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TechNote

Innovative Measurement Solutions

BOLT TORQUE SPECIFICATIONS

The below estimated torque calculations are only offered as a guide. Use of its content by anyone is the sole responsibility of that person and they assume all risk. Due to many variables that affect the torque-tension relationship like human error, surface texture, and lubrication the only way to determine the correct torque is through experimentation under actual joint and assembly conditions.

ASTM A354-BD / SAE GRADE 8*

Bolt Size	TPI	Proof Load (lbs)	Clamo Load (lbs)	Tightening Torque (ft/lbs)	
				Lubricated	Plain
1/4	20	3,800	2,850	6	12
5/16	18	6,300	4,725	12	25
3/8	16	9,300	6,975	22	44
7/16	14	12,750	9,563	35	70
1/2	13	17,050	12,788	53	107
9/16	12	21,850	16,388	77	154
5/8	11	27,100	20,325	106	212
3/4	10	40,100	30,075	188	376
7/8	9	55,450	41,588	303	606
1	8	72,700	54,525	454	909
1-1/8	7	91,550	68,663	644	1,287
1-1/4	7	120,000	90,000	938	1,875
1-3/8	6	138,600	103,950	1,191	2,382
1-1/2	6	168,600	126,45	1,581	3,161
1-3/4	5	228,000	171,000	2,494	4,988
2	4-1/2	300,000	225,000	3,750	7,500
2-1/4	4-1/2	390,000	292,500	5,484	10,969
2-1/2	4	480,000	360,000	7,500	15,000
2-3/4	4	517,650	388,238	8,897	17,794
3	4	626,850	470,138	11,753	23,507
3-1/4	4	745,500	559,125	15,143	30,286
3-1/2	4	874,650	655,988	19,133	38,266
3-3/4	4	101,430	760,725	23,773	47,545
4	4	1,163,400	872,550	29,085	58,100

*SAE J429 grade 8 botls do not exceed 1-1/2” diameter

For additional Bolt-Torque specifications data, please visit Portland Bolt & Manufacturing at **www.portlandbolt.com**

Explanation of Terms

[1] Proofload is the published number that full size headed bolts are tested to. The bolt is stressed up to the proofload value, and if there is no deformation, elongation, or fracture, then the bolt is deemed to have passed. For bolting specifications that do not have a published proofload, it is usually calculated at 92% of ultimate yield strength.

[2] Clampload is calculated at 75% of proofload. This is done to allow a safety buffer so that the bolt does not get too close to the proofload value. If you exceed the proofload value when tensioning the bolt, you run the risk of bolt failure. Clampload is only a estimated number, there maybe situations where the engineer calls for the bolts to be tensioned to a different value.

Notes:

- Values calculated using industry accepted formula T = KDP where T = Torque, K = torque coefficient (dimensionless), D = nominal diameter (inches), P = bolt clamp load, lb.
- K values: waxed (e.g. pressure wax as supplied on high strength nuts) = .10, hot dip galvanized = .25, and plain non-plated bolts (as received) = .20.
- Torque has been converted into ft/lbs by dividing the result of the formula by 12
- All calculations are for Coarse Thread Series (UNC).
- Grade 2 calculations only cover fasteners 1⁄4"-3⁄4" in diameter up to 6" long; for longer fasteners the torque is reduced significantly.
- Clamp loads are based on 75% of the minimum proof loads for each grade and size.
- Proof load, stress area, yield strength, and other data is based on IFI 7th Edition (2003) Technical Data N-68, SAE J429, ASTM A307, A325, A354, A449, and A490.

FAQ'S

Can someone explain how tension and torque relates to bolted connections?

We'll try our best. The relationship between tension and torque should be looked at cautiously, since it is very difficult to indicate the range of conditions expected to be experienced by a fastener. Torque is simply a measure of the twisting force required to spin the nut up along the threads of a bolt, whereas tension is the stretch or elongation of a bolt that provides the clamping force of a joint. Bolts are designed to stretch just a tiny bit, and this elongation is what clamps the joint together. Torque is a very indirect indication of tension, as many factors can affect this relationship, such as surface texture, rust, oil, debris, thread series and material type just to name a few. Virtually all the torque/tension tables that have been developed, including ours, are based on the following formula:

$T = (K\ D\ P)/12$

T = Torque (ft-lbs)
D = Nominal Diameter (inches)
P = Desired Clamp Load Tension (lbs)
K = Torque Coefficient (dimensionless)
The value of K is a dimensionless torque coefficient that encompasses variables such as those listed above, as well as the most significant variable, friction. The value of K can range from 0.10 for a well lubricated/waxed assembly, to over 0.30 for one that is dirty or rusty. The values we used when calculating our values are:

0.10 = Waxed/Lubricated
0.20 = Plain, as received condition, slightly oily
0.25 = Hot-Dip Galvanized

FAQ'S continued

The appropriate torque value to use in a specific application is best obtained by using a calibrated torque wrench and a Skidmore-Wilhelm load indicating device to equate actual torque to the desired tension. For ASTM A325 and A490 structural bolts The Research Council on Structural Connections (RCSC) recommends:

The pre-installation verification procedures specified in Section 7 shall be performed daily for the calibration of the installation wrench. Torque values determined from tables or from equations that claim to relate torque to pretension without verification shall not be used.
RCSC Specifications, June 2004, pg. 62, 8.2.2

An alternative and more accurate method for assuring proper tension would be to use a direct tension indicator or DTI. These are available for use with ASTM A325 and A490 structural bolts and are engineered to compress at the proper tension, assuring the installer that the proper clamp load is achieved. Hopefully, this short introduction to bolt connections helps address some of the confusion surrounding this issue.

Do torque charts for tensioning fasteners apply to anchor bolts?

The AISC Steel Construction Manual, 13th Edition has this to say about anchor rod nut installation.

"The majority of anchorage applications in buildings do not require special anchor rod nut installation procedures or pretension in the anchor rod. The anchor rod nuts should be "drawn down tight" as columns and bases are erected. This condition can be achieved by following the same practices as recommended for snug-tightened installation in steel-to-steel bolted joints in the RCSC Specification. That is, most anchor rod nuts can be installed using the full effort of an ironworker with an ordinary spud wrench.
When, in the judgment of the owner's designated representative for design, the performance of the structure will be compromised by excessive elongation of the anchor rods under tensile loads, pretension may be required. Some examples of applications that may require pretension include structures that cantilever from concrete foundations, moment-resisting column bases with significant tensile forces in the anchor rods, or where load reversal might result in the progressive loosening of the nuts on the anchor rods.
When pretensioning of anchor rods is specified, care must be taken in the design of the column base and the embedment of the anchor rod. The shaft of the anchor rod must be free of bond to the encasing concrete so that the rod is free to elongate as it is pretensioned. Also, loss of pretension due to creep in the concrete must be taken into account. Although the design of pretensioned anchorage devices is beyond the scope of this manual, it should be noted that pretension should not be specified for anchorage devices that have not been properly designed and configured to be pretensioned."

So, in a nutshell, what does this mean?
It means, that in normal circumstances, the normal effort of an ironworker with a regular spud wrench is sufficient to tighten the nuts on anchor bolts. In the event that special pretensioning is required, the design engineer should have carefully designed the anchor assembly specifically for that purpose and there should be detailed instructions so that the pretensioning is carried out properly.

How do I calculate torque for construction fasteners?

Torque is a difficult value to calculate accurately, especially for construction fasteners and should be used cautiously. The primary challenge is accounting for environmental factors, coatings, and a number of other variables including surface texture, material hardness, and thread series. In most situations, it is challenging to give reliable allowable torque values for bolted assemblies. For the most accurate data we recommend field testing the intended assemblies using a calibrated torque wrench and a Skidmore-Wilhelm load indicating device to equate actual torque to the desired tension.

The content of this Tech Note was sourced from Portland Bolt & Manufacturing Company, Inc.

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