

SECTION 03310 –STRUCTURAL CONCRETE AND EXTERIOR CONCRETE SLABS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place structural concrete for concrete structures and exterior slabs on grade as indicated on Drawings:
2. Aggregate base below slab.
3. Formwork, shoring, bracing, and anchorage.
4. Reinforcement and accessories.
5. Curing and finishing.
6. Grout, for setting and anchoring items in masonry and concrete.
7. Fast-setting concrete for Fuel Station pump island repair.

B. Related Requirements:

1. Section 01351 – Regulatory Compliance:
 - a. Disposal and removal of hazardous construction and universal waste.
 - b. Work practice control methods for airborne respirable dust.
2. Section 03314- Cast-In-Place Concrete Slabs. Concrete for interior slabs on ground except as specified above.
3. Section 05500 - Metal Fabrications: Other metal components cast into concrete.
4. Section 07900 - Joint Sealers: Expansion, Contraction, and Construction Joint Fillers and Sealants.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. Mandatory Provisions: In publications referred to herein, advisory provisions shall be considered to be mandatory.

C. American Association of State Highway and Transportation Officials (AASHTO): Standard Specification For Transportation Materials And Methods Of Sampling and Testing :

1. AASHTO T318 - Water Content of Freshly Mixed Concrete Using Microwave Oven Drying (Formerly AASHTO TP 23)

D. American Concrete Institute (ACI):

1. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
2. ACI 301 - Structural Concrete.
3. ACI 304.2R - Placing Concrete By Pumping Methods
4. ACI 305.1 – Specifications for Hot Weather Concreting.
5. ACI 306.1 - Cold Weather Concreting
6. ACI 308.1 - Standard Specification for Curing Concrete.
7. ACI 308R - Guide To Curing Concrete
8. ACI 347 - Guide To Formwork For Concrete
9. ACI SP66 - ACI Detailing Manual

E. ASTM International (ASTM):

1. ASTM A36 – Carbon Structural Steel.
2. ASTM A82 - Steel Wire, Plain, for Concrete Reinforcement.
3. ASTM A185 - Steel Welded Wire Fabric, Plain, for Carbon Steel, 60,000 PSI Tensile Strength Concrete Reinforcement.
4. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

5. ASTM A706 - Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
6. ASTM C33 - Concrete Aggregates.
7. ASTM C94 - Ready-Mixed Concrete.
8. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates
9. ASTM C150 - Portland cement.
10. ASTM C171 - Sheet Materials for Curing Concrete.
11. ASTM C260 - Air-Entraining Admixtures for Concrete.
12. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
13. ASTM C 403 - Time of Setting of Concrete Mixtures by Penetration Resistance
14. ASTM C494 - Chemical Admixtures for Concrete.
15. ASTM C618 - Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.
16. ASTM C989 - Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
17. ASTM C881 - Epoxy-Resin-Base Bonding Systems For Concrete
18. ASTM C1107 - Packaged Dry, Hydraulic-Cement Grout (Non-Shrink).
19. ASTM C 1218 - Water-Soluble Chloride in Mortar and Concrete.
20. ASTM C1315 - Liquid Membrane Forming Compounds Having Special Properties for Curing and Sealing Concrete.
21. ASTM D 98 - Calcium Chloride.
22. ASTM D 698 - Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb (2.49 Kg) Hammer and 12-in (305 mm) Drop.
23. ASTM D1241 - Materials for Soil-Aggregate Subbase, Base and Surface Courses
24. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
25. ASTM D1752: Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
26. ASTM D2628 - Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
27. ASTM D3575: Standard Test Methods for Flexible Cellular Materials Made From Olefin Polymers.
28. ASTM E96 - Water Vapor Transmission of Materials
29. ASTM E154 - Water Vapor Retarders Used in Contact with Earth under Concrete Slabs, on Walls or as Ground Cove.

F. American Welding Society (AWS):

1. AWS D1.4 - Structural Welding Code Reinforcing Steel.

G. Concrete Reinforcing Steel Institute (CRSI):

1. CRSI Manual of Standard Practice.
2. CRSI Placing Reinforcing Bars.

H. America Plywood Association (APA):

1. Grading Rules.

I. Department of Commerce (National Institute of Standards and Technology) – Product Standard (DOC):

1. DOC PS 1 - Construction and Industrial Plywood.

J. International Code Council, Inc.:

1. International Building Code (IBC).

K. National Concrete Ready-Mix Association:

1. NCRMA Inspection Standards

L. Occupational Safety and Health Administration (OSHA):

1. OSHA 01926.1153 Respirable Crystalline Silica.

1.3 ENVIRONMENTAL REQUIREMENTS

- A. Minimize dust emissions or provide equipment that suppresses dust.

1.4 SUBMITTALS

- A. Submittal Procedures: Unless otherwise specified herein, submit in accordance with procedures specified in Section 01330.
- B. Submit all submittals electronically in PDF format via email, unless otherwise specified, to Architect of Record.
- C. Submit submittal items required within this section concurrently. Do not submit submittals of this section together with submittals in section 03314 or any other section. Identify submittals explicitly in accordance with Procedures paragraphs in Section 01330.
- D. Sieve Analysis for Aggregate Base: Submit current sieve analysis report, sampled and tested within the last 60 days of submittal date, for aggregate base and choker material.
- E. Concrete Batch Plant Certifications: Submit name and address of the concrete supplier's batch plant and plant certification(s) by National Ready-Mix Concrete Association and/or State Department of Transportation.
- F. Shop Drawings: Submit shop drawing for field use. Do not use reproductions of Contract Documents as shop drawings. Prepare shop drawings in accordance with Part B, Chapter 3, ACI 315.
 - 1. Reinforcement:
 - a. Include concrete notes on shop drawings that relate to proper placing of reinforcing.
 - b. Show all reinforcing steel including dowels, embedded steel items, and anchor bolts .
 - c. Include number, grade, size, length, mark, location, splice lengths, and bending diagrams for reinforcing steel and related products.
 - 2. Placement Drawings:
 - a. Submit reinforcement placement drawings with bar lists. Include walls, grade beams, and plans of footings and slabs.
 - b. Show section cuts, details with piece marks, and control joint locations. Show reinforcing size, quantity, spacing, location, length, and required schedules.
- G. Samples: Materials as requested by the Engineer, including names, sources, and descriptions.
- H. Mix Design: Fill out and submit attached Concrete Mix Design Submittal Form. Submit each proposed mix design in accordance with ACI 301, Sections 3.9 "Proportioning on the basis of previous field experience or trial mixture", or 3.10 "Proportioning based on empirical data". Submit separate mix design for concrete to be placed by pumping in addition to the mix design for concrete to be placed directly from the truck chute. Submit mix design by e-mail to the Architect of Record. Include applicable information shown on the Mix Design Submittal Form and the following:
 - 1. Proportions of cementitious materials, fine and coarse aggregate, and water.
 - 2. Water-cementitious material ratio, 28-day compressive design strength, slump, and air content.
 - 3. Type of cement, fly ash, slag, and aggregate.
 - 4. Aggregate gradation.
 - 5. Type and dosage of admixtures.
 - 6. Special requirements for pumping.
 - 7. Range of ambient temperature and humidity for which design is valid.
 - 8. Special characteristics of mix which require precautions in mixing, placing, or finishing techniques to achieve finished product specified.
 - 9. Materials and methods for curing concrete.
- I. Submit Shop Drawings, and Quality Control Submittals within 5 working days of Contract date.

- J. Attachments to Concrete Mix Design: Submit the following as attachments to be included with the Concrete Mix Design:
1. Cementitious materials mill test reports for the following:
 - a. Portland cement
 - b. Fly ash
 - c. Slag
 2. Designation, type, quality, and source (natural or manufactured) of coarse and fine aggregate materials.
 3. Sieve Analysis Reports: Provide separate sieve analysis of percentages passing for coarse and fine aggregate. Show values for each sieve size shown on the mix design form. Do not leave any line blank. Sieve analysis sampling and testing for each aggregate source shall be conducted within 60 days of concrete submittal date.
 4. Aggregate Supplier Statement:
 - a. Stating if aggregate is possibly alkali-reactive based on tests or past service.
 - b. Stating if aggregate can possibly cause pop-outs, "D" cracking, or other disruptions due to moisture gain, freezing, or other mechanisms, based on tests or past service.
 5. Product data for the following concrete materials admixtures:
 - a. Water reducing
 - b. Set retarding
 - c. Set accelerating
 - d. Data indicating chloride ion content information for each admixture
 6. Concrete compressive strength data as required by ACI 301.
 7. Past compression test reports on each mix as required by ACI 301.
 8. Concrete Supplier Approval.
 9. Chloride-Ion Content: Measured water-soluble chloride-ion content (percent by weight of cementitious materials) in accordance with ASTM C1218.
 10. Time of Initial Setting: Initial setting time in accordance with ASTM C403.
- K. Product Data: Submit certified laboratory test data or manufacturer's certificates and data for the items listed below certifying that materials are in conformance requirements specified herein. Submit to the Civil Engineering Consultant of Record for review and approval and within 7 calendar days after receipt of Notice-to-Proceed.
1. Portland cement concrete mix design(s)
 2. Type and source of Portland cement, fly ash, and slag
 3. Aggregate gradations
 4. Soft preformed joint filler
 5. Pavement joint sealant
 6. Dowel bars
 7. Tie bars
 8. Reinforcing steel bars
 9. Welded wire fabric
 10. Air entraining admixtures
 11. Water-reducing, set-retarding, and set-accelerating admixtures (if used)
- L. Pavement Joint and Placement Plan: Provide a placement plan identifying the following:
1. Concrete truck access location.
 2. Extent of placements including width, length, slab placement area and volume.
 3. Locations of construction joints.
 4. Location of sawn contraction joints if different from those shown on the civil drawings.
- M. Pre-Slab Installation Meeting:
1. Provide record of notification of pre-slab meeting including company name, persons contacted, and date and method of contact.
 2. Provide meeting minutes to all participants and Walmart Construction Manager including sign-in sheet.
- N. Delivery Tickets:
1. Copies of delivery tickets for each load of concrete delivered to site.

2. Indicate information required by ASTM C 94 on each ticket including additional information required for slabs.
3. Information on ticket shall include quantities of material batched including the amount of free water in the aggregate and the quantity of water that can be added at the site without exceeding the maximum water cementitious ratio of the approved mix design. Aggregate moisture corrections shall be based on ASTM definitions of aggregate moisture content and absorption.
4. Mix identification number on ticket shall match number on submitted and approved mix design.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 1. ACI 301 - Specifications for Structural Concrete for Buildings.
 2. CRSI - Manual of Standard Practice.
- B. Pumped Concrete:
 1. Perform mix design, proportioning, and placement in accordance with ACI 304.2R.
 2. Submit documented evidence of experience in placing concrete by pumping on not less than three projects of similar size and complexity. List available pump size, standby pump size, piping, and other equipment.
 3. Submit documented evidence of concrete supplier's ability to dedicate sufficient mixing and delivery equipment to supply the concrete continuously for the volumes to be placed by pumping.
- C. Chemical Admixtures: Set control admixtures may be used only when adverse weather conditions are anticipated. Use of admixtures is subject to Walmart approval.
 1. Notify Walmart Construction Manager at Pre-Bid Conference if admixtures will be used in concrete.
 2. Provide Walmart Construction Manager with proposed Construction Schedule identifying anticipated adverse weather conditions justifying use of admixtures.
 3. Notify Walmart Construction Manager prior to installation for which admixtures will be used in concrete.
 4. Mix design shall indicate ingredients including the admixtures to be used and the slump and air content range for the project.
- D. Concrete Truck Inspection:
 1. Conform to ASTM C94, NRMCA, and Department of Transportation standards in state where project is located.
 2. Perform inspections immediately before starting concreting operations.
 3. Record acceptable truck numbers.
 4. Record the identification numbers of those trucks found to be acceptable on the basis of inspections.
 5. Do not bring on site for concreting operations, any truck whose identification numbers are not recorded as acceptable.
- E. Tolerances:
 1. Conform to most stringent requirements of ACI 117 and ACI 301 except as specified herein.
 2. Conform to ACI 117 thickness tolerances for slabs-on-ground.
- F. Concrete Supplier Approval:
 1. The concrete supplier shall be fully approved and acceptable by the concrete subcontractor as the producer of concrete for which the subcontractor is to place and finish. Prepare Statement of Approval of Concrete Supplier stating project name, name of concrete supplier, along with the statement of approval and the signatures of the Contractor and concrete pavement subcontractor. Submit statement as specified in Submittals paragraph above.
- G. Workmanship:
 1. When directed by the Owner, remove and replace or repair concrete and related Work which does not conform to specified requirements including strength, tolerances and finishes.
 2. Bear cost of corrections or delays to other work affected by, or resulting from, corrections to concrete Work.

3. If results of compressive strength tests reveal deficiencies in concrete, meet requirements of ACI 318 and ACI 301.
4. Establish and maintain required lines and elevations.
5. Check surface areas at intervals necessary to eliminate ponding areas.

H. Pre-installation Meeting: Convene a pre-installation meeting at the site at least two weeks prior to commencing work of this Section. Require attendance of parties directly affecting work of this Section, including, but not limited to, the Owner's representative, CTL's representative and inspector, Contractor, concrete sub-contractor and job foreman, concrete supplier, and base fine grading contractor.

1. Contact Walmart Construction Manager Thirty days prior to pre-installation conference to confirm schedule.
2. Record discussions of meeting and decisions and agreements (or disagreements) reached, and furnish copy of record to each party attending. Review foreseeable methods and procedures related to paving work, including the following:
 3. CTL's testing and inspection procedures.
 4. Concrete finishes and finishing.
 5. Cold- and hot-weather concreting procedures.
 6. Curing procedures.
 7. Concrete design mixture and examine procedures for ensuring quality of concrete materials.
 8. Proposed sources of concrete materials, including capabilities and location of plant that will manufacture concrete.
 9. Tour, inspect and discuss condition of subgrade, drainage structures, and other preparatory work.
10. Requirements for protecting concrete work, including restriction of traffic during installation period and for remainder of construction period.
11. Review and finalize construction schedule and verify availability of materials.
12. Concrete paving requirements (drawings, specifications and other contract documents).
13. Required submittals, both completed and yet to be completed.
14. Weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
15. Safety precautions relating to placement of concrete.
16. Changes to the contract documents from recommendations or discussions at the Pre-Construction meeting shall be approved in writing by the Walmart Construction Manager prior to implementation.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in unopened containers with labels identifying contents. Keep containers closed and upright to prevent leakage.
- B. Mark reinforcing, accessories and embedded items for proper identification and placement location.
- C. Store materials, except aggregate, off ground in dry area and in manner to prevent damage. Protect liquid materials from freezing.
- D. Stockpile aggregate in manner to prevent contamination with other materials or with other sizes of aggregates. Conduct tests for determining conformance to requirements at point of batching. Do not use bottom 6" of aggregate piles in contact with ground. Allow sand to drain until it has reached a uniform moisture content before it is used.
- E. Store admixtures in manner to prevent contamination. Protect admixtures from extreme temperatures which would adversely affect their characteristics.

1.7 PROJECT CONDITIONS

- A. Hot and cold weather concreting shall be in accordance with ACI 305.1 (hot weather) and 306.1 (cold weather).
- B. Concreting in Hot, Dry, or Windy Weather:

1. Employ precautions to avoid cracking when the concrete rate of evaporation exceeds 0.1 pounds per square foot per hour or when any combination of concrete materials and weather conditions are favorable for the formation of plastic shrinkage cracks.
 2. Maintain an accurate reading thermometer at the job site to check temperature of concrete.
 3. Reject concrete if more than one slump adjustment, as defined in ASTM C 94, is required.
 4. Do not place concrete when forms, subgrade, aggregate base, or reinforcing bars are more than 120 F or the temperature differential between the forms, aggregate base, or reinforcing bars and concrete will create conditions favorable for settlement cracks or thermal cracking.
- C. Concreting in Cold Weather:
1. Mix and place concrete when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F and rising.
 2. Conform to ACI 306.1 when temperature and other environmental conditions are as noted therein.
 3. Subgrade shall be thawed to depth of 12 inches immediately before placing concrete.
 4. Measure and record concrete temperature during protection period in each placement at regular time intervals, but not less than 3 times per 24 hour period.
 5. Do not place slabs on subgrade or base that is more than 20°F cooler than concrete. Warm subgrade or base to decrease temperature differential to 20 F or less

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with project requirements, provide products as manufactured by the following to the extent as specified hereinafter for the specific product:
1. American Colloid Company, (800) 527-9948.
 2. Ardex Engineered Cements, (412) 264-4240.
 3. A.W. Cook Cement Products, (706) 654-3677.
 4. BASF Admixtures Inc., Cleveland, OH (Formerly Master Builders) (800) 628-9990.
 5. BASF Building Systems, Shakopee, MN (Formerly Degussa Building Products) (800) 433-9517.
 6. Colloid Environmental Technologies Co. (CETCO), (800) 527-9948
 7. Conspec Marketing & Manufacturing, (800) 348-7351.
 8. CTS Cement Manufacturing Corp., (800) 929-3030.
 9. Degussa Building Products: See BASF Building Systems.
 10. DRC Inc., Carrollton, KY (502) 732-1001.
 11. E-Poxy Engineered Materials, (800) 833-3400.
 12. Euclid Chemical Co., (800) 321-7628.
 13. Henry Company (Synko-Flex Products Division); (800) 231-4551.
 14. Master Builders, Inc.: See BASF Admixtures.
 15. Permagile Industries, Inc., (800) 645-7546.
 16. Reef Industries, (800) 231-6074.
 17. Sika Corp., (800) 933-7452.
 18. Sonneborn Building Products: See BASF Building Products.
 19. Thoro System Products: See BASF Building Products.
 20. Unitex, (816) 231-7700 or (800) 821-5846.
 21. W.R. Meadows, Inc., (800) 342-5976.
 22. Vexcon Chemicals, Inc., (888) 839-2661.
- B. Substitutions: Not permitted unless otherwise specified.

2.2 AGGREGATE BASE MATERIALS

- A. Exterior pavement areas shown on the Drawings referencing the “Foundation Subsurface Preparation” for base preparation shall receive aggregate base materials as specified herein unless otherwise shown on the Foundation Subsurface Preparation.

- B. Aggregate Base: Use one of the following gradations:
1. Any local state DOT approved road base material with 100% passing No. 1½-inch sieve, 15% to 55% passing the No. 4 sieve and 5% to 12% passing the No. 200 sieve.
 2. Material that satisfies the General and Gradation “A”, ”C”, or “D” requirements (with the modified allowance of 5% to 12% passing the No. 200 sieve) as defined by ASTM D 1241.
 3. Material passing the No. 200 shall be clean granular fill with less than 3% clay and/or friable particles.
- C. Aggregate Choker Coarse: Clean granular fill with less than 3% clay and/or friable particles. Use one of the following gradations:
1. ASTM 448 No. 10 with 6% to 12% passing No. 200 sieve.
 2. Material that meets the following gradation:
 - a.

<u>Std. Sieve Size</u>	<u>% Passing</u>
No. 4	85-100
No. 8	75-95
No. 16	55-75
No. 50	22-45
No. 100	10-30
No. 200	6-12

2.3 FORMWORK

- A. Forms: Design, engineer, and construct forms, shores, bracing, and other temporary supports to support loads imposed during construction in accordance with ACI 347. Design under the direct supervision of a licensed Professional Engineer experienced in design of this Work.
1. Plywood: APA Plyform Class 1, complying with DOC PS 1, exterior-grade plywood panels, suitable for concrete forms, 5/8 inch minimum thickness unless otherwise shown or specified, and as follows.
 - a. Plywood for concrete surfaces to be exposed after construction is complete: APA HDO plyform (High Density Overlay) with straight, sealed edges.
 - b. Plywood for concrete surfaces not to be exposed after construction is complete: APA B-B Plyform .
 2. Lumber: Dressed, tongue and grooved, free from loose knots.
 3. Metal: Smooth, clean, corrosion-free, without dents or holes and with closely-matching edges.
 4. Fiberglass: Smooth, clean, without dents or holes and with closely-matching edges.
 5. Laminated Round Fiber Tubes: Spirally laminated paper fiber, wax impregnated on exterior surfaces and interior ply allowing uniform moisture penetration.
- B. Form Release Agents:
1. 100% biodegradable, non-toxic, 100% natural organic chemical release agent that will not cause surface imperfections, and is non-staining and compatible with field applied paints, toppings, curing compounds and other coatings.
 2. Use same brand form release agent for all forms.
 3. Products:
 - a. Form-EZE Natural by Euclid Chemical, (800) 321-7628.
 - b. Enviroform by Conspec, (913) 287-1700.
 - c. Certi-Vex V Form Release by Vexcon, (888) 839-2661.
 - d. Farm Fresh by Unitex, (816) 231-7700.
- C. Ties and Accessories:
1. Provide form ties, anchors, and hangers of sufficient strength to resist displacement of forms due to construction loads and depositing of concrete.
 2. Provide ties and spreader form ties designed so no metal will be within 1 inch of surface when forms are removed.
 3. Where concrete surfaces are exposed to view, use form ties that will leave a depression not more than 1 inch in diameter when removed.
- D. Waterstops: Provide one of the following.

1. Waterstop RX-101 Bentonite Waterstop, by CETCO (Colloid Environmental Technologies Co.)
2. SF302-Synko-Flex Waterstop, by Henry Co.

2.4 REINFORCEMENT

A. Reinforcing Bars:

1. ASTM A615, deformed, Grade 60.
2. ASTM A 706, deformed, Grade 60.

B. Joint Dowel Bars: ASTM A 615, Grade 40 minimum, or ASTM A36, smooth round plain-steel bars, cut bars true to length with ends square and free of burrs. Epoxy coat per State Highway Department Standard Specifications.

C. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A185. Furnish in flat sheets.

2.5 REINFORCEMENT ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage annealed type.

B. Reinforcing Support Devices:

1. Manufacturer support devices of metal (wire bar), concrete, or recycled plastic devices conforming to CRSI Manual of Standard Practice.
2. Plastic accessories shall have a minimum of 50% recycled content.
3. Do not use wood, brick and other devices that can expand due to moisture gain.
4. Precast concrete chairs shall have minimum compressive strength of 3,500 psi.
5. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
6. When precast concrete bar supports are used over aggregate base, or over waterproof membranes and vapor retarders, properly embed tie wires to prevent penetration of substrate.
7. Properly size foot of bar supports or similar devices to prevent settlement on base material or prevent puncture on vapor barrier.
8. When supporting multiple layers of reinforcement, provide the proper size and spacing of bar supports or similar devices to prevent deformation of plastic and to retain rebar within position tolerances.

2.6 CONCRETE MATERIALS

A. Cement: ASTM C 150 – If reactive aggregates are present in the area, use low alkali cement containing less than 0.6 percent alkalis. Use only one brand throughout project.

1. Required Cement Type based on ACI Exposure Category and Class as noted on Drawings.
 - a. Sulfate Exposure Class S0 – Type I, II, or III.
 - b. Sulfate Exposure Class S1 – Type II or Type III with C₃A content less than 8%.
 - c. Sulfate Exposure Class S2 – Type V or Type III with C₃A content less than 5%.
 - d. Sulfate Exposure Class S3 – Type V plus pozzolan or slag cement.

B. Concrete Aggregate:

1. Conform to ASTM C33.
2. Aggregate shall contain no coal or lignite in concrete that will not be covered by soil.
3. Fine Aggregate:
 - a. Conform to fine aggregate grading requirements as defined in section 6.1 of ASTM C 33 unless approved by the Structural Engineer.
 - b. If manufactured sand is used, blend with minimum 25% natural sand unless otherwise approved by the Structural Engineer.
4. Coarse Aggregate:
 - a) Nominal maximum coarse aggregate size shall be 1 inch for slabs \leq 5-1/2 inch thick.
 - b) The nominal maximum size of an aggregate is the smallest sieve size through which the major portion of the aggregate must pass, with a minimal amount retained on the maximum sieve size. Maximum 4% shall be retained on the nominal maximum size sieve.

5. Adjust proportions of combined coarse, intermediate, and fine aggregates to provide the following particle size distribution characteristics, unless otherwise approved:
 - a. Coarseness Factor of 60 to 75%.
 - 1) The Coarseness Factor (CF) is the percent of combined aggregate retained on the #8 sieve that is also retained on the 3/8" sieve.
 - 2) The Coarseness Factor is calculated as follows:
 $CF = \text{Aggregate retained on } 3/8'' \text{ sieve} / \text{Aggregate retained on } \#8 \text{ sieve.}$
 - b. Adjusted Workability Factor
 - 1) The Workability Factor (WF) is the percent of combined aggregate that passes the #8 sieve.
 - 2) The Adjusted Workability Factor (Adj-WF) is calculated as follows:
 $\text{Adj-WF} = \text{WF} + [(\text{Cementitious Material} - 564 \text{ lbs}) / 37.6]$
 - 3) The range of accepted Adj-WF for a given CF is as follows:
 $\text{Adj-WF} = [(11.25 - .15 \text{ CF}) + 33] \pm 2.5$
 - 4) Combined percent retained on any given sieve size shall not exceed 24%.
6. Gradation requirement of ASTM C33 may be waived in order to meet ranges specified.
- C. Fly Ash: ASTM C618, Type C or F. Use only one type and source throughout the project.
- D. Slag: ASTM C989, Grade 100 or 120. Use only one type and source throughout the project.
- E. Water: Clean potable water, not detrimental to concrete.

2.7 CHEMICAL ADMIXTURES

- A. Air Entrainment: ASTM C260.
 1. Air-Mix or AEA-92, by Euclid.
 2. MB-VR MB-AE 90, or Micro-Air, by Master Builders.
 3. Daravair or Darex Series, by W.R. Grace.
 4. Equivalent approved products.
 5. Sika Air Series, by Sika.
- B. Evaporation Retardant: Water-based polymer, sprayable.
 1. Euco-Bar, by Euclid
 2. Confilm, by BASF Admixtures (Master Builders)
 3. Aquafilm, by Dayton Superior.
- C. High-Range Water Reducing Admixture: ASTM C494, Type F or G.
 1. Type F:
 - a. Eucon 37, by Euclid.
 - b. Daracem 100, by W.R. Grace.
 - c. Rheobuild 1000 or Glenium Series, by MBT
 - d. ViscoCrete or Sikaplast by Sika
 2. Type G:
 - a. Eucon 537, by Euclid.
 - b. Daracem 100, by W.R. Grace.
 - c. Rheobuild 716, by Master Builders.
 3. Equivalent approved products.
- D. Other Admixtures: Additional admixtures including retarding, accelerating, and evaporation retardant, and integral color admixtures are specified in Section 03314.

2.8 RELATED MATERIALS

- A. Non-shrink Grout: Pre-mixed non-shrinking, high strength grout, ASTM C1107, Type A, B, or C; compressive strength of 5000 psi in 28 days.
 1. NS Grout, by Euclid.

2. Construction Grout, by Master Builders.
 3. SonogROUT, by Sonneborn.
 4. Certi-Vex Grout #1000, by Vexcon.
 5. Enduro 50, by Conspec.
- B. Joint Materials: Specified in Section 07900.
- C. Foundation Perimeter Insulation: Specified in Section 07210.
- D. Epoxy Bonding Agent: ASTM C881
1. Euco #452 or Corr-Bond, by Euclid.
 2. EVA-POX Epoxy Paste No. 22, by E-Poxy Industries.
 3. Concrecive Liquid (LPL), by Master Builders.
 4. Uniweld, by Permagile Industries.
 5. Sikadur 32, Hi-Mod LPL by Sika.
- E. Bond Breaker: ASTM D226, No. 15, unperforated asphalt saturated felt.
- F. Leveling Compound:
1. Ardex V-900, by Ardex. Contact: Jesse David.
 2. Flo-Top or Super Flo-Top, by Euclid.
 3. SikaTop Overlay System, by Sika.
 4. Thoro Underlayment Self-Leveling including Thoro Primer #800, by Thoro.
 5. Certi-Vex SLU TC including EnvioBond A Primer, by Vexcon.
 6. Conflow including Primeflow, by Conspec.
 7. MASTERTOP 110 UNDERLAYMENT, by Master Builders.
- G. Concrete Sealer: Solvent based concrete sealer having a minimum 25% solids similar to High Solids Clear Seal manufactured by Increte Systems Inc.

2.9 CONCRETE CURING MATERIALS

- A. Water: Clean, clear, and potable, not detrimental to concrete finish.
- B. Concrete Curing Cover:
1. AquaCure, by DRC.
 - a. Exclusive Distributor: Greenstreak Group, Inc., St. Louis, MO (800) 325-9504.
 2. Ultracure by McTech Group.
- C. Liquid Membrane Curing and Sealing Compound: ASTM C 1315, Type I, Class A or B, 25% minimum solids content, clear non-yellowing with no styrene-butadiene.
1. Water Based, VOC less than 350 g/l:
 - a. Super Aqua Cure, by Euclid Chemical Corp.
 - b. Kure 1315 by BASF Building Systems (Degussa).
- D. Dissipating Curing Compound: ASTM C 309 Type 1, Class A or B, solvent or water base, VOC less than 350 g/l.
1. Cetri Vex EnvioCure 100 by Vexcon. (Solvent base)
 2. Day Chem REZ Cure (J-11-W) or Safe Cure & Seal (J19) by Dayton Superior. (Water Base)
 3. Kurez DR VOX, by Euclid. (Water Base)

2.10 COLOR TEXTURED (STAMPED) CONCRETE

- A. Color textured concrete is specified in Section 03361.

2.11 CONCRETE MIX

- A. Mix and deliver concrete in accordance with ASTM C94. Prepare design mixes for each type and strength of concrete by the laboratory trial batch or the field experience method as specified in ACI 301.
- B. ACI Exposure Category and Class: ACI freeze/thaw and sulfate exposure category and class shall be as indicated on Drawings. Exposure class with highest compressive strength and lowest maximum water cementitious material ratio shall take precedence for each mix.
- C. Structural Concrete Footings:
 - 1. Compressive Strength: Strength at 28 days shall be as follows unless otherwise indicated on the Drawings:
 - a. Exposure Class F0, F2, F3, or S0: 3,000 psi
 - b. Exposure Class S1: 4,000 psi
 - c. Exposure Class S2 or S3: 4,500 psi
 - 2. Maximum Water-Cementitious Material Ratio (Cement Quantity Includes Fly Ash or slag):
 - a. Exposure Class F0, F2, F3, S0 or S1: 0.50 by wt.
 - b. Exposure Class S2 or S3: 0.45 by wt.
 - 3. Slump: Slump at the point of placement shall not exceed 5 inches and shall be of a consistency to be worked readily into forms and around reinforcement without segregation, voids, or excessive bleeding. Maximum slump variance shall be 2 inches.
 - 4. Air Content: Do not air-entrain unless required for concrete workability. Not to exceed 5.0 percent.
- D. Structural Concrete Formed Walls:
 - 1. Compressive Strength: Strength at 28 days shall be as follows unless otherwise indicated on the Drawings:
 - a. Exposure Class F0 or S0: 3,500 psi
 - b. Exposure Class S1: 4,000 psi
 - c. Exposure Class F2, S2 or S3: 4,500 psi
 - d. Exposure Class F3: 5,000 psi
 - 2. Maximum Water-Cementitious Material Ratio (Cement Quantity Includes Fly Ash or slag):
 - a. Exposure Class F0, S0 or S1: 0.50 by wt.
 - b. Exposure Class F2, S2 or S3: 0.45 by wt.
 - c. Exposure Class F3: 0.40 by wt.
 - 3. Slump: Slump at the point of placement shall not exceed 5 inches and shall be of a consistency to be worked readily into forms and around reinforcement without segregation, voids, or excessive bleeding. Maximum slump variance shall be 2 inches.
 - 4. Air Content: As specified in the Table below.
- E. Non-Structural Exterior Concrete Pavement and Slabs on Grade:
 - 1. Compressive Strength: Strength at 28 days shall be as follows unless otherwise indicated on the Drawings:
 - a. Exposure Class F0 or S0: 3,500 psi
 - b. Exposure Class S1: 4,000 psi
 - c. Exposure Class F2, F3, S2 or S3: 4,500 psi
 - d. Compactor pad (All exposures): 5,000 psi.
 - 2. Maximum Water-Cementitious Material Ratio (Cement Quantity Includes Fly Ash or slag): 0.45 by wt.
 - a. Exposure Class F0, S0 or S1: 0.50 by wt.
 - b. Exposure Class F2, F3, S2 or S3: 0.45 by wt.
 - c. Compactor pad (All exposures): 0.40 by wt.
 - 3. Slump Range: 2"- 4" for hand placed concrete, 1-1/4" to 3" for machine placed (slipform) concrete. Maximum slump variance shall be 2 inches.
- F. Non-Structural Interior Concrete Curbs and Equipment Pads:
 - 1. ACI Exposure Class: All Classes.
 - 2. Compressive Strength: Strength at 28 days shall be 3500 psi unless otherwise shown or specified.
 - 3. Maximum Water-Cementitious Material Ratio (Cement Quantity Includes Fly Ash or slag): 0.55 by wt.

4. Slump: Slump at the point of placement shall not exceed 5 inches subject to the requirement that concrete shall be of a consistency to be worked readily into forms and around reinforcement without segregation, voids, or excessive bleeding. Maximum slump variance shall be 2 inches.
5. Air Content: Do not air-entrain interior concrete.

G. Other Structural Concrete (Applies to concrete structures not listed in sections above):

1. Where concrete is not in contact with soil, backfill or base material, the sulfate exposure requirement can be disregarded.
2. Compressive Strength: Strength at 28 days shall be as follows unless otherwise indicated on the Drawings:
 - a. For Concrete Not Exposed to Weather: Min 3,500 psi
 - 1) Exposure Class S0: 3,500 psi
 - 2) Exposure Class S1: 4,000 psi
 - 3) Exposure Class S2 or S3: 4,500 psi
 - b. For Concrete Exposed to Weather:
 - 1) Exposure Class F0 or S0: 3,500 psi
 - 2) Exposure Class S1: 4,000 psi
 - 3) Exposure Class F2, S2 or S3: 4,500 psi
3. Maximum Water-Cementitious Material Ratio (Cement Quantity Includes Fly Ash or slag):
 - a. For Concrete Not Exposed to Weather: Min 0.50 by wt.
 - 1) Exposure Class S0 or S1: 0.50 by wt.
 - 2) Exposure Class S2 or S3: 0.45 by wt.
 - b. For Concrete Exposed to Weather:
 - 1) Exposure Class F0, S0 or S1: 0.50 by wt.
 - 2) Exposure Class F2, S2 or S3: 0.45 by wt.
 - 3) Exposure Class F3: 0.40 by wt.
4. Slump: Slump at the point of placement shall not exceed 5 inches subject to the requirement that concrete shall be of a consistency to be worked readily into forms and around reinforcement without segregation, voids, or excessive bleeding. Maximum slump variance shall be 2 inches.
5. Air Content:
 - a. For Concrete Not Exposed to Weather: Not to exceed 5.0 percent.
 - b. For Concrete Exposed to Weather: As specified in the Table below plus or minus 1.5 percent.

H. Concrete Mix Air Entrainment: Where an exterior concrete mix is noted to be air entrained, the air entrainment shall be as follows:

Nominal Maximum Size Aggregate (Inch)	Average Air Content (%) +/- 1.5% By Exposure Class	
	Class F0	Class F2 & F3
3/8	4.5	7.5
1/2	4.0	7.0
3/4	3.5	6.0
1	3.0	6.0
1-1/2	2.5	5.5

I. Concrete to be Placed by Pumping Methods:

- a. The minimum quantity of constituent materials passing the No. 50 sieve (fine aggregate and cementitious materials) shall be 600 pounds per cubic yard.
- b. The particle size distribution of the combined fine and coarse aggregate shall be uniform from the largest to the smallest particles.

J. Admixtures:

1. Use water-reducing admixture or high-range water-reducing admixture (Superplasticizer) in concrete as required for placement and workability. Unless otherwise permitted herein, chemical admixtures shall be dispensed at the batch plant. Use high-range water-reducing admixture (HRWR) in pumped concrete.

2. Use air-entraining admixture in exterior concrete exposed to weather. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content specified above.
 3. Use admixtures for water reduction and set control (accelerators and retarders) in strict compliance with manufacturer's directions.
 4. Verify with the admixture manufacturer the following:
 - a. The compatibility of the individual admixtures when combined in the concrete mix.
 - b. The compatibility of the individual admixtures with the concrete materials.
- K. Supplementary Cementitious Materials (SCM):
1. Concrete mix shall contain SCM at the amounts specified unless other amounts are approved by the Structural Engineering Consultant. Either fly ash or ground granulated blast furnace slag (GGBFS) may be used for the SCM but shall not be used together to form a ternary mix. Use of fly ash or GGBFS in the concrete mix is mandatory.
 2. Fly Ash: Substitute fly ash for Portland cement at 20% of the total cementitious content.
 - a. If used to mitigate potential aggregate reactivity, up to 25% fly ash substitution for Portland cement may be used. Only Type F fly ash may be used and shall have the following maximum properties: 1.5% available alkali and 8.0% CaO. When a maximum of 25% replacement is used, up to 10.0% CaO is permitted.
 3. Ground Granulated Blast Furnace Slag (GGBFS): Substitute GGBFS for Portland cement at 25% of the total cementitious content.
 - a. If required to mitigate potential sulfate exposure or aggregate reactivity, up to 50% GGBFS substitution for Portland cement may be used.
 4. Maintain air-entrainment at specified levels.
 5. In cold weather, provide adequate concrete strength gain so concrete will not be damaged from traffic and loads of use.
- L. Calcium Chloride Admixture:
1. Calcium chloride (Type L) conforming to ASTM D98 may be used in solution form as part of the mixing water to accelerate concrete setting and early-strength development.
 2. Amount of calcium chloride added shall not be more than necessary to produce the desired results and shall not exceed 2% by weight of cement.
 3. The dosage range for the calcium chloride for the entire project shall not vary by more than 1%. Range is defined as the difference between the maximum and minimum dosages of calcium chloride for the entire project.
 4. Calcium chloride shall not be used in the following applications unless approved by the Structural Engineer:
 - a. Concrete containing embedded dissimilar metals or aluminum
 - b. Slabs supported on permanent galvanized steel forms
 - c. Concrete exposed to deicing chemicals
 - d. Prestressed or post-tension concrete
 - e. Concrete containing aggregates with potentially deleterious reactivity and concrete exposed to soil
 - f. Concrete exposed to soil or water containing sulfates.
 5. Use calcium chloride in accordance with manufacturer's recommendation.
 6. Chloride-ion Concentration: Maximum water-soluble chloride-ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious material, and admixtures shall not exceed the following limits unless approved by the Structural Engineer:
 - a. Type of Member Maximum water-soluble chloride ion (Cl-) content in concrete (percent by weight of cement)
 - 1) Prestressed concrete - 0.06
 - 2) Reinforced concrete exposed to chloride in service - 0.15
 - 3) Reinforced concrete that will be dry or protected from moisture in service - 1.00
 - 4) Other reinforced concrete construction - 0.30
 7. When using calcium chloride or other admixtures containing chlorides, measure water-soluble chloride-ion content (percent by weight of cementitious materials) per ASTM C 1218. Sample shall be from concrete representing the submitted mix design and maximum chloride dosage anticipated for the project.

2.12 MIXING

- A. Ready-Mixed Concrete:
 - 1. Mix and transport in accordance with ASTM C 94 and ACI 301 except as specified.
 - 2. Reset drum revolution counter to zero on ready mix concrete truck when water is added to drum.
- B. Site-Mixed Concrete:
 - 1. Conform to ACI 301.
 - 2. Use central-mix type batch plant.
- C. Proportion concrete materials on basis of field experience or by laboratory trial batches.
- D. Ready-mix concrete supplier may proportion materials by field experience.
- E. Proportioning by Water-Cement ratio is not acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, held securely, and will not cause hardship in placing concrete.

3.2 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent. Use proper dust control methods. Apply bonding agent in accordance with manufacturer's instructions.
- B. Preplacement Inspection: All trades and participants involved shall verify that preparations are in conformance with Contract documents. Inspect reinforcement, inserts, and embedded parts before beginning concrete placement to ensure accurate size and location. Use approved sign-off forms.
- C. Cleaning Equipment: Remove hardened concrete and foreign materials from mixing and conveying equipment.
- D. Ensure that all work is properly coordinated:
 - 1. Structural Drawings and Specifications with those of other disciplines.
 - 2. Use final corrected Shop Drawings, placing Drawings and material / equipment Drawings

3.3 AGGREGATE BASE PLACEMENT

- A. Where exterior pavement areas are shown on the drawings referencing the "Foundation Subsurface Preparation" for base preparation, place aggregate base in accordance with requirements herein.
- B. Aggregate Base:
 - 1. Install aggregate base where shown on Drawings.
 - 2. Compact to final thickness shown in layers not exceeding 6 inches with minimum of 2 passes per layer with vibratory compactor.
 - 3. Compact fill to 98% of aggregate's Standard Proctor as determined by Method D of ASTM D698.
 - 4. Leave pad up to 2 inches low until just prior to concrete placement.
- C. Aggregate Base Fine Grading:
 - 1. Compact to final thickness noted with 2 passes minimum vibratory compactor to produce smooth, flat, dense surface.
 - 2. Aggregate choaker coarse or top 2" DOT approved road base shall be place dry immediately before placing concrete.
 - 3. Do not allow excess moisture or soft soil beneath vapor retarder at time of placing concrete.

4. Thickness shall not exceed 2 inches.
 5. Level off aggregate base top surface with aggregate chocker coarse material as necessary as follows:
 - a. to reduce surface friction and to meet specified fine grade tolerances specified below. Typically required up to 3/4" thick in areas exposed to rain, traffic, or excavation for pits and buried utilities.
 - b. where aggregate base material does not have sufficient fine particles to produce a surface that is free of exposed aggregate or surface voids greater than 3/8" in size at time of slab installation.
 6. Use laser guided equipment used to establish specified base elevation.
 7. Provide dry, smooth, flat, dense surface
 8. Proofroll 48 hrs maximum prior to concrete placement. Depression under a fully loaded ready mix truck shall not exceed 1/2 inch.
- D. Pavement Aggregate Base Fine Grade Tolerance: +0 inch, -3/4 inch with transition no greater than 3/4 inch vertically to 8 inches horizontally for level slab.

3.4 FORMWORK

- A. Form vertical surfaces of concrete work.
- B. Design, construct, erect, support, and remove formwork and related items in accordance with most stringent requirements of ACI 117, 301, 304R, and 347R
 1. Camber forms to allow for deflection due to weight of fresh concrete.
- C. Formwork for concrete surfaces to be painted or exposed to view after completion of project shall conform to the following:
 1. Do not use forms with dents, holes or patches.
 2. Individual formwork elements shall be as large as possible.
 3. Position individual formwork elements in regular, uniform pattern with joints aligned.
 4. Uniformly space and align form ties in horizontal and vertical rows.
 5. Construct forms for removal without hammering or prying against concrete.
 6. Temporary formwork openings (for cleaning, inspecting, etc) shall be placed on unexposed side or constructed so that concrete surface at opening will match adjacent concrete in appearance.
- D. Form Preparation
 1. Clean formwork.
 2. Remove rust from steel formwork.
- E. Erecting Forms:
 1. Solidly butt joints and provide backup at joints as required to prevent leakage of cement paste.
 2. Do not tape formwork joints.
 3. Just before placing concrete, clean forms and adjacent surfaces again as necessary. Remove wood, sawdust, chips dirt and other debris.
 4. If necessary to grease tie threads, do not allow grease to contact remainder of tie when wall will be exposed to hydrostatic pressure.
- F. Form Release Agent
 1. Before placing reinforcing steel, thoroughly coat contact surfaces of forms with an approved form release agent.
 2. Apply form release agent evenly without excess drip.
 3. Do not allow form release agent to come into contact with concrete surfaces against which fresh concrete will be placed.
 4. Moisten wood forms immediately before placing concrete where form release agents are not used.
- G. Form Construction for Paving:
 1. Set forms to required grades and lines, rigidly braced and secured.
 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.

3. Check completed formwork for grade and alignment to following tolerances:
 - a. Top of forms not more than 1/8-inch in 10'-0".
 - b. Vertical face on longitudinal axis, not more than 1/4-inch in 10'-0".
4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.

3.5 PLACING REINFORCEMENT

- A. Place reinforcing in accordance with most stringent requirements of ACI 117, 301 and 308 and CRSI Manual of Standard Practice and Placing Reinforcing Bars.
- B. Accurately place and secure reinforcement against displacement by firmly wiring at intersections and splices with not less than No. 18 U.S. Standard Gauge annealed wire.
- C. Perform concrete reinforcement work in accordance with CRSI Manual of Standard Practice, Documents 63 and 65. Detailing practices and fabrication shall conform to ACI SP66.
 1. Place and secure saddle ties at every other intersection with wire; hold in place with metal chairs or spacers during placing of concrete.
 2. Hold bars in beams and slabs to exact location during concrete placement. Use spacers, chairs, or other necessary supports with the following tolerances:
 - a. Bars in Slabs and Beams:
 - 1) Members 8 Inches Deep or Less: $\pm 1/4$ inch.
 - 2) Members 8 Inches to 2 Feet Deep: $\pm 1/2$ inch.
 - 3) Members more than 2 Feet Deep: ± 1 inch.
 - b. Lengthwise of Member: ± 2 inches.
 - c. Concrete Cover to Formed Surfaces: $\pm 1/4$ inch.
 - d. Minimum Spacing Between Bars: $\pm 1/4$ inch.
- D. Turn wire ends away from concrete exterior.
- E. Ensure reinforcing is clean, free from defects and kinks, loose mill or rust scale or coatings that will reduce bond.
- F. Protect exposed reinforcing bars, inserts and plates intended for bonding with future expansion from corrosion.
- G. When welding of reinforcement is specified, comply with AWS D1.4. Do not tack weld crossing bars for assembly of reinforcement, supports or embedded items.
- H. Slab on Grade and Pavement Dowels:
 1. Secure dowels and their sleeves perpendicular to joint and parallel to finished concrete surface.
 2. Use prefabricated dowel supports at ends of dowels to maintain alignment.
 3. Dowel alignment shall be within specified tolerances.
 4. Do not grease plate dowels

3.6 EMBEDMENTS

- A. Install anchor bolts and embedded bearing devices provided by others.
- B. Provide other anchor bolts and bearing devices shown on Drawings or anchor bolt setting plans or required equipment installation.
- C. Use templates as required for spacing between anchor bolts and set elevations with surveying equipment.
- D. Position and anchor steel shapes, anchor bolts, casings, conduit sleeves, masonry anchorages and other materials embedded in concrete.

- E. Place and secure against displacement miscellaneous steel, pipe sleeves, inserts, anchors, stair abrasive nosings, preformed joint fillers, vapor retarders and miscellaneous embedded items.
- F. Secure embedments to formwork when possible.
- G. Install clean embedments. After concrete placement, clean embedment exposed surfaces of concrete splatter and other foreign substances.
- H. Unless noted otherwise on the Drawings, ensure corner protection angles, bars and other similar embedded metal items are continuous between concrete joints. If shorter lengths are required for metal items, connect the ends by butt-welding entire joint and grinding smooth exposed surface. Ensure embedded metal items are discontinued at construction, contraction and isolation joints.
- I. Temporarily fill voids in sleeves and inserts with easily removable materials.
- J. Before placing concrete on grade, piping and other utilities under concrete shall be inspected, tested, and excavations backfilled and properly compacted to solid bearing.
- K. Allow sufficient time between erection of forms and placing concrete for other trades to install and test their work.

3.7 JOINTS

- A. Joints
 - 1. Provide construction, isolation and contraction joints as indicated on Drawings and as noted below.
 - 2. Bulkheads for construction joints shall be 1-1/2 inch minimum lumber. Do not use permanent preformed metal bulkheads.
 - 3. Provide bulkheads full depth of member.
 - 4. Space joints to allow one continuous placement between bulkheads.
 - 5. Ensure saws are equipped with HEPA-filtered dust collection vacuum systems as specified herein.
- B. Contraction Joints:
 - 1. Unless otherwise shown on the Drawings, do not extend reinforcement, corner protection angles, bars or other fixed metal items through construction joints or contraction joints in slabs on ground or pavements or through joints between slabs on ground and vertical surfaces.
 - 2. Match joints in walls and curbs with joints in slabs on ground and pavements.
 - 3. Extend joints across tops of walls and curbs unless noted otherwise on Drawings.
- C. Pavement Joint Construction: Construct weakened-plane control (contraction), and construction joints straight with face perpendicular to concrete surface. Construct transverse joints perpendicular to centerline, unless otherwise detailed.
 - 1. Weakened-Plane Control or Contraction Joints: Provide joints at spacing of 12'-0" on centers, maximum each way. Construct control joints for depth equal to at least 1/4 of the concrete thickness, as follows:
 - a. Form tooled joints in fresh concrete by grooving top with recommended tool and finishing edge with jointer.
 - b. Sawed Contraction Joints:
 - 1) Use saws, blades, skid plates, and accessories by Soff-Cut International, Inc., (800) 288-5040, or approved equal.
 - 2) Provide at least two Soff-Cut saws with blades capable of achieving the required depth of saw cut.
 - 3) Start cutting sawed joints as soon as concrete has hardened sufficiently to prevent raveling or dislodging of aggregates. This will typically be from 1 hour in hot weather to 4 hours in cold weather after completing finishing of slab in that joint location.
 - 4) Extend sawed joint to the slab boundaries and abutments, including columns, drains, and other penetrations in the path of a defined joint. Implement methods and timing of the saw cut beyond the limits of the Soff-Cut saw reach to provide a consistent depth of cut with minimal raveling of joint edges.

- c. Saw-Cut Control Joint Dust Collection: Connect one of the following dust collection systems directly to each Soff-Cut saw being used. Select collection system model recommended by the manufacturer to maintain dust emissions at the lowest permissible level for the size of the Soff-Cut blade.
 - 1) Pulsevac Dust Collector by E. G. Enterprises
 - 2) ProVac Dust Collection System by GladTech, Inc., (614) 251-8111.
 - 3) SoffVac by Soff-Cut International, Inc.
- 2. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for period of more than 1/2 hour. Construct joints in accordance with details shown.
 - a. Soft Preformed Joint Fillers: Extend preformed joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface. Furnish preformed joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip preformed joint filler sections together in a single plane.
 - b. Joint Sealants: Install joint sealants in accordance with manufacturer's recommendations.
- D. Doweled Joints: Install dowel bars and support assemblies at joints as indicated. Make provision to prevent concrete bonding to one side of joint by methods shown on the drawings.
- E. Joint filling and sealing is specified in Section 07900.

3.8 CONVEYING

- A. Handle concrete from mixer to place of final deposit as rapidly as practicable and in manner which will assure obtaining specified quality of concrete.
- B. Retempering: Discard concrete which has already begun to set. Do not retemper with water.
- C. Equipment: Provide mixing and conveying equipment of proper size and design to ensure a continuous flow of concrete to delivery end. Do not use aluminum pipe or equipment in contact with concrete.
 - 1. Mixers, agitators and non-agitating units: Conform to ASTM C 94 and current certification requirements of Department of Transportation in state where concrete plant is located.
 - 2. Belt Conveyers:
 - a. Use only types which will not cause segregation.
 - b. Discharge runs over 30 feet into hopper.
 - 3. Chutes: Metal or metal lined not to be installed at slopes greater than 1 vertical to 3 horizontal.
 - 4. Runways:
 - a. Provide runways or other means above finished concrete level for wheeled conveying equipment.
 - b. Do not support runways on reinforcing.
 - c. Do not wheel equipment directly over reinforcing or metal deck.
 - 5. Pumps:
 - a. Use pump hoses and other slickline components with 5 inch minimum inside diameter.
 - b. For slickline reducers, reduction in diameter shall not exceed 1 inch over a 5 foot length.

3.9 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301; including hot and cold weather placement procedures.
- B. Inspect reinforcement, inserts, and embedded parts before beginning concrete placement to verify accurate size and location.
- C. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.
- D. Place concrete in uniform layers, horizontal, 12 to 18 inches thick, exercising care to avoid vertical joints or inclined planes. Place concrete continuously between predetermined construction joints shown on structural drawings. Piling up of concrete in forms to cause separation or loss of ingredients is not permitted.

- E. Do not deposit concrete which has partially set or hardened. Do not deposit initial lubricating mortar when pumping concrete. Remove hardened or partially hardened concrete which has accumulated on forms or reinforcement. Do not place concrete on previously deposited concrete which has hardened sufficiently to cause formation of seams or planes of weakness within respective member or section except as specified.
- F. Deposit concrete as nearly in final position as practical to avoid rehandling. Exercise care to prevent splashing forms or reinforcing with concrete. Do not permit concrete to drop freely a distance greater than 3 feet. Where longer drops are necessary, use chute, tremie, or other conveyance to help avoid separation.
- G. Do not deposit concrete into excavation where water is standing. If place of deposit cannot be successfully pumped dry, place through tremie with outlet end near bottom of place of deposit.
- H. Do not deposit concrete when plasticity, measured by slump test, is outside specified limits. The addition of water to increase slump will not be permitted.
- I. Vibration: As soon as concrete is deposited, thoroughly agitate with mechanical vibrators and suitable hand tools to work mixture into corners of forms and around reinforcing and embedded items. Use mechanical vibrators with minimum frequency of 9000 revolutions/minute. Do not over vibrate or use vibrators to transport concrete within forms. Insert and withdraw vibrators at approximately 18 inches apart. At each insertion, vibrate generally 5-15 seconds, sufficient to consolidate concrete but not long enough to cause segregation. Keep spare vibrator on job site during concrete placement operations. Do not insert vibrator into lower courses that have begun to set.
- J. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Walmart Construction Manager upon discovery.
- K. Pumping: Maintain controls for proportioning, mixing, adjustment of mix, and placement in accordance with ACI 301 and ACI 304.2R

3.10 CURING

- A. General:
 - 1. Cure concrete in accordance with ACI 301, ACI 308R and ACI 308.1, except as noted.
 - 2. Start curing as soon as concrete surface will not be damaged by curing operations.
 - 3. Continuously cure concrete for at least 7 consecutive days.
 - 4. During curing period, do not allow any part of the concrete to become dry.
 - 5. If using forms for curing, keep forms in contact with concrete wet during curing period unless type of form is impervious to water, such as metal or fiberglass.
 - 6. If forms are removed before curing period is complete, continue curing immediately with other approved methods
- B. Methods of Curing:
 - 1. Impervious Sheet Cure: Wet exposed surfaces of concrete after completing finishing and then apply prewetted sheet with edges lapped 6 inches minimum and sealed & secured in such manner as to prevent moisture from escaping from concrete from laps or edges. Remove sheets after a 7 day curing period.
 - 2. Curing Compound:
 - a. Apply liquid curing compounds by spraying or rolling uniformly in a single coat on surfaces immediately following final finishing operation.
 - b. Apply curing compound in accordance with manufacturer's recommendations.
 - c. Do not use liquid curing compound on surface against which additional concrete, other finishing materials, or coatings are to be bonded if their bond will be affected by curing compound.
 - d. Spraying shall be by power sprayer.
 - e. Immediately recoat, at the rate specified above, surfaces subjected to rainfall within 3 hours after compound has been applied or surfaces damaged by subsequent construction operations within the curing period.
 - 3. Curing Schedule:

- a. Unformed surfaces shall receive an impervious sheet cure or curing compound as appropriate except as follows:
- b. Use impervious sheet cure for exterior color textured finished surfaces.
- c. Protect and cure finished concrete paving using curing compound.

3.11 FORM REMOVAL

- A. Do not remove forms until concrete has hardened sufficiently to support its own weight and imposed construction loads.
- B. Remove forms in manner to avoid damage to concrete.
- C. Formwork for slabs and pavements, curbs and other parts not supporting vertical load of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal operations, but in no case sooner than 12 hours.
- D. Remove wood forms from under floors, ramps, steps, and similar places (through temporary openings if necessary) so no material will be left to rot or to be infested by termites.

3.12 FINISHING PROCEDURE

- A. Formed Surfaces:
 - 1. Rough-Form Finish:
 - a. Patch tie holes and defects. Clip or rub off fins exceeding 1/2 inch in height. Leave surfaces with texture imparted by forms.
 - b. Apply on concrete surfaces not exposed to public view and where noted on Drawings.
 - 2. Smooth-Form Finish:
 - a. Patch tie holes and defects. Remove fins exceeding 1/8 inch in height.
 - b. Apply on concrete surfaces exposed to public view and where noted on Drawings.
- B. Initial Finishing:
 - 1. Re-straighten surface irregularities with a 10 ft highway screed in two directions as close to perpendicular as possible before water appears on concrete surface.
 - 2. Do no further working of surface until time for floating; do not work surface while water is present.
 - 3. "Dry Sprinkle" method finishing is not acceptable and will be cause for rejection
- C. Floating:
 - 1. Begin float operations when bleed water sheen has disappeared and concrete has stiffened sufficiently to allow walking on surface without leaving heel prints more than 1/4 inch deep. Check and level the surface lane to an initial tolerance not exceeding 1/4 inch in ten feet when tested with a ten foot straight edge. Immediately after leveling, refloat surface to a uniform smooth granular surface. Use magnesium or aluminum power float unless otherwise specified.
 - 2. Avoid premature finishing that brings excessive fines to surface causing finished slab to have soft surface which will dust.
- D. Troweling:
 - 1. Delay troweling as long as possible to prevent working excess fines and water to surface. Do not begin until surface moisture film and shine remaining after floating have disappeared. Trowel in alternate pass directions.
 - 2. Power trowel using riding trowel where possible. Use hand trowel in inaccessible areas.
 - 3. Do not over-trowel floors scheduled to receive curing/sealing compound unless specified otherwise.
 - 4. Do not re-wet surface to trowel.
 - 5. Final hand finish passes shall be done in the same direction. Finish all surfaces within a reasonable time period to provide uniformity of appearance.
- E. Broom Finish:

1. Provide a floated finish, then finish with broom.
 - a. Heavy Broom Finish: Steel wire or stiff, coarse, fiber broom.
 - b. Light Broom Finish: Soft-bristled fiber broom.
2. Allow surface to harden sufficiently to retain scoring or ridges.
3. Broom transverse to traffic or at right angles to slope of slab.

F. Sealing: Apply concrete sealer to interior concrete curbs in cart storage area.

G. Finish Schedule:

1. Unexposed Exterior Formed Surfaces: Rough form finish.
2. Exposed Exterior Formed Surfaces: Smooth form finish, stone rubbed.
3. Automotive Center Pit Floor and Slab above Pit: Troweled
4. Equipment Pads: Troweled
5. Dock : Light Broom.
6. Curbs: Troweled
7. Stair Treads: Heavy Broom.
8. Exposed exterior walking surfaces, truckwells, ramps, and outside slabs, unless otherwise noted on Drawings: Broom Finish.

3.13 JOINT FILLING AND SEALING

A. Joint filling and sealing is specified in Section 07900.

3.14 DEFECTIVE CONCRETE

A. Concrete that does not satisfy the performance requirements of this specification, including but not limited to, tolerance, strength, durability and finish shall be removed and replaced at no extra cost to the Owner if repair cannot be accomplished to the satisfaction of Walmart Construction Manager.

B. Patching;

1. Notify Walmart Construction Manager immediately upon discovery and before patching any imperfect areas.
2. Repair and patch imperfect areas, with cement mortar, immediately after discovery. Imperfect areas not acceptable to Walmart Construction Management will be considered defective.
3. Cut out honeycomb, rock pockets, voids over ¼ inch in any dimension, surface imperfections and holes left by tie rods and bolts down to solid concrete, but in no case, to a depth of less than one inch. Make edges of cut perpendicular to the concrete surface. Thoroughly clean, dampen with water and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.

3.15 FIELD QUALITY CONTROL

A. Field quality control shall be the responsibility of the Contractor in accordance with Section 01452. Except as specified as mandatory, field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements.

B. Contractor shall collect and certify each delivery ticket of concrete. Verify that tickets indicate type of concrete delivered, amount of water added and time at which cement and aggregate were loaded into truck, and time at which concrete was discharged from truck.

3.16 PROTECTION

A. Protect finished work.

B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and damage.

- C. Patch or replace damaged portions of concrete.
- D. Protect wet cured or impervious sheet cured surfaces as follows:
 - 1. Barricade concrete surfaces immediately after finishing
 - 2. Do not allow light traffic, except for curing purposes, on concrete surfaces until concrete has obtained 1800 psi (approx 3 days).
 - 3. Do not allow heavy traffic on concrete surface until concrete has obtained, by test, its design strength as noted on drawings, but not sooner than 9 days after placement.
 - 4. Permit concrete to dry minimum of 2 additional days after curing is completed before removing barricades.
- E. Protect surfaces cured with curing compound as follows:
 - 1. Barricade Concrete surfaces immediately after application of curing compound.
 - 2. Do not allow traffic on concrete surfaces sooner than 3 days after placement.

3.17 CLEANING

- A. Remove forms, equipment, protective coverings, and rubbish resulting from concreting operations. Leave finished concrete surfaces in clean conditions. Use vacuum with HEPA-rated filter to remove loose dirt and mud. Do not dry sweep. Remove mortar and concrete droppings. Wash concrete floors and platforms with soapy water and rinse with clean water.
- B. Dispose of construction and universal waste in accordance with the requirements of Section 01351.

END OF SECTION

WALMART STORES

CONCRETE MIX DESIGN SUBMITTAL FORM
 (Section 03310 – Structural Concrete and Exterior Concrete Slabs)

Date _____

PROJECT TYPE: _____

STORE INFORMATION

STORE # _____
ADDRESS _____
CITY, STATE _____
GENERAL CONTRACTOR _____
COMPANY _____
JOBSITE PHONE _____

A. CONCRETE INFORMATION

Supplier Mix Design #	_____
Design Strength (f'c)	_____ psi
Water / Cementitious Ratio	_____
Total Air Content	_____ %
Total Est. Volume of Concrete	_____ CY
Concrete Uses/Locations	_____

Mix Developed From:	
<input type="checkbox"/>	Trial Mix Test Data (<i>attach test data</i>)
<input type="checkbox"/>	Field Experience
Density	
Wet	_____ pcf Dry _____ pcf
Slump	
_____	" (± 1") WITHOUT WR Admixture
_____	" (± 1") WITH WR Admixture



B. ADMIXTURE INFORMATION

	ASTM Designation	Product (Manufacturer/Brand)	Dosage (ounces)	
			oz / cy	oz / cwt
Water Reducing				
Accelerating				
Retarding				

C. MIX DESIGN

Mix Proportions (per cubic yard)

	Identification (Type, size, source, etc.)	Weight (pounds)	Density (SSD)	Volume (cubic feet)	% Aggregate Absorption
Cement					
Fly Ash					
Slag					
Coarse Aggregate #1					
#2					
#3					
Fine Aggregate #1					
#2					
Water					
Air Content					
	TOTALS				

Coarse & Fine Aggregate Gradation Information

Sieve Size	% Passing Each Sieve (All Sieve Sizes must be entered)					Combined % Passing	Combined % Retained	
	Coarse Agg. # 1	Coarse Agg. # 2	Coarse Agg. # 3	Fine Agg. # 1	Fine Agg. # 2		Cumulative	Individual
1-1/2"								
1"								
3/4"								
1/2"								
3/8"								
# 4								
# 8								
# 16								
# 30								
# 50								
# 100								
# 200								
% of Vol								

Aggregate Ratios

Coarseness Factor =	$\frac{\text{Combined \% cumulative retained } 3/8'' \text{ sieve}}{\text{Combined \% cumulative retained } \#8 \text{ sieve}}$	=	
Workability Factor =	Combined % passing #8 sieve	=	
Adj-Workability Factor =	$WF + [(Cementitious \text{ Material} - 564) \div 37.6]$	=	
Allowable Adj-WF =	$Adj-WF = [(11.25 - .15 \text{ CF}) + 35.5] \pm 2.5$	=	Low High

D. ATTACHMENTS: Include the following with this Mix Design Report.

- Portland Cement mill test reports
- Fly ash mill test reports
- Slag mill test reports
- Designation, type, quality, and source (natural or manufactured) of coarse and fine aggregate materials
- Separate aggregate gradation reports including all required sieve sizes
 - All gradation sieve report tests dated within 60 days of this report
 - Report for each coarse and fine aggregate material in mix
- Statement if possible reactivity of aggregate, based on tests or past service
- Statement if possible aggregate pop-outs or their disruptions, based on tests or past service
- Product data for the following admixtures:
 - Chloride ion data and related calculations
 - Water reducing, set retarding, set accelerating, etc.
- Measured water-soluble chloride ion content in concrete (percent by weight of cement)
- Concrete compressive strength data used for standard deviation calculations

E. CONCRETE SUPPLIER INFORMATION

Company Name _____ **Tel. #** () _____

Address _____

City, ST Zip _____

Technical Contact _____ **Cell #** () _____

e-mail _____

Sales Contact _____ **Cell #** () _____

PRIMARY PLANT

SECONDARY PLANT

Plant Location: _____

Miles from Site: _____

Travel Time to Site: _____

NRMCA Certified: YES NO

YES NO

State DOT Certified: YES NO

YES NO

Batch Mixing Type: DRY CENTRAL MIX

DRY CENTRAL MIX