For Each Type of Bolting Stress, Another Locking "Dress"

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"The universal locking method of bolted joints that would be equally effective for all types of stresses does not exist" (C. O. Bauer)

The quotation above is probably the most important, but the least respected theorem in the practice and theory of screw connections. Why is that so? The purpose of this article is to try to answer this not easy question.

Stress Analysis of Screw Connections

Boled joints can be in service loaded by forces of different kinds, size and direction (**Figure 1**). The most dangerous force is dynamic stressing because this causes loss of clamp load (pre-stressing force) and in the end joint disintegration as a result of unscrewing or fatigue fracture.

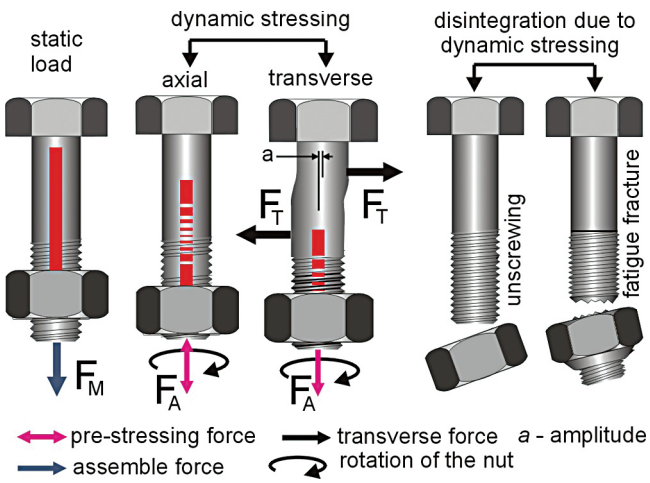

Fig. 1 — Bolting joints can be in service loaded by forces of different kinds, size and direction.

Of course, the stress of the screw connections during operation is more complicated than that shown here. Especially the combination of basic types, which is often the cause of failure. It is an irreplaceable role of the constructor to analyze the stress of the structure and to know the possibilities and limits relative to preventive measures. Shown in **Figure 1** is the difference between dynamic stressing in the axial and transverse direction. For both cases, specific measures must be applied in spirit of the proverb: *for each type of bolting stress another locking "dress".*

Properties of the Most Famous Mechanical Locking Methods & Their Limits

There are many nonstandard ways to secure screw connections. Two of the best known are described in **Figure 2**, and are as follows:

- Friction locking of contact surface represented by nut with serrated flange.

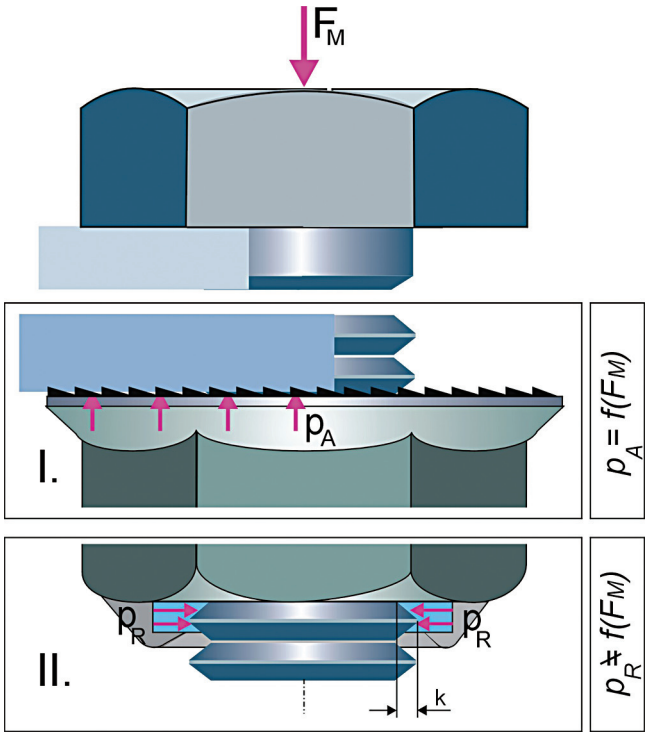

Fig. 2 — The two best known ways to secure screw connections.

- Friction-locking of threads represented by lock nut DIN 985.

The differences between the two are obvious. While in the first case the locking effect p_A is dependent on the montage force, it means $p_A = f(F_M)$ (read p_A is a function of F_M), the lock nut DIN 985 with nylon ring works independently from F_M. This system binds against the opposing threads and creates a prevailing torque. But it cannot prevent the decrease of the preload, and protects against the loss of the nuts and/or screws only. At a high assembly speed, there is a risk of nylon degradation (**Figure 3**) due to heat from friction between nylon and the opposing steel threads.

If we do not consider chemical methods of locking, then all other mechanical methods can be classified into one of the quoted groups. Either they are F_M dependent or not, except for the lock point TaTrim (**Figure 4**). This system is particularly suited to securing the wheels of cars. Its advantage is independence from the montage force or friction.

About Fastener Testing Due to DIN 25201

The role of testing is to determine the point at which a

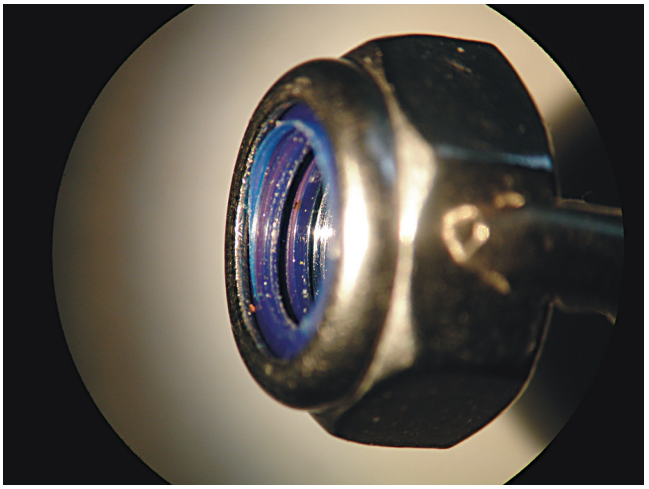

Fig. 3 — Risk of nylon degradation at high assembly speed.

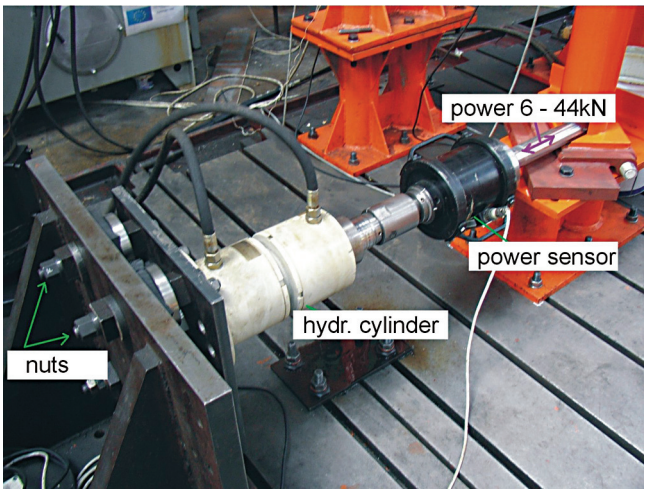

Fig. 5 — EDYZ pulsator test for axial dynamic stress.

Fig. 4 — Lock point TaTrim.

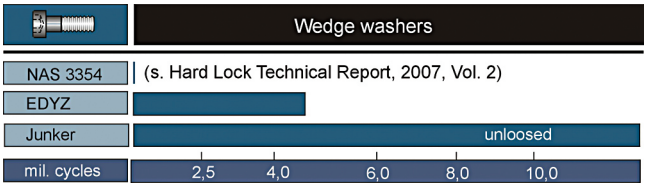

Fig. 6 — Graph showing the dependence of screw behavior on the test method.

bolted joint loses its preload. It is a very important task because it provides information on the effectiveness of selected locking elements.

The quoted standard is based on a known Junker test, which means the tested bolted joints are exposed to shear loading caused by transverse vibration. That should be emphasized.

Gerhard Junker published his perfect Test Bench in 1969 as "New Criteria for Self-Loosening of Fasteners Under Vibration" in the transactions of the **Society of Automotive Engineers**. The Junker test has gradually over the years become a symbol of trust in the fastener industry. In the euphoria of progression in the increase of security, only a few thought about the test's limits. Objective results can only be provided for identically stressed parts (see **Figure 1**). However, the standard does not mention this, which gives the impression of versatility. For axial dynamic stress, the EDYZ test is a more suitable pulsator (**Figure 5**), for example, and for a drastic stress the test relative to the **NAS (National Aerospace Standard)** 3350/3354.

The graph in **Figure 6** demonstrates the dependence of screw behavior on the test method. Known wedge washers showed diametrically different results in the Junker, EDYZ and NAS tests. Furthermore, the Junker test has proven this case to be the most benevolent of all others.

Of course, it is possible to agree with *Vibrationmaster* (Sept. 2011), that: "DIN 25201 represents a significant advance for the fastener industry" (but only with the reservation according to this article).

Conclusion & Recommendation

As there is no universal locking method for all types of bolted joint stresses, there is also not a universal testing method. For that reason, the validity of the standard DIN 25201 should be recognized as follows: "Securing of bolted joints under high transverse vibration." *www.ferodom.sk*

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Company Profile:

Ferodom Ltd. *was established at the end of 2000 as a family enterprise. Selected ware such as fastening materials and anchor techniques are the logical culmination of the company founder's effort to make use of his experience and knowledge in the area of mechanical fastening of steel and other materials by means of threaded or threadless fastening elements such as screws, nuts, washers, rivets, anchors, etc. An experienced team of specialists in collaboration with renowned scientific institutions is ready to offer customers technical know-how for the design of their production, which includes bolted fasteners. We are ready to help our customers in their choice of rational methods of assembly together with quality fastener materials. These two offerings of design and quality materials constitute the pillars of our business strategy.*

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