Q&A Session for Ball Screws 301: Advanced Design

Q: What is the bearing spacing relative to the bearing journal diameter for a fixed end support design as a rule of thumb?

A: A fixed bearing support will have the bearing centerlines spaced 1.5x the journal diameter apart.

Q: We have used 4 times the diameter of the journal for the bearing spacing to define a fixed end mount. Standard catalog bearings do not meet this criteria forcing us to make custom end mounts. Is this excessive?

A: Use 1.5x the journal diameter as the spacing between bearing centerlines.

Q: Does the nut have an influence on the critical speed? If the frequency/critical speed is calculated as a shaft without the nut, will the nut have an impact on the system?

A: Yes, the nut stiffness will have an impact on the critical speed in an application. As a ball screw is supported at both ends with a moving ball nut in the middle, there are different beams with different natural frequencies on either side of the ball nut. These natural frequencies vary as the nut moves along the shaft. A preloaded ball nut can be used when the screw speed approaches the critical speed to reduce vibration.

As the stiffness of the nut may vary due to backlash and over time due to wear, the critical screw speed calculation typically ignores the affect of the nut.

Q: How well can ball screws resist heavy contamination?

A: Contamination is one of the leading causes of premature failure for a ball screw. A ball screw relies on the lubrication to achieve stated life and if the lubrication is contaminated, the components will wear and fail prematurely. Different styles of wipers are available: brush wiper (light contamination), rubber wiper (fine particulates), plastic wiper (dirt and debris), scraper (actual physical contact between screw and nut to remove debris). External bellow systems are also commercially available to cover a ball screw in applications of heavy contamination.

Q: Does Thomson sell pre-fabricated bearing supports with a "true" fixed bearing condition?

A: The catalog bearing supports are all considered “simple” supports for the purposes of the critical speed and column loading equations. Thomson does have additional supports that are not listed in the catalog that are “fixed” supports. Please contact a Thomson

representative for details. Examples of available supports are the WBK flange supports and the Type H base supports.

Q: Critical speed corresponds to natural frequency. Normally you want to be significantly different from that. What percentage of fn is the keep out zone?

A: Typically recommend a safety factor of 0.8.

Q: What is the correlation between type of bearing support and assumed end fixity?

A: The end fixity defines the C_s value to use in the critical speed and column loading equations. The stiffer the system – the higher the C_s value.

Q: Can you explain how the load lock device works to prevent a ball screw from back driving and is there a device you can add to a nut in case of catastrophic ball loss to allow for continued control of nut (i.e. prevent free fall in vertical orientation).

A: The load lock device is a coiled spring that is inserted into the unused portion between the ball nut and the ball screw. Upon catastrophic ball loss, the free space will be taken up by the load lock spring. This essentially converts a ball screw into a lead / acme screw. The increased friction created by the load lock spring prevents the ball from free falling or back driving the screw. In addition to the load lock spring, some ball nuts are machined with an inverted ball form that acts in a similar capacity.

Q: We hard stop home some of our applications. In order to define if this is acceptable or not, do I check the static load of the ball screws and work backwards to limit the current level?

A: We would never recommend a hard stop as a method to stop a ball screw unless it is a fail safe with the intention of replacing the assembly upon failure. A hard stop creates an impact load that may deform the ball threads, compromise the strength of the ball bearings, damage the return system, and typically jams the ball nut onto the screw. Commercially available end of travel stops are available as well as using Bellville springs or elastomers as stops.

Q: 6mm dia x 1mm x 150mm loads<10N. Is it a concern to exceed 10,000 RPM?

A: The critical nut speed calculation, DN = 140,000 (metric series), is a general check only. As the size of the ball screw approaches miniature level (less than 16mm), the calculated RPM per the DN equation is not valid. The critical speed will be limited by the return system of the ball nut. If your application exceeds 4,500 rpm, please contact a Thomson representative to evaluate the design.

Q: On linear rails, is it okay to remove the rubber bumpers, especially for hard stop homing?

A: A hard stop with any degree of impact may damage the linear system; drives, and bearings.

Hard stops can damage the drives and linear bearings, depending on the impact forces. The rubber bumper would help to soften the impact somewhat. There should be something in place to protect the drives and bearings from damage.

Rubber, on the other hand, is not an ideal surface off of which to stage exact location, especially to establish highly accuracy and repeatable positioning. If the homing of the system is performed with all the appropriate and necessary care to ensure no damage to the bearings, and drives, then the rubber stop may be removed. Otherwise there will be risk of system damage.