



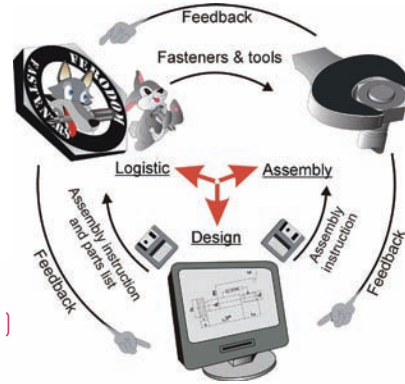
FASTENERS SYNERGISM

by Jozef Dominik

If we talk about quality, we often forget the importance of the organization of production. In particular, the relationship of “ construction - logistics - assembly ” is very important. There must be coordination between these three factors. We are expertly talking about fasteners synergism.

What is the “Fasteners Synergism”

Synergism, from Greek synergos, is understood as the cooperation or interaction of discrete factors or conditions such that the total effect is greater than the sum of the individual effects (Aristoteles). This can be seen in the example of screw connections (Fig. 1.)

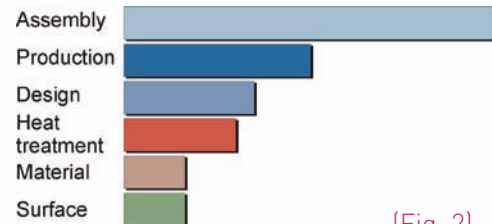


(Fig. 1)

Only the interplay of the displayed three factors “ design – logistic - assembly ” will ensure a quality product and economic and environment production. In this hierarchy, construction plays a dominant role. Not only the product’s technical parameters, but also its production efficiency, safety and environmental impact depend on the designer. As shown in Fig. 1, the engineer needs feedback from logistics and especially from assembly to optimize its design. This is very important. He can’t work in isolation. Traditional factors affecting screw joints are:

- Mechanical properties (Rel, Rm)
- Friction coefficient
- Operating conditions
- Surface pressing
- Tigthingen method

These factors are an important but not the only one criterion for a successful design. As shown in Fig. 1 (source: SKF) construction is the third most common cause of screw connection defects. In the next texts are some tips and tricks that could improve the unflattering position of the designer and reduce the negative assembly balance in this ranking.



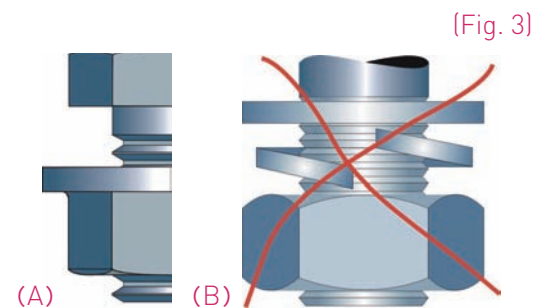
(Fig. 2)

Tips and Tricks:

1. Flange nut instead of washer + spring washer combination (Fig. 3)

Advantages:

- fewer interfaces
- simpler logistics and assembly
- compact connection
- lower surface pressure (surface pressure limit of various materials. Table Nr. 1)

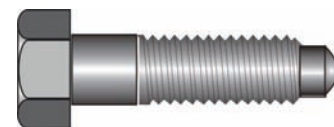


(Fig. 3)

| Material | Norm | Surface pressing [N/mm ²] |
|----------|--------------------------|---------------------------------------|
| steel | C15 | 300 |
| | C35 | 500 |
| | C45 | 600 |
| | Rm 900 N/mm ² | 900 |
| | Rm 1200 N/mm | 1200 |
| | 16MnCr5 | 1800 |

2. Nuts-free bolting

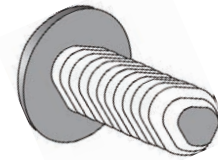
Such a variant is used mainly for automatic assembly in car manufacturing for example. Although they have a more complicated shape than normal screws (Fig. 4), their advantage lies in their simple assembly because they require only one mounting direction and in simple logistics.



(Table Nr. 1)

(Fig. 4)

A special case of nuts-free bolting are trilobular rolling screws (Fig. 5). Creating vibration resistant assemblies, eliminating the cutting of internal threads in ductile materials such as steel and aluminum, high strength of connection, thus lowering the cost of assembly are their biggest advantages.



(Fig. 5)

3. Exact assembly and optimization of tightening groove geometry

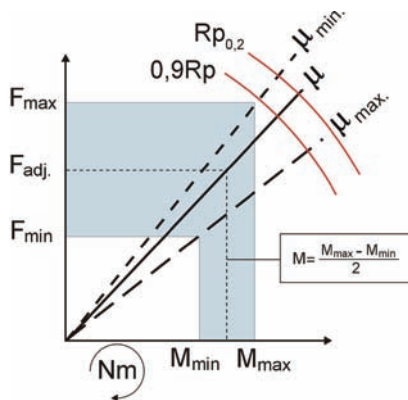
Tightening accuracy is defined by a factor α_A (Table Nr. 2). The lower it is, the more precise the tightening and the less the scattering of the prestressing force (Fig. 6) which makes it possible to reduce dimensions of screws.

Tightening groove geometry affects the amount of torque transmitted and the life of the tightening tool. In this respect, the six rounds in Fig. 7 is much better than a classic hexagon.

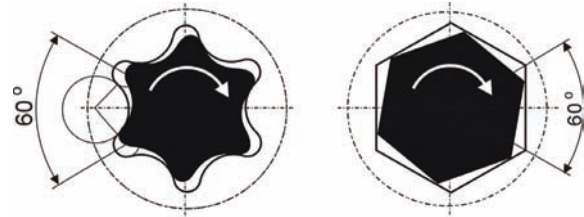
| α_A | Scattering in % | Oversizing in % | Tightening method |
|------------|-------------------|-----------------|-------------------|
| 1 | $\pm 5 - \pm 12$ | 0 | Yield strength |
| 1,2 - 1,8 | $\pm 9 - \pm 23$ | 20 - 60 | Hydraulically |
| 1,4 - 1,8 | $\pm 17 - \pm 23$ | 40 - 60 | Torque wrench |
| 2,5 - 4 | $\pm 43 - \pm 60$ | 150 - 300 | Per hand |

$$\alpha_A = FM_{max} / FM_{min} \text{ (FM - assembly force)}$$

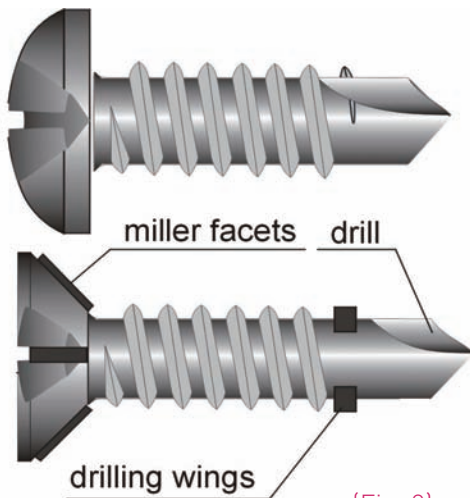
(Table Nr. 2)



(Fig. 6. μ - friction coefficient)



(Fig. 7)



(Fig. 8)

4. Application of polyfunctional fasteners elements

Polyfunctionality means the ability of a fastener to perform multiple functions at once. In Fig. 8 are two typical polyfunctional screws exemplified. The trilobular screws of Fig. 5 belong to polyfunctional screws, too. The difference lies in the thread production technology.

5. Unified fasteners and on technology oriented design

Unified structural parts are considerably cheaper than specially manufactured components. The current fasteners market provides designers with a wide range of choices, so in most cases it is not dependent on special production. If necessary, it is important that the unified element can be produced by conventional techniques. Interactive collaboration of designers with logistics and assembly is particularly important in this case.

Summary

The quality of screw joints is determined by the synergistic effect of three important categories: construction - logistics - assembly. Although

designers play a dominant role in this hierarchy only their interactive synergy gives a prerequisite for successful and competitive construction. ■