

Technical Note

TorqLOC® Versus Keyed Shaft

Purpose

This document demonstrates how keyed hollow-shafts and TorqLOC® hollow-shafts are capable of transmitting torque substantially above the maximum rating of the affected gear reducer.

Scope

Many applications require gear reducers with hollow output shafts, for which users often specify keyed hollow shafts. Depending on the application, keyed shafts could create maintenance problems in the long-term. For example, if the user's solid shaft consists of carbon steel in a wet environment, corrosion may eventually fuse the user's shaft to the hollow shaft, preventing shaft removal and necessitating costly repairs. In addition, frequent starts/stops or shock loads can produce stress points and potential deformation of the key even with a close fit.

The patented SEW TorqLOC® offers an alternative to a keyed shaft. It utilizes friction force instead of shear force to transfer torque. Because TorqLOC® contacts the user's shaft at only two locations—the support bushing and the torque bushing – and because these parts are made of bronze, stainless steel, or electroless nickel plating, the likelihood of corrosion is very minimal. Moreover, the same clamping pressure that creates torque also helps to prevent oxidation and corrosion at the contact area of the torque bushing.

Application

A customer needs a 2.00" bore hollow shaft. The following sections detail the torque-transmission properties of two acceptable solutions - an FA77 keyed connection and an FT77 TorqLOC® connection.

Keyed Connection

In a keyed connection, the key is the only component that locks the shafts together. Therefore, it transmits 100% of the torque. Refer to Figure 1, Keyed Hollow-Shaft Connection. Notice how the key is subject to stress and potential deformation.

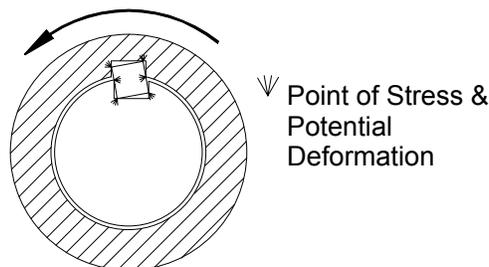


Figure 1: Keyed Hollow-Shaft Connection

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The amount of torque that the hollow shaft transmits depends upon two properties of the key: the material strength and the cross-sectional area. A longer key has a larger area and a greater torque capacity. The following calculations show the capacity of a keyed shaft. Refer to Figure 2, Shaft and Key Properties.

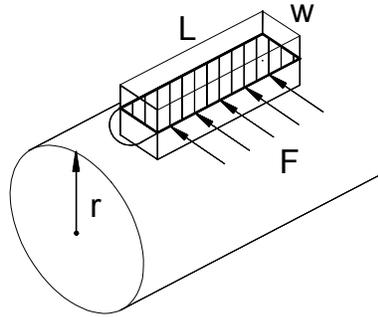


Figure 2: Shaft and Key Properties

Given: Shaft Diameter: $D = 2.0''$
Key Dimensions: $0.50 \text{ in} \times 0.50 \text{ in} \times 2.625 \text{ in}$.
Key material: AISI cold-drawn grade 1018 steel
Key Shear Strength: $\tau = 45,000 \text{ psi}$
FA77 Torque Capacity: $T_{\max} = 13,300 \text{ lb-in}$

Area (A): $A = l \times w = 0.50 \text{ in} \times 2.625 \text{ in} = 1.31 \text{ in}^2$

Force (F): $F = \tau \times A = \frac{45000 \text{ lbs}}{\text{in}^2} \times 1.31 \text{ in}^2 = 59,062 \text{ lbs}$

Torque (T): $T = F \times r = F \times \frac{D}{2} = 59,062 \text{ lb} \times \frac{2.0 \text{ in}}{2} = 59,062 \text{ lb-in}$

S.F: $SF = \frac{T}{T_{\max}} = \frac{59,062}{13,300} = 4.4$

In this case, the key can transmit **4.4** times more torque than the rated torque of an FA77. This value changes, depending on the reducer size and key length.

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TorqLOC® Connection

In a TorqLOC® connection, the shrink disc exerts a clamping force on the solid shaft, as shown in Figure 3. The friction between the shaft and the torque bushing transmits the torque, as shown in Figure 4.

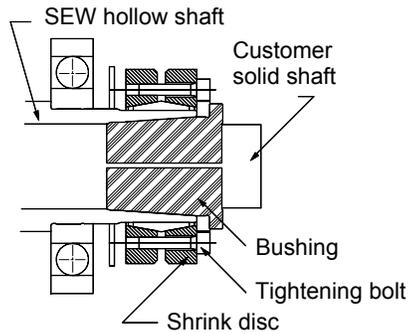


Figure 3: TorqLOC® Cross-section

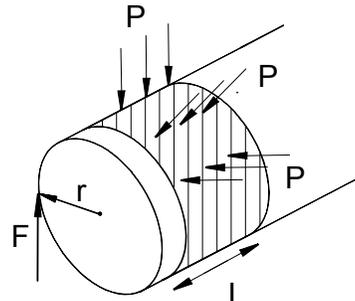


Figure 4: TorqLOC® Shaft Properties

Because of high clamping forces, no slip or wobble occurs in the connection. It is preferred over a keyed shaft if the application requires frequent starts/stops or contains shock loads. Unlike a keyed connection in which the amount of torque transmitted depends solely upon the shear strength and length of the key, the TorqLOC® transfers torque based on multiple factors:

- P, the amount of clamping force that the shrink disc exerts on the solid shaft
- SA, the amount of surface area between the torque bushing and the solid shaft
- μ , the coefficient of friction between the torque bushing and the solid shaft

Given: Bushing dimensions: 2.0 in (D) x 1.732 in (L)
 Clamping force: P = 28,410 lbs-in² per TorqLOC® factory specification
 Friction Coefficient: $\mu = 0.15$, steel-on-steel
 FT77 capacity: $T_{max} = 13,300$ lb-in

Area (SA): $SA = \pi \times D \times L = \pi \times 2.0 \text{ in} \times 1.732 \text{ in} = 10.88 \text{ in}^2$

Force (F): $F = P \times SA \times \mu = \frac{28,410 \text{ lbs}}{\text{in}^2} \times 10.88 \text{ in}^2 \times 0.15 = 46,365 \text{ lbs}$

Torque (T): $T = F \times r = F \times \frac{D}{2} = 46,365 \text{ lb} \times \frac{2.0 \text{ in}}{2} = 46,365 \text{ lb-in}$

S.F.: $SF = T/T_{max} = 46,365 / 13,300 = 3.5$

In this case, the TorqLOC® is capable of transmitting **3.5** times more torque than the rated torque of an FT77. This value changes, depending on the reducer size and the bore size.