

## MECHANICAL PROPERTIES OF COMMON ASTM A193/A193M AND A320/A320M FASTENERS ALLOY STEEL BOLTING MATERIALS FOR HIGH AND LOW TEMPERATURE SERVICE

Specification & Grade	Size Range (in.)	Min Tensile Strength (psi)	Min. Yield Strength (psi)	Core Hardness Rockwell (max)	Description	Grade Identification Marking	Compatible ASTM A194/A194M Heavy Hex Nut
ASTM A193/A193M B7	2 1/2 & under	125,000	105,000	C35	Chromium-molybdenum alloy (4140, 4142, 4145, 4140H, 4142H, 4145H) used for high-pressure, high-temperature applications.	B7	
	Over 2 1/2 - 4	115,000	95,000	C35			
	Over 4 - 7	100,000	75,000	C35			
ASTM A193/A193M B7M	4 & under	100,000	80,000	B99	Similar to B7 except heat-treated to limit the maximum hardness. Considered in areas where stress embrittlement may be a factor.	B7M	
	Over 4 - 7	100,000	75,000	B99			
ASTM A193/A193M B16	2 1/2 & under	125,000	105,000	C35	A chromium-molybdenum-vanadium alloy used for high-pressure, high-temperature service applications. Offers slightly higher temperature resistance than B7.	B16	
	Over 2 1/2 - 4	110,000	95,000	C35			
	Over 4 - 8	100,000	85,000	C35			
ASTM A320/A320M L7	2 1/2 & under	125,000	105,000	C35	Designed for low temperature applications. Similar chemical and mechanical properties as the A193 B7, however the material is also required to be impact tested at -150°F.	L7	
ASTM A320/A320M L7M	2 1/2 & under	100,000	80,000	B99	Designed for low temperature applications. Similar chemical and mechanical properties as the A193 B7M, however the material is also required to be impact tested at -100°F.	L7M	
ASTM A320/A320M L43	4 & under	125,000	105,000	C35	Designed for low temperature applications. A 4340 alloy steel with similar mechanical properties as the L7, but with better cold-temperature impact properties particularly at larger diameters.	L43	

Compatible denotes commercially available nut having suitable mechanical properties and dimensional configuration or style which will make it possible to obtain the desired bolt load. Higher strength nuts or nuts of equal strength may be a suitable substitute provided bolt standard allows.

## MECHANICAL PROPERTIES OF COMMON STAINLESS STEEL FASTENERS IN ACCORDANCE WITH ASTM F593

Stainless Alloy Group	Condition	Nominal Dia. (in.)	Tensile Strength (psi)	Core Hardness Rockwell		Min. Yield Strength (psi)	Grade Identification Marking
				Min.	Max.		
1 (304, 304L, 305, 384, 18-8LW, 302HQ)	CW	1/4 - 5/8	100,000 - 150,000	B95	C32	65,000	
		3/4 - 1-1/2	85,000 - 140,000	B80	C32	45,000	
2 (316, 316L)	CW	1/4 - 5/8	100,000 - 150,000	B95	C32	65,000	
		3/4 - 1-1/2	85,000 - 140,000	B80	C32	45,000	

## MECHANICAL PROPERTIES OF METRIC EXTERNALLY THREADED FASTENERS (ISO 898-1)

Metric Property Class	Typical Material	Size Range (mm)	Proof Strength (MPa)	Min. Yield Strength (MPa)	Min. Tensile Strength (MPa)	Core Hardness Rockwell		Grade Identification Marking
						Min.	Max.	
4.6	Low or medium carbon steel	M1.6 - M39	225	240	400 (58,000 PSI)	B67	B95	
8.8	Medium carbon steel: quenched & tempered	M1.6 - M16	580	640	800 (116,000 PSI)	C22	C32	
		M18 - M39	600	660	830 (120,000 PSI)	C23	C34	
10.9	Alloy steel: quenched & tempered	M1.6 - M39	830	940	1040 (150,800 PSI)	C32	C39	
12.9	Alloy steel: quenched & tempered	M1.6 - M39	970	1100	1220 (177,000 PSI)	C39	C44	

## MECHANICAL PROPERTIES OF INCH SERIES EXTERNALLY THREADED FASTENERS

Specification	Typical Material	Size Range (in.)	Proof Strength (psi)	Min. Tensile Strength (psi)	Core Hardness Rockwell		Min. Yield Strength (psi)	Grade Identification Marking	Compatible Nuts
					Min.	Max.			
SAE J429-Grade 1	Low or medium carbon steel	1/4 - 1-1/2	-	60,000	B70	B100	36,000		ASTM A563 Grade A or SAE J995 Grade 2 Hex
SAE J429-Grade 2		1/4 - 3/4 (4)	-	74,000	B80	B100	57,000		
		7/8 - 1-1/2	-	60,000	B70	B100	36,000		
ASTM A307-Grade A	Low or medium carbon steel	1/4 - 4	-	60,000	B69	B100	-		ASTM A563 Grade A (Hex up to 1-1/2 & Heavy Hex 1-1/2 and over)
ASTM A307-Grade B	Low or medium carbon steel	1/4 - 4	-	60,000 (min) 100,000 (max)	B69	B95	-		ASTM A563 Grade A Heavy Hex
SAE J429-Grade 5	Medium carbon steel: quenched & tempered	1/4 - 1	85,000	120,000	C25	C34	92,000		SAE J995 Grade 5 Hex
		1-1/8 - 1-1/2	74,000	105,000	C19	C30	81,000		
ASTM A325-Type 1	Medium carbon steel: quenched & tempered	1/2 - 1	85,000	120,000	C25	C34	92,000		ASTM A563 Grade C Heavy Hex; DH or A194 2H Heavy Hex if Galv
		1-1/8 - 1-1/2	74,000	105,000	C19	C30	81,000		
ASTM A449-Type 1	Medium carbon steel: quenched & tempered	1/4 - 1	85,000	120,000	C25	C34	92,000		SAE J995 Grade 5 up to 1-1/2, ASTM A563 Grade A Heavy Hex over 1-1/2, DH Heavy Hex if Galv
		Over 1-1/2 to 3	55,000	90,000	B90	B99	58,000		
ASTM A354-Grade BC	Medium carbon alloy steel: quenched & tempered	1/4 - 2-1/2	105,000	125,000	C26	C36	109,000		ASTM A563 Grade C Heavy Hex, DH if Galv
		Over 2-1/2	95,000	115,000	C22	C33	99,000		
SAE J429-Grade 8	Medium carbon alloy steel: quenched & tempered	1/4 - 1-1/2	120,000	150,000	C33	C39	130,000		SAE J995 Grade 8 Hex
ASTM A354-Grade BD	Medium carbon alloy steel: quenched & tempered	1/4 - 2-1/2	120,000	150,000	C33	C39	130,000		ASTM A563 Grade DH or A194 2H Heavy Hex
		Over 2-1/2	105,000	140,000	C31	C39	115,000		
ASTM A490-Type 1	Medium carbon alloy steel: quenched & tempered	1/2 - 1-1/2	120,000	150,000 (min) 173,000 (max)	C33	C38	130,000		ASTM A563 Grade DH or A194 2H Heavy Hex
SAE J429-Grade 8.2	Medium carbon boron steel: quenched & tempered	1/4 - 1	120,000	150,000	C33	C39	130,000		SAE J995 Grade 8 Hex
FNL Grade 9	Medium carbon alloy steel: quenched & tempered	1/4 - 1-1/2	140,650	180,000	C38	C42	159,500		FNL Grade 9 Thick Hex Nut
ASTM A574 Socket Head Cap Screw	Medium carbon alloy steel: quenched & tempered	#0 - 1/2	140,000	180,000	C39	C45	153,000	-	-
		Over 1/2 - 4	135,000	170,000	C37	C45	153,000		
ASTM F835 Socket Button & Flat Countersunk Head Cap Screw	Medium carbon alloy steel: quenched & tempered	#0 - 1/2	-	145,000	C39	C44	-	-	-
		Over 1/2	-	135,000	C37	C44	-		
ASTM F1554 Anchor Bolts, Grade 36	Low or medium carbon steel	1/4 - 4	-	58,000 (min) 80,000 (max)	-	-	36,000	-	ASTM A563 Grade A (Hex up to 1-1/2 & Heavy Hex 1-1/2 and over)

Notes:  
 1. "Compatible" denotes commercially available nut having suitable mechanical properties and dimensional configuration or style which will make it possible to obtain the desired bolt load. Higher strength nuts or nuts of equal strength may be a suitable substitute provided the bolt standard allows it.  
 2. Galvanized nuts are intended for use with externally threaded fasteners that are hot-dip or mechanically galvanized or have a coating of sufficient thickness to require over-tapping of the nut to provide assembly.  
 3. ASTM A194 2H heavy hex nuts may be substituted for ASTM A563 DH heavy hex nuts.  
 4. Grade 2 requirements for sizes 1/4 through 3/4 in apply only to bolts and screws 6 in. and shorter in lengths. For bolts and screws longer than 6 in. Grade 1 requirements shall apply.

## WASHER TYPES AND DIMENSIONS OF USS AND SAE FLAT WASHERS

Nominal Washer Size	Style	FLAT WASHER DIMENSIONS PER ASME B18.2.1		Nominal Washer Size	Style	FLAT WASHER DIMENSIONS PER ASME B18.2.1	
		Inside Dia. Basic	Outside Dia. Basic			Inside Dia. Basic	Outside Dia. Basic
1/4	SAE	0.281	0.625	3/4	SAE	0.812	1.469
1/4	USS	0.312	0.734	3/4	USS	0.812	2.000
5/16	SAE	0.344	0.688	7/8	SAE	0.938	1.750
5/16	USS	0.375	0.875	7/8	USS	0.938	2.250
3/8	SAE	0.406	0.812	1	SAE	1.062	2.000
3/8	USS	0.438	1.000	1	USS	1.062	2.500
7/16	SAE	0.469	0.922	1-1/8	SAE	1.250	2.250
7/16	USS	0.500	1.250	1-1/8	USS	1.250	2.750
1/2	SAE	0.531	1.062	1-1/4	SAE	1.375	2.500
1/2	USS	0.562	1.375	1-1/4	USS	1.375	3.000
9/16	SAE	0.594	1.156	1-3/8	SAE	1.500	2.750
9/16	USS	0.625	1.469	1-3/8	USS	1.500	3.250
5/8	SAE	0.656	1.312	1-1/2	SAE	1.625	3.000
5/8	USS	0.688	1.750	1-1/2	USS	1.625	3.500

## MECHANICAL PROPERTIES OF INCH SERIES NUTS

Specification	Typical Material	Nominal Size (in.)	Proof Load Stress (psi)		Hardness Rockwell		Grade Identification Marking			
			Plain	Galvanize coating (1)	Min.	Max.				
ASTM A563-Grade A / SAE J995 Grade 2	Carbon steel	1/4 - 1 1/2	90,000*	68,000**	B68	C32				
ASTM A563-Grade A Heavy Hex		1/4 - 4	100,000*	75,000**	B68	C32				
ASTM A563-Grade C Heavy Hex	Carbon steel, may be quenched & tempered	1/4 - 4	144,000		B78	C38				
ASTM A563-Grade DH Heavy Hex	Carbon steel, quenched & tempered	1/4 - 4	175,000	150,000	C24	C38				
ASTM A194-Grade 2H Heavy Hex	Medium carbon steel, quenched & tempered	1/4 - 1 1/2	175,000		C24	C35				
		Over 1 1/2			B95	C35				
FNL Grade 9 Thick Hex Nut	Medium carbon or alloy steel, quenched & tempered	1/4 - 5/8	180,000		C32	C38				
		3/4 - 1 1/2			C35	C40				
ASTM A194-Grade 8 Heavy Hex	304 Stainless Steel	1/4 - 1 1/2	80,000		B60	C32				
ASTM A194-Grade 8M Heavy Hex	316 Stainless Steel	1/4 - 1 1/2	80,000		B60	C32				
SAE J995 Grade 5	Carbon steel	1/4 - 1	120,000*			C32				
			109,000**							
			105,000*							
		Over 1 - 1 1/2	94,000**			C32				
SAE J995 Grade 8	Medium carbon or alloy steel, quenched & tempered	1/4 - 5/8	150,000			C24	C32			
						Over 5/8 - 1			C26	C34
						Over 1 - 1 1/2			C26	C36

(1): Galvanize coating refers to nuts that have been plated with a plating or coating of sufficient thickness to require over-tapping of the nut to provide assembly, for example hot-dip or mechanical galvanizing.  
 \* UNC and 8 UN  
 \*\* UNF, 12 UN & finer  
 \*\*\*When a zinc coated ASTM A194 2H nut is supplied, the zinc coating, over-tapping, lubrication, and rotational capacity testing shall be in accordance with ASTM A563. Nuts coated with zinc shall have ZN marked after the grade symbol. Nuts coated with cadmium shall have CD marked after the grade symbol.

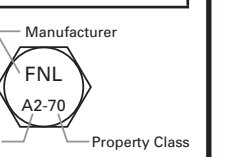
## MECHANICAL PROPERTIES OF COMMON ASTM A193/A193M STAINLESS STEEL FASTENERS CORROSION RESISTANT BOLTING MATERIALS FOR HIGH AND LOW TEMPERATURE SERVICE

Specification & Grade	Size Range (in.)	Min. Tensile Strength (psi)	Min. Yield Strength (psi)	Core Hardness Rockwell (max)	Description	Grade Identification Marking
ASTM A193/A193M B6	4-in and under	110,000	85,000		A martensitic 410 Stainless Steel heat treated to achieve mechanical properties	
ASTM A193/A193M B8 Class 1	All	75,000	30,000	B96	A 304 Stainless Steel used for high temperature applications. This material has been carbide solution treated.	
ASTM A193/A193M B8A Class 1A	All	75,000	30,000	B90	A 304 Stainless Steel used for high temperature applications. This material has been carbide solution treated in the finished condition.	
ASTM A193/A193M B8M Class 1	All	75,000	30,000	B96	A 316 Stainless Steel used for high temperature applications. This material has been carbide solution treated.	
ASTM A193/A193M B8MA Class 1A	All	75,000	30,000	B90	A 316 Stainless Steel used for high temperature applications. This material has been carbide solution treated in the finished condition.	
ASTM A193/A193M B8 Class 2	3/4 & under over 3/4 to 1 over 1 to 1-1/4 over 1-1/4 to 1-1/2	125,000 115,000 105,000 100,000	100,000 80,000 65,000 50,000	C35	A 304 Stainless Steel similar to the Class 1, but has been carbide solution treated and strain-hardened.	
ASTM A193/A193M B8M Class 2	3/4 & under over 3/4 to 1 over 1 to 1-1/4 over 1-1/4 to 1-1/2	110,000 100,000 95,000 90,000	95,000 80,000 65,000 50,000	C35	A 316 Stainless Steel similar to the Class 1, but has been carbide solution treated and strain-hardened.	

## MECHANICAL PROPERTIES OF METRIC STAINLESS STEEL PER ISO 3506-1 AND 3506-2

Group	Grade	Property Class	Diameter Range	Bolts, Screws & Studs		Nuts
				Tensile Strength (MPa)	Yield Strength (MPa)	Proof Stress (MPa)
Austenitic	A1, A2 & A4	50 (soft)	≤M39	500	210	500
		70 (cold-worked)	≤M39	700	450	700
		80 (high strength)*	≤M39	800	600	800
Martensitic	C1	50 (soft)	≤M39	500	250	500
		70 (hardened & tempered)	≤M39	700	410	700
	C3	80 (hardened & tempered)	≤M39	800	640	800
		50 (soft)	≤M39	500	250	500
C4	70 (hardened & tempered)	≤M39	700	410	700	
	45 (soft)	<M24	450	250	450	
Ferritic	F1	60 (cold-worked)	<M24	600	410	600

\* Property Class 90 mechanical properties for the Austenitic group are difficult to achieve for larger diameters. Consideration should be given to ASTM A193/A193M B8 and B8M Class 2 for diameters M20 and above.



## MECHANICAL PROPERTIES OF METRIC NUTS PER DIN 267 PART 4

Property Class	Typical Material	Proof Stress (MPa)	Core Hardness Rockwell (max.)	Grade Identification Marking	Your Local Fastenal Store:
Class 8	Low to medium carbon steel	800	C30		
Class 10	Medium carbon steel; quenched & tempered	1000	C36		
Class 12	Medium carbon steel; quenched & tempered	1200	C36		