by Jozef Dominik

Unlocked Bolted Joints - Unstable Construction

"Thursday morning, the loosed wheel of the lorry caused the unordinary accident with serious consequences. Policemen on the spot stated falling 10 fixing nuts from incriminted wheel off, and one of it was found close to the crash. By comprehensive inspection was discovered that on the second wheel another 3 nuts were missing. The case is in the stage of investigation"

As much the short announcement of the press.

The place and the time of accident is not important now not even the result of the investigation where in principle goes just to identificate who is guilty for the insurance office. Because the similar cases are frequent and don't concern the vehicles only, the problem of bolt loosening deserves corresponding care.

Loosening of Bolted Fasteners

Bolted joints are loosened when transverse or axial repeated external loadings are applied to the joints after they have been tightened. Although correctly dimensioned, exactly tightened and washer less, need the external locking, in certain cases. It concerns especially the design joints that are working under strong vibrations and dynamic load in utilisation conditions. As example of the bolt loosening can serve the wheel mounting on the vehicles. If we exclude the incorrect assembly the reasons of dangerous wheel devastation during the ride is the clamp force loss of the bolted joints in the majority of cases. Loosen bolts are causing the deformation of the fastening rim holes (Fig. 1) following by the fatigue failure (Fig. 2) or the whole joint disintegration. Both have equal catastrophic result.

Fig. 1

Fig. 2

Various manufacturers use different wheel fastening design. **In the majority of cases is used the fine pitch threads combined with flange nuts or bolts and nuts with the conical driving fit for increase of friction on the bearing surface.** As shown further quite other principle uses the locking system IstLock (IL) awarded on the Fastener Fair Stuttgart 2009.

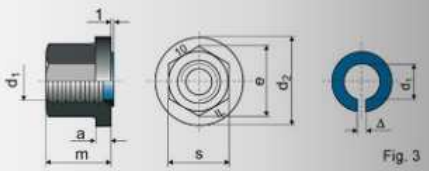

Fig. 3

IstLock System Fundamentals

IL system key-stone rests on application of variable locking ring (VLR) from plastic material (Fig.3 and 4) or from metal on the assembling side of the nut, for higher temperatures. VLR overhang the contact face of the nut by ~1mm. During assembly the VLR is forced to reduce its diameter, which provide the protection against self-loosening. The principle is similar to gripping collet of the machine tools.

Fig. 4

Vibration Loosening Tests

To test the resistance of bolted fasteners against vibration and dynamical loading was used two methods:

a) Transverse repeated vibration loosening test using Junker's machine (parameters: 12.5 Hz, ±0.5mm, tested nuts M16, class 8)
b) Axial repeated vibration loosening test using EDYZ machine, s. figure 5 (parameters: 4.6 Hz, ±0.2mm, 1.5 to 11kN, tested nuts M20, class 10)

Fig. 5

The measuring results are collected on figures 6 and 7. It is seen that IL showed the needed stability as the only one among tested elements either by dynamic cross- or by axis repeated load.

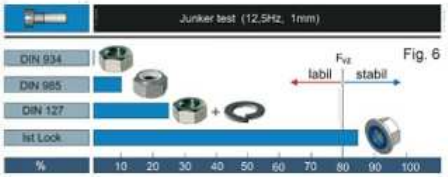

Fig. 6

Fig. 7

But not only outstanding vibration resistance classifies IL to the best protection methods. For example, in comparison to the popular nylon insert nuts DIN 985 has IL the advantage of the free rotation during tightening and disassembling and of its friction coefficient independence from assembly velocity. With IL locking systems can be fitted the different types of metric or inch threaded steel nuts of the tensile strength 800 - 1200 N/mm2. Typical example of the IL application is the nut FN 6331IL (~DIN 6331) class 10 with collar (Fig. 4 and table).

Table. Dimensions of FN 6331 IL (s. figure 3)

d1	d2	a	E	m	s
M16	31	5	26.8	24	24
M20	37	6	33.5	30	30
M24	45	6	40	36	36
M30	58	8	51.3	45	46
M36	68	10	61.3	54	55

Such nuts are repeatedly assembled and disassembled. By doing so the features have not to be changed substantially, especially the coefficient of friction. Otherwise the assembly preload with equal tightening torque would be changed. The IL nuts are keeping these conditions absolutely. Further application shows the fig 8 (from left DIN 6331 A2, DIN 934 1D, class 8 and DIN 6923 class 8, Zn).

In practice use following examples are recommended: Flange connection of pipelines, railway carriages, locomotives, wind power plants, cranes, vehicles, crude oil industry, shipbuilding and others. Shortly, every place where other bolt protection fails or is not applicable from various reasons. ■

Fig. 8