



Fasteners With Similar Strengths

1. Abstract

Below is a list of fastener specifications, the product designation (i.e. Grade or Class), and a number of the listed mechanical properties from those specifications. For the inch series parts (ASTM and SAE), it is strange to look at these Grades and see only minor changes to mechanical properties and realize entire specifications had been written independently. The work needed to create and maintain these unique specifications is significant. Note, there is primarily only one mechanical property specification for metric fasteners (ISO 898-1). Perhaps ISO is on to something by only having one spec.

2. Comments

Take note of the similarities between:

- ISO 898-1 Class 4.6, ASTM A307 Grade A and B, ASTM F1554 Grade 36, and SAE J429 Grade 2.
- ISO 898-1 Class 8.8, SAE J429 Grade 5, ASTM A193 Grade B7, ASTM A320 Grade L7, ASTM A449, and ASTM A354 Grade BC.
- ISO 898-1 Class 10.9, SAE J429 Grade 8, and ASTM A354 Grade BD.
- ISO 898-1 Class 12.9, Grade 9, and ASTM A574.

3. Tables

TABLE 1: ISO 898-1, *Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel, Part 1*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ISO 898-1	Cl 4.6	≥1.6, ≤39 mm	240 MPa [34.8 ksi]	400 MPa [58.0 ksi]	67-95 HRB	22	(na)
ISO 898-1	Cl 8.8	≥5, ≤16 mm	640 MPa [92.8 ksi]	800 MPa [116 ksi]	22-32 HRC	12	52
ISO 898-1	Cl 8.8	>16, ≤39 mm	660 MPa [95.7 ksi]	830 MPa [120.4 ksi]	23-34 HRC	12	52
ISO 898-1	Cl 10.9	≥1.6, ≤39 mm	940 MPa [136 ksi]	1040 MPa [151 ksi]	32-39 HRC	9	48
ISO 898-1	Cl 12.9	≥1.6, ≤39 mm	1100 MPa [160 ksi]	1220 MPa [177 ksi]	39-44 HRC	8	44

ISO 898-1 COMMENTS: These fasteners are common in the industry. Note, these Classes can be used to fabricate fasteners with diameters outside the ranges listed above, however, because the specification does not define requirements for sizes outside the diameter ranges, perhaps it is a good idea for the purchaser and supplier to agree on what the expectations will be.



TABLE 2: ASTM A307, *Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ASTM A307	Gr A	≥1/4, ≤4 in	36 ksi (a)	60 ksi	69-100 HRB	18	(na)
ASTM A307	Gr B	≥1/4, ≤4 in	36 ksi (a)	60-100 ksi	69-95 HRB	18	(na)

ASTM A307 COMMENTS: Grade A are far more common than Grade B. Grade A bolts are also more common than SAE J429 Grade 2. Grade B are usually specified when it is critical for the fastener to fail before the application fails; hence Grade B's specified *maximum* tensile strength. By specifying a maximum, design teams can appropriately specify stronger application materials. (a) Though the specification ASTM A307 does not define a yield strength, 36 ksi has been a commonly assumed stress.

TABLE 3: ASTM F1554, *Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ASTM F1554	Gr 36	≥1/2, ≤4 in	36 ksi	58-80 ksi	(na)	23	40
ASTM F1554	Gr 55	≥1/2, ≤4 in	55 ksi	75-95 ksi	(na)	21	30
ASTM F1554	Gr 105	≥1/2, ≤3 in	105 ksi	125-150 ksi	(na)	15	45

ASTM F1554 COMMENTS: This is an anchor bolt specification. F1554 will sometimes be requested in threaded rod. These Grades can be made into threaded rod, but, it is not very common. Often when F1554 Grade 36 threaded rod is requested, ASTM A307 Grade A is offered. Often when F1554 Grade 105 threaded rod is requested ASTM A193 Grade B7 is offered.

TABLE 4: SAE J429, *Mechanical and Material Requirements for Externally Threaded Fasteners*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
SAE J429	Gr 2	≥1/4, ≤3/4 in	57 ksi	74 ksi	80-100 HRB	18	35
SAE J429	Gr 2	>3/4, ≤1 1/2 in	36 ksi	60 ksi	70-100 HRB	18	35
SAE J429	Gr 5	≥1/4, ≤1 in	92 ksi	120 ksi	25-34 HRC	14	35
SAE J429	Gr 5	>1, ≤1 1/2 in	81 ksi	105 ksi	19-30 HRC	14	35
SAE J429	Gr 8	≥1/4, ≤1 1/2 in	130 ksi	150 ksi	33-39 HRC	12	35

SAE J429 COMMENTS: These fasteners are common in the industry. When Grade 5 fasteners are requested in a diameter >1 1/2 in., often ASTM A449 is offered. When Grade 8 fasteners are requested in a diameter >1 1/2 in., often ASTM A354 Grade BD is offered. If you are one of these people requesting a SAE J429 fastener >1 1/2 in., do not reinvent the wheel, use ASTM A307 or ASTM A449 or ASTM A354 Grade BD.

TABLE 5: ASTM A193/A193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ASTM A193	Gr B7M	≤4 in	80 ksi	100 ksi	99 HRB, max	18	50
ASTM A193	Gr B7M	>4, ≤7 in	75 ksi	100 ksi	99 HRB, max	18	50
ASTM A193	Gr B7	≤2 1/2 in	105 ksi	125 ksi	35 HRC, max	16	50
ASTM A193	Gr B7	>2.5, ≤4 in	95 ksi	115 ksi	35 HRC, max	16	50
ASTM A193	Gr B7	>4, ≤7 in	75 ksi	100 ksi	35 HRC, max	16	50
ASTM A193	Gr B16	≤2 1/2 in	105 ksi	125 ksi	35 HRC, max	18	50
ASTM A193	Gr B16	>2.5, ≤4 in	95 ksi	110 ksi	35 HRC, max	17	45
ASTM A193	Gr B16	>4, ≤8 in	85 ksi	100 ksi	35 HRC, max	16	45

ASTM A193/A193M COMMENTS: A193/A193M is written for high temperature applications. Note the similarities between A193 and ASTM A320. That said, ASTM A320 was written for low temperature applications.



TABLE 6: ASTM A320/A320M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ASTM A320	Gr L7M	≤2 1/2 in	80 ksi	100 ksi	99 HRB, max	18	50
ASTM A320	Gr L7	≤2 1/2 in	105 ksi	125 ksi	35 HRC, max	16	50
ASTM A320	Gr L43	≤4 in	105 ksi	125 ksi	35 HRC, max	16	50

ASTM A320/A320M COMMENTS: A320/A320M is written for low temperature applications. Note the similarities between A320 and ASTM A193. That said, ASTM A193 was written for high temperature applications. A320 often mirrors A193 for mechanical properties, except, A320 has Charpy V-notch impact energy absorption requirements.

TABLE 7: ASTM A449, *Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ASTM A449	(na)	≥1/4, ≤1 in	92 ksi	120 ksi	25-34 HRC	14	35
ASTM A449	(na)	>1, ≤1 1/2 in	81 ksi	105 ksi	19-30 HRC	14	35
ASTM A449	(na)	>1 1/2, ≤3 in	58 ksi	90 ksi	183-235 Brinell	14	35

ASTM A449 COMMENTS: Because A449 is nearly identical to SAE J429 Grade 5, they occupy the same market share. As typical with supply and demand, the industry chose to pick one as the primary spec to manufacture parts to; in this case the more common spec for 1/4 to 1 1/2 in. diameter is SAE J429 Grade 5. ASTM A449 takes over market share when SAE J429 Grade 5 fasteners are requested >1 1/2 in..

TABLE 8: ASTM F835, *Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ASTM F835	(na)	≥#0, ≤1/2 in	(c)	145 ksi	39-45 HRC	(na)	(na)
ASTM F835	(na)	>1/2, ≤1 1/2 in (b)	(c)	135 ksi	37-45 HRC	8	35

ASTM F835 COMMENTS: These fasteners are common in the industry. It is suggested in F835 to use these fasteners similar to how other 120 ksi tensile strength fasteners would be used.

(a) ASTM F835 button heads max diameter = 5/8 in while flat heads max diameter = 1 1/2 in.

(b) ASTM F835 has a yield strength greater than the tensile strength. This oddity is due to the reduced tensile strength a full size fastener has based on its head style (there is simply not enough material in the head to maintain tensile strength consistent with ASTM A574).

TABLE 9: ASTM A354, *Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ASTM A354	Gr BC	≥1/4, ≤2 1/2 in	109 ksi	120 ksi	26-36 HRC	16	50
ASTM A354	Gr BC	>2 1/2, ≤4 in	99 ksi	115 ksi	22-33 HRC	16	50
ASTM A354	Gr BD	≥1/4, ≤2 1/2 in	130 ksi	150 ksi	33-39 HRC	14	40
ASTM A354	Gr BD	>2 1/2, ≤4 in	115 ksi	140 ksi	31-39 HRC	14	40

ASTM A354 COMMENTS: Because Grade BD has so many similarities to SAE J429 Grade 8, they occupy the same market share. As typical with supply and demand, the industry chose to pick one as the primary spec to manufacture parts to; in this case the more common spec for 1/4 to 1 1/2 in. diameter is SAE J429 Grade 8. ASTM A354 Grade BD takes over market share when SAE J429 Grade 8 fasteners are requested >1 1/2 in..



TABLE 10: No Standardized Specification Controls "Grade 9"

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
Fastenal	Gr 9	≥1/4, ≤1 1/4 in	153 ksi	180 ksi	38-42 HRC	10	35
Lawson	Tru-Torq	≥1/4, ≤1 1/4 in	(?)	180 ksi	38-42 HRC	(?)	(?)
PFC	PFC9	≥1/4, ≤1 1/4 in	(?)	180 ksi	38-42 HRC	(?)	(?)
BBI	L9	≥1/4, ≤1 1/4 in	(?)	180 ksi	38-42 HRC	(?)	(?)
Barnes Group	Bowmalloy	≥1/4, ≤1 1/8 in	(?)	up to 200 ksi	(?)	(?)	(?)

Grade 9 COMMENTS: These fasteners are common in the industry. All "Grade 9" fasteners are made to proprietary specifications. Grade 9, along with ASTM A574 and ISO 898-1 Class 12.9, are the highest strength industry standardized fasteners. Note, in 2013 Brighton-Best International (BBI) purchased Porteous Fastener Company (PFC).

TABLE 11: ASTM A574, Standard Specification for Alloy Steel Socket-Head Cap Screws

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	RA (%)
ASTM A574	(na)	≥#0, ≤1/2 in	153 ksi	180 ksi	39-45 HRC	10	35
ASTM A574	(na)	>1/2, ≤4 in	153 ksi	170 ksi	37-45 HRC	10	35

ASTM A574 COMMENTS: These fasteners are common in the industry. A574, along with Grade 9 and ISO 898-1 Class 12.9, are the highest strength industry standardized fasteners.

TABLE 12: ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness (max)	EL (%)	RA (%)	Mat'l
ASTM A193	Gr B8, Cl 1	≤3/4 in	30 ksi	75 ksi	100 HRB	30	50	18-8
ASTM A193	Gr B8, Cl 1	>3/4 in	30 ksi	75 ksi	96 HRB	30	50	18-8
ASTM A193	Gr B8, Cl 2	≤3/4 in	100 ksi	125 ksi	35 HRC	12	35	18-8
ASTM A193	Gr B8, Cl 2	>3/4, ≤1 in	80 ksi	115 ksi	35 HRC	15	35	18-8
ASTM A193	Gr B8, Cl 2	>1, ≤1 1/4 in	65 ksi	105 ksi	35 HRC	20	35	18-8
ASTM A193	Gr B8, Cl 2	>1 1/4, ≤1 1/2 in	50 ksi	100 ksi	35 HRC	28	45	18-8
ASTM A193	Gr B8M, Cl 1	≤3/4 in	30 ksi	75 ksi	100 HRB	30	50	16-10-2
ASTM A193	Gr B8M, Cl 1	>3/4 in	30 ksi	75 ksi	96 HRB	30	50	16-10-2
ASTM A193	Gr B8M, Cl 2	≤3/4 in	95 ksi	110 ksi	35 HRC	15	45	16-10-2
ASTM A193	Gr B8M, Cl 2	>3/4, ≤1 in	80 ksi	100 ksi	35 HRC	20	45	16-10-2
ASTM A193	Gr B8M, Cl 2	>1, ≤1 1/4 in	65 ksi	95 ksi	35 HRC	25	45	16-10-2
ASTM A193	Gr B8M, Cl 2	>1 1/4, ≤1 1/2 in	50 ksi	90 ksi	35 HRC	30	45	16-10-2

ASTM A193/A193M COMMENTS: A193/A193M is written for high temperature applications. Class 1 are more common than Class 2.



TABLE 13: ASTM F593, *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	Mat'l
ASTM F593	AG 1, CW, F593C	≥1/4, ≤5/8 in	65 ksi	100-150 ksi	95 HRB - 32 HRC	20	18-8
ASTM F593	AG 1, CW, F593D	≥3/4, ≤1 1/2 in	45 ksi	85-140 ksi	80 HRB - 32 HRC	25	18-8
ASTM F593	AG 2, CW, F593G	≥1/4, ≤5/8 in	65 ksi	100-150 ksi	95 HRB - 32 HRC	20	316/316L
ASTM F593	AG 2, CW, F593H	≥3/4, ≤1 1/2 in	45 ksi	85-140 ksi	80 HRB - 32 HRC	25	316/316L
ASTM F593	AG 1, SH, <u>F593A</u>	≥1/4, ≤5/8 in	95 ksi	120-160 ksi	24-36 HRC	12	18-8
ASTM F593	AG 1, SH, <u>F593B</u>	≥3/4, ≤1 in	75 ksi	110-150 ksi	20-32 HRC	15	18-8
ASTM F593	AG 1, SH, <u>F593C</u>	≥1 1/8, ≤1 1/4 in	60 ksi	100-140 ksi	95 HRB - 30 HRC	20	18-8
ASTM F593	AG 1, SH, <u>F593D</u>	≥1 3/8, ≤1 1/2 in	45 ksi	95-130 ksi	90 HRB - 28 HRC	28	18-8
ASTM F593	AG 2, SH, <u>F593E</u>	≥1/4, ≤5/8 in	95 ksi	120-160 ksi	24-36 HRC	12	316/316L
ASTM F593	AG 2, SH, <u>F593F</u>	≥3/4, ≤1 in	75 ksi	110-150 ksi	20-32 HRC	15	316/316L
ASTM F593	AG 2, SH, <u>F593G</u>	≥1 1/8, ≤1 1/4 in	60 ksi	100-140 ksi	95 HRB - 30 HRC	20	316/316L
ASTM F593	AG 2, SH, <u>F593H</u>	≥1 3/8, ≤1 1/2 in	45 ksi	95-130 ksi	90 HRB - 28 HRC	28	316/316L

ASTM A593 COMMENTS: AG – alloy group. CW – cold worked. SH – strain hardened. F593C, F593D, F593G, F593H fasteners are common in the industry.



TABLE 14: ISO 3506-1, *Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners, Part 1: Bolts, Screws and Studs*

Standard	Grade/ Class	Diameter	Yield Stress	Tensile Stress	Hardness	EL (%)	Mat'l
ISO 3506-1	A2-50	≤39mm	210 MPa [30.5 ksi]	500 MPa [72.5 ksi]	(na)	(na)	18-8
ISO 3506-1	A2-70	≤39mm	450 MPa [65.2 ksi]	700 MPa [101.5 ksi]	(na)	(na)	18-8
ISO 3506-1	A2-80	≤39mm	600 MPa [87.0 ksi]	800 MPa [116.0 ksi]	(na)	(na)	18-8
ISO 3506-1	A4-50	≤39mm	210 MPa [30.5 ksi]	500 MPa [72.5 ksi]	(na)	(na)	16-10-2
ISO 3506-1	A4-70	≤39mm	450 MPa [65.2 ksi]	700 MPa [101.5 ksi]	(na)	(na)	16-10-2
ISO 3506-1	A4-80	≤39mm	600 MPa [87.0 ksi]	800 MPa [116.0 ksi]	(na)	(na)	16-10-2
ISO 3506-1	C1-50	≤39mm	250 MPa [36.3 ksi]	500 MPa [72.5 ksi]	155-220 HV	(na)	Martensitic
ISO 3506-1	C1-70	≤39mm	410 MPa [59.5 ksi]	700 MPa [101.5 ksi]	20-34 HRC	(na)	Martensitic
ISO 3506-1	C1-110	≤39mm	820 MPa [118.9 ksi]	1100 MPa [159.5 ksi]	36-45 HRC	(na)	Martensitic
ISO 3506-1	C3-80	≤39mm	640 MPa [92.8 ksi]	800 MPa [116.0 ksi]	21-35 HRC	(na)	Martensitic
ISO 3506-1	C4-50	≤39mm	250 MPa [36.3 ksi]	500 MPa [72.5 ksi]	155-220 HV	(na)	Martensitic
ISO 3506-1	C4-70	≤39mm	410 MPa [59.5 ksi]	700 MPa [101.5 ksi]	20-34 HRC	(na)	Martensitic
ISO 3506-1	F1-45	≤39mm	250 MPa [36.3 ksi]	450 MPa [65.3 ksi]	135-220 HV	(na)	Ferritic
ISO 3506-1	F1-60	≤39mm	410 MPa [59.5 ksi]	600 MPa [87.0 ksi]	180-285 HV	(na)	Ferritic

ASTM ISO 3506-1 COMMENTS: A2 is commonly 304 or 302HQ but not required to be. 18-8 is generic callout for an austenitic stainless steel with ~18% Cr & ~8% Ni. A4 is commonly 316 or 316L but not required to be. 16-10-2 is a generic callout for an austenitic stainless steel with ~16% Cr, ~10% Ni & ~2% Mo. C1 is commonly 410 but not required to be. A2-70 and A4-70 fasteners are common in the industry. A2-80 and A4-80 are the next most common ISO 3506-1 designations.

ADDITIONAL NOTES THAT APPLY TO ALL TABLES:

- (i) Yield, tensile, elongation (EL) and reduction of area (RA) are minimums unless otherwise specified.
- (ii) Any values in brackets, [], are non-mandatory and are provided for informational purposes only.

Respectfully,
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 Fastener Enthusiast
 Polycrew Contributor