Designation: ~~F1554 – 15ε2~~ F1554 – 15ε2

Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength[1]

This standard is issued under the fixed designation F1554; 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.

ε[1] NOTE—Editorial corrections were made to ~~Table 1,~~Table ~~Table 2,~~ 1, Table 2, and 6.7.1 in April 2016.
ε[2] NOTE—Editorial corrections were made to Table 2 in May 2017.

1. Scope*

1.1 This specification covers straight, bent, headed, and headless anchor bolts (also known as anchor rods) made of carbon, medium carbon boron, alloy, or high-strength low-alloy steel. It provides for anchor bolts in three strength grades, two thread classes, and in the diameters specified in Section 4. The specification also covers all-thread rod for use in anchoring to concrete. References to anchor bolts in this standard do not necessarily exclude all-thread rod.

1.2 Anchor bolts are intended for anchoring structural supports to concrete foundations. Such structural supports include building columns, column supports for highway signs, street lighting and traffic signals, steel bearing plates, and similar applications.

1.3 Supplementary requirements are included to provide for Grade 55 weldable steel, permanent manufacturers and grade identification, and impact properties for Grades 55 and 105.

1.4 Zinc coating requirements are in Section 7.

1.5 Suitable nuts and washers are listed in 6.7. Washers are detailed in 6.8.

1.6 This specification does not cover mechanical expansion anchors, powder-activated nails or studs, or anchor bolts fabricated from deformed bar.

1.7 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.8 *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]

A6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
A194/A194M Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A563 Specification for Carbon and Alloy Steel Nuts
A673/A673M Specification for Sampling Procedure for Impact Testing of Structural Steel
A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
F436 Specification for Hardened Steel Washers (Metric) F0436_F0436M
F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
F1789 Terminology for F16 Mechanical Fasteners

[1] This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets and Washers.

Current edition approved Sept. 1, 2015. Published November 2015. Originally approved in 1994. Last previous edition approved in 2007 as F1554 – 07a[ε1]. DOI: ~~10.1520/F1554-15E01.~~10.1520/F1554-15E02.

[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.

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

TABLE 1 Chemical Composition Requirements

Element	Grade 36		Grades 55 and 105
	Diameters up to ¾, incl	Over ⅞ to 4, incl	All Diameters
Carbon, max, %			
Heat	0.25	0.25	...
Product	0.28	0.28	...
Manganese, %			
Heat	...	0.60–0.90	...
Product	...	0.54–0.98	...
Phosphorus, max, %			
Heat	0.04	0.04	0.04
Product	0.05	0.05	0.048†
Sulfur, max, %			
Heat	0.05	0.05	0.05
Product	0.06	0.06	0.058†
Copper, min, % (when specified)			
Heat	0.20	0.20	0.20
Product	0.18	0.18	0.18

†Editorially corrected in April 2016.

F2329/F2329M Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

2.2 *American Institute of Steel Construction:*[3]

Design Guide 1: Base Plate and Anchor Rod Design

2.3 *ASME Standards:*[4]

B 1.1 Unified Inch Screw Threads (UN and UNR Thread Form)

B 1.3 Screw Thread Gaging Systems for Acceptability: Inch and Metric Screw Threads (UN, UNR, UNJ, M MJ)

B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

B 18.2.2 Square and Hex Nuts

B 18.18 Quality Assurance for Fasteners

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *anchor bolt*—steel fastener, typically made from bar stock or wire, and partially or fully threaded, one end of which is intended to be cast in concrete, while the opposite end projects from the concrete, for anchoring other material. The end cast in concrete may be either straight or provided with an uplift-resisting feature such as a bent hook, forged head, or a tapped or welded attachment.

3.1.2 *producer*—manufacturer of the steel bar stock or wire used for anchor bolts.

3.2 All other terms in this standard are used as defined in Terminology F1789.

4. Classification

4.1 Anchor bolts may be furnished in three grades (denoting minimum yield strength) and two classes (denoting thread class) as follows:

Grade	Tensile Strength, ksi (MPa)	Description Yield Strength, min, ksi (MPa)	Diameter Range, in.
36	58–80 (400–558)	36 (248)	½ –4
55	75–95 (517–655)	55 (380)	½ –4
105	125–150 (862–1034)	105 (724)	½ –3
Class			
1A		anchor bolts with Class 1A threads	
2A		anchor bolts with Class 2A threads	

[3] American Institute of Steel Construction, One East Wacker Drive, Suite 700, Chicago, IL 60601

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

TABLE 2 Axial Tensile Properties for Full-Size Tests of Anchor Bolts and Drawn Coupons[A]

Nominal Diameter, in.	Threads/ in.	Stress Area,[B] in.2	Anchor Bolt Grade					
			36		55		105	
			Tensile Strength, lbf	Yield, min, lbf	Tensile Load, lbf	Yield min, lbf	Tensile Load, lbf	Yield min, lbf
Unified Coarse Thread Series (UNC)								
~~1/2~~	~~13 UNC~~	~~0.1419~~	~~8,200–11,400~~	~~5,100~~	~~10,600–13,500~~	~~7,800~~	~~17,700–21,300~~	~~14,900~~
1/2	13 UNC	0.1419	8,200–11,400†	5,100	10,600–13,500	7,800	17,700–21,300	14,900
~~5/8~~	~~11 UNC~~	~~0.226~~	~~13,100–18,100~~	~~8,100~~	~~17,000–21,500~~	~~12,400~~	~~28,200–33,900~~	~~23,700~~
5/8	11 UNC	0.226	13,100–18,100†	8,100	17,000–21,500	12,400	28,200–33,900	23,700
~~3/4~~	~~10 UNC~~	~~0.334~~	~~19,400–26,700~~	~~12,000~~	~~25,000–31,700~~	~~18,400~~	~~41,800–50,100~~	~~35,100~~
3/4	10 UNC	0.334	19,400–26,700†	12,000	25,000–31,700	18,400	41,800–50,100	35,100
~~7/8~~	~~9 UNC~~	~~0.462~~	~~26,800–37,000~~	~~16,600~~	~~34,600–43,900~~	~~25,400~~	~~57,800–69,300~~	~~48,500~~
7/8	9 UNC	0.462	26,800–37,000†	16,600	34,600–43,900	25,400	57,800–69,300	48,500
~~1~~	~~8 UNC~~	~~0.606~~	~~35,200–48,500~~	~~21,800~~	~~45,400–57,600~~	~~33,300~~	~~75,800–90,900~~	~~63,600~~
1	8 UNC	0.606	35,200–48,500†	21,800	45,400–57,600	33,300	75,800–90,900	63,600
~~1 1/8~~	~~7 UNC~~	~~0.763~~	~~44,300–61,000~~	~~27,500~~	~~57,200–72,500~~	~~42,000~~	~~95,400–114,400~~	~~80,100~~
1 1/8	7 UNC	0.763	44,300–61,000†	27,500	57,200–72,500	42,000	95,400–114,400	80,100
1 1/4	7 UNC	0.969	56,200–77,500	34,900	72,700–92,100	53,300	121,000–145,000	102,000
1 1/2	6 UNC	1.405	81,500–112,400	50,600	105,000–133,000	77,300	176,000–216,000	148,000
1 3/4	5 UNC	1.90	110,000–152,000	68,400	142,000–180,000	104,500	238,000–285,000	200,000
2	4 1/2 UNC	2.50	145,000–200,000	90,000	188,000–238,000	138,000	312,000–375,000	262,000
2 1/4	4 1/2 UNC	3.25	188,000–260,000	117,000	244,000–309,000	179,000	406,000–488,000	341,000
2 1/2	4 UNC	4.00†	232,000–320,000	144,000	300,000–380,000	220,000	500,000–600,000	420,000
2 3/4	4 UNC	4.93	286,000–394,000	177,000	370,000–468,000	271,000	616,000–740,000	518,000
3	4 UNC	5.97	346,000–478,000	215,000	448,000–567,000	328,000	746,000–896,000	627,000
3 1/4	4 UNC	7.10	412,000–568,000	256,000	532,000–674,000	390,000	. . .	. . .
3 1/2	4 UNC	8.33	483,000–666,000	300,000	625,000–791,000	458,000	. . .	. . .
3 3/4	4 UNC	9.66	560,000–773,000	348,000	724,000–918,000	531,000	. . .	. . .
4	4 UNC	11.08	643,000–886,000	399,000	831,000–1,053,000	609,000	. . .	. . .
8 Thread Series (8 UN)								
1 1/8	8 UN	0.790	45,800–63,200	28,400	59,200–75,000	43,400	98,800–118,500	83,000
1 1/4	8 UN	1.000	58,000–80,000	36,000	75,000–95,000	55,000	125,000–150,000	105,000
1 1/2	8 UN	1.492	86,500–119,400	53,700	112,000–142,000	82,100	186,000–224,000	157,000
1 3/4	8 UN	2.08	121,000–166,000	74,900	156,000–198,000	114,000	260,000–312,000	218,000
2	8 UN	2.77	161,000–222,000	99,700	208,000–263,000	152,000	346,000–416,000	291,000
2 1/4	8 UN	3.56	206,000–285,000	128,000	267,000–338,000	196,000	445,000–534,000	374,000
2 1/2	8 UN	4.44	258,000–355,000	160,000	333,000–422,000	244,000	555,000–666,000	466,000
2 3/4	8 UN	5.43	315,000–434,000	195,000	407,000–516,000	299,000	679,000–815,000	570,000
3	8 UN	6.51	378,000–521,000	234,000	488,000–618,000	358,000	814,000–976,000	684,000
3 1/4	8 UN	7.69	446,000–615,000	277,000	577,000–731,000	423,000	. . .	. . .
3 1/2	8 UN	8.96	520,000–717,000	323,000	672,000–851,000	493,000	. . .	. . .
3 3/4	8 UN	10.34	600,000–827,000	372,000	776,000–982,000	569,000	. . .	. . .
4	8 UN	11.81	685,000–945,000	425,000	886,000–1,122,000	650,000	. . .	. . .

[A] Tensile properties calculated from the tensile requirements given in Table 3. Yield strength measured at 0.2% offset.
[B] Stress areas extracted from ASME B 1.1.
† Editorially corrected in April ~~2016.~~2016 and May 2017.

5. Ordering Information

5.1 Orders should include:
5.1.1 Quantity.
5.1.2 Product name.
5.1.3 ASTM designation and year of issue.
5.1.4 Grade and class.
5.1.5 Copper content, if copper bearing steel is required.
5.1.6 *Size and Dimensions*—Nominal diameter and thread pitch, bolt length, thread length, head type (if required) and hook angle and hook length (if required).
5.1.7 *Coatings*—If required, the coating process and the length to be coated as measured from the exposed end. See Section 7.
5.1.8 Number of nuts. See 6.7.
5.1.9 Number of washers, and washer dimensions and material, if applicable. See 6.8.
5.1.10 Source inspection requirements, if any. See Section 15.
5.1.11 Color coding, if different than Section 18.
5.1.12 Test reports, if required. See Section 17.
5.1.13 Supplementary requirements, if required.
5.1.14 Special packaging requirements, if required.

NOTE 1—An example of a typical order follows: 5000 pieces; anchor bolts; ASTM F1554-15 Grade 55; Class 2A; 1.0-8 tpi. diameter by 15-in. long, 3.0-in. thread length, 4.0-in. hook; zinc-coated by hot dipping 5.0 in. from exposed end; each with one zinc-coated nut and washer; test report required; Supplementary Requirement S1 required.

6. Materials and Manufacture

6.1 *Process*—Steel for anchor bolts shall be made by the open-hearth, basic-oxygen, or electric-furnace process.

6.2 *Threading*—Threads shall be rolled, cut, or ground at the option of the manufacturer, unless otherwise specified.

6.3 *Heat Treatment:*
6.3.1 Grade 105 bolts (or their raw material) shall be heat treated. Heat treatment may be performed prior to or after bending or threading.
6.3.2 When heat treatment is performed, anchor bolts (or their raw material) shall be quenched in a liquid medium from above the transformation temperature and then tempered by reheating to a temperature not less than 800°F for Grade 55 and 1100°F for Grade 105.

6.4 *Weldability*—Grade 36 anchor bolts are considered weldable. See Note 2. At the manufacturer's option, a weldable Grade 55 may be supplied when Grade 36 is specified. (Weldable steel for Grade 55 is provided for in Supplementary Requirement S1.) See 17.1.1.

6.5 *Bending:*
6.5.1 When required, bending may be performed by hot- or cold-bending, at the manufacturer's option. The bent portion shall be free from cracks when examined at 10× magnification after bending. Any bending shall not reduce the cross-sectional area below that required in 10.3.
6.5.2 Hot bending temperatures for non-heat-treated anchor bolts shall not exceed 1300°F. Anchor bolts shall be allowed to air cool after bending.
6.5.3 The maximum hot bending temperature for heat-treated anchor bolts shall be less than 700°F for Grade 55 and less than 1000°F for Grade 105. Anchor bolts shall be allowed to air cool after bending.

6.6 *Secondary Processing*—If a party other than the manufacturer or producer performs heat treatment, coating, welding, machining, or another process which affects the anchor bolt properties, that party shall inspect or test the anchor bolts for the affected properties.

6.7 *Nuts:*

6.7.1 Recommended nuts from Specification A563 for each grade and diameter of the anchor bolt are as follows:

Anchor Bolt Grade and Diameter, in.		Specification A563 Nut			
		Plain		Hot-Dip or Mechanical Zinc-coated in accordance with Section 7[A]	
Grade	Diameter, in.	Grade	Style	Grade	Style
36	½ –1½	A	Hex	A	Hex
	over 1½	A	Heavy Hex	A	Heavy Hex
55	½ –1½	A	Hex	A	Heavy Hex
	over 1½ –4	A	Heavy Hex	A	Heavy Hex
105	All	DH	Heavy Hex	DH	Heavy Hex

[A]See Note 3 and Section 7.

6.7.2 A listed nut may be substituted by a nut listed in Specifications A194/A194M or A563 having a proof load stress equal to or higher than the anchor bolt's specified minimum tensile strength.

6.7.3 Nuts for use with zinc-coated anchor bolts shall be zinc-coated by the same process as the bolts. See Section 7 and Note 3.

6.8 *Washers:*

6.8.1 Unless the washer material and dimensions are otherwise specified in the inquiry and the order, washers conforming to the requirements of Specification F436, Type 1 shall be furnished. (See Note 4.)

6.8.2 Unless otherwise specified, when zinc-coated anchor bolts are specified, the washers shall be zinc coated in accordance with 7.1.4.

NOTE 2—Many factors potentially affect steel weldability; this specification utilizes limits on carbon content for Grades 36 and 55 to help assure it. See Specification A6/A6M, Appendix X3 for more information. When anchor bolts are to be welded, welding procedures and techniques are of fundamental importance. Welding procedures suitable for the bolt's grade, chemistry, condition (that is, hot-rolled, cold-drawn, or heat-treated), and intended use or service should be utilized.

NOTE 3—Zinc-coated nuts of the grade and style recommended in 6.7, when overtapped with the diametral allowance for the thread series listed in Specification A563, will develop the bolt tensile strength required in Table 2 of this specification. However, coated nuts with 8 UN threads in sizes 1-¾ in. and larger, when overtapped, will not develop the tensile strength in Table 2 when the nut and associated bolt dimensions approach the minimum material limits of ASME B 1.1 and B 18.2.2, respectively.

NOTE 4—Washers used on anchor bolts or installed over base plate holes may require design consideration. (For guidance, refer to AISC Design Guide 1.)

7. Protective Coatings

7.1 *Zinc, Hot Dip or Mechanically Deposited:*

7.1.1 When zinc-coated anchor bolts are required, the purchaser shall specify the coating process, for example, hot dip, mechanically deposited, or no preference. When no preference is specified, the supplier may furnish bolts coated with either process. The supplier's option is limited to one process per item, with no mixed processes in a lot.

7.1.2 When hot-dip zinc coated anchor bolts are specified, the anchor bolts and nuts shall be zinc-coated in accordance with the requirements of Specification F2329/F2329M.

7.1.3 When mechanically deposited zinc coated anchor bolts are provided, the anchor bolts and nuts shall be zinc-coated in accordance with the requirements of Specification B695, Class 55.

7.1.4 Unless otherwise specified, when zinc-coated washers are required, the washers shall be hot-dip zinc-coated in accordance with Specification F2329/F2329M, or mechanically deposited zinc coated in accordance with Specification B695, Class 55. The coating process for the washers need not be the same as that for the anchor bolts and nuts.

7.2 *Other Coatings:*

7.2.1 When indicated on the inquiry and purchase order, coatings other than those in 7.1 shall be as agreed upon by the purchaser and supplier.

8. Chemical Composition

8.1 Anchor bolts shall conform to the chemical compositions listed in Table 1.

8.2 Grade 55 ordered as weldable shall conform to the requirements specified in Supplementary Requirement S1.

8.3 Anchor bolts made from low-carbon martensitic steel shall not be permitted.

8.4 The application of heats of steel to which bismuth, selenium, tellurium, or lead has been added intentionally shall not be permitted.

9. Mechanical Properties

9.1 Finished anchor bolts (or the bar stock from which they are made, when tested as permitted in 14.2.6) shall conform to the tensile properties listed in Table 2 for axial tests performed on full-size specimens and drawn coupons or in Table 3 for tests performed on machined specimens. See 14.2.

10. Anchor Bolt Dimensions

10.1 *Nominal Size*—The nominal anchor bolt diameter shall be the same as the nominal thread diameter.

10.2 *Body Diameter*—Finished anchor bolts' body diameters shall measure no less than the dimensions in Table 4.

10.3 *Bend Section*—The bend section of bent anchor bolts shall have a cross-sectional area not less than 90 % of the area of straight portions. The area in the bend shall be calculated by the following formula:

$$A_b = 0.25\pi D \cdot d$$

where:

A_b = cross-sectional area in the bend,
D = major diameter, at the same cross section as, and at 90 degrees to, the minor diameter, and
d = minor (or minimum) diameter at any point, generally in the plane of the bend.

10.4 *Length:*

10.4.1 The overall length of straight anchor bolts, or length to the inside of the hook if present, shall be the specified length ±½ in. for lengths 24 in. or less, and ±1 in. for longer bolts (see Fig. 1).

10.4.2 The length of hooks shall be the specified length, ±10 % of the specified hook length, or ±½ in., whichever is greater.

10.5 *Coated Length*—When only a portion of the anchor bolt is required to be coated, the coated length shall not be less than that specified on the order.

10.6 *Thread Length*—The thread length shall be the specified length, +1.0 in., –0.00 in.

10.7 *Bolt Heads*—At the manufacturer's option, headed bolts ordered under this specification shall be hex or heavy hex bolts conforming to ASME B18.2.1, unless otherwise specified.

10.8 *Bend Angle*—The bend angle of hooks shall be the specified angle, ±5°.

10.9 *Other Dimensions*—Unless otherwise specified, tolerances for dimensions other than those given in this section shall be in accordance with the manufacturer's practice.

11. Thread Dimensions

11.1 *Uncoated Anchor Bolts:*

11.1.1 Unless otherwise specified, threads on Class 1A and 2A anchor bolts shall conform to Class 1A and 2A, Unified Coarse Thread Series of ASME B 1.1, respectively. When an anchor bolt class is not specified, Class 2A shall be furnished.

11.1.2 For diameters above 1.0 in, a purchaser may specify threads conforming to Class 2A, 8 UN Thread Series of ASME B1.1.

11.2 *Zinc Coated Anchor Bolts:*

11.2.1 Unless otherwise specified, zinc-coated anchor bolts threads shall conform to Class 1A or 2A, Unified Coarse Thread Series of ASME B 1.1 before coating. For diameters 1.125 through 1.50 in, a purchaser may specify threads conforming to Class 2A, 8 UN Thread Series of ASME B1.1 before coating (see Note 3). After zinc coating, the pitch diameter and major diameters shall not exceed the dimensions listed in Table 5.

11.3 *Thread Gaging System*—Thread acceptability shall be in accordance with ASME B 1.3 System 21, unless otherwise specified.

TABLE 3 Tensile Properties for Bars and Machined Specimens

	Grade		
	36	55	105
Tensile strength, ksi	58–80	75–95	125–150
Yield strength, min, ksi (0.2 % offset)	36	55	105
Elongation in 8 in. , min, %[A]	20	18	12
Elongation in 2 in. min, %[A]	23	21	15
Reduction of Area, min, %	40	30	45

[A] Elongation in 8 in. applies to bars. Elongation in 2 in. applies to machined specimens.