Precast/Prestressed Concrete Plant Inspection – Plant Inspector

Required Certification: ACI Field Test Technician Grade 1; NDOR Field Technician; NDOR Plant Technician; PCI Quality Control Personnel Certification Level 1 & 2

Recommended Certification: ACI Strength Test Technician Grade 1

General: Refer to Section 705 in the 1997 Standard Specification for Highways, and all Supplements to the Standard Specifications.

Each inspector is expected to perform any or all tasks within the non-administrative area of prestressed concrete inspection and control. NDOR inspectors may observe and/or verify their assigned tasks. Production tasks may continue even though an NDOR inspector is not present, provided the production schedule has been given to the NDOR inspector, as provided below, and the work is proceeding according to schedule. The definition of "Verify" is that NDOR inspectors will review Plant inspectors written documentation of the task. All inspectors shall obtain the required certification and should obtain the recommended certification.

Section 705 of the Standard Specifications shall take precedence in all instances where there is a conflict with this policy.

I. Identification, examination, acceptance and plant testing of materials and subassemblies.

A. All precast/prestressed concrete structural units shall be produced in a Precast/Prestressed Concrete Institute (PCI) certified plant.

B. The contractor shall provide the NDOR inspector a 4-week productions schedule that is updated as necessary. The schedule shall include items being fabricated, time of day, and applicable phasing dates for construction. If the NDOR inspector is given less than 1 NDR workdays notice of a schedule change, then the fabricator may not proceed until the Engineer has reviewed the change. The Engineer may observe and/or verify any or all of the procedures and shall have access to all reported data at any time during fabrication. The NDOR inspector shall report any inconsistencies to the job superintendent and note them in the plant diary as indicated in Section 705.03, paragraph 5 of the Standard Specifications.

C. Quality control records should be identified with the same job number, piece number, and project number if known and any other information used to identify the product after inspection.

D. One sample of prestress strand twelve feet long from each reel shall be submitted to the NDOR inspector for testing 30 days before the anticipated time of use. Refer to the Sampling Guide and Section 705.02, paragraph 14 of the Standard Specifications.

II. Inspection and recording of tensioning.

A. NDOR inspector shall observer and/or verify the tensioning of all strands..

B. A small number of broken wires are acceptable in a setup as long as the number is limited to not more than 2%.

1. The area of broken wires shall not exceed 2% of the cross sectional area of the stressing strand when the number of strands is 14 or less.

2. The area of broken wire shall not exceed 1% of the cross sectional area of the stressing strands when the number of strands exceeds 14.

3. No more than 1 broken wire will be allowed in a single strand. (705.02 paragraphs 10, 11 & 12)

III. Inspection of beds and forms prior to concreting.

A. One of the most important inspections functions is the prepour inspection. It is much easier to make corrections before concrete is placed.

B. The overall length, width, thickness, and other basic dimensions should be checked on all sides of the form before concrete placement begins.

IV. Checking of dimensions of members, numbers, size and positions of tendons, reinforcing steel, other incorporated materials, opening, blockouts, etc.

A. The quality control department shall notify the NDOR inspector when a set-up is ready to be reviewed.

B. All reinforcing steel shall be reviewed to ensure the bars are of the correct type and size and have been placed in the proper location.

C. The type, size, anchorage and location of all embedded items shall be checked.

D. The NDOR inspector may perform checks to verify the quality control department data.

V. Regular inspection of batching, mixing, conveying, placing, compacting, finishing and curing of concrete.

A. Portland cement concrete shall be supplied by only those plants determined by the Engineer to be in substantial compliance with the requirements in the Quality Control Manual, Section 3, Certification of Ready Mixed Concrete Production Facilities as published by the National Ready Mixed Concrete Association. (1002.03 paragraph 2)

1. The production facility shall be inspected every two years.

2. Whenever there is reason to suspect a problem with the equipment, any or all of the equipment may be inspected.

B. The plant may choose to be certified by the National Ready Mixed Concrete Association or the Engineer must complete the inspection.

VI. Preparation of concrete specimens for strength testing and performance of concrete tests (slump, air content, unit weight, etc.).

A. Concrete quality control shall be the responsibility of the Contractor. Concrete shall be sampled and tested as shown in Table 705.03 of the Standard Specifications.

VII. Inspection of detensioning, product removal from beds, handling and storing operations.

A. The NDOR inspector shall observe and/or verify the de-tensioning operation

1. De-tensioning shall be accomplished before the temperatures of the units drop below 100°F and while the units are still moist as stated in Section 705.03, Paragraph 11b-9 of the Standard Specifications.

2. If the NDOR inspector observes cracks prior to de-tensioning prestressed concrete girders the Engineer shall determine whether to repair or reject the product as stated in Section 705.03, Paragraph 12a of the Standard Specifications.

B. Checking of dimensions of members, camber, numbers, opening, blockouts, etc.

1. The quality control department shall notify the NDOR inspector when the product is ready to be reviewed.

2. The NDOR inspector may perform checks to verify the quality control department data.

C. To identify the condition of a product as it moves through plant operations, paint marks shall be placed on the ends of the girders by the Plant inspector.

1. Products marked with red paint should be removed to the reject area or discarded.

2. Products marked with yellow paint should have their defects evaluated and repaired. Once the repair is complete and accepted, the yellow paint is covered with green paint.

3. Products marked with green paint are approved for shipment at the appropriate time.

D. Each precast/prestressed concrete structural unit shall be stamped or marked with an identification number and its manufacture date, by the NDOR inspector as stated in Section 705.03 paragraph 10.g of the Standard Specifications.

VIII. Final inspection by the NDOR inspector of finished products prior to shipment.

A. Each piece shall be marked with a number related to the shop drawings and product records for accurate identification.

B. Visual inspection of the product for general appearance should be made. Cracking is frequently indicative of incorrect procedures in design, production, or handling.

C. Strand slippage shall be monitored and evaluated.

1. Prior to detensioning, mark the strand at each end of the bed with respect to the concrete, at a constant distance.

2. After the strands are cut the distance to the mark is measured again.

3. If the slippage is sufficient to cause loss of bond in any member, the member shall be evaluated by a structural Engineer from the NDOR Bridge Division.

D. Camber shall be measured on all prestressed concrete products for which camber measurement is appropriate.

IX. Perform general observation of plant equipment, working conditions, weather and other items, which have the potential for affecting the products.

X. All products sent to state projects shall be accompanied by a shipping report. The NDOR inspector will be given the opportunity to perform a final inspection before it leaves the plant.

XI. Utilization of a record keeping system for the procedures outlined above to establish evidence of proper manufacturing and monitoring.

XII. Prior to leaving the plant the manufacturer shall certify that the product has been manufactured in conformance with the latest edition of the NDOR Standard Specifications for Highway Construction - Section 705 – Precast/Prestressed Concrete Structural Units and PCI Manual for Quality Control: Structural Pre-cast Concrete; MNL.-116.

Elongation Instructions

Elongation shall follow the recommended practice of the Precast/Prestressed Concrete Institute except as out lined below or stated on the plans. Elongation calculations shall be preformed by the plant inspector with a report submitted to the NDOR inspector for verification.

I. Calculate the elongations using the equation on page 36 of the PCI Quality Control Technician/Inspector Training Manual.

   A. The Modulus of Elasticity shall be determined by the Central Laboratory.

   B. Initial Tension should be from 5% to 25% of the final load, to pull the slack strand taut.

   C. Strands are tensioned to approximately 70% of their ultimate capacity, except where the plans indicate otherwise.

   D. Tolerance based on the PCI Quality Control Manual is ± 5% from the desired value. This relates to the actual gage pressure and elongation verses the calculated values of each. It also relates to an algebraic comparison of the variation of the gage pressure to variations in elongations.

II. Tensioning Corrections for elongation and load are:

   A. Strand Seating

      1. Dead End Seating

      2. Live End Seating

      3. Splice Chuck Seating

   B. Bed Shortening for self-stressing beds

   C. Abutment Rotation of movement of anchorages for fixed abutment beds

   D. Elongation of abutment anchor rods

   E. Thermal Effects

   F. Drape

Elongation Worksheet

Project: _____ **Pour Id.:** _____

Station: _____ **Date Elongated:** _____

Bed: _____ **Time Elongated:** _____

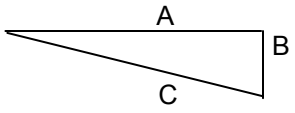
Theoretical Elongation: $E_T = (P \times L) / (A \times E)$

Where: P = Load Applied to Strand = $P_f - P_i$ A = Area of Strand
L = Length of Strand Between Anchorages E = Modulus of Elasticity of Strand

The Physical Tests Laboratory shall determine the modulus of elasticity and area of strand.

Load Corrections

If draped strand are used, the applied load shall be corrected because the draping process will add load.



Change in elongation for draping $E_d = C - A$ $C=\sqrt{A^2+B^2}$

A correction for temperature will be made if the temperature increases 25°F or more from the time of stressing to the time of initial set.

Δ Elongation $E_t = 0.0000065 \times T_\Delta \times L \times 12$ Corrected Load $P_t = (1+ E_\Delta / E_T) \times P \leq$ % Ultimate Strength

Corrected Elongation $E_C = E_T + E_t - E_d$ Target Load $P_T = (E_C \times A \times E) / L$

Elongation Corrections

Strand Seating = S = Dead End + Live End + Splice Chuck

Bed Shortening = B

Abutment Rotation, or Anchorage Movement = R

Elongation of Abutment Anchor Rods = A

Final Theoretical Elongation: $E_F = E_c + S + B + R + A$

Strand Load / Elongation Table

Strand	Load			Elongation		
Location	High	Actual	Low	High	Actual	Low

Computed By: *(Plant Inspector)* Verified By: *(NDOR Inspector)*

Elongation and Load Corrections

Initial Load: _____ P_i **Final Load:** _____ P_f **Applied Load:** _____ P

Elongation: _____ E **Temp. @ Elongation:** _____ T_E **Concrete Temp:** _____ T_C

Difference $T_C - T_E$ = _____ T_Δ **Corrected Elongation:** _____ E_C **Corrected Load:** _____ P_C

Strand	Elongation Correction					Final Theoretical	
Location	Strand Seating	Bed Shortening	Rotation/Movemnt	Anchor Rods	Drape Strand	Elongation	Load

Computed By: *(Plant Inspector)* Verified By: *(NDOR Inspector)*