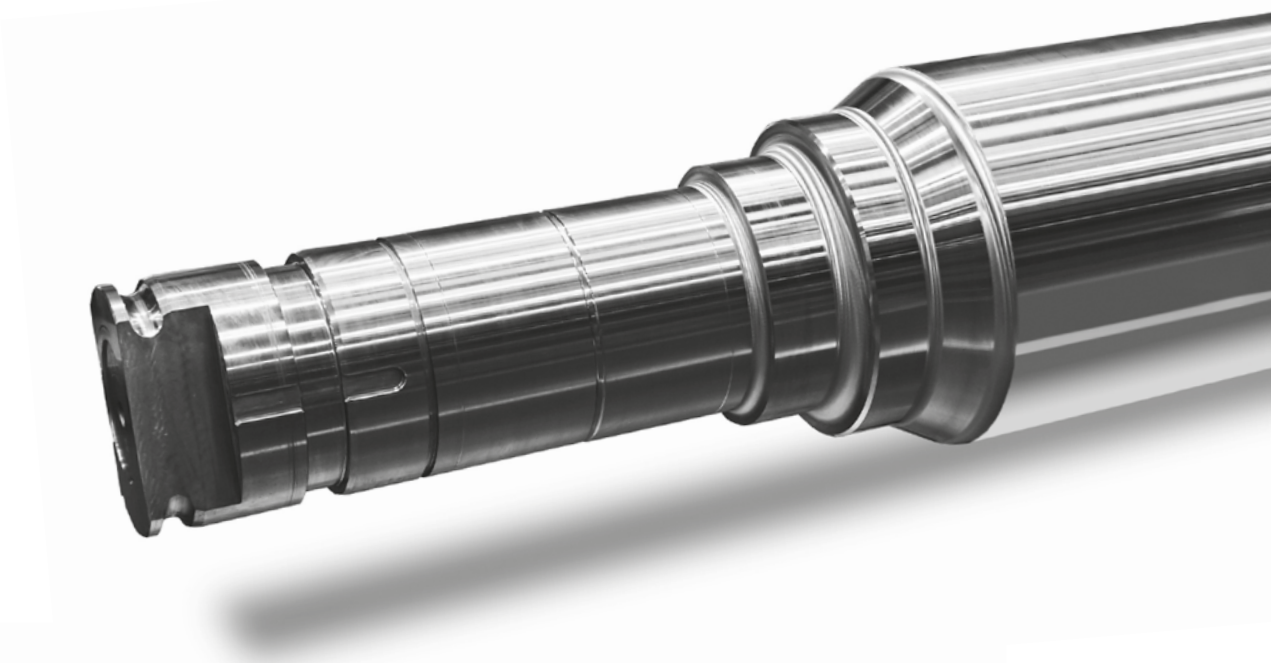


sij | ravne systems

Forged products for the
**ALUMINIUM INDUSTRY**

The SIJ Group is the largest Slovenian vertically integrated Slovenian metallurgical Group and one of the largest producers of stainless and special steels in Europe.

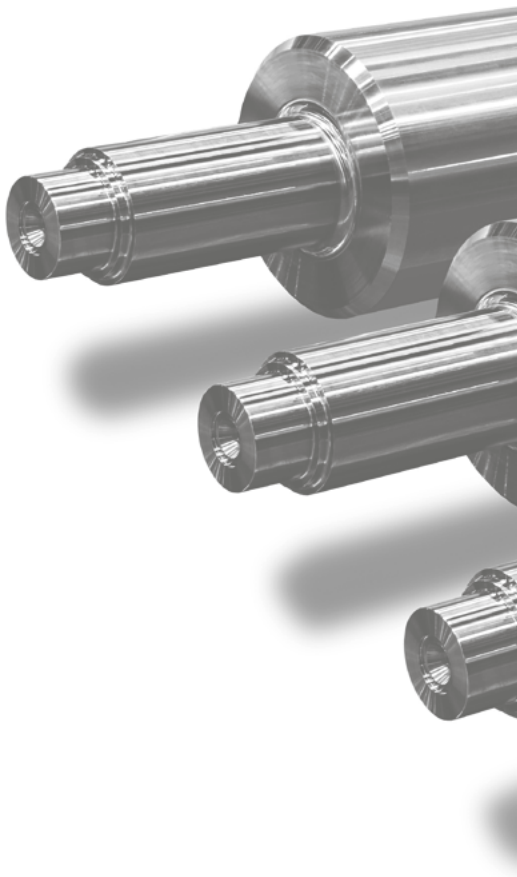
The SIJ Group consists of five divisions:

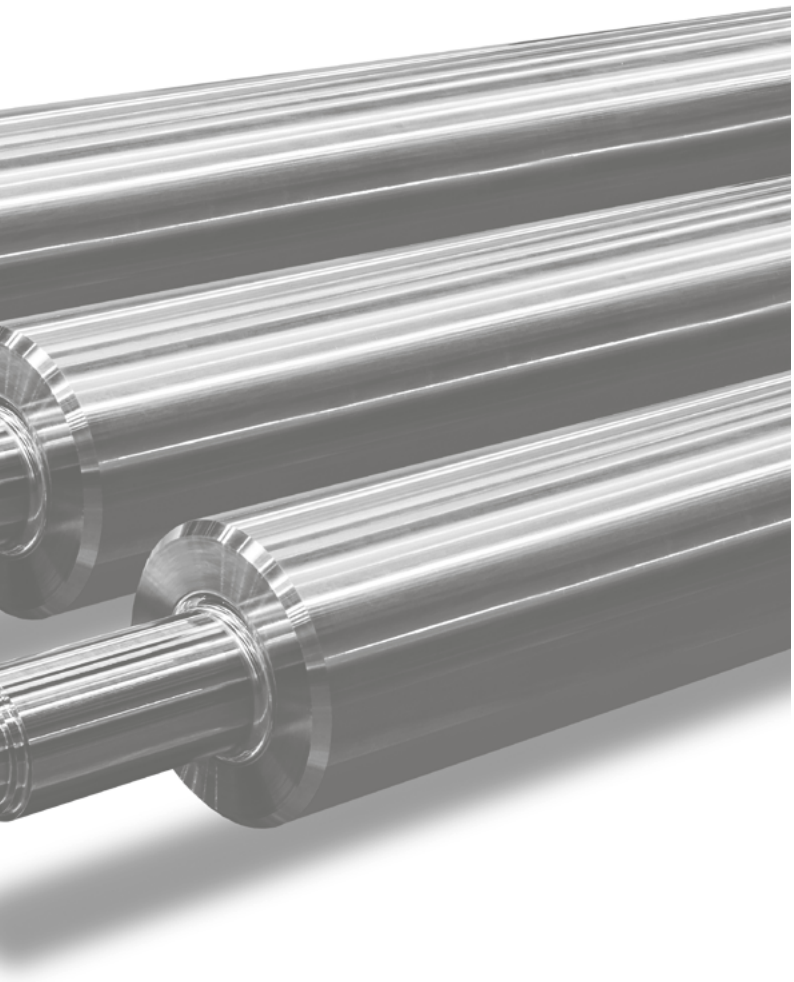
- Steel (Acroni and Metal Ravne)
- Manufacturing (Ravne Systems, Elektrode and SUZ)
- Distribution and Processing (Slovenia, EU and USA markets)
- Scrap (Slovenia and former Yugoslav republics)
- Headquarter and Other services

SIJ Ravne Systems has considerable experience and a long tradition in producing forged products for cold rolling mills, and much more. We manufacture all kinds of through hardened and surface hardened rolls for cold rolling steel sheets. 400 years of production tradition is supported by ISO quality certificates.

**SIJ Ravne Systems is a member of SIJ – Slovenian Steel Group.**

**www.sij.ravnesystems.com**
**www.sij.si**





## WHY SIJ RAVNE SYSTEMS?

Perfect quality, excellent service and the desire to build a longterm partnership. This is who we are – SIJ Ravne Systems, your reliable partner.

- A unique combination of metallurgical and engineering know-how.
- The highest product quality as a result of tight integration in a vertical chain, from steelmaking to the final product.
- Rolls made from ultra-clean steel as a result of the ESR method.
- In-house accredited laboratories performing a wide range of calibrations, tests and inspections.
- The ability to offer a complete package of products and services for the aluminum production process; from complete assembled equipment, subassemblies, components, spare parts and industrial knives for aluminum, to maintenance, reconstruction and revamping.

### INCREASE YOUR PRODUCT'S LIFESPAN

The highest product quality based on world class production equipment and more than 400 years' experience in steelmaking and steel processing.

### CUT YOUR MACHINING COSTS

Narrow dimensional tolerances, less than prescribed by international standards.

### OPTIMIZE YOUR PRODUCTION PROCESSES

Extensive range of mechanical and heat treatment options to find the optimal product completion stage for your production process.

### EXCEED YOUR CUSTOMERS` EXPECTATIONS

A strong in-house R&D department and broad application knowledge to find the best solutions for your customers` requirements.

## TYPES OF PRODUCTS PRODUCED BY SIJ RAVNE SYSTEMS FOR THE ALUMINUM INDUSTRY:

- Forged rolls for cold rolling mills
- Forged rolls for foil rolling mills
- Roll cores for continuous strip casting
- Shells for continuous strip casting, etc.

## FORGED ROLLS

### Dimensional range of roll production:

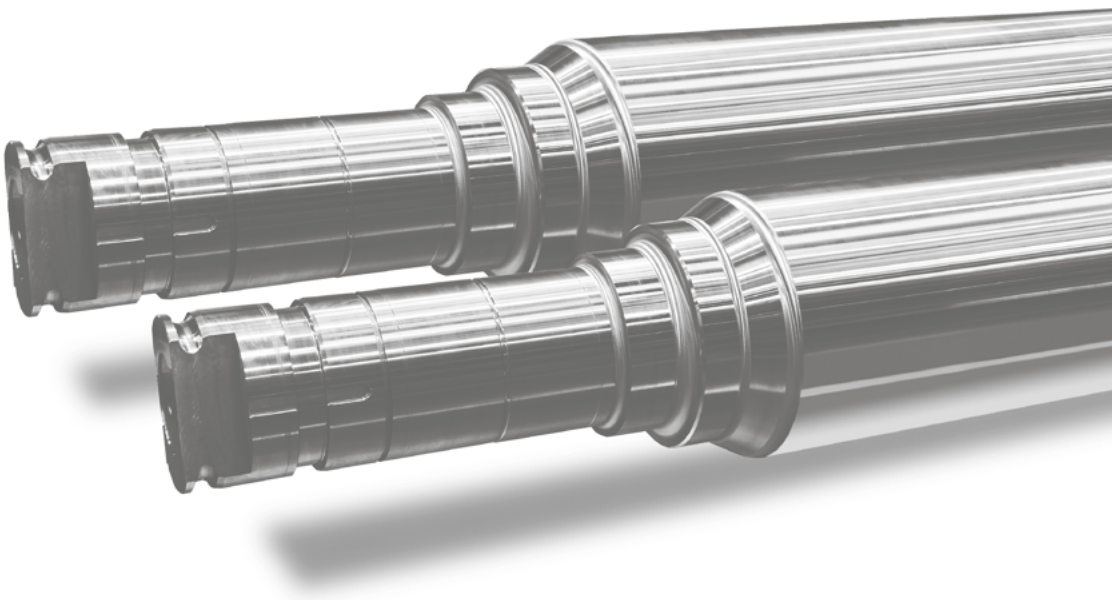
- Up to up to 800 mm (31") in diameter
- Up to 5,500 mm (216") in length
- Up to 8,000 kg (18,000 ibs) in weight

### Key characteristics of rolls:

- Application of ultra-clean steels
- Application of steels developed specifically for cold rolling
- Computerized guidance and control of the volume and surface heat treatment processes
- Permanent and sustained efforts to improve the quality and application of rolls in the form of research and development
- Application of modern NDT inspection methods
- Independent quality assurance system
- Partnership relations with customer-based experience

Rolls are produced from special alloyed tool steels which are made by using electric arc furnace with advanced vacuum technology processes or by an additional electroslag remelting process (ESR).

**We guarantee uniform hardness in the range +/-0.5 HRC.**



## SURFACE HARDENED ROLLS

For all types of rolling mills, including 2Hi, 4Hi, 6Hi etc.

Guaranteed hardness throughout the hardened layer depending on the steel used and optimal mechanical properties.

Our forged rolls withstand high pressure and are characterized by uniform hardness within +/- 0.5 HRC throughout the working barrel and a homogenous microstructure of the steel.

Hardness drop throughout the hardened layer is max. 3%.

**Our rolls offer:**

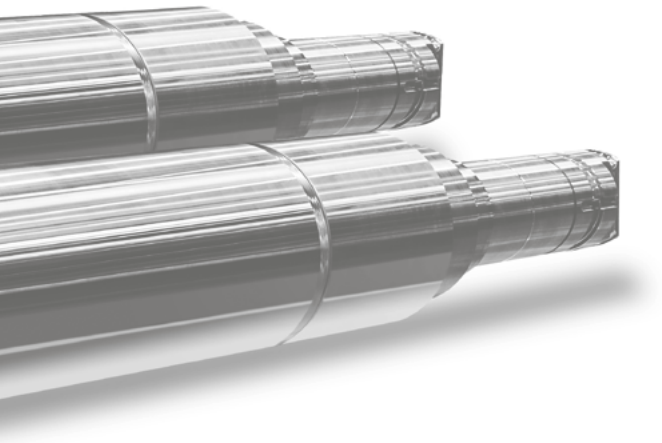
- Higher productivity
- High reliability
- Safety in operation
- Finer surface quality
- Higher rolling rate
- Positive influence on TCO

**Which is achieved by:**

- A combination of the best steel grades
- State-of-the-art heat treatment equipment
- Precise machining
- Multi-step inspection of each roll
- Continuous investment into the development of new grades

We have our own heat treatment facilities for optimal mechanical characteristics – optimal working hardness is guaranteed by a bi-frequency induction hardening machine which was developed, designed and produced in-house.

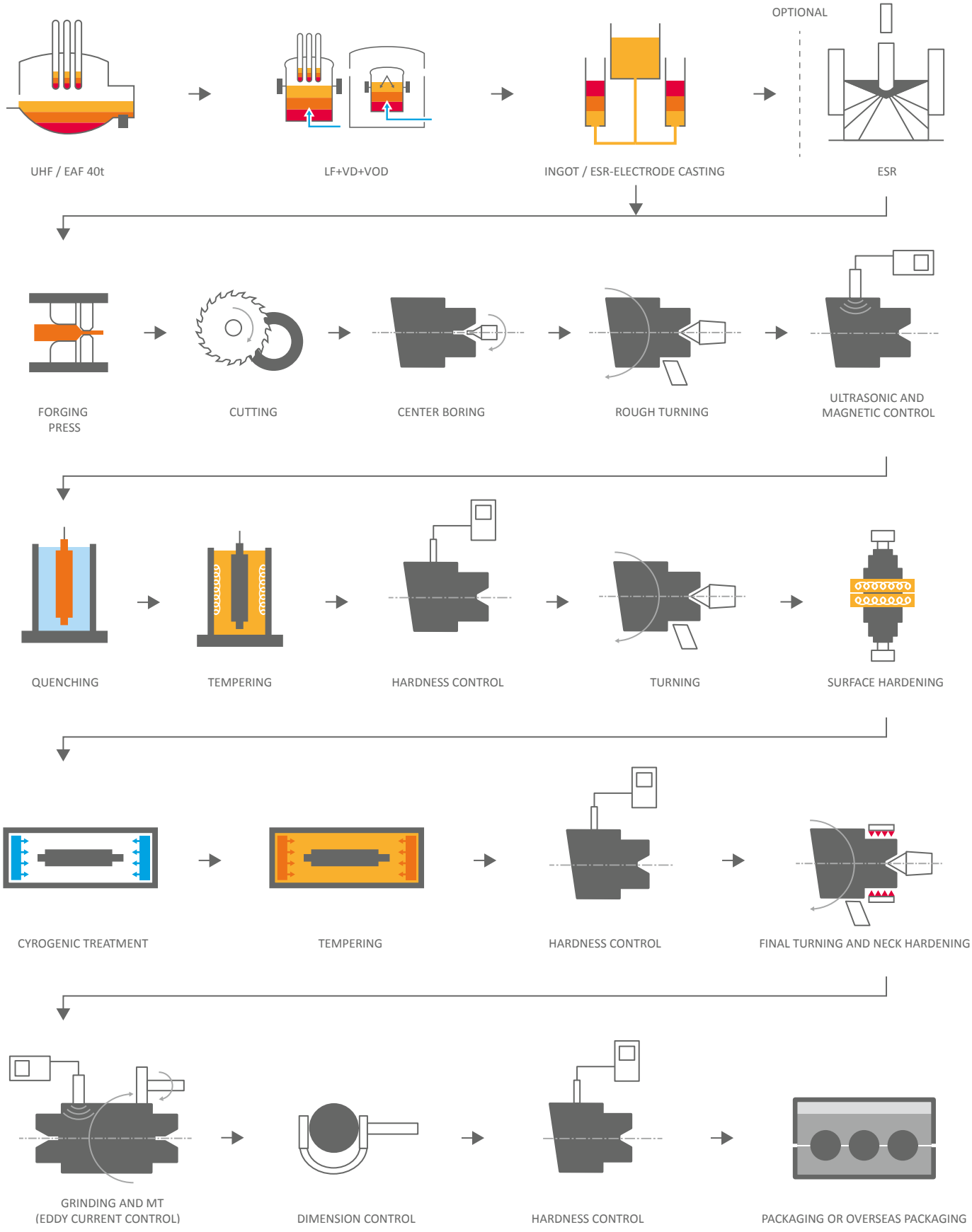
A highly advanced 3-D induction hardening machine (manually adjustable induction frequency) for the best mechanical characteristics of roll necks.



Cryogenic treatment – a step forward in the heat treatment hardening process which completes the transformation of the steel microstructure from austenite to a stronger martensitic structure with greater hardness. Steel hardness increases by raising the percentage of martensite in the steel structure – hence, wear resistance increases as it correlates positively with hardness.

Surface hardened rolls are made from high-quality steels and in accordance with customer requirements.

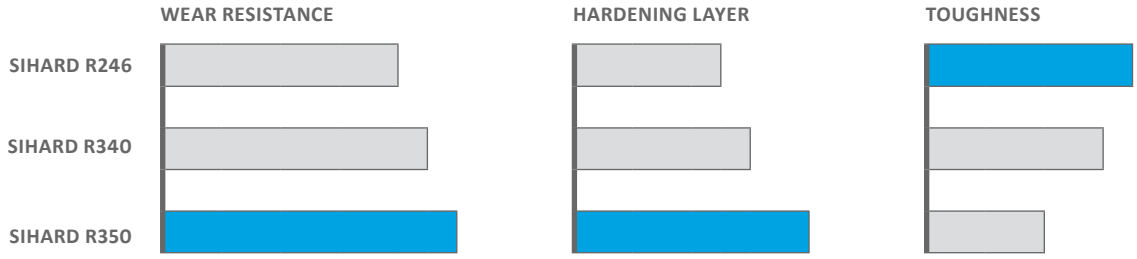
## ROLL PRODUCTION FLOWCHART – SURFACE HARDENED



## ROLL PRODUCTION FLOWCHART – SURFACE HARDENED

| | | | Directional Chemical Composition (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ravne brand name | W.Nr. | DIN | C | Cr | Mo | V | Ni | Hardnes HRC |
| SIHARD 2327 | 1.2327 | 86CrMoV7 | 0.85 | 1.70 | 0.30 | 0.10 | / | ≤ 67 |
| SIHARD 2375 | 1.2375 | 83CrMoV9 | 0.88 | 2.10 | 0.25 | 0.10 | / | ≤ 67 |
| SIHARD R246 | / | / | 0.80 | 3.00 | 0.50 | 0.10 | / | ≤ 67 |
| SIHARD R247 | / | / | 0.8 | 3.00 | 0.4 | 0.1 | 0.5 | ≤ 67 |
| SIHARD R340 | / | / | 0.8 | 4.0 | 0.5 | 0.1 | / | ≤ 67 |
| SIHARD R350 | / | / | 0.80 | 5.00 | 0.50 | 0.10 | / | ≤ 67 |

Comparison of the main properties:




The microstructure of the induction hardened layer is low tempered martensite and small carbides (magnification 500 ×).

The microstructure of the induction hardened layer is low tempered martensite and small carbides (magnification 500 ×) – 5 Cr steel.

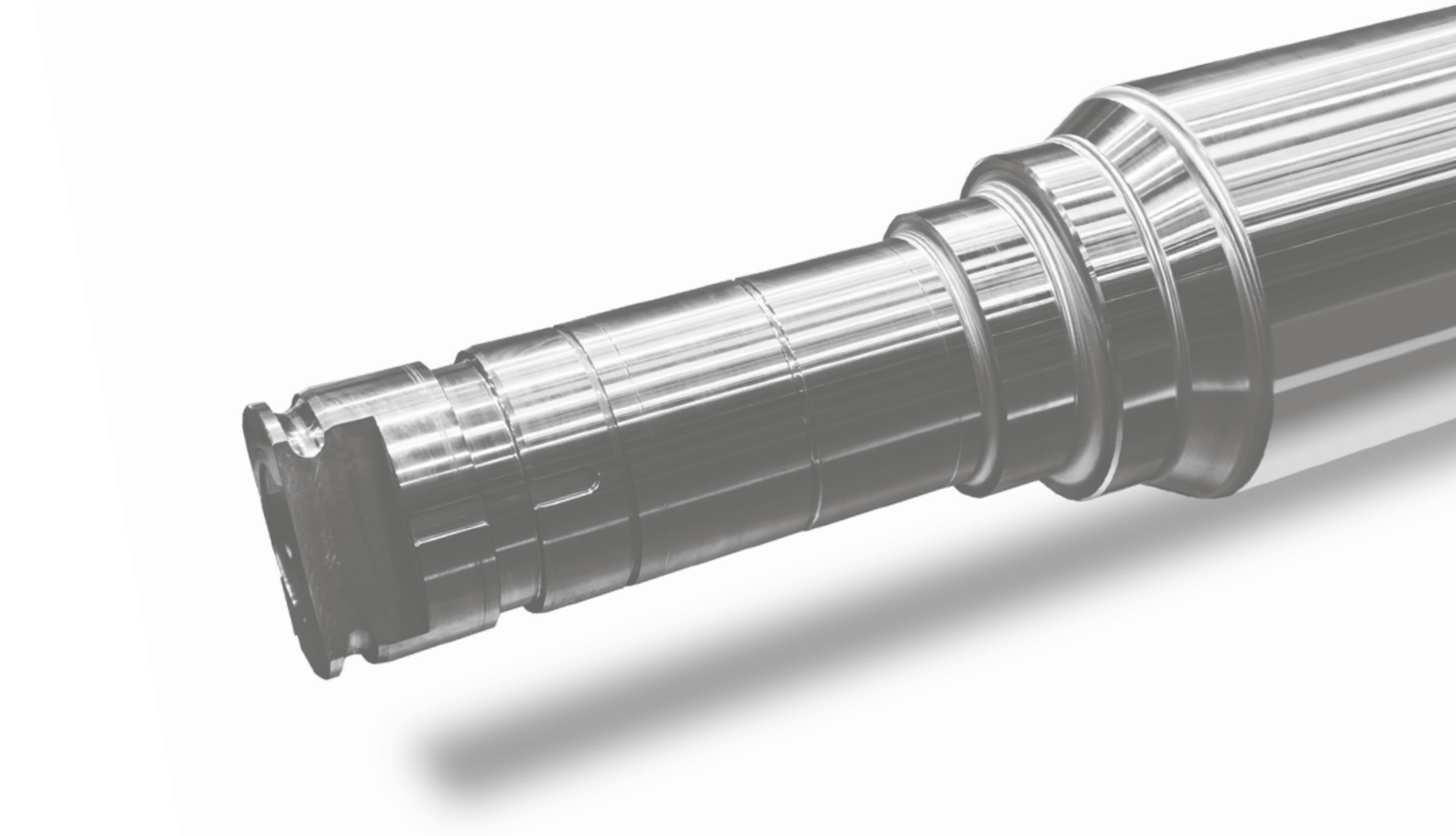
## FORGED ROLLS FOR FOIL

**Our customer reaches the highest speed of production with our rolls for foil, up to – 2000 m per minute.**

- Suitable for the highest rolling speeds and loads
- Meets the highest demands for surface quality
- High-quality and high-speed rolling of foil down to 4.5 microns

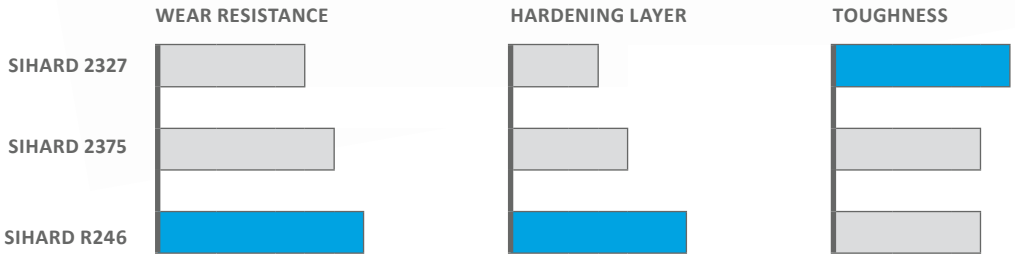
Special ESR technology for the production of ultra-clean steel glades, optimized for the cold rolling of foil.
Second refining, combined with our heat treatment technology, gives optimal results:

- The cleanest steel available on the market (DIN 50602 method K, K1 <5)
- Dense structure without porosity, greater cleanliness, homogenous structure and chemical analysis of the whole roll
- Concentricity between the barrel and bearing seats in tolerances of <= 0.005, or <= 0.002 mm if required

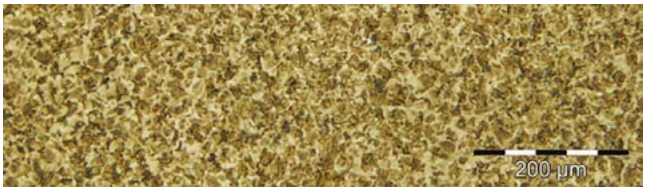


| Ravne brand name | Roll nomenclature | Wr. Nr. | DIN | C | Si | Mn | Cr | Mo | V |
|---|---|---|---|---|---|---|---|---|---|
| SIHARD 2327 | 2% Cr steel | 1.2327 | 86CrMoV7 | 0.85 | 0.40 | 0.34 | 1.9 | 0.25 | 0.10 |
| SIHARD 2375 | 2% Cr steel | 1.2375 | 83CrMoV9 | 0.88 | 0.40 | 0.35 | 2.1 | 0.25 | 0.10 |
| SIHARD R246 | 3% Cr steel | / | / | 0.80 | 0.85 | 0.60 | 3.0 | 0.50 | 0.10 |

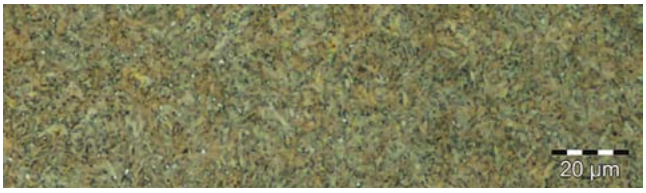
A comparison of the main properties:




The microstructure of the induction hardened layer is low tempered martensite and small carbides (magnification 500 ×) – 2 Cr steel.




The microstructure of the induction hardened layer is low tempered martensite and small carbides (magnification 200 ×) – 3 Cr steel.



## SHELLS FOR CONTINUOUS STRIP CASTING

Our shells last 30% longer than those of our competitors.

- Optimal casting speed
- Maximal tonnage per campaign
- Minimal crack development
- Minimal crack progression
- Low, evenly distributed roughness of the cast material surface

Increased tonnage is achieved by using special in-house developed steel grade combined with our own heat treatment. The results show optimal characteristics of our shells, such as high heat conductivity and excellent resistance to thermal fatigue. The microstructure of the shells for continuous strip casting is optimized during the production process. The final microstructure of the shells consists of a determined relationship between tempered martensite and fine dispersed carbides.

- The steel grade for our shells was developed by our experts, specifically for the requirements of the non-ferrous metals industry
- Optimal content of chemical alloys and the lowest possible levels of trace elements
- Homogenized steel with high cleanliness
- Equal material properties guaranteed from start to scrap diameter

### Chemical composition of SIQUAL 7765 steel:

| SIQUAL 7765 | C | Mn | Cr | Mo | V | Ni |
|---|---|---|---|---|---|---|
| Max | 0.25 | 0.40 | 2.00 | 0.80 | 0.20 | 0.20 |
| Min | 0.50 | 0.80 | 4.00 | 1.80 | 0.50 | 0.60 |
| Hardness (HB): | | | 380 – 420 | | | |
| Yield strength (MPa): | | | 1150 | | | |
| Impact strength (J): | | | 70 | | | |
| Grain size (acc. ASTM E112): | | | Min. 7 | | | |
| Thermal conductivity (Wm-1K-1): | | | 39 | | | |
| Thermal coefficient of linear expansion (10-6 °C-1): | | | 20 – 200 °C, 12.2 | 20 – 400 °C, 13.3 | | 20 – 600 °C, 13.6 |

### Ultra clean steel

Non-metallic inclusion (acc. DIN 50602 met. K1 < 10)
Homogenic microstructure: tempered martensite and equally distributed fine carbides.

### Dimensional range of shells production:

- Small shells outer diameter: D600-700 mm (24.8'-26.3')
- Medium-sized shells outer diameter: D700-1000 mm (37.0'-38.4')
- Large shells outer diameter: D1000-1200 (44'-46.5')

### Dimensional tolerances:

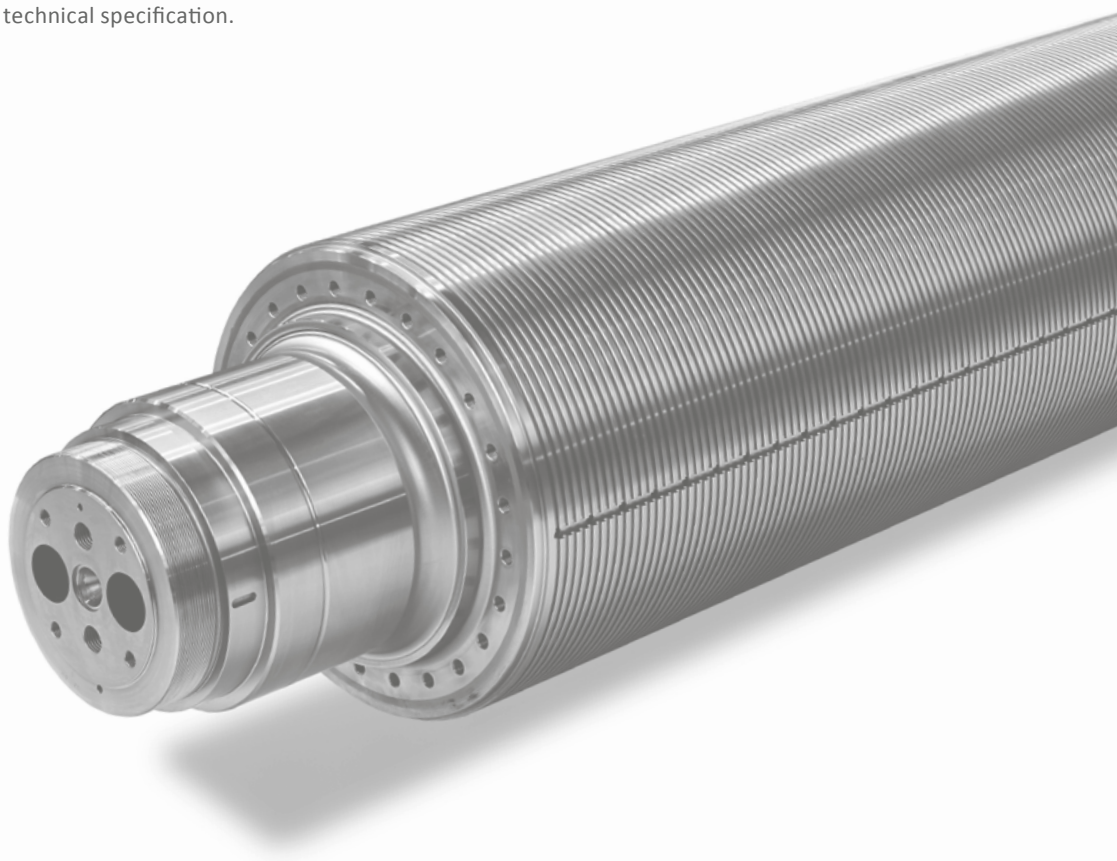
we deliver shells in three different conditions with following tolarences on dimensions.

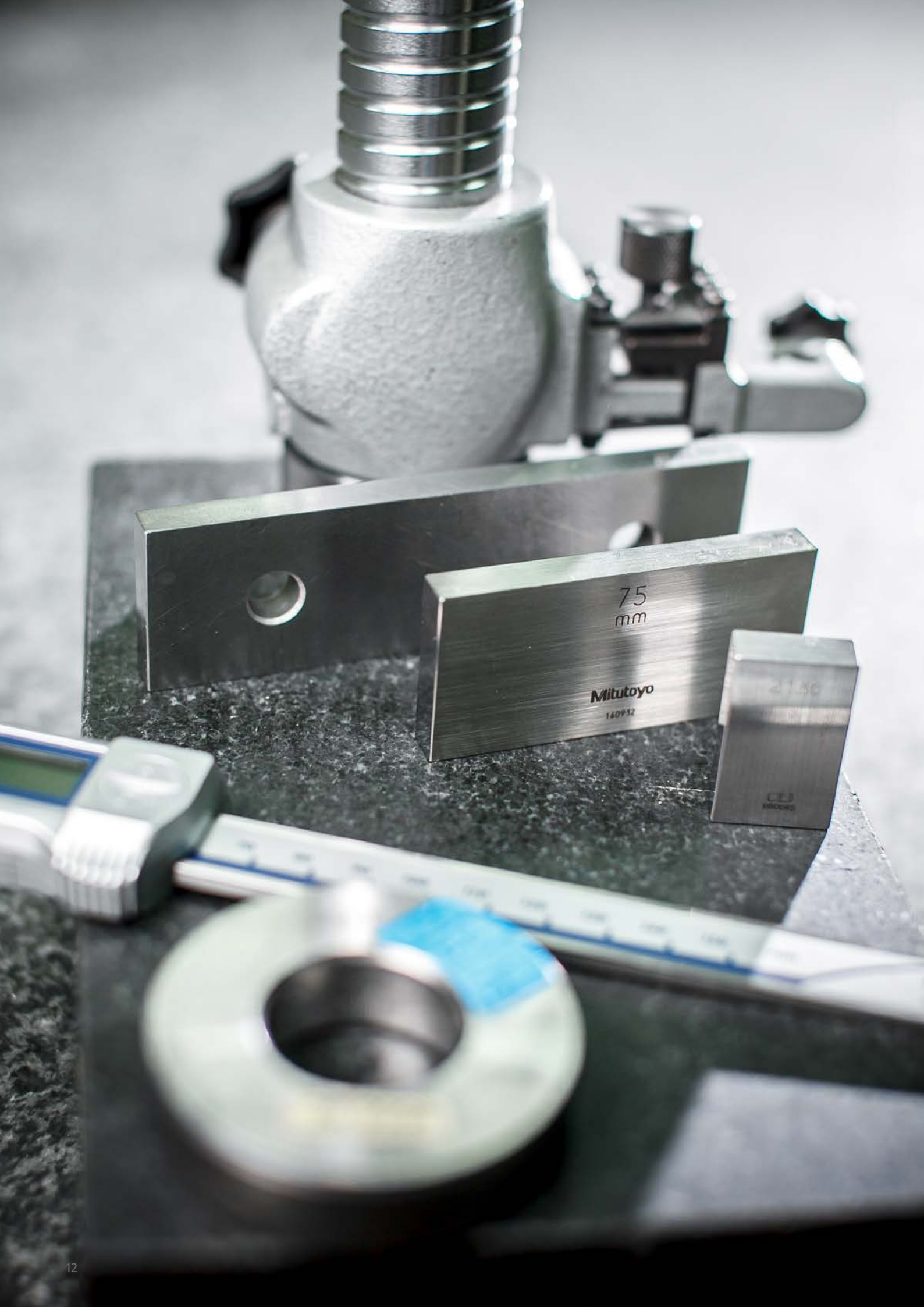
| Condition | OD | | ID | | L | |
|---|---|---|---|---|---|---|
| | [mm] | [inch] | [mm] | [inch] | [mm] | [inch] |
| Black | +5/0 | +0.197/0 | 0/-5 | 0/-0.197 | +5/0 | +0.197/0 |
| White | +3/0 | +0.078/0 | 0/-2 | 0/-0.078 | +5/0 | +0.197/0 |
| Ground | +5/0 | +0.197/0 | +/- 0.035 | +/- 0.00138` | +5/ | +0.197/0 |

## ROLL CORES FOR CONTINUOUS CASTING OF ALUMINIUM

SIJ Ravne Systems is also producer of »roll cores« for continuous casting of aluminium.

Roll cores are produced with welded or non-welded working surface according to customers technical specification.

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mm
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## IN-HOUSE R&D DEPARTMENT

We are continuously working to find optimal solutions for our customers according to their requirements and applications. Our inhouse R&D department has over 30 employees, and our modern testing equipment allows us to develop and implement turn-key capex projects to meet even the most complex and technically demanding tasks and requirements of our customers.

- Problem solving - unique products and solutions
- Innovative products outperforming the average supplier on the market
- Development and testing of new steel grades as a result of the vertical integration of the SIJ Group

## IN-HOUSE ACCREDITED LABORATORIES

SIJ Ravne Systems also has many well-respected accredited laboratories with highly qualified staff who perform a wide range of calibrations, tests and inspections according to ISO/IEC 17025 and ISO/IEC 17020. The services provided by our laboratories are all carried out in line with accredited internal procedures which conform to international standards.

Our main services include:

- Calibration of length gauges and instruments, including shape and roughness testing
- Calibration of mechanical quantities: hardness, torque, force, etc.
- Non-destructive testing using RT, MT, PT, UT and VT methods
- Ultrasonic measuring instrument inspection
- Residual stress measurement

## QUALITY ASSURANCE

### WITH EACH SHIPMENT, THE CUSTOMER RECEIVES INSPECTION CERTIFICATES AND A QUALITY GUARANTEE

We measure levels of retained austenite and residual stresses to guarantee the highest reliability and safety of operation. For this we use an accurate and safe X-ray diffractometer for measurement of residual stresses and retained austenite content. The Xstress unit measures stresses on crystalline material by X-rays, based on the phenomenon known as Bragg`s law.

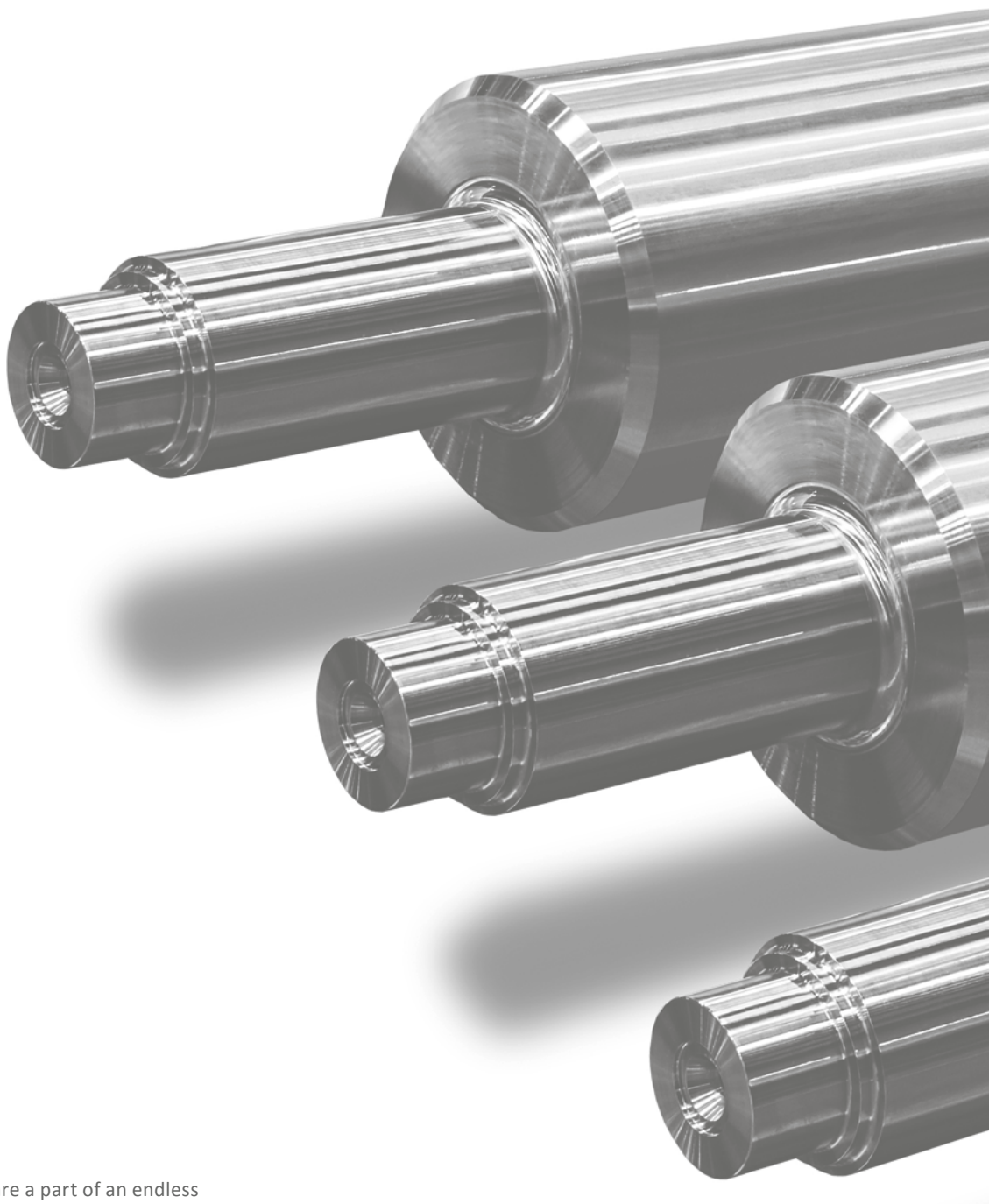
For quality assurance, our process inspection consists of:

- Ultrasonic testing
- Magnetic particle testing
- Hardness testing
- Eddy-Current testing
- Dimension control
- X-ray measurements

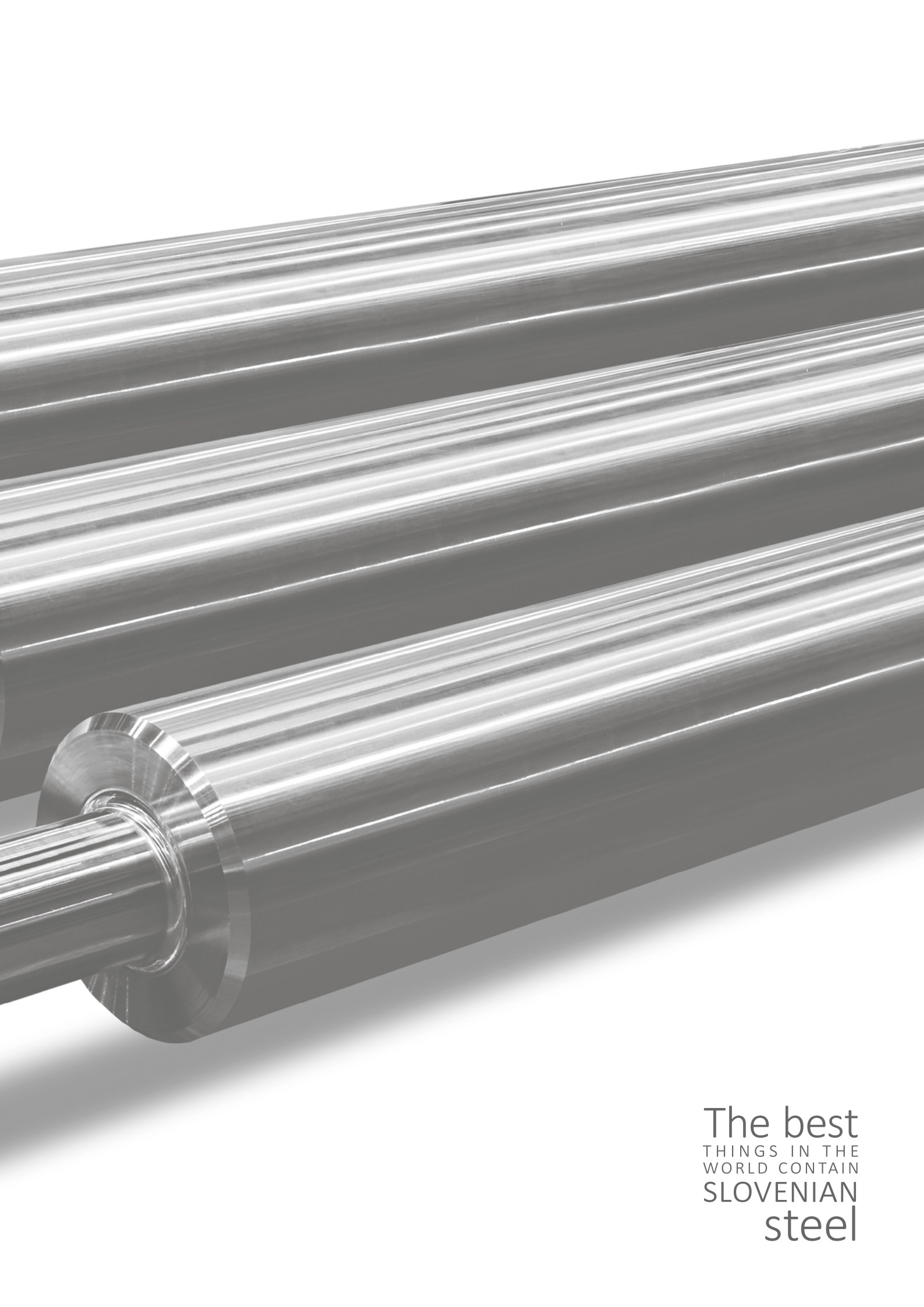
Certificates:

- ISO 9001:2015
- EN ISO 3834
- LK – 004
- LP – 107
- K – 091

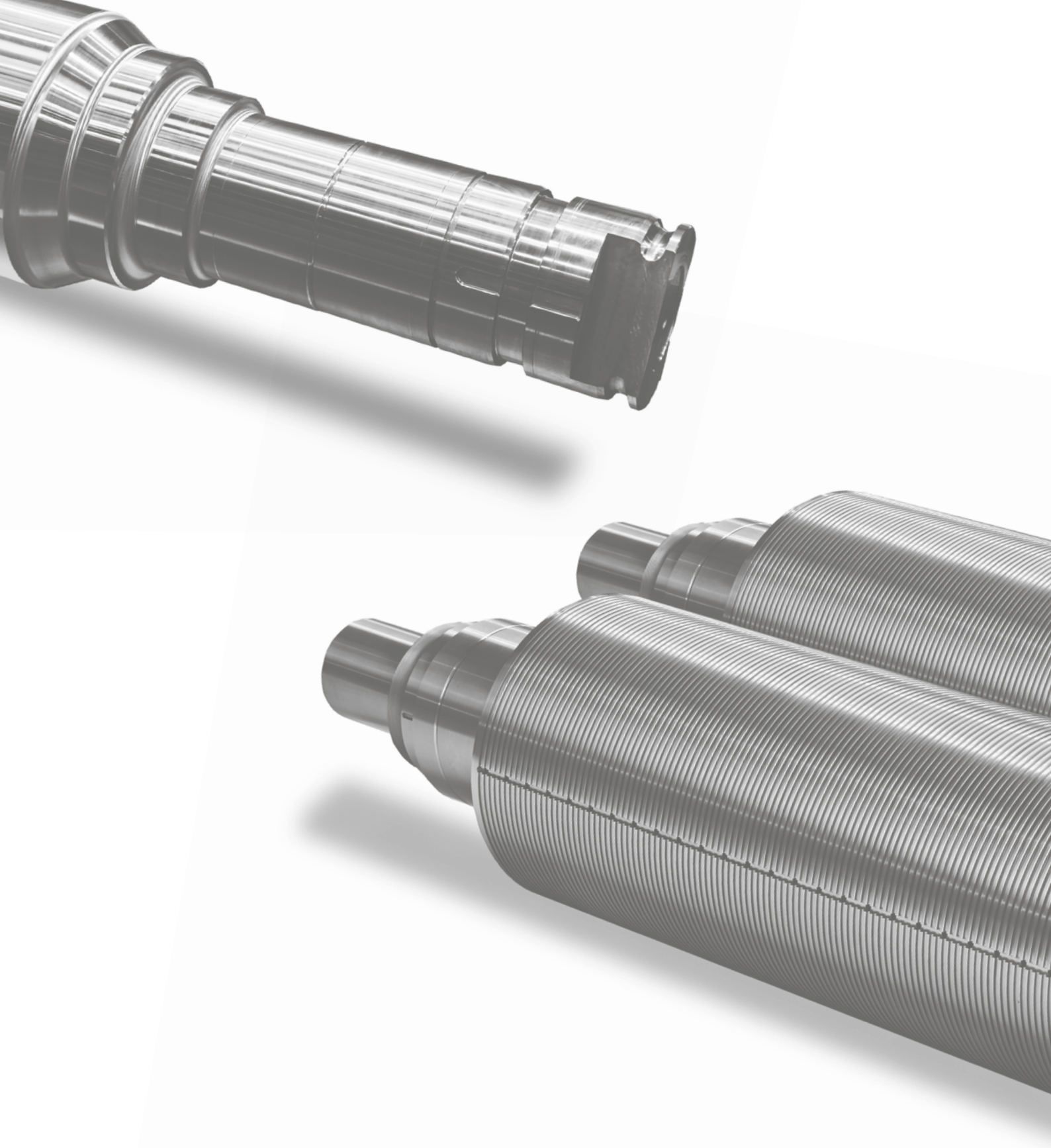
sij | group



Our work is never truly done; we are a part of an endless process. This is symbolized by the three dots in our corporate logo, and in the logos of each SIJ Group product and service brand. Three dots equals three values. Each one stands firmly on its own, and they all stand together, forever. As a sign of trust and quality, they symbolize our three main values, which define who and what we are.



The best
THINGS IN THE
WORLD CONTAIN
SLOVENIAN
steel



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