by Guy Avellon

Preventing Fastener Failures

There are four factors involved with preventing the failure of a fastener and its connection: ensuring the correct fastener is purchased; proper installation of all fastener components; continued maintenance of the joint; and the repair of the joint.

It is essential to have the correct fastener hardware on hand to meet the needs of production or maintenance.

This is where Engineering and Purchasing need to be informed and on the same page. It is Purchasing's job to procure the products at the lowest possible price. This is fine but it is Engineering's job to deliver the required specifications needed.

For example; if an SAE Grade 8 or ISO 10.9 fastener is specified, then it is expected that the requested products are ordered and delivered. However, if the purchasing request just states 'nuts', without any strength specification, then Purchasing will naturally seek out the lowest cost nut. This could very well be an SAE Grade 2 or ISO Property Class 5. These nuts will not provide the compatibility desired for the connection with the higher strength fasteners.

This appears to be fairly straight forward for production, but maintenance is looked at as being overhead where costs are also scrutinized. Maintenance should have their own separate inventory of fasteners so they do not use any from production, which may be the incorrect strength for the repair. Sometimes, outside contractors can contaminate the inventory of either production or maintenance by returning unused fastener products to storage racks where the products may be totally different or even used.

The same can be said for structural fasteners of the ASTM A325 and A490 types. Have the proper requirements been ordered and received? The nuts should be shipped with the A325 bolts as they were all galvanized and need to pass qualification tests as an assembly. In many cases, ASTM F436 hardened flat washers should be ordered and used together.

ASTM A193 bolts, threaded rods and studs, also known as SA 193, are primarily used for high temperature and pressure vessel applications. These are not to be plated when used in these high temperature applications due to possible liquid metal embrittlement. Studs and threaded rods will be stamped 'B7' on one end to avoid confusion with lesser graded products.

Proper installation of all fastener components goes beyond the methods used for tightening.

It includes joint preparation, joint surface condition, how the fasteners are stored, the types of loads being applied, its environment and the tools used for tightening.

Most structural joints are static loads in shear. Therefore, the condition of the faying surfaces must be considered to assure a solid joint and to avoid failures. For a joint connection to cut a bolt in two, it must slide on its mating surfaces. The rougher the surface area of the joint, the greater will be the shear resistance of the connection. Avoid grease, oil and paint on the surfaces of the connection.

Structural members and equipment are stored outdoors during construction. The slight rust formed on the steel I-beam sections will not interfere with tightening. However, the bolts and nuts supplied in metal containers may leak or not be sufficiently covered. The result will be rusty fasteners.

Red rust and even white corrosion product from zinc coatings will cause an interference fit between the mating threads of the nut and bolt. Therefore, its longevity depends upon the method of installation.

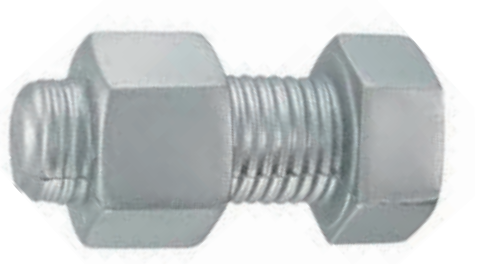
Contractors will qualify a batch of nuts and bolts on the job site using a tension load cell, commonly a Skidmore machine. Here, the load is verified by torque and turn. The most accurate way to tighten the structural fasteners is by the Turn-of-the-Nut method.

Severely rusted fasteners should be avoided. As the saying goes: "rust never sleeps". Connection joints should be designed to avoid trapping water. Oxidation still occurs which will lead to hydrogen embrittlement failure.

When joints are 'snugged' together, a quick inspection must be made to assure the joint surfaces are not separated by bowing, but are in fact together. When tightening the nut, it is also important to be sure the bolt head does not turn in the joint.

Production assembly practices will employ nut runners with a low torque signature. Even so, the fastener is still subject to the Laws of Friction. That is, any type of foreign material, debris in tapped holes, etc., will cause an increase in thread friction and a decrease in clamp load. Make sure all the parts are clean.

Excessive oils, other types of lubricants and even sealants will affect the connection by changing the friction variables between the threads. Lubricants reduce



friction and may cause the bolt to be tightened into yield. Sealants around the assembly area may get on the threads and create a hydraulic tightening effect on the sealant and not the threads. This will cause an under loaded connection subject to vibrational loosening and / or metal fatigue. Too much oil into a threaded hole may cause the bolt to tighten against the oil and not the joint: again, imminent failure.

Maintenance facilities must maintain and repair the shop's equipment. Here, identification is important. The failed parts must be properly identified so the correct replacement parts can be ordered and used. This is especially true with Metric socket head cap screws, as they come in three different Property Classes; 8.8, 10.9 and 12.9. The inch system only has one grade.

Multiple bolt assemblies are sensitive to failure and assembly. If one bolt fails, the adjacent bolts should also be replaced. If more than one bolt fails, all of the bolts or studs must be replaced.

Multiple bolt assemblies should be tightened in a criss-cross pattern to avoid over tightening and cracking the joint. Critical connections, like flanges, should be tightened in increments and with a torque wrench.

Continued maintenance of the joint connection.

A good preventive maintenance program will include visual inspections. Normally, in a sound connection, there is nothing to see wrong. So be aware of any slight differences, especially if there are different shift maintenance personnel who may have replaced some pars or retightened nuts.

Visually inspect for rust leaving a stain mark down the joint from the nut or bolt hole. This is indicative of a loose or broken bolt.

All fasteners were made from an automatic bolt making machine, they should all be the same length. Check flanges or other multiple bolt connections to see if any nuts display more bolt threads sticking out from the nut than the others. If so, the bolt has been tightened into yield. The only way to verify this is to take the bolt out of the connection and check the thread pitch.

Maintenance repair of the joint connection.

With a multiple bolt joint or flange, it is imperative to loosen all of the fasteners, and then retighten the fasteners together with the new bolt. However, once the fasteners have been loosened, the nuts should also be replaced.

Most failures occur because the nuts were reused over and over again. The threads of the nut become deformed enough to cause an increase in thread friction each time it is reused. Using the same torque, or elbow feel, the joint 'feels' tight but it is not. The bolt is now subject to metal fatigue because it is under tightened.

Many failures of this type may be avoided if the threads of the bolt were first lubricated with a metallic anti-seize. This will reduce thread friction. However, lower installation torques must be used to avoid over loading and thread stripping.