Fastener Fracture? Look for These 4 Overload Behaviors

During the use of fasteners, fracture is one of the most common failures. Once a fracture occurs, many people's immediate reaction is "the fastener quality is too poor," thereby questioning the product quality of the supplier and even triggering unnecessary disputes. However, according to industry data, over 70% of fastener fractures do not stem from material or manufacturing defects of the product itself, but are caused by "overload" behaviors resulting from improper installation. As operators of a fastener website, we frequently receive inquiries from users regarding such issues. Today, we will focus on breaking down the 4 most overlooked overload installation behaviors to help everyone understand the true causes of fractures, avoid usage misconceptions, and ensure fasteners perform as intended.

First, a core concept must be clarified: the load-bearing capacity of fasteners has a definite upper limit. Whether it is tensile strength, shear strength, or fatigue strength, there are corresponding industry standards and product parameters. "Overload installation" refers to the load on the fastener exceeding its design limit during installation due to manual operations or assembly deviations. Long-term or instantaneous overload can lead to thread damage and substrate fatigue, ultimately causing fractures. Especially in scenarios with extremely high reliability requirements for fasteners, such as industrial equipment, automotive manufacturing, and construction, fractures caused by overload installation may lead to equipment downtime and safety accidents, resulting in huge economic losses.

The first common overload installation behavior: tightening torque overload, blindly pursuing "the tighter, the better." This is the most universal and easily made mistake. Whether frontline installation workers or ordinary DIY enthusiasts, it is easy to fall into the cognitive trap of "tighter equals safer." Many people believe that the tighter a bolt is screwed, the more secure the connection, ignoring the torque tolerance limit of the fastener.

Fasteners of different specifications and strength grades have corresponding standard tightening torques. For example, the standard tightening torque for an 8.8 grade M12 bolt is about 80-100 N·m. Forcibly tightening it to over 150 N·m with an electric wrench is a typical case of torque overload. This behavior will directly cause tensile deformation of the bolt shank, thread stripping, and unthreading. After long-term use, when the tensile stress exceeds the yield strength of the material, fracture will occur. More insidiously, some overload tightening does not cause immediate fracture but leads to internal fatigue damage of the fastener. Under the action of equipment vibration and load changes, delayed fracture occurs in the short term, making it difficult to trace the cause.

The key to avoiding this overload is to select the appropriate torque wrench according to the fastener's specifications, strength grade, and application scenarios, and to tighten strictly according to the standard torque. Never rely on experience or brute force. For fasteners on critical equipment, torque re-inspection can be performed after tightening to ensure compliance, avoiding overload risks at the source.

The second overload installation behavior: eccentric overload caused by assembly deviation, ignoring installation alignment precision. In many cases, due to improper operation during installation, fasteners cannot be accurately aligned with the connected components, resulting in eccentricity and tilting, which leads to uneven stress distribution and localized overload fracture. This situation is particularly common in large equipment assembly and steel structure connections, yet it is often ignored by installation personnel.

For example, when connecting flanges, if the flange surface is uneven or the bolt holes are misaligned, forcibly inserting and tightening the bolts will cause the bolts to bear eccentric loads. At this point, the bolts must bear not only axial tensile force but also transverse shear force, and the stress state far exceeds the design expectations. Over time, cracks will gradually appear at the stress concentration points of the bolts, eventually leading to fracture. In addition, if the bolts are not fully inserted into the bolt holes during assembly and only partial threads are engaged, the load-bearing area will be reduced, and the localized load will be too large, causing fracture.

To solve such problems, the flatness of the connected components and the alignment precision of the bolt holes must be checked before assembly to ensure there is no deviation before installation. If there is a slight deviation, the position of the components can be adjusted; never force the assembly. For components with significant deviation, they need to be corrected or replaced to prevent the fasteners from bearing eccentric overload.

The third overload installation behavior: reusing old fasteners, ignoring fatigue overload. In industrial production and daily maintenance, some people reuse disassembled old fasteners to save costs, unaware that this behavior leads to fatigue overload and hidden fracture hazards. After a fastener undergoes one cycle of installation, tightening, and disassembly, internal fatigue stress is generated, and slight wear and deformation will occur on the threads and shank, significantly reducing its load-bearing capacity.

Especially for high-strength bolts, once subjected to tensile overload, even without obvious deformation or damage, their fatigue life will be drastically shortened. When reused, fatigue fracture may occur under normal loads. For example, connecting rod bolts for automobile engines and anchor bolts for equipment—these fasteners that bear high-frequency vibration and alternating loads—are strictly prohibited from being reused; otherwise, serious accidents are highly likely to occur.

We remind everyone that for fasteners bearing heavy loads and frequent vibrations, the "single-use" principle should be followed, and new parts should be replaced promptly after disassembly. For fasteners in secondary scenarios, careful inspection is required before reuse. If issues such as thread wear, shank deformation, or surface rust are found, they should be scrapped immediately. Never take chances.

The fourth overload installation behavior: assembly overload caused by foreign object interference, ignoring the cleaning of the installation environment. During installation, if there are debris in the bolt holes or on the thread surfaces, such as iron filings, dust, oil stains, etc., and assembly is carried out without timely cleaning, the fastener will not be installed in place, leading to overload fracture. Many people think a small amount of debris does not affect use, ignoring that these foreign objects will change the stress state of the fastener.

For example, iron filings in the bolt hole will prevent the bolt from being fully screwed in. During tightening, the iron filings will be squeezed, generating extra resistance, causing the tightening torque to increase abnormally and indirectly causing torque overload. Oil stains on the thread surface will reduce the friction between the threads, making it easy to experience a "false tight" phenomenon during tightening. It seems tightened, but the specified preload is not actually reached. After the equipment runs, the fastener easily loosens, thereby bearing alternating loads and causing fatigue fracture. If the foreign object is a hard particle, it may also scratch the threads, leading to stress concentration and accelerating fracture.

The method to avoid this type of overload is very simple: before assembly, be sure to clean the debris and oil stains in the bolt holes and on the thread surfaces to ensure a clean installation environment. For scenarios with high precision requirements, methods such as blowing air or wiping can be used for cleaning. If necessary, the threads can be lubricated (note the lubrication method to avoid affecting the preload) to ensure smooth assembly and uniform stress distribution of the fasteners.

In addition to the above 4 common overload installation behaviors, some other details may also lead to fastener overload fracture, such as mixing gaskets, selecting the wrong bolt specifications, or incorrect installation sequences. Many times, fastener fractures seem to be quality issues but are actually caused by improper manual installation. This also reminds us that correct installation operations are more important than selecting high-quality fasteners.

As practitioners in the fastener industry, we should not only select high-quality products that meet standards but also master the correct installation methods to avoid various overload behaviors. For enterprises, training for installation personnel should be strengthened, installation processes standardized, and requirements for tightening torque and assembly precision clarified. For individual users, when using fasteners, never rely on experience; pay more attention to installation details to effectively reduce the occurrence of fracture failures.