Friction Technologies

HIGH-QUALITY BRAKE PADS AND BLOCKS FOR ALL RAIL APPLICATIONS
WITH THE SYSTEM COMPETENCE AND GLOBAL KNOW-HOW of Knorr-Bremse, Friction Technologies provide the most comprehensive, individual and suitable offer of friction products for all train applications.

OPTIMUM FRICTION PAIRING FOR MAXIMIZING PERFORMANCE and operating life, and for minimizing costs, can only be achieved in a perfectly balanced braking system. As a supplier of brakes and a full range of friction products, Knorr-Bremse is in an ideal position to design the best system.

KNORR-BREMSE FRICTION TECHNOLOGIES offers a full range of sinter and organic brake pads and blocks. Our customers can rely on unique system expertise based on integrated engineering to achieve best brake performance.

**OPTIPAD**
Sinter pads both in flexible and rigid designs are composed mainly of sinter material elements in different forms and sizes. High technology degree for the most demanding applications.

**OPTIBLOCK**
Sinter material blocks for thermally highly demanding applications. Knorr-Bremse is actively working towards introducing this product family in its portfolio.

**PROPAD**
Produced with a variety of organic friction materials, organic pads cover the demands of a wide range of applications. Available both in standardized forms like UIC/KRS or specific design for hydraulic applications.

**PROBLOCK**
Wide range of organic material blocks both in UIC and AAR forms to cover a wide range of applications. Developing technologies towards wear- and noise-optimized products.
Knorr-Bremse offers a full range of flexible sinter brake pad designs for high-energy application:
- High friction stability at high temperatures and reduced hot spots on brake disc
- High mechanical resistance
- Supply chain which supports unique overhaul concept, elements produced at internal Knorr-Bremse site

### FLEXPAD®

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>UIC</th>
<th>KRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed application up to 250 km/h, UIC interface design</td>
<td>Speed application up to 250 km/h, increased 15% lifetime</td>
<td>Highest speed application &gt; 250 km/h</td>
</tr>
</tbody>
</table>

### ISOBAR®

- Specific designs fitting into all hydraulic interfaces
- Extensive portfolio with global certifications (UIC, GOST, ...)
- 15% increased lifetime in friction pairing

### PROPAD

- Organic friction materials
- Large product portfolio covering the specific demands of each application
- Noise-optimized design to avoid squealing
- Standard UIC dovetail designs or specific application-related hydraulic designs

### PROPAD Hydraulic

- Hydraulic specialized

### PROPAD UIC

- UIC standard

### PROPAD KRS

- KRS optimized
PROBLOCK – UIC

- Organic blocks covering demands of all UIC application types
- High and low friction levels optimized for each application
- Low wear levels, compared to gray cast iron blocks, 3 times longer lifetimes
- Standardized forms and wide range of friction material available, providing a large range of products

<table>
<thead>
<tr>
<th>LL Blocks – L Blocks</th>
<th>K Block</th>
<th>Metro Blocks</th>
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</thead>
<tbody>
<tr>
<td>Low friction to replace gray cast iron blocks, reduction of noticeable noise level by 50%</td>
<td>High friction level for modern freight cars</td>
<td>High friction level, stable for all applications (e.g.: ATO, emergency, ...)</td>
</tr>
</tbody>
</table>

PROBLOCK – AAR

- Applications for all AAR markets
- Product lines with differentiated value proposition for the customer
- Standardized forms and wide range of friction material available, providing a big range of products
- Wheel Saver tread conditioning brake shoes repair wheel tread defects keeping wheels in service longer

<table>
<thead>
<tr>
<th>Freight Shoes</th>
<th>Locomotive Shoes</th>
<th>Coaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHANGE SAVER</td>
<td>VALUESAVER</td>
<td>WHEELS AVER</td>
</tr>
<tr>
<td>PROSHOE High Friction</td>
<td>PROSHOE Low Friction</td>
<td>PROSHOE High Friction</td>
</tr>
</tbody>
</table>

- Provides 45% more friction material than all other AAR-certified products
- Optimized friction performance, competitive price design
- Different mixes and forms produce proven durability and life-cycle value
- Low friction formulas designed for today’s service environments are replacements for cast iron shoes
- Formulas and forms specifically designed for commuter rail service environments

FRICTION TECHNOLOGIES
TECHNOLOGICAL EXCELLENCE is a prime concern at Knorr-Bremse. One of the most advanced testing facilities worldwide, with test benches in different locations and its specially designed Technology Center in Munich, allows Knorr-Bremse to close up the cycle for every customer application with the assurance that the most reliable and sustainable system has been designed for our customers. Our state-of-the-art testing and analysis facilities allow us to examine and assess:

- UIC approvals
- Testing speeds up to 520 km/h
- Measurement of friction coefficient, temperature, wear, noise
- Thermographic examination
- Testing under extreme climatic conditions (snow, low temperatures, etc.)
- Material analysis

Knorr-Bremse integrated engineering is customer-oriented and offers optimized project-specific friction pairings. With more than 50 years of experience, Knorr-Bremse has the capability to provide customers with a selection of brake discs and brake pads that significantly influence life-cycle costs. Proven design principles are the basis for reliability and brake safety. A wide range of brake discs, brake pads, and materials for all railway applications guarantees high flexibility for customer requirements and a short lead time. Hundreds of service-proven friction pairing variations allow us to offer the most suitable solution for each and every customer.

- More than 50 years of know-how and experience in friction pairing designs
- Optimized LCC, high safety assurance and noise reduction with Knorr-Bremse friction pairing designs
- Friction pairing designs validated as a system at our testing facilities
PRODUCTION EXCELLENCE

With one of the world’s broadest portfolios, Knorr-Bremse assures high-quality production and supply chain excellence. Knorr-Bremse’s leading rail friction factories focus on the product portfolio of the world’s largest markets: UIC and AAR. Our facilities are equipped with the latest production technology to ensure high-quality, reliable products.

Main site for UIC material
- Manufacturing in Pamplona, Spain, since 1961
- **Products:** UIC organic friction material
  - Organic brake pads and blocks
  - Sinter friction elements

Main site for AAR friction material
- Manufacturing in West Chicago since 1977
- **Products:** AAR brake shoes
  - Organic brake blocks (= shoes)
  - Semi-metallic wheel-conditioning shoes

Manchester site
- Manufacturing in Manchester since 1879, owned by Knorr-Bremse since February 2016
- **Products:** Organic metro blocks and organic freight blocks (no UIC blocks)

REFERENCES (EXTRACT)

KNORR-BREMSE DELIVERS FRICTION PRODUCTS ALL OVER THE WORLD WITH LOCAL SALES TEAMS

- **London Underground**
- **InterCity Express Programme (IEP)**
- **STIB (Brussels)**
- **Deutsche Bahn Cargo**
- **VTG**
- **ICE 3**
- **Desiro Sochi**
- **Shinkansen**
- **CRH6**
- **Metro Shanghai**
- **Haramain Express**
- **Trans Adelaide**
- **New E Loco Madhepura**

**High-Speed Applications**
- EMU/DMU/Coach Applications

**Hydraulic**
- AAR Applications

**Low-Noise Freight Applications**
- Metro Applications