

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including general and supplementary conditions and Division 1 specification sections, apply to this section.
- B. Concrete paving and walks are specified in Division 31.
- C. Section 03 30 20: Concrete Slab on Grade.
- D. Section 03 30 25: Concrete Slab on Metal Deck.
- E. Waterproofing is specified in Division 7.

1.2 DESCRIPTION OF WORK

- A. This section specifies cast-in-place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.

1.3 QUALITY ASSURANCE

A. Reference Standards:

- 1. ACI 211.1 "Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete."
- 2. ACI 301 "Specifications for Structural Concrete for Buildings."
- 3. ACI 303 "Guide to Cast-in-Place Architectural Concrete Practice."
- 4. ACI 304 "Guide for Measuring, Mixing, Transporting, and Placing Concrete."
- 5. ACI 305 "Hot-Weather Concreting."
- 6. ACI 306 "Cold-Weather Concreting."
- 7. ACI 311 "Guide for Concrete Inspection" and "Batch Plant Inspection and Field Testing of Ready-Mixed Concrete."
- 8. ACI 315 "Details and Detailing of Concrete Reinforcement."
- 9. ACI 318 "Building Code Requirements for Structural Concrete."
- 10. ACI 347 "Guide to Formwork for Concrete."
- 11. ACI SP-15 "Field Reference Manual." A copy of this publication shall be kept in the field office at all times during concrete construction.
- 12. AWS "Structural Welding Code - Reinforcing Steel."
- 13. CRSI "Manual of Standard Practice."
- 14. NYSDOT "Standard Specification for Construction and Materials."

- B. To minimize irregularities in appearance or color, obtain cement, aggregates, admixtures, and water for each type of concrete construction exposed to view in completed project from same source for duration of that type of construction.

1.4 SPECIAL INSPECTIONS

- A. Refer to Specification Section 01 45 29 and Schedule of Special Inspections.

1.5 MATERIAL EVALUATION/QUALITY CONTROL

- A. Preconstruction Testing: Contractor shall employ Testing Agency acceptable to Engineer and Architect to perform material evaluation tests and evaluate concrete mixes prior to submitting.
- B. Submit concrete testing service qualifications demonstrating experience with similar projects.
- C. Require concrete supplier to provide delivery tickets for each truckload of concrete. Tickets shall be presented to and reviewed by Contractor and Special Inspector or Testing Agency prior to discharging concrete into structure.
 - 1. Tickets shall contain project identification name, name of Contractor, name of concrete supplier, location of batch plant, date and time of concrete batching, truck number, delivery ticket number, concrete type and class, concrete mix number, design compressive strength at 28 days, concrete mix proportions and materials, and amount of total mix design water that can be added at site prior to discharging into structure if total mix design water was not used when batched. See Part 3 of this section for maximum water amount that can be added at site.
- D. The Registered Design Professionals (RDPs) for Structural Engineering and Architecture and the Special Inspector will visit construction site at appropriate intervals to determine if work is in general conformance with Contract Documents and specifications. Notify RDPs 48 hours before anticipated time of completion of reinforcement for a given section of work so they may determine if site observations are required. If site observations are required, do not place concrete until RDPs have had opportunity to observe reinforcement.

1.6 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Show bar schedules, bar spacing, diagrams of bent bars, and arrangements of concrete reinforcement. Include special reinforcement required for openings through concrete.
 - a. Show elevations of reinforcement for all members at minimum 1/4 inch = 1 foot scale.
 - b. Show locations of construction and control joints.
 - c. Reference Contract Drawing number and addendum number in each shop drawing.
 - d. Do not place reinforcing information from more than one design discipline (structural, civil, landscape) in each drawing.
- B. Mix Designs: Submit proposed mix designs for concrete 15 days minimum before start of concreting. Submittal must be in the Concrete Mix Design Submittal Form at end of this section for each class of concrete.
- C. Submit data and installation instructions for proprietary material.

- D. Submit to Special Inspector and Engineer material certificates certifying each material complies with specifications.
- E. Submit chloride ion content of proposed admixtures prior to submitting mix design.

1.7 PRODUCT HANDLING

- A. Store materials so as to preserve their quality and fitness for work. Store reinforcement and formwork in manner to prevent damage and accumulation of dirt.

1.8 WORKMANSHIP

- A. Contractor shall be responsible for correction of concrete work not conforming to specified requirements, including strength, tolerances, and finishes. Correct deficient concrete as directed by Architect.
- B. Remove work found to be defective. Replace with new acceptable work.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed/plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown in drawings. Plywood materials shall be one of the following:
 - 1. Overlaid plywood complying with U.S. Product Standards PS-1 "A-C or B-B High Density Overlaid (HDO) Concrete Form," Class 1, exterior grade or better.
 - 2. Plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class 1, exterior grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Form Coatings: Provide commercial formulation form-coating compounds with maximum VOC of 450 g/l that will not bond with, stain, or adversely affect concrete surfaces or impair subsequent treatments of concrete surfaces requiring bond or adhesion or impede wetting of surfaces to be cured with water or curing compound.
- D. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off, metal form ties, designed to prevent form deflection and spalling concrete upon removal. Provide units that will leave no metal closer than 1 inch to exposed surface.
 - 1. Provide ties that will leave holes no larger than 1-inch diameter in concrete surface when removed.
 - 2. Unexposed concrete: "Type A-3 Snap Tie Standard" by Dayton Superior or accepted equivalent.
 - 3. Exposed concrete: "Type A-3 Snap Tie Heavy" by Dayton Superior or accepted equivalent.
 - 4. Provide galvanized or stainless steel ties for concrete elements that are reinforced with epoxy-coated or galvanized reinforcing.
 - 6. Internal wood spreaders are prohibited.

2.2 REINFORCING MATERIALS

- A. Deformed bars: ASTM A 615, Grade 60. Deformed bars to be welded, ASTM A 706.
- B. Deformed Epoxy-Coated Reinforcing Bars: ASTM A 775.
- C. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- D. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars in place. Use wire bar-type or all plastic-type supports complying with CRSI specifications. Use chairs with sand plates or horizontal runners where base material will not support chair legs.
 - 1. Concrete bricks may be used to support footing reinforcing. Stagger brick locations.
 - a. Do not use clay bricks.
 - b. Do not use bricks to support epoxy-coated or galvanized reinforcing.
 - 2. Supports for epoxy-coated reinforcing shall be either wire bar-type coated with epoxy, plastic, or vinyl compatible with concrete for a minimum distance of 2 inches from the point of contact with the reinforcing or all plastic-type.
 - 3. Finish for supports formed from reinforcing bars shall match the finish of the supported reinforcing.
 - 4. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are plastic-protected (CRSI, Class 1) or stainless-steel protected (CRSI, Class 2).
- E. Minimum 16-gauge annealed tie wire, ASTM A 82.
 - 1. Provide coated wire ties for use with epoxy-coated bars. Acceptable coatings include epoxy, nylon, or vinyl. Do not use plain wire ties.

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II.
- B. Aggregates: NYSDOT-approved, Section 703-02 (normal weight), one source and as specified.
 - 1. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps, or other deleterious substances.
 - 2. Coarse Aggregate: Clean, uncoated, processed aggregate free from clay, mud, loam, or foreign matter.
 - a. For footings, foundation walls, piers, grade beams, basement walls, retaining walls, and interior walls, blend of NYSDOT size 1 and 2 (25 percent size 1 and 75 percent size 2) or gradation conforming to ASTM C 33, size 467:

Sieve Size	Percent Passing
2 inch	100
1 1/2 inch	95 to 100
3/4 inch	35 to 70
3/8 inch	10 to 30
No. 4	0 to 5

- b. For other applications, blend of NYSDOT Size 1 and 2 (40 percent size 1 and 60 percent size 2) or gradation conforming to ASTM C 33, size 57:

Sieve Size	Percent Passing
1 1/2 inch	100
1 inch	95 to 100
1/2 inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5

- c. No size requirement for stair-pan fill and lean concrete.

C. Water: Clean, fresh, drinkable.

D. Air Entraining: ASTM C 260.

E. Water-Reducing Admixture: "Eucon WR-75" or "WR-89" by Euclid Chemical Co.; "Pozzolith 220N" by Master Builders; or "Plastocrete 161" by Sika Chemical Corp. Admixture shall conform to ASTM C 494, Type A, and not contain more chloride ions than in municipal drinking water.

F. Water-Reducing Retarder: "Eucon Retarder-75" by Euclid Chemical Co.; "Pozzolith 100XR" by Master Builders; or "Plastiment" by Sika Chemical Corp. Admixture shall conform to ASTM C 494, Type D, and not contain more chloride ions than in municipal drinking water.

G. Noncorrosive, Nonchloride Accelerator: ASTM C 494, Type E, and not contain more chloride ions than in municipal drinking water.

H. Fly Ash: ASTM C 618, Type F, with a loss on ignition of less than 4 percent.

I. Ground-Granulated, Blast-Furnace Slag: ASTM C 989, Grade 120.

J. High-Range, Water-Reducing Admixture (Superplasticizer): "Eucon 37" by Euclid Chemical Co. or "Sikament" by Sika Chemical Corp. Admixture shall conform to ASTM C 494, Type F or G, and not contain more chloride ions than in municipal drinking water.

K. Nonchloride Waterproofing Admixture: "KIM -Krystol Internal Membrane", by Kryton International Inc. "Xypex Admix C-500, C-1000, or C-2000" by Xypex Chemical Corporation, or "Anti-Hydro - NC or NCR Waterproof Concrete" by Anti-Hydro International, Inc.

L. Prohibited Admixtures: Calcium chloride, thiocyanates, and admixtures containing more than 0.05 percent water-soluble chloride ions by weight of cement or more than 0.3 percent thiocyanates by weight of cement shall not be permitted.

2.4 RELATED MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 ounces a square yard and complying with AASHTO M 182, Class 2.

- B. Curing-sheet Materials: One of the following moisture-retaining covers, complying with ASTM C 171: waterproof paper, polyethylene film, or polyethylene-coated burlap.
- C. Clear Curing and Sealing Compound (VOC compliant): ASTM C 309 with minimum 18 percent solids content. Use "Diamond Clear VOX" by Euclid Chemical Co. or accepted equivalent.
- D. Horizontal Joint Sealants: "Sonolastic SL2" by Sonneborn Building Products; "Sikaflex-2c SL" by Sika Corp.; "Eucolastic 2 SL" by Euclid Chemical Co.; or accepted equivalent.
- E. Vertical Joint Sealants: "Eucolastic 2" by Euclid Chemical Co.; "Sonolastic NP2" by Sonneborn Building Products; "Sikaflex-2c NS" by Sika Corporation; "Brutem 92" by Master Builders, Inc.; or accepted equivalent.
- F. Joint Filler: ASTM D 1751, ½-inch-thick, premolded, expansion joint filler strips.
- G. Backer Rod: "Sonofoam" polyethylene closed-cell foam by Sonneborn Building Products or accepted equivalent.
- H. Water Stops: "Volclay Waterstop-RX," 1 inch by ¾ inch, by American Colloid Company or accepted equivalent at below-grade wall construction joint locations and at locations shown in drawings.
- I. PVC Water Stops: Polyvinyl Chloride, dumbbell-type or center bulb-type, conforming to Corps of Engineers CRD-C 572. "Wirestop CR-6380" or "Wirestop FD-6380" by Paul Murphy Plastics Company; "Sealtight PVC Waterstop 6380" by W.R. Meadows; or accepted equivalent at below-grade wall control joint locations and at locations shown in drawings.
- J. Chamfer Strips: Provide wood, metal, PVC, or rubber chamfer strips fabricated to provide ¾-inch chamfer on exposed edges.
- K. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217-inch-thick (26-gauge) galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- L. Sleeves:
 - 1. Schedule 40, PVC for 12-inch diameter or smaller.
 - 2. ASTM A 53, hot-dip galvanized for larger than 12-inch diameter.
- M. Anchor Rods and Leveling Plates: Furnished in Section 05 12 00 and installed under this section.
- N. Non-shrink Grout: Corp of Engineers CRD-C 621. "Conspec 100" by Conspec Manufacturing Co.; "NS Grout" by Euclid Chemical Co.; "SikaGrout 212" by Sika Corp.; "Masterflow 928" or "Set Grout" by Master Builders, Inc.; "Sonogrout" by Sonneborn Building Products; or accepted equivalent.
- O. Bonding Agent: "Strongbond" by Conspec Manufacturing Co.; "SBR Latex" by Euclid Chemical Co.; "Everbond" by L&M Construction Chemicals, Inc.; "Acryl-Set" by Master Builders, Inc.; "SikaLatex" by Sika Corp.; "Sonocrete" by Sonneborn Building Products; or accepted equivalent.

2.5 PROPORTIONING AND MIX DESIGN

- A. Prepare design mixes for concrete. Use independent testing facility acceptable to Architect for preparing and reporting proposed mix designs.
- B. Where concrete production facility can establish uniformity of its production for concrete of similar strength and materials based on recent test data, the average strength used as a basis for determining mix design proportions shall exceed specified design strength by requirements of ACI 318, Section 5.3.2.1 or ACI 301, Section 3.9.
- C. When a concrete production facility does not have field-test records for calculation of standard deviation, the required average strength shall be determined in accordance with ACI 318, Section 5.3.2.2.
- D. Pozzolans:
 - 1. Pozzolans may be substituted for cement in normal-weight concrete, including fly ash, at a maximum rate of 20 percent by weight or ground-granulated, blast-furnace slag at a maximum rate of 35 percent by weight.
 - 2. Submittals shall include actual mix design, including percentage of pozzolans and test results showing mix meets specified 7-day compressive strength where indicated, 28-day compressive strength, and air content.
 - 3. Protect and heat concrete containing pozzolans during cold weather conditions. Maintain protection and heat until 70 percent of specified design strength is achieved.
- E. Quantity of coarse aggregate in pounds must be in the range of 1.25 to 1.5 times quantity of fine aggregate in pounds.
- F. Concrete Quality:

Location	Required 7-day Compressive Strength psi	Required 28-day Compressive Strength psi	Maximum Water/Cement Ratio	Percent Entrained Air
Footings, interior stair pans, misc. concrete.	NA	3,000	0.55	4.5*
Retaining walls, basement walls, interior walls, foundation walls, piers, grade beams, underpinning.	3,000	4,000	0.5	4.5*
Lean concrete	NA	1,500	0.65	4.5*

* Plus or minus 1.5 percent.

G. Slump:

1. Footings, foundation walls, piers, grade beams, misc. concrete: 3 inches to 5 inches.
2. Retaining walls, basement walls, interior walls: 4 inches maximum.
3. Concrete containing high-range, water-reducing admixture (superplasticizer) shall have a maximum slump of 9 inches unless otherwise accepted by Engineer. Concrete shall arrive at job site at a slump of 2 to 3 inches, shall be verified, then high-range, water-reducing admixture added to increase slump as required for placement and workability.
4. Type G superplasticizer may be added at plant if adequate quality control measures are implemented to verify slump and admixture quantities at plant before addition of superplasticizer. Concrete shall maintain required slump during transportation and placement. Quality control testing at plant shall be performed by an independent testing laboratory employed by Contractor and acceptable to Architect.
5. Ready Mix Concrete: ASTM C 94.
6. Provide batch ticket for each batch discharged and used in work indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

2.6 REINFORCING FABRICATION

- A. Fabricate bars to required lengths, shapes, and bends. Do not rebend or straighten reinforcement in manner that could weaken material.

PART 3 - EXECUTION**3.1 JOB CONDITIONS**

- A. Examine conditions under which concrete shall be placed. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 FORMWORK INSTALLATION

- 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 complying with ACI 347.
- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, sleeves, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent concrete mortar leakage.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, etc., for easy removal.

- D. Erect forms in logical sequence to allow placement and inspection of reinforcement and other embedded items.
- E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for concrete placement. Securely brace temporary openings, and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- F. Provide cleanout panels at bottoms of deep wall and column forms.
- G. 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.
- H. Fit corners and joints with gaskets or tape to prevent leakage.
- I. 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.
- J. Sleeves: Provide sleeves in concrete formwork for plumbing, electrical, and mechanical penetrations. Coordinate size and location of sleeves with Contractors and mechanical, electrical, and plumbing drawings.
 - 1. Accurately place and secure in forms.
 - 2. Coordinate sleeve locations with reinforcing bars.
 - 3. Penetrations shall not occur through footings, piers, columns, or grade beams unless shown in structural drawings.
- K. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before placing concrete as required to prevent mortar leaks and maintain proper alignment.
- L. Clean and repair surfaces of forms to be reused in the work. Split, frayed, delaminated, or otherwise damaged form-facing materials are not acceptable. Apply new form-coating compound material. When forms are reused for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joints to avoid offsets.
- M. Clean and coat forms before erection. Do not coat forms in place.
- N. Place concrete plugs in exposed holes left by form-tie cones.

3.3 REINFORCEMENT PLACEMENT

- A. Clean reinforcement of loose rust, mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- B. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, hangers, or concrete brick as required.
 - 1. Wire-tie intersections as required to prevent displacement of reinforcement.
 - 2. Do not wet set reinforcing bars. Wet setting is not permitted.

- C. Place reinforcement to obtain at least minimum concrete coverages for protection of bars. Minimum required concrete cover is noted in drawings.
- D. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Use of nails in forms and use of clay brick to support reinforcement shall be prohibited.
- F. Lap bar splices as indicated. Stagger splices in adjacent bars. Wire-tie all splices.
- G. Coordinate placement of reinforcement with openings, including sleeves and other embedded items. Where one or more bars are interrupted, provide additional reinforcement at openings. Additional reinforcement is noted in drawings.
- H. Place concrete in manner to ensure alignment of elements remains unchanged.
- I. Touch up damaged epoxy-coated reinforcement in field after placement with epoxy patching material provided by coating manufacturer.

3.4 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items including anchor rods, leveling plates, embedded plates, and angles required for other work attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto.
- B. Do not wet set embedded items. Accurately position, support, and secure embedded items against displacing by formwork, construction, or concrete placement operations.
 - 1. Provide No. 3 rebar ties at top and bottom of anchor rods to maintain position or other accepted method.
- C. Anchor rods and embedded structural supports incorrectly located or damaged after installation shall be field modified, including repair or replacement, by Contractor.
 - 1. Notify Engineer of defective work. Submit proposed field modifications to Engineer for review and acceptance prior to making corrections.
 - 2. Proposed field modifications shall include design details and calculations, signed and sealed by a licensed Professional Engineer hired by Contractor.
 - 3. Field modifications shall be tested in accordance with Section 05 12 00. Perform pull-out tests and other appropriate tests on each repair.
 - 4. Cost of field modifications shall be borne entirely by Contractor at no additional cost to Owner. Contractor shall reimburse Owner for cost of additional testing required.

3.5 INSTALLATION OF NON-STRUCTURAL EMBEDDED ITEMS

- A. General: Notify other trades to permit installation of their work, including reglets, conduit, and piping and to coordinate requirements of this section. Cooperate with other trades in setting work as required.
- B. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings on outer face of exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- C. ACI 318, Article 6.3, and guidelines listed below apply to conduit and piping.
 - 1. Do not embed aluminum items unless coated or covered to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.
 - 2. Other than those passing through concrete elements, do not embed items that are larger than one-third of thickness of concrete element in which they are embedded.
 - 3. Unless shown otherwise in structural drawings, install items as follows:
 - a. Space at least 12 inches apart and not less than three diameters or widths on center.
 - b. Place so they do not cross over each other within concrete elements.
 - c. Place so they do not displace reinforcing bars from their proper location.
 - d. Provide at least 3/4-inch concrete cover between items and reinforcing bars or concrete surfaces not exposed to weather or in contact with ground. Do not lay items on reinforcing bars. Provide at least 1½-inches concrete cover between items and concrete surfaces exposed to weather or earth.
 - e. Securely position items by wire tying to support chairs or supports formed from reinforcing bars.
 - f. Install sleeves at penetrations for nonstructural items passing through concrete elements.

3.6 PREPARATION OF FORM SURFACES

- A. General: Coat contact surfaces of forms with an accepted form-coating compound before placing reinforcement.
- B. Do not allow excess form-coating material to accumulate in forms or to come in contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- C. Coat steel forms with a nonstaining, rust-preventive material. Rust-stained steel formwork is not acceptable.

3.7 CONSTRUCTION JOINTS

- A. Locate and install construction joints not shown in drawings so as not to impair strength and appearance of structure as acceptable to Architect.

1. Provide keyways at least 1 1/2 inches deep in construction joints in walls. Roughen joints between reinforced concrete walls and footings.
2. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated. Do not continue reinforcement through sides of strip placements.
3. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
4. Provide water stops in construction joints below grade and where indicated. Install water stops to form continuous diaphragm in each joint. Make provisions to support and protect exposed water stops during progress of work. Field-fabricate joints in water stops in accordance with manufacturer's printed instructions.

3.8 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in.
 1. Notify other trades to permit installation of their work. Cooperate with other trades in setting work as required.
- B. General: Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete" and as specified.
- C. A maximum of 2 1/2 gallons for each cubic yard of total mix design water can be added in field. Water must be added prior to discharging and testing concrete. At no time shall total water exceed amount listed in accepted mix design.
- D. Deposit concrete continuously or in layers of such thickness that no concrete shall be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within section. Provide construction joints if section cannot be placed continuously.
- E. Deposit concrete as nearly as practicable to its final location to avoid segregation caused by rehandling or flowing.
- F. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in manner to avoid inclined construction joints.
- G. Keep excavations free of water. Do not deposit concrete in water, mud, snow, or on frozen ground.
- H. Maximum drop of concrete shall not exceed 5 feet. Use hopper and trunk for greater drops.
- I. Maintain reinforcing in proper position during concrete placement.
- J. Contractor shall be responsible for controlling the proper placing of embedded pipe, conduit, and other embedded items. See section "Installation of Non-Structural Embedded Items" for additional information.
- K. Pumping concrete is permitted only if mix designs specifically prepared and used previously for pumping are submitted. Pump line shall have 5-inch-minimum inside diameter and be used with 5-inch pumps.

3.9 CONSOLIDATION

- A. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
- B. Do not use vibrators to transport concrete inside formwork.
- C. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Vibrators shall penetrate placed layer of concrete at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set.
- D. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- E. Do not allow vibrator to come in contact with form.

3.10 SURFACE FINISHES

- A. Rough-Form Finish: Provide as-cast, rough-form finish to formed concrete surfaces that shall be concealed in finished work or by other construction. Standard rough-form finish is concrete surface having texture imparted by form-facing material used, with tie holes and other defective areas repaired and patched, and fins or other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth-Form Finish: Provide smooth-form finish for formed concrete surfaces that shall be exposed to view or covered with material applied directly to concrete such as waterproofing, dampproofing, veneer plaster, painting, or other similar systems. Produce smooth-form finish by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Smooth-Rubbed Finish: Provide smooth-rubbed finish to scheduled smooth-form finished concrete surfaces not later than one day after form removal.
 - 1. Moisten smooth-form finished concrete surfaces, and rub with carborundum brick or other abrasive until uniform color and texture are produced.
 - 2. Do not apply cement grout other than that created by the rubbing process.
- D. Grout-cleaned Finish: Provide grout-cleaned finish to scheduled smooth-form finished concrete surfaces.
 - 1. Combine 1 part portland cement to 1 1/2 parts fine sand by volume and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to consistency of thick paint. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout shall match adjacent surfaces.
 - 2. Thoroughly wet smooth-form finished concrete surfaces. Apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

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

3.11 CURING AND PROTECTION

- A. Protect concrete from premature drying, excessive hot or cold temperature, and mechanical injury in accordance with provisions of ACI 301, Section 5.3.6.
- B. Curing Methods: Perform concrete curing by wet-curing or moisture-retaining cover curing or combinations thereof as specified.
- C. Provide wet-curing by following methods:
 - 1. Keep concrete surface continuously wet by covering with water.
 - 2. Use continuous water-fog spray.
 - 3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges with 4-inch lap over adjacent absorptive covers.
- D. Provide moisture-cover curing as follows:
 - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair holes or tears during curing period using cover material and waterproof tape.
- E. Curing Vertical-Formed Surfaces:
 - 1. Keep forms in place for minimum of 7 days, 14 days in cold weather or until concrete has achieved 70 percent of its design strength.
 - 2. If forms are removed before minimum time period, alternate methods of curing, wet-curing, moisture-retaining cover curing, or liquid-membrane curing, are required.
 - a. Contractor shall submit procedures to Architect for review.
 - b. Forms shall remain in place for a minimum of 24 hours when alternating methods of curing are used. For placement during cold weather, the minimum time to form removal shall be extended based on expected weather conditions and Contractor's submitted procedures.
- F. Cure concrete placed under cold-weather conditions completely covering exposed surface of concrete with moisture-retaining cover completely sealed around edges. Cure concrete 14 days minimum with concrete temperature at or above 40 degrees F or 7 days minimum with concrete temperature at or above 70 degrees F.
- G. During hot weather after concrete has hardened, loosen form ties, keeping forms in place, and apply water to inside face of form to keep concrete continuously moist.

3.12 COLD-WEATHER CONCRETING

- A. Place concrete in accordance with ACI 306.

- B. For cold-weather concreting (defined as a period when for more than 3 successive days the mean daily temperature is below 40 degrees F), maintain concrete temperature in accordance with Table 3.1, and maintain concrete protection in accordance with Table 5.3 in "Cold-Weather Concreting" reported by ACI Committee 306.
- C. When air temperature has fallen to or is expected to fall below 40 degrees F (4 degrees C), uniformly heat water and aggregates before mixing to obtain concrete mixture temperature recommended in Table 3.1 of ACI 306.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators.

3.13 HOT-WEATHER CONCRETING

- A. Place concrete in accordance with ACI 305.
- B. Cool ingredients before mixing to maintain concrete temperature below 85 degrees F at time of placement.
- 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.
- D. Cover reinforcing steel with water-soaked burlap if temperature of reinforcing steel exceeds ambient air temperature.
- E. Wet forms thoroughly before placing concrete.
- F. Fog-spray forms and reinforcing steel just before placing concrete.
- G. Use water-reducing, retarding admixture when required by high temperature, low humidity, or other adverse placing conditions when acceptable to Architect.

3.14 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after form removal when acceptable to Architect.
 - 1. Cut out honeycombs, rock pockets, voids over 1/2 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but not to a depth of less than 1 inch. Make edges of cuts perpendicular to concrete surface. Thoroughly clean, dampen with water, and brush-coat area to be patched with bonding agent. Place patching mortar before bonding compound has dried.
 - 2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so patching mortar will match surrounding color when dry. 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.

- B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. These include surface defects such as color, texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on 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. Where possible, repair concealed formed surfaces containing defects affecting concrete durability. If defects cannot be repaired, remove and replace concrete.
- C. Repair of Unformed Surfaces: Test unformed surfaces for smoothness, and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using template having required slope.
 - 1. Repair finished unformed surfaces containing defects affecting concrete durability. These include surface defects such as crazing, cracks, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
- D. Repair methods not specified above may be used subject to acceptance of Architect.

3.15 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades unless otherwise shown or directed after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling required to complete work.
- B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown in drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
- C. Steel-Pan Stairs: Provide concrete fill for steel-pan stair treads, landings, and associated items. Cast-in safety inserts and accessories as shown in drawings. Screed, tamp, and finish concrete surfaces as scheduled.

3.16 TOLERANCES

- A. Footings:
 - 1. Variation of dimensions in plan: plus 2 inches or minus 1/2 inch.
 - 2. Variation of center from specified center in plan: 2 percent of width in direction of variation, plus or minus 2-inches maximum variation.
 - 3. Variation of bearing surface from specified elevation: plus or minus 1/2 inch, unless otherwise specified.
- B. Piers and Walls:
 - 1. Variation in cross-sectional dimensions of piers and grade beams and in thickness of walls: plus or minus 1/4 inch.

2. Variation in plan from specified location in plan: plus or minus 1/2 inch for any member in any location.
 3. Deviation in plan from straight lines parallel to specified linear building lines: 1/4 inch for adjacent members less than 20 feet apart or any wall length less than 20 feet; 1/2 inch for adjacent members 20 feet or more apart or any wall length of 20 feet and greater.
 4. Deviation from plumb: 1/4 inch for any 10 feet of height; 1 inch maximum for entire height.
 5. Variation in elevation from specified elevation: plus or minus 1/2 inch for any member in any location.
 6. Deviation in elevation from lines parallel to specified grade lines: 1/4 inch for adjacent members less than 20 feet apart or any wall length less than 20 feet; 1/2 inch for adjacent members 20 feet or more apart or any wall length of 20 feet and greater.
- C. Anchor Rods and Sleeves:
1. Variation from specified location in plan: plus or minus 1/4 inch.
 2. Variation from specified elevation: plus or minus 1/2 inch.
- D. Embedded Items (plates, angles, etc.) other than anchor rods and sleeves:
1. Variation from specified location in plan: plus or minus 1/4 inch.
 2. Variation from specified elevation: plus or minus 1/4 inch.

CONCRETE MIX DESIGN SUBMITTAL FORM
 Submit separate form for each mix design

Project:	Location:
General Contractor:	Concrete Supplier:
Mix Design No:	Concrete Grade:
Use (Describe):	
Methods of Placement (chute, pump, chute and buggy, etc.):	
If placing by pumping, verify concrete mix can be pumped distances required in project:	

A. DESIGN MIX INFORMATION:

Based on Standard Deviation Analysis:_____ or Trial Mix Design Data:_____

Design Characteristics - Density:_____ pcf; Strength:_____ psi (28-day);

Slump:_____ in. required BEFORE adding superplasticizer (if used)

Slump:_____ in. required AFTER adding superplasticizer (if used)

Entrained Air Content:_____ % specified

Materials:

Aggregates: (size; type; source; gradation; specification)

Coarse:_____

Fine:_____

<u>Other Materials:</u>	<u>Type</u>	<u>Product-Manufacturer (Source)</u>
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Cement:_____		
--------------	--	--

Fly Ash:_____		
---------------	--	--

Slag:_____		
------------	--	--

Admixtures:

Water Reducer:_____

Air-Entraining Agent:_____

High-Range, Water-Reducing Admixtures (superplasticizer):_____

Non-Corrosive Accelerator:_____

Other:_____

B. FINAL MIX DESIGN DATA:RATIOS

Water _____ lb
 Cementitious _____ lb = _____
 Materials

Course Agg. _____ lb
 Fine Agg. _____ lb = _____

SPECIFIC GRAVITIES

Fine Agg. _____

Coarse Agg. _____

Other: _____

ADMIXTURES

W.R.: _____ oz. per 100 # Cement

HRWR: _____ oz. per 100 #Cement

Non-Corrosive Accelerator: _____ oz.
 Per 100# Cement

A.E.A.: _____ oz. per 100 # Cement

Other: _____ oz. per 100# Cement

PLASTIC CONCRETE

Initial Slump = _____ in. Air Content = _____ %

Final Slump = _____ in. Unit Dry Wt. = _____ pcf

Unit Wet Wt. = _____ pcf

STANDARD DEVIATION ANALYSIS (from experience records):

Number of Test Cylinders Evaluated: _____ Standard Deviation: _____

$f_{cr} = f_c + 1.34s$ or $f_{cr} = f_c + 2.33s - 500$

(Refer to ACI for increased deviation factor when fewer than 30 tests are available.)

Mix # _____

Job Name _____

MIX PROPORTIONS

WEIGHT (LBS.) ABSOLUTE VOL. (CU. FT.)

Cement: _____

Fly Ash: _____

Slag: _____

Fine Aggregate: _____

Coarse Aggregate: _____

Water: _____

Entrained Air: _____

Other: _____

TOTALS: _____

C. LABORATORY TEST DATA (HARDENED CONCRETE):COMPRESSIVE STRENGTH

Age (days)	Mix #1	Mix #2	Mix #3
7	_____	_____	_____
14	_____	_____	_____
28	_____	_____	_____
Other	_____	_____	_____

28-day average compressive strength: _____ psi

Mix design proportioned to achieve $f_{cr} = f_c + 1200$ psi (1400 psi for strength higher than 5000 psi at 28 days)

CHLORIDE ION CONTENT: _____

Remarks: _____

NOTE: Fill in all blank spaces. Use -0- (Zero) or N.A. (Not Applicable) where appropriate. See "Design and Control of Concrete Mixtures," 13th Edition by Portland Cement Association, for assistance in completing this form.

D. REQUIRED ATTACHMENTS:

_____ Coarse aggregate gradation report and DOT certification
 _____ Fine aggregate gradation report and DOT certification
 _____ Concrete compressive strength data used for standard deviation calculations
 _____ Chloride ion data and related calculations
 _____ Rapid chloride permeability test report
 _____ Admixture compatibility certification letter

Submitted by

Ready-Mix

Supplier: Name _____

Address _____

Phone Number _____ Date _____

Main Plant Location _____ Miles from Project _____

Secondary Plant Location _____ Miles from Project _____

- - - END - - -