



Designation: C935 – 19

# Standard Specification for General Requirements for Prestressed Concrete Poles Statically Cast<sup>1</sup>

This standard is issued under the fixed designation C935; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 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.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- A36/A36M Specification for Carbon Structural Steel
- A370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A416/A416M Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete
- A421/A421M Specification for Stress-Relieved Steel Wire for Prestressed Concrete
- A586 Specification for Metallic-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 High-Strength Steel Bars for Prestressed Concrete
- A1064/A1064M Specification for Carbon-Steel Wire and

- Welded Wire Reinforcement, Plain and Deformed, for 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

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<sup>2</sup> 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.

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.

#### 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  $\frac{1}{2}$  the minimum dimension of the member or  $\frac{3}{4}$  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 A1064/A1064M 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  $\frac{1}{4}$  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  $\frac{1}{4}$  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  $4 \pm 1$  in. ( $100 \pm 30$  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