SECTION 11
CONCRETE

11.01 GENERAL

The work described in this section shall consist of furnishing all labor, materials and equipment and performing all work necessary for constructing and/or removing concrete structures and reinforcement steel.

Concrete and reinforcing steel for all classes and types of construction shall be furnished and placed in accordance with the applicable provisions of this section.

These specifications are intended to supplement the Alabama Department of Transportation Standard Specifications for Highway Construction. They shall take precedence over the Alabama Department of Transportation Standard Specifications except on State highways. For items not covered by these specifications, the Alabama Department of Transportation Highway Department standard specifications shall apply.

11.02 TESTING RESPONSIBILITY

The cost of testing will be borne by the Contractor, unless otherwise noted in the contract documents. Testing for concrete components will be as outlined in Section 9 or within this section.

11.03 CONTRACTOR RESPONSIBILITY

The contractor is responsible for subsurface investigation, construction, testing, etc. and perform all work required to complete the project. The plans show certain features of topography and certain underground utilities, but they do not purport to show in complete detail all such lines or underground features. Such topography and notes on the plans are inserted from records available and are for the Contractor's convenience only and shall not be used as a basis for claims of extra compensation. Wherever necessary to determine the location of existing pipes, valves, or other underground structures, the Contractor shall examine all available records and shall make all explorations and excavations for such purpose. The Contractor at no cost to the Owner shall immediately repair any damage to existing facilities resulting from the Contractor’s operations.

11.04 CLASSES OF CONCRETE

Concrete shall be composed of cement, fine and course aggregates, and water proportioned and mixed to produce a plastic, workable mix in accordance with the requirements of this section and shall be suitable for the specific conditions of placement. Concrete shall be classified as "A", "B", or “C” and shall have normal setting characteristics.

A. Class "A" Concrete shall be used for reinforced concrete cast-in-place in form for foundations, footings, piers, headwalls, tanks, walls, floors, manholes, vaults, and for unreinforced footings and slabs not thicker than eight inches (8").

B. Class "B" Concrete shall be used for unreinforced (plain) concrete work such as gravity type walls, pipe encasement, collars, thrust blocks, and similar massive sections; and for unreinforced footings and slabs thicker than eight inches (8").

C. Class “C” Concrete shall be used for machine laid curb, gutter, or combination curb and gutter.

11.05 MATERIALS

All concrete and reinforcement steel materials shall be in accordance with the ALDOT standards and specifications. The following is a list of materials:

A. Coarse Aggregates
B. Fine Aggregates
C. Admixtures
D. Water
E. Air Entraining Additives
F. Chemical Admixtures
G. Cement
H. Curing Material
I. Joint Fillers, sealers, and water stop materials
J. Steel Reinforcement

11.06 CONSTRUCTION METHODS

A. Design Mix

A design mix shall be computed in accordance with the Portland Cement Association Bulletin SF-100, "Design of Concrete Mixes", and tested by the approved testing laboratory. Each mix shall be prepared, proportioned, and mixed using samples of the cement, admixtures, and aggregates to be used in the work. At least four (4) cylinders shall be made from the design mix for each class of concrete, two (2) shall be tested at seven (7) days, and two (2) shall be tested at twenty eight (28) days in accordance with ASTM C31 and C39.

B. Proportioning and Mixing

1. Proportioning and mixing shall be accomplished at central mixing plant. The ingredients shall be selected, proportioned, and mixed in a manner that will produce a workable mixture having a slump within the required limits and having a minimum water content. All materials shall be measured by weight, except for water which may be measured by volume. One (1) bag of Portland Cement shall be considered to weigh ninety four pounds (94 lbs.). Concrete ingredients shall be proportioned to produce concrete within the following limiting requirements:

	Class A Concrete	Class B Concrete
Minimum compressive Strength at 28 days		
5 consecutive specimens (lb./sq.in.)	4,000	2,000
Any one specimen (lb/sq. in.)	3,600	1,600
Volume of cement per cubic yard concrete		
Minimum (Bag)	6.0	4.5
Maximum (Bag)	8.0	5.5
Volume of water per cubic feet of cement		
Maximum (Gal.)	5.0	7.5
Amount of Air Entrained in fresh mix		
Minimum (% of volume)	5	None
Maximum (% of volume)	7	None

2. Proportioning shall be identical to that established by the design mix, except that the proportions shall be changed whenever, in the opinion of the Engineer, a change is necessary to obtain the required strength and the desired density for uniformity and workability.

3. In calculating the total water content of mixes, the amount of water borne on the surfaces of the aggregate shall be included. The amount of water shall in all cases, be the least amount necessary to produce a plastic mix having the required strength and the desired durability, density, uniformity and workability, yet having a slump within the limits of two inches (2") minimum and four and one-half inches (4½") maximum.

4. The air content of the freshly mixed concrete shall be determined by ASTM Test C211, the frequency of the test being determined by the Engineer of record of the Geotechnical representative. Concrete containing more or less air than specified shall not be used in the work.

5. Concrete shall be mixed in a standard batch mixer that shall rotate at a peripheral speed of not fewer than two hundred feet (200') per minute. Mixing time shall be one (1) minute for batches of one (1) cubic yard, or less, and shall be increased fifteen (15) seconds for each additional one half (½) cubic yard. The entire batch shall be discharged before discharging the mixer.

6. Transit-mixed concrete may be used provided it is produced and transported to the forms in accordance with ASTM C24.

C. Forms

1.Forms shall be made of metal. Sheeting used to form permanently exposed concrete surfaces shall be steel or plywood of adequate strength.

2. Form work shall be build to conform to the shape, lines, and dimensions of the concrete work and shall be set true to line and grade. Forms shall be braced and tied in a manner that will withstand the pressure created by fresh concrete and will not bulge, sag, or leak concrete. Surfaces shall be smooth. Lumber used once in forms shall have nails removed before reusing as formwork. Forms shall be clean and thoroughly oiled with a non-straining mineral oil before placing concrete. Temporary openings shall be provided at the bottom of the forms to facilitate cleaning and inspection. Wall sleeves and inserts shall be set properly. Bolts and rods used for internal ties shall be set so that no metal will be less than one inch (1") from the surface after the forms are removed.

3. Forms shall not be removed until the member supported thereby has acquired sufficient strength to safely support its own weight, and the load imposed on it. The rod clamps shall be loosened twenty-four (24) hours after concrete has been placed. Standard snap ties shall be removed when forms are striped, care being taken to avoid spoiling the concrete surface. Under normal conditions, the time elapsing before the forms may be stripped shall be not less than that shown in the following schedule. The use of the schedule shall not relieve the Contractor from his responsibility for the safety of the structure.

Slabs	14 Days
Columns and Pedestals	7 Days
Walls and Vertical Faces not Supporting Other Work	2 Days
Other Concrete	2 Days

4. All exposed concrete edges shall be provided with a three fourths of an inch (¾") chamfer unless another size of chamfer is shown on the plans. Chamfer strips shall be adequately secured to the forms.

D. Placement

1. The Engineer must inspect the depth and character of the foundations, the formwork, and the placing of reinforcing steel and inserts before the concrete is placed. Unacceptable conditions shall be corrected before concrete is placed in the forms.

2. All water and debris shall be removed from the forms and excavations. Flowing water shall be diverted into side drains or sumps. Concrete shall be placed on clean, damp surfaces and shall not be placed on mud or on dry, porous earth.

3. Concrete shall be placed in daylight except when placement at night is specifically authorized by the Engineer.

4. Concrete shall be mixed and placed only when the temperature is at least forty degrees Fahrenheit (40ºF) and rising.

5. Concrete shall be carried from the mixer to the forms in bottom dump concrete buckets, concrete buggies, or wheelbarrows, and shall be deposited as close as practical to its final position in the forms. Place in continuous horizontal layers, approximately twelve inches (12") thick, in order that it can be effectively compacted with a minimum of lateral movement. Place each batch and each layer immediately following the preceding so that there will be no "cold joints" in the work, yet regulated in such a manner that the design pressure of the form work will not be exceeded. Work concrete into corners and ground reinforcement and embedded items, with spades, in a manner that will fill all voids and prevent honeycombing and segregation of coarse aggregate.

6. Concrete shall not be allowed to drop freely more than five feet (5'). When the vertical distance for placement exceeds five feet (5'), the concrete shall be placed with a tremic.

7. Concrete shall be compacted with mechanical, internal vibrating equipment supplemented with hand spading and tamping. Vibrators shall not be used for transporting concrete within the forms. Vibrating equipment shall maintain an impulse rate of not less than three thousand-six hundred (3,600) impulses per minute when submerged in the concrete. At least one (1) spare vibrator, in good operating condition, shall be maintained on the job site as a relief. Vibrators shall be moved continuously from point to point the duration of vibration at any point being limited to that time necessary to consolidate the concrete without causing objectionable segregation.

8. Thin section work shall be thoroughly worked with a steel rod. Small diameter holes shall be drilled in form work beneath large wall sleeves and other inserts to prevent entrapment of air beneath the inserts.

9. Immediately remove any water that accumulates during placement of the concrete.

10. Before placing new concrete on or against concrete that has recently set or cured, the surfaces of the hardened concrete shall be thoroughly roughened and cleaned of all foreign matter and laitance. The cleaned surfaces shall then be moistened, slushed with grout, and the new concrete placed before the grout has attained its initial set.

11. Top surfaces not covered shall be protected from rain and all other injurious conditions. Formwork and exposed reinforcing steel must not be jarred after concrete has taken its initial set.

12. Concrete found to be porous plastered, of less strength than specified, or otherwise defective, shall be removed and replaced in whole or in part, as directed by the Engineer, at no additional expense to the Owner.

E. Curing and Protection

1. Wet Burlap shall be used to cure concrete that is to be painted, topped with grout, or receive a coating that requires us of an adhesive. Burlap shall be kept wet
continuously for a period of seven (7) days.

2. Liquid membrane curing compound shall be used to cure all concrete not cured with wet burlap. Curing compound shall be Sonneborn-Contech Hydrocide Resin Base Compound, Lambert Corp. No 64-WB Compound, or Master Builders "Master Seal". Compound shall contain a fugitive red dye and shall be applied immediately after the forms are removed, at the rate recommended by the manufacturer. The Contractor shall submit literature on proposed curing compound to the Engineer for review before its use.

3. In cold weather, concrete shall be mixed and placed only when the temperature is at least forty degrees Fahrenheit (40ºF) and rising, unless specifically authorized by the Engineer, in which event all materials shall be heated in a manner acceptable to the Engineer. In freezing weather, suitable means shall be provided for maintaining the concrete at a temperature of a least fifty degrees Fahrenheit (50º F) for a period of not less than seventy two (72) hours after placing, or until the concrete has thoroughly hardened. Salt, chemicals or other foreign materials shall not be mixed with the concrete for the purpose of preventing freezing. Concrete temperature shall not be allowed to exceed ninety degrees Fahrenheit (90ºF) during pouring operations or for seventy-two (72) hours hereafter.

F. Joints

1. Construction joints and expansion and contraction joints shall be constructed only at locations shown on the plans or on the standard details. Concrete at all joints shall have been in place not less than twelve (12) hours before concrete is placed on or adjacent to it. The joints shall be straight and exactly horizontal or vertical as shown on the plans, molded water stops shall be used in construction joints and expansion and contraction joints. Molded water stops shall be of rubber or polyvinyl chloride composition.

2. Molded rubber water stops for construction joints shall be the flat type, six inches (6") in length, with a three-fourths of and inch (¾") bulb at each end. Molded rubber water stops for expansion and contraction joints shall be the flat type, nine inches (9") in length, with a one inch (1") bulb at each end and an one and one-half inch (1½") hollow bulb in the center. Splices in rubber water stops shall be made by vulcanizing or by the use of a rubber union and rubber cement. Molded rubber water stops shall be as manufactured by Servicised Products Corp., W. R. Meadows, Inc., or approved equal.

3. Molded polyvinyl chloride water stops for construction joints shall be the flat type, six inches (6") in length and 3/8" inch thick, with a three fourths of an inch (¾") bulb at each end, as manufactured by Servicised Products Corp., or the flat type six inches (6") in length and 3/8" inch thick with end and intermediate ribs, as manufactured by Vulcan Metal Products, Inc., A-H Products, or equal. Molded Polyvinyl chloride water stops for expansion and contraction joints shall be the flat type, nine inches (9") in length and 3/8" inch thick, with a one inch (1") bulb at each end and a one and one half inch (1½") hollow bulb in the center, as manufactured by

Servicised Products Corp., Vulcan Metal Products, Inc., A-H Products, or approved equal. Splices in polyvinyl chloride water stops shall be made by the heat softening process in strict accordance with the manufacturer's recommendations.

4. In expansion and contraction joints, premolded joint filler and cold applied joint sealing compound shall be applied to the opening on both sides of the molded water stop. Cold applied joint sealing compound shall be applied to the opening at the top of the molded water stop. Premolded joint filler shall be Self-Expanding Cork, code 4324, and cold applied joint sealing compound shall be Vertiseal (light gray), a polysulfide polymer, both as manufactured by Servicised Products Corp., W. R. Meadows, Inc., or approved equal.

11.07 FINISHING CONCRETE

A. All permanently exposed concrete surfaces, which are above water level, except floors and slabs, shall be given a rubbed finish consisting of filling small voids and two rubbings. In addition, all walls inside process basins shall be given a rubbed finish. Plastering and steel toweling or surfaces will not be permitted.

B. After the concrete has set sufficiently, forms and form ties shall be carefully removed and all depressions, holes, and rough places shall be wetted with water, filled with mortar (1 part cement & 2 parts sand), and floated smooth. The surfaces shall be kept wet until the initial rubbing is complete.

C. Initial rubbing shall commence as soon as the pointing is set. A No. 16 carborundum stone shall be used to remove all burrs, form marks, and irregularities. The concrete shall then be cured for at least seven (7) days before the final rubbing.

D. Final rubbing shall be done with a No. 30 carborundum stone. All swirl marks and surplus materials shall be removed and the surface shall be left with a uniform, smooth finish and uniform color.

E. Floors and slabs, after being compacted and vibrated, shall be prepared to receive the specified finish. All floors, walks, platforms, stairs, and other slabwork shall have a wood float finish. After screeding to the required grade while the concrete is still green, but has hardened sufficiently to bear the finisher's weight, the concrete surface shall be floated with a wood float to a true and even plane, have no visible coarse aggregate, and be sufficiently rough to prevent slipping. Floor topping shall be applied where shown. Sub-base shall be wire-brushed before sub-base has hardened, shall be swept clean, shall be thoroughly wetted, and shall be slushed with bonding grout. Topping shall be floated and troweled twice and in a manner that will prevent the fine material from being drawn up.

F. The second troweling shall be done after the surface produces a ringing sound. A liquid hardener shall be applied in three (3) applications in strict accordance with the manufacturer's written instructions. Hardener shall be Sonneborn Building Products "Lapidolith", A.C., Horn co., "Hornolith", or Standard Dry Wall Products, Inc., "P & W Floor Hardener". Hardener solution shall not be allowed to come in contact with metal or painted surfaces.

G. Waterproofing

1. Waterproofing materials of the paint and/or membrane types shall be applied to concrete structures at the locations shown on the plans. Waterproofing paint and its application shall be shown on the plans or as specified in the Special Conditions.

2. Membrane type waterproofing shall consist of four coats of hot applied waterproofing pitch and three layers of No. 15 tarred felt, or one coat of cold applied setting cement and one layer of synthetic sheeting. Pitch and felt shall be as manufactured by the Barrett Division, Allied Chemical Corp.; or approved equal. Cold applied cement shall be Nervastrol Seal-Pruf H-D, as manufactured by Building Products Division, American Cyanamid Co.; or approved equal. Membrane waterproofing shall be applied in accordance with the manufacturers' recommendations and as authorized by the Engineer.

H. Watertightness

All concrete structures for holding or transporting water, and pits or vaults below ground level, shall be watertight. Structures for holding water shall be filled with water and tested for twenty-four (24) to forty eight (48) hours. A drop in the water level more than 1/8" inch in
twenty-four (24) hours will not be acceptable. All leaks shall be repaired in an approved manner. Patching, caulking, or any other method of repair on the outside or normally dry side of the wall will not be acceptable. Damp spots on the exposed walls of pipe galleries and valve pits shall be considered leaks and shall be eliminated.

I. Defective Work

1. In the event test cylinders fail to show the specified strength, or where the quality of the concrete is otherwise sub-standard or defective, the Contractor may be directed to obtain cores from the concrete for further testing. The cost of coring and testing the cores will be borne by the developer, contractor, or material supplier.

2. Defective and/or damaged work shall be satisfactorily removed and replaced by the contractor in a manner that will not impair the strength of the structure. New materials and the workmanship in replacing the concrete shall be in accordance with the plans and specifications. All costs of removing and replacing defective concrete shall be at the expense of the Contractor.

11.08 REINFORCING STEEL

Bar reinforcement shall be Grade 60 steel conforming to the requirements of ASTM A615 or A616. Bars shall be deformed in accordance with ASTM A615. Mesh type reinforcement shall be electrically welded, cold drawn mild steel conforming to ASTM A185. Bars shall be bent cold, in the shop, to the shapes indicated on the plans. Hooks shall be not less than the standard hooks recommended in ACI "Building Code Requirements for Reinforced Concrete".

Satisfactory written evidence shall be submitted to the Engineer showing that the steel to be used conforms to these specifications. Certified true copies of test and acceptance reports will normally suffice. Steel reinforcement shall be accurately tagged, bundled, and stored on the job site in a manner that each piece is easily identified. Steel shall be stored on the job in a manner that it is protected from the elements.

Complete detailed shop drawings shall be submitted by the Contractor to the Engineer of record or the Geotechnical representative for review prior to fabrication, however, this review will not relieve the Contractor of his responsibility to check all dimensions and insure that the steel is sized, cut, and bent correctly. Steel that is incorrectly sized, cut, and bent, or otherwise unsuitable, shall not be used in the work.

All steel shall be thoroughly cleaned of oil, mill scale, rust, and dirt before it is tied in place, and shall be re-cleaned if necessary prior to placement of concrete. All steel shall be accurately positioned and securely tied with suitable wire, or clips at intersections, and shall be adequately supported by concrete or metal chairs, spacers, hangers, etc., to prevent movement during placement of the concrete.

The distance between parallel bars shall be exactly as shown on the plans. The bars nearest and parallel to the forms shall be placed such that the minimum distance between the face of the bars and the forms shall be as follows:

Slabs	1 inch
Floors, walkways, driveways	1½ inches
Walls	2 inches
Beams and Girders - Stirrup Steel	1½ inches
Beams and Girders - Main Reinforcement	2 inches
Columns	2 inches
Footings in contact with ground	3 inches

At splices, bars shall be lapped at least 36 diameters, and in all cases the lap shall be sufficient to transfer the stress between bars by bond and shear and to develop the full strength of each bar. Splices shall not be made at points of maximum stress in slabs, beams, or girders or at the same point in adjacent bars.

Supports and ties shall be placed such that they will not be exposed or discolor the finished concrete. In the event any steel moves or is displaced during placement of concrete, the steel shall be restored to its proper position before it is completely covered.