

SECTION LS 452**FIBER-REINFORCED CONCRETE PAVEMENT****PART 1 – GENERAL**

Concrete driveways, roadways, sidewalks, walkways, curbs, and gutters shall be constructed in accordance with this specification and the requirements of the State of Ohio, Department of Transportation, Construction and materials, current edition.

A. SCOPE

This Section specifies cast-in place concrete for driveways, roadways, sidewalks, curbs, gutters, and walkways, which consists of providing concrete materials, concrete mixture designs, formwork, reinforcement, mixing, transporting, placing, consolidating, finishing, curing, and protection of concrete.

B. RELATED WORK DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this section.

1. LS 101 Work Summary
2. LS 102 Third Party Inspection
3. LS 110 Preconstruction Videos
4. LS 452 SPECIAL – Sealers for Concrete Surfaces
5. LS 613 Flowable Fill LSM
6. LS 614 Maintaining Traffic
7. LS 623 Construction Layout and Survey
8. LS 659 Landscape Repair
9. LS 2300 Earthwork
10. LS 2745 Sandstone Sidewalk Salvage

C. REFERENCE DOCUMENTS

Comply with the most current edition of all reference documents.

- 1. Ohio Department of Transportation**
 - a. Construction and Material Specifications Manual
- 2. American Association of State Highway Officials (AASHTO)**
 - a. M182 Burlap Cloth Made from Jute or Kenaf

3. American Concrete Institute (ACI)

- a. ACI 117: Specification for Tolerances for Concrete Construction and Materials
- b. ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- c. ACI 214: Recommended Practice for Evaluation of Strength Test Results of Concrete
- d. ACI 301: Standard Specifications for Structural Concrete
- e. ACI 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete
- f. ACI 305R: Hot Weather Concreting
- g. ACI 306R: Cold Weather Concreting
- h. ACI 308: Standard Practice for Curing Concrete
- i. ACI 309R: Guide for Consolidation of Concrete
- j. ACI 310R: Guide to Decorative Concrete
- m. ACI 311.4R: Guide for Concrete Inspection
- n. ACI 360: Design of Slabs on Ground
- o. ACI 564: Guide to Concrete Repair

4. American Society for Testing and Materials (ASTM) Publications:

- a. C 31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
- b. C 33: Standard Specification for Concrete Aggregates
- c. C 39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- d. C 40: Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
- e. C 42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- f. C 87: Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
- g. C 88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- h. C 94: Standard Specification for Ready-Mixed Concrete
- i. C 109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or [50-mm] Cube Specimens)
- j. C 123: Standard Test Method for Lightweight Particles in Aggregate
- k. C 136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- l. C 138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
- m. C 143: Standard Test Method for Slump of Hydraulic Cement Concrete
- n. C 150: Standard Specification for Portland Cement
- o. C 157: Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete
- p. C 171: Standard Specification for Sheet Materials for Curing Concrete
- q. C 172: Standard Practice for Sampling Freshly Mixed Concrete
- r. C 192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
- s. C 231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

- t. C 260: Standard Specification for Air-Entraining Admixtures for Concrete
- u. C 289: Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
- v. C 295: Standard Guide for Petrographic Examination of Aggregates for Concrete
- w. C 309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- x. C 311: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
- y. C 494: Standard Specification for Chemical Admixtures for Concrete
- z. C 595: Standard Specification for Blended Hydraulic Cements
- aa. C 618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
- bb. C 979: Standard Specification for Pigments for Integrally Colored Concrete
- cc. C 989: Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
- dd. C 1064: Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
- ee. C 1116: Standard Specification for Fiber-Reinforced Concrete
- ff. C 1315: Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
- gg. C 1550: Standard Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel)
- hh. C 1609: Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)
- ii. D 75: Standard Practice for Sampling Aggregates
- jj. D 7508: Standard Specification for Polyolefin Chopped Strands for Use in Concrete
- kk. E 329: Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

D. DEFINITIONS

- A. **Cementitious Materials:** Portland cement, fly ash, and slag cement (ground granulated blast furnace slag (GGBFS), and other pozzolans.
- B. **Cold Weather Concrete (ACI 306R):** A period when for more than three successive days the average daily air temperature drops below 40 degrees Fahrenheit and stays below 50 degrees Fahrenheit for more than one-half of any 24-hour period.
- C. **Hot Weather Concrete (ACI 305R):** One or a combination of the following conditions that tends to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise causing detrimental results: high ambient temperature; high concrete temperature; low relative humidity; and high wind speed.

- D. **W/CM Ratio:** The ratio by weight of water to cementitious materials.
- E. **Defective Areas:** Surface defects that include honeycomb, rock pockets, indentations greater than 3/16 inch, cracks 0.005-inch wide and larger, spalls, chips, air bubbles greater than 3/4 inch in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form pop outs, texture irregularities, and stains and other color variations that cannot be removed by cleaning.

E. SUBMITTALS

1. ACTION SUBMITTALS

- a. Product Data: For each type of product indicated.
- b. Other Action Submittals
 1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results or other circumstances warrant adjustments.

2. INFORMATIONAL SUBMITTALS:

- a. Qualification Data: Submit field or laboratory test records used to document that proposed concrete mixture will achieve the required average compressive strength and other specified requirements for each class of concrete.
 - i. Field test records for concrete strength test records must be from concrete supplied from the same production facilities proposed for Work.
 - ii. Test data shall be from concrete mixtures containing similar materials proposed for Work.
 - iii. Strength test records for establishing a standard deviation for each class of concrete mixture or for documenting the required average strength for
 - i. Work shall not be greater than 12 months old and shall be collected over a period not less than 45 days.
- b. Submit properties and specified requirements of mixtures for each class of concrete including:
 - i. Each proposed mix design showing:
 1. Water/cement ratio
 2. Weights and test results of the ingredients
 3. Aggregate gradation
 4. Air content
 5. Compressive strength of mixture design at 7 and 28-days
 6. Slump, before and after introduction of high-range water-reducing admixture

7. Test results of mix design by an independent testing laboratory
 - c. Product literature and technical data for
 - i. Aggregates
 - ii. Cement
 - iii. Fly Ash
 - d. Product literature, technical data, and dosage of proposed admixtures including, but not limited to,
 - i. Air entrainment
 - ii. Water Reducers
 - iii. Superplasticizers
 - iv. Fibers
 - v. Pigments
 - e. Product literature, technical data, and dosage of synthetic macrofiber.
 - f. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in Part 3, include proposed method to extend set time without deleterious effects on final product. ENGINEER reserves the right to accept or reject such proposed methods.
 - g. Curing program description in sufficient detail to demonstrate that the CONTRACTOR will provide acceptable strength, finish, and crack control of completed pavement.
 - h. Product literature and technical data for curing and sealing compounds.
 - i. Submit documentation indicating installer, manufacturer, and testing agency meet the qualifications specified in Section F Quality Assurance
 - j. Field quality control reports

F. QUALITY ASSURANCE

1. The Contractor is responsible for obtaining and examining Federal, State, and Local Building Codes as they pertain to the contracted work. All such Codes that are more stringent than the contract documents shall be followed.
2. Slag/foundry sand is not permitted to be used on the project.
3. Qualifications:
 - a. Installer: A company specializing in placement of concrete with a minimum of 3 years' experience on projects of similar size and scope.

- i. At least one person on the finishing crew must be certified as an ACI Flatwork Finisher, or equivalent.
 - b. Ready Mixed Concrete Manufacturer: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
 - i. Ready-mixed concrete producer shall be certified by the National Ready Mixed Concrete Association or the Ohio Department of Transportation.
 - c. Testing Agency: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - i. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
4. Pre-installation Conference: Conduct conference to coordinate work and to assure compliance with requirements
 - a. Representatives of each entity directly concerned with cast-in-place concrete are recommended to attend, including:
 - i. Architect
 - ii. Structural Engineer
 - iii. General Contractor/Construction Manager
 - iv. Installer (Concrete Contractor)
 - v. Reinforcing Steel Contractor
 - vi. Post-tensioning Contractor
 - vii. Pumping Contractor
 - viii. Manufacturer (Ready-mixed concrete producer)
 - ix. Independent testing agency
5. Mock-Ups for Pigmented Concrete
 - a. A mock-up is required unless specifically waived by the City of Lakewood.
 - b. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - c. Construct mock-ups of concrete with pigments for approval of color by City of Lakewood.
 - d. Construction of mock-ups:
 - i. For accurate color, the quantity of concrete mixed to produce the sample should not be less than 3 cubic yards (or not less than 1/3 the capacity of the mixing drum on the ready-mix truck) and should always be in full cubic yard increments. Excess material should be discarded according to local regulations.
 - ii. Construct mock-up panel using processes and techniques intended for use on permanent work, including curing procedures.
 - iii. Include samples of control, construction, and expansion joints in sample panels.

- e. Mock-up sample shall be produced by the individual workers who will perform the work for the project.
 - f. Approved mock-ups shall become the standard for color, appearance, and workmanship.
 - g. Mock-ups shall remain as part of the completed Work.
6. Basis for Quality:
 - a. Perform concrete work in conformance with ACI-301 unless otherwise indicated or specified.
 7. Do not use admixtures, including calcium chloride, which will cause accelerated setting of cement in concrete and mottling of integrally pigmented concrete.
 8. Concrete mixtures, material tests (cement, fine aggregates, coarse aggregates, fly ash, slag cement, etc.) and trial concrete batch mix compression test results shall not be older than 12 months, accounted from the date received by the OWNER.
 9. Do not place concrete until design mix, material tests, and trial concrete batch mix compression test results are approved by the OWNER.
 10. The CONTRACTOR shall employ an independent testing laboratory, acceptable to the OWNER, to test conformity of materials to specification and to design concrete mixtures.
 11. Testing laboratory shall furnish trial concrete design mixes having proportions, admixtures and slump proposed for use, based upon ACI 211.1. Furnish at least three different water-cement ratios that will produce a range of strengths encompassing those required for the work. Report design mixes for maximum permitted air, slump and temperature of concrete used in trial batches.
 12. Produce new concrete design mixes at no additional cost to the OWNER when job site concrete is not of required strength. Provide additional testing when original sample materials produce unsatisfactory results or new material sources are to be used. All additional testing shall be done by the same testing laboratory and paid for by the CONTRACTOR.
 13. Measure all materials for concrete, including water, with equipment and facilities suitable for accurate measurement and capable of being adjusted in conformance with ASTM C 94. Use scales certified by local Sealer of Weights and Measures within one year of use and accurate when static load tested to plus or minus 0.4 percent of total capacity of scale. Batch all materials by weight except admixtures that may be batched by volume.
 14. The CONTRACTOR's testing agency will take control test specimens; conduct slump tests and measure air content and temperature in the field.

15. Methods of Sampling and Testing:
 - i. Fresh Concrete Sampling: ASTM C 172
 - ii. Specimen Preparation: ASTM C 31
 - iii. Compressive Strength: ASTM C 39
 - iv. Air Content: ASTM C 231 5. Slump: ASTM C 143
 - v. Temperature: ASTM C 1064
 - vi. Obtaining Drilled Cores: ASTM C 42
16. Acceptance of Work: Acceptance of completed concrete work requires conformance with dimensional tolerances, appearance and strength as indicated or specified.
17. Hot weather concrete to conform to ACI 305R and as specified herein.
18. Cold weather concrete to conform to ACI 306R and as specified herein.
19. Reject concrete delivered to job site that exceeds the concrete temperature limitations in ACI 301
 - a. *Minimum temperature*—If the average of the highest and lowest ambient temperature from midnight to midnight is expected to be less than 40°F for more than 3 successive days, deliver concrete to meet the following minimum temperatures immediately after placement unless otherwise specified:
 - i. 55°F for sections with least dimension less than 12 in.
 - ii. 50°F for sections with least dimension 12 to 36 in.
 - iii. 45°F for sections with least dimension 36 to 72 in.
 - iv. 40°F for sections with least dimension greater than 72 in.The temperature of concrete as placed shall not exceed these values by more than 20°F. These minimum temperature requirements may be terminated if temperatures above 50°F occur during more than half of any 24-hour duration.
 - b. *Maximum temperature*—Unless otherwise specified, the temperature of concrete as delivered shall not exceed 95°F.
20. Do not place concrete in water or on frozen or disturbed ground.

G. DELIVERY, STORAGE, AND HANDLING

1. Order concrete from batching plant so that trucks arrive at discharge locations when concrete is required. Avoid excessive mixing of concrete or delays in placing successive layers of concrete in forms.
2. Deliver concrete to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water-cement ratio, slump, air entrainment, temperature, and homogeneity.

Reject concrete not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations or not having a complete delivery batch ticket.

H. FIELD CONDITIONS

1. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
2. Do not place concrete until conditions and facilities for making and curing control test specimens are in compliance with ASTM C31 and as specified herein.
3. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - a. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 °F (10 °C) and not more than 80 °F (27 °C) at point of placement.
 - b. Do not use frozen materials or materials containing ice or snow.
 - c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
4. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
 - a. Cool ingredients before mixing to maintain concrete temperature below 90 °F (32 °C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - b. Fog-spray forms and subgrade just before placing concrete.
 - c. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 – PRODUCTS

2.1 CONCRETE, GENERAL

- A. Comply with Requirements of ACI 301 and ODOT Items 451, 452, 499, 511, 608, and 609 shall apply except as modified herein. The Contractor is responsible for products that comply with the specifications.

2.2 FORMWORK

- A. Formwork Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 1. Use flexible or uniformly curved forms for curves of a radius of 100 feet (30.5 m) or less. [Do not use notched and bent forms.]

- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 CONCRETE MATERIALS: use materials meeting the following requirements.

A. Cementitious Materials

1. Portland Cement: ASTM C150

- i. Use cementitious materials that are of the same brand, type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures. See Change of Materials paragraph below.
- ii. Use cement of uniform color.

1. Fly Ash: Provide fly ash conforming to the following requirements:

- a. Class F Fly ash conforming to ASTM C 618 for chemical and physical properties. Class C fly ash is not allowed. Pozzolan supplied during the life of the project shall have been formed at the same single source. See Change of Materials paragraph below.
- b. The fly ash color shall not substantially alter the resulting concrete from the normal gray color and appearance.
- c. Use fly ash materials that are of the same brand and type and from the same plant of manufacture as the materials used in the concrete represented by the submitted field test records or used in the trial mixtures.

B. AGGREGATES

1. General:

- a. Except as modified herein, fine, and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates are regarded as separate ingredients. Aggregates shall be non-reactive and washed before use.
- b. Test for size and grading of fine and coarse aggregates shall be in accordance with ASTM C136. Combined aggregates shall be well and uniformly graded from coarse to fine sizes to produce a concrete that has optimum workability and consolidation characteristics. Establish the final combined aggregate gradation during mix design.
- c. Aggregates used in the project production concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by the submittal historical data or trial mixtures. See Change of Materials paragraph below.

2. Fine Aggregate:
 - a. Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33.
3. Coarse Aggregate
 - a. Coarse aggregate shall be hard, dense, and durable gravel or crushed rock free from injurious amounts of soft and friable particles, alkali, and organic matter. Other deleterious substances shall not exceed the limits listed in ASTM C33, Table 3 for Class Designation 4S.
4. AIR ENTRAINING ADMIXTURE: ASTM C 260/C260M
5. CHEMICAL ADMIXTURES: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - b. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II
6. FIBER REINFORCEMENT: Synthetic macropolypropylene fiber shall comply with ASTM C 1116 and D7508, with a maximum of 2.25 inches (57 mm) length and an aspect ratio of 50 to 90.
 - a. Macro fibers shall be used with expressed approval of the manufacturer for the intended application and recommended dosage to achieve mixture performance requirements. Basis for testing may include test results of ASTM C1609 or C1550. The f_{e3} value required for structural design shall be in accordance with ACI 360 for slab on ground design and/or pavements to be calculated from ASTM C1609.
 - b. The Contractor will submit documentation to The City of Lakewood and obtain approval of the macro fiber material prior to use on the job.

7. COLOR PIGMENT: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
 - a. Color: Solomon – Apple Red or equal.

8. WATER
 - a. For washing aggregate, mixing, and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; comply with the requirements of ASTM C1602. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

9. EVAPORATION RETARDER: Liquid applied evaporation retarders shall form a continuous monomolecular film and reduce moisture loss from fresh concrete surface.
 - a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - i. Euclid, EUCOBAR
 - ii. BASF, CONFILM
 - iii. SIKAFILM as manufactured by Sika Corporation
 - iv. Or equal.

10. CURING MATERIALS
 - a. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

 - b. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

 - c. Water: Potable. Do not use water containing substances that will discolor or impair the durability of the concrete.

 - d. Curing and Sealing Compound – See LS 452 Special – Sealers for Concrete Surfaces

11. CHANGE OF MATERIALS
 - a. After each concrete mix design is approved, no changes of any sort or source will be allowed without prior written approval from the ENGINEER. When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed, new field data, data from new trial mixtures, or evidence that indicates that the change will not affect adversely the relevant properties of the concrete shall be submitted for approval by the ENGINEER before use in concrete.

2.3 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM Expansion joint filler composed of a synthetic foam of isomeric polymers in a very small, closed-cell structure. Joint filler shall be non-absorbent and have a resiliency of 99%. Joint filler shall conform to the following standards and have the following requirements:

1. ASTM D545 using a (1/2" (12.7 mm) thick test specimen).
 - a. Compression: 13 psi (9 g/mm²) 89.6 kPa.
 - b. Extrusion: 0.1• (2.5 mm).
 - c. Recovery: 99.21%.
 - d. Water Absorption, volume %: 0.246.
2. ASTM D 1752, Type II.
3. ASTM D5249, Type II.
4. Thickness: 1/2".

B. Imprinting/Texturing Tools

1. Stamp mats to be semi-rigid polyurethane with projected texture and ridged underside capable of imprinting texture and joint patterns to plastic concrete.
2. Stamping Patterns
 - a) Running Bond
 - b) Random Brick
 - c) Pattern matching existing concrete work in tree lawn or crosswalk and approved by City Inspector.

2.4 CONCRETE MIXTURE DESIGN REQUIREMENTS

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Exposure Class F3.
2. Cementitious material content shall be minimally 660 lbs./yd³.
3. Compressive Strength (28 Days): 5,000 psi.
4. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.40.
5. Slump Limit: 4 inches, plus or minus 1 inch.
6. Modulus of Rupture (24 Hr): 400 psi

- C. Air entrain all concrete. Use admixtures conforming to ASTM C260.
1. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - a) 8.5 percent plus or minus 1.5 percent for $\frac{3}{8}$ -inch aggregate for slabs of 4 to 8 inches in thickness.
 - b) 6 percent plus or minus 1.5 percent for $\frac{3}{4}$ -inch and 1-inch nominal maximum aggregate sizes for slabs of 4 to 8 inches in thickness.
 - c) 5.5 percent plus or minus 1.5 percent for 1 $\frac{1}{2}$ -inch nominal maximum aggregate size for slabs of 8 inches thickness or greater.
 2. Measure air content in accordance with ASTM C231.
 3. Adjust the admixture content to accommodate the fly ash requirements, and other admixtures when used, in order to obtain the specified air content.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- E. Chemical Admixtures: Admixtures shall be used with expressed approval of the manufacturer for the intended application and recommended dosage to achieve mix performance requirements.
1. Water-Reducing Admixtures: Conventional, normal- and mid-range water reducing admixtures shall be chloride-free (contribute no more than 0.005% chloride content by weight of cement) and meet the requirements of ASTM C94.
 2. High Range Water reducing admixtures will be permitted for the increase of slump at the job site for placement and workability. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Accelerators: Accelerating admixtures shall be chloride-free (contribute no more than 0.005% chloride content by weight of cement). An accelerator may be necessary to meet performance requirements based on the mixture design and/or lower ambient soil and concrete temperatures.
- F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
1. Fly Ash or Pozzolan: 15 percent.
 2. Slag Cement (GGBFS): 15 percent
 3. Combined Fly Ash and Slag Cement: 15 percent
 4. Portland cement replacement with fly ash or slag cement shall be permitted between March 15th and October 15th.
 5. If cold weather conditions exist, as defined in ACI 306R, cement replacement is strictly prohibited.

6. Cement replacement by fly ash or slag cement is prohibited in pigmented concrete mixtures.

G. Fiber Reinforcement

All concrete shall contain synthetic macrofiber reinforcement. Synthetic macro reinforcement fiber shall comply with ASTM C 1116 and D7508, with a minimum of 1.5 inches and a maximum of 2.25 inches (57 mm) length and an aspect ratio of 50 to 90,

1. Fiber dosage shall be as recommended by the manufacturer, but not less than 3.0 pounds per cubic yard for concrete thickness 8 inches or less and 4.0 pounds per cubic yard for 8.1 inches or greater.
2. Fiber shall be added to the mix at the plant during the batch or mixing process, and not at the job site, and mixed a minimum of 70 revolutions to ensure proper dispersion per ASTM C94 and ACI 304.
3. All concrete batch delivery tickets shall be provided to the city inspector, indicating quantity of fiber used.

H. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

- a. Add colored pigment to the mix at 3.8 % by weight of cementitious material content. For dry pigment this equates to 25 lbs./yd³ for Solomon Apple Red.
- b. Do not add calcium chloride to mix as it causes mottling and surface discoloration.
- c. Do not add water to the pigmented concrete mixture in the field.

2.5 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

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

i. Integral Colored Ready-Mixed Concrete:

1. As specified in A except for the following:

- a. Measure, batch, mix, and deliver concrete with pigments in accordance with manufacturer's instructions.
- b. Ensure mixer is clean and free of washout water before loading.
- c. Load mixer to a minimum of 1/3 capacity and not beyond capacity.

- d. Add concrete materials to mixer in same order for each batch.
- e. Do not add pigment to mixer as first concrete material.
- f. Maintain consistent amounts of batch water in each batch.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Tamp or proof-roll prepared subbase surface below the landside concrete paving to identify soft pockets and areas of excess yielding.
 1. Completely tamp or proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph when proof-rolling.

Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

2. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section LS 2300 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 PREPARATION

- A. Do not place concrete until data on materials and mixture proportions are accepted.

- B. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment.
- C. Immediately before placing concrete, remove loose and foreign materials from the subgrade and complete the following:
 - 1. Subgrade and base shall be prepared in accordance with Contract Documents.
 - 2. Tolerance for the base material elevation shall be in accordance with ACI 117.
- D. Before placing concrete in forms, complete the following:
 - 1. Inspect and complete formwork comply with formwork requirements specified in Section 2.
 - 2. Remove snow, ice, frost, water, and other foreign materials from surfaces against which concrete will be placed, and from reinforcement and embedded items.
 - 3. Pour concrete on well compacted firm subbases that are well drained.
 - 4. Moisten base to provide a uniform dampened condition at time concrete is placed.
 - 5. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- E. Make provisions in advance of concrete placement to limit the rate of evaporation of the water from the concrete surface during or immediately after placing or finishing.
- F. Seasonal Conditions:
 - 1. Conform to ACI 305R and as specified herein for hot weather concreting. Do not add retarder admixture to concrete without approval from Engineer.
 - 2. Conform to ACI 306R and as specified herein for cold weather concreting. Do not add accelerating admixture to concrete without approval from Engineer.
 - 3. Do not place concrete containing fly ash or slag cement during cold weather concreting, as defined in ACI 306R.

3.3 JOINTS AND EMBEDDED ITEMS

A. Provide construction and expansion joints as specified elsewhere in these specifications:

1. Bush hammer or lightly sandblast all construction joints to expose coarse aggregate and to remove loose concrete and laitance before placing adjoining concrete. Do not damage exposed concrete edges, key grooves, waterstops or reinforcement.

B. Embedded and Fixed Items:

1. Clean embedded items of oil and all foreign matter.
2. Provide expansion joint material around the perimeter of all fixed objects (utility poles, fire hydrants, etc.) unless noted otherwise to also install inserts, anchors, sleeves, and other items indicated or specified under other sections of these specifications in formwork.
3. Check location and support of piping and other embedded items before depositing concrete.

3.4 TRANSPORTING AND MIXING OF CONCRETE

A. Conform to concreting procedure set forth in ACI 304R and as specified herein.

1. Transport concrete to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature, and homogeneity.
 - a. Discharge concrete into forms within 1-1/2 hours after cement has entered mixing drum or before the drum has revolved 300 revolutions after the addition of batch water, whichever occurs first.
 - b. Unless otherwise stated, obtain the required slump or slump flow within the tolerances stated with the addition of water, or water-reducing admixture, or both. The maximum quantity of water-reducing admixture that can be added at the job site shall be determined by the manufacturer and shall not exceed the maximum water content for the batch as established by the designed mixture proportions. After the additions, the drum shall be turned at least 30 revolutions at mixing speed. The quantity of water and/or water-reducing admixture added shall be recorded.

- c. Water additions in excess of the proportioned maximum water content or w/cm to compensate for loss of workability are strictly prohibited.
 - d. Water additions to pigmented concrete is strictly prohibited once pour has begun.
3. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time is necessary, in conformance with the following:
- a. Reduce maximum mixing and placement time from 90 to 45 minutes maximum when concrete temperature at time of placement is between 85-and 90-degrees F.
 - b. Reject concrete with a temperature more than 95 degrees F unless a lower placing temperature is specified as the limit for rejection.

3.5 CONCRETE ACCEPTANCE

- A. The CONTRACTOR shall accept or reject each batch of concrete delivered to the point of agitator or mixer truck discharge. The signature of a CONTRACTOR's authorized representative on the delivery batch ticket shall indicate concrete acceptance.
- B. The CONTRACTOR shall reject concrete delivered without a complete concrete delivery batch ticket as specified herein. The concrete supplier will furnish copies of the signed batch ticket to the CONTRACTOR and OWNER.
- C. The CONTRACTOR's testing agency shall perform field tests at the point of agitator or mixer truck discharge. Accept or reject concrete based on conformity with slump, air content and temperature specified.
- D. The CONTRACTOR's testing agency shall inspect concrete transit truck's barrel revolution counter and gauge for measuring water added to the concrete. Reject concrete which exceeds the maximum barrel revolution of 300 or which has water content exceeding the specified water-cement ratio.
- E. The CONTRACTOR shall reject concrete exceeding time or temperature limitations specified.
- F. The CONTRACTOR shall reject concrete not conforming to specification before discharging into the forms.

3.6 PLACEMENT OF CONCRETE

A. WEATHER CONSIDERATIONS

1. Wet weather
 - a. Do not place concrete while rain, sleet, or snow is falling unless protection is provided. Do not allow precipitation to increase mixing water or to damage concrete surface.
2. Cold weather
 - a. In temperatures below 45 °F, place concrete in accordance with ACI 306.1. Do not place concrete in contact with surfaces less than 35°F.
3. Hot weather
 - a. In temperatures above 80 °F, place concrete in accordance with ACI 305.1. If temperature of reinforcement, embedments, or forms is greater than 120 °F, use a fine mist of water to moisten and cool hot surfaces. Remove standing water before placing concrete.

B. CONVEYING

1. Convey concrete from mixer to final deposition using equipment of sufficient capacity to place the concrete in the correct location without compromising its quality in conformance with ACI 301.
2. Convey concrete from agitator or mixer truck to place of final deposit in forms by one of the following methods:
 - a. Buckets or hoppers with discharge gates having a clear opening equal to not less than one-third the maximum interior horizontal area or five times the maximum aggregate size being used, whichever is greater, and side slopes of not less than 60 degrees to horizontal.
 - b. Buggies or wheelbarrows equipped with pneumatic tires.
 - c. Round bottom, metal, or metal-lined chutes with inclined slope of between two to three feet horizontally to one foot vertically and sufficient capacity to avoid overflow.

C. DEPOSITING

1. Deposit concrete into its final position in conformance with ACI 301 and as specified herein. Place concrete in one or multiple horizontal layers completely across forms.

2. Avoid inclined layers and cold joints. Place concrete at lower portion of slope first on sloping surfaces.
3. Do not deposit partially hardened concrete in forms. Re-tempering of partially hardened concrete is not permitted. Remove all partially hardened concrete from site at no additional compensation.
4. Do not allow concrete to fall freely in forms to cause segregation (separation of coarse aggregate from mortar). Do not move concrete horizontally more than four feet from point of discharge. Space points of deposit not more than eight feet apart.
5. Do not splash forms and reinforcing above level of concrete being placed. Regulate placing of concrete so that pressure caused by wet concrete will not distort or deflect forms beyond finish tolerances specified elsewhere in these specifications.

3.7 CONSOLIDATING CONCRETE

- A. Consolidate concrete in accordance with ACI 301 and ACI 304.
- B. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout its entire depth of the layer.
- C. Consolidate concrete around embedded items, filling all corners and angles, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete.

3.8 FINISHING OF CONCRETE SURFACES

A. GENERAL

1. Concrete surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface.
2. Do not add water to concrete surfaces during finishing operations.
3. Aluminum finishing tools shall not be used.
4. Sidewalks and aprons shall have a broom finish with picture frame finish along the perimeter per the City detail. Should the adjacent driveway or sidewalk have a fan finish or other specialty finish the Contractor shall match the finish at no additional expense to the City.

The Contractor shall review the required finishes with the City representative prior to placement.

B. SCREEDING AND FLOAT FINISH

1. Screed paving surface with a straightedge and strike off.
2. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
3. Begin the second floating operation when bleed-water sheen has disappeared, and concrete surface has stiffened sufficiently to permit operations. Float surface with power driven floats or by hand. Finish to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture free of waves, irregularities, or tool marks.

C. EDGE AND JOINT FINISHING

1. All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Sidewalks and driveway aprons will be finished with a picture frame as noted in 3.12, Section C.
2. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

D. BROOM TEXTURING

1. Medium-to-Fine Broom Finish: Draw a soft-bristled broom across float-finished concrete surface perpendicular to the line of traffic to provide a uniform, fine-line texture.

3.9 JOINTS

A. GENERAL

1. Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

2. All roadway concrete joints, including transverse joints, shall be installed per latest edition of ODOT CMS and standard details, including but not limited to BP 2.1 – 2.5, unless modified herein.
3. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. CONSTRUCTION JOINTS

1. Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

C. ISOLATION JOINTS

1. Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
2. Locate expansion joints at intervals of 15 feet unless otherwise indicated.

D. CONTRACTION JOINTS:

1. Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
 2. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 3. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

3.10 CONCRETE CURING AND PROTECTION

A. GENERAL

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
2. Protect finished work from damage by foot or vehicular traffic.

B. COLD WEATHER PROTECTION

1. Comply with ACI 306.1

C. EVAPORATION RETARDER

1. Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lbs./sq. ft. per hour before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. CURING INITIATION

1. Begin Curing after finishing concrete but not before free water has disappeared from the concrete surface.

E. CURING METHODS – See LS 452 Special – Sealers for Concrete Surfaces

3.11 PROTECTION OF FINISHED CONCRETE FROM DAMAGE

- A. Barricade area to protect paving.
- B. Prohibit foot traffic on paving surface for the time specified by manufacturer, or until paving is properly protected from damage.
- C. Exclude traffic from paving for at least seven days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

3.11 OPENING TO TRAFFIC

- A. Requirements of ODOT Items 451, 452, 499, 511, 608, 609 and the standard drawings shall apply except as modified herein.

- B. Approval to open the concrete paving, curbs and aprons to traffic will be granted by The City of Lakewood's representative upon receipt of a test beam report that shows at 600 psi has been achieved for that placement. No truck traffic will be permitted for at least seven days, unless permission is expressly granted by The City of Lakewood allowing truck traffic earlier than seven days.

3.13 TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
1. Elevations: $\frac{1}{2}$ inch
 2. Thickness: Plus $\frac{3}{8}$ -inch, minus $\frac{1}{4}$ inch
 3. Surface: Gap below 10-foot-long, unlevelled straightedge not to exceed $\frac{1}{2}$ inch.
 4. Lateral Alignment and Spacing of Dowels: 1 inch
 5. Vertical Alignment of Dowels: $\frac{1}{4}$ inch
 6. Alignment of Dowel Bar End Relative to Line Perpendicular to Paving Edge: $\frac{1}{4}$ inch per 12 inches of dowel.
 7. Joint Spacing: 3 inches
 8. Contraction Joint Depth: Plus $\frac{1}{4}$ inch. No minus.
 9. Joint Width: Plus $\frac{1}{8}$ inch. No minus.

3.14 CITY OF LAKEWOOD PAVEMENTS

A. GENERAL

1. Unless otherwise approved in advance by the City, all Fiber-Reinforced Concrete pavements shall be constructed using self-propelled paving machines.
2. The requirements specified in ODOT CMS 451.13, Surface Smoothness, shall apply.
3. Contraction joint spacing shall be 12 feet.
4. Expansion joints shall be installed at a maximum spacing of 500 feet, or as shown on the plans.

B. CAST-IN-PLACE CURBS

1. PAYMENT
 - a. Item for curb shall include all removal of curb, backfill behind curb, removal of old underdrains, furnishing and installing new underdrain with stone, furnishing, and installing fill, topsoil and new curb with preformed expansion material and joint filler, all sealing and curing work, complete.
2. Cast-in-place curb shall be installed in accordance with this specification, Item 609 and the cast-in-place curb detail shown on the

drawings. Washed #8 limestone aggregate shall be used as drainage fill around the underdrain as detailed on the plans.

3. All existing curb to be replaced shall be removed and are the responsibility of the Contractor. Butt joint with existing curb to remain shall be saw cut neat and true.
4. Contractor shall excavate and cast all curbs and aprons on one side of the street before any work commences on the opposite side of the street.
5. Curbs shall be slip-formed and integral with the concrete pavement, if possible. On concrete paved street with tight clearances, an integral curb and gutter is acceptable.

C. DRIVE APRON AND SIDEWALKS

1. PAYMENT

- a. Items for aprons and sidewalks include all removal of aprons and sidewalks, excavation, disposal, furnishing and installing all stone, concrete and expansion joint material, all saw-cut and curing compound application, complete.

2. DRIVEWAY APRON REMOVAL AND REPLACEMENT

- a. Shall be placed no later than three (3) days after excavation.
- b. This item shall conform to LS 2300, ODOT CMS Item 202 and 452 and the other provisions of this section, with the following additions:
 - i. Concrete shall have a minimum thickness of six inches (6") and shall be placed on a four-inch (4") layer of approved limestone aggregate base and shall extend from back of curb to back of walk.
 - ii. Full depth expansion material shall be placed between new apron and existing driveways where existing driveways are concrete.
 - iii. A 1-1/2" raised lip shall be constructed in the apron where new apron meets roadway pavement, per standard Lakewood detail.
 - iv. Surface shall be broom finished perpendicular to traffic flow with tooled control joints. The sidewalk section shall be broom finished perpendicular to pedestrian traffic flow and shall include

tooled joints. All tooled joints shall result in the Lakewood standard "picture frame" pattern or as stated in Section 3.8.A.4.

- c. Curb boxes and cleanout cover fixtures in aprons or walks: All such fixtures shall be installed/adjusted so that no part protrudes above the sloped surface of the apron. Concrete shall be shaped and molded around the fixtures so that no sharp edges or vertical surfaces result. Under no circumstances shall concrete be placed on top of the fixtures. All concrete shall be immediately removed from the top of the fixtures.

3. CONCRETE WALKWAYS

- a. Concrete shall be of a minimum four-inch (4") thickness placed on a two-inch (2") minimum approved limestone aggregate base.
- b. Sidewalk contraction joints shall be tooled and a minimum ¼" depth, not sawed.
- c. The new walk shall be measured through the handicap curb ramp area unless a separate curb ramp pay item appears in the bid tabulation.
- d. Sidewalk surface shall be broom finished perpendicular to pedestrian traffic flow with tooled joints and edges.
- e. All tooled joints shall result in the Lakewood standard "picture frame" pattern or as stated in Section 3.8.A.4.

4. CURB RAMPS

- a. Ramps shall be constructed per the referenced specifications and the details shown on the plans and extend from the back of curb to the edge of sidewalk.
- b. Ramp joints shall be tooled, not sawed.
- c. All tooled joints shall result in the Lakewood standard "picture frame" pattern.
- d. There shall be a zero (0) elevation difference between the toe of the ramp and the pavement.
- e. Curb ramp concrete materials shall be in accordance with this specification.

- f. Cast iron detectable warning plates shall only be used and treatments shall be installed according to the details shown on the plans and the manufacturer's specifications. The detectable warning plate treatments shall be completely bedded and flush with the surrounding concrete on all contact sides.
- g. The Contractor shall submit the proposed truncated dome treatment and bedding products for City approval prior to ordering.

5. COLORIZED AND STAMPED CONCRETE TREELAWN & BROOM-FINISHED CROSSWALKS

- a. All colored concrete will be integrally pigmented.
- b. Follow section 3.8.B as defined in this specification for finishing of all broom-finished, colored concrete crosswalks. Broom-finish shall be completed perpendicular to pedestrian traffic flow.
- c. Follow Section 2.3.B as defined in this specification for finishing of all stamped, colored concrete treelawns.

3.15 FIELD QUALITY CONTROL

A. GENERAL

- 1. CONTRACTOR to engage a qualified testing agency to perform tests.
- 2. The testing agency shall be approved by the City of Lakewood prior to commencing construction.

B. NOTIFICATION OF DELIVERY

- 1. Furnish delivery batch ticket to The City of Lakewood's representative in the field with each batch delivered to the discharge locations in conformance with ASTM C94. Batch tickets shall be written in ink or computer printed and to include:
 - a. Load number, truck number, and driver's name
 - b. Strength of concrete (compressive strength)
 - c. Amount of concrete (cubic yards)
 - d. Time truck is charged with cement
 - e. Revolution counter reading at first addition of water
 - f. Type, brand, and amount of cement

- g. Type, brand, and amount of supplemental cementitious material e.g. fly ash and slag cement
- h. Type, brand, and amount of admixtures
- i. Information necessary to calculate total mixing water
- j. Weights of fine and coarse aggregates
- k. Concrete temperature at batch plant

C. TESTING SERVICES

1. Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - a. Testing Frequency: Obtain at least one composite sample of each concrete mixture placed each day as follows:
 - i. Pavement and Curbs: One test daily for each of the FIRST two (2) trucks of each continuous placement and for every 50 yards thereafter, but not less than once a day.
 - ii. Aprons and Walkways: One for the FIRST truck of each continuous placement and for every 30 yards thereafter, but not less than once a day.
 - b. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - c. Air Content: ASTM C231 pressure method; one test for each composite sample but not less than one test for each day's pour of each concrete mixture.
 - d. Temperature: ASTM C1046; one test hourly when air temperature is 40 °F and below and when it is 80 °F and above, and one test for each composite sample.
 - e. Compressive Strength Test Specimens: ASTM C 39; one test specimens at 24-hours, 3-days, and 7-days; 2 test specimens at 28-days; and one test specimen to held for 56-days.
 - i. A compressive-strength test shall be the average compressive strength from two specimens obtained from the same composite sample at 28-days.

- f. The testing agency will immediately notify the CONTRACTOR and The City of Lakewood if the 28-day strength is deficient.
 - g. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive strength tests equals or exceeds specified compressive strength and no compressive strength test value falls below specified compressive strength by more than 500 psi.
 - h. No flexural beam tests per ODOT 451 will be required when the Contractor opens the poured area 48 hours after the pour. Any proposed time less than 48 hours will require beams to confirm that strength has been achieved.
2. Test results shall be reported immediately upon completion in writing to The City of Lakewood, Concrete Manufacturer, and Contractor. All test reports shall be forwarded within two (2) working days. Reports of compressive strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for 24, 3-day, and 28-day tests.
 3. Additional Tests: Testing Agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the City of Lakewood.
 4. Concrete paving will be considered defective if it does not pass tests and inspections.
 5. Additional testing, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 6. Prepare test and inspection reports.

D. SURFACE EVALUATION

1. The finished surface of the completed work will be inspected by the City of Lakewood and any deficiencies in appearance will be identified.
2. Areas which exhibit excessive cracking discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

E. CONCRETE CORING

1. The CONTRACTOR will be directed by the City of Lakewood to take concrete cores at least 2 inches in diameter from the structure in conformance with ASTM C 42 should the control test specimen's compression test fail to be in compliance with the Contract Documents or if the OWNER detects deficiencies in the concrete.
2. Take at least three representative cores from each member or area of concrete that is considered potentially deficient.
3. Replace cores that show evidence of having been damaged subsequent to or during removal from the structure.
4. The City of Lakewood will determine the core locations.
5. Remove all anchors used to secure coring machine to concrete patch holes as specified herein.

The City of Lakewood's testing laboratory agency shall compression test the cores taken from the structure in conformance with ASTM C 39. The City of Lakewood's testing agency will submit test reports of concrete field measurements specified above to the CONTRACTOR and to the City of Lakewood.

3.16 REPAIR OF DAMAGED AND CRACKED CONCRETE

A. ACCEPTANCE OF CONCRETE

1. Completed cast-in-place work shall conform to the applicable requirements of ACI 301, ODOT CMS, and the Contract Documents. Concrete work that fails to meet these requirements shall be repaired, as approved by the City of Lakewood, to bring the concrete into compliance.
2. Repair methods shall be in accordance with ACI standards, including ACI 546R, and are subject to the approval of the City of Lakewood.
 - a. Repair damaged colored concrete in accordance with manufacturer's instructions.
3. Concrete that cannot be brought into compliance by the approved repair methods will be rejected. Rejected work will be removed and replaced.

4. The cost of repairs and replacement of defective concrete shall be borne by the CONTRACTOR.

B. SURFACE DEFICIENCIES AND CORRECTIONS

1. Thickness Deficiency
 - a. When measurements indicate that the completed concrete section is deficient in thickness by more than $\frac{1}{4}$ inch, the deficient section will be removed, between regularly scheduled joints, and replaced.
2. High Areas
 - a. In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5% of the area of any integral slag, and the depth of grinding shall not exceed $\frac{1}{4}$ inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.
3. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by the City of Lakewood.
4. Drill test cores where directed by the City of Lakewood, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with Portland cement concrete bonded to paving with epoxy adhesive.

3.17 CONCRETE STRENGTHS

Payment for concrete used in the pavement, curbs and aprons will be made if 3000 psi is achieved within 24 hours. If the initial design mix does not meet 3000 psi within 72 hours but does so within seven (7) days, full payment will be withheld until such time as the concrete consistently achieves the 3000 psi 7-day strength. The allowed time period for mix adjustment is three (3) days; so the mix must be immediately adjusted to compensate. Otherwise, concrete work will be paid at a reduced contract rate.

3.18 CONCRETE BATCH TICKETS/WATER-CEMENTITIOUS MATERIAL RATIO

- A. Each load of concrete delivered shall have a separate ticket listing the amount of coarse aggregate, fine aggregate, cement, fly ash, slag cement, water-reducing admixtures, accelerating admixtures (if used), air-entraining admixture and water. The time the truck left the plant and time of arrival on

the job site shall be clearly illustrated. Concrete batch tickets will be given to The City of Lakewood's representative. Concrete must be placed within ninety (90) minutes of mixing. Loads delivered after this time will be rejected.

- B. The City of Lakewood's representative on the job must have sufficient information from the tickets to accurately calculate the water-cementitious material ratio to determine that this performance requirement (maximum 0.40) is not exceeded. The Contractor may add water on the job provided: that the concrete is mixed at least 70 revolutions at normal mixing speed per ASTM C94; that the water added is recorded on the ticket; that the water-cement ratio when calculated with additional water does not exceed the specifications; and that nominal slump requirements are not exceeded.

3.19 SEWER CLEANING AND DOCUMENTATION

- A. The Contractor shall provide a final cleaning of all manholes, catch basins and sewers that were exposed during, or subject to, pavement construction. This final cleaning shall take place following the completion of all other construction activities.
- B. All sewer system structures, and piping shall be kept clear of all construction debris and materials on a daily basis. The Contractor is financially liable for all expenses incurred as a result of construction debris, materials or other damage caused by his activities that restricted or blocked the functioning of any part of the sewer system.
- C. All catch basins exposed to construction activities, including those adjacent to the construction area, shall be opened and inspected down to the bottom of the sumps at the conclusion of construction. This item shall include removal of standing water.
- D. All debris identified by the videotaping and the manhole and catch basin inspections shall be removed by the Contractor.
- E. All cleaning, and documentation costs shall be included in the tabulated items for storm sewer, storm manhole, lateral and catch basin installation or pavement installation. All video tapes shall be turned over to the City.

PART 4 – PAYMENT

4.1 METHOD OF MEASUREMENT

- A. The City of Lakewood will measure and pay for Sidewalk and Driveway Aprons by the actual square foot installed. Payment for these items shall be considered full compensation for all labor and material for the removal and disposal of existing sidewalk, apron, aggregate base, temporary backfill,

and subgrade including the installation of finished concrete, aggregate base, saw cutting, expansion joint material, and curing/sealer compound application.

- B. The City of Lakewood will measure and pay for non-integral Curb (e.g. Type 6) by the actual linear foot installed. Payment for this item shall be considered full compensation for all labor and material and shall include removal of all existing curb, backfill and underdrains, furnishing and installing new curb, underdrain, fill, topsoil, preformed expansion joint material, joint filler, all sealing and curing/sealer work, complete.
- C. The City of Lakewood will measure and pay for Concrete Pavement by the actual Square Yards installed. Payment for this item shall be considered full compensation for all labor and material to install finished concrete pavement, integral curbs (e.g. Type 2-A or Type 4-A), all joint materials (expansion, contraction and construction joints) and curing/sealer compound application.
- D. The City of Lakewood will measure and pay for Curb Ramp removal by each which shall include all restoration and topsoil and seeding per LS 659. Payment for this item shall be considered full compensation for all labor and material for the saw cutting, removal and disposal of existing sidewalk, aggregate base, temporary backfill, and subgrade, and for the installation of finished concrete, aggregate base, expansion joint material, and curing/sealer compound application. Thirty square feet of sidewalk is included in each curb ramp location installed, with any remaining square foot quantity to be paid as 4” sidewalk removal and replacement.
- E. The City of Lakewood will measure and pay for 24” x 48” cast iron detectable warning plates by each actual number installed.

4.2 BASIS OF PAYMENT

- A. Payment for accepted quantities, complete in place, will be made at the contract price for:

<u>Item</u>	<u>Unit</u>	<u>Description</u>
LS 452	SF	___” Sidewalk, Removal and Replacement
LS 452	SF	___” Driveway Apron, as per plan
LS 452	EA	Curb Ramp, as per plan
LS 452	EA	Cast Iron Detectable Warning Plate

