The Pros and Cons of Locking Loose Fasteners

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Few aspects of threaded fasteners will generate an argument as quickly as the use and selection of locking methods. I probably won't settle any bets in this column, but I can point out the primary causes of loosening. I'll also categorize and compare how various locking methods prevent loose fasteners.

While a wide variety of loading profiles can cause fastener loosening, the forces that lead to slipping of the clamped parts relative to one another will cause the most dramatic losses. The force that resists loosening is generated by friction between the mating threads and between the bolt or nut and the mating part.

In the standard bolted joint, this resisting force is directly proportional to bolt tension—the greater the elongation of the bolt, the greater the friction force available to resist loosening. Because resistance to loosening decreases with decreased bolt elongation, the common occurrence of joint relaxation due to embedment within the joint stack will leave the joint more susceptible to loosening.

As you are probably well aware, there is no shortage of locking methods on the market to supplement resisting forces and maintain clamp load. But, if you look at how they actually function, the vast majority can be categorized as one of the following:

- Type 1—reduces the potential for relative movement between mating threads by eliminating or altering the clearance between them. Examples include thread-locking compounds and proprietary thread forms.
- Type 2—adds friction through interference between the screw head or nut and the mating component, or between mating threads. Examples include all types of serrated, toothed and deformed nuts, screw heads, washers and threads, in addition to thread-forming screws.
- Type 3—minimizes clamp load relaxation using secondary spring elements. Examples include conical washers or fastener heads.

So, what's the best option for your application? Well, there's a reason the selection of locking methods causes disagreement. The specifics of each application influence the decision, and it is often difficult to isolate the influence of locking methods to compare their effectiveness in actual field use. However, we can compare the fundamental characteristics of each type of locking method to common joint requirements to assess applicability.

While the Type 1 methods listed above operate on the same principle, they accomplish this objective in very different ways. Special thread forms have a geometry that improves resistance to lateral movement without the need for additional parts or processes, though this benefit is directly compromised by joint relaxation. Whether preapplied dry or a manually applied liquid, thread lockers provide both gap filling and adhesive benefits. However, through reuse, their effectiveness diminishes.

When choosing between Type 2 locking methods, the primary decision is whether the interference is under the head or at the threads. For under-head locking elements to be effective, the mating clamp member should be significantly softer than the fastener. Applications where the head bears against corrosion-resistant films or plating should be carefully considered. Type 2 methods based on mating thread interference are generally found in through-bolted applications with a separate nut. This nut creates prevailing torque during the entire rundown or removal.

Type 3 methods are unique in that their function is to maximize the inherent vibration resistance that bolt elongation provides, rather than to augment it. For this method to be most effective, the relative stiffness (spring rate) of the fastener at the designed grip length—and of the clamped components if they are not hard—should be known so the desired washer-head spring rate can be confirmed.

No discussion of threaded fastener locking methods would be complete without considering the option of avoiding them. All locking methods increase cost, complexity or variability of the joint's torque-tension relationship.

The preferable solution is to eliminate the need for locking methods by maximizing joint dependability with good joint design principles. The primary aims are large fastener length-to-diameter ratios; hard, stiff clamp members; sufficient bearing areas; and low, consistent friction factors. When attaining these goals is not possible or practical, it's probably time to consider locking methods. **A**

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