"Whipping-Boys" versus Superiors in Security of Bolting Technology

by Jozef Dominik

The technology of mechanical joining of parts through bolting connections has recently made considerable progress. The attention of the designers was mainly focused on dealing with dangerous uncontrolled loosening of threaded connections during the operation. Numerous cases of construction, transport and other machinery crashes have forced the search for new security solutions. In critical cases, classic locking systems (**Fig. 1**) are no longer available. Therefore, a new option has to be found. Figure 3 shows some of them. By comparing both images (**Fig. 1 and 3**) the meaning of the title of this article can be understood. That's what the following text is about.

Classic Screw Locking Systems ("Whipping Boys")

Typical representatives of the classic screw locking systems, the purposefully called "whipping boys" (WB), are the locking nuts DIN 985 in **Fig. 1**. Despite the fact that it is notoriously known that they no longer meet the demanding criteria, they are very popular and the constructors use them. The causes are as follows:

- At the time of their inception there was no possibility of testing them as today's Junker test for example.
- They are very cheap.
- Conservativism and poor education of constructors in the theory of mechanical joining of parts through screw connections.
- For uncomplicated operating conditions are these locking elements suitable.

splint pin | counter nut | DIN 985 | DIN 127

Fig. 1

Paradoxically, neither manufacturers of new more effective insurance elements (**Fig. 3**) are not interested in their total liquidation, because they need some "whipping boys" to demonstrate their own superiority. Just look at relevant brochures, prospects or advertising materials. Everywhere it is compared in level the superiors vs. WB only. Never superiors between themselves. Thereby these WB are not so insignificant. As an example of a locknut according to DIN 985 (**Fig. 2**) shows, although it does not prevent the loss of pre-stressing force, it protects the screw connection before total disintegration due to vibrations. From the point of view of construction safety, this is very important, too. Similarly a splint pin.

An interesting story relates to split washers according to DIN 127. Although this standard has been formally abolished, the washers are still used and continues to be produced on a massive scale. Even this fact proves that they are not quite so bad.

Selection of superiors to locking systems of bolting joints

It has already been suggested that the situation in the sphere of joining parts requires more effective insurance systems. The current market offers several such systems (see the anonymous selection in Figure 3). Their inventors had evident effort to achieve possible locking effect. For this purpose they sacrificed not only price, but also some other important parameters, such as assembly comfort, logistics, number of interfaces, etc.

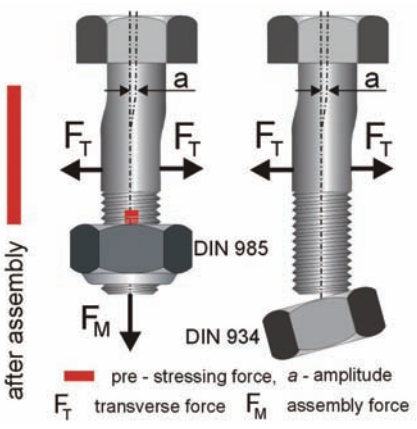
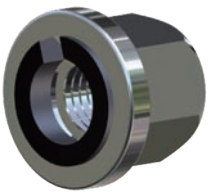


Fig. 2

I. II.



III. IV.

Fig. 3

Of course, there are a number of other superiors as shown in Figure 3. In any case, it is good that there is a rich choice. As written in another publication (Fastener Technology International/October 2017, For Each Type of Bolting Stress Another Locking "Dress"), the universal locking method of bolted joints doesn't exist. The correct choice of screw locking method is one of the most important decisions of a design engineer. He must not uncritically come under bombastic commercial advertising, but run his own professional intellect and experiences. It requires two assumptions:

1. Analysis of the stress of the concrete construction node in operation.
2. An objective evaluation of the properties of the locking elements.

(1) What happens by bolted joints after assembly and during operation?

It is important to remember that any change in the force ratios in the threaded joint sensitively responds to the assembled parts. The simplest case where the static operating force acts in the axial direction, illustrates **Fig. 4**. A more complicated situation occurs when the dynamic forces act in the transverse direction on the screw connection (**Fig. 2**). In such a case, the joint must be protected so that it does not disintegrate. There are several ways to do that. It is the indispensable role of the constructor (therefore not a purchaser) to choose the right option.

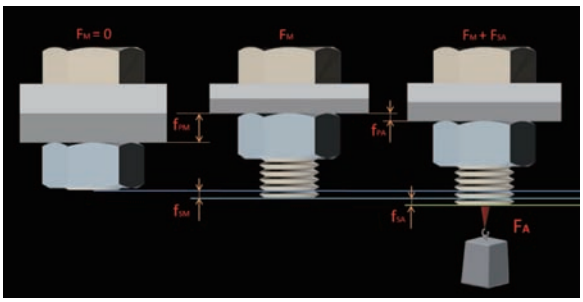


Fig. 4

(2) An objective evaluation of the properties of the locking elements

If we do not take into account the chemical methods of protection that make up a separate chapter, then there are only two basic types of external mechanical locking systems (**Fig. 5**):

Axial, dependent of the assembly force FM, it means pA = f(FM) (read "pA is a function of FM")

Radial, independent of the assembly force FM, it means pR‡f(FM) (read "pA isn`t a function of FM")

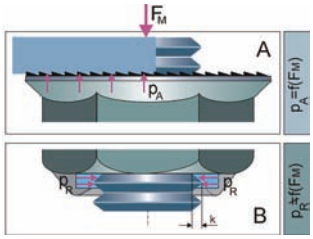


Fig. 5

Each of them has advantages and disadvantages. An example of this is to compare the locking systems I versus II (**Fig, 3**) and the DIN 985 in Fig. 6 as a ratio to the standard. The differences between the evaluated systems are obvious.

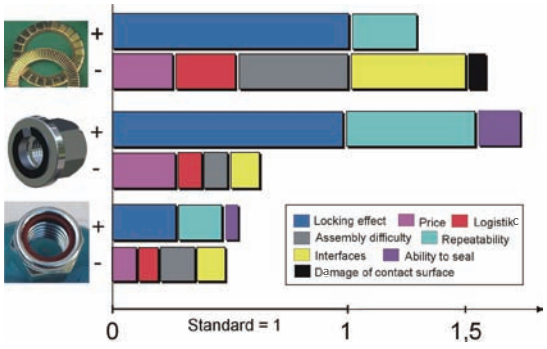


Fig. 6

Such a similar plus/minus analysis provides the constructor with useful information for the final decision. It is important to take into account all parameters for characteristics of the individual securing elements and to define their degree of importance to choose the optimal solution. While it is important to appoint the correct evaluation criteria, the more criteria the better.

Recapitulation

Screw connection locking systems can be divided into two groups. Classical systems and superiors, for which classic systems often, not always rightly, only serve as "whipping boys". But as the known proverb says: All that glitters is not gold. This also applies in the case of screw securing systems.

The present article does not have the ambition to recommend the best solutions, but to give the constructor a guideline how to achieve it. That's his main mission.

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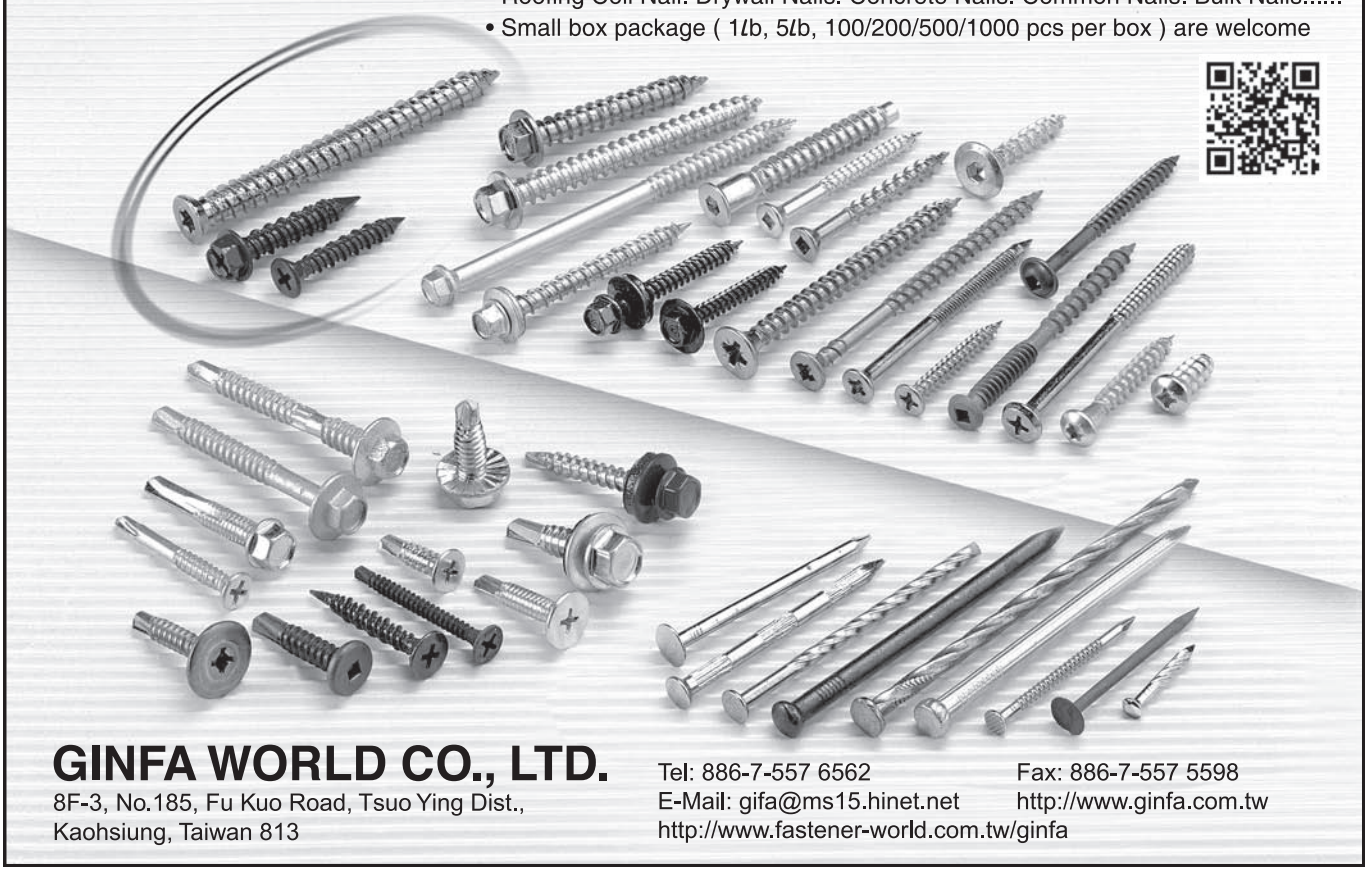

GINFA WORLD CO., LTD.
8F-3, No.185, Fu Kuo Road, Tsuo Ying Dist.,
Kaohsiung, Taiwan 813
Tel: 886-7-557 6562
Fax: 886-7-557 5598
E-Mail: gifa@ms15.hinet.net
http://www.ginfa.com.tw
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