SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies cast-in-place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes. This section applies to concrete work shown on the structural drawings. See Division 2 for site concrete.

B. Cast-in-place concrete includes the following:

1. Foundations and footings.
2. Slabs-on-grade.
3. Shear walls.
4. Drilled piers.
5. Load-bearing building walls.
6. Equipment pads and bases.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section “Structural Special Inspection.”
2. Division 3 Section “Structural Precast Concrete – Plant Cast.”
3. Division 3 Section “Permanent Forms – Insulated Concrete Forms.”
4. Division 7 Section “Thermal and Moisture Protection.”

D. Coordination: Unless other satisfactory agreements are specifically entered into by contractors concerned, all miscellaneous iron and steel, sleeves, anchors, etc., required by work of other contractors, will be furnished and installed by such other contractors with the cooperation of this contractor.

1.3 SUBMITTALS

A. General: Furnish submittals in quantity, format, and other Conditions of the Contract and as specified in Division 1 of the Project Manual.

B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, vapor retarder, joint systems, curing compounds, and others if requested by Architect.

C. Shop drawings for reinforcement detailing, fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 “Manual of Standard Practice for Detailing Reinforced Concrete Structures” showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.

1. Computer generated electronic structural construction document files (ACAD) will be made available to the Contractor. The Contractor will be required to sign the Engineer's standard release of liability form and pay a handling fee of $50.00 per drawing prior to receiving the drawing files. Rules for use of said files shall be as defined in the CRSI "Code of Standard Practice" Sections 4.19 and 6.4.1.
2. Shop drawing resubmittals are reviewed for conformance with review marks only. Any changes or questions originating on a resubmittal shall be clearly clouded.

D. Samples of materials as requested by Architect, including names, sources, and descriptions, as follows:

1. Vapor retarder.

E. Laboratory test reports for concrete mix design with the following data:

1. Method used to determine the proposed mix design (per ACI 301, Section 4).
2. Gradation and quantity of fine and coarse aggregates.
3. Proportions of all ingredients including all admixtures added either at the time of batching or at the job site.
4. Water/cement ratio and water/cementitious ratio.
5. Slump – ASTM C143.
6. Certification and test results of the total water soluble chloride ion content of the design mix – FHWA RD-77 or AASHTO T 260-84.
7. Air content of freshly mixed concrete by the pressure method, ASTM C231, or the volumetric method, ASTM C173.
8. Unit weight of concrete – ASTM C138.
9. Strength at 7 and 28 days – ASTM C39. Document strength on basis of previous field experience or trial mixtures, per ACI 301 Section 4. Submit strength test records, mix design materials, conditions, and proportions for concrete used for record of tests, standard calculation, and determination of required average compressive strength.
10. Complete and include Structural Engineer's standard mix design submittal form for each mix. A blank copy is included at the end of this section.

F. Laboratory test reports for concrete materials or material certificates in lieu of material laboratory test reports. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

G. Drawings showing proposed construction and/or contraction joint locations.

H. Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified. Each contractor having reference to ACI Documents shall maintain copies of same on project site.

AMERICAN CONCRETE INSTITUTE

1. ACI 117-90 – Tolerance for Concrete Construction and Material.

2. ACI 211.1-98 – Selecting Proportions Normal, Heavyweight and Mass.
3. ACI 301-05 – Specification for Structural Concrete for Buildings.
4. ACI 302.1R-04 – Guide for Concrete Floor and Slab Construction.
5. ACI 304.2R-96 – Placing Concrete by Pumping Methods.
6. ACI 305R-91 – Hot Weather Concreting.
7. ACI 306R-88 – Cold Weather Concreting.
8. ACI 308R-01 – Standard Practice for Curing Concrete.
9. ACI 309R-96 – Guide for Consolidation of Concrete.
10. ACI 311 – Recommended Practice for Concrete Inspection.
11. ACI 315-92 – Details and Detailing of Concrete Reinforcement.
12. ACI 318-05 – Building Code Requirements for Reinforced Concrete and Commentary.
13. ACI 347R-94 – Guide to Formwork for Concrete.

AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM)

1. ASTM A185 – Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
2. ASTM A615 – Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. ASTM C31 – Practice for Making and Curing Concrete Test Specimens in the Field.
4. ASTM C33 – Specification for Concrete Aggregates.
5. ASTM C39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens.
6. ASTM C94 – Specification for Ready-Mixed Concrete.
7. ASTM C143 – Test Method for Slump of Hydraulic Cement Concrete.
8. ASTM C150 –Specification for Portland Cement.
9. ASTM C171 – Specification for Sheet Materials for Curing Concrete.
10. ASTM C172 – Practice for Sampling Freshly Mixed Concrete.
11. ASTM C231 – Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
12. ASTM C260 – Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C309 – Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
14. ASTM C494 – Specification for Chemical Admixtures for Concrete.
15. ASTM C618 – Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.
16. ASTM C881 – Specification for Epoxy Resin Base Bonding Systems for Concrete.
17. ASTM E-329 – Inspecting and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.

CONCRETE REINFORCING STEEL INSTITUTE (CRSI):

1. CRSI – Manual of Standard Practice.
2. CRSI 63 – Recommended Practice for Placing Reinforcing Bars.
3. CRSI 65 – Recommended Practice for Placing Bar Nomenclature.

B. Qualifications of Workers: Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper execution of the work required by this Division.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section “Project Meetings” and the following:

1. At least 35 days prior to start of the concrete construction schedule, the contractor shall conduct a meeting to review the proposed mix designs and to discuss the required methods and procedures to achieve the required concrete construction.
2. The contractor shall require responsible representatives of every party who are concerned with the concrete work to attend the conference, including but not limited to, the following:

   a. Contractor’s superintendent – Laboratory responsible for the concrete design mix – Laboratory responsible for field quality control – Concrete subcontractor – Ready-mix concrete producer – Admixture manufacturer(s) – Concrete pumping contractor – Special Inspector.

3. The Architect and the Owner’s Representative may be present at the conference. The Contractor/Construction Manager shall notify the Architect at least five days prior to the scheduled date of the conference.
4. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within five days of the meeting. One copy of the minutes shall also be transmitted to the following for information purposes: Owner’s representative – Resident engineer – Consultant engineer.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Unexposed Finish Concrete: Plywood, lumber, metal or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

B. Form Release Agent: Provide commercial formulation form release agent with a maximum volatile organic compounds (VOCs), not to exceed those allowable by jurisdictional regulations, that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

C. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1 ½ inches to the plane of the exposed concrete surface.

D. Chamfer Strips: Dressed wood, ¾ by ¾ inch, minimum and as shown on Drawings; non-staining; in longest practical lengths.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Welded Wire Fabric: ASTM A 185, welded steel wire fabric in flat sheets.

C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

D. Mechanical Reinforcing Splices: The mechanical connection shall meet applicable building code requirements for developing in tension or compression. The connection shall be positive locking, taper threaded type coupler manufactured from high quality steel. Bar ends must be shop taper-threaded using the manufacturer's bar threading equipment to ensure proper taper and thread engagement.

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

a. Lenton Standard Coupler Type A2, by Erico for coupling between reinforcing bars.
b. Dayton Richmond Dowel Bar Splicer, by Dayton/Richmond Concrete Accessories for coupling between reinforcing bars at forms.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I. High early strength (when specified), ASTM C150, Type III.

1. Use one brand of cement throughout Project unless otherwise acceptable to Architect.

B. Fly Ash: ASTM C 618, Type C or F, except maximum loss on ignition: 3%.

C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.

1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling or surface discoloration due to oxidation.

D. Water: Potable.

E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

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

a. Air-Mix or Perma-Air, Euclid Chemical Co.
b. Darex or Daravair Series, W.R. Grace & Co.
c. MB-VR or Micro-Air, BASF Corporation – Admixture Systems.
d. Sealtight AEA, W.R. Meadows, Inc.
e. Sika AER, Sika Corp.
f. Catexol A.E. 260, Axim Concrete Technologies.
g. RSA-10 or RAE-260, RussTech Admixtures, Inc.

F. Water-Reducing Admixture: ASTM C 494, Type A.

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

a. Chemtard, ChemMasters Corp.
b. Eucon WR-75, Euclid Chemical Co.
c. WRDA Mira or Daracem Series, W.R. Grace & Co.
d. Pozzolith Normal or Polyheed, BASF Corporation – Admixture Systems.
e. Metco W.R., Metalcrete Industries.
f. Plastocrete 161, Sika Corp.
g. Catexol 1000N, Axim Concrete Technologies
h. LC-400P, LC-500, or FINISHEASE NC, RussTech Admixtures, Inc.

G. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.

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

a. Super P, Anti-Hydro Co., Inc.
b. Eucon 37, Euclid Chemical Co.
c. ADVA or Daracem Series, W.R. Grace & Co.
d. Rheobuild or Polyheed, BASF Corporation – Admixture Systems.
e. Superslump, Metalcrete Industries.
f. Sikament 300, Sika Corp.
g. Catexol 1000SP-MN, Axim Concrete Technologies.
h. SUPERFLO 2000RM, RussTech Admixtures, Inc.

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

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

a. Q-Set, Conspec Marketing & Manufacturing Co.
b. Accelguard 80, Euclid Chemical Co.
c. Daraset or Polarset Series, W.R. Grace & Co.
d. Pozzutec 20, BASF Corporation – Admixture Systems.
e. Accel-Set, Metalcrete Industries.
f. LCNC-166, RussTech Admixtures, Inc.

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

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

a. Eucon Retarder 75, Euclid Chemical Co.
b. Daratard-17, W.R. Grace & Co.
c. Pozzolith R, BASF Corporation – Admixture Systems.
d. Plastiment, Sika Corporation.
e. Catexol 1000R, Axim Concrete Technologies.
f. LC-400R or LC-500, RussTech Admixtures, Inc.

J. Controlled Low Strength Material (CLSM) Performance Additive

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

a. Darafill or Darafill Dry, W.R. Grace & Co.
b. Rheomac VMA 362, BASF Corporation – Admixture Systems.

K. Prohibited Admixture: Calcium chloride thiocyanates or admixture containing more than 0.05 percent chloride ions.

2.4 RELATED MATERIALS

A. Construction joint slip dowels: steel rod or plate in a nylon insert to allow contraction of the concrete while preventing vertical differential displacement.

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

a. #4x1’-6” long, Speed Dowel by Greenstreak, Inc. (800.325.9504).
b. ¼”x4 ½” plate, Diamond Dowel by PNA, Inc. (800.542.0214).

B. Slab Pourstop with Keyway: galvanized steel, vinyl, or plastic forming pourstop with integral keyway for use with slabs on grade.

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

a. Key-Loc Joint System, Cardinal Manufacturing Company, Inc.

C. Premolded Interior and Exterior Joint Filler: Non-impregnated, flexible, synthetic foam with standard bonding agent to hold in place.

D. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:

1. Polyolefin/Resin or mult-ply extrusion coated polyethylene sheet not less than 10 mils thick conforming to ASTM E 1745 Class A. Maximum water vapor permeance when tested in accordance with Test Method ASTM E154, Section 7 (based on ASTM E96) or ASTM F1249 of 0.38 perms. Minimum tensile strength when tested to ASTM D154 of 45 lbs-force/inch.

a. Perminator Vapor-Mat with Perminator Tape Seal. W.R. Meadows, Inc. Hampshire, Illinois.
b. Stego Wrap with Stego Tape Seal. Stego Industries, LLC. San Juan Capistrano, California.
c. Viper Vaporcheck with manufacturer’s recommended tape seal. Insulation Solutions, Inc. East Peoria, Illinois.
d. Vaporblock VB10 with Vapor Bond Plus Tape Seal. Raven Industries, Engineered Films Division, Sioux Falls, South Dakota.

E. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

F. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.
2. Polyethylene film.
3. Polyethylene-coated burlap.

G. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.

1. Provide material that has a maximum volatile organic compound (VOC) rating not to exceed those allowable by jurisdictional regulations.
2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

    a. Highseal, Conspec Marketing and Mfg. Co.
    b. Sealco-VOC, Cormix Construction Chemicals.
    c. Safe Cure and Seal, Dayton Superior Corp.
    d. Aqua-Cure, Euclid Chemical Co.
    e. Dress & Seal WB, L&M Construction Chemicals, Inc.
    f. Vocomp-20, W.R. Meadows, Inc.
    g. Metcure, Metalcrete Industries.
    h. Stontop CS1, Stonhard, Inc.

H. Water-Based Resin Membrane Dissipating Curing Compound: ASTM C 309, Type I, Class B. Compound to be formulated to dissipate after exposure to sunlight, weathering, and traffic.

1. Provide material that has a maximum volatile organic compound (VOC) rating not to exceed those allowable by jurisdictional regulations.
2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

    a. Day-Chem Rez Cure, Dayton Superior Corp.
    b. Kurez DR Vox, Euclid Chemical Co.
    c. 1100 Clear, W.R. Meadows, Inc.

I. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

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

    a. Aquafilm, Conspec Marketing and Mfg. Co.
    b. Eucobar, Euclid Chemical Co.
    c. E-Con, L&M Construction Chemicals, Inc.
    d. Confilm, Master Builders, Inc.
    e. Waterhold, Metalcrete Industries.
    f. EVRT, RussTech Admixtures Inc.

J. Bonding Agent: Polyvinyl acetate or acrylic base.

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

a. Polyvinyl Acetate (Interior Only):

1) Superior Concrete Bonder, Dayton Superior Corp.
2) Euco Weld, Euclid Chemical Co.
3) Weld-Crete, Larsen Products Corp.
4) Everweld, L&M Construction Chemicals, Inc.
5) Herculox, Metalcrete Industries.
6) Ready Bond, Symons Corp.

b. Acrylic or Styrene Butadiene:

1) Acrylic Bondcrete, The Burke Co.
2) Strongbond, Conspec Marketing and Mfg. Co.
3) Day-Chem Ad Bond, Dayton Superior Corp.
4) SBR Latex, Euclid Chemical Co.
5) Daraweld C, W.R. Grace & Co.
6) Hornweld, A.C. Horn, Inc.
7) Everbond, L&M Construction Chemicals, Inc.
8) Emaco, BASF Construction Chemicals.
9) Intralok, W.R. Meadows, Inc.
10) Acrylpave, Metalcrete Industries.
11) Sonocrete, Sonneborn-Chemrex.
12) Stonlock LB2, Stonhard, Inc.
13) Strong Bond, Symons Corp.

K. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107, of consistency suitable for application, and a 30-minute working time. Grout to have a minimum compressive strength at 28 days of 5,000 psi when applied in a fluid consistency.

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

a. NS Grout, The Euclid Company.
b. Five Star Grout, U.S. Grout Corp.
c. Masterflow 713, BASF Construction Chemicals.
d. Sikagrout 212, SIKA.

L. Penetrating Concrete Sealer (For Interior Use): ASTM C 309, Type I, Class B. The sealer shall be a water based acrylic copolymer solution formulated to seal, harden, and dustproof interior concrete surfaces.

1. Provide material that has a maximum volatile organic compound (VOC) rating not to exceed those allowable by jurisdictional regulations.

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

   a. Safe Seal (J-24), Dayton Superior.
   b. Rez-Seal Vox, Euclid Chemical Co.

2.5 PROPORTIONING AND DESIGNING MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect for preparing and reporting proposed mix designs. Trial batch and field experience tests shall have been performed within 12 months of submittal date. Use mix design submittal form included at the end of this section.

   1. Do not use the same testing agency for field quality control testing.
   2. Limit use of fly ash to not exceed 20 percent for Type F or 25 percent for Type C of the total cementitious material content by weight.

B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect. The approved mix designs shall be used throughout this project unless changes are approved by the Architect/Engineer prior to use.

C. The specified compressive strengths (f'c) of the concrete for each portion of the Structure and minimum cement content shall be as follows:

CLASS	WHERE USED	REQUIRED 28-DAY STRENGTH	MINIMUM CEMENTIOUS MATERIAL CONTENT-POUNDS PER CUBIC YARD
I	Footings	3,000 psi	470
II	Interior Slabs on Grade, Drilled Piers, Grade Beams and Walls	4,000 psi	550
III	Exterior and other concrete exposed to weather and deicers	4,500 psi (max.w/c=.45)	564

With an approved water-reducing agent, minimum cement content may be reduced by 47 pounds of cement per cubic yard.

D. Water/Cement Ratio: All concrete subject to freezing and thawing shall have a maximum water/cement ratio of 0.50 (4000 psi by 28 days). All concrete subjected to deicers shall have a maximum water/cement ratio of 0.45 (4500 psi by 28 days).

E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps and sloping surfaces: Not more than 3 inches.
2. Drilled piers: Not less than 4 inches and not more than 6 inches.
3. Reinforced foundation systems: Not less than 1 inch and not more than 3 inches.
4. Concrete containing mid-range or high-range water-reducing admixture: Not more than 8 inches after adding admixture to 2-to-3-inch slump concrete.
5. Other concrete: Not more than 4 inches.

F. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in Work.

G. Controlled Low Strength Material CLSM (Flowable fill): Provide blend of cement, flyash, and sand with minimum cementitious content as follows:

1. Excavatable flowable fill: 100 lb cement and 250 lb fly ash per cubic yard.
2. Structural flowable fill (250 psi): 175 lb cement and 200 lb fly ash per cubic yard. Add CLSM performance additive at manufacturer's recommended dosage rate, adjusting water content to provide desired flow and strength characteristics.

2.6 ADMIXTURES

A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability and in all pumped concrete.

B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).

C. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1 ½ percent within the following limits:

1. Drilled piers: 2.5 to 4.5 percent air.
2. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:

   a. 5.5 percent for 1 ½-inch maximum aggregate.
   b. 6.0 percent for 1-inch maximum aggregate.
   c. 6.0 percent for ¾-inch maximum aggregate.
   d. 7.0 percent for ½-inch maximum aggregate.

3. Interior slabs shall not be air entrained.

D. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions. Contractor may use set accelerating and retarding admixtures at his discretion to control set time.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.

1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials, vapor retarder, and other related materials with placement of forms and reinforcing steel.

3.2 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:

1. Provide Class D tolerances for earth formed foundation elements. Tolerances applies as a variation inward towards reinforcing only. No tolerance limit away from reinforcing applies.
2. Provide Class C tolerances for other concrete surfaces.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Kerf wood inserts for forming keyways, recesses, and the like for easy removal.

D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

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

G. Earthen forms may be used for footings when ground is stable and capable of resisting erosion and fluid pressure of wet concrete without sloughing. All tolerances and clear covers shall be maintained. Excavation shall be clean of all loose soil and mud along bottom and sides. Grade beams and pile caps shall be formed.

H. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER INSTALLATION

A. General: Place vapor retarder sheeting in position with longest dimension parallel with direction of pour.

B. Install vapor retarder over 4” of compacted crushed stone.

C. Lap joints 6 inches and seal with manufacturer’s recommended mastic or pressure-sensitive tape.

D. Seal around all penetrations through vapor retarder with manufacturer’s recommended mastic or pressure-sensitive tape.

3.4 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute’s recommended practice for “Placing Reinforcing Bars,” for details and methods of reinforcement placement and supports and as specified.

1. Avoid cutting or puncturing vapor retarder during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. Deliver reinforcement to job site bundled, tagged and marked. Use waterproof tags indicating bar size, length, and mark corresponding to placing drawings.

C. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect.

1. Chair welded wire fabric slab reinforcement with continuous chairs spaced a maximum of 32 inches on center. Provide additional chairs as required. Lift welded wire fabric back into position between chairs where depressed during concrete placement. Lifting welded wire fabric into position during concrete placement without the use of chairs is not permitted.

E. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

F. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire.

G. Welding of reinforcing bars will not be permitted without approval of the Architect/Engineer.

H. When permitted, field bend bars cold, except during cold weather when moderate heating is necessary to avoid brittle failures.

I. Install reinforcing to mechanical splices in accordance with the manufacturer's requirements.

3.5 JOINTS

A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect.

B. Provide keyways at least 1 ½" deep by ½ member width by ½ member depth in construction joints in grade beams and between grade beams and supporting members.

C. Provide slip dowels (as shown on drawings) for construction joints in field of slabs on grade less than 6" thickness.

1. Bulkheads designed and accepted for this purpose may be used where keyways are permitted.
2. Where construction joints at doorways that align with both faces of bearing wall are specified, utilize preformed pourstop with keyway in lieu of slip dowels.

D. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.

E. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

F. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations as indicated.

1. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."
2. Hold top of premolded filler material down ½" from top of slab.
3. At locations where drawings do not specifically call for premolded filler, provide bond breaker between slab and vertical surface. The vapor retarder may be turned up and used for this purpose.

G. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab depth or inserts ¼ inch wide by one-fourth of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

2. Contraction joints may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
3. Soft cut method may be used immediately after final finishing.
4. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
5. Joint fillers and sealants are specified in Division 7 Section “Joint Sealants.”

3.6 INSTALLING EMBEDDED ITEMS

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

B. Aluminum conduit shall not be installed in concrete.

3.7 PREPARING FORM SURFACES

A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.

B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer’s instructions.

1. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.
2. Do not spray reinforcing with form oil.

3.8 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. General: Comply with ACI 304, “Guide for Measuring, Mixing, Transporting, and Placing Concrete,” and as specified. Concrete delivery tickets shall show:

1. Batch number.
2. Mix by number with cement content in pounds and maximum size aggregate.
3. Admixtures.
4. Air content.
5. Slump.
6. Time dispatched and discharged.
7. Date.
8. Contractor.
9. Ready Mix Supplier.
10. Project Name and Address.
11. Volume of Concrete.

C. If any water is added to the mix on the job, it must be approved by the Architect's representative and delivery ticket noted with the amount of water and signed by the Architect's representative. The maximum water/cement ratio of an approved mix design may not be exceeded.

1. When the ambient air temperature is between 80 and 90 degrees Fahrenheit, one (1) gallon of water per cubic yard of concrete may be added at the job site to compensate for water evaporation during transit.

2. When the ambient air temperature exceeds 90 degrees Fahrenheit, two (2) gallons of water per cubic yard of concrete may be added at the job site to compensate for water evaporation during transit.

D. Discharge concrete within 1 ½ hours after water has been added to the cement, unless a longer time has been authorized by the Architect/Engineer. During hot weather or other conditions contributing to a quick stiffening of the concrete, the Architect/Engineer may require discharge in less than 1 ½ hours.

E. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location. Do not allow concrete to drop more than 5 feet or from a height which allows concrete to fall against reinforcing.

F. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. Do not subject concrete to any procedure that will cause segregation. Deposit concrete as near as possible to the final position to avoid segregation.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.

1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
3. Maintain reinforcing in proper position on chairs during concrete placement.

H. Cold-Weather Placement: When air temperature is expected to fall below 40 degrees Fahrenheit (4 deg C) within the first 72 hours after concrete placement, comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When mean daily air temperature is expected to fall below 40 deg F (4 deg C) for more than three successive days after concrete placement, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature at point of placement as follows:

   a. Not less than 55 deg F (13 deg C) or more than 75 deg F (24 deg C) for concrete sections less than 12 inches in the least dimension (width or thickness).
   b. Not less than 50 deg F (10 deg C) or more than 70 deg F (21 deg C) for concrete sections 12 inches or greater in the least dimension (width or thickness).

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

I. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

J. Pumping Concrete: Grout used to prime a pump shall not be placed in the forms of any concrete exposed to view in the final structure.

3.9 INSULATED CONCRETE FORMS

A. Finish to top of footings to receive permanent insulated concrete forms to within +/- ¼" (6 mm) of level.

B. Coordinate footing step increments with standard insulating form height. With Architect's permission adjust footing step heights to match form height. Minimum frost depth to footing shall be maintained.

C. Place concrete half-height of first course of formwork and allow to set overnight prior to placing concrete full height of wall.

D. Concrete placement rate shall not exceed 4 feet (1.22 m) of lift per hour.

E. Avoid completing a pour against a buck or in a corner. Terminate concrete pour at the center of the longest wall when possible.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding ¼ inch in height rubbed down or chipped off.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 MONOLITHIC SLAB FINISHES

A. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to specified tolerances for floor flatness and floor levelness measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

B. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.

1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surface to specified tolerances for floor flatness floor levelness measured according to ASTM E 1155. Grind smooth any surface defects that would telegraph through applied floor covering system.

C. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.12 FACE FLOOR PROFILE NUMBERS (F-NUMBERS)

A. Floor Flatness F(F) and Floor Levelness F(L) numbers shall be measured according to ASTM E1155. Unless otherwise shown or noted on the drawings, comply with the following table:

Slabs on grade		
Composite Flatness F(F)	Composite Levelness F(L)	Typical Use
35	25	All slab on grade

3.13 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

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

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment. Use the specified non-shrink, non-metallic grout. Finish all mechanical housekeeping pads to a finished tolerance of 1/8” in 10 feet.

3.14 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer’s instructions after screeding and bull floating, but before power floating and troweling.

B. Curing procedures shall conform with ACI 308 Standard Practice For Curing Concrete.

C. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.

D. Curing Methods: Cure concrete by curing compound or by moisture curing as specified.

E. Provide curing compound on interior slabs, exterior slabs that will not be exposed to de-icing salts, walks, and curbs as follows:

1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply

uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

F. Provide moisture curing on interior and exterior slab surfaces exposed to deicing salts and on slabs where the finish flooring is not compatible with curing compounds for 7 days by one of the following methods:

1. Keep concrete surface continuously wet by soaking with water.
2. Keep concrete surface continuously wet with water-saturated absorptive cover.
3. Keep concrete surface continuously wet by water-fog spray.

G. Curing Formed Surfaces: Cure formed concrete surfaces, including formed grade beams, walls in permanent insulated forms and other similar surfaces, by covering with moisture retaining cover for 3 days.

H. Cold Weather Concreting ("Cold Weather Concreting", ACI Report 306).

1. All freshly placed concrete shall be kept from freezing for the following periods:

   a. 3 days for all concrete with an air entraining admixture.
   b. 4 days for all concrete without an air entraining admixture.

2. A cumulative curing time of seven days at a minimum surface temperature of 50 degrees F (10 degrees C) shall be provided or until concrete has attained 75% of its design strength. This shall be followed by cooling of concrete in a gradual transition to surrounding conditions. The temperature drop during this period shall not be at a rate exceeding 2 degrees F per hour until the outside or surrounding temperature is reached.
3. When concrete is placed under conditions of cold weather concreting (defined as a period when the mean daily temperature drops below 40 degrees F for more than three successive days), take additional precautions as specified in "Cold Weather Concreting" by the American Concrete Institute (ACI Report 306) when placing, curing, monitoring and protecting the fresh concrete.

I. Hot Weather Concreting ("Hot Weather Concreting" by the American Concrete Institute Committee 305).

1. When concrete is placed under conditions of hot weather concreting, provide extra protection of the concrete against excessive placement temperatures and excessive drying throughout the placing and curing operations. Hot weather is defined as air temperature which exceeds 80 degrees F or any combination of high temperature, low humidity and/or high wind velocity which causes a rate of evaporation in excess of 0.2 pounds per square foot per hour as determined by Figure 2.1.5 of ACI Report 305. Hot weather curing is required if these conditions occur within a 24 hour period after completion of concrete placement.
2. Forms, reinforcing and the air shall be cooled by water fog spraying immediately before placing concrete.

3. Immediately following screeding, protect concrete by applying the specified evaporation retarder in accordance with the recommendations of the manufacturer.

3.15 PENETRATING CONCRETE SEALER

A. Apply penetrating concrete sealer to all concrete floor surfaces exposed to view in the finished structure.

B. Coverage rate shall be 300 square feet per gallon or greater.

C. Follow manufacturer's recommended installation instructions.

3.16 REMOVING FORMS

A. General: Formwork not supporting weight of concrete, such as sides of grade beams and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

3.17 REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Architect.

3.18 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.

B. Mix dry-pack mortar, consisting of one part portland cement to 2 ½ parts fine aggregate passing a No. 16 mesh sieve, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water. Use only enough water/bonding agent as required for handling and placing.

1. Cut out honeycombs and rock pockets where cement paste does not bond the interior face of the aggregate, voids over ¼ inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
2. For surfaces exposed to view, blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas 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.

C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces 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. Proprietary underlayment compounds may be used when acceptable to Architect.
4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least ¾-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

E. Repair isolated random cracks and single holes 1 inch or less in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Place dry-pack before bonding agent has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

F. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive and mortar.

G. Repair methods not specified above may be used, subject to acceptance of Architect.

3.19 QUALITY CONTROL

A. General: The Owner will employ a testing agency which meets the requirements of ASTM E329 to perform tests and to submit test reports. The agency will monitor concrete quality by means of site and laboratory tests. They will be authorized to reject plastic concrete not conforming to specifications. Failure to detect any defective materials shall not prevent later rejection when such defect is discovered, or obligate the Architect or Owner for final acceptance.

1. See Section 014110 – Structural Special Inspections for testing and inspection to be performed.
2. Test results will be reported in writing to the Architect, Engineer, ready-mix producer and General Contractor within 24 hours after tests.
3. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect.

END OF SECTION 033000

BROWN + KUBICAN, PSC

STRUCTURAL ENGINEERS

CONCRETE MIX DESIGN SUBMITTAL FORM

Project: _____

City, State: _____

General Contractor: _____

Concrete Contractor: _____

Mix Design Number: _____

Concrete Strength (Class): _____

Use (describe): _____

Design Mix Information

	Check one
Based on Standard Deviation Analysis	
Based on Trial Mix Laboratory Test Data	

Design Characteristics

Density		pcf
Strength		psi (28 days)
Air		%
Slump		inches

If trial mixes are used, the Mix Design is proportioned to achieve f'cr = f'c + 1200 psi (1400 psi for strength higher than 5000 psi at 28 days)

Materials

	Type	Source	Specific Gravity	Weight (lb.)	Absolute Vol. (cu. ft.)
cement					
flyash					
silica fume					
coarse aggregate					
fine aggregate					
water					
other ( )					
			Total		27.0 cu. ft.

Water/Cementitious Ratio (W/C) = _____% (lbs. water /lbs. cementitious)

Admixtures

	Manufacturer	Dosage (oz./cwt)
water reducer		
air entraining agent		
high range water reducer		
non-corrosive accelerator		
other ( )		

Slump before high range water reducer = _____inches
Slump after high range water reducer = _____inches

Standard Deviation Analysis (field experience records)

Number of test cylinders evaluated: _____ Standard deviation (s): _____
Required avg. compressive strength (f'c + 1.34s): _____ Actual avg. compressive strength:_____

(refer to ACI 301 for standard deviation calculation – attach copies of laboratory test reports)

Trial Mix Laboratory Test Data

	Mix #1		Mix #2		Mix #3	
Age	Date	Compressive Strength	Date	Compressive Strength	Date	Compressive Strength
7 days		psi		psi		psi
7 days		psi		psi		psi
28 days		psi		psi		psi
28 days		psi		psi		psi
28 days average	NA	psi	NA	psi	NA	psi

(refer to ACI 301 for trial mix procedure – attach copies of laboratory test reports)

Required Attachments

	Please check
Coarse aggregate gradation report	
Fine aggregate gradation report	
Laboratory test reports (strength tests)	
Admixture compatibility certification letters	

Ready Mix Supplier

Name and Address: _____
_____

Phone: _____ Miles from project: _____ Date: _____