
Standard Practice for

Pipe Joint Selection for Highway Culvert and Storm Drains

AASHTO Designation: PP 63-09 (2014)¹



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. Pipe joint design considerations are a critical component for the overall performance of culvert and storm drain installations. Experience has shown that the component responsible for many culvert and sewer performance problems and failures can be traced back to the pipe joint. The structural and hydraulic performance of the joint affects the stability of backfill and soil envelope around the pipe, the line and grade of the culvert, integrity of the overlying embankment and pavement, and compliance to storm and sanitary sewer permits. This practice is to provide clear definitions of joint performance terms, rational design methodology to determine appropriate joint performance requirements, and uniform criteria for manufacturers' joint qualification and contractors' post-installation pipe joint testing.
- 1.2. *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- [M 36](#), Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
 - [M 288](#), Geotextile Specification for Highway Applications
 - [M 294](#), Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
 - [M 304](#), Poly(Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
 - *AASHTO LRFD Bridge Construction Specifications*
- 2.2. *ASTM Standards:*
- [C443](#), Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 - [C497](#), Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
 - [C877](#), Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
 - [C924](#), Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method (Withdrawn 2013)
 - [C969](#), Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
 - [C990](#), Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

- [C1091](#), Standard Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines
- [C1103](#), Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
- [C1619](#), Standard Specification for Elastomeric Seals for Joining Concrete Structures
- [D3212](#), Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
- [F477](#), Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- [F1417](#), Standard Practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air

3. TERMINOLOGY

3.1. Definitions:

- 3.1.1. *brownfields*—abandoned industrial or commercial sites with some soil contamination from previous use, now available for new construction.
- 3.1.2. *erodible conditions*—soil or backfill materials or conditions where the soil or backfill surrounding the pipe may be removed by the flow of liquid (water) leaking from the pipe or pipe joint.
- 3.1.3. *exfiltration*—the passage of fluid from a pipe section through small openings or leaks in the pipe wall or in the joint. Fluid that enters the pipe backfill may change the structural characteristics of the backfill or cause migration of the backfill or surrounding soils.
- 3.1.4. *infiltration*—the passage of fluid into a pipe section through small openings in the pipe wall or in the joint. Extraneous flow entering a pipe system may cause migration of the backfill or surrounding soils into the pipe and change the structural characteristics of the backfill.
- 3.1.5. *leakage rate*—an amount of infiltration or exfiltration within the pipe system. A maximum leakage rate may be established as a condition of project compliance to assure structural quality and proper installation.
- 3.1.6. *leak resistance*—leak resistance refers to a system that is not completely (100 percent) watertight, but allows some defined allowable rate of water leakage into and out of the system.
- 3.1.7. *leak-resistant joint*—a joint that limits water leakage at a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for the project specified head or pressure.
- 3.1.8. *post-installation test*—leakage test conducted after pipe installation and backfill utilizing air or water to verify project specification compliance when required as a condition of project acceptance.
- 3.1.9. *proof of design*—laboratory or in-plant tests for leakage through the pipe or pipe joint under pressure or vacuum that verifies the performance of the pipe joint in a specific test. This type of test may not directly correlate to field performance.
- 3.1.10. *restrained joints*—joints used for applications in which the joint may be subject to significant tensile and shear forces and moments. Examples of these applications are installations on slopes, sites where differential settlement may occur, and pipes for high pressures and high heads or velocities.
- 3.1.11. *silt-tight joint*—a joint that is resistant to infiltration of particles that are smaller than particles passing the No. 200 sieve. Silt-tight joints provide protection against infiltration of backfill

material containing a high percentage of fines, and typically utilize some type of filtering or sealing component, such as an elastomeric rubber seal or geotextile.

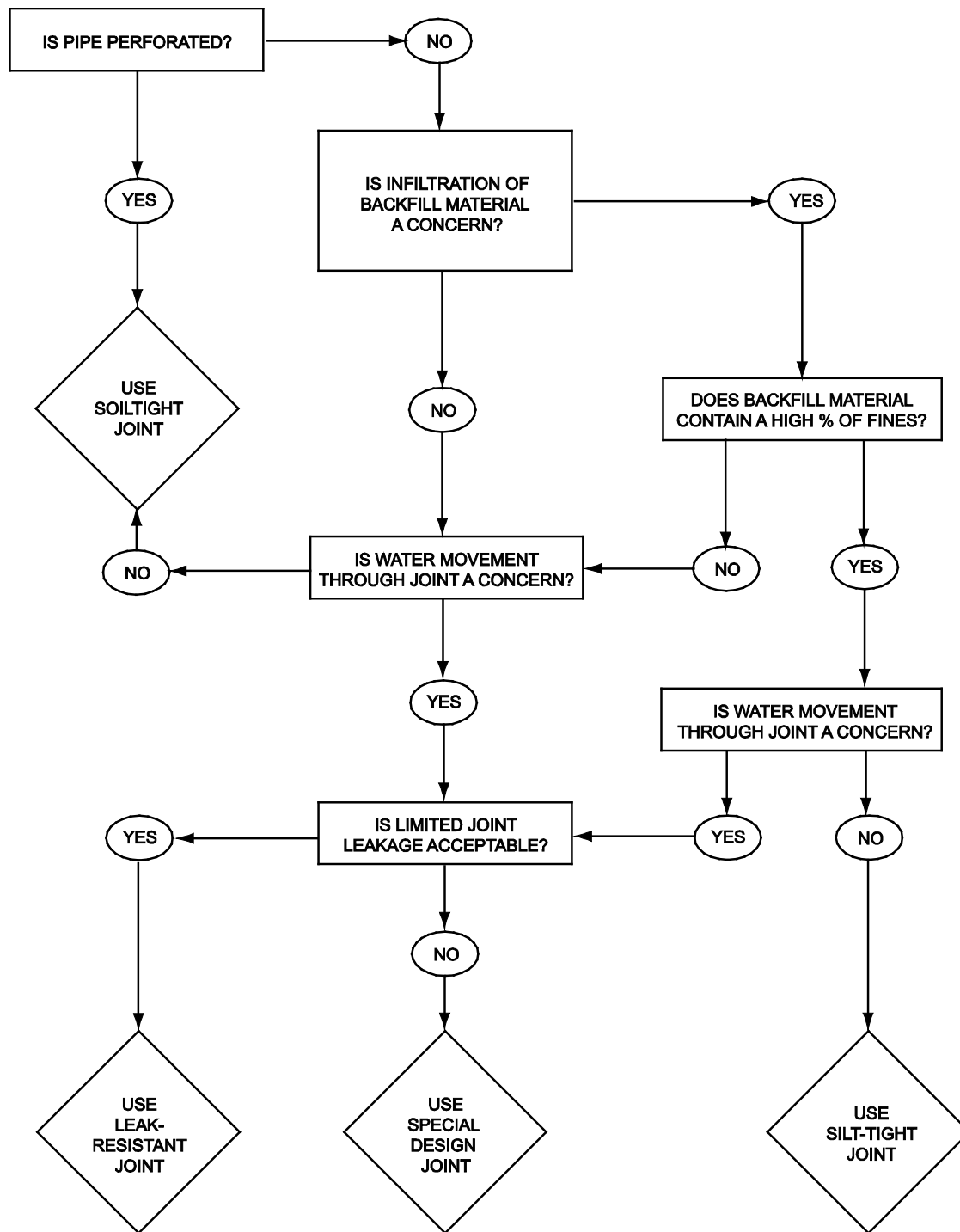
- 3.1.12. *silt-tightness*—refers to a pipe system’s resistance against fine soil migration through the openings of the joint.
- 3.1.13. *soiltight joint*—a joint that is resistant to infiltration of particles larger than those retained on the No. 200 sieve. Soiltight joints provide protection against infiltration of backfill material containing a high percentage of coarse grain soils, and are influenced by the size of the opening (maximum dimension normal to the direction that the soil may infiltrate) and the length of the channel (length of the path along which the soil may infiltrate).
- 3.1.14. *soiltightness*—refers to a pipe system’s resistance to coarse grained soil migration through the openings of the joint.
- 3.1.15. *special design joint*—joints requiring special strength in bending or shear, pull-apart capabilities, or unusual features such as restrained joints placed on severe slopes, welded joints, or flanged and bolted joints for high pressures, high heads, or velocities, etc., typically described within special provisions of the project specifications.
- 3.1.16. *watertight joint*—a joint that provides zero leakage of water infiltration and exfiltration for a specified head or pressure application. Watertight joints typically utilize a resilient rubber seal of some type and are capable of passing a laboratory hydrostatic pressure and vacuum test of at least 10.8 psi without leakage.
- 3.1.17. *watertightness*—refers to a system that has zero leakage or infiltration. This is most commonly applied to joints when lab-tested hydrostatically to a specified pressure and/or vacuum specified by the joint standard.

4. SUMMARY OF PRACTICE

- 4.1. This practice establishes accepted definitions and performance criteria for the joints of buried pipe. Guidance is provided on the selection process for the appropriate joint, and the standard procedures for verifying performance of the joint, both at the plant and in the field when specified, to ascertain that it meets the required performance criteria. The purpose of this practice is to produce consistent performance levels regardless of the piping material used on the project.

5. PROCEDURE

- 5.1. Examine the Pipe Joint Selection Process Flowchart in Figure 1. The first consideration in the pipe joint selection decision process is to determine whether the pipe for the application is solid or perforated. If the pipe is perforated, then the joint shall have openings no larger than the perforations in the pipe wall.



LEAKAGE RATE (MAXIMUM)
 ~200 gal/in.-dia/mi/day

Figure 1—Pipe Joint Selection Process Flowchart

- 5.1.1. For nonperforated pipe, a determination must be made as to the acceptability of allowing infiltration and/or exfiltration through the pipe joint. If infiltration of backfill material is not a concern and water movement through the joint is not a concern, then the default or soiltight joint should be selected for this type of application. The purpose of the soiltight joint is to maintain backfill integrity and pipe alignment and to join the ends/sections of pipe together to allow a continuous flow of water while maintaining the interior required gap between sections. This joint will limit the infiltration of soil particles in the backfill material to particles that will pass through a No. 200 sieve.
- 5.1.2. For nonperforated pipe where infiltration of backfill material is a concern, the designer should examine the composition of the backfill material. If there is a high percentage of soil fines (Note 1) finer than the No. 200 sieve, then a silt-tight joint should be selected for most applications.
Note 1—A high percentage of fines are defined as more than 35 percent passing the No. 200 sieve.
- 5.1.3. If water movement through a joint is a concern, a leak-resistant joint or a special design joint should be selected.
- 5.1.4. If limited joint leakage is acceptable, a leak-resistant joint shall be specified. This joint will limit water leakage to a maximum rate of 200 gallons/inch-diameter/mile/day for the pipeline system for a specified head or pressure.
- 5.1.5. If limited joint leakage is not acceptable, a special design joint shall be specified.
- 5.2. Sections 8 and 9 should be consulted once the type of joint has been selected. These sections present various methods for constructing a soiltight, silt-tight, leak-resistant, or special design joint for each type of pipe material.
- 5.3. To ensure proper joint performance, the pipe joint integrity shall be established by the pipe joint manufacturer prior to shipping the pipe, and further verified in the field by the contractor as witnessed by the project inspector. The manufacturer shall perform plant verification tests when specified in accordance with the Plant Test Requirements for the appropriate pipe material in Section 6. This will ensure a suitable pipe joint is being delivered to the job site. Upon completion of the installation of the pipe, field verification of any leakage requirements by visual inspection or applicable testing shall be performed by the contractor and/or engineer when specified in accordance with the Field Test Requirements outlined for the appropriate pipe material in Section 7. Failure to pass either one of these requirements when specified is cause for rejection of the pipe.

6. PLANT TEST REQUIREMENTS

- 6.1. *Soiltight Joint:*
- 6.1.1. Soiltight joints are specified as a function of opening size (maximum dimension normal to the direction that soil may infiltrate), channel length (length of the path along which the soil may infiltrate), and backfill particle size. If the size of the opening exceeds $\frac{1}{8}$ in., the length of the channel must be at least four times the size of the opening. No opening may exceed 1 in.