

Bolt Tension & Shear - ASD Allowables by Grade

Allowable tension and shear per bolt by grade and diameter, ASD. Area (A_b) · Tensile stress (F_{nt}) · Shear stress (F_{nv}) · Safety factor (Ω) · Ultimate strength (F_u)

TECHNICAL NOTES: HOW THE ALLOWABLE IS DERIVED

$$T_{\text{allow}} = F_{nt} \cdot A_b / \Omega \quad V_{\text{allow}} = F_{nv} \cdot A_b / \Omega$$

$$A_b = (\pi/4) \cdot d^2 \quad \Omega = 2.00 \quad \text{Group} = n \times \text{single bolt}$$

$$\text{A449: } F_{nt} = 0.75 F_u, F_{nv} = 0.450 F_u \quad (F_u \text{ steps with } d)$$

$$\text{SAE / ISO Quick Ref: } T = F_u \cdot A_b / 2.5, V = 0.60 F_u \cdot A_b / 2.5$$

A_b is gross nominal shank area, not thread root or stress area. ASTM grades: AISC 360 Table J3.2 nominal stresses over $\Omega = 2.00$, threads included (N). A449 has no J3.2 row; designed as a threaded part. SAE J429 and ISO are material specs with no published allowables: 04-2 values are Quick Ref calculated values, not a connection basis.

GRADE	F_u	F_{nt}	F_{nv}	BASIS
A307	60	45	27	J3.2, Ω 2.00
F3125 A325	120	90	54	J3.2, Ω 2.00
F3125 A490	150	113	68	J3.2, Ω 2.00
A449 (≤ 1 in)	120	90	54	0.75/0.45 F_u
A325M/A490M	830/1040	620/780	372/469	J3.2, MPa

ksi unless noted. Bearing-type. Snug-tight only where AISC/RCSC allow it; pretensioning may be required (e.g. A490 in tension, load reversal, fatigue).

WORKED EXAMPLE: 3/4 IN A325, SINGLE SHEAR

Given: F3125 A325, $d = 3/4$ in, threads included (N), bearing-type

- $A_b = (\pi/4)(0.75)^2 = 0.442 \text{ in}^2$
- $T_{\text{allow}} = 90 \times 0.442 / 2.00 = 19.9 \text{ kip}$
- $V_{\text{allow}} = 54 \times 0.442 / 2.00 = 11.9 \text{ kip}$
- Six bolts: $6 \times 11.9 = 71.6 \text{ kip}$ (one shear plane each)

19.9 kip tension and 11.9 kip shear per bolt. The same bolt in A490 gives 25.0 kip and 15.0 kip. Shear is 60% of tension for every ASTM grade on this sheet.

CONSIDERATIONS

- **Oversized & slotted holes.** Permitted only where allowed by AISC/RCSC. Increased hole clearance can affect slip, bearing, tearout, net section and edge-distance requirements. Additional detailing and installation requirements may apply.
- **Slip-critical connections.** Not covered by these tables. Additional design and installation requirements apply.
- **A449 applications.** A449 is not permitted in slip-critical joints and is not a substitute for F3125 A325/A490. Verify applicability where larger-diameter bolts are required. F1554 governs anchor rods.

BOLT LENGTH

Length $\approx$ Grip + Washers + Nut + Stick-through

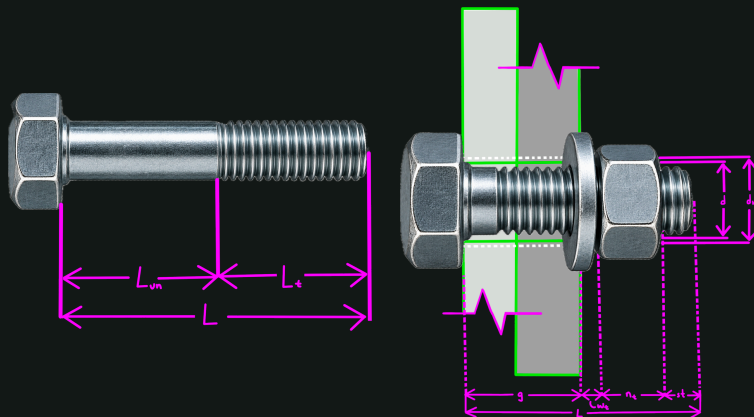
Length = Unthreaded length + Threaded length

Grip (g) · Washer thickness (w_t) · Nut thickness (n_t) · Stick-through (s_t) · Length (L) · Unthreaded length (L_{un}) · Threaded length (L_t) · Bolt diameter (d) · Hole diameter (d_h)

Grip is the total thickness of connected material. Stick-through is the bolt end past the nut after tightening.

STANDARD HOLE SIZE (MANUAL TABLE J3.3)

BOLT DIAMETER, D	STD. HOLE	EXAMPLE
1/4" to 7/8"	$d + 1/16"$	3/4" bolt $\rightarrow$ 13/16" hole
1" and larger	$d + 1/8"$	1" bolt $\rightarrow$ 1-1/8" hole



FIELD NOTES

- **Spacing & edge distance.** Spacing: $2-2/3 d$ minimum (J3.3); $3 d$ typical for detailing. Verify minimum edge distance using AISC Table J3.4.
- **Application may govern over bolt capacity.** Bolt capacity does not govern the connection. Check the surrounding material and connection geometry for bearing, tearout, block shear and net section.
- **Double shear.** Double shear increases shear strength, not tension. Count the shear planes, not the plies.
- **Threads in shear plane.** Values shown are based on threads included in the shear plane (N). Threads excluded (X) may provide increased shear strength where permitted by the connection detail; use the applicable AISC value.
- **A490 coating.** A490 is not hot-dip galvanized. Qualified alternative coatings exist; verify against ASTM F3125 / RCSC.

Bolt Tension & Shear - Allowable Load Tables

Allowable T and V per bolt, one shear plane, threads included, gross area A_b . ASTM: J3.2, $\Omega = 2.00$ · SAE / ISO: Quick Ref Method, F.S. 2.5

ASTM STRUCTURAL BOLTS — A307 · F3125 A325 · F3125 A490 — IMPERIAL, KIP

DIA.	A_B IN ²	TENSION, T (F_{NT})			SHEAR, V (F_{NV})		
		A307	A325	A490	A307	A325	A490
1/2"	0.196	4.4	8.8	11.1	2.7	5.3	6.7
5/8"	0.307	6.9	13.8	17.3	4.1	8.3	10.4
3/4"	0.442	9.9	19.9	25.0	6.0	11.9	15.0
7/8"	0.601	13.5	27.1	34.0	8.1	16.2	20.4
1"	0.785	17.7	35.3	44.4	10.6	21.2	26.7
1-1/8"	0.994	22.4	44.7	56.2	13.4	26.8	33.8
1-1/4"	1.227	27.6	55.2	69.3	16.6	33.1	41.7
1-1/2"	1.767	39.8	79.5	99.8	23.9	47.7	60.1

Allowable = $F_n \cdot A_b / 2.00$. F_{nt} / F_{nv} : A307 45 / 27, A325 90 / 54, A490 113 / 68 ksi (AISC 360 Table J3.2, threads included). Bearing-type; bolt strength only. T and V not simultaneously available (J3.7).

ASTM A449 — IMPERIAL, KIP

DIA.	A_B IN ²	F_U KSI	F_{NT}	F_{NV}	T	V
1/2"	0.196	120	90.0	54.0	8.8	5.3
5/8"	0.307	120	90.0	54.0	13.8	8.3
3/4"	0.442	120	90.0	54.0	19.9	11.9
1"	0.785	120	90.0	54.0	35.3	21.2
1-1/8"	0.994	105	78.8	47.2	39.1	23.5
1-1/4"	1.227	105	78.8	47.2	48.3	29.0
1-1/2"	1.767	105	78.8	47.2	69.6	41.7
3"	7.069	90	67.5	40.5	238.6	143.1

AISC 360 A3.4 threaded part: $F_m = 0.75 F_u$, $F_{nv} = 0.450 F_u$, $\Omega = 2.00$. F_u 120 ksi to 1 in, 105 to 1-1/2 in, 90 above. Not for slip-critical joints; not an F3125 substitute.

ASTM F3125 A325M · A490M — METRIC, KN

DIA.	A_B MM ²	A325M		A490M	
		T	V	T	V
M12	113	35.1	21.0	44.1	26.5
M16	201	62.3	37.4	78.4	47.1
M20	314	97.4	58.4	122.5	73.7
M24	452	140.2	84.1	176.4	106.1
M30	707	219.1	131.5	275.7	165.8
M36	1018	315.5	189.3	397.0	238.7

F_m / F_{nv} : A325M 620 / 372, A490M 780 / 469 MPa (Table J3.2, threads included), $\Omega = 2.00$. F3125 covers M12 to M36. kip = kN / 4.448.

■ SAE J429 QUICK REF METHOD — KIP over kN

DIA.	TENSION, T				SHEAR, V			
	GR 1	GR 2	GR 5	GR 8	GR 1	GR 2	GR 5	GR 8
1/2"	4.7	5.8	9.4	11.8	2.8	3.5	5.7	7.1
12.7 mm	21.0	25.9	41.9	52.4	12.6	15.5	25.2	31.4
5/8"	7.4	9.1	14.7	18.4	4.4	5.4	8.8	11.0
15.9 mm	32.8	40.4	65.5	81.9	19.7	24.2	39.3	49.1
3/4"	10.6	13.1	21.2	26.5	6.4	7.8	12.7	15.9
19.0 mm	47.2	58.2	94.3	117.9	28.3	34.9	56.6	70.7
1"	18.8	18.8	37.7	47.1	11.3	11.3	22.6	28.3
25.4 mm	83.8	83.8	167.7	209.6	50.3	50.3	100.6	125.8
1-1/4"	29.5	29.5	51.5	73.6	17.7	17.7	30.9	44.2
31.8 mm	131.0	131.0	229.3	327.5	78.6	78.6	137.6	196.5
1-1/2"	42.4	42.4	74.2	106.0	25.4	25.4	44.5	63.6
38.1 mm	188.6	188.6	330.1	471.6	113.2	113.2	198.1	283.0

STL calculated reference values ($T = F_u \cdot A_b / 2.5$, $V = 0.60 F_u \cdot A_b / 2.5$); not SAE J429 structural connection design allowables, not AISC values. SAE J429 min. F_u steps with diameter: Gr 1 60; Gr 2 74 to 3/4 in, 60 above; Gr 5 120 to 1 in, 105 above; Gr 8 150 ksi. Machine fasteners, not a connection basis. A_b as in the ASTM table. 1 in = 25.4 mm, 1 kip = 4.448 kN.

■ ISO 898-1 QUICK REF METHOD — kN over KIP

DIA.	TENSION, T			SHEAR, V		
	4.6	8.8	10.9	4.6	8.8	10.9
M12	10.9	29.0	40.7	6.5	17.4	24.4
0.472 in	2.4	6.5	9.2	1.5	3.9	5.5
M16	19.3	51.5	72.4	11.6	30.9	43.4
0.630 in	4.3	11.6	16.3	2.6	6.9	9.8
M20	30.2	80.4	113.1	18.1	48.3	67.9
0.787 in	6.8	18.1	25.4	4.1	10.8	15.3
M24	43.4	115.8	162.9	26.1	69.5	97.7
0.945 in	9.8	26.0	36.6	5.9	15.6	22.0
M30	67.9	181.0	254.5	40.7	108.6	152.7
1.181 in	15.3	40.7	57.2	9.2	24.4	34.3
M36	97.7	260.6	366.4	58.6	156.3	219.9
1.417 in	22.0	58.6	82.4	13.2	35.1	49.4

Deliberately conservative STL reference method, not an ISO 898-1 design allowable: nominal class yield (240, 640, 900 MPa) in place of tensile strength, 2.5 factor of safety, on gross nominal area A_b (as in the A325M table), not the ISO 898-1 stress area A_s . ISO 898-1 min. tensile: 400 / 800 (830 above M16) / 1040 MPa. Not a connection basis; use A325M / A490M. kip = kN / 4.448.