

2010.3.11

Torque vs. Clamping Pressure

Specification: All fasteners used for assembly of bicycle components

This bulletin is intended to inform the reader how torque affects the amount of clamping pressure applied to a component. The bulletin is subdivided into the following sections:

- **Torque**

- Definition
- Major factor that affects torque and clamping pressure:
 - Coefficient of Friction:
 - Fastener Surface Finish
 - Lubrication
 - Fastener Material



- **Torque vs. Clamping Force**

- How to interpret the torque rating on components.
 - Some torque ratings are actually the maximum torque for the bolt. Meaning that the rating is a percentage of torque the bolt can withstand before failure. It is not a direct indication of proper clamping pressure.
- Determining the proper torque for component assembly when only the maximum torque for the bolt is available.

- **Bolt tightening sequence**

- How bolt tightening sequence affects clamp pressure on a product.

- **Troubleshooting**

- What are the first steps if a component is loose even if the fasteners are tightened to recommended torque?

- **FSA Dynamic Paste:**

- Uses of Dynamic assembly paste, it's more than for Seatposts



Torque

Definition: (A) A twisting or wrenching effect or moment, exerted by a force acting at a distance on a body, equal to the force multiplied by the perpendicular distance between the line of action of the force, and the center of rotation at which it is exerted. (B) A force, which tends to produce rotation. The measurement of torque is based on the fundamental law of the lever.

The Basic Formula for Torque is expressed by

$$L \text{ (length)} \times F \text{ (force)} = T \text{ (torque)}$$



Factors that Affect Torque:

There are many factors that affect torque. These factors are the reason that bolts of the same size might have different maximum torque capabilities; or why bolts of the same size might apply different amounts of clamping force. For example: Seatpost clamps of different manufacturers may have use different sizes bolts (M5, M6 thread, etc) and use different types of bolt materials (steel, titanium, etc.) which will affect the amount of clamping pressure applied to the seatpost at specific torque values. Seatpost clamp and frame design also play a significant role in how much clamping pressure is applied to the seatpost, and how the pressure is distributed to the seatpost surface. There are too many variables to specify a single torque value for securing a seatpost for all the different seatclamp and frame manufacturer combinations.

The Coefficient of Friction (COF):

The Coefficient of Friction is the ratio of the force of friction between two bodies and the force pressing them together.

Surface Finish

- Rough or smooth finish: A rough finish on the bolt and threads will have a higher amount of surface friction between the threads and under the bolt head, whereas a smooth finish will have a lower surface friction.

Lubrication

- The presence of grease, Ti-prep or Loc Tite lowers the coefficient of friction. Always use thread preparation as indicated in the instruction manual or consult manufacturer.

Fastener Material

- Different materials - such as steel or titanium - will have different coefficients of friction resulting in different clamping pressure for same amount of torque applied to the bolt.

Torque vs. Clamping Force

What does the torque ratings listed on most components mean in terms of assembly?

Many published torque specifications are actually a percentage of the maximum torque capacity a bolt can withstand before failure. The CEN standard* requires that the recommended torque specifications for fasteners used on handlebars, stems, seat, posts, and bar ends be no more than 50% of the minimum failure torque of the bolt. For example, if a stem has 6Nm torque rating printed on the face plate. 6Nm may be 50% of the amount of torque before the bolt has been tested to fail (12Nm). The 6Nm torque has no relation to clamping pressure or proper assembly. It does not mean set the torque wrench to 6Nm and tighten until the wrench clicks.

To achieve the proper clamping pressure for a stem, handlebar, seatposts, and bar ends; start low and be built up torque incrementally. Stop when the component does not rotate under load. In most instances, the component will be assembled at a lower torque value than the value listed on the component.

This is the reason many carbon parts can get damaged despite using a manufacturer's listed torque for a component. For example, a 4-bolt faceplate on a stem with a maximum torque value 9Nm printed on it may not mean tighten each bolt to 9Nm. The 4 bolt face plate spreads out clamping pressure thru the 4 bolts, so that each bolt will only need a fraction of the 9Nm to effectively clamp a handle bar in place. In most cases no more that 5-7 Nm per bolt is needed to secure a handlebar depending on the material of the handle bar and stem.

Always ask the component manufacture if their listed torque ratings are the specification for the bolt or if it is for the proper assembly of the product.

FSA Torque specifications are written in two ways. The way the torque specification is written will tell you if it is for the bolt or for the assembly.



If the specification is an individual number: This usually means the torque is for the bolt capacity, not recommended torque for assembly. For example, the pictured bolt of this OS99 CSI stem has a rating of 6Nm. Meaning if the bolt is tightened beyond 6Nm there is a risk of bolt failure.



If the specification is a range: This usually means it is the recommended range of torque for assembly of the component. For example, a Mega Exo crankbolt for carbon cranksets has a torque listed of 450-550 kgf/cm. Meaning we recommend that tightening the crankbolt within this range of torque should assemble properly.

Determining the proper torque for component assembly

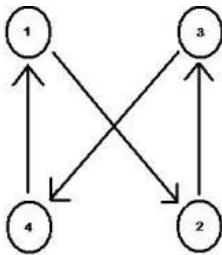
In instances where no torque specification is listed, or if the torque specification is a rating of bolt capacity, FSA recommends using the least amount of torque necessary to install the product so it doesn't slip or loosen while in use. Start by tightening the bolt(s) to half the maximum torque allowance and tighten the bolts 1/2 turn at a time until the components are secure. Using the stem example above, it may only require 5Nm of torque on the clamp bolts to secure a handlebar in the stem, and is unnecessary to go all the way to the 6Nm maximum.

*CEN is the Committee for European Standards. More information on CEN is available at www.cen.eu

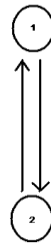
Bolt Tightening Sequence

Using the proper bolt tightening sequence evenly spreads clamping pressure across the product. Unevenly tightened bolts will not evenly distribute the clamping force along the product and is a major cause for bolt and clamp failure.

Torque Sequence Illustration:



4 bolt systems should be tightened in a star pattern, turning each bolt only 1/4 to 1/2 at a time so they reach desired torque simultaneously and evenly.



2 bolt systems (such as faceplates, alloy crank arms, and stem clamp bolts), should be tightened 1/4 to 1/2 turn at a time alternating between the two bolts so they reach desired torque simultaneously and evenly.

Troubleshooting

Handlebars, stems, and seatposts: Slipping after installation and tightening bolts to maximum torque capacity for bolt.

- Do NOT tighten bolt any further. Remove components and measure diameter with accurate calipers. Make sure diameters are within tolerance. Call Manufacturer for further instruction or if diameters do not measure within specification.
- Make sure there is adequate amount of lubricant (or other thread prep as recommended by manufacturer) on bolt threads and bolt head.
- Use Dynamic Assembly Paste on the clamping faces (see below)
- Make sure bolts are tightened evenly and within tightening sequences.

Cranksets: Issues with Mega Exo crank arms loosening or not tightening on usually are the result of problems with the bottom bracket installation.

- Make sure bottom bracket threads are chased and clean of chips and debris
- Make sure bottom bracket shell is faced and proper width (68mm, 73mm, etc). Installing bottom bracket and crankset on bb shells that are over-width will result in installation problems. (Example: 68.5mm shell width as opposed to true 68mm shell)
- Install Bottom Bracket using a socket type installation tool with torque wrench. Bottom brackets have specific installation torque recommendations. It is impossible to install bottom brackets to recommended torque using spanner type hand tools.
- Remove crank arms, check spindle and spindle inserts of crankarm for burrs, deformation, or debris which may be inhibiting crank installation.
- Apply grease on spindle of left arm, or retaining compound as per crankset instructions (all instructions are downloadable from www.fullspeedahead.com).

For Alloy cranksets:

- Make sure pinch-bolts are tightened alternating 1/4 to 1/2 turn at a time as described in above section “Bolt Tightening Sequence.”
- Use medium strength thread retainer (such as blue loctite) on pinch-bolts and end-bolt.
- Make sure spindle is engaged the crankarm fully. See “Alloy Spindle Engagement Bulletin” available in the service and tech section of www.fullspeedahead.com.



Full Speed Ahead

Dynamic Assembly Paste

When viewed under a microscope, surfaces of components like seatposts or handlebars are not perfectly cylindrical. This is due to finish applications like clear-coat and paint. Dynamic Assembly Paste spreads over the irregular cylindrical surface and distributes clamping pressure over a larger surface area. Dynamic Assembly paste will help secure adjoining products at a lower torque value. Assembling components with minimum torque values will reduce bolt fatigue and breakage; and also will eliminate excess pressure on the components which can cause damage.



Dynamic Assembly Paste can be used for all products that rely on clamping pressure for assembly. It can also be used for materials other than carbon. Use it on aluminum, steel and carbon products. The Assembly Paste can be used not only for seat posts, handle bars, and stems, but also brake lever clamps, clip-on aerobar extensions, and even lock on grips.



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