

# NCDOT Materials and Tests Unit

## Standard Operating Procedure

### Inspection of Reinforced Concrete Pipe

Effective July 1, 2018

#### **Objectives:**

The purpose of this SOP is to establish guidelines for the inspection, the acceptance and reporting of Reinforced Concrete Pipe. The guidelines are designed to ensure all technicians/inspectors follow the same procedures and comply with all NCDOT, AASHTO and ASTM specifications. The technicians/inspectors will ensure quality control techniques, quality control records, and testing equipment are being followed. The technician shall personally inspect each piece of pipe and either approve or reject it for use by NCDOT.

Concrete Pipe should meet Section 1032-6 of the NCDOT Standard Specifications, AASHTO M 170 and ASTM C 76 guidelines. Marking of Concrete Pipe marking shall conform to Section 1030-4 of the NCDOT Standard Specifications.

#### **Materials Inspection and Acceptance:**

It is mandatory for technicians/inspectors to follow these guidelines in order to establish, manage and monitor quality control, quality assurance and quality documentation. Following the proper inspection process will ensure effectiveness and efficiency in the quality systems of the NCDOT.

- Periodically review Reinforced Concrete Pipe guidelines.
- Periodically review ASTM C 76, AASHTO M 170 and NCDOT Standard Specifications Sub-Article 1032-6 to ensure proper procedures are followed during the inspection.
- Ensure all equipment required for testing the material and any safety equipment needed is in possession and serviceable before arrival.
- Verify that the facility is an approved NCDOT Producer with a NCDOT Annual Facility Inspection that is up to date.
- Verify that the facility has a current third-party inspection with a copy of the inspection and NCDOT Addendum available for review at the facility.
- Verify the facility technicians have all the required NCDOT certifications or approved alternatives required for the production of concrete pipe.
- Review the assigned NCDOT approved mix designs for the facility.

**Safety Equipment List:**

Safety Shoes with ANSI Z 41 rating  
Hard Hat with ANSI Z89.1 rating  
First Aid Kit  
Fire Extinguisher  
Safety Glasses  
Gloves  
Safety Vest  
Ear Plugs  
Sun Block (optional)  
Lifting Belt (optional)  
Dust Masks (optional)

**Safety Concerns:**

Pinch Points/Test Rack/Pipe Inspection  
Heavy Equipment/Backing Incidents  
Possible dusty conditions  
Trip hazards

**Equipment Required for Product Inspection:**

Concrete Pipe Inspection Field Worksheets  
Tape Measure  
0.01 Leaf Gauge  
Micrometer  
Calculator  
Calipers (wall thickness)  
Pencil or Pen  
RFID Scanner/Reader  
Android Tablet with adapter cable for scanner to tablet

**M&T Inspector's Duties for Reinforced Concrete Pipe Inspection:**

1. When arriving at the facility, inspectors should check into main office (if required).
2. Contact QC Technician to determine items to be inspected.
3. Concrete pipe will be accepted as a lot as described in the table below.

**Concrete Pipe Lot Sizes**

| <b>Diameter</b> | <b>Lot Size/Description</b>                           |
|-----------------|-------------------------------------------------------|
| 12"             | 4000 LF per consecutive day's production (max 5 days) |
| 15"             | 4000 LF per consecutive day's production (max 5 days) |
| 18"             | 4000 LF per consecutive day's production (max 5 days) |
| 24"             | 2000 LF per day's production                          |
| 36"             | 4000 LF per consecutive day's production (max 5 days) |
| 42"             | 2000 LF per day's production                          |
| 48              | 2000 LF per consecutive day's production (max 5 days) |
| D>48            | 2000 LF per day's production                          |

(Example: Producer has 2800 LF of 24" 3-B concrete pipe that was produced on 03/01/2013. Producer is asking that this material be stamped. The NCDOT inspector will

- randomly select two pieces of pipe to be tested. One pipe will represent 2000 LF and the other will represent 800 LF)
4. Technician will randomly select from stock the concrete pipe for testing.
  5. Technician shall make a determination at this point if the lot of pipe has excessive defects. Section 1032-6 (E) of the NCDOT Standard Specification states the rejection of more than 20% of any lot of pipe due to cracks, fractures, variations in alignment or other manufacturing defects will be cause for the rejection of the entire lot.
  6. If concrete pipe is 48" or larger in diameter, the concrete pipe can be accepted on cylinders or three edge bearing. If concrete pipe is <less than 48" in diameter, then a three-edge bearing test must be performed.
  7. Verify the pipe has an RFID tag attached to the bell end.
  8. Verify the pipe has been stenciled with the proper Alternate ID identification. Alternate ID will be the assigned State #, diameter of pipe, and year pipe was produced. Example: CP1-24-13. This information also shall be on the Manufacture's Bill of Lading.
  9. Verify the pipe has required AASHTO M 170 markings. This will consist of pipe class and specification designation, the date of manufacture and the name or trademark or manufacture. Markings shall be indented (scratched) or painted with waterproof paint.
  10. Three-Edge Bearing Tests
    - a. If pipe selected is <less than 48" then a three-edge bearing test is required. This test will consist of D-Loading the pipe which is external loading of the pipe. The readings you will get are pounds per foot of length per foot of diameter

### Three Edge Bearing Test Schedule

| Diameter | 0.01" Load Test | Ultimate Load Test        |
|----------|-----------------|---------------------------|
| 12"      | Each Lot        | 1/Quarter (each 4 months) |
| 15"      | Each Lot        | 1/Quarter (each 4 months) |
| 18"      | Each Lot        | 1/Quarter (each 4 months) |
| 24"      | Each Lot        | Each Lot                  |
| 36"      | Each Lot        | 1/Quarter (each 4 months) |
| 42"      | Each Lot        | Each Lot                  |

- b. Three-Edge Bearing test rack must be calibrated annually or when a question of accuracy arises.
- c. Before placing pipe in rack, a calculation must be done to determine lower bearing width. Example: ( 24" (Pipe Size) / 12 = 2" (lower bearing width)
- d. Refer to AASHTO M 170-4 to determine specification requirements of selected pipe.

### Three Edge Bearing Loading

| Classification | D-Load 0.01" crack | D-Load ultimate load |
|----------------|--------------------|----------------------|
| Class I        | 800                | 1200                 |
| Class II       | 1000               | 1500                 |
| Class III      | 1350               | 2000                 |
| Class IV       | 2000               | 3000                 |
| Class V        | 3000               | 3750                 |

e. Example: If a class III pipe is selected.

D-Load required to produce an 0.01" crack 1350

D-Load required to produce the ultimate load 2000

f. Example: Calculations for a 30" Class III 8' length pipe used to determine minimum readings required for acceptance in the test rack are as follows:

- 0.01" load = 1350 (D-Load) x 8' (length of pipe) x 2.5' (Diameter of pipe in decimal form) = 27000 lbs.
- Ultimate load = 2000 (D-load) x 8' (length of pipe) x 2.5' (Diameter of pipe in decimal form) = 40000 lbs.

g. The definition of a 0.01" crack is: "When the point of the measuring gage will, without forcing, penetrate 1/16" at close intervals throughout the specified distance of 1 FT."

h. The definition of Ultimate Load is: "Maximum load pipe will support."

i. Should the test pipe fail to meet the strength requirements, the manufacturer shall be allowed to retest two additional pipe for each pipe that failed, and the pipe shall be acceptable only when all of the retest specimens meet the strength requirements.

j. Failure of two consecutive lots of pipe to meet Three Edge Bearing Loading test requirements for either the 0.01" or Ultimate Load will result, as a minimum, in the lot size being reduced to 2000LF per day's production with Three Edge Bearing Loading testing for both the 0.01" and Ultimate Load being conducted for each lot until such time as the Producer can demonstrate that meeting specifications can consistently be produced.

### 17. Concrete Cylinder Compression Tests

a. Pipe diameters 48" or larger may be strength tested by means of compression testing of concrete cylinders, in lieu of three-edge bearing testing, at the manufacturer's discretion.

b. If concrete cylinders are to be used for acceptance. A minimum of four cylinders are to be made for each class, diameter and lot from that day's production. A NCDOT Certified Field Concrete Technician representing the manufacturer must perform tests and make cylinders for acceptance.

c. NCDOT will witness cylinder breaks at the manufacturer's facility.

Compression machines must be calibrated annually or when a question of accuracy applies. Acceptance is the average of two cylinders. Specified concrete strength for acceptance is listed in AASHTO M 170-4 for the size, class and wall. Testing shall be conducted in accordance with ASTM C39.

d. Should the average of two cylinders fail to meet the strength requirements, the manufacturer shall be allowed to perform a three-edge bearing test on pipe.

18. Visual/Walk Thru Inspection and NCDOT Approval.

a. Repairs

- Repair materials and methods must be approved by the Engineer before their use.
- AASHTO M 170-13  
"Pipe may be repaired, if necessary, because of imperfections in manufacturing or damage during handling and will be acceptable if, in the opinion of the owner, the repaired pipe conforms to the requirements of this specification."

b. Technician will refer to AASHTO M 170-15. Causes of Rejection.

- Any fracture or crack that visibly passes through the wall of pipe.
- Any fracture or crack that is 0.01" wide or greater at the surface and 12" or longer regardless of position in the wall of the pipe.
- Offsets in form seam that would prevent adequate concrete cover over reinforcing steel.
- Delamination in the body of the pipe when viewed from the ends.
- Evidence of inadequate concrete cover for reinforcing steel.
- Any severe surface condition that affects the majority of the pipe section surface and could reduce the durability and service life of the pipe.
- Damaged or cracked ends where such damage would prevent making a satisfactory joint.

c. Technician shall personally inspect and accept or reject each piece of pipe.

Technician must be able to visually look through the pipe and inspect both ends of the pipe and verify that an RFID tag is attached to each piece of pipe.

d. Pipe will be individually approved by the NCDOT technician after all criteria meets specifications. Each approved piece of pipe shall have the RFID tag scanned utilizing the NCDOT RFID App. The record of the scanned pipe will be emailed to the inspector and to the NCDOT email [Concretepipe@NCDOT.GOV](mailto:Concretepipe@NCDOT.GOV). See *Appendix A* for details on the required email format.

## 19. Reinforcement Check

- a. Technician will randomly inspect reinforcement area and placement for concrete pipe at each visit. Refer to AASHTO M170-4 for specified areas for each class and wall thickness of concrete pipe.
- b. Refer to AASHTO M 170-8 for reinforcement requirements for reinforced concrete pipe. Below is a list of some items from M 170-8 that will assist you in your inspection.
  - If splices are not welded, the reinforcement shall be lapped not less than 20 diameters for deformed bars, and deformed cold-worked wire, and 40 diameters for plain bars and cold-drawn wire. In addition, where lapped cages of welded-wire fabric are used without welding, the lap shall contain a longitudinal wire.
  - When splices are welded and are not lapped to the minimum requirements above pull tests of representative specimens shall develop at least 50 percent of the minimum specified strength of the steel, and there shall be a minimum lap of 2" for butt-welded splices in bars or wire, permitted only with helically wound cages, pull tests of representative specimens shall develop at least 75 percent of the minimum specified strength of the steel.
- c. Basic Wire Calculations for Area:

$$\text{Area} = \frac{2(\text{Wire diameter in inches}) \times (0.7854) \times (\text{\#of complete circumferential rolls})}{\text{Length of Pipe in LF}}$$

## 20. Annual Samples

### a. Absorption Core Samples

- Absorption for concrete pipe shall not exceed 9 percent of the dry mass. Each sample shall have a minimum mass of 2.2 lbs. shall be free visible cracks (4" cores are normally used for this test). If absorption fails, the absorption sample shall be made on another sample from the same pipe.
- Two absorption cores to be taken quarterly per mix design.
- One core to be taken from a random class and size <42-inch diameter RCP.
- One core to be taken from a random class and size ≥42-inch RCP.
- The random class and size shall be determined by the NCDOT Inspector assigned to each plant.
- The random class and size shall not be repeated within the same calendar year.
- Cores shall be taken from pipe produced during the current quarter or the previous quarter if current quarter is not available.
- Samples will be sent to Materials and Tests Unit Physical Lab.
- See **Appendix B** for Absorption Core sample frequency memo.

### b. Steel Reinforcement Samples

- Reinforcement wire and steel samples will be taken annually for each

size, with additional samples taken for every 10,000 LF produced and accepted.

- Wire samples will be 48" with a minimum of three circumferential reinforcement wires.
- If wire reinforcement is welded at the lap, a representative sample shall be taken with the weld as part of sample. Sample shall be 48" with a minimum of three circumferential reinforcement wires.
- Reinforcing steel samples shall be two 36" bars for each diameter.
- All samples will be sent to Materials and Tests Physical Lab along with mill certs.

c. Cement Samples

- Cement samples shall be taken annually or if a questionable material is an issue.

d. Pozzolan

- Pozzolan samples shall be taken annually or if a questionable material is an issue.

e. Coarse Aggregate\*

- Coarse Aggregate samples shall be taken quarterly or if a questionable material is an issue.
- Material must come from the NCDOT's Approved List.
- Aggregate stockpiles shall be maintained above Saturated Surface Dry condition.

f. Fine Aggregate\*

- Fine Aggregate samples shall be taken quarterly or if a questionable material is an issue.
- Material must come from the NCDOT's Approved List.
- Aggregate stockpiles shall be maintained above Saturated Surface Dry condition.

*\* Special Out-of-State aggregate producers are part of the Aggregate QC/QA Program. Samples are not to be collected from these producers.*

**Standards:**

NCDOT Standard Specs 1032-6

NCDOT Standard Specs 1030-4

AASHTO M170

ASTM C76

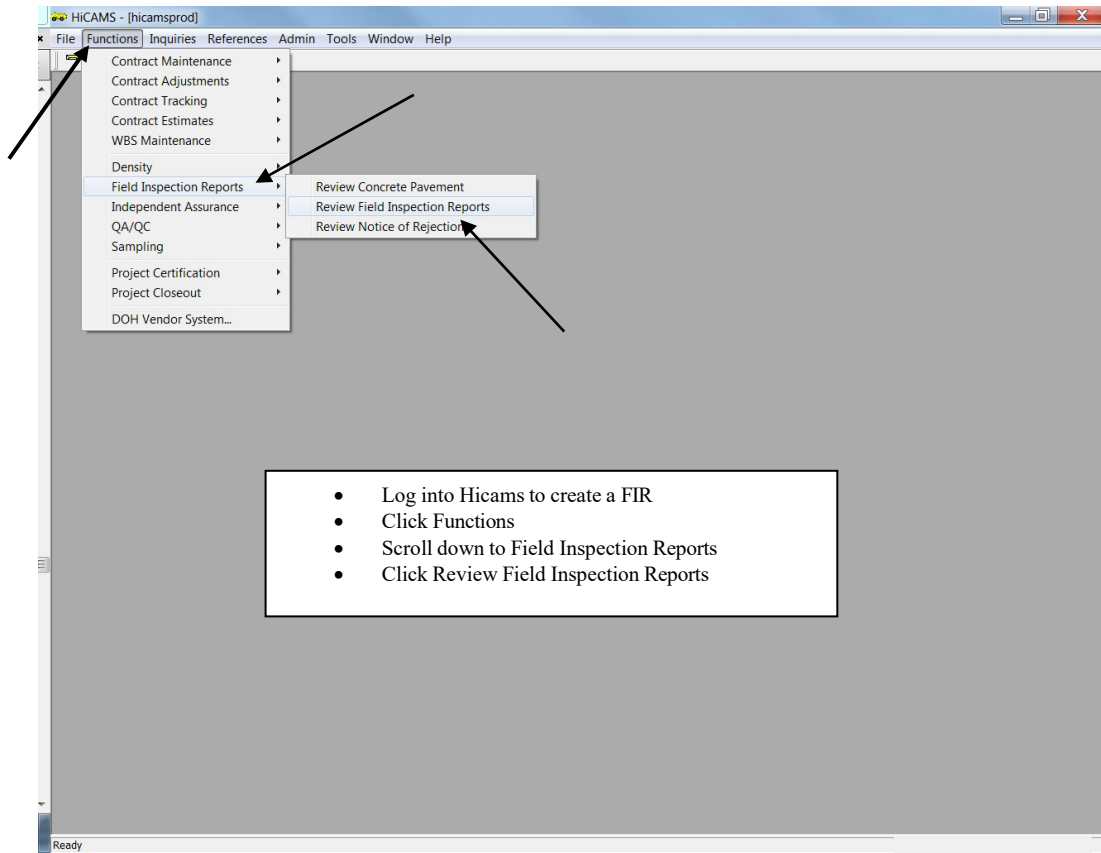
ASTM C39

## **Appendix A**

### **Sample Prep and Submittal:**

All inspections must be entered into Hicams under Field Inspection Report (FIR) within two working days.

### **Creating a PIPE FIR**



HiCAMS - [hicansprod]

File Edit Functions Inquiries References Admin Tools Window Help

Review Field Inspection Reports

Filter

Contract:

Report Name: Concrete Pipe

Report ID:  Section: (All)

Report Status: (All)

Test Category: (All)

Material Type: (All)

Inspected By:

Inspection Date: 00/00/0000

Inspection Result: (All)

Retrieve

Reset

New

| Report Name | Report ID | Contract | Material Type | Inspector | Inspection Date | Section | Inspection Result | Report Status | Test Category |
|-------------|-----------|----------|---------------|-----------|-----------------|---------|-------------------|---------------|---------------|
| 0 of 0 FIR  |           |          |               |           |                 |         |                   |               |               |

Details NOR Save As

- Click the arrow for Report Name
- Choose Concrete Pipe
- Click the "New" tab to create a new concrete pipe FIR

HiCAMS - [hicansprod]

File Edit Functions Inquiries References Admin Tools Window Help

Review Concrete Pipe (New)

Report Name: Concrete Pipe

Report ID:

Report Status: New

General Results Alt IDs Report History

Material Type: Pipe Culvert, Concrete - English

Sample From: Plant

Testing Category: Pretest

Search By Plant ID: cp11

Section: 10

Producer: Smith Setzer & Sons

Inspection Results

Inspector: Carnker, Pamela D

Inspection Date: 03/05/2015

Inspection Result: In Process

Notice of Rejection: Does Not Meet Specs - Accepted, Does Not Meet Specs - Pay Adjustment, Does Not Meet Specs - Rejected, In Process, Meets Specs

Comment:

- Enter in the following under the "General" Tab
- Choose the Material Type
- Choose the Producer
- Enter Section
- Enter Inspector name
- Enter Inspection Date
- Choose Inspection Results

HiCAMS - [train] Training Environment

File Edit Functions Inquiries References Admin Tools Window Help

Review Concrete Pipe (New)

Report Name: Concrete Pipe Report ID: Report Status: New

General Results Alt IDs Report History

| Material                                                        | Date Made  | Date Tested | Type | Laying Length | Accepted  | Rejected |
|-----------------------------------------------------------------|------------|-------------|------|---------------|-----------|----------|
| Reinforced Concrete Pipe Culvert, Class III, 15 in- Linear Feet | 08/09/2013 | 08/28/2013  | B    | 96            | 1,328,000 | 64,000   |

1 of 1 Material

First Crack Ultimate Load

D - Load Lbs: Lbs Per Ft: Compressive Strength: Available Accepted: 1,328,000

Click the "Results" Tab

- Next you will click the 4<sup>th</sup> icon from the top left. Click "Insert"
- Choose the Material tested from the drop down menu
- Enter the date made
- Enter the date tested
- Type
- Choose Lay Length
- Enter Accepted Laying Length
- Enter Rejected Laying Length
- Enter three-edge break-First Crack & Ultimate Load

Ready

File Edit Functions Inquiries References Admin Tools Window Help

Review Concrete Pipe (New) Training Environment

Report Name: Concrete Pipe Report ID: Report Status: New

General Results Alt IDs Report History

Alternate IDs for Material:  
Reinforced Concrete Pipe Culvert, Class III, 15 in- Linear Feet

| Alternate Type | Alternate ID | Status    | Quantity  | Available |
|----------------|--------------|-----------|-----------|-----------|
| Lot            | CP11-15-13   | Available | 1,328,000 | 1,328,000 |

1 of 1 Items 1,328,000 1,328,000

Click the "Alt IDs" tab

- Click on the 4<sup>th</sup> icon at top left "Insert"
- Add the Alternate ID by the facility number (example CP11-15-13)
- Enter Quantity
- Click the icon 3<sup>rd</sup> in from top left

Define Range

Count: 2

Create Range

Clear Range

**Documentation Submittal:**

- Supervisors should be checking daily for FIRs that need review.
- The FIR will be reviewed and authorized within two working days after being completed.
- The M&T technician will file a hard copy of the “Concrete Pipe Field Worksheets” which is filled out during inspection.

## Appendix B



# STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

ROY COOPER  
GOVERNOR

J.R. "JOEY" HOPKINS  
SECRETARY

December 11, 2024

NCDOT Approved  
Producers Concrete Pipe  
Producers

Greetings,

NCDOT M&T Manufactured Products has been reviewing the various sampling and testing frequency and quantities for concrete pipe. The quantity of cores for absorption testing in particular were considered for review and evaluation. The history of passing samples vs failing samples shows that there have been almost no failing absorption cores within the last 10 years.

The new sampling frequency will begin on January 1, 2025, and will be as follows:

- Two absorption cores to be taken quarterly per mix design.
- One core to be taken from a random class and size <42-inch diameter RCP.
- One core to be taken from a random class and size  $\geq$ 42-inch RCP.
- The random class and size shall be determined by the NCDOT Inspector assigned to each plant.
- The random class and size shall not be repeated within the same calendar year.
- The absorption cores shall be taken from the current quarter or previous quarter's production.
- The requirement for additional Absorption cores and reinforcing samples to be taken at the 10,000lf threshold will remain unchanged.

Sincerely,

Jason Civils  
Concrete Products Engineer  
NCDOT Materials & Tests

*Mailing Address:*  
NC DEPARTMENT OF TRANSPORTATION  
MATERIALS & TESTS  
1563 MSC  
RALEIGH, NC 27607

*Telephone:* (919) 329-4000  
*Fax:* (919) 733-8742  
*Customer Service:* 1-877-368-4968

*Website:* [www.ncdot.gov](http://www.ncdot.gov)

*Location:*  
1801 BLUE RIDGE RD.  
RALEIGH, NC 27607