

Section 4149. Sanitary and Storm Sewer Pipe and Structures Materials

4149.01 DESCRIPTION.

- A.** Materials for constructing sanitary and storm sewer.
- B.** Materials for constructing sanitary and storm sewer structures.

4149.02 SANITARY SEWER PIPE.

A. Sanitary Sewer (Gravity Mains).

- 1. Solid Wall Polyvinyl Chloride Pipe 8 inch to 15 inch (200 mm to 375 mm).**
 - a.** Comply with ASTM D 3034, SDR 26, unless SDR 35 is specified.
 - b.** Pipe Stiffness per ASTM D 2412.
 - 1)** SDR 26: Minimum pipe stiffness of 115 psi (795 kPa).
 - 2)** SDR 35: Minimum pipe stiffness of 46 psi (320 kPa).
 - c.** PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
 - d.** Integral bell and spigot type with elastomeric seals complying with ASTM D 3212 and ASTM F 477.
- 2. Solid Wall Polyvinyl Chloride Pipe 18 inch to 27 inch (450 mm to 675 mm).**
 - a.** Comply with ASTM F 679.
 - b.** Minimum pipe stiffness of 46 psi (320 kPa) as per ASTM D 2412.
 - c.** PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
 - d.** Integral bell and spigot type with elastomeric seals complying with ASTM D 3212 and ASTM F 477.
- 3. Corrugated Polyvinyl Chloride Pipe 8 inch to 36 inch (200 mm to 900 mm).**
 - a.** Comply with ASTM F 949, smooth interior, corrugated exterior.
 - b.** Pipe stiffness per ASTM D 2412.
 - 1)** 8 inch to 10 inch (200 mm to 250 mm): Minimum pipe stiffness of 115 psi (795 kPa), unless 46 psi (320 kPa) is specified.
 - 2)** 12 inch to 36 inch (300 mm to 900 mm): Minimum pipe stiffness of 46 psi (320 kPa).
 - c.** PVC resin meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
 - d.** Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

- 4. Closed Profile Polyvinyl Chloride Pipe 21 inch to 36 inch (525 mm to 960 mm).**
 - a. Comply with ASTM F 1803.
 - b. Pipe stiffness per ASTM D 2412, 46 psi (320 kPa).
 - c. PVC plastic meeting ASTM D 1784, Cell Classification 12364. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
 - d. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.
- 5. Polyvinyl Chloride Composite Pipe (truss type) 8 inch to 15 inch (200 mm to 375 mm).**
 - a. Comply with ASTM D 2680. Pipe constructed with truss type structure between inner and outer PVC walls with voids filled with lightweight concrete.
 - b. Pipe stiffness per ASTM D 2412, 200 psi (1380 kPa).
 - c. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
 - d. Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and F 477.
- 6. Reinforced Concrete Pipe 18 inch to 144 inch (450 mm to 3650 mm).**
 - a. General.**
 - 1) Comply with ASTM C 76/C 76M (AASHTO M 170/M 170M).
 - 2) Minimum Class IV (3000 D), Wall B.
 - 3) Tongue and groove joints.
 - 4) Rubber O-ring flexible joint complying with ASTM C 443/C 443M (AASHTO M 315/M 315M).
 - b. Pipe Lining.**
 - 1) Coat interior pipe barrel and all joint surfaces with two-component coal-tar epoxy-polyamide black paint or approved equal.
 - 2) Lining Material: SSPC Specification No. 16, Table 1.
 - a) Minimum epoxy resin content 34% to 35% by dry film weight.
 - b) Minimum sag resistance 40 mils (1 mm).
 - c) Minimum solids 80% by volume.
 - 3) Apply according to the lining material manufacturer's recommendations.
- 7. Ductile Iron Pipe (DIP) 8 inch to 54 inch (200 mm to 1350 mm).**
 - a. General.**
 - 1) Comply with AWWA C151.
 - 2) Minimum thickness Class 52.
 - b. Interior Linings.**
 - 1) Provide interior lining for ductile iron pipe and fittings used for all gravity sewers and drop connections.

- 2) Use linings specifically designed for sanitary sewer applications, which may include calcium aluminate, polyethylene, ceramic epoxy, and coal tar epoxy. Other lining types may be allowed upon approval of the Engineer.
 - 3) Apply lining to interior of unlined ductile iron pipe and fittings according to the published specifications from the manufacturer.
 - 4) Seal all cut ends and repair field damaged areas according to the manufacturer's recommendations.
 - c. **Exterior Coating.**
Asphalt.
 - d. **Joints.**
Push-on complying with AWWA C111.
 - e. **Fittings.**
Mechanical complying with AWWA C110 or AWWA C153.
 - f. **Polyethylene Encasement.**
 - 1) Comply with AWWA C105.
 - 2) Minimum thickness of 8 mils (200 µm).
 - 3) Use for all ductile iron pipe and fittings in buried service.
8. **Vitrified Clay Pipe 8 inch to 42 inch (200 mm to 1050 mm).**
- a. Pipe and fittings complying with ASTM C 700.
 - b. Compression joints complying with ASTM C 425 for plain end pipe or bell and spigot pipe.
 - c. Test according to ASTM C 301.

B. Sanitary Sewer Force Mains.

1. **Ductile Iron Pipe 4 inch to 54 inch (100 mm to 1350mm).**
Apply [Article 4149.02, A, 7](#). If joint restraints are specified, apply [Article 4150.02, C](#).
2. **Polyvinyl Chloride Pipe.**
Apply [Article 4150.02, A](#), for PVC pipe. Provide restrained joints when specified.
3. **Sewage Air Release Valve.**
 - a. **General.**
Consists of an elongated tapered or conical body with outward-slanting walls and a float to operate (open and close) under pressure without spillage. Use a float with a flexible connection to the seal plug assembly to prevent irregular air release and protect the connecting rod. Ensure the bottom of the valve is sloped or funnel-shaped to encourage the accumulated sewage and solids to drain from the valve. Preserve a volume of air at all times between the liquid sewage and the seal plug assembly.
 - b. **Materials.**
 - 1) **Body and Cover:** Stainless steel, fiberglass-reinforced nylon, or other corrosion-resistant materials.
 - 2) **Internal Metal Components:** Stainless steel.
 - 3) **Float:** Stainless Steel, ASTM A 240/A 240M, Type 304, or foamed polypropylene.

- 4) **Seal Plug Assembly:** Stainless steel, foamed polypropylene, EPDM rubber, and reinforced nylon.
 - c. **Tapping Saddle.**
Stainless steel or nylon.
 - d. **Pit.**
Construct according to the contract documents.
 - 4. **Tracer Wire.**
Apply [Article 4150.02, E, 2](#). Tracer wire will be required on all force mains.
 - 5. **Tracer Wire Station.**
 - a. Two internal terminals with shunt.
 - b. Five to six foot (1.5 to 1.8 meter) plastic post (color as specified by the Engineer).
 - c. Removable top cap with lock.
 - d. Decals indicating: "Sewer Force Main" or similar language.
- C. Casing Pipe.**
Apply [Article 2553.02, C](#), for casing pipe requirements.
- D. Sanitary Sewer Services.**
- 1. **Connection to Main.**
 - a. **PVC Main.**
 - 1) Preformed wye or tee service fitting with integral bell and spigot joints with elastomeric seals complying with ASTM D 3034 or ASTM F 949.
 - 2) Preformed saddle wye or saddle tee for service tap complying with ASTM D 3034 or ASTM F 949.
 - 3) PVC plastic meeting ASTM D 1784, Cell Classification 12454.
 - b. **PVC Composite Main.**
 - 1) Preformed wye or tee service fitting with integral bell and spigot joints with elastomeric seals complying with ASTM D 3212.
 - 2) Preformed saddle wye or saddle tee for service tap complying with ASTM D 2680.
 - c. **RCP Main.**
Preformed saddle wye or saddle tee service tap designed for use with RCP.
 - d. **VCP Main.**
 - 1) Precast VCP wye or tee service fitting complying with ASTM C 700 for pipe and ASTM C 425 for compression joints.
 - 2) Preformed saddle wye or saddle tee service tap designed for use with VCP.
 - e. **DIP Main.**
 - 1) Use DIP wye or tee fittings complying with AWWA C110 or AWWA C153.
 - 2) Preformed saddle wye or tee services tap designed for use with DIP. Cut the hole for the tap with equipment designed for that application.

2. Wye and Tee Pipe Stop.

All saddle wye or saddle tee fittings must provide an integrally molded pipe stop in the branch for positive protection against service pipe insertion beyond the inside of sewer main pipe wall.

3. Service Pipe.

Use products as required by local plumbing code or regulations, if applicable. Otherwise use the following:

a. PVC.

- 1) Comply with ASTM D 3034, minimum thickness SDR 23.5; minimum pipe stiffness of 153 psi (1055 kPa) as per ASTM D 2412.
- 2) PVC plastic meeting ASTM D 1784, Cell Classification 12454.
- 3) Integral bell and spigot type rubber gasket joint complying with ASTM D 3212.

b. DIP.

As specified for sanitary sewer force main, including polyethylene encasement.

4. Connection to Existing Service.

Apply [Article 4147.01, H](#).

E. Sanitary Sewer Service Relocations.

1. Apply the requirements of [Article 4149.02, D](#), for all materials used for sanitary service relocation.
2. Use the same nominal size as the existing service being relocated.

4149.03 STORM SEWER PIPE.

A. Reinforced Concrete Pipe.

1. Comply with ASTM C 76/C 76M.
2. Minimum Class 2000D (Class III, Wall B).
3. Tongue and groove joints with cold applied bituminous or rubber rope jointing materials, unless otherwise specified. If specified, use rubber O-ring or profile gasket complying with ASTM C 443/C 443M (AASHTO M 315/M 315M).
4. If specified, wrap exterior of each joint with engineering fabric.

B. Reinforced Concrete Arch Pipe.

1. Comply with ASTM C 506/C 506M.
2. Minimum Class 2000D (A-III).
3. Use tongue and groove joints with cold applied bituminous or rubber rope gasket jointing materials, unless specified otherwise.

4. If specified, wrap exterior of each joint with engineering fabric.

C. Polyvinyl Chloride Pipe.

Use pipe complying with the following:

1. Types of PVC pipes:
 - a. Corrugated exterior, smooth interior, ASTM F 949.
 - b. Solid wall, ASTM D 3034 or ASTM F 679.
 - c. Closed profile, ASTM F 1803.
 - d. Composite, ASTM D 2680.
2. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
3. Minimum pipe stiffness of 46 psi (320 kPa).
4. Integral bell and spigot joints with elastomeric seals according to ASTM D 3212 and ASTM F 477.

D. High Density Polyethylene Pipe.

Use pipe complying with the following:

1. AASHTO M 294, Type S corrugated exterior and smooth interior.
2. ASTM D 3350 minimum resin Cell Classification 335420 C.
3. Minimum pipe stiffness at 5% deflection complying with ASTM D 2412.
4. Integral bell and spigot joints with elastomeric seals complying with ASTM F 477.
5. Maximum 5% deflection of the average inside diameter by testing after installation according to [Article 2504.03, L, 5](#).

E. Jointing Material for Concrete Apron.

1. Bituminous Jointing Material.

Use a cold-applied mastic sewer joint sealing compound recommended by the manufacturer for the intended use and approved by the Engineer. Comply with AASHTO M 198.

2. Rubber Rope Gasket Jointing Material.

Comply with ASTM C 990/C 990M.

3. Rubber O-Ring or Profile Gasket.

Comply with ASTM C 443/C 443M (for RCP) or ASTM C 361/C 361M (for RCPP).

F. Bituminous Joint Primer.

Material intended for use in priming concrete joints. Comply with the requirements of ASTM D 41.

G. Engineering Fabric.

Apply [Article 4196.01](#).

H. Non-Shrink Grout.

Apply [Materials I.M. 491.13](#).

I. Casing Pipe.

Apply [Article 2553.02](#) for casing pipe requirements.

4149.04 SANITARY AND STORM SEWER STRUCTURES.

A. Concrete.

1. **Precast:** Comply with ASTM C 478/C 478M

2. **Cast-in-place:** Use Class C concrete. Apply [Section 2403](#).

B. Reinforcement.

Apply [Section 2404](#).

C. Non-shrink Grout.

Comply with [Materials I.M. 491.13](#).

D. Precast Riser Joints.

1. **Joint Ends.**

- a. Use tongue and groove ends.
- b. If cast-in-place base is used, provide bottom riser with square bottom edge.

2. **Joint Sealant.**

a. **Sanitary Sewers.**

- 1) **Rubber O-ring or Profile Gasket:** Flexible joint complying with ASTM C 443/C 443M.
- 2) **Bituminous Jointing Material:** Use a cold-applied mastic sewer joint sealing compound recommended by the manufacturer for the intended use and approved by the Engineer. Comply with AASHTO M 198.
- 3) **Butyl Sealant Wrap:** Comply with ASTM C 877/C 877M.

b. **Storm Sewers.**

All joint sealants used on sanitary sewers may also be used for storm sewers. The following may also be used.

- 1) **Rubber Rope Gasket Jointing Material:** Comply with ASTM C 990/C 990M.
- 2) **Engineering Fabric Wrap:** If specified in the contract documents, supply engineering fabric wrap complying with [Article 4196.01](#).

E. Manhole or Intake Top.

1. Capable of supporting HS-20 loading.
2. Use eccentric cone on sanitary sewer manholes unless otherwise specified or allowed.

F. Base.

1. **Sanitary Sewer Manhole.**
 - a. **Circular Manhole:** Integral base and lower riser section according to ASTM C 478/C 478M.
 - b. **All Other Manholes:** Use precast or cast-in-place concrete base.
2. **Storm Sewer Manhole.**
Use precast or cast-in-place concrete base.
3. **Intake.**
Use precast or cast-in-place concrete base.

G. Pipe Connections.

1. **Flexible Watertight Gasket.**
Comply with ASTM C 923/C 923M.
2. **Non-shrink Grout.**
Comply with [Materials I.M. 491.13](#).
3. **Waterstop.**
Provide elastomeric gasket that surrounds pipe and attaches with stainless steel bands and is designed to stop the movement of water along the interface between a pipe and a surrounding concrete collar.

H. Manhole or Intake Adjustment Rings (Grade Rings).

1. Use one of the following methods for grade adjustments of manhole or intake frame and cover assemblies:
 - a. Reinforced Concrete Adjustment Rings.
Comply with ASTM C 478/C 478M. Provide rings free from cracks, voids, and other defects.
 - b. High Density Polyethylene Adjustment Rings.
Comply with ASTM D 1248 for recycled plastic.
 - 1) Test and certify material properties by the methods in Table 4149.04-1:

Table 4149.04-1: Test Methods

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g/10 min.
Density	ASTM D 792	0.94 to 0.98 g/cm ³
Tensile Strength	ASTM D 638	2000 to 5000 psi (14 to 35 MPa)

- 2) Do not use polyethylene grade adjustment rings when they are exposed to HMA pavement.
 - 3) When used in a single configuration, provide tapered adjustment ring with thickness that varies from 1/2 inch to 3 inches (13 mm to 75 mm).
 - 4) Install adjustment rings on clean, flat surfaces according to the manufacturer's recommendations with the proper butyl rubber sealant/adhesive.
2. Ensure the inside diameter of the adjustment ring is not less than the inside diameter of the manhole frame or not less than the inside dimension of the intake grate opening.
 3. Construct manholes and intakes with the following adjustment ring stack heights:
 - a. Minimum: 4 inches (100 mm) for new manholes and intakes.
 - b. Maximum: 12 inches (300 mm) for new manholes and intakes; 16 inches (400 mm) for existing manholes and intakes.

I. Castings (Ring, Cover, Grate, and Extensions).

1. **Gray Cast Iron.**
Comply with AASHTO M 306.
2. **Load Capacity.**
Standard duty unless specified otherwise.
 - a. **Standard Duty:** Casting certified for 40,000 pound (18,150 kg) proof-load according to AASHTO M 306.
 - b. **Light Duty:** Casting certified according to requirements of AASHTO M 306 for a 16,000 pound (7260 kg) proof-load (HS-20). 40,000 pound (18,150 kg) proof-load is not required.
3. **Casting Types.**
 - a. **Manholes.**
Refer to the contract documents.
 - b. **Intakes.**
 - 1) Refer to the contract documents.
 - 2) Castings may include environmental symbols or messages, or both, such as "DUMP NO WASTE, DRAINS TO RIVER."
 - c. **Manhole Casting Extension Ring.**
 - 1) Match the dimensions of the existing ring and cover with an allowable diameter tolerance of -1/4 inch (6 mm) for the frame ridge and +1/4 inch (6 mm) for the cover recess.
 - 2) Provide extension ring with height as required to raise the top of the casting to make it level or no more than 1/4 inch (6 mm) below the finished pavement surface. Maximum ring height is 3 inches (75 mm).

J. Additional Materials for Sanitary Sewer Manholes.

1. Chimney Seal Infiltration Barrier.

a. External Rubber Chimney Seal.

1) Rubber Sleeve and Extension.

- a)** Corrugated; minimum thickness of 3/16 inches (5mm), according to ASTM C 923/C 923M.
- b)** Minimum allowable vertical expansion of at least 2 inches (50 mm).

2) Compression Bands.

- a)** One-piece band assembly to compress sleeve or extension against manhole and casting surfaces.
- b)** 16 gage ASTM A 240/A 240M, Type 304 stainless steel, minimum 1 inch (25 mm) width, minimum adjustment range of 4 inches (100 mm) more than the manhole outside diameter.
- c)** For standard two-piece castings, shape top band to lock sleeve to manhole frame's base flange. For three-piece adjustable castings, shape top band to lock sleeve to upper piece of adjustable frame.
- d)** Stainless steel fasteners complying with ASTM F 593 and ASTM F 594, Type 304.

b. Internal Rubber Chimney Seal.

1) Rubber Sleeve and Extension.

- a)** Double pleated, minimum thickness 3/16 inch (5 mm) thick, according to ASTM C 923/C 923M.
- b)** Minimum allowable vertical expansion of at least 2 inches (50 mm).
- c)** Integrally formed expansion band recess top and bottom with multiple sealing fins.

2) Expansion Bands.

- a)** One-piece band assembly to compress sleeve or extension against manhole and casting surfaces.
- b)** 16 gage ASTM A 240/A 240M, Type 304 stainless steel, minimum 1 3/4 inch (45 mm) width, minimum adjustment range of 2 inches (50 mm) more than the manhole inside diameter.
- c)** Stainless steel locking mechanism of studs and nuts complying with ASTM F 593 and ASTM F 594, Type 304.

c. Molded Shield.

1) Barrier Shield.

- a)** Medium Density polyethylene, according to ASTM D 1248.
- b)** Certified for 40,000 pound (18,150 kg) proof-load according to AASHTO M 306.
- c)** Diameter to match cone section and internal dimension of casting.

2) Sealant.

Butyl material according to AASHTO M 198.

2. Riser Section Coating.

- a. Exterior:** When exterior waterproof coating is specified, provide bituminous or coal tar coating.

- b. **Interior:** When interior manhole lining is specified, provide lining according to [Article 4149.02, A](#) (lined, reinforced concrete pipe).

K. Invert.

1. Cast-in-place Structure.

Provide cast-in-place invert with concrete meeting the requirements of [Section 2403](#).

2. Precast Base Section.

- a. For sanitary sewers, provide a precast invert, unless allowed otherwise by the Engineer. Apply [Article 2435.03, A](#).
- b. For storm sewers, provide a cast-in-place invert with concrete meeting the requirements of [Article 4149.04, A](#).

L. Steps.

- 1. Provide steps in all circular precast manholes unless specified otherwise in the contract documents.
- 2. Comply with ASTM C 478/C 478M.
- 3. Manufacture using polypropylene encased steel.
- 4. Uniformly space steps at 12 to 16 inches (300 to 400 mm).
- 5. Align with vertical side of eccentric top section.
- 6. Place first step no more than 36 inches (900 mm) from top of casting.

M. Precast Concrete Tee.

1. Tee and Eccentric Reducers.

Comply with ASTM C 478/C 478M.

2. Composite Tee.

Refer to the contract documents. May be substituted for pipe diameters less than 48 inches (1200 mm).

N. Anchor Bolts.

- 1. **Material:** Stainless steel or hot-dipped galvanized.
- 2. **Diameter:** Minimum 1/2 inch (13 mm) diameter.
- 3. **Length:** As required to pass through adjusting rings and into manhole or intake structure to embedment depth recommended by anchor manufacturer.

O. Excavation and Backfill Materials.

Apply [Section 2552](#) for bedding and backfill materials.