



SPINDEL- UND LAGERUNGSTECHNIK FRAUREUTH GMBH



Your industrial partner for
rolling bearing applications
in steel mill roll stands

20th May 2022

AT THE CENTER OF MOTION

Agenda

- Who we are - About SLF
- What we can do - our proposal for steel mill roll stand applications
- How we work – our engineering approach
- What we offer - your added value

Who we are - About SLF

History of bearing production at Fraureuth location:











2022

80 years of bearing production at Fraureuth location

2023

30 Years Spindel und Lagerungstechnik Fraureuth GmbH

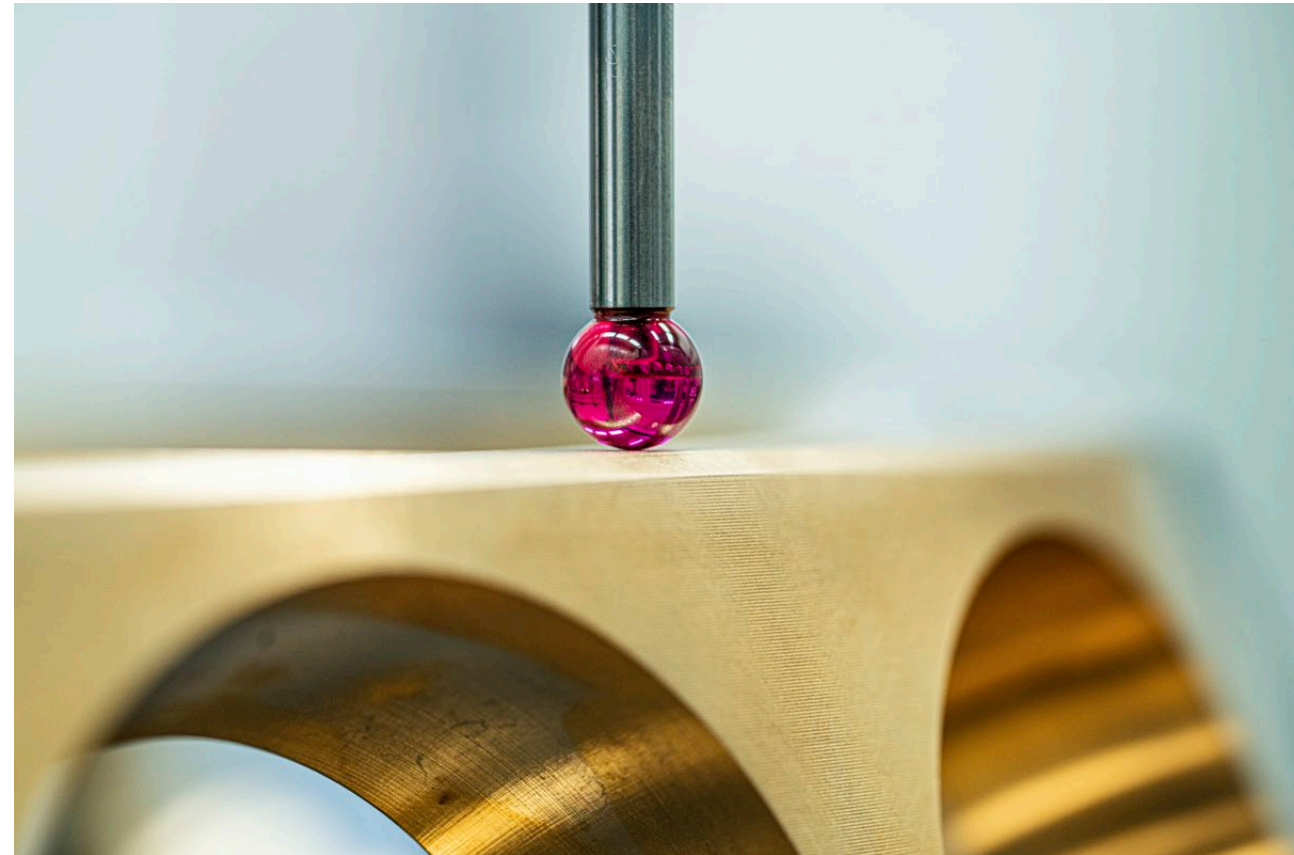


| | | | | | |
|---|---|---|---|--|---|
| <p>1942</p> <p>FAG Kugelfischer establishes production site in Fraureuth</p> | <p>1945</p> <p>The company develops into a cage supplier to the DKF (Deutsche Kugellagerfabrik)</p>  | <p>1954</p> <p>Production under the brand of DKF, more than 1,800 employees work at the Fraureuth location</p>  | <p>1993</p> <p>Founding of Spindel- und Lagerungstechnik Fraureuth GmbH with a total of 29 employees</p>  | <p>2019</p> <p>Avedon Capital Partners (Netherlands) acquires a majority stake in the company</p>  | <p>from 2020</p> <p>Internationalisation: Subsidiaries in USA (Cornelius, NC) and China (Kunshan)</p>  |
|  <p>1943</p> <p>Founding of „Thüringer Pressholz-Gesellschaft“, Production of bearings cages made of different materials</p> |  <p>1949</p> <p>Factory renamed to “VEB Wälzlagerwerk Fraureuth” begins production of bearings and grinding spindles</p> |  <p>1990</p> <p>After German reunification, acquired by FAG Group – Closure of the site in July 1993</p> |  <p>2000s</p> <p>SLF develops into an exceptional medium-sized bearing manufacturer while extending its international reputation</p> |  <p>2020</p> <p>Expansion of the SLF Group by STI Bearings GmbH, a specialized industrial service provider for components and parts for rolling bearings and drive technology</p> | |

Key to success

Our products are renowned for the highest quality and precision. SLF stands for perfection down to the last detail.

Made in Germany.



SLF- Commitment

Dependability

SLF responsibly ensures stable product availability and high delivery performance

Flexibility

Nimble manufacturing processes guarantee high flexible variety

Reliability

The superior quality of our products ensures maximum life and performance for our customers

SLF- Partnership

Customer Focus

Developing specialized solutions to fit customer individual needs that is our passion

Service

Our customers benefit from highest level of consulting expertise and industry knowledge of our employees

SLF- Expertise

Tradition & Experience

SLF convinces with almost 30 years of experience in the manufacture of rolling bearings and spindles at the traditional location in Fraureuth

Expertise

With the combined knowledge of our employees, we meet the most challenging customer requirements

Process Management

Our processes are designed effectively, efficiently and safely. This is how we optimize our performance

SLF key figures



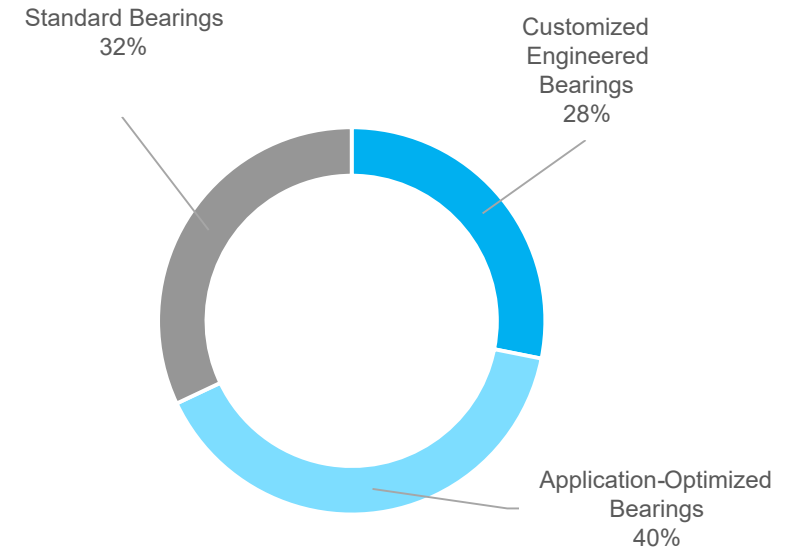
Product solutions

BEARINGS

Consistent in quality and versatile in use

SLF designs and manufactures a variety of standard and specialized bearing types ranging from 32mm to 1,600mm in outer diameter

Production of more than 2,000,000 million roller bearings per year



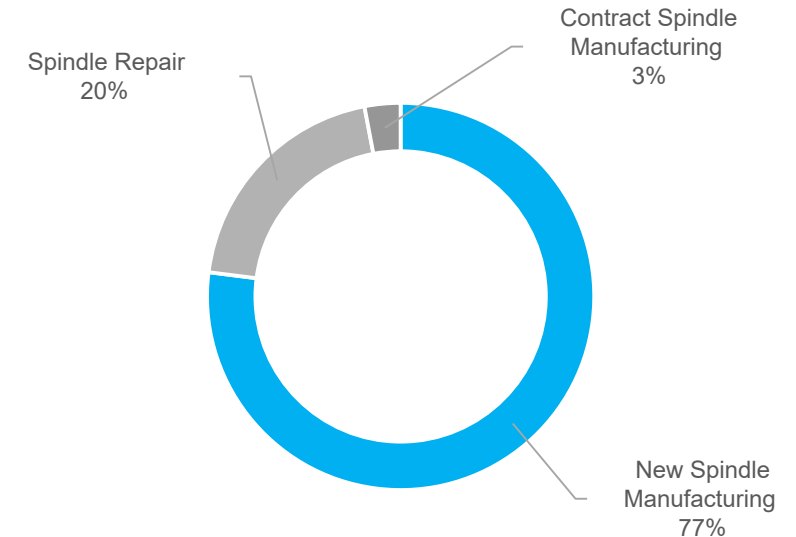
Product solutions

SPINDLE UNITS

Individual manufacturing and quick repair

SLF designs and manufactures spindle units optimized for each application. We produce spindle diameters ranging from 32mm to 525mm and capable of lengths up to 1.800mm

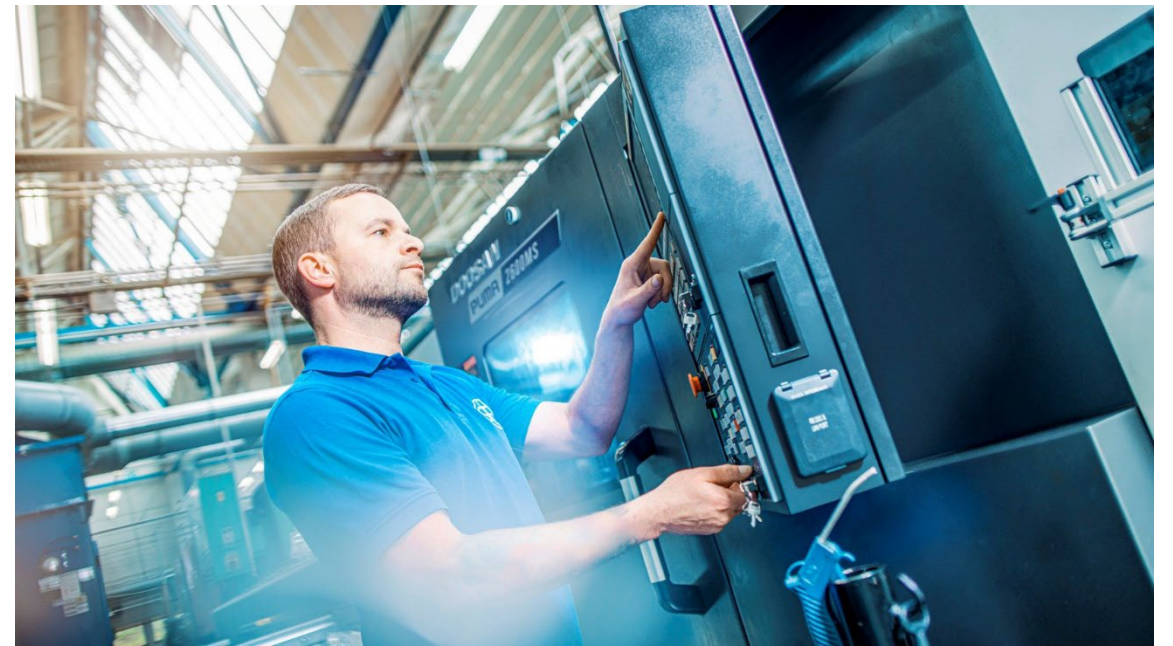
Production of more than 1,000 spindle units per year



Manufacturing

MADE IN GERMANY SLF Products are manufactured at the Fraureuth location on a total area of 60,000m²

Perfectly coordinated manufacturing processes and state-of-the-art technologies enable flexibility, short delivery times and a large variety of products. The production is always closely coordinated with individual customers requirements we finalize customer projects in a time and cost optimized way

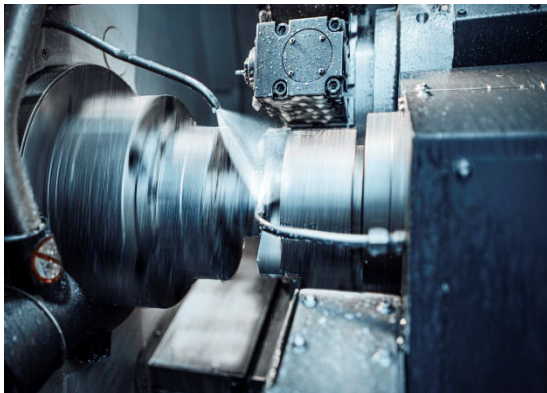


Manufacturing

Just a high level of vertical integration within the value chain guarantees control over all manufacturing steps that contribute to the quality of the final product.

Soft Machining

SLF broad selection of modern machines, inhouse "grinding" capabilities enables us to produce complex bearing geometries, provides quality control and minimizes lead time.



Heat Treatment

The inhouse hardening plant sets the optimal material properties for our high quality products.

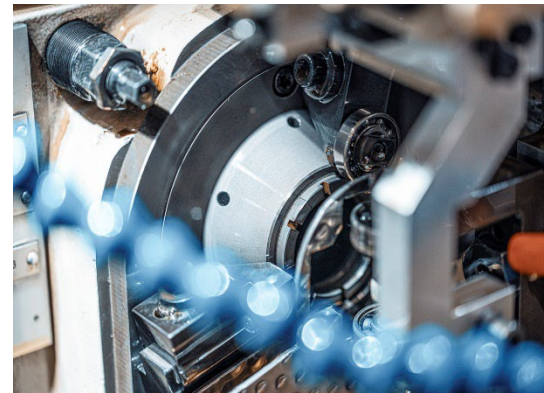
Our pass through plant hardens over 750 tons of steel per year.



Hard Machining

The precision of our products arises in hard machining.

Our exceptional flexibility enables one off production as well as large series production.



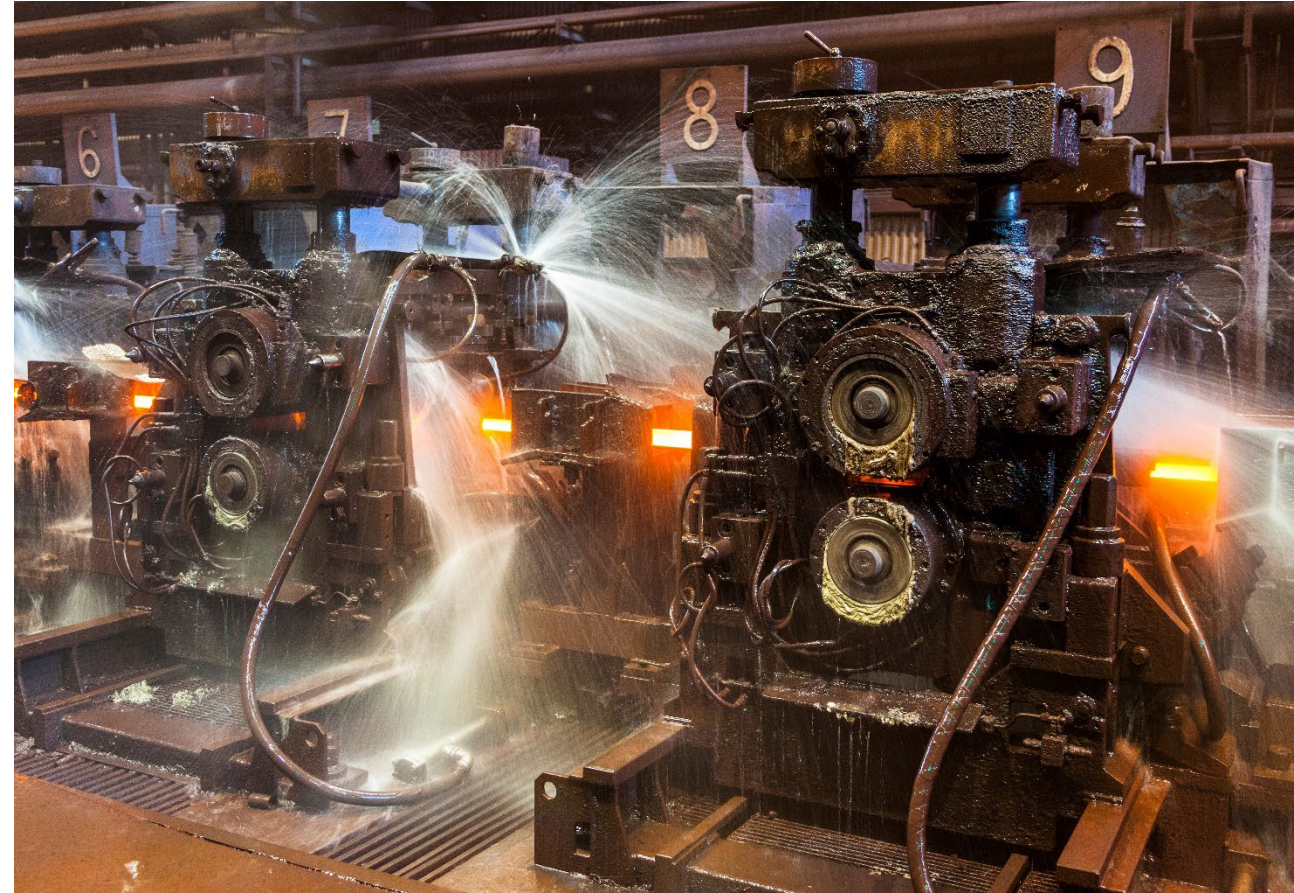
Assembling

Completed individual components are put together to form a high quality SLF product.

SLF ensures the highest quality level by final inhouse testing and inspection.



What we can do - our proposal for
steel mill roll stand applications





First Test Install / Beam Mill /
SLF Bearings – Nucor Berkley

Thorough understanding of design conditions in roll stands

- Bearings in roll stands are highly loaded components. Therefore they need to provide high load rating capacities and long life time.
- Radial loads in roll stands are usually very high, axial loads are comparably small.
- Available installation specification is often limited (e.g. building height, ratio D/d small).
- Variety of roller bearings is huge but shall fit best to the application.
- Cylindrical roller bearings offer compact radial design with comparably highest load ratings and lowest friction level at highest rolling speeds.
- Proper selection of axial cylindrical roller bearings improves rolling accuracy results for work pieces.
- Material for rings: through hardened martensitic or bainitic bearing steel or case hardened.
- Specific knowledge on rolling contact conditions as driver for optimum contact geometry profiles.
- Nominal radial bearing bore and outer diameter range up to 1.600 mm.

Selection and calculation of bearings layout principles

Load case:

Dominating high
(constant/varying radial load)

Lowlevel axial load

Higher level axial loads

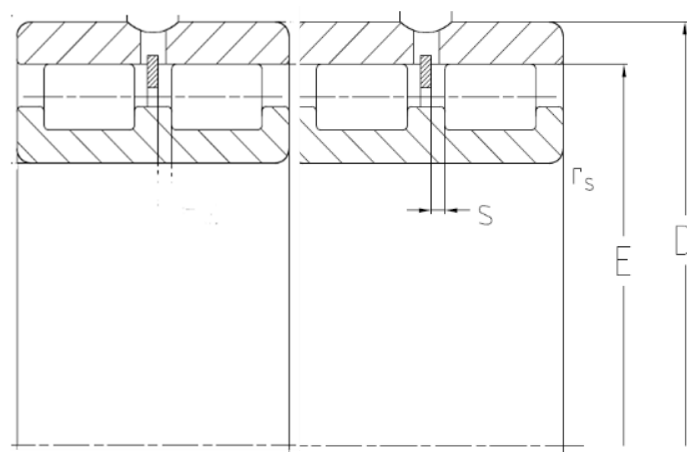
Proposed solution:

Four row cylindrical roller configuration

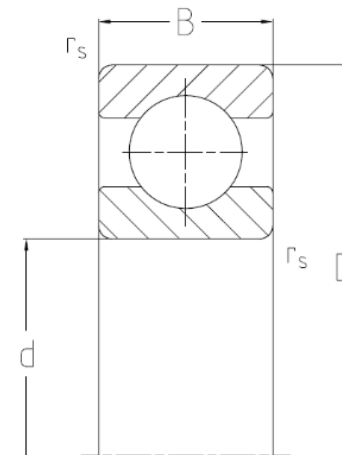
Radial ball bearing

Axial cylindrical roller bearing

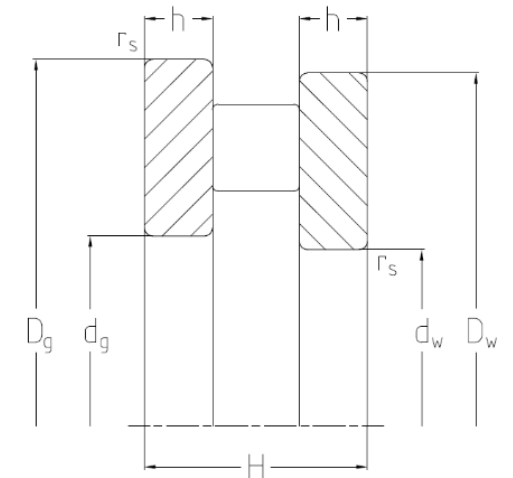
Illustration:



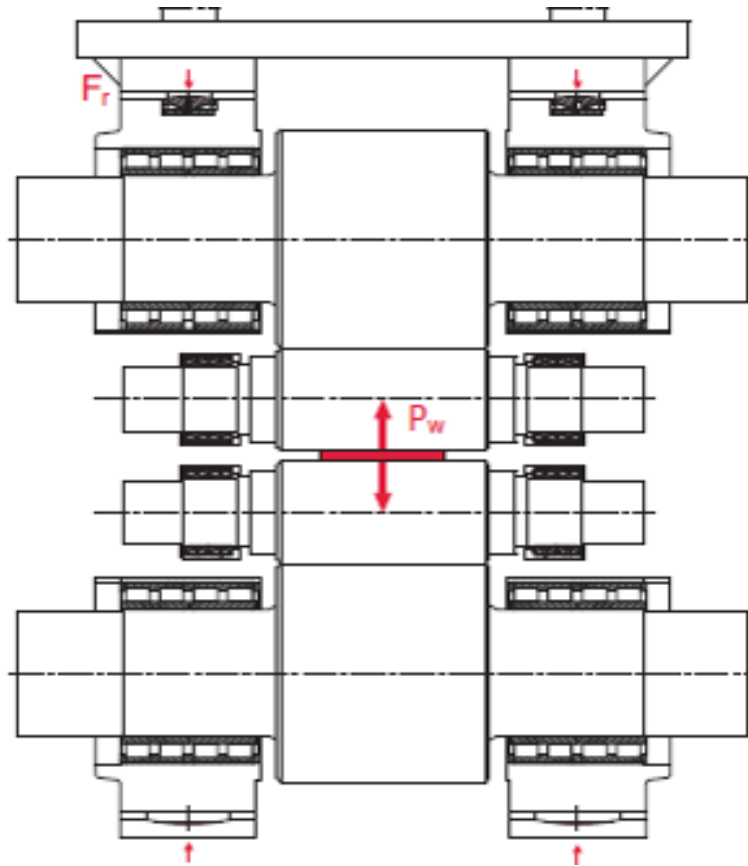
60/850M



812/800M



Layout example roll stand (4hi) equipped with SLF bearings



Selected bearing types are based on customer application input data and subsequent SLF engineering approach, illustrated in the following slides.

How we work - Our engineering approach



Critical success factor proper selection of steel material

SLF is the preferred partner for selection of high quality steels for bearing applications based on the following national and international bearing steel grades:

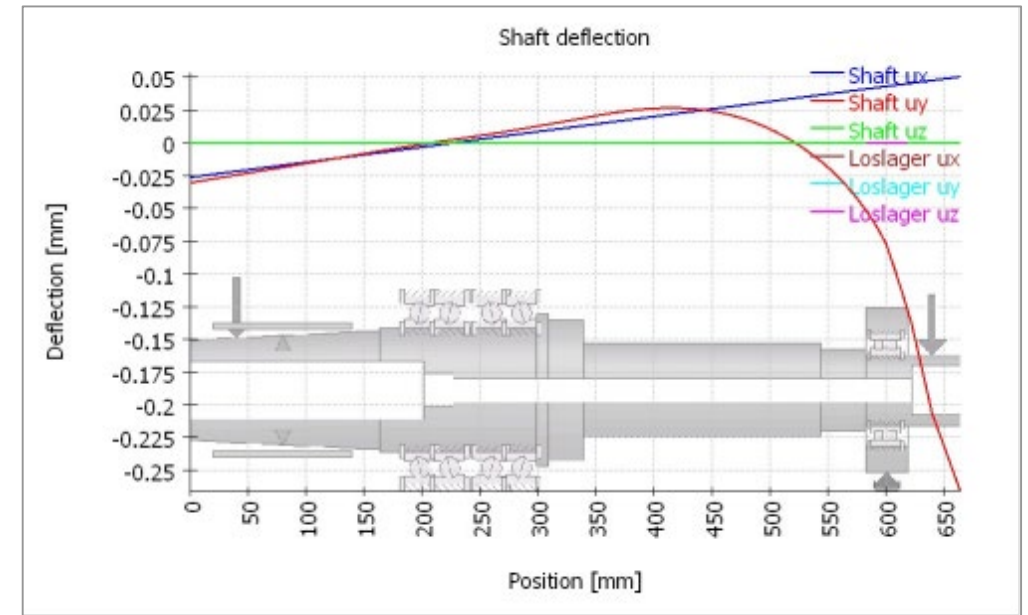
- DIN 17230 Ball and roller bearing steels, technical conditions of delivery
- DIN EN ISO 683 part 3 Heat-treatable steels, alloy steels and free-cutting steels / case-hardening steels
- DIN EN ISO 683 part 17 Heat-treatable steels, alloy steels and free-cutting steels / ball and roller bearing steels

- Utilization of high-purity steel grades, supplied from specialized West European steel mills.
- Own heat treatment facilities to secure process control and guarantee very good carbide structure & distribution.
- Results: steels, durable against contamination in order to reach excellent life time.

Example for an SLF advanced bearing calculation method

Calculation of:

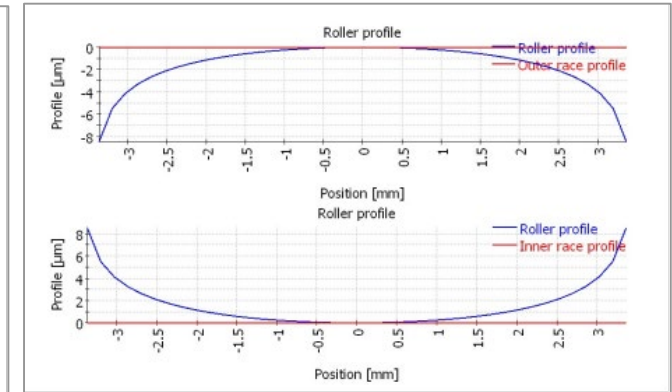
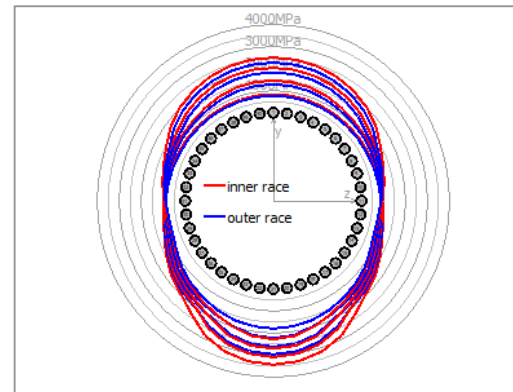
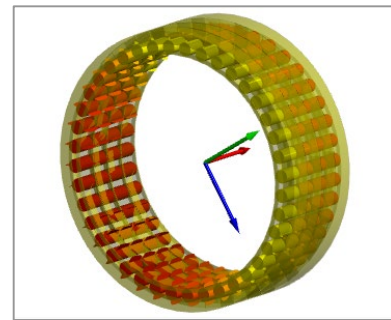
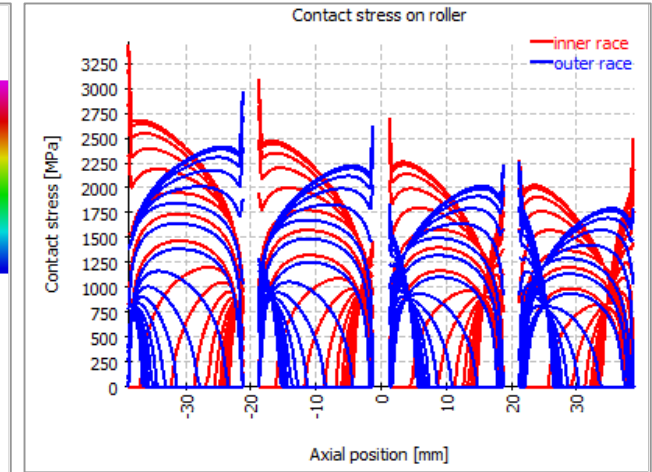
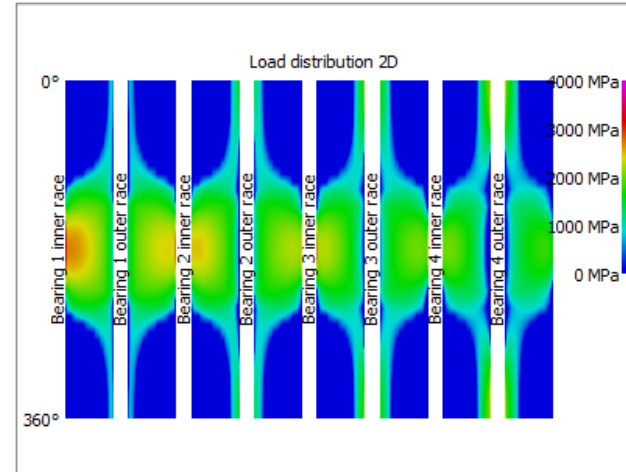
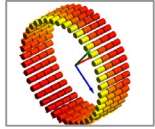
- Load conditions on the shaft-bearing configuration
- Contact pressure for each rolling element
- Load distribution over rolling elements for all bearings
- Static safety
- Expected lifetime under all operating conditions (varying loads, speeds, combination of both..).
- Critical frequencies



Example for an SLF advanced bearing calculation

With:

- SLF specific bearing design data
- Consideration of geometrical tolerance conditions & clearance
- Specific roller geometry



SFL tolerance specifications for inner rings

Inner ring

Tolerance class P6 (reduced tolerances upon request)

| Inner ring (dimensions in mm) | | 10 | 18 | 30 | 50 | 80 | 120 | 180 | 250 | 315 | 400 | 500 | 630 | 800 | 1000 |
|---|------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|
| Nominal bore diameter | over up to | 10 | 18 | 30 | 50 | 80 | 120 | 180 | 250 | 315 | 400 | 500 | 630 | 800 | 1000 |
| Tolerance class P6 (tolerances in μm) | | | | | | | | | | | | | | | |
| Deviation | Δ_{dmp} | 0 -7 | 0 -8 | 0 -10 | 0 -12 | 0 -15 | 0 -18 | 0 -22 | 0 -25 | 0 -30 | 0 -35 | 0 -40 | 0 -50 | 0 -65 | 0 -80 |
| Variation V_{dp} | Diameter series 7 • 8 • 9 | 9 | 10 | 13 | 15 | 19 | 23 | 28 | 31 | 38 | 44 | 50 | 64 | 80 | 100 |
| | 0 • 1 | 7 | 8 | 10 | 15 | 19 | 23 | 28 | 31 | 38 | 44 | 50 | 64 | 80 | 100 |
| | 2 • 3 • 4 | 5 | 6 | 8 | 9 | 11 | 14 | 17 | 19 | 23 | 26 | 30 | 38 | 50 | 60 |
| Variation | V_{dmp} | 5 | 6 | 8 | 9 | 11 | 14 | 17 | 19 | 23 | 26 | 30 | 38 | 50 | 60 |
| Width deviation | Δ_{Bs} | 0 -120 | 0 -120 | 0 -120 | 0 -150 | 0 -200 | 0 -250 | 0 -300 | 0 -350 | 0 -400 | 0 -450 | 0 -500 | 0 -750 | 0 -1000 | 0 -1200 |
| Width variation | V_{Bs} | 20 | 20 | 20 | 25 | 25 | 30 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 70 |
| Radial runout | K_{ia} | 7 | 8 | 10 | 10 | 13 | 18 | 20 | 25 | 30 | 35 | 40 | 50 | 60 | 70 |

< Typical diameter range for roll stand application

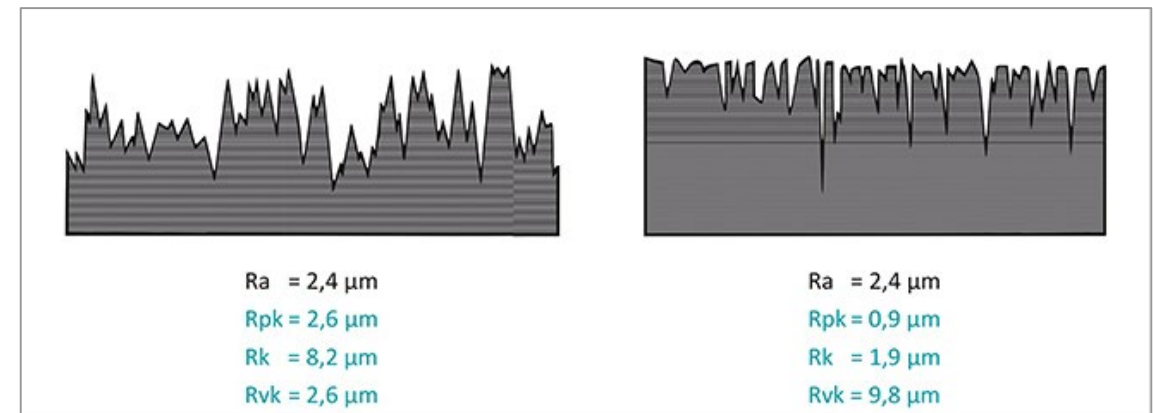
Roughness values as characteristics for tribological bearing contact surface

- Cylindrical rollers are made in-house.
- Particular logarithmic profile characteristics for optimum load distribution.
- Profile characteristics can further be optimized especially for high load applications.
- Surfaces are super finished for very high carrying values focusing on R_{PK} and R_{VK} for increased contact area ratio of contact length.

R_{PK} reduced peak height (carrying ratio) and

R_{VK} reduced depth (lubricant reservoir)

Surface texture parameters according to DIN EN ISO 13565-2



What we offer - your added value



Our offer for your customer satisfaction

Added value for your individual application through:

- High purity European steel grades
- Various hardening options
- Ultra precise accuracy for rings: inner ring standard P5 (or better, upon request)
- Super precise grading of cylindrical rollers
- Super finished contact surface roughness parameters
- Aligned profile raceways on all contact partners (rollers, inner ring and outer ring raceways)
- Specialized bearing types to 1.600mm in outer diameter
- Advanced engineering tool for comprehensive bearing calculations available
- MADE IN GERMANY



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