Section 9.2
Volume II

STRUCTURAL CONCRETE PRODUCTION FACILITIES GUIDE

9.2.1 PURPOSE

This guide establishes policies that govern the production of structural concrete used by the Florida Department of Transportation, herein after called the Department. The guide also provides a concrete producer with information related to the methods and the minimum requirements for Quality Control (QC) Plan, and the criteria by which the Department will review that acceptance.

9.2.2 AUTHORITY

Sections 20.23(3)(a) and 334.048(3), Florida Statutes

9.2.3 SCOPE

The principal user of this document is a structural concrete producer.

9.2.4 REFERENCES

Code of Federal Regulations (CFR), Federal-Aid Policy Guide (FAPG), Subchapter G – Engineering and Traffic Operations, Part 637 – Construction Inspection and Approval, Subpart B – Quality Assurance Procedures for Construction Sections 334.044(2), 334.044(10)(a), and 334.048 Florida Statutes

American Society for Testing and Materials (ASTM) Standard Test Methods and Specifications, Philadelphia, Pennsylvania

American Association of State Highway and Transportation Officials (AASHTO), Part II Tests, Washington, D.C.

Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

Florida Department of Transportation Approved Products List

Florida Department of Transportation Sampling and Testing Methods (FSTM)

9.2.5 GENERAL INFORMATION

Concrete production facilities that supply concrete to Department projects must have a QC Plan accepted by the Department in accordance with the ***Specifications Section 105***. A list of concrete production facilities, herein after called plants, with accepted QC Plans that meet the requirements of this guide, will be maintained by the Department.

Concrete produced in accordance with the ***Specifications Section 346*** and this guide shall be accepted with the proper certification and verification of job site acceptance criteria.

Methods of sampling and testing materials shall be in accordance with the ***Specifications***. References to the sampling and testing methods shall be construed to mean the most current issuance, including interims or addenda.

The Department will inspect the plants every three months or less. The concrete producer may request a reduced scheduling frequency for the plant inspections from the District Materials and Research Engineer (DMRE). The reduced scheduling frequency shall be based on the plant coefficient of variation ($Cv=\sigma/\mu$: σ=standard deviation; μ=mean), previous plant inspections, failing samples attributed to the plant, and a request from the producer. Upon meeting all criteria, the plant may be changed to a reduced inspection frequency. If approved by the DMRE, the inspection frequency shall be a minimum frequency of once every six (6) months or less. These inspections will assist in ensuring that the plant continues to produce a material that is in accordance with the accepted QC Plan, ***Specifications and other Contract Documents***.

9.2.6 CONCRETE PRODUCERS ROLES AND RESPONSIBILITIES

9.2.6.1 Material Requirements

Meet the requirements found in the ***Specifications Section 346***.

9.2.6.2 Cementitious Materials

Acceptance of the cementitious materials at the plant shall be based upon the delivery ticket and Mill Certificate. As a check on current quality, samples may be obtained and tested by the Producer or the Department.

Each brand or type of cementitious material shall be stored in a separate and clearly labeled weatherproof facility. Suitable, safe, and convenient means of collecting cementitious material samples will be provided.

Measure the cementitious materials by mass within an accuracy of 1 percent of the required total amount. For concrete batches of 3 yd^3 or less, an accuracy of 2 percent is allowed. Weigh the cementitious materials separately from other materials. When weighing the cementitious materials in a cumulative weigh hopper, weigh the cement first.

If bagged highly reactive pozzolans or other cementitious materiall are permitted, proportion the batch to use only whole bags. Store the highly reactive pozzolans in accordance with the manufacturer's recommendation.

9.2.6.3 Aggregates

Aggregate used on Department projects must be accordance with ***Rule 14-103, FAC***. A list of approved sources will be maintained by the Department and made available from the State Materials Office (SMO).

As a minimum, suitable bins, stockpiles or silos shall be provided to store and identify aggregates without mixing, segregating, degradation or contaminating the different sources or grades. Department designated, approved pit number and aggregate grade shall be included in the identification.

Aggregates shall be measured by mass or volume within an accuracy of 1 percent of the required amount.

The handling of the aggregates, so as to minimize segregation and to recover the material from the stockpile for use in the mix so it will remain within Specification limits, is the responsibility of the concrete producer. Stockpiles shall be maintained in a well drained condition to minimize free water content and not promote algae/fungal growth. The plant shall make available to the Department, from the recovery side of the stockpile where feasible, the quantities of aggregate necessary for sampling and testing to ensure compliance with the ***Specifications and other Contract Documents***.

9.2.6.3.1 Wetting Coarse Aggregate Stockpiles, Storage Bins and Silos

The coarse aggregate shall be continuously and uniformly sprinkled with water for a period of 24 hours immediately preceding introduction into the concrete. Any request for deviations from the 24-hour sprinkling requirement shall be addressed in the Producer's QC Plan for consideration by the DMRE.

9.2.6.4 Admixtures

Concrete mixes shall use only admixtures approved by the Department. A certification from the admixture supplier that the admixture meets the requirements of ***Specifications Section 924*** is required. The certification will include a statement from the admixture's supplier or an accepted independent testing laboratory that the proposed admixture is compatible with all other admixtures to be included in the concrete design mix. The admixture dosage rate of the product to be used should be within the range of the manufacturer's technical data sheet. Dosage rates outside of this range may only be used with written recommendation from the admixture producer's technical representative.
Measure the admixtures by mass or volume. Use measuring equipment that has accuracy (under all operating conditions) within 3 percent of the quantity of admixture required for the batch. Measure each admixture separately, and add it to the mixing water in a separate sequence as the mixing water is introduced into the mix.

Store the admixtures in accordance with the manufacturer's recommendation.

9.2.6.5 Scales, Meters, and other Weighing or Measuring Devices

9.2.6.5.1 General Requirements

The accuracy of all scales, meters, and other weighing or measuring devices, excluding admixture dispensers, shall be checked prior to the production of concrete and, at a minimum, once every three months thereafter. A qualified representative of a scale company registered with the Bureau of Weights and Measures, Division of Standards of the Florida Department of Agriculture and Consumer Services, shall conduct the check for accuracy. The Department reserves the right to be present during all accuracy checks.

The date of inspection, signature of the company representative, observed deviations for each quantity checked and a statement that the device conforms to the ***Specifications and other Contract Documents*** shall be included in the report provided by the qualified company performing the check. A copy of the report corresponding with the current certificate of inspection shall be available at the plant where the device is located.

Affix a certificate of inspection bearing the date of the certification showing signature of the company representative to each weighing or measuring device.

9.2.6.5.2 Scales and Meters

Maintain scales to an accuracy of 0.5 percent of the maximum load normally handled.

9.2.6.5.3 Water Measuring Devices

The check for accuracy will be by weight or volume. Whichever method is used, construct the equipment so that the accuracy of measurement is not affected by variations in pressure in the water supply line. Use a meter or weighing device capable of being set to deliver the required quantity and to automatically cut off the flow when the required quantity has been discharged. Ensure that the measuring equipment has accuracy, under all operating conditions, within 1 percent of the quantity of water required as total mixing water for the batch. The total mixing water shall include: water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures.

Use of flow meters mounted in series is acceptable provided the accuracy of the flow meters is traceable to the National Institute of Standards and Technology.

9.2.6.6 Admixture Measuring Dispensers

Annual certification of admixture measuring dispenser accuracy shall be completed by the admixture supplier. Calibrate the dispensing equipment for calcium nitrite quarterly.

9.2.6.7 Recorders

Plants equipped with recording mechanisms must provide records that are clear, complete, and with permanent indications of the plant's performance. Recorder information may be supplemented by the batcher during the batching operation. The Department shall be allowed to review the recorder history at any time.

9.2.6.8 Batching Accuracy

The failure to maintain batching operations of the plastic concrete within the tolerance for each component material requires immediate investigation and corrective action by the concrete producer. A failure to immediately investigate and implement corrective measures may be cause for suspension of the QC Plan.

9.2.6.8.1 Batch Adjustments for Materials

Permissible adjustments to previously approved design mixes that may be made without a new design mix request are as follows:

(1) Allowable variation of Coarse or Fine Aggregate: The variation for each aggregate can be ±75 lbs/yd^3 of concrete.

(2) Admixtures: Should be within the manufacturer's technical data sheet range. Dosage rates outside of this range may be used with written recommendation from the admixture producer's technical representative. Mixes with adjustments falling outside the technical data sheet range shall be suspended when written recommendation from the admixture producer's technical representative has not been obtained.

(3) Allowable variation of Cementitious Materials: ±6.5 percent per cubic yard but not less than the specified minimum for that class of concrete.

The adjusted mix must meet the theoretical yield requirements of the approved mix design.

The DMRE will be advised of any adjustments to the concrete mix design. Batch adjustments shall not be used for batch tolerances of aggregate and cementitious materials. The adjustments shall be noted on the concrete delivery tickets.

9.2.6.8.2 Batch Adjustments for Moisture

Free moisture for the coarse and fine aggregates will be determined within two hours prior to each day's batching, unless moisture meters are used. Determine the free moisture content of aggregates at 4-hour intervals during continuous batching operations, and at any time a change in moisture content becomes apparent. Adjustment of batch proportions will be made using these values.

One or more of the following methods shall be used to determine aggregate free moisture:

(1) Use moisture meter readings, speedy moisture tester or Chapman flask for fine aggregate moisture. The moisture meter readings may be used for coarse or fine aggregate moistures. The accuracy of the moisture meter shall be verified at least weekly by the manufacturer's recommended method and by method (2) below. The Chapman flask

and speedy moisture tester shall be verified at least weekly by method (2) below.

(2) Calculate both coarse and fine aggregate free moisture based upon dry sample weights and adjusting for absorption per AASHTO T 255. The following minimum sample sizes shall be used in lieu of the sample sizes required in AASHTO T 255 Table 1.

Fine Aggregate – 500 grams
Coarse Aggregate – 1500 grams

(3) Towel dry coarse aggregate to calculate free moisture on saturated surface dry aggregate. The accuracy of towel drying shall be verified weekly by method (2) above.

(4) The comparison criteria between any of these methods shall be no more than 0.5%.

9.2.6.9 Substitution of Materials

Obtain the Department's approval for aggregate or fly ash substitutions before beginning concrete placement. The Department may take up to five working days to review any material substitution request. A purchase order or delivery ticket for the new material used in the substitution shall be submitted with the request to substitute material. The producer will forward the proposed aggregate substitution to the appropriate DMRE or their representative for verification.

Fly ash from an approved source may be substituted within an approved mix design. The mix design may contain only one fly ash source. When a fly ash is substituted in the mix design, a new mix number will be issued for that mix.

Aggregate sources may be substituted within an approved base mix design provided that the aggregates are the same geological type, same size, and are from an approved source. The new aggregate source shall have a specific gravity (saturated surface dry) within 0.08 of the original aggregate source.

Ensure that the substituted mix meets the theoretical yield requirements, does not exceed the maximum water to cementitious materials ratio, and the cementitious content equals or exceeds the approved base mix design. The theoretical unit weight of the proposed mix design will be within 2.0 lbs/ft^3 of the originally approved theoretical mix design unit weight. Aggregate or fly ash substitution shall not require chloride testing for design mix approval.

The Department may require a single 3.0 yd^3 minimum test batch at the plant to demonstrate that the properties of the adjusted mix design is within the slump, air, compressive strength and chloride tolerances provided in ***Specifications Section 346***. When the Engineer determines that unsatisfactory results are obtained during production, the concrete producer shall return to the originally approved base mix design or obtain approval of a new mix design.

9.2.6.10 Equipment

Use equipment that has no detrimental effect on the plastic concrete for handling ingredients, mixing concrete, handling the mixed concrete, transporting and depositing the mixed concrete. Do not use equipment with aluminum surfaces in physical contact with the mixed product.

9.2.7 DESIGN MIXES

Concrete design mixes shall meet the requirements of ***Section 346*** of the **FDOT *Standard Specifications for Road and Bridge Construction.*** Use the provided ***Proposed Concrete Design Mix*** (Appendix B) document, or a similar document containing the same information, for design mix submittals. The concrete producer shall submit design mix verification requests directly to the DMRE in the District where the design mix will be verified. If a design mix is to be verified at a location that is out-of-state, submit the design mix design to the DMRE closest to that location.

Ensure that preparation and testing of the trial mixes is performed by a laboratory that is inspected and meets the requirements of ASTM C1077. Personnel performing plastic or hardened concrete testing shall be qualified as described in this guide.

Make a separate submittal for each class of concrete and each particular combination of component materials to be used at a trial mix concrete temperature of 68°F to 86°F, for hot weather mixes at a minimum concrete temperature of 94ºF or for hot weather concrete for extended transit time mixes. Slab replacement mixes shall not require hot weather verification for design mix approval. Use only design mixes approved by the SMO for Department use. Ensure that the 28-day strength (or strength at any other designated age) of all trial mixes meets the over design requirements to ensure that concrete sampled and tested at the point of placement has a strength exceeding the specified minimum strength.

Include the following with the mix design submittal:

(1) The Department approved source identification number for coarse and fine aggregates, specific gravity, along with the grade of coarse aggregate and target Fineness Modulus for fine aggregate. Identify other component materials by manufacturer, brand name, and type or class. Provide material certificate with specific gravity for all cementitious material.

(2) The actual proportions of raw materials intended to be combined to produce the concrete with a theoretical yield of 27 ± 0.02 ft^3.

(3) Test data from a single trial mix which demonstrates that the produced concrete using the proposed mix, designated ingredients and designated water to cementitious materials ratio will meet the plastic properties described in this guide. Apply an over design requirement, that is the minimum required strength plus 1,200 psi for specified concrete strengths of 5,000 psi or less. For specified concrete strengths above 5,000 psi, apply an over design requirement that is the minimum required strength plus 1,400 psi.

As an option, strength test data for establishing the standard deviation of the plant to meet the specified strength of the mix within 1,000 psi may be submitted for approval. The strength test data shall represent either a group of at least 30 consecutive tests or a statistical average for two groups totaling 30 or more tests. The strength test data from the trial batch is required to meet an over design, which is the minimum required strength for that class of concrete plus 1.6 standard deviations.

(4) The chloride content of the proposed design mix. The Department will not approve mix designs when the chloride content of the trial mix exceeds the limits shown in ***Specifications Section 346***.

(5) The admixture producer's technical representative's written recommendation when the admixture dosage rate of the product to be used is outside the range of the manufacturer's technical data sheet.

(6) A copy of any changes to the Standard Specifications, to include but not limited to Technical Special Provisions and Supplemental Specifications. Include any supporting documentation demonstrating compliance with the changes.

9.2.7.1 Concrete trial mix temperature between 68°F to 86°F (standard temperature mixes):

(1) Ensure that preparation and testing of the trial mix is performed in accordance with ASTM C192. Perform water to cementitious ratio calculations in accordance with FM 5-501.

(2) On completion of the mixing period, ensure that the trial mix concrete has a slump within ±0.50 inch of the target value (±1.0 inch for mixes utilizing a High Range Water-Reducing admixture), and an air content less than or equal to 6.0 percent.

9.2.7.2 Concrete trial mix temperature of 94°F (hot weather mixes):

(1) Ensure that preparation and testing of the trial mixes is performed in accordance with ASTM C192, with the following exceptions:

(2) Initial mixing shall be done in accordance with ASTM C192, except concrete materials shall be brought to a temperature that will ensure the mix temperature is not less than 94ºF at any time.

(3) Hold the trial mix in the mixer for 90 minutes after completion of initial mixing. During the extended mixing period, turn the drum intermittently for 30 seconds every five minutes. Cover the drum with wet burlap or an impermeable cover material during the rest periods. At the end of the 90-minute period, remix the trial mix for a minimum of one minute and make a slump test to verify that the concrete is within the specified range for slump. Ensure that the mix temperature is not less than 94ºF at any time.

(4) On completion of the extended mixing period, ensure that the trial mix concrete has a slump within ±0.75 inch of the target value (±1.0 inch for mixes utilizing a High Range Water-Reducing admixture), and an air content less than or equal to 6.0 percent. If below the target range, the producer may adjust the slump by a water addition. After the water addition, remix the concrete for a minimum of two minutes and perform slump and air content tests.

(5) The total water used in initial mixing and the final slump adjustment constitutes the design mix water content. Perform water to cementitious ratio calculations in accordance with FM 5-501. Ensure that the total water to cementitious materials ratio does not exceed the maximum water to cementitious materials ratio in the ***Specifications Section 346***, for the respective class of concrete.

9.2.7.3 Hot Weather concrete trial mix for extended transit time mixes:

Ensure that preparation and testing of the trial mixes are performed in accordance with the hot weather procedure, with the following additional requirements.

Upon completion of the hot weather procedure, no additional water shall be added to the batch. Hold the trial mix in the mixer for the additional time required after completion of the 90 minute mixing period. During the extended mixing period, turn the drum intermittently for 30 seconds every five minutes. Cover the drum with wet burlap or an impermeable cover material during the rest periods. At the end of the required additional time extension period, remix the trial mix for a minimum of one minute and perform a slump test to verify that the concrete is within the specified range for slump. Ensure that the mix temperature is not less than 94ºF at any time.

9.2.7.4 Concrete trial mix for *Specifications Section 353* (slab replacement):

Ensure that preparation and testing of the trial mix is performed in accordance with ASTM C192. Perform water to cementitious ratio calculations in accordance with FM 5-501.

On completion of the mixing period, ensure that the trial mix concrete has a slump within ±0.50 inch of the target value (±1.0 inch for mixes utilizing a High Range Water-Reducing admixture), an air content less than or equal to 6.0 percent.

Hold the trial mix in the mixer for 60 minutes after completion of initial mixing. During the extended mixing period, turn the drum intermittently for 30 seconds every five minutes. Cover the drum with wet burlap or an impermeable cover material during the rest periods. Forty-five (45) minutes after completion of initial mixing add the accelerator and prepare the compressive strength specimens.

9.2.8 Drilled Shaft Concrete

The plant shall provide drilled shaft concrete meeting the requirements of ***Specifications Section 346*** and the slump loss test data. When drilled shaft concrete is placed in any shaft, provide concrete in accordance with the following specified slump loss requirements.

Ensure that the slump loss is gradual as evidenced by slump loss tests described below. The concrete elapsed time is defined in Section 455.

Provide slump loss tests before drilled shaft concrete operations begin, demonstrating that the drilled shaft concrete maintains a slump of at least 5 inches throughout the concrete elapsed time. Slump loss tests shall be performed during design mix verification for drilled shafts used for miscellaneous structures must be 30 cubic yards of concrete or less and a maximum elapsed time of 5 hours. Obtain all other slump loss test results in the field. The slump loss test is performed at an ambient temperature consistent with the summer condition (85°F or higher) or the normal condition (below 85°F).

Inform the DMRE at least 48 hours before performing such tests. Perform slump loss testing of the drilled shaft mix using qualified personnel as defined by this section.

Perform the following procedures for the field slump loss tests, summer condition:

(1) Begin all elapsed times when water is initially introduced into the mixer.

(2) During field slump loss testing for summer condition, the concrete temperature must exceed an average of 90°F.

(3) Ensure that the mix is at least 3 cubic yards and is mixed in a truck mixer with a valid mixer identification card.

(4) After initial mixing, determine the slump, ambient and concrete temperatures and air content. Ensure that the concrete properties are within the required limits as specified in ***Specifications Section 346***.

(5) Verify the water to cementitious materials ratio and other delivery ticket data meet design mix requirements.

(6) When concrete is not being mixed, agitate the mixer at the midrange of the manufacturer's recommended agitating speed. Remix the batch for one minute at the mixing speed of the mixer before determining slump, ambient and concrete temperatures.

(7) Determine slump, ambient and concrete temperatures at 30 minute intervals until the slump is 5 inches or less.

Perform the following procedures for the field slump loss tests, normal condition:

(1) Begin all elapsed times when water is initially introduced into the mixer.

(2) During field slump loss testing for normal condition, the concrete temperature does not exceed an average of 85°F.

(3) Ensure that the mix is at least 3 cubic yards and is mixed in a truck mixer with a valid mixer identification card.

(4) After initial mixing, determine the slump, ambient and concrete temperatures and air content. Ensure that the concrete properties are within the required limits as specified in ***Specifications Section 346***.

(5) Verify the water to cementitious materials ratio and other delivery ticket data meet design mix requirements.

(6) When concrete is not being mixed, agitate the mixer at the midrange of the manufacturer's recommended agitating speed. Remix the batch for one minute at the mixing speed of the mixer before determining slump, ambient and concrete temperatures.

(7) Determine slump, ambient and concrete temperatures at 30 minute intervals until the slump is 5 inches or less.

During laboratory slump loss testing for summer condition, the concrete temperature shall meet the requirements for hot weather trail batching (94°F).

(1) Begin all elapsed times when water is initially introduced into the mixer.

(2) Follow the procedure for Concrete Trial Mix Temperature of 94°F (hot weather mixes).

(3) At the end of the Concrete Trial Mix Temperature of 94°F (hot weather mixes). Turn the drum intermittently for 30 seconds every five minutes. Cover the drum with wet burlap or an impermeable cover material during the rest periods.

(4) After initial mixing, determine the slump, ambient and concrete temperatures and air content. Ensure that the concrete properties are within the required limits as specified in ***Specifications Section 346***.

(5) Remix the batch for one minute before determining slump, ambient and concrete temperatures at 15 minute intervals until the slump is 5 inches or less.

During laboratory slump loss testing for normal condition, the concrete temperature shall in the range of 68°F to 86°F.

(1) Begin all elapsed times when water is initially introduced into the mixer.

(2) Ensure that preparation and testing of the trial mix is performed in accordance with ASTM C192.

(3) At the end of the mix procedure, turn the drum intermittently for 30 seconds every five minutes. Cover the drum with wet burlap or an impermeable cover material during the rest periods.

(4) After initial mixing, determine the slump, ambient and concrete temperatures and air content. Ensure that the concrete properties are within the required limits as specified in ***Specifications Section 346***.

(5) Remix the batch for one minute before determining slump, ambient and concrete temperatures at 15 minute intervals until the slump is 5 inches or less.

Submit slump loss test results to the DMO for obtaining the approval in terms of elapsed time before concrete placement.

Design mixes approved based on aggregate substitution shall not require a new slump loss test.

9.2.9 PLANT BATCHING REQUIREMENTS

9.2.9.1 Bins

Provide bins of adequate capacity for the required concrete production. Support the bins upon a rigid framework founded upon a stable foundation capable of holding them in a safe and secure position. Design each compartment to discharge efficiently and freely into the weigh hopper. Provide positive means of control so that as the quantity desired in the weigh hopper is approached, the material can be added slowly and the addition of further material can be stopped precisely. Use a discharging mechanism that prevents loss of material when it is closed. Construct aggregate storage bins sufficiently tight to prevent leakage of material, and divide them into at least one compartment for the fine aggregate and one compartment for each size of coarse aggregate to be used. Provide compartment partitions that are sufficiently tight and high enough to prevent intermingling of the different materials. Construct leak-proof and moisture-proof cementitious bins, and provide them with vibrators or other means to aid the flow of cement from the bin.

9.2.9.2 Weigh Hoppers

Provide weigh hoppers consisting of suitable containers freely suspended from scales and protected from the elements so that accuracy is not adversely affected. Equip the hoppers with a discharge mechanism that prevents leakage or loss of material when closed. Vent hoppers to permit air to escape and equip them with vibrators or other equipment that ensures complete and efficient discharge of materials.

9.2.9.3 Scales

Provide either beam type or spring less dial type scales, or electronic devices such as load cells. Where using beam type scales, provide suitable means to hold poises securely in position after they are set. Keep scales clean and in good operating condition. Provide the scale operator with an unobstructed view of all indicating devices and convenient access to all controls. Use graduated weigh beam or dials to permit reading to 0.1 percent of the capacity of the scales. Check scales up to at least the maximum load normally handled on each respective scale.

9.2.10 MIXERS

9.2.10.1 General Requirements

Provide mixers that are capable of combining the components of the concrete into a thoroughly mixed and uniform mass, free from balls or lumps, which are capable of discharging the concrete with a satisfactory degree of uniformity.

Inspect all mixers at least once each week for changes due to accumulation of hardened concrete or to wear of blades.

9.2.10.2 Design

Use truck mixers of the inclined axis revolving drum type, or concrete plant central mixers of the non-tilting, tilting, vertical or horizontal shaft types.

Make available at the plant at all times a copy of the manufacturer's design, showing dimensions and arrangement of blades. The concrete producer may use mixers that have been altered from such design in respect to blade design and arrangement, or to drum volume, when authorized by the manufacturer and approved by the DMRE. For initial design changes, provide uniformity test data, based on ASTM C94 testing.

The metal rating plates must be attached to each mixer to specify its mixing speed, agitating speed, rated capacity and unit serial number. The unit serial number represents the entire mixing system. The metal rating plate may be located on the inside of the driver’s door. Mixer drum Id numbers or part numbers may or may not compare with the serial number on the rating plate. Should a drum be replaced, documentation from the manufacturer must identify any deviations from the rating plate.

9.2.10.3 Truck Mixers

Use truck mixers with a drum that is actuated by a power source independent of the truck engine or by a suitable power take-off. Either system must provide control of the rotation of the drum within the limits specified on the manufacturer's rating plate, regardless of the speed of the truck. Use truck mixers that are equipped with a hatch in the periphery of the drum shell which permits access to the inside of the drum for inspection, cleaning and repair of the blades.

Use truck mixers equipped with revolution counters and mounting, by which the number of revolutions of the drum may be readily verified.

Ensure that the water supply system mounted on truck mixers is equipped with a volumetric water gauge or a water meter in operating condition. Annually calibrate water measuring devices on truck mixers or other water sources used for concrete water adjustments.

Where a truck mixer volumetric gauge controls job site water additions, ensure that the truck mixer is parked in a level condition during on-site water adjustments and for calibration so that the gauge is indicating a specific tank volume before and after the concrete adjustment. Ensure that the water measuring equipment has an accuracy of within 3 percent of the indicated quantity.

Truck mixers meeting these requirements will be issued a mixer identification card by the DMRE upon request from the concrete producer. Failure to present the identification card upon request shall be cause for rejection of the delivered concrete. The Contractor will remove the identification cards when a truck mixer is discovered to be in noncompliance and the deficiency cannot be repaired immediately. When the identification card is removed for noncompliance, the Contractor shall note the deficiency on the identification card and forward the identification card to the DMRE in the District with Quality Control Plan acceptance authority.

The concrete producer shall inspect all truck mixers at least once each week for changes due to accumulation of hardened concrete or to wear of blades or chutes. The blades or chutes shall be repaired or replaced as necessary to meet these requirements. Any appreciable accumulation of hardened concrete shall be removed before any mixer may be used.

Copies of the most recent water measuring equipment calibration shall be kept in the truck cab and made available upon request.

9.2.10.4 Automated Slump Monitoring System

The automated slump monitoring system includes the following new technology:

(1) Slump is measured by the ready mix truck

(2) Slump is adjusted and controlled by the ready mix truck

(3) All water additions and slump adjustments are recorded. As a minimum all proposed automated slump monitoring systems must include the aforementioned three items.

Automated slump monitoring system information shall be included in the producer's quality control plan. The quality control plan shall also include

provisions for training on the proposed automated slump monitoring systems. As a minimum the producer shall provide training on the automated slump monitoring system for drivers, quality control personnel, and verification personnel. The quality control plan shall also include the calibration procedure.

Calibration of the automated slump monitoring system shall be done on an annual basis, or when a truck is rejected in accordance with the ***Specifications Section 346***. All system records including calibration records shall be made available at the plant to the Department upon request.

Mix concrete at speeds and number of revolutions as recommended by the manufacturer, when water is added enroute to the project site. Automatic introduction of water will be disabled when entering the project site or when the maximum water to cementitious materials ratio for the mix design is reached. If the system adds water in transit, the concrete shall be re-mixed at mixing speed upon arrival to the project for an additional 30 revolutions. Water shall not be added during the discharge of the batch.

9.2.10.5 Central Mixers

Use stationary type mixers equipped with a timing device which will automatically lock the discharge lever when the drum is charged and release it at the end of the mixing period. In the event of failure of the timing device, the Department may allow operations to continue during the day that failure was noticed for the first time. Do not extend such operations beyond the end of that working day. Operate the mixer at the speed recommended by the manufacturer.

9.2.10.6 Mixer Cleaning and Maintenance

Repair or replace mixer blades of revolving drum type mixers when the radial height of the blade at the point of maximum drum diameter is less than 90 percent of the design radial height. Repair or adjust mixers of other designs per manufacturer's instructions. Resolve questions of performance by performing mixer uniformity tests as described in ***ASTM C 94***.

9.2.11 MIXING AND DELIVERING CONCRETE

9.2.11.1 General Requirements

Operate all plant mixers at speeds per the manufacturer's design or recommendation. Do not allow the volume of mixed batch material to exceed the manufacturer's rated mixing capacity. Mix concrete containing silica fume,

metakaolin or ultra fine fly ash in accordance with the supplier's recommendations.

Account for all water entering the drum as batch water.

When necessary, during cold weather conditions, heat either the mix water, the aggregates or both prior to batching. Apply the heat uniformly in a manner which is not detrimental to the mix. Do not heat the aggregates directly by gas or oil flame or on sheet metal over fire. Do not heat the aggregates or water to a temperature of over 150° F. If either component is heated to over 100° F, mix them together prior to the addition of the cement. The cement must not come in contact with the materials which are in excess of 100° F. Include in the QC Plan measures to maintain free moisture in a well drained condition when heating aggregates.

9.2.11.2 Central Mixing:

After all materials are in the mixer, mix the concrete a minimum of two minutes or the manufacturer's recommended minimum mixing time, whichever is longer.

9.2.11.3 Transit Mixing:

Initially mix each batch between 70 and 100 revolutions of the drum at mixing speed. All concrete from truck mixers must be discharged before total drum revolutions exceed 300. Count all revolutions of the drum in the total number of revolutions. The number of initial mixing revolutions may be modified when using specialty ingredients (silica fume, metakaolin, ultra fine fly ash, corrosion inhibitor calcium nitrite, accelerators, high range water reducers, etc.), as recommended by the specialty ingredients supplier.

Do not haul concrete in mixer trucks loaded with more than the rated capacity shown on their attached plates.

The water storage tanks on the truck shall be filled after reporting all water used and the delivery ticket is printed, before leaving for the project site. Water missing from the water storage tanks upon arrival at the project site shall be included in the jobsite water added.

9.2.11.4 Charging the Mixer:

Charge each batch into the drum so that some water enters both in advance of and after the cementitious material and aggregates. If using fly ash (other than ultra fine fly ash) in the mix, charge it into the drum over approximately the same interval as the cement. The concrete producer may use other time

intervals for the introduction of materials into the mix when he demonstrates, using test requirements specified in ***ASTM C 94***, that he can achieve uniformity of the concrete mix.

For concrete mixes containing specialty ingredients, charge the batch materials into the mixer in a sequence recommended by the manufacturer of the specialty ingredients. Adjust the weight of mixing water for a concrete mix containing a corrosion inhibitor and/or accelerator admixture. Account for water in the corrosion inhibitor and/or accelerator as described in the manufacturer's technical data sheet.

9.2.12 QUALITY CONTROL PROGRAM

The QC Plan of any concrete producer shall meet the requirements of ***Specifications Sections 105***. The QC Plan shall also address the following items:

(1) Describe how the concrete producer will maintain the properties of concrete to the point of discharge at the project site.

(2) Describe how the water to cementitious materials ratio and the plastic properties tests of concrete will be controlled to meet ***Specification*** requirements.

(3) Describe the action that will be taken when batching high slump concrete to prevent lumps and balls shall also be addressed.

(4) Describe personnel qualification, source of materials, and equipment used to produce concrete shall be addressed in the QC Plan.

When more than two trucks from a plant delivering high slump concrete (6" slump or higher) is found to contain lumps and balls, the Department will notify the plant that the Department will not accept high slump concrete from the plant on any Department projects. To resume production of high slump concrete, the plant must demonstrate the ability to batch a full size load as defined by the QC Plan of high slump concrete free of lumps and balls. In addition, the plant must revise that portion of its QC Plan that addresses batching of high slump concrete to reflect QC improvements made.

The plant shall be on the Department's Production Facility Listing prior to production of concrete for Department projects. The accepted QC Plan shall be the minimum required control of concrete on all Department projects.

9.2.13 PERSONNEL

Plants supplying concrete to Department projects shall have adequate qualified personnel. Concrete Batch Plant Operator, qualified technicians and Concrete Production Facility Manager of Quality Control are required positions for a plant. At the discretion of the Department, certain functions of the above positions may be combined when it can be demonstrated that the plant's operation and quality of the concrete will not be detrimentally affected. Personnel shall be qualified through the Construction Training and Qualification Program (CTQP) or an equivalent ACI training program. Qualified technicians utilizing equipment with a valid calibration/verification will perform quality control sampling and testing. The qualification records of any personnel shall be made available upon request.

9.2.13.1 Concrete Batch Plant Operator

Personnel who have quality control functions or who sign concrete certification/delivery tickets must demonstrate, through examination, adequate concrete related knowledge. Batch Plant Operators shall be present during batching operations. The Batch Plant Operator shall be qualified as a Concrete Batch Plant Operator.

9.2.13.2 Qualified Technicians

If personnel perform concrete plastic properties test, such as slump, temperature, air content, making/curing concrete cylinders, and calculating the water to cementitious materials ratio, they shall be certified as an ***ACI Concrete Field Testing Technician Grade I***.

If personnel perform tests on hardened properties of concrete, such as strength determination of cylinders or beams, they shall be certified as an ***ACI Concrete Strength Testing Technician***.

9.2.13.3 Concrete Production Facility Manager of Quality Control

Personnel who perform the duties of managing the quality control of the plant shall have the duties, responsibilities, and be qualified as follows:

Duties and responsibilities:

(1) Implement policies and procedures of the QC Plan.

(2) Maintain liaison with the Department on all activities related to quality control.

(3) Supervise the activities of all quality control technicians, ensuring sufficient manpower in all areas related to quality control testing and inspection.

(4) Review all quality control procedures to ensure compliance with the ***Specifications and other Contract Documents***.

(5) Ensure all quality control records are properly prepared and reviewed.

(6) Ensure that quality control activities are performed in accordance with documented instructions and procedures.

(7) Develop and maintain a filing, storage, and retrieval system for quality control records.

(8) Concrete Production Facility Manager of Quality Control must be on-site at the plant on a daily basis or always available on-site upon four hours notice.

Qualification:

(1) Concrete Laboratory Technician Level I, Concrete Field Technician-Level I, and Concrete Batch Plant Operator. As alternatives to these qualifications, the Department will accept, as a minimum:
   a. Prestressed Concrete Institute (PCI) Level III
   b. Precast Concrete Pipe, Box Culverts, Drainage Structures or
   c. Incidental Precast Concrete Plants Level II Quality Control Inspector Certifications
   d. National Ready Mixed Concrete Association (NRMCA) Level 2 Production Control Technician Certification I, as equivalent qualifications.

(2) Three years of QC experience directly related to cement concrete production.

(3) Demonstrated proficiency in implementing, supervising, and maintaining surveillance over a QC Plan.

(4) Experience and certification in performance of required QC tests and statistical evaluation of QC test results.

9.2.13.4 Concrete Mix Designer

Personnel who have quality control functions of designing a concrete mix must demonstrate, through examination, adequate concrete related knowledge. Such examinations will deal with Specifications and concrete

quality control procedures. The Concrete Mix Designer shall be qualified as a ***Concrete Laboratory Technician Level II***. The expiration for this qualification has been removed, personnel with this qualification will no longer be required to requalify.

As an alternative to the Level II qualification the Department will accept any of the following qualifications:

(1) PCI Quality Control Personnel, Level III Certification, for concrete mix designs of prestressed products.

(2) National Ready Mix Concrete Association Level 2 Production Control Technician Certification.

(3) Precast Concrete Pipe, Precast Box Culverts, Drainage Structures, and Incidental Precast Concrete Level II Quality Control Inspector meeting the requirements of ***Specifications Section 105.***

9.2.14 RECORDS

All records shall be kept on file and made available at each plant upon request by the Department. The following updated information shall be available at each plant:

(1) Accepted concrete producer QC Plan.

(2) Approved concrete design mixes.

(3) Materials source/specification compliance (delivery tickets, certifications, miscellaneous test reports).

(4) Quality control data (aggregate gradation, Total Minus 200, and concrete chloride test data).

(5) Aggregate moisture control records including date and time of test. Verify the accuracy of the moisture test method at least weekly. Is the scale calibrated annually and does it cover the full weighing range?

(6) Annual calibration records for water measuring devices on trucks or other water sources for concrete water adjustments.

(7) Manufacturer's mixer design data.

(8) Federal poster shall be posted so as to be visible to all employees.

(9) A copy of the scale company's report corresponding with the current certificate of inspection, showing the date of inspection, signature of the scale company representative, and the observed scale deviations for the loads checked.

(10) Certification documents for admixture weighing and measuring dispensers.

(11) Weekly mixer inspection reports.

(12) A daily record of all concrete batched for delivery to Department projects, including respective design mix numbers and quantities of batched concrete.

(13) Recorder history, if the plant is equipped.

9.2.15 SAMPLING AND TESTING OF MATERIALS

9.2.15.1 General

Sampling and testing of materials and concrete for quality control purposes is the responsibility of the concrete producer. The frequency of sampling must be designed to provide adequate data to operate the QC Plan for each design mix. Table 1 designates the minimum sampling and testing frequencies that will be performed in a well controlled plant. The QC Plan shall indicate an increased sampling rate when any QC Plan limit is reached. All sampling and testing shall be conducted in accordance with the Department's current Florida Sampling and Testing Methods, AASHTO, or ASTM sampling and testing methods. For both coarse and fine aggregate being used, the specific gravity (saturated surface dry) and absorption values shall be provided to the plant by the aggregate producer providing the coarse and fine aggregate.

TABLE 1	
Material and Required Tests	Minimum Sampling Frequency For Each Source and Grade
Coarse Aggregate Gradation (AASHTO T 27) Total Minus 200 (FM 1-T011)	 1 every 30 days 1 every 30 days
Fine Aggregate Gradation (FM 1-T 027) Total Minus 200 (FM 1-T011)	 1 every 30 days 1 every 30 days
Cementitious Materials	Delivery Ticket and Mill Certificate
Admixtures	Certification
Water*	As required in ***Specification Section 923***
Chlorides (FM 5-516)	1 every 30 days or in accordance with this guide

*When evidence shows the concrete producer has failed to sample water within the required frequency, an increased sampling frequency shall be implemented. Open bodies of water and recycled water shall be tested every 15 days during production. Well and other sources of water will be tested every 45 days during production, until approval to return to the normal sampling frequency is given by the DMRE for the District which has QC Plan acceptance responsibility. Failure to comply with the sampling frequency shall be cause for suspension of the QC Plan.

9.2.15.2 Chloride Testing

It is the responsibility of the concrete producer to make sure chloride content of all reinforced concrete produced for the Department does not exceed the maximum allowable limits indicated in ***Specifications Section 346***.

Obtain access to the Department's database prior to testing for chlorides. Database access information is available through the Department's website at the following link: http://www.dot.state.fl.us/statematerialsoffice/mac/index.shtm. Enter all required documentation and test results of the chloride test in the Department database. Chloride test results shall be entered into the Department's database within 72 hours of obtaining the chloride test results. Failure to comply with the time frame for data entry may be cause for suspension of the QC Plan.

The sampling for chloride determination shall start on the first day of production of each mix design at the plant and repeat every 30 calendar days or less thereafter, as necessary to produce concrete meeting ***Specification Section 346***. When evidence shows the concrete producer has failed to sample for chlorides within the required frequency, an increased sampling frequency shall be implemented. Chlorides shall be sampled once per week during production, until approval to return to the normal sampling frequency is given by the DMRE for the District which has QC Plan acceptance responsibility. Failure to comply with the sampling frequency shall be cause for suspension of the QC Plan.

Chloride test results shall be obtained within 14 calendar days of sampling. The testing laboratory must be acceptable to the Steel Materials Administrator. Determine the chloride content of each mix design in production at the plant or as described in this section. Concrete sampling for a mix design shall restart any time concrete production is suspended for any reason for more than 30 calendar days.

When more than one mix design uses the same cementitious materials, aggregates, and admixtures, the concrete producer has the option to only test for chlorides of the mix design with the highest cement content to represent all such mixes. The test report shall clearly indicate all mix designs covered by the test.

If chloride test results exceed the limits shown in ***Specifications Section 346***, suspend concrete production immediately for every mix design represented by the failing chloride test results until corrective measures are made. Send a copy of the sample information and chloride test report for the failed sample to the DMRE and the SMO Structures Corrosion Laboratory as soon as the test results are available.

If the chloride test results are not obtained within 14 calendar days of concrete sampling, the Engineer may suspend concrete production until corrective measures are made.

When the source of any component material, including admixtures, for the concrete is changed, sampling for chloride determination shall restart the first day of production of the mix with the new component material.

9.2.16 DELIVERY TICKET/CERTIFICATION

The following information is required information for each concrete delivery and must be furnished with each load. The information contained within ***Specifications Section 346*** is required information on each delivery ticket/certification. The original signature on the delivery ticket shall certify to the accuracy of the recorded information and compliance with the approved design mix. A sample of a delivery ticket is provided in ***Appendix "A".*** Use this form or a similar form containing the same information:

(1) Serial number of delivery ticket.

(2) The plant number as assigned by the Department.

(3) Date of batching.

(4) Contractor's name.

(5) FDOT Financial Project Number.

(6) Truck number making the concrete delivery shall match the truck number on the delivery ticket.

(7) Class of concrete.

(8) Design mix number.

(9) Time all materials are introduced into mixer.

(10) Cubic yards in this load.

(11) Cumulative total cubic yards batched for job on date of delivery.

(12) Maximum allowable water addition at the job site. Unit of measure must be indicated.

(13) Number of revolutions at mixing speed before leaving for job site.

(14) Amount of mixing time for central mixer.

(15) Coarse and fine aggregate sources (Department assigned Pit No.).

(16) Actual amount of coarse and fine aggregates batched in pounds.

(17) Percent of free moisture in coarse and fine aggregates.

(18) Cement producer and type.

(19) Total amount of cement batched in pounds.

(20) Producer, brand name and class (whichever might apply) of Pozzolan or Slag.

(21) Total amount of pozzolan or slag batched in pounds.

(22) Manufacturer and total amount of air entraining agent used.

(23) Manufacturer, type and total amount of admixtures used.

(24) Total amount of water batched at the plant in gallons or pounds before leaving for the job site. Unit of measure must be indicated.

(25) Statement of compliance with ***the Contract Documents.***

(26) Original signature of Batch Plant Operator and technician identification number.

Note: Items 12 and 13 do not apply to non-agitating concrete transporting vehicles.
Note: Items 1, 2, 4, 6, and 9 through 13 do not apply to precast operations with onsite production facilities.

9.2.17 TRAINING

Training will be in accordance with Specifications Section 105 and the appropriate Materials Manual Volume II Sections.

9.2.18 FORMS

Example Concrete Delivery Ticket – Appendix A, Materials Manual Volume II, Section 9.2
Example Proposed Concrete Design Mix Form – Appendix B, Materials Manual Volume II, Section 9.2

APPENDIX "A"
Sample Delivery Ticket for Structural Concrete

Financial Project No.: _____ Serial No.: _____

Plant No.: _____ Date: _____

Concrete Supplier: _____ Delivered to: _____

Phone Number: _____ Phone Number: _____

Address: _____ Address: _____

_____ _____

Truck No.	DOT Class	DOT Mix No.	Cubic Yards This Load
Allowable Jobsite Water Addition (gal. or lbs.)	Time Loaded	Mixing revolutions or time	Cubic Yards Total Today

Cement _____ _____ _____ Source Type Amount	Fly Ash: _____ _____ _____ Source Grade Amount Slag: _____ _____ _____ Source Class Amount
Coarse Agg. _____ _____ _____ Pit Num. Moisture (%) Amount	Air Entrainment Admixture _____ _____ _____ _____ Source Brand Type Amount
Fine Agg. _____ _____ _____ Pit Num. Moisture (%) Amount	Admixture _____ _____ _____ _____ Source Brand Type Amount
Batch Water (gals. or lbs.) _____ Amount	Admixture _____ _____ _____ _____ Source Brand Type Amount

Issuance of this ticket constitutes certification that the batched concrete was produced and is in compliance with the ***Contract Document*** requirements for Structural Concrete.

_____ _____

Technician Identification Number Signature of Batch Plant Operator

Arrival time at job site		Number of revolutions upon arrival at job site	
Total Water added at job site (gallons)	Admixtures added at the job site (ounces)	Additional mixing revolutions with added water	
Time concrete completely discharged	Time admixture added	Total number of revolutions	
Initial Slump	Initial Air	Initial Concrete Temp.	Initial w/cm Ratio
Acceptance Slump	Acceptance Air	Acceptance Concrete Temp.	Acceptance w/cm Ratio

Signature on this ticket constitutes certification that the maximum specified water cementitious materials ratio was not exceeded and the batch was delivered and placed in compliance with the ***Contract Document*** requirements.

_____ _____

Technician Identification Number Signature of Contractor's Representative

APPENDIX B
PROPOSED CONCRETE DESIGN MIX

REVIEWED BY: _____

DATE: _____

FDOT Assigned Plant No.:			Financial No.:		
Slip Form Mix	Yes	No	Mix Designer (TIN):		
Transferable Mix	Yes	No	Hot Weather Mix	Yes	No

CONCRETE CLASS:

Cement (Plant No.):		Type:	SpGr:
Pozzolan (Plant No.):		Class:	SpGr:
Pozzolan (Plant No.):		Class:	SpGr:
Slag (Plant No.):		Type:	SpGr:
Coarse Aggregate (Pit No.):		Grade:	SpGr(SSD):
Coarse Aggregate (Pit No.):		Grade:	SpGr(SSD):
Coarse Aggregate (Pit No.):		Grade:	SpGr(SSD):
Fine Aggregate (Pit No.):		Grade:	SpGr(SSD):
Fine Aggregate (Pit No.):		Grade:	SpGr(SSD):
Air-Entraining Admixture		APL No.:	
Admixture (APL No.):		Type:	
Admixture (APL No.):		Type:	
Admixture (APL No.):		Type:	
Admixture (APL No.):		Type:	

Remarks: _____

Cement (lbs):		Slump Range (in):	From To
Pozzolan (lbs):		Air Content Range (%):	From To
Pozzolan (lbs):		Theo Unit Weight (wet) (PCF):	
Slag (lbs):		W/CM Ratio (lbs/lb):	
Coarse Aggregate (lbs):		Theo Yield (CuFt):	
Coarse Aggregate (lbs):			
Coarse Aggregate (lbs):		Water in Corrosion Inhib. (lbs):	
Fine Aggregate (lbs):		Aggregate Correction Factor:	
Fine Aggregate (lbs):			
Water (gals):			
Water (lbs):		**Lab Test Data**	
Air-Entraining Admixture (oz)::			
Admixture (oz):		Chloride (lb/cy):	
Admixture (oz):		Slump (in):	
Admixture (oz):		Air Content (%):	
Admixture (oz):		Temperature (°F):	
		Compressive Strength (PSI)	
		Day	Day
		Day	Day