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| 4. | ACI 302.1R | - | Guide for Concrete Floor and Slab Construction. |
| 5. | ACI 302.2R | - | Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials. |
| 6. | ACI 303R | - | Guide to Cast-In-Place Architectural Concrete Practice. |
| 7. | ACI 303.1 | - | Standard Specification for Cast-in-Place Architectural Concrete. |
| 8. | ACI 305R | - | Guide to Hot Weather Concreting. |
| 9. | ACI 305.1 | - | Specification for Hot Weather Concreting. |
| 10. | ACI 306R | - | Guide to Cold Weather Concreting. |
| 11. | ACI 306.1 | - | Standard Specification for Cold Weather Concreting. |
| 12. | ACI 309R | - | Guide for Consolidation of Concrete. |
| 13. | ACI 318 | - | Building Code Requirements for Structural Concrete. |
| 14. | ACI SP-15 | - | Field Reference Manual: Specifications for Structural Concrete ACI 301-10 with Selected ACI and ASTM References. |
| 15. | ASTM C31/C31M | - | Standard Practice for Making and Curing Concrete Test Specimens in the Field. |
| 16. | ASTM C33 | - | Standard Specification for Concrete Aggregates. |
| 17. | ASTM C39/C39M | - | Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. |
| 18. | ASTM C94/C94M | - | Standard Specification for Ready Mixed Concrete. |
| 19. | ASTM C109 | - | Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens). |
| 20. | ASTM C114 | - | Standard Test Methods for Chemical Analysis of Hydraulic Cement. |
| 21. | ASTM C143/C143M | - | Standard Test Method for Slump of Hydraulic Cement Concrete. |
| 22. | ASTM C150 | - | Standard Specification for Portland Cement. |
| 23. | ASTM C157/C157M | - | Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar and Concrete. |
| 24. | ASTM C171 | - | Standard Specification for Sheet Materials for Curing Concrete. |
| 25. | ASTM C172 | - | Standard Practice for Sampling |

Freshly Mixed Concrete.

26. ASTM C309 – Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete.
27. ASTM C330 – Standard Specification for Lightweight Aggregates for Structural Concrete.
28. ASTM C348 – Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
29. ASTM C494/C494M – Standard Specification for Chemical Admixtures for Concrete.
30. ASTM C595 – Standard Specification for Blended Hydraulic Cements.
31. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
32. ASTM C881/C881M – Standard Specification for Epoxy Resin Base Bonding Systems for Concrete.
33. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
34. ASTM C928 – Standard Specification for Packaged, Dry, Rapid Hardening Cementitious Materials for Concrete Repairs.
35. ASTM C939 – Standard Test Method for Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method).
36. ASTM C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars.
37. ASTM C1028 – Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Meter Method.
38. ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
39. ASTM C1077 – Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
40. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
41. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
42. ASTM C1602/C1602M – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
43. ASTM D882 – Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
44. ASTM D1709 – Standard Test Methods for

Impact Resistance of Plastic Film by the Free-Falling Dart Method.

45. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
46. ASTM D4397 – Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
47. ASTM E96/E96M – Standard Test Methods for Water Vapor Transmission of Materials.
48. ASTM E154 – Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
49. ASTM E329 – Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
50. ASTM E1155 – Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.
51. ASTM E1643 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
52. ASTM E1745 – Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
53. ASTM F1249– Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
54. ISO/IEC/EN 17025 – General Requirements for the Competence of Testing and Calibration Laboratories (formerly ISO/IEC Guide 25-1990 and ASTM E548).
55. NRMCA – Quality Control Checklist – Section 2.
56. NRMCA – Plant Certification Checklist – Section 3.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01.
- B. Product Data: Submit manufacturer's descriptive literature and product specification for each product. Include manufacturer's written instructions and installation procedures.
- C. Drawings: Submit concrete pouring plan showing proposed locations of construction and control joints for review by Architect prior to concrete placement.
- D. Samples: Submit product samples when requested by Architect or testing laboratory.
- E. Quality Assurance/Control Submittals:
 1. Certificates:

- a. Manufacturer's Certification of Compliance that materials (cementitious materials, aggregates, and admixtures) conform to specifications.
 - b. Manufacturer's certificate of compatibility stating that admixtures, slab curing materials, and surface treatments are compatible with subsequent floor finishes and adhesives.
2. Reference Documents: Maintain one copy of ACI SP-15 on site.
 3. Concrete mixture proportions and characteristics for each class/type of concrete used.
 4. Concrete mixture proportion data for each class/type of concrete used:
 - a. Calculation of required average compressive strength and supporting test records.
 - b. Documentation indicating proposed mixture proportions will produce an average compressive strength greater than the required average compressive strength, including field strength test records or trial mixtures.
 - c. Provide documentation in accordance with Concrete Mix Design Submittal Checklist located at the end of this Section.
 5. Test Reports.
 6. Batch Ticket: Furnish accepted batch tickets at the time of delivery for each concrete load. Indicate on each ticket equipment used for measuring and quantities, by weight, of cement, sand, each class of aggregate, admixtures, and amount of water in the aggregate, water added at the batching plant, and any water withheld at the batch plant. In addition, include mix number, total yield in cubic yards, date and time of day (dispatch time, plant departure time, site arrival time, unloading start and end time).
 7. Concrete Placement Record: Keep a record on site including time and date of concrete placing for each portion of the structure for the duration of the project. Record additional information not included in batch ticket such as admixtures added at the job site. Make records available to Architect and DSA for review. Submit record to Architect at project completion.
 8. Protection of Slabs and Foundations: Submit plans for protection of slabs and foundations, including the following, if applicable:
 - a. Cold Weather Concreting: Comply with submittal requirements of ACI 306.1.
 - b. Hot Weather Concreting: Comply with submittal requirements of ACI 305.1.
- F. Closeout Submittals:
1. Concrete placement record.
 2. Show location of embedded utilities in record drawings.

1.5 SPECIAL COORDINATION REQUIREMENTS FOR CONCRETE FLOORS TO RECEIVE DYED AND POLISHED FINISH

- A. At concrete floors scheduled to receive dyed and polished concrete finish, the following shall apply. Note that some requirements listed below may differ from and/or exceed those for non-dyed and polished concrete floors:
1. The compressive strength of the concrete shall be 4,000 psi minimum.

2. The concrete water/cement ratio shall be 0.45.
3. The concrete shall not be air entrained.
4. Concrete admixtures are subject to acceptance by Architect.
5. In the concrete mix, Supplementary Cementitious Materials (SCM) shall not exceed fifteen percent by weight of the total cementitious materials.
6. Concrete Troweling: Hard steel-trowel in three passes with no burn marks. Trowel finish shall conform to ACI 302.1R, Class 5 floor.
7. Concrete Flatness Requirements: Overall FF of 50; local FF of 40.
8. Concrete Levelness Requirements: FL of 30.
9. Curing:
 - a. At Contractor's option, use one of the following curing methods:
 - 1) Curing Agent:
 - a) Product: Ashford Formula by Curecrete Distribution Inc., Springville, UT; 800-998-5664, www.ashfordformula.com.
 - b) Do not use membrane-forming curing compounds.
 - 2) Curing Sheet Materials: Use curing blankets conforming to ASTM C171. Do not use polyethylene film type sheet material for curing. Concrete shall be damp cured for a minimum of seven consecutive days; maintain 100 percent relative humidity condition on slab.
 - a) Product: UltraCure NCF long term wet curing blanket as manufactured by McTech Group, Inc. or accepted equal.
10. Protect concrete from damage and disfiguration from the time of initial trowel finishing through Project Final Completion.
11. Dyed and polished concrete floor finishing shall be performed under provisions of Section 03 35 43.16.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Concrete Supplier: Firm specializing in products specified in this Section with a minimum five years documented experience; successfully supplying similar materials (design, content, and performance) as specified in this Section.
2. Concrete Batch Plant: Complies with requirements of ASTM C94 and is currently certified per NRMCA Plant Certification Checklist - Section 3 or other certification acceptable to Architect and DSA.
3. Contractor's Design Laboratory: Under the direction of civil engineer licensed by the State of California; conforming to ASTM E329 and ASTM C1077.
4. Independent Testing Laboratory: Conforming to ASTM E329, ASTM C1077, and ISO/IEC/EN 17025, acceptable to Architect and DSA.

- B. Structural Tests and Inspections: Refer to DSA Structural Tests and Inspection Sheet (Form DSA-103).
- C. Regulatory Requirements: Conform to requirements of 2016 California Building Code (CBC), Chapter 19A, "Concrete", Chapter 17A "Special Inspections and Tests", and as follows:
1. Materials:
 - a. Cementitious Materials: CBC Chapter 19A, Section 1903A "Specifications for Tests and Materials" and Section 1910A.1 "Cementitious Material".
 - b. Concrete Aggregates: CBC Chapter 19A, Section 1903A "Specifications for Tests and Materials".
 - c. Batch Plant Inspection: CBC Section 1705A, Paragraph 1705A.3.3 "Batch Plant Inspection".
 2. Quality:
 - a. Proportions of Concrete: CBC Chapter 19A, Section 1905A "Modifications to ACI 318", Paragraph 1905A.1 "General" and Paragraph 1905A.1.1.
 - b. Strength Tests of Concrete: CBC Chapter 19A, Section 1905A "Modifications to ACI 318" Paragraph 1905A.1.2.
 3. Inspection: CBC Chapter 17A, Section 1705A "Required Special Inspections and Tests" Article 1705A.3 "Concrete Construction", as applicable.
 - a. Batch Plant Weighmaster Inspection: CBC Section 1705A, Paragraph 1705A.3.3 "Batch Plant Inspection".
- D. Drying Shrinkage Test: Perform per ASTM C157/C157M modified as follows:
1. Prepare 4 inch x 4 inch x 11 inch prisms with an effective gage length of 10 inches fabricated, cured, dried, and measured per ASTM C157/C157M except that specimens shall be removed from molds at an age of 23 hours +/- 1 hour after trial batching, and shall be placed immediately in water at 73 degrees F +/- 3 degrees for at least thirty minutes, and shall be measured within thirty minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F +/- 3 degrees.
 2. Measurement to determine expansion expressed as a percentage of original length shall be made at seven days. This length at seven days shall be the base length for drying shrinkage calculations. Specimens shall then be stored immediately in a humidity control room, maintained at 73 degrees F +/- three degrees F and fifty percent +/- four percent relative humidity for the remainder of the test.
 3. Measurements to determine shrinkage expressed as a percentage of base length shall be made and reported separately for 7, 14, and 21 days of drying after 7 days of moist curing.
- E. Quality Control: Comply with NRMCA Quality Control Checklist – Section 2.
- F. Materials Quality Assurance: Obtain cement and aggregates from same source for the duration of the work unless specifically accepted by Architect.
- G. Pre-Installation Meetings:

1. Conduct pre-installation (pre-pour) meeting in accordance with Division 01.
 2. Convene pre-installation (pre-pour) meeting one week prior to commencing work of this Section attended by concrete supplier.
 3. Meeting minutes shall be taken and distributed to meeting attendees within three days of meeting.
 4. Coordinate work in this Section with work in related Sections.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Comply with requirements of Division 01.
 - B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.
 - C. Store cement and other cementitious materials in weathertight buildings, bins, or silos which exclude moisture and contaminants and keep building materials completely separated.
 - D. Arrange and use aggregate stockpiles in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Do not store aggregates directly on ground unless a sacrificial layer is left undisturbed.
 - E. Refer to manufacturers' product data sheets for recommended shelf life and storage conditions for admixtures.
 - F. Clearly and accurately label materials after containers have been opened.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. BASF Corporation – Admixture Systems, Cleveland, OH; 800-228-3318, www.basf-admixtures.com.
 2. BASF Corporation – Building Systems, Shakopee, MN; 800-433-9517, www.buildingsystems.basf.com.
 3. Curecrete Distribution Inc., Springville, UT; 800-998-5664, www.ashfordformula.com.
 4. Grace Construction Products – W. R. Grace & Co., Cambridge, MA; 877-423-6491, www.na.graceconstruction.com.
 5. Insulation Solutions, Inc., East Peoria, IL; 866-698-6562, www.insulationsolutions.com.
 6. L. M. Scofield Company, Los Angeles, CA; 323-720-3000, www.scofield.com.
 7. Pecora Corp., Harleysville, PA; 800-523-6688, www.pecora.com.
 8. Raven Industries Inc, Sioux Falls, SD; 800-635-3456, www.ravenind.com.
 9. Reef Industries, Inc., Houston, TX; 800-231-6074, www.reefindustries.com.

10. Sika Corp., Lyndhurst, NJ; 800-933-7452, www.sikaconstruction.com.
11. Stego Industries, LLC, San Clemente, CA; 877-464-7834, www.stegoindustries.com.
12. The Euclid Chemical Co., Cleveland, OH; 800-321-7628, www.euclidchemical.com.
13. Tremco, Beachwood, OH; 800-852-9068, www.tremcosealants.com.
14. TXI – Pacific Custom Material, Inc., Port Costa, CA; 510-787-0150.
15. US Mix Products Co., Denver, CO; 800-397-9903, www.usspec.com.
16. W. R. Meadows, Inc., Hampshire, IL; 800-342-5976, www.wrmeadows.com.

B. Substitutions: Manufacturers and products are listed in this Section to establish minimum requirements as to quality and performance. Comply with requirements of Division 01 for substitutions.

2.2 CONCRETE MATERIALS

A. Cementitious Materials:

1. Cement: ASTM C150, Type II, low alkali (equivalent alkalis ($\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$) no more than 0.6 percent per ASTM C114), gray.
2. Supplementary Cementitious Materials (SCM):
 - a. Fly Ash: ASTM C618, Class F or Class N. Class C is not permitted.
 - b. Slag Cement: ASTM C989, Grade 100 or Grade 120.

B. Aggregates: Aggregates used in concrete shall have a combined aggregate distribution similar to the aggregates used in the concrete represented by field test data or used in trial mixtures. Fine and coarse aggregates: ASTM C33. Low-shrinkage producing coarse aggregates per ACI 221R; and uniformly graded as follows:

Sieve Number or Size in Inches	Percent Retained by Weight		
	1-1/2 inch Max.	1 inch Max.	3/4 inch Max.
2 inch	0-5	-	-

1-1/2 inch	0-8	0-5	-
1 inch	8-18	0-8	0-5
3/4 inch	8-18	8-18	0-8
1/2 inch	8-18	8-18	8-18
3/8 inch	8-18	8-18	8-18
No. 4	8-18	8-18	8-18
No. 8	8-18	8-18	8-18
No. 16	8-18	8-18	8-18
No. 30	8-18	8-18	8-18
No. 50	0-18	0-18	0-18
No. 100	0-8	0-8	0-8
No. 200	0-8	0-8	0-8

1. Maximum Nominal Size of Coarse Aggregate: CBC Section 1903A "Specifications for Tests and Materials", and as follows:

- a. 1/5 the narrowest dimension between sides of forms,
- b. 1/3 depth of slab, or
- c. 3/4 the minimum clear spacing between individual reinforcing bars or wires, and bundles of bars.

2. Lightweight: ASTM C330.

a. Acceptable products:

- 1) Expanded shale as manufactured by TXI – Pacific Custom Material, Inc.
- 2) Or accepted equal.

3. Aggregate sources shall not contain any alkali-silica reactive material in accordance with ASTM C33, Appendix XI.

C. Water: Potable and complying with ASTM C1602/C1602M.

2.3 ADMIXTURES

A. General:

1. Manufacturer certified to contain no more than 0.05 percent water-soluble chloride ions by mass of cementitious material. Admixtures containing calcium chloride or thiocyanates not allowed.

2. Compatible with other admixtures and cementitious materials in the concrete mix.

3. Obtain Architect's and DSA's written acceptance prior to use of admixtures. Use admixtures according to manufacturer's written instructions.

B. Water Reducing:

1. Normal Range: ASTM C494/C494M, Type A.

- a. Acceptable Products:
 - 1) MasterPozzolith Series by BASF Corporation – Admixture Systems.
 - 2) Eucon Series by The Euclid Chemical Co.
 - 3) WRDA 64 by Grace Construction Products.
 - 4) Plastocrete 161 by Sika Corp.
 - 5) Or accepted equal.
- 2. Mid Range Water-Reducing: ASTM C494/C494M, Type A or Type F.
 - a. Acceptable Products:
 - 1) MasterPolyheed Series BASF Corporation – Admixture Systems.
 - 2) Eucon Series by The Euclid Chemical Co.
 - 3) Duracem 55 by Grace Construction Products.
 - 4) Or accepted equal.
 - 3. High Range Water-Reducing: ASTM C494/C494M, Type F or G.
 - a. Acceptable Products:
 - 1) MasterRheobuild 1000 or MasterGlenium Series by BASF Corporation – Admixture Systems.
 - 2) Eucon Series or Plastol Series by The Euclid Chemical Co.
 - 3) Duracem 100 by Grace Construction Products.
 - 4) Sikament 10 ESL by Sika Corp.
 - 5) Or accepted equal.
- C. Shrinkage Reducing: Reduces dry shrinkage up to 80 percent at 28 days, and up to 50 percent at one year and beyond as tested per ASTM C157/C157M.
 - 1. Acceptable Products:
 - a. MasterLife SRA 20 by BASF Corporation – Admixture Systems.
 - b. Eclipse Floor and Eclipse Plus by Grace Construction Products.
 - c. Eucon SRA Series or Conex by The Euclid Chemical Co.
 - d. Or accepted equal.
- D. Set Retarding: ASTM C494/C494M, Type B or Type D.
 - 1. Acceptable Products:
 - a. Pozzolith Series or MasterSet DELVO Series by BASF Corporation – Admixture Systems.
 - b. Eucon Retarder Series, Eucon DS, or Eucon Stasis by The Euclid Chemical Co.
 - c. Or accepted equal.
- E. Set Accelerating: ASTM C494/C494M, Type C or Type E.
 - 1. Acceptable Products:

- a. MasterSet AC 534 or MasterSet FP 20 by BASF Corporation – Admixture Systems.
- b. Accelguard Series by The Euclid Chemical Co.
- c. Or accepted equal.

F. Workability-Retaining: Shall retain concrete workability without affecting time of setting or early-age strength development. ASTM C494/C494M, Type S.

1. Acceptable Products:

- a. MasterSure Z 60 by BASF Corporation – Admixture Systems.
- b. Plastol AMP Series by The Euclid Chemical Co.
- c. Or accepted equal.

2.4 CURING MATERIALS AND SLAB TREATMENT

A. General:

1. Comply with regulations of the California Air Resources Board and the local Air Pollution Control/Air Quality Management District.

a. VOC Limit: 350 g/L.

2. Verify compatibility with subsequent adhesives and coatings before application; furnish Manufacturer's certificate of compatibility. Coordinate with related Sections.

B. Curing and Sealing Compound: Select as appropriate for compatibility of subsequent adhesives and coatings.

1. Acrylic emulsion blend; meets or exceed ASTM C309, Type 1, Class B.

a. Acceptable Products:

- 1) MasterKure CC 160WB by BASF Corporation – Building Systems.
- 2) Diamond Clear VOX by The Euclid Chemical Co.
- 3) Vocomp 20 by W. R. Meadows, Inc.
- 4) US SPEC Hydrasheen 15% by US Mix Products Co.
- 5) Or accepted equal.

2. Water-emulsion, white, wax-based; meets or exceed ASTM C309, Type 2, Class A.

a. Acceptable Products:

- 1) Kurez VOX White Pigmented by The Euclid Chemical Co.
- 2) US SPEC Maxcure Wax White by US Mix Products Co.
- 3) Or accepted equal.

3. Water-emulsion, dissipating resin based; meets or exceed ASTM C309, Type 1, Class B. Use this type of curing compound at all areas of dyed and polished concrete floor finish.

a. Acceptable Products:

- 1) Ashford Formula by Curecrete Distribution Inc.
- 2) Kurez DR VOX by The Euclid Chemical Co.

- 3) US SPEC Maxcure Resin Clear by US Mix Products Co.
- 4) Or accepted equal.
4. Water based, acrylic emulsion; meets ASTM C1315, Type 1, Class A or Class B.
 - a. Acceptable Products:
 - 1) MasterKure CC 1315 by BASF Corporation – Building Systems.
 - 2) Super Aqua-Cure VOX by The Euclid Chemical Co.
 - 3) US SPEC Roca Seal by US Mix Products Co.
 - 4) Or accepted equal.
- C. Waterproof Sheet Materials for Curing: ASTM C171 and as follows:
 1. Curing paper consisting of two sheets of kraft paper adhered together with a bituminous material with embedded cords or strands of fiber running in both directions not more than 1-1/4 inches apart.
 - a. Tensile strength in machine direction: Thirty foot-pounds per inch of width minimum.
 - b. Tensile strength in cross direction: Fifteen foot-pounds per inch of width minimum.
 2. Polyethylene Film: ASTM D4397; minimum six mil thickness.
 3. White burlap-polyethylene sheeting: Consisting of burlap weighing not less than nine ounces per square yard extrusion coated on one side with at least four mil white opaque polyethylene sheet.
- D. Evaporation Retarder: Water-based polymer concentrate, readily dilutable in water.
 1. Acceptable Products:
 - a. MasterKure ER50 by BASF Corporation – Admixture Systems.
 - b. Eucobar by The Euclid Chemical Co.
 - c. US SPEC Monofilm ER by US Mix Products Co.
 - d. Or accepted equal.
- E. Surface Retarder: Water soluble liquid, formulated to retard wet surface of mortar in concrete.
 1. Acceptable Products:
 - a. MBT EAC-S Regular or Deep by BASF Corporation – Admixture Systems.
 - b. Sure Etch Series by The Euclid Chemical Co.
 - c. Rugasol-S by Sika Corp.
 - d. Or accepted equal.
- F. Penetrating Sealer: Chemically reactive, waterborne solution of inorganic silicate or siliconate materials; odorless, colorless; penetrates, densifies, and hardens concrete surfaces.
 1. Acceptable Products:
 - a. Cementone Clear Concrete Sealer by L. M. Scofield Company.
 - b. MasterKure HD 200 WB by BASF Corporation – Building Systems.

- c. Eucosil by The Euclid Chemical Co.
 - d. Aqua-Trete SG by Evonik.
 - e. US SPEC Industraseal by US Mix Products Co.
 - f. Or accepted equal.
- G. Vapor Emission Control System: Refer to Section 07 26 50.

2.5 GROUTING, BONDING, AND PATCHING MATERIALS

A. Grout:

1. Non-shrink Grout: ASTM C1107, non-metallic aggregate grout; 7000 psi minimum 28-day compressive strength at fluid water ratio per ASTM C939.

a. Acceptable Products:

- 1) MasterFlow 928 by BASF Corporation – Building Systems.
- 2) NS Grout, Hi-Flow Grout, or Euco Pre-Cast Grout by The Euclid Chemical Co.
- 3) US SPEC MP Grout by US Mix Products Co.
- 4) Or accepted equal.

2. Non-shrink Drypack Grout: Non-shrink, natural aggregates, 7000 psi minimum 28-day compressive strength.

a. Acceptable Products:

- 1) MasterFlow 100 by BASF Corporation – Building Systems.
- 2) Dry Pack Grout by The Euclid Chemical Co.
- 3) Sealtight Pac-it by W.R. Meadows, Inc.
- 4) US SPEC GP Grout by US Mix Products Co.
- 5) Or accepted equal.

B. Bonding Materials:

1. Bonding Agent/Admixture:

a. Interior or exterior applications: Acrylic or SBR, latex cement bonding agent/admixture; non-re-emulsifiable; meets or exceeds ASTM C1059, Type II.

1) Acceptable Products:

- a) Akkro-7T, Flex-Con, or SBR Latex by The Euclid Chemical Co.
- b) US SPEC Acrylcoat by US Mix Products Co.
- c) Sealtight Acry-Lok by W. R. Meadows, Inc.
- d) Or accepted equal.

b. Interior applications or exterior applications not subject to constant water immersions: Ethyl-vinyl acetate (EVA) copolymer liquid bonding agent and admixture; re-emulsifies once and will not re-wet; meets or exceeds ASTM C1059.

1) Acceptable Products:

- a) Tammsweld by The Euclid Chemical Co.

- b) US SPEC Multicoat by US Mix Products Co.
- c) Or accepted equal.
- 2. Structural Bonding Epoxy Adhesive: Two component, 100 percent solids, 100 percent reactive; meets or exceeds ASTM C881/C881M, Type II, Grade 2, Class B or C as appropriate.
 - a. Acceptable Products:
 - 1) MasterEmaco ADH 1090RS, MasterEmaco ADH 1420, or MasterEmaco ADH 327RS by BASF Corporation – Building Systems.
 - 2) Dural 452 MV by The Euclid Chemical Co.
 - 3) Sealtight Rezi-Weld 1000 by W. R. Meadows, Inc.
 - 4) Or accepted equal.
- C. Self-Leveling Underlayment: Portland cement based, self-leveling 1 inch thick to featheredge. Fast setting – minimum compressive strength 2200 psi after one day; minimum 4000 psi compressive strength at 28 days per ASTM C109.
 - 1. Acceptable Products:
 - a. K-15 Self-Leveling Underlayment Concrete by ARDEX Engineered Cements.
 - b. MasterTop 110 SL by BASF Corporation – Building Systems.
 - c. Flo-Top or EucoFloor SL 160 by The Euclid Chemical Co.
 - d. US SPEC Self-Leveling Underlayment by US Mix Products Co.
 - e. Or accepted equal.
- D. Repair Mortar: Exceeds ASTM C928, R1 and R2; rapid setting – minimum 1300 psi at three hours; 5500 psi at seven days per ASTM C109.
 - 1. Acceptable Products:
 - a. MasterEmaco T 415/430 or MasterEmaco T 1060/1061 Repair Mortars by BASF Corporation – Building Systems.
 - b. Euco-Speed, Versaspeed, or Speedcrete 2028 by The Euclid Chemical Co.
 - c. US SPEC Transpatch by US Mix Products Co.
 - d. Or accepted equal.
- E. Repair Mortar (for patching over steel): Liquid polymer modified, containing an integral corrosion inhibitor, exceeds C928, R2; rapid setting – minimum compressive strength 1500 psi at one day; 3500 psi at seven days; 5000 psi at 28 days per ASTM C109.
 - 1. Acceptable Products:
 - a. MasterEmaco N 350CI with Acrylic Additive or MasterEmaco T 310CI by BASF Corporation – Building Systems.
 - b. Concrete-Top Supreme by The Euclid Chemical Co.
 - c. US SPEC H2 by US Mix Products Co.
 - d. Sikatop 122 Plus by Sika Corp.
 - e. Or accepted equal.

F. Epoxy Joint Filler: Two component, 100 percent solids, semi-rigid epoxy; hardness: minimum 75 Shore A per ASTM D2240.

1. Acceptable Products:

- a. MasterSeal CR 190 by BASF Corporation – Building Systems.
- b. Euco 700 by The Euclid Chemical Co.
- c. Sikadur 51 NS by Sika Corp.
- d. Or accepted equal.

2.6 ACCESSORIES

A. Underslab Vapor Retarder, Plastic: Performance shall exceed ASTM E1745, Class A requirements, as modified below. Material properties shall match one of the acceptable products listed below.

1. Properties:

- a. Thickness: Minimum 15 mils (ACI 302.2R, as applicable).
- b. Water Vapor Permeance (as tested before and after ASTM E1745 mandatory conditioning): Maximum 0.01 Perms (based on Test Method ASTM E1745).
- c. Tensile Strength: Minimum 60 lbf/in (ASTM D882).
- d. Puncture Resistance: Minimum 3000 g (ASTM D1709, Method B).

2. Acceptable Products:

- a. Viper Vaporcheck II 15 Mil by Insulation Solutions, Inc.
- b. VaporBlock VB15 by Raven Industries.
- c. Griffolyn® 15 Mil Green by Reef Industries, Inc.
- d. 15 Mil Vapor Barrier by Stego Industries, LLC.
- e. Perminator 15 Mil by W.R. Meadows, Inc.
- f. Substitutions: Under provisions of Division 01.

B. Vapor Retarder Accessories:

1. Seam Tape: Water vapor transmission rate 0.03 perms or lower, per ASTM E96. Provide seam tape as standard with vapor retarder manufacturer.
2. Vapor Proofing Mastic: Water vapor transmission rate 0.03 perms or lower per ASTM E96 as standard with vapor retarder manufacturer.
3. Boots for Pipe Penetrations: Provide prefabricated pipe boots as standard with vapor retarder manufacturer.
4. Bedding Layer and Cushion/Protection Course: Fine graded material such as crusher fines or manufactured sand.

C. Cone Hole Plugs: Precast high strength cement compound plugs matching size and shape of form tie cone and matching color of poured-in-place concrete as provided by same manufacturer of form ties. Refer to Section 03 11 00.

D. Capillary Barrier: Clean crushed rock; 3/4 inch nominal maximum size with no material passing a No. 4 sieve.

E. Expansion Joints:

1. Joint-Filler Strips: ASTM D1751; bituminous type; preformed, resilient, flexible, and non-extruding.

a. Acceptable Product:

1) Sealtight Fiber Expansion Joint by W.R. Meadows, Inc.

2) Or accepted equal.

2. Self-Leveling Polyurethane Sealant: ASTM C920; Type M; Grade P; Class 25; use T and M.

a. Acceptable Products:

1) THC 900/901 by Tremco Inc.,

2) Urexpan NR-200 by Pecora Corp.,

3) MasterSeal SL2 by BASF Building Systems,

4) Or accepted equal.

F. Anchors, Anchor Bolts, Nuts, and Washers: Refer to Section 05 12 00.

2.7 CONCRETE MIX

A. General:

1. Proportion concrete design mixes per ACI 301 Section 3.9, ACI 318 Chapter 5, and CBC Section 1904A "Durability Requirements".

2. Proportion concrete design mixes per ACI, prepared and tested by an independent testing laboratory acceptable to Architect and DSA prior to design mix approval. For each mix design, prepare and perform tests as follows:

a. Drying shrinkage test per modified ASTM C157/C157M as specified in this Section; provide at least three test specimens. Drying shrinkage test not required for below grade concrete.

b. Compression test; provide at least six test specimens.

3. Proportioning without field experience or trial mixtures may be permitted with written approval from Architect and DSA, where concrete manufacturer can establish the uniformity of its production for concrete of similar type and strength based on recent test data in accordance with ACI 318, Chapter 5 "Concrete Quality, Mixing and Placing", Article 5.4 "Proportioning without Field Experience or Trial Mixtures".

4. Proportion concrete design mix to attain compressive strength as specified below and as needed, with early strength to meet Contractor's work program.

B. Mix Design: Refer to Drawings

1. Maximum Water Content: 300 pounds per cubic yard.

2. Maximum Drying Shrinkage: 0.048 percent as tested per modified ASTM C157/C157M as specified in this Section after 7 days moist curing plus 21 days drying. This requirement does not apply to below grade concrete.

3. Slump shown in Mix Design Table above is for concrete without water reducing admixtures and is to be measured at the point of delivery. Slump tolerance shall be +/- 1 inch.

4. Slump Limits for Concrete with Water-Reducing and or Mid-Range Water Reducing Admixtures: 8 inches with a tolerance of +/- 1-1/2 inch at point of delivery. Concrete shall be proportioned to a slump of 2 to 4 inches before admixture is added.

5. Slump Limits for Concrete with High-Range Water-Reducing Admixture: 10 inches with a tolerance of +/- 1-1/2 inch at point of delivery. Concrete shall be proportioned to a slump of 2 to 4 inches before admixture is added.

6. For concrete in ACI Exposure Class C2, the maximum water-soluble chloride ion content that is contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall be determined on the concrete mixture by ASTM C1218 at age between 28 days and 42 days, and shall be less than 0.15 percent by weight of cement.

B. Admixtures:

1. Use specified admixtures as acceptable to Architect and DSA. Verify compatibility of concrete admixtures when using multiple admixtures.

2.2 CONCRETE MIXING

A. Concrete shall be mixed per ACI 318 Chapter 5, Section 5.8.

B. Ready-Mixed Concrete: Per ACI 318 Section 5.8.2.

C. Job-Mixed Concrete: Per ACI 318 Section 5.8.3.

2.3 SOURCE QUALITY CONTROL

A. Owner shall employ a testing laboratory accepted by Architect and DSA to perform the following:

1. Review mix designs and certificates of compliance for materials Contractor proposes to use.

2. Provide continuous batch plant inspections per CBC Chapter 17A, Paragraph 1705A.3.3 "Batch Plant Inspection".

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine and verify the following prior to concrete placement.

1. Forms are erected, adequately braced, sealed, lubricated (if required), and bulkhead provided where placing is to stop.

2. Thoroughly water soak wood forms other than plywood at least twelve hours before concrete placement.

3. Steel reinforcement are accurately positioned, securely tied and braced. Verify concrete cover requirements.
 4. Coordination with related work is completed.
 5. Anchors and embedded items are in position, securely held and braced.
 6. Construction joints and previously placed concrete are prepared as specified.
 7. Compliance with cold-weather or hot-weather requirements.
 8. Compliance with cleaning and preparation requirements.
- B. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.
- C. Concrete formwork, reinforcement, inserts, and embedded items are subject to Architect's acceptance. Notify Architect at least 48 hours prior to concrete placement.

3.2 PREPARATION

- A. Capillary barrier below interior slabs shall be compacted using one pass of a smooth drum or vibratory roller. Compaction shall be verified by Geotechnical Engineer.
- B. Underslab Vapor Retarder: Install in accordance with manufacturer's written instructions, ASTM E1643, and as specified in this Section.
1. Lay underslab vapor retarder at interior on-ground concrete work.
 2. Apply underslab vapor retarder directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular materials which could puncture the underslab vapor retarder. In this case, choke the surface with a bedding layer of approximately 1/2 inch fine-graded material rolled or compacted over the fill before placing the underslab vapor retarder.
 3. Unroll vapor retarder with longest dimension parallel with direction of concrete placement.
 4. Lay vapor retarder using the greatest widths and lengths practicable to eliminate joints wherever possible. Lap over footings and seal to foundation walls.
 5. Overlap joints 6 inches and seal with compatible seal tape per manufacturer's written recommendations.
 6. Seal all penetrations per manufacturer's written instructions using mastic and seal tape. No penetration of underslab vapor retarder is permitted except for reinforcing steel and permanent utilities.
 7. Replace torn, punctured, and damaged underslab vapor retarder material prior to placing concrete.
 8. Minor repairs may be made by patches of underslab vapor retarder overlapping edges 6 inches and sealing all four sides with tape.
 9. Control concrete placement so as to prevent damage to underslab vapor retarder. Screed pins and similar implements that will puncture underslab vapor retarder are not permissible.

C. Cleaning: Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris before placing concrete.

D. Refer to Section 03 11 00 for formwork preparation.

E. Refer to Section 03 20 00 for reinforcing steel preparation.

3.3 PLACING CONCRETE

A. Place concrete in accordance with ACI 301 and as specified in this Section.

1. Place and finish Architectural Concrete in the locations indicated on Drawings in accordance with ACI 303.1 and 303R.

B. Add no water during delivery and at the project site unless specifically accepted by Architect. If water is withheld at batch plant, indicate in delivery ticket the design water for accepted mix, moisture content of aggregates, and free water added at batch plant. If total water added at plant is less than design water to attain slump of accepted mix design, water may be added to concrete at job site, not to exceed the design water content, subject to the limitations specified in ASTM C94/C94M. If additional slump is required, use water reducing admixture.

C. Discharge mixed concrete within 1-1/2 hours or before mixer has revolved 300 revolutions, whichever comes first, after the introduction of mixing water to the cement and aggregates. Reduce this time to 45 minutes when the concrete temperature exceeds 85 degrees F, unless appropriate measures as specified in ACI 305.1 are taken to maintain slump and temperature of concrete. Slump and concrete temperature can be maintained within limits longer with the use of retarding admixtures or hydration-control admixtures or ice.

D. Place concrete within fifteen minutes after it has been discharged from the mixer. Handle concrete from mixer to forms in a continuous manner.

E. Deposit concrete as close as possible to its final position in the forms, with no vertical drop greater than five feet except where suitable equipment is provided to prevent segregation and where specifically authorized.

F. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If concrete cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

G. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic to avoid cold joints.

H. Pumping concrete, when specifically accepted, may be conveyed by positive displacement pump such as piston or squeeze pressure type; pneumatic placing equipment is not permitted. Use rigid steel pipe or heavy-duty flexible hose with an inside diameter at least three times the nominal maximum-size coarse aggregate, but not less than 4 inches. Aluminum pipe is not allowed.

- I. Provide adequate scaffolding, ramps and walkways in a manner so that personnel and equipment are not supported by in-place reinforcement.
- J. Consolidation: Consolidate placed concrete with mechanical vibrating equipment per ACI 309R.
 1. Consolidate each layer of concrete immediately after placing using internal vibrators, except for slabs 4 inches thick or less.
 2. Insert and withdraw vibrators vertically at uniformly spaced location no farther than the visible effectiveness of the vibrator. Hold vibrator stationary and slowly withdraw vertically while operating.
 3. Do not use vibrators to transport concrete inside forms.
 4. Place vibrator to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers that have begun to lose plasticity. Limit vibration duration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- K. Concrete Floors and Slabs: Deposit and consolidate concrete for floors and slabs in a continuous operation within limits of construction joints until placement of a panel or section is complete.
 1. Consolidate concrete during placement so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope exterior surfaces for drainage as directed, unless otherwise shown. Slope interior floors to drains uniformly, where provided.
- L. Hot Weather Concreting: Place concrete according to ACI 305.1 and as follows:
 1. Cool components before mixing to maintain concrete temperature below 85 degrees F at time of placement. Chilled mixing water or chopped ice may be used to control temperature. Calculate and include water equivalent of ice in designed water cement ratio.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
 4. Protect concrete from surface drying; moisture loss from concrete in plastic state shall be maintained below 0.1 pounds per square foot per hour. Methods may include, but are not limited to: evaporation retardant, sun shades, wind breaks, and fog misting.
- M. Cold Weather Concreting: Place concrete according to ACI 306.1 and as follows:
 1. Protect concrete work from physical damage or reduced strength as a result of frost, freezing, or low temperatures.
 2. When ambient temperature is expected to fall below 40 degrees F, uniformly heat

water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 75 degrees F.

3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade.

4. Do not incorporate calcium chloride, salt or other materials containing antifreeze agents into the concrete mix.

5. Upon Architect's written acceptance and subject to prior approval of mix design, accelerating admixtures, containing no calcium chloride, as specified in this Section may be used.

N. Do not allow concrete overpour from formwork where underground products and systems need to be installed at or adjacent to the concrete work. If overpour occurs, remove as necessary to accommodate the installation of such items.

3.4 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete, unless otherwise indicated on Drawings.

B. Construction Joints: Locate and install joints as indicated on Drawings or as accepted by Architect, and in a manner that strength and appearance of concrete are not impaired.

1. Comply with ACI 318, Chapter 6, Section 6.4 "Construction Joints".

2. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.

3. Expose concrete aggregates, a minimum of 1/4 inch depth, creating a rough surface using a surface retardant. Within 24 hours after placing concrete, remove retarded surface mortar using either high pressure water jetting or stiff brushing or a combination of both to expose coarse aggregate. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting.

4. Where new concrete joins existing concrete (concrete more than sixty days old), clean and roughen existing concrete to expose coarse aggregate. Coat with epoxy bonding compound prior to placing new concrete.

5. Horizontal joints: Apply a 1 inch wood grade strip, level and straight, 1/2 inch below the placement lift elevation for a neat joint.

C. Slab-on-Ground Control Joints: Tool or saw-cut weakened plane joints at a depth of at least 1/4 slab thickness where shown on Drawings. Where not indicated in Drawings, provide at distances (in feet) every two times to three times of slab thickness (in inches).

1. Tooled Joint: Form control joints after initial floating by grooving and finishing each joint edge to a 1/8-inch radius. Repeat grooving after applying surface finish.

2. Sawed Joint: Saw cut 1/8-inch width as soon as the concrete has hardened sufficiently to prevent raveling (dislodging of the aggregates) of the edges of the saw cut and completed before shrinkage stresses become sufficient to produce cracking.

3. Fill control joints with epoxy joint filler in accordance with manufacturer's written instructions.

D. Slab-on-Ground Expansion Joints and Isolation Joints: Provide expansion joints and isolation joints where shown on Drawings, where slab abuts vertical surfaces such as curbs, gutters, and sidewalks.

1. Extend joint-filler strips full width and extend to full depth of joint, terminating not less than 1/2 inch and not more than 1 inch from finish surface. Apply a removable capping flush to slab finish.

2. Install strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3. Remove capping when concrete has cured and apply joint sealant.

E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where shown on Drawings.

3.5 FORMED SURFACES FINISHING

A. Leave texture imparted on formed concrete surface, unless otherwise specified, except that defective surfaces shall be repaired. Repair defective concrete as specified in this Section.

B. Maintain uniform color of the concrete, unless painting of surfaces is required, by using only one mixture without changes in material or proportions for any structure or portion of structure exposed to public view.

C. Repair and patch tie holes. Apply cone hole plugs matching color of cured concrete; and unless otherwise indicated, flush to concrete surface, as provided by form tie manufacturer using waterproof adhesive.

3.6 CONCRETE FLOORS AND SLABS FINISHING

A. Comply with ACI 302.2R and as specified in this Section. Comply with flatness and levelness tolerance requirements of this Section.

B. Float Finish:

1. Immediately following placing and consolidating concrete, begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface.

2. When concrete has sufficiently stiffened begin floating to a true and even plane free of ridges. Perform floating using power-driven equipment or hand floats if area is small or inaccessible to power-driven floats.

3. If bleedwater is present prior to finishing, carefully drag-off or remove by absorption with porous materials such as burlap. Dusting of surfaces with dry cement or other materials or the addition of any water during finishing is not permitted.

4. Check slab surfaces with a ten-foot straightedge at regular intervals while concrete is still plastic, to detect high or low areas.

5. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighten until surface is left with a uniform, smooth, granular texture.

6. Take extreme care during finishing operations to prevent over finishing or to prevent working water into the surface; this can cause crazing (surface shrinkage cracks which appear

after hardening) of the surface. Slabs with surfaces exhibiting significant crazing as determined by Architect shall be removed and replaced.

C. Trowel Finish:

1. Refer to Article 1.5 of this Section for troweling requirements for dyed and polished concrete floors.
2. After floating is complete and after surface moisture has disappeared, apply trowel finish using a power-driven trowel or hand trowel if area is small or inaccessible to power-driven trowel.
3. Steel trowel to a smooth, even, dense finish, free of blemishes including trowel marks.
4. Apply final steel troweling by hand.
5. Hard troweling (steel troweling) of air entrained concrete will not be permitted, unless otherwise indicated on Drawings or specified in other Sections.

D. Broom Finish:

1. After floating, lightly trowel surface and then carefully score by pulling a broom across the surface. Use appropriate type of broom to achieve texture specified.
2. Broom as indicated or as directed by Architect. Where not specifically indicated, broom transverse to traffic or at right angles to the slope of the slab.
3. Adding water to facilitate brooming is not permitted.
4. Exterior ramps, walks, and slabs: Apply a slip-resistant finish as follows:
 - a. Where slope is six percent or greater: Heavy broom finish with at least 0.8 coefficient of friction per ASTM C1028.
 - b. Where slope is less than six percent: Medium broom finish with a minimum 0.6 coefficient of friction per ASTM C1028.

E. Floor and Slab Flatness and Levelness Tolerance: Determine flatness and levelness of floor slabs using the F-Number System in accordance with ASTM E1155 using the inch-pound system of units. Calculate F-Numbers as follows:

1. Definitions:
 - a. Face Flatness Number (F_F): The maximum slab curvature allowed over 24 inches computed on the basis of successive 12 inch elevation differentials.
 - b. Face Levelness Number (F_L): The relative conformity of the slab surface to a horizontal plane as measured over a ten foot distance.

2. These floor flatness and floor levelness tolerances apply to concrete slabs-on-ground. At raised slabs, only the floor flatness tolerance applies.

3. Sampling Requirements: As described in ACI 117.

4. Calculations:

$$F_F = \frac{\quad\quad\quad}{\quad\quad\quad} 4.57$$

Maximum difference in elevation (in decimals of inches) between successive 12 inch elevation differences.

$$F_L = \frac{12.5}{\text{Maximum difference in elevation (in decimals of inches) between two points 10 feet apart.}}$$

5. Tolerances, unless noted otherwise:
 - a. Trowel finish surfaces on ground: F_F 25; F_L 20 (overall tolerance values).
 - b. Float finish surfaces on ground: F_F 20; F_L 17 (overall tolerance values).
 - c. Trowel finish surfaces for concrete fill over steel deck and elevated structural concrete slabs: F_F 25.
 - 1) Depressions in floors between high spots shall not be greater than 5/16 inch below a 10 foot long straight edge.
 - 2) Top of concrete surface elevation shall not vary by more than $\pm 3/4$ inch from the average elevation.
 - d. Minimum local tolerance (1/2 bay or as designated by Architect): 2/3 of specified tolerance values.
 6. Refer to Article 1.5 of this Section for floor flatness requirements for dyed and polished concrete floors.
 7. Refer to Article 3.9 of this Section for remedial work required for out-of-tolerance concrete.
- F. Site Concrete Flatness Tolerance: 1/4 inch in 10 feet, non-cumulative; unless more restrictive tolerance is indicated or specified. This tolerance does not allow slopes to exceed the specified maximum slopes.
1. Surface cross slopes shall not exceed one unit vertical in fifty units horizontal (two percent).

3.7 CURING AND PROTECTION

- A. Refer to Article 1.5 of this Section for curing requirements for dyed and polished concrete floors.
- B. Protect freshly placed concrete from premature drying, rapid temperature change, mechanical injury, and injury from flowing water for a curing period not less than seven days. Comply with ACI 306.1 for cold-weather protection and ACI 305R for hot-weather protection during curing.
- C. Curing Methods:
 1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. If curing compound is applied using a hand held, pump-up sprayer, it shall be back-rolled using a short nap roller.

2. Moist Curing: Keep surfaces in a moist condition for not less than seven days using water saturated absorptive cover (burlap-polyethylene sheeting) kept wet continuously. Cover concrete completely in widest practicable width, with sides and ends lapped at least 12 inches, and sealed with waterproof tape or adhesive. Immediately repair and maintain rips and tears and keep traffic away from surface during curing period.

3. Ponding or Immersion: Continuously immerse concrete throughout the curing period in water not more than twenty degrees below the temperature of the concrete.

D. Concrete in Forms: Keep forms and exposed concrete surfaces covered and continuously moist. Provide soaker hoses at top of walls or other accepted means of keeping concrete and forms wet while forms remain in place. If forms are removed before end of curing period, continue curing by methods described in this Section.

E. Floors and Slabs:

1. Evaporation Retarder: Apply evaporation retarder to floors and slabs if hot, dry, or windy conditions cause moisture loss of 0.1 pounds per square foot per hour before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

2. Cure by application of curing and sealing compound or by moist curing. Use appropriate curing method compatible with subsequent floor adhesives and coatings. Moist cure concrete surfaces to receive penetrating liquid floor treatments.

3. Begin curing as soon as free water has disappeared from the concrete surface after placing and final finishing.

F. Protection:

1. Protect concrete surfaces from damage by tools, equipment, materials, and construction activity.

2. Traffic, shoring, or loading will not be permitted on concrete surface until it has sufficiently hardened to prevent injury to finish and strength.

3. Protect all flat work and other surfaces as required with full board of plywood coverings as necessary.

3.8 REMOVAL OF FORMS

A. Formwork for sides of curbs, walls, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 degrees F for 48 hours after placing concrete provided concrete is hard enough not to be damaged by form-removal operations and provided curing and protection operations are maintained.

3.9 CONCRETE REPAIRS

A. General: Comply with ACI 301, Article 1.7 as follows:

1. Completed concrete work shall conform to applicable requirements of this Section and Contract Documents.

2. Concrete work that fails to meet one or more requirements of the Contract Documents

but subsequently is repaired to bring the concrete into compliance will be acceptable.

3. Concrete work that fails to meet one or more requirements of the Contract Documents and cannot be brought into compliance with the Contract Documents is subject to rejection.

4. Repair rejected concrete work by removing and replacing or by additional construction to strengthen or otherwise satisfy project requirements as directed by Architect. To bring rejected Work into compliance, use repair methods that meet applicable requirements for function, durability, dimensional tolerances, and appearance as determined by Architect.

5. Submit proposed repair methods, materials, and modifications needed to repair concrete work to meet the requirements of the Contract Documents.

6. Contractor shall be responsible to bring concrete work into compliance with requirements of Contract Documents.

B. Defective Concrete: Repair and patch defective concrete work and concrete not conforming to required lines, details, and elevations. Use materials and methods specified in this Section as accepted by Architect. Serious defects, defects affecting structural strength, or unsatisfactory patching may be cause for complete removal and replacement of concrete.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycomb, rock pockets, and voids more than 1/2 inch in any direction in solid concrete. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with drypack grout before bonding agent has dried. Fill form-tie voids with patching mortar or cone hole plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, repair mortar will match surrounding color. Patch a test area 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.

3. Repair defects on concealed, formed surfaces that affect concrete's durability and structural performance as determined by Architect and DSA.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness.

1. Repair defective finished surfaces including spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced section regardless of width, and other objectionable conditions.

2. After concrete has cured fourteen days, correct high spots by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply mortar underlayment and primer according to

manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch clearance all around. Dampen concrete surface in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete. Place, compact, and finish to blend with adjacent finished concrete.

6. Repair random cracks and single holes 1 inch or less in diameter with drypack grout. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place drypack grout before bonding agent has dried. Compact and finish grouted areas to match adjacent concrete.

E. Moist cure patches and repairs for at least 72 hours.

F. Perform concrete structural repairs subject to Architect's and DSA's acceptance.

3.10 FIELD QUALITY CONTROL

A. General: Comply with requirements of Division 01.

B. Testing Service: Owner will select and pay for independent testing agency.

C. Strength Test Specimen Cylinders: Conduct sampling, curing, and testing per ASTM C172, ASTM C31/C31M, and ASTM C39/C39M. Contractor shall provide moulds required for strength test cylinders.

1. Frequency: Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 50 cubic yards of concrete, nor less than once for each 2000 square feet of surface area for slabs or walls. Additional samples for seven-day compressive strength tests shall be taken for each class of concrete at the beginning of the concrete work or whenever the mix or aggregate is changed.

2. A strength test shall be the average of the strengths of at least two 6 inch by 12 inch cylinders or at least three 4 inch by 8 inch cylinders made from the same sample of concrete and tested at the test age designated for the determination of concrete compressive strength.

3. Cylinder Label and Records: Mark and date each test cylinder. Maintain records of test specimen cylinders and send copies to Contractor, Architect, DSA, Project Inspector, and Owner. Record the following information:

- a. Cylinder identification mark.
- b. Date made.
- c. Concrete supplier.
- d. Slump/slump flow.
- e. Specified concrete design strength.
- f. Pour location and type of structural member.
- g. Compressive strength test date and age.

- h. Admixtures added to concrete mix.
- i. Air content.
- 4. Compressive Strength Tests: Test laboratory cured specimens at the following ages and report compressive strengths as follows:
 - a. 7 days at the start of use of each class of concrete or change in mix or aggregates.
 - b. 7 days where early compressive strength is required.
 - c. 28 days.
 - d. 56 days.
 - e. Hold specimens for one strength test in reserve.
- 5. Test Reports: Furnish copies of test reports directly from testing agency to Contractor, Architect, DSA, Project Inspector, and Owner.
- D. Slump Test: ASTM C143/C143M. Conduct slump testing when test cylinders are made and additionally for every 150 cubic yards of concrete. Perform additional tests when concrete consistency appears to change. Contractor shall provide slump cones.
- E. In the event the cylinders tested do not meet the required concrete design strength, conduct core tests and additional tests or inspections as may be required by Architect to ascertain strength of placed concrete. Costs for additional tests and inspections shall be borne by Contractor.

END OF SECTION

See next page for Concrete Mixture Design Submittal Checklist

Concrete Mixture Design Submittal Checklist

- Specify Use:** All mix designs must clearly note the concrete type or use. (i.e. footings, slab on grade, site concrete)
- Mix Design:** Provide concrete mixture designs with proportions and characteristics including all admixtures.
- Gradation:** Provide combined aggregate gradation by weight for all course and fine aggregates.
- Weight:** Provide dry unit weight of mix. Light weight concrete shall be limited to 110 PCF. Normal weight concrete shall be limited to 145 PCF.
- Material Certificates:** Provide supplier's certification that materials conform to specifications. This includes aggregates, admixtures, and cementitious materials such as cement and fly ash.
- Product Data:** Provide product literature for each product and admixture used. Include manufacturer's specification, written instructions, and installation procedures.
- Required SCM:** Mix design must contain the percentage of supplementary cementitious materials noted in mix design table of the specifications.
- Admixtures:** Where multiple admixtures are used, provide a letter from all manufacturers indicating there are no compatibility problems or adverse effects resulting from combination of products.
- Shrinkage:** Provide shrinkage test per modified ASTM C157/C157M at 21 days. Shrinkage test must be for the same mix specified or a similar mix with the same water cement ratio and aggregate source. (Exception: shrinkage testing is not required for below grade concrete)
- Testing / Proportion Method:** Concrete must be proportioned per the requirements of ACI 318-11, Section 5. Indicated method used and provide complete test data and documentation for the chosen proportion method.