

# 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 insure all technicians/inspectors follow the same procedures and comply with all NCDOT, AASHTO and ASTM specifications. The technicians/inspectors will insure quality control techniques, quality control records, and testing equipment are being followed. The technician shall personally inspect each piece of pipe and place a “NCDOT Approved” stamp on each piece of pipe once it meets approval.

Concrete Pipe should meet Section 1032-6 of the NCDOT Standard Specifications, AASHTO M 170 and ASTM C 76 guidelines.

#### **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 insure 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 inspection and NCDOT Addendum available for inspection 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

**Equipment Required for Product Inspection:**

- Concrete Pipe Inspection Field Worksheets
- Tape Measure
- 0.01 Leaf Gauge
- Micrometer
- Calculator
- Calipers (wall thickness)
- Black Paint
- Pencil or Pen
- “NC Approved DOT” Stencil

**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. Make contact with 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
30”	4000 LF per consecutive day’s production (max 5 days)
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 pipe lot 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 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.
8. 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.
9. 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**

<b>Diameter</b>	<b>0.01" Load Test</b>	<b>Ultimate Load Test</b>
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
30"	Each Lot	1/Quarter (each 4 months)
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**

<b>Classification</b>	<b>D-Load 0.01” crack</b>	<b>D-Load ultimate load</b>
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 a 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 manufacture's facility. Compression machine 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 Approved" stamp.

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 each pipe. Technician must be able to visually look through pipe and inspect both ends of pipe.

d. Pipe will be accepted and individually stamped, by the NCDOT technician after all criteria meets specifications.

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:

Area =

$$\frac{(\text{Diameter of Wire in Inches})^2 \times (\# \text{ of complete circumferential rolls}) \times (0.7854)}{\text{Length of Pipe in LF}}$$

20. Annual Samples

a. Cores for Absorption

- 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.
- Concrete cores shall be taken for each diameter, class and wall annually, with additional samples taken for each diameter, class and wall after every 10,000 LF is produced and accepted.
- Cores shall be taken from pipe produced during the current year or the previous year if current year is not available.
- Samples will be sent to Materials and Tests Unit Physical Lab.

b. Reinforcement Sample

- 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 30" 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 30" with a minimum of three circumferential reinforcement wires.
- Reinforcing steel samples shall be two 30" 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.

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.

**Standards:**

NCDOT Standard Specs 1032-6

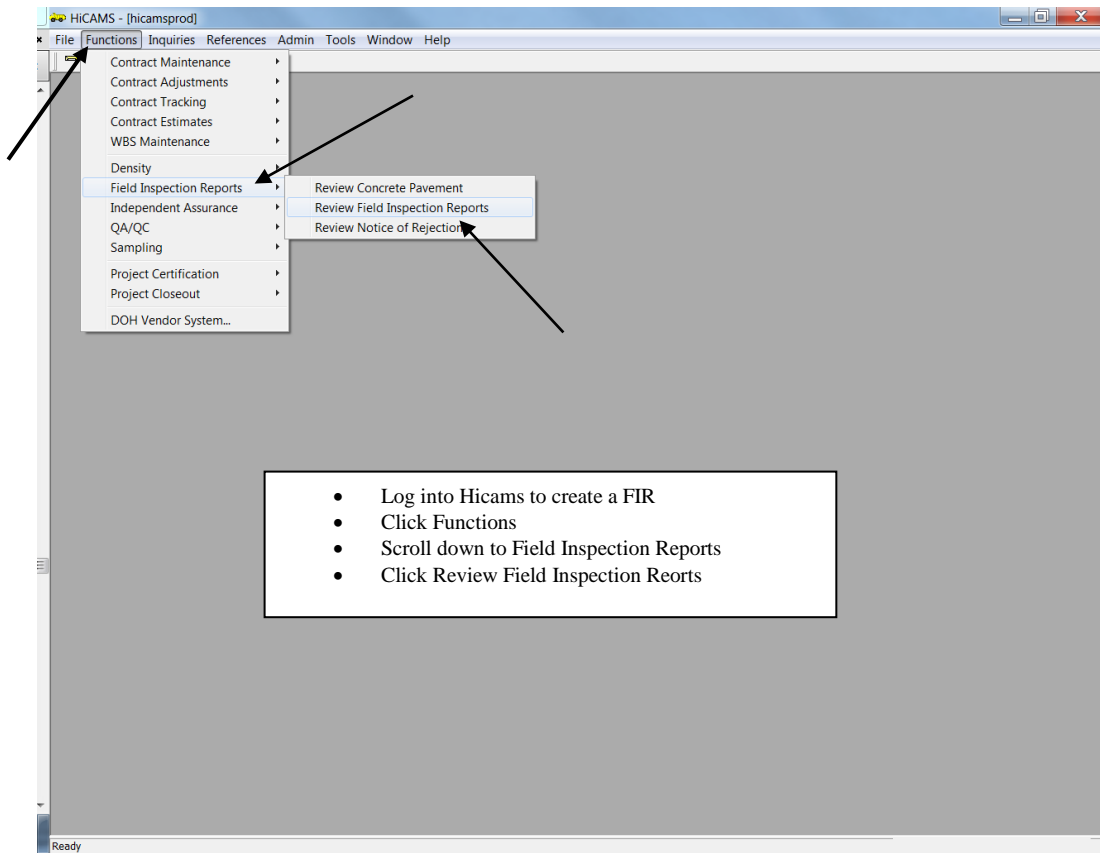
AASHTO M170

ASTM C76

ASTM C39

**Sample Prep and Submittal:**

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





Filter

Contract:  Material Type: (All)

Report Name: Concrete Pipe Inspected By:

Report ID:  Section: (All) Inspection Date: 00/00/0000

Report Status: (All) Inspection Result: (All)

Test Category: (All)

Retrieve  
Reset  
New

Report Name	Report ID	Contract	Material Type	Inspector	Inspection Date	Section	Inspection Result	Report Status	Test Category
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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

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, Smith Setzer & Sons - Catawba - CP11

Inspection Results

Inspector: Carniker, Pamela D Inspection Result: In Process

Inspection Date: 03/05/2015 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

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: D - Load Lbs:  Lbs Per Ft:

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

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:

Create Range

Clear Range

**Documentation Submittal:**

- 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.