Retaining Ring Load Capacity Determination

If you need rings to position and secure bearings in a critical piece of machinery, load capacity can be critically important for function, safety and reliability of the ring application. Here's what you need to know to accurately assess static thrust load capacity for retaining rings.

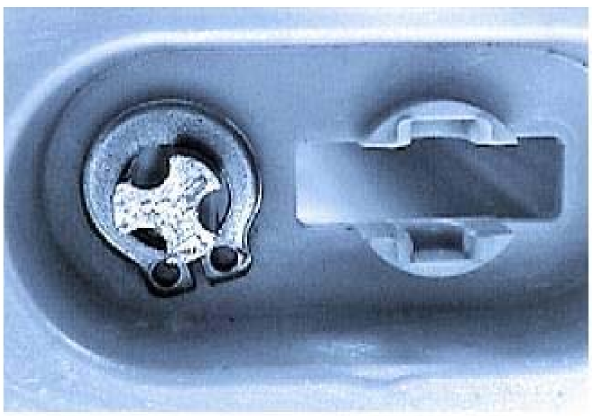
By Henry Yates, Technical Sales Engineer, Rotor Clip Co. Inc. -- Design News, July 28, 2010

Even though the maximum allowable thrust load capacities for retaining rings are given in the manufacturer's technical manual, there are numerous design applications issues to consider. For example, if a ring is seated in a groove cut in material softer than the ring, the thrust load capacity of the groove becomes the limiting factor in the assembly. If a ring is installed in a housing or on a shaft made of hardened steel, however, the maximum allowable static thrust load capacity listed in the manufacturer's technical manual may be used.

Application Considerations

How important is thrust load capacity for your design? If you plan to use rings to position and secure bearings in a pump, or lock up components in a car or truck transmission, load capacity can be critically important for function, safety and reliability of the ring application. On the other hand, if you plan to use a ring merely to hold a plastic name plate in place on a piece of equipment, you likely will not have to worry about loads on the ring. All you need is a ring that will stay put once you have it positioned. It is pointless to over design for high load capacity and pay the price for rings and grooves when another ring will do the job for less.

For example, consider an assembly in which you have to fasten components in a bore or housing .750" (19.0mm) in diameter. A self-locking retaining ring, which does not need a groove, provides 66 lbs. of static thrust load capacity; an external retaining ring for the same application installed in a soft groove provides 1,200 lbs. of static load capacity with a safety factor of 2. If the load capacity of your application is 66 lbs. or less, then the self-locking ring presents the most economical and effective approach to meeting this fastener requirement.



A self-locking retaining ring (left) retains the end cap on the shaft of this window blind. Since the application generates less than 66 lb. of static thrust load capacity, the ring does not require a groove; in contrast, the gear application (right) requires a standard external ring installed in a groove in order to accommodate greater thrust loads and RPMs than the blind application.

The bottom line here is that paying close attention to load capacity requirements before making any ring selections can save costs in this stage of your design.

Ring Thrust Loads
For maximum thrust capacity in both static and dynamic loading, the abutting face of the retained part should have a square corner. Fit of the retained part in the housing or on a shaft should allow reasonably concentric uniform loading against the ring.

When there is radial play between the retained part and the shaft or housing, such play must be treated as though the retained part had a chamfered corner. The magnitude of the chamfer should be considered equal to the play. Therefore, loading data for rings abutted by chamfered parts as shown in the specific manufacturer's ring data charts must be considered.

Allowable load capacities for rings apply only to standard thickness rings made of standard materials using the shear strength values listed in Table 1.

Table 1: Shear Strength of Ring Material

Material	Ring Type	Ring Thickness (in.)	Shear Strength (psi)
Carbon Spring Steel (SAE 1060-1090)	Housing Shaft Housing, Bowed Shaft, Bowed Housing, Beveled Shaft, Beveled Housing, Inverted Shaft, Inverted Shaft, Crescent	Up to and including .035	120,000
		.042 and over	150,000
	Shaft, Reinforced	.035 and over	150,000
	Shaft, Miniature	.020 and .025	120,000
		.035 and over	150,000
	Shaft, Two part Shaft, Reinforced "E" Shaft, "Poodle"	All available	150,000
	Shaft, Bowed "E" Shaft, "E"	.010 and .015	100,000
		.025	120,000
		.035 and over	150,000
	Shaft, Prong Lock	All available	130,000
Beryllium Copper (Alloy #25 UNS C17200)	Shaft	.010 and .015 (Sizes -12 thru -23)	110,000
	Shaft, Bowed	.015 (Sizes -18 thru -23)	110,000
	Shaft, "E"	.010 (Size -4 only)	95,000

When the special materials listed in Table 2 are used, multiply the allowable thrust load of the ring by the conversion factor shown.

Ring Material	Type	Rotor Clip Code	Conversion Factor All Sizes
Stainless Steel	PH 15-7Mo or equivalent AISI 632-AMS 5520	SS	1.0
Beryllium Copper*	Alloy = 25, UNS C17200	BC	0.75

* Except those noted in Table 1.

Groove Thrust Loads

The allowable thrust loads listed for rings used in grooves are based upon a housing or shaft material of cold rolled steel with a tensile yield strength of 45,000 psi. In the case of beveled retaining rings, the values given in Table 3 are for minimum contact between ring and groove-i.e., engagement of the beveled edge of the ring with the beveled groove wall at a length equal to half of the groove depth (d/2).

When the following materials are used, multiply the allowable thrust load of the groove by the conversion factor shown in Table 3.

Groove Material	Tensile Yield Strength Type	Conversion Factor
Hardened Steel (RC-40)	150,000 psi	3.3
Hardened Steel (RC-50)	200,000 psi	4.45
Aluminum (2024-T4)	40,000 psi	0.89
Brass (Naval)	30,000 psi	0.66
Other	x psi	x psi/45,000

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