
Standard Specification for

Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches

AASHTO Designation: M 190-04



1. SCOPE

- 1.1. This specification covers bituminous-coated corrugated metal pipe and pipe arches intended to be used for the construction of metal culverts of the following types.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- M 36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
- M 196, Corrugated Aluminum Pipe for Sewers and Drains
- T 44, Solubility of Bituminous Materials
- T 47, Loss on Heating of Oil and Asphaltic Compounds
- T 49, Penetration of Bituminous Materials

2.2. *ASTM Standard:*

- A 849, Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
- A 862/A 862M, Application of Asphalt Coatings to Corrugated Steel Sewer and Drainage Pipe
- C 670, Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- D 1005, Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

3. DESCRIPTION

- 3.1. This specification covers four types of pipe as follows:

Type A—Fully Bituminous-Coated

Type B—Half Bituminous-Coated with Paved-Invert

Type C—Fully Bituminous-Coated and Paved-Invert

Type D—Fully Bituminous-Coated and 100 Percent Paved or Lined

- 3.2. Bituminous-coated corrugated metal culvert pipe and pipe arches shall conform to the requirements of M 36 or M 196, and in addition shall be coated with bituminous material as hereinafter described for the particular type specified.

- 3.2.1. *Type A*—The pipe shall be uniformly coated, inside and outside, to a minimum thickness of 1.3 mm measured on the crest of the corrugations, or in the case of Type 1A pipe, over the inner surface of the pipe. This coating is also used for Type 1A pipe.
- 3.2.2. *Type B*—The pipe shall be uniformly coated for approximately one-half of the circumference of the pipe (bottom of the pipe installed), inside and outside to a minimum thickness of 1.3 mm, and in addition, the bituminous material shall be applied in such a manner that one or more smooth pavements will be formed in the invert (inside bottom of the pipe when installed), filling the corrugations for at least 25 percent of the circumference of a pipe and 40 percent of the circumference of a pipe arch. The pavement shall have a minimum thickness of 3.2 mm above the crest of the corrugations, except where the upper edges intersect the corrugations.
- 3.2.3. *Type C*—The pipe shall be fully coated as required for Type A, and in addition, a smooth pavement shall be provided as required for Type B.
- 3.2.4. *Type D*—The pipe shall be fully coated as required for Type A and in addition, a smooth lining of asphalt shall be centrifugally spun inside the pipe. The lining shall have a minimum thickness of 3.2 mm above the crest of the corrugations.

4. BITUMINOUS MATERIAL

- 4.1. The bituminous material for coating shall be an asphalt having the following properties:

	Limit, percent
Solubility in trichloroethylene, not less than	99.0
Loss on heating to 163°C, not more than	1
Penetration of residue after heating compared with penetration of same sample before testing for loss on heating, not less than	85

- 4.2. *Shock Test*—The bitumen shall be considered acceptable if not more than one of the four test specimens shows a crack. If it is difficult to determine visually whether a specimen has cracked, the specimen should be removed from the test apparatus and subjected to a slight bending.
- 4.3. *Flow Tests*—The bitumen shall be considered acceptable if the flow does not exceed 6.4 mm on either of the two test specimens.

5. TANK CONTROL AND MAINTENANCE

- 5.1. *Tank Temperature*—The asphalt temperature in the tank shall be maintained between 200 and 210°C during the coating operation.
- 5.2. *Tank Cleanliness:*
- 5.2.1. The asphalt in the tank shall be kept free of contaminants such as dirt, drum paper, and asphalt drippings from the shop floor.
- 5.2.2. The asphalt tank shall be cleaned as necessary with a minimum frequency of once per year.

- 5.2.3. The foam that results from the inadvertent introduction of moisture to the tank shall be skimmed off or moved to the side of the tank before inserting or extracting the product.

6. PROCEDURE

- 6.1. *Coating Application*—Apply the asphalt coating by inserting the product into the bath twice; the first application results in a thin coating to achieve good adherence, and the second achieves the coating thickness required in Section 3.2.
- 6.1.1. Steel surfaces shall be free of dirt, grease, dust, and moisture before placement in the asphalt bath. The product shall be prepared immediately prior to the coating operation.
- 6.1.2. Rotate any large structures in the tank to ensure that all surfaces are coated.
- 6.1.3. The product must remain in the tank until it achieves a minimum temperature of 190°C. The specific time requirements will depend on factors unique to each operation and the product being coated. The time to reach the required temperature is dependent on the initial temperature of the product, the steel thickness, the size of the product, and the volume of the tank.

- 6.1.4. The following table contains minimum immersion times:

Steel Thickness, mm	Time, min
1.32	2 to 2.5
1.63	2.5 to 3
2.01	3.5 to 5
2.77	5 to 6
3.50	6.5 to 8
4.27	8 to 14

- 6.1.5. Cool the product to ambient temperature before application of the second coat.
- 6.1.6. Insert the product a second time to provide the minimum thickness of each surface.
- 6.2. *Paving:*
- 6.2.1. Pave the interior of the coated pipe by applying the hot asphalt from the tank to the interior surface of the pipe to provide a thickness over the crest of the corrugation as required by Section 3.2. Pump the hot asphalt to the pipe by appropriate mechanical means, not by transfer with buckets. The asphalt used for paving shall be at least 200°C to ensure good adhesion to the coated pipe. Pave the pipe as soon as possible after coating to avoid poor adhesion associated with the accumulation of dirt and other residue on the coating surface.
- 6.2.2. Place end dams of wood or heavy paper at the ends of the pipe to retain the asphalt in the pipe. Three or more applications are usually required for most operations.
- 6.3. *Smooth Lining:*
- 6.3.1. Line the interior of the pipe that has been coated by covering the corrugations with hot asphalt. Provide a thickness over the crest of the corrugations as required by Section 3.2.
- 6.3.2. Spray the hot asphalt, taken from the tank, while rotating the pipe on a powered rotary device to provide a uniform smooth lining.

- 6.4. *Storage and Handling:*
- 6.4.1. Store and handle the coated product properly to avoid bruising, scaling, or scuffing of the asphalt coating.
- 6.5. *Repair*— Repair damaged coatings with a cold-applied asphalt mastic material described in ASTM A 849. Repair coatings shall be of equal thickness to the previous coating as a minimum and shall have equal adherence.

7. POST TESTING OF APPLIED ASPHALT

- 7.1. All asphalt used by pipe fabricators/coaters shall be purchased to meet the requirements of Section 4.1. Post testing of applied asphalt coatings shall be in accordance with state DOT requirements and follow the procedures described in this specification. Samples of the bituminous coating shall be obtained by gathering strippings, sufficient to make a 0.283-kg sample, from the inside top of one or more lengths of pipe on or about to be delivered to the project. Care shall be taken in sampling to avoid contamination from sand or soapstone that may have been applied after dipping.
- 7.2. Testing of the asphalts shall be in accordance with the following standard methods of the American Association of State Highway and Transportation Officials:

Solubility in trichloroethylene	T 44
Loss on heating	T 47
Penetration of residue	T 49

- 7.3. Physical requirements of the coating.
- 7.3.1. *Shock Test*—The apparatus for making the test consists of a rigid metal anvil or base plate not less than 12.7 mm thick resting on a solid foundation; a 2000-gr hammer arranged to fall freely in suitable guides against a 1000-gr plunger sliding freely in a vertical sleeve; the lower end of the plunger being spherical in shape with a radius of 12.7 mm; means for raising the hammer and dropping it through a distance of 130 mm upon the head of the plunger.
- 7.3.1.1. Four test specimens shall be prepared in the form of disks 44.5 mm in diameter and 9.5 mm thick. Approximately 110 g of the bituminous sample shall be heated over a low flame until it becomes fluid and then poured into a brass mold or molds. Care must be exercised to melt the sample at the lowest possible temperature and to stir thoroughly until it is homogeneous and free from air bubbles. The test specimens may be molded separately or the material may be poured in one cylinder 44.5 mm in diameter and of such length that the four specimens may be cut from it with a wire cutter.
- Split brass molds, coated with a suitable release agent (Note 1) having an inside diameter of 44.5 mm, slightly tapered outside surfaces and held together by slip rings will be found suitable for molding the test specimens.
- 7.3.1.2. If disk molds are used to prepare the specimens, they shall be removed after the asphalt has cooled to room temperature. The four specimens, shall be cooled for a period of at least one hour in a bath of ice and salt brine at a temperature of -1°C . The specimens shall then be removed from the bath one at a time and quickly placed on the anvil of the test apparatus and centered under the plunger, the hammer tripped to fall through a height of 130 mm upon the head of the plunger. Not more

than 8 seconds shall elapse from the time each specimen is removed from the bath until the hammer strikes the plunger.

7.3.1.3. *Precision*—The shock test described in this method is defined as a determination that at least three of four separate specimens comprising a single test sample will exhibit no cracking to yield an acceptable result. Analysis of an inter-laboratory study (a blind study carried out by nine laboratories on four different materials with three replicates of each material) reveals a pass/fail ratio for tests on the same material ranging from 0.22 to 1.45, with an overall pass/fail ratio for all 108 samples (27 samples of each of 4 materials) of 0.54. Further in each of 11, out of the total of 36 cases, where three replicate samples of the same material were tested in the same laboratory, the same laboratory obtained passing results on one of the three replicate samples and failing results on the other two replicate samples or vice versa.

7.3.1.4. *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in the test method for measuring shock, no statement on bias is being made.

7.3.2. *Flow Tests*—The apparatus for making the test shall consist of corrugated brass plate approximately 0.8 mm thick, 203.2 mm long and 101.6 mm wide, with corrugations running lengthwise of the plate, and a metal support to hold the plate on a 45-degree angle with the horizontal. The corrugations shall have a crest to crest dimension of 15.9 mm and a depth of 4.8 mm. A line shall be scribed 150 mm from the lower edge.

7.3.2.1. Test specimens shall be in the form of cylinders 9.5 mm in diameter and 19.0 mm in length. Two specimens shall be used for each test. These shall be made by pouring the excess bituminous material from the specimens for the shock test into split brass molds coated with a suitable release agent (Note 1).

Note 1—Mixtures of glycerine and dextrin or talc, Dow-Corning Stop Cock Grease and castor oil—Versamid 900 (100:1 mixture by mass heated to 204°C–232°C and stirred until homogeneous, have proven suitable. Other release agents may be used provided results obtained are comparable to those obtained when using one of the above.

7.3.2.2. With the corrugated plate held at an angle of 45 degrees with the horizontal, lay each test specimen in a corrugation so that its lower end will rest exactly along the line scribed 150 mm from the bottom edge of the plate and place the test apparatus in an oven maintained at a temperature of $65 \pm 1^\circ\text{C}$. After four hours in the oven, remove the apparatus and specimens and allow to cool to room temperature. Measure the distance from the bottom of the corrugated plate to the lower edge of the test specimens. This distance subtracted from 150 mm determines the amount of flow.

7.3.2.3. *Precision:*

Single Operator Precision-Flow Test—The single operator coefficient of variation for a single test result (a test result in this method has been defined as the measurements on two separate specimens) has been found to be 65 percent (Note 2). Therefore, two properly conducted tests by the same operator (each consisting of measurements on two specimens from the same sample) should not differ by more than 184 percent (Note 2) of their average. The range (difference between the highest and lowest) of the two individual measurements comprising a test result should not exceed 260 percent (Note 3) of the average of the two.

Multi-Laboratory Precision-Flow Test—The multi-laboratory coefficient of variation of a single test result (a test result in this method has been defined as the measurements on two separate specimens) has been found to be 97 percent (Note 2). Therefore, results of two properly conducted tests in different laboratories on the same bituminous coating should not differ by more than 275 percent (Note 2) of their average.

Note 2—These numbers represent respectively the (1S percent) and (D2S percent) limits described in ASTM C 670.

Note 3—Calculated as described in the paragraph on precision of individual measurements averaged to obtain a test result in ASTM C 670.

Note 4—These precision statements are based on results of an interlaboratory test program using three replicates of each of four materials. Nine laboratories participated in the tests.

7.3.2.4. *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in the test method for measuring flow, no statement on bias is being made.

7.3.3. *Imperviousness Test*—A 25 percent solution of sulfuric acid, a 25 percent solution of sodium hydroxide, and a saturated solution of sodium chloride shall be held in separate valleys of the coated corrugations for a period of 48 hours during which time no loosening or separation of the bituminous material from the galvanizing shall have taken place. This test may be made on an uncut section of pipe provided provision is made to prevent excessive evaporation of the three test solutions.

7.3.3.1. *Precision and Bias*—No statement is made about either the precision or the bias of the imperviousness test since the result only states whether there is conformance to the criteria for success specified in the procedure.

8. INSPECTION

- 8.1. The purchaser or his representative shall have free access to the fabricating plant for inspection, and every facility shall be extended to him for this purpose. This inspection shall include an examination of the pipe for defects in the coating. Defects include bruising, cracking, disbanding, or other damage.
- 8.2. On a random basis samples may be taken for analysis and asphalt coating measurements for check purposes. These samples may be taken from post-coated pipe or from the dip tank during the dipping process. The thickness of the asphalt coating shall be measured in accordance with test ASTM D 1005.

9. REJECTION

- 9.1. Asphalt coatings failing to conform to the specific requirements of this specification, or that show poor workmanship in general or poor workmanship in limited areas that have not been repaired in accordance with Section 6.5. This requirement applies not only to the individual pipe, but to any shipment as a whole where a substantial number of pipe have defective coatings.

10. CERTIFICATION

- 10.1. Pipe fabricator/coater shall furnish certifications from the asphalt suppliers that the asphalt meets the requirements of Section 4 and that the asphalt for the supplied pipe has been applied in accordance with this specification and the appropriate tank control and maintenance has been performed in accordance with this specification.