Section 6.3
Volume II

PRECAST CONCRETE DRAINAGE STRUCTURES AND BOX CULVERTS

6.3.1 PURPOSE

This procedure provides guidance for the development and implementation of the Quality Control (QC) Programs for the manufacture, storage, and transportation of precast concrete drainage structures and box culverts (Structures) for Florida Department of Transportation (Department) projects. The Structures may include, but are not limited to, inlets, manholes, junction boxes, endwalls, three-sided precast concrete culverts, and precast concrete box culverts.

6.3.2 AUTHORITY

Sections 334.044(10)(a) and 334.048(3), Florida Statutes

6.3.3 REFERENCES

Code of Federal Regulations (CFR), Federal-Aid Policy Guide (FAPG), Subchapter G–Engineering and Traffic Operations, Part 637–Construction Inspection and Approval, Subpart B – Quality Assurance Procedures for Construction

Standard Plans for Road and Bridge Construction Topic No. 625-010-003, Florida Department of Transportation (FDOT)

Florida Department of Transportation Standard Specifications for Road and Bridge Construction

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

American Association of State Highway and Transportation Officials (AASHTO), Part I Specifications, and Part II Tests

Approved Product List (APL), Florida Department of Transportation

Materials Acceptance and Certification system (MAC) QC Program Maintenance User Manual

6.3.4 SCOPE

This procedure is used by the Precast Concrete Drainage Structures and Box Culverts Producers (Plants). These requirements and activities pertain to the inspections, measurements, and necessary tests to substantiate materials and Structures in conformity with the Contract Documents. The Plant's QC Plan is designed to provide guidelines that are used by Plants to produce Structures in conformance with the Specifications and project Plans.

6.3.5 GENERAL INFORMATION

The Plants are responsible for the production, inspection, storage, and shipment of the Structures. The delivered Structures to the project site shall meet the requirements of the Specifications, Plans, and other Contract Documents.

6.3.6 PLANT QUALIFICATION PROCESS

6.3.6.1 General

Prepare the Plant's proposed QC Plan in accordance with ***FDOT Specifications Section 105.*** Submit the proposed QC Plan to the District Materials and Research Office (DMRO) for the District in which the Plant is located. For out-of-state Plants, submit the proposed QC Plan to the nearest DMRO. Upon the Plant's submittal of a QC Plan, the DMRO will review the proposed QC Plan and make arrangements for the Plant qualification review in accordance with ***Section 6.3.6.3***.

6.3.6.2 Review of the Plant's Proposed QC Plan

In the QC Plan, include the work experience, qualifications, and responsibilities of the Plant's production and QC personnel. Identify the on-site production manager, Plant general manager, QC inspectors/technicians, and QC manager. Identify the key quality attributes in the QC Plan. Identify the responsibilities for monitoring key quality attributes and QC data. Include the applicable information required in ***FDOT Specification Sections 105, 346, 407, 410***, ***449,*** the Standard Plans***,*** and other Contract Documents.

Include a management statement of dedication to quality. Include any available proposed repair methods for minor deficiencies as part of the QC Plan.

Complete the Precast Concrete Drainage Structures and Box Culverts Producer QC Plan Checklist (***Appendix B05***) and submit it with the QC Plan. The checklist can be found at the following link.

https://www.fdot.gov/materials/quality/programs/qualitycontrol/checklists/index.shtm

When requested by Department inspectors, ***National Precast Concrete Association (NPCA)*** certified Plants are required to provide the two most recent NPCA inspection reports, including the Plant's responses to the deficiency reports, if applicable.

6.3.6.2.1 Source of Supply

The Plant shall comply with the Build America, Buy America Act (BABA), in accordance with ***FDOT Specifications Section 6*** (Source of Supply).

At the beginning of each project, provide a notarized certification on the Plant's letterhead to the Engineer stating that the Structures will be manufactured in accordance with the requirements set forth in the ***Contract Documents***, the Plant's accepted QC Plan, and ***FDOT Specifications Section 6*** (Source of Supply). Provide an example copy of this certification in the QC Plan. Examples of acceptable material certifications can be found at the following link.

https://www.fdot.gov/materials/administration/resources/library/publications/certifications/sampleforms.shtm

The Plant shall track steel and iron usage to declare the dollar amount of any foreign steel or iron on each delivery ticket. The QC Plan shall include the following:

A. Methods for tracking the placement of all quantities of foreign steel and iron. Implement an accountable system that tracks the monetary value of foreign steel or iron used in each product.
B. Methods and locations for segregating foreign steel and iron stockpiles from domestic steel and iron stockpiles.
C. Methods for identifying and cataloging finished products containing foreign steel or iron.

D. An example delivery ticket which includes a Buy America compliance statement and the dollar amount of foreign steel or iron used in the finished products for each delivery. The Buy America compliance statement and the dollar amount of foreign steel and iron shall appear on each delivery ticket. If no foreign steel or iron is used, then $0 shall be declared.

6.3.6.3 Plant Qualification Review

The Department will perform the qualification reviews of the Plants. A qualification review includes an in-depth inspection by the Department of a Plant that submits its first QC Plan and Plants that have not produced for Department projects for more than a year.

6.3.6.4 Maintenance of Plant QC Plan and Qualification

Upon the Department's satisfactory review of the proposed QC Plan, and a satisfactory Plant qualification review, the DMRO will accept the proposed QC Plan and include the Plant on the Department's ***Production Facility Listing***. Immediately notify the DMRO in writing of any changes to the QC Plan. In case of change(s), revise the QC Plan annually in the form of addenda or complete revision of the entire document. Submit the revised QC Plan or its addenda to the DMRO annually. Any revisions to an accepted QC Plan shall be submitted and accepted by the DMRO prior to the implementation of the changes.

Plants that are on the Department's ***Production Facility Listing*** will be subject to the Plant qualification review or routine verification inspection at any time. At a minimum, quarterly verification inspections will be performed by DMRO personnel. The Plants with an acceptable QC Plan, a satisfactory Department qualification review, and continued satisfactory verification inspections are qualified Plants.

Finished product storage areas shall provide adequate space for Department verification inspection that allows reasonable room for inspection of all surfaces. Structures shall not be stored too close to adjacent Structures, the ground, or in overgrown areas where inspection is not possible.

If the Plant has not produced for Department projects for three consecutive quarters, the verification inspection frequency will be reduced to once every three quarters until the Plant produces for Department projects again. The frequency will revert back to once per quarter immediately after the Plant reinitiates production. The QC manager is responsible to inform the DMRO

at least two weeks before the Plant resumes production for Department projects.

6.3.6.5 Maintenance of MAC Company and Production Facility Profile

During the Plant Qualification process, a Production Facility Profile (and a Company Profile if it does not yet exist) will be created in MAC. A Plant representative is responsible for acquiring the necessary Profile Manager roles within the system and maintaining contact information for the Profile Manager and Contact Person.

The Plant representative is responsible for uploading a copy of the Plant's QC Stamp to the Documents tab of the MAC Production Facility Profile.

6.3.6.6 Photographs and Videos

Allow Department representatives to take photographs of disputed infractions occurring within the manufacture of products designated for Department use. Photographs and videos will be taken for documentation and timely resolution of possible concerns observed and disputed by the facility during Department Plant inspections.

If Department inspectors observe a product or action that they feel is in violation of a Specifications, Materials Manual or QC Plan requirement and before a photograph or video is taken, the Department representative must attempt to notify the Plant's QC personnel of the existence of any infractions. No photograph or video will be taken if the infraction is immediately resolved to comply with the Specification in question.

If Plant personnel cannot be contacted or cannot respond in a timely manner that would otherwise result in a loss of photographic evidence, then a photograph or video may be taken of the specific infraction. The Plant's QC personnel may dispute the existence of the infraction, in such case the Department representative may photograph the questionable infraction. The Plant will be allowed to review and comment on all photographs, videos, and documentation within 48 hours of their receipt by hand delivery or email.

The Department will coordinate with the Plant in advance to make arrangements for photographs and videos that will be taken for educational and/or technical publications.

6.3.6.7 Producer Shop Drawings

Drainage Structures shall be manufactured in strict accordance with the Standard Plans or current approved shop drawings. Requests for modified

Structure designs require the Plant to submit shop drawings to the State Drainage Office, including Signed and Sealed structural calculations to demonstrate the revised design meets or exceeds the structural and hydraulic intent of the design represented in the most current version of the Standard Plans.

Approved Producer shop drawings for modified Structures shall be incorporated into the Plant's QC Plan and shall reflect the most current Standard Plans Index number and Last Revision date. These Producer shop drawings are independent of project specific shop drawings.

6.3.7 FUNCTIONS AND RESPONSIBILITIES OF PRECAST CONCRETE PLANTS

6.3.7.1 General

The Plants are responsible for the quality of the finished Structures. Provide facilities and qualified QC personnel to perform specified inspections and tests and maintain an acceptable QC program in compliance with the requirements specified herein and the Specifications.

6.3.7.2 Quality Control Manager

The QC manager is responsible to ensure that the quality of the products at each Plant meets the quality requirements of the Specifications and other Contract Documents. The QC manager may serve in more than one Plant. The responsibilities of the QC manager include, but are not limited to, the following:

A. Maintains the QC approval stamp and applies it to acceptable Structures, or designates a technician who is working under their direct supervision to apply the Plant approval stamp. The Plant approval stamp mark shall be legible and applied to each Structure before its shipment to the project site. The QC stamp shall include the Department assigned Precast Concrete Drainage Plant (PC) number.

B. Be present or designates a QC technician/inspector working under their direct supervision to be present, at all times during the production of all Structures that will be shipped to Department projects.

C. Performs and/or supervises the QC testing and inspection.

D. Ensures that the Plant has a sufficient number of QC technician(s)/inspector(s) to maintain adequate inspection and testing during the production of Structures for Department projects. In lieu of a

permanent staff, the Plant may retain the services of an engineering consulting firm or qualified laboratory meeting the requirements of ***FDOT Specifications Section 105***.

E. Ensures that testing equipment is properly maintained in accordance with the applicable test methods and Specifications. Makes readily available, the current certification on testing equipment that is requiring calibration.

F. Visually inspects or ensures that a qualified QC technician inspects each Structure before it is shipped to the project site.

G. Ensures that all materials used to manufacture Structures are from a Department approved source.

H. Maintains a daily production log of the manufactured Structures.

I. Ensures that all Structures are properly stored and marked indelibly with the Plant's name and number, Structure number that is traceable to the Department project, and date of manufacture.

J. Maintains the QC files of material certifications, test data, and inspection results.

K. Arranges quarterly meetings with the verification inspector and representatives of the Plant's QC and production personnel when the Plant is producing for Department projects or according to the reduced frequency schedules to discuss any deficiencies and QC issues. Provides minutes from these meetings to the DMRO.

When the Plant's assigned QC manager discontinues his/her work without advanced notice, the Plant is required to notify the DMRO within two working days and employ reasonable efforts to seek a replacement. During such efforts to seek a replacement, the Plant engineer, technician, or other knowledgeable person designated in the Plant's QC Plan may perform the duties of the QC manager for a period established by the District Materials and Research Engineer (DMRE), based on efforts employed by the Plant to seek a qualified replacement and/or training another person leading up to the next available Department accredited training/certification programs.

6.3.7.3 Quality Control Technicians/Inspectors

The QC technicians may perform any or all of the inspections, sampling, or testing as directed by the QC manager, and may stamp the Plant approved Structures, when directed by the QC manager.

6.3.7.3.1 Level I Quality Control Inspector

Level I QC inspectors perform routine inspection and testing of products, including but not limited to: materials, pre-pour forms, reinforcing steel/fiber placement, concrete placement, curing, and post-placement inspections of finished products. The QC inspectors must demonstrate sufficient knowledge of the Plant's QC functions to perform their job responsibilities as defined in the QC Plan, including but not limited to shop drawings, Specifications, Standard Plans, and test methods.

6.3.7.3.2 Level II Quality Control Inspector

In addition to the responsibilities of level I QC inspectors, level II QC inspectors may be involved in the design and verification of concrete mixes, and may evaluate the Plant's repair methods and their implementation. Level II inspectors must demonstrate understanding of all aspects of the plant's QC functions as defined in the QC Plan, including but not limited to shop drawings, Specifications, Standard Plans, and test methods.

6.3.7.4 Quality Control of Certified Materials

6.3.7.4.1 General

Ensure that all materials used to manufacture Structures are from Department approved sources and comply with requirements as specified herein.

6.3.7.4.2 Reinforcing Steel and Welded Wire Reinforcement

The QC inspectors must obtain steel Plant's certifications for all welded wire reinforcement (WWR) and reinforcing steel that are used to manufacture Structures. These certifications shall indicate compliance with the appropriate ASTM or AASHTO standards for wire, wire reinforcement and for steel bars. The Department verification inspectors will obtain samples of reinforcing steel and WWR from at least one randomly selected LOT every six months. The Department will perform the testing of these samples. A LOT is defined as a single vehicle load of reinforcing steel or welded wire fabric of the same grade and manufacturer that is delivered to the Plant. Reinforcing steel and WWR shall meet the requirements of ***FDOT Specifications Section 415***.

6.3.7.4.3 Fiber Reinforced Polymer (FRP) Reinforcing Bar

FRP reinforcing bars are obtained from producers on the Department's ***Fiber Reinforced Polymer Production Facility Listing***. The QC inspector must

obtain the FRP manufacturers' Certificate of Analysis (COA) and notarized Material Certification for each LOT of FRP reinforcing bars that are used for the manufacture of Products. Each Material Certification shall indicate compliance with ***FDOT Specifications Section 932***. Department verification inspectors will obtain samples of FRP reinforcing bars for testing in accordance with ***FDOT Specifications Section 932***.

6.3.7.4.4 Coarse and Fine Aggregates

The aggregates delivery tickets shall include the following information:

A. Name of producer
B. Location of mine
C. Department pit number
D. Department material code
E. Delivery date
F. Aggregate producer's statement with each shipment indicating that the shipped products comply with the Specifications.

Maintain each size of aggregates and mine sources in separate stockpiles. Each stockpile shall be labeled with the Department Identification pit number. Prevent the contamination, segregation, or intermingling of stockpiled aggregates of different sizes with each other.

6.3.7.4.5 Cement

Accept the delivered cement on the basis of the cement producer's certification. The certification shall indicate compliance with ***FDOT Specifications Section 921***. A certification for each shipment of cement is required.

6.3.7.4.6 Supplementary Cementitious Materials

Accept supplementary cementitious materials on the basis of the supplier's certification indicating compliance with ***FDOT Specifications Section 929*** and other Contract Documents. A certificate for each shipment of supplementary cementitious materials is required.

6.3.7.4.7 Batch Water

Water used for mixing concrete shall comply with ***FDOT Specifications Section 923***. The record of the water testing will be maintained on file.

6.3.7.4.8 Chemical Admixtures

Admixtures shall meet the requirements of ***FDOT Specifications Section 924***. The Department allows the use of admixtures by one of the following qualification processes:

A. The admixtures that are listed in the ***FDOT Specifications Section 924*** are required to be on the ***APL***. The manufacturer must use the products that are included as part of this list.

B. As part of the Plant's QC Plan, the DMRO reviews and approves the use of admixtures that are used for workability, ease of machine processing, and better consolidation of dry-cast concrete Structures and other machine-formed concrete products. The approval of the admixture as part of the Plant's QC Plan indicates that the admixture has been given contingent approval, as evidenced by previous tests and its apparent effectiveness under field conditions. This approval will continue as long as the admixture performs as claimed. For the use of reinforced concrete products, the concrete admixtures shall not contain calcium chloride or calcium chloride-based ingredients.

6.3.7.4.9 Resilient Connectors for Sealing Structures to Pipe Joints

The resilient connectors shall conform to the requirements of ***FDOT Specifications Section 942***. Maintain a copy of the certification of compliance in the QC file.

6.3.7.4.10 Resilient Connector Lubricant

Ensure that the producers of the resilient connector lubricant provide a certification statement indicating compliance with requirements of the Contract Documents.

6.3.7.4.11 Patching Materials

All patching compounds shall comply with ***FDOT Specifications Section 449***. Pre-mixed packaged compounds may be used when listed on the ***APL***. Cosmetic defects may be repaired in accordance with ***FDOT Specifications Section 450***, if approved by the DMRO and if included in the Plant's QC Plan.

6.3.7.4.12 Fiber-Reinforced Concrete (FRC)

6.3.7.4.12.1 Fiber Uses

Steel or carbon fiber-reinforced concrete may be used as structural reinforcement in the following drainage structures:

1. Type P Structures Bottoms (***Index 425-010***)
2. Manhole Risers and Conical Tops (***Index 425-001, Type 8***)
3. Drainage Inlet Bottoms with inside wall lengths less than 4’ -6” (***Index 425-021, 425-031, 425-040***)
4. Ditch Bottom Inlets Types A, C, and J (***Index 425-050, 425-052***, and ***425-054***)
5. U-Type Concrete Endwalls (***Index 430-011***)
6. Flared End Sections (***Index 430-020***)

Polymer fibers are not permitted as primary structural reinforcement.

6.3.7.4.12.2 Environment Use Location Restrictions

1. Slightly or moderately aggressive environments - Plain steel fibers, galvanized steel, stainless steel, or carbon fibers are allowed on the projects that are located in the slightly and moderately aggressive environments.
2. Extremely aggressive environments - Use only galvanized steel, stainless steel, or carbon fibers on the projects that have been classified by the Department as extremely aggressive environments.

6.3.7.4.12.3 Shop Drawings

Structure dimensions and FRC mix design shall match the details shown on the shop drawings approved by the State Drainage Office for each structure that utilizes the fibers as substitution of all, or part of, the reinforcement in the concrete. The drawings shall include the following information:

1. Design Method (fib Model Code 2010 or an approved Evaluation Report).
2. The type of fiber and its ultimate strength meeting the requirements of ***ASTM A820*** and ***ASTM C1116***.
3. Flexural performance values of the FRC in accordance with the Design Method.

4. Toughness value of the FRC in accordance with ***ASTM C1609*** reference test.
5. Fiber reinforced concrete mix design, including fiber dosage, dimensions (length, effective diameter, slenderness).
6. Slump and air content of FRC.
7. Compressive strength of FRC.
8. Absorption of FRC.

6.3.7.4.12.4 Certifications

Furnish a certificate of compliance and test reports indicating that the fibers meet the requirements of the Specifications and approved shop drawings.

The Department verification inspector may take samples of the fibers at the fabrication facility.

6.3.7.4.12.5 Laboratory Trial Batch of the Proposed Mix Design

Submit the proposed mix design to the DMRO for review. Include proportions of the FRC mix ingredients, including fiber dosage. Make and cure test specimens in accordance with ***ASTM C192***, as modified herein.

1. Perform air content (***ASTM C173*** or ***ASTM C231***), slump (***ASTM C143***), and unit weight (density) test (***ASTM C138***).
2. Make and cure samples of compressive strength test cylinders (***ASTM C31***)
3. During the laboratory trial batch process, determine the acceptable batching sequence and mixing time associated with this batching sequence to produce the required properties.
4. Cast five 6-inch x 6-inch x 20-inch reference test beams (***ASTM C 1609***) during the laboratory trial batch. Deliver the beams to the SMO for verification and approval of the mix design.
5. Cast and test five beams for determining characteristic flexural properties in accordance with the selected Design Method and provide the test results to the SMO.

6.3.7.4.12.6 Flexural Performance of FRC Reference Test Beams

The SMO will verify the flexural performance of FRC beams that were cast during the laboratory trial batch process. The following properties of the FRC mix will be determined for each test beam:

1. First peak load and first peak strength
2. Peak load and peak strength
3. Residual strengths at net deflections
4. Toughness
5. Equivalent flexural strength ratio

The established flexural performance of the mix design is based on the average values of the five test beams.

6.3.7.4.12.7 Field Demonstration of the FRC

1. Subsequent to a satisfactory laboratory trial batch, perform field demonstration of the proposed mix design by casting a full-scale mockup of drainage structure utilizing FRC.
2. Mix, deliver, place, vibrate, finish and cure the proposed FRC mix in accordance with the batching method and sequence that are described in the QC Plan.
3. Ensure that FRC remains workable during concrete placement.
4. Perform slump, air content, and unit weight (density) of the batched concrete.
5. Determine the fiber contents of the first ¼ discharge and last ¾ discharge of FRC batch being tested by taking representative concrete samples from each portion. Determine the uniformity of the fiber content of the batched concrete using the following test method:
   a. Perform the unit weight (density) tests of each sample taken in accordance with ***ASTM C 138***.
   b. Pour and wash each sample over a number 8 sieve. All cement paste and aggregate shall be completely removed from the fibers during the washing. A magnet may be used to separate the steel fibers from the concrete and flotation method may be used to recuperate the synthetic fibers from concrete.
   c. Oven dry the extracted fibers at temperature of 230 ± 10° F for a period of at least 16 hours or to obtain constant weight, whichever comes first.

   Note: For immediate approximate field determination of the fiber content of FRC, towel drying may be used in lieu of oven drying.

   d. Measure the mass of the fibers, W, in grams.
   e. Calculate the fiber content (F) of each sample in lb/yd^3 as follows:

F = 0.059525 x W/V

V = Volume of unit weight container in ft^3

f. Report the results the fiber content of each sample and their average value.

6.3.7.4.12.8 Post Fabrication inspection of the FRC Mockup Structures

1. After removal of forms, perform inspection of the mockup structures in accordance with the applicable sections of ***ASTM C823 – Standard Practice for Examination and Sampling of Hardened Concrete in Constructions***.
2. Ensure that FRC is free from defects such as honeycombs, cracks, fiber or aggregate segregations, sedimentation, and cold joints.
3. Obtain five drilled core samples from randomly selected locations of each mockup structure.
4. Examine the cores for any sign of defects.
5. Perform compressive strength (***ASTM C42***) and absorption (***ASTM C478***) tests on the cores samples to determine if they meet the requirements of the specifications.

6.3.7.4.12.9 Submittal of the Verified Mix Design

Submit the proposed mix design along with the results of the laboratory and field demonstration of the verified FRC trial batches to the DMRO for review. Upon concurrence, the DMRO will forward the proposed mix design and verification data to the SMO for FRC mix design approval.

6.3.7.4.12.10 Production of FRC

1. During the production of FRC use the same batching sequence and mixing time determined during the satisfactory laboratory and field demonstration process.
2. The fabrication facility must perform routine applicable QC testing for the class of concrete, as specified in ***FDOT Specifications Section 346*** or ***ASTM C478***.
3. The QC inspector must make a minimum of five FRC flexural beams for quarterly verification testing of the flexural properties of FRC. The ASTM C1609 Toughness, based on the average of 5 test beams, shall not be less than 10% below the mix design value.

4. Determine the fiber contents of the FRC samples, taken at the first ¼ discharge and last ¾ discharge of the batch, at a frequency of once per LOT.
5. The average fiber content of the samples taken at the first and last portions of the batch shall remain within ± 10% of the mix design value.
6. Cast and test five beams (***ASTM C1609***) per lot subsequent to any LOT with fiber content more than 10% below the approved mix design value.
7. The ***ASTM C1609*** Toughness, based on the average of 5 test beams, shall not be less than 10% below the mix design value.

6.3.7.4.12.11 FRC Quality Control Plan Requirements

Include the following information in the fabrication facility's QC plan:

1. FRC mixing, delivery, placement, finishing and curing process.
2. Approved mix designs and guidelines for the production and QC personnel. The guidelines shall include information about production, QC, and inspection of the FRC material ingredients and products.

6.3.7.5 Quality Control of Concrete Production and Placement Equipment

Ensure that the batching and mixing equipment are capable of properly proportioning and mixing the various ingredients into a uniform mixture. Use adequate means for casting, consolidation, and curing of concrete.

6.3.7.6 Calibration of Equipment

Check or calibrate all QC testing equipment such as the compressive strength testing machines, portable weighing scales, air meters, density buckets, calipers, and temperature recording devices for compliance with the applicable ASTM Test Methods and Specifications, and ***Materials Manual Volume II, Section 9.2***.

6.3.7.7 Quality Control of Structures Manufacturing Process

The following are QC inspections and testing, related to operations prior to, during, and after concrete placement.

6.3.7.7.1 Concrete Mix Design

6.3.7.7.1.1 General

Follow the instructions set out in ***FDOT Specifications Section 449*** (Construction Requirements) except as modified herein.

6.3.7.7.1.2 ASTM or AASHTO Mix Design Approval and Testing

ASTM or AASHTO class of concrete mix designs approved by the DMRO, shall meet the following requirements, in addition to the specified strength, minimum amount of cementitious materials, and maximum water/cementitious ratio requirements:

1. Submit the proposed mix design to the DMRO. Coordinate with the appropriate DMRO personnel to schedule the laboratory trial for the initial mix qualification of Flowing Concrete and Self-Consolidating Concrete (SCC) mix designs.
2. Identify the type of concrete intended to be produced for the proposed mix design, based on ***Table 6.3-1***.
3. List sources of aggregates, cementitious materials, and admixtures, along with the specific gravities and proportions of all concrete ingredients. Include the Department approved mix designs as part of the QC Plan.
4. Perform a laboratory trial for Flowing Concrete and SCC mix designs, in accordance with ***Materials Manual Volume II, Sections 8.6 or 8.4,*** as appropriate.
5. The DMRO shall be invited to witness laboratory trials.

Table 6.3-1 Concrete Mix Identification

Type of Concrete	Target Slump/Slump-Flow	Test Method
Conventional(1)	3 inches	***ASTM C143***
Flowing	9 inches	***ASTM C143***
SCC	22.5 inches (minimum)	***ASTM C1611***

Notes:
(1) The Engineer may allow a maximum target slump of 7 inches when a Type F, G, I or II admixture is used.

6.3.7.7.2 Structure Materials Storage

Properly handle and store aggregates to minimize the segregation of particle size and prevent contamination.
Store all reinforcing bar according to ***FDOT Specifications Section 415***.

6.3.7.7.3 Concrete Forms

Provide concrete forms made of wood, metal, or other materials meeting the requirements of this section and ***FDOT Specifications Section 400***.

Forms used in the manufacture of Structures shall be sufficiently rigid and accurate to maintain the Structures designed dimensions and avoid irregularities in the Structure surface. Forms not meeting governing document requirements shall be repaired or removed from service.
Ensure that the condition of all forms are of a quality to produce acceptable Structures within the dimensional tolerances. The QC inspector must check cleanliness of the forms prior to each use. Check the form dimensions prior to its first use and at least annually for dimensional conformance.

6.3.7.7.3.1 Aluminum Concrete Forms

The Plant shall take the following actions when using aluminum forms for the first time:

1. In the QC Plan include information regarding the application of the protective barrier to minimize the natural reactivity between aluminum and fresh concrete. Also, include the name of the form release agent that will be used.
2. Prior to its first use, perform the field demonstration of the proposed aluminum form by casting a full-scale mockup of the precast concrete product. Demonstrate that the use of aluminum forms will not cause any adverse effect in the quality of the concrete products.
3. Ensure that after stripping of the forms, the product does not show any sign of bug hole, stain, spall, surface void, and streak in concrete.
4. Ensure that the forms do not show any sign of concrete buildup and sticking on their surfaces and panel edges.

6.3.7.7.4 Reinforcing Bar Placement

Reinforcing bar placement shall meet the requirements of ***FDOT Specifications Section 415***. Prior to concrete placement, check the fabrication, positioning, and minimum concrete cover requirements of steel reinforcement on all types of manufactured Structures. Ensure that that the steel reinforcement meets the specification requirements. Check the minimum steel area requirements for Structures in accordance with the applicable design standards such as AASHTO, ASTM, Plans, or approved shop drawings.

6.3.7.7.5 Non-metallic Rebar-Fasteners

6.3.7.7.5.1 General

As an alternative to wire ties, non-metallic rebar fasteners may be used to fasten two reinforcing steel or non-metallic bars of the same or different sizes placed at 90 degrees to each other. The sizes of reinforcing bars vary from #3 to #6 bars. The use of non-metallic rebar fasteners, utilizing a four-point connection, is limited to the fastening of reinforcing bars of precast concrete drainage structures and incidental precast concrete products where no weight other than the weight of concrete is loaded onto the reinforcement.

6.3.7.7.5.2 Properties

The non-metallic rebar fasteners must be able to withstand the stresses due to fastening of steel bars, the handling of the reinforcing steel cages, and concrete placement operations without permanent deformation, slippage or breakage within a working temperature range of 20 to 150°F. The fasteners shall not exceed the maximum allowable water absorption of 0.5% at 7 days, tested in accordance with ***ASTM D570***.

6.3.7.7.5.3 Approval Process

~~1. Plants or manufacturers of the fasteners will send a request to demonstrate their use to the appropriate DMRO.~~

~~1. Once the request is approved by the DMRO, cast a mock-up of the product intended to be fabricated with the fasteners in lieu of wire ties.~~

~~1. Place and position the reinforcement per plan.~~

~~1. Use the non-metallic rebar fasteners to fasten the bars at their intersections to ensure no movement of the bars occurs during the placement of concrete. Record the locations of the bars within the element and the intersections of those bars to be able to verify if any movement of the bars has occurred after casting the concrete.~~

~~1. Place the concrete in the form, providing the greatest free fall possible given the producers equipment and placement methods. Consolidate, finish, and cure the concrete.~~

~~6. Allow time for at least 80% of the design strength to develop. Cast and test cylinders to verify strength has been met.~~

~~7. Demonstrate that the bars have not moved from their original location prior to the concrete placement by saw cutting the element and verifying that the rebar intersections are still held in place by the fasteners, and the concrete cover is not compromised.~~

~~8. If the bars have not separated or pulled away from the non-metallic rebar fasteners and the bars are still at their original location, then the fasteners are considered to have served their intended purpose and the fasteners will be approved for use.~~

Plants must ~~also~~ include guidelines in their QC Plan regarding the protection and use of the fasteners. It is expected that the manufacturers of the non-metallic rebar fasteners provide potential users with sufficient information on the design and installation requirements of their fasteners to ensure proper performance. The guidelines shall also include processes to ensure that the fasteners are held securely enough so that they do not displace or deflect the reinforcing steel or interfere with smooth flow of concrete during placement and consolidation.

Plants using the non-metallic rebar fasteners must obtain manufacturer's statement of compliance with each shipment.

6.3.7.7.6 Concrete Production and Placement Operation

Mix, deliver, and place concrete in accordance with the applicable standards to produce a homogeneous concrete. Perform plastic property testing in accordance with ***Section 6.3.7.7.1.1***, as applicable.

For Flowing Concrete or SCC, perform initial slump or slump-flow testing, as appropriate, on the first batch of each day's production and every 4 hours of continuous production thereafter. Retest if there is a delay of concrete production exceeding 4 hours.

Visually check every batch before the concrete is transported to the placement area to ensure that there is no indication of segregation. Perform additional testing to verify any concrete batch that appears to be out of tolerance, as appropriate.

Reject all segregated concrete. Placement shall be stopped until the reason for the segregated batch is identified and resolved. Do not place segregated concrete in Products for Department projects.

6.3.7.7.7 Concrete Curing

Cure the Structures in accordance with the applicable curing methods that are included as part of the QC Plan.

6.3.7.8 QC Testing and Inspection of Structures

6.3.7.8.1 General

Perform the QC inspection and tests at the frequencies and LOT (Group) sizes that are specified in the applicable Specifications and other applicable Contract Documents.

The QC Plan shall include the QC test methods, inspections, and minimum frequency and LOT sizes of tests that are used as the basis of acceptance of each type of Structures. The QC inspectors must obtain randomly selected samples from each LOT in accordance with the applicable Specifications. Take one sample per LOT. The LOT size shall not exceed one day's production or 50 sections of the Structures, whichever results in smaller quantity.

Each LOT of the Structures components is accepted when:

A. The test results and inspections meet the requirements as specified herein and in the applicable specifications.
B. The Plant has completed all patching and repair work.
C. The QC manager or his/her designated technician has stamped the Structures.
D. The list of the Structures is included with each shipment to the project site.

6.3.7.8.2 Compressive Strength of Test Cylinders

When the Plant is using a ***346 Specification*** class of concrete, sample and test concrete in accordance with ***FDOT Specifications Section 346***.

When the Plant is using ***ASTM C478*** concrete, sample and test compressive strength test cylinders in accordance with ***Section 6.3.7.8.1***.

Ensure that the Structures attain the required stripping (form removal) strength prior to stripping and handling.

Do not ship precast concrete structures to the project site prior to attainment of the required acceptance strength. The Producer is permitted to verify the shipping strength before 28 days by testing compressive strength cylinders that are cured under the conditions similar to the product or by testing temperature match cured cylinders.

For the purposes of stripping and shipping strength attainment, the strength test is the average compressive strength of two test cylinders, tested at the same age.

6.3.7.8.3 Absorption Test

ASTM C478 Section 8.2.2 is modified to waive the absorption test requirements of the precast reinforced concrete inlets, manholes, junction boxes, and endwalls.

6.3.7.8.4 Appearance and Inspection of Final Finished Structures

The QC manager or his/her designee performs final QC inspection of the finished Structures, before the application of the QC approval stamp, to ensure that the Structures are free from deficiencies and meet the specified dimensional tolerances. Structures may be repaired if necessitated by occasional imperfections in the manufacture or damage during handling, and will be considered acceptable if the repairs are sound and properly finished to conform to the dimensional tolerances of the specifications. Submit the proposed repair method for Department review and approval. Use the repair material from the ***APL***. Dimensional tolerances shall comply with the applicable requirements of ASTM or AASHTO standards, except as modified in ***FDOT Specifications Section 449***.

The QC inspectors must perform visual inspection of all finished Structures, measure the dimensions of at least 20% of the randomly selected units in each LOT, and maintain a record of the inspections, including the deficiencies. Minor deficiencies may be repaired in accordance with the repair methods included as part of the QC Plan. The repair of major damage to a Structure requires engineering evaluation meeting the requirements of ***FDOT Specifications Section 450***. The Plant must determine the cause of repetitive nonconformances and develop a corrective action plan. Submit the revised QC Plan to address the type of deficiencies and corrective action that will be taken to prevent or minimize the deficiencies.

6.3.7.8.5 Repair of Precast Concrete Structures

The Plant's QC manager must examine and determine the magnitude of the deficiency. The QC manager may authorize the immediate repair of minor deficiencies in accordance with the repair method that is included as part of the QC Plan. Perform the repair under the observation of the QC manager or under the observation of personnel working under his/her direct supervision. The Plant's QC personnel must document the type of deficiency and its repair method.

6.3.7.8.6 Handling and Storage

Handle and store all Structures properly to prevent damage. The QC inspectors must inspect the Structure handling operations and appropriate practices that will prevent damage. The QC inspectors must inspect Structures during storage to ensure that they are stored correctly and are not being damaged by point loading or stacking too high. Describe the method of storing Structures in the QC Plan. Do not store the rejected Structures in the same area with the acceptable Structures. Rejected Structures shall be culled and marked as rejected.

6.3.7.8.7 Stamping

The Plant's QC manager or his/her designee must affix the Plant's QC stamp to the wall of each Structure, indicating that the manufactured Structure meets the requirements of the Specifications, Contract Documents and Plant's QC Plan. The QC stamp shall include the Department assigned Precast Concrete Drainage Plant (PC) number. The stamp configuration shall be included in the QC Plan. The QC stamp shall be clearly applied with waterproof paint or indelible ink on the inside and outside of opposite walls of each structure.

In the QC Plan include a statement that the Plant's QC stamp will be applied only on the Structures that are manufactured for Department projects or any other projects that require Department verification inspection.

A copy of the certification statement from the general manager of the Plant shall be included in the QC Plan regarding the stamp configuration.

6.3.7.8.8 Shipment

Address the Plant's shipping policy as part of the QC Plan.

~~Ensure that at the beginning of each project, the Plant provides a notarized statement to the project administrator (PA) from a responsible company representative certifying that the Plant will manufacture the products in accordance with the requirements set forth in the ***Contract Documents*** and~~

~~Plant's approved QC Plan. Ensure that each shipment of precast concrete products to the project site is accompanied with a signed or stamped delivery ticket providing the description and the list of the products.~~

Each delivery ticket shall be on the Plant's letterhead and shall include as a minimum:

A. Financial Project Number
B. Date shipped
C. Cast date
D. Type of Structures
E. Quantity of Structures
F. Serial number
G. Buy America compliance statement and dollar amount of non-domestic steel and iron used in the finished products for each delivery.

The QC manager or QC personnel working under the direct supervision of the QC manager must stamp each Structure prior to its shipment to the project site. The Plant must address the shipping policy as part of the QC Plan.

6.3.7.8.9 Documentation

The QC manager must maintain documentation files in each Plant. Maintain these documents for a period of not less than three years after the last delivery of the Structures to the project site. The QC documentation shall as a minimum include the following items:

A. A copy of the approved QC Plan and addenda.
B. Approved shop drawings (if applicable).
C. Applicable ASTM and AASHTO Standards.
D. Applicable Specifications and Standard Plans.
E. QC personnel training and qualification records.
F. Materials certification records for cement, aggregates, cementitious materials, chemical admixtures, reinforcing steel, and welded wire reinforcement.
G. Concrete mix designs.
H. Equipment verifications/calibrations, including concrete batching equipment, water meter, admixture dispensing equipment, concrete compression testing machine, and laboratory scales. Batch plants

furnishing concrete in accordance with ***FDOT Specifications Section 346*** are required to be on the Department's ***Production Facility Listing***. For ASTM or AASHTO classes of concrete, perform the calibration of the testing machine and batch equipment in accordance with the applicable ASTM/AASHTO standards or equipment manufacturers' recommendation.

I. LOT number identification of each product.

J. Number and type of Structures.

K. Applicable test data.

L. Disposition of all manufactured Structures.

M. Record of the delivery tickets of each shipment of the products to the job site.

N. Record of all structural deficiencies found as a result of QC inspection and testing or verification inspection and testing and the corrective action taken. A copy of the deficiency reports shall also be maintained in the Plant's permanent file.

O. Record of minutes from quarterly meetings with verification inspector and representatives from the Plant's QC and production personnel.

6.3.8 TRAINING

6.3.8.1 General

The Plant's QC personnel who are involved in the inspection and testing of the precast concrete drainage structures and precast concrete box culverts must have the required qualifications as specified in ***FDOT Specifications Section 105***.

The SMO maintains the list of the accredited precast concrete courses. The list can be found at the following link.

http://www.fdot.gov/materials/administration/resources/training/structural/index.shtm

6.3.9 FORMS

None needed.