American Concrete Pipe Association

An Introduction to ASTM Concrete Pipe & Box Culvert Joint Standards

By Eric Carleton, P.E.
Independent Concrete Pipe Company
ASTM C13 Secretary

www.concrete-pipe.org
Dave Anderson – The Real RCP Joints Guru

www.concrete-pipe.org

American Concrete Pipe Association
What is ASTM?

- American Society for Testing and Materials, established in 1898
- ASTM International
  - A voluntary consensus based organization which establishes material standards or testing protocols
- American Section of the International Association for Testing Materials. The members grappled with two questions that were widely discussed throughout the engineering community at the turn of the century. First, **how could standards for materials contribute to industrial progress?** And second, **how could producers and users of industrial materials reach a consensus on standards?** ASTM’s early history was in large part a quest to find answers to these pivotal questions.
Weakest Link of Conduit
ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

11.11 Test Equipment—Every manufacturer furnishing pipe under this specification shall furnish all facilities and personnel necessary to carry out the tests described in Test Methods C 497.

12. Permissible Variations

12.1 Internal Diameter—The internal diameter of 12-in. through 24-in. pipe shall not vary by more than 2% of the design diameter for 12-in. pipe and 1.5% for 24-in. pipe with intermediate sizes variation being a linear scale between 2% and 1.5%. The internal diameter of sizes 27-in. and larger shall not vary by more than 1% of the design diameter or ± ½-in., whichever is greater. These diameter requirements are based on the average of four diameter measurements at a distance of 12 in. from the end of the bell or spigot of the pipe. Diameter verification shall be made on the number of pipe selected for test per Section 11.

12.2 Wall Thickness—The wall thickness shall not vary more than shown in the design or specified wall by more than ±5% or ±⅜ in., whichever is greater. A specified wall thickness more than required in the design is not cause for rejection. Pipe having localized variations in wall thickness exceeding those specified above shall be accepted if the three-edge-bearing strength and minimum steel cover requirements are met.

12.3 Length of Two Opposite Sides—Variations in the lay length of two opposite sides of the pipe shall not be more
ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

TABLE 3 Design Requirements for Class III Reinforced Concrete Pipe

<table>
<thead>
<tr>
<th>Designated Diameter, in.</th>
<th>Designated Wall Thickness, in.</th>
<th>Wall A</th>
<th>Wall B</th>
<th>Wall C</th>
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<tbody>
<tr>
<td>12</td>
<td>1%</td>
<td>0.07</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>15</td>
<td>1%</td>
<td>0.07</td>
<td>0.03</td>
<td>0.07</td>
</tr>
<tr>
<td>18</td>
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<td>0.03</td>
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<tr>
<td>24</td>
<td>1%</td>
<td>0.15</td>
<td>0.18</td>
<td>0.20</td>
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<tr>
<td>30</td>
<td>1%</td>
<td>0.18</td>
<td>0.18</td>
<td>0.15</td>
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<tr>
<td>36</td>
<td>1%</td>
<td>0.21</td>
<td>0.15</td>
<td>0.15</td>
</tr>
</tbody>
</table>

www.concrete-pipe.org
ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

9. Joints

9.1 The joints shall be of such design and the ends of the concrete pipe sections so formed that the pipe can be laid together to make a continuous line of pipe compatible with the permissible variations given in Section 12.
8.1.6 Where the wall reinforcement does not extend into the joint, the maximum longitudinal distance to the last circumferential from the inside shoulder of the bell or the shoulder of the spigot shall be 3 in. except that if this distance exceeds one-half the wall thickness, the pipe wall shall contain at least a total reinforcement area of the minimum specified area per linear foot times the laying length of the pipe section. The minimum cover on the last circumferential near the spigot shoulder shall be 1.2 in.

8.1.6.1 Where reinforcement is in the bell or spigot the minimum end cover on the last circumferential shall be ½ in. in the bell or ¼ in. in the spigot.
8.3 Joint Reinforcement—The length of the joint as used herein means the inside length of the bell or the outside length of the spigot from the shoulder to the end of the pipe section. The end distances or cover on the end circumferential shall apply to any point on the circumference of the pipe or joint. When convoluted reinforcement is used, these distances and reinforcement areas shall be taken from the points on the convolutions closest to the end of the pipe section. Unless otherwise permitted by the owner, the following requirements for joint reinforcement shall apply.

8.3.1 Joint Reinforcement for Non-Rubber Gasket Joints:
8.3.1.1 For pipe 36 in. and larger in diameter, either the bell or spigot shall contain circumferential reinforcement. This reinforcement shall be an extension of a wall cage, or may be a separate cage of at least the area per foot of that specified for the outer cage or one-half of that specified for single cage wall reinforcement, whichever is less.
8.3.1.2 Where bells or spigots require reinforcement, the maximum end cover on the last circumferential shall be one-half the length of the joint or 3 in., whichever is less.

8.3.2 Joint Reinforcement for Rubber Gasket Joints:
8.3.2.1 For pipe 12 in. and larger in diameter, the bell ends shall contain circumferential reinforcement. This reinforcement shall be an extension of the outer cage or a single wall cage, whichever is less, or may be a separate cage of at least the same area per foot with longitudinals as required in 8.2. If a separate cage is used, the cage shall extend into the pipe with the last circumferential wire at least one in. past the inside shoulder where the pipe barrel meets the bell of the joint.
8.3.2.2 Where bells require reinforcement, the maximum end cover on the last circumferential shall be 1 1/2 in.
The “Good ol’ Days”

If the pipe goes home, it’s a good joint!
Making the pipe Today

If we’re not backcharged

It’s a good joint!
SOME HISTORICAL PERSPECTIVE

- Most early sewer and culvert installations used plain, mortar, or mastic joint sealant.

- Gasketed pipe joints were primarily used for pressure applications
  - England mid 1800’s
  - 1st US concrete pressure line 1914

- US profile gaskets use early 1930’s
  - “Flexlock” by B.F. Goodrich-T.D. Nathan
  - Hamilton-Kent; Tylox 1944
ASTM Gasketed Joint Standards Development

C361-1955 Reinforced Concrete Low-Head Pressure Pipe

C443-1959 Joints for *Circular* Concrete Sewer and Culvert Pipe, Using Rubber Gaskets

O-ring Detail

Profile Detail
ASTM Alternate Joint Standards Development

C877-1977 External Sealing Bands for Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe

C990-1991 Joints for Concrete Pipe, Manholes, and Precast Box Sections Using *Preformed* Flexible Joint Sealants
CONCRETE PIPE JOINT STANDARDS USE IN MUNICIPAL PIPE APPLICATIONS

LOW-HEAD
SANITARY
STORM
CULVERT

Infiltration limits: 500 in.-gal/mi/day
Now tested to: 200 in-gal/mi/day!
Concrete Pipe Joint Standards Use in Municipal Pipe Applications

Low-Head Sanitary
Storm

Infiltration limits: Now tested to 200 in-gal/mi/day!
CONCRETE PIPE JOINT STANDARDS USE IN TRANSPORTATION PIPE APPLICATIONS

CULVERT STORM
# AASHTO PP63-09 – Standard Recommended Practice for Pipe Joint Selection for Highway Culvert and Storm Drains

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<tbody>
<tr>
<td><strong>Soil Tight</strong></td>
<td>Mastic filler</td>
<td>AASHTO M198</td>
<td>ASTM C990</td>
<td>Material Certification</td>
<td>Dimensional checks</td>
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<tr>
<td></td>
<td>External Geotextile wrap</td>
<td>AASHTO M288</td>
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<tr>
<td></td>
<td>External Sealing Bands</td>
<td>-</td>
<td>ASTM C877</td>
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<tr>
<td></td>
<td>Rubber Gasket</td>
<td>AASHTO M315</td>
<td>ASTM C443</td>
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<tr>
<td><strong>Silt Tight</strong></td>
<td>Mastic filler</td>
<td>AASHTO M198</td>
<td>ASTM C990</td>
<td>Material Certification &amp; 3 psi joint test</td>
<td>Dimensional Checks &amp; Joint Test AASHTO M315 (3 psi test in deflected position in lieu of 10 psi)</td>
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<tr>
<td></td>
<td>External Sealing Bands</td>
<td>-</td>
<td>ASTM C877</td>
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<tr>
<td></td>
<td>Rubber Gasket</td>
<td>AASHTO M315</td>
<td>ASTM C443</td>
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<td><strong>Water Resistant</strong></td>
<td>Rubber Gasket</td>
<td>AASHTO M315</td>
<td>ASTM C443</td>
<td>Material Certification &amp; 13 psi joint test</td>
<td>Dimensional Checks &amp; Joint Test AASHTO M315 (13 psi test in straight alignment, and 10.8 psi in deflected position)</td>
</tr>
</tbody>
</table>

**Soil Tight** Conduit joint which will not allow the transmission of backfill or native soil through the joint with design flow conditions. Application: Culverts and storm sewers above water table, open channel flow

**Silt Tight** Conduit joint which will not allow the transmission of course or fine grain backfill or native soil through the joint with design flow conditions in the presence of external ground water or low internal head conditions. Application: Culverts and storm sewers presence of water table at or near top of pipe and fine grain insitu soil.

**Water Resistant** Conduit joint which will not allow the transmission of water in excess of a defined measurable rate through the joint with design flow conditions with or without the presence of external ground water or low internal head conditions. Must also meet/exceed “Soil and Silt Tight Joints Application: Storm sewers with presence of water table over top of pipe and fine grain insitu soil, possible low head flow conditions.

[www.concrete-pipe.org](http://www.concrete-pipe.org)
A Complete Pipe Standard

Pipe Barrel Standard (round, elliptical, arch, box)

+ Pipe Joint Standard (gasket, mastic, exterior wrap)

Total Concrete Pipe Product
ASTM Concrete Pipe Joint Standards 2010

- ASTM C 361 08
  - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
- ASTM C 443 05
  - Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets
- ASTM C 1628 06
- ASTM C 1677 09
  - Standard Specification for Joints for Concrete Box, Using Rubber Gaskets
- ASTM C 1619 05
  - Standard Specification for Elastomeric Seals for Joining Concrete Structures
- ASTM C 505 05a
  - Standard Specification for Irrigation Pipe with Rubber Gasket Joints
ASTM Concrete Pipe Joint Standards 2010

- **ASTM C 877 08**
  - Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections

- **ASTM C 990 09**
  - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants

- **ASTM C 1103 03**
  - Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

- **ASTM C 497 05**
  - Standard Test methods for Concrete Pipe, Manhole Sections, or Tile
ASTM Concrete Pipe Rubber Gasketed Joint Standards 2010

- **ASTM C 361 08**
  - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe

- **ASTM C 443 05**
  - Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets

- **ASTM C 1628 06**

- **ASTM C 1677 09**
  - Standard Specification for Joints for Concrete Box, Using Rubber Gaskets

- **ASTM C 1619 05**
  - Standard Specification for Elastomeric Seals for Joining Concrete Structures

- **ASTM C 505 05a**
  - Standard Specification for Irrigation Pipe with Rubber Gasket Joints
ASTM C 361

Standard Specification for Reinforced Concrete Low-Head Pressure Pipe (1955)
C361 Key Points

- **Complete pipe standard**, 6 Sack Mix (564 Lbs)
- Steel End Ring and Concrete Joints
- Gasket Deformation Limits (50%/15%) - Deformation Calculations w/Full Tolerances Applied
- Hydrostatic Test to 120% of Design Pressure for 20 minutes (design 25’ -125’) Off-Center (Concrete to Concrete Contact or 150 lbs/inch) Hydrostatic Test Required
- Alternate Designs & Gaskets Allowed (Par. 8.5)
- 100% of Gsk. To Be Contained In Groove
C361 Key Points
ASTM C 443

Gasketed Joint Material Standards

Gasketed Joint Material Standards

C443 Key Points

- Gasket Deformation Limits (25%) Centered Position
- Bell taper 3.5°, up to 5° if proven by testing
- Reduced Gasket Tensile Properties from C361
- Alternate Designs Allowed (Par. 7.2)
- When Required by Owner, Hydrostatic Test to 13 psi Straight & 10 psi Deflected ½ “ all in the Centered Position
ASTM C 1628

Designation: C 1628

1. Scope
1.1 This specification covers flexible leak resistant joints for concrete gravity flow sewer pipe using rubber gaskets for sealing the joints, where measurable or defined infiltration or exfiltration is a factor of the design. The specification covers the design of joints and the requirements for rubber gaskets to be used therewith, for pipe conforming in all other respects to Specifications C14, C76, C655, C985, and C1417, provided that, if there is conflict in permissible variations in dimension, the requirements of this specification shall govern for joints.
C1628 Key Points
C1628 Key Points

- Rubber gasketed—include rational design parameters for o-ring & profile & alternate concepts
- Include plant proof of design C443 hydrostatic test criteria, “deflected and off-centered” (concrete to concrete contact or 150 lbs/inch)
- Include plant proof of design joint shear test criteria (4000#/ft. dia.)
- Include design and testing submittal examples to insure uniformity
- Include manufacturing QC/QA criteria to insure the joint submitted is the joint shipped
ASTM C 1677

Gasketed box section joints are a reality in many areas
C1677 Key Points

- Gasket deformation limits (25%) centered position including manufacturing tolerances in calculations, not less that 15% in off-centered position

- Gasket properties similar to C443

- Alternate designs allowed (Par 6 2)

- Hydrostatic proof of design test to 5 psi straight & 3 psi deflected for 10 minutes
ASTM C 1619

C1619 Key Points

- All ASTM C13 joint standards using gaskets to refer to this standard for gasket properties
- Gasket properties are defined in five classifications A-E
- Gasket markings to meet this standard

<table>
<thead>
<tr>
<th>TABLE 1 Physical Property Requirements for Elastomeric Seals</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>Tensile, min, psi (MPa)</td>
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<tr>
<td>Elongation at break, min, %</td>
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<tr>
<td>Specified Hardness, Shore A</td>
</tr>
<tr>
<td>Oven-Age Tensile reduction, max % of original</td>
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<tr>
<td>Oven-Age Elongation reduction, max % of original</td>
</tr>
<tr>
<td>Oven-Age hardness increase, max</td>
</tr>
<tr>
<td>Compression Set, max %</td>
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<tr>
<td>Water Absorption, max % weight increase</td>
</tr>
<tr>
<td>Ozone Resistance level, 50 ppm</td>
</tr>
<tr>
<td>Liquid Immersion IPM 903 Oil. Max % volume change</td>
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<tr>
<td>Splice Strength Classification</td>
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<td>DESCRIPTION</td>
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<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td>Low-Head</td>
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<tr>
<td>Measurable infiltration &amp; exfiltration</td>
</tr>
<tr>
<td>Water resistant, no visible leakage</td>
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<tr>
<td>Soil resistant</td>
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INNOVATION:
Independent Concrete Pipe Companies' first self-unloading truck

THE END