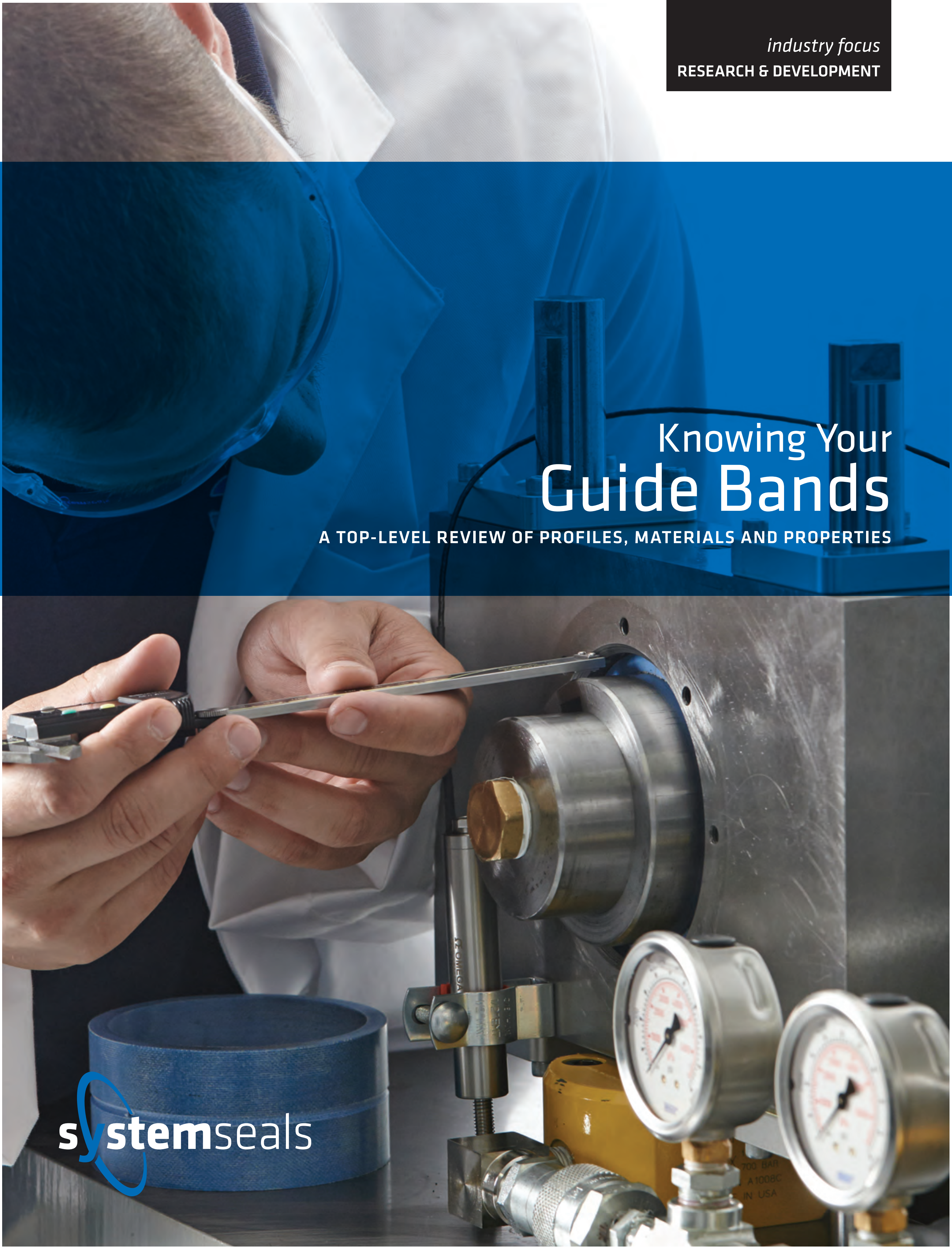
industry focus
RESEARCH & DEVELOPMENT

Knowing Your Guide Bands

A TOP-LEVEL REVIEW OF PROFILES, MATERIALS AND PROPERTIES



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Research and Development

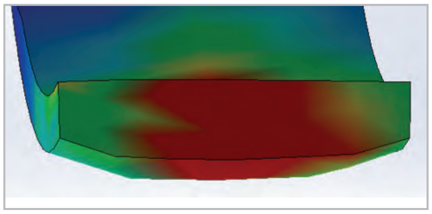
In an ongoing research-and-development project, System Seals put a variety of guide bands to the test and measured various properties, shapes, materials and dynamics.

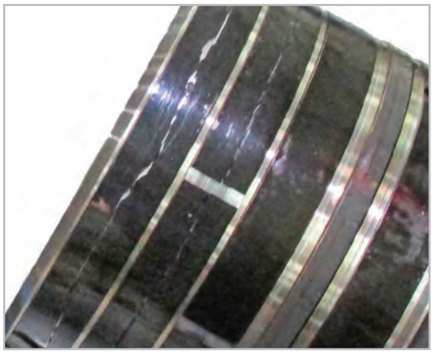
The process revealed some common misunderstandings about shapes and materials. What researchers concluded is that there are no catchall solutions. Different applications require different materials designs. This brochure is intended to provide the top-level finding from a research project that lasted several years.

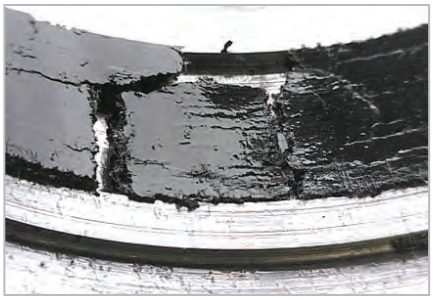
Convex Contoured Rings are Prone to Fracturing

Testing and simulations using Finite Element Analysis indicated that convex contoured ring profile intentionally concentrates the load to the center of the guide band. Because this shape is not fully supported, it begins to deform from high bending and shear stresses, which can later result in fracturing.

In this profile, flexural and shear limits are significantly lower than the compression limits. Side loads normally carried by flat profiles under pure compression cannot be carried by curved profiles without the high risk of fracturing. Flat profiles, despite their tendency for edge loading, are scientifically more reliable since there is no flexural or shear action while under compression.



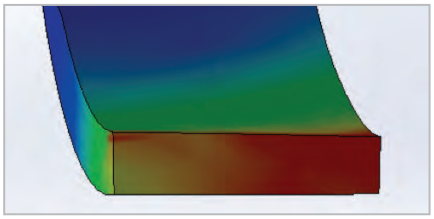




Left: In this Finite Element Analysis, the simulation confirms that because a curved convex contoured ring shape is not fully supported, it will lead to center loading and become prone to fracturing.

Right top: This image shows a center fracture failure in a guide band made of a Phenolic material in a convex contoured ring shape.

Right bottom: This image shows fatigue cycle failure in a flat-shaped guide band. Fracturing is from the use of Phenolic material that can be brittle.



A standard rectangular configuration guide band loaded on one edge from side-load forces resists flexing and bending because it is fully supported. Introducing a curved top profile, as with convex contoured rings, will result in increased center loading and enables fracturing.

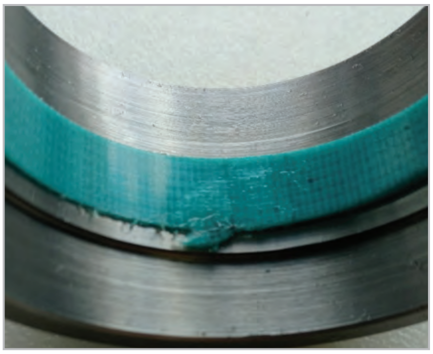
Misconceptions About Edge Loading

The curved convex contoured ring shapes were initially developed to reduce edge loading. It was thought that edge loading created an uneven distribution of load across the width of the band. It was later discovered, however, that because the curved shape of the convex contoured ring is not fully supported, it can lead to deformation and fracturing.

Edge loading on a standard rectangular configuration guide band might seem misaligned, but it has been proven to be a far more reliable shape because it remains fully supported and resists flexing and bending. Any concerns with edge loading are easily managed by analyzing the precise side load forces for a given application. System Seals' new Cylinder Optimization Process includes a side load analysis specifically for this purpose.

Delamination

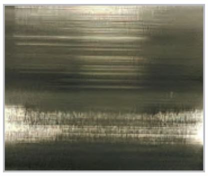
Many lesser-quality polyester guide bands have been found to delaminate over time. Delamination is a failure mode in composite materials when layers begin to separate. This can be caused by repeated cycle stresses and lead to significant loss of mechanical toughness. System Seals' new custom formulations are designed and tested specifically to prevent delamination.



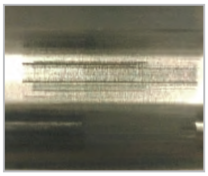
Delamination is the separation of layers in composite materials, often caused by repeated cycle stresses. Delaminated guide bands lose significant mechanical toughness and can ultimately fail.

Unfilled PE Composites

Glass filled Nylon



Phenolic



System Seals' MTC1

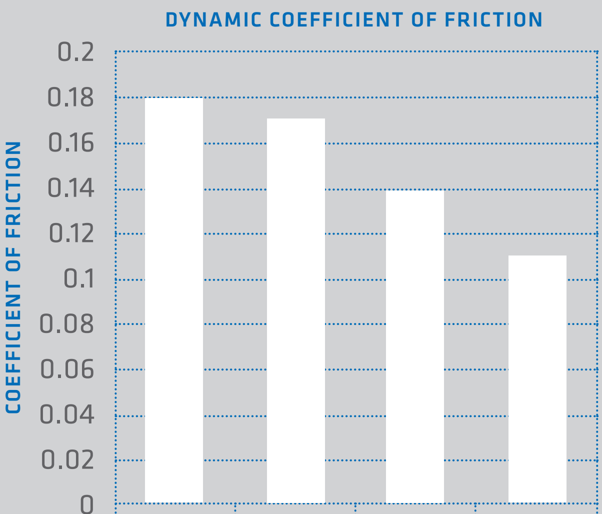
Abrasion Resistance

Research shows that materials used in guide bands play a major role in rod surface abrasion. In an extensive lab test, 30km of short strokes with 40MPa of side load were applied to multiple materials. The results showed that unfilled polyester was the most abrasive, followed by glass-filled nylon, and then phenolic.

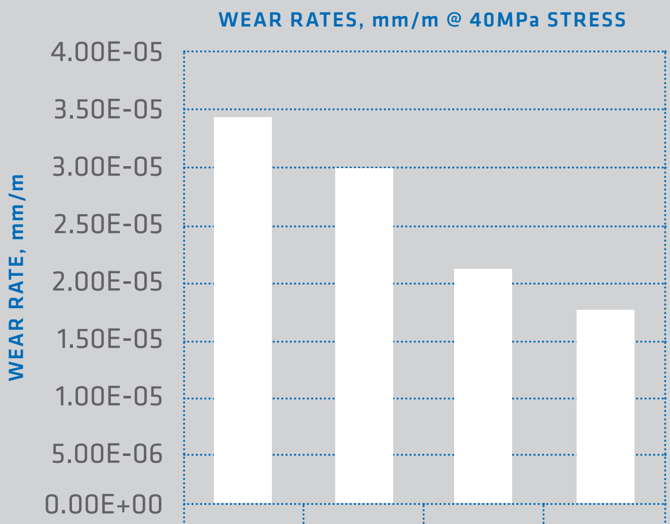
While all three materials left some signs of scoring on the rod, System Seals' custom blended MTC1 left only polishing streaks, which had no significant change in roughness.

Ranking Wear and Friction

The research project recorded wear rates and coefficients of friction.
The tables below show the respective properties for four popular guide-band materials.



	GF NYLON	PHENOLIC	UNFILLED PE	SSI MTC1
SERIES 1	0.18	0.17	0.14	0.11



	PHENOLIC	UNFILLED PE	SSI MTC1	GF NYLON
SERIES 1	3.41E-05	3.02E-05	2.14E-05	1.76E-05

Comparing Guide Bands

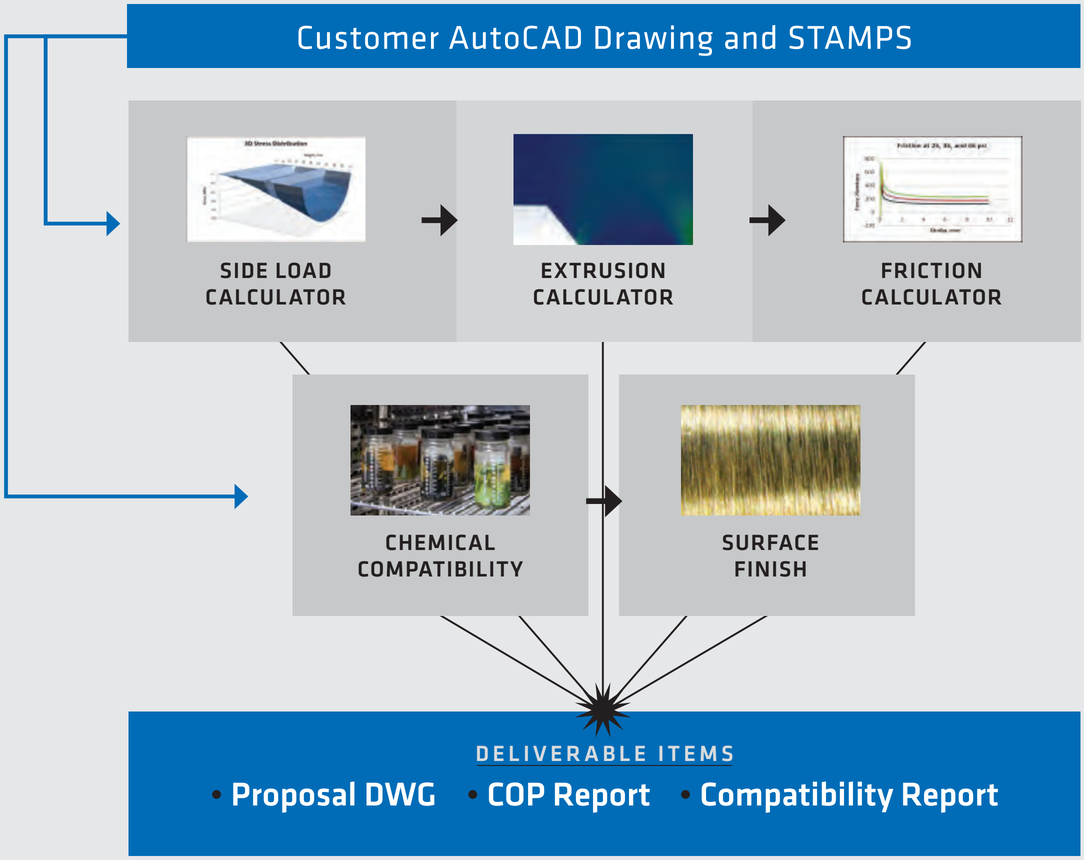
The table below shows a comparison of popular guide bands, based on extensive research and in-house testing.

	PHENOLIC	UNFILLED POLYESTER	SYSTEM SEALS POLYESTER	SYSTEM SEALS GLASS-FILLED NYLON	SYSTEM SEALS POM
LOW FRICTION			✓	✓	✓
LOW WEAR RATE			✓		✓
DELAMINATION RESISTANCE	✓		✓	✓	✓
HIGH COMPRESSIVE LIMIT	✓	✓	✓	✓	
HIGH YIELD STRESS	✓	✓	✓		
RESISTS CENTER LOADING AND CRACKING		✓	✓	✓	✓
RESISTS ROD SCORING			✓		✓
RESISTS HEAT DISCOLORATION		✓	✓	✓	✓
RESISTS CYCLE FATIGUE		✓	✓	✓	✓
HIGH FLEXURAL LIMITS		✓	✓	✓	✓
COP ANALYSIS			✓	✓	✓
CUSTOMIZATION OPTION			✓	✓	✓

System Seals' Cylinder Optimization Process

System Seals' Research & Development Lab has created new mathematical tools that take the guesswork out of cylinder performance. These tools calculate precise levels of side-load, friction and the potential for seal extrusion.

The process uncovers unique data points that enable engineers to design guide bands and sealing systems in ways that optimize a cylinder's performance and reliability. Some customers have saved millions of dollars using System Seal's analytic tools, while finding hidden potential to extend uptime, reduce risk and increase productivity.



This graphic shows the Cylinder Optimization Process through its sequential steps. The information it produces uncovers ideal parameters to design and position guide bands, sealing systems and other opportunities to optimize a cylinder's performance.

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