

## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. Section Includes
  - 1. Cast-in-place structural concrete as shown on Drawings and as specified.
- B. Products Installed But Not Supplied Under This Section.
  - 1. Anchor rods built into concrete work.
  - 2. Miscellaneous metal items built into concrete work.
    - a. Guard or edge angles.
    - b. Bearing plates.
    - c. Anchor plates.
    - d. Sump cover frames.
    - e. Trench cover frames
    - f. Ladder rungs.
- C. Related Sections.
  - 1. Concrete for roads, sidewalks, curbs, gutters and exterior pavements - Division 2.
  - 2. Earthwork - Division 2.
  - 3. Concrete Slabs-On-Grade - Section 03315.
  - 4. Grout - Section 03600.
  - 5. Concrete for mechanical work, except housekeeping pads - Division 15.
  - 6. Concrete for electrical work, except housekeeping pads - Division 16.

##### 1.2 REFERENCES

- A. Reference standards - Standards of ACI, ASTM, CRD, PTI, and AWS referred to in this Section are listed with attendant serial designation. Use latest year of adoption or revision unless otherwise specified in Contract Documents.

###### **ACI standards**

ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 301	Standard Specification for Structural Concrete

###### **ASTM standards**

A 82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
A 184	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
A 185	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

A 496	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
A 497	Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 616	Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
A 767	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A 775	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
A 780	Standard Practice for Repair of Damaged Hot-Dip Galvanized Coatings
A 884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement
A 934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
A 955M	Standard Specification for Deformed and Plain Stainless Steel Bars for Concrete Reinforcement
A 970	Standard Specification for Welded or Forged Headed Bars for Concrete Reinforcement
A 996	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
C 31	Standard Practice for Making and Curing Concrete Test Specimens in Field
C 33	Standard Specification for Concrete Aggregates
C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 94	Standard Specification for Ready-Mixed Concrete
C 138	Standard Test Method for Unit Weight, Yield, and Air Content of Concrete
C 143	Standard Test Method for Slump of Hydraulic-Cement Concrete
C 150	Standard Specification for Portland Cement
C 171	Standard Specification for Sheet Materials for Curing Concrete
C 172	Standard Practice for Sampling Freshly Mixed Concrete
C 173	Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method
C 192	Standard Practice for Making and Curing Concrete Test Specimens in Laboratory
C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by Pressure Method
C 260	Standard Specification for Air-Entraining Admixtures for Concrete
C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 330	Standard Specification for Lightweight Aggregates for Structural Concrete
C 387	Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
C 494	Standard Specification for Chemical Admixtures for Concrete

C 567	Standard Test Method for Density of Structural Lightweight Concrete
C 595	Standard Specification for Blended Hydraulic Cements
C 597	Standard Test Method for Pulse Velocity Through Concrete
C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as Mineral Admixture in Portland Cement Concrete
C 684	Standard Test Method for Making, Accelerated Curing, and Testing Concrete Compression Test Specimens
C 685	Standard Specification for Concrete Made By Volumetric Batching and Continuous Mixing
C 803	Standard Test Method for Penetration Resistance of Hardened Concrete
C 805	Standard Test Method for Rebound Number of Hardened Concrete
C 873	Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
C 881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
C 900	Standard Test Method for Pullout Strength of Hardened Concrete
C 928	Standard Specification for Packaged, Dry, Rapid Hardening Cementitious Materials for Concrete Repairs
C 989	Standard Specification for Blast Furnace Slag
C 1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
C 1059	Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
C 1064	Standard Test Methods for Temperature of Freshly Mixed Portland Cement Concrete
C 1074	Standard Practice for Estimating Concrete Strength by Maturity Method
C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
C 1150	Standard Test Method for Break-Off Number of Concrete
C 1218	Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
C 1240	Standard Specification for Silica Fume for Use in Hydraulic-Cement Concrete, Mortar, and Grout
C 1315	Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for curing and Sealing Concrete
D 98	Standard Specification for Calcium Chloride
D 994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
D 1621	Standard Test Methods for Compressive Properties of Rigid Cellular Plastics
D 1751	Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
D 1752	Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
D 3575	STANDARD TEST METHODS FOR FLEXIBLE CELLULAR MATERIALS MADE FROM OLEFIN POLYMERS
E 329	Standard Specification for Agencies Engaged in Testing and/or Inspection of Materials Used in Construction

E 1155 Standard Test Method for Determining Floor Flatness and Levelness Using F-Number System

**Other referenced standards**

ANSI Structural Welding Code - Steel Reinforcing AWS D1.4  
CRD-C 513-74 Specification for Rubber Waterstops  
CRD-C 572-74 Specification for Polyvinyl Chloride Waterstops

B. Cited publications - Publications cited in this Section:

ACI 318 Building Code Requirements for Reinforced Concrete  
ACI CP1 ACI Certification Concrete Field Testing Technician-Grade I  
ACI SP-15 Field Reference Manual  
CRSI MSP-1 Manual of Standard Practice, Current Edition

C. Field references - Keep copies of the following references in Contractor's field office:

SP-15 Field Reference Manual: Specification for Structural Concrete (ACI 301) with Selected ACI and ASTM References

### 1.3 DEFINITIONS

- A. *ACI Concrete Field Testing Technician Grade 1* - Personnel who have demonstrated knowledge and ability to perform and record results of ASTM standard tests on freshly mixed concrete and to make and cure test specimens. Knowledge and ability shall be demonstrated by passing prescribed written and performance examinations and having credentials that are current with American Concrete Institute.
- B. *Architectural concrete* - Concrete that is exposed as an interior or exterior surface in completed structure and is designated as architectural concrete in Contract Documents; contributes to visual character of completed structure and therefore requires special care in selection of concrete materials, forming, placing, and finishing to obtain desired architectural appearance.
- C. *Backshores* - Shores placed snugly under concrete slabs or structural members after original formwork and shores have been removed from various areas without allowing slabs or members to deflect or support its own weight or existing construction loads from above.
- D. *Contract Documents* - Documents, including Project Drawings and Project Specifications, covering required Work. Refer to Conditions Of Contract.
- E. *Exposed to public view* - Situated so that it can be seen from public locations after building completion.
- F. *High-early-strength concrete* - Concrete that, uses ASTM C 150 Type III cement or admixtures, and is capable of attaining specified strength at earlier ages than normal concrete.
- G. *Mass concrete* - Any volume of concrete with dimensions large enough to require that measures be taken to cope with generation of heat from hydration of cement and attendant volume change

to minimize cracking. Concrete 2 feet or more in thickness shall be classified as mass concrete unless otherwise shown in Contract Documents.

- H. *Mass concrete, plain* - Mass concrete containing no reinforcement or less reinforcement than necessary to be considered reinforced mass concrete.
- I. *Mass concrete, reinforced* - Mass concrete containing adequate reinforcement and designed to act together with concrete in resisting forces including those induced by temperature and shrinkage.
- J. *Normal Weight Concrete* - Concrete having densities of roughly 150 pounds per cubic foot made with gravel or crushed stone aggregates.
- K. *Reference specification* - Specifications that are intended by Registered Design Professional to be reference standards for Contractor to use in constructing projects by citing reference specifications in Contract Documents, together with project requirements.
- L. *Reference standards* - Standards of technical societies, organizations, or associations, including codes of local or state authorities that are referenced in Contract Documents.
- M. *Reshores* - Shores placed snugly under stripped concrete slabs or other structural members after original forms and shores have been removed from areas, thus requiring new slabs or structural members to deflect and support its own weight and existing construction loads applied before installing reshores.
- N. *Strength test* - Compressive strength average of two cylinders made from one sample of concrete and tested at 28 days or at test age designated for determination of specified compressive strength.
- O. *Structural lightweight concrete* - Structural concrete made with lightweight aggregate; density usually between 90 to 115 pounds per cubic foot.
- P. *Work* - entire construction or separately identifiable parts thereof that are required to be furnished under Contract Documents; Work is result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into construction in accordance with Contract Documents.

#### 1.4 SYSTEM DESCRIPTION

- A. Completed concrete work shall conform to applicable requirements of this Specification and Contract Documents.
- B. Concrete work that fails to meet one or more requirements of Contract Documents but is repaired using specified methods or methods approved by Registered Design Professional to bring concrete into compliance will be accepted without qualification.

- C. Concrete work that fails to meet one or more requirements of Contract Documents and cannot be brought into compliance will be rejected and shall be removed from site. Non-compliant concrete shall be replaced with satisfactory work or reinforced.
- D. Submit for acceptance proposed repair methods, materials, and modifications needed to ensure that concrete work shall meet requirements of Contract Documents.
- E. Contractor shall pay costs to bring concrete work into compliance with requirements of Contract Documents.
- F. Members cast in wrong location may be rejected.
- G. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances of ACI 117, may be considered deficient in strength and subject to provisions of Paragraph 1.4.L.
- H. Formed surfaces resulting in concrete outlines larger than permitted by ACI 117 may be rejected. Remove excess materials when required by Registered Design Professional.
- I. Inaccurately formed concrete surfaces that exceed ACI 117 tolerances may be rejected.
- J. Concrete not matching appearances of sample finishes on sample panels shall be brought into compliance.
- K. Concrete strength will be considered satisfactory if averages of specimens of three consecutive strength test results performed at specified age equal or exceed specified compressive strength test result is below specified compressive strength by more than 500 pounds per square inch.
- L. Strength of Structure will be considered deficient and concrete work will be rejected when Work fails to comply with requirements that control structure strength including, but not limited to, the following conditions:
  - 1. Concrete strength failing to comply with requirements of stated design criteria as measured by average compressive strength of standard molded strength specimens.
  - 2. Reinforcing steel size, quantity, strength, position, or arrangement at variance with requirements stated in Contract Documents.
  - 3. Concrete elements that differ from required dimensions or location.
  - 4. Curing not in accordance with Contract Documents.
  - 5. Inadequate protection of concrete from extreme temperature and other environmental conditions during early stages of hardening and strength development.
  - 6. Mechanical injury, construction fires, accidents, or premature removal of formwork resulting in deficient strength.

## 1.5 SUBMITTALS

- A. General
  - 1. Furnish submittals for items that are identified in this Section by different typefaces and bracketed codes (e.g., Item [D]). Refer to Section 01340 for code definitions, submittal

types, and administrative requirements governing submittal procedure. Additional submittals required by this Section are specified under this Article.

- B. Submit product data or manufacturer's specifications and installation instructions. Include laboratory test reports and other data to show compliance with specifications (including specified codes and ASTM standards) and Material Safety Data Sheets for following:
1. *Cement [P]*., including type, class, manufacturer, and plant location.
  2. *Coarse and fine aggregates [P]*., including type, pit or quarry location, producer, gradation, and specific gravity.
  3. *Admixtures [P]*:
  4. *Column isolation joint forms [P]*:
  5. *Expansion joint fillers [P]*:
  6. *Curing materials and methods [P]*:
  7. *Bonding agents [P]*:
  8. *Waterstops [P]*:
  9. *Perimeter insulation below grade [P]*:
  10. *Formwork Release Agents [P]*:
  11. *Vapor Retarder [P]*:
  12. *Vapor Barrier [P]*:
- C. *Concrete Reinforcing Shop Drawings [D]*: Submit shop drawings for concrete reinforcing, including complete details for fabricating, bending, and placing. Include reinforcement sizes and grade; fabricated dimensions; location of reinforcing bars or wire mesh; lap requirements and lengths; splices; concrete cover; and bar support spacings and location.
- D. *Concrete Mix Design [T]*: Submit laboratory test reports for qualifying proposed concrete materials and establishing concrete mix designs.
1. Demonstrate by test or previous field experience that mixing water, including that contributed by aggregates, and any admixtures used shall not contain deleterious quantity of chloride ions.
  2. Submit concrete mix design information for each proposed concrete mix. Submit information on standard mix design submittal forms printed at end of this Section. Information can be submitted on concrete supplier formatted sheets if required information is provided. Include information about:
    - a. Cement, coarse aggregates, fine aggregates, mineral admixtures (fly ash or ground granulated blast furnace slag) and water supply.
    - b. Chemical admixtures containing manufacture's name, brand, proposed use, and chloride content.
    - c. Selection of concrete mix proportions based in either trial laboratory data or historical field test records used to establish required average strength in accordance with ACI 301.
    - d. Aggregate gradations including producers name, pit and quarry locations, and specific gravities. Include dated information that shows that information is not more than ninety (90) days old.

- e. When historical field test records are used as basis for selecting proportions for concrete mix, include data on materials and mixture proportions confirming conformance.
- E. *Hot and Cold Weather Concrete Placement Procedure [R]*: Submit detailed procedures for producing, transporting, placing, protecting, curing, and monitoring temperature of concrete during hot and cold weather.
- 1. Include what preparations will be made for abrupt changes in weather conditions or equipment failures and procedures to be implemented.
  - 2. The submittal shall include, but is not limited to, following:
    - a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement or forms before concrete placement. Include methods for removing frost, ice, or snow in event they accumulate before precautions are implemented or precautions proves to be inadequate.
    - b. Methods of temperature protection during placement.
    - c. Types of covering, insulation, housing, heating, or cooling to be provided.
    - d. Curing methods to be used during and following protection period.
    - e. Use of retarding or accelerating admixtures.
    - f. Methods for verification of in-place strength other than those instances noted as being provided by Owner.
    - g. Procedures for measuring and recording concrete temperatures after placement.
    - h. Procedures for preventing excessive evaporation during hot, dry, or windy conditions.
  - 3. Use of admixtures shall not be first or second option planned or used to address hot or cold weather during concreting operations. First and second options planned and used shall be either concrete mixes specially designed for hot or cold weather, control of concrete temperature when placed, more extensive curing methods, more extensive protection methods, or longer protection periods.
- F. *Concrete Temperature Record [R]*: Submit records of concrete surface temperatures and protection methods implemented during placement and curing for periods when ambient air temperature is outside range of 40-90 degrees F.
- G. Quality Assurance/Control Submittals
- 1. Test Reports
    - a. *Concrete Cylinder Test Reports [R]*: Submit preliminary reports within three days of testing to Contractor, Owner's Representative, and Concrete Supplier. Submit final reports to Owner, Contractor, Owner's Representative, Registered Design Professional and Concrete Supplier within seven days of test completion.
  - 2. Field reports
    - a. *Pouring Schedules, Casting Plan and Records [R]*: Prepare detailed, written event schedules and casting plans with joint locations for Project, and submit to Owner's Representative before starting Work.
      - 1) Keep written concrete casts records, denoting location, date, cubic yards of concrete including signed trip ticket for each truck, ambient air temperature, and unusual occurrences during each cast placement. Permit records inspection by

Owner's Representative at any time. At Project completion submit data summary to Owner's Representative.

3. Repair Methods
  - a. *Repair Method for Defective Work [R]*: Submit documentation of methods and materials used for repairing or reinforcing of noncompliant Work.

## 1.6 QUALITY ASSURANCE

### A. Qualifications

1. Contractor shall furnish, construct, and install Work in accordance with provisions in recent editions of ACI, ASTM and AWS reference standards listed in Part 1 General unless otherwise noted.
2. Contractor shall secure and pay for testing agency services to perform laboratory tests necessary for qualifying proposed concrete materials, establishing concrete mix designs and any other testing services as needed or required by Contractor for proper execution of his Work. Testing Agency shall perform tests noted in accordance with ACI 301 Section 1.
3. Owner will secure and pay for testing agency services to evaluate concrete construction, test concrete materials and samples during construction, inspect preparations for concrete placement, and perform tests, inspections and procedures noted in accordance with ACI 301 Section 1.
  - a. The Testing Agency shall report items of nonconformance verbally to Owner's Representative immediately upon discovery. Final written reports shall be submitted within 7 days for each test or inspection to Owner's Representative.
  - b. The Testing Agency and their representatives are not authorized to revoke, alter, relax, enlarge, or release any requirement of contract documents nor to approve any portion of Work.

B. Testing Agencies that perform testing services on concrete materials shall meet ASTM C1077 requirements. Testing Agencies that perform testing services on reinforcing steel shall meet ASTM E 329. Concrete Field Tests required by Contractor or Owner shall be made by an ACI Concrete Field Testing Technician Grade 1 per ACI CPI or equivalent. Equivalent certification programs shall include requirements for written and performance examinations as stipulated in ACI publication CPI.

C. *Testing Agencies Qualifications [Q]*: Submit proposed testing agency qualification data for review.

1. Tests on hardened concrete in place.

## 1.7 DELIVERY, STORAGE AND HANDLING

A. Prevent, coating with earth, oil, or other material. Prevent bending or damaging reinforcement.

B. For handling coated reinforcement, use equipment having contact areas padded to avoid damaging coating. Lift bundles of coated reinforcement at multiple pick-up points to prevent bar-to-bar abrasion from sags in bundles. Do not drop or drag coated reinforcement. Store coated reinforcement on cribbing that will not damage coating.

- C. Store Welded Wire Fabric Reinforcing Mats to avoid contact with soils or surface moisture.

## PART 2 PRODUCTS

### 2.1 FORM MATERIALS AND ACCESORIES

- A. Form facing materials. Materials for form faces in contact with concrete shall meet the following requirements unless otherwise specified in Contract Documents.
  - 1. For rough form finish - No form-facing material is specified.
  - 2. For smooth form finish - Use plywood, tempered concrete form grade hardboard, metal, plastic, paper, or other acceptable materials capable of producing desired finish for form-facing materials. Form-facing materials shall produce smooth, uniform textures on concrete. Do not use form-facing materials with raised grain, torn surfaces, worn edges, patches, dents, or other defects that impairs texture of concrete surfaces.
- B. Formwork accessories. Use commercially manufactured accessories for formwork accessories that are partially or wholly embedded in concrete, including ties and hangers. Do not use non-fabricated wire form ties. Where shown in Contract Documents, use form ties with integral water barrier plates in walls.
- C. Formwork release agents. Use commercially manufactured formwork release agents with maximum 3 pounds per gallon VOC's that prevents formwork absorption of moisture, prevent bond with concrete, and not stain concrete surfaces.
  - 1. Form release coat shall be non-residual and shall be compatible with protective coatings and waterproofing scheduled for application to concrete surfaces. Coatings shall not prevent bonding later work to concrete.
- D. Circular concrete forms
  - 1. Provide circular concrete forms for column encasement and where shown. Forms shall be metal, glass-fiber reinforced plastic or fiber tubes that produce smooth surfaces without joint indications. Forms shall have sufficient wall thickness to resist wet concrete loads without deformation.
    - a. The Burke Company "BurkeTube Column Forms"
    - b. Alton Building Products "Sleektubes"
    - c. Sonoco Products Company "Sonotube Fiber Forms"
    - d. Symons Corporation "Springform"
    - e. Deslauriers Column Mould Company "Econ-O-Mold"

### 2.2 REINFORCING MATERIALS AND ACCESSORIES

- A. Reinforcing bars. Use deformed bars as reinforcement conforming to ASTM A 615, A 616, or A 617.
- B. Steel Wire: ASTM A 82 cold-drawn steel wire for concrete reinforcement.

- C. Welded Wire Reinforcement: ASTM A185 welded wire for concrete reinforcement.
  - 1. In flat sheets for wire 0.192 inches in diameter and larger.
  - 2. In rolls for wire less than 0.192 inches diameter.
- D. Deformed Welded Wire Reinforcement: ASTM A497 deformed welded wire for concrete reinforcement.
  - 1. In flat sheets for wire 0.192 inches in diameter and larger.
  - 2. In rolls for wire less than 0.192 inches in diameter.
- E. Wire reinforcement supports. Unless otherwise specified or permitted, use wire reinforcement supports complying with Class 1, maximum protection, or Class 2, moderate protection as shown in Chapter 3-Bar Supports of CRSI Manual of Standard Practice.

### 2.3 FIBER REINFORCEMENT

- A. Steel Fibers - Provide high strength, drawn wire, steel fibers conforming to ASTM A-820, Type I, with 120,000 pounds per square inch minimum yield, 2-inches minimum length, and minimum aspect ratio of 60. Use between 30 and 75 pounds of fibers per cubic yard.
  - 1. Supply Contractor with waterproof copies of instructional charts or tables clearly showing site-added admixture quantities and steel fiber bags to be added to various cubic yard quantities of concrete (full and partial loads) which may be delivered to site.
  - 2. Subject to compliance with requirements, products incorporated in Work are limited to following:
    - a. Bekaert Corporation "Dramix"
    - b. Fibercon International, Inc.
    - c. Novocon International, Inc. "Xorex"

### 2.4 CONCRETE MATERIALS

- A. Cementitious materials. Use cementitious materials that are of same brand and type and from same plant of manufacture as cementitious materials used in concrete represented by submitted field test records or used in trial mixtures.
  - 1. Cement. Cement materials shall conform to ASTM C 150 Type I, Type II or type III.
    - a. Use Type I for standard (28-day) strength concrete
    - b. Use Type II for mass concrete
    - c. Use Type III for high early (7-day) strength
  - 2. Fly ash pozzolonic mineral admixture conforming to ASTM C 618, Type C or F with 3 percent maximum carbon content. When fly ash is used, minimum quantity shall be 15 percent by weight of total cementitious materials, unless otherwise specified.
  - 3. Ground granulated blast furnace slag mineral admixture conforming to ASTM C 618.
  - 4. Silica fume mineral admixture conforming to ASTM C 1240.

- B. Aggregates. Aggregates shall conform to ASTM C 33, unless otherwise specified. When single size or combination of two or more sizes of coarse aggregates is used, final grading shall conform to grading requirements of ASTM C 33, unless otherwise specified or permitted.
1. Aggregates used in concrete shall be obtained from same sources and have same size ranges as aggregates used in concrete represented by submitted historical data or used in trial mixtures.
  2. Do not use aggregates that are classified as "moderate stain" or darker, when tested for staining.
  3. Maximum aggregate size for mass concrete shall be 2 inches. Furnish in two separate component sizes until mixing in concrete.
  4. Maximum aggregate size shall be 3/8 inch for:
    - a. Concrete steel stair pan fill.
    - b. Concrete floor topping, less than 2 inches thick.
    - c. Concrete pipe posts and column fill.
    - d. Concrete with under floor ducts.
  5. Materials
    - a. Coarse aggregates for normal weight concrete shall be crushed stone, crushed gravel, or washed gravel conforming to ASTM C 33, including Table 2 for Gradation and Table 3 for Deleterious Substances and Physical Property Requirements.
    - b. Coarse aggregate for lightweight aggregate for lightweight concrete shall be expanded shale, or clay coarse aggregate conforming to ASTM C 330. Use 100 percent lightweight coarse aggregate or lightweight mixture and normal weight aggregate to provide concrete that does not exceed maximum air-dry weight.
    - c. Fine aggregate shall be natural sand conforming to ASTM C 33.
- C. Water and Ice. Mixing water for concrete and water used to make ice shall meet requirements of ASTM C 94. Unless otherwise specified or permitted, use moderate heat of hydration Portland cement, blended hydraulic cement with moderate or low heat of hydration properties, or Portland cement with fly ash, pozzolan.
- D. Change of Materials. When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed, new field data or data from new trial mixtures or evidence that shows that change does not adversely affect relevant properties of concrete mix.
- E. Air-Entraining Admixture. Shall conform to ASTM C260, including certification that chloride was not added during manufacture.
1. Euclid Chemical Co. "Air Mix, AEA-92, or Air Mix 200"
  2. Grace Construction Products "Darex II AEA or Daravair 1000"
  3. Master Builders "Micro-Air"
  4. Sika Corp. "Sika AER"
- F. Water-Reducing Admixture. Shall conform to ASTM C494, Type A, with certification that chloride was not added during manufacture. admixture shall be used when ambient temperature is between 50 and 85 degF.
1. Euclid Chemical Co. "Eucon WR 75,"

2. Grace Construction Products “WRDA-20 or WRDA-82”
  3. Sika Corp. “Plastocrete 161 or Plastiment NS”
- G. Water-Reducing, Retarding Admixture. Shall conform to ASTM C494, Type D, with certification that chloride was not added during manufacture. Admixture shall be used when
1. Ambient temperature at time of placement is above 85degF.
  2. Necessary to prevent cold joints because placed concrete quantity is large.
  3. Necessary to offset high concrete temperature effects or temperature rises.
  4. Mass concrete is shown.
    - a. Euclid Chemical Co. “Eucon Retarder-75”
    - b. Grace Construction Products “Daratard-17”
    - c. Master Builders “Rheobuild”(reduced dosage)
- H. Accelerating Admixture. Shall conform to ASTM C494, Type C or E, with certification that admixture is non-chloride and non-corrosive. Use in slabs less than 8 inches thick when ambient air temperature is below 50 degF and when required by finishing operations,
1. Euclid Chemical Co. “Accelguard 80”
  2. Grace Construction Products “Daraset”
  3. Master Builders “Pozzutec 20”
- I. Water reducing admixtures termed "mid-range" conforming to ASTM C 494 Type A or Type F may be used but only with prior Registered Design Professional approval
1. Grace Construction Products "Daracem 50 & 55".
  2. Master Builders, Inc. "PolyHeed 997".
  3. Euclid Chemical Company "Eucon MR”.
- J. High-range water-reducing admixture (superplasticizer) shall conform to ASTM C 494, Type F or G. High-range water reducing admixture may be used for:
1. Concrete that is pumped.
  2. Water-tightness.
  3. Water-cement ratios below 0.45.
    - a. Euclid Chemical Company "Eucon 37".
    - b. Grace Construction Products "Daracem-100".
    - c. Master Builders, Inc. "Rheobuild 1000, or Conchem SPN,”
- K. Water Proofing Admixture
1. Crystalline Water Proofing Admixture for concrete where indicated on drawings. Dosage and application per manufacturers recommendations.
    - a. XYPEX Admixture – XYPE Chemical Corporatin.

## 2.5 FINISH MATERIALS

- A. Non-Slip Finish. Crushed natural emery ore containing not less than 50 percent aluminum oxide and not less than 21 percent ferric oxide with specific gravity of 3.5, absorption of 0.6 and Mohr hardness of 8 to 9, uniformly graded within 3/8 inch to fine sieve limits. Aggregates shall be factory packaged from one source and shall not be blended.
1. Dayton Superior “Emery-Tuff”

2. Sternson "Emeri-Crete"
3. L&M Construction Chemicals "Emery Plate II"

B. Liquid Hardeners

1. Curecrete Chemical Company Inc. "Ashford Formula"
2. Euclid Chemical Company "Euco Diamond Hard or Surfhard"
3. Dayton Superior "J-17 Day-Chem Sure Hard"
4. Sonneborn Building Products "Sonneborn Kure-N-Harden"
5. W.R. Meadows, Inc. "Liquidhard"
6. L & M Construction Chemicals "Fluohard"
7. Sonneborn Building Products "Lapidolith"

## 2.6 CURING MATERIALS

- A. Absorptive cover. AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing at least 9 ounces per square yard, or other Registered Design Professional approved alternate.

B. Geosynthetic Cloth for Wet Curings.

1. Terrafix "240R"
2. Mirafi

- C. Waterproof sheet materials. Use waterproof sheet materials conforming to ASTM C 171. Materials shall be waterproof paper, polyethelene firm or burlap-polyethelene material with moisture loss of no more than 0.06 pounds per square foot when tested in accordance with ASTM C 156.

1. Minimum 4 mils thick, complying with maximum allowable moisture loss requirements of ASTM C156.

- D. Water-based acrylic membrane curing compounds. Use water based acrylic membrane curing compound conforming to ASTM C 309, Type I, Class B. Curing compounds shall have maximum 3 pounds per gallon VOC's, minimum solids content of 30 percent and moisture loss of no more than 0.06 pounds per square foot when tested in accordance with ASTM C 156.

1. Dayton Superior "Safe Cure & Seal (J-19)"
2. Euclid Chemical Company "Super Aqua-Cure VOX"
3. L&M Construction Chemicals "Dress & Seal WB 30"
4. Sonneborn Building Products "Kure 1315"
5. Master Builders, Inc. "MasterKure 200W"

E. Non-residual cure.

1. Dayton Superior "J-13 Day-Chem Sil Cure"
2. Euclid Chemical Company "Eucosil"
3. L & M Construction Chemicals "L & M Cure"
4. Sonneborn Building Products "Sonneborn Sonosil"
5. W.R. Meadows, Inc. "Med-Cure"

F. Dissipating resin type cure.

1. Dayton Superior "J-11 Day-Chem Rez Cure"

2. Euclid Chemical Company “KUREZ DR VOX”
3. L & M Construction Chemicals “L & M Cure R”
4. W.R. Meadows, Inc. “1100 Clear”

## 2.7 RELATED MATERIALS

- A. Epoxy joint sealant for regular sawcut joints shall be cold-applied, epoxy compound with minimum Shore D hardness of 50.
  1. Dayton Superior “J-52 Poxy-Fil”
  2. Euclid Chemical Company “Euco 700”
  3. Metzger McGuire Company “MM-80”
  4. W.R. Meadows, Inc. “Sealtight Rezi-Weld Flex”
  5. Master Builders “Masterfil 300i”
- B. Expansion joint filler.
  1. Premolded expansion joint filler conforming to ASTM D 994, D 1751, or D 1752.
    - a. W.R. Meadows, Inc. "Ceramar"
    - b. Sonneborn “Expansion Joint Filler” Sonoflex F
- C. Expanding foam joint filler.
  1. Provide in compressed thickness as recommended by manufacturer to fill and seal joints.
    - a. Emseal Joint Systems, Ltd. "Emseal 20H".
    - b. Illbruck/USA "Will-Seal".
- D. Expansion joint sealant.
  1. Cold-applied, coal-tar-modified urethane compound. Use primer as recommended by sealant manufacturer. Use same material in vertical joints, as horizontal joint continuation, unless otherwise noted. However, use non-sag vertical grade compound.
    - a. Elastomeric joint sealant over premolded joint filler in interior concrete and for sawcuts in suspended floor slabs shall be cold-applied 2-component polyurethane modified:
      - 1) Euclid Chemical Company “Eucolastic II”
      - 2) Sika Chemical Company “Sikaflex 2C NS/SL”
      - 3) W.R. Meadows “sealtight Pourthane”
      - 4) Tremco “Vulkem 245”
      - 5) Sonneborn “Sonolastic SL2”
    - b. Elastomeric joint sealant over premolded joint filler in exterior concrete shall be cold applied, coal tar modified urethane compound. Use primer recommended by sealant manufacturer:
      - 1) W.R. Meadows, Inc. "Sealtight Gardox".
      - 2) Pecora Corporation "Urexpan NR-300".

- E. Waterstops. Materials shall conform to requirements of CRD C 513 for rubber waterstop or CRD C 572 for polyvinylchloride waterstop. Make splices in waterstops and use molded pieces as recommended by manufacturer.
1. Flexible-strip bentonite waterstop. Provide 1 inch by  $\frac{3}{4}$  inch size, placed on interior side of outermost reinforcing and in other locations as shown, for concrete provide 6 inches thick or less, use smaller size strip to prevent concrete blowout:
    - a. Colloid Environmental Technologies Company “Waterstop RX”
    - b. Tremco “Superstop”
  2. Vinyl or SBR flat dumbbell waterstop. Provide 6-inch wide size throughout except at expansion joints use 9-inch wide size with hollow, tubular center. Provide in joints except where flexible bentonite type is shown or specified.
    - a. Greenstreak Plastic Products
    - b. Vinylex Corporation
    - c. W.R. Meadows, Inc.
- F. Chemical Bonding Compounds.
1. Provide where shown for concrete exposed to weather and for interior use where bonded surface is subject to water, steam or vibration.
    - a. Dayton Superior “Resi-Bond J58”
    - b. Master Builders, Inc. “Concresive Liquid LPL or Concresive 1090”
    - c. Euclid Chemical Company “Epoxy No. 452”
    - d. Sika Corporation “Sikadur 32 Hi-Mod”
    - e. W.R. Meadows, Inc. “Rezi-Weld 1000”
  2. Bonding Agents for interior use not described above in foregoing paragraph.
    - a. Dayton Superior “J-41 Superior Concrete Bonder”
    - b. Euclid Chemical Company “Euco Weld”:
    - c. L&M Construction Chemicals “Everweld”
- G. Vapor Retarder.
1. Flexible, preformed sheet membrane having water-vapor permeance rate of no greater than 0.012 perms when tested in accordance with ASTM E 154, Section 7, and otherwise conforming to ASTM E 1745, Class B or higher. Vapor barrier shall be no less than 10 mils thick.
    - a. Stego Industries, LLC “Stego Wrap Vapor Barrier (10 mil)”
    - b. Reef Industries “Griffolyn Vaporguard”
- H. Evaporation Control Compound.
1. Molecular film-forming compound applied to exposed concrete surfaces for temporary protection from rapid moisture loss.
    - a. Conspec Marketing and Manufacturing Company “Aquafilm”
    - b. Euclid Chemical Company “Eucobar”
    - c. L&M Construction Chemicals “E-Con”
    - d. Master Builders, Inc. “Confilm”

I. Corrosion and Chemical Resistant Coating

1. Two component 100% Solids, polymer system coating for corrosion and chemical resistance, where shown on drawings. Scrape sandblast or scarify and prepare all surfaces per manufacturer's instructions. Apply primer and final coating per manufacturers recommendations.
  - a. Chemclad P42 Primer and Chemclad SC Coating system by ENECON or approved equal.
2. All products shall be applied by manufacturer authorized application personnel.
3. Submit applicable procedure, safety plan, per General Conditions GC-7 and GC-8 and obtain approval.

2.8 PROPORTIONING AND DESIGNING CONCRETE MIXES

- A. Prepare mix designs for each type and strength of concrete as shown in Table 1 and 2 below or in Contract Documents. Use proportioning on basis of previous field experience or trial mixtures, in accordance with ACI 301 Section 4. Proportion solid materials by weight, not by volume. Liquids may be proportioned by weight or volume. Proportioning based on empirical data is not permitted.

<b>Table 1</b>			
<b>USE, STRENGTH, AND AIR REQUIREMENTS</b>			
Location	Typical Uses	Strength, psi	Air Entrainment Required
Supporting Structure	Interior Beams, Columns	4,000	No
Supporting Superstructure	Exterior Beams, Columns	4,000	Yes
Weight Bearing Slabs	Interior Floor slabs, Slabs on Grade	4,000	No
Exposed Top Slabs	Exterior Pads, Tank Tops	4,000	Yes
Sub Grade	Spread Footings, Grade Beams	3,500	No
Sub Grade	Exposed Grade Walls	3,500	Yes
Excavation and Fills	Fill, Pipe Encasement	2,000	No
Pit Walls		4,000	No
Pit Slabs		4,000	No
Mass Concrete		3,000	No

- B. Proportion and design mixes so that minimum compressive strength, minimum cement factor and maximum slump is as follows:

<b>Table 2</b>			
<b>REQUIRED STRENGTHS, CEMENT FACTOR, AND SLUMPS</b>			
<b>Type</b>	<b>Compressive Strength (28 days, psi)</b>	<b>Cement Factor (lbs./c.y.)</b>	<b>Slump**</b>
Standard, Normal Wt.	4000 min.	560 min.	4"
Floor Slab	4000 min.	560 min.	4"
Air Entrained, Normal Wt.	4000 min.	560 min.	4"
Standard, Normal Wt.	3500 min.	530 min.	4"
Air Entrained, Normal Wt.	3500 min.	530 min.	4"
Concrete Fill and Mud Mat	2000 min.	350 min.	4"

\*\* Slump shall be 4-inches maximum at point of placement unless specified or permitted. Slump levels shown in table above may be increased to 8 inches plus or minus 1 inch by using specified high-range water-reducing admixture (superplasticizer) use. Installing Contractor shall be responsible for adding high-range water-reducing admixture to increase slump and improve workability.

- C. Mix design shall incorporate fly ash up to 20% or ground granulated blast furnace slag up to 60%.
- D. Proportion and design mixes for normal weight concrete (except slabs on grade) that results in air contents from 2 to 4 percent. Concrete where identified in Table 1 or exposed to exterior conditions subject to freezing and thawing; severe weathering; or deicers shall be air entrained having an air content of 6 percent plus or minus 1 percent.
- E. Proportion and design mixes that result in fresh concrete with adequate workability and proper consistency to be readily worked into forms and around reinforcing without segregation or excessive bleeding under conditions of placement.
- F. Proportion and design mixes that result in hardened concrete with total water soluble chloride ion content at 28 to 42 days as noted in ACI 301 Section 4 when tested in accordance with ASTM C 1218. Admixtures shall contain no added chlorides.
- G. Maintain maximum water/cement ratios for the following conditions:
1. Concrete subject to freezing and thawing – 0.50
  2. Concrete subject to deicers or required to be watertight – 0.45

3. Reinforced concrete subjected to brackish water or salt spray – 0.40
4. Floor slabs – 0.45 to 0.48

## PART 3 EXECUTION

### 3.1 SUBGRADE PREPARATION

- A. Recompact subgrade using methods, materials, equipment and procedures specified in Section 02200 – Earth Work before placing reinforcing steel. Place compacted base material over prepared subgrade as specified.
- B. Provide protection course consisting of lean concrete fill or compacted coarse aggregate fill to protect subgrade from damage attributable to water or construction operations.
- C. Place vapor retarders in location as specified.

### 3.2 FORMWORK

- A. Unless otherwise specified in Contract Documents, construct formwork so concrete surfaces conform to tolerance limits of ACI 117. class of surface for offset between adjacent pieces of formwork facing material shall be Class A for surfaces permanently exposed to public view and Class C for surfaces that are permanently concealed, unless otherwise specified.
- B. Use forms whenever necessary to confine concrete and shape it to required dimensions. Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied, until concrete structure is capable of supporting applied loads. Also, meet local building code requirements for allowable stresses and for other loads, including live loads and wind loads. Provide formwork so as not to damage existing structures.
- C. Clean interior surfaces of forms and interior form accessories of accumulated mortar or grout and other foreign material before each use.
- D. Earth cuts shall not be used as forms for surfaces unless otherwise noted or approved by Registered Design Professional.
- E. Construct and maintain formwork so completed concrete members and structures are within specified tolerance for size, shape, alignment, elevation, location, plumbness, and levelness. Camber formwork to compensate for anticipated deflections in formwork before concrete hardens or provide positive means of adjustment by wedges or jacks. If wood forms are used, provide means of adjustment to counteract swelling of forms where necessary.
- F. For architectural concrete surfaces, except those to receive applied or exposed aggregate finishes, provide formwork that produces surfaces that require little dressing to arrive at true surfaces.

- G. For concrete surfaces with textured or exposed aggregate finishes, use formwork materials and construction methods to duplicate mockup panels.
- H. Provide temporary access openings in forms for cleaning and inspection where interior areas of formwork would otherwise be inaccessible immediately before concrete placement.
- I. Position and support expansion joint materials, water stop s, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
- J. Cover surfaces of formwork with an acceptable material that prevents bonding with concrete. Field-applied formwork release agents or factory-applied liners may be used. If formwork release agents are used, apply to surfaces of formwork in accordance with manufacturer's recommendations before placing reinforcing steel. Do not allow formwork release agent to puddle in forms. Do not allow formwork release agent to contact reinforcing steel or hardened concrete against which fresh concrete is placed.
- K. Place 3/4-inch minimum chamfer strips in corners of formwork to produce beveled edges on permanently exposed surfaces unless otherwise specified. Do not bevel re-entrant corners or edges of formed joints of concrete unless specified in Contract Documents.
- L. Fabricate form ties so ends or end fasteners can be removed with minimum spalling at faces of concrete.
- M. Design and engineering of formwork shall be responsibility of Contractor. When required by Contract Documents, design calculations for formwork and formwork drawings shall be sealed by a Professional Engineer licensed in state where Work is done.
- N. Maximum deflection of facing materials reflected on concrete surfaces exposed to public view shall be 1/240 of span between structural members of formwork.
- O. When finishing is required, remove forms as soon as removal operations will not damage concrete.
- P. Unless otherwise specified, leave formwork and shoring in place to support weight of concrete in beams, slabs, and in-place structural members until concrete has reached specified compressive strength. If lower compressive strength is proposed for removal of formwork and shoring, submit detailed plans for review and acceptance. When shores and other vertical supports are arranged to allow form-facing material to be removed without loosening or disturbing shores and supports, facing material may be removed at an earlier age unless otherwise specified.
- Q. When removal of formwork or reshoring is based on concrete reaching specified compressive strengths, concrete shall be presumed to have reached this strength when test cylinders, field cured same as concrete they represent, have reached compressive strength specified for removal of formwork or reshoring. Mold cylinders in accordance with ASTM C 31, and cure them

under same conditions for moisture and temperature as used for concrete they represent. Test cylinders in accordance with ASTM C 39.

### 3.3 STEEL REINFORCEMENT

- A. When concrete is placed, reinforcement shall be free of materials deleterious to bond. Reinforcement with rust, mill scale, or combination of both will be considered satisfactory provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.
- B. Place, support, and fasten reinforcement as shown on project drawings. Do not exceed placing tolerances specified in ACI 117 before concrete is placed. Placing tolerances shall not reduce cover requirements except as specified in ACI 117.
- C. Do not cut reinforcing in field without approval from Registered Design Professional.
- D. Provide minimum concrete cover for reinforcement in accordance with ACI 301 unless otherwise noted.
- E. For bundled bars, minimum concrete cover shall be equal to equivalent diameter of bundle but need not be greater than 2 inches except minimum cover shall not be less than specified in ACI 301. equivalent diameter of bundle shall be based on single bar of diameter derived from equivalent total area. Tolerances on minimum concrete cover shall meet requirements of ACI 117.
- F. Reinforcement supported from ground or mud mat shall be placed on precast concrete reinforcement supports, or manufactured metal or plastic supports. Chair legs shall bear on continuous sand plates.
- G. Reinforcement supported from formwork shall rest on bar supports made of metal or plastic. Masonry, concrete, tile, or wood reinforcement supports on formwork are not permitted. Furnish plastic tips on chair legs at exposed ceilings.
- H. Do not use mechanical connections for reinforcing splices unless approved by Registered Design Professional.
- I. Bend or straighten reinforcement partially embedded in concrete in accordance with the following procedures. Reinforcing bar sizes No. 3 through No. 5 may be bent cold first time provided reinforcing bar temperature is above 32 deg F. For other bar sizes, preheat reinforcing bars before bending.
  - 1. Preheating - Apply heat by any method that does not harm reinforcing bar material or cause damage to concrete. Preheat length of reinforcing bar equal to at least five bar diameters in each direction from center of bend but do not extend preheating below surface of concrete. Do not allow temperature of reinforcing bar at concrete interface to exceed 500 deg F.
    - a. The preheat temperature of reinforcing bar shall be between 1100 to 1200 deg F.

- b. Maintain preheat temperature until bending or straightening is complete.
  - c. Measure preheat temperature by temperature measurement crayons, contact pyrometer, or other acceptable methods.
  - d. Do not artificially cool heated reinforcing bars until temperature of bar is less than 600 deg F.
2. Minimum bend diameters shall conform to requirements of ACI 301.

### 3.4 EMBEDDED ITEMS

#### A. Waterstops

1. Locate waterstops in joints below grade and in locations as shown.. Use pieces of premolded waterstop with maximum practicable length to hold number of end joints to a minimum. Make joints in waterstops in accordance with manufacturer's recommendations. Ensure that joints develop effective water tightness equal to continuous waterstop material, permanently develop not less than 50 percent of mechanical strength of parent section and permanently retain flexibility.

### 3.5 JOINTS

- A. Locate and install construction and control joints where noted on drawings or approved by Registered Design Professional.
- B. Locate and form construction joints that least impair strength of structure and meet requirements of ACI 301. Unless otherwise specified or permitted, locate and detail formed construction joints to the following requirements:
  1. Locate construction joints within middle third of spans of slabs, beams, and girders. When beams intersects a girder at this point, offset joints in girders a distance equal to or greater than twice width of beam.
  2. Locate joints in walls and columns at underside of floors, slabs, beams, or girders and at tops of footings or floor slabs.
  3. Make joints perpendicular to main reinforcement.
- C. Continue reinforcing through construction joints, unless otherwise noted.

### 3.6 CONCRETE MIXING AND DELIVERY

- A. Ready-mixed and site-produced concrete suppliers—,unless otherwise specified, shall measure, batch, deliver, and mix concrete materials and concrete in conformance with ASTM C 94.
- B. When concrete made by volumetric batching and continuous mixing is acceptable, it shall conform to requirements of ASTM C 685 and shall satisfy requirements of Contract Documents.
- C. Concrete shall have specified characteristics in freshly mixed state at point of placing. Ready mixed concrete may be retempered at site using not more than the quantity of water held back at batch plant. Water held back at initial batching shall be distinctly shown on concrete delivery ticket. Only that additional quantity of water shall be permitted for addition at delivery site. Do

not add water to concrete delivered in equipment not acceptable for mixing. Do not retemper site mixed concrete.

- D. Concrete Mixes that include high-range water reducing admixtures or steel fiber reinforcing, add admixture or steel fiber reinforcing on site after Testing Agency verifies initial slump.
- E. Only concrete mix design with admixtures and their combinations, submitted and approved, shall be used. Substitutions are not permitted.

### 3.7 CONCRETE PLACEMENT

- A. Do not place concrete before receiving notification from Owner's Representative that embedded items required in particular placement have been installed, inspected, and approved.
- B. Do not place any concrete without approval of concrete mix from Registered Design Professional.
- C. Do not place any slabs-on-grade, pits, or trenches before receiving notification from Owner's Representative that required subgrade construction has been installed, inspected, and approved.
- D. Do not place concrete during hot or cold weather without procedures approved by Registered Design Professional and Testing Agency verification of availability of equipment and materials necessary to fully implement procedures.
- E. Do not place concrete during rain, sleet, or snow without adequate protection and approval of Registered Design Professional.
- F. When high ambient temperatures necessitate protection of concrete immediately after placing or finishing, make provisions before concrete placement for windbreaks, shading, fogging, sprinkling, ponding, or wet covering.
- G. During hot weather temperature of concrete as placed shall not exceed 90 degrees F unless otherwise permitted. Loss of slump, flash set, or cold joints due to temperature of concrete as placed will not be acceptable. When temperature of concrete exceeds 90 deg F, obtain approval of proposed precautionary measures from Registered Design Professional. When temperature of steel reinforcement, embedments, or forms is greater than 120 deg F, fog steel reinforcement, embedments, and forms with water immediately before placing concrete. Remove standing water before placing concrete.
- H. During cold weather concrete temperature and ambient temperature shall meet minimum temperature requirements as noted in Part 2 "Proportioning and Designing Concrete Mixes". Make provisions before concrete placement to maintain temperature of concrete. Use heating, covering, or other means adequate to maintain required temperature without overheating or drying of concrete due to concentration of heat.

- I. Do not place concrete before removing forms from previous placements that would prohibit new concrete from being placed directly against adjacent hardened concrete or specified joint material.
- J. Convey concrete from mixer to place of final deposit rapidly by methods that prevent segregation or loss of ingredients and ensures required quality of concrete. Do not use aluminum pipes or chutes. Use acceptable conveying equipment of size and design that prevents cold joints from occurring. Clean conveying equipment before each placement.
- K. Deposit concrete continuously in one layer or in layers to have fresh concrete deposited on in-place concrete that is still plastic. Do not deposit fresh concrete on concrete that has hardened sufficiently to cause formation of seams or planes of weakness.
- L. Deposit concrete as near as possible to its final location and towards concrete in place to avoid segregation. Do not use vibrators to transport concrete.
- M. Concrete free fall shall not exceed 10 feet for concrete containing high-range water reducing admixture (superplasticizer) or 5 feet for other concrete. Provide elephant trunks or tremies or other placing equipment approved by Registered Design Professional, or provide openings in sides of forms to limit free dropping to above requirements.
- N. Consolidate placed concrete with internal vibrating equipment supplemented with hand-spading, rodding, or tamping. Use vibrators that are as large and powerful as possible without affecting proper execution of Work. Thoroughly work concrete around reinforcement and embedded items and into corners of forms, eliminating air and stone pockets that may cause honeycombing, pitting, or planes of weakness. Do not use vibrators to move concrete within forms.

### 3.8 FINISHING FORMED SURFACES

- A. After removal of forms provide formed surface one or more of finishes with following:
  - 1. Rough form finish: For surfaces that are concealed in finish work.
  - 2. Smooth form finish: For surfaces that are exposed in finish work. Examples are exposed foundations, equipment bases, and interior curbs.
  - 3. Smooth rubbed finish: For interior surfaces that are exposed in finish work. Produce finish within 24 hours of form removal.
  - 4. Grout Cleaned finish: For interior surfaces that are exposed in finish work.
  - 5. Light sand blast finish: For exterior surfaces that are exposed in finish work. Provide smooth form finish then lightly sand blast finish to provide uniform texture but not to expose aggregate.
  - 6. Tops of grade walls and retaining wall shall be troweled smooth.
- B. Rough Form Finish: Patch tie holes and defects. Chip or rub off fins exceeding ½ inch in height. Remainder of surfaces shall be left with texture imparted by forms.
- C. Smooth Form Finish: Patch tie holes and defects. Remove fins exceeding 1/8 inch in height.

- D. Smooth Rubbed Finish: Remove forms and perform necessary patching. Produce finish on newly hardened concrete no later than day following formwork removal. Wet surface and rub it with carborundum brick or other abrasive until uniform color and texture are produced. Use no cement grout other than cement paste drawn from concrete itself by rubbing process.
- E. Grout Cleaned Finish: Begin cleaning operations after surfaces to be cleaned are completed and accessible. Do not clean surfaces as work progresses. Wet surface and apply grout consisting of one part Portland cement and one and one-half parts fine sand with enough water to produce consistency of thick paint. Add white cement as needed to match color of surrounding concrete. Scrub grout into voids, and remove excess grout. When grout whitens, rub surface and keep surface damp for 36 hours afterward.

### 3.9 FINISHING UNFORMED SURFACES

- A. Refer to Section 03315 Slabs-on-Grade for finishing surface requirements for slab on grade.
- B. Finish concrete surfaces other than slabs on grade in accordance with one of the following finishing methods or:
  1. As designated in Contract Documents.
  2. Or as required by specified manufacturer's finishing material.

LOCATION	FINISHING METHOD
Foundations above finish floor	Trowel
Foundations below finish floor	Float
Elevated supported concrete floor for Mechanical and Electrical Rooms	Trowel
Stair Treads and landings	Non slip
Interior Truckwells and Railroad trackwells	Trowel
Pits and Trenches	Trowel
Exterior Ramps and sidewalks	Float /Broom near building entrance

- C. Place concrete at rate that allows spreading, straightedging, and darbying or bullfloating before bleed water appears. Strike smooth top of walls, buttresses, horizontal offsets, and other similar unformed surfaces and float them to textures consistent with finish of adjacent formed surface.
- D. Scratched finish - Place, consolidate, strike off, and level concrete, eliminating high spots and low spots. Roughen surface with stiff brushes or rakes before final set. Produce finish that meets conventional bullfloated tolerance requirements of ACI 117.
- E. Floated finish - Place, consolidate, strike off, and level concrete, eliminating high spots and low spots. Do not work concrete further until it is ready for floating. Begin floating with hand floats, bladed power floats equipped with float shoes, or powered disk floats when bleed water sheen has disappeared and surface has stiffened sufficiently to permit operation. Produce finish that meets conventional straightedge tolerance requirements of ACI 117, and then refloat slab immediately to uniform texture.

- F. Troweled finish - Float concrete surface, then power-trowel surface. Hand-trowel surface smooth and free of trowel marks. Continue hand-troweling until ringing sound is produced as floor is troweled. Tolerance for concrete floors shall be conventional straightedge tolerance in accordance with ACI 117, unless otherwise specified.
- G. Broom or belt finish - Immediately after concrete has received floated finish, give concrete surface coarse transverse scored texture by drawing broom or burlap belt across surface.
- H. Where nonslip finish is required, give surface broom or belt finish or dry-shake application of crushed aluminum oxide or other abrasive particles, as specified in Contract Documents. Rate of application shall be not less than 25 pounds per 100 square feet.

### 3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Concrete Fill
  - 1. Fill in holes and openings left in concrete structures, unless otherwise shown, 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.
  - 2. Concrete Fill for Column Washes - Fill in space inside column isolation joints after column is erected. Fill can be placed either before or after surrounding slab is placed.
  - 3. Concrete Fill for Steel Pan Stairs - Provide concrete fill for steel pan stairs tread, landings and associated items. Cast-in inserts and accessories as shown. Screed, tamp and trowel finish concrete surfaces.
- B. Curbs - Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to hard, dense finish with corners, intersections and terminations slightly rounded or chamfered.
- C. Equipment Bases and Foundations - Provide machine and equipment bases and foundations as shown. Set anchor rods for machines and equipment at elevations complying with diagrams or templates of manufacturer furnishing machines or equipment.

### 3.11 CURING AND PROTECTION

- A. Refer to Section 03315 – Slabs-on-Grade for curing and protecting slab on grade.
- B. Protect concrete from mechanical injury.
  - 1. Do not allow rain water to increase mixing water or damage surface finish. Provide protection from snow, sleet, hail, and freezing rain.
  - 2. Protect finished surfaces from damage by construction equipment, materials, or methods or by implementation of curing procedures.
  - 3. During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.
- C. Begin curing immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury. Protect concrete during curing period so that

concrete temperature does not fall below requirements as noted in ACI 301 Section 4. Maintain concrete with minimal moisture loss at nearly constant temperatures for periods necessary for hydration of cement and hardening of concrete.

- D. Cold weather: When mean daily outdoor temperature is less than 40 degF, temperature of concrete shall be maintained between 50 and 70 degF for required curing period. When necessary, arrange for heating, covering, insulation, or housing concrete work before placement. Arrangements shall be adequate to maintain required temperature without injury as a result of concentration of heat. Combustion heaters shall not be used during first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gasses which contain carbon dioxide.
- E. Hot weather: When necessary to maintain evaporation control, make provision for windbreaks, shading, fog spraying, sprinkling, ponding, wet covering with light colored materials, or moisture evaporative retardants. Protective measures shall be installed as quickly as concrete hardening and finishing operations allow.
- F. Curing concrete shall be continued for at least seven days:
  - 1. If tests are made of cylinders kept adjacent to structure and cured by same methods, moisture retention measures may be concluded when average test compressive strength has reached 70 percent of specified compressive strength  $f'_c$ .
  - 2. Moisture retention measures may also be concluded when temperature of concrete is maintained at least at 50 degF for same length of time that laboratory-cured cylinders, representative of concrete-in-place, require to achieve 85 percent of compressive strength,  $f'_c$ .
  - 3. If one curing procedure is used initially, it may be replaced by other procedures any time after concrete is 1 day old provided concrete is not permitted to become surface dry during transition.
- G. After placing and finishing concrete use one or more of the following methods to preserve moisture in concrete:
  - 1. Ponding or continuous sprinkling.
  - 2. Application of absorptive mats of fabric kept continuously wet.
  - 3. Continuous application of mist spray.
  - 4. Application of waterproof sheet materials conforming to ASTM C 171.
  - 5. Application of acceptable specified curing compound conforming to ASTM C 309 and in accordance with manufacturer's guidelines.

### 3.12 REPAIR OF SURFACE DEFECTS

- A. General - Repair tie holes and surface defects immediately after formwork removal. Where concrete surface will be textured by sandblasting or bush hammering, repair surface defects before texturing.

- B. Repair of tie holes - Plug tie holes except where stainless steel ties, non-corroding ties, or acceptably coated ties are used.
  - 1. When Portland cement patching mortar is face used for plugging, clean and dampen tie holes before applying mortar.
  - 2. When other materials are used, apply them in accordance with manufacturer's recommendations.
  
- C. Repair of surface defects other than tie holes.
  - 1. Outline honeycombed or defective concrete with 1/2 to 3/4 in. deep saw cut and remove concrete down to sound concrete. When chipping is necessary, leave chipped edges perpendicular to surface or slightly undercut. Do not feather edges.
  - 2. Dampen area to be patched, plus another 6 in. around patch area perimeter.
  - 3. Thoroughly brush grout into surface. When bond coat begins to lose water sheen, apply patching mortar and thoroughly consolidate mortar into place.
  - 4. Strike off mortar, leaving patch slightly higher than surrounding surface to permit initial shrinkage.
  - 5. Leave patch undisturbed for 1 hr before finishing. Keep patch damp for 7 days.
  
- D. Preparation of bonding grout - For bonding grout, mix roughly one part cement and one part fine sand with water to consistency of thick cream.
  
- E. Site-mixed Portland cement repair mortar - Mix repair mortar using same materials as concrete to be patched with no coarse aggregate. Do not use more than one part cement to two and one-half parts sand by damp loose volume.
  
- F. For repairs in exposed concrete, make trial batch and check color compatibility of repair material with surrounding concrete. When repair is too dark, substitute white Portland cement for part of gray cement to produce color closely matching surrounding concrete. Use repair mortar at stiff consistency with no more mixing water than is necessary for handling and placing. Mix repair mortar and manipulate mortar with trowel without adding water. Use mortar at stiff consistency.
  
- G. Remove stains, rust, efflorescence, and surface standard face deposits considered objectionable by Owner's Representative.

### 3.13 REPAIR RESTORATION

- A. Repair Method For Defective Work: Make structural repairs only after prior approval by Registered Design Professional. Submit repair material specification, manufacturer's data and preparation and application procedure.

### 3.14 FIELD QUALITY CONTROL

- A. Responsibilities of Owner's Testing Agency related to on site Work includes, but is not limited to:
  - 1. Obtain samples of freshly mixed concrete for tests in accordance with ASTM C 172.

2. Obtain at least one composite sample for each 100 cubic yards, or fraction thereof, of each concrete mixture placed in any one day.
  3. Conduct strength tests of concrete during construction in accordance with the following procedures:
    - a. Mold and cure four cylinders from each sample in accordance with ASTM C 31. Record any deviations from ASTM requirements in test report.
    - b. Test cylinders in accordance with ASTM C 39. Test one specimen at 7 days for information, and two specimens at 28 days for acceptance, unless otherwise specified. Hold remaining cylinder for later testing.
  4. Determining slump in accordance with ASTM C143, once for each set of strength test specimens and whenever concrete consistency appears to vary.
  5. Determining unit weight of lightweight concrete in accordance with ASTM C567, once for each set of strength test specimens.
  6. Determining air content of concrete in accordance with ASTM C173 or ASTM C231, once for each set of strength test specimens.
  7. Checking temperature of fresh concrete in accordance with ASTM C1064, once for each set of strength test specimens and hourly when ambient air temperature is not within range of 40 to 80 degrees F.
- B. Field-cured test cylinders, requested and paid for by Contractor, shall be molded at same time and from same samples as laboratory-cured test cylinders.
- C. Strength tests, requested by Contractor in order to obtain approval of early form removal or accelerated curing methods, shall be at Contractor's expense.
- D. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete, unless field-cured strength exceeds specified compressive strength by more than 500 pounds per square inch.

SUBMITTAL FORM  
CONCRETE MIX DESIGN

**Project INFORMATION**

Project:	
Location:	
General Contractor	
Concrete Contractor:	
Concrete Strength (Class)	
Use (Describe):	

<b>Type, Number, or Name of Concrete Mix</b>	
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**Method of Selecting Mix Proportions**

	Please Check One	Sct.
Based on Field Test Data	<input type="checkbox"/>	A.
Based on Trial Mix Data	<input type="checkbox"/>	B.

**Section A. Field Test Data**

See ACI 301 Paragraph 4.2.3.2

Number of Test Cylinder Results Included	
Average Compressive Strength of Test Results	psi
Standard Deviation of Compressive Strength	psi
Inclusive Dates of Field Tests	From <input style="width: 100px;" type="text"/> To <input style="width: 100px;" type="text"/>

**Section B. Trial Mix Test Data**

Age (Days)	Mix #1	Mix #2	Mix #3
7	psi	psi	psi
7	psi	psi	psi
28	psi	psi	psi
28	psi	psi	psi
28 Day Average	psi	psi	psi
Trial Mix Batching Date			

Summary of Selected Mix Characteristics

Name of Mix	
Strength	psi (28day)
Density	pcf
Air Content (Percent)	percent

Details of Selected Mix.

Materials	Source/Type	Specific Gravity	Weight/Pound	Absolute Volume, cu.ft.
Cement				
Fly Ash				
Microsilica				
Coarse Aggregate				
Fine Aggregate				
Water				
Other				
Total				27.0 Cu. Ft.

E. **Water/Cement Ratio (Pounds of water/ Pounds of Cement) = \_\_\_\_\_**  
 Slump \_\_\_\_\_ inches.

Required Backup Information	Please Check
Coarse Aggregate Gradation Report	
Fine Aggregate Gradation Report	
Admixture Compatibility Certification Letter.	

Proposed Admixtures	Manufacturer	Dosage oz./cwt.
Water Reducer (Type?)		
Air Entraining Agent		
Accelerator (Non Chloride)		
Other		

Slump with Water Reducer \_\_\_\_\_ inches.

**Submitted by:**

Name:	
Address:	
Phone Number:	
Fax Number	
Main Plant Location:	
Miles from Project Site	
Secondary Plant Location	
Miles from Project Site	
Date	

END OF SECTION

Revision History	
Date	Rev. No.
A	0
B	0
C	0
D	0
E	0
F	0
02-19-09	0

SM/djo [ST,AR,EL,CV]

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