

SECTION 232—PIPE AND PIPE ARCHES

232.01—Description.

These specifications cover materials used for the conveyance of water, including drainage, storm water, sanitary systems, and waste water.

232.02—Detail Requirements.

The Contractor shall obtain and provide from his supplier a quality control plan, acceptable to the Department, for determination of conformance with the applicable requirements in the production of concrete and corrugated metal culvert and underdrain pipe. The field strutting method of elongation will not be permitted except with the written permission of the Engineer or unless indicated on the plans.

When pipe is furnished with a paved invert, storage after manufacture shall be with the paved invert down.

(a) Concrete Pipe:

1. **Concrete pipe for culverts and sewers** shall be circular or elliptical in cross section, either plain concrete or reinforced concrete, and of the modified tongue-and-groove design in sizes up to and including 18 inches in internal diameter and either standard or modified reinforced tongue-and-groove in sizes above 18 inches in internal diameter. Pipe shall conform to the specified AASHTO requirements, except that pipe having an internal diameter of 36 inches or less shall be manufactured without lift holes. Pipe larger than 36 inches in internal diameter may be manufactured with lift holes provided the holes are created by molding, forming, coring or other methods to be cylindrical or conical in shape and are sufficiently smooth to permit plugging with an elastomeric or other approved plug type.
 - a. **Plain concrete culvert pipe** shall be composed of hydraulic cement, water, and mineral aggregates conforming to b(3) and b(4) herein. Pipe shall conform to the following:

Min. Inside Diameter (in)	Min. Wall Thickness (in)	Groove Depth (in)	Crushing Strength (lb/lin ft)
12	1 3/4	1 3/4	1,800
15	2	1 3/4	2,125
18	2	1 3/4	2,400
21	2 3/4	2	2,700
24	3	2 1/4	3,000

Pipe shall also comply with the requirements of AASHTO M170 for manufacture, finish, marking, inspection, and rejection.

b. **Reinforced concrete culvert pipe:**

- (1) **Circular pipe** shall conform to the requirements of AASHTO M170, class as specified, or AASHTO M242. Circular pipe that does not have values listed in the AASHTO M170 design tables for diameter, wall thickness, compressive strength, and reinforcement shall be certified in accordance with the requirements of Section 105.02. Pipe conforming to the requirements of AASHTO M242 shall also be certified in accordance with Section 105.02.
 - (2) **Elliptical pipe** shall conform to the requirements of AASHTO M207, class as specified. Elliptical pipe that does not have values listed in the AASHTO M207 design tables for wall thickness, compressive strength, and reinforcement shall be certified in accordance with the requirements of Section 105.02.
 - (3) **Fine aggregate** shall conform to the requirements of Section 202 for quality except that the void content, grading, and uniformity shall be controlled as necessary to produce the specified level of strength and absorption.
 - (4) **Coarse aggregate** shall conform to the requirements of Section 203 for Grade A crushed stone or gravel.
 - (5) **Positioning of reinforcement** when two layers of wire or bar reinforcement are used shall be such that welded joints are at an angle of approximately 60 degrees to each other.
 - (6) **Strength tests** will be performed by the three-edge bearing method in accordance with the requirements of AASHTO T280 or by the testing of cores in accordance with the requirements of AASHTO T24. Hand cast pipe and end sections may be tested in accordance with the requirements of AASHTO T22 and T23.
 - (7) **Absorption tests** will be performed in accordance with the requirements of AASHTO T280 on specimens of broken pipe or cores.
2. **Concrete pipe for underdrains** shall conform to the requirements of AASHTO M86, Class I, and the perforation requirements of AASHTO M175, Type I, except that spalls shall be not more than 1

1/2 inches in diameter or 3/16 inch in depth and shall not adjoin. When used as combination underdrains, pipe shall not be perforated.

Porous concrete pipe for underdrains shall conform to the requirements of AASHTO M176, standard strength.

3. **Concrete pipe for water lines, water mains, and sanitary sewers:**

- a. **Concrete pressure pipe** (steel cylinder) shall conform to the requirements of AWWA C300, C301, or C303 for the size, minimum working pressure, protective coating, seal coat, and type of joint as specified.
- b. **Nonreinforced concrete sanitary sewer pipe** shall conform to the requirements of AASHTO M86 for the class specified.
- c. **Reinforced concrete water pipe** (noncylinder) shall conform to the requirements of AWWA C302 for size, minimum working pressure, seal coat, protective coating, and type of joint specified.
- d. **Reinforced concrete sanitary sewer pipe** shall conform to the requirements of AASHTO M170 for the class specified.

(b) **Cast Iron and Ductile Iron Pipe and Fittings:**

1. **Cast iron pipe** shall conform to the requirements of AASHTO M64 for the class specified except that the provisions of paragraph 16.1 will not apply.
2. **Ductile iron pipe** shall conform to the requirements of AWWA C151 for size, joint type, class, type of coating and lining as specified, and minimum working pressure if applicable. Flanged joints shall conform to the requirements of AWWA C115.
3. **Fittings** for cast iron and ductile iron pipe for water lines, water mains, and sanitary sewers shall conform to the requirements of AWWA C110 (ANSI A21.10) or AWWA C153 (ANSI A21.53) for size, joint type, pressure rating, and type of coating and lining as specified.
4. **Cement mortar linings** shall conform to the requirements of AWWA C104 (ANSI A21.4).

(c) **Steel Pipe:**

1. **Corrugated Steel Culvert Pipe and Pipe Arches** shall conform to AASHTO M36, except that helically formed pipe shall be tested in

accordance with the requirements of AASHTO T249 at the rate of one test per week per corrugation machine per work shift. Records of such test shall be maintained for a period of 24 months. When connecting bands or flared end sections are required, helically formed pipe shall have rerolled ends with a minimum of two annular corrugations. Aluminum zinc alloy coated sheet steel conforming to the requirements of AASHTO M289 and fabricated in accordance with the requirements of AASHTO M36 may be used. End sections shall be fabricated from materials conforming to the applicable requirements of AASHTO M218 for galvanized pipe, AASHTO M274 for aluminum-coated pipe, or AASHTO M289 for aluminum zinc alloy-coated pipe.

Pipe sections shall be joined with annular corrugated bands, hugger bands, or maxidimple bands conforming to the requirements of AASHTO M36 and shall be designed to form a leak resistant joint. Maxidimple bands shall have two rows of circumferential dimples spaced approximately 4 to 6 inches on center. Coupling band widths shall be at least 7 inches for pipe 12 through 30 inches in diameter and 10 1/2 inches for pipe 36 through 120 inches in diameter. Coupling bands shall be not more than 0.109 inch (12 gage) and not less than 0.052 inch (18 gage) in thickness and shall be equal to the pipe thickness or up to two numerical thicknesses lighter than the pipe thickness. (*Example:* For 12-gage pipe, coupling bands may be 12, 14, or 16 gage.) Where required by the plans, the vertical diameter of round flexible pipe shall be increased 5 percent in accordance with the standard drawings.

2. **Asphalt-coated corrugated steel culvert pipe and pipe arches** shall conform to the requirements of AASHTO M190 with the following modifications:
 - a. Steel to be coated shall be free from contaminants and shall be immersed in asphalt having a temperature of 400 ± 5 degrees F. When pipe is preheated to 300 degrees F, the temperature of the asphalt shall be at least 375 degrees F.

The duration of the first immersion of the steel in the hot asphalt shall be at least as follows:

Pipe Thickness (in)	Time (min)
0.052	2
0.064	2.5
0.079	3
0.109	5
0.138	6.5
0.168	8

- b. Steel shall be dipped a second time to give a total coating of at least 0.050 inch in thickness.
 - c. Coupling bands need not be coated unless required for water-tightness.
 - d. Samples for testing asphalt may be taken from the dipping vat prior to coating.
 - e. When a sheet thickness other than the minimum specified for a particular size of pipe or arch is to be coated, an embossed seal bearing the thickness of the steel shall be attached to each pipe or arch prior to dipping the pipe or arch in asphalt. The seal shall be secured through a drilled or punched hole, having a diameter of not more than 3/8 inch, approximately 1 inch from the end of the section of the pipe or arch. The seal shall remain attached to the pipe or arch for rapid identification of the thickness of the steel.
 - f. A mastic may be used in lieu of applying asphalt coating in the shop. Mastic shall conform to the requirements of, and be applied in accordance with the requirements of AASHTO M243.
3. **Corrugated steel pipe for underdrains** shall conform to the requirements of AASHTO M36.
4. **Black and galvanized steel pipe:**
- a. **Black steel pipe for bridge deck drains and drainage systems** shall conform to the requirements of ASTM A53, extra strong (Schedule 80), with a wall thickness of at least 0.337 inch except that the hydrostatic test will not be required.
 - b. **Galvanized steel pipe for handrails** shall conform to the requirements of ASTM A120 or A53 for standard or extra strong pipe as indicated except that the hydrostatic test will not be required.
 - c. **Black and galvanized steel pipe for miscellaneous items** shall conform to the requirements of ASTM A53 except that the hydrostatic test will be required only when the pipe is used as pressure pipe.
5. **Smooth wall pipe (Jacked or casing for general use):**
- a. **Steel encasement pipe** shall conform to the requirements of ASTM A139 with a minimum wall thickness of 0.500 inch or ASTM A53 Standard Weight Class, and shall have beveled

edges suitable for welding or be threaded. The hydrostatic test for such pipe shall be waived.

- b. **Pipe for jacking** shall be of sufficient strength, diameter and wall thickness to accomplish the specific task and shall be approved by the Engineer.

6. **Steel water pipe, flanges, and fittings:**

- a. **Steel pipe** shall conform to the requirements of AWWA C200 for the minimum design working pressure, wall thickness, and type of pipe ends as specified. The protective coating shall conform to the requirements of AWWA C203 for coal tar protective coating, and the lining shall conform to the requirements of AWWA C205 for cement mortar lining.
- b. **Flanges** shall conform to the requirements of AWWA C207 as specified for pressure rating and size.
- c. **Fittings** shall conform to the requirements of AWWA C208.

7. **Galvanized steel water pipe and fittings:**

- a. **Galvanized steel pipe** shall conform to the requirements of ASTM A53, Schedule 40 or 80, for the size; method of manufacture; type, plain or threaded; couplings; and class specified.
- b. **Fittings** shall be galvanized, malleable iron conforming to the requirements of ASTM A47. Threads shall conform to the requirements of ANSI B2.1.

- 8. **Concrete lined corrugated steel pipe** shall conform to the requirements of (c)1. herein. Prior to placement of the concrete lining, steel pipe shall be asphalt coated in accordance with the requirements of (c)2. herein. The concrete lining shall be at least 1/8 inch in thickness over the inside crest of corrugation. Concrete for the lining shall be composed of cement, sand, and water, mixed to produce a dense, homogeneous lining.

Pipe sections shall be connected using a hugger band with O-rings. After pipe is installed, the separation between pipe sections shall be filled with a cement grout. After finishing, the area shall be sprayed with a liquid membrane forming compound.

- (d) **Structural Plate Pipe, Pipe Arches, and Arches:** Pipe, pipe arches, and arches shall conform to the requirements of AASHTO M167. When asphalt coating is required, it shall be an asphalt mastic applied to the structure after assembly. The asphalt mastic shall conform to the require-

ments of, and be applied in accordance with the requirements of AASHTO M243.

Aluminum structural plate pipe, pipe arches, and arches shall conform to the requirements of AASHTO M219.

(e) **Aluminum Alloy Pipe:**

1. **Corrugated aluminum alloy culvert pipe and pipe arches** shall conform to the requirements of AASHTO M196.

When the plans specify that corrugated aluminum pipe is to be furnished with a paved invert, the pipe shall be asphalt coated in accordance with the requirements of AASHTO M190, Type B.

Aluminum pipe used for storm drains shall conform to the requirements of AASHTO M196 except that it shall be of smooth wall, spiral ribbed construction. Connecting bands for aluminum drainpipe shall conform to the corrugations or rib of the pipe to which it is connecting.

2. **Corrugated aluminum alloy pipe underdrains** shall conform to the requirements of AASHTO M196, Type III. When used as combination underdrains, pipe shall not be perforated.

- (f) **Vitrified Clay Pipe and Fittings:** Pipe and fittings shall conform to the requirements of AASHTO M65, extra strength, or, for sanitary sewer, may conform to the requirements of ASTM C700, extra strength. Joints for sanitary sewer shall conform to the requirements of ASTM C425. Plain and perforated clay pipe for drain fields shall conform to the requirements of ASTM C700, extra strength.

(g) **PVC Plastic Pipe:**

1. **PVC water and pressure sewer pipe** shall conform to the requirements of AWWA C-900, PC-150 for water facilities and ASTM D1785 for pressure sewers and shall have a pressure rating of at least 150 pounds per square inch.
2. **PVC gravity sewer pipe** shall conform to the requirements of ASTM D3034; SDR35, ASTM F794, Series 46 or ASTM F949.
3. **PVC storm drains** shall conform to the requirements of AASHTO M304 or ASTM F949.
4. **PVC underdrains** shall conform to the requirements of ASTM F758, Type PS 28 or ASTM F949.

- (h) **Glass Fiber Reinforced Epoxy Pipe and Fittings:** Pipe and fittings shall conform to the requirements of ASTM D2996, ASTM D2997, or AWWA C950 with a continuous rating of at least 150 pounds per square inch at 150 degrees F for pipe, fittings, and adhesive joints.
- (i) **ABS Pipe:**
1. **ABS semiround underdrain pipe with top shield** shall be at least 4 5/8 inches in diameter with drain holes 1/4 or 3/8 inch in diameter drilled at least 7/8 inch apart under the roof line. Pipe shall weigh at least 0.80 pounds per foot. When used as combination underdrains, pipe shall not be perforated.
 2. **ABS sewer pipe and fittings** shall conform to the requirements of ASTM D2680 for the type of joints specified and shall have a pressure rating of at least 150 pounds per square inch.
- (j) **PE Pipe:**
1. **PE corrugated underdrain pipe** shall conform to AASHTO M252. Pipe shall be supplied in individual lengths with no lengths shorter than 10 feet. Coil pipe will only be permitted in 4 inch or 6-inch diameters, provided it is machine installed. If the pipe starts to recoil during installation, the Contractor shall cease operations until an approved method of anchoring the pipe in the trench is approved. When used as combination underdrain or outlet pipe, the pipe shall be smooth wall, nonperforated.
 2. **PE corrugated culvert pipe** shall conform to the requirements of AASHTO M294. PE pipe used for storm drains and entrances shall conform to classification Type S. For all other applications, PE pipe shall be Type C.
 3. **PE pipe and fittings** shall conform to the requirements of AWWA C-901 for water mains and ASTM D2239, Grade P34, for sanitary sewers and shall have a pressure rating of at least 150 pounds per square inch.
- (k) **Copper Water Pipe or Tubing:** Pipe or tubing shall conform to the requirements of ASTM B88 and shall have the cast or wrought pattern. Fittings for concealed soft drawn pipe may be the flared mechanical type. Unions shall be the ground joint type.
- (l) **Polybutylene Pipe and Fittings:** Pipe and fittings shall conform to the requirements of AWWA C902 for water mains and ASTM F809 for sanitary sewers.