Uni-Key Application Guide

This Application Guide is a step-by-step guide for helping you design an application using Uni-Key Expandable Fasteners.
Dimensional Information of the various Uni-Key products along with example applications is also available on our website at www.frankroth.com. This guide discusses common operating modes using the Uni-Key fastener. If at any time you need additional assistance, our experienced suspension experts are here to help.

WARNING — USER RESPONSIBILITY

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE UNI-KEY DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND/OR PROPERTY DAMAGE.

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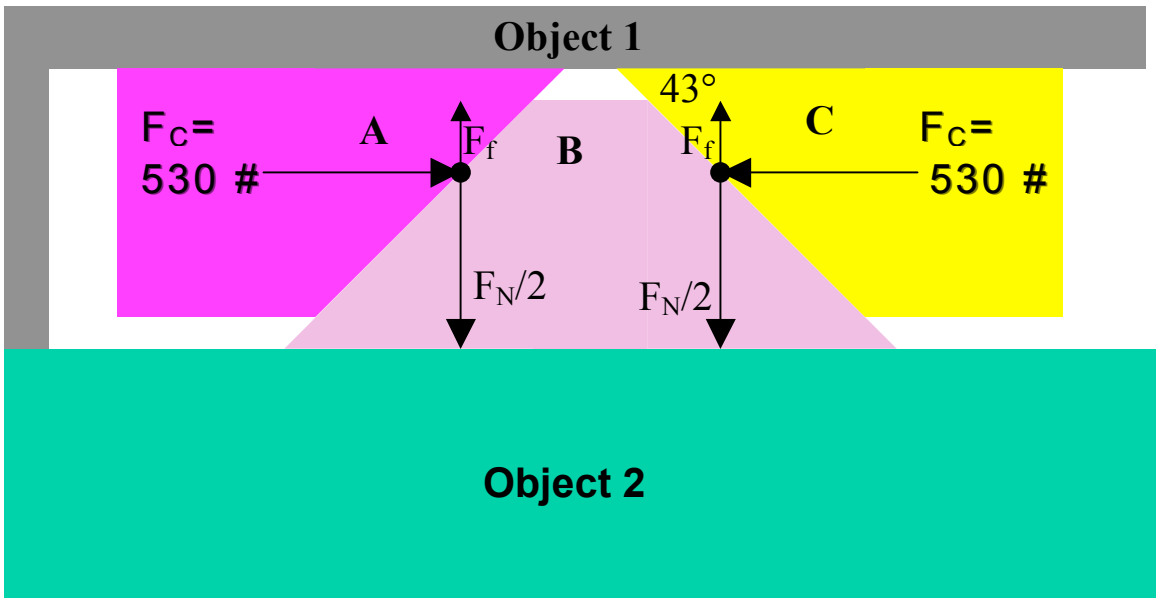
Common Uni-Key Operating Modes

The Uni-Key can operate in two modes:
Friction Mode – Mode in which the Uni-Key fastener is completely imbedded in one of the two objects being fastened.
Shear Mode – Mode in which the Uni-Key fastener is partially imbedded in both objects being fastened.
Shear mode is typically the stronger mode.

Friction Mode:
In Friction Mode, the Uni-Key fastener screw is tightened generating a clamping force pushing the middle section B of the Uni-Key against the surface of the opposing part. Figure 1 shows a cross-sectional view of the Uni-Key (UK200) being pressed against Object 2 in friction mode. Assume that the Uni-Key screw is torqued to 67% of its maximum proof rating, a clamping force F_c is generated on each side of segment B. Opposing this force is the frictional force F_f between Uni-Key segments A and B and B and C. The Frictional force preventing Object 2 from moving is the normal force F_N multiplied by the coefficient of friction between the Uni-Key and Object 2.

Figure 1
Friction Mode



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Assuming a coefficient of friction of .33 between the Uni-Key UK200 and Object 2 along with the Uni-Key members , a force of roughly 320 pounds of force would be required to cause Object 2 to slip.

Friction Mode Calculations:

1) Calculate the appropriate Clamping Force F_c.

   $F_c = P*S*A_s$

   P= Proof Pressure(psi) for screw
   S= Safety Factor (user determined)
   A_s = Screw Tensile Stress Area

2) Calculate the normal Force of the Uni-Key against Object 2

   $F_N = 2F_c*\tan(47^o)-2F_f$

   F_f is the vertical component of the frictional force between the Uni-Key members.
   $F_f = \mu * F_c \cos^2(47^o)$ where μ is the coefficient of friction between the Uni-Key members.

   $F_N=2F_c(1.072- .465\mu)$

3) Calculate the force before Object 2 slips:

   Slip Force **$F_s = \varepsilon * F_N$,** where ε is the coefficient of friction between the Uni-Key and Object 2

   Simplifying,
   $F_s = 2\varepsilon F_c(1.072- .465\mu)$

Note: Uni-Key fasteners can be used in multiples in which case the cumulative slip force would be $N*F_s$, where N = the number of Uni-Key expandable fasteners.

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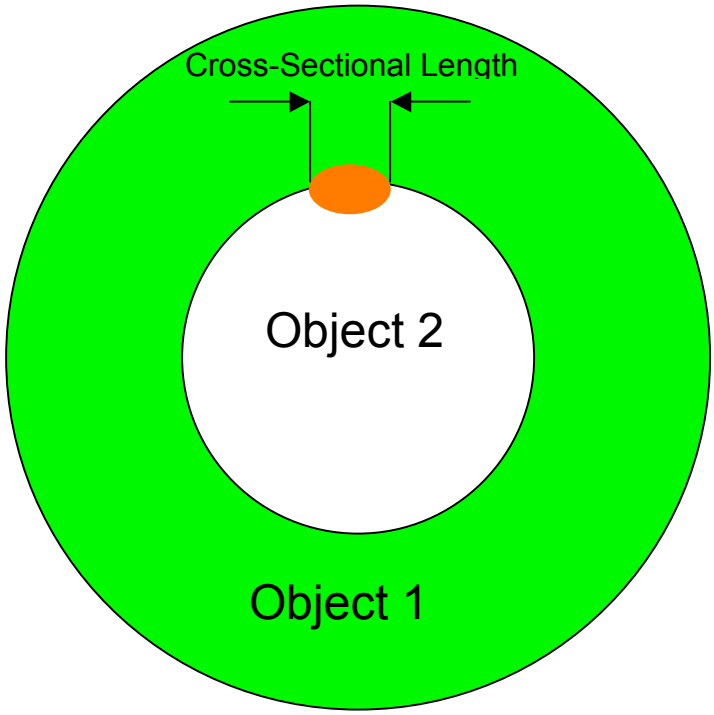
Shear Mode

In Shear Mode, the force required to shear the Uni-Key is as follows:

The maximum force F= ζ* P, where P is the pressure area and ζ is the maximum shear stress in psi of the material.

Figure 2 shows a Uni-Key (UK-200) in shear mode with a portion of the Uni-Key imbedded in both Object1 and Object2. Consider that the Uni-Key is imbedded such that the screw is completely imbedded in Object 1.

Figure 2



Shear Force F = Cross-Sectional Length * Length of Uni-Key Fastener * ζ
Where:

a) Cross-Section Length is the amount of the Uni-Key imbedded in Object 1
b) Length of the Uni-Key fastener (UK-400 = 1 in.)
c) Shear Stress (psi) =

In the case where only the Uni-Key material is imbedded in Object 1, the Uni-Key material under shear is 6061-T6 aluminum . The shear strength is 30,000 psi.

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For example:
UK-400 under shear.
Cross-Sectional Area = .300 in.

The Shear Force F required to shear the uni-key:

F=.3*30,000*1=**9000 lbs**

Maximum shear strength can be achieved by imbedding 50% of the Uni-Key in both objects. In this case the shear strength of the screw is effective. The screw shear strength is estimated to be 110,000psi (65% of tensile strength of 170,000psi). The shear force with the Uni-Key half imbedded in each object would then be 33000 lbs.
Note: Multiple Uni-Key fasteners can be used to increase the shear strength capability.

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