

R.G. KREUSLER PARK RESTROOM BUILDING
AND ENTRY DRIVE MODIFICATIOIS - #14204

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SECTION 03050
CONCRETE TESTING AND CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.02 DESCRIPTION OF WORK:

- A. This section includes the laboratory, in-house and field design of concrete mixes, inspection and testing of concrete to insure quality control.

1.03 QUALITY ASSURANCE:

- A. The following specifications and standards of the issues listed in this paragraph (including the addenda, amendments, and errata listed), but referred to herein after by basic designation only, form a part of this specification to the extent required by the references thereto.

1. Florida Building Code 2010.
2. American Concrete Institute Publications (ACI):
 - a. ACI-301 Specifications for Structural Concrete for Buildings
 - b. ACI-311-4R Recommended Guide for Concrete Inspection
 - c. ACI-318 Building Code Requirements for Reinforced Concrete
 - d. ACI-304 Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
3. American Society for Testing and Materials (ASTM):
 - a. ASTM-C31 Making and Curing Concrete Test Specimens in the field
 - b. ASTM-C39 Method of Test for Compressive Strength of Molded Concrete Cylinders
 - c. ASTM-C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 - d. ASTM-C94 Ready Mixed Concrete
 - e. ASTM-C143 Slump of Portland Cement Concrete
 - f. ASTM-C172 Sampling Fresh Concrete
 - g. ASTM-C192 Methods for Making and Curing Concrete Test Specimens in the

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Laboratory

- h. ASTM-C231 Air Content of Freshly Mixed Concrete by the Pressure Method
- 4. Compliance with Standard and Industry Specifications:
 - a. Any material or operation specified by reference to published specifications listed herein or of a manufacturer, or other published standard shall comply with requirements of standard listed.
 - 1. In case of conflict between referenced specification and project specifications, project specifications will govern.
 - 2. In case of conflict between referenced specifications or standards, one having more stringent requirements shall govern.

1.04 SUBMITTALS:

- A. Submit four (4) copies of all tests to the Architects for distribution.

PART 2 - PRODUCTS

2.01 TESTING LABORATORY SELECTION:

- A. The owner will select an independent testing laboratory to perform all design, testing and control herein specified.
 - 1. All cost of testing, design, control or supervision specified herein except concrete mix design, shall be paid for by the Owner.
 - 2. The Architect/Engineer reserves the right to dispense with the services of any engineer or testing laboratory at any time and select any other testing laboratory or engineer to continue with the design, control or supervision work herein specified, if he believes it is in the interest of the Owner.

PART 3 - EXECUTION

3.01 CONCRETE MIX DESIGN:

- A. The laboratory shall design mixes for each strength and type of concrete, in accordance with ACI 301 - Chapter 3, Method 2.
 - 1. Ability to produce the required average strength calculated in accordance with Section 3.8.2.3 of ACI 01 shall be determine on the basis of the strength test record of 30 or more tests made during the past year which will permit establishing directly or by interpolation, the water-cement ratio corresponding to the required average strength.
 - 2. Mixes shall be designed according to placement methods in addition to the criteria specified above.

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- a. Placement by gravity.
 - b. Placement by pumping (if method is approved by the Architect/ Engineer for use).
3. The testing laboratory shall submit in writing to the Architect/Engineer four (4) copies of proposed mix designs. Final recommended job mixtures shall be presented to the Architect/Engineer for approval as soon as possible and no later than five (5) working days prior to commencing concrete placement.
- B. All concrete shall have a minimum compressive strength as indicated on the drawings. Concrete not so designated shall have a minimum compressive strength of 3000 psi at 28 days.
 - C. When a source, type, kind or brand of each constituent has been established and accepted for job mixtures, this source, type, kind or brand shall not be changed throughout the duration of the concreting.
 - D. Batch all constituents, including admixtures, at the central batch plant.

3.02 CONCRETE INSPECTION, CONTROL AND TESTS:

- A. The testing laboratory shall perform inspection, control and testing of concrete as required by the Architect/Engineer and specified herein, and shall correlate field practices with the specification requirements. Laboratory shall aid the contractor in the perfection of techniques for insuring the test results.
- B. The Architect/Engineer or his designated representative and the laboratory each shall have the authority to delay the time of starting or to stop concreting if deficiencies in concrete forms, form supports or reinforcing is evident or reasonably suspected, or if weather or any other condition in his opinion, deem it necessary. No increase in contractual price or completion time shall be allowed because of such delay or stoppage.
- C. Inspection and control shall conform to ACI-311.
- D. Control of concrete shall include tests of materials for moisture, gradation and cleanliness; adjustments of batches for consistency, workability and yield; and checking of all quantities going into the mixture in compliance with the original design and project requirement.
- E. Control of concrete on job site and during placement, including sampling, testing and inspecting to insure the quality of the concrete is being maintained.
- F. Test cylinders shall be taken, made and tested in accordance with ASTM C172, C-31 and C-39 respectively. Set of six (6) field control cylinder specimens are to be taken at random during the progress of the work. The total number of specimens taken shall average one set per 50 cubic yards of concrete poured. When less than 50 cubic yards is placed in any one day, one set of test cylinders shall be made from each type of concrete placed that day. Test one (1) cylinder at three days and one (1) set of cylinders at seven (7) days and three (3) of each set at 28 days. The sixth cylinder shall be held in reserve to be tested in 54 days in the event the 28 day cylinder tests do not meet the strength requirements defined in this section. Send four (4) copies of each test to the Architect/Engineer for distribution.

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- G. Air entrainment tests shall be made in accordance with ASTM C231. The regularity of the tests shall be determined by the laboratory and the Architect/Engineer.
- H. Slump tests shall be in accordance with ASTM C143.
- I. Method of tests shall in all cases comply in detail with the latest applicable ASTM and ACI methods except as modified herein.
- J. The contractor shall cooperate with the laboratory in the making of tests, including providing free access to the work and any necessary casual labor for the selection of samples, providing storage facilities with heat and humidity control for the specimens as directed by the laboratory and affording protection to the specimens against injury or loss through his operations.
- K. Signed certificates (delivery tickets) for each load of concrete, and a daily report thereof, shall be forwarded to the Architect/Engineer upon request.
 - 1. Delivery tickets shall indicate the delivery date, time dispatched, time received for unloading, name of project, name of contractor, name of ready-mix producer, truck number, number of cubic yards of concrete in load, class of concrete, type and brand of cement, admixtures, maximum size of aggregate, water content, and amount of water added at jobsite if permitted by laboratory inspector.

3.03 FAILURE TO MEET CONCRETE STRENGTH REQUIREMENTS:

- A. The average of any three (3) consecutive strength tests of laboratory cured specimens representing each class of concrete shall be equal to or greater than the specified strength and not more than 10% of the strength tests shall have values less than the specified strength.
 - 1. No strength tests shall be under 90% of the specified strength.
 - 2. In the event of failure to meet any of these requirements, the Architect/Engineer shall have the right to order additional moist curing of the questionable concrete, or cylinder core tests in accordance with ASTM C42 and load tests in accordance with ACI 318.
 - 3. Cylinder core samples, testing and any additional testing required by Architect/Engineer of defective concrete shall be paid for by the contractor.
- B. Concrete which is unacceptable due to failure to comply with strength requirements shall be removed, reinforced or strengthened as directed by the Architect/Engineer with no additional expense to the Owner.
- C. Whenever 54 day strength of test cylinders still falls below the strengths specified, the concrete mixture, temperature and curing may be changed as required by the Engineer at no additional cost to the Owner.

3.04 READY-MIX CONCRETE:

- A. All concrete shall be ready-mixed produced by a plant acceptable to the Architect/Engineer

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and the testing laboratory. All constituents including admixtures shall be batched at the central plant in accordance with ACI 304 and ASTM C94.

- B. All central plant equipment, methods and rolling stock shall conform to the requirements of the Truck Mixer and Agitator Standard of the Truck Mixer Manufacturer's Bureau of the National Ready-Mixed Concrete Association.

END OF SECTION 03050

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SECTION 03100
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 REFERENCE:

- A. General Provisions of the Contract, including General, Special and Supplementary Conditions and Division One General Requirements, apply to work specified in this Section.
 - 1. 02515 – Concrete curbs, headers, sidewalks, and driveways
 - 2. 03200 - Concrete Reinforcement
 - 3. 03300 - Cast-In-Place Concrete
 - 4. 03550 - Architectural Concrete
 - 5. 05500 - Miscellaneous Metals

1.02 WORK INCLUDES:

- A. All formwork for concrete as described in this section, indicated on the drawings or required by other sections of these specifications. Openings for other affected work. Form accessories and stripping forms.

1.03 QUALITY ASSURANCE:

- A. Codes and Standards
 - 1. Formwork shall comply with the provisions of ACI 347 "Recommended Practice for Concrete Formwork".
 - 2. ACI "Formwork for Concrete" and Specifications for Structural Concrete for Buildings.
 - 3. PSI - "Construction and Industrial Plywood".
- B. The Contractor is solely responsible for the design, construction and performance of the formwork. The engineers examination of formwork plans and shoring operations shall in no way relieve the contractor of this responsibility.

1.04 SUBMITTALS:

- A. Submit to the Engineer shop drawings prepared and designed by an engineer registered in the state of Florida, for record purposes showing layout of shoring, sections and unusual details in accordance with the General Conditions of the Contract for construction. Submit sufficient information for full description of capacity.

PART 2 - PRODUCTS

2.01 MATERIALS:

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A. Forms

1. Wood

- a. For concrete below grade, use standard grade or better boards or planks; or use 3/4" minimum thickness exterior type plywood, Grade B/B, Class I, PS-1.
- b. For exposed concrete surfaces use 3/4" minimum thickness exterior type plywood, Grade B/B, Class I, sanded both sides, PS-1.

2. Steel

- a. Steel forms shall be of such thickness that they shall remain true to shape. Metal forms, which do not present a smooth surface or do not properly align shall not be used.

3. Column Forms

- a. For round columns use fiberglass forms.

B. Form Oil

1. The inside of the forms shall be coated with a non-staining form oil, such as:

- a. Magic-Kote by Symons Manufacturing Company, Des Plaines, Illinois;
- b. Form-coat by Concrete Service Company, Philadelphia, Pennsylvania.
- c. Eucoslip by Euclid Chemical Company.

C. Form Ties

1. Form ties shall be snap-in form tie with a 1 inch minimum break off depth from the face of the concrete.

2. Ties shall be removed after forms are removed and holes shall then be filled with mortar that matches the adjacent surfaces.

3. Provide stainless steel form ties for all exterior surfaces exposed to view.

4. Approved Manufacturers

- a. Dayton "Sure-Grip"

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- b. Hechman "Snapties"
 - c. Richmond "Snap-Tys"
- D. Anchors
- 1. Zinc-coated dovetail slots (oriented vertically) shall be located at 3 feet - 0 inches on center horizontally wherever concrete surfaces adjoin masonry. Where concrete masonry (CMU) abuts columns, provide dovetail slot at centerline of adjoining CMU.
 - 2. Approved Manufacturers
 - a. Hechman Number 100 Standard, 24 gauge
 - b. Hohman & Barnard, Inc., Number 305
 - c. Wire Products Company, Number F-17
 - d. DAS-STD by Gateway Building Products
- E. Vapor Barrier: 10 mil thick conforming to ASTM E1745 as manufactured by W.R. Meadows or equal.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Forms, bracing, and supports shall be designed and constructed to withstand the pressure of freshly placed concrete. Temperatures of the concrete at time of placing, effect of vibration, speed of placement, the height of plastic concrete and similar factors shall be considered in the design. Concrete surfaces that are to be exposed shall be free of misalignment, unsightly bulges, offsets or ledges.
- B. Forms shall conform to the shape, lines, grades and dimensions of the concrete as called for on the drawings. Joints in forms shall be horizontal and vertical and shall be tightly fitted to prevent leakage of mortar. All vertical surfaces shall be formed.
- C. Removable sections shall be provided at sufficient intervals at the base of walls and columns to allow cleaning and inspection before concrete is placed. All open joints, holes or other blemishes shall be filled to provide a blemish free surface.
- D. Forms for concrete floor slabs shall have sufficient strength and stiffness to prevent sagging or deflection while subjected to the usual construction loads. Walking on forms will not be permitted. Planks (2 in. thick) shall be distributed over the forms to prevent abuse. Wheeling of concrete or other materials directly over the forms will not be permitted. Runways above the top of the finished concrete shall be required throughout the construction period. Runways shall not rest on the reinforcing steel.
- E. Embedded structural steel shapes meant to provide support for other structural elements shall be bolted to the formwork to maintain accurate positioning. Wiring or nailing will not be permitted.
- F. 3/4 inch by 3/4" chamfer strips shall be placed in the corners of forms to produce beveled edges on all permanently exposed surfaces. Corners, which abut masonry walls, shall not be chamfered.

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- G. Forms shall be checked just prior to placing concrete and tightened as required to produce flush surfaces.
- H. Provisions shall be made for chases, offsets, openings, depressions, curbs and bulkheads.
- I. Camber formwork to compensate for anticipated deflections in the formwork due to weight of forms and wet concrete, and/or any additional camber as shown on the drawings.
- J. Floors have not been designed to carry the construction loads of the floor above. Contractor must design and furnish necessary shoring and reshoring to support the loads.
- K. The shores and supports for the formwork shall have ample strength to support all applied loads without settlement. Provide positive means of adjustment (wedges or jacks) for shores to take up any settlement during placement.
- L. Sills, if any, shall rest on solid ground, free from frost. Studs, walls, and bracing shall be dimension stock of sizes as required by form design. Dimensions of centering, bracing, etc. shall be in accordance with "ACI Recommended Practices for Concrete Formwork" (ACI 347).
- M. Sleeves, Reglets, Inserts and Conduits: After forms are erected and before reinforcement is placed, all sleeves, reglets and inserts for mechanical trades must be set in place by the trade involved. Other sleeves, anchors, inserts, anchor bolts, specialties and similar items embedded in the concrete shall be furnished, accurately located as shown and set by the Contractor. In general, electric conduits shall be placed within the middle one-third of the thickness of the concrete in which it is embedded.
- N. Before placing reinforcement or concrete the surface of the form shall be coated with approved non-staining form oil to prevent bond with the concrete surface.
- O. Reinforcements shall be adjusted to fit the sleeves, inserts, and openings, using additional bars where required around openings.

3.02 BULKHEADS:

- A. Place bulkheads where end of days work requires a joint in a wall, beam or slab. Reinforcing steel shall extend through the bulkhead. All joints shall be keyed for 2 of the member thickness unless directed otherwise by the Architect/Engineer. Location of bulkhead must be approved by the Architect/Engineer.

3.03 REMOVAL OF FORMS:

- A. Forms shall not be removed from concrete surfaces until the following minimum requirements are met.
 - 1. Formwork for concrete slabs and beams shall remain in place for a minimum of 48 hours, and until the concrete has achieved 75% of its design strength. Strength shall be determined by tests on cylinders site-cured under the same conditions as the work in question.
 - 2. Column and wall formwork can be removed in 48 hours provided curing compound is applied immediately. If Contractor elects not to provide curing compound, forms

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must remain in place 7 days minimum.

3.04 RESHORING:

- A. When reshoring is permitted or required, the operations shall be planned in advance and shall be subject to approval. While reshoring is under way, no live load shall be permitted on the new construction.
- B. In no case during reshoring shall concrete in beam, slab, column or any other structural member be subjected to combined dead and construction loads in excess of the loads permitted by the Architect/Engineer for the developed concrete strength at the time of reshoring. Reshores shall be placed as soon as practicable after stripping operations are complete but in no case later than the end of the working day on which stripping occurs. Reshores shall be tightened to carry their required loads without over stressing the construction. Reshores shall remain in place until tests representative of the concrete being supported have reached the specified strength or the strength specified in the contract documents for removal of reshores.
- C. Floors supporting shores under newly placed concrete shall have their original supporting shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half of the capacity of the shoring system above. The reshores shall be located directly under a shore position above unless other locations are acceptable.

3.05 REUSE OF FORMS:

- A. Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound to concrete contact form surfaces as specified for new formwork.
- B. When forms are intended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, unless as acceptable to Architect/Engineer.

3.06 VAPOR BARRIER:

- A. Before laying of sheet, subgrade must be smoothed eliminating any protrusions that may cause damage or rupturing of film.
- B. Use widest practical widths; lapping where required shall be a Z-lock not less than 6 inches wide with top lap placed in the direction of the spreading of the concrete and underneath the reinforcing mesh prior to pouring.

END OF SECTION 03100

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SECTION 03200
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 REFERENCE

- A. General Provisions of the Contract, including General, Special and Supplementary Conditions and Division One General Requirements, apply to work specified in this Section.
 - 1. 02515 – Concrete curbs, headers, sidewalks, and driveways
 - 2. 03100 - Concrete Formwork
 - 3. 03300 - Cast-In-Place Concrete
 - 4. 03420 - Precast Prestressed Concrete

1.02 WORK INCLUDES

- A. Provide concrete, concrete masonry unit and precast concrete reinforcement as shown on the drawings, required by these specifications or necessary for proper completion of the work.

1.03 SUBMITTALS

- A. Shop drawings showing all bar sizes, supports, fabrication dimensions and location for placing of the reinforcing in accordance with the General Conditions of the Contractor for construction shall be submitted for approval. Approval shall be obtained prior to fabrication.
- B. Comply with the ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, diagrams of bent bars, and arrangements of concrete reinforcement.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with the provisions of the most recent edition of the following codes, specifications and standards, except as otherwise shown or specified.
 - 1. ACI 301 - Guidelines for Structural Concrete for Building.
 - 2. ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 3. ANSI/ASTM A83 - Cold Drawn Steel Wire for Concrete Reinforcement.
 - 4. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.
 - 5. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
 - 6. ANSI/AWS D1.4 - Structural Welding Code Reinforcing Steel.
 - 7. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

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8. ASTM A616 - Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.
9. ASTM A617 - Axle-Steel Deformed and Plain Bars for Concrete Reinforcement.
10. CRSI - Manual of Practice.
11. CRSI 63 - Recommended Practice for Placing Reinforcing Bars.
12. CRSI 65 - Recommended Practice for Placing Bar Supports, Guidelines and Nomenclature.
13. No foreign steel shall be used.

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Reinforcing Bars shall be rolled from new billet steel, Grade 60 and deformed in accordance with ASTM A615, for bars numbers 3 to number 18 and shall be epoxy coated conforming to ASTM A776 81 for piles and grade beams only.
- B. Welded wire fabric shall be ASTM A185, welded steel wire fabric. The yield strength of the steel wire shall not be less than 60,000 pounds per square inch and shall be epoxy coated conforming to ASTM A776 81.
- C. Bar Supports and Spacers
 1. For unexposed concrete, bar supports and spacers shall be manufactured of standard brights basic wire upturned legs.
 2. For concrete which will be exposed to view from the underside upon completion of the structures, use plastic capped bar supports and spacers.
 3. For slabs on grade, use bolsters with runners where base will not support chair legs.
 4. Do not use wood, brick or other non-specified material.
- D. Tie wire: Federal specifications QQ-W-461 Annealed Steel, 16 ga. minimum for use on epoxy coated steel reinforcement.
- E. Welded electrodes: AWS A5.1, Low Hydrogen, E70 Series.
- F. Welded Inserts: Provide wedge inserts for the support of brick ledger angles. Wedge inserts shall be placed at 4'-0" o.c. unless drawings indicate a more restrictive spacing. Provide the F-7 wedge insert and 3/4" diameter askew bolt, nut and washers as manufactured by Dayton Superior, 10101 C General Drive, Orlando, Florida, or equal.

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Wedge inserts and 3/4" diameter bolts to be deemed equal shall submit test information documenting an ultimate capacity of at least 8,500 pounds when the shelf angle is loaded 2-1/4" from the face of concrete, with the bottom of the insert 1-1/2" clear from the beam bottom, for concrete strength of 4,000 psi.

PART 3 - EXECUTION

3.01 GENERAL

- A. Cleaning and storage reinforcement: Steel reinforcement at the time concrete is placed shall be free from heavy rust, scale or other coating that will destroy or reduce the bond.
- B. All reinforcing steel shall be stored in neat piles at the site clear of the ground in such a manner that all bars can be readily identified when required.
- C. Excessive form oil on the reinforcing shall be removed by washing the reinforcing with kerosene. Exercise due care that no smoking or welding is permitted in the area of cleaning. Provide fire extinguisher at cleaning site.
- D. Supports for reinforcing steel: All reinforcing steel shall be rigidly supported, accurately located and held in position by the use of proper reinforcing steel supports, spacers and accessories before the concrete placement begins.
- E. The legs of all reinforcing supports shall be bent to form a foot so that the side and not the end of leg rods bears on the form.
- F. Metal reinforcement shall be protected by the thickness of the concrete indicated on the drawings. Where not otherwise shown, the concrete cover shall be not less than the following:
 - 1. 3 inches for footings and other principal structural members poured directly against the ground.
 - 2. 2 inches for bars larger than number 4, and 1-1/2 inches for number 5 bars and smaller where concrete will be exposed to the ground or weather after removal of forms.
 - 3. 1-1/2 inches in all beams, girders and columns.
 - 4. 3/4 inches for all slabs and walls not exposed to the ground or weather.
 - 5. In any event, there shall be not less than 3/4" of concrete protection over all reinforcing bars.
- G. Do not use bar supports or reinforcing as support for concrete runways or construction loads.
- H. Placing tolerances: Clear distance to formed surfaces: +/- 1/4 inch. Minimum spacing between bars: -1/4 inch:
 - 1. Top Bars in Slabs or Beams:
 - Members 8" or less in depth: +/- 1/4 inch
 - Members 8" to 24" in depth: +/- 1/4 inch

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Members 24" or greater in depth: +/- 1/2 inch

2. Crosswire of Slabs or Beams: Spaced evenly within 2 inches.
 3. Lengthwise of Member: +/- 2 inches
- I. Bending details: Typical bending and placing diagrams are shown on the drawings. For parts not shown, bending details and lengths shall conform to the requirements of the ACI Building Code 318 and "Manual of Standard Practice for Detailing Reinforced Concrete Structures" ACI 315.
 - J. Bends for stirrups and ties shall be made around a pin having the diameter no less than 1-1/2 inches for number 3, and 2 inches for number 4.
 - K. Bends for other bars shall be made around a pin having a diameter not less than six bar diameters for number 3 to number 6, 8 bar diameters for number 9, number 10 and number 11, 10 bar diameters for number 14 and number 18.
 - L. All bars shall be bent cold. Heating of bars will not be allowed.

3.02 SPECIAL REINFORCING REQUIREMENTS

- A. Where walls or other items are shown as built integrally with other section, but are placed as separate pours, key and dowels must be provided. Dowels shall be the same size and at the same spacing as reinforcing.
- B. Main reinforcing bars shall not be spliced unless so noted on the drawings or approved by the Architect/Engineer.
- C. Provide 6 X 6 - W1.4 X W1.4 electrically welded wire fabric, ASTM A-185 reinforcing in all concrete slabs on ground unless shown otherwise.
- D. Provide corner bars of same size and spacing as main reinforcement at all intersections and corners.
- E. Where openings occur in walls, or slabs, provide two number 5 bars at all sides and extending at least two feet beyond the corners and two number 5 bars at least three feet long diagonally across each re-entrant corner.
- F. Unless permitted by an Inspector employed by the owner reinforcement shall not be bent after being embedded in hardened concrete.

3.03 INSPECTION OF REINFORCEMENT

- A. Reinforcing placement must be checked by an Inspector employed by the owner before any concrete is placed. Any corrections shall be made before concrete is placed.
- B. Placement of reinforcing shall occur in such sequence that the Inspector has sufficient time to inspect the correctness of the reinforcing within the placement area and retains the right to require necessary revisions be made before concrete is placed.

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- C. The Contractor shall notify the Inspector at least 24 hours in advance of concrete placement for a particular portion of the building.
- D. Galvanized wire ties of double loop and tightly fastened to secure the proper spacing of rods and ties are required.

3.04 LAP SPLICING

- A. Welded wire fabric shall be overlapped wherever successive mats or rolls are continuous such that the overlap measured between outermost cross wires is not less than one wire spacing plus 2 inches.
- B. Longitudinal (continuous) footing reinforcing: Class B.
- C. Beam Reinforcing: Class B.
- D. Column Reinforcing: Class B Offset lap splices.
- E. Column/footing dowels: Class B.
- F. Masonry vertical reinforcing: Class B.
- G. Splices not included above: Class B.

END OF SECTION 03200

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SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 REFERENCE:

- A. General Provisions of the Contract, including General, Special and Supplementary Conditions and Division One General Requirements, apply to work specified in this Section.
 - 1. 03100 - Concrete Formwork
 - 2. 03200 - Concrete Reinforcement
 - 3. 03420 - Precast Prestressed Concrete
 - 4. 04340 - Reinforced Unit Masonry

1.02 WORK INCLUDES:

- A. All labor and materials required for cast-in-place concrete shown on the drawings or specified herein. Concrete bases and pads for mechanical and electrical equipment. Coordinates with respective Contractors. Concrete for grouting of concrete unit masonry.

1.03 QUALITY ASSURANCE:

- A. Codes and Standards
 - 1. Comply with the provisions of the most recent edition of the following codes, specifications and standards, except as otherwise shown or specified.
 - a. ACI 318 "Building Code Requirements for Reinforced Concrete."
 - b. ACI 301, "Specifications for Structural Concrete for Buildings."
 - d. ACI 302, "Recommended Practice for Concrete Floor or Slab Construction."
 - e. ACI 304 "Recommended Practice for Measuring Mixing, Transporting and Placing Concrete."
 - f. ACI 305 "Recommended Practice for Hot Weather Concreting."
 - g. ACI 307 "Recommended Practice for Cold Weather Concreting."
 - h. ACI 309 "Recommended Practice for Consolidation of Concrete."
 - i. CRSI Manual of Standard Practice.
 - j. CRSI Placing Reinforcing Bars.
 - k. ASTM C476, "Standard Specification for Grout for Reinforced or Non-Reinforced Masonry."

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- I. ASTM C-31, Making and Curing Concrete Compression and Flexure Strength Test Specimens in Field.
- m. ASTM C-33, Concrete Aggregates.
- n. ASTM C-39, Compressive Strength of Molded Concrete Cylinders.
- o. ASTM C-42, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- p. ASTM C-94, Ready-Mixed Concrete.
- q. ASTM C-143, Slump of Portland Cement Concrete.
- r. ASTM C-150, Portland Cement
- s. ASTM C-172, Sampling Fresh Concrete.

1.04 QUALITY CONTROL:

- A. Do not commence placement of concrete until mix designs have been approved by the Architect/Engineer.
- B. Any concrete work which does not conform to the specified requirements, including strength, tolerance and finishes shall be corrected by the Contractor at his expense and as directed by the Architect/Engineer.

1.05 DIMENSIONAL TOLERANCE FOR FORMED SURFACES:

- A. Variation from plumb:
 - 1. In the lines and surfaces of columns, piers, walls and in arises:
 - In any 10 ft. of length.....1/4 in.
 - Maximum for the entire length
(length greater than 40'-0").....1 in.
 - 2. Exposed corner columns, control-joint grooves, and other conspicuous lines:
 - In any 20 ft. of length.....1/4 in.
 - Maximum for the entire length.....1/2 in.
- B. Variation from the level or from the grades specified in the contract documents:
 - 1. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores
 - In any 10 ft. of length.....1/4 in.
 - In any bay or in any 20 ft. of length.....3/8 in.
 - Maximum for the entire length.....3/4 in.

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2. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:

In any bay or in 20 ft. length.....1/4 in.
Maximum for the entire length.....1/2 in.

C. Variation of the linear building lines from established position in plan and related position of columns, walls, and partitions:

In any bay.....1/2 in.
In any 20 ft. of length.....1/2 in.
Maximum for the entire length.....1 in.

D. Variation in the sizes and location of sleeves, floor openings, and wall openings..... +1/4 in.

E. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls:

Minus.....1/4 in.
Plus.....1/2 in.

F. Footings*

1. Variations in dimensions in plan:

Minus.....1/4 in.
Plus.....1/2 in.

2. Misplacement or eccentricity:

2 percent of the footing width in the direction of misplacement but not more than.....2 in.

3. Thickness:

Decrease in specified thickness.....5%
Increase in specified thickness.....No limit

G. Variation in steps:

1. In a flight of stairs:

Rise..... $\pm 1/8$ in.
Tread..... $\pm 1/4$ in.

2. In consecutive steps:

Rise..... $\pm 1/16$ in.
Tread..... $\pm 1/8$ in.

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- * Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items.

1.06 SUBMITTALS:

A. Concrete Mix Report

1. For each proposed concrete mix, submit two copies of the test mix report. Submit report at least 15 days prior to start of concrete pouring.

B. Material Certificates

1. Provide material certificates signed by material manufacturer, certifying that each material complies with the specified requirements.

C. Test Reports

1. Submit results of all compression, slump and air content tests performed during mix design and throughout the duration of the project as required by the Specifications.
2. Submit sieve analysis of coarse and fine aggregate intended for use in the project.
3. Submit a copy of State Certification that the concrete batching and weighing equipment has been inspected and approved.
4. Submit letters from the cement and aggregate suppliers certifying that furnished materials meet appropriate ASTM Standards.

1.07 TESTING:

A. Concrete shall be sampled and tested for Quality Control during placement of concrete.

B. Failure to detect defective work or material shall not in any way prevent later rejection when such defect is discovered nor shall it obligate Architect/Engineer for final acceptance.

C. Required Sampling and Testing

1. Samples, for strength tests of each concrete mix shall be taken not less than once a day nor less than once for each 50 cu. yd. of concrete.

D. If the total volume of concrete is such that the frequency of testing required above would provide less than five strength tests for a given mix, tests shall be made from at least five randomly selected batches.

1. Secure composite samples in accordance with ASTM C172.
2. Mold and cure five specimens from each sample in accordance with ASTM C31.
 - a. Samples for test shall be taken at the 1/4 and 3/4 points of the load mixer.

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- b. Cure specimens under laboratory conditions except as follows:
 - 1. When in the opinion of the Architect/Engineer there is a possibility of the surrounding air temperature falling below 40 degrees F, he may require additional specimens to be cured under job conditions.
 - 2. In hot weather or periods of low humidity the Architect/Engineer may require additional specimens to be cured under job conditions
 - a. Test specimens in accordance with ASTM C39.
 - 1. Test one specimen at 3 days.
 - 2. Test one specimen at 7 days.
 - 3. Test two specimens at 28 days for acceptance. This test of two specimens constitutes one strength test. The results of the strength test shall be the average of the strengths of the two specimens tested.
 - b. Hold one specimen for future use if test does not comply at 28 days.
 - c. Determine slump of the concrete sample for each strength test and whenever consistency appears to vary, using ASTM C143.
 - d. Determine air content for each strength test in accordance with either ASTM C231, ASTM C173, or ASTM C138.
 - e. Determine temperature of concrete sample for each strength test.
- E. Evaluation of Test Results
 - 1. For evaluation each specified concrete mix shall be represented by at least five strength tests.
- F. The strength level of the concrete will be considered satisfactory if both of the following requirements are met.
 - 1. The average of all sets of three consecutive strength tests (average of two cylinders) exceeds specified strength.
 - 2. No individual strength test (average of two cylinders) falls below the specified strength by 500 psi.
- G. If the strength level does not meet the above requirements, the Architect/Engineer shall consider the concrete to be deficient and shall have the right to reject the work or require

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load tests on the structure in the areas the tests represent at no cost to the Owner.

H. Report tests results in writing to the Architect/Engineer and the Contractor on the same day that tests are made. Reports of compressive strength tests shall contain:

1. Project identification name and number
2. Date of concrete placement
3. Name of Contractor
4. Name of Concrete Supplier and Truck Number
5. Name of Concrete Testing Service
6. Concrete type and class
7. Location of concrete batch in the structure
8. Design compressive strength at 28 days
9. Slump
10. Air Content
11. Concrete temperature
12. Concrete mix identification number
13. Compressive breaking strength
14. Type of break for both 7-day tests and 28-day tests.

1.08 TESTING SERVICES:

A. The Owner will employ an independent testing laboratory meeting the requirements of ASTM E329 and approved by the Architect/Engineer to perform the following services:

1. Sample concrete at placement and make slump, air content, temperature and compression tests as described above.
2. Report tests results to the Architect/Engineer.

B. Contractor Responsibilities

1. Pay for additional testing and inspection of materials or concrete occasioned by their failure by test or inspection to meet specification requirements.
2. Provide the necessary testing services for the qualification of proposed materials and the establishment of mix designs; and for any other testing services required by the Contractor.
3. Furnish any necessary labor to assist the designated testing agency in obtaining and handling samples.
4. Advise the testing agency sufficiently in advance of operations to allow for completion of tests.
5. Provide and maintain for the sole use of the testing agency adequate facilities for safe storage and proper curing of concrete test specimens as required by ASTM C31.
6. The use of Testing Services shall in no way relieve the Contractor of the

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responsibility to furnish materials and construction in full compliance with the
Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIAL:

A. Portland Cement

1. ASTM C150, Type I (Normal)

B. Aggregate

1. ASTM C 33, and as herein specified. Provide aggregates from a single source for all exposed concrete.
 - a. Fine Aggregate: Clean, sharp sand, free from loam, clay, lumps or other deleterious substance.
2. Coarse Aggregate For Normal Weight Concrete: Comply with ASTM C33 size #57. Clean, uncoated, processed aggregate of crushed stone or washed gravel containing no clay, mud, loam or foreign matter. Use of pit or bank run gravel is not permitted. Aggregate shall meet ASTM C33 Size No. 56 or 57.
3. Where contractor elects to place concrete by pumping he shall provide a pump with sufficient capacity to place this size of aggregate.
4. ASTM C404 for masonry grout. Maximum aggregate size shall be 3/8".

C. Water:

1. Water shall be fresh and potable. Water shall be obtained from city water system. The Contractor shall pay for the quantity of water used during construction and also furnish, install and maintain a water meter if required by the Water Department.
2. Air-Entraining Admixtures - ASTM C260
 - a. "Darex" by W.R. Grace
 - b. "SikaAer" by Sika Chemical Co.
 - c. "MBVR" by Master Builders
 - d. "Air-Mix" by Euclid
 - c. "Sealtight" by W.R. Meadows

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- D. Water Reducing Admixture - ASTM C494 Type A
 - 1. "Pozzolith 300 Series" by Master Builders
 - 2. "WRDA/HYCOL" by Grace
 - 3. "Plastocrete 161" by Sika
 - 4. "Eucon-WR-75" by Euclid

- E. High Range Water Reducing Admixture (Superplasticizer)
 - 1. Admixtures shall meet the requirements of ASTM C494 Type F and shall contain no chloride ions.
 - 2. Acceptable Products
 - a. "Melmet" by American Admixtures
 - b. "WRDA 19" by W.R. Grace Co.
 - c. "Sikament" by Sika Chemical Co.
 - 3. Dosage and use of any mix containing this admixture shall be in strict accordance with the manufacturers direction and only with the written permission of the Engineer.
 - 4. A representative of the admixture manufacturer shall be present to observe the products use and to assure that it is being used in accordance with the manufacturers directions.

- F. Water Reducing, Retarding Admixture
 - 1. Shall comply with ASTM C494 Type D.
 - 2. Acceptable Products
 - a. "Daratarad 17" by W.R. Grace & Company
 - b. "Pozzolith 100XR" by Master Builders, Inc.
 - c. "Lubricon R" by American Admixture
 - d. "Plastocrete 161R" by Sika Chemical Co.

- G. Calcium Chloride
 - 1. Do not use calcium chloride in any concrete.

- H. Concrete Color Admixtures
 - 1. Carblack by Euclid Chemical Company
 - 2. Integral Colors by Davis Colors
 - 3. Chromix by L.M. Scofield

- I. Integral Concrete Waterproofing: Shall be Anti-Hydro by Anti-Hydro Company or approved

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equal.

PART 3 - RELATED MATERIALS

3.01 VAPOR BARRIER:

- A. Provide water-vapor cover over sub-grade materials as shown on the drawings. Use only materials which are resistant to decay when tested in accordance with ASTM E154.

3.02 PERFORMED JOINT FILLERS:

- A. Provide preformed strips, non-staining, non-extruding and resilient bituminous type complying with ASTM D1751.
- B. Thickness to be as indicated on drawings. If no thickness is indicated use 1/2".

3.03 WATERPROOF SHEET FOR CURING:

- A. Conform to ASTM C171.
- B. Polyethylene film thickness shall be at least 4 mils.

3.04 MEMBRANE CURING COMPOUND:

- A. Conform to ASTM C171, Class B, Clear 100% resin type.
- B. Do not use on any surface which will later receive paint, sealer, hardener, carpeting, tile or other bonded covering.
- C. Acceptable Products:
 - 1. Sealtight AR-30 W.R. Meadows
 - 2. Kurez Euclid Chemical
 - 3. Horncure W.R. Grace
 - 4. Hydrocide Resin Sonneborn

3.05 CURING/SEALING COMPOUND:

- A. Sodium Silicate Sealer
 - 1. Acceptable Products
 - a. Cure Hard Meadows
 - b. Eucosil Euclid Chemical
 - c. WB-309 Grace
 - d. Sonosil Sonneborn
 - e. Acurion Anti-Hydro Waterproofing
- B. Verify compatibility of finish with curing/sealing compounds.

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3.06 BONDING AGENT (EPOXY TYPE) ASTM C881:

- | | | |
|----|----------------|-----------------|
| A. | Sikadur Hi-Mod | Sika Chemical |
| B. | Thiopoxy | W.R. Grace |
| C. | Epoxy #452 | Euclid Chemical |

3.07 NON-SHRINK, NON-METALLIC GROUT:

- | | | |
|----|----------------|-----------------|
| A. | Five Star | U.S. Grout |
| B. | Euco NS | Euclid Chemical |
| C. | Masterflow 713 | Master Builders |

3.08 WATER STOP:

- A. Provide rubber or PVC flat, center build type water stops as shown on drawings.

PART 4 - EXECUTION

4.01. GENERAL

- A. Proportioning
1. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each class of concrete required, complying with the latest edition of ACI 211.1.
 2. Contractor shall provide all testing services for approval of mixes.
 3. The Contractor shall furnish the Architect/Engineer for approval a mix design for each class of concrete at least 15 days prior to start of work.
- B. Report to Include
1. Total weight of water, cement, coarse aggregate fine aggregate and admixtures to be used.
 2. Slump.
 3. Percent of Air.
 4. Results of Compression Test for 6 cylinders cast and broken 7, 14 and 28 days.
 5. Grain size curves for both aggregates.
- C. Do not begin production until mixes have been approved by Architect/Engineer.
- D. When field experience methods are used to select concrete proportions, establish proportions as specified in ACI 301-72. Strength data for establishing standard deviation will

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be considered suitable if the concrete production facility has certified records consisting of at least 30 consecutive tests in one group or the statistical average for 2 groups totaling 30 or more tests, representing similar materials and project conditions.

- E. The proper proportions of cement, aggregate and water to obtain the required strength shall be determined from ACI 211.1 "Recommended Practice for Selection Proportions for Normal and Heavy Weight Concrete".
 - 1. Strength requirements shall be 4000 and 3000 pounds per square inch.
 - 2. In all cases, not more than 6 gallons of water per each sack of cement will be allowed.
 - 3. Unit weight for normal weight concrete shall be 150 pcf \pm 5%.
 - 4. Air content for mixes requiring air entrainment shall be 3.5% \pm 1.5%.
 - 5. Slump at the point of placement shall be not less than 4" and not more than 6".
 - 6. Water/cement ratio not to exceed 0.4.
- F. Concrete containing a high range water-reducing admixture (superplasticizer) shall have an initial slump or 1-1/2 to 2 inches and a final slump not to exceed 8 inches after addition of the admixture.
- G. Mix design adjustments may be requested by the Contractor when characteristics of material, job conditions, weather, test results, or other circumstances warrant, at no additional cost to Owner and as approved by the Architect/Engineer. Laboratory test data for revised mix and designs and strength results must be submitted to and accepted by the Architect/Engineer before using it in the work.
- H. Ready-Mix Concrete shall be mixed and delivered in accordance with ASTM C94, "Specifications for Ready-Mix Concrete" and shall meet other applicable requirements of this Section.

4.02 AIR-ENTRAINING ADMIXTURE:

- A. Use air-entraining admixture in all concrete exposed directly to the elements, such as foundation and retaining walls, exterior slabs-on-grade, concrete canopies and walkways.
- B. Add air-entraining admixture in accordance with manufacturer's recommendations.

4.03 WATER REDUCING ADMIXTURE

- A. Use water-reducing admixtures in all concrete and in strict compliance with the manufacturer's directions.
- B. Admixture to increase cement dispersion, or provide increased workability for low-slump concrete, any be used at the Contractor's option subject to the Architect/Engineer's acceptance.

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- C. The reduced water content shall be taken into account when proportioning mixes.

4.04 MIXING

- A. Unless otherwise approved by the Architect/Engineer use ready mix concrete conforming to ASTM C494.
- B. Place concrete no more than 90 minutes after initial mixing.
- C. Tempering: All concrete shall be placed within 1-1/2 hours after introduction of water to the mix. Under no conditions may additional water be added that will exceed the quantity of water called for in the design mix. Submit time stamped batching tickets on delivery of concrete to job site. All concrete where the quantity of water has exceeded the design mix will be removed and replaced with proper concrete at no cost to the Owner.
- D. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required.
1. When the air temperature is between 85 degrees Fahrenheit and 90 degrees Fahrenheit reduce the mixing and delivery time from 1-1/2 hours to 75 minutes, and when the air temperature is over 90 degrees Fahrenheit, reduce the mixing and delivery time to 60 minutes.

4.05 PLACING CONCRETE

- A. Pre-Placement Inspection
1. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts and contractors to permit the installation of their work; cooperate with other trades in setting such work, as required.
 2. The Contractor shall notify the Inspector at least 24 hours in advance of concrete placement for a particular portion of the building. Placement of reinforcing shall occur in such sequence that the Inspector has sufficient time to inspect the correctness of the reinforcing within placement area & retains the right to require necessary revisions be made before concrete is placed.
- B. Placement
1. Clean out all chips, saw dust, dirt and other foreign matter from forms and assure that inside of forms are free of frost. Remove any dirt, debris, and water from trenches and other excavations. Remove any dirt, debris and mud from tops of footings or pile caps before pouring walls.
 2. Deposit concrete in forms in horizontal layers not deeper than 18 inches and in a manner to avoid inclined construction joints.
 3. Deposit concrete continuously or in layers of such thickness that no concrete will be

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placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified.

4. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing.
5. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use vibrators designed to operate with vibratory element submerged in concrete.
6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Do not insert vibrators into lower layers of concrete that have begun to set. Limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
7. Dropping the concrete a distance of more than 6 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted. An "elephant trunk" shall be used for all wall pours, which are over 6 feet high.

C. Cold Weather Placing

1. Protect concrete work from physical damage or reduced strength, which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
2. When air temperature has fallen to or is expected to fall below 40 degrees Fahrenheit, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55 degrees Fahrenheit, and not more than 80 degrees Fahrenheit at point of placement.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
5. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators.

D. Hot Weather Placing

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees Fahrenheit. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature, provided the water equivalent

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of the ice is calculated to the total amount of mixing water.

3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperatures immediately before embedment in concrete.
4. Wet forms thoroughly before placing concrete.
5. Do not use retarding admixtures without the written approval of the Architect/Engineer.
6. Place concrete in column forms before beam and slab steel is in place. Place column concrete in not more than 36 inch lifts before vibrating.
7. Slabs and Beams: Thoroughly clean beam and slab forms after placing column concrete. Do not place concrete in roof or wall beams or slabs until concrete in columns have been in place at least 4 hours. Place concrete for slabs and beams continuously in layers not over 12 inches deep. Arrange the work so that the joints will be located at points indicated.
8. Place slabs on fill carefully to avoid damage to vapor barrier.

E. Compaction

1. Compact concrete in layers by internal vibrating equipment, supplemented by hand rodding and tamping as required. Do not use vibrators to move the concrete laterally inside the forms.
2. Internal vibrators should maintain a speed of at least 5,000 impulses per minute when submerged in concrete (at least one spare vibrator in working condition should be maintained at the site at all times).
3. Limit duration of vibration to the time necessary to produce satisfactory consolidation without causing segregation, but in no case more than 15 seconds per square foot of exposed surface. Move vibrator constantly and place in each specific spot only once.

F. Placing Concrete Slabs

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Bring slab surfaces to the correct level with a straight-edge and strike-off. Use bull floats and darbies to smooth the surface, leaving it free of humps or hollows.
4. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

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5. Concrete to be placed on grade shall be placed over 10 mil polyethylene film.
 - a. This film shall be laid continuously and in as large of pieces as possible.
 - b. Any holes or perforations caused by pipes, conduits, ducts and general construction activity shall be securely taped to make the film vapor tight.
6. Floor slabs shall be level or pitched to drains as required.
7. All top of slab elevations shall be determined by the use of preset runners supported at the proper elevation.

G. Joints

1. Construction Joints

- a. Construction joints not shown on the drawings shall be located so as not to impair the strength and appearance of the structure, and at locations approved by the Architect/ Engineer.
- b. Provide keyways at least 1-1/2 inches deep in all construction joints in walls and slabs. Accepted bulkheads designed for this purpose may be used in slabs.
- c. Place construction joints perpendicular to main reinforcement.
- d. Roughened construction joints where indicated on the drawings shall be clean, free of laitance and intentionally roughened to a full amplitude of 1/4 inch by raking. Remove laitance entirely by high pressure water blasting.
- e. Continue all reinforcement across construction joints. Welded wire fabric in slabs on grade may stop at those joints, which are shown on the drawings.

2. Isolation Joints in Slabs-on-Grade

- a. Locate where indicated or detailed on Drawings to points of contact between the slabs on ground and vertical surfaces, such as foundations, curbs, etc.
- b. Install preformed joint filler according to manufacturer's recommendations. Filler shall be closely fitted to wall faces and to slab edges.
- c. Reinforcement shall not extend through isolation joints.

3. Weakened-Plane (Control) Joints

- a. Locate where required and as indicated on the drawings.
- b. Form weakened-plane joints in fresh concrete by grooving top portion with a recommended jointing tool and finishing edges with an edger.

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- c. If joints are saw-cut cutting shall be started as soon as the concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw; and cutting shall be completed before shrinkage stresses become sufficient to project cracking.
- d. Form or cut joints to a depth of 1/3 of slab or wall thickness.

H. Expansion Joints

- 1. Locate as shown on drawings.
- 2. Joints in on-grade walkways maximum at 20 feet o.c., at every change in thickness, direction and at center line of drives. Score and tool between expansion joints in equal bays at not over 5 feet o.c.
- 3. Joints shall be straight and smooth. They shall have hardened before fresh concrete is deposited against them.

I. Other Embedded Items

- 1. All sleeves, inserts, anchors, and embedded items required for adjoining work shall be placed prior to concreting.
- 2. All Contractors whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.

4.06 FINISHES

A. Formed Surfaced

- 1. Patching: Immediately after stripping forms, patch all defective areas with mortar similar to the concrete mix; coarse aggregate should be omitted. Bulges, minor honeycomb and other minor defects, as designated by the Architect, shall be patched only where exposed to view. Clean, dampen and fill tie holes with patching mortar.
 - a. Defective Areas as judged by the Architect and Engineer, including those resulting from leakage of forms, excessive honeycomb, large bulges and large offsets at form joints shall be chipped away to a depth of at least 1/4 inch, and the surfaces that are to be patched shall be coated with an epoxy polysulfide adhesive. The patching mortar shall be pressed in for a complete bond and finished to match adjacent areas, or where defective areas impair the strength of the member in question (as judged by the Architect), the member should be removed or gunited as determined by the Architect and Engineer.
- 2. Finishes:
 - a. Rough or Board Finish: For all concrete surfaces not exposed to public view, including concrete in utility spaces.

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- b. Plywood Finish: For all other exposed exterior overhead surfaces.
 - c. Grout Cleaned Surfaces: For all other exposed exterior surfaces and exposed vertical interior surfaces.
 - 1). Rough or board finish, reasonably true to line and plane. Tie holes and defects patched and ins exceeding 1/4 inch rubbed down; otherwise, surfaced may be left with texture imparted by forms.
 - 2). Plywood Finish: Same as board finish except forms should be constructed of 5/8 inch minimum thickness plywood in as large size as practicable, arranged in an orderly and symmetrical manner. Sheets showing torn grain, worn edges, holes or similar defects shall not be used. Remove all fins.
 - 3). Grout Cleaned Finish: After concrete, still freshly hardened, had been predampened, a slurry consistency of 1 part cement and 1-1/2 parts sand passing No. 16 sieve by dry loose volume shall be spread over the surface with burlap pads or rubber floats. Surplus shall be removed by scraping and then rubbing with clean burlap. Cure in an approved manner. (All work will conform with ACI Standard 301-72).
- B. Unformed Surfaced - Flatwork (Interior)
- 1. Grade and screen the surfaces to the exact elevation or slope shown or required. Make proper allowances for setting beds for ceramic tile. After screening, tamp mixture thoroughly to drive the coarse aggregate down from the surfaces and apply the applicable finish indicated hereinafter. Always slope exterior walks away from the building a minimum of 1/4 inch per foot unless noted otherwise on the drawings. Covered walks between buildings always slope to drain to the exterior and away from the buildings. At cross sections of the walks, warp the surfaces to drain water from the walls. Provide control joints as indicated on drawings.
 - 2. Scratch Finish: For surfaces to receive thickset bonded continuous applications, i.e., ceramic tile, etc., refer to drawings for locations of depressed areas.
 - 3. Float Finish: For surfaces to receive roofing waterproofing membranes.
 - 4. Trowel Finish: For all interior floor surfaces intended as smooth waling surfaces or for receipt of floor coverings except as noted in paragraph 2 above.
 - 5. Wood Float Finish: For exterior play courts.
 - 6. Non-Slip Finish: Where indicated on drawings.
 - 7. Definition of Finish Types:
 - a. Scratch Finish: After concrete has been placed, struck off, consolidate and

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leveled to a Class C tolerance, surface shall be roughened with stiff brush, rakes or metal lather roller before final set.

- b. Float Finish: After concrete has been placed, struck off and consolidated and leveled, concrete shall not be worked further until water sheen has disappeared and/or when mix has stiffened sufficiently to permit proper operations or a power-driven float. Consolidated with power drive float, check trueness of surface, fill low spots and cut down high spots to achieve Class B tolerance. Refloat to uniform, smooth, granular texture.
 - c. Trowel Finish: Finish same as above for floated finish and in addition, steel trowel the surface to produce a smooth, glassy, impervious surface free of trowel marks to a Class A tolerance. On surfaces intended to support floor coverings, defects of sufficient magnitude to show through the floor covering shall be removed by grinding.
 - d. Broom Finish: Finish same as above for float finish to a Class B tolerance and then draw a broom or burlap belt across surface transversely.
8. Tolerances: Finishes as indicated above should be as follows:
- a. Class A - true planes within 1/8 inch to 10 feet.
 - b. Class B - true planes within 1/4 inch to 10 feet.
 - c. Class C - true planes within 1/4 inch to 2 feet.
 - d. Tolerances should be measured by placing a 10-foot straightedge anywhere in any direction.
9. Sealer: Apply 2 coats Thompson's Waterseal (or equal) after concrete has cured as follows:
- a. Where indicated on the finish schedule.
 - b. To floor slabs receiving ceramic tile (except shower rooms scheduled to receive waterproofing barrier membrane), application of sealer shall be made no more than 48 hours prior to installation of tile Contractors to coordinate.
10. It shall be the Contractors responsibility to provide the proper substrate to receive floor finishes as required by manufacturers thereof.

4.07 CONCRETE CURING AND PROTECTION

A. General

- 1. Protect freshly placed concrete from premature drying and excessive cold or heat,

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and maintain without drying at a relatively constant temperature for a period of time necessary for hydration of cement and proper hardening.

2. For concrete not in contact with forms, one of the following curing methods shall be applied immediately after completion of placement and finishing. Floors to receive hardener or mortar bonded topping shall be cured in accordance with #3 listed below under Curing Methods.
3. Curing shall be continued for at least seven days. Curing may be terminated in less than seven days if cylinder tests show that the concrete has reached 2/3 of the specified design strength.
4. For concrete surfaces placed against forms the concrete shall be cured by one of the following methods after form removal until the end of the time period specified above.

B. Curing Methods

1. Membrane Curing Compound: To be used on all exterior flatwork.
 - a. May not be used on surfaces to receive paint, sealer, hardener, carpeting, tile, or other bonded coating.
 - b. Spray or roll apply material as specified and in accordance with manufacturers directions immediately after any water sheen which may develop after finishing has disappeared from the concrete surface.
 - c. The compound shall form a uniform, continuous film that will not check, crack or peel.
 - d. It is the Contractors responsibility to determine that the curing compound used will not leave discoloration on concrete exposed to view.
 - e. Recoat areas which are subject to heavy rainfall within 3 hours after initial application; maintain continuity of coating and repair damage during curing period.
2. Curing/Sealing Compound
 - a. All interior concrete floors and slabs except those to receive hardener or mortar bonded topping, shall be cured/sealed in this manner. Spray or roll apply the specified materials in accordance with the manufacturers directions immediately after any water sheen which may develop after finishing has disappeared from the concrete surface.
 - b. The compound shall form a uniform continuous film that will not check, crack or peel.
 - c. It is the Contractors responsibility to determine that the curing/sealing compound uses is compatible with any carpet, tile or specific brand of paint

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to be used.

3. Waterproof Sheet Material

- a. Cover concrete surfaces with waterproof sheet material conforming to ASTM C171, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed with waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

4. Application of burlap mats kept continuously wet.

4.08 FLOOR HARDENER

- A. Those areas noted to receive floor hardener shall be treated with materials as specified and in accordance with manufacturers directions.
- B. Concrete shall be cured using waterproof sheet material or continuously wet burlap as described above. No curing or sealing compound may be applied to areas to receive hardener.

4.09 PATCHING CONCRETE

- A. Any concrete work not formed as shown on the drawings or which for any reason is out of alignment or level, or shows defective surfaces, shall be considered as not conforming with the intent of the specifications and shall be removed unless the Architect/Engineer grant permission to patch a defective area.
- B. Immediately after removing the forms, all concrete surfaces shall be inspected. Any pockets showing unsolidified materials, or any other defective areas permitted by the Architect/Engineer to be patched, and all holes and honeycombed areas shall be patched before the concrete is thoroughly dry. The patching shall be made of the same material and of the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and white cement shall be substituted for a part of the dry Portland cement to match color of surrounding concrete.
- C. The mortar shall be thoroughly compacted into place and screened off so as to leave the patch slightly higher than the surrounding surface. It shall be left undisturbed for a period of one to two hours to permit shrinkage before being finally finished. Patches shall be finished in such a manner and texture as to match the adjoining surface.
- D. Patches shall be bonded with a re-wetable bonding agent.

4.10 EPOXY MORTAR REPAIR

- A. The areas to be patched shall have all loose, unsound concrete removed and then cleaned by sandblasting, vacuumed and/or blown clean with oil-free compressed air. The sound concrete remaining shall then be scrubbed with the epoxy binder only (without aggregate) just prior to the placement of the epoxy mortar.

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- B. The epoxy mortar shall be mixed and placed in accordance with the manufacturer's printed instructions. Such instructions shall be supplied to the Contractor by the supplier of the epoxy system.
- C. Do not apply mortar in layers greater than 1" thick. Maximum thickness for outdoor applications is 1/2".

4.11 EPOXY GROUTING OF BOLTS AND REINFORCING BARS

- A. Drill holes in concrete 1/4" larger than the diameter of the bolt or bar and to the depth required. Holes to be blown free of dust and to be dry prior to placing epoxy grout.
- B. Use epoxy grout in accordance with these specifications and the manufacturers directions.
- C. Fill hole 1/3 with epoxy grout, insert bolt or bar and move up and down several times while filling hole.
- D. No load shall be applied to the bar or bolt for at least 24 hours.

4.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in place construction. Provide other miscellaneous concrete filling shown or required to complete the work.
- B. 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.
- C. Equipment Bases and Foundation: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment with a template at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing machines and equipment.

4.13 MINIMUM REQUIREMENTS FOR SIDEWALKS

- A. Where the drawings do not specify thickness, reinforcement, or jointing, the following minimum requirements shall be met:
 - 1. Minimum thickness shall be 4 (four) inches.
 - 2. Minimum reinforcement shall be woven wired fabric 6 x 6 - W1.4 x W1.4 placed at slab mid-depth.
- B. Sidewalks shall be formed or sawn into squares.
 - 1. For sidewalks less than ten feet in width longitudinal spacing of formed or sawn joints shall be equal to sidewalk width.
 - 2. For sidewalks greater than ten feet in width spacing of formed or sawn joints shall

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not exceed ten feet in either direction.

3. Sawn joint depth shall be one and one-half inches in depth.
 4. Formed joints shall be keyed together. Key shall be at slab mid-depth and be 1-1/2" x 1-1/2" at mid-depth of slab.
 5. Expansion joints shall be installed at no greater than fifty (50') foot intervals or at any change in direction or width of walk, at locations where walk abuts other concrete or masonry construction. An expansion joint is defined as wood or metal formed at one side, the two surfaces separated by a 1/2" preformed expansion joint filler.
- C. Sidewalk concrete shall have a minimum 28-day compressive strength of 4,000 pounds per square inch.

END OF SECTION 03300

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**SECTION 03310
CONCRETE WORK**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 SUMMARY:

- A. Extent of concrete work is shown on drawings.

1.03 SUBMITTALS:

- A. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested by Architect.
- B. Shop Drawings; Reinforcement: Submit original shop drawings prepared by registered Professional Engineer for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- C. Shop Drawings; Formwork: Submit shop drawings prepared by a registered Professional Engineer for fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joint or reveals, location and pattern of form tie placement, and other items, which affect exposed concrete visually.
 - 1. Architect's review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor's responsibility.
- D. Samples: Submit samples of materials as requested by Architect, including names, sources, and descriptions.
- E. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design test.

1.04 QUALITY ASSURANCE:

- A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. ACI 301 "Specifications for Structural Concrete for Buildings".
 - 2. ACI 318 "Building Code Requirements for Reinforced Concrete".
 - 3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".
- B. Concrete Testing Service: To be provided by the Owner as outlined in Section 01400.

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1.05 PROJECT CONDITIONS:

- A. Protect adjacent finish materials against spatter during concrete placement.

PART 2 - PRODUCTS

2.01 FORM MATERIALS:

- A. 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.
 - 1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Architect's control sample. Provide solid backing and form supports to ensure stability of textured form liners.
- D. Forms for Cylindrical Columns and Supports: Metal, fiberglass reinforced plastic, or paper or fiber tubes. Construct paper or fiber tubes of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
- E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.
- F. Form Ties: Factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units which will leave no metal closer than 1-1/2" to surface.

2.02 REINFORCING MATERIALS:

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- D. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.
 - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base

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material will not support chair legs.

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).

2.03 CONCRETE MATERIALS:

- A. Portland Cement: ASTM C 150, Type I.
- B. Use one brand of cement throughout project, unless otherwise acceptable to Architect.
- C. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete.
 1. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
 2. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Architect.
- D. Water: Drinkable.
- E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Air-Mix"; Euclid Chemical Co.
 - b. "Sika Aer"; Sika Corp.
 - c. "MB-VR or MB-AE"; Master Builders.
 - d. "Darex AEA" or "Daravair"; W.R. Grace.
 - e. "Edoco 2001 or 2002"; Edoco Technical Products.
 - f. "Air-Tite"; Gifford-Hill/American Admixtures.
- F. Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.
 1. "Forta CR"; Forta Corp.
 2. "Fibermesh"; Fibermesh, Inc.

2.04 RELATED MATERIALS:

- A. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gage galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- B. Waterstops: Provide flat, dumbbell type or centerbulb type waterstops at construction joints and other joints as indicated. Size to suit joints.

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- C. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 2. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - a. AFCO Products.
 - b. The Burke Co.
 - c. Edoco Technical Products.
 - d. Greenstreet Plastic Products.
 - e. Harbour Town Products.
 - f. W.R. Meadows.
 - g. Progress Unlimited.
 - h. Schleigel Corp.
 - i. Vinylex Corp.
- D. Vapor Retarder: Provide vapor retarder cover over prepared base material where indicated below slabs on grade. Use only materials which are resistant to decay when tested in accordance with ASTM E 154, as follows:
1. Polyethylene sheet not less than 8 mils thick.
- E. Non-Shrink Grout: CRD-C 621, factory pre-mixed grout.
1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Metallic
 - 1) "Vibrofoil"; A.C. Horn, Inc.
 - 2) "Metallic Spec. Grout"; The Burke Co.
 - 3) "Embeco 636"; Master Builders.
 - 4) "Ferrolith GDS"; Sonneborn-Rexnord.
 - 5) "Hi-Mod Grout"; Euclid Chemical Co.
 - 6) "Kemox G"; Sika Chemical Co.
 - 7) "Ferrogrout"; L & M Const. Chemical Co.
 - 8) "Supreme Plus"; Gifford-Hill/American Admixtures.
- F. Chemical Hardener: Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 lbs. of fluosilicates per gal.
1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Surfhard"; Euclid Chemical Co.

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- b. "Lapidolith"; Sonneborn-Rexnord.
 - c. "Saniseal"; Master Builders.
 - d. "Burk-O-Lith"; The Burke Co.
- G. Liquid Membrane-Forming Curing Compound: Liquid type membrane- forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.
- 1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Masterseal"; Master Builders.
 - b. "A-H 3 Way Sealer"; Anti-Hydro Waterproofing Co.
 - c. "Ecocure"; Euclid Chemical Co.
 - d. "Clear Seal"; A.C. Horn, Inc.
 - e. "Sealco 309"; Gifford-Hill/American Admixtures.
 - f. "J-20 Acrylic Cure"; Dayton Superior.
 - g. "Spartan-Cote"; The Burke Co.
 - h. "Sealkure"; Toch Div. - Carboline.
 - i. "Kure-N-Seal"; Sonneborn-Rexnord.
 - j. "Polyclear"; Upco Chemical/USM Corp.
 - k. "L&M Cure"; L & M Construction Chemicals.
 - l. "Klearseal"; Setcon Industries.
 - m. "LR-152"; Protex Industries.
 - n. "Hardtop"; Gifford-Hill.

2.05 PROPORTIONING AND DESIGN OF MIXES:

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Architect for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
 - 1. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- B. Submit written reports to Architect and Structural Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Architect.
- C. Design mixes to provide normal weight concrete as indicated on drawings and schedules.
- D. 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 Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in work.
- E. Admixtures:
 - 1. Use water-reducing admixture or high range water-reducing admixture (super plasticizer) in concrete as required for placement and workability.

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2. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
 3. Use high-range water-reducing admixture in pumped concrete, concrete for industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight, and concrete with water/cement ratios below 0.50.
 4. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or-minus 1-1/2 percent within following limits:
- F. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Ramps, slabs, and sloping surfaces: Not more than 3".
 2. Reinforced foundation systems: Not less than 1" and not more than 3".
 3. Concrete containing HRWR admixture (super-plasticizer): Not more than 8" after addition of HRWR to site-verified 2"-3" slump concrete.
 4. Other concrete: Not less than 1" nor more than 4".

2.06 CONCRETE MIXING:

- A. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.
- C. 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.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

3.02 FORMS:

- A. Design, erect, support, brace, and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.
- B. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers,

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blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
- E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.03 VAPOR RETARDER INSTALLATION:

- A. Following leveling and tamping of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour.
- B. Lap joints 6" and seal with appropriate tape.

3.04 PLACING REINFORCEMENT:

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
 - 1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
- D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward

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exposed concrete surfaces.

- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.05 JOINTS:

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Architect.
- B. Provide keyways at least 1-1/2" deep in construction joints in walls, slabs, and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.
- D. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.
- E. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
 - 1. Joint filler and sealant materials are specified in Division-7 sections of these specifications.
- F. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 1/8" x 1/4 slab depth or inserts 1/4" wide x 1/4 of slab depth, unless otherwise indicated.
- G. Form contraction joints by inserting premolded plastic, hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
 - 1. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
- H. If joint pattern not shown, provide joints not exceeding 15' in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third-bays).
 - 1. Joint sealant material is specified in Division-7 sections of these specifications.

3.06 INSTALLATION OF EMBEDDED ITEMS:

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be

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attached thereto.

- B. Install reglets to receive top edge of foundation sheet waterproofing, and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- C. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

3.07 PREPARATION OF FORM SURFACES:

- A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.
- B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.
- C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

3.08 CONCRETE PLACEMENT:

- A. Preplacement 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. Moisten wood forms immediately before placing concrete where form coatings are not used.
 - 1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.
- B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.
- C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
- E. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
- F. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators

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vertically at uniformly spaced locations not farther than visible effectiveness of machine. 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.

- G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
- H. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- I. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
- J. Maintain reinforcing in proper position during concrete placement operations.
- K. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
- L. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (27 deg C) at point of placement.
- M. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
- N. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- O. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
- P. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
- Q. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
- R. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
- S. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

3.09 FINISH OF FORMED SURFACES:

- A. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be

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covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.

- B. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaces, which have received smooth form finish treatment, not later than one day after form removal.
- C. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
- D. Grout Cleaned Finish: Provide grout cleaned finish to scheduled concrete surfaces which have received smooth form finish treatment.
- E. Combine one part portland cement to 1-1/2 parts fine sand by volume, and mix with water to consistency of thick paint. Proprietary additives may be used at Contractor's option. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.
- F. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.
- G. 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.

3.10 MONOLITHIC SLAB FINISHES:

- A. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating, system.
- B. 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, and with surface leveled to tolerances of $F_F 20 - F_L 17$. Grind smooth surface defects which would telegraph through applied floor covering system.
- C. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.
- D. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
- E. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

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- F. Chemical-Hardener Finish: Apply chemical-hardener finish to interior concrete floors where indicated. Apply liquid chemical- hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water (parts of hardener/water as follows), and apply in 3 coats; first coat, 1/3-strength; second coat, 1/2-strength; third coat, 2/3-strength. Evenly apply each coat, and allow 24 hours for drying between coats.
- G. Apply proprietary chemical hardeners, in accordance with manufacturer's printed instructions.
- H. After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

3.11 CONCRETE CURING AND PROTECTION:

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- D. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.
- E. Provide moisture curing by following methods.
 - 1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
- F. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting, and other coatings and finish materials, unless otherwise acceptable to Architect.
- G. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- H. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.
- I. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.
- J. Sealer and Dustproofers: Apply a second coat of specified curing and sealing compound only to surfaces given a first coat.

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3.12 SHORES AND SUPPORTS:

- A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.
- B. Extend shoring from ground to roof for structures 4 stories or less, unless otherwise permitted.
- C. Extend shoring at least 3 floors under floor or roof being placed for structures over 4 stories. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure.
- D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.
- E. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.13 REMOVAL OF FORMS:

- A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

3.14 RE-USE OF FORMS:

- A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Architect.

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3.15 MISCELLANEOUS CONCRETE ITEMS:

- A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. 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.
- C. 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.
- D. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.
- E. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and finish concrete surfaces as scheduled.
- F. 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.

3.16 CONCRETE SURFACE REPAIRS:

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.
- B. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.
- C. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- D. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.
- E. Repair concealed formed surfaces, where possible, that contain defects that affect the

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durability of concrete. If defects cannot be repaired, remove and replace concrete.

- F. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness using a template having required slope.
 - G. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.
 - H. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
 - I. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Architect.
 - J. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 - K. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
 - L. Perform structural repairs with prior approval of Architect or Structural Engineer for method and procedure, using specified epoxy adhesive and mortar.
 - M. Repair methods not specified above may be used, subject to acceptance of Architect.
- 3.17 QUALITY CONTROL TESTING DURING CONSTRUCTION:
- A. The Owner will employ a testing laboratory to perform tests and to submit test reports as outlined in Section 01400.
 - B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Architect.
 - C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

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1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 2. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air- entrained concrete.
 3. Concrete Temperature: Test hourly when air temperature is 40 deg F (4 deg C) and below, and when 80 deg F (27 deg C) and above; and each time a set of compression test specimens made.
 4. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
 5. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yds. plus additional sets for each 50 cu. yds. over and above the first 25 cu. yds. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 6. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
 7. When total quantity of a given class of concrete is less than 50 cu. yds., strength test may be waived by Architect if, in his judgement, adequate evidence of satisfactory strength is provided.
 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 9. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
- D. Test results will be reported in writing to Architect, Structural Engineer and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- F. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

END OF SECTION 03310

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SECTION 03345
CONCRETE FINISHING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included: Provide finishes on cast-in-place concrete as called for on the Drawings, specified herein, and need-ed for a complete and proper installation.
- B. Related work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. Section 03300: Cast-in-place concrete.

1.2 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Except as may be modified herein or otherwise directed by the Architect, comply with ACI 301, "Specifications for Structural Concrete for Buildings."

1.3 SUBMITTALS

- A. Comply with pertinent provisions of Section 01340~
- B. Product data: Within 35 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section;
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
 - 3. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

1.4 PRODUCT HANDLING

- A. Comply with pertinent provisions of Section 01640.

PART 2 - PRODUCTS

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2.1 MATERIALS

A. General:

1. Carefully study the Drawings and these Specifications, and determine the location, extent, and type of required concrete finishes.
2. As required for the Work, provide the following materials, or equals approved in advance by the Architect.

B. Concrete materials: Comply with pertinent provisions of Section 03300, except as may be modified herein.

C. Liquid bonding agent: "Weld-Crete," manufactured by the Larsen Products Corporation.

D. Curing and protection paper:

1. Approved products:
 - a. "Sisalkraft, Orange Label";
 - b. Equal products complying with ASTM C171.
2. Where concrete will be exposed and will be subjected to abrasion, such as floor slabs, use non-staining paper such as "Sisalkraft, Seekure 896," or equal paper faced with polyethylene film.

E. Liquid curing agents:

1. Where application of specified finish materials will be inhibited by use of curing agents, cure the surface by water only; do not use chemical cure.
2. For curing other areas, use "Hunt TLF" manufactured by Hunt Process Company, Inc.

F. Floor sealer: Acceptable products:

1. "Superkote Special Clear Sealer" manufactured by Ven-Chem Company, Inc., P.O. Box 3186, Santa Barbara, California 93105 (213) 342-1195.
2. "Supershield" manufactured by James Darcey Company, Inc., 19712 Merridy Street, Chatsworth, California 91311 (213) 349-3705.

G. Slip-resistant abrasive aggregate:

1. Provide aluminum oxide, 14/36 grading.
2. Acceptable manufacturers:
 - a. Carborundum Company;
 - b. Norton Company;

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c. L. M. Scofield Company.

2.2 OTHER MATERIALS

A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 FINISHING OF FORMED SURFACES

A. General:

1. After removal of forms, give the concrete surfaces one or more of the finishes specified below where so indicated on the Drawings.
2. Revise the finishes as needed to secure the approval of the Architect.

B. As-cast finish:

1. Rough form finish:
 - a. Leave surfaces with the texture imparted by forms, except patch tie holes and defects.
 - b. Remove fins exceeding 1/4" in height.
2. Smooth form finish:
 - a. Coordinate as necessary to secure form construction using smooth, hard, uniform surfaces, with number of seams kept to a practical minimum and in a uniform and orderly pattern.
 - b. Patch tie holes and defects.
 - c. Remove fins completely.

C. Rubbed finishes:

1. Provide these finishes only where specifically called for, and then only on a "smooth form finish" base as described above.
2. Smooth rubbed finish:

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- a. Produce on newly hardened concrete no later than the day following form removal.
 - b. Wet the surfaces, and rub with carborundum brick or other abrasive until uniform color and texture are produced.
 - c. Do not use a cement grout other than the cement paste drawn from the concrete itself by the rubbing process.
3. Grout cleaned finish:
- a. Do not start cleaning operations until all contiguous surfaces to be cleaned are completed and accessible.
 - b. Do not permit cleaning as the work progresses.
 - c. Mix one part portland cement and 1-1/2 parts fine sand with sufficient water to produce a grout having the consistency of thick paint.
 - d. Substitute white portland cement for part of the gray portland cement as required to produce a color matching the color of surrounding concrete, as determined by a trial patch.
 - e. Wet the surface of the concrete sufficiently to prevent absorption of water from the grout, and apply the grout uniformly with brushes or spray gun.
 - f. Immediately after applying the grout, scrub the surface vigorously with a cork float or stone to coat the surface and fill all air bubbles and holes.
 - g. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, sack, or other means.
 - h. After the surface whites from drying (about 30 minutes at normal temperatures), rub vigorously with clean burlap.
 - i. Keep the surface damp for at least 36 hours after final rubbing.
- D. Unspecified finish: If the finish of formed surfaces is not specifically called out elsewhere in the Contract Documents, provide the following finishes as applicable.
1. Rough form finish:
 - a. For all concrete surfaces not exposed to public view.
 2. Smooth form finish:
 - a. For all concrete surfaces exposed to public view.
- 3.3 FINISHING SLABS
- A. Definition of finishing tolerances:

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1. "Class A": True plane within 1/8" in ten feet as determined by a ten foot straightedge placed anywhere on the slab in any direction.
 2. "Class B": True plane within 1/4" in ten feet as determined by a ten foot straightedge placed anywhere on the slab in any direction.
 3. "Class C": True plane within 1/4" in two feet as determined by a two foot straightedge placed anywhere on the slab in any direction.
- B. Scratched finish: After the concrete has been placed, consolidated, struck off, and leveled to a Class C tolerance, roughen the surface with stiff brushes or rakes before the final set.
- C. Floated finish:
1. After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further until ready for floating.
 2. Begin floating when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation.
 3. During or after the first floating, check the planeness of the surface with a ten-foot straightedge applied at not less than two different angles.
 4. Cut down high spots and fill low spots, and produce a surface with a Class B tolerance throughout.
 5. Refloat the slab immediately to a uniform sandy texture.
- D. Troweled finish:
1. Provide a floated finish as described above, followed by a power troweling and then a hand troweling.
 - a. Produce an initial surface which is relatively free from defects, but which still may show some trowel marks.
 - b. Provide hand troweling when a ringing sound is produced as the trowel is moved over the surface.
 - c. Thoroughly consolidate the surface by hand troweling.
 2. Provide a finished surface essentially free from trowel marks, uniform in texture and appearance, and in a plane of Class A tolerance.
 - a. For concrete on metal deck, Class B plane tolerance is acceptable.
 - b. On surfaces intended to support floor coverings, use grinding or other means as necessary and remove all defects of such magnitude as would show through the floor covering.

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- E. Broom finish:
1. Provide a floated finish as described above.
 2. While the surface is still plastic, provide a textured finish by drawing a fiber bristle broom uniformly over the surface.
 3. Unless otherwise directed by the Architect, provide the texturing in one direction only. Provide "light," "medium," or "coarse" texturing as directed by the Architect or otherwise called for on the Drawings,
 4. Provide "light," "medium," or "coarse" texturing as directed by the Architect or otherwise called for on the Drawings.
- F. Unspecified finish: If the finish of slab surfaces is not specifically called for elsewhere in the Contract Documents, provide the following finishes as applicable:
1. Scratched finish:
 - a. For surfaces scheduled to receive bond-applied cementitious applications.
 2. Floated finish:
 - a. For surfaces intended to receive roofing.
 3. Troweled finish:
 - a. For floors intended as walking surfaces;
 - b. Floors scheduled to receive floor coverings or waterproof membrane;
 4. Broom finish:
 - a. Exterior pedestrian ramps.
 5. Non-slip finish:
 - a. Platforms, steps, and landings;
 - b. Exterior pedestrian ramps.
- 3.4 CURING AND PROTECTION
- A. Beginning immediately after placement, protect concrete from premature drying, excessively hot and cold temperatures, and mechanical injury.
- B. Preservation of moisture:
1. Unless otherwise directed by the Architect, apply one of the following procedures to concrete not in contact with forms, immediately after completion of placement and finishing.

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- a. Ponding or continuous sprinkling;
 - b. Application of absorptive mats or fabric kept continuously wet;
 - c. Application of sand kept continuously wet;
 - d. Continuous application of steam (not exceeding 150 degrees F) or mist spray;
 - e. Application of waterproof sheet materials specified in Part 2 of this Section;
 - f. Application of other moisture-retaining covering as approved by the Architect;
 - g. Application of the curing agent specified in Part 2 of this Section or elsewhere in the Contract Documents.
2. Where forms are exposed to the sun, minimize moisture loss by keeping the forms wet until they can be removed safely.
 3. Cure concrete by preserving moisture as specified above for at least seven days.
- C. Temperature, wind, and humidity:
1. Cold weather:
 - a. When the mean daily temperature outdoors is less than 40 degrees F, maintain the temperature of the concrete between 50 degrees F and 70 degrees F for the required curing Period.
 - b. When necessary, provide proper and adequate heating system capable of maintaining the required heat without injury due to concentration of heat.
 - c. Do not use combustion heaters during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases, which contain carbon dioxide.
 2. Hot weather: When necessary, provide wind breaks, fog spraying, shading, sprinkling, ponding, or wet covering with a light colored material, applying as quickly as concrete hardening and finishing operations will allow.
 3. Rate of temperature change: Keep the temperature of the air immediately adjacent to the concrete during and immediately following the curing period as uniform as possible and not exceeding a change of 5 degrees F in any one hour period, or 50 degrees F in any 24 hour period.
- D. Protection from mechanical injury:
1. During the curing period, protect the concrete from damaging mechanical disturbances such as heavy shock, load stresses, and excessive vibration.

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2. Protect finished concrete surfaces from damage from construction equipment, materials, and methods, by application of curing procedures, and by rain and running water.
3. Do not load self-supporting structures in such a way as to overstress the concrete.

END OF SECTION 03345