SP-151152
(Replaces SP-151137)

SPECIAL PROVISIONS
FOR
IN-RIVER STRUCTURAL CONCRETE

Polk County
EDP-PA26(001)--7Y-77

Effective Date
November 1, 2022

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

151152.01 DESCRIPTION.

A. This section covers in-river cast-in-place concrete, including furnishing materials, transporting, placing, finishing, curing and other appurtenant items of construction. “In-river” is defined as all improvements riverward of the recreational and viewing path on the south bank and riverward of the levee trail on the north bank.

B. Inform Engineer at least 2 weeks in advance of time and places at which Contractor intends to place concrete. All preparation work for concrete placements shall be substantially completed at least 2 workdays prior to the scheduled start of concrete placement to allow for the Engineer's review and any necessary corrections.

151152.02 QUALITY ASSURANCE.

A. Reference standards.

1. Except as noted or modified in this Section, all concrete materials, transporting, placing, finishing, and curing shall conform to requirements of the latest and current versions of following standards:

a. American Association of State Highway and Transportation Officials (AASHTO).

1) M 154 Standard Specification For Air-Entraining Admixtures for Concrete.
2) M 194 Standard Specification For Chemical Admixtures for Concrete.
3) T-260 Standard Method of Test for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials.

b. American Concrete Institute Standards (ACI).

1) 117 Specification for Tolerances for Concrete Construction and Materials
2) 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
3) 301 Specifications for Structural Concrete.
4) 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
5) 304 Placing Concrete by Pumping Methods.

6) 305 Recommended Practice for Hot Weather Concreting.
7) 306 Recommended Practice for Cold Weather Concreting.
8) 308 Standard Practice for Curing Concrete.
9) 309 Recommended Practice for Consolidation of Concrete.
10) 318 Building Code Requirements for Structural Concrete.
11) 350 Code Requirements for Environmental Engineering Concrete Structures.

c. American Society for Testing and Materials (ASTM).

1) C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2) C 33 Standard Specification for Concrete Aggregate.
3) C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4) C 94 Standard Specification for Ready Mixed Concrete.
5) C 109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
6) C 127 Standard Test Method for Relative Density and Absorption of Coarse Aggregate.
7) C 128 Standard Test Method for Relative Density and Absorption of Fine Aggregate.
8) C 138 Standard Test Method for Density, Yield, and Air Content of Concrete.
9) C 143 Standard Test Method for Slump of Hydraulic-Cement Concrete.
10) C 150 Standard Specification for Portland Cement.
11) C 172 Standard Practice for Sampling Freshly Mixed Concrete.
12) C 173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
13) C 192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
14) C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
15) C 260 Standard Specification for Air-Entraining Admixtures for Concrete.
16) C 494 Standard Specification for Chemical Admixtures for Concrete.
17) C 618 Standard Specification for Coal Fly Ash and Raw of Calcined Natural Pozzolan for Use in Concrete.
18) C 827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
19) C 900 Standard Test Method for Pullout Strength of Hardened Concrete.
20) C 979 Standard Specification for Pigments for Integrally Colored Concrete.
21) C 1017 Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
22) C 1064 Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
23) C 1090 Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout.
24) C 1116 Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
25) C 1399 Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete.
26) C 1602 Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete.
27) C 1611 Standard Test Method for Slump Flow of Self-Consolidating Concrete.
28) D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
29) D 2475 Standard Specification for Felt.

d. International Concrete Repair Institute, Inc. (ICRI).

1) 310.2R-2013 Selecting and Specifying Concrete Surface Preparation For Sealers, Coatings, Polymer Overlays, and Concrete Repair.

e. United States Army Corps. Of Engineers (USACE)

1) CRD-C 661-06 Specification for Anti-Washout Admixtures for Concrete.

B. Contractor shall keep at least one copy of above listed ACI publications, latest edition, in project field office at all times.

C. Any material or operation specified by reference to the published specifications of a manufacturer shall be complied with unless directed otherwise by the Engineer.

D. In case of a conflict between the referenced specifications or standards and this Specification, the one having the more stringent requirements, as determined by the Engineer, will govern.

151152.03 SUBMITTALS.

Mix designs, shop drawings and catalog information shall be submitted for related equipment and components, in order to show that concrete and items selected and to be installed by the Contractor generally conform to the contract documents. Submittal information includes, but is not necessarily limited to the following:

A. Miscellaneous product information.
Catalog information and shop drawings for: waterstops, admixtures, bonding agents, membrane curing compound, joint sealer, embedded items, non-shrink grout, wedge-type expansion anchors, and other concrete appurtenances.

B. Proposed concrete mix design. (Note: Contractor shall be responsible for fully informing the concrete supplier of all specification requirements regarding the concrete mix before the proposed mix design is submitted.)

1. The proportions of ingredients shall be selected to produce the proper workability (slump), durability (air content), strength, maximum water-cementitious materials ratio, time of set and other required properties of Articles 151152.06 and 151152.07.

The proportion of ingredients shall be such as to produce a mixture with slump and durability that will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation employed on the work. Do not permit the materials to segregate or excessive free water to collect on the surface.

An independent testing laboratory acceptable to the Engineer will perform concrete trial mixtures and testing. The cost of testing will be paid for by the Contracting Authority.

2. Prior to commencing concrete work, submit and obtain Engineer's review of certified test reports describing proposed concrete mix design, which will be prepared in compliance with ACI Standard 301, with concrete proportions established on the basis of previous field experience or laboratory trial batches, except as modified herein. Test reports shall also include:

- **a.** Fine aggregates: Source, type, gradation, deleterious substances, and bulk specific gravity on basis of weight of saturated surface-dry aggregate. ASTM C 128.
- **b.** Coarse aggregates: Source, type, gradation, deleterious substances, and bulk specific gravity on basis of weight of saturated surface-dry aggregate. ASTM C 127.
- **c.** Ratio of fine to total aggregates.
- **d.** Weight (saturated surface-dry) of each aggregate per cubic yard.
- **e.** Total water content in gallons per cubic yard.
- **f.** Slump on which design is based.
- **g.** Brand, type, and quantity of cement.
- **h.** Brand, type, and quantity of admixtures.
- **i.** Proportioning of all materials.
- **j.** Brand, type, ASTM designation, and quantity of each admixture proposed for use.
- **k.** Water-cementitious materials ratio (shall be not greater than specified in Article 151152.07).
- **l.** Air content (which shall be within the upper half of the allowable range).
- **m.** For the laboratory trial batches method, the determination of the cementitious materials content necessary to attain the required strength and other properties, without exceeding

the maximum water-cementitious materials ratio, shall be by preliminary tests in accordance with the following procedures:

1) Concrete trial mixtures having proportions and consistency suitable for the work shall be made using at least three different cementitious materials contents which will produce a range in strengths encompassing those required for the work.

2) Proportions of ingredients shall be determined, and tests conducted in accordance with the basic relationships and procedures outlined in ACI 211.1.

3) For each cementitious materials content, at least three specimens for each age to be tested shall be made and cured in accordance with ASTM C 192 and tested for strength at 7, 14, and 28 days. Tests shall be conducted in accordance with ASTM C 39.

4) From the results of these tests, a curve shall be plotted showing the relationship between cementitious materials content and the average 28 day compressive strength. The minimum cementitious materials content to be used shall be that value shown by the curve to produce a strength of at least 1500 psi in 24 hours and at least 1200 psi greater than the 28 day strength specified. In any case, the minimum cementitious materials content shall not be less than that specified in Article 151152.07.

5) If the previous field experience method is used in proportioning, the strengths shall be in compliance with ACI 301. In addition, the Contractor shall demonstrate the ability of the proposed mixture proportions to produce concrete meeting all the requirements of these Specifications. Field test records must be acceptable to the Engineer to use this method.

n. Color additive can be added to a qualified mix without separate qualification testing of the colored mix as long as the water content of the mix is not increased as compared to the mixture without color additive. Add compatible water-reducing admixtures as needed (within recommended limits) to compensate for the increased water demand caused by the color additive. Alternatively, the cement content of the mixture to be used with color can be increased up to 50 pounds per cubic yard to maintain the original water/cement ratio of the base mix without color.

3. In addition to the test data described above, when it is expected that concrete will be placed under hot weather concrete conditions as defined in Article 151152.06, C, trial batches shall be tested at the maximum temperature that the concrete is expected to be placed. Alternatively, sufficient records may be submitted that show field concrete performance under these temperatures and which are acceptable to Engineer. Provisions for concrete placed under cold weather, see Article 151152.06, B.

C. Cylinder Compression Test Reports.
Submit two copies of certified test reports to Engineer per Article 151152.03, B, 2.

D. Ready-Mix Delivery Tickets.
Submit delivery tickets for each load at time of delivery indicating following:

1. Quantity delivered with Mix Identification Number.

2. Quantity of each material in batch.

3. Outdoor temperature in shade.

4. Time at which water was added.

5. Elapsed time between when water was added and concrete load was in place.

6. Amounts of initial and supplemental water added, including any corrections for water in aggregate. Note: Total water amount shall result in a water-cementitious materials ratio not greater than the maximum permissible.

7. Name of individual authorizing supplemental water.

8. Numerical sequence of delivery by indicating cumulative yardage delivered on each ticket.

151152.04 PRODUCT DELIVERY, STORAGE AND HANDLING.

A. Cementitious Materials.

1. Store in weather-tight enclosures and protect against dampness, contamination, and warehouse set.

2. Do not use cementitious materials that have become caked or lumpy.

B. Aggregates.

1. Stockpile to prevent excessive segregation, or contamination with other materials or other sizes of aggregates.

2. Use only one supply source for each aggregate stockpile.

3. The bottom 6 inch of all aggregate piles in contact with ground shall not be used.

4. Frozen or partially frozen aggregates shall not be used.

C. Admixtures.

1. Store to prevent contamination, evaporation, or damage.

2. Protect liquid admixtures from freezing or harmful temperature ranges.

3. Agitate emulsions prior to use.

D. Rubber and Plastic Materials.

Store in cool place away from direct sunlight.

E. Mixing and Transporting Ready-Mixed Concrete.

1. Maximum elapsed time from time water is added to mix until concrete is in place shall not exceed 90 minutes when concrete is transported in revolving drum truck bodies unless all other provisions of these specifications can be met, including maximum water-cementitious materials ratio, workability, strength, and air content. Comply with ASTM C 94.

2. Do not use concrete transported without continuous agitation if the elapsed period between the time the concrete is mixed and the time it is placed is greater than 30 minutes. With the Engineer's approval, an approved retarding admixture may be used at the rate prescribed in 151152.06, D, 6. Also with the Engineer's approval, the mixed-to-placed time period may be extended an additional 30 minutes.

3. Do not use concrete transported with agitation when the time between start of mixing and placement is more than 90 minutes.

4. Deliver and handle concrete in a manner that will:
- **a.** Prevent objectionable segregation or damage to the concrete, and
- **b.** Facilitate placing with a minimum of handling.

5. Thoroughly clean and flush the compartment in which the concrete is transported to the work at intervals necessary to ensure hardened concrete will not accumulate in the compartment. Discharge flushing water from the compartment before it is charged with the next batch.

6. Obtain Engineer's approval for plant equipment, operation, and procedures.

151152.05 JOB CONDITIONS.

A. Environmental Requirements:

1. Do not place concrete during rain, sleet, or snow unless adequate protection is provided and Engineer's approval is obtained.

2. Do not allow rainwater to increase mixing water or damage surface finish.

3. For cold or hot weather concreting conditions, lab cured cylinder tests may not be an accurate indication of field achieved strengths. Under these weather conditions, the Engineer may require job cured cylinder breaks to determine field strength (cylinders to be job cured in same manner as the in-place concrete.) The Contracting Authority will pay for testing. Refer to Article 151152 Sculpted Rock or related items to be furnished by Contractor. If cold or hot weather concreting practices specified in Articles 151152.06 B and C are not adhered to, the Engineer may require Contractor, at Contractor's expense, to provide additional pullout tests in accordance with ASTM C 900, job cured cylinder tests, or 2 inch diameter cored samples from areas in question to determine field strengths achieved.

4. Changes in temperature of the concrete shall be as uniform as possible and shall not exceed 10°F in any 1 hour or 45°F in any 24 hour period.

B. Cold Weather Concreting. Conform to ACI 306 in addition to this Specification.

1. Temperature of concrete when placed shall not be less than following: Minimum Concrete Temp, Degrees F.

Air Temp.	Sections with least dimension	
Degrees F	Under 12 inches	12 inches and Over
30 to 45	60	50
0 to 30	65	55
Below 0	70	60

If water or aggregate has been heated, the water and aggregate shall be combined in the mixer before cementitious materials are added. Cementitious materials shall not be added to mixture of water and aggregate when the temperature of the mixture is greater than 95ºF.

2. When placed, heated concrete shall not be warmer than 80ºF.

3. Prior to placing concrete, all ice, snow, surface, and subsurface frost shall be removed, and temperature of surfaces to be in contact with new concrete, including subgrade materials and massive embedments such as rock, shall be raised to a minimum of 35ºF and a maximum of 60ºF. The entire mass of all massive embedments must be raised to this temperature range.

4. Protect concrete from freezing during specified curing period. See Article 151152.09, I, for temperature to be maintained during initial curing period.

5. When the mean daily temperature of the atmosphere is less than 40ºF, forms shall be left in place a minimum of 5 days to aid in retaining heat.

6. Heated enclosures shall be strong and windproof to insure adequate protection of corners, edges, and thin sections.

7. Do not permit heating units to locally heat or dry concrete.

8. Do not use combustion heaters during first 24 hours unless concrete is protected from exposure to exhaust gases, which contain carbon dioxide.

9. If air temperatures drop below 35ºF, the Contractor shall install a high-low temperature gauge into the most exposed portion of concrete during the curing protection period. The gauge shall be equipped to register the lowest overnight temperature. If the concrete temperature drops below the specified temperature, the curing period shall be extended until the degree-days (Article 151152.09, I) are satisfied.

10. Refer to ACI 306 for further requirements.

C. Hot Weather Concreting: Conform to ACI 305 in addition to this Specification.

1. Take precautions when ambient air temperature is 90ºF or above. These measures may include installation of windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering of a light color. If daytime highs are expected to exceed 100ºF, floor and roof slab concrete shall be placed overnight, with placement commencing not prior to 3 hours before sunset.

2. Temperature of concrete when placed shall not exceed 85ºF.

3. Cool forms and reinforcing to a maximum of 90ºF by spraying with water prior to placing concrete.

4. Do not use cementitious materials that have reached a temperature of 105ºF or more at the time they enter the concrete mix.

5. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.

6. Do not place concrete when evaporation rate (actual or anticipated) is 1.0 kg per square m per hour or above, as determined by Figure 2.1.5 of ACI 305.

7. Set-retarding and water-reducing admixtures may be used when the ambient air temperature is 90ºF or above to offset accelerating effects of high temperature.

8. Refer to ACI 305 for further requirements.

D. Protection from Mechanical Injury: During the curing period, the concrete shall be protected from damaging mechanical disturbances particularly load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage caused by construction equipment, materials, or methods and by rain or running water. Self-supporting structures shall not be loaded in such a way as to over-stress the concrete.

151152.06 CONCRETE MATERIALS.

A. Cement shall conform to ASTM C 150, Type II low-alkali. Once cement type is chosen, the type and source shall remain the same throughout the project.

B. Fly ash shall be Class F (ASTM C 618).

C. Aggregates.

1. Fine aggregate - ASTM C 33.

2. Coarse aggregate - ASTM C 33 Size No. 57 or 67.

3. Once aggregates are chosen, the same source and type of aggregates shall be used throughout the project.

D. Water.

Shall be clean, fresh, and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.

E. Admixtures.

1. Use only as specified or reviewed and acceptable to Engineer.

2. Include any admixtures to be used in the proposed concrete mix designs. Use only admixtures which are compatible with each other and adjust required dosages accordingly.

3. Non-Corrosive, Non-Chloride Accelerator: Accelguard 80 by the Euclid Chemical Company, Sika CNI by the Sika Corporation, NitroCast® NC by Premiere Concrete Admixtures, or approved equal by the Engineer. The admixture shall conform to ASTM C 494, Type C or E specifications, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures.

4. Prohibited Admixtures: Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are not permitted.

5. Air Entraining Admixture: shall conform to AASHTO M 154 specification. Use Eucon AEA-92 or Air Mac 6 by the Euclid Chemical Company, Polychem SA-50 by the Mapei Corporation, or equal approved by the Engineer.

6. Water Reducing and Retarding Admixtures: shall conform to AASHTO M 194 Type B or D specifications. The contractor shall be responsible for its use and application of the proper dosage rate. It may also be necessary to adjust the quantity of air entraining agent. When fly ash is used in the concrete, the dosage rate shall be applied to both the cement and fly ash combined. Water reducing admixture shall be added at the plant and shall be Eucon SE, or WR, by the Euclid Chemical Company, OptiFlo® 500 by Premiere Concrete Admixtures, or an approved equal acceptable to the Engineer. Use retarders only as specified or with the Engineer's approval. Mixed-to-placed time period may be extended per Article 151152.04, E, 2. For patching with extended haul time, rate may be reduced to half dosage.

7. Mid-Range Water-Reducing Admixture: shall conform to AASHTO M 194, Type A specification. Use Eucon MR by the Euclid Chemical Company, KB 1200 by the Mapei Corporation, OptiFlo® MR by Premiere Concrete Admixtures, or an approved equal approved by the Engineer. A combination of a water-reducing admixture and a retarding admixture may be used to aid in air entrainment and slump retention.

8. High Range Water-Reducing Admixture (Superplasticizer): shall conform to AASHTO M 194, Type F specification. Use Dynamon NRG 1092 by the Mapei Corporation, Eucon 1037 by the Euclid Chemical Company, UltraFlo® 2000 by Premiere Concrete Admixtures, or an approved equal acceptable to the engineer.

9. Anti-Washout Admixture: shall comply with USACE CRD-C 661-06 Specification for Anti-Washout Admixtures for Concrete and ASTM C 494 Type S specifications. Where concrete

placement is in a submerged condition and is called out on the contract documents, use MasterMatrix 450 by Master Builders Solutions US LLC, Eucon AWA by the Euclid Chemical Company, Chryso® UW-61 by Chryslo Inc, or an equal approved by the Engineer. Use anti-washout admixtures only with the Engineer's approval.

10. Fibrous Concrete Reinforcement: For all locations where fiber reinforcing is called out on the contract documents, add 100% virgin polypropylene, fibrillated fibers to the concrete. Volume per cubic yard shall equal a minimum of 0.10% (1.5 pounds per cubic yard). Fiber length shall be graded per manufacturer. Fiber manufacturer must document evidence of 5 year satisfactory performance history, compliance with applicable building codes, ASTM C 1399, and ASTM C 1116/C 1116 M, Type III fiber reinforced concrete. Fibrous concrete reinforcement shall be Fibermesh 300 or Fibercast 500 manufactured by Propex Concrete Systems, Chattanooga, TN, Strux® products manufactured by GCP Applied Technologies, or an or an approved equal acceptable to the Engineer. Product use shall be in accordance with manufacturer's instructions and recommendations.

11. Color Additive: Refer to Special Provisions for Sculpted Concrete and Special Provisions for Rock for color additive specifications.

F. Tests for Chloride Ions.
For all concrete in which aluminum or galvanized metal is to be embedded, it shall be demonstrated by tests in accordance with AASHTO T-260 that the hardened concrete, including the aggregates, cementitious materials and any admixtures used, will not contain more than 0.06 percent water soluble chloride ions by weight of cement.

151152.07 CONCRETE PRODUCTION.

A. Ready-mixed concrete.

1. Mixed and delivered, ASTM C 94.

2. Retempering. Indiscriminate addition of water to increase slump shall be prohibited.

Concrete shall be mixed only in quantities required for immediate use. Concrete that has partially set shall not be retempered but shall be discarded.

When concrete arrives at the project with slump below that suitable for placing, first the concrete shall be remixed for at least one minute at mixing speed. If the slump is still too low, water may be added only if the maximum permissible water-cementitious materials ratio is not exceeded, the maximum slump is not exceeded, and the temperature of the concrete is less than 90ºF. The water must be incorporated by additional mixing equal to at least half of the total mixing required. The Engineer must review such addition.

B. Batching and mixing equipment.
Conform to ACI 304.

C. Proportioning.

1. Proportion ingredients to produce a well-graded mix of high density and maximum workability consistent with the accepted mix design.

2. Entrained air, 6% ± 1½% for ASTM C 33 Size 57 or 67 coarse aggregate. Refer to ACI 301 for air entrainment required for other coarse aggregate sizes.

3. Refer to Article 151152.04, E for mixing and transporting ready-mixed concrete requirements.

4. Strength and General Requirements.
Design and proportion concrete to meet the following minimum compressive strengths and other criteria:

Location	Design Strength 28 Day (psi)	ASTM C 33 Aggregate Size No.	Slump Inches ± 1.5 inch	Minimum Cement Content lb/yd^3	Fly Ash Content lb/yd^3	Maximum W-C Materials Ratio*
Structural Concrete	4500	57 or 67	5	500	120 - 150	0.38
Concrete Fill Material	1500	57 or 67	2	**	90	0.33

*The maximum water-cementitious materials ratio by weight, which shall be based on all water in the mix, including correction for moisture in aggregates, and shall be based on the total cementitious materials including cement and fly ash, if any.

** To be determined in mix design.

Admixtures Required Within this Specification (May be required in other Specifications, does not include admixtures related to mix design.)				
Type	Fibrous Concrete Reinforcement	Color Additive	Anti-Washout Admixture	Other
Structural	None	On Invert Blocks only	When placed or cured in submerged conditions, See Article 151152.06, E, 9	
Concrete Fill Material	None	None	See Article 151152.09, C, 5	

151152.08 CONCRETE ACCESSORY MATERIALS.

A. Curing Materials.
Sheet Material: shall conform to ASTM C 171 specification. Sheet material shall not be used on colored concrete.

B. Liquid Curing Compounds

1. Sprayability: Use compounds of a consistency that they can be readily applied by spraying to a uniform coating at a material temperature above 40°F.

2. Drying Time: Use liquid curing compounds that:
- **a.** Dry to the touch in no more than 4 hours, and
- **b.** Do not track off the concrete when walked upon after 12 hours.

3. White Pigmented Compounds: Use compounds consisting of finely ground white pigment and vehicle, ready mixed for use without alteration.
- **a.** Ensure the pigment does not:
  - **1)** Settle excessively or cake in the container, and
  - **2)** Thicken in storage to cause a change in consistency which may result in a nonuniform spray.

b. Use a compound that after being sprayed on a test slab and drying has an apparent daylight reflectance no less than 60% relative to magnesium oxide. Agitate the compound just prior to it being removed from the container. Agitate it continuously during application. Contractor shall restrict the loss of water to not more than 0.20 kg/m2 in 24 hours or 0.40 kg/m2 in 72 hours, in accordance with ASTM C 156 and when using an application rate of 200 square feet per gallon.

c. Use Sealtight 1646 by W.R. Meadows, Inc, Thinfilm 450 by Kaufman Products Inc, DSCC White Wax Cure J9A by Dayton Superior, or an equal approved by the Engineer.

4. Clear Compounds: Use clear liquid membrane curing compounds complying with the requirements of ASTM C 309, Type 1-D, Class A. Use only one type of compound on a structure. Do not use different compounds on the same structure. Use Euco Rez-Seal by the Euclid Chemical Company, Sealtight 1100 by W.R. Meadows, Inc., Safe-Cure 1200 Clear by ChemMasters, or an equal approved by the Engineer.

C. Joint Sealers.

Joint Sealer: See Section 4136 of the Standard Specifications.

D. Non-Shrink Grout.

1. Compressive Strength: shall comply with ASTM C 109 and meet or exceed 1000 psi compressive strength after 1 day tests, and 3500 psi compressive strength for a 7 day test.

2. Height change: shall comply with ASTM C 827 for early age requirements, and ASTM C 1090 for hardened grout requirements. Expansion must be limited to 0.3% at 1, 3, 14, and 28 day test intervals.

3. Use Eucon NS Grout by Euclid Chemical Company, SureGrout by Kauffman Products Inc., Planigrout 712 by the Mapei Corporation, or an equal approved by the Engineer.

E. Underwater Grout:

1. When placed under Span 6, shall consist of ASTM C 1107 non-shrink grout of Grades A,B, or C as shown on the Plans.

2. Compressive Strength: shall comply with ASTM C 109 and meet or exceed 2000 psi compressive strength after 1 day test, and 6500 psi after a 7 day test.

3. Height change: shall comply ASTM C 827 for early age requirements, and ASTM C 1090 for hardened grout requirements. Expansion must be limited to 0.3% at 1, 3, 14, and 28 day test intervals.

4. Anti-Washout Admixture: shall comply with USACE CRD-C 661-06 Specification for Anti-Washout Admixtures for Concrete and ASTM C 494 Type S specifications. See Article 151152.06, D.

F. Epoxy Bonding Agent: Bonding agent shall be a two-component moisture insensitive epoxy adhesive, Sikadur 32, Hi-Mod or equivalent acceptable to the Engineer.

G. Expansion Joint Filler Material: See Section 4136 of the Standard Specifications

H. Sand-Cement Grout: Sand-cement grout, where specified, shall be a mixture of Portland cement, sand, and water with a maximum water-cement ratio of 0.38 by weight. The cement used shall be of the same type and source as used in the other concrete on this project. The grout shall have a consistency similar to thick paint.

I. Wedge-Type Expansion Anchors: Wedge type anchors shall be used only where specifically shown on contract documents and are prohibited under water. Expansion bolts and anchors fastened to concrete shall be stainless steel.

J. Epoxy Anchors: Epoxy anchor bolts shall be the length and diameter indicated on the contract documents and shall be stainless steel.

K. Epoxy Sealant: Epoxy sealant shall be a two-component, moisture insensitive, low viscosity, solvent free, epoxy resin, acceptable to the Engineer.

L. Concrete Support Blocks: Concrete support blocks for the floor reinforcement and the support of the vertical reinforcement at the base of the wall shall be a mixture of Portland cement, sand, and water with a maximum water-cement ratio of 0.38 by weight. The cement used shall be of the same type and source as used in the other concrete on this project.

M. Waterstops – Unless otherwise specified on the plan, waterstops shall be adhesive expansive rubber waterstops Adeka MC-2010MN, Spearfish SD, Greenstreak CJ-1020-2K Hyudrotite, St. Louis MO, or equivalent acceptable to the Engineer, unless noted otherwise on the Plans.

N. Anti-Graffiti Coating: The coating shall be Chemprobe Series 626 Dur A Pell GS (Graffiti Shield) by Chemprobe Coating Systems, Invisi-Shield by Sherwin-Williams, Permaclean by TK Products, or approved equal. Where the Anti-Graffiti Coating is to be used over stone veneers or Structural Concrete Coatings, verify compatibility of the materials prior to application. A material safety data sheet (MSDS) and a complete set of manufacturer's mixing and application instructions shall be submitted to the Engineer before the Contractor begins applying the coating.

151152.09 CONSTRUCTION.

A. Inspection.

1. Assure that excavations and formwork are completed. Refer to Special Provisions for In-River Formwork for requirements.

2. Assure that dirt, mud, encrusted concrete, debris, and excess water have been removed.

3. Check that reinforcement is properly positioned and secured in place. Refer to Section 2404 for steel reinforcement requirements.

4. Verify that expansion joint material, anchors, and other embedded items are secured in proper position.

5. Check that reinforcement is properly positioned and secured in place. Refer to Section 2301 of the Standard Specifications for requirements.

6. If directed by the Engineer, conduct non-destructive testing (NDT) using ground penetrating radar prior to placing grout or concrete for Spans 4 and 6 to identify extent of voids. NDT directed by the Engineer will be considered extra work in accordance with Article 1109.03, B of the Standard Specifications.

B. Preparation.

1. General.

a. Remove any hardened concrete and foreign material from inner surface of conveying equipment.

b. Prepare slab subgrade in accordance with ACI 301.

c. Designate limits of each placement and obtain Engineer's review of entire installation prior to proceeding.

d. Subgrade for concrete flatwork (walks, trails, curb & gutter, etc.): Excavate to required depth, remove all soft, yielding material, replace with suitable on-site material. Place 6 inch layer of approved free draining on-site material if determined to be necessary by the Engineer. Compact base to a firm, even surface. Compaction shall not be less than 95% dry density (ASTM D 698).

2. Concrete Placed Against Gravel or Crushed Stone.

Prevent loss of water from concrete with a minimum 2 inch layer of material having 25% fines passing a No. 4 sieve.

3. Concrete Placed Against Rock.

a. Remove all loose pieces of rock.

b. Clean exposed rock surface in accordance with Engineer's recommendations.

c. Thoroughly wet hardened surface before placing fresh concrete.

4. Concrete Placed Against Hardened or Existing Concrete.

a. Prior to placing fresh concrete against surface of hardened concrete, complete the following:

1) Remove all laitance, foreign substances (including curing compound), wash with clean water, and thoroughly wet hardened surface before placing fresh concrete.

2) Apply epoxy-bonding agent at blockouts, cutouts and in locations directed by Engineer.

b. Intentionally roughen all hardened surfaces to 1/4 inch diameter per ICRI 310.2R-2013 CSP 5 or above.

C. Placement.

1. Conveying.

a. Convey concrete from mixer to final position as rapidly as practicable without segregation or loss of material.

b. Use only metal or metal-lined chutes with maximum length of 20 feet, having a maximum slope of 1 vertical to 2 horizontal, and a minimum slope of 1 vertical to 3 horizontal.

c. Provide a hopper at the end of long-belt conveyors and chutes not meeting the requirements in Article 151152.09, C, 1, b above.

d. Conveying by pumping methods shall conform to ACI 304, Chapter 9.

2. Depositing in Walls.

a. Deposit concrete in a continuous operation until section is completed.

b. Concrete shall be deposited as nearly as practicable to its final position to avoid segregation due to rehandling or flowing.

c. Place concrete in approximately horizontal layers 2 feet maximum thickness.

d. Each layer of concrete shall be plastic when covered with following layer.

e. Rate of vertical rise not more than 2 feet per hour.

f. Provide placement capacity as necessary to comply with these requirements with construction and other joint locations shown on the contract documents.

g. Maximum height of concrete free fall during concrete pouring is not to exceed 4 feet.

h. Pump concrete or use a tremie having varying lengths for placing concrete in columns and walls to prevent free fall of more than 4 feet.

i. Concrete shall not be dropped through reinforcing steel nor subjected to any other procedure that will cause segregation.

j. Place and consolidate concrete in wall or column forms at least 24 hours prior to the time concrete or any reinforcing steel is placed in the system to be supported by such walls or columns except as noted below.

k. Allow concrete to thoroughly settle before top is finished. Remove all laitance, debris, and surplus water from surfaces at tops of forms by screeding, scraping, or other effective means.

l. Overfill forms wherever top of a wall will be exposed to weathering and after concrete has settled, screed off excess.

m. See Article 151152.09, D, 3 for preparation of construction joints prior to placing wall concrete.

3. Depositing in Flatwork (Walks, Trails, Curb & Gutter, etc.).
Place concrete monolithically between expansion joints.

4. Submerged Depositing or Curing of Boulder Grout, Grout, and Concrete.

a. Underwater placement shall be deposited only when allowed by the contract documents and approved by the Engineer. It shall be conducted in a manner meeting with the approval of the Engineer for each application and the placement shall not be started until the Engineer's approval has been obtained.

b. Underwater concrete or grout placement is not permitted on the dam modifications with the exception of placement beneath the apron slab to fill possible voids in Span 6 and 4 per the contract documents.

c. Use Anti-Washout Admixtures as specified in Article 151152.06, E, 9, and in addition the concrete mix and testing guidelines within USACE CRD-C 661-06.

1) Water Content: The Contractor shall determine the quantity of water used in the concrete mix, except that the Engineer may direct that such quantity of water be reduced if the slump flow of the concrete exceeds the maximum limits as prescribed within USACE CRD-C 661-06. Concrete consistency shall be uniform from batch to batch. Water shall not be added to compensate for stiffening of the concrete during placement. However, the Contractor shall be permitted to add additional plasticizing admixture.

d. All underwater placement of concrete for water depths greater than 3 feet shall be placed by diver-directed pumping. The Contractor shall conduct a pre-placement meeting with his placement staff, the Engineer’s staff, divers (if necessary), concrete supplier, and testing technicians to review and discuss the placement plan.

e. Isolate areas with a floating or containment silt curtains as required to ensure calm waters, no velocities or currents, prevent migration of sediments, and as required by permitting agencies.

f. Depositing operations shall not be conducted in running water or in water with a temperature below 35 degrees F.

g. To prevent segregation, grout, concrete, or Boulder Grout deposited under water shall be carefully deposited in a compact mass in its final position by means of a tremie pipe, concrete pump, or other approved method, and shall not be disturbed after being deposited. The tremie shall be watertight and sufficiently large to permit a free flow of concrete. Concrete buckets shall not be used for underwater placement of concrete except to deliver concrete to the tremie. Still water shall be maintained at the point of deposit. The water level shall be regulated so that there shall be no fluctuation of water head that may be injurious to the grout.

h. Prior to placement of concrete the Contractor shall provide acceptable facilities and made ready for accomplishment of the work as specified including truck access and truck cleanout facilities.

i. The discharge end shall be closed (using a “pig” or other method) at the start of the work in order to prevent water from entering the tube and it shall be sealed at all times when not in the deposited grout. Keep the discharge end of the pump line or tremie shaft continuously submerged in the placed material. Mixing of concrete and water shall be maintained at an absolute minimum. The tremie tube shall be kept full up to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited grout.

j. Concrete shall be supplied to the pump continuously. Concrete shall be carefully placed in a compact, monolithic mass and by a procedure that will prevent washing of the concrete. At no time shall concrete be allowed to fall through water. Should the pumpline or tremie pipe come out of the fresh concrete for any reason, the line shall be cleared, and the placement re-started with the "pig" re-inserted in the line. The minimum pumpline inside diameter shall be 5 inches.

k. All horizontal movements of the pumpline or tremie shall be conducted slowly and with care to prevent loss of the embedment of the line. If necessary, the Contractor shall provide a crane to assist in lifting and moving the end of the boom and discharge line.

l. If a bottom dump tremie bucket is used for depositing the grout, the rate of lowering and raising shall be such that the bucket shall not create undue turbulence inside the cofferdam. The bucket shall always be in the deposited grout before the bottom is opened. The Contractor shall deposit tremie grout to such elevations that after all unsound grout has been removed from the surface, the finished elevations shall be those which are shown on the plans.

m. The Contractor shall provide a means to determine the level of fresh concrete with respect to the required completed elevation. These means may include markings, vertical pins and alignment wires.

n. In the event of long delays in the placement during which the already deposited tremie has started to set, the Contractor shall remove the laitance, drill holes and supply and grout dowels in the already deposited portion before resuming the tremie pour; or the Contractor may be required to remove the grout, concrete, or Boulder Grout already deposited and start again.

o. Submerged Grout Placement (in Submerged Voids Underneath Span 6 Slab): Depositing of grout under water shall be carried out continuously from start to finish. The surface of the grout shall be kept as horizontal as is practicable at all times. To ensure thorough bonding, each succeeding layer of concrete shall be deposited before the preceding layer has taken its initial set.

p. Submerged Concrete and Boulder Grout Placement: The concrete or Boulder Grout shall be deposited so that it enters the mass of the previously placed material from within, displacing water with a minimum disturbance to the surface. The underwater seal at start of placing shall not produce undue turbulence in the water. Keep the tremie shaft full of concrete or Boulder Grout to a point well above the water surface. Placement shall proceed without interruption until the concrete or Boulder Grout has been brought to the required height. The tremie shall not be moved horizontally during a placing operation, and a sufficient number of tremies shall be provided so that the maximum horizontal flow of concrete or Boulder Grout shall be limited to 10 feet or less.

5. Consolidation.

a. During and immediately after placement, thoroughly compact and work around all reinforcements, embedments, and into corners of forms, eliminating all air or stone pockets that may cause honeycombing, pitting, or planes of weakness.

b. Use mechanical vibrators that will maintain at least 9000 cycles per minute when immersed in concrete.

c. Minimum horsepower per vibrator shall be 1 ½ hp.

d. Number and type of vibrators shall be as acceptable to Engineer. A spare vibrator will be available at all times in case of mechanical problems.

e. Over-vibrating and the use of vibrators to transport concrete laterally in forms will not be allowed.

f. Vertically insert vibrators at points approximately 2 feet apart and to a depth to penetrate 6 inch into the preceding layer.

g. Vibrate each location for a length of time to obtain adequate consolidation (generally 5 to 15 seconds).

D. Joints.

1. Waterstops.
Use at all locations where water is to be contained, groundwater is to be resisted and as shown on Plans. Approved water stop is required at all such joints.

2. Expansion and Contraction (Control) joints.
- **a.** At locations shown on plans.
- **b.** Extend reinforcement continuously through joints, except "Expansion Joints," unless specifically shown on contract documents.
- **c.** Form joint with felt, ASTM D 2475, where "bond breaker" is indicated.
- **d.** Flexible joint filler material as indicated in Article.151152.08, C, 1, shall be used in Expansion Joints.
- **e.** Expansion and contraction joints shall be caulked with a joint sealer as indicated in Article.151152.08, F.

3. Construction Joints.
- **a.** Provide where shown on plans.
- **b.** Obtain Engineer's approval for proposed locations of construction joints not shown on Plans or for proposed elimination of construction joints shown on Plans.
- **c.** Locate joints to least impair the strength and serviceability of the structure, generally as follows:
  - **1) Columns and Walls.**
    - **a)** At underside of beams, girders, haunches, drop panels, slabs, and at floor levels.
    - **b)** All haunches and drop panels shall be considered as parts of supported floor or roof and shall be placed monolithically therewith.
  - **2) Suspended slabs.**
    At or near mid-span in flat slab construction.
  - **3)** Construction joints in walls, beams, girders, and slabs shall be perpendicular to planes of their surfaces, with expansive rubber waterstops, and shall not be keyed except as shown on plans.
  - **4)** Maximum length of wall segments without construction joints shall be 500 feet or as shown on the plans.
- **d.** The surfaces of concrete to be cast against shall be thoroughly cleaned and all laitance removed. Concrete shall be vibrated adequately to prevent honeycombing at the joint.
- **e.** Construction joints shall require bond. After cleaning, before new concrete is placed, vertical joints shall be wetted unless otherwise detailed on contract documents or directed by Engineer. Prior to placement of concrete in walls, the bottom construction joint must be slushed with 2 to 3 inches of sand-cement grout. The sand-cement grout shall have a consistency similar to thick paint and shall be proportioned as specified in Article 151152.07. The fresh concrete shall be placed before the grout has attained its initial set.
- **f.** Joints where indicated on Plans or where directed by the Engineer to receive an epoxy bonding agent shall have been prepared and the bonding agent applied in accordance with the manufacturer's recommendations prior to placing fresh concrete.

E. Embedded Items.
Refer to Special Provisions for In-River Concrete Formwork and Section 2301 of the Standard Specifications.

F. Finishing Unformed Exposed Surfaces.

1. Slabs For Aprons, Slabs-On-Grade, And Tops Of Walls.
Provide surface conforming to proper elevation and contour. Except as noted otherwise on the plans, all walks and slabs shall slope 2% away from buildings. All other walks, exterior concrete steps, etc. shall be pitched to drain out with a slope of 1/4 inch per feet. Tops of retaining walls shall be pitched back (into the backfill) 1/4 inch per foot unless designated otherwise by the Engineer. All aggregates shall be completely embedded in mortar by screeding.
- **a.** Screeded surfaces shall be free of surface irregularities.

b. Maximum variation from a plane surface in any 10 feet section shall be 1/4 inch.

2. Coordination of Finishing and Placement.

a. Mixing and placing shall be carefully coordinated with finishing. Concrete shall not be placed on the subgrade or forms more rapidly than it can be spread, straight edged, and bull floated. These operations must be performed before bleeding water has an opportunity to collect on the surface.

b. To obtain good surfaces and avoid cold joints, the size of placing and finishing crews shall be planned with due regard for the effects of concrete temperature and atmospheric conditions on the rate of hardening of the concrete.

c. All flatwork finishers on the project shall be ACI Certified flatwork finishers or equivalent acceptable to the Engineer.

3. Jointing and Edging.

a. Joints in slabs shall be located and detailed as indicated in the contract documents.

b. Where saw-cut joints are required or permitted, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. In all cases, the saw cutting shall be completed no later than within the first 12 hours after the slab finishing operations have been completed.

c. Edge exposed edges of floated or troweled surfaces with a tool having a 1 ½ inch corner radius unless these edges are specified to be beveled.

4. Consolidation.

Concrete in slabs shall be thoroughly consolidated. Internal vibration shall be used in beams and girders of framed slabs and along the bulkheads of slabs on grade. Consolidation of slabs shall be obtained with vibrating screeds, roller pipe screeds, internal vibrators, or other acceptable means. The concrete surfaces shall not be manipulated prior to finishing operations.

5. Finishes.

a. Unless selection of finishes is made in the contract documents, the following finishes shall be used, as applicable.

1) Floated Finish - Use for tops of walls, footings, pile caps, etc.

2) Troweled Finish - Use for floors in finished areas and where called for on contract documents.

3) Broom Finish - Use for floor slabs, concrete stairs, landings, sidewalks, concrete trails, curb, and gutters.

4) Raked Finish - Use for slabs to receive topping or secondary concrete

5) Light Sandblast – As indicated in the contract documents

6) Medium Sandblast – As indicated in the contract documents

b. The following finishes shall be utilized on this project unless specified or detailed otherwise.

1) Floated Finish.

After the concrete has been placed, consolidated, struck-off, and leveled by bull floating, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheen has disappeared and/or when the mix has stiffened sufficiently to permit the proper operation of a power-driven float. The surface shall then be consolidated with power-driven floats of the impact type, except in thin sections, such as pan slabs, which shall be floated by hand. Hand floating with wood or cork-faced floats shall be used in locations inaccessible to the power-driven machine. Trueness of surface shall be rechecked at this stage with a 10 foot straightedge applied at not less than two different angles. All high spots shall be cut down and all low spots filled during this procedure to produce planes checking true under the straightedge in any direction, with tolerances not exceeding 1/4 inch in 10

feet. The slab shall then be refloated immediately to a uniform, smooth, granular texture.

2) Troweled Finish.
Where a troweled finish is specified, the surface shall be finished first with impact power floats, as specified above where applicable, then with power trowels and finally with hand trowels. The first troweling after power floating shall be done by a power trowel and shall produce a smooth surface that is relatively free of defects, but which may still contain some trowel marks. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be free of any trowel marks and shall be uniform in texture and appearance, with tolerances not exceeding ¼ inch in 10 feet. On surfaces that support floor coverings, any defects of sufficient magnitude to show through the floor covering shall be removed by grinding.

3) Broom Finish.
Slabs shall be given a coarse transverse-scored texture by drawing a broom across the surface. This operation shall follow immediately after bull floating operations and hand floating as required to close the surface. Provide a uniform abrasive texture of constant color. On paths, walks, and trails, broom at right angles to normal traffic direction.

4) Rake Finish.
Roughened concrete surface to a ½ inch minimum amplitude by raking.

5) Light Sandblast.
Light sandblast is defined as that which leaves an even fine-grained surface in which the cement mortar has been removed to the extent of starting to expose the small aggregate. Complete operations for a smooth form finish. If necessary, use grout rubbed finish to repair surface areas. Add color to grout mix to match color of concrete where colored concrete is specified. Contractor shall prepare a 3 foot square sample panel, including color additive, for review by the Engineer.

6) Medium Sandblast.
Medium sandblast is defined as that which leaves an even fine grained surface in which cement mortar has been removed to the extent of exposing the small aggregate, and just starting to expose large aggregate. Complete operations for a smooth form finish. If necessary, use grout rubbed finish to repair surface areas. Add color to grout mix to match color of concrete where colored concrete is specified. Contractor shall prepare a 3 foot square sample panel, including color additive, for review by the Engineer.

G. Replacement, Repairing and Patching of Defective Concrete.

1. Removal and Replacement of Defective Concrete:

a. After forms have been removed, any concrete that is not formed as shown on the contract documents, is out of alignment or level beyond the required tolerance, shows a defective surface that cannot be properly repaired or patched, or cannot be shown to prevent water migration through concrete surfaces or joints, shall be removed and replaced at the Contractor's expense.

b. Liquid retaining concrete walls, slabs, beams, etc., cannot have any honeycombing, cold joints, cracks greater than 0.004 inch wide, or leakage of water through the concrete thickness or joints. If in the opinion of the Engineer the honeycombing, cold joints, cracks, or leakage are excessive, the Contractor shall be required to remove the complete concrete segment and replace it. Where minor honeycombing, cold joints, cracks, or leakage occurs, it shall be repaired as indicated below.

2. Repair of Tie Holes, Blockouts, Cutouts and Defective Concrete.

a. Immediately after form removal, repair, to the satisfaction of the Engineer, all repairable surface defects, including tie holes, in concrete surfaces. In all cases, repair work shall be

completed within 24 hours of removal of the forms and prior to application of curing compound.

b. Replace, to satisfaction of Engineer, within 48 hours after adjacent forms have been removed, all other honeycombed and defective concrete areas that cannot be immediately repaired as noted in Article 151152.09, G, 2, a above.

c. Cut out and remove to sound concrete, with edges square-cut to avoid feathering, all honeycombed or otherwise defective concrete.

d. Repair work shall conform to ACI 301 and these specifications. At all blockouts, tie-holes and cutouts, after being thoroughly cleaned, apply an epoxy-bonding agent, and fill with non-shrink grout, as specified in Article 151152.08, J. Color shall be added to match surrounding concrete.

e. Perform in a manner that will not interfere with thorough curing of surrounding concrete.

f. Adequately cure all repair work.

3. Repair of Cracks and Minor Honeycombed Areas.
All cracks, minor honeycombed concrete, or other areas of apparent leakage, including wet spots on walls, shall be sealed with Epoxy Sealant injection or other acceptable means so that the concrete is watertight.

H. Finishing Formed Surfaces.

1. Rough form finish: All surfaces not exposed to view such as surfaces in contact with earth.

a. Chip off all fins and other surface projections greater than 1/4 inch high.

b. Fill all tie holes and repair and patch all defects.

2. Smooth form finish: All exposed surfaces not generally exposed to view including interior surfaces of structures.

a. Use form facing to produce a smooth, hard uniform surface.

b. Keep number of seams to a minimum.

c. Remove all fins and projections.

d. Clean, coat, and fill all tie holes.

e. Repair and patch all defects.

3. Grout-Rubbed Finish – Provide a grout-rubbed finish on all non-colored concrete surfaces exposed to view. Do not begin cleaning surface until all contiguous surfaces are completed and accessible and can be completed at the same time.

a. Complete operation for smooth form finish (see above), then wet surface and apply grout mix of 1 part of Portland cement and 1 1/2 parts of fine sand by volume with sufficient water to produce a grout having the consistency of thick paint. Substitute white Portland Cement for a part of the gray as required in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch. Wet the surface of the concrete sufficiently to prevent absorption of water from the grout and apply the grout uniformly with brushes or a spray gun.

b. Immediately after applying the grout, scrub the surface vigorously with a cork float or stone to coat the surface and fill all air bubbles and holes.

c. While the grout is still plastic, remove all excess grout by working (rubbing) the surface with a rubber float, burlap, or other means.

d. After the surface whitens from drying (about thirty minutes at normal temperatures), rub vigorously with clean burlap.

e. The finish shall be kept damp for at least 36 hours after final rubbing.

f. Proper curing temperatures need to be maintained just as with other concrete work.

4. Sandblast finish – Exposed surfaces exposed to view, where indicated on the plans to be sandblasted, shall include requirements of a smooth form finish followed by sandblasting to remove approximately 1/8 inch of surface concrete.

5. Anti-Graffiti Coating - All surfaces where in the contract documents to receive an Anti-Graffiti Coating.
- **a.** The coating shall be applied to all exposed surfaces of the structure above the ground line, including all walls and headwalls, and shall also extend 6 inches below the finished ground line. This will require staged backfilling of the front face of the wall.
- **b.** Sidewalks, paths, concrete wall surfaces, wall caps, bridge bearing= devices, curb and barrier cover plates, steel fence, and steel rail shall be masked or otherwise protected to prevent Anti-Graffiti Coating from coming into contact with them.
- **c.** The final color of the Anti-Graffiti Coating shall be clear.
- **d.** The Anti-Graffiti Coating shall be applied in accordance with the manufacturer's instructions and recommendations.
- **e.** New mortar joints of any stonework shall be at least 28 days old, or as otherwise approved in writing by the Coating manufacturer, before the coating is applied.

I. Curing.

1. General.
- **a.** Freshly deposited concrete shall be protected from premature drying and excessively hot or cold temperatures and shall be maintained without drying at a relatively constant temperature for the period of time necessary for the hydration of the cementitious materials and proper hardening of the concrete. A list of all intended curing methods including a description of materials shall be submitted to the Engineer for review.
- **b.** Initially, the concrete temperature shall be maintained at or above 70º F for 3 days or at or above 50ºF for 5 days. Continue curing as required to achieve the specified 28 day strength. See Article 151152.05 for additional information.
- **c.** Keep concrete continuously moist for at least 7 days after placement by use of:
  - **1)** Ponding or continuous sprinkling.
    - **a)** Begin as quickly as possible after initial set.
    - **b)** Provide complete coverage with minimum of runoff by regulating rate of water application.
    - **c)** Interrupt application of water to walls for finishing or repair work only over areas being finished.
    - **d)** Do not permit wall areas to become dry that are not being finished.
    - **e)** Resume curing immediately after each day's finishing operations.
  - **2)** Polyethylene film see Article 151152.09, 3.
  - **3)** Wet burlap, wet absorptive mats, or wet sand.
  - **4)** Leave forms in place for concrete walls and keep wet.
- **d.** Use membrane-curing compound as noted below.

2. Membrane Curing Compound (Conforming to ASTM C 309).
- **a.** Shall be used prior to placement of plastic sheeting on concrete floor and roof slabs, walls, and other miscellaneous concrete areas where acceptable to Engineer.
- **b.** Spray-apply in two coats perpendicular to each other at coverage recommended by manufacturer. Use clear membrane curing compound, not white, on flatwork (walks, trails, paths, etc.).
- **c.** Cover unformed surfaces with curing compound within 30 minutes after final finishing.
- **d.** Apply curing compound immediately to formed surfaces if forms are removed before end of specified curing period. Curing compound sprayed in tie holes is to be cleaned out before patching tie holes. Forms may be left in place for all or part of the curing period; wood forms shall be kept wet.
- **e.** Protect compound against abrasion during curing period.

3. Film Curing (Conforming to ASTM C 171).
- **a.** Film curing shall not be used in lieu of water curing on tank floor and roof slabs. Use only where specifically reviewed and acceptable to Engineer.

b. Concrete placed early in the concrete placing operation shall not be allowed to dry out. Apply Membrane Curing Compound, or other material acceptable to the Engineer, as noted above prior to placing the polyethylene film or other coverings.
c. Begin as quickly as possible after initial set of concrete.
d. Cover surfaces completely with polyethylene sheeting.
e. Overlap edges for proper sealing and anchorage.
f. Cover joints between sheets with dunnage as required to prevent displacement due to wind or other factors.
g. Promptly repair all tears, holes, and other damage.
h. Anchor continuously all edges and anchor surface as necessary to prevent billowing.

151152.10 QUALITY CONTROL.

A. Concrete tests.

1. Shall be paid for by the Contracting Authority except where noted otherwise in these specifications, and shall be in accordance with the requirements of ACI 301, except as noted or modified in this Section. Test specimens shall be taken by an ACI Certified Concrete Field-Testing Technician - Grade 1 in accordance with the ASTM C 31.

a. Strength test.
1) Mold and laboratory cure seven cylinders from each sample.
2) Test two cylinders at 7 days, and an additional two cylinders at 14 days per ASTM C 39. Test two cylinders at 28 days for acceptance. Keep the remaining one as a spare to be tested as directed by Engineer.
3) The spare cylinder for each sample may be eliminated after the first several concrete placements of each type of concrete if, in the opinion of the Engineer, test results are consistent and within specifications.

b. Minimum samples.
Collect the following minimum samples for each 28 day strength concrete used in the work for each day's placing:

Concrete Quantity	Number of Samples
50 cubic yards or less	one
50 to 100 cubic yards	two
100 cubic yards or more	two plus one sample for each additional 100 cubic yards

c. Slump test.
1) Conduct test for each strength test sample and whenever consistency of concrete appears to vary.
2) Slump tests shall be made using ASTM C 143.

d. Air content.
1) Conduct test from one of first three batches mixed each day and for each strength test sample.
2) Samples indicating low air contents by the pressure method air content tests in accordance with ASTM C 231 shall be verified by the gravimetric method, ASTM C 138, and the volumetric method, ASTM C 173, before adding additional air entraining admixture in the field.

2. The Contractor shall provide the following to the Contracting Authority at no additional cost to the Contracting Authority:
a. Incidental labor required to facilitate testing.
b. Minimum one day's advance notice when concrete is to be placed.
c. Storage facilities for concrete test cylinders; including, when necessary, a specially prepared box with high-low thermometer and thermostatically controlled heating devices in

accordance with Section 9.2 of ASTM C 31 for storage of the cylinders for the first 24 hours after molding.

d. Materials, samples, and access to materials as required for testing.

e. Reimbursement of costs for testing and inspection resulting as a consequence of the following:

1) Work not in compliance with the contract documents.

2) Testing requested by the Contractor such as field-cured cylinder tests for stripping strengths, etc.

3) Testing to verify the adequacy of work done, without prior notice, without proper supervision, or contrary to standard construction practice.

f. The use of testing services shall in no way relieve the Contractor of his responsibility to furnish materials and construction in full compliance with the contract documents.

B. Acceptance of Concrete.

1. If the early strength tests fall below the early strengths deemed necessary to achieve the specified 28 day strength, the Engineer will have the right to require conditions of temperature and moisture necessary to secure the required strength. The Engineer may also require pull out tests in accordance with ASTM C 900 or core tests in accordance with ASTM C 42.

2. Strength level of concrete will be considered satisfactory so long as average of all sets of two consecutive strength test results equals or exceeds specified 28 day strength and no individual strength test result falls below the specified strength by more than 500 psi.

C. Failure of Test Cylinder Results.

1. Upon failure of the 28 day test cylinder results, Engineer may require Contractor at his expense, to obtain and test at least three pullout tests or 2 inch diameter cored samples from area in question.

2. Concrete will be considered adequate if average of three pullout or core tests is at least 85% of, and if no single core is less than 75% of the specified 28 day strength.

3. Upon failure of the pullout or core test results, Engineer may require Contractor, at his expense, to perform load tests as specified in ACI 318, Chapter 20, or remove and replace as directed by the Engineer.

4. In the event an area is found to be structurally unsound, the Engineer may order removal and replacement of concrete as required. The cost of the pullout or core tests, and the load test and the structural evaluation shall be borne by the Contractor.

5. Fill all pullout or core holes as specified for repairing defective concrete.

151152.11 SPECIAL TESTING REQUIREMENTS.

A. Further concrete testing, in addition to Quality Control Testing and testing for proposed mix designs, may become necessary during the project. Testing shall be provided under the conditions stated in each specification section and shall be in accordance with the requirements of ACI 301 and this Specification. Refer to Articles 151152.10, B and C for acceptance criteria and procedures upon failure of tests.

B. In all cases, the Contractor shall provide the Contracting Authority at no additional cost to the Contracting Authority, with the items listed in 151152.10, A, 2.

C. Sampling and Test Groups.

1. When job cured cylinders are used, samples shall be obtained as specified in Article 151152.10, A, 1, a, b, c, and d, unless directed otherwise by the Engineer.

2. When core tests are used, samples shall be obtained in accordance with ASTM C 42 and as directed by the Engineer.

151152.12 METHOD OF MEASUREMENT.

Measurement will be as follows:

A. Structural Concrete (Miscellaneous or Dam) – Smooth Concrete:

1. Quantity shown in the contract documents.

2. The Engineer will compute in cubic yards the total volume of the respective classes of structural concrete placed using dimensions shown in the contract documents, along with the changes that have been made according to a written order from the Engineer. From this volume, 0.8 cubic foot will be deducted for each linear foot of concrete, steel shell, or wood piling projecting into the footings or caps. Deductions from the volume of concrete will not be made for the volume of concrete displaced by the steel reinforcement, floor drains, expansion joints, shear lugs, beam flanges, H-piles, or metal strips for sealing joints.

3. Additional concrete required to bring floors, curbs, and handrails to the required elevation will not be measured for payment if such addition is made necessary by inaccuracies in the shape or placement of steel or concrete beams or by distortion of falsework.

4. Reinforcing Steel and Structural Steel: ~~not~~ measured ~~separately~~ for payment according to Sections 2404 and 2408 of the Standard Specifications, respectively.

B. The surface area on which concrete sealer is applied to structural concrete: not measured separately for payment.

151152.13 BASIS OF PAYMENT.

A. Payment for Structural Concrete (Miscellaneous or Dam) as specified above will be the actual number of cubic yards of concrete placed in accordance with the contract documents or as otherwise directed by the Engineer. The unit price will include all of the Contractor's costs.

B. This bid item includes, but is not limited to:

1. Furnishing and installing the In-River structural concrete and related components shown on the Plans or specified, and items which may not specifically be shown or specified but which are required to provide a complete and proper installation.

~~**2. Fabrication and installation of steel rebar reinforcement.**~~

3. Formwork.

4. Excavation, loading, stockpiling, or hauling offsite and proper disposal of excess excavated material not re-used onsite.

5. Preparing and stabilizing subgrade.

6. Supporting excavations, shoring, or laying slopes back if shoring is not used.

7. Concrete curing.

8. Cold and hot weather concrete protection.

9. Protecting aboveground and underground utilities and service connections Disposing of debris, pipe, excess excavated materials, and damaged materials.

10. Concrete sealer.

11. Providing all other related and necessary labor, equipment, and materials to complete the work as designed and intended to a satisfactory and properly functioning condition.

C. Reinforcing Steel and Structural Steel: according to Sections 2404 and 2408 of the Standard Specifications, respectively.