INTECH Power-Core

Power of knowledge engineering®

Door Rollers Done Right

Hybrid plastic rollers improve sliding door performance.

Of all the maintenance headaches associated with sliding doors, rollers cause most of the pain.

Metal rollers, while still the default choice for heavy doors, require ongoing lubrication. And even when properly lubricated, metal rollers will eventually wear and need replacement. Or worse from a maintenance-cost perspective, the metal rollers will wear out their expensive steel door tracks.

Ordinary plastic rollers have problems of their own. All too often, plastic rollers are not dimensioned properly or made from the right material for the job. They lack dimensional stability and can fail when exposed to real-world dynamic loads, operating temperatures, moisture or chemicals. Many plastics also tend to creep in door applications, developing flat spots under static load. These flat spots will ultimately interfere with the smooth operation of the door.

When poorly designed or maintained, both metal and plastic rollers can also be noisy. And excess noise is typically a strong sign that the door will soon stop operating properly. In the case of metals, the noise occurs because of the metal-on-metal contact with the track, and the problem gets worse as the metal bearing surfaces wear. In the case of plastics, the dimensional changes and flat spots make for a rough, noisy ride.

Sliding door rollers tend to be minor component in the context of expensive architectural, industrial, transportation, and medical systems. So it's tempting to specify rollers without giving them much thought. However, paying too little attention to rollers can be a costly mistake. In industrial applications, inoperable sliding doors will drive maintenance costs and cause downtime. In consumer-facing applications—such as automobiles or railway cars—poorly operating doors can trigger complaints, frustration, repair costs and operational delays.

At Intech, we've been able to address the pain points associated with sliding door rollers. Thanks to proprietary roller simulation techniques that we developed and refined over two decades, we've created patent-pending roller design that fuses a polymer bearing surface with top-of-the-line roller bearings.

Here's a closer look at the design of these hybrid rollers as well as the engineering simulation work that made them possible:

Hybrid Roller Design

Sliding door applications vary widely. Hybrid rollers, for example, support sliding doors for passenger and cargo vans, public transit systems, agricultural machines, construction equipment, mall security, machine tools, medical imaging systems, cleanrooms and more. In general, these applications tend to have some common requirements, including:

- **Demanding lifecycle and reliability requirements**, with typical lifecycles measured in the hundreds of millions.
- **Heavy loads**, with some doors weighing nearly 2,000 lbs.
- **Demanding operating environments** with extreme thermal conditions, moisture, particulate contamination and aggressive chemicals.

Door rollers can be engineered in a variety of different profile shapes, depending on application requirements. Shafts and spacers can be similarly customized.

- **Noise reduction requirements**, often for medical systems used in proximity to patients.

The ability to work well in such a diverse group of applications begins with the roller material. We typically use a proprietary nylon called Power-Core™ for our rollers. While not the only material that could work, Power-Core has a number of advantages over both metals and other plastics in sliding door applications:

- **What goes around stays round.** Power-Core produces highly concentric rollers that stay that way in use. The concentricity comes from precision machining of roller surfaces. And the dimensional stability is an intrinsic material property. Unlike most polymers, Power-Core does not swell if exposed to moisture. Power-Core is also stable across a wide operating temperature range of - 40 to 140ºC.
- **No flat spots.** Power-Core features an entirely crystalline molecular structure that makes it more resistant to the compressive forces that cause flat spots when rollers are statically loaded over time.
- **A quiet, smooth ride.** Power-Core rollers can damp vibration more effectively than metals. Power-Core also exhibits lower rolling resistance than metals. Taken together, these two factors result in sliding doors that operate smoothly and quietly. Most rollers also experience shock loads that can damage metal or plastic rollers over time. Power-Core's inherent damping characteristics can counteract the shocks.
- **Keeps on rolling.** Power-Core rollers eliminate the metal-on-metal wear that can prematurely end of the life of metal sliding door rollers and tracks. And Power-Core needs no lubrication whatsoever to keep rolling smoothly for the life of the door.
- **Cost out.** One overlooked aspect of high-quality rollers is their beneficial effect on the cost of door systems—both installed and lifecycle cost. One of the main cost drivers on sliding doors with

Smooth Doors For Public Transit

With their long life and maintenance-free operations, Power-Core door rollers have been adopted in public transit applications, such as trains, people movers and light rail systems. One such application is the people mover system made by Bombardier Transportation for the Orlando International Airport in Florida.

Intech engineers custom designed a concave roller for the people mover doors after accounting for a lengthy list of application requirements that included thermal loads and high humidity. The roller assembly features a precision machined Intech Power-Core bearing surface that has been thermally installed over a sealed ball bearing.

Based on a load of 100 ft-lbs per roller running at 53.82 ft/min, Intech engineers determined roller performance life of between 500 to 700 million door-opening cycles, which could potentially provide the Orlando International Airport with 5 to 7 years of quiet maintenance-free operations.

metal rollers is the need for hardened steel tracks, which are expensive upfront and expensive to replace when they wear out. Power-Core, by contrast, can roll on much less costly aluminum track for the life of the door. Once you add in the savings from not having to lubricate the door rollers, the lifetime savings from switching from metal to plastic rollers can be significant.

- **Chemical-resistant materials.** In addition to the ability to withstand wide temperature swings, Power-Core polymer bearings also resist chemical degradation, which can be important in many applications. Machine tool doors, for instance, can expose doors and rollers to cutting fluids that could degrade less capable plastics. In these applications, stainless steel rollers have often been the default choice since many engineers were not aware of a suitable plastic alternative.

- **Contamination free and cleanroom approved.** When used in medical or electronics manufacturing environments, sliding doors and their hardware can be a source of unwanted contamination in the form of wear-generated particulate and lubricant. Power-Core rollers eliminate the wear mechanism that generates some of the particulate. What's more, Power-Core rollers are available with stainless steel bearings and cleanroom-approved lubricants if needed.

Simulating Roller Performance

Our ability to design and predict the performance of hybrid rollers rests on a proprietary roller simulation. Using an algorithm developed by Intech engineers, the simulation compares the results of Hertzian stress analysis to empirical data we've collected from real-world roller applications over the last two decades.

Inputs for the simulation include application details—such as roller dimensions, operating conditions and environment, material the rail runs against, bearing size and type, minimum and maximum

Roller Lifecycle Simulation

APPLICATION PARAMETERS	
Roller radius	0.625 in
Face width	0.500 in
Fillet radius	0.063 in
Rail radius	Infinite
Contact width	0.375 in
Contact length	0.024 in
Radial load	130 lb-ft
Speed	70 fpm
Duty cycle	Continuous
Temperature (min/max)	–40 to 140°F
Bearing	R6
Material damping factor	0.2
RESULTS:	
Hertzian stress	47.59 N/mm2
Perpetual rolling force	2.6 N
ROLLER LIFE	
Roller life expectancy	100,000,000 cycles
Number of hours at 70 ft/m	8,000 hr

Vehicle doors, particularly those on vans for passenger and commercial use, have to withstand millions of trouble-free openings. Hybrid rollers have proven to be a succesful selling feature.

forces, speeds, cycle and idle times, shock loads and desired life expectancy.

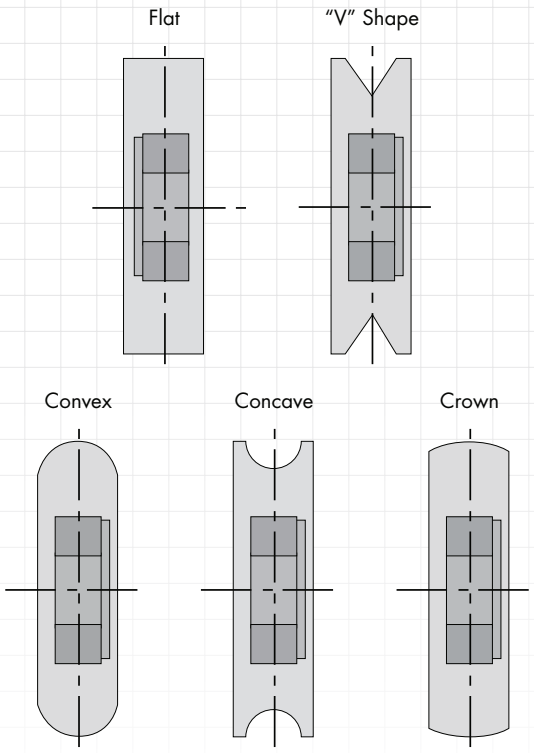
The simulation then returns predictions of the roller's life expectancy in hours of operation. It also returns a prediction of two forces. One is the force required while the roller operates under a dynamic load. The other is the initial force needed to overcome the temporary flattening that occurs when a roller is statically loaded—with the simulation calculating the extent of that flattening to make the initial force prediction. Lastly, the simulation evaluates the bearing selection.

If any of the application factors are unfavorable—for example, the applied load is too high—alternate design solutions are generated from the calculation results.

Custom or Ship From Stock?

Many sliding door applications do require their share of custom engineering—if they have very heavy loads, unusual mechanical constraints, damaging chemical exposures, temperature extremes or other challenging application requirements. Or they may just need a custom shaft. Increasingly, though, many sliding door applications can take advantage of off-the-shelf replacement rollers and track-and-trolley systems.

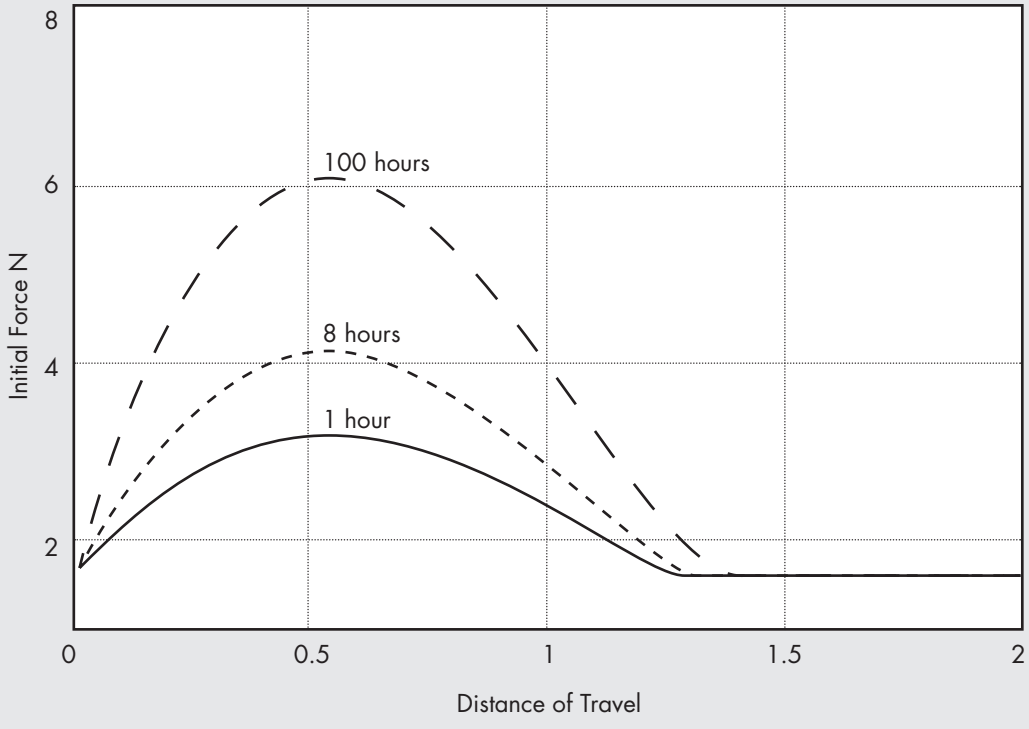
Roller Profiles



Any profile can be custom designed to last the life of the application. Or for a drop-in replacement for existing sliding door designs, a standard roller can be paired with a custom shaft.

Initial Rolling Force Calculation

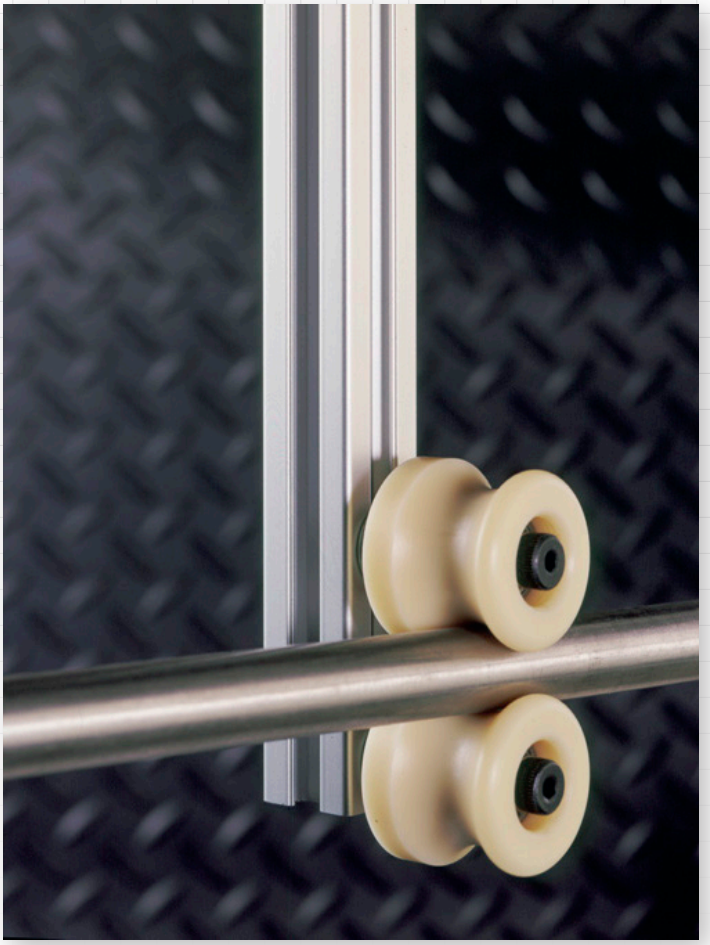
Initial force indicates the extent of the flat that develops when the roller is statically loaded. The larger the flat surface, the higher the initial force. And the higher the force, the more likely the roller will slide, making the door more difficult to operate and potentially generating damaging amounts of heat and wear. This graph shows the difference in initial force and extent of flattenting at three different time scales.



Sliding Door Applications

Power-Core rollers have gone into a wide variety of sliding door applications, including:

- **Public transport**—doors for trains, light rail and people movers.
- **Automotive**—passenger van, cargo van and refrigeration truck doors.
- **Architectural**—hotels and storefront doors, mall security doors, office doors, sliding wall systems, barn doors and airplane hangars.
- **Industrial**—machine tool enclosures, industrial curtains and cleanroom doors.
- **Medical**—imaging system enclosures, operating room and patient care systems.
- **Heavy equipment**—agricultural and earth moving machines.
- **Marine Applications**—ship and luxury yacht doors.



Concave rollers are particularly suited for sliding door applications, however, they often require a custom design to best ensure trouble-free operation.

The off-the-shelf rollers can be considered drop-in replacements for metal and plastic rollers used with standard guide roller systems, such as those found in architectural applications.

The track-and-trolley system, developed here at Intech, ships from stock in 8-foot lengths that can be joined for longer tracks or cut for shorter ones. The system features our hybrid rollers, made from a proprietary process that permanently installs a Power-Core bearing surface over a precision roller bearing. The track for the system is made from aluminum, which saves cost and weight.

The system can handle substantial loads without the need for custom engineering. Each trolley assembly, consisting of two rollers, can handle loads up to 250 lbs. A typical installation would have two trolley assemblies for a maximum load of 500 lbs. for this off-the-shelf system.

And because the rollers make use of Power-Core, they offer dimensional stability, vibration damping and wear characteristics that we can predict with a high degree of reliability. For a detailed lifecycle calculation, contact our application engineering team **info@intechpower.com**.

Cam Follower and Roller Design Tips

Composite cam followers and rollers combine a plastic load bearing surface with a metal roller bearing or structural hub. They offer some compelling technical advantages, including

- Reduced maintenance costs.
- Improved performance.
- Extended lifecycle.

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