

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 (~~products~~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.

~~The Department will perform periodic quality assurance (QA) inspections, sampling, and testing to ensure of the quality and acceptability of the materials, methods, techniques, procedures and processes being utilized by the manufacturer in the fabrication of precast concrete products. The QA inspection and testing will be performed in accordance with **Materials Manual Section 6.3, Volume I.**~~

6.3.2 AUTHORITY

Sections ~~334.044(2)~~, 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, ~~Philadelphia, Pennsylvania.~~

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

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

Approved Product List (APL), Florida Department of Transportation.

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 quality control QC Plan (QCP) 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

~~Submit~~ 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 to the District Materials and Research Office (DMRO) for review and acceptance and make arrangements for the Plant qualification review of the Plant prior to commencement of any work for Department projects in accordance with 6.3.6.3. Materials Manual Section 5.6 may be used as a guideline.

6.3.6.2 Review of Plant's Proposed QC Plan

~~Submit the proposed QCP to the DMRO for the District in which the Plant is located. For out-of-state Plants, submit the proposed QCP to the nearest DMRO. Upon the Plant's submittal of a QCP, the DMRO will review the proposed QCP in accordance with Materials Manual Section 5.6 and make necessary arrangements for the initial Plant qualification review in accordance with Materials Manual Section 6.3.6.3.~~

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, and 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.

~~National Precast Concrete Association (NPCA) certified Plants may submit the document entitled "NPCA Quality Control Manual for Precast Plants (NPCA Manual)" as their QCP. In their submittal, NPCA certified Plants include a statement that the Plants will comply with the requirements of the NPCA Manual. The **Specifications** and other **Contract Documents** will govern, when there is a discrepancy between the NPCA Manual and **FDOT Specifications**. Submit any additional information, which is required by this Section of the **Materials Manual**, but are not included as part of the NPCA Manual, as an addendum to the NPCA Manual. 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.~~

~~In addition,~~ **Ensure that** the Plant's QC Plan ~~shall include~~ **s** ~~in their QCP~~ their methods of compliance with Buy America provisions including:

- A. Methods for tracking the placement of all quantities of non-domestic steel and iron.
- B. Methods and locations for segregating non-domestic and domestic steel and iron stockpiles.
- C. Methods for identifying and cataloging finished products containing non-domestic steel and iron.
- ~~D.~~ An example delivery ticket with Buy America compliance statement and dollar amount of non-domestic steel and iron used in the finished products for each delivery.

D.

6.3.6.3 Plant Qualification Review

The Department will perform the ~~initial Plant~~ qualification reviews of the ~~production facilities~~ Plants. An ~~initial~~ 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 ~~Structures~~ for Department projects for more than a year.

~~Upon the approval of the Plant's QCP, the Department will also perform routine quarterly verification inspections, and annually Plant qualification reviews, on all Plants that have continued to furnish Structures for Department projects.~~

~~If the Plant has not produced any FDOT products for three consecutive quarters, the verification inspection frequency will be reduced to once every three quarters until the Plant produces for FDOT projects again. The frequency shall revert back to once per quarter immediately after the Plant reinitiates production. The QC Manager is responsible to inform the DMRO when the Plant resumes FDOT production.~~

6.3.6.4 Maintenance of Plant QC Plan and Qualification

Upon the Department's satisfactory review of the proposed QC Plan, ~~in compliance with Materials Manual Section 5.6~~, 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.

Plants that are on the Department's ***Production Facility Listing*** will be subject to the Plant qualification review or routine verification inspection process at any time. At a minimum, quarterly verification inspections will be performed by DMRO personnel. The Plant qualification review team will perform at least one annual in-depth review of Plants that are producing for Department projects. The Plants with an acceptable QC Plan, a satisfactory Department qualification review, and continued satisfactory verification inspections are qualified Plants

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 when the Plant resumes production for Department projects.

6.3.6.5 ~~Department Inspection Access~~ Photographs and Videos

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

~~If in the event that FDOT Department~~ inspectors observe a product or action that they feel is in violation of ~~the FDOT a~~ **Specifications, Materials Manual** or QC Plan requirement and before a ~~picture photograph or video~~ is taken, the ~~FDOT Department~~ representative must attempt to notify the Plant's QC personnel of the existence of any infraction's ~~existence before a picture is taken~~. No ~~picture photograph or video~~ will be taken if the infraction is immediately resolved to comply with the ~~FDOT 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 ~~FDOT 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 ~~producers Plant~~ in advance to make arrangements for photographs and videos that will be taken for educational and/or technical publications.

6.3.6.6 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 quality control **QC** program in compliance with the requirements specified herein and in the **Specifications**, **Sections 407, 410, and 449.**

6.3.7.2 Quality Control Manager

The QC mManager shall 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 mManager may serve in more than one Plant. The responsibilities of the QC mManager 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** and QC personnel qualification of this Section.
- 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 mManufacture.
- 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 production personnel when the Plant is producing for FDOT Department projects or according to the reduced frequency schedules to discuss any deficiencies and QC issues.

When the Plant's assigned QC mManager discontinues his/her work without advanced notice, the Plant shall 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 mManager 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 mManager, and may stamp the Plant approved Structures, when directed by the QC mManager.

6.3.7.3.1 Level I Quality Control Inspector

Level I ~~quality control~~ 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 ~~quality control~~ QC inspectors must~~shall~~ 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, ~~FDOT~~ **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 ~~P~~plant's repair methods and their implementation. Level II inspectors ~~must~~shall demonstrate understanding of all aspects of the plant's QC functions as defined in the QC Plan, including but not limited to shop drawings, ~~FDOT 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 ~~shall~~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. ~~I Upon request, provide samples for the Department verification inspectors at each Plant, from at least two randomly selected LOTs per year~~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**.

6.3.7.4.2.1 **Source of Supply-Steel**

~~Precast concrete drainage structures and box culvert producers~~Plants, prior to the use of non-domestic steel or iron materials on a project, must follow the following process:

- A. ~~D~~Shall describe in the QC Plan the method of compliance with the Buy America provisions according to 6.3.6.2.
- B. After obtaining approval of the QC Plan, and at the beginning of each project, provide a notarized certification on the ~~Plant~~producer's letterhead to the Engineer stating that precast concrete drainage structures and/or box culvertss will be manufactured in accordance with the requirements set forth set forth in the **FDOT Contract Documents**, the Plant's ~~approved~~accepted QC Plan, and **Section 6** (Source of Supply-Steel) of the **FDOT Standard Specifications**.
- C. Implement an accountable system that tracks the monetary value of non-domestic steel or iron used in each product.

- D. In the event of contract modifications in which the use of non-domestic steel or iron is increased, obtain prior authorization from the Engineer.
- E. Each delivery ticket must include the dollar amount of non-domestic steel or iron incorporated in the delivered precast concrete drainage structures and/or box culvert products, as well as a compliance statement with Buy America provisions.
- F. The stockpile of non-domestic steel or iron shall be identified and segregated from the domestic steel or iron.
- G. The stockpile of product which has non-domestic steel or iron shall be identified and segregated from products containing domestic steel or iron.

The DMRO will be responsible for performing audits to verify the Producer's compliance with the Buy America provisions.

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) for each LOT of FRP reinforcing bars that are used for the manufacture of Products. Each COA shall indicate compliance with **FDOT Specifications Section 932**. The Department verification inspectors will obtain samples of FRP reinforcing bars for testing in accordance with **FDOT Specifications Section 932**.

6.3.7.4.36.3.7.4.4 Coarse and Fine Aggregates

The aggregates delivery tickets shall include the following information:

- A. Name of ~~the approved~~ 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~~ **Department 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.

6.3.7.4.46.3.7.4.5 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. ~~Verification samples may be obtained at the discretion of the DMRE. Cooperate with the verification inspector in obtaining the cement sample.~~

~~6.3.7.4.5~~**6.3.7.4.6** Pozzolans and Slag**Supplementary Cementitious Materials**

Accept ~~the ground granulated blast furnace slag~~**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 ~~pozzolans and slag~~**supplementary cementitious materials** is required. ~~The verification inspector may take a sample at the Plant or source. Cooperate with the verification inspector in obtaining the required sample of the supplemental cementitious materials.~~

~~6.3.7.4.6~~**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.

~~6.3.7.4.7~~**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 process:

- A. The admixtures that are listed in the **FDOT Specifications Section 924** are required to be on the **APL**. The manufacturer ~~must~~**shall** 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.

~~6.3.7.4.8~~**6.3.7.4.9** Resilient Connectors for Sealing Structures to Pipe Joints

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

~~6.3.7.4.9~~ **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**.

~~6.3.7.4.10~~ **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 ~~District Materials Office~~ **the DMRO** and if included in the Plant's QC ~~P~~**lan**.

~~6.3.7.4.11~~ **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 ~~425-010200~~)
2. Manhole Risers and Conical Tops (Index ~~425-001201~~, -Type 8)
3. Drainage Inlet Bottoms with inside wall lengths less than 4' -6" (Index ~~425-021211~~, ~~425-031218~~, ~~425-040220~~)
4. Ditch Bottom Inlets Types A, C, and J (Index ~~425-050230~~, ~~425-052232~~, and ~~425-054234~~)
5. U-Type Concrete Endwalls (Index ~~430-011261~~);
- 6. Flared End Sections (Index ~~430-020270~~)**

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 A 820** and **ASTM C 1116**.
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 District Materials Office **DMRO** for review. Include proportions of the FRC mix ingredients, including fiber dosage. Make and cure test specimens in accordance with **ASTM C 192**, as modified herein.

1. Perform air content (**ASTM C 173** or **ASTM C 231**), slump (**ASTM C 143**), and unit weight (density) test (**ASTM C 138**).
2. Make and cure samples of compressive strength test cylinders (**ASTM C 31**).
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 State Materials Office (**SMO**) for verification and approval of the mix design.

4.5. 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.

~~Cast and test five beams for determining characteristic flexural properties in accordance with the selected Design Method and provide the test results to the State Materials Office.~~

6.3.7.4.12.6 Flexural Performance of FRC Reference Test Beams

The ~~State Materials Office~~ 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 QCquality control Pplan.
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 $\frac{1}{4}$ discharge and last $\frac{3}{4}$ 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:

~~6.5.~~

- a. Perform the unit weight (density) tests of each sample taken in accordance with **ASTM C 138**.
- b. ~~Then P~~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 $230 \pm 10^{\circ}$ 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/yd³ as follows:
$$F = 0.059525 \times W/V$$

V = Volume of unit weight container in ft³
- f. Report the results the fiber content of each sample and their average value.

~~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 ~~s~~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 C-42***) and absorption (***ASTM C 478***) 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 ~~DMROistrict Materials Office~~ for review. Upon concurrence, the ~~District Materials Office~~**DMRO** will forward the proposed mix design and verification data to the State Materials Office (**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 ~~shall~~must perform routine applicable ~~quality control~~QC testing for the class of concrete, as specified in FDOT 346 Specifications Section 346 or ASTM C-478.
3. The ~~quality control~~QC inspector ~~must~~shall make a minimum of five FRC flexural beams for quarterly verification testing of the flexural properties of FRC. The ASTM C-1609 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~~et~~.
5. The average fiber content of the samples taken at the first and last portions of the batch shall remain within $\pm 10\%$ of the mix design value.
6. Cast and test five beams (ASTM C-1609) per lot subsequent to any LOT~~et~~ with fiber content more than 10% below the approved mix design value.
7. The ASTM C-1609 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~~uality~~Control~~ontrol Plan Requirements

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

1. FRC mixing, delivery, placement, finishing and curing process.;
2. Approved mix designs and guidelines for the production and ~~quality control~~QC personnel. The guidelines shall include information about production, QC~~quality control~~, 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

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

The mix design information shall include the source of aggregates, cementitious materials, and admixtures, along with the proportions of all concrete ingredients. Include the Department approved mix designs as part of the QC Plan.

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 barsteel 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 shall ~~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 Steel Bar Placement

~~Ensure that the~~ Reinforcing barsteel placement shall meet the requirements of **FDOT Specifications Section 415**. Prior to the concrete placement, check the fabrication, positioning, and minimum concrete cover requirements of steel reinforcement on all types of manufactured Structures. Ensure 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.
2. 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.
3. Place and position the reinforcement per plan.
4. 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.
5. 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 certification with each shipment.

6.3.7.7.5.6.3.7.7.6 Concrete Mixture and Placement Operation

Mix, deliver, and place concrete in accordance with the applicable standards to produce a homogeneous concrete.

6.3.7.7.5.6.3.7.7.7 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** Sections 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~~shall obtain randomly selected samples from each LOT in accordance with the applicable **Specifications** Sections. Take one sample per LOT. The LOT size shall not exceed one day's production or 50 sSections 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 ~~m~~Manager or his/her designated technician has stamped the Structures.
- D. The list of the Structures is included with each shipment ~~of the products~~ to the project site.

6.3.7.8.2 Compressive Strength of Test Cylinders

When the Plant is using a ~~Specification Section 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.

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 ~~m~~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~~~~shall~~ 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~~~~shall~~ determine the cause of ~~the~~ 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 ~~m~~Manager ~~must~~~~shall~~ 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 ~~m~~Manager or under the observation of personnel working under his/her direct supervision. The Plant's QC personnel ~~must~~~~shall~~ 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~~~~shall~~ inspect the Structure handling operations and appropriate practices that will prevent damage. The QC inspectors ~~shall~~~~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 ~~inspector or his/her designee must~~ shall affix the Plant's QC stamp ~~inspect the identification and stamp marks onto the~~ the wall of ~~each~~ the Structure, indicating that the manufactured Structure meets the requirements of the **Specifications, Contract Documents** and Plant's QC Plan. ~~s to ensure that they are valid stamp marks. The Plant shall affix the Plant's QC stamp to each section of Structure, indicating that the manufactured Structure meets the requirements of the Contract Documents and Plant's QCP.~~ 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 ~~Plant's~~ 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 pProject aAdministrator (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.

~~E~~The list of the product with 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
- ~~B.~~E. Quantity of Structures.
- F. Serial nNumber

~~G.G. Buy America compliance statement and dollar amount of non-domestic steel and iron used in the finished products for each delivery. of the Structure section.~~

The QC ~~m~~Manager or QC personnel working under the direct supervision of the QC ~~m~~Manager ~~must~~shall stamp each Structure prior to its shipment to the project site. ~~Each shipment of the Structures to the project site shall include the list of the Structures.~~ The Plant must address the shipping policy as part of the QC Plan.

6.3.7.8.9 Documentation

The QC ~~m~~Manager ~~must~~shall 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.
- B. Approved shop drawings (if applicable).
- C. Applicable ASTM and AASHTO Standards.
- D. Applicable ***FDOT 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 ~~m~~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.

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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~~shall have the required qualifications as specified in **FDOT Specifications Section 105**.

The ~~State Materials Office (SMO)~~ maintains the list of the accredited precast concrete courses. The list can be found at this link:

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

6.3.9 FORMS

~~There are no forms associated with this procedure.~~ None needed.