



Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength¹

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1. Scope*

1.1 This specification covers straight and bent, headed and headless, carbon, carbon boron, alloy, or high-strength low-alloy steel anchor bolts (also known as anchor rods). The anchor bolts are furnished in three strength grades, two thread classes, and in the sizes specified in Section 4.

1.2 The 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 included in Section 7 for applications requiring corrosion protection.

1.5 The recommended grade and style of nut and washer are included in 6.6 and 6.7 for each grade.

1.6 This specification does not cover the requirements for 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.

2. Referenced Documents

2.1 ASTM Standards:²

A 194/A 194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 563 Specification for Carbons and Alloy Steel Nuts

A 673/A 673M Specification for Sampling Procedure for Impact Testing of Structural Steel

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

D 3951 Practice for Commercial Packaging

F 436 Specification for Hardened Steel Washers

F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

F 2329 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

2.2 *Research Council on Structural Connections Standard*:³

Specification for Structural Joints Using ASTM A325 or A490 Bolts

2.3 *ASME Standards*:⁴

B 1.1 Unified Screw Threads

B 1.3 Screw Thread Gaging Systems for Dimensional Acceptability

B 18.2.2 Square and Hex Nuts

B 18.18.2M Inspection and Quality Assurance for High Volume Machine Assembly Fasteners

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *anchor bolt*—steel rod or bar, one end of which is intended to be cast in concrete, while the opposite end is threaded and projects from the concrete, for anchoring other material to the concrete. The end cast in concrete may be either straight or provided with an anchor such as a bent hook, forged head, or a tapped or welded attachment to resist forces imposed on the anchor bolt, as required.

3.1.2 *manufacturer*—manufacturer of the anchor bolt; the party that performs the cutting, bending, and threading operations.

3.1.3 *producer*—manufacturer of the steel rods or bars.

3.1.4 *purchaser*—purchaser of the finished anchor bolt, or his designated agent.

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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 Research Council on Structural Connections, c/o Industrial Fasteners Institute, 1717 East 9th Street, Cleveland, OH 44114.

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

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

3.1.5 *responsible party*—see Section 18; this may be the manufacturer or supplier.

3.1.6 *supplier*—agent who furnishes the finished anchor bolt and nuts to the purchaser; this may be the manufacturer.

4. Classification

4.1 The anchor bolts are 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)	Size Range, in. (mm)
36 ^A	58–80 (400–558)	36 (248)	¼–4 (6.4–102)
55	75–95 (517–655)	55 (380)	¼–4 (6.4–102)
105	125–150 (862–1034)	105 (724)	¼–3 (6.4–76)
Class			
1A	anchor bolts with Class 1A threads		
2A	anchor bolts with Class 2A threads		

^A When Grade 36 is specified, a weldable Grade 55 may be furnished at the supplier's option.

4.2 Weldable steel for Grade 55 is provided for in Supplementary Requirement SI.

5. Ordering Information

5.1 Orders for anchor bolts should include the following information:

5.1.1 *Quantity (Number of Pieces)*—If the purchaser intends to perform destructive tests on finished anchor bolts, the manufacturer should be advised so that an adequate number are produced, especially for the sizes and types not readily available from stock.

5.1.2 Name of product (steel anchor bolt).

5.1.3 ASTM designation and year of issue.

5.1.4 Grade and class, that is, Grade 36, 55, or 105 and Class 1A or 2A. Weldable Grade 55 may be furnished when Grade 36 is ordered (see 4.1).

5.1.5 Copper, if copper bearing steel is required.

5.1.6 *Size and Dimensions*—Include the diameter and threads (based on nominal thread diameter), bolt length, thread length, and length of hook if a hook is required, or provide a drawing showing the required information.

5.1.7 Zinc coatings in accordance with 7.1. When zinc coatings in accordance with 7.1 are required, specify the zinc coating process to be used, that is, hot dip, mechanically deposited, or no preference (see 7.1). Also, specify the length to be coated as measured from the exposed end.

5.1.8 *Other Coatings*—Specify other protective coatings, if required (see 7.2).

5.1.9 Number of nuts, either the total number or number per bolt.

5.1.10 Number of washers, either the total number or number per bolt, and dimensions if other than standard.

5.1.11 Inspection at place of manufacture, if required (see 15.1).

5.1.12 Color coding, if different from the standard in 19.1.

5.1.13 Test reports, if required (see 17.1).

5.1.14 Supplementary requirements, if required.

5.1.15 Special requirements, if required.

NOTE 1—An example of a typical order follows: 5000 pieces; steel anchor bolts; ASTM designations including issue date; Grade 55; Class 2A; Supplementary Requirement S 1; 1.0-8-in. thread size 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.

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 When required, the anchor bolts may be heat treated to develop the specified properties. Heat treatment shall be at the option of the manufacturer.

6.3.2 Heat treatment may be performed prior to or after bending or threading.

6.3.3 When heat treatment is required, the anchor bolts shall be heat treated by quenching in a liquid medium from above the transformation temperature and then tempering by reheating to a temperature not less than 800°F (425°C) for Grade 55 and 1100°F (593°C) for Grade 105.

6.4 *Bending*:

6.4.1 When required, hooks, shall be made by cold bending or hot bending. The bent portion shall be free from cracks when examined at 10× magnification after bending.

6.4.2 Hot bending performed on bar stock without heat treatment shall not have the temperature exceed 1300°F (705°C) at any location during hot bending and shall be allowed to air cool after bending.

6.4.3 Hot bending performed on heat-treated bar stock shall not have the temperature come within 100°F (56°C) of the tempering (stress relieve) temperature of the heat-treat process at any location during hot bending and shall be allowed to air cool after bending.

6.4.4 The bending shall not reduce the cross-sectional area below that required in 10.3.

6.5 *Secondary Processing*—If a subcontractor, or party other than the manufacturer or producer, performs heat treatment, coating, welding, machining, or other process affecting the properties or performance of the anchor bolts, the anchor bolts shall be inspected and tested after such processing by the party responsible for supplying the anchor bolts to the purchaser.

6.6 *Recommended Nuts*:

6.6.1 Unless otherwise specified, all nuts used on these anchor bolts shall conform to the requirements of Specifications A 194/A 194M or A 563 and shall be of the grade, surface finish, and style for each grade and size of anchor bolt as follows:

Anchor Bolt Grade and Size, in. (mm)		Specification A 563 Recommended Nut			
		Plain	Hot-Dip or Mechanical Zinc Coated in accordance with 7.1		
Grade	Size, in. (mm)	Grade	Style	Grade	Style
36	¼ – 1½ (6.4–38) over 1½ – 4.0 (38–102)	A	Hex	A	Hex
		A	Heavy Hex	A	Hvy Hex
55	¼ – 1½ (6.4–38) over 1½ – 4.0 (38–102)	A	Hex	A	Hvy Hex
		A	Heavy Hex	A	Hvy Hex
105	¼ – 1½ (6.4–38) over 1½ – 3.0 (38–76)	D	Hex	DH	Hvy Hex
		DH	Heavy Hex	DH	Hvy Hex

6.6.2 The requirements for the recommended grade and style of nut may be fulfilled by furnishing a nut of one of the grades or styles listed in Specifications A 194/A 194M or A 563 having a proof load stress equal to or higher than the minimum tensile strength specified for the anchor bolt.

6.7 Recommended Washers:

6.7.1 The washer material and dimensions shall be specified in the inquiry and the order (see Note 2).

6.7.2 Unless the requirement of 6.7.1 is met, washers conforming to the requirements of Specification F 436, Type 1 shall be furnished.

6.7.3 When anchor bolts are specified to be zinc coated, the washers shall be zinc coated as specified in 7.1, except that the coating process for the washers need not be the same as that for the anchor bolts and nuts.

NOTE 2—Washers used on anchor bolts, installed in holes with dimensions greater than oversize or short slot as defined by the Research Council on Structural Connections, require design consideration. (For guidance refer to Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.)

7. Protective Coatings

7.1 Zinc, Hot Dip or Mechanically Deposited—Specification F 2329, and mechanically deposited, Specification B 695, Class 50.

7.1.1 When zinc-coated anchor bolts with the coating specified in 7.1 are required, the purchaser shall specify the zinc coating process, for example, hot dip, mechanically deposited, or no preference.

7.1.2 When hot-dip is specified, the fasteners shall be zinc coated by the hot-dip process in accordance with the requirements of Specification F 2329.

7.1.3 When mechanically deposited is specified, the fasteners shall be zinc coated by the mechanical deposition process in accordance with the requirements of Class 50 of Specification B 695.

7.1.4 When no preference is specified, the supplier may furnish either a hot-dip zinc coating in accordance with Specification F 2329, or a mechanically deposited zinc coating in accordance with Specification B 695, Class 50. Threaded components (bolts and nuts) shall be coated by the same zinc-coating process, and the supplier’s option is limited to one process per item, with no mixed processes in a lot.

7.2 Other Coatings:

7.2.1 Coatings other than the zinc coatings specified in 7.1 shall be as specified by the purchaser on the purchase order.

7.2.2 The complete specification shall be included as part of the purchase order when other coatings are specified.

8. Chemical Composition

8.1 Anchor bolts shall have a chemical composition conforming to the requirements listed in Table 1 for Grade 36 and Table 2 for Grades 55 and 105.

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.

8.5 Product analyses may be made by the purchaser from finished anchor bolts representing each heat. The chemical composition thus determined shall conform to the requirements specified in 8.1 through 8.4.

9. Mechanical Properties

9.1 Bars—The bars or rods from which the anchor bolts are made shall conform to the tensile properties listed in Table 3, except when heat treated after bending or threading.

9.2 Anchor Bolts—The finished anchor bolts shall conform to the tensile properties listed in Table 3 for tests on machined specimens and Table 4 for axial tests on full-size threaded anchor bolts.

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:

10.2.1 When threads are rolled, the body diameter shall not be less than the minimum pitch diameter for the thread class, 1A or 2A, designated by the purchaser and specified in ANSI/ASME B 1.1. Class 2A shall be furnished when the thread class is not specified.

10.2.2 The body diameter shall not be less than the minimum major diameter when threads are cut.

10.2.3 The minimum body diameters are listed in Table 5 based on the requirements specified in 10.2.1 and 10.2.2.

TABLE 1 Chemical Requirements for Grade 36

Element	Diameter, in. (mm)		
	To ¾ (20), incl	Over ¾ to 1½ (20 to 40), incl	Over 1½ to 4 (40 to 100), incl
Carbon, max, %			
Heat	0.26	0.27	0.28
Product	0.29	0.30	0.31
Manganese, %			
Heat	A	0.60–0.90	0.60–0.90
Product	A	0.54–0.98	0.54–0.98
Phosphorus, max, %			
Heat	0.04	0.04	0.04
Product	0.05	0.05	0.05
Sulfur, max, %			
Heat	0.05	0.05	0.05
Product	0.06	0.06	0.06
Copper, min, % (when specified)			
Heat	0.20	0.20	0.20
Product	0.18	0.18	0.18

^A Optional with the manufacturer but shall be compatible with weldable steel.

TABLE 2 Chemical Requirements for Grades 55 and 105

Element	Composition, %	
	Heat Analysis	Product Analysis
Phosphorous, max	0.040	0.048
Sulfur, max	0.050	0.058
Copper, min (when Cu is specified)	0.20	0.18

TABLE 3 Tensile Properties for Bars and Machined Specimens

	Grade		
	36	55	105
Tensile strength, ksi	58–80	75–95	125–150
Tensile strength, MPa	(400–552)	(517–655)	(862–1034)
Yield strength, min, ksi (0.2 % offset)	36	55	105
Yield strength, min, MPa (0.2 % offset)	248	380	724
Elongation in 8 in. (200 mm), min, % ^A	20	18	12
Elongation in 2 in. (50 mm), min, % ^A	23	21	15
Reduction of Area, min, %			
¼ to 2 in. (6.4 to 50 mm), incl	40	30	45
over 2 to 2½ in. (50 to 63 mm), incl	40	22	–45
over 2½ to 3 in. (63 to 76), incl	40	20	45
over 3 to 4 in. (76 to 102 mm), incl	40	18	...

^A Elongation in 8 in. (200 mm) applies to bars. Elongation in 2 in. (50 mm) applies to tests on machined specimens.

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 = minor (or minimum) diameter at any point, generally in the plane of the bend, and

D = major diameter, at the same cross section as, and at 90 degrees to, the minor diameter.

10.4 Length:

10.4.1 The overall length of straight anchor bolts, or length to the inside of the hook, shall be the specified length $\pm \frac{1}{2}$ in. (13 mm) for lengths 24 in. (600 mm) or less, and ± 1 in. (25 mm) 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 $\pm \frac{1}{2}$ in. (13 mm), whichever is greater.

10.5 *Bend Angle*—The bend angle of hooks shall not vary from that specified by more than $\pm 5^\circ$.

10.6 *Coated Length*—When only the exposed end of the anchor bolt is required to be zinc coated, the length of zinc coating shall not be less than that specified on the order.

10.7 Other Dimensions:

10.7.1 Tolerances for dimensions other than those given in 10.1 through 10.6 shall be as specified by the purchaser.

10.7.2 When tolerances are not specified, they shall be in accordance with the manufacturer's documented standard practice.

11. Thread Dimensions

11.1 Uncoated Anchor Bolts:

11.1.1 Unless otherwise specified, uncoated threads shall be Unified Coarse Thread Series as specified in the latest issue of ANSI/ASME B 1.1, and they shall have Class 1A or 2A

tolerances, as specified by the purchaser. Class 2A shall be furnished when the class is not specified.

11.1.2 When required, anchor bolts having a nominal diameter greater than 1.0 in. (25.5 mm) may be specified to have threads conforming to the 8-Thread Series (8 UN Series) in ANSI/ASME B 1.1, and they shall have Class 2A tolerances.

11.2 *Anchor Bolts Zinc Coated in Accordance With 7.1, Specification F 2329, and Specification B 695, Class 50:*

11.2.1 Unless otherwise specified, anchor bolts hot dip or mechanically zinc coated in accordance with 7.1.1 through 7.1.4 (requiring overtapped nuts, see Note 3) shall be the Unified Coarse Thread Series and shall have Class 1A or 2A threads, as specified by the purchaser, before zinc coating. After zinc coating, and due to the zinc buildup, the pitch and major diameters for hot-dip zinc-coated anchor bolts shall not exceed the dimensions listed in Table 6.

NOTE 3—Zinc-coated nuts of the grade and style recommended in 6.6.1, when overtapped the diametral allowance for the thread series listed in the table entitled "Thread Dimensions and Overtapping Allowances for Nuts" in Specification A 563, will develop the bolt tensile strength required in Table 4 of this specification.

11.2.2 Thread conformance shall be verified during manufacture. In case of dispute, a calibrated thread ring gage of the same size as the oversize limit specified in 11.2.1 (Class X tolerance, gage tolerance plus) shall be used to verify compliance. Assembly of the gage shall be possible with hand effort, following the application of light machine oil to prevent galling and damage to the gage.

11.3 *Thread Length*—The thread length shall not vary from that specified more than +1.0 in. (25.5 mm), –0.00 in. (0.00 mm).

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

12. Workmanship

12.1 Anchor bolts shall be commercially smooth and free of burrs, laps, seams, cracks, and other injurious manufacturing defects that would make them unsuitable for the intended application.

13. Number of Tests and Retests

13.1 Testing Responsibility:

13.1.1 The anchor bolt manufacturer or supplier, whichever is the responsible party as defined in Section 18, shall be responsible for conducting or ensuring that the required tests have been conducted to determine compliance with all of the requirements of this specification and the purchaser order.

13.1.2 Reports of tension tests, conducted by the steel producer on bar stock used to manufacture the anchor bolts without additional heat treatment, may be used to qualify the finished anchor bolt tensile properties.

13.1.3 The purchaser shall be permitted to perform any of the tests and inspections listed in this specification or the purchaser order.

13.2 Lot Definition:

13.2.1 *Bar Stock Tensile Tests*—For tensile tests conducted by the steel producer on bars to be used for the manufacture of

TABLE 4 Axial Tensile Properties for Full-Size Anchor Bolts

Nominal Size, in.	Threads/ in.	Stress Area, ^A in. ²	Anchor Bolt Grade						
			36		55		105		
			Tensile Strength, ^B klf	Yield Strength, ^{B,C} min, klf	Tensile Strength, ^B klf	Yield Strength, ^{B,C} min, klf	Tensile Strength, ^B klf	Yield Strength, ^{B,C} min, klf	
Unified Coarse Thread Series (UNC)									
1/4	20 UNC	0.0318	1.89–2.54	1.15	2.4–3.0	1.75	3.98–4.27	3.34	
3/8	16 UNC	0.0775	4.5–6.2	2.8	5.8–7.36	4.26	9.7–11.6	8.14	
1/2	13 UNC	0.1419	8.2–11.4	5.1	10.6–13.5	7.8	17.7–21.3	14.9	
5/8	11 UNC	0.226	13.1–18.1	8.1	17.0–21.5	12.4	28.2–33.9	23.7	
3/4	10 UNC	0.334	19.4–26.7	12.0	25.0–31.7	18.4	41.8–50.1	35.1	
7/8	9 UNC	0.462	26.8–37.0	16.6	34.6–43.9	25.4	57.8–69.3	48.5	
1	8 UNC	0.606	35.2–48.5	21.8	45.4–57.6	33.3	75.8–90.9	63.6	
1 1/8	7 UNC	0.763	44.3–61.0	27.5	57.2–72.5	42.0	95.4–114.4	80.1	
1 1/4	7 UNC	0.969	56.2–77.5	34.9	72.7–92.1	53.3	121–145	102	
1 1/2	6 UNC	1.405	81.5–112.4	50.6	105.0–133.0	77.3	176–216	148	
1 3/4	5 UNC	1.90	110–152	68.4	142–180	104.5	238–285	200	
2	4 1/2 UNC	2.50	145–200	90.0	188–238	138	312–375	262	
2 1/4	4 1/2 UNC	3.25	188–260	117	244–309	179	406–488	341	
2 1/2	4 UNC	4.0	232–320	144	300–380	220	500–600	420	
2 3/4	4 UNC	4.93	286–394	177	370–468	271	616–740	518	
3	4 UNC	5.97	346–478	215	448–567	328	746–896	627	
3 1/4	4 UNC	7.10	412–568	256	532–674	390	...	...
3 1/2	4 UNC	8.33	483–666	300	625–791	458	...	...
3 3/4	4 UNC	9.66	560–773	348	724–918	531	...	...
4	4 UNC	11.08	643–886	399	831–1053	609	...	...
8 Thread Series (8 UN) ^D									
1 1/8	8 UN	0.790	45.8–63.2	28.4	59.2–75.0	43.4	98.8–118.5	83.0	
1 1/4	8 UN	1.000	58.0–80.0	36.0	75.0–95.0	55.0	125–150	105	
1 1/2	8 UN	1.492	86.5–119.4	53.7	112–142	82.1	186–224	157	
1 3/4	8 UN	2.08	121–166	74.9	156–198	114	260–312	218	
2	8 UN	2.77	161–222	99.7	208–263	152	346–416	291	
2 1/4	8 UN	3.56	206–285	128	267–338	196	445–534	374	
2 1/2	8 UN	4.44	258–355	160	333–422	244	555–666	466	
2 3/4	8 UN	5.43	315–434	195	407–516	299	679–815	570	
3	8 UN	6.51	378–521	234	488–618	358	814–976	684	
3 1/4	8 UN	7.69	446–615	277	577–731	423	...	...
3 1/2	8 UN	8.96	520–717	323	672–851	493	...	...
3 3/4	8 UN	10.34	600–827	372	776–982	569	...	...
4	8 UN	11.81	685–945	425	886–1122	650	...	...

^A Stress areas extracted from ANSI/ASME B 1.1.

^B Tensile properties calculated from the tensile requirements given in Table 3.

^C Yield strength measured at 0.2 % offset.

^D Anchor bolts to 1 3/4 in. (44.5 mm) and larger with 8 UN threads and the nuts overlapped to the limits stated in 11.2.1 will not develop the tensile strength in Table 4 when the bolt and nut dimensions approach the minimum material limits of ANSI/ASME B 1.1 and B 18.2.2. See 11.2.1 for thread series that have been qualified for strength when the nuts are overlapped to the limits stated in 11.2.1.

anchor bolts, a lot shall consist of bars from the same heat, having the same diameter, and, if heat treated, heat treated in the same furnace lot.

13.2.2 *All Other Tests*—A lot is a quantity of product of one part number made by the same production process and subsequently submitted for final inspection at one time. The maximum lot size traceable to final inspection shall not be larger than 250 000 pieces.

13.3 Test Frequency:

13.3.1 The number of tests shall be as follows and in Table 7 and Table 8:

Test	Number of Tests
Composition	one per heat, minimum
Tensile tests	
Bar stock	one per lot, min, as defined in 13.2.1
Anchor bolts	in accordance with Table 7 and Table 8 on each lot defined in 13.2.2
Coating weight and thickness	
Dimensions	
Thread conformance	in accordance with Table 7 and Table 8 on each lot defined in 13.2.2
Workmanship	
Overall compliance	

TABLE 5 Minimum Body Diameter

Nominal Size, in.	Threads/in.	Body Diameter, min, in.		
		Rolled Threads ^A		Cut Threads ^B Classes 1A and 2A
		Class 1A	Class 2A	
Unified Coarse Thread Series (UNC)				
1/4	20 UNC	0.2108	0.2127	0.2367
3/8	16 UNC	0.3266	0.3287	0.3595
1/2	13 UNC	0.4411	0.4435	0.4822
5/8	11 UNC	0.5561	0.5589	0.6052
3/4	10 UNC	0.6744	0.6773	0.7288
7/8	9 UNC	0.7914	0.7946	0.8523
1	8 UNC	0.9067	0.9100	0.9755
1 1/8	7 UNC	1.0191	1.0228	1.0982
1 1/4	7 UNC	1.1439	1.1476	1.2232
1 1/2	6 UNC	1.3772	1.3812	1.4703
1 3/4	5 UNC	1.6040	1.6085	1.7165
2	4 1/2 UNC	1.8385	1.8433	1.9641
2 1/4	4 1/2 UNC	2.0882	2.0931	2.2141
2 1/2	4 UNC	2.3190	2.3241	2.4612
2 3/4	4 UNC	2.5686	2.5739	2.7111
3	4 UNC	2.8183	2.8237	2.9611
3 1/4	4 UNC	3.0680	3.0734	3.2110
3 1/2	4 UNC	3.3177	3.3233	3.4610
3 3/4	4 UNC	3.5674	3.5730	3.7109
4	4 UNC	3.8172	3.8229	3.9609
8 Thread Series (8UN)				
1 1/8	8 UN	...	1.0348	1.1004
1 1/4	8 UN	...	1.1597	1.2254
1 1/2	8 UN	...	1.4093	1.4753
1 3/4	8 UN	...	1.6590	1.7252
2	8 UN	...	1.9087	1.9752
2 1/4	8 UN	...	2.1584	2.2251
2 1/2	8 UN	...	2.4082	2.4751
2 3/4	8 UN	...	2.6580	2.7250
3	8 UN	...	2.9077	2.9749
3 1/4	8 UN	...	3.1575	3.2249
3 1/2	8 UN	...	3.4074	3.4749
3 3/4	8 UN	...	3.6571	3.7248
4	8 UN	...	3.9070	3.9748

^A Minimum body diameter is the same as minimum pitch diameter. Extracted from ANSI/ASME B 1.1.
^B Minimum body diameter is the same as minimum major diameter. Extracted from ANSI/ASME B 1.1 for Class 1A and Footnote 5 for Class 2A.

13.3.2 When the identity to a specific heat number (and furnace lot number for heat-treated bars) has not been maintained, the number of tests for all requirements, including tensile, shall be based on the quantity of anchor bolts of a given description as shown in **Table 8**.

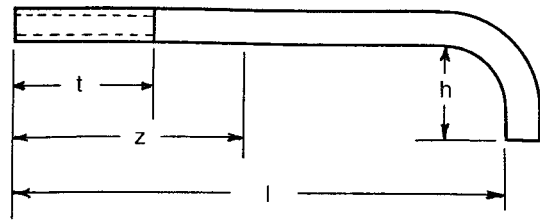
13.3.3 Tensile tests on finished anchor bolts apply only when bar stock tests are not available or applicable or heat treatment is performed after threading or bending.

13.4 *Retests*—If a single nonconforming characteristic is found in final inspection, the lot may be resampled for this characteristic with a sample four times the size of the original final acceptance sample. The acceptance criterion shall then be zero discrepancies in this larger sample.

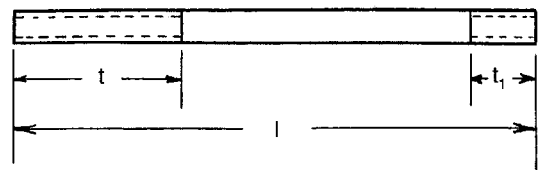
13.5 Purchaser's Inspection:

13.5.1 If, on receipt of anchor bolts, the purchaser discovers a single nonconforming part, he may sample the lot for such nonconforming characteristic(s) in accordance with **13.3** using an acceptance number of zero.

13.5.2 If the nonconforming characteristic in **13.5.1** is thread dimension and the anchor bolt manufacturer or supplier contests the findings, the final determination of thread acceptability shall be as follows: a full-size axial tension test shall be



Anchor Bolt with Hook



Straight Anchor Bolt

- h = length of hook
- l = length of bolt
- t = length of threads (exposed end)
- t₁ = length of threads (encased end), when required
- z = length of zinc coating, min, when partial zinc coating is required

FIG. 1 Anchor Bolt Dimensions

TABLE 6 Zinc Buildup on Coated Threads and Corresponding Thread Dimensions; Hot-Dip Zinc Coated in Accordance With Specification F 2329

Nominal Size, in.	Threads/in.	Diametral Zinc Buildup, in. ^A	Anchor Bolt Diameter, max, in.	
			Major	Pitch
1/4	20	0.016	0.2649	0.2324
3/8	16	0.017	0.3907	0.3501
1/2	13	0.018	0.5165	0.4685
5/8	11	0.020	0.6434	0.5844
3/4	10	0.020	0.7682	0.7032
7/8	9	0.022	0.8951	0.8229
1	8	0.024	1.0220	0.9408
1 1/8	8	0.024	1.1469	1.0657
1 1/4	7	0.024	1.1468	1.0540
1 1/4	8	0.024	1.2719	1.1667
1 1/4	7	0.024	1.2718	1.1740
1 1/2	8	0.027	1.5248	1.4436
1 1/2	6	0.027	1.5246	1.4163
1 3/4	5	0.050	1.7973	1.6674
2	4.5	0.050	2.0471	1.9028
2 1/4	4.5	0.050	2.2971	2.1528
2 1/2	4	0.050	2.5469	2.3845
2 3/4	4	0.050	2.7968	2.6344
3	4	0.050	3.0468	2.8844
3 1/4	4	0.050	3.2967	3.1343
3 1/2	4	0.050	3.5467	3.3843
3 3/4	4	0.050	3.7966	3.6342
4	4	0.050	4.0466	3.8842

^A These values are the same as the overlap requirements for zinc-coated nuts given in Specification **A 563**.

made on the threaded anchor bolt and nut assembly at the manufacturer's or supplier's expense. The assembly shall develop the tensile load specified in **Table 4**.

14. Test Methods

14.1 *Chemical Composition*—Chemical analysis shall be conducted in accordance with Test Methods, Practices, and Terminology **A 751**.

TABLE 7 Inspection Level for Final Inspection^A

Type of Test	Nondestructive Tests	Destructive Tests
Body diameter	C	...
Length	B	...
Head	C	...
Thread acceptance	B	...
Visual inspection ^B	A	...
Tensile properties	...	B
Coating weight/ Thickness	B	...

^A Extracted from ANSI/ASME B 18.18.2M.

^B Visual inspection for type identification, presence of finish, duds, surface discontinuities, and general workmanship.

TABLE 8 Number of Tests for Final Inspection^A

Lot Size	Level of Inspection	Sample Size	
		Nondestructive Tests	Destructive Tests
999 and less	A	25	4
	B	8	2
	C	2	1
1 000 to 5 000	A	50	6
	B	16	3
	C	4	1
5 001 to 250 000	A	100	8
	B	32	4
	C	8	1

^A Extracted from ANSI/ASME B 18.18.2M.

14.2 Tensile Tests:

14.2.1 Tensile tests on bars shall be conducted in accordance with Test Methods and Definitions **A 370**.

14.2.2 Tensile tests on finished anchor bolts shall be conducted in accordance with the Axial Tension Test Method in Methods **F 606**.

14.2.3 Yield strength shall be determined by the 0.2 % offset method.

14.2.4 Tension tests shall be conducted on the bar stock or finished anchor bolt at the manufacturer's or supplier's option but shall be conducted after the final heat treatment.

14.2.5 Grades 36 and 55 in sizes 1½ in. (38 mm) and less, and Grade 105 in sizes 1¼ in. (32 mm) and less, shall be tested using the full-bar section as rolled or the full-size finished anchor bolt.

14.2.6 Bars and finished anchor bolts larger than those specified in **14.2.5** shall preferably be tested full size, and when so tested the results shall be compared to the tensile properties given in **Table 3** for bars and **Table 4** for finished anchor bolts. When equipment for full-size testing of these larger sizes is not available, or when the length of the anchor bolt makes full-size testing impractical, standard 0.500-in. (12.7-mm) diameter machined test specimens shall be tested in accordance with Test Methods **F 606** and the results compared to the tensile properties given in **Table 3**.

14.2.7 In the event that anchor bolts are tested by both full-size and machined test specimen methods, the full-size test shall govern if a discrepancy between the two methods exists.

14.3 *Zinc Coating*—Zinc coating weight and thickness shall be determined in accordance with the methods specified in the applicable zinc coating specifications referenced in **7.1**.

15. Inspection

15.1 If the inspection described in **15.2** is required by the purchaser, it shall be specified in the inquiry and contract or order.

15.2 The inspector representing the purchaser shall have free entry to all parts of the manufacturer's works or supplier's place of business that concern the manufacture or supply of the material ordered. The manufacturer or supplier shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections required by the specifications that are requested by the purchaser's representative shall be made before shipment and shall be conducted so as not to interfere unnecessarily with the operation of the works.

16. Rejection and Rehearing

16.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the manufacturer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the manufacturer or supplier may make claim for a rehearing.

17. Certification

17.1 When specified in the purchase order, the manufacturer or supplier, whomever is the responsible party as specified in Section **18**, shall furnish the purchaser a test report that includes the following:

17.1.1 Steel producer's heat analysis and heat number. The carbon equivalent shall be included for bars and anchor bolts ordered in accordance with Supplementary Requirement S 1.

17.1.2 Results of tensile tests.

17.1.3 Zinc coating, measured coating weight, and thickness.

17.1.4 Statement of compliance with dimensional and thread fit requirements.

17.1.5 Certification that the anchor bolts were manufactured and tested in accordance with this specification.

17.1.6 Lot number and purchase order number.

17.1.7 ASTM designation (including year), grade, and class.

17.1.8 Size, description, or purchaser's drawing number.

17.1.9 Complete mailing address or responsible party.

17.1.10 Title and signature of individual assigned certification responsibility by the company officers.

18. Responsibility

18.1 The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser.

19. Product Marking

19.1 Unless otherwise specified (see **Note 4**), the end of each anchor bolt intended to project from the concrete shall be color coded to identify the grade as follows:

Grade	Color
36	Blue
55	Yellow
105	Red

NOTE 4—This color coding is intended to facilitate locating the proper grade of anchor bolt at its designed location. The color code also identifies

the grade at delivery and at final field inspection. When other color coding is required to define diameter, configuration, dimensions, etc., see 19.2.

19.2 When color coding other than specified in 19.1 is required, it shall be specified on the inquiry and purchase order.

19.3 When permanent manufacturers identification, or permanent grade identification, or both are required, Supplementary Requirement S2 or S3, or both, as needed, shall be specified on the inquiry and purchase order.

20. Packaging and Package Marking

20.1 Packaging:

20.1.1 Unless otherwise specified, packaging shall be in accordance with Practice D 3951.

20.1.2 When zinc-coated nuts are included on the same order as zinc-coated anchor bolts, the anchor bolts and nuts shall be shipped in the same container.

20.1.3 When special packaging requirements are required, they shall be defined at the time of the inquiry and order.

20.2 Package Marking:

20.2.1 Each shipping unit shall include or be marked plainly with the following information:

20.2.1.1 ASTM designation, Grade, and Class;

20.2.1.2 Size;

20.2.1.3 Name and brand or trademark of the manufacturer;

20.2.1.4 Number of pieces;

20.2.1.5 Lot number;

20.2.1.6 Purchase order number; and

20.2.1.7 Country of origin.

21. Keywords

21.1 anchor bolts; steel

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified in the purchase order or contract:

S1. Grade 55 Bars and Anchor Bolts

S1.1 The material described in this section is intended for welding. This supplemental section, by chemical composition restrictions and by a carbon equivalent formula, provides assurance of weldability.

S1.2 Welding technique is of fundamental importance when bolts produced to this supplementary section are welded. It is assumed that suitable welding procedures for the steel being welded and the intended service will be selected.

S1.3 The requirements of this supplementary requirement supersede conflicting provisions of the general specification.

S1.4 Because of the embrittling effects of welding temperatures on cold-forged steel, this supplemental section is limited to hot-forged bolts, or, if not forged, to the thread bars, studs, or bolts produced from hot-rolled bars without forging. Cold-forged bolts or cold-drawn threaded bars are suitable if they are given a thermal treatment by heating to a temperature of not less than 1500°F (815°C) and air-cooled.

S1.5 Chemical Composition:

S1.5.1 Steel shall conform to the following limitations:

	Heat Analysis	Product Analysis
Carbon, max, %	0.30	0.33
Manganese, max, %	1.35	1.41
Phosphorus, max, %	0.040	0.048
Sulfur, max, %	0.050	0.058
Silicon, max, %	0.50	0.55

S1.5.2 *Carbon Equivalent*—In addition to the requirements specified in S1.5.1, the analysis shall be such as to provide a carbon equivalent (CE) meeting the following requirements:

S1.5.2.1 For alloy or low-alloy steel, the carbon equivalent shall not exceed 0.45 % when calculated as follows:

$$CE = \% C + \frac{\% Mn}{6} + \frac{\% Cu}{40} + \frac{\% Ni}{20} + \frac{\% Cr}{10} - \frac{\% Mo}{50} - \frac{\% V}{10}$$

S1.5.2.2 For carbon steel, the carbon equivalent shall not exceed 0.40 % when calculated as follows:

$$CE = \% C + \frac{\% Mn}{4}$$

S1.6 Marking—Each anchor bolt conforming to this supplementary requirement S1 shall be designated by a white paint mark on the side of the bar near the end to be encased in concrete.

S2. Permanent Manufacturer's Identification

S2.1 The end of the anchor bolt intended to project from the concrete shall be steel die stamped with the manufacturer's identification. Marking small sizes (customarily less than 0.375 in. (9.525 mm)) may not be practical. Consult the anchor bolt manufacturer for the minimum size that can be marked.

S2.2 When required, grade and manufacturer's or private label distribution's identifications shall be separate and distinct. The two identifications shall preferably be in different locations and shall be separated by at least two spaces when on the same level.

S3. Permanent Grade Identification

S3.1 Instead of color coding as specified in 19.1, the end of the anchor bolt intended to project from the concrete shall be steel die stamped with the grade identification as follows:

Grade	Identification
36	AB36
55	AB55
105	AB105

S3.2 The requirements given in S2.1 for marking small sizes, and, in S2.2 that grade and manufacturer's identifications be separate and distinct, shall also apply to this supplementary requirement.

S4. Grades 55 and 105 Charpy Impact Requirements at +40°F (+5°C)

S4.1 Grades 55 and 105 shall have a Charpy V-Notch impact strength conforming to the requirements listed in **Table S1.1**.

S4.2 Tests shall be conducted in accordance with Test Methods and Definitions **A 370**.

S4.3 Notch toughness tests shall be performed at the Test Frequency P (Piece Testing) of Specification **A 673/A 673M** on finished anchor bolts when the results of notch toughness tests are not available on bar stock.

TABLE S1.1 Energy and Test Temperature Requirements

Charpy V-Notch Energy Requirements		Test Temperature, °F (°C)
Average for 3 Specimens, min, ft·lbf (J)	Minimum for 1 Specimen, ft·lbf (J)	
15 (20)	12 (16)	+40 (5)

TABLE S1.2 Energy and Test Temperature Requirements

Charpy V-Notch Energy Requirements		Test Temperature, °F (°C)
Average for 3 Specimens, min, ft·lbf (J)	Minimum for 1 Specimen, ft·lbf (J)	
15 (20)	12 (16)	-20 (29)

S4.4 Notch toughness tests shall be performed at the Test Frequency H (Heat Lot Testing) of Specification **A 673/A 673M** on bar stock, except when heat treatment is performed after threading or bending, in which case the tests shall be those required in S4.3.

S5. Grade 105 Charpy Impact Requirements at -20°F (-29°C)

S5.1 Grade 105 shall have Charpy V Notch impact strength conforming to the requirements listed in **Table S1.2**.

S5.2 Test methods and frequency of testing shall be as specified in S4.2 through S4.4.

SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue, F 1554 – 04^{e1}, that may impact the use of this standard.

(I) Changed the reference hot dip zinc coating Specification **F 2329**, from Specification A 153/A 153M Gr. C, to Specification

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