

Stainless Steel & Stainless Steel Fasteners

Chemical, Physical and Mechanical Properties

Stainless steel describes a family of steels highly resistant to tarnishing and rusting that contain at least two separate elements alloyed together. In its most basic form, chromium is added to ordinary steel in order to become corrosion resistant. The mechanical properties of stainless steel (eg strength, ductility), and how well the alloy withstands corrosion depends entirely on which elements were alloyed together and their relative proportions.

Corrosion Resistance

The corrosion resistance of stainless steel is derived from chromium. Chromium has a strong affinity for oxygen and when added to steel in sufficient quantity (minimum 11%), it will form a microscopic film of chromium oxide on the surface of the alloy. The film is only about 0.01 microns thick but prevents further surface corrosion as well as any corrosion from spreading into the metal's internal structure. This chromium oxide film is nonreactive with other materials and does not promote further oxidation of adjacent chromium. It is also bonded solidly to the surface of the alloy and in the event of surface damage (eg scratching), the newly exposed chromium will react immediately with oxygen in the air to renew the protective chromium oxide film.

Besides chromium, another important element often added to stainless steel to increase corrosion resistance is molybdenum. Molybdenum becomes far more important than chromium to further enhance corrosion resistance in stainless steel once the amount of chromium in the alloy exceeds 18%.

Strength and workability

Nickel is added to stabilize the austenitic structure of stainless steel making the alloy more workable and improve ductility. Manganese is added to partially replace nickel in order to stabilize the austenitic structure. Similar to nickel, molybdenum improves the workability of the alloy, and also increases yield and tensile strengths in concentrations above 2%. The addition of sulfur and selenium to the austenitic grades of stainless steel improves machining of the alloy. The addition of carbon and nitrogen directly impact the strength of stainless steel. Nitrogen added to these alloys improves the mechanical properties of low carbon grades of austenitic stainless steels. Other elements like aluminum, titanium and/or columbium can be added to stainless steel to increase the mechanical properties of stainless steel. They also help to increase the strength of the alloy while retaining corrosion resistant properties.

Grades

Many different grades of stainless steel are available. Each contains varying ratios of steel to chromium in addition to varying amounts of other elements such as nickel, molybdenum and manganese. Each specific grade of stainless steel has its own unique chemical, mechanical and physical property profile making it ideal for specific applications. To compare corrosion resistances of common stainless steel grades see table 1.



Table 1	Corrosior	Corrosion Resistance Comparison Among Common Stainless Steels									
Grade	UNS No	Mild Atmospheric	Atmos	pheric		Chemical					
Glade	ONO NO	and fresh water	Industrial	Marine	Mild	Oxidizing	Reducing				
201	(S20100)	x	х	х	х	Х					
202	(S20200)	X	X	X	Х	X					
205	(S20500)	X	X	X	Х	X					
301	(S30100)	X	X	X	Х	X					
302	(S30200)	X	X	X	Х	X					
302B	(S30215)	X	X	Х	Х	X					
303	(S30300)	x	X	x							
303 Se	(S30323)	X	X	Х	Х						
304	(S30400)	x	Х	Х	Х	X					
304L	(S30403)	X	X	Х	Х	X					
304N	(S30451)	X	X	Х	Х	X					
305	(S30500)	X	X	Х	Х	X					
308	(S30800)	X	X	Х	Х	X					
309	(S30900)	X	X	Х	Х	X					
309S	(S30908)	X	X	Х	Х	X					
310	(S31000)	X	Х	X	Х	X					
310S	(S31008)	X	X	Х	Х	X					
314	(S31400)	X	X	X	Х	X					
316	(S31600)	X	X	X	Х	X	X				
316F	(S31620)	X	X	Х	Х	X	X				
316L	(S31603)	X	X	Х	Х	X	X				
316N	(S31651)	X	X	X	Х	X	X				
317	(S31700)	X	X	Х	Х	X	X				
317L	(S31703)	X	X	X	Х	X					
321	(S32100)	X	X	X	Х	X					
329	(S32900)	X	Х	X	Х	X	Х				
330	(N08330)	X	X	X	Х	X	X				
347	(S34700)	X	X	X	Х	X					
348	(S34800)	X	X	X	Х	X					
384	(S38400)	x	Х	X	х	X					
403	(S40300)	x	Х								
405	(S40500)	x	Х								
409	(S40900)	x	Х								
410	(S41000)	x	X								
414	(S41400)	Х	Х								



Table 1 cont

rable	COIIL.			1			
Grade	UNS No	Mild Atmospheric	Atmos	spheric	Chem	nical	
Grade	ONO NO	and fresh water	Industrial	Marine	Mild	Oxidizing	Reducing
416	(S41600)	х					
416 Se	(S41623)	X					
420	(S42000)	X					
420F	(S42020)	x					
422	(S42200)	x					
429	(S42900)	x	X	X	х		
430	(S43000)	x	X	X	x		
430F	(S43020)	x	X	X			
430F Se	(S43023)	x	X	X			
431	(S43100)	х	Х	Х	Х		
434	(S43400)	x	X	X	x	X	
436	(S43600)	x	X	X	х	X	
440A	(S44002)	x	X				
440B	(S44003)	x					
440C	(S44004)	x					
442	(S44200)	x	X	X	х		
446	(S44600)	x	x	x	x	x	
	(S13800)	x	x	x	x		
	(S15500)	x	x	x	х	x	
	(S17400)	x	x	x	х	x	
	(S17700)	X	X	X	х	х	

[&]quot;X" stainless steel type displaying resistance to specific corrosive environment categories. For use as a guideline only.

The many grades of stainless steel can be further sub-classified into one of five distinct metallurgical "families" or classifications:

- 1) Austenitic
- 2) Ferritic
- 3) Martensitic
- 4) Precipitation hardening
- 5) Duplex

Each familiy defines the metallurgical composition of the alloys within each classification, and in turn, reflects differences in property profiles (corrosion resistance, durability, workability) and potential uses.



Austenitic Grade Stainless Steels

Austenitic stainless steels are chromium-nickel-manganese or chromium-nickel containing alloys identified by the 200 and 300 series, respectively. The 300 series stainless steels are the most widely used of all stainless steels. The austenitic stainless steels, because of their high chromium and nickel content, are highly corrosion resistant, nonmagnetic, workable and are hardened by cold working. For chemical and physical properties of austenitic stainless steels see table 2.

Basic properties

- excellent corrosion resistance
- excellent for welding
- excellent formability, fabricability and ductility
- · excellent cleaning and hygiene characteristics
- good high and excellent low temperature properties
- non magnetic
- · hardened by cold work only

Straight Grades

The straight grades of austenitic stainless steel contain a maximum of .08% carbon, with no minimum carbon requirement as long as the material meets the physical requirements of the specific grade.

"L" Grades

The "L" grades are typically used in welding for optimal corrosion resistance. The "L" after a stainless steel grade indicates low carbon (eg 304L). The carbon is kept to .03% or under to minimize carbide precipitation. Carbon in steel precipitates out when heated to temperatures between 800°F to 1600°F and then combines with the chromium. This interferes with chromium's ability to protect the steel and results in corrosion adjacent to the grain boundaries. By reducing the amount of carbon precipitation, corrosion is reduced.

"H" Grades

The "H" grades contain a minimum of .04% carbon and a maximum of .10% carbon and have the letter "H" following the alloy number. The "H" grades are most typically used when the alloy is to be exposed to extreme temperatures as the higher carbon content in the alloy improves the strength of the metal under those conditions



Table 2

AUSTENITIC STAINLESS STEELS

Chemical Analysis % (Max. unless noted otherwise)

Nominal Mechanical Properties
(Annealed Sheet unless noted otherwise)

									Tensile Strength		Yield gation Strength in 2" (0.2% offset) (50.80mm)		(Rock-	Prod- uct Form		
Туре	c	Mn	P	s	Si	Cr	Ni	Мо	Other	ksi	MPa	ksi	MPa	5		
201	0.15	5.50.7.50	0.060	0.030	1.00	16.00 18.00	3.50 5.50		0.25N	95	655	45	310	40	B90	
202	0.15	7.50/10:00	0.060	0.030	1.00	17.00 19.00	4.00-6.00		0.25N	90	612	45	310	40	B90	
205	0.12/0.25	14.00(15.50	0.030	0.030	0.50	16.50 18.00	1.00 1.75		0.32/0.40N	120.5	831	69	476	58	B98	(Plate
301	0.15	2.00	0.045	0.030	1.00	16.00 18.00	6.00 8.00			110	758	40	276	60	B85	
302	0.15	2.00	0.045	0.030	1.00	17:00:19:00	8.00/10/00			90	612	40	276	50	B85	
302B	0.15	2.00	0.045	0.030	2 00 3 00	17.00 19.00	8.00 10.00			95	655	40	276	55	B85	
303	0.15	2 00	0.20	0.15 mm	1.00	17:00 19:00	8.00 10.00	0.60*		90	621	35	241	50		(Ba
3035e	0.15	2.00	0.20	0.060	1.00	17.00 19.00	8.00 10.00		0.15Se (min)	90	621	35	241	50		(Bar
304	0.06	5.00	0.045	0.030	1.00	18.00 20.00	8.00 10 50			84	579	42	290	55	880	
304L	0.030	2.00	0.045	0.030	1.00	18 00 20 00	8.00/12.00			81	558	39	269	55	879	
530430	0.08	2.00	0.045	0.030	1.00	17.00 19.00	8.00 10.00		3.00/4.00Cu	73	503	31	214	70	B70	(Wire
304N	0.08	2.00	0.045	0.030	1 00	18.00/20.00	8.00 10.50		0.10/0.16N	90	621	48	331	50	B85	
305	0.12	2.00	0.045	0.030	1.00	17.00 19.00	10.50 13.00			85	586	38	262	50	B80	
308	0.08	2.00	0.045	0.030	1.00	19.00 21.00	10.00 12.00			115	793	80	552	40		(Wire
309	0.20	2.00	0.045	0.030	1.00	22.00 24.00	12.00/15.00			90	621	45	310	45	B85	
309S	0.08	2 00	0.045	0.030	1.00	22.00/24.00	12.00 15.00			90	621	45	310	45	B85	
310	0.25	2.00	0.045	0.030	1.50	24.00/26.00	19.00/22.00			95	655	45	310	45	B85	
3105	0.08	2.00	0.045	0.030	1.50	24.00/26.00	19 00 22 00			95	655	45	310	45	B85	
314	0.25	2.00	0.045	0.030	1.50/3.00	23.00/26.00	19.00/22.00			100	689	50	345	40	B85	
316	0.08	2.00	0.045	0.030	1.00	16.00/18.00	10.00 14.00	2.00/3.00		84	579	42	290	50	B79	
316F	0.08	2 00	0.20	0.10mm	1.00	16.00/18.00	10.00/14.00	1.75 2.50		85	586	38	262	60	B85	
316L	0.030	2.00	0.045	0.030	1.00	16.00/18.00	10.00/14.00	2 00/3 00		81	558	42	290	50	B79	
116N	0.08	2.00	0.045	0.030	1.00	16.00/18.00	10.00/14.00	2.00/3.00	0.10/0.16N	90	621	48	331	48	B85	
317	0.08	2.00	0.045	0.030	1.00	18.00/20.00	11.00/15.00	3.00/4.00		90	621	40	276	45	B85	
17L	0.030	2.00	0.045	0.030	1.00	18.00/20.00	11.00/15.00	3 00/4 00		86	593	38	262	55	B85	
17LMN	0.030	2.00	0045	0.030	0.75	17.00/20.00	13.50/17.50	400/500	0.10/0.20N	96	662	54	373	49	888	
121	0.08	2.00	0.045	0.030	1.00	17.00-19.00	9.00 12.00		5xC Ti (min.)	90	621	35	241	45	B80	
130	0.08	2.00	0.040	0.030	0.75/1.50	17.00/20.00	34.00/37.00		0.10Ta 0.20Cb	80	552	38	262	40	B80	
147	0.08	2.00	0.045	0.030	1.00	17.00:19.00	9.00/13.00		10xC Cb (mn)	95	655	40	276	45	B85	
48	0.08	2.00	0.045	0.030	1.00	17.00/19.00	9.00/13.00	Tai	+ Ta 10xC (min) 0.10 max 0.20 max	95	655	40	276	45	B85	
84	0.08	2.00	0.045	0.030	1.00	15.00/17.00	17.00/19.00	- 50	S. S. S. THUY	75	517	35	241	55	B70	(Wire

^{*} May be added at manufacturer's option.



Ferritic Grade Stainless Steels

Stainless Steels of the ferritic family, have low carbon (.08 to .20%), high chromium but <u>no</u> nickel, and identified by the 400 series numbers. As such they do not harden by heat treatment. They are all magnetic, resist corrosion and oxidation, and are highly resistant to stress induced cracking. They can be cold worked and softened by annealing. They are highly resistant to atmospheric oxidation and strong oxidizing solutions. As a group, they are more corrosion resistant than the martensitic grades, but inferior to the austenitic grades. They are typically used for decorative trim, sinks, and automotive applications, particularly exhaust systems. For chemical and physical properties of ferritic stainless steels see tables 3 & 4.

Basic properties

- moderate to good corrosion resistance increasing with chromium content
- not hardened by heat treatment
- always used in the annealed condition
- magnetic
- poor welding properties
- formability not as good as austenitics

Ferritic Stainless Steels

Table 3 Chemical Analysis % (Max. Unless otherwise noted)

Type	Cr	Ni	С	Mn	Р	S	Si	Мо	Other
405	11.50/14.50	0.60	0.08	1.00	0.040	0.030	1.00		0.10/0.30 Al
409	10.50/11.75	0.50	0.08	1.00	0.045	0.045	1.00		6x C/0.75 Ti
429	14.00/16.00	0.75	0.12	1.00	0.040	0.030	1.00		
430	16.00/18.00	0.75	0.12	1.00	0.040	0.030	1.00		
430F	16.00/18.00		0.12	1.25	0.060	0.015 (min)	1.00	0.60	
430F Se	16.00/18.00		0.12	1.25	0.060	0.060	1.00		0.15 Se (min)
434	16.00/18.00		0.12	1.00	0.040	0.030	1.00	0.75/1.25	, ,
436	16.00/18.00		0.12	1.00	0.040	0.030	1.00	0.75/1.25	
442	18.00/23.00	0.60	0.20	1.00	0.040	0.030	1.00		
446	23.00/27.00	0.75	0.20	1.50	0.040	0.030	1.00		0.25 N

Ferritic Stainless Steels

Table 4 Mechanical Properties (Annealed Sheet Unless otherwise noted)

Туре	Tensile	Strength		Strength offset)	Elongation in 2" (50.80mm)	Hardness (Rockwell)	Product Form
	Ksi	MPa	Ksi	MPa	%	,	
405	65	448	40	276	25	B75	
409	65	448	35	241	25	B75	
429	70	483	40	276	30	B80	Plate
430	75	517	50	345	25	B85	
430F	95	655	85	586	10	B92	
430F Se	95	655	85	586	10	B92	Wire
434	77	531	53	365	23	B83	
436	77	531	53	365	23	B83	
442	80	552	45	310	20	B90	Bar
446	80	552	50	345	20	B83	



Martensitic Grade Stainless Steels

The martensitic grades are straight chromium steels containing no nickel. They are a group of stainless alloys that are corrosion resistant, hardened by heat treating and are magnetic. They are suited for applications that require corrosion resistance, hardness, strength, and wear resistance (resist atmospheric oxidation, mildly corrosive chemicals and wet or dry corrosion, such as in steam and gas turbine parts, bearings and cutlery). For chemical properties of martensitic stainless steels see tables 5 & 6.

Basic properties

- moderate corrosion resistance
- hardened by heat treatment (high strength and hardness levels obtainable)
- poor welding properties
- magnetic

Martensitic Stainless Steels

Table 5 Chemical Analysis % (Max. Unless otherwise noted)

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Туре	Cr	Ni	С	Mn	Р	S	Si	Мо	Other
403	11.50/13.00		0.15	1.00	0.040	0.030	0.50		
410	11.50/13.50		0.15	1.00	0.040	0.030	1.00		
414	11.50/13.50	1.25/2.50	0.15	1.00	0.040	0.030	1.00		
416	12.00/14.00		0.15	1.25	0.060	0.015 (min)	1.00	0.60*	
416 Se	12.00/14.00		0.15	1.25	0.060	0.060	1.00		0.15 Se (min)
420	12.00/14.00		0.12	1.20	0.040	0.030	1.00		
420 F	12.00/14.00		0.15 (min)	1.25	0.060	0.015 (min)	1.00	0.60*	
422	11.00/13.00		0.15 (min)	1.00	0.025	0.025	0.75	0.75/1.25	0.15/0.30 V
431	15.00/17.00	0.50/1.00	0.20/0.25	1.00	0.040	0.030	1.00		0.75/1.25 W
440 A	16.00/18.00		0.60/0.75	1.00	0.040	0.030	1.00	0.75	
440 B	16.00/18.00		0.75/0.95	1.00	0.040	0.030	1.00	0.75	
440C	16.00/18.00	1.25/2.50	0.95/1.20	1.00	0.040	0.030	1.00	0.75	

Martensitic Stainless Steels

Table 6 Mechanical Properties (Annealed Sheet Unless otherwise noted)

Туре	Tensile	Strength	Yield Strength (0.2% offset)		Elongation in 2" (50.80mm)	Hardness (Rockwell)	Product Form
	Ksi	MPa	Ksi	MPa	` %	,	
403	70	483	45	310	25	B80	
410	70	483	45	310	25	B80	
414	120	827	105	724	15	B98	
416	75	517	40	276	30	B82	Bar
416 Se	75	517	40	276	30	B82	Bar
420	95	655	50	345	25	B92	Bar
420 F	95	655	55	379	22	220 (Brinell)	Bar
422	145	1000	125	862	18	320 (Brinell)	Bar
431	80125	862	95	655	20	C24	Bar
440 A	105	724	60	414	20	B95	Bar
440 B	107	738	62	427	18	B96	Bar
440C	110	738	65	448	14	B97	Bar

Product Specifications ASPEN FASTENERS Inc. Stainless Steel



Precipitation Hardening Stainless Steels

Precipitation Hardening stainless steels can be hardened by a combination of a low-temperature aging treatment and cold working. They are identified by UNS numbers (e.g. Type S17400), but often referred to by proprietary trade names (eg 17-4PH). Precipitation hardening stainless steels are particularly useful because uniform hardening can be obtained without a high-temperature treatment that can result in distortion and scaling. For chemical and physical properties of precipitation hardening stainless steels see tables 7 & 8.

Basic properties

- moderate to good corrosion resistance
- very high strength
- good welding properties
- magnetic

Precipitation Hardening Stainless Steels

Table 7 Chemical Analysis % (Max. Unless otherwise noted)

	one mean and the second of the												
Туре	Cr	Ni	С	Mn	Р	S	Si	Мо	Other				
S13800	12.25/13.25	7.50/8.50	0.05	0.10	0.010	0.008	0.10	2.00/2.50	0.90/1.35 Al/0.01 N				
S15500	14.00/15.50	3.50/5.50	0.07	1.00	0.040	0.030	1.00		2.50/4.50 Cu 0.15/0.45 Cb + Ta				
S17400	15.50/17.50	3,005.00	0.07	1.00	0.040	0.030	1.00		3.00/5.00 Cu 0.15/0.45 Cb + Ta				
S17700	16.00/18.00	6.50/7.75	0.09	1.00	0.040	0.040)	0.040		0.75/1.50 Al				

Precipitation Hardening Stainless Steels

-	Table 8	Mechanical Pro	perties ((Annealed	Sheet Unless oth	erwise noted)
Γ	Type	Tensile Strength	Yield	Strength	Elongation in	Hardness

Туре	Tensile	Strength	Yield Strength (0.2% offset)		Elongation in 2" (50.80mm)	Hardness (Rockwell)
	Ksi	MPa	Ksi	MPa	%	, ,
S13800	160	1103	120	827	17	C33
S15500	160	1103	145	1000	15	C35
S17400	160	1103	145	1000	15	C35
S17700	130	896	40	276	10	B90



Duplex Grade Stainless Steels

DUPLEX stainless steels are characterized by their 50% austenitic 50% ferritic structures, containing relatively high chromium (between 18 and 28%) and moderate amounts of nickel (between 4.5 and 8%). The nickel content is insufficient to generate a fully austenitic structure and the resulting combination of ferritic and austenitic structures is called duplex. Most duplex steels contain molybdenum in a range of 2.5 - 4% which allow these materials to offer the corrosion resistance for the austenitic grades of material while providing good design properties. For chemical and physical properties of duplex stainless steels see tables 9, 10 & 11.

Basic properties

- high resistance to stress corrosion cracking
- increased resistance to chloride ion attack
- higher tensile and yield strength than austenitic and ferritic steels
- good welding properties and formability
- work hardened
- magnetic

Duplex Stainless Steels

Table 9

Chemical analysis %

Grade	UNS No	Typical Compositions (%)										
Grade		С	Mn	Si	Р	S	Cr	Мо	Ni	N	Cu	
2205	S31803/S32205	0-0.03	2.00	1.00	0-0.03	0-0.03	21-23	2.5-3.5	4.5-6.5	0.08-0.2	-	
UR52N+	S32520/S32550	0.03max	1.50	0.80	0.035	0.035	34-36	3.0-5.0	5.5-8	0.2-0.35	.5-3	

Duplex Stainless Steels

Table 10 Mechanical Properties

Grade	Tensile Strength (MPa)	Proof Stress 0.2% (MPa)	Elongation A5 (%)
2205	620	450	25
UR52N+	770	550	25

Duplex Stainless Steels

Table 11

Physical Properties

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Common Name		Density (g.cm³)	Modulus of Elasticity (GPa)	Electrical Resistivity (Ω.m)	Thermal Conductivity (W/m.K)	Thermal Expansion (m/m.K)	
	2205	7.805	200	0.085x10 ⁻⁶	19 at 100°C	13.7x10 ⁻⁶ to 100°C	
	UR52N+	7.81	205	0.085x10 ⁻⁶	17 at 100°C	13.5x10 ⁻⁶ to 200°C	



Stainless Steel Fasteners

The two primary methods for producing fasteners; machining and cold heading still apply in the fabrication of stainless steel fasteners.

MACHINING is common for very large diameters and for small production runs. However machining disrupts the structural integrity of the alloy particularly in the head-to-shank area causing a reduction in load-carrying capability as well as fatigue resistance.

COLD HEADING a common and economical method of forming wire into various types of standard and specialty bolts, screws, nails and rivets, particularly for large production runs. Cold heading also cold works the alloy resulting in significant increases in strength for the 300 Series austenitic steels.

Following heading, the blank is ready for secondary processes like threading. This is achieved typically by either cutting or rolling. The best quality highest-strength thread is achieved by thread rolling because it is considered a form of cold working and thus increases yield and tensile strength of the austenitic family of alloys.

TENSILE STRENGTH ultimately determines how much load the fastener can carry before failure. Yield strength is a measure of the resistance to deformation under load, both of which can be increased by either cold working or heat treating see Table 12



Table 12

MECHANICAL PROPERTIES OF STAINLESS STEEL BOLTS. SCREWS. STUDS AND NUTS (per ASTM F593-91)

MECHANICAL PROPERTIES OF STAINLESS STEEL BOLTS, SCREWS, STUDS AND NUTS (per ASTM F593-91)							13-91)		
	BOLTS, SCREWS AND STUDS						NUTS		
		FULL SIZE BOLTS, SCREWS, STUDS		MACHINED TEST SPECIMENS OF BOLTS, SCREWS, STUDS					
GRADE	DESCRIPTION	YIELD ² STRENGTH min ksi	TENSILE STRENGT H min ksi	YIELD ² STRENGTH min ksi	TENSILE STRENGTH min ksi	ELON- GATION ³ % Min	HARDNESS ROCKWELL Min	PROOF LOAD STRESS ksi	HARDNESS ROCKWELL Min
303 304	Austenitic Sol ⁿ annealed 30		75	30	75	20	B75	75	B75
304 305 316 384 XM7	Austenitic Cold Worked	50	90	45	85	20	B85	90	B85
304 305 316	Austenitic Strain Hardened	-> 5/8" 100 5/8" -> 1" 70 1" -> 1-1/2" 50		90 65 45	115 100 85	16	C25	125 105 90	C20
410 416	Martensitic Hardened and Tempered*	95	125	95	125	20	C22	125	C22
410 416	Martensitic Hardened and Tempered**	135	180	135	180	12	C36	180	C36
430	Ferritic	40	70	40	70	20	B75	70	B75

^{*} hardened and tempered at 1100°F min.

^{**} hardened and tempered at 525°F± 50°F



SHEAR STRENGTH - Shear is resistance to lateral forces perpendicular to the axis of the material. It is defined as the load required to cause rupture, divided by the cross sectional area in square inches of the part along the rupture plane. Acceptable shear stresses for stainless steel bolts are given in Table 13.

Table 13 Permitted Shear Stress of Stainless Steel Bolts

		Condition & Specification	Dia (in.)	Min. Tensile	e Requirement	Shear Stress (ksi)	
Туре	Finish			0.2% Yield Strength (ksi)	Tensile Strength (ksi)	No Threads in Shear Plane	Threads in Shear Plane
302 304 316	Hot Finished	Condition A (Annealed) in ASTM A276-71 Class 1 (solution treated) in ASTM A193-71	all	30	75	15	10.5
302 304 316	Cold Finished	Condition A (Annealed) in ASTM A276-71	=1/2</td <td>45</td> <td>90</td> <td>18</td> <td>12.6</td>	45	90	18	12.6
302 304 316	Cold Finished	Condition B (cold-worked) in ASTM A276-71 Class 2 (solution treated and strain hardened) in ASTM A193-71*	=3/4</td <td>100</td> <td>125</td> <td>25</td> <td>17.5</td>	100	125	25	17.5

TORQUE – defined as the twisting force applied to a fastener. Table 14 illustrates maximum torque acceptable for 304 and 3-16 stainless steel fasteners.



Table 14 Maximum Torque for Stainless Steel Bolts

BOLT SIZE	304	316	BOLT SIZE	304	316
2-56	2.5	2.6	7/16"-14	376	393
2-64	3	3.2	7/16"-20	400	418
3-48	3.9	4	1⁄2"-13	517	542
3-56	4.4	4.6	1/2"-20	541	565
4-40	5.2	5.5	9⁄16"-12	682	713
4-48	6.6	6.9	9⁄16"-18	752	787
5-40	7.7	8.1	5⁄8"-11	1110	1160
5-44	9.4	9.8	5⁄8"-18	1244	1301
6-32	9.6	10.1	3⁄4"-10	1530	1582
6-40	12.1	12.7	3⁄4"-16	1490	1558
8-32	19.8	20.7	7/8"-9	2328	2430
8-36	22	23	7⁄8"-14	2318	2420
10-24	22.8	23.8	1"-8	3440	3595
10-32	31.7	33.1	1"-14	3110	3250
1/4"-20	75.2	78.8	11⁄8"-7	413	432
1/4"-28	94	99	11⁄8"-12	390	408
5⁄16"-18	132	138	11⁄4"-7	523	546
5⁄16"-24	142	147	11⁄4"-12	480	504
3⁄8"-16	236	247	11⁄2"-6	888	930
3⁄8"-24	259	271	11⁄2"-12	703	732

Torque values upto 1" diameter are in inch pounds; over 1" diameter in foot pounds.

Disclaimer

All technical, mechanical and chemical information in this document was obtained from publicly available sources and not acquired through standards agencies. It has been completed and compiled for reference purposes only; where discrepancies are found they are subject to change without notice. Aspen Fasteners makes no warranties or representations regarding the accuracy and validity of any of the compiled information and data. Contact the relevant standards authorities for accurate and detailed information. Our expertise is limited to the marketing and distribution of fasteners. We are not manufacturers, designers or engineers and not able to offer advice with specific applications. Therefore, it is the responsibility of those using this information to select the proper part and to test those parts at a level that is commensurate with the nature of the application.



Stainless Steel Fastener Types In Stock at Aspen Fasteners

Materials:

18-8, 316, 410 stainless steel

Plating:

stainless steel are typically available with no additional coating, but in some cases are also available with a black oxide and oil finish is available.

Inch and Metric Stainless Steel Bolts:





Stainless Steel Flange Bolts



Stainless Steel hanger Bolts









Inch and Metric Stainless Steel Nuts:

Stainless Steel Spring Nuts



Stainless Steel Cage Nuts



Stainless Steel hex Nuts









Stainless Steel Weld Nuts



Stainless Steel Wing Nuts



Inch and Metric Stainless Steel Screws:

Stainless Steel Deck Screws





Stainless Steel Hi Lo Tapping Screws



Stainless Steel lag Screws



Stainless Steel machine Screws



Stainless Steel plastite Screws



Stainless Steel Self Drilling Screws





Stainless Steel Self Piercing Screws



Stainless Steel Self Tapping Screws



Stainless Steel Sems Screws



Stainless Steel Taptite Screws



Stainless Steel Thread Cutting Screws





Stainless Steel Thumb Screws



Stainless Steel U Drive Screws

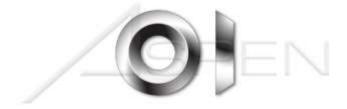


Stainless Steel Wood Screws



Inch and Metric Stainless Steel Washers:

Stainless Steel Countersunk Finishing Washers





Stainless Steel Flat Washers



Stainless Steel lock Washers



Stainless Steel tooth lock Washers

