



Designation: A911/A911M – 21

Standard Specification for Low-Relaxation Steel Bars for Prestressed Concrete Railroad Ties¹

This standard is issued under the fixed designation A911/A911M; 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 low-relaxation steel bars for use in prestressed concrete railroad ties.

1.2 This specification is applicable for orders in either inch-pounds units (as Specification A911) or in SI units (as Specification A911M).

1.3 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 the specification.

1.4 *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

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

E328 Test Methods for Stress Relaxation for Materials and Structures

2.2 *Federal Standard:*³

Fed. Std. No. 123 Marking for Shipments (Civil Agencies)

2.3 *Military Standards:*³

MIL-STD-129 Marking for Shipment and Storage

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 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 DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

3. Terminology

3.1 *Definition of Term Specific to This Specification:*

3.1.1 *lot, n*—all the coils of bars of the same nominal bar size contained on an individual shipping release or shipping order, from the same heat of steel.

4. Ordering Information

4.1 Orders for low-relaxation steel bars for prestressed concrete railroad ties under this specification shall contain the following information:

4.1.1 Quantity (weight) [mass],

4.1.2 Nominal diameter of bar (inches) [millimetres],

4.1.3 Core diameter and length of coils (15.1),

4.1.4 Packaging,

4.1.5 Supplementary Requirement S1 (if desired), and

4.1.6 ASTM designation (A911 [A911M]) 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 Prior relaxation tests of similarly-dimensioned bars (7.6.3),

4.2.2 Inspection and witnessing of testing (Section 12),

4.2.3 Load-elongation curves for each test (14.2),

4.2.4 Special packaging and marking (Section 15), and

4.2.5 Other special requirements, if any.

5. Manufacture

5.1 The bars shall be made from properly identified heats of steel made by the electric-furnace, the basic-oxygen, or other commercially accepted steelmaking process.

5.2 After hot-rolling, the bars shall be cold-drawn and finally stress-relieved by induction heat treatment to produce the desired mechanical properties and then coiled.

6. Chemical Requirements

6.1 An analysis of each heat of steel shall be made by the manufacturer from test samples taken during the pouring of each heat.

6.2 The analysis of the steel shall conform to the chemical requirements specified in Table 1.

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

**TABLE 1 Chemical Requirements**

Element	Composition, %
Carbon	0.70–0.90 ^A
Silicon	0.10–0.35
Manganese	0.50–0.90 ^B
Chromium, max	0.15
Phosphorus, max	0.030
Sulphur, max	0.035
Copper, max	0.30

^A Carbon in any one lot shall not vary more than 0.13 %.

^B Manganese in any one lot shall not vary more than 0.30 %.

TABLE 2 Mechanical Requirements

Yield strength, min	200 ksi [1375 MPa]
Tensile strength, min	228 ksi [1570 MPa]
Ratio of yield strength to tensile strength, max	0.95
Elongation after rupture in a gauge length of 4 in. [100 mm], min	6.0 %
Reduction of area, min	30.0 %

TABLE 3 Relaxation Requirements

f_{pi}/f_{pu} ^A	Max Stress Losses after 1000 h, %
0.50	1.0
0.60	1.0
0.70	2.5
0.80	5.0

^A f_{pi} = initial prestress load, and
 f_{pu} = specified minimum tensile strength.

7. Mechanical Property Requirements

7.1 *Test Method*—Tests shall be made in accordance with Test Methods and Definitions A370, including Annex A4, using full-size bar specimens taken from either end of the coil of the finished product.

7.2 *Tensile Strength*—The minimum tensile strength of the finished bar, as represented by test specimens, shall conform to the requirements prescribed in Table 2.

7.3 *Yield Strength*—Yield strength shall be measured at 1 % extension under load. The load at this extension is recorded as yield strength and shall meet the requirements of Table 2.

7.4 *Elongation*—The total elongation after rupture shall not be less than 6.0 % and shall be measured in a gauge length of 4 in. [100 mm].

7.5 *Wrapping Test*—Bars shall withstand being wound around a mandrel with a diameter of five times the bar diameter without cracking or other surface defects occurring on the outside of the bent portion. The bar shall be bent around the mandrel 1-1/2 turns beginning with a 90° bend.

7.6 *Low-Relaxation Test*—Bars shall be tested as prescribed in Test Methods E328.

7.6.1 Low-relaxation bars shall meet the mechanical property requirements of this specification, with the added requirements listed in Table 3.

7.6.2 Yield strength of low-relaxation bars, as described in 7.3, shall not be less than 90 % of the specified minimum tensile strength of the bar.

7.6.3 If required in the purchase order, relaxation evidence shall be provided from the manufacturer's records of tests on similarly dimensioned bars.

7.6.4 The test specimen shall not be subjected to loading prior to the relaxation test. The temperature of the test specimen shall be maintained at $68 \pm 3.5^\circ\text{F}$ [$20 \pm 2^\circ\text{C}$]. The test gauge length shall be at least 40 times the nominal diameter.

7.6.5 The initial load shall be applied uniformly over a period of not less than 3 minutes and not more than 5 minutes, and the gauge length shall be maintained constant; load-relaxation readings shall commence 1 minute after application of the total load.

7.6.6 Overstressing of the test specimen by application of loads beyond the limits stated in Table 3 during the loading operation shall not be permitted.

8. Dimensions and Permissible Variations

8.1 The size of the finished bar shall be expressed as the nominal diameter of the bar in decimals of an inch [millimetre]. The required initial diameters before cold-drawing, and the final diameters after cold-drawing shall be as follows:

Initial Diameter	Final Diameter
0.591 in. [15 mm]	0.370 in. [9.4 mm]
0.614 in. [15.6 mm]	0.394 in. [10 mm]
0.654 in. [16.6 mm]	0.413 in. [10.5 mm]

8.2 Permissible Variations in Diameter:

8.2.1 All bars shall conform to a size tolerance of ± 0.002 in. [± 0.05 mm] from the nominal diameter.

8.3 *Out-of-Round*—The difference between the largest and smallest diameter, measured at the same section, shall not be greater than 0.002 in. [0.05 mm].

9. Workmanship, Finish, and Appearance

9.1 Joints:

9.1.1 There shall be no welds or joints in the finished bar. Any welds or joints made during manufacture to promote continuity of operations shall be removed.

9.2 The finished bar shall be uniform in diameter in conformance with Section 8 and shall be free of imperfections not consistent with good commercial practice.

9.3 *Straightness*—After uncoiling, there shall be no residual out-of-line deformation greater than 0.4 in. [10 mm] in a length of 40 in. [1000 mm].

10. Sampling

10.1 Test specimens taken from either end of the coil are permitted.

11. Number of Tests

11.1 One test specimen each for the tensile test and the wrapping test shall be taken for each 10 coils or fraction thereof in a lot.

12. Inspection

12.1 Inspection of the low-relaxation steel bars shall be agreed upon between the purchaser and the manufacturer as part of the purchase order or contract.