

ROLLON®
Linear Evolution

Understanding linear bearing speed and acceleration

Engineers focused on fast, light automation systems may pay too much attention to speed specs when acceleration is what really counts.



Look through the specifications of any linear bearing, and you'll come across a maximum speed. It's an important spec, but not nearly as important as many engineers think it is. Speed does play a role in bearing life. Consistently moving loads above a bearing's speed limit can result in premature wear. It is also possible, usually through a control error, to drive a bearing so fast that it will fail. For example, recirculating ball linear guides can experience end cap failure when driven at high speeds or accelerations. And roller bearings can freeze up at extremely high speeds. Yet these over-speed conditions are rare in well-designed motion systems. What's more, bearing speed is rarely the limiting performance factor in today's motion applications. Standard linear bearings can handle speeds of 3 m/s without any difficulty, while high-performance models can reach 5 m/s. Some bearings are even faster, with top speeds approaching 9 m/s. The majority of automation

applications, meanwhile, run at top speeds well under 5 m/s. So if today's bearings have speed to spare and over-speed conditions are rare, what good are speed specifications? The answer is that speed doesn't tell us all that much as stand-alone value. Only when considered in the context of acceleration and the overall motion profile does speed become important.

Acceleration Considerations

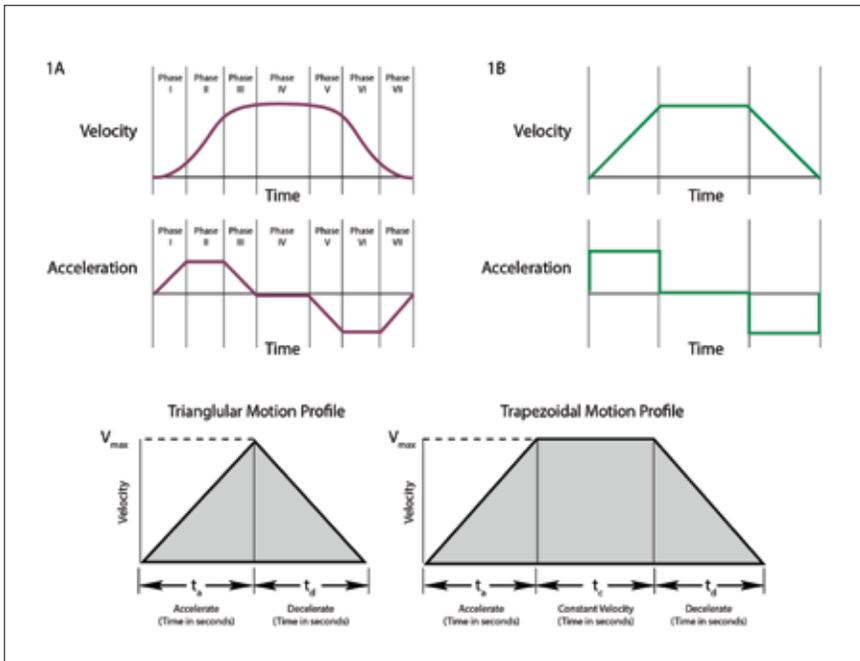
There is a connection between speed and acceleration beyond their mathematical relationship. Bearings that are engineered to withstand high speeds also tend to be robust enough to withstand high acceleration and vibration forces. And these are the forces that make or break most real-world motion applications. Acceleration and its rate of change (or "jerk") are the chief determinants of a motion system's stability and ability to hit position targets. When control engineers do overtax a linear

bearing, excess velocity is rarely the culprit. More typically, the engineer has pushed the system past its ability to handle acceleration, deceleration or vibration forces. In mild cases, this condition can manifest itself as skidding, which can increase wear and shorten bearing life. In extreme cases, excessive acceleration may result in catastrophic bearing failures.

Working With The Mechanics

Control engineers can obviously limit these forces when they program a motion profile--but only if the profile realistically relates to the bearing's mechanical limitations. All too often it does not. Motion profiles are routinely created around speed targets without reference to the fundamental limitation of the mechanical components. When this disconnect between the motion profile and the mechanical components happens,

Continue on page no.146



Continued from page no.144

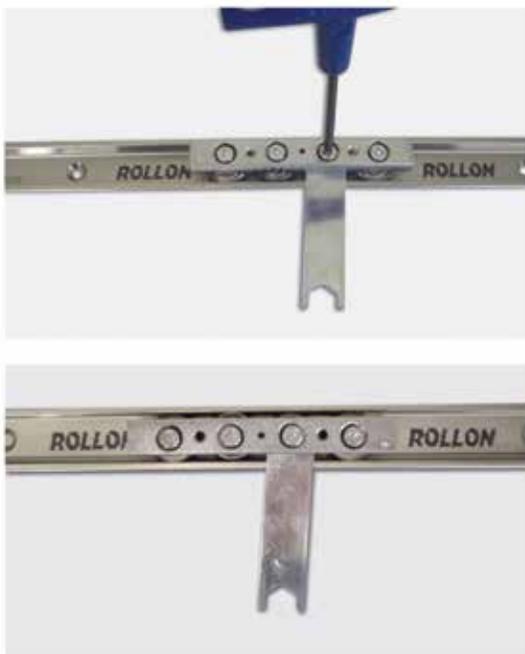
no amount of drive tuning will help. And keep in mind that not all the remedies for acceleration difficulties involve the motion programming. Preloading the bearing, which is purely a mechanical process, can help too. Some amount of preloading is often desirable because it removes excess clearance between the rolling elements and the rail surfaces,

eliminating uneven contact conditions and minimizing wear. As acceleration rises and skidding becomes a risk, keeping the rolling elements in contact with the rail at all times becomes even more important. Increasing the preload also makes the system stiffer, which helps improve positioning accuracy when acceleration, jerk and vibration forces are high. In general, high acceleration applications demand a higher preload. But there are a couple of trade-offs in that preloading reduces the bearing's load carrying capacity and increases wear. These trade-offs can be kept to a minimum by experimenting

to optimize the preload levels. There's usually a level at which the needs of an aggressive motion profile can be met without sacrificing much load carrying capacity or life expectancy. Experimenting with different preload levels will require some physical adjustments to the bearings. And not all bearing systems make this task all that easy. Some systems have their preloads determined by their factory set-up. The preload on recirculating ball guides, for instance, relates to the size of the ball bearings in relation to raceways. Changing the

preload on these systems typically requires changes to the slider, the rails or both. Other bearing styles allow simple preload adjustments in the field. Rollon's Compact Rail system can be adjusted from outside the rail by turning screws that compress the rail flanges. Aside from allowing adjustments without removing the slider from the rail, this system allows localized fine-tuning.

Preloads can be set higher in areas where high dynamic loads occur--for example, where the carriage reverses direction. Minimizing the amount of the rail subjected to higher preloads reduces the wear effect accordingly. It may always be tempting to look at a linear bearing's maximum speed to see if it will do the trick in a fast motion system. But focusing solely on speed without regard for the underlying mechanics of the linear bearing system will only slow you down.



ROLLON®
 Linear Evolution

*For more information,
 Rollon India Pvt. Ltd.
 1st floor Regus Gem Business Centre
 26/1 Hosur road, Bommanahalli
 Bangalore 560068, INDIA
 Telefono: +91 80 67027066
 Fax: +91 80 67027004
 E-mail: info@rollonindia.in
<http://www.rollonindia.in>*