**SECTION 03 30 00**

**CAST-IN-PLACE CONCRETE**

**BASED ON DFD MASTER SPECIFICATION DATED 9/10/2024**

***This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.***

**PART 1 - GENERAL**

**SCOPE**

Section includes cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes. The work under this section consists of providing all work, materials, labor equipment and supervision necessary to provide cast in-place concrete as required in these specifications and the drawings.

PART 1 - GENERAL

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Concrete Mixtures

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Joint Filling

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Field Quality Control

Protection

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

***(Editor Note: Check with project PM and Agency representative to verify if carbon budget targets are required for this project. If they are not, edit specifications to remove items.)***

The basis for designing concrete mixtures and demonstrating compliance with carbon budget targets shall be in accordance with:

National Ready Mixed Concrete Association (NRMCA) Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Manufactured by NRMCA Members – Version 3 (or later).

National Ready Mixed Concrete Association, NRMCA Member Industry Average EPD for Ready Mixed Concrete – Version 3 (or later).

***(The A/E to review all scope of work and determine other related work, work which impacts this section, or work is impacted by this section. A/E to add or remove sections below as needed. (Examples may include site civil or utility work, interior flooring and finishes, coatings, etc.)***

Related work specified elsewhere:

03 08 00 – Commissioning of Concrete

03 10 00 – Concrete Forming and Accessories

03 20 00 – Concrete Reinforcing

03 30 10 – Cast-In-Place Concrete for Site Work

04 20 11 - Unit Masonry

07 10 16 - Waterproofing for Utilities

07 63 00 - Sheet Metal Roofing Specialties

31 20 00 - Earthmoving

Section 00 00 00 – (Section Title)

Section 00 00 00 – (Section Title)

Embodied Carbon Footprint Goals

This project has a goal of reducing the embodied carbon footprint relative to a benchmark or typical project by < %> **<Insert percentage>.** To accomplish this goal, the target carbon footprint reduction for concrete is < %> **<Insert percentage>** below benchmark established in the NRMCA Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Version 3 (or later). Specific targets for Global Warming Potential (GWP) are provided in Section 2, CONCRETE MIXTURES. It shall be permitted to propose innovative products and manufacturing processes for approval by the Engineer of Record. Proposed alternatives shall meet all performance criteria for strength, durability, and constructability, and achieve the required reduction in carbon footprint.

**REFERENCES**

Incorporated Guides and References

American Concrete Institute (ACI):

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

 ACI 305R - Hot Weather Concreting.

Specifications

American Concrete Institute (ACI):

 ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.

 ACI 301 - Specifications for Structural Concrete.

 ACI 303.1 – Specification for Cast-In-Place Architectural Concrete.

 ACI 306.1 – Specification for Cold Weather Concreting.

 ACI 308.1 – Specification for Curing Concrete.

 ACI 315 - Details and Detailing of Concrete Reinforcement.

 ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

ASTM International (ASTM):

 ASTM A820 – Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.

 ASTM C33 – Standard Specification for Concrete Aggregates.

 ASTM C94 – Standard Specification for Ready-Mixed Concrete.

 ASTM C150 – Standard Specification for Portland Cement.

ASTM C156 – Standard Test Method for Water Loss (From a Mortar Specimen) Through Liquid Membrane-Forming Curing Compounds for Concrete.

 ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete.

 ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.

ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

 ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.

 ASTM C595 – Standard Specification for Blended Hydraulic Cements

ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete.

ASTM C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars.

ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.

 ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete.

ASTM C1240 – Standard Specification for Silica Fume Used in Cementitious Mixtures.

ASTM C1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

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.

ASTM E1745 – Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

**DEFINITIONS**

***(The A/E to include technical definitions for this section only. Do not include or repeat definitions found in related sections)***

Cementitious Materials: Materials that have cementing value if used in grout, mortar, or concrete, including Portland cement, blended hydraulic cements, expansive cement, fly ash, raw or calcined natural pozzolan, ground glass pozzolan, slag cement, and silica fume

Water/Cement Ratio (w/cm): Ratio of mass of water, excluding that absorbed by aggregate, to the mass of cementitious materials in a mixture, stated as a decimal

Embodied Carbon Footprint: Embodied carbon is the carbon dioxide equivalent (CO2e) footprint of a building or infrastructure project before it becomes operational. Embodied carbon is distinct from operational carbon — the carbon that comes from energy, heat, lighting, etc. Embodied carbon is generally expressed as Global Warming Potential. Typically, the embodied carbon is the initial embodied carbon which only accounts for the cradle to gate impacts.

Global Warming Potential: Global warming potential (GWP) is the heat absorbed by any greenhouse gas in the atmosphere, as a multiple of the heat that would be absorbed by the same mass of carbon dioxide. GWP is 1 for CO2. For other gases it depends on the gas and the time frame. GWP for concrete is expressed in kg of CO2e per unit of concrete (cubic yard or cubic meter)

Environmental Product Declaration: An Environmental Product Declaration (EPD) quantifies environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function. EPDs are conducted in accordance with a Product Category Rule for the specific product being evaluated. (International Organization for Standardization 14025 as a Type III declaration)

Product Category Rule: Product Category Rules (PCR) are a set of rules, requirements, and guidelines for developing Environmental Product Declarations (EPD) for one or more product categories. The PCR for concrete is published by NSF International.

Life Cycle Assessment: Life cycle assessment (LCA) is a methodology for assessing environmental impacts associated with all the stages of the life cycle of a commercial product, process, or service.

Concrete Category and Classes:

 Freezing and Thawing (F) Category:

F0: Concrete not exposed to freezing and thawing cycles

F1: Concrete exposed to freezing and thawing cycles with limited exposure to water

F2: Concrete exposed to freezing and thawing cycles with frequent exposure to water

F3: Concrete exposed to freezing and thawing exposure to deicing chemicals.

Sulfate (S) Category. Water Soluble Sulfate (SO42-) in soil, percent by mass:

S0: SO42 < 0.10

S1: 0.10 ≤ SO42 < 0.20

S2: 0.20 ≤ SO42 < 2.00

S3: SO42 > 2.0

In Contact with Water (W) Category:

W0: Concrete dry in service, Concrete in contact with water and low permeability in not required.

W1: Concrete in contact with water where low permeability is not required.

W2: Concrete in touch with water where low permeability is required.

Corrosion Protection of Reinforcement (C):

C0: Concrete dry or protected from moisture

C1: Concrete exposed to moisture but not to an external source of chlorides

C2: Concrete exposed to moisture and an external source of chlorides form deicing chemicals, sault, brackish water, seawater, or spray for the sources.

Aggregate Class Designations:

 Severe Weather Regions:

1S: Footings, foundations, columns and beams not exposed to weather, interior floor slabs to be given coverings.

2S: Interior floors without coverings

3S: Foundation walls above grade, retaining walls, columns, slabs, and beams exposed to weather

4S: Pavements, driveways and curbs, walks, garage floors, exposed floors or waterfront structures, subject to frequent wetting.

5S: Exposed architectural concrete.

Cured Concrete: C[oncrete that has undergone the process of maintaining satisfactory temperature and moisture conditions](https://www.bing.com/ck/a?!&&p=64f436ec261809faJmltdHM9MTcyNDAyNTYwMCZpZ3VpZD0xNDExZjZiMi1kM2M2LTYzZGQtMjA1OS1lNTU2ZDJlMzYyOWQmaW5zaWQ9NTAzNQ&ptn=3&ver=2&hsh=3&fclid=1411f6b2-d3c6-63dd-2059-e556d2e3629d&u=a1aHR0cHM6Ly93d3cuY29uY3JldGUub3JnL3RvcGljc2luY29uY3JldGUvdG9waWNkZXRhaWwvY3VyaW5nJTIwb2YlMjBjb25jcmV0ZT9zZWFyY2g9Y3VyaW5nJTIwb2YlMjBjb25jcmV0ZQ&ntb=1). [This allows the hydration of the cement and reaction of supplementary cementitious materials (SCMs), leading to improved strength and durability](https://www.bing.com/ck/a?!&&p=ad8408b634d84452JmltdHM9MTcyNDAyNTYwMCZpZ3VpZD0xNDExZjZiMi1kM2M2LTYzZGQtMjA1OS1lNTU2ZDJlMzYyOWQmaW5zaWQ9NTAzNw&ptn=3&ver=2&hsh=3&fclid=1411f6b2-d3c6-63dd-2059-e556d2e3629d&u=a1aHR0cHM6Ly93d3cuYWNpZm91bmRhdGlvbi5vcmcvUG9ydGFscy8xMi94QmxvZy91cGxvYWRzLzIwMjIvNy8yMS9DUkNfMjAyMF9QMDAzNl9EZXRlcm1pbmF0aW9uX0N1cmluZ19FZmZpY2llbmN5LnBkZg&ntb=1).

Curing Period: Duration of time in which continuous curing procedures are employed.

 When Testing is not performed to determine the curing period, cure concrete for at least 7 days.

When strength basis testing is performed to determine curing period, maintain curing procedures until test results meet or exceed requirements. Concrete must reach a minimum of 70% of the required specified concrete strength.

Dry Concrete: The measure of concrete at 80% relative humidity at 40% of the concrete slab-on-ground depth.

Self-Consolidating Concrete (SCC): a highly workable concrete that can flow through densely reinforced or complex structural elements under its own weight and adequately fill voids without segregation or excessive bleeding without the need for vibration.

Floor Flatness Number, FF, flatness relates to the bumpiness of the floor: even, plane, homoloidal, free of undulation. For the purposes of this test method, flatness will be measured by calculating curvature value, q, between all 12-in. reading points separated by 24 in. The curvature value is the difference between successive elevation differences. The mean and standard deviation of all the curvature values for a given test section are then converted according to the equations in this test method to get the dimensionless FF Flatness Number.

Floor Levelness Number, FL, levelness describes the tilt or pitch of the slab: horizontal, normal to the direction of gravity. For the purposes of this test method, levelness will be measured by collecting elevation differences at points spaced 10 ft apart and that will be described by the FL Levelness number (dimensionless).

Floor Levelness, (FL), tolerances only apply to non-sloping slabs-on-grade and suspended slabs shored at time of testing. Floor Levelness tolerances shall not apply to slabs placed on unshored form surfaces, shored surfaces after removal of shores, or pitched slab surfaces per ACI 302.

Overall FF/FL numbers represent minimum values acceptable for all combined local floor test sections representing the specified floor finish area per ACI 302. D. Local FF/FL test areas shall be defined as follows per ACI 302.

Areas bounded by construction or control joints for slabs-on-ground.

Areas bounded by columns and/or wall lines for elevated structural slabs. No less than one-half bay size

**PREINSTALLATION MEETINGS**

Prior to submitting design mixtures, contractor shall hold a meeting to review detailed requirements for preparing final concrete design mixes and to establish procedures for placing, finishing, curing, and protecting concrete to meet required quality under anticipated conditions. Representatives of each entity directly concerned with cast-in-place concrete to attend, including the following. It is recommended that these meetings be scheduled at least 30 days prior to each major class of concrete placed. Multiple meetings may be required.

Architect

Structural Engineer

General Contractor/Construction Manager

Installer (Concrete subcontractor)

Reinforcing Steel Contractor

Post-tensioning Contractor

Pumping Contractor

Manufacturer (Ready-mixed concrete producer)

Independent testing agency

Review the following:

Concrete mixtures – specification and constructability requirements

Scheduling and details for placement

Contact information of responsible persons during placement

Placement procedures and rate of placement

Jobsite adjustments permitted and decision process

Cold and hot weather requirements

Concrete protection

Concrete inspection and field quality control

Testing frequency, sampling location,

Initial curing facilities and site access for strength test and other specimens

Field-cured cylinders curing and intent of results

Minutes of the meeting shall be recorded, typed, reproduced and distributed by the Contractor to all parties concerned within five working days of meeting. Minutes shall include a statement by admixture manufacturer(s) indicating that proposed mix design and placing can produce concrete quality required by this Section.

Contractor shall notify Architect at least 10 days prior to scheduled date of meeting.

**SUBMITTALS**

Product Data: For each of the following, if used for concrete mixtures.

Portland cement.

Fly ash.

Slag cement.

Blended hydraulic cement.

Silica fume.

Performance-based hydraulic cement

Natural or other pozzolanic materials

Mineral Fillers

Aggregates.

Admixtures.

Color pigments.

Fiber reinforcement.

Vapor retarders.

Floor and slab treatments.

Liquid floor treatments.

Curing materials.

Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.

Joint fillers.

Repair materials.

Embodied Carbon Footprint Submittals:

Plant specific Environmental Product Declaration (EPD) for each concrete mixture proposed for the project accompanying each concrete mixture submittal.

 It shall be permitted to substitute plant-specific EPDs with those listed in NRMCA Member Industry Average EPD for Ready Mixed Concrete if the proposed mixtures are similar to those listed and the concrete producer participated in providing data for the NRMCA Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete.

A calculation showing that the Global Warming Potential (GWP) of all the concrete supplied for the project shall be lower than the GWP target set in Section 2.

Sustainable Design Submittals:

<Insert required sustainable design submittals>

Concrete Mixtures: For each concrete mixture, submit the following:

Mixture identification by class.

Type and source information on concrete materials proposed for use including:

Cementitious Materials

Aggregates

Mineral Fillers

Admixtures

Water

Fibers, color pigments, and other additions.

Compressive strength, f’c, applicable for the class.

Required average compressive strength, f’cr, for each class of concrete.

Documentation of strength test records of similar class of concrete used to establish standard deviation in accordance with ACI 301, when test records exist.

Documentation of compliance with f’cr of proposed mixture(s) and test age

Strength of concrete at other specified ages

The applicable durability exposure classes for each class of concrete

w/cm of proposed concrete mixtures, when specified.

Nominal maximum aggregate size or size number (ASTM C33) of coarse aggregate

Target slump or slump flow

Air content of concrete assigned to Exposure Classes F1, F2, and F3

Density, if specified

Documentation of compliance with maximum limits on supplementary cementitious materials for concrete assigned to Exposure Class F3

Cementitious materials and documentation of tests or service for concrete assigned to Exposure Class S1, S2, and S3

Documentation on chloride content of concrete mixtures for conformance to limits in Exposure Class C – calculated total chloride or measured water-soluble chlorides by ASTM C1218/C1218M, expressed as a percentage of cementitious materials.

Documentation on alkali aggregate reactivity for concrete assigned to Exposure Class W1 or W2, as specified.

Intended placement method.

Equilibrium density of lightweight concrete and correlated density of fresh concrete, if specified

Intended placement method.

Documentation supporting other specified requirements of concrete mixtures.

Anticipated changes to concrete mixtures for anticipated routine variability of in materials, and changes in project conditions, weather, test results, or other circumstances that warrant adjustments.

Laboratory Test Reports – For evaluating concrete materials and mix design tests.

 Field test records per ACI 301-10, Section 4.

Shop Drawings:

 Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

 Location of construction joints is subject to approval of the Architect.

Samples: For [manufacturer's standard colors for color pigment] [vapor retarder] **<Insert products>**.

Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

Concrete Class designation.

Location within Project.

Exposure Class designation.

Formed Surface Finish designation and final finish.

Final finish for floors.

Curing process.

Floor treatment if any.

Qualification Information for the following:

Installer: Include copies of applicable ACI certificates.

Ready-mixed concrete manufacturer.

Testing agency retained by the contractor for field quality control: Include conformance to ASTM C1077 or ASTM E329 and copies of ACI certificates of testing technicians.

Concrete Mixture Certification for each class of concrete:

Signed and sealed by professional engineer licensed in the state of the project.

Documentation of test results indicating compliance with specified requirements for each concrete mixture

Identify characteristics of each mixture that will be used for quality assurance during construction.

Testing agency retained by the contractor for field quality control: Include conformance to ASTM C1077 or ASTM E329 and copies of ACI certificates of testing technicians.

Material Certificates: For each of the following, provided by the material supplier:

Cementitious materials.

Aggregates.

Admixtures.

Fiber reinforcement.

Curing compounds.

Floor and slab treatments.

Bonding agents.

Adhesives.

Vapor retarders.

Semirigid joint filler.

Joint-filler strips.

Repair materials.

Material Test Reports: For the following, from a qualified testing agency:

Portland cement.

Fly ash.

Slag cement.

Blended hydraulic cement.

Silica fume.

Performance-based hydraulic cement.

Aggregates.

Admixtures:

Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

Research Reports:

For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.

Performance data for ASTM C494 Type S admixtures.

For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

Preconstruction Test Reports: For each mix design as specified.

Field quality-control reports.

Minutes of preinstallation conference.

**QUALITY ASSURANCE**

Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.

Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

Concrete shall be supplied from concrete plants with current certification under the NRMCA Certification of Ready Mixed Concrete Production Facilities, certification or approval by a state or highway agency or equivalent. Criteria of equivalent certification shall be included in the submittal.

Quality Control personnel with responsibility for concrete mixtures shall document qualifications demonstrating knowledge and experience with concrete technology and development of performance-based concrete mixtures. certified as an NRMCA Concrete Technologist Level 2, or equivalent. Details covered in equivalent certification program shall be documented in the submittal.

When requested, the manufacturer shall furnish a Quality Plan.

Documentation that the concrete supplier participated in supplying data to the NRMCA Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete.

Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

Testing Agency Qualifications: Independent testing agency complying with the requirements of ASTM C1077 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

Personnel performing field tests for acceptance shall be certified as ACI Concrete Field-Testing Technician Grade

Personnel conducting laboratory tests for acceptance shall be certified as ACI Concrete Strength Testing Technician or ACI Concrete Laboratory Testing Technician – Level I, or equivalent.

Test results for the purpose of acceptance shall be certified by a registered design professional employed with the Testing Agency

Field Quality-Control Testing Agency Qualifications: An independent agency**,**  acceptable to the AE and DFD, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

Personnel conducting field tests to be qualified as an ACI Concrete Field-Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

Concrete In-Situ Relative Humidity and pH:

ASTM F2170-11 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs using In-Situ Probes.

ASTM F710-11 – Standard Practice for Preparing Concrete Floors and Other Monolithic Floors to Receive Resilient Flooring.

Digital “Reader” and calibrated relative humidity sensors

Factory-calibrated “Smart Sensors” using Touch-n-Sense TM technology or similar testing equipment.

National Institute of Standards for Testing (NIST) – traceable factory calibration.

Wide range pH paper and distilled or de-ionized water.

Mockups: Cast concrete [slab-on-ground] [and] [formed-surface] **<insert required mockups>** panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.

Slab-On-Ground: Build panel approximately 15 feet by 15 feet <**insert area**> in the location indicated or, if not indicated, as directed by Architect.

Divide panel into four equal panels to demonstrate saw joint cutting.

Formed Surfaces: Build panel approximately 100 sq. ft. <**insert area**> in the location indicated or, if not indicated, as directed by Architect.

Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

**PRECONSTRUCTION TESTING**

Preconstruction Testing Service: Engage a qualified testing agency to perform specified testing on concrete mixtures.

Include the following information in each test report:

Admixture dosage rates.

Slump.

Air content.

Seven-day compressive strength.

28-day compressive strength.

**DELIVERY, STORAGE, AND HANDLING**

Comply with ASTM C94/C94M and ACI 301.

**FIELD CONDITIONS**

Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

Do not use frozen materials or materials containing ice or snow.

Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.

Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

Maintain concrete temperature at time of discharge to not exceed 95 deg F.

Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

**WARRANTY**

Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

Warranty Period: 10 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

**CONCRETE, GENERAL**

ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

**CONCRETE MATERIALS**

Source Limitations:

Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.

Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.

Obtain aggregate from single source.

Obtain each type of admixture from single source from single manufacturer.

Cementitious Materials:

Portland Cement: ASTM C150/C150M, [Type I] [Type II] [Type I/II] [Type III] [Type V] **<insert Type>**, per concrete mix design requirements.

Fly Ash: ASTM C618/C618M.

Slag Cement: ASTM C989/C989M.

Silica Fume: ASTM C1240/C1240M

Ground Glass Pozzolan: ASTM C1866/C1866M

Blended Hydraulic Cement: ASTM C595/C595M, [Exclude Type IS, Portland blast-furnace sla g>70] [Type IP, Portland-pozzolan] [Type IL, Portland-limestone] [Exclude Type IT, ternary blended S>70] **<insert exclusions and Types>** cement.

Performance-Based Hydraulic Cement: ASTM C1157/C1157M: [Type GU, general use] [Type HE, high early strength] [Type MS, moderate sulfate resistance] [Type HS, high sulfate resistance] [Type MH, moderate heat of hydration] [Type LH, low heat of hydration] **<insert Type>**.

Hydraulic cement: ASTM C1157/C1157M

Normal-Weight Aggregates: Coarse and fine aggregates that conform to ASTM C33, [Class 3S] [Class 3M] [Class 1N] <**Insert class**> coarse aggregate or better, graded.

Nominal maximum size of coarse aggregate.

Provide documentation of tests or service record of adequate strength/durability for aggregates that do not conform to ASTM C33

Alkali-Silica Reaction: Comply with one of the following:

Aggregates are determined to be non-reactive: ASTM C1260 14-day expansion less than or equal to 0.10%, or ASTM C1293 1-year expansion less than or equal to 0.04%.

Aggregate and cementitious materials combination determined to be innocuous: ASTM C1567 14-day expansion less than or equal to 0.10%

Alkali content in concrete:

For aggregate with C1260 expansion between 0.1 and 0.3 percent or C1293 expansion between 0.04 and 0.12 percent – concrete alkali content shall be less than 4 lb/C.Y..

For aggregate with C1260 expansion between 0.3 and 0.45 percent or C1293 expansion between 0.12 and 0.24 percent – concrete alkali content shall be less than 3 lb/C.Y..

Alkali content is determined by weight of Portland cement content in mixture multiplied by the equivalent alkali content of Portland cement.

Maximum Coarse-Aggregate Size: [1-1/2 inches] [1 inch] [3/4 inch] <**insert dimension**> nominal.

Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

Mineral Filler: ASTM C1797

Lightweight Aggregate: ASTM C330/C330M, [1-inch] [3/4-inch] [1/2-inch] [3/8-inch] **<insert dimension>** nominal maximum aggregate size.

Heavyweight Aggregate: ASTM C637/C637M

**CHEMICAL ADMIXTURES**

Admixtures to be used in the concrete mixture shall be submitted for approval as part of the mixture design. No other admixtures will be allowed except those listed without the Architect’s approval.

Air-Entraining Admixture: ASTM C260/C260M.

Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.

Air-Entraining Admixture: ASTM C260/C260M

Water-Reducing Admixture: ASTM C494/C494M, Type A.

Retarding Admixture: ASTM C494/C494M, Type B or D.

Accelerating Admixture: ASTM C494/C494M Type C or E

Extended Set-Retarding Admixture: ASTM C494/C494M Type B or D

Workability-Retaining Admixture: ASTM C494/C494M Type S

High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.

High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.

Shrinkage-Reducing Admixture: ASTM C494/C494M Type S

Viscosity Modifying Admixtures: ASTM C494/C494M Type S

Alkali-Silica Reaction Inhibiting Admixture: ASTM C494/C494M Type S

Corrosion-Inhibiting Admixture: ASTM 1582/C1581M

Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

**Editor Note:. When working on utility projects, consider the use of Crystalline waterproofing Ad mix as a secondary means of protection of the reinforcing steel, if used, provide the following:**

**Cementitious Crystalline Concrete Waterproofing Admixture: Xypex C-1000/C-1000NF, BASF 300D or approved equal.**

Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.

Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).

Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRD C48 at a hydraulic pressure of 200 psi for 14 days.

Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments, color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] **<insert color>**.

Water and Water Used to Make Ice: ASTM C1602/C1602M

**FIBER REINFORCEMENT**

(AE Note: Fiber reinforcement to be reviewed and approved by DFD prior to use)

Carbon-Steel-Wire Fiber: ASTM A820/A820M, Type 1, cold-drawn wire, deformed, minimum of [1.5 inches] [2 inches] [2.4 inches] <**insert dimension**> long, with an aspect ratio of [35 to 40] [45 to 50] [60 to 65] <**insert ratio**>.

Carbon-Steel Cut Sheet Fiber: ASTM A820/A820M, Type 2, cut sheet, deformed, minimum of [1.5 inches] [2 inches] [2.4 inches] <**insert dimension**> long, and aspect ratio of [35 to 40] [45 to 50] [60 to 65] <**insert ratio**>.

Synthetic Monofilament Micro-Fiber: Monofilament polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, [1/2 to 1-1/2 inches] [1 to 2-1/4 inches] <**insert dimensions**> long.

Synthetic Fibrillated Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, [1/2 to 1-1/2 inches] [1 to 2-1/4 inches] <**insert dimensions**> long.

Synthetic Macro-Fiber: Synthetic macro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, [1 to 2-1/4 inches] <**insert dimensions**> long.

**VAPOR RETARDERS**

Sheet Vapor Retarder, Class A: ASTM E1745, Class A [, except with maximum water-vapor permeance of 0.03 perms] <**insert rating**>; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

Low-Temperature Flexibility: Pass at minus 15 deg F; ASTM D146/D146M.

Puncture Resistance: 224 lbf minimum; ASTM E154/E154M.

Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D570.

Hydrostatic-Head Resistance: 231 feet minimum; ASTM D5385.

Sheet Vapor Retarder, Class C: ASTM E1745, Class C [, except with maximum water-vapor permeance of] <**insert rating**>; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

Bituminous Vapor Retarder: ASTM E1993/E1993M, 110-mil-thick, semiflexible, seven-ply sheet membrane, consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weather coating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.

Water-Vapor Permeance: 0.0011 grains/h x sq. ft. x inches Hg when tested in accordance with ASTM E154/E154M.

Tensile Strength: 156 lbf/inch when tested in accordance with ASTM E154/E154M.

Puncture Resistance: 140 lbf when tested in accordance with ASTM E154/E154M.

**FLOOR AND SLAB TREATMENTS**

Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing [3/8-inch] [No. 4] [No. 8] <**insert size or gradation**> sieve.

Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

Emery Dry-Shake Floor Hardener: [**Pigmented**] [**Unpigmented**], factory-packaged, dry combination of Portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] **<insert color>.**

Metallic Dry-Shake Floor Hardener: **[Pigmented] [Unpigmented]**, factory-packaged, dry combination of Portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] **<insert color>.**

Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of Portland cement, graded quartz aggregate, and plasticizing admixture.

Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of Portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] **<insert color>.**

**LIQUID FLOOR TREATMENTS**

Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

**CURING MATERIALS**

Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

Color:

Ambient Temperature Below 50 deg F: Black.

Ambient Temperature between 50 deg F and 85 deg F: Any color.

Ambient Temperature Above 85 deg F: White.

Curing Paper: 8-feet-wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

Water: Potable or complying with ASTM C1602/C1602M.

Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.

Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

**RELATED MATERIALS**

Expansion- and Isolation-Joint-Filler Strips: [ASTM D1751, asphalt-saturated cellulosic fiber] [or] [ASTM D1752, cork or self-expanding cork] **<insert ASTM requirement>**.

Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, [epoxy resin with a Type A shore durometer hardness of 80] [aromatic polyurea with a Type A shore durometer hardness range of 90 to 95] **<insert filler type>** in accordance with ASTM D2240.

Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

[Types I and II, nonload bearing] [Types IV and V, load bearing] **<insert Types>**, for bonding hardened or freshly mixed concrete to hardened concrete.

Floor Slab Protective Covering: 8-feet-wide cellulose fabric.

**REPAIR MATERIALS**

Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

Cement Binder: ASTM C150/C150M Portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.

Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.

Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.

Compressive Strength: Not less than [4100 psi] <**Insert strength**> at 28 days when tested in accordance with ASTM C109/C109M.

Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

Cement Binder: ASTM C150/C150M Portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.

Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.

Compressive Strength: Not less than [5000 psi] <**insert strength**> at 28 days when tested in accordance with ASTM C109/C109M.

**CONCRETE MIXTURES, GENERAL**

Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).

Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete assigned to Exposure Class F3 as follows:

Fly Ash or Other Pozzolans: 25 percent by mass.

Slag Cement: 50 percent by mass.

Silica Fume: 10 percent by mass.

Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 35 percent by mass

Total of Fly Ash or Other Pozzolans and Silica Fume: 50 percent by mass.

Admixtures: Use admixtures in accordance with manufacturer's written instructions.

Use [water-reducing] [high-range water-reducing] [or] [plasticizing] **<insert admixture type>** admixture in concrete, as required, for placement and workability.

Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

Use water-reducing admixture in [pumped concrete,] [concrete for heavy-use industrial slabs] [concrete for parking structure slabs,] [and] [concrete with a w/cm below 0.50] **<insert admixture type>.**

Use corrosion-inhibiting admixture in concrete mixtures where indicated.

Use permeability-reducing admixture in concrete mixtures where indicated.

Color Pigment: Use color pigment in accordance with manufacturer’s instructions. If specified, color of hardened concrete should match approved mockup.

**CONCRETE MIXTURES**

***(AE Note: Below is a template of mixes. AE is responsible for editing for specific design requirements encountered on project.***

***AE should coordinate any concrete strengths listed in this specification with any listed concrete strengths providing in the construction documents. Preference would be to only list strengths in the specifications and reference this specification section on the construction documents.)***

Requirements for different classes of concrete mixtures for different locations or structural members shall be as indicated below.

For members where control of curling or reduction in the potential for cracking is required and as designated in Contract documents, submit data on the length change characteristics of the concrete mixture tested in accordance with ASTM C157. Perform ASTM C157 tests and submit data showing length change not exceeding 0.05% after 7 days of moist curing followed by 21 days of air drying.

The installer and manufacturer shall coordinate to establish properties of the fresh concrete to facilitate placement and finishing with reduced potential for segregation and bleeding. Factors shall include but are not limited to slump or slump flow, setting time, method of placement, rate of placement, hot and cold weather placement, curing, and concrete temperature. Selection of fresh concrete properties shall be submitted.

Contractor shall indicate reportable changes in sources of materials and quantities when such changes are necessary to ensure constructability, performance of concrete and compliance with the specification requirements. The contractor is permitted to make minor adjustments less than the reportable deviations noted in the original submittal to concrete mixtures to ensure uniformity of concrete without a re-submittal for review or approval.

Provide documentation that the total GWP of all proposed concrete on the project is less than or equal to **<insert number>** kg of CO2 equivalents.

(AE Note: If SCC concrete is to be used on the project, provide additional spec section 033126 Self-Consolidating Concrete. Review with DFD and get approval prior to use)

Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] **<insert strength>** at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class B: Normal-weight concrete used for foundation walls.

Exposure Class: ACI 318 **[F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] <insert class>.**

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] **<insert strength>** at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert type>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>.**

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class C: Normal-weight concrete used for interior slabs-on-ground.

Exposure Class: ACI 318 **[**F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] **<insert strength>** at 28 days.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<Insert size>** [3/4 inch or 1 inch at 4 inch thick slabs, and 1-1/2” at slab thickness over 4 inches].

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>.**

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] **<insert weight>**.

Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] **<insert dosage>**.

Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] **<insert dosage>**.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class D: Normal-weight concrete used for exterior slabs-on-ground.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>.**

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] **<insert strength>** at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Aggregate Size: [1 1/2][1][3/4][1/2] **<insert size>** [3/4 inch or 1 inch at 4 inch thick slabs, and 1-1/2” at slab thickness over 4 inches].

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>**.

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] **<insert weight>**.

Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] **<insert dosage>**.

Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] **<insert dosage>**.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class E: Normal-weight concrete used for interior suspended slabs, beams, and stairs.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>.**

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **<insert strength>** [As indicated] at 28 days.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>.**

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>.**

Air Content:

Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] **<insert weight>**.

Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] **<insert dosage>**.

Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] **<insert dosage>**.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class F: Structural lightweight concrete used for interior suspended slabs, beams and stairs.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **<insert strength>** [As indicated] at 28 days.

Calculated Equilibrium Unit Weight: [115 lb/cu. ft.] [110 lb/cu. ft.] [105 lb/cu. ft.] **<insert weight>**, plus or minus 3 lb/cu. ft. as determined by ASTM C567/C567M.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>.**

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] **<insert weight>**.

Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] **<insert dosage>**.

Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] **<insert dosage>**.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class G: Normal-weight concrete used for concrete toppings on metal deck.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **<Insert strength>** [As indicated] at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1][3/4][1/2] **<insert size>** inch

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>**.

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished toppings.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of [50 lb/cu. yd.] **<insert weight>**.

Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] **<insert dosage>**.

Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] **<insert dosage>**.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class H: Normal-weight concrete used for concrete toppings on precast plank.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **<insert strength>** [As indicated] at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>**.

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished toppings.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's written instructions, at a rate of **[**50 lb/cu. yd.] **<insert weight>**.

Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] **<insert dosage>**.

Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] **<insert dosage>**.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Provide bonding agents at structural topping slabs.

Class I: Normal-weight concrete used for interior [and exterior] columns.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>.**

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **<insert strength>** [As indicated] at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>.**

Slump Limit**:** [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>.**

Air Content: **[**0**] <insert number>** percent, plus or minus 0.5 percent at point of delivery.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as per cementitious materials information provided.

Class J: Normal-weight concrete used for exterior columns.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **insert strength>** [As indicated] at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>**.

Slump Limit**:** [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>.**

Air Content:

Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class K: Normal-weight concrete used for building walls.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **<insert strength> [**As indicated] at 28 days.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>**.

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

**[**0**] <insert number>** percent, plus or minus 0.5 percent at point of delivery.

Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class L: Normal-weight concrete used for interior metal pan stairs and landings:

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [3000 psi] **<insert strength>** [As indicated] at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: 1/2 inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>**.

Slump Limit: 3 inches, plus 1 inch or minus 2 inches.

Air Content: **[**0**] <insert number>** percent, plus or minus 0.5 percent at point of delivery.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

Retarding Admixture: Not allowed.

Accelerating Admixture: Not allowed.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class M: Normal-weight concrete used for exterior retaining walls.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **<insert strength>** [As indicated] at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>**.

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<insert number>** percent by weight of cement.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class N: Normal-weight concrete used for curb, gutter and sidewalks.

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>**.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] **<insert strength>** at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Aggregate Size: 3/4 inch or 1 inch at 4 inch thick slabs, and 1-1/2” at slab thickness over 4 inches

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>.**

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<insert limits>**.

Air Content:

Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

Limit water-soluble, chloride-ion content in hardened concrete to [1.00] [0.30] [0.15] **<Insert number>** percent by weight of cement.

Steel-Fiber Reinforcement: Add to concrete mixture, in accordance with manufacturer's wriiten instructions, at a rate of [50 lb/cu. yd.] **<insert weight>**.

Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [1.0 lb/cu. yd.] [1.5 lb/cu. yd.] **<insert dosage>**.

Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of [4.0 lb/cu. yd.] [5 lb/cu. yd.] **<insert dosage>**.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

Class O: Normal-weight concrete used for Utility Concrete.

***(AE Note: Discuss the type of Utility concrete to be used for project with DFD as SCC concrete is typically only used on select projects.)***

Exposure Class: ACI 318 [F0] [F1] [F2] [F3]- [S0] [S1] [S2] [S3]- [W0] [W1]- [C0] [C1] [C2] **<insert class>.**

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] [As indicated] **<insert strength>** at 28 days.

Aggregate: [1S][2S][3S][4S][5S] **<insert aggregate>**

Maximum Size Aggregate: [1 1/2][1][3/4][1/2] **<insert size>** inch.

Maximum w/cm: [0.50] [0.45] [0.40] **<insert number>**.

Supplementary Cementitious Materials: The mass of SCM shall not exceed the percentages listed for concrete exposed to freezing-and-thawing cycles with frequent exposure to water and exposure to deicing chemicals (ACI SPEC-301 (ACI SPEC-301M) Exposure Class F3).

Cementitious Material color: [gray] [white][pigmented/gray Portland cement][pigmented/white Portland cement] **<insert color>.**

Slump Limit: [4 inches, plus or minus 1 inch] [5 inches, plus or minus 1 inch] [8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site] **<Insert limits>**.

Air Content:

[0] **<Insert number>** percent, plus or minus 0.5 percent at point of delivery.

Exposure Class F1: [5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Exposure Classes F2 and F3: [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size] [6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size] [5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size] **<insert class>**.

Limit water-soluble, chloride-ion content in hardened concrete to **[**1.00] [0.30] [0.15] **<Insert number>** percent by weight of cement.

For sustainable mix designs: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as per cementitious materials information provided.

**CONCRETE MIXING**

Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M **[and ASTM C1116/C1116M]** and furnish batch ticket information.

Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.

For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.

Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

**PART 3 - EXECUTION**

**EXAMINATION**

Verification of Conditions:

Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.

Do not proceed until unsatisfactory conditions have been corrected.

**PREPARATION**

Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

Daily access to the Work.

Incidental labor and facilities necessary to facilitate tests and inspections.

Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.

Security and protection for test samples and for testing and inspection equipment at Project site.

**INSTALLATION OF EMBEDDED ITEMS**

Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.

Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

**INSTALLATION OF VAPOR RETARDER**

Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

Install vapor retarder with longest dimension parallel with direction of concrete pour.

Face laps away from exposed direction of concrete pour.

Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.

Lap joints 6 inches and seal with manufacturer's recommended tape.

Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.

Seal penetrations in accordance with vapor retarder manufacturer's instructions.

Protect vapor retarder during placement of reinforcement and concrete.

Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

**JOINTS**

Construct joints true to line, with faces perpendicular to surface plane of concrete.

Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.

Place joints perpendicular to main reinforcement.

Continue reinforcement across construction joints unless otherwise indicated.

Do not continue reinforcement through sides of strip placements of floors and slabs.

Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.

Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

Space vertical joints in walls **[as indicated on Drawings] <Insert spacing>**. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.

Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least **[**one-fourth**] <Insert depth>** of concrete thickness as follows:

Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.

Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 07 92 00 "Joint Sealants," are indicated.

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

Doweled Joints:

Install dowel bars and support assemblies at joints where indicated on Drawings.

Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

Dowel Plates: Install dowel plates at joints where indicated on Drawings.

**CONCRETE PLACEMENT**

Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.

Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

Measure, batch, mix, deliver, and provide delivery ticket for each batch of concrete in accordance with ASTM C94/C94M.

Water is permitted to be added to a batch of concrete at the project site before placement provided that the amount of water added does not exceed the allowed amount indicated on the delivery ticket. Water addition shall only be permitted before any portion of the load is discharged. Samples for quality assurance tests shall be obtained after water addition and additional mixing in accordance with ASTM C94/C94M.

It is permitted to add water to the concrete mixture during transportation to the jobsite when concrete is transported in truck mixers equipped with automated water measurement and slump or slump flow monitoring equipment in accordance with ASTM C94/C94M.

Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

If a section cannot be placed continuously, provide construction joints as indicated.

Deposit concrete to avoid segregation.

Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.

Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

Do not use vibrators to transport concrete inside forms.

Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.

Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.

At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

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.

Do not place concrete floors and slabs in a checkerboard sequence.

Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

Maintain reinforcement in position on chairs during concrete placement.

Screed slab surfaces with a straightedge and strike off to correct elevations.

Level concrete, cut high areas, and fill low areas.

Slope surfaces uniformly to drains where required.

Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.

Do not further disturb slab surfaces before starting finishing operations.

**FINISHING FORMED SURFACES**

As-Cast Surface Finishes:

ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.

Remove projections larger than 1 inch.

Tie holes do not require patching.

Surface Tolerance: ACI 117 Class D.

Apply to concrete surfaces [not exposed to public view] **<insert locations>**.

ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

Patch voids larger than 3/4 inch wide or 1/2 inch deep.

Remove projections larger than 1/4 inch.

Patch tie holes.

Surface Tolerance: ACI 117 Class B.

Locations: Apply to concrete surfaces [exposed to public view,] [to receive a rubbed finish,] [or to be covered with a coating or covering material applied directly to concrete] **<insert locations>**.

ACI 301 Surface Finish SF-3.0:

Patch voids larger than 3/4 inch wide or 1/2 inch deep.

Remove projections larger than 1/8 inch.

Patch tie holes.

Surface Tolerance: ACI 117 Class A.

Locations: Apply to concrete surfaces **[**exposed to public view,] [to receive a rubbed finish,] [or to be covered with a coating or covering material applied directly to concrete] **<insert locations>**.

Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:

Smooth-Rubbed Finish:

Perform no later than one day after form removal.

Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.

If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.

Maintain required patterns or variances as shown on Drawings or to match **[design reference sample] [field sample panels] [mockups]**.

Grout-Cleaned Rubbed Finish:

Clean concrete surfaces after contiguous surfaces are completed and accessible.

Do not clean concrete surfaces as Work progresses.

Mix 1-part Portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white Portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.

Wet concrete surfaces.

Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.

Maintain required patterns or variances as shown on Drawings or to match **[design reference sample] [field sample panels] [mockups]**.

Cork-Floated Finish:

Mix 1-part Portland cement to 1-part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.

Mix 1-part Portland cement and 1-part fine sand with sufficient water to produce a mixture of stiff grout. Add white Portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.

Wet concrete surfaces.

Compress grout into voids by grinding surface.

In a swirling motion, finish surface with a cork float.

Maintain required patterns or variances as shown on Drawings or to match **[design reference sample] [field sample panels] [mockups]**.

Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi, apply scrubbed finish.

Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed, and aggregate is uniformly exposed.

Rinse scrubbed surfaces with clean water.

Maintain continuity of finish on each surface or area of Work.

Remove only enough concrete mortar from surfaces to match **[design reference sample] [field sample panels] [mockups]**.

Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi.

Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.

Surface Continuity:

Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.

Maintain required patterns or variances in depths of blast to match **[design reference sample] [field sample panels] [mockups]**.

Abrasive Blasting:

Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.

Determine type of nozzle pressure and blasting techniques required to match field sample.

Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:

Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.

Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of 1/16 inch.

Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4 inch.

Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of 1/4 to 1/2 inch.

Maintain required patterns or variances in reveal projection to match **[design reference sample] [field sample panels] [mockups]**.

High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi.

Coordinate with formwork removal to ensure that surfaces to be high-pressure waterjet finished are treated at same age for uniform results.

Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.

Maintain required patterns or variances in reveal projection to match **[design reference sample] [field sample panels] [mockups]**.

Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

Perform bushhammer finish to concrete that has achieved a minimum compressive strength of 4500 psi.

Surface Continuity:

Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.

Surface Cut:

Maintain required depth of cut and general aggregate exposure.

Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.

Remove impressions of formwork and form facings with exception of tie holes.

Maintain required patterns or variances of cut as shown on Drawings or to match **[design reference sample] [field sample panels] [mockups]**.

Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, windbreaks, or similar devices.

Related Unformed Surfaces:

At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.

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

**FINISHING FLOORS AND SLABS**

Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

Scratch Finish:

While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.

Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.

Apply scratch finish to surfaces [to receive concrete floor toppings] [to receive mortar setting beds for bonded cementitious floor finishes] **<insert locations>**.

Float Finish:

When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.

Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.

Apply float finish to surfaces [to receive trowel finish] [and] [to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo] **<insert locations>**.

Trowel Finish:

After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.

Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.

Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

Do not add water to concrete surface.

Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.

Apply a trowel finish to surfaces [exposed to view] [or] [to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system] **<insert locations>**.

Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

Slabs on Ground:

Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed [1/4 inch] [3/16 inch] [1/8 inch] [1/8 inch and also no more than 1/16 inch in 2 feet] **insert measurement>**.

Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.

Specified overall values of flatness, FF 35; and of levelness, FL 25; with minimum local values of flatness, FF 24; and of levelness, FL 17.

Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.

Specified overall values of flatness, FF 50; and of levelness, FL 25; with minimum local values of flatness, FF 40; and of levelness, FL 17.

Suspended Slabs:

Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed [1/4 inch] [3/16 inch] [1/8 inch] [1/8 inch and also no more than 1/16 inch in 2 feet] **<insert measurement>**.

Specified overall values of flatness, FF 25; and of levelness, FL 20; with minimum local values of flatness, FF 17; and of levelness, FL 15.

Specified overall values of flatness, FF 35; and of levelness, FL 20; with minimum local values of flatness, FF 24; and of levelness, FL 15.

Specified overall values of flatness, FF 45; and of levelness, FL 35; with minimum local values of flatness, FF 30; and of levelness, FL 24.

Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces **[indicated on Drawings] [where ceramic or quarry tile is to be installed by either thickset or thinset method]**. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

Coordinate required final finish with Architect before application.

Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

Coordinate required final finish with Architect before application.

Slip-Resistive Finish: Before final floating, apply slip-resistive **[aggregate] [aluminum granule]** finish to concrete stair treads, platforms, ramps as indicated on Drawings

Apply in accordance with manufacturer's written instructions and as follows:

Uniformly spread [25 lb/100 sq. ft.] **<insert rate>** of dampened slip-resistive **[aggregate] [aluminum granules]** over surface in one or two applications.

Tamp aggregate flush with surface, but do not force below surface.

After broadcasting and tamping, apply float finish.

After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive **[aggregate] [aluminum granules]**.

Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:

Uniformly apply dry-shake floor hardener at a rate of [100 lb/100 sq. ft.] **<insert rate>** unless greater amount is recommended by manufacturer.

Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader and embed by power floating.

Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.

After final floating, apply a trowel finish.

Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

**INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS**

Filling In:

Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.

Mix, place, and cure concrete, as specified, to blend with in-place construction.

Provide other miscellaneous concrete filling indicated or required to complete the Work.

Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

Equipment Bases and Foundations:

Coordinate sizes and locations of concrete bases with actual equipment provided.

Construct concrete bases [4 inches] [6 inches] [8 inches] **<insert dimension>** high unless otherwise indicated on Drawings and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.

Minimum Compressive Strength: [5000 psi] [4500 psi] [4000 psi] [3500 psi] [3000 psi] **<insert value>** at 28 days.

Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.

Prior to pouring concrete, place and secure anchorage devices.

Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

Cast anchor-bolt insert into bases.

Install anchor bolts to elevations required for proper attachment to supported equipment.

Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

Cast-in inserts and accessories, as shown on Drawings.

Screed, tamp, and trowel finish concrete surfaces.

**CONCRETE CURING**

Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.

Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.

Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

Curing Formed Surfaces: Comply with ACI 308.1 as follows:

Cure all formed concrete surfaces, including underside of beams, supported slabs, footings, columns, walls, and other similar surfaces.

Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.

If forms remain during curing period, moist cure after loosening forms.

If removing forms before end of curing period, continue curing for remainder of curing period, as follows:

Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.

Continuous Sprinkling: Maintain concrete surface continuously wet.

Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.

Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.

Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

Recoat areas subject to heavy rainfall within three hours after initial application.

Maintain continuity of coating and repair damage during curing period.

Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

Begin curing immediately after finishing concrete. Cure all unformed surfaces, including floors and slabs, concrete floor toppings, footings, walls, columns, and other similar exposed surfaces. Interior Concrete Floors: James – see Matt’s note

Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

Lap edges and ends of absorptive cover not less than 12 inches.

Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

Cure for not less than seven days.

Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

Water.

Continuous water-fog spray.

Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

Lap edges and ends of absorptive cover not less than 12 inches.

Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

Cure for not less than seven days.

Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

Water.

Continuous water-fog spray.

Floors to Receive Polished Finish: Contractor has option of the following:

Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

Lap edges and ends of absorptive cover not less than 12 inches.

Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

Water.

Continuous water-fog spray.

Floors to Receive Chemical Stain:

As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.

Install curing paper square to building lines, without wrinkles, and in a single length without end joints.

Butt sides of curing paper tight; do not overlap sides of curing paper.

Leave curing paper in place for duration of curing period, but not less than 28 days.

Floors to Receive Urethane Flooring:

As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

Rewet absorptive cover and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.

Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.

Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

Floors to Receive Curing Compound:

Apply uniformly in continuous operation by power spray or roller in accordance with 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.

Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturerunless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

Floors to Receive Curing and Sealing Compound:

Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.

Recoat areas subjected to heavy rainfall within three hours after initial application.

Repeat process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

Unformed Surfaces (tops of footings, walls, etc.) to Receive Moisture Retaining Cover or Curing Compound where surfaces are exposed to the elements to prevent premature drying:

Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

Cure for not less than seven days.

Curing Compound:

Apply uniformly in continuous operation by power spray or roller in accordance with 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.

**TOLERANCES**

Conform to ACI 117 and tolerances listed below.

Concrete properties:

Slump

Where slump is specified as “maximum” or “not to exceed”

For all values........................................................+0 in.

Specified slump 3 in. or less ..........................–1-1/2 in.

Specified slump more than 3 in........................–2-1/2 in.

Where slump is specified as a single value

Specified slump 2 in. and less........................ ±1/2 in.

Specified slump more than 2 in. but not greater than 4 in..................................................................±1 in.

Specified slump more than 4 in........................±1-1/2 in.

Where slump is specified as a range........ no tolerance

Air Content:

Where no range is specified, the air content tolerance is ........................................ ±1-1/2%

**APPLICATION OF LIQUID FLOOR TREATMENTS**

Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.

Do not apply to concrete that is less than [three] [seven] [14] [28] **<insert days>** days old.

Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.

Rinse with water; remove excess material until surface is dry.

Apply a second coat in a similar manner if surface is rough or porous.

Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

**JOINT FILLING**

Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

Defer joint filling until concrete has aged at least **[one] [six]** month(s).

Do not fill joints until construction traffic has permanently ceased.

Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

Overfill joint, and trim joint filler flush with top of joint after hardening.

**CONCRETE SURFACE REPAIRS**

Defective Concrete:

Repair and patch defective areas when approved by Architect.

Remove and replace concrete that cannot be repaired and patched to Architect's approval.

Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

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

Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

Limit cut depth to 3/4 inch.

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 patching mortar before bonding agent has dried.

Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement, so that, when dry, patching mortar matches surrounding color.

Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.

Compact mortar in place and strike off slightly higher than surrounding surface.

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

Repairing Unformed Surfaces:

Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

Correct low and high areas.

Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

Repair finished surfaces containing surface defects, 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 sections regardless of width, and other objectionable conditions.

After concrete has cured at least 14 days, correct high areas by grinding.

Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.

Finish repaired areas to blend into adjacent concrete.

Correct other low areas scheduled to receive floor coverings with a repair underlayment.

Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

Feather edges to match adjacent floor elevations.

Correct other low areas scheduled to remain exposed with repair topping.

Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.

Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

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 a 3/4-inch clearance all around.

Dampen concrete surfaces in contact with patching concrete and apply bonding agent.

Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.

Place, compact, and finish to blend with adjacent finished concrete.

Cure in same manner as adjacent concrete.

Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

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 patching mortar before bonding agent has dried.

Compact patching mortar and finish to match adjacent concrete.

Keep patched area continuously moist for at least 72 hours.

Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

Repair materials and installation not specified above may be used, subject to Architect's approval.

**FIELD QUALITY CONTROL**

Special Inspections: Engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

Unless otherwise specified, the testing agency shall be responsible for providing containers and securing means with the contractor for initial curing at the jobsite for standard-cured strength test specimens used for determining acceptance of concrete and shall be responsible for maintaining and transporting these specimens to the laboratory in accordance with ASTM C31/C31M; and shall be responsible for verifying that standard-cured and field-cured strength specimens, when specified, are cured in accordance with ASTM C31/C31M

Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.

Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

Test reports of concrete strength to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, including the following as applicable to each test and inspection:

Project name.

Name of testing agency.

Names and certification numbers of field and laboratory technicians performing inspections and testing.

Name of concrete manufacturer.

Date and time of inspection, sampling, and field testing.

Date and time of concrete placement.

Location in Work of concrete represented by samples.

Date and time sample was obtained.

Truck and batch ticket numbers.

Specified compressive strength and test age.

Concrete mixture designation.

Results of tests of fresh concrete performed.

Information on storage and curing of test specimens, including curing method and maximum and minimum temperatures during initial curing period.

Compressive strength test results at required test ages and type of fracture of specimen tested.

The contractor shall be responsible for providing space, water, and source of electrical power for storage of test specimens during the initial curing period at the jobsite. Storage of test specimens shall be in a secured location and the testing agency shall be provided access.

Concrete Delivery Tickets: For each load delivered, collect and submit three copies of delivery tickets that include the reporting requirement of ASTM C94/C94M and include additional information as specified. Record jobsite addition of water or admixtures with a signature of person requiring the adjustment.

Inspections:

Headed bolts and studs.

Verification of concrete mixtures delivered consistent with submittals.

Concrete placement, including conveying and depositing.

Curing procedures and maintenance of curing temperature.

Verification of concrete strength before removal of shores and forms from beams and slabs.

Batch Plant Inspections: As required.

Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M and tests shall be performed in accordance with the following requirements:

Testing Frequency: Obtain one composite sample for each class of concrete at least once per day, once for each 150 C.Y. of concrete, or once for each 5000 S.F. surface area for slabs and walls.

If the total volume of concrete for a class is such that frequency of testing required is less than five tests, then samples shall be obtained from at least five randomly selected batches or from each batch if fewer than five batches are used.

Slump: ASTM C143/C143M:

One test on each sample obtained to prepare strength test specimens

Additional tests as needed to monitor control of batches

Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.

One test on each sample obtained to prepare strength test specimens

Additional tests as needed to monitor control of batches

Concrete Temperature: ASTM C1064/C1064M:

One test on each sample obtained to prepare strength test specimens

One test hourly when ambient temperature is 40°F or lower or 90°F or higher

Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.

One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

Density: ASTM C138/C138M

One test on each sample obtained to prepare strength test specimens

For lightweight concrete, one test as needed and at least once daily to verify conformance to equilibrium density determined in accordance with ASTM C567/C567M

Compressive Strength Specimens: ASTM C31/C31M:

For strength specimens to be standard cured for acceptance of concrete, cast a set of cylinders and cure specimens at the jobsite in accordance with ASTM C31/C31M. Cast at least two specimens for each age that strength will be tested for information and additional reserve specimens as needed. Strength test results at the designated age shall be the average of two 6 × 12-in. or three 4 × 8-in. specimens.

If required, cast additional sets of cylinders for field-curing in accordance with ASTM C31/C31M

Transport specimens to the lab within 48 hours after casting and cure them in accordance with final curing requirements of ASTM C31/C31M until tested.

Compressive-Strength Tests: ASTM C39/C39M.

Test specimens for compressive strength at 7 days or at an alternative early age as required and one set at 28 days or at an alternate test age as designated for specified strength.

Acceptance of concrete shall be based on strength test results of standard cured cylinders in accordance with ASTM C31 and tested at 28 days in accordance with ASTM C39. Strength test results at the designated age shall be the average of two 6 × 12 inch or three 4 × 8 inch specimens.

When strength cylinders are made, tests of slump, air content, temperature and density shall be made and recorded with the strength test results.

Strength of each concrete class shall be deemed satisfactory when both of the following criteria are met:

The average of three consecutive compressive-strength tests equals or exceeds specified compressive strength

Any individual compressive-strength test result does not fall below specified compressive strength, ƒ´c:

by more than 500 psi when ƒ´c ≤ 5000 psi

by more than 0.1ƒ´c when ƒ´c > 5000 psi

When compressive strength tests fail to meet the provisions of (d), follow procedure in ACI 301 for evaluation of concrete strength tests.

When it is deemed necessary to evaluate the adequacy of concrete strength, at least 3 cores shall be obtained from the portion of the structure represented by the low strength tests. Cores shall be removed and conditioned in accordance with ASTM C42. The strength of cores shall comply with the following:

Average strength of 3 cores ≥ 0.85ƒ´c

Individual core strength ≥ 0.75ƒ´c

A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.

Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

Additional Tests:

Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.6.6.3.

Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

Measure floor and slab flatness and levelness in accordance with ASTM E1155 within [24] [48] [72] **<insert number>** hours of completion of floor finishing and promptly report test results to Architect.

**PROTECTION**

Protect all concrete surfaces including but not limited to the following:

Protect from petroleum stains.

Diaper hydraulic equipment used over concrete surfaces.

Prohibit vehicles from interior concrete slabs.

Prohibit use of pipe-cutting machinery over concrete surfaces.

Prohibit placement of steel items on concrete surfaces.

Prohibit use of acids or acidic detergents over concrete surfaces.

Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

**END OF SECTION 03 30 00**