

SECTION 03290 – UNDER-SLAB VAPOR BARRIER

PART 1 – GENERAL

1.1 SUMMARY

- A. Products Supplied Under This Section
 - 1. Vapor Barrier, seam tape, pipe boots, detail strip for installation under concrete slabs.
- B. Related Sections
 - 1. Section 03300 Cast-in-place Structural Concrete

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM E 1745-97 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil Or Granular Fill Under Concrete Slabs
 - 2. ASTM E 154-88 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs
 - 3. ASTM E 96-95 Standard Test Methods for Water Vapor Transmission of Materials
 - 4. ASTM E 1643-98 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
- B. American Concrete Institute (ACI)
 - 1. ACI 302.1R-96 Vapor Barrier Component

1.3 SUBMITTALS

- A. Quality Control / Assurance
 - 1. Independent laboratory test results showing compliance with ASTM & ACI Standards.
 - 2. Manufacturer's samples, literature
 - 3. Manufacturer's installation instructions for placement, seaming and pipe boot installation

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Vapor Barrier (Performance based specification)

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1. Vapor Barrier membrane must have the following properties.
 - a. Minimum WVTR as tested by ASTM E96 of 0.008
 - b. Water Vapor Barrier ASTM E-1745, 0.01 Perms. Meets or exceeds Class B
 - c. Water Vapor Transmission Rate ASTM E-96 0.006 gr./ft²/hr. or lower
 - d. Permeance Rating ASTM E-96 0.01 gr./ft²/hr. or lower
 - e. Puncture Resistance ASTM E-1745 minimum 1970 grams
 - f. Tensile Strength ASTM E-1745 minimum 45.0 lbf/in

2. Vapor Barriers
 - a. Stego (15mil) Vapor Barrier by STEGO INDUSTRIES LLC.
 - b. W.R. Meadows Premoulded Membrane with Plasmatic Core
 - c. Vaporguard by Reef industries.

2.2 ACCESSORIES

- A. Seam Tape
 1. High Density Polyethylene Tape with pressure sensitive adhesive. Minimum width 4 inches.

- B. Pipe Boots
 2. Construct pipe boots from vapor barrier material and pressure sensitive tape per manufacturer's instructions.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Ensure that subsoil is approved by architect
 1. Level and tamp or roll aggregate, sand or tamped earth base.

3.2 INSTALLATION

- A. Install Vapor Barrier:
 1. Installation shall be in accordance with manufacturer's instructions and ASTM E 1643–98.
 - a. Unroll Vapor Barrier with the longest dimension parallel with the direction of the pour.
 - b. Lap Vapor Barrier over footings and seal to foundation walls.
 - c. Overlap joints 6 inches and seal with manufacturer's tape.
 - d. Seal all penetrations (including pipes) with manufacturer's pipe boot.
 - e. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities.

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- f. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all four sides with tape.

END OF SECTION 03290

SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
- B. Related Sections:
 - 1. Division 01 Section "Construction Waste Management"
 - 2. Division 01 Section "LEED Requirements"
 - 3. Division 03 Section "Cast-in-Place Architectural Concrete" for general building applications of specially finished formed concrete.

1.3 SUBMITTALS

- A. General - Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product 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 for reinforcement, prepared by registered Professional Engineer for fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual," showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- C. Shop drawings for formwork, 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 that affect exposed concrete visually. Formwork shop drawings must be signed and sealed by a professional engineer In the State of Florida.
 - 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 of materials as requested by Architect, including names, sources, and

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descriptions, as follows:

1. Normal weight aggregates.
 2. Fibrous reinforcement.
 3. Reglets.
 4. Waterstops.
 5. Vapor retarder.
- E. Laboratory test reports for concrete materials and mix design test. Provide test data sample with standard deviation calculations for each mix submitted.
- F. Materials certificates in lieu of materials laboratory test reports when permitted by Architect. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.4 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 318, "Building Code Requirements for Reinforced Concrete."
 2. ACI 301 "Specifications for Structural Concrete for Buildings."
 3. ACI 304 "Recommended Practice for Measuring, Transporting, and Placing Concrete."
 4. ACI 311 "Recommended Practice for Concrete Inspection."
 5. ACI 315 "Manual of Standard Practice for Detailing Concrete Structures"
 6. ACI 347 "Recommended Practice for Concrete Formwork"
 7. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."
- B. Concrete Testing Service - Engage a testing laboratory acceptable to Architect to perform material evaluation tests and to design concrete mixes.
- C. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.
- D. Full cooperation shall be given to mechanical, electrical, and plumbing installers to allow them time to coordinate and install all items of their work which are to be encased or built into concrete. Contractor to assure that other work such as sleeves, electrical conduits, pipes, anchors, etc., are properly placed and secured in position before concrete is placed. Items that require inspection shall have been inspected and tested for both material and mechanical operation and shall have been completed before concrete is placed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site at such intervals to insure uninterrupted progress of work.
- B. Store materials to permit easy access for inspection and identification. Keep

reinforcement steel under cover and off the ground using supports. Protect reinforcing steel from rusting, oil, grease, or distortion.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Unless otherwise shown or specified, construct all formwork for exposed concrete surfaces with a rigid non-absorptive material to offer optimum appearance and leave a smooth, stain-free surface. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without objectionable bow or deflection. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
 - 1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.
 - 2. 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. Form Coatings - Provide commercial formulation form-coating compounds with a maximum VOC of 350 mg/l that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Form Ties - Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface.
 - 1. Provide ties that, when removed, will leave holes not larger than 1-inch diameter in concrete surface.
- E. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars - Reinforcing steel must be correctly rolled to section and free from all surface defects and shall be in accordance with ASTM A615 Grade 60 as evidenced by manufacturer's certificates. The grade of steel shall be intermediate, new billet stock. All bars shall be deformed and rolled with raised symbols to identify the manufacturer and the size of the bar.
- B. Galvanized Reinforcing Bars - ASTM A 767, Class II (2.0 oz. zinc psf) hot-dip galvanized, after fabrication and bending.

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- C. Epoxy-Coated Reinforcing Bars - ASTM A 775.
- D. Steel Wire - ASTM A 82, plain, cold-drawn steel.
- E. Welded Wire Fabric - ASTM A 185, welded steel wire fabric.
- F. Welded Deformed Steel Wire Fabric - ASTM A 497.
- G. 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 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 that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.3 CONCRETE MATERIALS

- A. Portland Cement - ASTM C 150, Type I.
 - 1. Use one brand of cement throughout project unless otherwise acceptable to Architect.
- B. Fly Ash - ASTM C 618, Type C or Type F., 20% max.
- 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 that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when acceptable to Architect.
 - 3. Use #89 Georgia Granite aggregate in all concrete mixtures for all interior polished concrete floor slabs including the Apparatus Bay floor slab.
- D. Lightweight Aggregates - ASTM C 330.
- E. Water - Drinkable.
- F. Admixtures, General - Provide admixtures for concrete that contain not more than 0.05 percent chloride ions.
- G. 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 that may be incorporated in the work include, but are not limited to, the following:
 - a. "Air-Tite," Cormix.

- b. "Air-Mix" or "Perma-Air," Euclid Chemical Co.
- c. "Darex AEA" or "Daravair," W.R. Grace & Co.
- d. "MB-VR" or "Micro-Air," Master Builders, Inc.
- e. "Sealtight AEA," W.R. Meadows, Inc.
- f. "Sika AER," Sika Corp.

2. **Omit Air-entraining admixture from all concrete mixtures for all interior concrete floor slabs including the Apparatus Bay floor slab.**

H. Water-Reducing Admixture - ASTM C 494, Type A.

- 1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Chemtard," ChemMasters Corp.
 - b. "PSI N," Cormix.
 - c. "Eucon WR-75," Euclid Chemical Co.
 - d. "WRDA," W.R. Grace & Co.
 - e. "Pozzolith Normal" or "Polyheed," Master Builders, Inc.
 - f. "Prokrete-N," Prokrete Industries.
 - g. "Plastocrete 161," Sika Corp.

I. High-Range Water-Reducing Admixture (Super Plasticizer) - ASTM C 494, Type F or Type G. May be used in all pumped concrete and concrete with a water-cement ratio below 0.50.

- 1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Super P," Anti-Hydro Co., Inc.
 - b. "PSI Super," Cormix.
 - c. "Eucon 37," Euclid Chemical Co.
 - d. "WRDA 19" or "Daracem," W.R. Grace & Co.
 - e. "Rheobuild," Master Builders, Inc.
 - f. "PSP," Prokrete Industries.
 - g. "Sikament 300," Sika Corp.

J. Water-Reducing, Accelerating Admixture - ASTM C 494, Type E.

- 1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Q-Set," Conspec Marketing & Manufacturing Co.
 - b. "Gilco Accelerator," Cormix.
 - c. "Accelguard 80," Euclid Chemical Co.
 - d. "Daraset," W.R. Grace & Co.
 - e. "Pozzutec 20," Master Builders, Inc.

K. Water-Reducing, Retarding Admixture - ASTM C 494, Type D.

- 1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

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- a. "PSI-R Plus," Cormix.
 - b. "Eucon Retarder 75," Euclid Chemical Co.
 - c. "Daratard-17," W.R. Grace & Co.
 - d. "Pozzolith R," Master Builders, Inc.
 - e. "Protard," Prokrete Industries.
 - f. "Plastiment," Sika Corporation.
- L. Fibrous Reinforcement - Engineered polypropylene fibers designed for secondary reinforcement of concrete slabs.
1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Fiberstrand 100," Euclid Chemical Co.
 - b. "Fibermesh," Fibermesh, Inc.
 - c. "Forta CR," Forta Corp.
 - d. "Grace Fibers," W.R. Grace & Co.

2.4 RELATED MATERIALS

- A. Joint Filler: Expansion joint fillers shall be asphalt impregnated fiber board conforming to ASTM D-1751. Joint fillers shall extend full depth of slab or joint and be thickness and lengths indicated on drawings.
- B. Anchor Slots: Hot-Dipped galvanized, #22 ga. metal, felt filled, equal to No. 305 made by Hohman & Bernard or approved equal.
- C. Inserts: Inserts shall be either adjustable, threaded or wedge types depending on use as manufactured by Hohman & Bernard or approved equal.
- D. Reglets - Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217 inch thick (26-gage) galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- E. Waterstops - Provide flat, dumbbell-type or centerbulb-type waterstops at construction joints and other joints as indicated. Size to suit joints.
- F. Rubber Waterstops - Corps of Engineers CRD-C 513.
 1. Available Manufacturers - Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
 - a. The Burke Co.
 - b. Progress Unlimited.
 - c. Williams Products, Inc.
- G. Polyvinyl Chloride Waterstops - Corps of Engineers CRD-C 572.

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1. Available Manufacturers - Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
 - a. The Burke Co.
 - b. Greenstreak Plastic Products Co.
 - c. W.R. Meadows, Inc.
 - d. Progress Unlimited.
 - e. Schlegel Corp.
 - f. Vinylex Corp.

- H. Granular Base - Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.

- I. Sand Cushion - Clean, manufactured or natural sand.

- J. Vapor Retarder - Provide vapor retarder cover over prepared base material where indicated below slabs on grade. Use only materials that are resistant to deterioration when tested in accordance with ASTM E 154, as follows:
 1. Water-resistant barrier consisting of heavy Kraft papers laminated together with glass-fiber reinforcement and overcoated with black polyethylene on each side.

- K. Vapor Barrier - Premoulded membrane, seven-ply construction consisting of reinforced core and carrier sheet with fortified bitumen layers, protective weathercoating, and plastic antistick sheet. Water vapor transmission rate of 0.00 grains/sq. ft./hr. when tested in accordance with ASTM E 96, Method B. Provide manufacturer's recommended mastics and gusset tape.
 1. Product - "Sealtight Premoulded Membrane with Plasmatic Core," W.R. Meadows, Inc.
 2. Absorptive Cover - Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

- L. Moisture-Retaining Cover - One of the following, complying with ASTM C 171.
 1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.

- M. Water-Based Acrylic Membrane Curing Compound - ASTM C 309, Type I, Class B.
 1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Conhard," Conspec Marketing and Mfg. Co.
 - b. "Safe Cure and Seal," Dayton Superior Corp.
 - c. "Aqua-Cure," Euclid Chemical Co.

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- d. "Dress & Seal #18WB," L&M Construction Chemicals, Inc.
 - e. "Masterseal W," Master Builders, Inc.
 - f. "Intex," W.R. Meadows, Inc.
 - g. "Sika Membrane," Sika Corp.
- N. Evaporation Control - Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
- 1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Eucobar," Euclid Chemical Co.
 - b. "E-Con," L&M Construction Chemicals, Inc.
 - c. "Confilm," Master Builders, Inc.
- O. Underlayment Compound - Free-flowing, self-leveling, pumpable, cement-based compound for applications from one inch thick to feathered edges.
- 1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "K-15," Ardex, Inc.
 - b. "Conflow," Conspec Marketing and Mfg. Co.
 - c. "LevelLayer II," Dayton Superior Corp.
 - d. "Flo-Top," Euclid Chemical Co.
 - e. "Levelex," L&M Construction Chemicals, Inc.
 - f. "Pourcrete," Master Builders, Inc.
 - g. "Stoncrete UL1," Stonhard, Inc.
 - h. "Thoro Underlayment Self-Leveling," Thoro System Products.
- P. Bonding Compound - Polyvinyl acetate or acrylic base.
- 1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. Polyvinyl Acetate (Interior Only):
 - 1. "Superior Concrete Bonder," Dayton Superior Corp.
 - 2. "Euco Weld," Euclid Chemical Co.
 - 3. "Weld-Crete," Larsen Products Corp.
 - 4. "Everweld," L&M Construction Chemicals, Inc.
 - b. Acrylic or Styrene Butadiene:
 - 1. "Acrylic Bondcrete," The Burke Co.
 - 2. "Strongbond," Conspec Marketing and Mfg. Co.
 - 3. "Day-Chem Ad Bond," Dayton Superior Corp.
 - 4. "SBR Latex," Euclid Chemical Co.
 - 5. "Daraweld C," W.R. Grace & Co.
 - 6. "Hornweld," A.C. Horn, Inc.
 - 7. "Everbond," L & M Construction Chemicals, Inc.

8. "Acryl-Set," Master Builders Inc.
 9. "Intralok," W.R. Meadows, Inc.
 10. "Sonocrete," Sonneborn-Rexnord.
 11. "Stonlock LB2," Stonhard, Inc.
- Q. Epoxy Adhesive - ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type," "Grade," and "Class" to suit project requirements.
1. Available Products - Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Burke Epoxy M.V.," The Burke Co.
 - b. "Spec-Bond 100," Conspec Marketing and Mfg. Co.
 - c. "Euco Epoxy System #452 or #620," Euclid Chemical Co.
 - d. "Epoxite Binder 2390," A.C. Horn, Inc.
 - e. "Epabond," L&M Construction Chemicals, Inc.
 - f. "Concresive 1001," Master Builders, Inc.
 - g. "Sikadur 32 Hi-Mod," Sika Corp.
- R. Non-Shrink Grout: Non-Shrink Grout: Pre-mixed non-shrink grout as called for on drawings shall be manufactured by:
1. The Euclid Chemical Company -"Euco N-S Group" (All exposed grout).
 2. The Euclid Chemical Company - "Firmix".
 3. Master Builders - "Embeco 885".
 4. Anto-Hydro Company - "Axpandcrete Metallics."
 5. Sonneborn - "Ferrolith G".
 6. Lambert Corporation - "Vibropruf #11"
- S. Chemical 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 fluosilicate per gal.

2.5 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 batches are selected as the method of proportioning, the mix design shall be proportioned to achieve an average 28-day compressive strength of 1200 psi in excess of the design strength indicated on the Contract drawings, 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 20 percent of cement content by weight.
- B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until proposed mix designs have been reviewed by Architect.

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- C. Design mixes to provide normal weight concrete with the following properties, as indicated on drawings and schedules:
1. 5000-psi, 28-day compressive strength; W/C ratio, 0.42 maximum (non-air-entrained), 0.40 maximum (air-entrained).
 2. 4000-psi, 28-day compressive strength; W/C ratio, 0.45 maximum (non-air-entrained), 0.42 maximum (air-entrained)
 3. 3500-psi, 28-day compressive strength; W/C ratio, 0.48 maximum (non-air-entrained), 0.45 maximum (air-entrained).
 4. 3000-psi, 28-day compressive strength; W/C ratio, 0.52 maximum (non-air-entrained), 0.48 maximum (air-entrained).
 5. 2500-psi, 28-day compressive strength; W/C ratio, 0.56 maximum (non-air-entrained), 0.54 maximum (air-entrained).
 6. Maximum water-cement (W/C) ratio for the following conditions should be as follows:
 - a. Subjected to freezing and thawing; W/C 0.45.
 - b. Subjected to brackish water, salt spray, or deicers; W/C 0.40
 - c. Concrete required to be watertight; W/C 0.40.
- D. Lightweight Concrete - Proportion mix as specified. Design mix to produce strength and modulus of elasticity as noted on drawings, with a splitting tensile strength factor (Fct) of not less than 5.5 for 3000-psi concrete and a dry weight of not less than 95 lbs. or more than 110 lbs. after 28 days. Limit shrinkage to 0.03 percent at 28 days.
- E. Maximum Slump:
1. Concrete containing the specified high range water reducing admixture (superplasticizer) shall have a maximum slump of 8 inches after addition of HRWR, unless otherwise approved by the Architect.
 2. Ramps Slabs, and sloping surfaces – Not more than 3 inches.
 3. Reinforced foundations system – Not less than 1 inch and not more than 4 inches.
 4. All other concrete shall have a maximum slump of 4 inches, +/- 1 inch.
- F. 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, 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.

2.6 ADMIXTURES

- A. Use water-reducing admixture or high-range water-reducing admixture (Superplasticizer) in concrete as required for placement and workability.
- B. Use nonchloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
- C. Use high-range water-reducing admixture (HRWR) 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.

- D. 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 1.5% within following limits:
- E.
 - 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
 - a. 4.5 percent (moderate exposure); 5.5 percent (severe exposure) 1-1/2-inch max. aggregate.
 - b. 4.5 percent (moderate exposure); 6.0 percent (severe exposure) 1-inch max. aggregate.
 - c. 5.0 percent (moderate exposure); 6.0 percent (severe exposure) 3/4-inch max. aggregate.
 - d. 5.5 percent (moderate exposure); 7.0 percent (severe exposure) 1/2-inch max. aggregate.
 - 2. Other concrete (not exposed to freezing, thawing, or hydraulic pressure) or to receive a surface hardener: 3% air.
- F. Use admixtures for water reduction and set control in strict compliance with manufacturer's directions.

2.7 CONCRETE MIXING

- A. Job-Site Mixing - Mix materials for concrete in appropriate drum-type batch machine mixer. For mixers of one cu. yd. or smaller capacity, continue mixing at least 2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum and maximum mixing time by 15 seconds for each additional cu. yd. or fraction thereof.
- B. 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.
- C. Ready-Mix Concrete - Comply with requirements of ASTM C 94, and as specified.
- D. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

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3.1 GENERAL

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

3.2 FORMS

- A. General - Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. 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. 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, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- C. 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, 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 in 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. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER/BARRIER INSTALLATION

- A. General - Following leveling and tamping of granular base for slabs on grade, place vapor retarder/barrier sheeting with longest dimension parallel with direction of pour.

- B. Lap joints 6 inches and seal vapor barrier joints with manufacturers' recommended mastic and pressure-sensitive tape.
- C. After placement of vapor retarder/barrier, cover with sand cushion and compact to depth as shown on drawings.

3.4 PLACING REINFORCEMENT

- A. General - 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.
- B. Avoid cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- C. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect.
- E. 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 exposed concrete surfaces.
- F. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 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. Construction joints must be per FBC Sections 1907.4.1 and 1907.4.2.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and 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. Do not continue reinforcement through sides of strip placements.
- D. Use bonding agent on existing concrete surfaces that will be joined with fresh

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concrete.

- E. 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. Field-fabricate joints in waterstops in accordance with manufacturer's printed instructions.
- F. 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.
- G. Joint filler and sealant materials are specified in Division 7 Sections of these specifications.
- H. 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 inch wide by 1/4 slab depth or inserts 1/4 inch wide by 1/4 of slab depth, unless otherwise indicated.
 - 1. 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.
 - 2. 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.
 - 3. If joint pattern not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
- I. Joint Spacing: Unless otherwise noted, the maximum spacing of construction joints shall be as follows:
 - 1. Foundation walls, walls: Forty-five (45) feet.
 - 2. Slabs: Fifteen (15) feet.

3.6 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 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. Forms for Slabs - Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type

screeds.

3.7 PREPARATION OF FORM SURFACES

- A. General - Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before reinforcement is placed.
- B. 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.
- C. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.8 CONCRETE PLACEMENT

- A. General: Concrete shall be conveyed from the mixer to the forms as quickly as possible by method which will prevent segregation and loss of materials. Concrete shall be deposited in the forms as nearly as practicable in its final position to avoid re-handling. Special care shall be exercised to prevent splashing of forms or reinforcement with concrete in advance of pouring. Concrete shall be deposited in a continuous manner until a given unit of construction, as approved by the Architect, has been completed.

Placement of the following concrete shall be prohibited:

- 1. Partially hardened concrete.
- 2. Contaminated concrete.
- 3. Re-tempered concrete.
- 4. Concrete that has been re-mixed after initial set.

- B. 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.
- C. General - Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.
- D. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that 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 to avoid segregation at its final location.
- E. Placing Concrete in Forms - Deposit concrete in forms in horizontal layers not deeper than 24 inches 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.

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- F. 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.
1. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches 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.
1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position during concrete placement.
- H. Cold-Weather Placing - Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. 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. Water shall not be heated over 180 deg. F.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
 4. Concrete work shall be protected by wind breaks, curing compounds, and blanket covers if necessary in order to maintain the concrete in-place temperatures of at least 50 deg. F. for a period of seven (7) days after placing. If high early strength concrete is used, this time period may be reduced to three (3) days
- I. 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.
4. 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.

5. 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.
6. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
7. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, when acceptable to Architect.

3.9 FINISH OF FORMED SURFACES

- A. Rough Form Finish - For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth Form Finish - For formed concrete surfaces exposed to view or to be 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 an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. 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.
 1. 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 that have received smooth form finish treatment.
 1. Combine one part portland cement to 1-1/2 parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to consistency of thick paint. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.
 2. Thoroughly wet concrete surfaces, 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.
- E. Related Unformed Surfaces - At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and

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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. Scratch Finish - Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated. After placing slabs, plane surface to tolerances for floor flatness (Ff) of 15 and floor levelness (Fl) of 13. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.
- B. Float Finish - Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and as otherwise indicated.

After screening, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to tolerances of Ff 18 - Fl 15. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

- C. 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. 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 Ff 20 - Fl 17. Grind smooth surface defects that would telegraph through applied floor covering system.
- D. 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.
- E. Nonslip Broom Finish - Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. 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.
- F. After completion of float finishing and before starting trowel finish, uniformly spread 25 lbs. of dampened nonslip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.

- G. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose nonslip aggregate.

3.11 CONCRETE CURING AND PROTECTION

- A. General - Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- 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 at 50 degrees F minimum temperature.
- C. 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.
- D. Provide moisture curing by following methods.
 - 1. Keep concrete surface continuously wet by covering with water.
 - 2. Use continuous water-fog spray.
 - 3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
- E. Provide moisture-cover curing as follows:
 - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- F. Provide curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs as follows:
 - 1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). 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.
 - 2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
- G. Curing Formed Surfaces - Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in

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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.

3.12 SHORES AND SUPPORTS

- A. General - 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 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. General - 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 at least 75 percent of 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 REUSE OF FORMS

- A. Clean and repair surfaces of forms to be reused 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.

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. 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 inch 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 inch. 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 before 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.

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- E. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.
- F. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- G. 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 and smoothness by using a template having required slope.
- H. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
- I. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
- J. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.
- K. Repair defective areas, except random cracks and single holes not exceeding 1 inch in 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-inch 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.
- L. Repair isolated random cracks and single holes not over 1 inch 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 before 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.
- M. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive and mortar.
- N. Repair methods not specified above may be used, subject to acceptance of Architect.

3.17 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General - The Owner will employ a testing laboratory to perform tests and to submit test reports.
- B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Architect.
 - 1. Sampling Fresh Concrete - ASTM C 172, except modified for slump to comply with ASTM C 94.
 - 2. 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.
 - 3. 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.
 - 4. Concrete Temperature - Test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and each time a set of compression test specimens is made.
 - 5. 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.
- C. 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. more than 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.
- D. When frequency of testing will provide fewer 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.
- E. When total quantity of a given class of concrete is less than 50 cu. yds., Architect may waive strength test if adequate evidence of satisfactory strength is provided.
- F. 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.
- G. 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.
- H. Test results will be reported in writing to Architect, Structural Engineer, Ready-Mix Producer, 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,

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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.

- I. 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.
- J. 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
- K. ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

END OF SECTION 03300

SECTION 03351 – POLISHED CONCRETE FINISHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: This Section specifies [Dyed and] polished concrete.

B. Related Sections:

1. Division 1 Section “LEED Requirements”.
2. Division 3 Section “Cast-in-Place Concrete”.
3. Division 7 Section “Joint Fillers”.

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 302.1R Guide for Concrete Floor and Slab Construction.

B. ASTM International:

1. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
2. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete.
3. ASTM C779 Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.

C. Reunion Internationale des Laboratoires D'Essais et de Recherches sur les Matériaux et les Constructions (RILEM):

1. Rilem Test Method 11.4 Standard Measurement of Reduction of Moisture Penetration Through Horizontal Concrete Surfaces.

D. National Floor Safety Institute (NFSI):

1. NFSI Test Method 101-A Standard for Evaluating High-Traction Flooring Materials, Coatings, and Finishes.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements: Provide polished flooring that has been selected, manufactured and installed to achieve the following:

1. Abrasion Resistance: ASTM C779, Method A, high resistance, no more than 0.008 inch (0.20 mm) wear in 30 minutes.
2. Reflectivity: Increase of 35% as determined by standard gloss meter.
3. Waterproof Properties: Rilem Test Method 11.4, 70% or greater reduction in absorption.
4. High Traction Rating: NFSI 101-A, non-slip properties.

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B. Design Requirements:

1. Hardened Concrete Properties:

- a. Minimum Concrete Compressive Strength: 3500 psi (24 MPa).
- b. Normal Weight Concrete: No lightweight aggregate.
- c. Non-air entrained.

2. Placement Properties:

- a. Natural concrete slump of 4 1/2 inches - 5 inches (114 - 127 mm). Admixtures may be used.

b. Flatness Requirements:

- 1) Overall FF 40.
- 2) Local FF 20.

3. Hard-Steel Troweled (3 passes) Concrete: No burn marks. Finish to ACI 302.1R, Class 5 floor.

- a. Class 6 floors, special colored mineral aggregate hardener with repeated hard steel trowel finish.

4. Curing Options:

- a. Membrane forming curing compounds (ASTM C309, Type 1, Class B, all resin, dissipating cure).

- 1) Acrylic curing and sealing compounds not recommended.

- b. Sheet membrane (ASTM C171); polyethylene film not recommended.

- c. Damp Curing: Seven day cure.

1.4 ACTION SUBMITTALS

A. General: Submit listed action submittals in accordance with Contract Conditions and Division 1 Section "Submittal Procedures".

B. Shop Drawings: Indicate information on shop drawings as follows:

- 1. Typical layout including dimensions and floor grinding schedule.
- 2. Plan view of floor and joint pattern layout.
- 3. Areas to receive colored surface treatment.
- 4. Hardener, sealer, densifier in notes.

C. Product Data: Submit product data, including manufacturer's SPEC-DATA® product sheet, for specified products.

- 1. Material Safety Data Sheets (MSDS).
- 2. Preparation and concrete grinding procedures.
- 3. Colored Concrete Surface, Dye Selection Guides.

1.5 INFORMATION SUBMITTALS

A. Quality Assurance:

1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties as cited in 1.03 Performance Requirements.

2. Certificates:

- a. Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

- b. Letter of certification from the National Floor Safety Institute confirming the system has been tested and passed phase Two Level of certification when tested by Method 101-A.
- c. Current contractor's certificate signed by manufacturer declaring contractor as an approved installer of polishing system.
- 3. Manufacturer's Instructions: Manufacturer's installation instructions.

1.6 CLOSEOUT SUBMITTALS

- A. Warranty: Submit warranty documents specified.

- B. Operation and Maintenance Data: Submit operation and maintenance data for installed products in accordance with Division 1 Section "Closeout Procedures".
 - 1. Include:
 - a. Manufacturer's instructions on maintenance renewal of applied treatments.
 - b. Protocols and product specifications for joint filing, crack repair and/or surface repair.

1.7 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
 - 2. Installer trained and holding current certification for FGS PermaShine installation.
 - 3. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.

 - 4. .

- B. Regulatory Requirements.
 - 1. NFSI Test Method 101-A Phase Two Level High Traction Material.

- C. Mock-Ups:
 - 1. Construct mock-ups in accordance with Division 1 Section "Quality Requirements".
 - 2. Mock-Up Size: [100 ft² (9.3 m²)] sample panel at jobsite at location as directed under conditions similar to those which will exist during actual placement.
 - 3. Mock-up will be used to judge workmanship, concrete substrate preparation, operation of equipment, material application, color selection and shine.
 - 4. Allow [24] hours for inspection of mock-up before proceeding with work.
 - 5. When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

- D. Preinstallation Meetings: Conduct a preinstallation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with [Section 01 31 19 - Project Meetings]. Review the following:
 - 1. Environmental requirements.
 - 2. Scheduling and phasing of work.
 - 3. Coordinating with other work and personnel.
 - 4. Protection of adjacent surfaces.
 - 5. Surface preparation.
 - 6. Repair of defects and defective work prior to installation.

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7. Cleaning.
8. Installation of polished floor finishes.
9. Application of liquid hardener, densifier.
10. Protection of finished surfaces after installation.

1.8 DELIVERY, STORAGE & HANDLING

A. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

B. Delivery:

1. Deliver materials in manufacturer's original packaging with identification labels and seals intact.

C. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
2. Protect concrete slab.
 - a. Protect from petroleum stains during construction.
 - b. Diaper hydraulic power equipment.
 - c. Restrict vehicular parking.
 - d. Restrict use of pipe cutting machinery.
 - e. Restrict placement of reinforcing steel on slab.
 - f. Restrict use of acids or acidic detergents on slab.

D. Waste Management and Disposal:

1. Separate waste materials for Reuse And Recycling in accordance with Division 1 Section "Construction Waste Management".
2. Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.9 PROJECT AMBIENT CONDITIONS

A. Installation Location: Comply with manufacturer's written recommendations.

1.10 SEQUENCING

A. Sequence With Other Work: Comply with manufacturer's written recommendations for sequencing construction operations.

1.11 WARRANTY

A. Project Warranty: Refer to Contract Conditions for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and does not limit, other rights Owner may have under Contract Documents.

C. Warranty: Commencing on date of acceptance by Owner.

1.12 MAINTENANCE

A. Comply with manufacturer's written instructions to maintain installed product.

1.13 EXTRA MATERIALS

A. General Contractor to provide maintenance materials in accordance with Section [01 78 00 - Closeout Submittals].

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Ensure manufacturer has minimum [5] years experience in manufacturing components similar to or exceeding requirements of project.

2.2 Polished Concrete Finishing Products

A. Manufacturer: L & M Construction Chemicals, Inc.

1. Contact: 14851 Calhoun Rd., Omaha, NE 68152-1140; Telephone: (800) 362-3331, (402) 453-6600; Fax: (402) 453-0244; website: www.LMCC.com, www.fgs-permashine.com; E-mail: info@lmcc.com.

B. Proprietary Products/Systems:

1. Hardener, Sealer, Densifier: Proprietary, water based, odorless liquid, VOC compliant, environmentally safe chemical hardening solution leaving no surface film.

a. Acceptable Material: L & M Construction Chemicals, Inc., FGS Hardener Plus.

2. Joint Filler: Semi-rigid, 2-component, self-leveling, 100% solids, rapid curing, polyurea control joint and crack filler with Shore A 80 or higher hardness.

a. Acceptable Material: L & M Construction Chemicals, Inc., Joint Tite 750.

3. Oil Repellent Sealer: Ready to use, silane, siloxane and fluoropolymers blended water based solution sealer, quick drying, low-odor, oil and water repellent, VOC compliant and compatible with chemically hardened floors.

a. Acceptable Material: L & M Construction Chemicals, Inc., Petrotex.

4. Concrete Dyes: Fast-drying dye, packaged in premeasured units ready for mixing with VOC exempt solvent; formulated for application to polished cementitious surfaces.

a. Acceptable Material: L & M Construction Chemicals, Inc., Vivid Concrete Dyes.

5. Cleaning Solution: Proprietary, mild, highly concentrated liquid concrete cleaner and conditioner containing wetting and emulsifying agents; biodegradable, environmentally safe and certified High Traction by National Floor Safety Institute (NFSI).

a. Acceptable Material: L & M Construction Chemicals, Inc., FGS Concrete Conditioner.

6. Finish: Standard High gloss (HG-1), 1500 grit, and Medium gloss (MG-2), 800 grit in the Apparatus Bay. See plans for location.

7. Color: As selected by the Architect from the manufacturer's available colors.

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2.3 SOURCE QUALITY CONTROL

A. Ensure concrete finishing components and materials are from single manufacturer.

2.4 PRODUCT SUBSTITUTIONS

A. Substitutions: No substitutions permitted.

PART 3 EXECUTION

3.1 MANUFACTURERS INSTRUCTIONS

A. Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalog installation instructions, product carton installation instructions and L & M Construction Chemicals, Inc., SPEC-DATA sheets.

B. Use only L & M certified FGS/PermaShine installers.

3.2 EXAMINATION

A. Site Verification of Conditions:

1. Verify that concrete substrate conditions, which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of concrete finishing materials.

B. Verify Concrete Slab Performance Requirements:

1. Verify concrete is cured to [28 day] [3500 psi (24 MPa)] strength.
2. Verify concrete surfaces received a hard steel-trowel finish (3 passes) during placement.

3.3 PREPARATION

A. Ensure surfaces are clean and free of dirt and other foreign matter harmful to performance of concrete finishing materials.

B. Examine surface to determine soundness of concrete for polishing.

C. General Contractor to remove surface contamination.

3.4 INSTALLATION

A. Floor Surface Polishing and Treatment:

1. Provide polished concrete floor treatment in entirety of slab indicated by drawings. Provide consistent finish in all contiguous areas.
2. Apply floor finish prior to installation of fixtures and accessories.

3. Diamond polish concrete floor surfaces with power disc machine recommended by floor finish manufacturer. Sequence with coarse to fine grit using dry method.
 - a. Comply with manufacturer's recommended polishing grits for each sequence to achieve desired finish level. Level of sheen shall match that of approved mock-up.
 - b. Expose aggregate in concrete surface only as determined by approved mock-up.
 - c. All concrete surfaces shall be as uniform in appearance as possible.
4. Dyed and Polished Concrete (option):
 - a. Locate demarcation line between dyed surfaces and other finishes.
 - b. Polish concrete to final finish level.
 - c. Apply diluted dyes to polished concrete surface.
 - d. Allow dye to dry.
 - e. Remove residue with dry buffer; reapply as necessary for desired result.
5. Apply FGS Hardener Plus, Hardener, Densifier As Follows:
 - a. First coat at 250 ft²/gal (6.25 m²/L).
 - b. Second coat at 350 ft²/gal (8.75 m²/L).
 - c. Follow manufacturer's recommendations for drying time between successive coats.
6. Remove defects and repolish defective areas.
7. Finish edges of floor finish adjoining other materials in a clean and sharp manner.

3.5 ADJUSTMENTS

- A. Polish to higher gloss those areas not meeting specified gloss levels per mock-up.
- B. Fill joints flush to surface.

3.6 FINAL CLEANING

- A. Do cleanup in accordance with Division 1 Section "Construction Waste Management".
- B. Mechanically scrub treated floors for seven days with soft to medium pads with approved cleaning solution.
- C. Upon completion, General Contractor must remove surplus and excess materials, rubbish, tools and equipment.

3.7 PROTECTION

- A. Protect with EZ Cover™ by McTech Corp., or comparable product.
 1. Contact: Phone: (866) 913-8363; website: www.ezform.net.

3.8 SCHEDULE

- A. Standard Finish High Gloss HG-1, Color: All locations except the Apparatus Bay. See Plans.
- B. Optional Finish Medium Gloss MG-2, Color: Apparatus Bay. See Plans.

END OF SECTION 03351

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