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SECTION 03 00 00**

CONCRETE DEFINITIONS AND REFERENCE CODES, SPECIFICATIONS AND STANDARDS

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SECTION 03 00 00**CONCRETE DEFINITIONS AND REFERENCE CODES,
SPECIFICATIONS AND STANDARDS****PART 1 – GENERAL****1.01 PURPOSE**

- A. The purpose of this Section is to provide the Contractor with a list of applicable codes, definitions, specifications, and standards associated with the Division 03 Specifications.

1.02 SCOPE

- A. These definitions and references apply to concrete materials.

1.03 DEFINITIONS

- A. Active Cracks: Those cracks for which the mechanism causing the cracking is still at work. An active crack is any crack that is still active.
- B. Architectural Concrete: Concrete that is exposed as an interior or exterior surface in the completed structure that contributes to visual character of the completed structure, as indicated on Drawings.
- C. Architectural Finish: Produce architectural finishes including special textured finishes, exposed aggregate finish, and aggregate transfer finish.
- D. As-Cast Finishes: Use form facing materials meeting requirements of ACI 301. Also known as rough-form, smooth-form, or architectural finishes. No coating.
- E. Basin Train: Series of interconnected basins that will be operated as a unit with the same water level.
- F. Bleed: The autogenous flow of mixing water within, or its emergence from, newly placed grout caused by the settlement of the solid materials within the mass, also called water gain.
- G. Brooming: Use for exposed exterior walking surfaces, loading docks, ramps, and outside paving.
- H. Chemical Grout: Any grouting material characterized by being a true solution with no particles in suspension. In the context of this document, the term "chemical grout" will be further restricted to referring to a flexible polymer such as a polyurethane, capable of expanding upon contact with water.
- I. Clear Sealer: Compound use on new or existing concrete and cementitious toppings to improve resistance to staining, abrasion and the effects of ultraviolet (UV) radiation.
- J. Coated Concrete: As cast concrete requiring an additional application of coating.

- K. Codes: Legal documents whose use is determined by the jurisdictions governing the project. Codes are typically geographically dependent.
- L. Cold Weather: A period when for more than 3 successive days the average daily outdoor temperature drops below 40 degrees F. The average daily temperature is the average of the highest and lowest temperature during the period from midnight to midnight. When temperatures above 50 degrees F occur more than half of any 24-hour period, that period shall no longer be regarded as cold weather.
- M. Consistency: The relative mobility or ability to flow.
- N. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.
- O. Crack Injection: Method of sealing or repairing cracks by pressure injecting a polymer.
- P. Curing Compound: A liquid that is sprayed or otherwise applied to newly placed concrete which retards the loss of water during curing.
- Q. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations greater than 3/16-inch, cracks 0.005-inch wide and larger, as well as a crack that leaks for liquid containment basins and below grade habitable spaces; cracks 0.010-inch wide and larger in nonfluid holding structures spalls, chips, air bubbles greater than 3/4-inch in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from joints, fins and other projections, form popouts, texture irregularities, and stains and other color variations that cannot be removed by cleaning.
- R. Dry Pack: A natural aggregate, high strength, non-shrink material designed specifically for mixing and placing at a no slump consistency. When mixed with a minimum of water, it can be placed into voids and spaces where forming or containment of self-leveling grouts is not possible or desirable.
- S. Epoxy Grout: Rigid polymer resin capable of restoring the structural integrity of a concrete section.
- T. Evaporation Retardant: A water-based compound that is specifically designed to form a thin monomolecular film to reduce rapid moisture loss from the concrete surfaces prior to curing.
- U. Exposed Concrete: Concrete surfaces that can be seen inside or outside of structures regardless whether concrete is above water, dry at all times, or can be seen when structure is drained.
- V. Floating: Use for surfaces scheduled to receive roofing, waterproofing membranes, etc.
- W. Formed Finishes:
1. Rubbed Finishes: Remove forms as early as permitted by ACI 301 and produce smooth-rubbed, grout cleaned, or cork floated finish.

2. Rough-form Finish (F-1): Patch tie-holes and defects. Chip or rub off fins exceeding 1/2 inch in height. Leave surfaces with the texture imparted by the forms.
 3. Smooth-form Finish (F-2): Patch tie holes and defects. Remove fins exceeding 1/8 inch in height.
 4. Smooth Form Finish Prepared for Cementitious Coating (F-4): Same as F-2 except follow cementitious coating manufactures written instructions for surface preparation.
 5. Smooth Form Finish Prepared for painting (F-5): Same as F-2 except follow paint manufacturers written instructions for surface preparation.
 6. Smooth-rubbed Finish (F-7): Remove forms as early as permitted by ACI 301 and perform necessary patching. Produce finish on hardened concrete no later than the day following formwork removal. Wet the surface and rub it with carborundum brick or other abrasive until uniform color and texture are produced. Use no cement or grout other than cement paste drawn from the concrete itself by the rubbing process.
- X. Green Concrete: Concrete that has set but not hardened.
- Y. Hardener: Concrete hardeners are silicate-based penetrating sealers. They react with soluble calcium compounds (free lime) in the concrete and form insoluble calcium silicates to create a breathable protective barrier.
- Z. Hot Weather: Any combination of the following conditions that tends to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise causing detrimental results:
1. High ambient temperature.
 2. High concrete temperature.
 3. Low relative humidity.
 4. Wind speed.
 5. Solar radiation.
- AA. Hydraulic Structures: Liquid containment basins.
- BB. ICC-ES Reports: Published by ICBO for concrete anchor manufacturers.
- CC. Inspection: Observation of Work by Inspector for conformance to approved design Drawings and Specifications.
- DD. Inspector: Qualified person who shall demonstrate competence, to satisfaction of

building official, for inspection of Work specified within this section.

- EE. Large Cracks: Wider than 0.015 inch.
- FF. Low-Pressure Mortar: Mortar applied by low-pressure spraying or in small areas by hand troweling.
- GG. New Concrete: Concrete that is less than 60 days old.
- HH. Nonshrink Grout: Prepackaged dry hydraulic cement product intended for use under applied load intended to support a structure, a machine and the like where a change in height below initial placement height is to be avoided.
- II. Nonstructural Defect:
 - 1. Areas with defects that meet the following:
 - a. Deemed by Design/Build Contractor to be superficial.
 - b. Less 1 inch in depth.
 - c. Not subjected to structural loads or heavy wear.
- JJ. Pointing: To place plastic grout into joints to correct defects or to completely fill joints in newly poured concrete.
- KK. Regulations: Legal design standards that must be incorporated into the design.
- LL. Seeding: Select aggregate is carefully placed by shovel or hand to completely cover the entire surface with one layer of stone.
- MM. Segregation: The unintentional separation of the constituents of grout causing a lack of uniformity in distribution.
- NN. Slurry Concrete: Mixture of sand, 3/8-inch minus aggregate, cement, and water for wall construction joints and pre-stressed concrete reservoir wall base.
- OO. Small Cracks: Width equal to 0.015 inch or less.
- PP. Spall: A fragment detached from a larger mass.
- QQ. Spalling: A development of spalls.
- RR. Standards: Opinions and recommendations that form design guidelines that are not legal in nature but are considered to be standard of practice." Standards are often published by industry associations but may also be internal or client-developed.
- SS. SS. Structural Defect: Condition or characteristic that detracts from appearance, strength, or durability of concrete. Structural defects may be in the following areas:
 - 1. Areas subject to structural loading.

2. Areas subject to heavy wear.
 3. Interior of hydraulic structure.
 4. Below grade structure.
 5. Display defect or parts of defect that extend 1 inch or deeper into the concrete and deemed by the Design/Build Contractor as a structural defect.
- TT. Troweling: Use for exposed interior walking surfaces and surfaces to be covered with carpet, resilient flooring, paint and other thin film finishes.
- UU. Unformed Finishes:
1. Trowel Finish (U-1): Float concrete finish, then power-trowel the surface. Hand-trowel the surface smooth and free of trowel marks. Continue hand-troweling until a ringing sound is produced as the floor is trowelled. Tolerance for concrete floors shall be conventional straight edged tolerance in accordance with ACI 117 unless otherwise specified. Provide hard, smooth surface uniform in appearance and texture.
 2. Float Finish (U-2): Place, consolidate, strike off, and level concrete, eliminating high spots and low spots. Power float and/or hand float surface.
 3. Broom Finish (U-5): Immediately after concrete has received a floated finish, give the concrete surface a coarse transverse scored texture by drawing a broom across the surface.
 4. Sidewalk Finish (U-6): Same as U-5.

1.04 REFERENCES

- A. The following is a list of codes, specifications, and standards that may be referenced in this section:
1. American Concrete Institute (ACI):
 - a. 117/117R, Standard Tolerances for Concrete Construction and Materials.
 - b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - c. 301, Specifications for Structural Concrete.
 - d. 302.1R, Guide for Concrete Floor and Slab Construction.
 - e. 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.

- f. 305R, Hot Weather Concreting.
 - g. 306.1, Standard Specification for Cold Weather Concreting.
 - h. 309R, Guide for Consolidation of Concrete.
 - i. 318/318R, Building Code Requirements for Structural Concrete and Commentary.
 - j. 347, Guide to Formwork for Concrete.
 - k. 503R, Use of Epoxy Compounds with Concrete.
 - l. 506, Guide to Shotcrete.
 - m. 506.2, Specification for Shotcrete.
 - n. 506.3, Guide to Certification of Shotcrete Nozzlemen.
 - o. 506.4, Guide for the Evaluation of Shotcrete.
 - p. SP-66, Detailing Manual.
2. ASTM International (ASTM):
- a. A36, Standard Specification for Structural Steel.
 - b. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - c. A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 - d. A416, Standard Specification for Steel Strand, Uncoated Seven Wire for Prestressed Concrete.
 - e. A497, Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
 - f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - g. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - h. A767/767M, Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - i. A775/A775M, Standard Specification for Epoxy-Coated Reinforcing Steel Bars.

- j. C31/C31 M, Standard Practice for making and Curing Concrete Test Specimens in the Field.
- k. C33, Standard Specification for Concrete Aggregates.
- l. C39/C39M, Standard Test Method or Compressive Strength of Cylindrical Concrete Specimens.
- m. C42/C42M, Standard Test Method or Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- n. C78, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
- o. C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- p. C94/C94M, Standard Specification for Ready-Mixed Concrete.
- q. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
- r. C143/C143M, Standard Test Method for Slump of Hydraulic Cement Concrete.
- s. C150, Standard Specification for Portland Cement.
- t. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
- u. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
- v. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
- w. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- x. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
- y. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing concrete.
- z. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
- aa. C332, Standard Specification for Lightweight Aggregates for Insulating Concrete.

- bb. C348, Standard Test Method for Flexural Strength of Hydraulic Cement Mortars.
- cc. C452, Standard Test Method for Potential Expansion of Portland-Cement Mortars Exposed to Sulfate.
- dd. C457, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete.
- ee. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
- ff. C478, Standard Specifications for Precast Reinforced Concrete Manhole Sections.
- gg. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
- hh. C495, Standard Test Method for Compressive Strength of Lightweight Insulating Concrete.
- ii. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
- jj. C513, Standard Test Method for Obtaining and Testing Specimens of Hardened Lightweight Insulating Concrete for Compressive Strength.
- kk. C578, Standard Specification for Preformed, Cellular Polystyrene Thermal Insulation.
- ll. C595, Standard Specification for Blended Hydraulic Cements.
- mm. C596, Standard Test Method of Drying Shrinkage of Mortar Containing Hydraulic Cement.
- nn. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- oo. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
- pp. C672, Standard Test Method for Scaling Resistance for Concrete Surfaces Exposed to Deicing Chemicals.
- qq. C779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
- rr. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

- ss. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
- tt. C890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
- uu. C913, Standard Specifications for Precast Water and Wastewater Structures.
- vv. C928, Standard Specification for Packaged, Dry, Rapid Hardening Cementitious Materials for Concrete Repairs.
- ww. C939, Standard Test Method for Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method).
- xx. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
- yy. C1012, Standard Test Method for Length Change of Hydraulic Cement Mortars Exposed to a Sulfate Solution.
- zz. C1042, Standard Test Method for Bond Strength of Latex Systems Used with Concrete by Slant Shear.
- aaa. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- bbb. C1116, Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
- ccc. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetrations.
- ddd. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
- eee. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
- fff. C1315, Standard Specification for liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- ggg. C1602/C1602M-06, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
- hhh. D1056, Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber.
- iii. D2000, Standard Classification System for Rubber Products in

Automotive Applications.

- jjj. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by sounding.
 - kkk. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
 - lll. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
 - mmm. E1155, Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.
3. Precast/Prestressed Concrete Institute (PCI):
 - a. MNL-117, Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
 - b. MNL-120, Design Handbook for Precast and Prestressed Concrete.
 4. Corps of Engineers (COE)
 - a. CRD-C611, Flow of Grout for Pre-placed Aggregate Concrete.
 - b. CRD-C621, Specification for Non shrink Grout.
 5. Concrete Reinforcing Steel Institute (CRSI):
 - a. Placing Reinforcing Bars.
 - b. Manual of Standard Practice.
 6. National Institute of Standards and Technology (NIST): Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices.
 7. National Ready Mixed Concrete Association (NRMCA).
 8. NSF International (NSF): 61, Drinking Water System Components Health Effects.
 9. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40: 52.254, Approval and Promulgation of Implementation Plans.
 10. International Concrete Repair Institute (ICRI): 03730, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.
 11. American Association of State Highway and Transportation Officials.

- a. T277, Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
- 12. International Conference of Building Officials (ICBO): ICBO Research Report.
- 13. Wire Reinforcement Institute (WRI): Manual of Standard Practice, Welded Wire Fabric.

PART 2 – PRODUCTS

Not used in this section.

PART 3 – EXECUTION

Not used in this section.

END OF SECTION

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SECTION 03 10 00**CONCRETE FORMWORK AND ACCESSORIES****PART 1 – GENERAL****1.01 PURPOSE**

- A. This Section is to provide the Contractor with the applicable information to support formwork and accessories for cast-in-place concrete.

1.02 SCOPE

- A. This Section is for the design of concrete formwork,

1.03 DEFINITIONS, REFERENCE CODES, SPECIFICATIONS, AND STANDARDS

- A. Refer to Section 03 00 00, Concrete Definitions and Reference Codes, Specifications, and Standards for information applicable to this Section.

1.04 DESIGN REQUIREMENTS

- A. Design formwork in accordance with ACI 347 and ACI 318/318R to provide concrete finishes specified in Section 03 35 00.13, Concrete Finishes and Tolerances.
- B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure per ACI 347.
- C. Make joints in forms watertight.
- D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.

1.05 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Form Ties-Tapered Through-Bolts: Proposed method of sealing form tie hole; coordinate with details shown.
 - b. Manufacturer's data for form release agent.
 - 2. Samples: One each as follows:
 - c. Form ties.
- B. Information Submittals: Statement of qualification for formwork designer.

1.06 QUALIFICATIONS

- A. Formwork Designer: Formwork, falsework, and shoring design shall be by an engineer licensed in the State of Georgia.

PART 2 – PRODUCTS

2.01 FORM MATERIALS

- A. Wall Forms and Underside of Slabs and Beams:
 - 1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in "new and undamaged" condition, of sufficient strength and surface smoothness to produce specified finish.
- B. Column Forms:
 - 1. Rectangular Columns: As specified for walls.
- C. Sandblasted Surface Forms: Medium density overlay plywood for flat concrete surfaces to be sandblasted.
- D. Painted Surface Forms: High-density overlay plywood for flat concrete surfaces to be painted.
- E. All Other Forms: Materials as specified for wall forms.
- F. Form Release Agent:
 - 1. Material: Release agent shall not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatments of concrete surfaces when applied to forms. A ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations.
 - 2. Manufacturers and Products:
 - a. BASF, Shakopee, MN; MBT, Rheofinish 211.
 - b. Cresset Chemical Company; Crete-Lease 20-VOC.
 - c. Unifex Chemicals; Farm Fresh.
 - d. Atlas Construction Supply, Inc.; Bio-Guard.

- G. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.
- H. Form Ties:
1. Material: Steel.
 2. Spreader Inserts:
 - a. Conical or spherical type.
 - b. Design to maintain positive contact with forming material.
 - c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
 3. Wire ties not permitted.
 4. Flat bar ties for panel forms; furnish Plastic or rubber inserts with minimum 1.5-inch depth and sufficient dimensions to permit patching of tie hole.
 5. Water Stop Ties: For hydraulic structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
 - a. Integral steel water stop 0.103 inch thick and 0.625 inch in diameter tightly and continuously welded to tie.
 - b. Neoprene water stop 3/16 inch thick and 15/16 inch diameter whose center hole is one half diameter of tie, or molded plastic water stop of comparable size.
 - c. Orient water stop perpendicular to tie and symmetrical about center of tie.
 - d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
 6. Through-Bolts: Tapered minimum 1-inch diameter at smallest end.
 7. Elastic Vinyl Plug:
 - a. Design and size of plug to allow insertion with tool to enable plug to elongate and return to Original length, and diameter upon removal forming watertight seal.
 - b. Manufacturer and Product: Dayton/Richmond Co., Miamisburg, OH; A58 Sure Plug.

PART 3 – EXECUTION

3.01 PROCEDURE

A. Form Surface Preparation:

1. Thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants prior to coating surface.
2. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by the manufacturer.
3. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

B. Erection:

1. General: Unless specified otherwise, follow applicable recommendations of ACI 347.
2. Beveled Edges (Chamfer):
 - a. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
 - b. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain Engineer's approval of size prior to placement of beveled edge.
3. Wall Forms:
 - a. Do not reuse forms with damaged surfaces.
 - b. Locate form ties and joints in an uninterrupted uniform pattern.
 - c. Inspect form surfaces prior to installation to assure conformance with specified tolerances.
4. Forms for Curbs, Sidewalks, and Driveways:
 - a. Provide standard steel or wood forms.
 - b. Set forms to true lines and grades, and securely stake in position.
5. Form Tolerances: Provide forms in accordance with Section 03 35 00.13, Concrete Finishes and Tolerances.

C. Formwork Removal:

1. When formed surfaces require finishing, remove forms as soon as removal operations will not damage concrete.
2. Nonsupporting forms (sides of beams, walls, columns, and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
 - a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
 - b. Curing and protection operations are maintained.
3. Elevated Structural Slabs or Beams: In accordance with ACI 318/318R, Chapter 6, and at such time as concrete has reached compressive strength equal to 80 percent of specified 28-day compressive strength as determined by test cylinders.

END OF SECTION

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SECTION 03 21 00**REINFORCING STEEL****PART 1 – GENERAL****1.01 PURPOSE**

- A. The purpose of this Section is to provide the Contractor with applicable information for use of concrete reinforcing steel.

1.02 SCOPE

- A. This Section is for selection of mild steel reinforcing.

1.02 DEFINITIONS, REFERENCE CODES, SPECIFICATIONS, AND STANDARDS

- A. Refer to Section 03 00 00, Concrete Definitions and Reference Codes, Specifications, and Standards for information applicable to this Section.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66 Detailing Manual:
 - a. Bending lists.
 - b. Placing drawings.
 - 2. Welded, metallic sleeve splice, and mechanical threaded connection.
- B. Informational Submittals:
 - 1. Lab test reports for reinforcing steel showing stress-strain curves and ultimate strengths.
 - 2. Mechanical Splices:
 - a. Current International Conference of Building Officials (ICBO) Research Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
 - b. Manufacturer's instructions.
 - c. Verification that device threads have been tested and meet requirements for thread quality, in accordance with manufacturers published methods.
 - 3. Welding Qualification: Prior to welding, submit welder qualifications and

nondestructive testing procedures in accordance with Section 05 05 23, Welding.

4. Test results of field testing.

1.05 QUALITY ASSURANCE

- A. Welder Qualifications: Certified in accordance with AWS DI.4.

PART 2 - PRODUCTS

SEE ATTACHMENT A

PART 3 - EXECUTION

3.01 PREPARATION

- A. Notify Contractor when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.
- B. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.02 REINFORCING BAR INSTALLATION

- A. Conform to requirements of ACI 301 and ACI 318.
- B. Splicing:
 1. Use lap splices, unless otherwise shown or permitted in writing by Engineer.
 2. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
- C. Mechanical Splices and Connections:
 1. Use only in areas specifically approved in writing by Engineer.
 2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICBO Research Report.
 3. For metal sleeve splice, follow manufacturer's installation recommendations.
 4. Maintain minimum edge distance and concrete cover.
- D. Tying Reinforcing Bars:
 1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
 2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.

- E. Reinforcement around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.
- F. Welding Reinforcement: Do not perform welding until welder qualifications are approved.
- G. Straightening and Rebending: Field bending of reinforcing steel bars is not permitted.
- H. Unless permitted by Contractor, do not cut reinforcing bars in field.

3.04 WELDED WIRE FABRIC INSTALLATION

- A. Lap splices at least 1-1/2 courses of fabric or minimum 8 inches.
- B. Tie laps and splices securely at ends and at least every 24 inches with tie wire.
- C. Place welded wire fabric on concrete blocks and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.
- D. Follow ACI 318/318R and current Manual of Standard Practice, Welded Wire Fabric.
- E. Do not use fabric that has been rolled. Install flat sheets only.

END OF SECTION

ATTACHMENT A CONCRETE REINFORCING

2.01 MATERIALS

<input checked="" type="checkbox"/> Mild Reinforcing Steel	<ul style="list-style-type: none"> • ASTM A615M, Grade 60. • Includes stirrups, ties, and spirals.
<input checked="" type="checkbox"/> Welded Reinforcing Steel	<ul style="list-style-type: none"> • ASTM A706/A706M, Grade 60. • Welder Qualifications: Certified in accordance with AWS D1.4. • Includes stirrups, ties, and spirals. • Submit test results of field welding.
<input checked="" type="checkbox"/> Metal Sleeve Splice	<ul style="list-style-type: none"> • Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
<input checked="" type="checkbox"/> Mechanical Threaded Connections	<ul style="list-style-type: none"> • Furnish metal coupling sleeve with internal threads engaging threaded ends of bars developing in tension or compression 125 percent of yield strength of bar.
<input checked="" type="checkbox"/> Welded Wire Fabric	<ul style="list-style-type: none"> • ASTM A185 or ASTM A497 and ACI 318/3218R, using ASTM A82 wire of 75 ksi minimum tensile strength.
<input checked="" type="checkbox"/> Tie Wire	<ul style="list-style-type: none"> • Black, soft-annealed 16 gauge wire. • Nylon-, epoxy-, or plastic-coated wire.

2.02 ACCESSORIES

A. Bar Supports and Spacers:

1. Use precast bar supports or all-plastic bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
3. Where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals, bar supports and spacers shall be precast concrete and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to the reinforcing steel.

5. In Beams, Columns, Walls, and Slabs of Exposed Concrete: Use small precast concrete blocks made of same color as concrete in which they are embedded.

6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.

END OF ATTACHMENT

ATTACHMENT A
CONCRETE REINFORCING

2.01 MATERIALS

Mild Reinforcing Steel:	<ul style="list-style-type: none"> • ASTM A615/A615M, Grade 60 • Includes stirrups, ties, and spirals
Welded Reinforcing Steel:	<ul style="list-style-type: none"> • ASTM A 706/A 706M, Grade 60 Steel • Welder Qualifications: Certified in accordance with AWS D1.4. • Includes stirrups, ties, and spirals • Submit test results of field welding
Metal Sleeve Splice:	<ul style="list-style-type: none"> • Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
Mechanical Threaded:	<ul style="list-style-type: none"> • Furnish metal coupling sleeve with internal Connections threads engaging threaded ends of bars developing in tension or compression 125 percent of yield strength of bar.
Welded Wire Fabric:	<ul style="list-style-type: none"> • ASTM A 185 or ASTM A497 and ACI 318/318R, using ASTM A82 wire of 75 ksi minimum tensile strength
Tie Wire	<ul style="list-style-type: none"> • Black, soft-annealed 16-gauge wire. • Nylon-, epoxy-, or plastic-coated wire.

2.02 ACCESSORIES**A. Bar Supports and Spacers:**

1. Use precast concrete bar supports or all-plastic bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
3. Where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals, bar supports and spacers shall be precast concrete and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to the reinforcing steel.
5. In Beams, Columns, Walls, and Slabs of Exposed Concrete: Use small precast concrete blocks made of same color as concrete in which they are embedded.
6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.

END OF ATTACHMENT

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SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Cast-in-place concrete for basin slab, walls, beams, slab on grade of building, equipment slabs, dumpster pad, wash pad, and stair slabs.
- B. Formwork, form accessories, and bracing.
- C. Reinforcement.
- D. Joint Materials.
- E. Waterstops.

1.2 RELATED SECTIONS

- A. Section 02 30 00 – Subsurface Investigation
- B. Section 31 00 00 – Earthwork
- C. Section 31 23 13 – Subgrade Preparation

1.3 REFERENCES (LATEST REVISION)

- A. Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice.
- B. CRSI Placing Reinforcing Bars
- C. AASHTO M 182 – Burlap Cloth Made from Jute or Kenaf
- D. ACI 211.1 – Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- E. ACI 301 – Specifications for Structural Concrete.
- F. ACI 302.1R – Guide for Concrete Floor and Slab Construction.
- G. ACI 304R – Guide for Measuring, Mixing, Transporting and Placing Concrete.
- H. ACI 305R – Hot Weather Concreting.
- I. ACI 306R – Cold Weather Concreting.
- J. ACI 308R – Guide to Curing Concrete.
- K. ACI 318 – Building Code Requirements for Structural Concrete.
- L. ACI 347 – Guide to Formwork for Concrete.

- M. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
- N. ACI 350.1 – Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary
- O. ASTM A185 – Steel Welded Wire Reinforcement, Plain, for Concrete
- P. ASTM A615 – Deformed and Plain Carbon – Steel Bars for Concrete Reinforcement.
- Q. ASTM C 31 - Making and Curing Concrete Test Specimens in the Field
- R. ASTM C 33 – Concrete Aggregates.
- S. ASTM C 39 – Compressive Strength of Cylindrical Concrete Specimens.
- T. ASTM C 42 – Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- U. ASTM C 94 – Ready-Mixed Concrete.
- V. ASTM C 143 - Slump of Hydraulic Cement Concrete
- W. ASTM C 150 – Portland Cement.
- X. ASTM C 171 - Sheet Materials for Curing Concrete
- Y. ASTM C 172 – Practice for Sampling Freshly Mixed Concrete.
- Z. ASTM C 231 – Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- AA. ASTM C 260 – Air-Entraining Admixtures for Concrete.
- BB. ASTM C 309 – Liquid Membrane-Forming Compounds for Curing Concrete.
- CC. ASTM C 494 – Chemical Admixtures for Concrete.
- DD. ASTM C 618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- EE. ASTM C 920 – Standard Specification for Elastomeric Joint Sealants
- FF. ASTM C 989 – Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
- GG. ASTM C 1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- HH. ASTM D 1751 – Preformed Expansion Joint Filler for Concrete paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

- II. ASTM D 2103 – Polyethylene Film and Sheeting
- JJ. ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- KK. ASTM E 329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
- LL. ASTM E 1155 - Determining Floor Flatness and Floor Levelness Numbers

1.4 MEASUREMENT AND PAYMENT

Under this contract concrete items will be covered in the Contractor's bid as a lump sum amount. The cost for concrete items will include all materials, accessories, testing and labor required to satisfy the requirements of this specification and the designs provided on the construction drawings.

1.5 SUBMITTALS FOR REVIEW

The Engineer of Record will review the submittals identified herein.

- A. Product Data: Provide data for proprietary materials and items, including reinforcements, admixtures, forming accessories, curing compounds and others if requested by Engineer.
- B. Mix designs and test results as specified hereinafter.
- C. Shop Drawings: Submit shop drawings for fabrication, bending and placement of reinforcing steel to Engineer for review. Comply with ACI 315 "Manual of Standard Practice for Detailing Concrete Reinforced Structures". Indicate sizes, spacing, and locations of reinforcing steel, supporting and spacing devices, bar bending details, and bar lists.
- D. Water Test Program, further detailed herein.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301, 318 and 350, as applicable. ACI 350 requirements shall be applied to the Basins (water containing structures) and Chlorine Contact Basin, and Primary Influent Screen slab.
- B. Maintain at least one copy of ACI 301 document on site at all times.
- C. Acquire cement and aggregate from same source for all work.
- D. Conform to ACI 305R when concreting during hot weather.
- E. Conform to ACI 306R when concreting during cold weather.
- F. Conform to ACI 117 –Specifications for Tolerances for Concrete Construction and Materials.

- G. Engineer reserves the right to mark and reject portions of concrete not within tolerance as specified.
- H. Concrete Mix Design: Employ a testing laboratory acceptable to the Engineer to perform material evaluating tests and to design concrete mixes. Concrete mix design shall be at Contractor's expense. Submit mix designs to Engineer at least 25 days prior to start of work.
- I. Materials and installed work may require testing and retesting at any time during process of work, and shall be done at Contractor's expense.
- J. Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades (as applicable) or shall have written evidence of having completed similar qualification programs:
 - 1. Concrete Field Testing Technician, Grade I
 - 2. Concrete Laboratory Testing Technician, Grade I or II
 - 3. Concrete Construction Inspector, Level II
 - 4. Concrete Transportation Construction Inspector or
 - 5. Reinforced Concrete Special Inspector, jointly certified by American Concrete Institute (ACI) and International Code Council (ICC) and licensed by Georgia Department of Labor, Licensing and Regulations (GALLR).

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation

1.7 TESTS

- A. All sampling and testing services shall be performed by a testing agency which operates in accordance to ASTM D 3740 and E 329 latest revision and acceptable to the Engineer, as part of the special inspections, at Owner's expense. Contractor shall conduct all coordination and scheduling with testing and inspection agency. Owner shall not pay for testing agency services if, due to Contractor's schedule mishaps or lack of preparedness, testing and inspecting services are scheduled and not required.
- B. Contractor shall submit to the Engineer, concrete materials and concrete mix designs of concrete proposed for use. This submittal shall include results of all testing performed to qualify materials and establish mix designs. All mix designs shall be proportioned in accordance with Section 3.9 of ACI 301, Method 1 (trial batches) or Method 2 (field experience). The average strength used as basis for selecting proportions shall be as specified in Paragraph 3.9.2 of ACI 301.
- C. Testing laboratory shall conduct strength tests of the concrete during construction in accordance with Section 16.3.4 of ACI 301. At least one strength test (6 test cylinders) shall be made for each 50 cubic yards or fraction thereof, of each mix design placed each day.

- D. Slump tests shall be conducted regularly during construction in accordance with Section 16.3.5 of ACI 301.
- E. Air content of the concrete sample for each strength test shall be determined in accordance with Section 16.3.6 of ACI 301.
- F. Density (unit weight) of concrete shall be determined for each sample, in accordance with ASTM C138.
- G. Results of all tests shall be submitted to Engineer within three days of testing, with copies to Contractor. Test reports shall include the exact location in the work at which batch represented by a test was deposited.
- H. Evaluation of test results and acceptance of concrete shall be in accordance with Chapter 17 of ACI 301.
- I. Floor flatness and levelness shall be as specified herein. All floor tolerance measurements shall be made within 48 hours of slab installation and shall precede the removal of forms. The results of all floor profile tests shall be provided to the Engineer within 72 hours after each slab installation.
- J. Water Tightness Test shall be conducted in accordance with ACI 350.1 and as specified herein.

1.8 ACCEPTANCE OF COMPLETED WORK:

- A. Acceptance or rejection of completed concrete work shall be in accordance with Chapter 18 of ACI 301.

PART 2 – PRODUCTS

2.1 FORM MATERIALS

- A. Shall conform to ACI 301.
- B. All form materials shall be selected to provide desired finish, prevent any deflection at any point in time and spalling during form removal.
- C. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings.
- D. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material.
- E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with or adversely affect concrete surfaces.
- F. Form Ties: factory fabricated, adjustable length, removable or snap-off type, galvanized metal form ties with cones. Ties shall be free of defects and shall not

leave holes larger than 1-inch in concrete surface upon removal. Provide units that will leave metal no closer than 1½ inches to surface.

- G. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.
- H. Chamfered Corners: Chamfered strip type; ¾"x¾" typically; maximum possible lengths.
- I. Dovetail Anchor Slot: Galvanized steel, 22 gage thick, foam filled slots, nail holes for securing to concrete formwork; Heckman Building Products No. 100 or as approved.
- J. Flashing Reglets: Galvanized steel, 26 gage thick, longest possible lengths, with alignment splines for joints, tape sealed slots, anchors for securing to concrete formwork, sloped strip-out, Heckman Building Products No. 230 or as approved.

2.2 REINFORCING MATERIALS

- A. Reinforcing Steel: ASTM A 615, Grade 60 billet steel deformed bars; uncoated finish.
- B. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting, and fastening reinforcing bars in place. Use wire bar type supports complying with CRSI specifications.
 1. For concrete cast on grade, use supports with sand plates or horizontal runners where base material will not support chair legs or 6,000 psi solid concrete blocks meeting CRSI requirements.
 2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.3 CONCRETE MATERIALS

- A. Cement: ASTM C 150, Type I – Normal. Use one (1) brand of cement throughout the project.
- B. Fine and Coarse Aggregates: ASTM C 33. Coarse aggregate shall be No. 57 (up to 1"). Provide aggregate from a single source. All aggregate shall be washed, free from dirt and debris and shall be uniformly graded.
- C. Water: Clean, fresh and not detrimental to concrete, ASTM C 94.
- D. Fly Ash: ASTM C 618 Type F. Loss of ignition shall not exceed 3%. Amount of fly ash not to exceed 25% by weight of total cementitious material.
- E. Ground Granulated Blast Furnace Slag: ASTM C 989. Amount of slag not to exceed 45% by weight of total cementitious material.

2.4 ADMIXTURES

- A. Air Entrainment: ASTM C 260. Certified by manufacturer to be compatible with other required admixtures. Use air-entraining admixture in concrete for all structural concrete exposed to the weather. Do not use for interior building slabs. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of that specified in concrete mix requirements stated below.
- B. Chemical: ASTM C 494. Types A-G, containing not more than 0.1 percent chloride ions. A high range water reducer (HRWR) is required for all concrete in walls and for other concrete which is pumped. It is optional for other concrete which is not pumped.
- C. Pozzolanic Admixtures: ASTM C 618.
- D. Calcium chloride or admixtures containing more than 0.1% chloride ions are not permitted.
- E. Certification: Written certification of conformance to above-mentioned requirements and the chloride ion content will be required from admixture manufacturer prior to mix design review by Engineer.

2.5 ACCESSORIES

- A. Bonding Compound: Polyvinyl acetate, rewettable type; by the Sika Corporation or equivalent.
- B. Epoxy Adhesive: Two component, 100% solids, 100% reactive compound suitable for use on dry or damp surfaces; Sikadur by Sika Corporation or equivalent.
- C. Non-Shrink Grout: ASTM C 1107, Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 6,000 psi in 28 days.
- D. Concrete Repair Grout: For the repair of defective areas of concrete.
 - 1. For vertical and overhead surfaces, use one (1) of the following (or approved equal):
 - a. "Five Star Structural Concrete V/O"; Five Star Products, Inc.
 - b. "Euco Verticoat"; Euclid Chemical Co.
 - c. "Sikatop 122"; Sika Corp.
 - 2. For horizontal surfaces, use one (1) of the following (or approved equal):
 - a. "Five Star Structural Concrete"; Five Star Products, Inc.
 - b. "Concrete Coat"; Euclid Chemical Co.
 - c. "Sikatop 122"; Sika Corp.
- E. Concrete Slab on Grade Crack Repair: Cracks up to ¼" wide are to be filled with Spal-Pro 2000 by Metzger/McGuire or approved equal.

- F. Structural Slab & Wall Crack Repair: Cracks up to 1/8" wide are to be filled with Prime Flex 900 XLV by Prime Resins or approved equal.
- G. Joint Filler (to be applied at joints between vertical edges where noted on drawings): Preformed, Nonextruding, Resilient, Bituminous; ½"-1" joint width; ASTM D1751. Size of filler shall be determined in accordance with typical joint detail provided on Structural Drawings.
- H. Joint Sealant (to be applied at joints between vertical edges where noted on drawings): Elastomeric sealant, ASTM C920, single component (Type S), pourable or non-sag grade (Grade P or NS), class 50 or 100/50, use T; ½"-1" joint width.
- I. Waterstops: All waterstops shall be PVC Flat Ribbed profile, fabricated and installed per manufacturer's recommendations. Waterstops shall be provided at all joints in the water containing basins unless noted otherwise. Waterstops are not required at joints occurring above elevation 26.0.
 - 1. All waterstops shall be 6" wide by 3/8" thick Greenstreak style number 679 or equal, except where noted otherwise.
 - 2. Where 4" waterstop is required, a 4" wide by 3/16" thick Greenstreak style number 781 or equal shall be used.
- J. Vapor Barrier: 10 mil polyethylene sheeting shall be provided underneath the concrete slab on grade of the building. Vapor barrier shall be in accordance with ASTM D 2103.

2.6 CURING MATERIALS

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171:
 - 1. Waterproof paper
 - 2. Polyethylene film
 - 3. Polyethylene-coated burlap
- C. Membrane Curing Compound: ASTM C 309, clear with fugitive dye, 30% solids.

2.7 CONCRETE MIX DESIGN

The following shall apply to all concrete shown on the structural drawings:

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch (with 3 point curve) or field experience methods as specified in ACI 301. If trial batch method is used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs.
- B. Submit written reports to Structural Engineer of proposed mix for concrete at least 25 days prior to start of work. Do not begin concrete production until mixes have been approved by Engineer.

- C. Concrete shall be batched, mixed and transported from a supplier with sufficient facilities to deliver concrete at the rate required and in accordance with ASTM C 94. Ready-mix concrete supplier shall furnish Engineer a certified statement the concrete furnished conforms to provisions of these specifications.
- D. Compressive Strength: Minimum 4,000 psi in 28 days.
- E. Water/cement ratio (maximum): 0.5 by weight.
- F. Slump: 4 to 5 inches maximum, measured at the point of discharge, before the addition of any high range water reducer (HRWR). If HRWR is added at the concrete plant, then slump may be measured at the job site after the HRWR has been added.
- G. Air Entrainment: 3.5% ± 1%.
- H. Fly Ash Content: 15-25% of total cementitious material
- I. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Owner and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

2.8 CONCRETE MIXING

- A. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.
- B. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.
 - 1. When air temperature is between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C), reduce mixing and delivery time from 90 minutes to 75 minutes, and when air temperature is above 90 degrees F (32 degrees C), reduce mixing and delivery time to 60 minutes. Concrete shall not be placed when the air temperature exceeds 95 degrees.

PART 3 – EXECUTION

3.1 ON SITE OBSERVATIONS OF WORK

- A. Coordination: Coordinate the installation of joint materials with placement of forms and reinforcing steel. Coordinate opening sizes and locations, as well as reinforcing around the openings, with the architectural, mechanical, electrical and plumbing drawings.
- B. Engineer or Project Representative will have the right to require any portion of work be completed in their presence and if work is covered up after such instruction, it shall be exposed by Contractor for observation. However, if

Contractor notifies Engineer such work is scheduled, and the Engineer fails to appear within 48 hours, Contractor may proceed.

- C. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. Improper work shall be reconstructed. All materials, which do not conform to requirements of specifications, shall be removed from work upon notice being received from the Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.
- D. Contractor shall give the Project Engineer or Project Representative and Special Inspector a minimum of 48 hours notice for all required observations or tests.
- E. Special Inspector shall inspect forms and reinforcing within 24 hours prior to concrete pours. Engineer shall have the option to inspect forms and reinforcing within 24 hours prior to concrete pours. It is Contractor's responsibility to notify Special Inspector Engineer as required herein.

3.2 FORMWORK PREPARATION AND ERECTION

- A. Design of formwork is Contractor's responsibility. Erect formwork, shoring, and bracing to support vertical, lateral, static and dynamic loads until such loads can be supported by concrete structure in accordance with requirements of ACI 301. Maintain formwork construction tolerances complying with ACI 347.
- B. Forms shall conform to shapes, lines, elevations, locations and dimensions of members as called for on the plans. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes.
- C. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
- D. Earth forms shall not be permitted for the installation of structural concrete.
- E. Contractor shall coordinate the work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.
- F. Before placing of either reinforcing steel, embedded items, or concrete, surfaces of forms shall be thoroughly cleaned and covered with an accepted coating material which will effectively prevent absorption of moisture and prevent bond with the concrete. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.
- G. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

- H. Chamfer all exposed corners and edges $\frac{3}{4}$ " unless noted otherwise, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- I. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
- J. During cold weather remove ice and snow from within the forms. Do not use de-icing salts. Do not use water to clean out forms unless formwork and concrete construction proceed within heated enclosed areas.

3.3 FORM REMOVAL

- A. Forms shall be removed carefully to avoid damage to green concrete. Ties shall be cut back 1 inch from the surface and all holes, stone pockets, voids, and minor defects shall be patched immediately upon removal of forms.
- B. Forms shall not be removed within 7 days of pouring concrete, unless 70% of compressive strength has been achieved AND Engineer has approved removal.
- C. Contractor shall keep live loads off the concrete until it has sufficient strength to support applied loads.
- B. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- C. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- D. Store removed forms so surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

3.4 REINFORCEMENT

- A. All reinforcement shall be free of rust, mill scale, ice, mud, oil or other materials which may adversely affect or reduce the bond.
- B. Reinforcement shall be placed, supported, and secured against displacement by construction loads or the placing of concrete. Bar supports and spacers shall be made of concrete, metal, plastic, or other accepted material and subject to review by the Engineer. Where concrete surfaces will be exposed to weather in the finished structure, portions of all accessories within 1/2 inch of surface shall be noncorrosive or protected against corrosion.
- C. Reinforcement shall be placed in accordance with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars". Minimum concrete cover for reinforcement shall be as required in ACI 318 and 350, as applicable.
- D. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement and operations. Set wire ties so ends are

directed in to concrete, not toward exposed concrete surfaces. As a minimum, tie alternate bar intersections.

- E. Field bending of bars partially imbedded in concrete will not be permitted.
- F. Locate reinforcing splices not indicated on the drawings at points of minimum stress.
- G. Accommodate placement of formed openings. Provide additional reinforcing as required.

3.5 PREPARATION FOR PLACING

- A. Water shall be removed from excavations before concrete is deposited. Hardened concrete debris and other foreign materials shall be removed from the interior of forms and inside of mixing and conveying equipment.
- B. Care shall be taken in the placement of the vapor barrier. Sheeting shall not be punctured or otherwise damaged in such a way that compromises the functionality of the vapor barrier.
- C. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
- D. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.
- E. Templates shall be used for the proper installation of anchor bolts. Templates and anchor bolts shall be in position prior to placing the concrete.
- F. Waterstop shall be placed where shown on the construction drawings and specified herein, in accordance with instructions and products supplied by the manufacturer. Placement within the form and amount of concrete coverage shall be as required by manufacturer. Waterstop shall be held in place by acceptable measures so there will be no lateral movement or bending of the material during placement of concrete.
- G. Construction Joints: Locate construction joints so as not to impair strength and appearance of the structure, as acceptable to Engineer. Where specified, provide construction joint layout plans for Engineers' approval.
- H. Continue reinforcement across construction joints.
- I. Isolation/Expansion Joints: Construct isolation joints between structural concrete and site concrete & pavement, as indicated on the plans. Materials for isolation/expansion joints are to be as specified previously in this specification.

3.6 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301, 304, 318, and 350, as applicable.

- B. Pre-placement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Notify Engineer minimum 48 hours prior to commencement of placement.
- C. Moisten wood forms immediately before placing concrete where form coatings are not used.
- D. Concrete shall be placed only upon surfaces free from frost, ice, mud, standing water and other detrimental substances or conditions.
- E. Concrete shall be handled and deposited using equipment and methods which will prevent segregation or loss of ingredients. Equipment and methods for placing concrete shall be subject to review by the Engineer.
- F. Water shall not be added at the site without permission from the Engineer.
- G. Concrete having attained its initial set or having contained water for more than 90 minutes shall not be used in the work.
- H. Sufficient mixing and placing capacity shall be provided so concrete which is being integrated with fresh concrete is still plastic. Concrete shall be deposited continuously or in layers of such thickness so no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be placed subject to acceptance by the Engineer.
- I. Concrete shall not be allowed or caused to flow horizontally or on slopes in the forms. Concrete placing on a slope shall begin at lower end of the slope and progress upward.
- J. Consolidate by mechanical vibration so concrete is thoroughly worked around the reinforcement, around embedded items and into corners of forms and around piling. Use of vibrators to transport concrete within forms shall not be allowed. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- K. A spare vibrator shall be kept on the job site during all concrete placing operations.
- L. When temperature of the surrounding air is expected to be below 40 degrees F during placing or 24 hours thereafter, temperature of concrete as placed, shall be no lower than 55 degrees for sections less than 12 inches in any dimension nor 50 degrees for any other sections. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set or cold joints and shall not exceed 95 degrees F.

- M. Ensure reinforcement, inserts, embedded parts, and shear studs are not disturbed during concrete placement.
- N. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- O. Place Concrete continuously in designated section. Do not interrupt successive placement or permit cold joints to occur.
- P. Separate slabs on grade from vertical surfaces with joint filler, as specified on the construction drawings.
- Q. Place joint filler securely to resist movement by wet concrete. Set top to required elevation to accommodate joint sealant.
- R. Saw cut control joints (where indicated and as specified on drawings) within 8 hours of hardening.

3.7 CONCRETE FINISHING

- A. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or derbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
- B. Interior Floor Flatness Tolerance for Building Slab on Grade: A nonslip conventional flatness requirement of $F_F/F_L = 15/15$, SWI = 5mm, is applicable to interior slab surfaces. Testing shall be accordance with ASTM E 1155.
- C. Formed surfaces of concrete shall be given finishes specified below unless the contract documents specify otherwise.
 - 1. Rough Form Finish – For all concrete surfaces not exposed to public view. No selected form facing materials shall be specified for rough form finish surfaces. Tie holes and defects shall be patched. Fins exceeding 1/4 inch in height shall be chipped or rubbed off. Otherwise, surfaces shall be left with texture imparted by the forms.
 - 2. Rubbed Form Finish: For sides of formed concrete surfaces exposed-to-view. This includes walls, slabs, & beams extending to one (1) foot below grade. Use smooth, high quality forms. Chip away all high spots. Within 72 hours after forms are removed, fill all air bubbles and small holes with a sand-cement-bonding agent grout proportional to match the surrounding finish. Rub the entire surface of with a fine abrasive stone to create a smooth surface, free of all form marks and holes. Do not finish by leaving a thin "plastered" layer of grout. For repair of defective areas with holes deeper than 1/2", refer to concrete repair products listed in section 2 of this specification.
 - 3. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces.

Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

4. Float Finish: Provide a float finish to 2nd level floor slabs except where noted otherwise herein. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane as required to obtain floor flatness and levelness. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
5. Medium Broom (Non-Slip) Finish: After floating, provide a non-slip broom finish to exterior intermediate stair landing, stair treads and exterior structural concrete pads, unless noted otherwise.
6. Trowel Finish: Provide a trowel finish to equipment building and centrifuge building interior slabs on grade. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance. Grind smooth surface defects which would telegraph through applied floor covering system.
7. Burnished Finish: Provide a burnished finish (or similar) on the floors of the electrical/MCC, mechanical and server rooms. Typically, this finish is achieved by repeatedly troweling the concrete floor until it has a mirror-like appearance. Finished result shall have a glossy appearance.
8. Where surfaces are to receive a specialty paint, coating or finish product, the method of finishing the concrete surface shall be coordinated and confirmed by the manufacturer of the paint, coating or finishing products. The following areas must be coordinated:
 - a. Equipment Building slab on grade and the bottom 6 inches of the interior face of the walls of the equipment support room, equipment room and chemical room (ground floor) shall receive a corrosion and abrasion resistant coating of Stonchem, identified in the Paintings and Coatings Specification.
 - b. The Equipment Building 2nd floor exterior slab, including the landing at the top of the stairs, the control room, store room and bathroom floors shall receive a decorative, chemical and abrasion resistant coating of Stontec UTF, identified in the Paintings and Coatings Specification.
 - c. The interior walls and base slab of the basins and underside of all concrete walkways over the basins shall receive waterproof or anti-corrosion coating systems, as detailed in the Paintings and Coatings Specification.

3.8 CONCRETE CURING

- A. Curing shall be provided by either a moisture cure or membrane cure, in accordance with the requirements listed herein.
- B. Unformed Surfaces shall be moisture cured for a minimum of 7 days. Following initial period, the use of membrane curing compounds may be used for subsequent curing.
- C. Horizontal Formed Surfaces shall be moisture cured for a minimum of 7 days. Following initial period, the use of membrane curing compounds may be used for subsequent curing.
- D. Vertical Formed Surfaces shall be either moisture cured for a minimum of 7 days or cured via membrane curing compound.
- E. Non-Structural Concrete: Sidewalks, curbs & maintenance pads may be cured with a membrane curing compound in addition to any of the moisture curing methods listed herein. During hot weather concreting, if a curing compound is used, the non-structural slabs shall still be moist cured for 12 hours immediately following initial set.
- F. For **moisture cure**: Immediately after placement and finishing, provide moisture curing by one (1) of the methods below. Forms shall be left in place for a minimum of 7 days during moisture curing.
 - 1. Keep concrete surface continuously wet by covering with water.
 - 2. Continuous water-fog spray.
 - 3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
 - 4. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

Hot Weather Curing: During hot weather concreting keep forms moist and covered with plastic during the initial 7-day curing period. Hot weather curing shall be in accordance with ACI 305
- G. For **membrane cure**: Immediately after placement and finishing, concrete shall be protected from moisture loss for not less than 7 days. For surfaces not in contact with forms, curing compound shall be uniformly applied after water sheen disappears from the concrete. Formed surfaces shall receive an application of curing compound if forms are removed during the 7-day curing period. Curing compound shall not be applied during rainfall.

1. Apply one (1) coat of specified curing compound to concrete at the manufacturer's recommended rate. Apply uniformly in continuous operation by power-spray or roller. Care shall be taken to prevent application to joints where concrete bond is required, to reinforcement steel and to joints where joint sealer is to be placed. The compound shall form a uniform continuous coherent film which will not crack or peel and shall be free from pinholes and other imperfections. Concrete surfaces subjected to heavy rainfall within 3 hours after curing compound has been applied shall be resprayed by above method and at the above coverage at no additional expense to Owner.
 2. Do not use membrane curing compounds on concrete surfaces which are to receive liquid floor hardener, waterproofing, damp proofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting, or other coatings and finish materials, unless the Contractor obtains written verification from the manufacturer that his product is compatible with the curing compound.
- H. No pedestrian traffic shall be allowed over the surface for 7 days unless surface is protected by planks or plywood. The protection shall not be placed until at least 24 hours after application of curing materials (if applicable). No vehicular or equipment traffic shall be allowed over the surface for 30 days.
- I. Protect concrete by suitable methods to prevent damage by mechanical injury or excessively hot or cold temperatures.

3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Interior Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.
- C. Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on Drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement. Refer to Concrete Unit Masonry Specification 04 22 00 for additional information.

3.10 CONCRETE SURFACE REPAIRS

- A. Formed Surfaces: Normal form tie holes shall be filled with a sand-cement grout applied with a bonding agent. Defective areas due to spalls, air bubbles, honeycombing, or segregation with a void depth (after weak material is chipped out) greater than or equal to 1/2" shall be repaired with a concrete repair grout specified in this Section. The defective area shall be chipped out to solid concrete such that the thickness of patching material is at least 1/4" all around. Do not feather-edge. At defective areas exposed-to-view, the Engineer may

substitute a sand-cement grout applied with a bonding agent to more closely match the color of the wall.

- B. Slabs:
1. Repair spalls and holes by sawcutting with square cuts and chipping to a minimum depth of 1/2" and patching with a concrete repair grout specified in Products section of this specification. Do not feather-edge.
 2. Cracks in the slabs on grade up to 1/4" wide are to be filled with sealant listed in Products section of this specification. Follow manufacturer's recommendations. Engineer shall be consulted for investigation and repair of cracks in slabs on grade that are larger than 1/4" wide.
 3. Cracks in the structural slabs and walls up to 1/8" wide are to be filled with sealant listed in the Products section of this specification. Follow manufacturer's recommendations for preparation and installation. Engineer shall be consulted for investigation and repair of cracks in structural slabs and walls that are larger than 1/8" wide.
 4. Severely defective areas which cannot be repaired by one of the above methods shall be removed and replaced at the Contractor's expense.
- C. Voids in concrete surfaces resulting from the removal of temporary anchors, shall be repaired with a concrete repair grout specified in Products section of this specification, per manufacturers recommendations.
- D. For surface preparation and installation of concrete repair grouts, follow manufacturer's recommended procedures.

3.11 FIELD QUALITY CONTROL

- A. Field sampling and testing shall be performed by an independent testing lab. Samples of concrete shall be taken at random locations from work and at such times to represent quality of materials and work throughout the project. The laboratory shall provide necessary labor, materials, equipment, and facilities for sampling concrete and for casting, handling and storing concrete samples at site of work. Sampling of concrete will be in accordance with ASTM C172. Samples for pumped concrete shall be taken at the hose discharge point. Samples for other concrete shall be taken at the hopper of concreting equipment or transit mix truck.
- B. Contractor shall pay for the following services when required:
1. Additional testing and inspection required because of changes in materials or proportions requested by the Contractor.
 2. Additional testing of materials or concrete occasioned by their failure by test or observation to meet specification requirements. For example, if compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited

to, cores in accordance with ASTM C 42 and any other load tests acceptable to the Engineer. Costs of such tests will be borne by the Contractor.

- C. To facilitate testing and observation, Contractor shall advise Owner and designated testing agency sufficiently in advance of operations to allow for the assignment of personnel and for completion of quality tests and checking of forms.

- D. Strength Tests:
1. General – Strength of the concrete will be verified by the testing laboratory during placement of concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site.
 2. Frequency – As a minimum, one set of four standard cylinders shall be cast of each class of concrete based on the most stringent of the following requirements as applicable:
 - for each 50 cubic yards or less
 - for each 4,000 square feet of surface area
 - for each day a pour is made
 3. Lab Testing – Testing of specimens for compressive strength shall be made in accordance with ASTM C39. Tests shall be made at 3, 7 and 28 days from time of casting. One test cylinder from each group of six shall be tested at the end of 3 and 7 days and three shall be tested at the end of 28 days. One cylinder will be held in reserve. The 28-day strength test result shall be the average of the strengths of three test cylinders (cast from material taken from a single load of concrete) at 28 days.
 4. Acceptance of Concrete Strength – Strength level of concrete will be considered satisfactory so long as the average of all sets of three consecutive strength results equal or exceed specified compressive strength and not more than 10% of strength test results shall have values less than specified value. No individual strength test shall be less than the specified compressive strength by more than 500 psi.
- E. Slump Tests – The slump shall be as specified when measured in accordance with ASTM C 143. Samples for slump determination shall be taken from the concrete during placing. Tests shall be made at the beginning of concrete placing operations and at subsequent intervals to insure specification requirements are met. When concrete is pumped, slump tests shall be taken from the discharge end of pump hose. Slump tests shall also be performed whenever standard cylinders are cast.
- F. Temperature and Air Content Tests: Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Test hourly when air temperature is 40° F and below and when 80° F and above. Whenever standard cylinders are cast, temperature tests shall be performed. Air content tests shall be in accordance with ASTM C 231 and measured whenever standard cylinders are cast.
- G. Contractor responsibilities regarding test specimens are as defined in ACI 301, including, but not limited to, the following:
1. Contractor shall provide and maintain adequate facilities on the project site for safe storage and initial curing of concrete test specimens as required by ASTM C 31/C 31M for the sole use of the testing agency.

2. Test specimens shall be stored and cured on site in a curing box, within a temperature range of 60-80 degrees Fahrenheit, without the loss of moisture, unless otherwise approved by Engineer.
- H. Testing agency shall secure samples on the site at a location agreeable to both the testing agency and the Contractor. If samples are missing when collected by testing agency, Contractor shall compensate Owner in the amount of \$1,000 per missing sample. Said compensation shall be deducted from the Contract Amount by Change Order. Contractor shall also be responsible for the cost of coring and testing the concrete from which the missing samples were taken, at the direction of the Engineer, as well as the cost to repair the cored areas.
- I. Substandard Concrete: Any concrete furnished under this Specification that fails to reach the required design compressive strength after 28 days, as evidenced by the compressive strength test specified herein, shall be considered substandard.
1. The procedure specified in ACI 318 and 350 (as applicable) for the Evaluation and Acceptance of Concrete shall be used to determine if the substandard concrete is to be removed and replaced. The Engineer shall make the final decision. Any substandard concrete which is removed and replaced shall be done so at the Contractor's expense.
 2. For substandard concrete which is left in place, the Contractor shall compensate the Owner an amount of \$0.10 for each psi that the actual 28-day concrete strength is below the specified compressive strength for each cubic yard of concrete in the pour. The strength of concrete for a particular pour shall be the average of all but the one (1) lowest of the 28-day compression tests for that pour. Said compensation shall be deducted from the Contract Amount by Change Order.

3.12 WATER TIGHTNESS TESTING

Upon completion of finishing and curing, and prior to application of waterproof and anti-corrosion coatings, hydrostatic tests (HST), in accordance with ACI 350.1, shall be conducted on the 6 Basin structures, as detailed herein.

A. General:

1. Coordinate timing and procedures for obtaining testing water and structure testing with the Owner and Engineer, well in advance of the actual testing.
2. At least 30 days prior to conducting tests, prepare a Water Tightness Testing Program and submit to Engineer for review and acceptance. Program shall include timeline for installation and finalization of concrete, curing method(s) of concrete structures to be tested, duration of curing, and testing sequence for filling and monitoring specific Basins.
3. Test water shall be potable and shall be provided by the Contractor.
4. All labor, equipment and materials shall be supplied by the Contractor.

5. No backfill shall be placed against the walls of the basins until hydrostatic testing is complete and Engineer has authorized backfilling to occur.

B. Preparation:

1. Ground water level shall be brought to a level below that of the top of the base slab and kept at or below that elevation throughout the test.
2. Thoroughly clean the structure to be tested of dirt, mud and construction debris prior to initiating the hydrostatic tests. The floor and sumps shall be flushed with water to provide a clean surface, ready for testing.
3. Inspect the surfaces of all Basins to be tested for potential leakage paths such as cracks, voids etc. and repair such deficiencies, as directed in this Specification. Document any deficiencies with photographs and a corresponding location system.
4. Confirm presence and adequacy of seals around gates, valves, outlets and pipe penetrations. Engineer shall inspect for acceptance prior to commencement of testing.
5. Pipe wall sleeves with water stops and seals should be fully installed and securely capped prior to testing.
6. Weir openings shall be temporarily covered for purpose of testing.
7. Install two evaporation and precipitation measurement devices, as defined in ACI 350.1.
8. Two thermometers shall be installed on the Basin being tested for the purpose of monitoring air temperature throughout testing. A thermometer to measure the water temperature shall also be provided.

C. Testing:

1. Conditions of Testing:

- a. Do not begin initial filling of concrete structures until all concrete elements of the structure have attained the design compressive strength of the concrete. Contractor shall assume this duration to be 28 days from placement, but Engineer reserves right to modify this duration based upon concrete test results and selected curing method(s).
- b. Do not begin initial filling of concrete structures until all walls and base slabs have been coated with the designated waterproofing and corrosion resistant systems and proper curing time has been achieved (per manufacturer).
- c. The test measurements shall not be scheduled for a period when the forecast is for a substantial change in the weather pattern (35-degree temperature differential from commencement to conclusion). The test

shall also not be scheduled when the weather forecast indicates the water surface may freeze before the test is completed.

- d. Initial filling rate shall conform to the requirements of ACI 350.1 and shall not exceed four (4) feet per hour.
- e. Contractor shall notify Engineer a minimum of three (3) days prior to testing.

2. Execution:

- a. Hydrostatic tests shall include HST-VIO followed by HST-100, as defined in ACI 350.1.
- b. Basins shall be tested independently as follows (refer to Drawings for basin names and locations):
 - i. Anoxic Basin, one Membrane Basin and one Pre-Aeration Basin (not adjacent to the Membrane Basin being tested) shall be tested first and in conjunction with each other.
 - ii. Remaining Membrane Basin and Pre-Aeration Basin shall be tested second.
 - iii. Chlorine Contact Basin can be tested in conjunction with any of the above.
- c. Where possible, contractor shall recycle test water from the Basin(s) most recently tested into the Basin(s) scheduled to be tested next. If excess water remains in the Basin(s) most recently tested, it shall be drained and/or pumped out.
- d. Contractor shall wait to perform tests on designated Basin(s) until the surrounding Basins walls and slabs are dry. Contractor may use fans to dry out basins quickly, if desired.
- e. Photographs of all Basins, clearly identifying the Basin(s) to be tested, shall be taken just prior to testing to document that the surrounding Basins are dry. If surrounding Basins are not dry, test results shall be voided.
- f. The Basin(s) to be tested shall be filled with water at a maximum rate of four (4) feet per hour, to elevation of 2' below the top and shall be left to stabilize for three (3) days.
- g. Damp spots and standing water on surrounding surfaces due to spillage during process of filling the Basin(s) shall be absorbed and/or dried prior to commencement of testing so as not to be confused with leakage.
- h. Conduct HST-VIO: From the time that test Basin(s) are filled and throughout the duration of the test, all wall and slab surfaces surrounding the test Basin(s) shall be inspected daily for visible indications of leakage. If, during the first three (3) days of filling (prior to commencement of test) any flow of water is observed from the Basin exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired. After

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testing has begun, any visible indications of leakage shall be viewed as failure.

- i. After three (3) days, the water level in the test Basin(s) shall be measured and recorded and the test shall begin. Measure water surface elevation at not less than four (4) locations, 90 degrees apart. Record water temperature 18 inches below the surface for all measurements.
 - j. The vertical distance to the water surface shall be measured from a fixed point on the tank above the water surface. Measurements shall be taken at the same locations each time they are recorded.
 - k. Conduct HST-100: Test shall consist of measuring the liquid level over the next **48 hours** to determine any change that occurs, taking measurements at 24-hour intervals. The maximum permissible loss is **0.1 percent of water volume**. The loss of volume shall be determined by measuring the drop-in water surface elevation and calculating the change in volume of the contained water.
 - l. If the change observed in 48 hours exceeds the maximum allowable, the test shall be extended to a total of five (5) days with testing every 24 hour period. If, at the end of the five (5) days, the average daily change has not exceeded the maximum allowable loss, the test shall be considered satisfactory.
 - m. Engineer shall be present at the end of the 24-hour test period to observe all wall and slab surfaces surrounding test Basin(s) for visible indications of leakage.
 - n. Evaporation and rainfall during testing shall be measured and recorded at commencement of test and every 24 hours, in conjunction with the water level measurements.
 - o. Air temperature shall be recorded at the commencement of testing and again every six (6) hours throughout testing.
 - p. If, at any time during the filling and/or testing procedure, visible signs of leakage are observed, photographs shall be taken and Engineer shall be notified immediately. If, for safety reasons, Engineer deems it necessary, the testing process may be stopped.
3. Reports: Testing reports shall be provided for each Basin tested and shall include the following information:
- a. Date and time of commencement of test.
 - b. Initial water elevation and corresponding volume (taken at 4 locations).
 - c. Subsequent water elevations (taken at 4 locations every 24 hours) and corresponding volume, calculated using the average of the four (4) elevations.

- d. Initial water levels and volume of evaporation and precipitation sample.
 - e. Subsequent water levels of evaporation and precipitation sample.
 - f. All air and water temperatures readings throughout testing and the times at which they were recorded.
 - g. Calculation showing conformance or nonconformance with maximum loss.
 - h. Date, time, duration and measurement of rainfall.
4. Failure: The following conditions shall be considered as NOT meeting criteria for acceptance, regardless of the actual loss of water volume measured:
- a. Water volume loss exceeding allowable.
 - b. Ground water leakage into the structure.
 - c. Structures which exhibit water flowing from the Basin(s) or from beneath the foundation (except for under-drain systems).
 - d. Presence of damp spots on surfaces. Damp spots are defined as spots where moisture can be picked up by a dry hand from the exterior surface.
5. Repairs and Retesting:
- a. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.
 - b. Structures failing the hydrostatic tests and not exhibiting visible leakage may be retested after an additional stabilization period of not less than three (3) days. Basins that fail the second test shall be investigated and repaired prior to additional tests.
 - c. Repair structures which fail the hydrostatic tests and structures showing visible leakage under the direction of the Engineer.
 - d. The expense of repairs and retesting, including consultation of the Engineer, shall be borne by the Contractor at no additional cost to the Owner.
6. Conclusion:
- a. Following successful completion of all hydrostatic testing, the test water shall be disposed of by draining and/or pumping out of the Basins.
 - b. All surfaces shall be dry prior to application of waterproof and anti-corrosion coatings. The coating manufacturers shall be consulted regarding the recommended moisture content of the concrete surfaces to be coated. This may entail moisture testing of the concrete surfaces. If surfaces are too moist for coating, Contractor shall follow procedural

recommendations from coating manufacturers to obtain acceptable levels for application of coatings.

END OF SECTION

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SECTION 03 40 00
PRECAST CONCRETE

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SECTION 03 40 00**PRECAST CONCRETE****PART 1 – GENERAL****1.01 PURPOSE**

- A. This Section intended to provide Contractor with applicable information related to any precast boxes and manholes required for the site. It does not apply to precast concrete piles.

1.02 SCOPE

- A. This Section is limited to precast concrete structures.

1.03 REFERENCES (LATEST REVISION)

- A. Not Used

1.04 SUBMITTALS

- A. Submittals for Review:

1. Calculations and Technical Design Data (including codes & loads) for each precast item, signed and sealed by a professional engineer registered in the State of Georgia.
2. Shop Drawings and calculations for each precast item.
 - a. Shop Drawings that clearly show dimensions, elevations, sizes, proposed details, and concepts for slabs, precast boxes and manholes, and their included accessories, signed and sealed by a professional engineer registered in the State of Georgia.

- B. Informational Submittals:

1. For Precasting Manufacturers Not Listed in Article Quality Assurance:
 - a. Experience record on production of precast concrete as shown, with information on precasting plant that will indicate capability to satisfactorily perform the Work.
 - b. Evidence of current PCI plant certification.
2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
3. Test Reports:
 - a. For precast manufacturer's concrete test cylinders.

- b. Inspection of installed units.

1.05 QUALITY ASSURANCE

- A. Qualifications of Precasting Manufacturers:
 - 1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with three years' experience producing precast concrete products of quality specified.
 - 2. Precast Plant(s): PCI certified plants with current certification.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Formwork, Reinforcing, Cement, Aggregates, Admixtures, Grout:
 - 1. As specified in Section 03 30 00, Cast-in-Place Concrete.
- B. Embedded Items:
 - 1. ASTM A36 steel.
 - 2. Anchor Studs: Headed anchor studs (HAS), deformed bar anchors (DBA), or threaded studs as manufactured by Nelson Stud Welding Co., Lorain, OH. '
 - 3. Furnish inserts for lifting tilt-up walls, bolting stiffeners, attaching braces, and as otherwise required.

2.02 CONCRETE MIX

- A. As specified in Section 03 30 00, Cast-in-Place Concrete.
- B. Design Strength: 4,500 psi at 28 days, minimum.
- C. Water/Cement Ratio: 0.40 maximum.
- D. Durability Requirements: Concrete mix shall be suitable for moderate sulfate exposure per Table 4.3.1 of ACI 318.

2.03 DESIGN AND CONSTRUCTION REQUIREMENTS

- A. Structural Precast Units:
 - 1. Design for loads specified on the structural Construction Drawings:

2. Conform to recommendations in the following standards and specifications:
 - a. PCI MNL-116, Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.
 - b. PCI MNL-120, PCI Design Handbook – Precast and Prestressed Concrete.
 - c. PCI MNL-135, Tolerance Manual for Precast and Prestressed Concrete Construction.
 - d. ASTM C478, Standard Specifications for Precast Reinforced Concrete Manhole Sections.
 - e. ASTM C890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
 - f. ASTM C913, Standard Specifications for Precast Water and Wastewater Structures.
3. In event of conflicting criteria, most severe governs.

2.04 FABRICATION

A. General:

1. Comply with PCI MNL-116, Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.
2. Reinforcing Steel:
 - a. Place in position before concrete is cast.
 - b. Keep clean and free from oil or other substances harmful to bond.
3. Forms: Produce smooth surfaces.
4. Concrete: Deposit, vibrate, finish, and cure in accordance with recommended practices of ACI 304R. Steam curing is permitted.
5. Coordinate dimensions, determine type, quantity, size, and location of, and furnish necessary embedded items in precast concrete. Coordinate location of embedded items in cast-in-place concrete necessary to connect precast items.

B. Surface Finish for Precast Boxes & Manholes: smooth.

2.05 SOURCE QUALITY CONTROL

- A. Prepare minimum three standard concrete test cylinders for each 50 cubic yards or fraction thereof of concrete placed in the precast work in accordance with ASTM C31.
- B. Test and record concrete strengths as required in Section 03 30 00 Cast-In-Place Concrete.

PART 3 – EXECUTION**3.01 ERECTION**

- A. Verify that anchorage inserts are in correct locations.
- B. Handle and erect precast concrete with care as recommended by manufacturer.
- C. Erect precast units plumb, straight, level, square, and in proper alignment.
- D. Fasten units securely in place and brace to maintain position, stability, and alignment until permanently connected and structure is complete and stable.
- E. Field Cutting: Not allowed without prior approval of Contractor.

3.02 PATCHING

- A. Mix and place patching mixture to match color and texture of surrounding concrete and to minimize shrinkage.
- B. Demonstrate patching method and obtain acceptance and approval.

3.03 CLEANING

- A. After installation, clean soiled precast concrete surfaces with detergent and water, using fiber brush and sponge.
- B. Use acid solution only to clean particularly stubborn stains after more conservative methods have been tried unsuccessfully.
- C. Use extreme care to prevent damage to precast concrete surfaces and to adjacent materials.
- D. Rinse thoroughly with clean water immediately after using cleaner.

3.04 FIELD QUALITY CONTROL

- A. Inspection:
 - 1. With Engineer's Inspector, inspect units for chips, cracks, and other damage.
 - 2. Record location and condition of damaged or nonmatching units.
- B. Resolution:
 - 1. Repair damage to satisfaction of Engineer.
 - 2. Remove units with damage or repairs not acceptable to Engineer.
 - 3. Install new acceptable units in place of those removed.
 - 4. Perform reinspection and obtain acceptance by Engineer.

3.05 PROTECTION

- A. Protect precast units from chipping, spalling, cracking, or other damage to the units after delivery to Site.
- B. After erection, protect units from damage.

END OF SECTION

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SECTION 03 63 00
CONCRETE DOWELING

PART 1 – GENERAL

1.01 PURPOSE

- A. This Section intended to provide Contractor with applicable information related to doweling reinforcing steel into existing concrete using an adhesive anchoring system.

1.02 SCOPE

- A. This Section is for doweling reinforcing steel into existing concrete using an adhesive anchoring system.

1.03 DEFINITIONS, REFERENCE CODES, SPECIFICATIONS, AND STANDARDS

- A. Refer to Section 03 00 00, Concrete Definitions and Reference Codes, Specifications, and Standards for information applicable to this Section.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: Manufacturer's catalog information.
- B. International Submittals:
 - 1. Manufacturer's instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
 - 2. ICC-ES Reports:
 - a. Doweling system manufacturer.
 - b. Detailed step-by-step instructions for Inspection Procedure.
 - 3. Inspection Report.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installer: Trained and certified by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store adhesive cartridges on pallets or shelving a covered storage area.

- B. Store at temperatures as indicated in manufacturer's literature and ICC-ES report.
- C. Dispose of When:
 - 1. Shelf life has expired.
 - 2. Stored other than per manufacturer's instructions.
- D. Container Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

PART 2 – PRODUCTS

2.01 ADHESIVE

- A. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and that fit into manually or pneumatically operated caulking gun.
- B. Meet requirements of ASTM C881/C881M.
- C. Two-component, insensitive to moisture, designed to be installed in adverse freeze/thaw environments.
- D. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
- E. Mixed Adhesive: Nonsag light paste consistency with ability to remain in a 1-inch-diameter overhead drilled hole without runout.
- F. Adhesive Anchorage System shall be certified to meet AC308.
- G. Manufacturers and Products: Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500-SD (HIT HY 20 for hollow masonry).

2.02 MIXING NOZZLES

- A. Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

2.03 REINFORCING DOWELS

- A. As specified in Section 03 21 00, Reinforcing Steel.
- B. Smooth Epoxy-Coated Expansion Joint Dowels: As specified in Section 03 15 00, Concrete Accessories.

PART 3 – EXECUTION

3.01 GENERAL

- A. Install in accordance with manufacturer's recommended instructions.
- B. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.02 DOWEL SIZING AND INSTALLATION

- A. Install per adhesive manufacturer's instructions.
- B. Drilling Equipment:
 - 1. Drilling Hammers for Dowel Holes: Electric or pneumatic rotary type with medium or light impact.
 - 2. Hollow drills with flushing air systems are preferred.
 - 3. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
- C. Hole Diameter: Use drill bit diameter meeting ICC-ES Report requirements and as recommended by the manufacturer.
- D. Obstructions in Drill Path:
 - 1. When existing reinforcing steel is encountered during drilling and when approved by Engineer, enlarge hole by 1/8 inch, core through existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter; or redrill hole 1 inch from original location, beginning in same line at surface, redirecting drill to miss reinforcing steel.
 - 2. Place dowels in both the misdrilled hole and the new one.
 - 3. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
 - 4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.
 - 5. Bent Bar Dowels: Where edge distances are critical, and striking reinforcing steel is likely, drill hole at 10 degree angle or less and use prebent reinforcing bars.

3.03 FIELD QUALITY CONTROL

A. Dowel Testing:

1. Test every dowel for the first ten dowels. Provided every dowel passes, frequency of test may be reduced to every other dowel for the next ten dowels. Provided every dowel passes, frequency of test may be reduced to every fourth dowel. Upon failure of test, previous ten dowels must be tested, and graduated frequency of tests must start over.
2. Dowels shall be tested to specified yield strength of reinforcing bar.
3. Testing apparatus shall not interfere with development of concrete failure cone at dowel.
4. Testing shall occur only after adhesive has achieved proper cure per manufacturer's requirements.
5. Failure of reinforcing bar or of base concrete will cause dowel to be rejected. Rejected dowels shall be reinstalled in sound concrete and retested.
6. If yield strength of reinforcing bar cannot be achieved when tested, manufacturer's representative shall recommend revised installation procedures or adhesive products. Modified installations must be tested at same frequency as specified herein.

B. Inspection:

1. Inspector shall be onsite during dowel installation.
2. Inspector shall observe installation and shall submit report containing the following:
 - a. Drill bit compliance.
 - b. Hole depth and cleanliness.
 - c. Product Description: Product name, rod diameter, and length.
 - d. Adhesive expiration date.
 - e. Verification of dowel installation in accordance with manufacturer's published instructions.
 - f. ICC-ES Report.

C. Manufacturer's Field Services: Provide manufacturer's representative at Site in accordance with Section 01 0001, General Requirements, for installation assistance, inspection, and certification of proper installation.

END OF SECTION