Concrete Batch Plant Operator

Study Guide

Developed by the

FLORIDA DEPARTMENT OF TRANSPORTATION

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1. General Production Requirements

Although all orders for concrete are placed with the Producer by the Contractor, all structural concrete produced for Department projects must come from Department approved plants. The concrete must be produced by qualified personnel, it must be a Department approved design mix and it must be produced, transported, handled, sampled and tested in accordance with the current version of the Department's Standard Specifications for Road and Bridge Construction (hereafter called the specifications) governing the project. Many of the references made in this document are to the 2004 version of the standard specifications. The specifications will include, but are not limited to Section 6, 346 and Chapter 9.2 of the Materials Manual.

2. General Concrete Information

In very broad terms, concrete can be considered as the combination of aggregates and paste. The aggregates consist of fine and coarse aggregate. In combination, they make up approximately 75 to 85% of the volume of concrete with the coarse aggregate taking up the majority of this volume. The paste is a combination of cement, water and entrained air, and comprises approximately 15 to 25% of the volume of concrete.

The cement and water combine in a chemical reaction called hydration. Hydration is what causes the concrete to set and is also what causes the heat in the curing process. The ratio of water to all cementitious materials in the paste is the key factor in determining the strength and quality of concrete. In general, the lower the water cementitious ratio, the stronger and more durable the concrete will be.

The characteristics of a batch of concrete can be catered to specific environments, conditions and intended uses with the careful addition of pozzolans and admixtures. Workability, durability, strength and temperature can be greatly effected by how the concrete is batched, mixed, placed and cured.

3. Department Parameters for Classes of Concrete (per the 2004 FDOT Standard Specifications for Road and Bridge Construction)

Table 1					
Class of Concrete	Minimum 28 Day Strength	Target Slump (c)	Air Content Range (%)	Minimum Total Cementitious Content	*Maximum Water Cement Ratio
I (Pavement)	3000 psi [21 MPa]	2 in. [50 mm]	1 to 6	508 lbs/yd³ [300 kg/m³]	0.50
I (Special) (a)	3000 psi [21 MPa]	3 in. (b) [75 mm]	1 to 6	508 lbs/yd³ [300 kg/m³]	0.50
II (a)	3400psi [23 MPa]	3 in. (b) [75 mm]	1 to 6	564 lbs/yd³ [335 kg/m³]	0.49
II (Bridge Deck)	4500 psi [31 MPa]	3 in. (b) [75 mm]	1 to 6	611 lbs/yd³ [365 kg/m³]	0.44
III	5000 psi [35 MPa]	3 in. (b) [75 mm]	1 to 6	611 lbs/yd³ [365 kg/m³]	0.44
III (Seal)	3000 psi [21 MPa]	8 in. [200 mm]	1 to 6	611 lbs/yd³ [365 kg/m³]	0.52
IV	5500 psi [38 MPa]	3 in. (b) [75 mm]	1 to 6	658 lbs/yd³ [390 kg/m³]	0.41
IV (Drilled Shaft)	4000 psi [28 MPa]	8 in. [200 mm]	0 to 6	658 lbs/yd³ [390 kg/m³]	0.41
V (Special)	6000 psi [41 MPa]	3 in. (b) (d) [75 mm]	1 to 5	752 lbs/yd³ [445 kg/m³]	0.37 (e)
V	6500 psi [45 MPa]	3 in. (b) [75 mm]	1 to 5	752 lbs/yd³ [445 kg/m³]	0.37 (e)
VI	8500 psi [59 MPa]	3 in. (b) [75 mm]	1 to 5	752 lbs/yd³ [445 kg/m³]	0.37

*Calculation of water to cementitious materials ratio (w/cm) is based on the total cementitious materials including silica fume, fly ash, metakaolin, or slag.

(a) The Contractor is permitted to use concrete meeting the requirements of ASTM C 478 (4000 psi [30 MPa]) in lieu of Class I or Class II concrete in precast items manufactured in plants which meet the Department's Standard Operating Procedures for Precast Drainage products. Apply the chloride content limits specified in 346-4.2 to all precast or cast-in-place box culverts.

(b) The Engineer may allow higher target slump, not to exceed 7 in. [180 mm], when a high range water reducer is used.

(c) The Engineer may approve a reduction in the target slump for slip formed or prestressed elements.

(d) When the use of silica fume or metakaolin is required as a pozzolan in Class V (Special) concrete, ensure that the concrete does not exceed a permeability of 1000 coulombs at 28-days when tested per AASHTO T 277. Submit two 4 in. [102 mm] diameter by 8 in. [203 mm] length cylindrical test specimens to the Engineer for permeability testing prior to mix design approval. The permeability of the concrete will be taken as the average of two tests. The Engineer may require permeability tests during production.

(e) When the use of silica fume or metakaolin is required as a pozzolan, the engineer will approve mix designs at maximum water to cementitious materials ratio of 0.35.

4. <u>Maximum Chloride Content Limits for Concrete</u> (as per the 2004 book)

Table 2

Application	Production	Mix Design
Non Reinforced	N/A	N/A
Reinforced	0.70 lb/yd^3 [0.42 kg/m^3]	0.64 lb/yd^3 [0.38 kg/m^3]
All applications that require Type II cement plus pozzolans	0.40 lb/yd^3 [0.24 kg/m^3]	0.34 lb/yd^3 [0.20 kg/m^3]
Prestress	0.40 lb/yd^3 [0.24 kg/m^3]	0.34 lb/yd^3 [0.20 kg/m^3]

5. <u>Initial Plant Approval</u>

For a plant to be considered for Department approval, it must be reasonably assured it will be producing concrete for a Department project. The plant owner or manager must make a written request to the District Materials Engineer to have his plant placed on approved status. The Producer must develop a Quality Control Plan (QCP), in accordance with Section 6-8, to be included with the written request for plant approval. Once the request is received, the plant will be scheduled for an inspection by Department personnel. Following successful completion of the inspection, the plant will be assigned an identification number, placed on approved status and entered into the Departments list of approved Concrete Production Facilities.

6. Normal Operation

While the plant is actively supplying concrete to Department projects, it will be re-inspected by Department personnel every two months. These will be unannounced inspections. If discrepancies are found in the inspections, the plant may be removed from fully approved status and placed on either conditional status or non-approved status depending on the nature of the discrepancies and the corrective action required.

7. Expiration of Approval

If a plant goes over two months without doing any Department work, the bimonthly inspections may be terminated and the plant's approval status may be considered expired. The plant owner or manager may request removal from the approved status at anytime the plant is not producing for the Department. To bring a plant back on line, the plant owner or manager must notify the District Materials Engineer at least five working days in advance of expected Department work.

8. Plant Personnel Requirements

Concrete production facilities supplying concrete to Department projects shall have adequate qualified personnel. Batch Plant operator, certified technicians and manager of quality control are required positions for an approved concrete production facility. At the discretion of the Department, certain functions of the above positions may be combined when it can be demonstrated that the plant operation and quality of the concrete will not be detrimentally affected. CTQP Qualified Technicians utilizing equipment with a valid calibration/verification will perform Quality Control sampling and testing. This qualification of any technician shall be made available upon request.

a. Batch Plant Operator

Personnel who have quality control functions or who sign concrete certification/delivery tickets must demonstrate, through examination, adequate concrete related knowledge. Plant Operators shall be present during batching operations. The Plant Operator shall be qualified by the Department's Construction Training and Qualification Program (CTQP).

b. Certified Technicians

Personnel who perform the tests on the plastic properties of concrete, such as slump, temperature, air content, making/curing concrete cylinders and calculating the water to cementitious materials ratio, shall be qualified as a Concrete Field Inspector – Level I by the Department's Construction Training and Qualification Program (CTQP).

Personnel who perform the tests on the hardened properties of concrete, such as strength of cylinders, shall be qualified as a Concrete Laboratory Technician – Level I by the Department's Construction Training and Qualification Program (CTQP).

c. Mix Design Technician

Personnel who have quality control functions of designing a concrete mix must demonstrate, through examination, adequate concrete related knowledge. Such examinations will deal with Department specifications and concrete quality control procedures. The Mix Design Technician shall be qualified as a Concrete Laboratory Technician – Level II by the Department's Construction Training and Qualification Program (CTQP).

d. Manager of Quality Control

Personnel who perform the duties of managing the quality control of the plant shall be qualified as a Concrete Laboratory Technician – Level II by the Department's Construction Training and Qualification Program (CTQP). The personnel shall also have the following qualifications:

1. Three years of quality control experience directly related to cement concrete production.
2. Demonstrated proficiency in implementing, supervising and maintaining surveillance over a quality control program.
3. Experience or certification in performance of required quality control tests and in organization and statistical evaluation of quality control test results.

The personnel who perform the duties of managing the quality control of the production facility shall have the following duties and responsibilities:

Implement policies and procedures of the quality control program.

Maintain liaison with Project Manager and the Department on all activities related to quality control.

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

Review all quality control procedures to ensure compliance with project specifications.

Ensure all quality control records are properly prepared and reviewed.

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

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

9. <u>Material Information and Requirements</u>

a. Portland Cement

Portland cement will meet the requirements of Section 921 of FDOT's Standard Specifications. Acceptance of the Portland cement at the batch plant will be based upon certified mill analyses from the cement producer. The certification must state the type of cement and that it meets the requirements of AASHTO M-85. Certifications must be kept at the plant for at least three years.

Unless specifically designated elsewhere, use one of the following types of cement:

1. **Type I**. General purpose cement. Used in areas not subjected to aggressive exposures. Used in placements not subject to objectionable temperature rise due to heat of hydration.

2. **Type II.** Used when a moderately aggressive environment is a concern. Generates less heat than Type I. Suggested for mass placements. Mixed with pozzolans for extremely aggressive environments.

3. **Type III**. Higher early strength, quicker set, and generates more heat than Type I. It is similar to Type I except the particles are ground finer. Suggested in situations requiring early form removal.

4. **Type IP.** Portland-pozzolan cement is a mix of 15% to 40% by weight of pozzolan and cement. Suitable for general construction.

5. **Type IS.** Portland blast-furnace slag cement is a mix of 25% to 40% by weigh of granulated blast-furnace slag and cement. Suitable for general construction.

6. **Type IP(MS)**. A type of Type IP cement which is designated moderate sulfate resistant and must have a pozzolan constituent in the range of 15 to 40% by weight.

Use only the types of cements designated for the environmental conditions shown in the following table (as per the 2004 book).

Table 3

Bridge Superstructures			
Component	Slightly Aggressive Environment	Moderately Aggressive Environment	Extremely Aggressive Environment
Precast Superstructure and Prestressed Elements	Type I, or Type III	Type I or Type III with Fly Ash or Slag; Type II, Type IP, Type IS, or Type IP(MS)	Type II with Fly Ash or Slag
C.I.P. Superstructure Slabs and Barriers	Type I	Type I with Fly Ash or Slag, Type II, Type IP, Type IS, or Type IP(MS)	Type II with Fly Ash or Slag
Bridge Substructure, Drainage Structures, and Other Structures			
All Structure Components	Type I, or Type III	Type I with Fly Ash or Slag, Type II, Type IP, Type IP(MS), or Type IS	Type II with Fly Ash or Slag

Plants must provide a separate and clearly labeled weather-proof facility to store each brand or type of cement available during production. The cement bins must have a vibratory system to aid the flow of cement from the bins. There must be a suitable, safe and convenient means of collecting samples. Samples will be taken periodically from the plant and tested by the Department.

Cement quantity must be determined by weight. Weigh cement and pozzolanic materials separately from other materials. When weighing cement, other pozzolans and slag in a cumulative weigh hopper, weigh the cement first.

If bagged Cementitious material is permitted, proportion the batch to use only whole bags. In the United States, a bag of Portland Cement weighs 94 pounds and has a volume of about 1 cu ft when freshly packed.

b. Pozzolans and Slag

Fly ash, silica fume, metakaolin and slag must meet the requirements of Section 929 of the Standard Specifications. The quantities of pozzolans and slag must be determined by weight. When weighing pozzolans in a cumulative weigh hopper with cement, the cement must be weighed first.

Fly ash will be accepted based on certified test reports from laboratory meeting the requirements of Section 6-9. Fly ash must meet the requirements of ASTM C 618 for Class F. Class C Fly ash must meet the requirements of ASTM C 1012.

Slag will be accepted based on certified test results from the slag manufacturer and meet the requirements of ASTM C 989.

Silica Fume will be accepted based on certified test results received from the supplier indicating that it meets the requirements of ASTM C 1240.

Metakaolin will be accepted based on certified mill test results from the metakaolin producer that it meets the requirements of ASTM C-618 Class N pozzolan.

Plants must provide a separate and clearly labeled weatherproof facility to store each brand or type of pozzolan on hand. There must be a suitable, safe and convenient means of collecting samples. Samples will be taken periodically from the plant and tested by the Department. Certifications must be kept at the plant for each type of pozzolan used on Department projects.

Pozzolanic materials may be used as a cement replacement, on a pound per pound [kg per kg] basis, in all classes of concrete using Type I, II, or III cement, with the following limitations:

1. Mass Concrete:
   a. Fly Ash-ensure that the quantity of cement replaced with fly ash is 18% to 50% by weight.
   b. Slag-ensure that the quantity of cement replaced with slag is 50% to 70% by weight. Ensure that slag is 50% to 55% of total cementitious content by weight of total cementitious materials when use in combination with silica fume and/or metakaolin.
2. Drilled Shaft:
   a. Fly Ash-ensure that the quantity of cement replaced with fly ash is 33% to 37% by weight.
   b. Slag-ensure that the quantity of cement replaced with slag is 58% to 62% by weight.
3. For all other concrete uses not covered in (1) and (2) above,
   a. Fly Ash-ensure that the quantity of cement replaced with fly ash is 18% to 22% by weight.
   b. Slag-ensure that the quantity of cement replaced with slag is 25% to 70% for Slightly and Moderately Aggressive environments, and 50% to 70% by weight when used in Extremely Aggressive environments. Ensure that slag is 50% to 55% of total cementitious content by weight of total cementitious materials when use in combination with silica fume and/or metakaolin.
4. Type IP (MS): Ensure that the quantity of pozzolan in Type IP (MS) is in the range of 15% to 40% by weight.

5. Silica Fume and Metakaolin:
    a. Cure in accordance with the manufacturer's recommendation and approved by the Engineer.
    b. Silica Fume-ensure that the quantity of cement replaced with silica fume is 7% to 9% by weight.
    c. Metakaolin-ensure that the quantity of cement replaced with metakaolin is 8% to 12% by weight.

c. Aggregate

Gradations - Coarse aggregate must meet the requirements of Section 901 of the Standard Specifications. Concrete will be batched with Size No. 57 or 67 coarse aggregate. The Engineer may approve the use of Size No. 8 or 89, either alone or blended, with Size No. 57 or 67 coarse aggregate. The Engineer may consider other gradations after the Producer has submitted sufficient statistical data to show production quality and uniformity.

Fine aggregate must meet the requirements of Section 902 of the Standard Specifications.

All Aggregate shall be obtained from Department approved sources. A list of approved sources will be maintained by the Department and made available from the State Materials Office.

As a minimum, each plant must provide suitable bins, stockpiles or silos to store and identify aggregates without mixing, segregating or contaminating the different sources or grades. Identification shall include DOT designated, approved pit number and aggregate grade. Measure aggregates by mass or volume within an accuracy of 1% of the required amount. Apply aggregate surface moisture corrections.

The Producer shall be responsible for handling the aggregates so as to minimize segregation and recover material from the stockpile for use in the mix so it will remain within specification limits. Stockpiles shall be maintained in a well drained condition to minimize free water content and to not promote algae/fungal growth. The Producer 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 project specifications.

Wetting Coarse Aggregate - The entire surface of the coarse aggregate shall be continuously and uniformly sprinkled with water for a minimum period of 24-hours immediately preceding introduction into the concrete. Any request for deviations from the 24-hour sprinkling requirement should be addressed in the Producer's Quality Control Program for consideration by the District Materials Engineer.

d. Water

Water must meet the requirements of Section 923 of the Standard Specifications.

If water is from a city source and approved for public use, it does not need to be sampled. If water is from a well, it must be sampled prior to use on a Department project and every six months thereafter. If water comes from an open body of water, it must be sampled and tested prior to use and then every 30 days.

Water trivia: one gallon weighs 8.33 pounds, one cubic foot contains 7.49 gallons which weighs 62.4 pounds. Water is used as the base substance for determining specific gravity so its specific gravity equals 1.

e. Admixtures

Admixtures will meet the requirements of Section 924 of the Standard Specficiations. Chemical admixtures not covered in Section 924 may be approved by the Engineer. Submit statistical evidence supporting successful laboratory and field trial mixes which demonstrate improved concrete quality or handling characteristics.

Do not use admixtures or additives containing calcium chloride (either in the raw materials or introduced during the manufacturing process) in reinforced concrete.

1. **Air Entraining Admixtures**

Air entraining admixtures are used to introduce microscopic air bubbles into a concrete mix. The benefits include improved workability, increased freeze-thaw resistance and improved durability. Entrained air can slightly reduce the strength of the concrete.

All concrete (except counterweight) used for FDOT projects must contain air entraining admixture.

2. **Water-Reducing Admixtures (Type A)**

Water-reducers are used to reduce the amount of water in a mix while maintaining a certain workability or consistency. For a given water content in a mix, water reducers will increase the slump.

Concrete must contain either a water-reducing (Type A) or water-reducing and retarding (Type D) admixture.

3. **Water Reducing and Retarding Admixtures (Type D)**

Retarders are used to delay the set time of concrete and reduce the amount of water in a mix while maintaining a certain workability or consistency. It may be used to offset the effects of hot weather or to provide sufficient time before setting in difficult placement or finishing operations.

Concrete must contain either a water-reducing (Type A) or water-reducing and retarding (Type D) admixture.

4. **High Range Water Reducer (HRWR) (Type F or G, or Class I, or II)**

HRWR will provide significantly increased slump with reduced water requirements. This has the benefit of providing high slump, high strength concrete that has a low water cement ratio. The latest HRWRs will provide a flowable concrete that does not segregate, has water cement ratios below 0.30, and results in a very strong finished product.

If the design mix uses silica fume or metakaolin, the concrete must contain an approved high range water reducer. If the proper approval has been obtained, HRWR may be used in other applications, as well.

5. **Corrosion Inhibitors - Calcium Nitrite**

Calcium Nitrite is used to protect the reinforcing steel from the penetration of chloride ions. It form a protective layer around the steel to mitigate the chloride attach. It is generally used in projects in extremely aggressive environments. If calcium nitrite is required, the design mix must also consist of Type II cement, ground granulated blast furnace slag or Class F fly ash, and a Type D water reducing and retarding admixture. It may also require a type F, HRWR to provide required workability.

Calcium nitrite must be stored in dark containers to protect it from the sun. The total batch water of a concrete mix must be adjusted when using calcium nitrite. For example if the mix is in English units, each gallon of calcium nitrite may add 7.0 lbs or 0.84 gallons of water to the mix. If it is a metric unit batch, each liter of calcium nitrite may add 0.84 kg or 0.84 liters of water to the mix.

10. Scales and Meters

All scales, meters and other weighing or measuring devices, excluding admixture dispensers, shall be checked for accuracy by a qualified representative of a scale company registered with the Bureau of Weights and Measures of the Florida Department of Agriculture prior to production of concrete. Scales, meters and other weighing or measuring devices, excluding admixture dispensers, shall be checked quarterly at a minimum. The Department reserves the right to be present during all scale checks.

a. Water Measuring Devices

Water measuring devices used during batching operations at concrete plants are to be checked for accuracy at least quarterly. Accuracy of these devices is checked by weight or volume. Any container used for accuracy verification must be capable of holding the maximum quantity of water normally used during batching sequence.

If accuracy is checked by volume, the maximum capacity of the container used must be known in gallons [liters]. Graduation marks must be readily visible on the container at each level checked, ensuring accurate volume determination to the nearest 0.5 gallon [2 L]. Accuracy of these graduation marks must be documented by a scale company registered with the Bureau of Weights and Measurements, Florida Department of Agriculture and Consumer Services.

Use of a flow meter mounted in series is acceptable provided the accuracy of the flow meter is traceable to the National Institute of Standards and Technology. The accuracy of the calibration device should be checked annually.

Measure water by volume or weight. 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% of the quantity of water required for the batch.

Regardless of the method used, the following guidelines will be followed when measuring devices are checked for conformity with accuracy requirements of the specification or accuracy requirements as specified herein:

Devices will be checked up to the maximum quantity normally required for a batch. At least four step - checks will be made at approximately equal intervals, including the maximum quantity normally required for a batch.

The report supplied by the qualified agency performing the check shall include the date of inspection, signature of the agency representative, observed deviations for each quantity checked and a statement that the device conforms to Department specifications. A copy of the report corresponding with the current certificate of inspection shall be available at the plant where the device is located.

A certificate of inspection bearing the date of certification and signed by a representative of the qualified agency shall be affixed to the measuring device.

Methods not specifically detailed above are considered acceptable if District Materials Personnel verify compliance with conditions and guidelines stated in the specifications, or other written authority.

b. Admixture Measuring Dispensers

Admixture measuring dispenser accuracy shall be certified annually by the admixture supplier. Calibrate the dispensing equipment for calcium nitrite quarterly.

c. Recorders

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

11. Batching Accuracy

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, and automatically places the plant on conditional approved status. Failure to implement corrective measures will be cause for placing the plant on non-approved status and suspension of the Quality Control Plan.

Admixture measuring equipment (whether volume or weight) must have an accuracy, under all operating conditions, of 3% of the quantity required for any potential batch size produced at the plant.

Graduated weigh beams or dials must be able to read to 0.1% of the scale's capacity.

Scales to weigh cements, pozzolans, coarse and fine aggregates must be maintained to an accuracy of 0.5% of the maximum load it normally handles.

Calcium nitrite dispensers must be calibrated quarterly, other admixture measuring dispensers shall be certified annually by the admixture supplier.

12. Required Plant Records

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

1. Producer Quality Control program and plant approval status.
2. Approved concrete design mixes.
3. Materials source/specification compliance (delivery tickets, certifications, certified mill test reports, miscellaneous test reports).
4. Quality Control data (gradation and absorption worksheets, fresh and hardened concrete test results, sample frequency data, and any additional information required by the District Materials Engineer).
5. Plant and mixer design data as required by project specifications.
6. Federal poster.
7. Contract documents, as determined necessary by the District Materials Engineer.
8. A copy of the scale company or testing agency report showing the observed deviations from quantities checked during calibration of scales or meters. Certification documents for admixture weighing and measuring dispensers.

9. Chloride test data. Ensure that testing for chlorides is performed by a laboratory meeting the requirements of ***Standard Specification Section* 6-9**.
10. Weekly mixer inspection certification (a copy of the truck mixer certification shall be located in the truck cab and in the plant).
11. Moisture Control records including date and time of test.
12. Daily records of all concrete batched for delivery to Department projects, including respective design mix numbers and quantities of batched concrete.

12. <u>Production Criteria</u>

Concrete production must continually meet the following criteria:

a. The average of any three consecutive strength test results can not fall below the specified minimum strength.

b. No single strength test result can fall more than 500 psi [3 MPA] below the specified minimum strength.

If either of the above criterion are not met, the Department will automatically void plant approval.

13. <u>Design Mixes</u>

Design mixes shall meet the requirements of Standard Specification 346. Form 675-010-03, Concrete Design Mix [Form 675-010-04 for metric projects] shall be used for design mix submittals.

Plants furnishing concrete to multiple projects may use approved concrete mix designs on different projects, provided component materials and project requirements of the approved mix design remain the same. The concrete production facility shall submit mix design requests directly to the District Materials Engineer in the District that the concrete production facility is located. If a concrete producer is located out-of-state, then the mix design submission will be to the nearest District Materials Engineer.

The District Materials Engineer will monitor or otherwise review the proportioning, mixing and testing of the proposed mix. When the mix properties and components have been verified, the District Materials Office will so advise the State Materials Office, who will issue approval for the mix design. Those mix designs that cannot be verified regarding final properties or components will be returned to the concrete producer as unacceptable for use on Department projects. Make a separate submittal for each class of concrete and each particular combination of component materials to be used at trial mix temperatures of 70 to 85ºF [20 to 30ºC], and for hot weather mixes at a minimum temperature of 94ºF [35ºC]. Use only design mixes approved by the State Materials Office for Department use. The approved concrete mix design will remain in effect until the District Materials Office authorizes a change in writing.

Include the following with the mix design submittal:

a. The Department approved source identification number for coarse and fine aggregates, specific gravity, along with the size of coarse aggregate and target Fineness Modulus for fine aggregate. Identify other component materials by manufacturer, brand name, and type.
b. The actual proportions of raw materials intended to be combined to produce the concrete.
c. Historical or trial mix data:

1) Historical data from a minimum of 15 consecutive Department acceptance tests of production concrete, made in accordance with the proposed mix design, which demonstrates that the proposed mix has met all applicable plastic and hardened concrete specification criteria without failure. For drilled-shaft concrete to be placed in (1) a wet shaft, or (2) a dry shaft requiring a temporary removable casing, provide slump loss test results. The Department will not approve hot weather mixes based on historical data.
2) Alternatively, 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 have a slump within ± 0.5 inch [±15 mm] of the target value (or for mixes utilizing HRWR, within ±1 inch [±25 mm] of the target value), air content of 2.5% to 5% and strength required to meet an over design which is the minimum required strength plus 1.6 standard deviations.

d. 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 ***Standard Specification Section*** **346-4**.

e. For design mixes developed for use under hot weather concreting conditions: 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.

On completion of the extended mixing period, ensure that the trial mix concrete has a slump within ±0.75 inch [±20 mm] of the target value (±1 inch [±25 mm] for mixes utilizing HRWR), and an air content between 2% and 5%. 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. Ensure that the mix temperature is not less than 94ºF [34ºC] at any time.

The total water used in initial mixing and the final slump adjustment constitutes the design mix water content. Ensure that the total water to cementitious materials ratio does not exceed the maximum water to cementitious ratio of Table 3 in the ***Standard Specification*** **346-4**, for the respective class of concrete. The Department may require extended mixing for precast/prestressed concrete when centrally mixed at the placement site.

For design mixes proposed for use in wet drilled shafts, demonstrate the additional requirements in ***Standard Specification Section*** **346-3.2**.

Submit strength test data for establishing the standard deviation of the plant to meet the specified strength of the mix submitted for approval within 1,000 psi [7 MPa]. 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. When the Department cannot determine the plant standard deviation from historical data, apply an over design requirement, based on a singular trial mix, that is the minimum required strength plus 1,200 psi [8 MPa] for minimum required concrete strengths of 5,000 psi [35 MPa] or less. For minimum required concrete strengths above 5,000 psi [35 MPa], apply an over design requirement that is the minimum required strength plus 1,400 psi [10 MPa].

Ensure that preparation and testing of the trial mixes is performed by a laboratory acceptable to the Department which (A) has been inspected by the CCRL on a regular basis, with all deficiencies corrected, and under the supervision of a Specialty Engineer, Engineer's representative or a professional Engineer, or (B) meets all the requirements of ASTM C 1077. The Department may give consideration to approval of laboratories operating under other independent inspection programs demonstrated to be equivalent to the programs recognized in (A) and (B). Ensure that the 28-day strength (or strength at any other designated age) of trial mixes meets the above stated over design requirements to ensure that concrete sampled and tested at the point of placement has a strength exceeding the specified minimum strength.

All structural concrete supplied to Department projects must be from an approved design mix. The design mix will have an identification number assigned by the Department. Additionally, the design mix must be approved for the project it will be delivered to.

14. Batching Tolerances

Concrete must be batched within the following tolerances.

a. Silica fume and metakaolin must be within 1% of the required batch quantity.
b. Cementitious materials (batch size over 3 yd^3) must be within 1% of the required batch quantity.
c. Cementitious materials (batch size of 3 yd^3 or less) must be within 2% of the required batch quantity.
d. Fine and Coarse Aggregates must be within 1% of the their respective required batch quantity.

Failure to maintain the batching tolerance for each component material automatically places the plant on conditional status.

15. Batch Adjustments for Material

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

a. Coarse or Fine Aggregate: ±75 lbs/yd^3 [±45 kg/m^3] of concrete
b. Admixtures: Shall be within the manufacturer's technical data sheet range. Adjustments falling outside the technical data sheet range shall require design mix re-verification.
c. Cementitious Materials: ±6.5% per cubic yard [cubic meter], 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 Producer shall inform the District Materials Engineer of any adjustments to the mix. Batch adjustments shall be noted on the concrete delivery tickets.

16. Batch Adjustments for Aggregate Moisture

Within two hours prior to each day's batching, free moisture shall be determined for the coarse and fine aggregates. On continuous concrete placements expected to exceed three hours, an additional moisture test shall be required approximately half way through the batching operations. The concrete producer shall use these values for adjustment of batch proportions.

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

By using moisture probe readings, speedy moisture tester or Chapman flask for fine aggregate moisture. The accuracy of the moisture probe 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.

By calculating both coarse and fine aggregate free moisture based upon dry sample weights and adjusting for absorption.

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

17. TruckMixers

a. **General Requirements**

Provide mixers of an approved type 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.

b. **Design**

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

Make available at the batching 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 concurred by the manufacturer and approved by the Department.

Ensure that metal rating plates are attached to each mixer specifying its mixing speed, agitating speed, rated capacity and unit serial number.

c. **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. Ensure that either system provides 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 of the revolving drum type 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 of an approved type 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 approved 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 the truck mixer is parked in a level condition during on-site water adjustments so that the gauge is indicating a specific tank volume before and after the concrete adjustment. When water additions exceed 4 gal/yd^3 [20 L/m^3] of concrete, ensure that the water measuring equipment has an accuracy of within 3% of the indicated quantity.

Truck mixers meeting these requirements and *Standard Specification Section* 346 will be issued an identification card by the District Materials Engineer upon request from the concrete producer. Identification cards shall be displayed in the truck cab when delivering concrete for Department use. Failure to display the identification card in the truck cab shall be cause for rejection of the delivered concrete. The Department may remove the identification cards when a truck mixer is discovered to be in noncompliance.

As an exception to the above, when the deficiency involves only an inoperable revolution counter, the truck mixer identification card will not be removed. However, the Department will note the deficiency on the card. The Producer will be allowed to deposit the concrete in the mixer, and the truck mixer will then be removed from use until the revolution counter is repaired or replaced. On the next delivery to any Department project, after repair or replacement of the counter, the truck mixer operator shall make known that the revolution counter is operable and obtain the Department’s initial on the truck mixer identification card. Without such inspection and documentation of corrective action, the Department may reject the truck mixer at any time it is again found to have an inoperable revolution counter. The revolution counter will be set to zero prior to mixing.

The Producer shall inspect all truck mixers at least once each week for changes due to accumulation of hardened concrete or to wear of blades. The blades shall be repaired as necessary to meet the 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 available upon request.

18. Central Mixers

Use stationary type mixers equipped with an approved 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. The mixer shall be operated at the speed recommended by the manufacturer.

The Producer shall inspect all mixers at least once each week for changes due to accumulation of hardened concrete or to wear of blades.

19. Cleaning and Maintenance of Mixers

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% of the design radial height. Ensure all appreciable buildup of hardened concrete is removed from the drum. If not removed it may cause inadequate mixing. Repair or adjust mixers of other designs per manufacturer’s instructions. Resolve questions of performance through mixer uniformity tests as described in ASTM C 94.

20. Mixing and Delivering Concrete

a. General Requirements

Operate all concrete plant mixers at speeds per the manufacturer's design or recommendation. Do not allow the volume of mixed batch material to exceed the manufacturers rated mixing capacity. Mix concrete containing metakaolin or silica fume in accordance with their supplier's recommendations.

When necessary and in order to produce concrete of the specified temperature during cold weather conditions, heat either the mix water or the aggregates or both prior to batching. Apply the heating 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 (66° C). If either is heated to over 100° F (38° C), mix them together prior to the addition of the cement so that the cement does not come in contact with the materials, which are in excess of 100° F (38° C). Include in the Quality Control Plan measures to maintain free moisture in a well drained condition when heating aggregates.

b. Central Mixing

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

c. Transit Mixing

Initially mix each batch between 70 and 100 revolutions of the drum at mixing speed. When water is added at the job site, mix the concrete 30 additional mixing revolutions. When mixing for the purpose of adjusting consistency, do not allow the total number of revolutions at mixing speed to exceed 160. Discharge all concrete from truck mixers before total drum revolutions exceed 300. All revolutions of the drum shall be counted in the total number of revolutions.

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

d. 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 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 the concrete producer demonstrates, using test requirements specified in ASTM C 94, that he can achieve uniformity of the concrete mix.

For concrete mixes containing specialty ingredients (silica fume, metakaolin, corrosion inhibitor calcium nitrite, accelerators, high range water reducers, etc.), charge the batch materials into the mixer in a sequence recommended by the supplier. Adjust the weight of mixing water for a concrete mix containing corrosion inhibitor admixture or silica fume slurry. Account for water in the corrosion inhibitor or silica fume slurry as described in the manufacture's technical data sheet.

21 <u>Transit Time</u> (per the 2004 book)

The maximum allowable time between initial introduction of water into the mix and depositing the concrete in place is given below.

	Non-Agitating Trucks	Agitating Trucks
No water reducing and retarding admixture (Type D or G) is used in the mix.	45 minutes	60 minutes
Water reducing and retarding admixture (Type D or G) is used in the mix.	75 minutes	90 minutes

22 <u>Delivery Ticket</u>

The following information is required information for each delivery ticket/certification. All information shown on the delivery ticket/certification must be furnished with each load. The information contained within Chapter 9.2 of the Materials Manual 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 including the chloride content requirements. A sample of a delivery ticket is provided in Attachment "B".

1. Serial number of delivery ticket.

2. Plant number assigned by the Department.
3. Date of batching.
4. Contractor's name.
5. A description of the delivery location.
6. FDOT Financial Project Number.
7. Truck number making the concrete delivery.
8. Class of concrete.
9. Design mix number.
10. Time all materials are introduced into mixer.
11. Cubic yards [cubic meters] in this load.
12. Cumulative total cubic yards [cubic meters] batched for job on date of delivery.
13. Maximum allowable water addition at the job site.
14. Number of revolutions at mixing speed before leaving for job site.
15. Amount of mixing time for central mixer.
16. Coarse and fine aggregate sources (Department assigned Pit No.).
17. Actual weight of coarse and fine aggregates batched in pounds [kilograms].
18. Percent of free moisture in coarse and fine aggregates.
19. Cement producer and type.
20. Total weight of cement batched in pounds [kilograms].
21. Producer, brand name and class (whichever might apply) of Pozzolan or Slag.
22. Total amount of Pozzolan or Slag batched in pounds [kilograms].
23. Producer, supplier, type and total amount of air entraining agent used.
24. Producer, supplier, type and total amount of admixtures used.
25. Total amount of water batched at the plant in gallons [liters] or pounds [kilograms].
26. Statement of compliance with Department specifications.
27. Original signature of Plant Operator and Technician Identification Number.

The delivery ticket serves as certification to the Department that the concrete was batched in accordance with the plans and specifications. There must be a delivery ticket with each load of concrete delivered to the job site. It must be signed by the Plant Operator and have the actual batched quantities (as opposed to the design mix quantities) on the delivery ticket.

23. Cold Weather Concreting

Do not mix concrete when the air temperature is below 45ºF [7ºC] and falling. The Contractor may mix and place concrete when the air temperature in the shade, and away from artificial heat, is 40ºF [4ºC] and rising. Protect the fresh concrete from freezing until the concrete reaches a minimum compressive strength of 1,500 psi [10 MPa] unless the concrete is to be heat cured.

24. Hot Weather Concreting

Hot weather concreting is defined as the production, placing and curing of concrete when the concrete temperature at placing exceeds 85ºF [30ºC] but is less than 100ºF [40ºC].

Unless the specified hot weather concreting measures are in effect reject concrete exceeding 85ºF [30ºC] at the time of placement. Regardless of special measures taken, reject concrete exceeding 100ºF [40ºC]. Predict the concrete temperatures at placement time and implement hot weather measures to avoid production shutdown.

25. <u>Acceptance/Rejection of Delivered Concrete</u>

The acceptance or rejection of a load of concrete is based on many criterion. The following list is by no means all-inclusive.

a. **Slump**. The following applies to non-Drill Shaft and non-HRWR concrete.

The target range is ± 0.75" [± 20 mm] of the target slump listed in Table 1 based on the class of concrete. The target slump will also be shown on the design mix.

The tolerance range is ±1.5" [40 mm] of the target slump listed in Table 1 based on the class of concrete.

1. Out of tolerance range. If the slump differs more than 1.5" [40 mm] from the target slump, high or low, the load will be rejected. If the slump is too high, neither adding cement nor letting the truck sit to reduce slump are acceptable practices; neither will be allowed. If the slump is too low, even if job site water is available, the load will be rejected. Immediate corrective action is required at the plant to bring the succeeding loads within target range.

2. Within tolerance range but out of target range. If the slump is greater than 0.75" [± 20 mm] but less than 1.5" [40 mm] from the target, the concrete is acceptable. However, immediate corrective action is required at the plant to bring the slump within 0.75" [± 20 mm] of the target on successive deliveries. If the slump is on the low (dry) side and the delivery ticket shows allowable job site water, the mix may be adjusted to bring it within target range.

3. Within target range. If the slump is within 0.75" [± 20 mm] of the target, the concrete is accepted as is and no adjustments are allowed to the concrete.

		TARGET SLUMP			
LOW SLUMP	**← TOLERANCE RANGE →**				**HIGH SLUMP**
	← 1.5" [40 mm] →		**← 1.5"[40 mm] →**		
	ACCEPT	**←TARGET RANGE →**		**ACCEPT**	
		←0.75" [20 mm]→	**←0.75" [20 mm]→**		
Load is always REJECTED without job site adjustment. Do not add water even if job site water is available.	**If job site water available, adjustment allowed. Plant must make an immediate batching adjustment.**	**ACCEPT Do not adjust load.**	**ACCEPT Do not adjust load.**	**No job site adjustment allowed. Plant must make an immediate batching adjustment.**	**Load is always REJECTED without job site adjustment. Do not add cement. Do not allow truck to sit and wait for slump loss.**

4. Adjusting out of range. If a load that was initially acceptable and in tolerance is adjusted out of tolerance, it will be rejected.

5. A load of concrete that arrives within tolerance range and has job site water available

can only be adjusted once to bring it within target range. Adjustments are not permitted after placement of the load has begun.

b. **Slump**. The following applies to Drill Shaft and any other concrete using HRWR.

In this case, the target range and the tolerance range are the same at ± 1.0" [± 25 mm] of the target slump. The target slump for Drill Shaft concrete is 8" [200 mm]. For any other class of concrete using HRWR, the target slump will be shown on the design mix and will not exceed 7" [180 mm]. Delivered concrete must be within the ± 1.0" [± 25 mm] of the target slump, or the load will be rejected.

1. If the air content is outside of the ranges listed in Table 1, the load will be rejected.
2. Water Cement Ratio. If the water cement ratio of the class of concrete or the design mix is exceeded, the load will always be rejected.
3. If total revolutions of the mixer exceed 300, the load will be rejected.
4. Any transit times exceeding those shown in paragraph 17 will result in rejection of the load.
5. Any concrete exceeding 100°F [40°C] will be rejected. Any concrete that is not from an approved hot weather design mix will be rejected when it exceeds 85°F [30°C].

26. <u>Definitions</u>

Absolute volume	The volume of a material in a voidless state. This means that the absolute volume of a granular material like cement or aggregate is the volume of the solid matter in the material only, it does not include the volume of the voids between particles. $$\textit{Absolute volume} = \frac{\textit{Weight of Material}}{\textit{(Specific Gravity of Material) x (Unit Weight of Water)}}$$
Absorbed moisture	The moisture in the pores and capillaries of a material. If an aggregate has all the moisture it is capable of absorbing (SSD), it will not give or take any water from the batch water. If an aggregate has not absorbed all the moisture it is capable of absorbing (less than SSD), it will pull batch water from the mix resulting in a drier than anticipated mix. If an aggregate has more moisture than it is capable of absorbing (more than SSD), it has free moisture it will contribute to the batch water resulting in a wetter than anticipated mix.
Absorption	The ability to take moisture into pores or capillaries. For aggregate, it is the moisture content, given as a percent of the aggregate's weight, when it has reached a saturated surface dry condition. For example, if an aggregate has an absorption of 1.0%, it will absorb a weight of water equal to 1.0% of its own weight.
Accelerator	An admixture designed to accelerate strength gain of concrete at an early age. It should be noted that any admixture containing calcium chloride is prohibited from use in any reinforced concrete application.

Admixtures	Ingredients other than cement, water and aggregates that are added to a concrete mix for any or all of the following reasons: reduce construction costs; alter plastic properties; alter curing characteristics; improve inclement weather concrete quality; improve durability; etc.
Air entraining admixture	Admixtures designed to purposely distribute microscopic air bubbles throughout a batch of concrete. Air entrainment significantly improves the durability of concrete to freeze-thaw cycles, improves workability, and reduces segregation and bleeding. All FDOT concrete is required to have an air entraining admixture.
Air dry aggregate	Aggregate that is dry at the surface but contains some interior moisture. Aggregate that is air dry is considered somewhat absorbent because it does not contain all the moisture it is capable of holding (less than SSD).
Approved status	Fully approved plant status that is the normal operating status for concrete plants which meet the requirements of Department specifications and requirements.
Batch Plant Operator	The Department approved individual responsible for certifying the delivery ticket with his original signature. Shall be present during all batching operations for Department concrete. Department approval is currently obtained by passing the Batch Plant Operator Exam conducted by Construction Training Qualification Program (CTQP).
Bleed water	Water that has migrated to the surface of freshly placed concrete. It is caused by the settlement and consolidation of the solids in the mix due to vibration and gravity.
Cement	The bonding agent of concrete. All cements are hydraulic which set and harden due to a chemical reaction with water called hydration.
Cementitious materials	Substances that have hydraulic cementing properties. Although pozzolans have little or no cementitious value, they are included in the total weight of cementitious material in a mix design.
Certified Technician	An individual with a current ACI Grade I certification. Will include additional certifications from UF in the 2000-2001 time frame as part of the Construction Training Qualification Program (CTQP).
Chloride content	The water soluble chloride-ion content in concrete measured in weight/volume of concrete. See Table 2.
Coarse aggregate	Aggregate substantially retained on the No. 4 [4.75 mm] sieve. There is a wide range of grading in classifying coarse aggregates.
Concrete	A basic mixture of two components: aggregates and paste. Aggregates are generally divided into two groups: fine and course. The paste is comprised of cement and water and binds the aggregates into a hardened mass due to the chemical reaction of the cement and water (see hydration).
Conditional plant status	Temporary operating status which may be used during the correction of minor discrepancies.

Consistency	Measured with the slump test, it refers to the wetness, flowability, stiffness and cohesion of the plastic concrete.
Cookout method	The method of determining aggregate moisture by cooking out all the moisture in an oven. Total moisture is determined by subtracting the oven dry weight from the wet weight of the aggregate.
Corrosion inhibitor	An admixture used to chemically arrest the corrosion reaction caused when chloride ions reach the reinforcing steel in concrete structures. Calcium nitrite is the most commonly used corrosion inhibitor.
Deleterious substances	Generally refers to undesirable substances that may be found in aggregates and water. These may include clay, soft particles, salt, alkali, organic matter, loam, oil, acid, chlorides, etc.
Delivery ticket	Paperwork required to accompany every load of concrete delivered to the Department. All information required on the delivery ticket may be obtained from the District Materials Office. An original signature from a certified Batch Plant Operator is required on each delivery ticket to certify to the accuracy of the information and compliance with the approved design mix.
Dry aggregate weight	Total weight of an aggregate with zero moisture content. Generally determined by cooking the aggregate in an oven until it reaches a stabilized weight.
Durability	A broad term referring to the ability of concrete to withstand the environment and service conditions in which it is placed. It encompasses the following and more: freeze/thaw resistance, abrasion resistance, chemical resistance, permeability, control of cracking, etc.
Entrained air	Microscopic air bubbles purposely trapped in the concrete mix for improved properties and characteristics. See air entraining admixture.
Entrapped air	"Large" air bubbles trapped in the concrete mix - as opposed to microscopic entrained bubbles. Also known as bug holes.
False set	A significant loss of plasticity shortly after mixing. If this occurs, remix the concrete without additional water before it is placed.
Fineness modulus (FM)	A general indication of the fineness or coarseness of an aggregate. It is determined by a specific sieve analysis procedure.
Fine aggregate	Natural sand or crushed stone with most particles less than 0.2".
Fly ash	It is the finely divided residue of the coal burning process in power plants. This pozzolan contributes to the concrete's long-term strength and durability.
Free moisture	The moisture on the surface of an aggregate that is above and beyond the absorbed moisture in an aggregate. It is expressed as a percentage of the weight of the aggregate. *Free moisture = Total moisture - absorbed moisture*

Fully absorbent aggregate	Aggregate that has been oven dried removing all free and absorbed moisture.
Grading	See sieve analysis.
Heat of hydration	The heat generated by the chemical reaction between water and cement. The amount of heat produced is primarily a function of the chemical make-up of the cement but is also effected by such things as water-cement ratio, cement fineness and temperature of curing.
High Range Water Reducer (HRWR)	See water reducing admixture. Reduces water by 12% to 30%.
Hot weather concreting	Defined as the production, placing and curing of concrete when the concrete temperature at placing is above 85°F [30°C] but below 100°F [40°C].
Hot weather design mix	A design mix that has been batched to satisfy the temperature, slump loss, plastic and hardened properties, and maximum water cement ratio requirements of the specifications to be designated a hot weather mix. See hot weather concreting for definition.
Hydration	The chemical reaction between the hydraulic calcium silicates of cement and water. Hydration begins as soon as cement comes in contact with water. Hydration will stop when there is insufficient moisture available in the concrete to support the reaction.
Concrete Production Facility Quality Control Plan (QCP)	The concrete producer's plan delineating all actions to be carried out to ensure the produced concrete maintains the required properties from point of production to the point of delivery. The required format for the Concrete Production Facility QCP is available in Chapter 9.2 of the Materials Manual located on the State Materials Office website.
Contractor's Quality Control Plan	The contractor's plan delineating all actions to be carried out to ensure the concrete maintains specified quality and properties from the point of delivery to the point of placement. The required format for the Contractor's QCP may be obtained from Section 105 of the Standard Specifications and is located on the Specifications Office website.
Manager of Quality Control	A required individual in any plant producing concrete for the Department. Requires previous quality control experience and demonstrated proficiency in managing a quality control program. Responsibilities include, but are not limited to, implementing QC policies, maintaining communications with Project Managers and Engineers, supervising QC technicians, and ensuring QC records are properly prepared, maintained and filed.
Mass concrete	Defined as any volume of cast-in-place concrete large enough to require measures to deal with large temperature differentials within the mass of concrete and the inherent cracking problems associated with those temperature differentials. For Department projects, mass concrete will be

	designated in the contract documents. A mass concrete mix design and a proposed plan to monitor and control temperature differential is required for Department projects. Temperature differentials must be kept at or below 35°F [20°C] between internal and external portions of the mass.
Mixing revolutions	Generally refers to transit truck mixers. Each batch must be initially mixed between 70 - 100 revolutions at mixing speed. If water is added at the job site, an additional 30 mixing revolutions is required. The total mixing speed revolutions is not to exceed 160 and the total drum revolutions is not to exceed 300 prior to total discharge of the load.
Moisture content	The amount of moisture in a given material. Given as a percent of the weight of the aggregate. The moisture content of a sample, in percent, is found with the following equation: $moisture\ (\%) = 100 * \frac{(weight\ of\ original\ sample - weight\ of\ dried\ sample)}{(weight\ of\ dried\ sample)}$
Moisture probe	Generally an electrical resistance type meter used to determine the moisture content of aggregates. The probes require periodic calibration and their accuracy shall be verified at least weekly by the manufacturer's recommended method.
Non-approved plant status	Not qualified to supply concrete to the Department.
Oven-dried aggregate weight	The weight of aggregate that has had all its moisture dried out by oven cooking. Aggregate in this condition is considered fully absorbent because of its potential to absorb water.
Plant Batcher	Individuals who perform only the function of batching concrete. They do not have to pass an exam to be Department approved but demonstrated proficiency is required. A Batch Plant Operator must be present during batching and to sign the delivery ticket.
Pozzolanic Materials	Materials which have little or no cementitious value by themselves but, in a finely divided form, have cementitious properties when mixed with water and the byproduct of cement hydration.
Qualified Products List	The Department generated list of all products suitable for immediate use in Department projects.
Re-tempered concrete	Concrete that has initially started to set (hydrate) and water has been added to it to provide additional workability.
Retarding admixture	Admixtures designed to slow the rate of setting of concrete. These may be used to counteract the accelerating effects of hot weather or delay set for unusual placements like drilled shafts.
Saturated	Refers to aggregate that has absorbed all the moisture it is capable of

surface dry (SSD)	absorbing and is dry on the outside. All design mix aggregate quantities refer to SSD aggregate. SSD aggregate can neither absorb water from nor contribute water to the concrete mix.
Sieve Analysis	A process used to determine the particle size distribution of an aggregate. The aggregate is sieved through several screens of known size to determine the size distribution and grading of an aggregate.
Slag	Ground granulated blast-furnace slag is a nonmetallic byproduct of iron blast-furnace operations. This material is cementitious and will hydrate with the addition of water. Only Grade 100 or better is allowed in Department projects.
Specific gravity	The relative density of a material compared to water. It is the ratio of the material's weight to the weight of an equal absolute volume of water. Aggregates generally run between 2.4 and 2.9; cement is 3.15.
Superplasticizer	See High Range Water Reducer.
Surface moisture	See free moisture.
Tare	A deduction from gross weight made to allow for the weight of a container. For example, the tare weight of a pan is subtracted from the gross weight of the pan and aggregate to get the net weight of the aggregate.
Target range	Refers to a slump range. The target range is ±¾" [±20 mm] of the specified target slump. Concrete delivered within the target range is accepted on the job site without any adjustment.
Target slump	Each class of concrete has a specified target slump. See Table 1.
Tolerance range	Refers to slump range. For concrete other than drilled shaft, the tolerance range is ±1.5" [±40 mm] of the specified target slump. For drilled shaft concrete, the tolerance range is ±1" [±25 mm]. Concrete delivered within the tolerance range is accepted on the job site. However, if the concrete is outside the target range, the concrete producer must make immediate corrections to bring the slump back within the target range.
Total aggregate moisture	Absorbed plus free moisture.
Unit weight	The weight of a given unit of concrete is a measure of its density. Generally expressed in pounds per cubic foot or kilograms per cubic meter. Standard weight concrete has a unit weight between 140 and 150 lbs/ft^3 [2200 and 2400 kg/m^3]. (ASTM C 138)
Unmetered water	Any water added to a batch that is unaccounted for. This is strictly prohibited in FDOT mixes,
Water reducing admixture	Admixtures designed to reduce the water required to produce concrete at a given slump, to reduce the water cement ratio of a given slump mix, or to increase the slump of a mix with a set amount of batch water. Reduces water by 5% to 10%.

Water-cementitious ratio	Total weight of all water in a mix divided by the total weight of all cementitious materials in the mix. Water total must include contributions/deductions for aggregate moistures (above or below SSD), contributions from any admixtures or silica fume slurry, etc. Cementitious materials must include all cement plus any fly ash, slag, silica fume, metakaolin or any other pozzolan used in the mix design.
Wet aggregate weight	Total weight of an aggregate including any absorbed and free moisture it has.
Yield	The volume of concrete produced in a batch. The yield is determined by dividing the total weight of all the component materials batched by the unit weight of the concrete. (ASTM C 138)

27. Calculations and examples

a. Calculating aggregate moisture from the cook-out method. Information you will need to be able to collect:

1) W_{wet} = weight of the wet aggregate and weighing pan (lbs [kg]).
2) W_{dry} = weight of oven dried aggregate and weighing pan (lbs [kg]).
3) P_{tw} = tare weight of the weighing pan

Determine the moisture content as a percent of the aggregate dry weight:

$$100 * [(W_{wet} - W_{dry})/(W_{dry} - P_{tw})] = \text{moisture content (\%)}$$

Example (1):

A sample of course aggregate is taken, weighed (W_{wet}), dried, then re-weighed (W_{dry}). The weights measured are given below. What is the moisture content of the stockpile represented by the sample?

W_{wet} = 3.64 lbs

W_{dry} = 3.45 lbs

P_{tw} = 0.54 lbs

Calculate moisture content of the sample:

Moisture content (%) = 100 * [(3.64 – 3.45)/(3.45 – 0.54)] = 100 * [0.19/2.91] = 6.53%

Example (2):

W_{wet} = 1,509.6 g

W_{dry} = 1,476.4 g

P_{tw} = 295.3 g

Calculate moisture content of the sample:

Moisture content (%) = 100 * [(1,509.6 - 1,476.4)/(1,476.4 - 295.3)] = 100 * [33.2/1181.1] = 2.81%

===

b. Calculating free moisture in aggregate. Information you will need to be able to collect:

1) Moisture content (see preceding examples).
2) Aggregate absorption.

Moisture content (%) - absorption (%) = free moisture (%)

Example (3):

The moisture content is determined to be 5.65% for a stockpile of coarse aggregate. This same aggregate has an absorption of 2.5%. What is the free moisture?

Free moisture = 5.65 - 2.5 = 3.15%

Example (4):

The moisture content is determined to be 2.89% for a stockpile of fine aggregate. This same aggregate has an absorption of 1.4%. What is the free moisture?

Free moisture = 2.89 - 1.4 = 1.49%

===

c. Determine the adjustment to batch water quantity and aggregate quantity due to aggregate moisture. Information you will need to be able to collect:

1) Free moisture (see Examples (3) and (4)).

2) Weight of SSD aggregate used per yd^3 [m^3] from the design mix.

A. This calculation takes a moisture content as a percentage of aggregate weight and turns it into a measurable quantity (lbs, gal [kg, L]) to be used in the adjustment of both batch water and aggregate quantities. Convert the free moisture percent to a numeric value by dividing by 100. For example, in Example (4), the free moisture was determined to be 1.49%. The value used in calculating adjustments is 1.49/100 = 0.0149.

Adjustment = aggregate weight x converted free moisture

When the moisture content is greater than the absorption (usual case), the aggregate will give up water to the mix. The aggregate quantity must be increased by the adjustment and the water quantity must be reduced by the adjustment.

B. The water adjustment can be left in terms of pounds [kg] or can easily be converted to gal [l]. One gallon of water weighs 8.33 lbs. One liter of water weighs 1 kg.

Water adjustment (gal) = [Water adjustment (lbs)]/8.33

Water adjustment (l) = [Water adjustment (kg)]/1.00

Example (5):

A design mix calls for 1,820 lbs of coarse aggregate and 270 lbs (32.4 gal) of water per yd^3. The aggregate has an absorption of 2.4% and the moisture content is determined to be 6.1%. Calculate the adjustments to batch quantities per yd^3. Figure the water adjustment in pounds and gallons.

Free moisture = 6.1 - 2.4 = 3.7%

Convert free moisture percent to a numeric value: 3.7/100 = 0.037

Determine the adjustment in pounds: 1,820 x 0.037 = 67.34 lbs

Adjusted aggregate quantity = 1,820 + 67.34 = 1,887.34 = 1,887 lbs/yd^3

Adjusted water quantity (lbs) = 270 - 67.34 = 202.66 = 203 lbs

Determine water adjustment in gallons: 67.34/8.33 = 8.08

Adjusted water quantity (gal) = 32.4 - 8.08 = 24.32 = 24.3 gal

Example (6):

A design mix calls for 1,032 lbs of fine aggregate and 250 lbs (30.0 gal) of water per yd^3. The aggregate has an absorption of 1.3% and the moisture content is determined to be 3.9%. Calculate the adjustments to batch quantities per yd^3. Figure the water adjustment in pounds and gallons.

Free moisture = 3.9 - 1.3 = 2.6%

Convert free moisture percent to a numeric value: 2.6/100 = 0.026

Determine the adjustment in pounds: 1,032 x 0.026 = 26.83 lbs

Adjusted aggregate quantity = 1,032 + 26.83 = 1,058.83 = 1,059 lbs/yd^3

Adjusted water quantity (lbs) = 250 - 26.83 = 223.17 = 223 lbs

Determine water adjustment in gallons: 26.83/8.33 = 3.22 gal

Adjusted water quantity (gal) = 30.0 - 3.22 = 26.78 = 26.8 gal

Example (7):

A design mix calls for 1,086 kg of coarse aggregate and 159 kg (159 L) of water per m^3. The aggregate has an absorption of 2.6% and the moisture content is determined to be 5.9%. Calculate the adjustments to batch quantities per m^3.

Free moisture = 5.9 - 2.6 = 3.3%

Convert free moisture percent to a numeric value: 3.3/100 = 0.033

Determine the adjustment in pounds: 1,086 x 0.033 = 35.84 kg

Adjusted aggregate quantity = 1,086 + 35.84 = 1,121.84 = 1,122 kg/m^3

Adjusted water quantity (kg and L) = 159 – 35.84 = 123.16 = 123 kg (or L)

Example (8):

A design mix calls for 679 kg of fine aggregate and 161 kg (161 L) of water per m^3. The aggregate has an absorption of 1.1% and the moisture content is determined to be 2.3%. Calculate the adjustments to batch quantities per m^3.

Free moisture = 2.3 - 1.1 = 1.2%

Convert free moisture percent to a numeric value: 1.2/100 = 0.012

Determine the adjustment in pounds: 679 x 0.012 = 8.15 kg

Adjusted aggregate quantity = 679 + 8.15 = 687.15 = 687 kg / m^3

Adjusted water quantity (kg and L) = 161 - 8.15 = 152.85 = 153 kg (or L)

Example (9):

The following data applies to a design mix. Calculate the adjusted aggregate and water quantities.

	Moisture	Absorption	Quantity / yd³
Coarse aggregate:	5.7	2.2	1,765
Fine aggregate:	4.4	1.5	1115
Water:			260 lbs (31.2 gal)

Coarse aggregate free moisture = 3.5% → 0.035

Adjustment due to extra water in the coarse aggregate = 1,765 x 0.035 = 61.78 lb

Fine aggregate free moisture = 2.9% → 0.029

Adjustment due to extra water in the fine aggregate = 1,115 x 0.029 = 32.34 lb

Adjustment to the batch water = 61.78 + 32.34 = 94.12 lb

Adjusted aggregate and water quantities are:

Coarse aggregate: 1,765 + 61.78 = 1,826.78 = 1,827 lb

Fine aggregate: 1,115 + 32.34 = 1,147.34 = 1,147 lb

Water: 260 - 94.12 = 165.88 = 166 lb = 19.9 gal

Example (10):

The following data applies to a design mix. Calculate the adjusted aggregate and water quantities.

	Moisture	Absorption	Quantity / m³
Coarse aggregate:	6.5	2.7	1,083
Fine aggregate:	4.1	1.4	703
Water:			155 kg (155 L)

Coarse aggregate free moisture = 3.8% → 0.038

Adjustment due to extra water in the coarse aggregate = 1,083 x 0.038 = 41.15 kg

Fine aggregate free moisture = 2.7% → 0.027

Adjustment due to extra water in the fine aggregate = 703 x 0.027 = 18.98 kg

Adjustment to the batch water = 41.15 + 18.98 = 60.13 kg

Adjusted aggregate and water quantities are:

Coarse aggregate: 1,083 + 41.15 = 1,124.15 = 1,124 kg

Fine aggregate: 703 + 18.98 = 721.98 = 722 kg

Water: 155 - 60.13 = 94.87 = 94.9 kg = 95 L

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d. Determine water cementitious ratio and/or batch quantities based on a given water cementitious ratio.

1) The water cementitious ratio is simply the total weight of all water in a batch divided by the total weight of all cementitious materials (cement, fly ash, slag, etc.) in the batch.

$$\text{water cementitious ratio} = w/c = \frac{\text{(weight of all water in a batch)}}{\text{(weight of all cementitious material in a batch)}}$$

Example (11):

A certain design mix contains 475 lbs cement, 158 lbs fly ash and 26.6 gal water per cubic yard. What is the water cementitious ratio for this mix?

Convert batch water from gallons to pounds: 26.6 x 8.33 = 221.58 lbs.

Calculate water cementitious ratio: w/c = 221.58/(475 + 158) = 221.58/633 = 0.350 = 0.35

Example (12):

A certain design mix calls for a cement content of 390 kg/m³ and a maximum water cementitious ratio of 0.41. What is the maximum water allowed per m³?

w/c = 0.41 = (weight of water)/(weight of cementitious material) = (weight of water)/390

Solve for the weight of water:

weight of water = 0.41 x 390 = 159.9 = 160 kg (or L)

Example (13):

A 9 yd^3 batch is called for that requires 752 lbs/ yd^3 cementitious and a maximum water cementitious ratio of 0.37. It is to be batched to allow 27 gal of job site allowable water addition. How much water per cubic yard should be used in the initial batching?

Figure total water required from w/c and cement requirements:

0.37 = (weight of water)/752 → weight of water = 0.37 x 752 = 278.24 = 278 lbs.

Convert to gallons→ 278.24/8.33 = 33.40 = 33.4 gal/yd^3

Since 27 gallons are to be held back from the entire load for allowable job site addition, the hold back per yd^3 is 27/9 = 3.0 gal/ yd^3.

The load should be batched with 33.4 – 3.0 = 30.4 gal/ yd^3 to allow 27 gallon addition at the job site and a maximum water cementitious ratio of 0.37.

Example (14):

A mix design calls for 160 L of water and a water cement ratio of 0.44. How much cement is required for this mix?

The weight of water is 160 L = 160 kg

W/c = 0.44 = (weight of water)/(weight of cement) = 160/(weight of cement)

Solve for weight of cement → weight of cement = 160/0.44 = 363.64 = 364 kg/m^3

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e. Specific gravity, unit weight, absolute volume, yield.

1) When talking about specific gravity, everything is compared to water. Water is considered to have a specific gravity of 1 and has a unit weight of 62.4 lbs/ft^3 [1,000 kg/m^3]. If something has a specific gravity greater than 1, it is more dense (weighs more per ft^3 [m^3]) than water. Specific gravities have no units of measure (ft^3, m^3, lb, kg, etc.). They are the same whether you are in English or metric units.

2) To determine the unit weight of a material with a known specific gravity, multiply the material's specific gravity by 62.4 lb/ft^3 [1,000 kg/m^3].

In English units:

unit weight of a material (lb/ft^3) = (material's specific gravity) x 62.4

In metric units:

unit weight of a material (kg/m^3) = (material's specific gravity) x 1,000

Example (15):

Determine the unit weight of cement (specify gravity = 3.15) in both English and metric units:

English units: 3.15 x 62.4 = 196.6 lbs/ft^3.

Metric units: 3.15 x 1000 = 3,150 kg/m^3.

3) To determine the absolute volume of a certain amount of a material, divide its weight by its unit weight.

$$\text{English: absolute volume} = \frac{\text{weight of material}}{\text{Specific gravity of material x 62.4}}$$

$$\text{Metric: absolute volume} = \frac{\text{weight of material}}{\text{Specific gravity of material x 1000}}$$

Example (16):

Determine the absolute volume of 2,000 lbs [907.2 kg] of aggregate with a specific gravity of 2.63 in English and metric units:

In English units:

2,000/(2.63 x 62.4) = 2,000/164.1 = 12.2 ft^3

In metric units:

907.2/(2.63 x 1,000) = 907.2/2,630 = 0.35 m^3

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4) To determine the yield of a design mix, total the absolute volumes of all the ingredients (including air and, in general, disregarding admixtures). To determine the unit weight of a mix, divide the yield by the total weights of all the ingredients.

Example (17):

Determine the yield and unit weight of the following English units mix:

Ingredient	Weight	SG	Calculation	Absolute Volume
Cement	705	3.15	705/(3.15 x 62.4)	3.587
Coarse aggregate	1,826	2.61	1826/(2.61 x 62.4)	11.212
Fine aggregate	1,145	2.68	1,145/(2.68 x 62.4)	6.847
Air	4.5%		0.045 x 27	1.215
Water	260	1	260/(1 x 62.4)	4.167

Yield = 3.587 + 11.212 + 6.847 + 1.215 + 4.167 = 27.028 ft^3

Unit Weight = (705 + 1,826 + 1,145 + 260)/27.028 = 3,936/27.028 = 145.6 lbs/ft^3

Example (18):

Determine the yield and unit weight of the following metric units mix:

Ingredient	Weight	SG	Calculation	Absolute Volume
Cement	183	3.15	183/(3.15 x 1,000)	0.0581
Fly Ash	182	2.21	182/(2.21 x 1,000)	0.0824
Coarse aggregate	1,038	2.48	1,038/(2.48 x 1,000)	0.4185
Fine aggregate	691	2.63	691/(2.63 x 1,000)	0.2627
Air	3.5%		0.035 x 1	0.0350
Water	159	1	159/(1 x 1,000)	0.1590

Yield = 0.0581 + 0.0824 + 0.4185 + 0.2627 + 0.0350 + 0.1590 = 1.016 m^3

Unit Weight = (183 + 182 + 1038 + 691 + 159)/1.016 = 2,253/1.016 = 2,218 kg/m^3

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5) When the specific gravity (SG) of one of the batch materials changes by more than 0.03, adjustments need to be made to the mix design quantities to prevent over or under yielding. To calculate the necessary adjustment, determine the volume of the original specific gravity. Using the new specific gravity, determine the weight required to fill the volume that was just calculated. You will find that if the SG goes up (more dense), it will take more weight of the material to fill a given volume and if the SG goes down (less dense), it will take less weight of the material to fill a given volume.

In English units:

[original mix quantity (lbs)]/[original SG x 62.4] = volume from original SG (ft^3)

[volume from original SG (ft^3)] x (new SG) x 62.4 = new mix quantity (lbs)

In metric units:

[original mix quantity (kg)]/[original SG x 1,000] = volume from original SG (m^3)

[volume from original SG (m^3)] x (new SG) x 1,000 = new mix quantity (kg)

Example (19):

A certain design mix calls for 1,880 lbs of coarse aggregate with a specific gravity of 2.46. It is determined that the specific gravity of that aggregate is now 2.51. Determine the new design mix quantity for this coarse aggregate.

1,880/(2.46 x 62.4) = 12.247 (ft^3) → 12.247 x 2.512 x 62.4 = 1,918.17 = 1,918 lbs

Example (20):

A certain design mix calls for 701 kg of fine aggregate with a specific gravity of 2.64. It is determined that the specific gravity of that aggregate is now 2.59. Determine the new design mix quantity for this fine aggregate.

701/(2.64 x 1,000) = 0.2655 (m^3) → 0.2655 x 2.59 x 1,000 = 687.72 = 688 kg

ATTACHMENT "A"

CONCRETE Production Facility inspection checklist

PLANT NUMBER: __________		
INSPECTION DATE: _____ / _____ / _____		
Inspected for: 346 _______, 347_______, Both _______		
Today's Inspection: Initial _________, Routine __________, Reinspection __________		
Concrete Supplier:	Plant Inspected By:	
Plant Address:	Plant Location:	
Plant Telephone No.:	Plant Fax Number:	
QUALITY CONTROL PERSONNEL		
Quality Control Manager:	CTQP Batch Plant Certification Date:	
QC Manager Location:	Quality Control Telephone No.:	
Quality Control Mobile No.:	Quality Control Fax. No.:	

	PLANT PERSONNEL	**Y**	**N**
1	The plant personnel are certified through the CTQP program.		
2	The plant personnel are indicated in the Quality Control Plan.		

Batch Operator:	CTQP TIN:	Expiration Date:
QC Manager:	CTQP TIN:	Expiration Date:
Other:	CTQP TIN:	Expiration Date:
Other:	CTQP TIN:	Expiration Date:

Based on today's inspection, this plant is placed on the following status:

APPROVED __________	CONDITIONALLY APPROVED__________	NON-APPROVED __________

________________________________ FDOT PLANT INSPECTOR

________________________________ PLANT REPRESENTATIVE

Plant Representative signature does not indicate agreement or disagreement with inspector findings.

AREA	**REMARK OR DEFFICIENCY**	**Y**	**N**	**N/A**
CEMENT				
POZZOLANS / SLAG				
COARSE AGGREGATE				
FINE AGGREGATE				
ADMIXTURES				
WATER				
PLANT RECORDS				
SCALES				
MIXING CONCRETE				
RAW MATERIALS				
MIXERS				

THIS INFORMATION IS COLLECTED INSIDE THE BATCH HOUSE

No.	Item	Y	N	N/A
CEMENT				
1	The certification for cement complies with AASHTO M-85 & FDOT specification.			
2	The cement is identified in the Quality Control Plan.			
POZZOLANS / SLAG				
3	The certification for Fly Ash complies with ASTM C-618 (Class F) or ASTM C-311 (Class C) and FDOT specification.			
4	The certification for Blast Furnace Slag complies with ASTM C-989 and FDOT specification.			
5	The fly ash and slag are identified in the Quality Control Plan.			

Material	Type	Brand	Source	Delivery Date	Mill Cert. Date

REMARKS OR DEFFICIENCY:

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No.	Item	Y	N	N/A
COARSE AGGREGATE				
1	The coarse aggregates are indicated in the Quality Control Plan.			
2	The coarse aggregates meet all specification requirements.			
3	The Gradation / Absorption tests is being performed by approved personnel or lab. Technician Identification Number (TIN) _______________________			
4	The Gradation / Absorption tests is being performed in a timely manner (at least once per 30 days).			
5	The free moisture test is being performed by an approved method. (cook out or towel drying)			
6	The plant is verifying the accuracy weekly if the towel method is being used.			

Pit No.	Grade	FDOT Code	Delivery Date	Date Certified

REMARKS OR DEFFICIENCY:

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No.	Item	Y	N	N/A
FINE AGGREGATE				
1	The fine aggregates are indicated in the Quality Control Plan.			
2	The fine aggregates meet all specification requirements.			
3	The Gradation / Absorption tests is being performed by approved personnel or lab. Technician Identification Number (TIN) ______________________			
4	The Gradation / Absorption tests is being performed in a timely manner (at least once per 30 days).			
5	The free moisture test is being performed by an approved method. (cook out, moisture probe reading, speedy moisture tester or Chapman flask)			
6	The plant is verifying the accuracy weekly if the speedy moisture tester or Chapman flask method is being used.			
7	The plant is verifying the accuracy at least weekly if the moisture probe is being used by the recommendation of the manufacture.			

Pit No.	Grade	FDOT Code	Delivery Date	Date Certified

REMARKS OR DEFFICIENCY:

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No.	Item	Y	N	N/A
ADMIXTURES				
1	All admixtures are indicated in the Quality Control Plan.			
2	All admixtures are on the Qualified Products List as approved for FDOT.			
3	The number of measuring devices is sufficient.			

Material Identification (Brand)	Delivery Date	Dispenser Calibration Date

REMARKS OR DEFFICIENCY:

No.	Item	Y	N	N/A
WATER				
1	The source of the water is indicated in the Quality Control Plan.			
2a	The source of water is from the city. (no testing needed)			
2b	The source of water is from a well and tested once every three months, unless the past eight consecutive tests pass in which only require once every six months. (last test date of: ____________________)			
2c	The source of water is from a stream or lake and tested once every thirty days. (last test date of: ____________________)			
2d	The source of water is recycled and tested once every thirty days. (last test date of: ____________________)			
2e	The source of water is reclaimed wash water and tested once every thirty days. (last test date of: ____________________)			
3	The source of water was tested at an approved laboratory. (name of laboratory: ____________________)			

REMARKS OR DEFFICIENCY:

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No.	Item	Y	N	N/A
PLANT RECORDS				
1	The various Applicable Specifications on File (both English and Metric if applicable).			
2	The Plant Quality Control Plan on file.			
3	A copy of the Federal Poster posted.			
4	A daily record of concrete batched for the Department on file.			
5	Copies of the manufacturers design showing dimensions and arrangements of blades for each mixer available.			
6	All approved Design Mixes are on file.			
7	The records for the Coarse Aggregates are available.			
8	The records for the Fine Aggregates are available.			
9	The records for moisture probe and other methods of determining the free moisture being verified at least once per 7 days.			
10	The plant deviated from the standard 24-hour aggregate watering.			
11	If the plant deviated from the standard 24-hour aggregate watering, the deviation is shown in their quality control plan and approved by the District Materials Engineer.			
12	Project information was recorded (fill in below).			
13	Concrete test data was recorded (fill in below).			

Concrete Test Data:

FIN Project #	Mix # (Mix Class)	Date Cast	Plastic Property	Strength 28-Day	Chloride Results

REMARKS OR DEFFICIENCY:

No.	Item	Y	N	N/A
SCALES				
1	A company registered with the Bureau of Weights and Measures of the Department of Agriculture calibrated the scales and water meters for accuracy.			
2	Company Name & Registration #:			
3	Cement scale was calibrated (date: ______________________).			
4	Course & Fine Aggregates scale was calibrated (date : ____________________).			
5	Water measuring device was calibrated (date : ______________________).			
6	There is an automatic cutoff for water measuring device.			
7	The scale company report includes observed scale deviations.			
8	The scale deviations were checked within 0.5% of maximum load.			
9	Suitable means were provided to hold poises on beam type scales.			
10	Scales permit reading to 0.1% of capacity.			
11	A device to indicate the required load is being reached is provided.			
12	All weighing devices are in view of the operator.			
13	Cementitious materials are measured within an accuracy of 1% of the required amounts.			
14	Aggregates are measured within an accuracy of 1% of the required amounts.			
15	Water is measured within an accuracy of 1% of the required amounts.			

REMARKS OR DEFFICIENCY:

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No.	Item	Y	N	N/A
MIXING CONCRETE				
1	The batching sequence is in accordance with the specifications.			
2	The mixing is at proper drum speed.			
3	If a truck mixer is used, the drum revolutions are according to specifications.			
4	The maximum mixer volume is not exceeded.			
5	All water going into the mixer is metered or weighed.			
6	If a central mixer is used, the concrete is mixed a minimum of two minutes or as approved in the quality control plan.			
7	The central mixer is equipped with an approved timing device.			
8	Admixtures are measured separately.			
9	Admixtures are added with the mixing water.			
10	Cement is weighed independently from other materials.			
11	Cement is weighed first when using a cumulative weigh hopper.			
12	Cementitious materials are being protected from loss in handling after weighing.			

REMARKS OR DEFFICIENCY:

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THIS INFORMATION IS COLLECTED OUTSIDE THE BATCH HOUSE

No.	Item	Y	N	N/A
RAW MATERIALS				
1	The cement is stored in a weatherproof facility that is labeled.			
2	For the cementitious materials there is a suitable, safe and convenient means of collecting samples.			
3	Aggregates are handled and stored in silos, ground storage, or batch bins, free of contamination & segregation, and clearly labeled.			
4	Aggregates are in a well-drained condition.			
5	Aggregates stockpiles are formed properly.			
6	Aggregate silos are kept in a reasonably full condition.			
7	The entire surface of the coarse aggregate is continuously and uniformly sprinkled with fresh water 24-hours immediately preceding introduction into the concrete mix (unless otherwise identified in the Quality Control Plan).			
8	All scales have adequate protection from the elements.			
9	All scales are clean to assure accurate and efficient operation.			

REMARKS OR DEFFICIENCY:

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No.	Item	Y	N	N/A
M I X E R S / M A I N T E N A N C E O F M I X E R S				
1	Mixers are free of hardened concrete.			
2	All Blades are greater than 90% of design height.			
3	The supplier examines the mixers weekly for hardened concrete and blade wear and a record of the truck inspection being kept (both in the cab of the truck mixer and in the plant).			
4	The manufacturer metal rating plate (consisting of mixing speed, agitation speed, rated capacity and unit serial number) of the drum is available, attached, and legible on each truck mixer.			
5	The mixer is equipped with a hatch in the periphery of the drum, revolution counter, and a clean operating water gauge (calibrated annually) that are all in good operation.			
6	Either **central** or **truck** (circle one) mixers demonstrate the capability to combine the concrete component materials into a thoroughly mixed and uniform mass.			
7	Either **central** or **truck** (circle one) mixers demonstrate the capability to discharge the concrete with a satisfactory degree of uniformity.			
8	Mixers were inspected and recorded (fill in below).			

Mixer Inspection:

Truck Number	Counter Condition	Blade Condition	Drum Condition	Rating Plates	Water Gauge	Remarks

*Superficial Inspection, hatch need not be open (E) English (M) Metric (B) Both

REMARKS OR DEFFICIENCY:

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ATTACHMENT "B"

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	Time Loaded	Mixing revolutions	Cubic Yards Total Today

Cement Source Type Amount	Fly Ash or Slag Source Type 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 concrete batched was produced and information recorded in compliance with Department specification requirements for Structural Concrete.

CTQP Technician Identification Number

Signature of Batcher Plant Operator

Arrival time at job site		Number of revolutions upon arrival at job site	
Water added at job site (gal. or lbs.)		Additional mixing revolutions with added water	
Time concrete completely discharged		Total number of revolutions	
Initial Slump	Initial Air	Initial Concrete Temp.	Initial w/c Ratio
Acceptance Slump	Acceptance Air	Acceptance Concrete Temp.	Acceptance w/c Ratio

Issuance of this ticket constitutes certification that the maximum specified water cementitious ratio was not exceeded and the batch was delivered and placed in compliance with Department specification requirements.

CTQP Technician Identification Number

Signature of Contractor's Representative