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Standard Specification for General Requirements for Prestressed Concrete Poles Statically Cast[1]

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1. Scope

1.1 This specification covers general requirements for prestressed concrete poles statically cast for use as structural supports for lights, distribution, transmission, and dead end poles.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A36/A36M Specification for Carbon Structural Steel
A82/A82M Specification for Steel Wire, Plain, for Concrete Reinforcement
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A416/A416M Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
A421/A421M Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
A586 Specification for Zinc-Coated Parallel and Helical Steel Wire Structural Strand
A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A722/A722M Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete
C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field
C33/C33M Specification for Concrete Aggregates
C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C94/C94M Specification for Ready-Mixed Concrete
C150/C150M Specification for Portland Cement
C172/C172M Practice for Sampling Freshly Mixed Concrete
C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C231/C231M Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C260/C260M Specification for Air-Entraining Admixtures for Concrete
C309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C330/C330M Specification for Lightweight Aggregates for Structural Concrete
C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
C494/C494M Specification for Chemical Admixtures for Concrete
C595/C595M Specification for Blended Hydraulic Cements
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

3. Basis of Acceptance

3.1 Acceptability of prestressed concrete poles produced in accordance with this specification shall be determined by the results of compressive strength tests of concrete cylinders and mill certificates for the reinforcing steel. A written statement, signed by the manufacturer, shall verify that the cement, aggregates, admixtures, and steel conform to the applicable specifications for the material and that the preparation of equipment, mixing, conveying, placing, consolidation, and curing conforms to the requirements of the applicable standard specifications. Concrete strength shall be determined by the compressive strength tests of cylinders. The manufacturer's statement shall also certify adherence to tolerance on dimensions. Acceptability of the concrete strength of completed prestressed concrete poles may also be determined by compression tests of concrete cores in accordance with Test Method C42/C42M.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4. Materials

4.1 *Cement*—Portland cement shall conform to the requirements of Specification C150/C150M or shall be blended hydraulic cement conforming to the requirements of Types IS or IP Specification C595/C595M.

4.2 *Aggregate*—The concrete shall be made with fine and coarse aggregates that conform to Specification C33/C33M or C330/C330M. The nominal maximum size of the coarse aggregate shall not exceed ⅕ the minimum dimension of the member or ¾ of either the clear spacing between the reinforcing steel or the clear cover.

4.3 *Water*—Water used for curing, for washing aggregates, and for mixing concrete shall be free of oils, organic materials, and other substances in amounts that may be deleterious to concrete or steel, and it shall not contain concentrations of chloride ions in excess of 500 ppm or sulfate ions in excess of 1000 ppm.

4.4 *Admixtures*—Air-entraining admixtures shall conform to Specification C260/C260M. Chemical admixtures shall conform to Specification C494/C494M. Fly ash or other pozzolanic admixtures shall conform to the requirements of Specification C618. Admixtures shall not contain chloride ions in quantities that will cause the total chloride content of the concrete to exceed 0.06 %.

4.5 *Steel*—Prestressing steel shall conform to Specifications A416/A416M, A421/A421M, A586, or A722/A722M. Auxiliary nontensioned reinforcement shall conform to Specification A82/A82M or A615/A615M. Base plates, anchor bolts, and top mount couplings shall conform to ASTM specifications designated on contract drawings.

5. Requirements

5.1 Poles shall be designed to carry all forces associated with prestressing, handling, storage, installation, loading, and other service conditions. Consideration shall be given to the level of prestress forces both before and after losses.

5.2 *Concrete*—Concrete shall have a minimum design compressive strength of 5000 psi (37.5 MPa) at 28 days.

5.3 *Concrete Cover*—The minimum concrete cover over the reinforcement shall be 1 in. (25 mm). Ends of prestressed steel shall be recessed ¼ in. (6 mm) and shall be covered with a suitable waterproofing product.

5.4 *Air Entrainment*—Unless otherwise specified by the purchaser, all concrete shall have an air content of 5 % plus or minus 1 % as measured by Test Method C173/C173M or C231/C231M.

5.5 *Lifting Devices*—Flush inserts may be cast into the pole at locations agreeable to the purchaser. Removable attachments may utilize the flush inserts to provide for lifting of the pole. Steel strand loops may be used instead of flush inserts for lifting. The loops shall be installed with a recess in the pole the depth of the required minimum concrete cover over the reinforcement, and a diameter no less than 1¼ in. (32 mm). Steel strand lifting loops shall be removed flush to the concrete in the recess. The recess shall be filled and sealed with epoxy-based grout and the pole surface shall be troweled to match the finish. All repair work involved with the loops shall be completed before delivery.

5.6 *Grounding*—In order to provide good electrical continuity, the spiral steel shall be securely tied to each reinforcing steel member it contacts within 1 ft (0.3 m) of the top and the butt of the pole. An embedded ground wire or provisions to attach a ground wire to the surface of the pole may be specified. The embedded ground wire shall be copper and not smaller than No. 6 AWG (4 mm). It shall be bonded with a suitable electrical connector to the reinforcing steel within 2 ft (0.6 m) of both the top and butt of the pole. Grounding pigtail wire of soft-drawn stranded copper, not smaller than No. 6 AWG (4 mm), shall be bonded with a suitable compression or mechanical connector to the embedded ground wire, and shall extend from the pole surface 4 ± 1 in. (100 ± 30 mm). Unless otherwise specified, grounding pigtails shall be located 3 ft (0.9 m) from the top and 4 ft (1.2 m) from the butt. Provisions to attach a ground wire to the surface of the pole must be specified by the purchaser. The type of fastener or provisions for fastening to be supplied by the pole manufacturer, the location, the spacing, and any electrical connection to the reinforcing steel must be covered in the purchaser's specifications.

6. Manufacture

6.1 *Mixture*—The aggregates shall be sized, graded, proportioned, and thoroughly mixed with proportions of cement and water that will produce a concrete mixture of quality such that the poles will conform to the test and design requirements of this specification. Concrete conforming to Specification C94/C94M may be used.

6.2 *Placing*—Concrete should be placed in the forms as nearly as possible in its final position. Special care should be taken to fill all parts of the forms, and to place concrete under and around all reinforcing steel. Reinforcement shall be adequately secured so as to remain in the proper position during the placing of the concrete. Tie wires, if used to fasten the reinforcing steel, shall be bent down to provide the maximum protective cover of concrete over the wires.

6.3 *Curing*—Poles shall be cured by one of the following methods or combination thereof. They shall be cured so that the concrete will develop the required compressive strength. The temperature of the concrete shall not exceed 100°F (38°C) nor drop below 40°F (4°C) for a minimum of 1 h after placing regardless of the curing option selected.

6.3.1 *Accelerated Curing*—Poles may be cured with either steam or radiant heat in a moist environment.

6.3.2 *Water Curing*—Poles may be water-cured by covering with water-saturated material or by a system of perforated pipes.

6.3.3 *Membrane Curing*—A curing compound conforming to the requirements of Specification C309 may be applied and should be left intact until strength requirements are met. The concrete at the time of application shall be within 10°F (6°C) of the ambient air temperature. All surfaces shall be kept moist prior to the application of the compounds and shall be damp when the compound is applied.

6.3.4 *Steam Curing*—Steam chamber shall be so constructed to retain the live steam, to minimize moisture and heat losses, to allow free air circulation of the steam around the pole. The steam jets shall be positioned so they do not discharge directly on the forms or test cylinders. The cycle of steam curing shall conform to the following:

6.3.4.1 After placing and vibration, the concrete shall be allowed to attain an initial set (approximately 500 psi (3.5 MPa), determined by Test Method C403/C403M) before starting to raise the temperature of concrete with the steam. If the ambient temperature is below 50°F (10°C) enough heat shall be applied to maintain the concrete at its placing temperature.

6.3.4.2 The temperature rise in the curing enclosure shall be uniform with a rate of rise between 30°F (17°C) and 60°F (33°C) per hour. The concrete shall be cured at a steam temperature of 130°F (54°C) to 165°F (74°C) until the concrete reaches the detensioning strength specified in 6.4.

6.3.4.3 The concrete test cylinders shall be subject to the same curing as the poles.

6.3.4.4 Recording thermometers shall be used to record the time-temperature relationship through the curing period from placing concrete to the transfer of the prestressing.

6.3.5 *Curing Option*—Other methods of curing may be used if approved by the purchaser.

6.4 *Prestressing:*

6.4.1 Initial prestress shall not be applied until the concrete strength has reached the greater of 3500 psi (24 MPa) or 1.67 times the maximum expected stress in the concrete due to the prestressing forces immediately after transfer and before losses occur.

6.4.2 Detensioning sequence of strands and wires shall be predetermined to avoid undesired temporary stresses.

6.5 *Reinforcement*—Steel reinforcement shall conform to the requirements set forth in this specification and shall be placed in position in the form within specified tolerances.

6.6 *Forms*—Forms shall be rigid and sufficiently strong to support the weight of the concrete without deformation or deflection exceeding specified tolerances. Seepage of water from the form shall be minimal. All forms shall be constructed so that they can be removed without damaging the concrete. All exposed concrete edges at an angle of 100° or less shall be beveled.

6.6.1 *Cleaning and Oiling*—Forms shall be cleaned before each use. New forms shall be free of paint or other protective coatings that might cling to the surface of the members. Forms shall have a suitable release agent applied as necessary to aid in breaking bond between form wall and concrete.

6.7 *Concrete Finish*—Concrete finishing shall be as specified by the purchaser.

7. Physical Requirements

7.1 *Compression Test Specimens*—Compression tests for satisfying the design concrete strength requirements shall be made on standard concrete cylinders. Test cylinders shall be identified with poles. Two cylinders will be required for each 10 yd^3 (8 m^3) with a minimum of two cylinders for each casting bed, whichever is the greater number of cylinders, and shall be made at random from different batches. Compression test specimens for satisfying minimum specified concrete strength requirement shall be made in accordance with Practice C31/C31M except that curing shall be in accordance with 7.2.

7.2 *Curing Compression Test Specimens*—Test specimens shall be cured in a manner similar to the poles if they are steam-cured. If poles are cured at normal ambient temperatures, the specimens shall be cured in accordance with Practice C31/C31M.

7.3 *Compression Test*—Cylinders shall be tested in accordance with Test Method C39/C39M. The average compressive strength of all cylinders tested for each days production shall be equal to or greater than specified design strength of the concrete. In no case shall any cylinder tested fall below 80 % of the design strength.

7.4 *Core Compression Tests*—If the criteria of 7.3 are not met or as an alternative to 7.3, the producer or purchaser may agree to use cores taken from the poles in accordance with Test Method C42/C42M. The number of tests required shall be as specified in 7.1. Test results shall conform to 7.3 except that if cores are used, the average compressive strength of the test specimens shall be equal to or greater than 4250 psi (29 MPa) or 85 % of f'_c, whichever is less. No single core shall have a compressive strength of less than 3750 psi (27 MPa). If the tests fail each pole or pole segment may be individually cored for acceptance.

8. Tolerances and Permissible Variations

8.1 *Cross Sectional Dimensions*—Cross-sectional dimensions shall not deviate from design dimensions by more than ¼ in. (6 mm).

8.2 *Longitudinal Dimensions*—Longitudinal dimensions shall not deviate from the design dimensions by more than 1 in. (25 mm) from the nominal design dimensions.

8.3 *Location of Hardware and Holes*—The hardware and hole locations on the pole shall not deviate more than ⅜ in. (9 mm) from the nominal design dimensions. The hole spacing shall not deviate more than ⅛ in. (3 mm) from the nominal design dimensions where there is a pattern of holes where material will be bolted in at a later date.

8.4 *Surface Straightness*—When checked with a 10-ft (3-m) straightedge, irregularities measuring more than ¼ in. (6 mm) shall be corrected as the purchaser may order or approve.

9. Inspection

9.1 The quality of materials, the process of manufacture, and the finished poles shall be subject to inspection and approval by a representative of the purchaser. If the manufacturer is required to obtain the services of an independent testing laboratory, the cost shall be borne by the purchaser. The manufacturer shall afford the inspector all reasonable access for making necessary checks of the production facilities and for performing any tests the purchaser may direct his inspector to conduct. All tests and inspection shall be so conducted as not to interfere unnecessarily with the manufacture and delivery of the pole. The manufacturer shall have poles out of the forms available for inspection.

10. Rejection

10.1 Poles shall be subject to rejection for failure to conform to any of the specifications requirements. Individual poles may also be rejected because of any of the following:

10.1.1 Defects that indicate incorrect proportioning, mixing and molding.

10.1.2 Surface defects that indicate honeycombed or open texture.

10.1.3 Damaged or cracked areas where such damage would cause the member not to perform as designed.

10.1.4 Loss of prestress.

11. Repair

11.1 The manufacturer shall not apply any cosmetic treatment to the poles without written approval by the purchaser. Sections may be repaired if necessary, because of occasional imperfections in manufacture or damage during handling, such repairs may be made only after authorization by the purchaser. They will be acceptable if, in the opinion of the purchaser, the repairs are sound, properly finished, and cured. The repaired sections shall conform to the requirements of this specification.

12. Marking

12.1 The following information shall be clearly marked on each pole:

12.1.1 The date of manufacture of the pole.

12.1.2 The name of manufacturer of the pole located on a plate or plaque or cast in the pole.

12.1.3 Any additional information as required by the purchaser.

12.1.4 The bottom of the plate or plaque shall appear on the pole at a point 10 ft (3.1 m) from the butt end of the pole on poles 50 ft (15.2 m) long or less and at a point 14 ft (4.2 m) from the butt end of the pole on poles over 50 ft (15.2 m).