



Designation: F432 – 19

Standard Specification for Roof and Rock Bolts and Accessories¹

This standard is issued under the fixed designation F432; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This specification covers the chemical, mechanical, and dimensional requirements for roof and rock bolts and accessories. Addressed in this specification are double-end threaded bars; fully grouted bolts and threaded bars; mechanical anchorage devices used for point anchorage applications; roof truss systems; partially grouted deformed bolts; bearing plates; cable bolt systems; expandable rock bolts and other frictional anchorage devices. All of these products represent various designs used for ground support systems. This specification can be revised to address new technologies.

1.2 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 This hazard statement applies only to Section 10, Test Methods 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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

[A29/A29M Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought](#)

[A47/A47M Specification for Ferritic Malleable Iron Castings](#)

[A194/A194M Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both](#)

[A220/A220M Specification for Pearlitic Malleable Iron](#)

[A370 Test Methods and Definitions for Mechanical Testing of Steel Products](#)

[A416/A416M Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete](#)

[A536 Specification for Ductile Iron Castings](#)

[A563 Specification for Carbon and Alloy Steel Nuts](#)

[A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement](#)

[A882/A882M Specification for Filled Epoxy-Coated Seven-Wire Steel Prestressing Strand](#)

[A1011/A1011M Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength](#)

[A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products](#)

[D6637 Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method](#)

[D1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable](#)

[F436/F436M Specification for Hardened Steel Washers Inch and Metric Dimensions](#)

[F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets](#)

2.2 ASME Standards:³

[B 1.1 Unified Screw Threads](#)

[B 1.3M Screw Thread Gaging Systems for Dimensional Acceptability—Inch and Metric Screw Threads](#)

[B 18.2.2 Square and Hex Nuts](#)

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.

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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. Terminology

3.1 Definitions:

3.1.1 *barrel*—a device housing normally either 2 or 3 piece cable strand wedges

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

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

3.1.2 *bearing plates, plate washers, mine roof plates*—plates that serve to distribute the load from the exposed end of the bolt or threaded bar to the rock face or intermediate member.

3.1.2.1 *header plates*—large rectangular bearing plates, usually 6 in. wide by 16 to 18 in. long, or any other shape with an equivalent area, used in substitution for wooden header blocks for wider distribution of the bolt load than is possible with standard bearing plates.

3.1.3 *bendable bolts*—bolts furnished with an altered section at some location, to be specified by the customer, at which the bar will bend.

3.1.3.1 *Discussion*—Bending is necessary to permit installation of bars longer than the mine opening height. This altered section may be produced by hot or cold forging, or by shearing, sawing, trimming, machining, grinding, or a combination of these processes.

3.1.4 *beveled washers*—washers whose faces are at an angle permitting a headed bolt or threaded bar to be installed at a slight angle to the rock face and yet maintained the face of the bolt head perpendicular to the bolt axis.

3.1.5 *cable bolt*—cable strand with an assembly placed on the end for installation and load resistance purposes.

3.1.6 *chemical anchors*—chemical materials that provide anchorage between the bolt or bar and the drilled hole.

3.1.7 *discontinuous turn*—discontinuous turn shall include material heat changes, interruptions to the manufacturing operation exceeding 8 hrs, and significant machinery adjustments that materially alter the manufacturing process. The discontinuous turn shall apply to all separate manufacturing stations separate from the material heat change criteria. A material length change will not constitute a “discontinuous turn” as provided in this definition.

3.1.8 *expandable rock bolt*—rock support device that consists of a steel tube, folded or collapsed on itself, that can be inserted into a borehole and expanded, by means of high internal pressure, against the wall of the borehole. The product anchorage is developed through a combination of friction and mechanical interlock of the expanded profile against the borehole wall after the internal expansion pressure used for installation has been relieved.

3.1.9 *expansion shells*—anchorage devices that, separate from the bar or bolt, mechanically expand to grip the sides of a drilled hole and transfer load between the location of the anchor to the bar or bolt.

3.1.10 *extensions*—threaded bars used to extend the length of threaded or threaded slotted bars.

3.1.11 *frictional anchorage devices*—ground support devices, friction stabilizers, that are designed so that the holding force/anchorage is generated by frictional forces between the surface of the borehole and the surface of the device. The frictional forces can be active over the full or partial length of the device.

3.1.12 *fully grouted bolts and threaded bars*—deformed bars or plain bars used with full-length grouting and having

special deformations or other design features to provide interlocking between the steel and the grout.

3.1.13 *hardened washers*—washers that have been hardened by heat treatment to provide consistency to the torque tension relation necessary to control installation tension of bolts and threaded bars.

3.1.14 *minimum non-seizure load (MNSL)*—the load level in pounds through which bolt/plug thread seizure must not occur.

3.1.15 *minimum ultimate load (MUL)*—the load level in pounds through which bolt/plug thread failure must not occur.

3.1.16 *rollers, cams*—moving devices that, when used with internally threaded cylinders containing external tapered slots, provide expansion to grip the sides of a drilled hole mechanically and transfer load from the location of the anchor to the bar or bolt.

3.1.17 *roof and rock bolts*—headed hot-rolled bars with cold-rolled or machine-cut threads at the end, to be used with anchorage devices to hold up mine roofs, hold back walls, or hold down equipment or foundations.

3.1.18 *roof truss system*—a roof support system incorporating bolts that are joined together by crossmember(s) that is (are) tensioned by design.

3.1.19 *strand*—a group of wires normally having helically placed outer wires with uniform pitch.

3.1.20 *spherical washers or seats*—washers that are flat on one side and have a spherical face on the other side. The combination of spherical washer together with a depression in the bearing plate produces a ball-and-socket joint permitting bolts to be installed at a slight angle to the rock face while still maintaining the face of the bolt head perpendicular to the bolt axis.

3.1.21 *tension nuts*—nuts that are intended to induce and maintain tension in a bolt.

3.1.22 *threaded bars*—bars that are used with a nut on one end and an anchorage device on the other. They are used in a manner similar to the bolts described in 3.1.17.

3.1.23 *threaded couplings*—couplings used to permit the assembly of additional externally threaded items.

3.1.24 *threaded tapered plugs*—threaded wedge that expands the expansion shell by the movement of the threaded plug within the shell as tightening progresses.

3.1.25 *wedge*—pieces of tapered metal with teeth which bite into the strand under load.

3.1.25.1 *Discussion*—Two or three piece wedges are normally used.

4. Ordering Information

4.1 Orders for material under this specification shall include at least the following information:

4.1.1 Quantity (number of pieces),

4.1.2 Name of product together with description of accessories,

4.1.3 Dimensions,

4.1.4 ASTM designation and year of issue, including strength grade,

4.1.5 Special requirements, if any, including packaging and thread protection instructions, and

4.1.6 Certifications, if required.

4.2 The products covered by this specification are currently produced by many manufacturers to a wide variety of designs. It is necessary for the user and the manufacturer to establish the requirements of the individual installation and to agree as to the type of assembly to be employed. See **Annex A1** and **Appendix X1** for additional information.

5. Manufacturing Processes

5.1 Materials for Bolts, Extensions, and Threaded Bars:

5.1.1 Steel used for plain bars shall conform to the requirements shown in **Table 2** and in Specification **A29/A29M**. Steel used for deformed or plain bars shall conform to the requirements shown in **Table 2** and Specification **A615/A615M**.

5.1.1.1 Threads on bolts or threaded bars may be cold rolled or machine cut on the hot-rolled bars.

5.1.2 Steel strands for use as cable bolts shall conform to Specification **A416/A416M**.

5.1.3 Filled epoxy steel strands for use as cable bolts shall conform to Specification **A882/A882M**.

5.2 Materials for Expansion Shells:

5.2.1 Malleable iron castings shall conform to Specification **A47/A47M**.

5.2.2 Steel shall conform to the requirements shown in **Table 2**.

5.2.3 Ductile iron castings shall conform to Specification **A536**, Grades 60-40-18.

5.3 Materials for Threaded Tapered Plugs Used with Expansion Shells:

5.3.1 Materials for threaded tapered plugs used with expansion shells shall conform to the test specifications in **10.6**.

5.4 Materials for Bearing and Header Plates, Also Known As Plate Washers or Mine Roof Plates:

5.4.1 Steel shall conform to the requirements shown in **Table 2**.

5.4.1.1 Bearing and header plates may be strengthened by cold forming or may be hardened by quenching in a liquid medium from above the austenitizing temperature and tempering at a temperature of not less than 650°F.

5.5 Materials for Spherical, Flat, or Beveled Hardened Washers:

5.5.1 Steel shall conform to the requirements shown in **Table 2**.

5.5.1.1 Hardened steel washers shall be through hardened by quenching in a liquid medium from above the austenitizing temperature and tempering at a temperature of not less than 650 °F. Case-hardened washers are not permitted.

5.6 Materials for Spherical or Beveled Washers:

TABLE 2 Chemical Requirements

Product	Carbon, max, %		Sulfur, max, %		Phosphorus, max, %	
	Heat	Product	Heat	Product	Heat	Product
Bolts, threaded bars ^A	0.75	0.79	0.13	^B	0.050	0.058
Hardened spherical, flat, or beveled washers	0.80	0.84	0.050	0.058	0.050	0.058
Spherical or beveled washers	0.80	0.84	0.050	0.058	0.050	0.058
Bearing and header plates	1.00	1.04	0.050	0.058	0.050	0.058
Steel threaded tapered plugs	0.60	0.64	0.13	^B	0.050	0.058
Steel expansion shells	0.30	0.33	0.050	0.058	0.050	0.058

^A Bars furnished in accordance with the chemical composition section of Specification **A615/A615M** may be substituted for these requirements.

^B Check analysis for sulfur if a resulfurized steel is not technically appropriate.

5.6.1 Malleable iron castings shall conform to Specification **A47/A47M**.

5.6.2 Pearlitic malleable iron castings shall conform to Specification **A220/A220M**, Grades 45006, 50005, or 60004.

5.6.3 Steel shall conform to the requirements shown in **Table 2**.

5.7 Materials for Nuts:

5.7.1 Nuts shall be in accordance with Specifications **A194/A194M** or **A563**. Appropriate nuts for each grade of threaded bar are shown in **Table 1**. Higher strength nuts conforming to Specifications **A194/A194M** or **A563** may be substituted. When specified on the order or contract, nuts with external dimensions of nominal 3/4 in. heavy hex or heavy square size may be supplied with 5/8 in. threads for use with 5/8 in. threaded bars.

5.8 Materials for Chemical Grouting Materials:

5.8.1 Chemical grouting materials are covered in **Annex A3** of this specification.

5.9 Materials for Threaded Couplings:

5.9.1 Materials for threaded couplings shall be selected by the manufacturer to ensure compliance with **7.6** and **8.6.1**.

5.10 **Materials for Bolts and Threaded Bars for Use in Grouted Systems**—Plain or deformed steel bars shall conform to **Table 2** or Specification **A615/A615M** chemical properties. Mechanical properties shall conform to requirements listed within this specification.

5.11 **Materials for Friction Stabilizers**—Sheet steel shall conform to requirements specified in Specification **A1011/A1011M**, Table 2 HSLAS Class 2 material per Table 6.

5.12 Materials for Truss Systems:

5.12.1 Components of roof truss systems shall be manufactured in accordance with the appropriate paragraph(s) of Section **5** of this specification.

6. Chemical Composition

6.1 Materials used for bolts, threaded bars, spherical, flat, or beveled washers, threaded tapered plugs, expansion shells, bearing plates, and roof truss components shall be as specified in **Table 2** and Section **5**.

TABLE 1 Appropriate Nuts

Bolt or Threaded Bar Grade	Nut Specification
30 (regular strength)	A194/A194M , Grade 1; A563 , Grade B
55 (high strength)	A194/A194M , Grade 1; A563 , Grade B
75 (extra high strength)	A194/A194M , Grade 2; A563 , Grade C