

**SECTION 03 30 00
CAST-IN-PLACE CONCRETE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete formwork.
- B. Concrete anchors
- C. Concrete foundation walls.
- D. Concrete reinforcement.
- E. Joint devices associated with concrete work.
- F. Miscellaneous concrete elements, including equipment pads, equipment pits, light pole bases, flagpole bases, thrust blocks, and manholes.
- G. Concrete curing.

1.02 REFERENCE STANDARDS

- A. ANSI/NFSI B101.1 - Test Method for Measuring the Wet SCOF of Hard-Surface Walkways; 2022.
- B. ANSI/NFSI B101.3 - Test Method for Measuring the Wet DCOF of Hard Surface Walkways; 2020.
- C. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2018.
- D. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- E. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- F. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2022.
- G. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement; 2019, with Editorial Revision (2020).
- H. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- I. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.
- J. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2023.
- K. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.
- L. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
- M. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- N. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2020.
- O. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2023.
- P. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
- Q. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2019.
- R. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).
- S. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.
- T. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2017.

- U. ASTM C779/C779M - Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces; 2019.
- V. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures; 2023.
- W. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2021.
- X. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation; 2024.
- Y. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- Z. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2020.
- AA. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete; 2019.
- BB. ASTM C1582/C1582M - Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete; 2011, with Editorial Revision (2017).
- CC. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2022.
- DD. ASTM D471 - Standard Test Method for Rubber Property--Effect of Liquids; 2016a (Reapproved 2021).
- EE. ASTM D523 - Standard Test Method for Specular Gloss; 2014 (Reapproved 2018).
- FF. ASTM D994/D994M - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type); 2011 (Reapproved 2022).
- GG. ASTM D1709 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method; 2016a, with Editorial Revision (2017).
- HH. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types); 2023.
- II. ASTM D1752 - Standard Specification for Preformed Sponge Rubber, Cork, and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2018 (Reapproved 2023).
- JJ. ASTM D2103 - Standard Specification for Polyethylene Film; 2023a.
- KK. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars; 2021.
- LL. ASTM D5767 - Standard Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces; 2018 (Reapproved 2023).
- MM. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.
- NN. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a (Reapproved 2019).
- OO. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2021.
- PP. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2020.
- QQ. 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; 2018a.
- RR. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).
- SS. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.

- TT. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2022.
- UU. COE CRD-C 48 - Handbook for Concrete and Cement Standard Test Method for Water Permeability of Concrete; 1992.
- VV. COE CRD-C 513 - Handbook for Concrete and Cement Corps of Engineers Specifications for Rubber Waterstops; 1974.
- WW. COE CRD-C 572 - Handbook for Concrete and Cement Corps of Engineers Specifications for Polyvinylchloride Waterstop; 1974.
- XX. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
- YY. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.
- ZZ. ICC-ES AC380 - Acceptance Criteria for Termite Physical Barrier Systems; 2021, with Editorial Revision (2022).
- AAA. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair; 2013.
- BBB. NSF 61 - Drinking Water System Components - Health Effects; 2023, with Errata.
- CCC. NSF 372 - Drinking Water System Components - Lead Content; 2022.
- DDD. ACI 117 - Specification for Tolerances for Concrete Construction and Materials 2010 (Reapproved 2015).
- EEE. ACI 211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide 2022.
- FFF. ACI 301 - Specifications for Concrete Construction 2020.
- GGG. ACI 302.1R - Guide to Concrete Floor and Slab Construction 2015.
- HHH. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- III. ACI 305R - Guide to Hot Weather Concreting 2020.
- JJJ. ACI 306R - Guide to Cold Weather Concreting 2016.
- KKK. ACI 308R - Guide to External Curing of Concrete 2016.
- LLL. ACI 318 - Building Code Requirements for Structural Concrete 2019 (Reapproved 2022).
- MMM. ACI 347R - Guide to Formwork for Concrete 2014 (Reapproved 2021).
- NNN. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts 2021a.
- OOO. ASTM E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric) 2014.
- PPP. COE CRD-C 621 - Handbook for Concrete and Cement Standard Specification for Packaged, Dry 1997.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
 - 2. For chemical-resistant waterstops, provide data on ASTM D471 test results.
 - 3. Printed application instructions for form release agents.
- B. Mix Design: Submit proposed concrete mix design.

1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
 2. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.
- C. Shop Drawings:
1. Show dimensioned locations of anchor bolts for hold-down anchors and columns.
 2. Show reinforcement and all necessary bending diagrams and reinforcing steel list, and construction joint locations.
 3. Provide bar schedules and bending details.
 4. Show all formwork for concrete surfaces which are to remain exposed in the finished work.
 5. Joint layout plan for control and expansion joints for sidewalks, curbs, and gutters for written approval before starting work on this Section.
- D. Manufacturer's Installation Instructions: For concrete accessories and form release agents, indicate installation procedures and interface required with adjacent construction.
- E. Manufacturer's Reports:
1. Provide Manufacturer's performance and testing data for following:
 - a. Each admixture used.
- F. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.
- G. Closeout Submittals:
1. Include following in Operations And Maintenance Manual specified in Section 01 7800:
 - a. Record Documentation:
 - 1) Pour Reports:
 - (a) Provide report that records following information:
 - (1) Date and time of start of pour, Date and time of end of pour, and Date and time of end of finishing procedures.
 - (2) Temperature at start of pour, Temperature at end of Pour, and Maximum temperature during performance of finishing procedures.
 - (3) Wind speed at start of pour, Wind speed at end of pour, and Maximum wind speed during performance of finishing procedures.
 - (4) Humidity at start of pour, Humidity at end of pour, and High and low humidity during performance of finishing procedures.
 - (5) Cloud cover at start of pour, Cloud cover at end of pour, and High and low cloud cover during performance of finishing procedures.
 - (6) Screeding method and equipment used.
 - (7) Saw cut method and equipment used.
 - 2) Testing and Inspection Reports:
 - (a) Testing Agency Testing and Inspecting Reports of concrete.
 - 3) Warranty. Submit rapid concrete drying or MVRA manufacturer warranties for concrete moisture vapor emission induced flooring failure and adhesion; ensure both have been completed in project's name and registered with manufacturer.
 - (a) Provide warranty to cover cost of flooring failures due to moisture migration from slabs for life of concrete. Include cost of repair or removal of failed flooring, placement of topical moisture remediation system, and replacement of flooring with comparable flooring system.
 - (b) Provide stand-alone adhesion warranty matching duration of flooring adhesive or primer manufacturer's material defect warranty.
- H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 DEFINITIONS

- A. Cold Weather, as referred to in this Section, is four (4) hours with ambient temperature below 40 deg F in twenty-four (24) hour period.

- B. Floor Flatness (FF): Rate of change in elevation of floor over 12 inches section.
- C. Floor Levelness (FL): Measures difference in elevation between two points which are 10 feet apart.
- D. Hot Weather, as referred to in this Section, is ambient air temperature above 100 deg F or ambient air temperature above 90 deg F with wind velocity 8 mph or greater.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
 - 1. Maintain one copy of each document on site.
- B. Qualifications: Requirements of Section 01 4000 applies, but is not limited to following:
 - 1. Installers and Installation Supervisor:
 - a. ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
 - b. Certification for National Ready Mixed Concrete Association (NRMCA).
 - 2. Ready-Mix Supplier:
 - a. Comply with ASTM C94/C94M requirements and be certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities".
 - 3. Testing Agencies:
 - a. Independent agency qualified according to ASTM C1077 and ASTM E329.
 - 1) Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technicians, Grade I according to ACI CP-1 or equivalent certification program.
 - 2) Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. Testing and Inspection:
 - 1. Owner is responsible for Quality Assurance. Quality assurance performed by Owner will be used to validate Quality Control performed by Contractor.
 - 2. Owner will provide Testing and Inspection on concrete:
 - a. Owner will employ testing agencies to perform testing and inspection on concrete as specified in Field Quality Control in Part 3 of this specification:
 - 1) Owner's employment of an independent Testing Agency does not relieve Contractor of Contractor's obligation to perform the Work in strict accordance with requirements of Contract Documents and perform contractor testing and inspection.
- D. Follow recommendations of ACI 305R when concreting during hot weather.
- E. Follow recommendations of ACI 306R when concreting during cold weather.
- F. For slabs required to include moisture vapor reducing admixture (MVRA), do not proceed with placement unless manufacturer's representative is present for every day of placement.
- G. MANDATORY Pre-Installation Conference:
 - 1. Agenda items, review following:
 - a. Review Section 01 4000 for Testing and Inspection administrative requirements and responsibilities and Field Quality Control tests and inspections required of this section.
 - 1) Review requirements and frequency of testing and inspections.
 - b. Set up concrete placement pour card system and verify that all relevant trades have signed off prior to concrete placement.
 - c. Obtaining trade sign-offs on each pour card will be responsibility of General Contractor's foreman or whoever is in charge of ordering concrete.
 - d. Pour cards will be turned in to Quality Assurance representative after the work has been completed so that they can be reviewed and filed.
 - e. Review installation scheduling, coordination, placement of building concrete, and placement of items installed in and under concrete.

- f. Review installation scheduling, coordination and placement of site concrete and of items installed in concrete.
 - g. Review "Verification of Conditions" requirements.
 - h. Review requirements for preparation of subgrade and aggregate base requirements.
 - i. Review formwork requirements.
 - j. Review approved mix design requirements, mix designs and use of admixtures.
 - k. Review reinforcing bar submittals.
 - l. Review installation schedule and placement of reinforcing bars.
 - m. Review placement, finishing, and curing of concrete, including cold and hot weather requirements.
 - n. Review joint layout plan for control and expansion joints, fillers for sidewalks, curbs, and gutters:
 - 1) Review jointing requirements.
 - 2) Joint layout for concrete paving is specified in Section 32 1313.
 - o. Review smooth rubbed concrete finish procedures and requirements (applied immediately after removing concrete formwork while concrete is "green").
 - p. Review layout plan, scheduling, coordination, and placement requirements of detectable warning panels.
 - q. Review concrete slab tolerances and corrective measures if tolerances not met.
 - r. Review safety issues.
- H. Scheduling:
- 1. Notify Testing Agency and Architect twenty-four (24) hours minimum before placing concrete.
 - 2. Schedule pre-installation conference prior to placing of footings, installation of foundation forms and reinforcing steel, and installation of anchors, dowels, inserts, and block outs in foundation walls and slabs.

1.06 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Slabs with Porosity Inhibiting Admixture (PIA) or Moisture Vapor Reducing Admixture (MVRA): Provide warranty to cover cost of flooring failures due to moisture migration from slabs for life of the concrete.
 - 1. Include cost of repair or removal of failed flooring, placement of topical moisture remediation system, and replacement of flooring with comparable flooring system.
- C. Moisture Emission-Reducing Curing and Sealing Compound, Membrane-Forming: Provide warranty to cover cost of flooring delamination failures for 10 years.
 - 1. Include cost of repair or removal of failed flooring, remediation with a moisture vapor impermeable surface coating, and replacement of flooring with comparable flooring system.
- D. Moisture Emission-Reducing Curing and Sealing Compound, Penetrating: Provide non-prorated warranty to cover cost of flooring delamination failures for 20 years.
 - 1. Include cost of repair or removal of failed flooring, remediation with a moisture vapor impermeable surface coating, and replacement of flooring with comparable flooring system.
- E. Termite-Resistant Vapor Barrier Sheet: Provide five year manufacturer's limited warranty.

PART 2 PRODUCTS

2.01 CONCRETE FORMWORK

- A. Formwork Design and Construction: Comply with guidelines of ACI 347R to provide formwork that will produce concrete complying with tolerances of ACI 117.
- B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
 - 1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.

2. Form Facing for Exposed Finish Concrete: Steel.
3. Earth Cuts: Do not use earth cuts as forms for vertical surfaces. Natural rock formations that maintain a stable vertical edge may be used as side forms.
 - a. Vertical earth cuts may be used for footings provided the footing width and length are 6" wider and longer than scheduled.
4. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.
5. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches of concrete surface.

2.02 CONCRETE ANCHORS

A. General:

1. Use hot-dipped galvanized or stainless steel with matching nuts and washers in exterior and moist interior applications unless indicated otherwise on Contract Drawings.
 - a. Install hot-dipped or stainless steel anchor bolts to attach wood sill plates to foundation with 1/4 inch by 3 inch x 3 inch minimum adjustable plate washers and standard cut washers between wood sill plates and nuts.
 - b. Nut: Conform to requirements of ASTM A563, Grade A, Hex.
 - c. Conform to requirements of ASTM F3125/F3125M for chemical, physical and mechanical requirements for quenched and tempered bolts manufactured from steel and alloy steel.
2. Threaded rod for adhesive anchors and cast-in anchors:
 - a. Conform to requirements of ASTM A307, Grade A or ASTM F1554 Grade 36 unless indicated otherwise on Contract Drawings.
3. Cast-In-Place Anchor Bolts:
 - a. J-Bolts:
 - 1) Non-headed type threaded 2 inches minimum conforming to requirements of ASTM F1554, Grade A.
 - 2) Anchor hook to project 2 inches minimum including bolt diameter.
 - b. Headed Bolts:
 - 1) Headed type threaded 2 inches minimum conforming to requirements of ASTM F1554, Grade A.
4. Headed Concrete Anchor Studs:
 - a. Composed of low carbon steel meeting requirements of ASTM A108.
 - b. Tensile Strength: 61,000 psi minimum.
 - c. Yield Strength: 49,000 psi minimum.
5. Deformed Bar Anchors:
 - a. Manufactured in accordance with requirements of ASTM A1064/A1064M.
 - b. Tensile Strength: 80,000 psi minimum.
 - c. Yield Strength: 70,000 psi minimum.
6. Reinforcing Bars:
 - a. Composed of deformed carbon steel meeting requirements of ASTM A615/A615M, Grade 60 (field bent bars may be Grade 40)
7. Adhesive Anchors:
 - a. Products shall have current ESR conforming to current ICC Acceptance Criteria ICC-ES AC308 for concrete.
 - b. Rod diameter and embedment length as indicated on Contract Drawings.
 - c. Acceptable Products:
 - 1) HIT-RE 500V3 with SafeSet Epoxy Adhesive by Hilti Fastening Systems, Tulsa, OK www.us.hilti.com.
 - 2) Pure 110+ by Powers Fasteners Inc., Brewster NY www.powers.com.
 - 3) SET-XP Epoxy by Simpson Strong-Tie Co., Pleasanton, CA www.simpsonanchors.com.
 - 4) Equal as approved by Architect before installation. See Section 01 6000.
8. Expansion Anchors:

- a. Products shall have current ESR conforming to current ICC Acceptance Criteria ICC-ES AC193 for concrete.
 - b. Acceptable Products:
 - 1) KWIK Bolt TZ Expansion Anchor by Hilti Fastening Systems, Tulsa, OK
www.us.hilti.com.
 - 2) Power-Stud +SD2 by Powers Fasteners Inc., Brewster NY www.powers.com.
 - 3) Strong-Bolt by Simpson Strong-Tie Co., Pleasanton, CA
www.simpsonanchors.com.
 - 4) Equal as approved by Architect before installation. See Section 01 6000.
9. Screw Anchors:
- a. Provide anchors with length identification markings conforming to ICC Acceptance Criteria ICC-ES AC193 for concrete.
 - b. Type Two Acceptable Products:
 - 1) KWIK HUS-EZ by Hilti Fastening Systems, Tulsa, OK www.us.hilti.com.
 - 2) Wedge-Bolt+ by Powers Fasteners Inc., Brewster NY www.powers.com.
 - 3) Titen HD by Simpson Strong Tie Co, Pleasanton, CA
www.simpsonanchors.com.
 - 4) Equals as approved by Architect through shop drawing submittal before installation. See Section 01 6000.

2.03 REINFORCEMENT MATERIALS

- A. Epoxy Coated Reinforcement Steel Bars:
 - 1. Bars shall have grade identification marks and conform to ASTM A615/A615M with coating conforming to ASTM A775/A775M and comply with requirements of ACI 318.21.2.5:
 - a. Bar supports shall be completely coated with epoxy or vinyl, compatible with both concrete and epoxy coating on bars. Coating shall be at least 1/8 inch thick at tips.
 - b. Tie wire shall be nylon coated.
 - 2. Actual yield strength based on mill tests does not exceed specified yield strength by more than 18,000 psi and Ratio of actual ultimate stress (at breaking point) to actual tensile yield stress shall not be less than 1.25.
 - a. Grade 60 minimum, except dowels that are to be field bent, Grade 40 minimum.
 - 3. Bars shall be deformed type.
 - 4. Bars shall be free of heavy rust scales and flakes, or other bond-reducing coatings.
- B. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch.
 - 2. Bar Supports:
 - a. Concrete masonry units or bricks are not acceptable.
 - b. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).
 - c. Acceptable Products:
 - 1) Concrete 'dobies' or blocks wired to reinforcing.
 - 2) Manufactured chairs with 4 sq inch bearing surface on sub-grade, or other feature to prevent chair from being pushed into sub-grade or damaging vapor retarder under slabs on grade.
 - 3. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
 - 4. Provide stainless steel, galvanized, plastic, or plastic coated steel components for placement within 1-1/2 inches of weathering surfaces.

2.04 CONCRETE MATERIALS

- A. Performance:
 - 1. Design Criteria: Conform to requirements of ASTM C94/C94M unless specified otherwise:
 - 2. Capacities:
 - a. For testing purposes, following concrete strengths are required:

- 1) At 7 days: 70 percent minimum of 28 day strengths.
 - 2) At 28 days: 100 percent minimum of 28 day strengths.
- B. Cement: ASTM C150/C150M, Type I - Normal Portland type.
1. Acquire cement for entire project from same source.
- C. Concrete mix design: Submit mix designs to meet following requirements:
1. Mix Type A:
 - a. For exterior concrete exposed to freeze/thaw cycles and deicing salts or where soils are "corrosive" and as otherwise required by the contract drawings.
 - b. 4500 psi (31.03 MPa) minimum at twenty-eight (28) days.
 - c. Water / Cementitious Material: 0.40 maximum by weight.
 - d. Use twenty-five (25) percent Class F fly ash as part of cementitious material.
 - e. Mix Type E should be used for all exterior concrete exposed to freeze/thaw cycles and deicing salts, unless dictated otherwise by site conditions.
 - f. For concrete paving, use mix design based upon use of 1-1/2 inches coarse aggregate (about 15 percent).
 2. Air Entrainment: Six (6) percent, plus or minus 1-1/2 percent for exterior concrete and foundation walls exposed to freeze/thaw cycles.
 3. Do not add water any time during mixing cycle above amount required to meet specified water / cement ratio. No reduction in amount of cementitious material is allowed.
 4. Mix design strengths specified are a minimum due to exposure to sulfates, chlorides, freeze/thaw, water, etc. Refer to the structural drawings for additional concrete strength requirements. The most stringent requirements should be met.
- D. Slump:
1. 4 inch (100 mm) slump maximum before addition of high range water reducer.
 2. 8 inch (200 mm) slump maximum with use of high range water reducer.
- E. General:
1. Submit a letter on quarry's letterhead that certifies all aggregate for concrete complies with the requirements of this section. Material certificates which are submitted shall be signed by both the materials producer and the contractor, certifying that materials comply with or exceed requirements specified herein to the Architect, Civil and Structural Engineering Consultant and the Independent Testing Laboratory for review and approval.
 2. Aggregates for all concrete shall come from a quarry that is DOT approved and meets or exceeds durability Class I aggregate. The quarry shall submit a letter to Engineer that certifies that all aggregate complies with DOT requirements for durability. Aggregate not meeting DOT durability requirements shall not be used.
- F. Fine and Coarse Aggregates: ASTM C33/C33M.
1. Acquire aggregates for entire project from same source.
- G. Fly Ash: ASTM C618, Class C or F.
1. Not to exceed twenty-five (25) percent of weight of cementitious materials.
- H. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.05 ADMIXTURES

- A. No admixture shall contain calcium chloride nor shall calcium chloride be used as an admixture. All chemical admixtures used shall be from same manufacturer and compatible with each other.
1. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Mix design shall show proposed admixtures, amount, usage instructions, and justification for proposed use. Do not use any admixtures without Architect's written approval.
1. Chemical accelerator or retarder may be used if necessary to meet environmental conditions and construction schedules.
- C. Alkali-Silica Reactivity Inhibiting Admixture:
1. Specially formulated lithium nitrate admixture for prevention of alkali-silica reactivity (ASR) in concrete. Admixture must have test data indicating conformance to ASTM C1293.

2. Manufacturer: As approved by Architect before use. See Section 01 6000.
- D. Viscosity Modifying Admixture (VMA):
1. Liquid admixture used to optimize viscosity of Self-Consolidating Concrete (SCC). Subject to compliance with requirements, provide following at dosage rates per manufacturer's recommendations.
 2. Manufacturer: As approved by Architect before use. See Section 01 6000.
- E. Air Entraining Admixture: ASTM C260/C260M.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- F. High Range Water Reducing Admixture: ASTM C494/C494 Type F.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- G. High Range Water Reducing and Retarding Admixture (Superplasticizer): ASTM C494/C494M Type G.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- H. Water Reducing Admixture: ASTM C494/C494M Type A.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- I. Water Reducing and Accelerating Admixture: ASTM C494/C494 Type E.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- J. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- K. Accelerating Admixture: ASTM C494/C494M Type C.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- L. Retarding Admixture: ASTM C494/C494M Type B.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- M. Shrinkage Reducing Admixture: ASTM C494/C494M Type S.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- N. Non-Chloride, Non-Corrosive Accelerating Admixture: ASTM C494/C494M Type C or E.
1. Manufacturer: As approved by Architect before use. See Section 01 6000.
- O. Corrosion Inhibiting Admixture: ASTM C494/C494M Type C and ASTM C1582/C1582M.
1. Liquid admixture to inhibit corrosion of steel reinforcement in concrete by introducing proper amount of anodic inhibitor. Admixture shall contain thirty (30) percent calcium nitrite solution and shall be used where called for in specifications or on drawings.
 2. Manufacturer: As approved by Architect before use. See Section 01 6000.
- P. Moisture Vapor Reduction Admixture (MVRA):
1. Liquid, inorganic admixture free of volatile organic compounds (VOCs) and formulated to close capillary systems formed during curing to reduce moisture vapor emission and transmission with no adverse effect on concrete properties or finish flooring.
 2. Manufacturer: As approved by Architect before use. See Section 01 6000.
- Q. Waterproofing Admixture:
1. Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.
 2. Admixture Composition: Crystalline, functioning by growth of crystals in capillary pores.
 3. Admixture Composition: Hydrophobic polymer waterproofing and corrosion inhibitor, functioning by closing concrete pores and chemical bonding.
 4. Permeability of Cured Concrete: No measurable leakage when tested in accordance with COE CRD-C 48 at 200 psi; provide test reports.
 5. Potable Water Contact Approval: National Science Foundation (NSF) certification for use on structures holding potable water, based on testing in accordance with NSF 61 and NSF 372.
 6. Manufacturer: As approved by Architect before use. See Section 01 6000.

2.06 BONDING AND JOINTING PRODUCTS

- A. Bonding Agents:
 - 1. Manufacturers: As approved by Architect before use. See Section 01 6000.
- B. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.
 - 1. Manufacturers: As approved by Architect before use. See Section 01 6000.
- C. Waterstops (Contractor Option):
 - 1. Waterstops: PVC, complying with COE CRD-C 572.
 - a. Configuration: As indicated on drawings.
 - b. Size: As indicated on drawings.
 - c. Manufacturers: As approved by Architect before use. See Section 01 6000.
 - 2. Waterstops: Bentonite and butyl rubber, complying with NSF 61 and NSF 372.
 - a. Configuration: As indicated on drawings.
 - b. Size: As indicated on drawings.
 - c. Manufacturers: As approved by Architect before use. See Section 01 6000.
- D. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
 - 1. Material: ASTM D1751, cellulose fiber.
 - 2. Manufacturers: As approved by Architect before use. See Section 01 6000.
- E. Expansion Joint Filler:
 - 1. Expansion Joint Filler Material:
 - a. Design Criteria:
 - 1) Resilient, flexible, non-extruding, expansion-contraction joint filler meeting requirements of ASTM D1751.
 - 2) 1/2 inch (12.7 mm) thick.
 - 3) Resilience:
 - (a) When compressed to half of original thickness, recover to minimum of seventy (70) percent of original thickness.
 - b. Manufacturers: As approved by Architect before use. See Section 01 6000.
- F. Finishing Material (Exposed Vertical Faces of Foundation and Retaining Walls):
 - 1. Do not apply finishing material (parge coat) to foundation or retaining walls.
- G. Slab Contraction Joint Device (if used): Preformed linear strip intended for pressing into wet concrete to provide straight route for shrinkage cracking.
 - 1. Manufacturers: As approved by Architect before use. See Section 01 6000.
- H. Slab Construction Joint Devices (if used and required by contract drawings): Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.
 - 1. Provide removable plastic cap strip that forms wedge-shaped joint for sealant installation.
 - a. Height: To suit slab thickness.
 - b. Manufacturers: As approved by Architect before use. See Section 01 6000.
 - 2. Dowel Sleeves: Plastic sleeve for smooth, round, steel load-transfer dowels.
 - a. Manufacturers: As approved by Architect before use. See Section 01 6000.

2.07 CURING MATERIALS

- A. Membrane Curing:
 - 1. Clear water-based, ready-to use membrane curing agent that cures freshly placed concrete, forming effective barrier against moisture loss from concrete surface.
 - 2. Design Criteria:
 - a. Exterior Concrete:
 - 1) Dissipating or non-dissipating membrane curing agent.
 - b. Interior Concrete:
 - 1) Dissipating membrane curing agent only.

- 2) Gradually dissipate after twenty-eight (28) days without leaving stain or discoloring concrete surface.
 - c. VOC-compliant compound.
 - d. Meet requirements of ASTM C309 and AASHTO M 148, Type 1 or 1-D, Class B.
 - e. Interior concrete: containing no mineral spirits, naphtha, or other components detrimental to finish flooring installation.
 - f. Maintain ninety-five (95) percent of mix water present in concrete mass after application.
3. Horizontal and Vertical Cast-In-Place Structural Concrete:
- a. Acceptable Products.
 - 1) Exterior Concrete:
 - (a) Clear Cure J7WB by Dayton Superior Corporation, Miamisburg. OH www.daytonsuperior.com.
 - (b) Clear Water Resin by Right Point, Dekalb, IL www.rightpointe.com.
 - (c) L&M Cure R by L&M Construction Chemicals, Inc. Omaha, NE www.lmcc.com.
 - (d) VOCOMP 20 (do not use when concrete sealer will be applied in areas of freeze/thaw and deicer salts) by W.R. Meadows, Inc. Hampshire, IL www.wrmeadows.com.
 - (e) 1100-Clear by W. R. Meadows, Inc. Hampshire, IL www.wrmeadows.com.
 - (f) Equal as approved by Architect before use. See Section 01 67000
 - 2) Interior Concrete:
 - (a) Clear Cure J7WB by Dayton Superior Corporation, Miamisburg. OH www.daytonsuperior.com.
 - (b) Clear Water Resin by Right Point, Dekalb, IL www.rightpointe.com.
 - (c) L&M Cure R by L&M Construction Chemicals, Inc. Omaha, NE www.lmcc.com.
 - (1) 1100-Clear by W. R. Meadows, Inc. Hampshire, IL www.wrmeadows.com.
 - (d) Equal as approved by Architect before use. See Section 01 6000.
- B. Water Curing:
- 1. Required Locations:
 - a. Use on polished concrete finishing surfaces in areas as shown on Contract Drawings.
 - b. Used on all interior concrete floor surfaces including offices that receive carpet.
 - c. Used on concrete surfaces in Process Area, Process Area Custodial Room, and Yard Sales Area only.
 - d. Used on concrete surfaces in areas as shown in Contract Documents.
 - 2. Water-Curing Materials:
 - a. Type Two Acceptable Products:
 - 1) Absorptive Cover: Meet requirements of AASHTO M 182, Class 2 burlap cloth made from jute or kenaf and weighing minimum of 9 oz per sq yd (305 grams per sq m) when dry.
 - 2) Moisture-Retaining Cover: White, opaque membrane meeting requirements of ASTM C171 minimum.
 - 3) Equals as approved by Architect before using. See Section 01 6000.

2.08 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
- B. Transit Mixers: Comply with ASTM C94/C94M.
- C. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section and before concrete is placed.
 - 1. Notify Architect of incorrect dimensions or spot elevations in writing.
 - 2. Do not place concrete until corrections are made and verified.
- B. Detectable Warning Panels:
 - 1. Examine substrate and verify substrate is suitable for installation of detectable warning panels:
 - a. Notify Architect of unsuitable conditions in writing.
 - b. Do not install detectable warning panels over unsuitable conditions.
 - c. 3) Commencement of Work by installer is considered acceptance of substrate.

3.02 PREPARATION

- A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.
- B. Verify that forms are clean and free of rust before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- D. Concrete Mixing:
 - 1. General:
 - a. All concrete shall be machine mixed.
 - b. Water gauge shall be provided to deliver exact predetermined amount of water for each batch.
 - c. Reliable system must be employed to insure that no less than predetermined amount of cement goes into each batch.
 - d. Re-tempering partly set concrete will not be permitted.
 - 2. Transit Mix:
 - a. Transit mix concrete may be used provided it conforms to Specifications and tests herein described and ASTM C94/C94M.
 - b. Central plant producing concrete and equipment transporting it are suitable for production and transportation of controlled concrete and plant is currently approved by local state DOT.
 - c. Maximum elapsed time between time of introduction of water and placing shall be one (1) hour.
 - d. Minimum time of mixing shall be one (1) minute per cubic yard after all material, including water, has been placed in drum, and drum shall be reversed for an additional two (2) minutes.
 - e. Mixing water shall be added only in presence of Inspecting Engineer or inspector employed by Testing Agency.
 - f. Trucks shall not be overloaded in excess of rated capacity as recommended by manufacturer.
 - 3. Cold Weather Concreting Procedures:
 - a. General Requirements:
 - 1) Materials and equipment required for heating and protection of concrete shall be approved and available at Project site before beginning cold weather concreting.
 - 2) Forms, reinforcement, metallic embedments, and fillers shall be free from snow, ice, and frost. Surfaces that will be in contact with newly placed concrete, including subgrade materials, shall be 35 deg F (2 deg C) minimum at time of concrete placement.
 - 3) Thaw sub-grade 6 inches (150 mm) deep minimum before beginning concrete placement. If necessary, re-compact thawed material.
 - 4) Use no frozen materials or materials containing ice.

- 5) See ACI 306.1 'Standard Specification for Cold Weather Concreting' for additional requirements.
4. Hot Weather Concreting Procedures:
 - a. General:
 - 1) Maximum concrete temperature allowed is 90 deg F (32 deg C) in hot weather.
 - 2) Cool aggregate and subgrades by sprinkling.
 - 3) Avoid cement over 140 deg F (60 deg C).
 - 4) Use cold mixing water or ice.
 - 5) Use fog spray or evaporation retardant to lessen rapid evaporation from concrete surface.
 - 6) See ACI 305.1 'Specification for Hot Weather Concreting' for additional requirements.
- E. Surface Preparation:
 1. Earthwork Preparation:
 - a. Aggregate base and subgrade:
 - 1) Prepare aggregate base as specified in Section 312323.
 - 2) Prepare natural soil subgrade as specified in Section 31 2200.
 - 3) Prepare fill subgrade as specified in Section 31 2323.
 2. Concrete Slab Thickness:
 - a. Increase thickness of concrete beneath detectable warning panels one inch (25 mm).
 3. Inserts, bolts, boxes, templates, pipes, conduits, and other accessories required by Divisions 22, 23, and 26 shall be installed and inspected before placing concrete.
 4. Install inserts, bolts, boxes, templates, pipes, conduits, and other accessories furnished under other Sections to be installed as part of work of this Section:
 - a. Tie anchor bolts for hold-down anchors and columns securely to reinforcing steel.
- F. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
 1. Use latex bonding agent only for non-load-bearing applications.
- G. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.
- H. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- I. Removal:
 1. Remove water and debris from space to be placed.
 2. Vapor Retarder Over Aggregate Base: Install compactible granular fill before placing vapor retarder as indicated on drawings. Do not use sand.

3.03 INSTALLATION OF FORMWORK

- A. Forms:
 1. Assemble forms so forms are sufficiently tight to prevent leakage.
 2. Properly brace and tie forms.
 3. Provide temporary cleanouts at base of tall forms if used to facilitate cleaning and inspection.
 4. Make proper form adjustments before, during, and after concreting.
 5. Use new forms, or used forms that have been cleaned of loose concrete and other debris from previous concreting and repaired to proper condition. Use APA Plyform B-B Class I, or APA HDO Plyform B-B Class I, on exposed to view concrete that do not receive a smooth rubbed finish.
 6. Use metal cold joint forms when unable to place concrete for footings, foundations, and slabs in continuous pours.

7. Provide beveled 2 inch by 4 inch keys where shown on Contract Drawings for tall or heavily loaded walls.
- B. Accessories:
1. General:
 - a. Provide for installation of inserts, templates, fastening devices, sleeves, and other accessories to be set in concrete before placing.
 - b. Position anchor bolts for hold-down anchors and columns and securely tie in place before placing concrete.
 2. Form Release / Finish Agents:
 - a. Film thickness shall be no thicker than as recommended by Manufacturer.
 - b. Allow no release / finish agent on reinforcing steel or footings.
 3. Expansion Joints:
 - a. Install at joints between floor slab and foundation wall where shown on Drawings.
- C. Form Removal (Slab on Grade):
1. Removal of forms can usually be accomplished in twelve (12) to twenty-four (24) hours.
 2. If temperature is below 50 deg F (10 deg C) or if concrete (stairs, beams, etc) depends on forms for structural support, leave forms intact for sufficient period for concrete to reach adequate strength.
 3. For exposed to view surfaces that receive a smooth rubbed finish, remove forms while concrete is still "green".
 4. Metal bars or prys should not be used. Use wood wedges, tapping gradually when necessary.

3.04 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

- A. Fabricate reinforcement bars according to the Concrete Reinforcing Steel Institute (CRSI) 'Manual of Standard Practice' and details on Contract Documents.
- B. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.
- C. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.
- D. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.
- E. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.
- F. Avoid cutting or puncturing vapor retarder during reinforcement placement and concrete operations.
- G. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
- H. Blowtorch shall not be used to facilitate field cutting or bending or any other reinforcing work.
- I. Reinforcement shall not be bent after partially embedded in hardened concrete.
- J. Placing Reinforcement:
 1. Comply with Concrete Reinforcing Steel Institute CRSI 'Manual of Standard Practice' recommended practice for 'Placing Reinforcing Bars' for details and methods of reinforcement placement and supports. and as herein specified.
 2. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations:
 - a. Locate and support reinforcing by chairs, runners, bolsters, bar supports, spacers, or hangers, as required as recommended by 'ACI Detailing Manual, except slab on grade work.
 - b. Support bars in slabs on grade and footings with specified bar supports around perimeter and at 4-1/2 feet on center each way maximum to maintain specified concrete cover.

- c. Install bar supports at bar intersections.
- 3. Bend bars cold.
- 4. Dowel vertical reinforcement for formed concrete columns or walls out of footing or structure below with rebar of same size and spacing required above.
- 5. Securely anchor and tie reinforcement bars and dowels before placing concrete. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- K. Splices:
 - 1. Per requirements of Structural Drawings.
- L. Tolerances:
 - 1. Provide following minimum concrete cover for reinforcement as per ACI 318 or ACI 318M.
- M. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations:
 - 1. Concrete cast against and permanently exposed to earth:
 - a. Interior Slabs on Grade: 1 inch clear from top of slab at 4 inches slabs, 2 inches clear at 6 inches slabs.
 - 1) Sections other than Slabs: 3 inches.
 - b. Concrete Exposed to Earth or Weather:
 - 1) No. 6 and Larger Bars: 2 inches.
 - 2) No. 5 and Smaller Bars, W31 and D31 Wire: 1-1/2 inches.

3.05 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Notify Architect not less than 24 hours prior to commencement of placement operations.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- E. General:
 - 1. Place as soon after mixing as possible.
 - 2. Deposit as nearly as possible in final position.
 - 3. No concrete shall be deposited in water.
 - 4. Placing of concrete shall be continuous until panel or section is complete.
 - 5. Compact concrete in forms by vibrating and other means where required.
 - a. Thoroughly consolidate concrete around reinforcing bars (Consolidation not required in concrete around reinforcing bars with Mix Type G).
 - b. Use and type of vibrators shall conform to ACI 309.
 - 6. Form vertical surfaces full depth. Do not allow concrete to flow out from under forms in any degree into landscaped areas.
 - 7. Consolidate concrete thoroughly.
 - 8. Do not embed aluminum in concrete.
 - 9. Do not use contaminated, deteriorated, or re-tempered concrete.
 - 10. Avoid accumulation of hardened concrete.
 - 11. Dusting with cement not permitted.
- F. Footings:
 - 1. Bear 12 inches (300 mm) minimum into undisturbed earth or on mechanically compacted engineered fill. Step footings at ratio of 1-1/2 horizontal to One vertical unless detailed otherwise.
 - 2. Level top of finish footing and leave rough.
 - 3. Where joints are required, bulkhead, key horizontally, and dowel with two No. 5 reinforcing bars, 48 inches (1 200 mm) long.
- G. Foundation Walls: Leave steel projecting where required for floor tie.
- H. Exterior Slabs:

1. For continuous placing and where shown on Drawings, saw cut one inch (25 mm) deep control joints before shrinkage occurs (2 inches at 6 inch slabs) (50 mm at 150 mm slabs).
- I. Miscellaneous Concrete Elements:
 1. Sidewalks, Exterior Stairs, And Landings:
 - a. Slope with cross slope of 1/8 to 1/4 inch per ft (3 to 6 mm per 300 mm) (one to two percent) in direction of intended drainage.
 - b. Slope away from building 1/8 to 1/4 inch per ft (3 to 6 mm per 300 mm) (one to two percent) minimum.
 - c. Concrete walks shall be screeded to bring surface to grades and lines as indicated.
 - d. Surface shall be floated with wood float with no coarse aggregate showing and then given broom finish before concrete sets.
 - J. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
 - K. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.

3.06 SLAB JOINTING

- A. Locate joints as indicated on drawings (do not use control joints in interior concrete slabs in meetinghouse).
 1. Concrete Control Joints on Center Spacing.
 - a. Sidewalks: 4-6 feet
 - b. Curbs and Gutters: 10 feet
 2. Concrete Expansion Joint (isolation) Joints on Center Spacing.
 - a. Sidewalks, Curbs and Gutters: 40-100 feet
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
 1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
- D. Load Transfer Construction and Contraction Joints: Install load transfer devices as indicated; saw cut joint at surface as indicated for contraction joints.
- E. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
- F. Contraction Joint Devices: Use preformed joint device, with top set flush with top of slab.
- G. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.
- H. Seal expansion joints as specified in Section 07 9200 for following areas:
 1. Between entryway slabs and building foundations.
 2. Between sidewalks and building foundations.
 3. Concrete retaining walls.
 4. Within curbs and gutters.
 5. Within flat drainage structures and at joints between flat drainage structures and other concrete elements.
- I. Expansion joints are not required to be sealed for following areas:
 1. Within aprons and where apron abuts sidewalks.
 2. Within mow strips and where mow strip abuts building foundation and sidewalks.
 3. Within sidewalks.

3.07 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
 - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, immediately after form removal.

3.08 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
 - 1. Normal concrete: Not less than seven days.
 - 2. High early strength concrete: Not less than four days.
- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:
 - 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by membrane curing, water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - 2. Slabs and Floors To Receive Adhesive-Applied Flooring: Membrane Cure. Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
 - 3. Slabs and Floors to Receive Polished Finish: Water cure
 - 4. Final Curing: Begin after initial curing but before surface is dry.
 - a. Moisture-Retaining Sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges.
 - b. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.09 POST INSTALLED ANCHORS

- A. General:
 - 1. Drill holes with rotary impact hammer drills using carbide-tipped bits.
 - 2. Unless otherwise shown on Drawings, drill holes perpendicular to concrete surface.
 - 3. Perform anchor installation in accordance with Manufacturer's published instructions.
- B. Adhesive Anchors:
 - 1. Clean holes in accordance with Manufacturer's published instructions before installation of adhesive:
 - a. Follow Manufacturer's recommendations to ensure proper mixing of adhesive components.
 - 2. Adhesive:
 - a. Inject adhesive into holes proceeding from bottom of hole and progressing toward surface so as to avoid introduction of air pockets into adhesive.
 - b. Inject sufficient adhesive into hole to ensure that annular gap is filled to surface.
 - c. Remove excess adhesive from surface and threads of anchor as necessary.
 - 3. Shim anchors with suitable device to center anchor in hole. Do not disturb or load anchors before Manufacturer's specified cure time has elapsed.
 - 4. Temperature:
 - a. Observe Manufacturer's recommendations with respect to installation temperatures for adhesive anchors.

- b. Base material temperatures must be maintained above minimum temperatures allowed by Manufacturer for full required epoxy cure time.
- C. Expansion Anchors:
 - 1. Protect threads from damage during anchor installation and prior to use.
 - 2. Set anchors to Manufacturer's recommended torque, using a torque wrench. Following attainment of ten (10) percent of specified torque, one hundred (100) percent of specified torque shall be reached within 7 or fewer complete turns of nut. If specified torque is not achieved within required number of turns, remove and replace anchor, unless otherwise directed by Architect.
- D. Screw Anchors:
 - 1. Protect threads from damage during anchor installation and prior to use.
 - 2. Set anchor flush, collared.
 - 3. Do not exceed Manufacturer's maximum allowed torque when seating anchor.

3.10 NON-SHRINK GROUTING

- A. Surface Preparation:
 - 1. Prepare concrete surfaces in accordance with Manufacturer's written instructions.
 - 2. Remove all loose materials.
 - 3. Clean surface of any substance that could interfere with bond on material including dirt, paint, tar, asphalt, wax, oil, grease, latex compounds, form release agents, laitance, loose toppings, foreign substances and any other residues.
 - 4. Saturate area to be grouted with water in accordance with Manufacturer's written instructions.
- B. Mixing:
 - 1. Mix grout in accordance with Manufacturer's written instructions.
 - 2. Add mix water in amount in accordance with Manufacturer's written instructions to provide required placing consistency.
 - 3. Do not add water in amount that will cause bleeding or segregation of mixed grout.
 - 4. Do not add any sand, cement, admixtures, or fluidifiers to grout.
- C. Placement:
 - 1. Place grout in accordance with Manufacturer's written instruction including but not limited to the following:
 - a. Proper curing is required.
 - b. Use cold weather or hot weather grouting procedures in accordance with Manufacturer's written instructions, as temperature dictates:
 - 1) Do not use at temperatures that may cause premature freezing.
 - 2) Do not allow to freeze until 4000 psi (27.6 MPa) is attained.
 - c. Employ cold weather or hot weather grouting practices as temperatures dictates.
 - 2. Completely eliminate air pockets and provide full contact between grout and item being grouted. Do not exceed Manufacturer's recommended thickness.
- D. Curing:
 - 1. Cure grout in accordance with Manufacturer's written instructions or ACI curing practices.
 - 2. Wet cure grout until forms are removed.
 - 3. Seal grout surfaces after forms are removed as recommended by Manufacturer.
- E. Keep grout surfaces wet after curing compound has dried for as long as recommended by Manufacturer.
- F. Protect placed grout from freezing until minimum strength of 4000 psi (27.58 MPa) is reached.
- G. Protect placed grout from damage during construction.

3.11 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.
- B. Quality Control is sole responsibility of Contractor.

1. Owner's employment of an independent Testing Agency does not relieve Contractor of Contractor's obligation to perform testing and inspection as part of his Quality Control:
 - a. Testing and inspections, if performed by Contractor, will be responsibility of Contractor to be performed by an independent entity.
- C. Provide free access to concrete operations at project site and cooperate with appointed firm.
- D. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- E. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- F. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cubic yards or less of each class of concrete placed.
- G. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- H. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.
- I. Slab Testing: Cooperate with manufacturer of specified moisture vapor reducing admixture (MVRA) to allow access for sampling and testing concrete for compliance with warranty requirements.
- J. Precast Concrete:
 1. Testing Agency shall provide inspection including following:
 - a. Review all precast plant test reports.
 - b. Provide inspection of all precast during construction, transportation, and erection, verifying precast is undamaged, and installed in accordance with requirements of Contract Documents.
 - c. Provide inspection of precast concrete anchorages to other components of structure.
- K. Expansion Anchors / Adhesive Anchors / Screw Anchors:
 1. Certified Inspector from Testing Agency shall verify procedures used for installation of all concrete anchors and monitor their installation for compliance with Manufacturer's requirements.
 2. Inspections:
 - a. Inspections shall include required verification and inspection of anchors as referenced in IBC Table 1704.4 and in accordance with most current version of ACI 318 or ACI 318M and applicable ASTM material standards that:
 - 1) The correct rod/anchor is used; size and type.
 - 2) The correct hole size is used and prepared per Manufacturer's instructions.
 - 3) That climactic conditions, and concrete temperature, allow for the anchors' installation and use.
 - 4) Proper hole cleaning equipment, per Manufacturer's instructions, is used.
 - 5) Torque applied to anchors does not exceed Manufacturer's allowable limits.
 - (a) Torque applied to anchors is per Manufacturer's instructions.

3.12 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.13 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.
- B. Protect installed products from damage during construction.

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