Tech Tips - *a periodic newsletter*

HIGH STRENGTH THREADED FASTENERS

High Strength threaded fasteners play a major role in the safety of cranes and material handling equipment.

Inspectors and operators of mobile equipment must be aware of certain fundamental issues relating to proper use and security of threaded fasteners.

We start this discussion with some basic facts about threaded fasteners:

1) The primary function of the threaded fastener is to apply a compressive load on the connection that resists opposing static, tensile and dynamic loads.

2) Once connected, the fastener must resist impact, shock, vibration, shear, bend, torque, angular and compressive forces.

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Tech Tip Continued:

3) Not only is the fastener supposed to hold materials together, it must do so safely, and for the duration of the expected service life of the assembly.

4) In order to obtain the required clamping force necessary to resist all external forces, the fastener must be physically stretched.

A fastener is much like a spring, a properly applied load will cause it to stretch. As with the spring, the farther it is stretched, the more opposing resistance is encountered, which relates to clamping force. Because steel wants to return to its original "at rest" position clamping force is provided.

Steel possesses a certain amount of elasticity as it is stretched. The elasticity of steel is what allows the stretched fastener to return to its original dimension once the load is removed, providing it is stretched within its elastic range. Once a bolt is stretched beyond its elastic range, it enters the plastic range. Here the steel starts to take a "set" and will no longer return to its original dimension when the load is removed. The point at which permanent elongation occurs is called the yield strength.

To produce a clamp load, the fastener must be placed in tension. And, if the fastener is not stretched, there is no clamping load.

In the case of a bolt and nut, the bolt stretches elastically, proportional to the amount of nut advancement. As the nut is turned, the threads of both the nut and bolt are forced together under great pressure. This high pressure generates friction between the mating threads creating a torsional twist to the body of the bolt.

In a bolted connection, the bolt must be stretched sufficiently to produce a static preload upon the connection that is greater than the expected external loads. These external loads must be known so the proper grade, diameter, thread pitch and number of fasteners can be selected to accomplish the task safely and without failure.

Common reasons for fastener failure is the use of a grade of bolt which is too low for the application or a load that exceeds the expected fastener strength. For example, we bolt two members together with a 1/2" diameter UNC Grade 5 bolt with a minimum yield strength of 13,055-lbs. and an ultimate tensile strength is 17,030-lbs.

Tech Tip Continued:

If the connection is exposed to a service load of 15,000 pounds the bolt will stretch and stay stretched. When this machinery shuts down and the 15,000 pound load is removed, you have a loose nut on a bolt which is now longer.

A mechanic may check for loose nuts and tighten them. Unfortunately, vibration is blamed for causing the loose nuts, because the mechanic cannot see that inside the hole, ahead of the nut, the bolt has stretched permanently. So the mechanic tightens the loose nut and restarts the machine which impacts the same 15,000 pound load on the connection, and the bolt continues to stretch even farther. When the bolt first experienced yield, it suffered a reduction in area from stretching causing it to become weaker. Consequently, the yield point is now much lower, which means that the bolt will continue to stretch with each additional amount of yield strength lost below 13,050 pounds.

Again the mechanic finds the nut loose and becomes angry having to tighten the same nut again, so this time he may even use a “cheater bar” to really tighten it. If he’s lucky, the bolt will break while he’s tightening it rather than when it is in service. If he replaces the bolt with the same bolt that was initially installed he hasn’t corrected the problem, because he has not properly diagnosed the cause. He will continue getting stretched bolts and loose nuts forever, unless he does one of two things. First, he can drill the hole to the next LARGER DIAMETER and use the same grade of bolt; or he can do it the easy way, use the same diameter but use a HIGHER GRADE bolt.

While the subject of fastener safety is not easily addressed in a short Tech Tip, users must ensure that mechanics are properly trained on high strength fastener application and maintenance. Whenever a loose bolt is discovered a mechanic should first think that the bolt was overloaded, not that it wasn’t tightened sufficiently when initially installed.

Contact your equipment distributors and ask for literature on structural threaded fasteners specific to your equipment. What you learn may prevent a catastrophic loss. And, ALWAYS follow the equipment manufacturer’s recommendations.