Designation: A767/A767M – 19

Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement[1]

This standard is issued under the fixed designation A767/A767M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers steel reinforcing bars with protective zinc coatings applied by immersing the properly prepared reinforcing bars into a molten bath of zinc.

NOTE 1—The galvanizer is identified throughout this specification as the manufacturer.

1.2 Guidelines for construction practices at the job-site are presented in Appendix X1.

1.3 Guidelines for use of zinc-coated (galvanized) reinforcing bars with non-galvanized steel forms are presented in Appendix X2.

1.4 The text of this specification references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables) shall not be considered as requirements of the specification.

1.5 This specification is applicable for orders in either inch-pound units (as Specification A767) or SI units (as Specification A767M).

1.6 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents. Therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with this specification.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A90/A90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A706/A706M Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

A780/A780M Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

A996/A996M Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

B6 Specification for Zinc

B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section

E376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy Current (Electromagnetic) Testing Methods

2.2 *ACI Standard:*[3]

ACI 301 Specifications for Structural Concrete

2.3 *AWS Standard:*[4]

AWS D1.4/D1.4M Structural Welding Code—Reinforcing Steel

3. Terminology

3.1 *Definition of Term Specific to This Specification:*

3.1.1 *galvanizing, n*—the process of immersing (hot-dipping) steel in molten zinc for a sufficient time to allow a metallurgical reaction between iron from the steel surface and the molten zinc.

3.1.1.1 *Discussion*—The reaction between steel and molten

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Concrete Institute (ACI), 38800 Country Club Dr., Farmington Hills, MI 48331-3439, http://www.concrete.org.

[4] Available from American Welding Society (AWS), 8669 NW 36 St., #130, Miami, FL 33166-6672, http://www.aws.org.

***A Summary of Changes section appears at the end of this standard**

zinc forms zinc/iron alloy layers that bond the coating to the steel. The galvanizer may add trace amounts of certain elements (for example, aluminum, nickel, bismuth, or tin) to the zinc bath to help in the processing of certain reactive steels or to modify the appearance of the finished product. The elements are supplied to the molten coating bath, either as specified ingredients in the zinc spelter or by the addition of a master alloy containing the elements.

3.1.2 *lot, n*—all bars of one size furnished to the same steel reinforcing bar specification that have been coated within a single production shift.

4. Ordering Information

4.1 Orders for zinc-coated (galvanized) bars for concrete reinforcement under this specification shall include the following information:

4.1.1 Specification for reinforcing bars to be coated (ASTM designation and year of issue) (5.1),

4.1.2 Quantity of bars,

4.1.3 Size and grade of bars,

4.1.4 Class of coating (Class 1 or Class 2) (6.5),

4.1.5 Galvanizing before or after fabrication for Class 1 coating (7.3),

4.1.6 ASTM designation A767 [A767M] and year of issue.

4.2 The purchaser shall have the option to specify additional requirements, including but not limited to, the following:

4.2.1 Requirements for inspection (8.1),

4.2.2 Manufacturer certification (10.1), and

4.2.3 Other special requirements, if any.

5. Materials

5.1 Steel reinforcing bars to be zinc-coated (galvanized) shall conform to one of the following Specifications: A615, A706, or A996 [A615M, A706M, or A996M], as specified by the purchaser.

5.2 The zinc used for coating shall be any grade that conforms to Specification B6.

6. Zinc Coating Process

6.1 Reinforcing bars shall be prepared for galvanizing using any surface cleaning process that allows the zinc to bond with the steel, such that the galvanized bar coating appearance and continuity requirements in Section 7 of this specification are satisfied.

6.2 The reinforcing bars shall be coated by immersing the reinforcing bars into a molten bath of zinc until the zinc reacts with the steel surface to form zinc-iron inter-metallic alloys.

6.3 After solidification of the zinc coating, the coated reinforcing bars shall meet the minimum coating thickness or equivalent weight [mass] requirements in Table 1.

NOTE 2—Excess liquid zinc can be removed from freshly coated bars either by allowing liquid zinc to drain off the surface by gravity, or by subjecting the bars to an air or wiping process, where in the case of the latter method, care should be taken to maintain a uniformly thick coating around the perimeter of the bar.

NOTE 3—Class 2 coatings are preferred for fabrication after galvanizing. Coatings that exceed 4.3 mils [110 µm] zinc thickness are more prone to cracking when bent to the requirements of 7.4.

6.4 It shall be the responsibility of the galvanizer to maintain identity of the reinforcing bars throughout the galvanizing process and to the point of shipment.

6.5 *Class of Coating Thickness and Equivalent Weight [Mass]:*

6.5.1 This specification includes two classes of zinc coating thickness and corresponding equivalent weight [mass]. The equivalent weight [mass] of zinc coating on the bar shall conform to the requirements in Table 1.

6.6 *Coating Thickness Tests:*

6.6.1 Coating thickness tests shall be performed in accordance with one of the following test methods:

6.6.1.1 *Magnetic Thickness Gauge Measurements*—The thickness of the coating shall be determined by magnetic thickness gauge measurements in accordance with Practice E376. Use Table 1 to determine the equivalent weight [mass] of the coating. One or more of the following methods shall be permitted to be used to referee the results obtained by magnetic thickness gauge measurements.

6.6.1.2 *Stripping Method*—The weight [mass] shall be determined by stripping the coating from the steel reinforcing bar section in accordance with Test Method A90/A90M. This test method shall not be used for deformed reinforcing bars.

6.6.1.3 *Weighing Before and After Galvanizing*—The weight [mass] shall be determined by weighing steel reinforcing bars before and after galvanizing. The difference between the two measurements divided by the surface area of the bars provides the weight [mass]/unit area. The original weighing shall occur after pickling and drying. The second weighing shall occur after cooling to ambient temperature. This test method shall not be used for deformed reinforcing bars.

TABLE 1 Zinc Coating Thickness and Equivalent Weight [Mass]

NOTE 1—The key value in this table is micrometres (µm) and is based on a zinc density of 7140 kg/m^3. The other values are based on conventions using the following formulae: mils = µm × 0.03937; oz/ft^2 = µm × 0.0232; g/m^2 = µm × 7.14; and mg/cm^2 = µm × 0.714.

Classification	Zinc Thickness		Weight [Mass]/Unit Area	
	mils	µm	oz/ft^2	mg/cm^2
Class 1				
Bar Designation No. 3 [10]	5.1	129	3.0	92
Bar Designation No. 4 [13] and Larger	5.9	150	3.5	107
Class 2				
Bar Designation No. 3 [10] and Larger	3.4	86	2.0	62

NOTE 4—Due to variations in the surface areas of deformed bars as a function of deformation pattern and bar size, the methods in 6.6.1.2 and 6.6.1.3 to measure coating thickness are not appropriate for deformed bars. These are destructive tests appropriate for small samples of a minimum of 3 in.^{2} [2000 mm^2] of surface area. These tests do not include the weight [mass] of iron reacted with the zinc coating and may overestimate coating weight [mass] by up to 10 %.

6.6.1.4 *Microscopy*—The equivalent weight [mass] shall be determined by cross-sectional and optical measurement in accordance with Test Method B487. A cross-section sample of the steel shall be polished and examined with an optical microscope to determine the coating thickness. Measurements of thickness shall not be taken on points located on longitudinal ribs or transverse deformations. Use Table 1 to determine the equivalent weight [mass] of the coating.

6.6.2 *Number of Tests*—The following number of coated steel samples and measurements shall be made to determine coating thickness:

6.6.2.1 For determination of the coating weight [mass] using magnetic thickness gauge measurements, three random samples shall be tested from each lot. For each magnetic thickness gauge measurement sample, five or more measurements shall be made at various points throughout the sample so as to represent the entire surface of the sample. A total of at least fifteen measurements shall be averaged to obtain the coating thickness.

6.6.2.2 For determination of the coating thickness or equivalent weight [mass] using the stripping method and the weighing method, three random coated steel samples shall be tested from each lot.

6.6.2.3 For determination of the coating thickness or equivalent weight [mass] using the microscopy method, five random coated steel samples shall be tested per lot. Each sample shall be measured on four sides and the total of twenty measurements shall be averaged to obtain the coating thickness.

6.7 *Retests*—If the average zinc coating thickness or equivalent weight [mass] fails to meet the requirements of Table 1, six additional random samples from the lot shall be permitted to be tested. If the average zinc coating thickness or equivalent weight [mass] of the six samples conforms to the requirements of Table 1, the lot shall be accepted.

6.8 *Chromating*—The zinc coating shall be chromate treated unless waived by the purchaser.

NOTE 5—The purpose of chromate treatment is to preclude a reaction between the bars and fresh portland cement paste.

6.8.1 If the chromate treatment is performed immediately after zinc or zinc-alloy coating, it shall be accomplished either by quenching the coated steel reinforcing bars in a solution containing at least 0.2 weight [mass] % of pure sodium dichromate in water (such as 3 oz of each 10 gal [2 kg/m^3] of quench water) or by quench chromating in a minimum of 0.2 % chromic acid solution. The solution shall be at least 90°F [32°C]. The galvanized zinc or zinc-alloy coated reinforcing bars shall be immersed in the solution for at least 20 s.

6.8.2 Proprietary chromating solutions of equivalent strength shall be permitted in place of the generic chemical treatment specified in 6.8.1.

6.8.3 If the zinc or zinc-alloy coated reinforcing bars are at ambient temperature, the chromate treatment shall be the same as specified in 6.8.1 except that 0.5 to 1.0 % concentration of sulfuric acid shall be added as an activator of the chromate solution. In this case, there is no temperature requirement for the activated chromate solution.

7. Finish and Adherence of Coating

7.1 The zinc-coated bars shall have no uncoated areas. The coating shall be free of blisters, flux spots or inclusions, dross, and acid spots. Bars that adhere together after galvanizing shall be rejected. In addition, the presence of tears or sharp spikes which make the bar hazardous to handle shall be cause for rejection. A matte gray finish appearance shall not be itself a cause for rejection.

NOTE 6—Specific concentrations of elements such as silicon, carbon, and phosphorus in steel tend to accelerate the growth of the zinc-iron alloy layer so that the galvanized coating may have a matte finish with little or no free zinc outer layer. The mass, shape, and amount of cold working of the bar being galvanized may also affect this condition.

7.2 The coating shall be adherent so it cannot be removed by any reasonable process of handling.

7.3 *Class 1 Coatings—Fabrication:*

7.3.1 *Fabrication Before Galvanizing:*

7.3.1.1 Minimum finished bend diameters for reinforcing bars that are fabricated before galvanizing shall be equal to or greater than those specified in Table 2.

7.3.1.2 When reinforcing bars are fabricated to smaller finished bend diameters than those specified in Table 2, the bars shall be stress relieved at a temperature from 900 to 1050°F [480 to 560°C] for 1 h per in. [25 mm] of bar diameter.

7.3.2 *Fabrication After Galvanizing:*

7.3.2.1 When fabrication is performed after galvanizing, some cracking and flaking of the galvanized coating in the bend areas shall not be cause for rejection (Note 7).

7.3.2.2 Damaged coating due to fabrication shall be repaired and cut ends shall be coated in accordance with Section 9.

NOTE 7—The tendency for cracking of the zinc coating increases with bar diameter, severity and rate of bending, and coating thickness.

7.4 *Class 2 Coatings*—The zinc coating shall not peel or flake off in any bend test meeting the requirements of Specifications A615, A706, or A996 [A615M, A706M, or A996M]. Refer also to Note 3.

TABLE 2 Minimum Finished Bend Diameters

Bar Designation No.	Grade 40 [280]	Grade 50 [350]	Grades 60, 75, 80 [420, 520, 550]
3, 4, 5 [10, 13, 16]	6*d*[A]	6*d*	6*d*
6 [19]	6*d*	6*d*	6*d*
7, 8 [22, 25]	6*d*	8*d*	8*d*
9, 10 [29, 32]	...	...	8*d*
11 [36]	...	...	8*d*
14, 18 [43, 57]	...	...	10*d*

[A] *d* = nominal diameter of the bar.