

# QUALITY ASSURANCE PROGRAM FOR PRESTRESSED AND PRECAST CONCRETE PRODUCTS



Prepared by

**MATERIALS AND RESEARCH DIVISION**

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**NORTH DAKOTA DEPARTMENT OF TRANSPORTATION**

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**PURPOSE**

The purpose of this document is to define the fundamental requirements of a quality assurance program for prestressed and precast concrete products and to ensure that quality products are being used on North Dakota Department of Transportation (NDDOT) projects. This document is also intended to be used by our Local Public Agency (LPA) partners and other entities that utilize the NDDOT Standard Specifications for Road and Bridge Construction.

**RESPONSIBILITY**

On NDDOT projects, there will be several entities involved in the Quality Assurance process including Districts, Materials & Research, and Bridge Division. The Project Engineer is responsible for notification prior to inspection and testing. The District Materials Coordinator will be responsible for inspection of precast box culverts and concrete pipes. The Materials and Research Division will carry out the inspection and testing of prestressed concrete beams. Bridge Division plays a role in approving the work drawings and being a resource for approval of products. If a production plant is utilized that is outside of the normal locations (inside ND or within 60 miles of the state border), contact the Materials & Research Division to set up inspection and testing services to be performed by another State DOT or consultant.

On LPA projects, the owner of the project is responsible for carrying out the Quality Assurance process. The LPA or a consultant representing the LPA would be designated as the Engineer or Materials Coordinator in this manual and would be responsible for inspection and testing of prestressed and precast concrete products.

Other entities that use the “NDDOT Standard Specifications for Road and Bridge Construction” would be responsible for the Quality Assurance process on their projects.

## I. PRESTRESSED CONCRETE BEAMS

### A. Plant Review

The plant review will consist of a review of all plant operations and will include an inspection of the plant facilities. Required documentation review and testing will be conducted annually (before the first NDDOT project begins) as follows:

#### 1. Concrete Batch Plant

The concrete batch plant must meet the requirements found in Section 155 of the current NDDOT Standard Specifications for Road and Bridge Construction.

#### 2. Prestressing Jack

The Department will obtain a "Certificate of Calibration." The "Certificate" shall indicate that the gauges, jacks and pumps have been calibrated as a system in the same manner as they are used in tensioning operations. The "Certificate" shall indicate that the calibration was performed by an ASTM approved testing laboratory or calibration service and a certified calibration curve shall accompany each tensioning system. Pressure reading can be used directly if the calibration determines a reading is within a  $\pm 2\%$  tolerance of actual load. Calibrations shall be performed at any time a tensioning system indicates erratic results, and in any case at intervals not greater than 12 months. The loads to be gauged shall not be less than 1/4 or more than 3/4 of the total graduated gauge capacity, unless the calibration chart clearly establishes consistent accuracy over a wider range.

All jacking and load measuring equipment shall be calibrated as specified above.

Calibration records shall show the following data:

- a. Date of calibration.
- b. Agency or laboratory supervising the calibration.
- c. Method of calibration, i.e., proving ring, load cell, testing machine, etc., and its calibration reference.
- d. The full range of calibration with gauge readings indicated against actual load.

Calibration records for all tensioning systems in use shall be kept on hand for use in preparing theoretical tensioning values. Personnel involved in preparing tensioning calculations shall have a copy of these records for reference.

#### 3. Water

Mix water must meet requirements found in Section 812 of the current NDDOT Standard Specifications for Road and Bridge Construction.

#### 4. Quality Control Evaluation

The Materials and Research Division of the NDDOT will annually evaluate the fabricators QC program. A copy of the QC program shall be sent to the Materials and Research Division. The Project Engineer or District Materials Coordinator will review all material certifications for individual projects.

### **B. Project/Production Review**

#### 1. Mix Design

A written mix design for each project will be provided by the fabricator and shall include the following information:

- a. Type and amount of cement.
- b. Amount of water.
- c. Amount, maximum size, and coarse aggregate source.
- d. Amount and fine aggregate source.
- e. Amount and types of admixtures.
- f. Fines/total aggregate ratio.
- g. Water/cement ratio.
- h. Unit weight of concrete mix.
- i. Maximum slump of concrete mix.

This mix design shall be reviewed prior to the initial inspection.

#### 2. Production Observation

The Materials and Research Division will observe 25 to 50% of the beams fabricated for each project. The observation will be conducted on the first set of beams fabricated on each project and then randomly thereafter. The observation will address the following:

##### a. Initial Tensioning

The placement and the amount of tension in the prestressing cables shall be in accordance with the approved shop drawings. This shall be done by checking the readings on the calibrated jacks and observing the elongation of the cables.

b. Steel Inventory

The reinforcing steel shall agree with the approved shop drawings for grade, proper size, and quantity before the forms are placed.

c. Steel Placement

The reinforcing steel placement shall agree with the approved shop drawings before the forms are placed. The following are acceptable tolerances:

1. Prestress Cable - The prestress cable shall be within  $\pm 1/4$ " of the position shown on the approved shop drawings. Cables shall be always protected against physical damage and rust or other results of corrosion. Cables shall be free of deleterious material such as grease, oil, wax, or paint. Cables shall not have nicks or kinks. Steel that has sustained physical damage at any time shall be rejected. The development of pitting or other results of corrosion, other than rust stain, shall be cause for rejection. Hold down devices for deflected cables shall be placed within  $\pm 6$ " of the approved shop drawing positions.
2. Reinforcing Steel - Reinforcing steel shall be adequately supported by chairs and rigidly held in place within the forms. Chairs in contact with the forms must be either plastic or stainless steel tipped. Stirrups shall be within  $\pm 1$ " of the position shown in the approved shop drawings. Stirrups projecting above the top of the beam shall be within a tolerance of  $+1/4$ ",  $- 3/4$ ". The clear cover shall be within a tolerance of  $+1/4$ " to  $0$ ". Welding or tack welding of reinforcing steel is prohibited.
3. Inserts - The inserts shall be within  $\pm 1/2$ " of the positions shown on the approved shop drawings. Any metal devices in contact with the forms shall be galvanized or coated as specified on the plans.
4. Lift Hooks - Lift hooks shall be placed within  $\pm 6$ " of the position shown on the approved shop drawings.

d. Beds and Forms

Beds and forms shall be clean, smooth and without warps; set on a rigid foundation; able to withstand fluid pressures of concrete; mortar tight at all joints; accurately built to the proper dimensions; and coated with a release agent.

e. Concrete

The concrete's slump and temperature shall be recorded. In addition, air temperature and weather conditions shall be recorded. Batching equipment shall be capable of achieving a rate of pour that will avoid cold joints and will allow float finishing of the top of the beam before initial set. If the vibrator will not sink under its own weight, a cold joint has developed. When cold joints have developed, the partial cast member shall be rejected.

f. Curing Process

The fabricator shall cure the beams by steam or radiant heat if the ambient air temperature does not provide an adequate cure. The concrete shall reach its initial set before application of steam or heat curing. Time of set may be determined by ASTM C 403. During the initial set period the curing chamber temperature must be maintained at or above 50°F. The fabricator shall have at least two maximum and minimum temperature recording thermometers per curing chamber. The maximum curing temperature shall not exceed 160°F.

g. Detensioning

The detensioning shall not be done until control cylinders, cured with the beams, indicate the concrete has reached the design prestress transfer stress, or 4,000 psi, whichever is greater. The forms, ties, inserts, hold-downs, or other devices that would restrict longitudinal movement of the beams along the bed shall be removed. Heating of individual strands shall be done simultaneously at a minimum of two locations along the casting bed. The sequence of the heating of each strand along the bed, and the sequence between strands, and the release of hold down devices, shall be accomplished so that no damage occurs to the girder. Detensioning by simply cutting the strand with a shear will not be allowed.

h. Beam Dimensions

To ensure that the beams have been accurately cast to the dimensions shown on the plans, all major dimensions of five completed beams selected randomly from each NDDOT project shall be measured, including length, height, flange widths, sweep and camber. In addition, the fabricator's quality control paperwork shall be reviewed by the Materials and Research Division regarding beam dimensions for the remaining beams. Camber shall be measured not sooner than 24 hours after the beam has been cast.

i. Acceptance

Beams cast that vary from the approved shop drawings with respect to

dimensions; reinforcement steel size, quantity, or location; prestressing cable size, quantity, or location; and void form size or location shall be subject to rejection or evaluation by the Department Bridge Engineer.

If honeycombing is present or any reinforcing or prestressing cable is exposed at the time of form removal, a beam shall be subject to rejection by the Department Bridge Engineer.

Beam repairs shall be submitted in writing and approved by the Department Bridge Engineer. Any variation from approved shop drawings shall be subject to rejection by the Department Bridge Engineer if said Engineer determines that the variation will result in an inferior product.

After the Materials and Research Division has determined that the beam has been constructed in accordance with the approved shop drawings, the beam will receive the Department stamp. The Materials and Research Division shall record all beams dimensions, any repair work, and the date stamped. Final acceptance of beams will be conducted by the project engineer.

### **C. Materials Testing**

#### 1. Materials

##### a. Random Aggregate Testing

One (1) random test shall be performed per project or when source changes. The testing shall be conducted in accordance with NDDOT Field Sampling and Testing Manual. Aggregates must meet all requirements found in Section 802.01.C of the current NDDOT Standard Specifications for Road and Bridge Construction.

Sodium sulfate soundness tests may be omitted if this test has been run on the source pit. Aggregate testing may be omitted if similar tests have been conducted by the Department for a different concrete product, i.e., prestressed beams or precast concrete pipe. The Materials and Research Division will review all certifications for this material.

##### b. Cement Testing

Three (3) random samples shall be tested each construction season or one test at a change in source. Testing shall be in accordance with NDDOT Specification 804.01. Cement testing may be omitted if similar tests have been conducted by the Department for a different concrete product, i.e., prestressed beams or

precast concrete pipe. The Materials and Research Division will review all certifications for this material.

c. Steel Strand

Steel strand shall be accepted by certification. All materials must be in accordance with NDDOT Specification 836.03. The Materials and Research Division shall be provided with a certified copy of the mill report for material used in each project.

d. Steel Reinforcement

Steel Reinforcement shall be accepted by certification. All materials must be in accordance with NDDOT Specification 836.02. The Materials and Research Division shall be provided with a certified copy of the mill report for material used in each project.

e. Admixtures

Concrete admixtures shall be accepted by certification. All materials must be in accordance with NDDOT Specification 808. The Materials and Research Division shall be provided with a certificate of compliance for admixtures used in each project.

f. Concrete Strength Testing

One set of three cylinders on three random occasions shall be cast each year for verification. The average concrete strength of the fabricator's cylinders must be within 5% of the Department average cylinder strength.

4. Certifications

The Materials and Research Division will review the manufacturer's QC documentation and applicable certifications and affidavits for materials used to produce each concrete beam. These will also be reviewed by the project engineer.

## II. PRECAST BOX CULVERTS

### A. Plant Review

Plants are required to be American Concrete Pipe Association (ACPA) or National Precast Concrete Association (NPCA) certified. No other plant review is required.



## **B. Quality Control Evaluation**

District Materials Coordinators will annually evaluate the fabricators Quality Control (QC) program. A copy of the QC program shall be sent to the Materials and Research Division. The Project Engineer or District Materials Coordinators will review all material certifications for individual projects.

## **C. Materials Testing**

### 1. Aggregate Testing

Three (3) random tests shall be performed each year or when a source changes. The testing shall be conducted in accordance with NDDOT Field Sampling and Testing Manual. Aggregates must meet all requirements found in Section 802.01.C of the current NDDOT Standard Specifications for Road and Bridge Construction.

Sodium sulfate soundness tests may be omitted if this test has been run on the source pit. Aggregate testing may be omitted if similar tests have been conducted by the Department for a different concrete product, i.e., prestressed beams or precast concrete pipe. The District Materials Coordinator will review all certifications for this material.

### 2. Cement Testing

Three (3) random samples shall be tested each construction season or one test at a change in source. Testing shall be in accordance with NDDOT Specification 804.01. Cement testing may be omitted if similar tests have been conducted by the Department for a different concrete product, i.e., prestressed beams or precast concrete pipe. The District Materials Coordinator will review all certifications for this material.

### 3. Steel Reinforcement

Steel Reinforcement shall be accepted by certification. All materials must be in accordance with NDDOT Specification 836. The District Materials Coordinator shall be provided with a certified copy of the mill report for material used in each project.

### 4. Concrete Admixtures

Concrete admixtures shall be accepted by certification. All materials must be in accordance with NDDOT Specification 808. The District Materials Coordinator shall be provided with a certificate of compliance for admixtures used on each project.

### 5. Concrete Strength Testing

The District Materials Coordinator shall be provided and review all the manufacturer's compression test results for concrete.

#### **D. Product Observation**

The District Materials Coordinator or a designated representative will inspect (at a minimum) the first section of a box culvert for each project. If fabrication does not occur in the District Materials Coordinator's own district, then the District Materials Coordinator shall arrange inspection with the District Materials Coordinator who is nearest the plant.

This observation will include the following:

1. Steel Inventory

The reinforcing steel shall agree with the approved shop drawings for grade, proper size, and quantity, before the forms are placed.

2. Steel Placement

The reinforcing steel placement shall agree with the approved shop drawings before the forms are placed. The reinforcing steel shall be adequately supported by chairs and rigidly held in place within the forms. Chairs in contact with the forms must be either plastic or stainless steel tipped.

3. Forms

Forms shall be clean, smooth and without warps; able to withstand fluid pressures of concrete; mortar tight at all joints; accurately built to the proper dimensions; and coated with a release agent.

#### **E. Acceptance**

Box culverts cast that vary from the approved work drawings with respect to dimensions, reinforcement steel size, quantity, or location shall be subject to rejection or evaluation by the NDDOT Bridge Engineer.

If honeycombing is present, or if any reinforcing steel is exposed at the time of form removal, the box culvert shall be subject to rejection by the NDDOT Bridge Engineer. Any repairs to the box culvert shall be submitted in writing and approved by the Department Bridge Engineer.

Any variation from approved shop drawings shall be subject to rejection by the NDDOT

Bridge Engineer, if said Engineer determines that the variation will result in an inferior product.

Final acceptance of box culvert in the field will be conducted by the project engineer.

### **III. PRECAST CONCRETE PIPE**

#### **A. Plant Review**

Plants are required to be American Concrete Pipe Association (ACPA) or National Precast Concrete Association (NPCA) certified. No other plant review is required.

#### **B. Quality Control Evaluation**

District Materials Coordinators will annually evaluate the fabricators QC program. A copy of the QC program shall be sent to the Materials and Research Division. The Project Engineer or District Materials Coordinator will review all certifications for individual projects.

##### **1. Three-Point Bearing Jack**

District Materials Coordinators shall review the independent laboratories results of the three-point bearing tests conducted at least three times a year. The District Materials Coordinators will document the review and report results to the Materials and Research Division. In addition, the District Materials Coordinators will review the three-point bearing jack calibration documentation annually.

Calibration records shall show the following data:

- Date of calibration.
- Agency or laboratory supervising the calibration.
- Method of calibration, i.e., proving ring, load cell, testing machine, etc., and its calibration reference.
- The full range of calibration with gauge readings indicated against actual load.

#### **C. Materials Testing**

##### **1. Aggregate Testing**

Three (3) random tests shall be performed each year or when a source changes. The testing shall be conducted in accordance with NDDOT Field Sampling and Testing Manual. Aggregates must meet all requirements found in Section 802.01.C of the current

NDDOT Standard Specifications for Road and Bridge Construction.

Sodium sulfate soundness tests may be omitted if this test has been run on the source pit. Aggregate testing may be omitted if similar tests have been conducted by the Department for a different concrete product, i.e., prestressed beams or precast concrete pipe. The District Materials Coordinator will review all certifications for this material.

## 2. Cement Testing

Three (3) random samples shall be tested each construction season or one test at a change in source. Testing shall be in accordance with NDDOT Specification 804.01. Cement testing may be omitted if similar tests have been conducted by the Department for a different concrete product, i.e., prestressed beams or precast concrete pipe. On NDDOT projects, send cement samples to the Materials and Research Division. The District Materials Coordinator will review all certifications for this material.

## 3. Steel Reinforcement

Steel Reinforcement shall be accepted by certification. All materials must be in accordance with NDDOT Specification 836. The District Materials Coordinator shall be provided with a certified copy of the mill report for material used in each project.

## 4. Concrete Admixtures

Concrete admixtures shall be accepted by certification. All materials must be in accordance with NDDOT Specification 808. The District Materials Coordinator shall be provided with a certificate of compliance for admixtures used in each project.

## 5. Water Testing

Mix water must meet requirements found in Section 812 of the current NDDOT Standard Specifications for Road and Bridge Construction.

## 6. Absorption Testing

Two samples shall be taken per year per plant and sent to the Materials and Research Division for absorption testing. One sample can be taken each construction season for absorption verification testing if the manufacturer is doing frequent absorptions. The samples may be taken from the wall of the pipe after they have been strength tested for  $D_{ultimate}$ . The samples shall not be of the same pipe size. Absorption tests may not be omitted.

## 7. Strength Testing

One pipe section for each pipe size, up to 60", used on NDDOT construction projects each year shall be obtained for three-edge-bearing testing for D0.01 and D<sub>ultimate</sub>. Pipe sections greater than 60" shall be tested for compressive strengths using molded cylinders. Strength testing is not required for concrete end sections. This verification testing cannot be omitted. The District Materials Coordinator will review all the manufacturer's compression test results for concrete.

#### **D. Acceptance**

When all the above test results meet specifications and the District Materials Coordinator determines that the plant is in compliance, then 100% of the precast concrete pipe produced at the subject plant may be accepted on certification. The final acceptance in the field will be conducted by the project engineer. If one or more of the above material tests fail, the District Materials Coordinator will increase the sampling and testing frequency. Precast concrete pipe will not be accepted on certification for the lot represented by the failed tests. Testing will then be in accordance with Section 830.01. The precast concrete pipe may be accepted on certification when the quality control and quality assurance tests indicate that the product is within specification.

**REFERENCE FORMS:**

SFN 19847 [Beam Inspection Worksheet](#)

SFN 10093 [Reinforced Concrete Pipe Test and Inspection Record](#)

SFN 19848 [Concrete Plant Inspection Worksheet](#)