

Don't ask How Much Security Isn't Penny

by Jozef Dominik



The slogan in the title is intended to emphasize the importance of security in general and, as will be shown in the following text, particular in the screw connections and that it is not a cheap matter. Dramatic accidents on railways, on the road, in various constructions, means of transport and others are a sufficient reason to be serious about this issue.

Introduction

As shown in the table below, there are five reasons why screw connections must be secured. They are disintegration due to the vibration and dynamic stress, mechanical overload, theft and vandalism.

With the exception of vandalism in all other cases, the designer is competent to take appropriate measures.

SECURITY
against:



-  Disintegration
-  Mechanical destruction
-  Corrosion
-  Theft
-  Vandalism

Measures

Against disintegration

In principle, a properly dimensioned and well-tightened screw connection does not need external protection due to vibration and/or dynamic stressing. In practice, however, there are cases of extreme stress where necessary. The process of spontaneous loosening of bolted joints is sufficiently explored and therefore there is no need to talk about it in this post. Unfortunately, the current theory of screw joint self loosening is based only on one type of dynamic stress, that is in the radial direction. In the previous publications, the author has often emphasized that dynamic axial stress is equally dangerous (Fig. 1). Typical examples are in Fig. 2 and 3. Since there is no universal way of securing the screw connections, the constructor must make the professional decision and not succumb to overblown advertising.



Against mechanical destruction

Even in the case of mechanical destruction of screw joints, there is no universal advice. In particular, for an effective measure, a detailed analysis of the stress of the given construction node is necessary. According to Figure 4, the basic types of stress under operating conditions are static and dynamic.

The only measure against static load destruction is the respect of mechanical

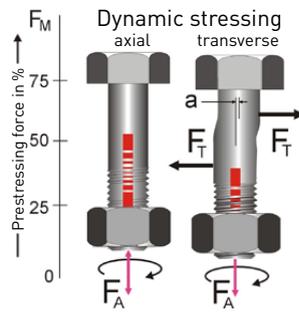


Fig. 1



Fig. 2



Fig. 3

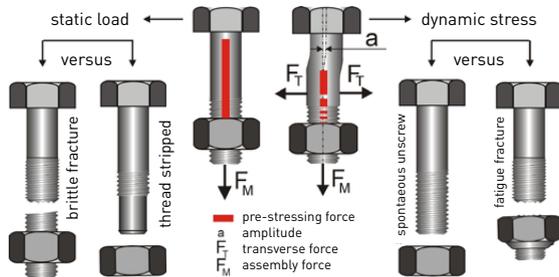


Fig. 4



Fig. 5



Fig. 6

limit values. In particular, drivers should be aware of the dangers of overloading the vehicle. The consequences are noticeable on the wheels of cars (Fig. 5). For the sake of completeness, it should be added that the overloading of vehicles does not only suffer from screw joints, but also bearings and other structural elements.

Material fatigue due to repeating dynamic stress is more dangerous because it comes unexpectedly, without previous alarm. Fatigue fracture occurs in the area of maximum concentration of stress peaks (Fig. 6).

The measure consists in eliminating the dynamic shocks transmitted to the screw joint by using hardened dowel pins (Fig. 7). Such a construction is often used in press tools.

Against corrosion

There are several types of corrosion, which is standardised (DIN 50900) and often published. From the point of view of anti-corrosion measures, it should be noted that no Panacea* exists. It means no universal corrosion medicament. Specific measures should therefore be taken. The most dangerous is the corrosion that is not visible to the naked eye. This includes stress corrosion cracking and hydrogen embrittlement. Current science provides enough good insight into the nature of corrosion and the possibilities of its elimination and therefore, the detailed elaboration of this extensive subject is abandoned.

*Panacea comes from a Greek word meaning "all-healing"

Against theft

It is sad, but sometimes it is necessary to secure the screws against theft. The current market offers several variants. For example Mercedes car manufacturer secures the wheels of its cars against theft with special screws and assembly tools (Fig. 8). Without such a tool, the wheel cannot be removed.

In the end

Safety of bolted structures is a serious problem and cannot be underestimated. As has been shown, there are more dangerous factors whose ignorance can cause the collapse of not only screw joints, but also entire structures. Although "security isn't penny", effective action must be taken to prevent damage and crash.

Here are basic postulates of safe screw connections:

- the screw connection must not be the weakest link in the structure
- exact assembly
- visual control
- timely exchange
- external protection

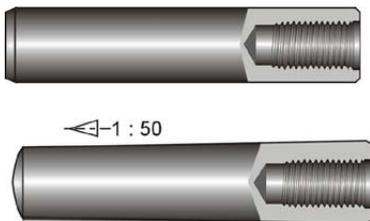


Fig. 7



Fig. 8