Designation: C1924 – 24

Standard Practice for Design of Buried Precast Concrete Low-Head Pressure Pipe[1]

This standard is issued under the fixed designation C1924; 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 (ε) indicates an editorial change since the last revision or reapproval.

NOTE—Equations 25, 35, 37, 38, and 56 were corrected and the yeardate changed on February 29, 2024.

1. Scope

1.1 This practice covers the design of buried precast concrete low head pressure pipe having a circular shape and manufactured in accordance with Specification C361/C361M subject to internal pressure not exceeding a pressure head of 125 ft (54 psi), or as otherwise limited herein.

1.2 When buried, concrete pipe is part of a composite system comprised of the pipe and the surrounding soil envelope. Both the pipe and soil envelope contribute to the strength and structural behavior of the system.

1.3 This practice presents the method for evaluating the effects of external loads combined with internal pressure on buried precast concrete low-head pressure pipe manufactured per Specification C361/C361M. This method includes an analysis that accounts for the interaction between the pipe and soil envelope in determining external loads, earth pressure distributions, and the moments, thrusts, and shears for the pipe. It also includes a detailed procedure for designing reinforcement for these installations.

1.4 Construction requirements for precast concrete low-head pressure pipe are in accordance with Specification C361/C361M.

1.5 This practice may be used as a reference by the owner and the owner's engineer in preparing project specifications for low head pressure pipe.

1.6 The design procedures given in this standard are intended for use by engineers who are familiar with the installation and pipe characteristics that affect the structural behavior of buried concrete pipe installations and the significance of the installation requirements.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *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]

A1064/A1064M Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

C361/C361M Specification for Reinforced Concrete Low-Head Pressure Pipe

C443 Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

C655 Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

C822 Terminology Relating to Concrete Pipe and Related Products

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)

2.2 *ASCE Standards:*[3]

ASCE 15 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)

2.3 *AASHTO Documents:*[4]

LRFD Bridge Design Specifications

[1] This test method is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.04 on Low Head Pressure Pipe.

Current edition approved Feb. 29, 2024. Published March 2024. Originally approved in 1987. Last previous edition approved in 2023 as C1924 – 23. DOI: 10.1520/C1924-24.

[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] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

[4] 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.

2.4 *AREMA Documents:*[5]
Railroad Engineering Manual
2.5 *AWWA Documents:*[6]
Manual M9 Design of Reinforced Concrete Pressure Pipe

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms relating to concrete pipe, see Terminology C822.

3.1.2 For terminology related to soil classifications, see Practices D2487 and D2488.

3.1.3 For terminology and definition of terms relating to structural design, see AASHTO LRFD Bridge Design Specification.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *installation requirements, n*—(See Fig. 1.) definitions and limits are shown in Fig. 1.

3.2.2 *internal pressure, n*—The pressure at the inside springline of a concrete pipe.

3.2.2.1 *Discussion*—The designated (design) internal hydrostatic pressure includes operating pressure and transient pressure. Transient pressure includes surge, water hammer and any other dynamic pressure specified by the owner. The designated internal hydrostatic pressure is measured from the springline of the pipe as is customary in pressure pipe terminology, however, precast concrete low head pressure pipe is designed by considering the weight of fluid up to the crown of the pipe and then the pressure above the crown.

3.2.3 *prism load, n*—weight of column of earth over the outside diameter of pipe.

3.2.4 *radial tension strength, n*—the limiting average tensile strength of the concrete in the plane of the inner reinforcement and concrete at the crown and invert regions.

3.2.5 *radial tension stress, n*—(See Fig. 2.) radial tension stress is caused by tensile stress in the inner cage.

3.2.5.1 *Discussion*—The inner reinforcing tends to straighten from an arc to a chord in the crown or invert of the pipe. Only tensile force produced by bending from external load produces radial tension. The tensile force in the reinforcement produced by internal pressure does not produce radial tension.

3.2.6 *shear force, n*—The diagonal tension component of the internal stress resultant produced by external load.

[5] Available from American Railway Engineering and Maintenance-of-Way Association (AREMA), 4501 Forbes Blvd., Suite 130, Lanham, MD 20706, https://www.arema.org.

[6] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

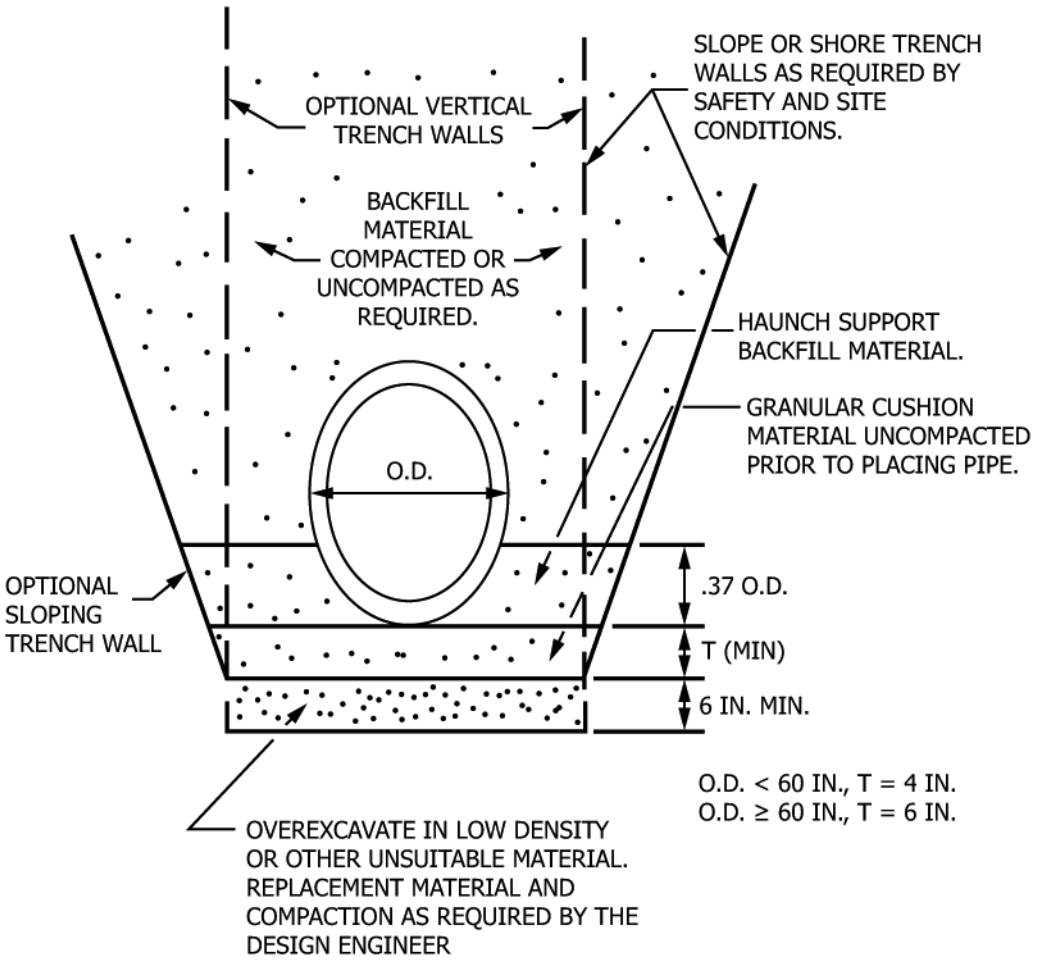

FIG. 1 Installation Definitions