



Standard Specification for Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement¹

This standard is issued under the fixed designation A1094/A1094M; 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.

1. Scope*

1.1 This specification covers steel reinforcing bars, with protective zinc or zinc-alloy coatings applied by the continuous hot-dip process.

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 continuous hot-dip 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 shall not be considered requirements of the specification.

1.5 This specification is applicable for orders in either inch-pound units (as Specification A1094) or SI units (as Specification A1094M).

1.6 The values stated in either inch-pound 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 specification does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this specification to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.05 on Steel Reinforcement.

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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](#)
- [B852 Specification for Continuous Galvanizing Grade \(CGG\) Zinc Alloys for Hot-Dip Galvanizing of Sheet Steel](#)
- [E376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current \(Electromagnetic\) Testing Methods](#)

3. Terminology

3.1 Definitions of Terms Specific to This Specification:

3.1.1 *black, adj*—denotes the condition of not galvanized. For purposes of this specification the word “black” does not refer to the color or condition of the surface, or to a surface deposit or contamination.

3.1.2 *continuous hot-dip galvanizing, n*—the process of uninterrupted passage of long lengths of steel products through a molten bath of zinc or zinc-alloy.

3.1.2.1 *Discussion*—To control alloy formation and promote adhesion of the zinc or zinc-alloy coating with the steel base

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.

metal, the molten coating metal composition normally contains a percentage of aluminum usually in the range from 0.05 to 0.25. This aluminum is purposely supplied to the molten coating bath, either as a specified ingredient in the zinc spelter or by the addition of a master alloy containing aluminum.

3.1.3 *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 continuous hot-dip galvanized steel bars for concrete reinforcement under this specification shall include the following information:

- 4.1.1 Specification for reinforcing bars, deformed or plain, 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, and
- 4.1.4 ASTM designation A1094 [A1094M] 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 If chromate treatment is waived (6.5),
- 4.2.2 Requirements for inspection (8.1),
- 4.2.3 Manufacturer certification and report of test results (10.1), and
- 4.2.4 Other special requirements, if any.

5. Materials

5.1 The steel reinforcing bars shall conform to one of the following specifications: A615, A706, or A996 [A615M, A706M, or A996M].

5.2 *Coating Bath Metal*—The bath metal used to produce continuous hot-dip galvanized steel bars for concrete reinforcement shall meet the requirements of Specifications B6 or B852.

6. Zinc Coating Process

6.1 The reinforcing bars shall be coated by passing individual bars through a zinc or zinc-alloy flooded trough or tube located above a zinc or zinc-alloy bath, then immediately through an air or steam wiping device to remove excess coating from the bars.

NOTE 2—During the wiping process, care should be taken to maintain a uniformly thick coating around the perimeter of the bar.

6.2 It shall be the responsibility of the manufacturer to maintain identity of the reinforcing bars throughout the coating process and to the point of shipment.

6.3 Thickness of Coating:

6.3.1 The average thickness of zinc or zinc-alloy coating for all specimens tested shall not be less than specified in Table 1.

6.4 Coating Thickness Tests:

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

6.4.1.1 *Magnetic Thickness Gauge Measurements*—The thickness of the coating shall be determined by magnetic thickness gauge measurements in accordance with Practice E376, or

TABLE 1 Minimum Average Coating Thickness Grade and Equivalent Weight [Mass]^A

Coating Grade	μm	mils	oz/ft ²	g/m ²	mg/cm ²
50	50	2.0	1.2	360	36

^A The value in micrometres (μm) is based on the Coating Grade. The other values are based on conventions using the following formulae: mils = μm × 0.03937; oz/ft² = μm × 0.0232; g/m² = μm × 7.14; and mg/cm² = μm × 0.714.

6.4.1.2 *Microscopy*—The thickness of the coating shall be determined by cross-sectional and optical measurement in accordance with Test Method B487. A cross-section sample of the coated 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 ribs or deformations, or

6.4.1.3 *Stripping Method*—The thickness of the coating shall be determined by stripping the coating from a reinforcing bar in accordance with Test Method A90/A90M. This test method shall not be used for deformed steel reinforcing bars.

NOTE 3—Due to variations in the surface areas of deformed bars as a function of deformation pattern and bar size, this method to measure coating thickness is not appropriate for deformed bars. This is a destructive test for small samples of plain bars with a minimum of 3 in.² [200 mm²] of surface area.

6.4.2 The referee method to be used shall be Test Method B487.

6.4.3 *Number of Tests*—For determination of the coating thickness using the magnetic method, 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. For the microscopy method, five 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. For the stripping method, three samples per lot shall be tested.

6.4.4 *Retests*—If the average zinc coating thickness fails to meet the requirements of Table 1, six additional random samples from the lot shall be tested. If the average zinc coating thickness of the six samples conforms to the requirements of Table 1, the lot shall be accepted.

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

NOTE 4—The purpose of chromate treatment is to preclude a reaction between the bars and fresh portland cement paste.

6.5.1 If the chromate treatment is performed immediately after zinc or zinc-alloy coating, it shall be accomplished by quenching the steel reinforcing bars in a solution containing at least 0.2 weight [mass] % of pure sodium dichromate in water (such as 3 oz/10 gal [2 kg/m³] 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 zinc or zinc-alloy coated reinforcing bars shall be immersed in the solution for at least 20 s.



NOTE 5—Proprietary chromating solutions of equivalent strength are permitted in place of the generic chemical treatment specified.

6.5.2 If the zinc or zinc-alloy coated reinforcing bars are at ambient temperature, the chromate treatment shall be the same as specified in 6.5.1 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 or black spots. In addition, the presence of tears or sharp spikes, which make the bar hazardous to handle, shall be cause for rejection.

7.2 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] and be adherent so it cannot be removed by any reasonable process of handling.

8. Inspection

8.1 Inspection of the zinc-coated (galvanized) reinforcing bars shall be agreed upon between the purchaser and the manufacturer as part of the purchase order or contract.

9. Permissible Amount of Damaged Coating and Repair of Damaged Coating

9.1 The maximum amount of repaired damaged coating shall not exceed 1 % of the total surface area in each 0.3-m

[1-ft] length of the bar. This limit on repaired damaged coating shall not include sheared or cut ends that are repaired with a zinc-rich formulation in accordance with Practice A780/A780M.

10. Certification

10.1 When specified in the purchase order or contract, the manufacturer shall furnish, at the time of shipment, a certification that the material was manufactured and tested in accordance with this specification. A report of the test results, shall be included with the certification.

10.2 A Material Test Report, Certificate of Inspection, or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI transmitted document shall meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the manufacturer. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

NOTE 6—The industry definition as invoked here is: EDI is the computer-to-computer exchange of business information in a standard format such as ANSI ASC X12.

11. Keywords

11.1 galvanizing; continuous hot-dip galvanized; steel reinforcing bars

APPENDIXES

(Nonmandatory Information)

X1. GUIDELINES FOR CONSTRUCTION PRACTICES AT THE JOB-SITE

X1.1 Specification A1094/A1094M is a product specification. Requirements for continuous hot-dip galvanized steel reinforcing bars from the point of shipment to the job-site and subsequent construction practices at the job-site are not delineated in this product specification.

X1.2 The project specifications should prescribe requirements for the continuous hot-dip galvanized steel reinforcing bars from the point of shipment to the job-site and subsequent construction practices at the job-site. The following guidelines are intended to serve as a resource for preparing requirements in project specifications:

X1.2.1 Coating damage incurred during shipment, storage, handling, and placing of continuous hot-dip galvanized reinforcing bars should be repaired with a zinc-rich formulation in accordance with Practice A780/A780M. Prior to repairing damaged coating, rust should be removed from the damaged areas by suitable means.

X1.2.2 When handling continuous hot-dip galvanized reinforcing bars, care should be exercised to avoid damaging the coating.

X1.2.3 Continuous hot-dip galvanized reinforcing bars should be off-loaded as close as possible to their points of placement or under the crane so that the bars can be hoisted to the area of placement to minimize rehandling.

X1.2.4 Continuous hot-dip galvanized reinforcing bars should be stored off the ground on protective cribbing, and timbers should be placed between bundles when stacking of the bundles is necessary. Space the cribbing sufficiently close to prevent sags in the bundles.

X1.2.5 Continuous hot-dip galvanized reinforcing bars and uncoated reinforcing bars should be stored separately.

X1.2.6 If the extent of damaged coating exceeds 2 % of the surface area of the continuous hot-dip galvanized reinforcing bar in any 1-ft [0.3-m] length, the coated bar should be rejected.

X1.2.7 If the extent of damaged coating does not exceed 2 % of the surface area in any 1-ft [0.3-m] length, all damaged coating discernible to a person with normal or corrected vision should be repaired with a zinc-rich formulation in accordance with Practice A780/A780M. The 2 % limit on maximum



allowed damaged coating should include previously repaired areas damaged before shipment as required by Specification A1094/A1094M.

X1.2.8 No uncoated steel reinforcement, or any other embedded metal dissimilar to zinc, should be permitted in the same structural concrete member with or in close proximity to continuous galvanized reinforcing bars, except as part of a cathodic-protection system. Continuous galvanized bars should not be electrically coupled to uncoated bars.

X1.2.9 Continuous hot-dip galvanized reinforcing bars should be supported on wire bar supports that are hot-dip galvanized, on wire bar supports coated with epoxy or another polymer, or on supports made of plastic. When precast concrete bar supports with embedded tie wires or dowels are used with coated bars, the wires or dowels should be coated with zinc or polymer. Reinforcing bars used as support bars should be hot-dip galvanized.

X1.2.10 Embedded steel items used with continuous hot-dip galvanized reinforcing bars should be zinc-coated (galvanized) or coated with non-metallic materials.

X1.2.11 Continuous hot-dip galvanized reinforcing bars should be fastened (tied) with tie wire coated with zinc or polymer.

X1.2.12 If continuous hot-dip galvanized reinforcing bars are cut in the field, the bar ends should be coated with a zinc-rich formulation in accordance with Practice **A780/A780M**.

X1.2.13 After installing mechanical splices on continuous hot-dip galvanized reinforcing bars, damaged coating and areas of removed coating should be repaired with a zinc-rich formulation in accordance with Practice **A780/A780M**. Exposed parts of mechanical splices should be coated with the same zinc-rich formulation that is used for the repair of damaged coating

X1.2.14 After completing welds on continuous hot-dip galvanized reinforcing bars, damaged coating should be repaired with a zinc-rich formulation in accordance with Practice **A780/A780M**. Welds should be coated with the same zinc-rich formulation that is used for the repair of damaged coating

X1.2.15 After field bending or straightening continuous hot-dip galvanized reinforcing bars, damaged coating should be repaired with a zinc-rich formulation in accordance with Practice **A780/A780M**.

X1.2.16 After placement of continuous hot-dip galvanized reinforcing bars; the coated bars should be inspected for damaged coating prior to placing concrete. Where damaged coating exists, it should be repaired with a zinc-rich formulation in accordance with Practice **A780/A780M**.

X2. GUIDELINES FOR USE OF CONTINUOUS HOT-DIP GALVANIZED REINFORCING BARS WITH NON-GALVANIZED STEEL FORMS

X2.1 Continuous hot-dip galvanized steel reinforcing bars contain a zinc or zinc-alloy coated surface that is of a different electrochemical potential than uncoated steel or stainless steel. When forms for casting concrete are made of uncoated steel or stainless steel, the use of continuous hot-dip galvanized steel reinforcing bars necessitates an electrical isolation of the continuous hot-dip galvanized steel reinforcing bars from the

forms. Should electrical contact between the two occur, the result will be a shadowing of a ghost appearance of the reinforcing bar on the finished concrete surface. Zinc ions will tend to migrate to the surface of the concrete and appear in a darker color, or shadow, on the concrete surface, in the shape of the reinforcing bar configuration. In more severe cases, the concrete can adhere to the metal forms.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A1094/A1094M – 15a) that may impact the use of this standard. (Approved April 1, 2016.)

(1) Revised Sections **4** and **8**.

Committee A01 has identified the location of selected changes to this standard since the last issue (A1094/A1094M – 15) that may impact the use of this standard. (Approved Nov. 1, 2015.)

(1) Revised **Table 1**.



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