~~Designation:F2280–06~~ Designation: F 2280 – 08

Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi Minimum Tensile Strength[1]

This standard is issued under the fixed designation F 2280; 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 two types of heat treated, steel, tension control bolt-nut-washer assemblies, also referred to as "sets," having a tensile strength of 150 to 173 ksi. These assemblies are capable of developing a minimum predetermined tension when installed by applying torque to the nut, while at the same time applying a counter torque to separate the spline end from the body of the bolt using an appropriate spline drive installation tool.

1.2 An assembly consists of a tension control bolt with spline end (covered by this specification) and a suitable nut and washer covered by reference to applicable ASTM specifications.

1.3 The fastener assemblies are intended for use in structural connections. These connections, installation procedures, and the use of alternate design structural bolts are covered under the requirements of the "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts", approved by the Research Council on Structural Connections.

1.4 The assemblies are available with either round (button or dome) heads, heavy hex structural heads, or alternate design heads described in Section 11 ~~and Fig. 1~~, in sizes ½ to 1 ⅛ in. inclusive, in two types specified in Section 4.

1.5 Tension control bolts manufactured and marked in accordance with the requirements of Specification A 490, and conforming to the dimensional and other requirements of this specification, will be considered an acceptable alternate under this specification for two years following initial publication.

1.6 *The following precautionary statement pertains only to the test method portions, Sections 15 and 16, of this Specification: This standard 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2] ~~*A194/A194MTest Method for Determining Short-Term Compression Behavior of Geosynthetics*~~

A 490~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

A 563~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Specification for Carbons and Alloy Steel Nuts

A 751~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~

~~D3951Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E 709~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Guide for Magnetic Particle Examination

E 1444~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Practice for Magnetic Particle Testing

F 436~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Specification for Hardened Steel Washers

F 606~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

F 788/F 788M~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Specification for Surface

[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 April 1, 2006. Published April 2006.~~

Current edition approved Jan. 1, 2008. Published January 2008. Originally approved in 2006. Last previous edition approved in 2006 as F 2280–06.

[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.**

Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
F 1470 ~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
F 1789 ~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Terminology for F16 Mechanical Fasteners
F 2328 ~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws and Studs
G 101 ~~Test Method for Determining Short-Term Compression Behavior of Geosynthetics~~ Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

2.2 *ASME Standards:*[3]
B1.1 Unified Inch Screw Threads
B1.3M Screw Threads Gaging Systems for Dimensional Acceptability—Inch and Metric Screw Threads
B18.2.6 Fasteners for Use in Structural Applications
2.3 *Research Council on Structural Connections:*[4]
Specification for Structural Joints Using ASTM A 325 or A 490 Bolts

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*
The definition of terms used in this specification shall be as specified in Terminology F 1789, unless otherwise defined herein.
3.1.1 *component lot*—component lot, for the purpose of assigning an identification number and from which test samples shall be selected, shall consist of all tension control bolts, all nuts or all washers processed essentially together through all operations to the shipping container, of which each component has the following common characteristics: heat number (mill heat); ASTM designation and grade or type, as applicable; nominal dimensions (size) and head style; and heat treatment lot.
3.1.2 *manufacturer*—entity that assembles, lubricates, tests, and certifies compliance with this specification.
3.1.3 *secondary processing*—any processing performed by any entity on the assemblies or individual components after initial testing.

4. Classification

4.1 The tension control bolts are designated by type denoting chemical composition as follows:
4.1.1 *Type 1*—Alloy steel, and
4.1.2 *Type 3*—Weathering steel.

5. Ordering Information

5.1 Orders for assemblies shall include the items of information below. Optional items not on the purchase order shall be considered as not being required (see Note 1):
5.1.1 Quantity of assemblies,
5.1.2 Size, include nominal tension control bolt diameter and length (without the spline end),
5.1.3 Name of product, that is, twist off type tension control bolt/nut/washer assemblies,
5.1.4 Head style (see 11.1.1),
5.1.5 Type of assembly, that is, Type 1 or Type 3,
5.1.6 ASTM designation and year of publication, and
5.1.7 Special requirements, if required.

NOTE 1—A typical order description follows: 2520 assemblies, ~~1–8~~1⅛ –7 UNC in. diameter by 3 in. long Tension Control Bolt/Nut/Washer Assemblies, Round Heads, Type 1 ASTM F 2280.

6. Materials and Manufacture

6.1 *Heat Treatment:*
6.1.1 Tension control bolts shall be heat treated by quenching in oil from the austenitizing temperature and then tempering by reheating to a temperature not less than 800°F.
6.2 *Thread*—The threads of tension control bolts shall be rolled.
6.3 *Lubrication*:
~~6.3.1At least one component of each assembly shall be lubricated by the manufacturer. The lubricant shall be clean and dry to the touch.~~
6.3.1 The assemblies shall be lubricated by the manufacturer to meet the Assembly Lot Tension requirements in Section 9.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.
[4] Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 3100, Chicago, IL 60601-2001.

6.3.2 Lubrication other than that applied by the manufacturer shall not be permitted, as the type and amount of lubrication is critical to meeting the minimum clamping forces specified.

6.4 *Secondary Processing*—Secondary processing shall not be permitted to an assembly lot.

6.5 *Assembly*:

6.5.1 The assemblies shall be of the type specified by the purchaser.

~~6.5.2The assemblies shall consist of one tension control bolt, with one nut and one or more washer(s).~~

6.5.2 The assemblies shall consist of one tension control bolt, with one nut and one or more washer(s) assembled on the bolt and the nut threaded on the bolt a minimum of one turn.

6.5.3 Nuts and washers used on the assemblies shall conform to the requirements of the specifications below:

Assembly Type and Finish	Nut Specification, Class and Finish	Washer Specification, Type and Finish
~~Type 1 Plain~~	~~Specification A 563 DH plain Specification A 194/ A 194M 2H plain~~	~~Specification F 436 Type 1plain~~
Type 1 Plain	Specification A 563 DH plain	Specification F 436 Type 1plain
Type 3 Weathering Steel	Specification A 563 DH3 plain	Specification F 436 Type 3 plain weathering steel

6.5.4 All nuts shall be heavy hex. All washers used in the assembly shall be circular and through hardened.

6.6 *Protective Coatings*—The bolts, nuts and washers shall not be coated by hot dip zinc coating, mechanical deposition or electroplating with zinc or other metallic coatings

7. Chemical Composition

7.1 *Tension Control Bolts*:

7.1.1 Type 1 tension control bolts shall be alloy steel conforming to the chemical composition in Table 1. The steel shall contain sufficient alloying elements to qualify it as an alloy steel.

7.1.2 Type 3 tension control bolts shall be weathering steel and shall conform to the chemical compositions specified in Table 2. See Guide G 101 for method of estimating the atmospheric corrosion resistance of low alloy steels.

7.1.3 Product analysis made on finished bolts representing each lot shall conform to the product analysis requirements specified in Tables 1 and 2, as applicable.

7.1.4 Heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted.

7.1.5 For Type 1 bolts heats of steel, with intentionally added boron, or boron heat analysis exceeding 0.0035 %, shall not be permitted.

7.1.6 Compliance with 7.1.4 and 7.1.5 shall be based on certification that heats of steel having any of the listed elements intentionally added were not used to produce the bolts.

7.1.7 Chemical analysis shall be performed in accordance with Test Methods, Practices, and Terminology A 751.

7.2 *Nuts and Washers*—Chemical requirements for nuts and washers shall be in accordance with the applicable specification specified in 6.5.3.

8. Mechanical Property Requirements for Tension Control Bolts

8.1 *Hardness:* The bolts shall conform to the hardness specified in Table 3.

TABLE 1 Chemical Requirements for Type 1 Alloy Steel Tension Control Bolts

Element	Composition % Heat Analysis, %	Composition % Product Analysis, %
~~Carbon~~		
~~For sizesthrough 1⅛ in.~~	~~0.30–0.48~~	~~0.28–0.50~~
Carbon	0.30–0.48	0.28–0.50
Phosphorus, max	0.040	0.045
Sulfur, max	0.040	0.045
Alloying Elements	[A]	[A]

[A] Steel, as defined by the American Iron and Steel Institute, shall be considered to be alloy when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: manganese, 1.65 %, silicon, 0.60 %, copper, 0.60 %; or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99 %, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

TABLE 2 Chemical Requirements for Type 3 Weathering Steel Tension Control Bolts

Element	Composition, %	
	Heat Analysis, %	Product Analysis, %
Carbon		
Sizes ¾ in. and smaller	0.20-0.53	0.19-0.55
Sizes ⅞ to 1⅛ in. incl.	0.30-0.53	0.28-0.55
Manganese, min	0.40	0.37
Phosphorus, max	0.035	0.040
Sulfur	0.040	0.045
Copper	0.20-0.60	0.17-0.63
Chromium	0.45-0.90	0.42-0.93
Nickel or	0.20-0.60	0.17-0.63
Molybdenum	0.15-0.25	0.14-0.26

TABLE 3 Hardness Requirements for Tension Control Bolts

Bolt Size in.	Bolt Length, in.	Brinell		Rockwell C	
		Min	Max.	Min	Max.
~~½ to 1 in., incl~~	~~Less than 3D[A]~~	~~311~~	~~352~~	~~33~~	~~39~~
½ to 1 in., incl	Less than 2D[A]	311	352	33	39
	3D and over	. . .	352	. . .	39
1⅛ in.	Less than 3D[A]	311	352	33	39
	3D and over	. . .	352	. . .	39

[A] Tension control bolts 1.00 in. nominal diameter and smaller and shorter than 2D are subject only to minimum and maximum hardness. Tension control bolts 1⅛ inch nominal diameter and shorter than 3D are subject only to minimum and maximum hardness.

8.2 *Tensile Properties*:

8.2.1 Except as permitted in 8.2.2 for long bolts, and 8.2.3 for short bolts, sizes 1.0 in. and smaller having a length of 2¼ in. D and longer; and sizes larger than 1.0 in. having a length of 3D and longer; shall be wedge tested full size and shall conform to the minimum and maximum wedge tensile load, and proof load or alternative proof load specified in Table 4. The load achieved during proof load testing shall be equal to or greater than the specified proof load.

8.2.2 When the length of the bolt makes full size testing impractical, machined specimens shall be tested and shall conform to the requirements specified in Table 5. When bolts are tested by both full size and machined specimen methods, the full size test shall take precedence.

8.2.3 Sizes 1.0 in. and smaller having a length shorter than 2¼ D down to 2D inclusive, which cannot be wedge tensile tested shall be axially tension tested full size and shall conform to the minimum tensile load and proof load or alternate proof load specified in Table 4. Sizes 1.0 in. and smaller having a length shorter than 2D, which cannot axially tensile tested shall be qualified on the basis of hardness.

8.2.4 Size 1⅛ in. having a length shorter than 3D shall be qualified on the basis of hardness.

8.2.5 For bolts on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event of low hardness readings.

TABLE 4 Tensile Requirements for Full Size Tension Control Bolts

Bolt Size, Threads per in. and Series Designation	Stress Area[A] in.^{2}	Tensile Load[B] lbf		Proof Load Length Measurement Method, lbs	Alternative Proof Load[B] Yield Strength Method min lbs
		Min	Max.		
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
½ in. — 13 UNC	0.142	21 300	24 600	17 050	18 500
⅝ in. — 11 UNC	0.226	33 900	39 100	27 100	29 400
¾ in. — 10 UNC	0.334	50 100	57 800	40 100	43 400
⅞ in. — 9 UNC	0.462	69 300	79 950	55 450	60 100
1 in. — 8 UNC	0.606	90 900	104 800	72 700	78 800
1⅛ in. — 7 UNC	0.763	114 450	132 000	91 550	99 200

[A] The stress area is calculated as follows:

$$A_s = 0.7854\,[D - (0.9743/n)]^2$$

where:

A_s = stress area, in.^{2},
D = nominal bolt size, and
n = threads per inch.

[B] Loads tabulated are based on the following:

Bolt Size, in.	Column 3	Column 4	Column 5	Column 6
½ to 1⅛	150 000 psi	173 000 psi	120 000 psi	130 000 psi