# SALZ

MAGAZINE FOR STRIP STEEL

No. 9

# Hot-rolled strip

**PARTNERS:** The Mendritzki Group – Joint effort for the optimal solution **PROCESSES:** Customized hot-rolled strip from Salzgitter Flachstahl **PRODUCTS:** Hot-rolled strip for the cold-rolling industry

SALZGITTER FLACHSTAHL

A Member of the Salzgitter Group

# Welcome!

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Every sector places its own requirements on our material. The cold-rolling industry calls for hot-rolled strip that meets the highest demands with regard to purity level, thickness tolerances and degrees of evenness in specially coordinated case-hardened steels and quenched and tempered steels. The greatest precision combined with flexibility is consequently a basic requirement for our hot-roll line. In addition to precise configuration of the mechanical-technical characteristics, we can produce customized profiles that virtually ensure an “ideal profile” for each purpose.

The cold rollers roll the different case-hardened steels and quenched and tempered steels and process them into many different products: As a gearwheel or a shaft in a gearbox, as a mounting element or a saw blade, or as various sizes of springs.

In this issue of the Sal-Z magazine, we show how we are working closely with one of our long-standing customers to enhance hot-rolled strip in practice, we present the many products that cold rollers such as Reinhold Mendritzki Kaltwalzwerk and Finova Feinschneidtechnik GmbH, both members of the Mendritzki Group, can manufacture from it, and we demonstrate how all the partners are profiting from the close cooperation.

I hope you will enjoy reading these interesting articles.

Frank Heidelberger
Salzgitter Flachstahl GmbH Marketing Director

The Mendritzki Group

Finova Feinschneidtechnik

Customized hot-rolled strip

Hot-rolled strip for the cold-rolling industry

Reinhold Mendritzki
Kaltwalzwerk GmbH & Co. KG

# Reinhold Mendritzki cold rolling mill

Since 1970, the Reinhold Mendritzki cold rolling mill has been offering customer-oriented solutions in steel strip at the site in Plettenberg, which meanwhile comprises two factories. The third factory in Bochum opened in 2000, and is currently undergoing expansion.

At Mendritzki, quality assurance already begins with the selection of the pre-material suppliers. ISO/TS 16949 certification confirms the high level at which the roughly 250 employees in the three cold rolling mills fulfill the extremely stringent requirements. High performance in steel strip production demands not only the staff's know-how and experience, but also constant expansion of the production plants and use of the most modern machining tools. The result: steadily decreasing tolerance deviations with constant, reproducible product quality.

The Mendritzki Group owns Finova and Meteor, leading companies in fine cutting technology, as well as MWS Schneidwerkzeuge GmbH.

The group has been supplying the automotive industry with door hinges, engine mounts and springs for couplings for four decades. Blades for power saws and lawn mowers and rotary mower parts for agriculture also contain steel parts produced by Mendritzki. The challenge for the future: utilizing the synergies among all five companies with a total of more than 700 employees to deliver customer benefits.

&

finova

## Finova Feinschneidtechnik

Fine cutting, punching, assemblies – this is what Finova has represented for many years.
Finova produces gearbox parts and door lock parts for the automotive industry. The plant's history began in 1854 when it produced pipe dies under the name Dako.
In 1964, the company was the first in Germany to use the fine cutting procedure in large-scale production, which 30 years later was then expressed in the new name "Finova" – fine cutting innovations. Fine cutting is a manufacturing technique that allows chipless cutting and simultaneous shaping of metal so as to enable the production of highly precise parts.

At the new location in Remscheid, investments were made in modern systems that were configured with a focus on material flow. Finova has been a member of the Mendritzki Group since 2012.

As a specialist in this technology and thanks to its special know-how, the company is able to use fine cutting technology particularly effectively and economically for its customers. Finova delivers demanding parts and assemblies made in the fine cutting procedure and including all surface finishes.

# Joint effort for the optimal solution

## What motivates the Mendritzki Group

**“We are strong when it comes to processing material thicknesses up to 0.53 in.”**
Dr. Peter Remer in a talk with SAL-Z

**Comprehensive problem-solving expertise, from steel strip to pre-finished components: this best sums up the Mendritzki Group. Reinhold Mendritzki Kaltwalzwerk, one of the top addresses for steel strip on the market, is the first stop in the value chain. As specialists for individual solutions, the plants in Plettenberg and Bochum produce high quality, cold-rolled products for the automotive industry. “Precision products that are easily overlooked at first glance, but that are extremely important for a vehicle's smooth operation,” discloses Dr. Peter Remer, CEO Mendritzki Holding**

“Roughly 80 percent of our orders go to the automotive sector. The automotive industry is increasingly thinking in terms of assemblies. As a result, the number of parts to be manufactured will be reduced in the foreseeable future. At the same time, the volume of individual components will skyrocket. Suppliers to OEMs (Original Equipment Manufacturers) or system suppliers will therefore have to ensure these capacities in the future. This is what we are working towards.”

This calls for a company of a certain size as well as efficient processes. Mendritzki is tirelessly working to ensure these conditions.

Cold-rolled strip always comes into play when absolute precision is demanded for safety-relevant components. The Mendritzki Group's manufacturing technologies are deployed everywhere that there are parts that turn (for example, gearwheels and couplings) and also for brake linings. Selected steel grades combined with sophisticated manufacturing procedures guarantee outstanding quality. Thanks to its special facilities, Mendritzki is one of the few cold rollers that is strong in the upper thickness range. Moreover, the company is known for its extremely flexible and rapid response times. Dr. Remer: “We can also implement things on short notice that the large competitors cannot. And we have partners, such as Salzgitter Flachstahl, who are just as flexible.”

"The central development department in the holding should leverage the synergies."

Bernd Thies

## JOINT MATERIALS DEVELOPMENT

"After the mergers of two large steel producers in the 1990s, Mendritzki lost both suppliers overnight," remembers Bernd Thies, materials developer and responsible for research and development. "We did not want, and also were not able, to count on just one supplier. In Salzgitter Flachstahl, we found a partner who worked with us to re-issue the 58CrV4, a spring steel for automotive couplings. A further challenge was mastered with 16MnCr5, a case-hardened steel for gearbox parts. The analysis was coordinated directly with the client, a well-known automotive name, in such a way that this party could complete its further processing under optimized conditions. That was a major, joint success resulting from close cooperation between the cold rolling mill and Salzgitter Flachstahl." Further joint projects are being arranged: Materials that are no longer or not yet in the product portfolio must be considered. Very specifically, boron-alloyed steels are being jointly developed.

"This type of cooperation cannot just be taken for granted, because it takes a tremendous amount of mutual trust, a certain proximity and flexibility. An opportunity for both sides to deal with future assignments," adds Dr. Remer.

A central Development Department is currently being set up for the Holding. It is intended to leverage the synergy potential within the group. Steel fits in with the value chain extension in order to make it possible to offer complete solutions in the future.

## FACTS & FIGURES

**> 700 employees**
altogether in the Mendritzki Group

**15,000 metric tons steel/month**
leave the 3 cold rolling mills

**430,556 sq ft. space**
in the new Plant III in Bochum

**up to 0.53 in**
processing for thicknesses

**> 20,000 metric tons steel coil**
are ready in the bays

**16MnCr5**
case-hardened steel for gearbox parts

At Mendritzki, quality assurance already begins with the selection of the pre-material suppliers.

Quality and availability are the crucial factors in international competition.

Mendritzki currently has a 70 percent business volume share within Germany. A stronger international focus in the future is the logical consequence of the advancing internationalization of the automotive sector. "The Mendritzki Group will grow through the increasing internationalization, and as a result make even more efficient use of resources," Dr. Remer forecasts. "We are expanding segments such as blade production. Further automation and the increased use of smart production technology will be added to the Industrie 4.0 manufacturing area, and meshing industrial production with the most modern information and communication technology will be a major driving force." It goes without saying that the suppliers are involved in this development process. In the near future, the exact documentation of the product and process data at the steelmaker will supply valuable information that will determine the further use and optimal processing steps at the cold roller. "The wealth of information resulting from the comprehensive exchange of data along the entire production chain puts us in a position to ensure optimal process control using various production parameters," explains Dr. Remer, "and that will then be something that will massively change the market in the next ten years."

**Martin Watermann has been with Finova since 2006 and its managing director since 2013. He studied mechanical engineering with a focus on automotive engineering, culminating in a MBA, and began working in engine development immediately after graduation. He consequently has gasoline in his blood, and this is a good thing since 98 percent of Finova's customers come from the automotive sector.**

# Special grades for special applications

**SAL-Z:** Mr. Watermann, Finova Feinschneidtechnik GmbH has belongs to the Reinhold Mendritzki Group since 2012. How has this affected your company?

**Watermann:** We have become substantially stronger financially and we were able to make large-scale investments in machining. Since then, we have been able to deliver finished components to our customers without any further mechanical processing being necessary. We were the first in Germany to use the fine cutting procedure, which came from Switzerland, in large-scale production. First for office machine parts, which were produced in gigantic production runs, and then for the automotive industry. Today we can manufacture large series of fine-cut parts and finish them all the way through to assemblies ready for installation.

**SAL-Z:** Which parts and assemblies are involved here?

**Watermann:** These are parts for automotive transmissions, engines and vehicle seat adjustment systems, as well as automotive locking systems. The fine cutting involved here is the pure process, which works with the steel strip: Steel strip runs through the machine, the hydraulic press opens and closes, because inside there is a tool that cuts with absolutely no chips. What is special about fine cutting is that it allows very fine tolerances while creating very precise machining surfaces. This is particularly important when these areas are functional surfaces in gearboxes. We - and our customers - need special, coordinated steel grades for these special applications. Salzgitter Flachstahl is the kind of supplier that can manufacture these grades. The requirements are becoming more and more demanding, and as a result we need competent partners, with whom we can work to produce jointly coordinated solutions at our client.

**SAL-Z:** The automotive industry is your principal customer. You have made a name for yourself in the area of coupling pieces. What do you attribute this to?

**Watermann:** We revolutionized the manufacture of coupling pieces in the synchronization area and already held a patent here in the 1980s. We were the player capable of producing angles in the teeth using the fine cutting procedure with special filing. It was possible to make these parts much more economically with only a single press stroke instead of using rough castings, which would have required further complex machining. We now deliver these components ready for machining, ground, heat treated and completely packaged, so that the parts can be directly installed anywhere. Further technical optimizations followed. Work starts with simple progression dies, then double progression dies that work faster and allow overall quality improvement, so that parts that previously needed finishing could be completely produced in the fine cutting process. Even today, we continue to perfect this method. This places very strict requirements on the pre-material, its purity level, thickness tolerances and degrees of evenness.

Martin Watermann in a talk with Ulrike Schlegel and Dr. Martin Faes from Salzgitter Flachstahl.





1. Component from the automotive seat back adjustment
2. Fine cut spiral gearing (patented)
3. Fine cut fine toothing from a special grade
4. Axle cam with fine cut functional surface

**Sal-Z:** Where do you see Finova five years from now, what are the next steps?

**Watermann:** We want to move forward with a further increase in vertical integration, which means we want to offer even more finished products. And we are going to work even harder to bring together the experts from all along the supply chain in order to get their knowledge to the customer. This includes the steel mill just as much as the cold roller and fine cutter. We are consequently developing from a supplier into a problem solver. Finova itself will carry out further optimizations in production and exploit possibilities of weight reduction and material and energy saving potential. We also hope to take this beyond the automotive sector. Together with our partners, such as Salzgitter Flachstahl, we are working on developments that allow a stable heat treatment in order to increase the durability. The challenge in any modification or enhancement is the pairing of two materials that have to show the same behavior during the heat treatment.

Closure elements for door locks in unprocessed state

# Customized hot-rolled strip


Roll plot over meter 100 to 700 of a coil





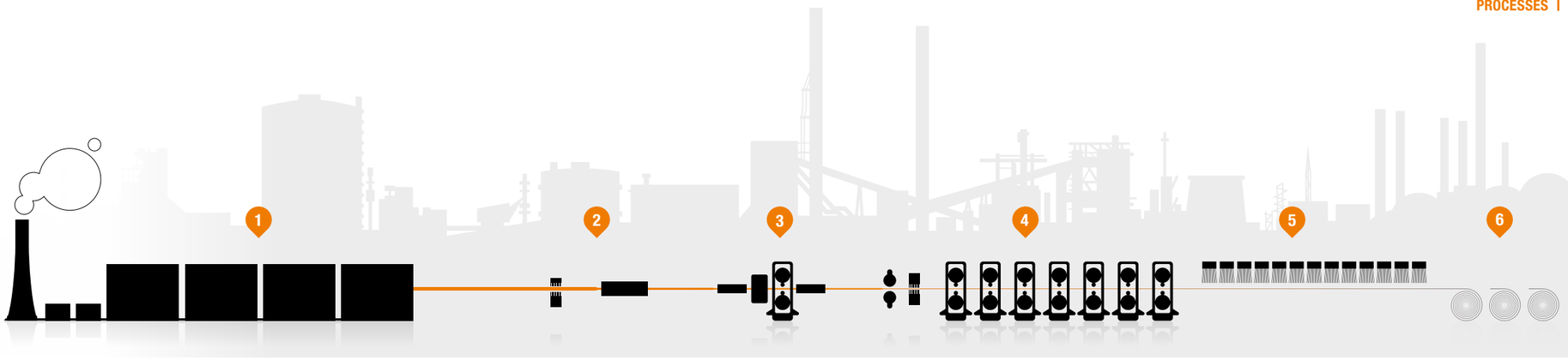
## Designer profiles from the Salzgitter Flachstahl hot-strip mill

**Continual development of the rolling process in the hot-strip mill allows Salzgitter Flachstahl to guarantee the ever-tougher requirements on the hot-rolled strip individually for each customer. The interaction of the most modern technology and our employees' many years of experience achieves continuous hot-rolled strip quality.**

The hot-strip mill is one of the most important units in the Salzgitter Flachstahl (SZFG) production process. Here, the pre-material, the slab, is rolled into a flat steel coil up to 2187 yards long. During this complex rolling process, the steel coil is given its fundamental mechanical-technical and geometric characteristics. Thanks to state-of-the-art process control, these characteristics are configured for the individual customer. The core of the hot-strip mill automation consists of a number of model computers and regulation systems. They allow extremely precise configuration of the most demanding customer requirements in a broad range of characteristics, from very wide to very narrow, from very thin to very thick, and all with ultra high strength up to 1,400 MPa. The hot-rolled strip's key features are the profile along the entire strip length, the dimensional tolerances and the microstructure, and consequently the mechanical characteristics.

**"The short-stroke technology reduces width variations to a minimum."**
Thomas Rothe, Processing Technology and Metrology Hot-rolled Flat Products

PROCESSES



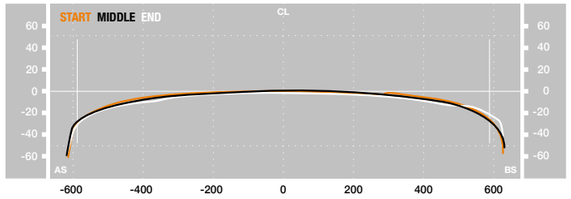

The production process on the hot-strip mill might appear coarse to the observer. It is a sequence of extremely complex and delicate process steps, however, that, due to the combination of the employees' many years of experience and state-of-the-art technology, allows SZFG's to produce its high quality products. These products are only possible when the process steps for slab preparation (heating furnace and sizing press, 1 and 2 in the figure), roughing train 3, finishing train 4, cooling line 5 and finally the tension reel 6 are exactly tuned to one another, for example as far as temperature control and conveyor speed.

First, the rolling process requires a supply of uniformly heated slabs. Four heating furnaces are available for the task. These are heated with the mill's own coke oven gas, among other sources. The exhaust gases that develop here are also used as an energy source to generate steam in the mill's own power plant, so that optimal use of the by-products is guaranteed, evidence of the importance of sustainable processes at SZFG.

Before the actual rolling process with the roughing train and subsequent finishing train, the slabs are shaped in the sizing press. Thanks to the use of short-stroke technology (variable width adjustment) for the slab start and stop, width deviations in the end product are further reduced.

The roughing train is a reversing rolling stand with flange-mounted edging mill. Here the slab is shaped horizontally and vertically. Particularly the edging stand serves to regulate the strip width and consequently significantly helps to ensure compliance with the tightest width tolerances.

**Profile plot at three points of the coil measured across the width**




The finishing train in the hot-strip mill consists of seven rolling stands. Using hydraulic positioning and with the help of the most modern automatic control engineering, the rolling stock is rolled down to its final strip thickness. This process is capable of achieving hot-rolled strip thicknesses of 0.45 in. In order to ensure a constant strip profile along the entire strip length, the CVC (Continuous Variable Crown) and WRB (Work Roll Bending) technologies are used. Bending and shifting the working rolls makes it possible to achieve an exact adjustment of the hot-rolled strip geometry. This complex interaction between working roll displacement, load distribution by means of the optimal adjustment of the roll forces, and working roll bending, makes it possible to implement the strictest thickness and width tolerances as well as a constant strip profile along the strip length. Thanks to the continual development of the rolling process SZFG is able to guarantee the increased demands made on the hot-rolled strip profile for each individual customer. The latest software developments integrated into the finishing train's profile and evenness computer allow the so-called "designer profile". With the objective of offering the customer hot-rolled strip quality that is comparable to that of medium-wide strip, profiles are reproducibly configured to match the customer's requirements. This designer profile is registered without contact directly behind the finishing train by measuring the strip thickness, strip width, and evenness and storing them for visualization and quality assurance.

After being rolled in the finishing train, the finished strip has reached its target dimensions. Thickness, width and profile have been achieved. All that is missing now is the microstructure and consequently the mechanical-technical characteristics that are precisely configured in the subsequent cooling line: the widest range of characteristics can be achieved by means of selective cooling with water. Powerful computers allow the optimal switch over to the cooling line. The quantity of water and conveyor speed are calculated and implemented in real time at speeds of up to 1312 yd/min.

Located at the end of the rolling mill is a coiling system with three reels. Here, the finished strip is wound into a coil under constant temperature control. The interaction of all these individual units results in a product that can be manufactured with pinpoint precision and that offers tremendous versatility in terms of machining options and possibilities.

## FACTS & FIGURES

**In 7 stands and at a maximum speed of 1312 yd./min, strip widths from 35.43 – 78.74 in., strip thicknesses from 0.45 – 1 in., and strip lengths of up to 2178.23 yd. are produced.**

**The grades range from**

- LC (Low Carbon)
- ELC (Extra Low Carbon)
- C-steels to C80
- Microalloyed steels
- Pipework grades up to X80
- Thermomechanically rolled up to polyphase steels.

**This corresponds to some 400 grades.**

# Hot-rolled strip for the cold-rolling industry

The employees from the Quality, Planning and Production Departments escort each order in the Mendritzki cold rolling mill in order to ensure the individual requirements on the steel strip at all times.

## Variety for virtually every requirement

**Salzgitter Flachstahl's broad product range for the cold-rolling industry focuses on mass customization and variety in the highest product quality. The portfolio includes classic case-hardened steels and quenched and tempered steels, alloyed chromium and nickel steels and boron-alloyed quenched and tempered steels. Each material is backed up by different analysis concepts that are coordinated to our customers' requirements. The steel's characteristics can be diversely varied and selectively adapted to almost every requirement.**

Not only the individual alloying concept, however, is relevant for flawless further processing at the customer. Compliance with very tight geometric tolerances and generation of profile cross-sections in the hot-rolled strip that are appropriate for the application are just as important. Thanks to many years of intensive cooperation with our customers and continual improvement in the plant processes, today we can achieve the tightest dimensional tolerances in the hot-rolled strip across the entire strip length and width in order to guarantee optimal machining in the cold rolling process. This demanding goal imposes extremely strict demands on the production plants and processes. In order to maintain this, we shall also continue to make major efforts in the future in order to keep the expertise of our employees, from developers to central system controllers, and the plant's technology at the state of the art at all times.

The cold roller then configures the final material characteristics for the end product during the further processing of the hot-rolled strip. Annealing steps, quenching and tempering, sometimes repeatedly, selectively achieve the mechanical-technical characteristics such as high yield point and tensile strength and good fatigue properties, wear resistances and toughness. The large analysis range, greatest purity and narrowest strip geometry make Salzgitter Flachstahl a dependable partner for the tough requirements in the cold-rolling industry.





Source: finova Feinschneidtechnik GmbH



The Mendritzki Finova and Meteor fine cutting plants produce the highest quality precision parts for the widest range of applications.

**Case-hardened steels**

The case-hardened steels include unalloyed and low alloy steels up to a maximum carbon content of 0.20 percent. Case-hardened steels, either hot rolled or cold-rolled, are used primarily for gearbox parts (disk springs, clutch plates and converter caps). In the hot rolled delivery state, the material features good punchability and formability. As a result of the heat treatment at the cold roller, the components have a high toughness level in the interior and a significantly greater hardness at the surface, resulting in good resistance to wear.

**Quenched and tempered steels**

Quenched and tempered steels comprise steel grades that exhibit high tensile strength and good fatigue properties thanks to the hardening and tempering. They feature a carbon content of more than 0.20 percent. The heat treatment allows a selective influence on the relationship between strength and toughness. The goal is to give the component both higher strength and toughness. The group of quenched and tempered steels includes both unalloyed and alloyed steel grades. In the alloyed quenched and tempered steels, the different contents of the alloys chromium, manganese, molybdenum and nickel are very precisely matched to the particular intended use. Typical application areas are chain plates, belt locks, springs, steel caps for safety shoes, saw blades, knives and scissors.

### FACTS & FIGURES

**Overview of the Salzgitter Flachstahl product range**

**Case-hardened steels**

**Manganese chromium alloyed**
16MnCr5
20MnCr5

**Quenched and tempered steels**

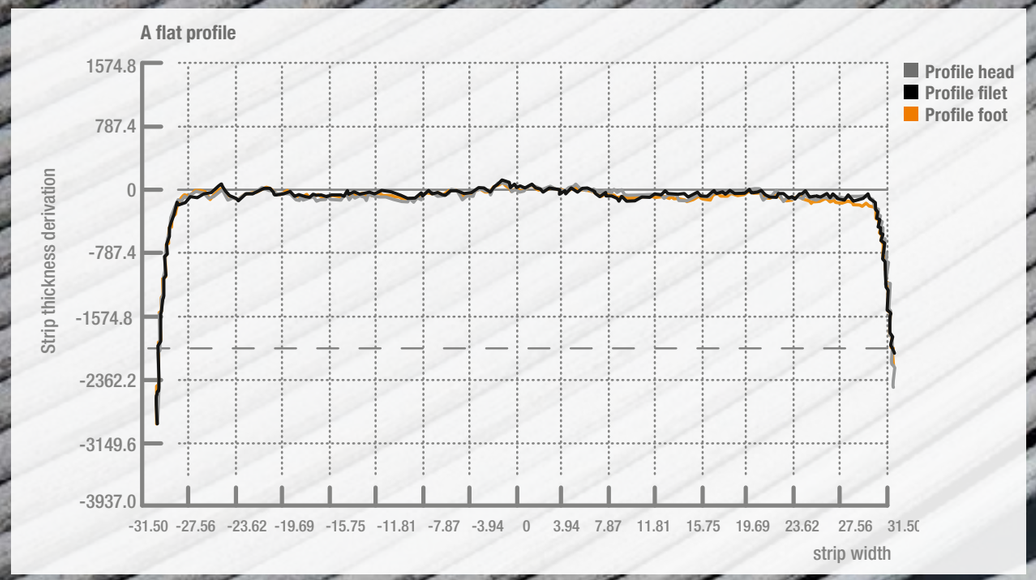
| Manganese boron alloyed | Carbon alloyed |
|---|---|
| 8MnB5 to 46MnB4 | C22E bis C60E |
| 27MnCrB5-2 | |
| 33MnCrB5-2 | |

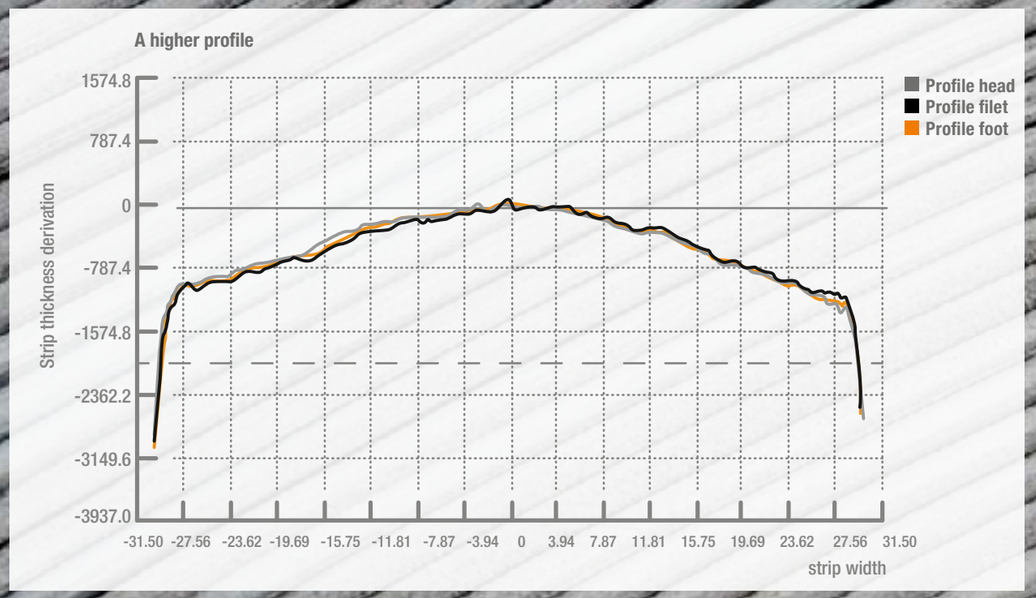
| Chromium alloyed | Carbon alloyed |
|---|---|
| 25CrMo4 | C55 S |
| 34CrMo4 | C60 S |
| 42CrMo4 | C67 S |
| 50CrMo4 | C75 S |
| 51CrV4 | |

**Special steels**

58CrV4
63NiNb4
68CrNiMo33
80CrV2
C80

# Profiles to suit the need








## Designer profiles from Salzgitter Flachstahl

In addition to the mechanical-technical parameters, an essential characteristic of hot rolled wide strip is the geometry: the so-called hot-rolled strip profile. Our customers demand defined profiles to suit the application or further processing. This "ideal profile" can assume very different geometries. For example, in the case of later finishing into a rotationally symmetrical component, as in gearwheels for instance, a flat profile is advantageous (see Figure 1). In the case of further processing in the cold rolling mill, on the other hand, higher profiles are necessary (see Figure 2) in order to guarantee the required characteristics in the plant and consequently the processability.

A “designer profile” is the solution. Salzgitter Flachstahl is able to individually configure the hot-rolled strip geometry to suit the customer's requirements, depending on the material's dimensions (thickness and width) and strength. Thanks to the know-how accumulated in the many years of cooperation with our customers and to the continuous enhancement of the processes on the hot-strip mill, Salzgitter Flachstahl has succeeded in developing a procedure that allows the hot-rolled strip geometry to be configured individually and reproducibly according to the customer's requirements.

As a result, Salzgitter Flachstahl can supply "designer profiles" fresh from the conveyor belt to match the individual customer's needs.

### WORTH KNOWING

**The hot-rolled strip profile is a thickness profile across the entire strip width; it describes the hot-rolled strip's geometry. The parameters B25 and C40 are used to describe the profile level's height. Both values reflect the difference in the thickness at the strip middle and at the edge. For trimmed hot-rolled strip, the B25 value is measured 0.98 in. from the trimmed strip edge, and for untrimmed strip the C40 level is measured 1.57 in. from the natural edge (see Figure 3).**

**The hot-rolled strip profile develops on the hot-rolled wide strip line during rolling as a result of the roll deflection setting. Once the hot-rolled strip has been rolled with a certain profile, it is virtually impossible to change it during the subsequent process steps. The ability to implement the different profile requests reliably is therefore particularly important.**

**Cross profile**

**Figure 3:** C40 = Difference between strip thickness in the middle (A) and at the edge (B), each 1.57 in. away from the natural edge (C).

PEOPLE

# Hot-rolled Strip Team

## The people to contact

"We regard individualized customer care and diversity - in connection with maximum product quality - as paramount."

**Thorsten Gintaut**
Sales Cold Roller Industry

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"No matter what your plans, we have the right steel for your application."

**Martin Scharf**
Sales Cold Roller Industry

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"The ongoing development of steel as a material is creating new application fields."

**Dr. Christian Lesch**
Salzgitter Mannesmann Forschung

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"Continuous process optimization delivers sound results – now and in the future."

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"Our knowledge and experience stand for the highest quality."

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