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27-17

Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction

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PART I
GENERAL

1.0 SCOPE

1.1 This practice covers design and recommended installation procedures for precast concrete pipe for jacking in trenchless construction intended for the conveyance of sewage, industrial wastes, stormwater, and drainage, and for utilities and access ways.

1.2 Trenchless Construction. Trenchless construction is a method of installing pipe without excavating an open trench.

1.2.1 Jacking. Jacking is a trenchless construction technique in which prefabricated pipes are installed by pushing (jacking) them longitudinally into position, usually from a pit. The spoil material is removed either manually or mechanically through the pipe being installed.

1.2.2 Microtunneling. Microtunneling is a method of installing pipe by trenchless construction techniques behind a remotely controlled, steerable, guided, articulated boring machine that is connected to and followed by the pipe that is being installed by jacking. Excess spoil material is removed mechanically through the pipe being installed.

1.3 The exterior surface of the pipe shall not contain projections such as enlarged bells, unless special provisions are made.

1.4 The successful performance of concrete pipe installed using jacking techniques requires proper design by the engineer for loading conditions during and after installation. It requires skillful placement by the installing contractor utilizing methods that maintain jacking loads to acceptable levels and maintain acceptable levels of variance from established line and grade. It requires precise fabrication of the pipe by the manufacturer to the standards and tolerance levels specified.

1.5 Part II of this standard practice presents a direct design method for jacked pipe installations. This design and analysis method considers the interaction between the pipe and surrounding soil and/or grout envelope in determining longitudinal loads developed during jacking, as well as transverse pressure distributions and circumferential moment, thrust, and shear in the pipe wall. A procedure for calculating the required reinforcement in the pipe wall is included.

1.6 Appendix A of this standard practice presents manufacturing requirements for precast concrete pipe intended for use in trenchless construction installed by jacking methods.

1.7 Appendix B of this standard practice presents guidelines for jacking operations.

1.8 Appendix C of this standard practice presents guidelines for estimating required jacking force.

1.9 This standard practice may be used as a reference by the owner and the owner's engineer in preparing project specifications.

1.10 The design procedures given in this standard practice are intended for use by engineers who are familiar with the installation and pipe characteristics that affect the structural behavior of jacked concrete pipe installations and the significance of the installation requirements. Before applying the design procedures given in Part II, the engineer should review the guidance and requirements given in other sections of this standard practice and its accompanying commentary.

1.11 The values of dimensions and quantities are expressed in inch-pound (English) units, which are to be regarded as standard. Where English unit values are converted to SI unit values they are presented in parentheses or a section following the English units. For clarity, Appendix D repeats the notation and contains the full translation of equations to SI units. The use of SI units is in accord with ASTM Practice E 380. SI units expressed in parentheses and in Appendix D are supplied for information only and are not part of this standard practice.

Note 1: Some of the applicable standards referenced may have a double designation (Axxx/AxxxM) or separate inch-pound (English) and SI (metric) unit editions. Only the inch-pound unit edition of a standard is listed in this practice.

Note 2: SI (metric) unit editions of ASTM standards on precast concrete pipe use the units of cm^2/m to denote steel reinforcement cross-sectional area, which is an acceptable, but not a preferred, SI unit.

2.0 APPLICABLE DOCUMENTS

2.1 ASTM (American Society for Testing and Materials)

2.1.1 A 1064/A 1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

2.1.2 A 615/A 615M Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

2.1.3 C 76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

2.1.4 C 822 Definitions of Concrete Pipe and Related Products

2.1.5 C 985 Specification for Nonreinforced Concrete Specified Strength Culvert, Storm Drain, and Sewer Pipe

2.1.6 C 1417 Specification for Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design

2.1.7 D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)

2.1.8 D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)

2.1.9 E 380 Practice for Use of the International System of Units (SI) the Modernized Metric System

2.2 AASHTO (American Association of State Highway and Transportation Officials)

2.2.1 Standard Specifications for Highway Bridges and Structures

2.3 ACI (American Concrete Institute)

2.3.1 ACI 318 Building Code Requirements for Reinforced Concrete and Commentary

2.4 ASCE (American Society of Civil Engineers)

2.4.1 ASCE 15-98 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations

2.5 AREMA (American Railway Engineering and Maintenance-of-Way Association)

2.5.1 Manual for Railway Engineering

3.0 DEFINITIONS

3.1 For definitions of terms relating to concrete pipe, see ASTM Definitions C 822 and Fig. 3-1.

3.2 For terminology related to soil classifications, see ASTM Classification D 2487 and ASTM Practice D 2488.

3.3 For terminology and definition of terms relating to structural design, see AASHTO Standard Specifications for Highway Bridges and Structures.

3.4 Fig. 3-1 illustrates the definition and limits of the terms bottom, invert, crown, top, springline, and diameter of pipe as used in this standard practice.

4.0 NOTATIONS

The following symbols are used in this standard practice:

A_p = contact area between joint packing and concrete surface with no joint separation, in.^{2} (mm^2);
A'_p = contact area between joint packing and concrete surface with joint separation, in.^{2} (mm^2);
A_s = area of tension reinforcement required in length b, in.^{2}/ft (mm^2/m);
A_{si} = area of total inner cage reinforcement required in length b, in.^{2}/ft (mm^2/m);
A_{so} = area of total outer cage reinforcement required in length b, in.^{2}/ft (mm^2/m);
A_{vr} = area of stirrup reinforcement required to resist radial tension forces, in.^{2}/ft (mm^2/m) in each line of stirrups at circumferential spacing s_v;
A_{vs} = area of stirrup reinforcement required to resist shear, in.^{2}/ft (mm^2/m) in each line of stirrups at circumferential spacing s_v;
a = length (thickness) of joint packing, in. (mm);
B_{Th} = maximum span of tunnel bore for jacked pipe, in. (mm);
B_{Tv} = maximum rise of tunnel bore for jacked pipe including pipe dimension plus overbore, in. (mm);
B_1 = crack control coefficient for effect of spacing and number of layers of reinforcement;

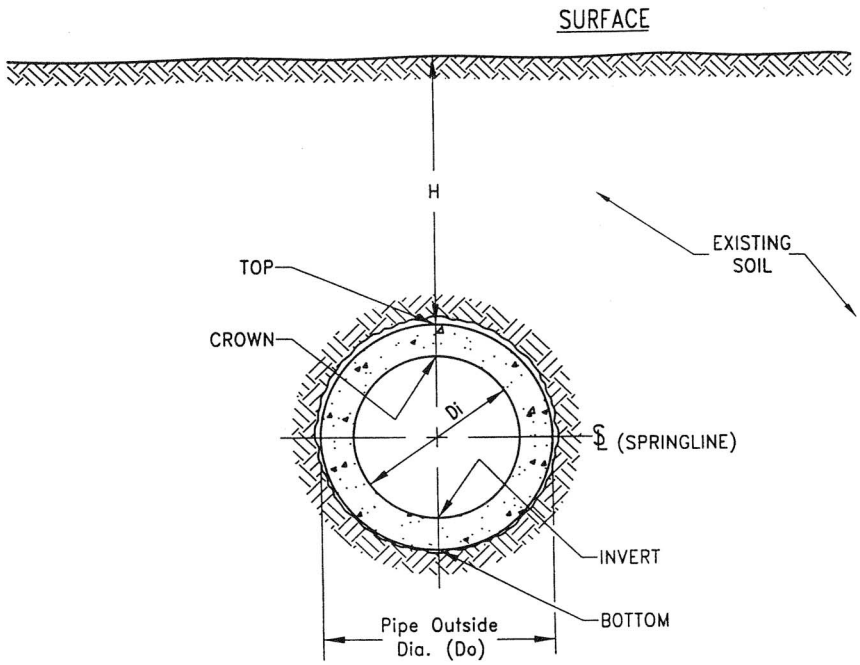


FIGURE 3-1. Jacked Pipe/Installation Terminology