An Attempt to Objectify the Properties of Bolting Locking Systems

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Theory

It is the natural effort of any stressed construction systems to get back into equilibrium, it means get rid of the ballast. For screw connections this indicates a gradual loss of preload Fv. This loosening is helped by vibration and dynamic stress during operation (Fig. 1).

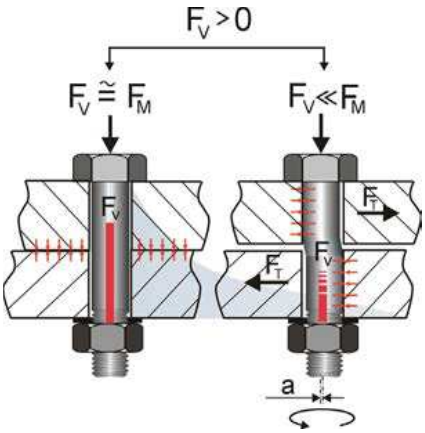

Fig. 1
(F_V – pre-steressing force, F_M – montage force, F_T – transverse force, a – amplitude)

In principle, there are two ways to prevent this:
1. Increase friction on the contact surfaces
2. Capture cross-operating forces with hardened dowel pins for example

The most common method of preventing the pre-stressing force decrease of bolted connections is by applying external locking elements. Almost all this known methods are based on increasing of friction on the contact surfaces, thereby increasing the energy required for loosening (Fig. 2).

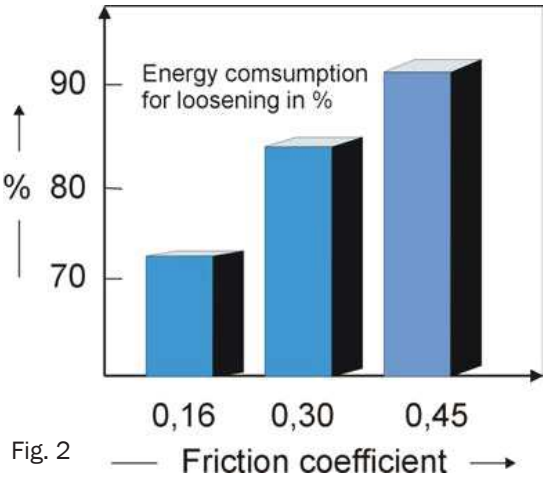

Fig. 2

The current market offers a great choice in this regard. In principle, they can be divided into two basic groups A and B (Fig. 3).

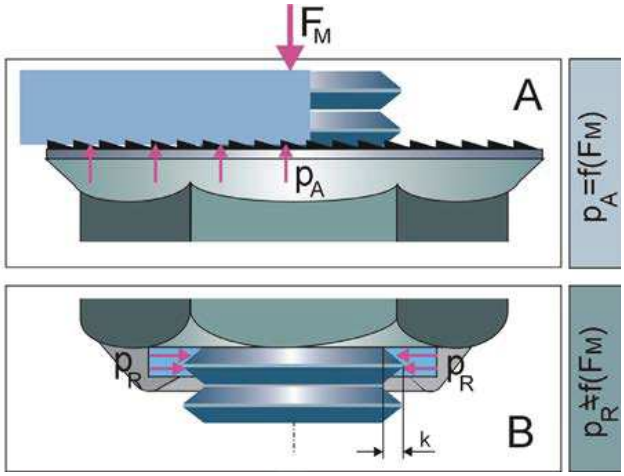

Fig. 3

Group A includes locking elements whose effect is dependent on the size of the assemble force F_M. Group B includes elements which act in the radial direction on the screw thread. Their locking effect does not depend on the size of the assemble force F_M. The best known representatives of this group are locking nuts with nylon ring according to DIN 985 and chemical locking systems.

Criteria for the correct choice of method of locking screw connections

It has already been mentioned that a wide range of locking elements is available on the market. At the same time, design and construction offices are producing more and more new variants. It is therefore important for the designer to be well informed about the complexity of the many systems offered.
But the following theorem applies:

For each type of bolting stress another locking "dress"!

Therefore, the first prerequisite for a successful design is to know the type of stress to which it will be subjected given construction node in operation. Only then can the choice of method of bolted joints locking be followed. It sounds simple, but choosing from the wide assortment of locking elements and methods is not so easy. It is important to accept their multifunctionality, it means:

- Locking effect
- Temperature resistance
- Assembly difficulty
- Price
- Number of interfaces
- Ability to seal
- Logistics
- Environment
- Repeatability
- Damage of contact surface

Figure 4 shows an example of a comprehensive analysis of the selected bolting locking methods. This picture clearly shows the pros and cons of the technologies being compared. A similar analysis should be made by each designer before the final decision. He is the only one who can make the decision and bears responsibility.

Although the diagram on Fig. 4 has no official status, it provides the designer with instructions on how to objectively evaluate the various ways of securing the bolted connections.

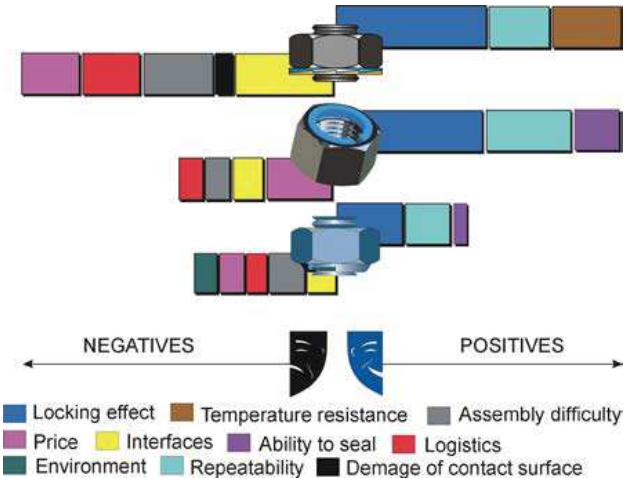

Fig. 4

Conclusion

The choice of the method of locking the bolted connections is a serious design decision and special attention should be paid to this. The role of the designer in this respect is unmistakable. It has already been mentioned that the locking ability is not the only criterion for a correct design decision. There are many other influential factors that need to be comprehensively evaluated. This is what the article is about. Its role is not to provide guidance, but to help designers navigate in the commercial environment. ■