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# **Standard Specification for Steel Sheet, Zinc-Coated (Galvanized), for Corrugated Steel Pipe**

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**AASHTO Designation: M 218-03 (2011)**



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## 1. SCOPE

- 1.1. This specification covers steel sheet used in the manufacture of corrugated steel pipe (CSP) for storm sewers, culverts, drains, and similar uses. The sheet is zinc-coated (galvanized) by the hot-dip process, and is produced in two coating weights, 610 g/m<sup>2</sup> and 1220 g/m<sup>2</sup>. Material for this use is furnished in coils, flat in cut lengths, and corrugated in cut lengths.

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## 2. REFERENCED DOCUMENTS

2.1. *AASHTO Standard:*

- T 65M/T 65, Mass [Weight] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

2.2. *ASTM Standards:*

- A754/A754M, Standard Test Method for Coating Weight (Mass) of Metallic Coatings on Steel by X-Ray Fluorescence
- A902, Standard Terminology Relating to Metallic Coated Steel Products
- A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- B6, Standard Specification for Zinc
- E29, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E376, Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods

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## 3. TERMINOLOGY

- 3.1. *Definitions*—For definitions of terms used in this standard, refer to ASTM A902. The following definitions are as stated in that standard.

- 3.1.1. *fabricator*—(1) the organization that produces the finished pipe, or (2) for structural plate pipe, the organization that processes flat sheets and other items needed for the field assembly of the finished products.

- 3.1.2. *manufacturer*—the organization that produces the metal sheet from which pipe is made.

- 3.1.3. *purchaser*—the person or agency that purchases the finished pipe.

**Note 1**—With regard to this specification for sheet for corrugated steel pipe, the fabricator may also be considered as the “purchaser” of the sheet, where that term is used in this specification.

Such interpretation would not restrict the purchaser of the finished pipe from enforcing any provisions of this specification.

## 4. ORDERING INFORMATION

- 4.1. All sheet, both flat and formed, covered by this specification shall be ordered only to the specified thicknesses listed in Table 4.
- 4.2. Unless otherwise specified in the purchase order, all material furnished to this specification shall be chemically treated.
- 4.3. Orders for material to this specification shall include the following information, as necessary, to adequately describe the desired product:
- 4.3.1. Name of material (galvanized steel sheet for CSP);
- 4.3.2. AASHTO designation and year of issue as M 218-\_\_\_;
- 4.3.3. Coating thickness (610 g/m<sup>2</sup> or 1220 g/m<sup>2</sup>). A coating weight of 610 g/m<sup>2</sup> will be supplied as a default if no coating weight is specified;
- 4.3.4. *Quantity and dimensions:*
- 4.3.4.1. *Cut Lengths*—show number of sheets; thickness; width; either flat or overall corrugated; length; pitch and depth of corrugations, if corrugated;
- 4.3.4.2. *Coiled Sheet*—show total mass; thickness; width; coil requirements (maximum outside diameter, acceptable inside diameter, and maximum mass of individual coils);
- 4.3.5. Certification, if required (Section 11.1); and
- 4.3.6. Special requirements.

**Note 2**—A typical ordering description is as follows: Galvanized steel sheet for CSP in accordance with M 218-\_\_\_, 610 g/m<sup>2</sup>, 45 000 kg, 2.77 by 700 mm by coil, 1500 mm max OD, 600 mm ID, 7000 kg max, certified.

## 5. CHEMICAL COMPOSITION

- 5.1. *Base Metal Analysis*—The base metal cast or product analyses shall conform to the chemical requirements of Table 1.

**Table 1**—Chemical Composition

	Cast Analysis	Product Analysis
Sulfur, max, %	0.05	0.06
Sum of carbon, manganese, phosphorus, silicon, and sulfur, max, %	0.70	0.74

- 5.2. *Coating Bath Composition (Zinc Coating)*—the coating bath metal shall contain not less than 99 percent zinc.



## 6. MECHANICAL PROPERTIES

6.1. The galvanized steel sheet shall conform to the mechanical requirements in Table 2.

**Table 2—Mechanical Requirements**  
(Properties of Flat Sheet Prior to Fabrication)<sup>a</sup>

Tensile strength, min, <sup>b</sup> MPa	310
Yield point, min, <sup>b</sup> MPa	230
Elongation in 50 mm, <sup>c</sup> min, %	20

<sup>a</sup> To determine conformance with this specification, round each value for tensile strength and for yield strength to the nearest 1 MPa and each value for elongation to the nearest 1 percent, both in accordance with the rounding method of ASTM E29.

<sup>b</sup> Yield point and tensile strength are based on thickness of the base metal. If tests are made after coating, determine the base metal thickness after stripping the coating from the ends of the specimen contacting the grips of the tension-testing machine prior to tensile testing.

<sup>c</sup> Elongation requirement does not apply to material tested after corrugating.

6.2. Two tension tests shall be made on random samples of finished material from each cast or heat. When the finished material from said cast or heat is less than 45 Mg, one test is sufficient. When material rolled from one cast or heat differs 1.25 mm or more in thickness, one tension test shall be made from both the thickest and thinnest material rolled regardless of the mass represented. The samples shall be prepared and tested in accordance with the method specified in ASTM A924/A924M.

## 7. COATING REQUIREMENTS

7.1. The mass of zinc coating shall conform to the requirements in Table 3. The mass of coating is the total amount on both surfaces of the sheet expressed in g/m<sup>2</sup> of sheet.

**Table 3—Coating Mass Requirements**

Coating Mass, Total Both Sides		Equivalent Coating Thickness, Total Both Sides <sup>a</sup>	
Triple Spot Average, Min, g/m <sup>2</sup>	Single Spot, Min, g/m <sup>2</sup>	Triple Spot Average, Min, μm	Single Spot, Min, μm
610	550	86	78
1220	1100	172	156

<sup>a</sup> Coating thicknesses are approximate, for information only. (See Section 9.5.1.) Conversion is based on the following relationship: 1 g/m<sup>2</sup> = 0.1415 μm.

7.2. Adhesion of the coating shall be such that no peeling or flaking occurs while the coated sheet is being corrugated and formed into pipe.

## 8. DIMENSIONS AND TOLERANCES

8.1. *Thickness*—Sheet thickness shall conform to dimensions prescribed in Table 4. The thickness of the sheet includes both the base steel and the zinc coating.

**Table 4—Coated Steel Sheet Thickness Requirements**

Specified Thickness, mm	Minimum Thickness, mm
1.02	0.91
1.32	1.17
1.63	1.45
2.01	1.83
2.77	2.57
3.51	3.28
4.27	4.04

Note: Thickness is measured not less than 10 mm from an edge. On corrugated sheet, thickness is measured on the tangents of corrugations. For 1220 g/m<sup>2</sup> coating, the specified thickness and the minimum thickness shall be increased by 0.076 mm to account for the greater thickness as compared with the 610 g/m<sup>2</sup>.

- 8.2. *Length*—Permissible variations in length of cut-length sheets, both flat and corrugated, shall be in accordance with ASTM A924/A924M.
- 8.3. *Flat Sheet*—Permissible variations in width and camber of flat materials shall be in accordance with ASTM A924/A924M. Flatness tolerances are shown in Table 5.

**Table 5—Flatness Tolerances (Cut Lengths Only)**

Specified Thickness, mm	Specified Width, mm	Flatness Tolerance (Maximum Deviation from a Horizontal Flat Surface), mm
1.63 and thicker	To 1500, incl	13
1.32 and thinner	To 900, incl	13
	Over 900 to 1500, incl	19

Note: This table also applies to sheets cut to length from coils by the fabricator when adequate flattening measures are performed.

- 8.4. *Corrugated Sheet:*
- 8.4.1. *Corrugations*—Corrugations shall form smooth continuous curves and tangents. The dimensions of the corrugations shall be in accordance with Table 6.

**Table 6—Corrugation Size**

Nominal Size, mm	Max Pitch, <sup>a</sup> mm	Min Depth, <sup>b</sup> mm	Radius of Curvature, mm	
			Nominal	Min
68 by 13	73	12	17	12
75 by 25	83	24	14	12
125 by 25	135	24	40	36

<sup>a</sup> Pitch is measured from crest to crest of corrugations, at 90 degrees to the direction of the corrugations.

<sup>b</sup> Depth is measured as the vertical distance from a straightedge resting on the corrugation crests to the bottom of the intervening valley.

- 8.4.2. *Covering Width and Lip Dimension*—Covering width of corrugated sheet shall be in accordance with Table 7. Covering width is the distance between the crests of the extreme corrugations. The lip dimension of corrugated sheet shall be in accordance with Table 8 and is measured along the radial curvature from the crest of the corrugation to the edge of the sheet. There is no established tolerance for overall width since the covering width and lip dimensions are the governing factors for the formed product.

**Table 7**—Covering Width Tolerance for Corrugated Sheet

Covering Width, mm	Tolerance Over and Under, mm
To 600, incl	6
Over 600 to 900, incl	10
Over 900 to 1200, incl	13

**Table 8**—Corrugated Sheet Lip Dimensions

Nominal Corrugation Size, mm	For Riveted Pipe Construction, <sup>a</sup> mm	For Spot-Welded Pipe Construction, Min, mm
68 by 13	19	11
75 by 25	22	13
125 by 25	22	13

<sup>a</sup> Tolerances, +5 mm, -0.

## 9. TESTING

- 9.1. The manufacturer shall make such tests and measurements as deemed necessary to ensure that the coated sheet produced complies with this specification.
- 9.2. The purchaser may make tests and measurements as determined to be necessary to confirm conformance with this specification.
- 9.3. *Chemical Analysis of Steel*—Cast analysis (by the manufacturer) and product analysis (by the purchaser) shall be in accordance with ASTM A924/A924M.
- 9.4. *Mechanical Testing*—Mechanical property tests shall be conducted on the sheet prior to corrugating or other fabrication, when possible, and shall be in accordance with ASTM A924/A924M. If tests are made after corrugating, specimens shall be taken on the tangents of corrugations and used for determination of tensile and yield strengths only.
- 9.5. *Coating Mass:*
- 9.5.1. Sampling for coating mass determinations shall be in accordance with ASTM A924/A924M. The mass of coating shall be determined according to T 65M/T 65.
- 9.5.2. The mass may be converted from the sum of readings on both surfaces of the sheet by a magnetic thickness gauge suitably checked and demonstrated for accuracy (Note 3)  $1 \mu\text{m} = 7.1 \text{ g/m}^2$  each surface. When a magnetic thickness gauge is used and a dispute arises, the mass shall be determined by the stripping test in T 65M/T 65.
- 9.5.3. The mass of coating may be determined from the coating thickness measured by the x-ray fluorescence method, according to ASTM A754/A754M. When this method is used and a dispute arises, the mass shall be determined by the stripping test in T 65M/T 65.
- Note 3**—Several magnetic and electromagnetic types of coating thickness gauges are commercially available and are a satisfactory basis for acceptance when properly calibrated just prior to inspection use (see ASTM E376).



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## **10. REJECTION AND REHEARING**

- 10.1. Material tested by the purchaser and found not conforming to this specification may be rejected subject to the rejection and rehearing provisions of ASTM A924/A924M.

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## **11. CERTIFICATION**

- 11.1. When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser. The certification shall be in accordance with the provisions of ASTM A924/A924M and shall include reference to this product specification designation.
- 11.2. Test results, including chemical composition, mechanical properties, and mass of coating for each heat and coating lot, shall be maintained by the sheet manufacturer for 7 years and shall be made available to the fabricator and purchaser upon request.

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## **12. PRODUCT MARKING**

- 12.1. Each 0.5 to 1.5 m of sheet in coils or cut lengths shall be identified by showing the following:
- 12.1.1. Name of manufacturer;
  - 12.1.2. Brand name;
  - 12.1.3. Specified thickness;
  - 12.1.4. Specified coating mass;
  - 12.1.5. Identification symbols relating to a specific heat number and coating lot number; and
  - 12.1.6. AASHTO designation number.
- 12.2. The brand shall be removed, obliterated, or rebranded "Non-Specification" on each 0.5 to 1.5 m of sheet in a coating lot or heat in which control tests show, as prescribed herein, nonconformance to this specification.