEEL REINFORCEMENT

A. Welded wire mesh: epoxy coated welded cold-drawn steel wire fabric, ASTM A884 / A884M.

B. Reinforcing Bars: Epoxy coated ASTM A775

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice." Welded wire shall conform to ASTM A185.

D. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.1 MATERIALS

A. Portland Cement, ASTM C150, Type I or Type III showing no efflorescence when tested in conformity with ASTM C67. Portland Cement shall be of color acceptable to the Architect. More than one Type or brand may be required; after approval of color and brand that shall be used throughout the Project.

B. Fine Aggregate: Clean, insert silica sand, ASTM C33.

Gradation:

Sieve	Retained
#4	0-5 %
#8	10-20
#16	20-40
#30	40-70
#50	70-85
#100	93-97

C. The contractor shall provide concrete pavement as shown on the drawings. Concrete shall comply with the specifications for concrete detailed in the sitework concrete Section.

D. Forms:

1. Steel, wood, glass fiber, or other suitable material of size and strength to Resist movement during concrete placement and to retain horizontal and Vertical

alignment until removal. Use straight forms, free of distortion and Defects, extending the full depth of concrete.

2. Coat forms with form release agent which will not discolor or deface the Surface of the concrete.
3. Use flexible spring steel forms or laminated boards to form radius bonds as required.

E. Concrete materials: concrete materials shall comply with requirements of applicable Division 03 section "sitework concrete" for concrete materials, admixtures, bonding Materials, curing materials, and others as required.

F. Expansion joint materials: expansion joint materials comply with requirements of Applicable section specifications for preformed expansion joint fillers and sealers.

G. Anti-spalling compound: 50 percent (by volume) boiled linseed oil and 50 percent (by Volume) commercial grade kerosene or mineral spirits.

H. Epoxy coated joint dowel bars: astm a775, grade 60, plain steel bars. Cut bars true to Length with ends square and free of burrs.

I. Welded wire mesh: welded cold-drawn steel wire fabric, ASTM A884 / A884M.

J. Metal expansion caps: furnish for one end of each dowel bar in expansion joints. Design caps with one end closed and a minimum length of 3 inches (75 mm) to allow bar movement of not less than 1 inch (25 mm), unless otherwise indicated.

K. Epoxy resin grout: fs mmm-g-650.

L. ADD ALTERNATE 1 - Exposed aggregate: selected, hard, and durable; washed; free of material that reacts with cementitious material or causes staining; from a single source, with gap graded coarse aggregate as follows:

1. Aggregate sizes: 3/8-inch nominal.
2. Aggregate composition: finished pavement will be selected from submitted Concrete samples. For the purpose of preparing initial samples, provide 4 Samples of colored concrete (french gray) and 4 samples of standard gray

M. Concrete that illustrate a range of the following stone types (percentages Are by weight):

All coarse aggregate for concrete shall consist of sound, washed, durable rock, free from objectionable coatings and frozen and cemented lumps. The percentage of deleterious substances shall not exceed the following values, and the sum of percentages of all deleterious substances, , shall not exceed 5.0 percent.

O. Air-entraining admixture: ASTM C260. Acceptable products: W.R. Grace and Co (Darex AEA or Daravair.), or Master Builders Co. (MB-VR or Micro-Air).

P. Water reducing Admixture: ASTM C494 Type A containing max 0.1% chloride ions. Acceptable products: W.R. Grace and Co. (I WRDA), Master Builders Model (Pozzolith Normal or Polyheed), Sika Corp. (Plastocrete 161)

2.2 Colored concrete materials

A. Colored admixture for integrally colored concrete and ADD Alternate 1 - exposed aggregate concrete
   1. Manufacturer: L.M. Scofield Company, Douglasville, Georgia (800) 800-9900 or approved equal.
   2. Materials:
      a. Admixture shall be a colored, water-reducing, admixture containing no calcium chloride with coloring agents that are limeproof and UV resistant.
      b. Colored admixture shall conform to the following:
         1) ASTM c979 - standard specification for pigments for integrally colored concrete.
         2) ASTM c494 - standard specification for chemical admixtures for concrete
         3) AASHTO m194 - chemical admixtures

B. Acceptable product: Chromix admixture as manufactured by the L.M. Scofield Company, Douglasville, Georgia, are considered to conform to the requirements of this specification.

C. Color shall be selected during the submittal process.

D. 2. Curing compound for integrally colored concrete: curing compound shall comply with astm c309 and be approved by color additive manufacturer for use with colored concrete.
   1. manufacturer: L.M. Scofield Company, Douglasville, Georgia (800) 800-9900 or approved equal.

E. Sealants: joint sealants shall be color-matched to the concrete and specially formulated for high- performance in pedestrian and vehicular traffic areas.
   1. Manufacturer: L.M. Scofield Company, Douglasville, Georgia (800) 800-99 or approved equal.
   2. Materials: Lithoseal trafficalk-3g as manufactured by the L.M. Scofield Company, Douglasville, Georgia or approved equal, is considered to conform to the requirements of this specification.

2.3 ADD ALTERNATE 1 – SEEDED AGGREGATE MATERIAL

A. Aggregates:
   1. Size: 3/8-inch (13mm).
   2. Colors: two of the following three aggregates shall be selected for seeding.
      a. Salt and pepper.
      b. New York white
      c. Hudson blue grey.
   3. Supplier: George Schofield co.; p.o. Box 110, Bridgewater, NJ. 08807; 732-356-0858; or approved equal

2.4 Curing materials

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. The curing surfaces shall remain uncovered for at least four days, after which time new and un wrinkled, nonstaining reinforced kraft curing paper may be used for additional protection.Moisture- Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick.

2.4 CONSTRUCTION JOINTS

A. Butt joint with dowels or thickened edge joint shall be used if construction joints occurs at location of control joint. Submit sketch to Architect for review and acceptance of proposed system.

B. Keyed joints with tiebars shall be used if the joint occurs at any other location.

2.5 EXPANSION JOINTS

A. Unless otherwise indicated on the Contract Documents, expansion joints shall be located 20 feet on-center or closer.

B. Provide only materials which are known to be fully compatible with the actual installation condi tion, as shown by the manufacturer’s published data or certification. Use manufacturer’s recom mended joint primer.

2.6 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.0 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

3.1 EMBEDDED ITEM INSTALLATION

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

B. Accurately place all reinforcement, attachment, lifting devices and inserts. All reinforcement shall have 2 1/2" cover. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.2 CONCRETE MIXING

A. Accurately measure all cement, aggregates, pigments and water.

B. Admixture use shall strictly comply with manufacturer's requirements.
Mix concrete for not less than two minutes in mechanical mixer. Place concrete in forms promptly, discard all material not placed within one hour.

3.3 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

C. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M). No voids or honeycombs shall be allowed.

3.4 CURING

A. Cover filled forms with polyethylene for twenty-four hours to promote cure.

B. After stripping forms provide additional cure; protect units from direct sun, protect from moisture damage and staining. No unit less than seven days old shall be exposed to temperatures less than forty (40) degrees Farenheit.

C. Curing: protect and cure finished concrete walks complying with applicable requirements of division 3 sections. Use moist-curing methods for initial curing whenever possible.
1. Do not use liquid membrane-forming materials where anti-spalling treatment will be applied.
2. Colored concrete: apply curing compound for colored concrete in accordance with manufacturer's instructions using manufacturer's recommended application techniques. Apply curing compound at consistent time for each pour to maintain close color consistency.
3. Curing compound shall be the same color as the colored concrete and supplied by the same manufacturer of the colored admixture.

4. Precautions must be taken in hot weather to prevent plastic cracking resulting from excessively rapid drying at the surface as described in cip 5 plastic shrinkage cracking published by the national ready mixed concrete association.
5. The concrete shall never be covered with plastic sheeting.

D. Anti-spalling treatment: apply compound to concrete surfaces no sooner than 28 days after placement. Apply to clean, dry concrete, free of oil, dirt, and other foreign materials, in 2 sprayed applications. First application at the rate of 40 square yards per gallon; second application, 60 square yards per gallon. Allow drying between applications.

3.5 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape..

B. Insert spacing of contraction (control) joints here or on Drawings if required. Contraction-joint spacings vary with slab thickness, aggregate size, and slump based on PCA's recommendations. Depth of joint may be varied to suit cutting method or if steel-fiber reinforcement is used.

3.6 JOINTS

A. Coordinate joint types, description, and location with Drawings. Joint types are consolidated in this article for consistency rather than for strict sequence of installation.

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
2. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade

3.7 FLOAT FINISHING

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

B. Float Finish: Begin the second floating operation when bleedwater 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.
   1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.8 ADD ALTERNATE 1 FINISHING - EXPOSED AGGREGATE PAVING

One or more of the following methods shall be used to produce required finish:

A. Washing to expose aggregate. The washing phase is very important as this determines the look of the concrete. The timing needs to be precise with the initial set and the length of time that the retardant works. A good rule of thumb for when to start is when the concrete finisher can be on knee boards without making an indentation. The workers can then begin to use a stiff bristle broom and remove some dry paste. When this has been done, the concrete can be brushed and lightly scrubbed with water using a softer broom. This will take a few passes. Be sure to keep a light mist to begin, and avoid power washers. Some brooms come equipped with water jets to aid in removal. If there are areas where the paste is hard to remove, it may be necessary to use a stiffer broom. This procedure should continue until the aggregate has a uniform look, the water is clear, and all unwanted paste is removed. This will normally take several passes depending on the size of the concrete slab and the degree of exposure desired. If aggregates start to become loose and pop out. Stop and wait for the concrete to become more firm. Use of low pressure washers or power washers is not recommended.

B. Acid washing to expose aggregate. Use a mild solution of acid to aid in the breakdown of the paste. If this method is used, it should be done before the sealing application, which is usually 14-28 days. Utilize a solution of 10-15 parts water to 1 part acid. Apply while the concrete is damp. Use of a plastic type watering can is acceptable; metal cans shall not be used. Work the solution in with an acid resistant broom and rinse completely clean. Care needs to be taken not to overdose the acid as this can have adverse effects on the alkalinity of the concrete. Wear protective boots, gloves, and protect exposed skin and eyes from the acid.

C. Seeding to provide exposed aggregate. Immediately after the concrete has been placed, screeded and darbied, the approved aggregates shall be scattered by hand or mechanical devised and evenly, uniformly and densely covered with a single layer. The aggregates shall be floated to thoroughly embed and evenly distribute the aggregate. Imbed aggregate by patting with a darby or flat side of a strike-off rod. All aggegate shall be completely embedded just below the surface, maintaining proper grade tolerances. Apply retarder, after required time, brush and wash to expose aggregate. After aggregate exposure, wet cure for an additional 3 days. Additional acid washings shall be required to remove surface laitance, and as required to provide exposure. Care must be taken to not overexpose or dislodge aggregate. Four (4) days of additional curing shall be required after acid washing.

D. Repair all defects. Provide repair mix using the same mixture as the cast units, but without coarse aggregate. Thoroughly wet all areas requiring repair. Apply thick repair mixture as a slurry coat using a scrub brush to thoroughly coat all pits and cavities. Before slurry coat

dries apply "dry-pack" consistency repair mortar. Compact all repairs. After 1 to 2 hours, strike off surface to match surrounding stone. Most cure all repairs. Sandblast/acid etch as required to blend repair surfaces. Repairs that are unacceptable to the Architect shall be removed and replaced until a repair acceptable to the Architect is obtained. Units that cannot be satisfactorily repaired shall be replaced at no cost to the Owner

3.9 CLEANING

A. Final cleaning to be accomplished after installation of units. Provide diluted chemical cleaners, approved by the Architect, specially designed for use on pigmented concrete. Prewet all surfaces Apply cleaners and scrub with bristle brush to remove all soil, laitance and construction dirt. After three minutes thoroughly pressure rinse all cleaners from surfaces.

3.10 REPAIR AND PROTECTION

A. Repair or replace broken or defective concrete bases, as directed by the architect.

B. Protect the bases from damage until acceptance of the work. Exclude traffic from walks for at least 14 days after placement. When construction traffic is permitted, maintain walks as clean as possible by removing surface stains and spillage of materials as they occur.

END OF SECTION 321313.13