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Standard Specification for Precast Concrete Duct Bank¹

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1. Scope

1.1 This specification includes the manufacturing requirements and installation guidelines of a precast duct bank system including polyvinyl chloride (PVC) duct enclosed in a concrete envelope. This specification also includes information relating to trenching, backfilling, plugging, and other incidentals necessary for a complete installation.

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:²

- A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- A706/A706M Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- 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
- C138/C138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- C143/C143M Test Method for Slump of Hydraulic-Cement Concrete
- C150/C150M Specification for Portland Cement
- 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
- C494/C494M Specification for Chemical Admixtures for Concrete
- C595/C595M Specification for Blended Hydraulic Cements
- C618 Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- C805/C805M Test Method for Rebound Number of Hardened Concrete
- C822 Terminology Relating to Concrete Pipe and Related Products
- C979/C979M Specification for Pigments for Integrally Colored Concrete
- C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
- C1017/C1017M Specification for Chemical Admixtures for Use in Producing Flowing Concrete (Withdrawn 2022)³
- C1064/C1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
- C1116/C1116M Specification for Fiber-Reinforced Concrete
- C1157/C1157M Performance Specification for Hydraulic Cement
- C1602/C1602M Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- C1609/C1609M Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)
- C1611/C1611M Test Method for Slump Flow of Self-Consolidating Concrete
- C1619 Specification for Elastomeric Seals for Joining Concrete Structures

¹ This test method is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.01 on Non-Reinforced Concrete Sewer, Drain and Irrigation Pipe.

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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.

³ The last approved version of this historical standard is referenced on www.astm.org.

C1812/C1812M Practice for Design of Journal Bearing Supports to be Used in Fiber Reinforced Concrete Beam Tests
D5334 Test Method for Determination of Thermal Conductivity of Soil and Rock by Thermal Needle Probe Procedure

D7957/D7957M Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement

F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

2.2 Other Standards:

NEMA TC-2 Standard for Electrical Polyvinyl Chloride (PVC) Conduit⁴

NEMA TC-6&8 Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations⁴

NECA/NEMA 605 Standard for Installing Underground Nonmetallic Utility Duct⁴

UL 651 Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings⁵

IEEE 442 Guide for Thermal Resistivity Measurements of Soils and Backfill Materials⁶

AASHTO LRFD Bridge Design Specifications⁷

3. Terminology

3.1 *Definitions*—For definitions of terms relating to precast concrete duct bank, see Terminology **C822**.

4. Basis of Acceptance

4.1 *Acceptance on the Basis of Proof of Design Tests, Material Tests, and Inspection of Manufactured Precast Duct Bank Sections for Visual Defects and Imperfections*—Acceptability of precast duct bank sections shall be determined by such material tests as are required in Section 5 and Section 6; and by visual inspection of the finished sections to determine conformance with the accepted design and its freedom from defects in accordance with Section 10.

4.2 *Thermal Resistance (Rho)*—When required by project specifications, Precast Duct Bank Sections shall be verified to have a thermal resistivity (Rho) value no greater than specified as tested in accordance with Test Method **D5334** or IEEE 442. Test to be completed at least annually or whenever concrete mixture proportions or materials change.

4.3 *Age for Acceptance*—Precast duct bank sections shall be considered ready for acceptance when it conforms to the requirements as indicated by the specified tests, but not before design strength has been met.

5. Materials

5.1 Cementitious Materials:

5.1.1 *Cement*—Cement shall conform to the requirements of Specification **C150/C150M** or **C1157/C1157M**, or shall be blended cement conforming to the requirements of Specification **C595/C595M**.

5.1.2 *Slag Cement*—Slag cement shall conform to the requirements of Specification **C989/C989M**.

5.1.3 *Fly Ash*—Fly ash shall conform to the requirements of Class F or Class C of Specification **C618**.

5.2 *Allowable Combinations of Cementitious Materials*—Any combination of cementitious materials shall be acceptable for use in the concrete if the mix meets the testing requirements of Section 9 in this specification.

5.3 *Aggregates*—Aggregates shall conform to Specification **C33/C33M** except that the requirement for gradation shall not apply.

5.4 *Admixtures*—The following admixtures and blends are acceptable:

5.4.1 Air-entraining admixture conforming to Specification **C260/C260M**;

5.4.2 Chemical admixture conforming to Specification **C494/C494M**;

5.4.3 Chemical admixture for use in producing flowing concrete conforming to Specification **C1017/C1017M**; and

5.4.4 Chemical admixture or blend meeting requirements of this standard.

5.5 *Fibers*—The use of fiber-reinforced concrete (FRC) conforming to the requirements of Specification **C1116/C1116M** Type I (steel FRC), Type II (glass FRC), and Type III (synthetic FRC) shall be permitted in precast duct bank sections.

5.6 *Integral Color*—Concrete incorporated into precast duct bank sections to be mixed with integral red color to indicate electrical encasement shall meet the requirements of Specification **C979/C979M**.

5.7 *Water*—Water used in the production of concrete shall be potable, or non-potable water that meets the requirements of Specification **C1602/C1602M**.

5.8 *Reinforcement*—When required by manufacturer's design, reinforcement shall meet the requirements of Specification **A615/A615M**, **A706/A706M**, **A1064/A1064M**, or **D7957/D7957M**.

NOTE 1—Typical manufacturing procedures do not require reinforcement.

5.9 *Conduit*—Conduit cast into precast duct bank sections shall be sized according to project requirements and meet all material and dimensional requirements UL 651, TC-6 & 8 Schedule 40 or Type EB, except as modified below:

5.9.1 It shall be permissible to modify the bottom socket dimension to match entrance dimension to allow for field fit of precast sections.

5.9.2 Conduit with modified socket dimensions shall be marked "Precast-EB" for use in precast concrete duct bank sections built to the requirements of this specification.

⁴ Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 900, Arlington, VA 22209, <http://www.nema.org>.

⁵ Available from Underwriters Laboratories (UL), UL Headquarters, 333 Pfingsten Road, Northbrook, IL, 60062, <http://www.ul.com>.

⁶ Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854-4141, <http://www.ieee.org>.

⁷ Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, <http://www.transportation.org>.

5.10 *Gasket Material*—When required by project specifications, conduit gaskets shall meet the requirements of Specification **C1619** Class E or Specification **F477**.

6. Design

6.1 Precast duct bank sections shall be designed to meet dead load and HL93 live load requirements in accordance with AASHTO LRFD Bridge Design Specifications or project specific requirements as specified by the owner at the time of order.

6.2 *Dimensions*—Overall dimensions of precast duct bank sections shall be designed to provide for the following:

6.2.1 Conduit Spacing:

6.2.1.1 From face of concrete to OD of conduit = 3 in. (76 mm) minimum. This requirement does not apply to bell surfaces.

6.2.1.2 From OD of conduit to OD of adjacent conduit = 3 in. (76 mm) minimum. This requirement does not apply to bell surfaces of adjacent conduit.

6.2.2 *Length of Section*—Laying length of a precast duct bank section, as measured from face to face parallel to the center axis of the section along a given edge, shall be as shown on manufacturer's product details with tolerances as defined in Section **10**.

6.3 *Material Strengths*—The manufacturer shall define the following to meet the design requirements of the precast duct bank sections:

6.3.1 *Minimum Handling Compressive Strength of the Concrete*—(f'_{ci}) as required by the design, but shall not be less than 2,000 psi (13.8 MPa) or as required by the handling devices incorporated into the section. It is not prohibited to determine initial handling strength of a precast duct bank section through application of a properly correlated rebound hammer in accordance with Test Method **C805/C805M**.

6.3.2 *Minimum Compressive Strength of the Concrete at Time of Delivery*—(f'_c) as required by the design, but shall not be less than 4,000 psi (25.6 MPa), to be determined in accordance with Test Method **C39/C39M**.

6.3.3 *Minimum Reinforcement Yield Strength and Ultimate Strength*—(f_y) and (f_u), if required.

6.3.4 *Minimum Elastic Modulus of Reinforcement*—(E_s), if required.

6.3.5 *Fiber*—FRC shall provide a minimum average equivalent strength ratio, R_{e3} , of 30 % when tested in accordance with Test Method **C1609/C1609M**, using the roller support system described in Practice **C1812/C1812M**. Dosage shall be as recommended by the manufacturer.

NOTE 2—An R_{e3} value of 30 % is chosen to correspond to 0.18 % minimum reinforcement ratio used in typical concrete design.

6.4 *Product Details*—Precast duct bank section documentation when required by owner/purchaser to define the following:

6.4.1 The concrete mix design, including all materials and admixtures within the concrete matrix.

6.4.2 Area and locations of reinforcement in units of in.²/ft (mm²/m), if required.

6.4.3 Volume of fiber reinforcement, if required, in units of lb/yd³ (kg/m³) or percent of volume of concrete.

6.4.4 Product dimensions and tolerances.

7. Joints

7.1 Conduit Shear Protection:

7.1.1 Precast duct bank system shall be designed, manufactured, and installed to develop adequate support at the ends of the precast sections to protect the conduit from excessive shear loads induced by differential movement of adjacent sections caused by design dead and live loads.

7.1.2 At a minimum, the installed system shall be of sufficient strength to transfer a factored wheel load included in AASHTO HL93 design from section to section without deflecting conduit by more than 10 % of the inside diameter. Determination of provided strength to be performed using structural analysis in accordance with AASHTO LRFD requirements, or by physical testing.

7.2 *Conduit*—Each individual conduit section cast integrally into precast concrete duct bank shall meet the following:

7.2.1 End of conduit bell to be cast flush with the end mating surface of the concrete section.

7.2.2 End of spigot that will be inserted into the bell to extend from the mating surface of the precast concrete duct bank section a sufficient length to engage the bell as detailed in the joint design provided by the manufacturer.

7.2.3 Joint to be provided with one of the following sealing options as required by the project specifications:

7.2.3.1 *Gasket Joint*—Gasket joint shall be integral with bell of conduit, installed in gasket groove on Spigot end of conduit, or another configuration that meets the requirements of Specification **C1619** or **F477**. Gasket joint shall meet the pressure test requirements of **9.7** of this standard.

7.2.3.2 *Slip Joint*—No gasket required. Maximum centered annular space between bell and spigot to be no greater than 0.03 in. (0.8 mm).

7.2.3.3 *Regardless of Joint type*—minimum insertion length of spigot into bell to be no less than ½ of the nominal conduit inside diameter or that distance where the gasket is fully engaged.

8. Manufacture

8.1 Mixture:

8.1.1 The aggregates shall be sized, graded, proportioned, and mixed with such proportions of cementitious materials, water, and admixtures, if any, to produce a thoroughly mixed concrete of such quality that the precast duct bank will conform to the test and design requirements of this specification.

8.1.2 Cementitious materials shall be as specified in **5.2** and shall be added to the mix in a proportion not less than 470 lb/yd³ (280 kg/m³) unless mix designs with a lower cementitious materials content demonstrate that the quality and performance of the precast duct bank meet the requirements of this specification.

8.1.3 For wetcast concrete, air content shall be as specified on the manufacturer's mix design and tested in accordance with Test Method **C231/C231M**. If air content is not specified on the mix design, target air content shall be 6 % (±2 %).

8.1.4 For wetcast concrete, unit weight test shall be performed in accordance with Test Method **C138/C138M** using