OVAKO

MACHINE LESS, MANUFACTURE MORE M-STEEL®

"The combination of ultra-hard CBN inserts and superior hardened steel makes the hard turning of complex parts a cost-efficient alternative to grinding. In our experience, Ovako M-Steel is the best material choice due to its consistent high performance and repeatability at high turning speeds."

Åke Nilsson
Turning Specialist, Sandvik Coromant

M stands for machinability and making more money

Our popular M-Steel now lets you earn even more money than before. Its advantages are especially pronounced in automated turning or drilling processes. In short, M-Steel is smart way to stay ahead of the competition.

For more than 30 years, M-Steel has been the ultimate choice for superior machinability. After decades of close collaboration with customers, we now hear that 'M' also stands for 'money-making'. How do we know? In case after case, working together with more than 400 customers, we have identified clear savings.

30–40% cost savings
Some customers have recorded a 30-40% reduction in total machining costs compared with conventional steel. Others tell us that our M-Steel enables the hard turning of case-hardened steel with cubic boron nitride (CBN) inserts at roughly double the speeds previously possible. Remarkably, at higher speeds, crater wear on the tool edge is actually reduced and the life of the cutting tool is doubled or even trebled

Repeatability through consistency
The success of M-Steel is based on a close collaboration with you, cutting experts and our own R&D team. The superior machining properties of M-Steel are due to the careful selection of raw materials and accurate process control – from recycled scrap to hot rolling and final treatment. This is critical for automated series production as it eliminates the need to change machine settings such as cutting speeds, feed rates and tools.

Added fatigue strength
With our quenching and tempered steel, you also get the added benefit of higher fatique strength in both the longitudinal and transverse directions. (See diagram on page 11).

Let us help you make money
Our service goes well beyond supplying you with treated non-alloy or low-alloy M-Steel products. We invite you to share the knowledge we have gathered over many years. Together we can boost your productivity to new levels.

BENEFITS OF M-STEEL

- Enables automation and faster machining
- Extends tool life
- M-Steel treatment can be applied to most steel grades
- Complies with standards and improves machining properties
- Up to 50% higher throughput
- Unmatched consistency of quality

The secret of higher productivity

Until recently, it was unthinkable for many metalworking shops to boost productivity through automation. Robots were expensive and hardened steels often meant uneven tolerances, poor chip formation and high vibration levels. Operators had to be on standby 24/7. For Jarkko Haavisto, Managing Director at Juhani Haavisto Oy, this all changed with M-Steel, which enables unmanned production and productivity gains of up to 30% – day and night!

The word 'automation' might make you think of longer series production of similar parts. But automation can also be used for shorter series production to free up skilled staff to handle other machining operations. This, at least, was the reasoning at Juhani Haavisto Oy, a custom engineering subcontractor that supplies parts to the Nordic pulp and paper, mining and process industries.

Modern shaft production

Founded in 1987 in the town of Kotka, Finland, Juhani Haavisto Oy today has 52 employees and annual sales of €7.5 million. The family owned company is always looking for ways to sttreamline and modernize its highly varied production. For the shafts it was producing, the company decided to establish a new manufacturing cell to optimize productivity using unmanned production.

Finnish ingenuity

In the past, says Managing Director Jarkko Haavisto, the machining production of shafts had required three steps and was fraught with problems relating to straightness, vibration, high-carbide insert tool wear and long chips. The idea now was to use a bit of Finnish ingenuity to save money and time by combining a robot, standard CNC machine and superior material – in just one step.

Cost savings through automation

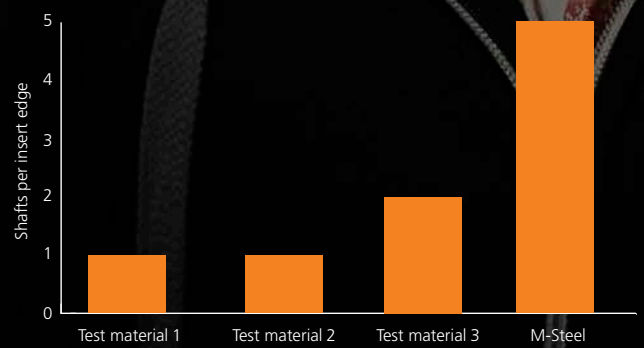
A test was made of M-Steel-treated 42CrMo4 + QT Ø100 mm bar (1091 mm length) against products from three other European producers. The steels were comparable in composition and mechanical properties according to EN10083-3. While the cutting speed could be increased by 20% for all steels, the M-Steel-treated bar had far fewer problems with straightness, vibration and chip performance – and tool life was extended fivefold. Of all the tested materials, only M-Steel could be considered for automated production. "The cost savings for us are quite dramatic," Haavisto says (see calculation below).

TOTAL COST SAVINGS THROUGH AUTOMATION WITH M-STEEL (INCLUDING INVESTMENT FOR 1 ROBOT)

PREVIOUS SETUP	Three steps in machining, always manned operation, conventional steel		
		Time	Cost per piece
Machine costs	€20 /h	1.2 h	€24
Labor costs	€25 /h	1.2 h	€30
Tools	€10 /h	1.2 h	€12
Materials	€1 /kg	68 kg	€68
			€134

NEW SETUP	Done in one automated step M-Steel		
		Time	Cost per piece
Machine costs	€30 /h	0.75 h	€24.50
Labor costs	€25 /h	0.1 h	€2.50
Tools	€2 /h	0.75 h	€1.50
Materials	€1.1 /kg	68 kg	€74.80
			€101.30

PRODUCTIVITY COMPARISON TEST:
M-STEEL VERSUS THREE OTHER 42CRMO4 GRADES



"You can hear the difference when using bar made from M-Steel – quiet, efficient and making money."

Jarkko Haavisto, Managing Director
Juhani Haavisto Oy, Kotka, Finland

Protective film deposit cuts tooling costs by 50%

Hard-part turning is often the critical last machining operation in the production of steel transmission components. And with the development of new tool materials, such as super-hard polycrystalline cubic boron (PCBN) inserts, it is now possible to turn materials over 55 HRC in hardness. In many situations, this process is a cost-effective alternative to grinding or heat treatment.

There are many opinions about the suitability of different steels for hard-part turning. One key question is the link between tool life and wear mechanisms on the cutting edge. Another relates to inclusion levels and machinability. We asked SWERIM, an independent test institute, to put some carburized steels to the test.

Testing on the cutting edge

For this investigation, they compared two steels used in truck gearbox components – both case hardened to a surface hardness of 60 HRC and a case depth of 0.7 mm. As shown in the diagrams below, the reference steel was EN 19MnVs6 (R) and the machinability improved M-Steel was also of the type EN 19MnVS6 (M). Both grades had the same classification with respect to steel cleanness standards.

The test criteria

A PCBN cutting tool was used on a turning lathe under dry conditions. The test times were 7.5 and 16 minutes for the R and M-Steels and the chip cut lengths were 1230 m and 2590 m. The tool life criterion was defined as the surface roughness Ra ≥ 0.7 µm of the machined component or failure of the tool's cutting edge.

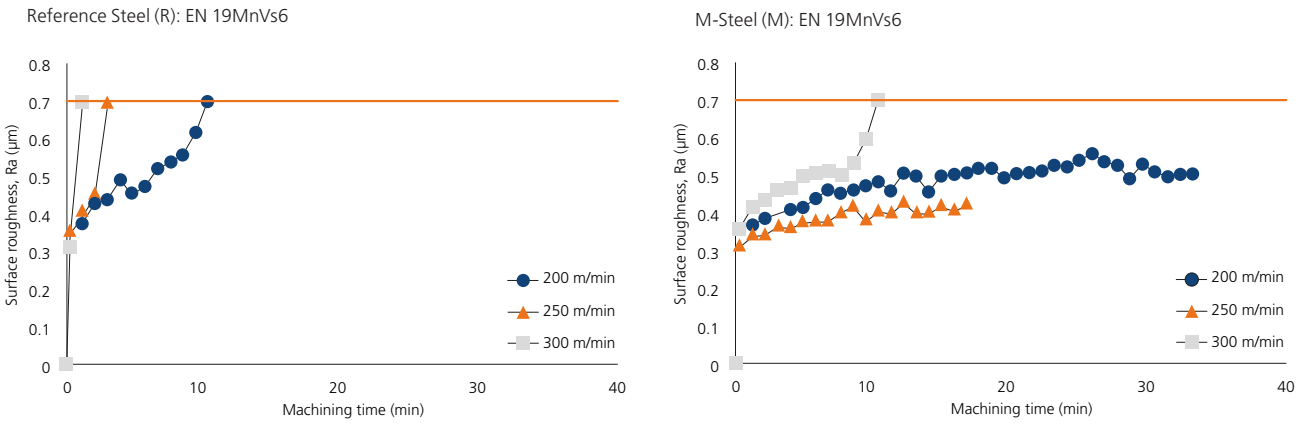
50% reduction in tooling costs

The main conclusion of the study was that the use of M-Steel resulted in a doubling of the tool life compared to the reference steel. This corresponds to a 50% reduction in tooling costs for the industrial production of transmission components.

Beneficial protective film

What makes this improvement possible? Simply, with M-Steel, the composition of the hard non-metallic inclusions (usually the cause of wear) is modified during turning, forming a protective deposit on the insert rake face and allowing for faster machining – yet with lower wear.

LOWER SURFACE ROUGHNESS & LONGER TOOL LIFE WITH M-STEEL



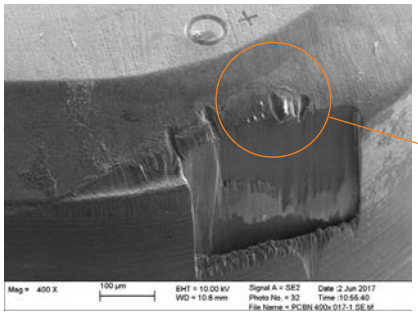
"M-Steel showed superior machinability compared to the other steels tested in this work."

Niclas Ånmark, SWERIM

"Effects of the composition of Ca-rich inclusions on tool wear mechanisms during the hard-turning of steels for transmission components,"

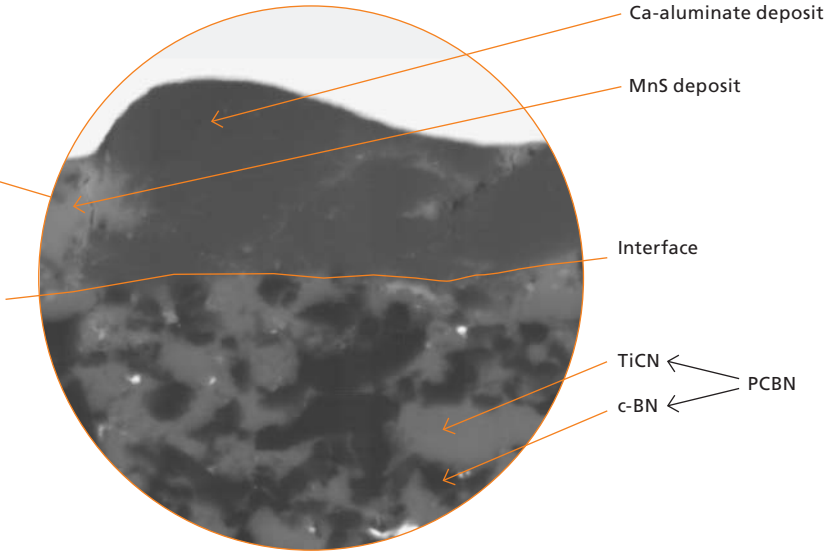
Wear, Vol. 368-369 (2016)

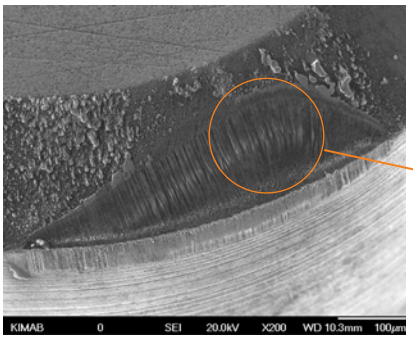
PCBN EDGES IMAGED BY SEM AFTER REACHING FULL TOOL LIFE



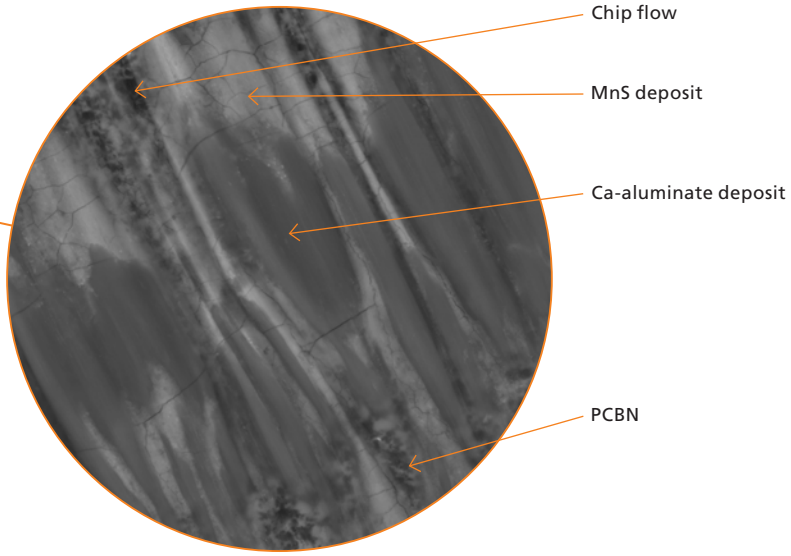
When hard turning the reference steel with a PCBN insert, crater wear could be observed in the chip exit of the rake face, leading to higher surface roughness.

Energy-dispersive x-ray spectroscopic image of insert rake face shows presence of protective slag deposits of Mn, S, Ca, Al and O following use with M-Steel.





With M-Steel, both progressive flank wear and chipping were significantly reduced, as shown by this clean ridge, with no fracturing.



Source: SWERIM is an independent Sweden-based test institute dedicated to applied research, development and problem-solving within the field of metallic materials.

"The comparison between the two steel grades 'Standard' and 'M-Steel' shows significant advantages for the M-Steel grade regarding the grindability under the shown process conditions."

Dr.-Ing. Markus Weiß, Head of Tyrolit Grinding Technology Department, Schwaz, Austria

How to reduce grinding wheel wear by 30–70%

Today, the grinding, deburring and surface engineering of steel components for industry has become an exacting science. The pressure is on to tighten the tolerances, tailor surface integrity, reduce cycle times and extend the dressing cycles of grinding tools. A large number of grinding wheel grades are available to meet the demands of alloy design, hardness and grindability aspects of certain steels. So which grades and surfaces are optimal? Tyrolit Group, a global leader in solutions for grinding, cutting, drilling, honing, dressing and polishing, put the contenders to the test at its Grinding Technology Department in Schwaz, Austria.

Tyrolit has a global reputation for innovation, high quality and customer satisfaction. Part of its secret is working closely with industrial customers in the automotive, aerospace, energy and other sectors to jointly boost productivity. And now, with many customers relying on robotic CNC production, it aims to raise the bar on productivity even further.

Trend toward automated grinding lines

As abrasion experts, the engineers at Tyrolit are often confronted with various types of materials that require grinding. If they had to choose, it would always be easier-to-grind materials that provide beneficial results in terms of lower forces, less wear and more productive processes. This is particularly true in the automotive industry, where the trend is towards fully integrated automated grinding tool lines. Clearly, lower grinding wheel wear and favorable surface integrity when producing crank shafts and other engine parts are hugely beneficial in terms of higher productivity and lower production costs.

The grindability check

Since Ovako and Tyrolit share common customers for powertrain components, it was decided to carry out a grindability check on soft and hard versions of M-Steel, compared to corresponding conventional steels. Tyrolit engineers tested different grinding workpieces (discs) and surfaces under a range of test conditions. They evaluated radial wear, power consumption and surface roughness.

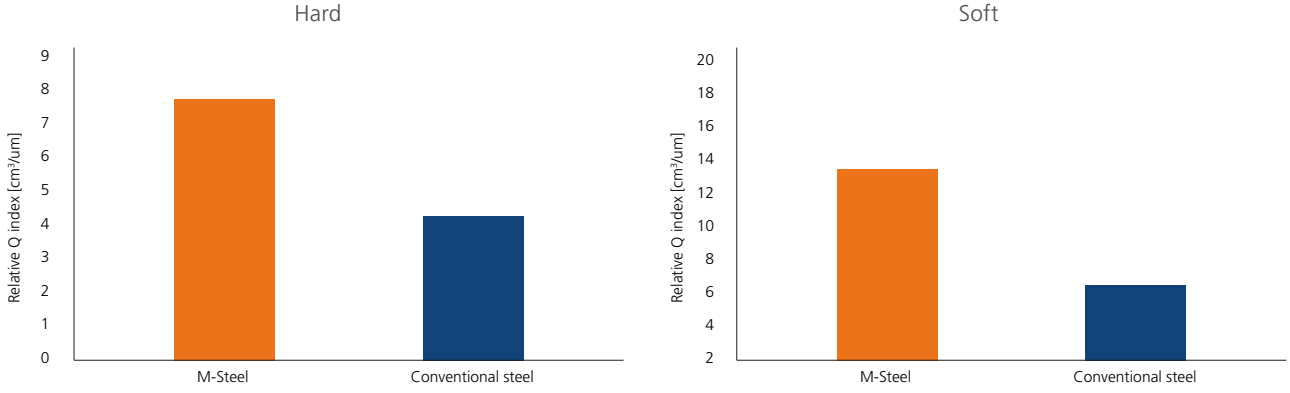
Lower wheel wear, smooth surface

The test engineers found that grinding wheel wear was almost halved with M-Steel, for both hard and soft grinding. In both tests, vitrified bonded CBN-grinding wheels were used. Note that the comparisons shown below are highly relevant for each respective configuration, but not the soft vs hard comparison.

Formation of protective layers

An analogy to this result may be found in the hard part turning of carburized M-Steel using CBN cutting tools, where the rake face "crater wear" of the CBN tools is reduced by some 80%. This is due to the formation of protective layers from the M-Steel inclusions, which minimize chemical wear of the CBN tool by the passing steel. Observations indicate that the same phenomenon is also present in grinding using CBN wheels. At this stage, however, no difference could be found in terms of spindle power consumption and grinding forces, nor any difference in surface roughness.

GRINDABILITY INDEX: M-STEEL VS CONVENTIONAL STEEL



Source: Tyrolit Grinding Technology Department, Schwaz, Austria

What's your "sweet spot" for the lowest machining cost?

We call it the sweet spot – the optimal balance between machining speed and tool wear. Naturally this will depend on multiple factors: the steel grade you are using, tool properties, tool exchange times and desired product surface characteristics. One of our customers in Sweden recently performed a test to find out how M-Steel could help.

The customer in question, based in Sweden, was carrying out automated CNC machining of steel components for the automotive industry. The company wanted to find the optimal machining speed to reduce its cost per component with M-Steel, compared to standard steel.

Calculating the optimal speed

In making the calcuation, the customer also realized it was important to factor in tool and tool exchange costs as well as cycle times. As shown in the diagram below, the optimal speed to achieve the highest cost savings proved to be approximately 360 meters per minute. In this instance, it resulted in a total cost of EUR 1.70 per piece produced with M-Steel, compared to EUR 2.35 with conventional steel.

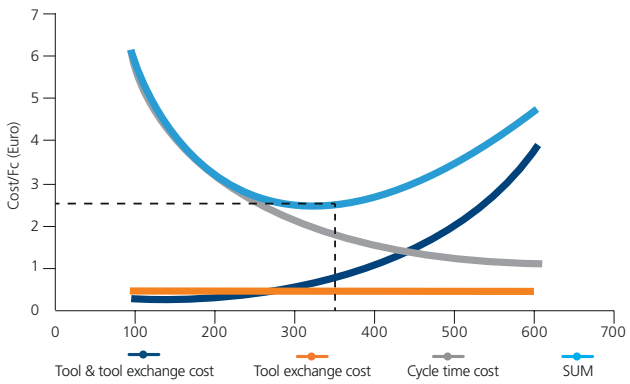
Significant savings over time

In other words, this customer is achieving a total saving of EUR 0.65 per component by using M-Steel. Naturally these cost savings start to add up in series manufacturing at higher volumes.

M-treatment advantages

The beauty of M-treatment is that it can be used for most steel grades. In addition to machinability benefits, it also boosts fatigue strength compared to conventional steel.

FINDING THE "SWEET SPOT" FOR LOWEST TOTAL COST



The fatigue strength advantage of a machinability-enhanced steel

In addition to offering superior machinability, a key advantage of M-Steel over conventional steel is that it improves fatigue strength in both the transverse and longitudinal directions. This is good to know if you are machining components that will be exposed to cyclic stresses.

M-Steel is not a steel grade. Rather, it's a machinability improvement treatment that can be applied to almost any steel grade in our stock program. Essentially, we modify and control the non-metallic inclusions in the steelmaking process by adding calcium and oxygen before applying a number of proprietary steps. The result is better machinability and higher fatigue strength.

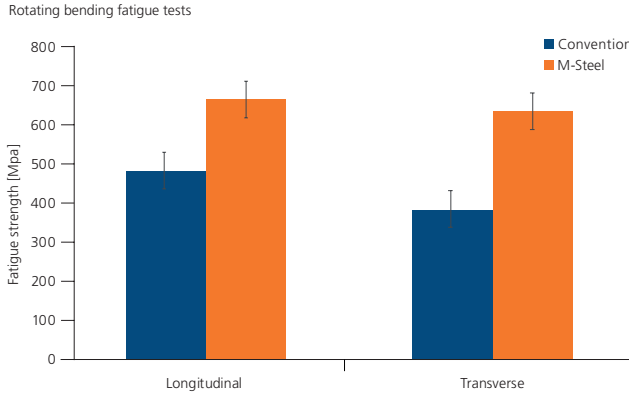
The pros and cons of inclusions

The right kind of inclusions improve machinability and fatigue strenght in the quenched and tempered condition. (see diagram, below left), but there are some limitations due to the size and number of inclusions. For example, M-Steel may be suitable for components that are exposed to moderate stress levels, but requirements should be evaluated carefully for certain very high stress items.

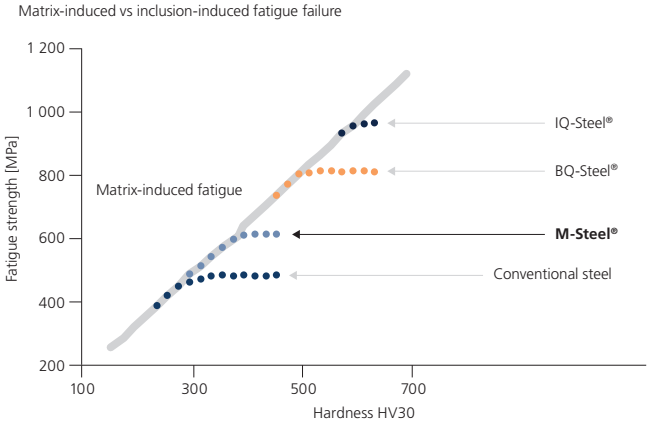
Where M-Steel fits into the portfolio

As shown in the diagram (below right), there are clear tradeoffs in terms of matrix-induced or inclusion-induced fatigue failure. For example, M-Steel offers higher fatigue strength than conventional steel for components exposed to moderate to medium stress levels, but it is not at the same level as our hard clean steels: IQ-Steel® and BQ-Steel®. Such steels will generally offer better protection against cracking or failure, particularly at higher stress levels.

FATIGUE STRENGTH, SS 2541 (QUENCHED AND TEMPERED) @ 500 HV



WHERE M-STEEL FITS INTO THE FATIGUE-STRENGTH CURVE



Get the benefits of M-Steel in many different formats

Our M-treatment can be applied to almost any steel grade, including special formats for near-net-shape manufacturing. As a result, M-Steel offers dual advantages. First, you get bar, hollow bar or seamless tube, flat bar or profiles tailored to your end shape, reducing the need for excessive machining. Second, machining is up to 30% faster with M-Steel.

SEAMLESS TUBE AND HOLLOW BAR

We stock 250 dimensions based on the Ovako 280 general structural steel grade. Tight tolerances throughout the size range result in higher yield and reduced cost for raw materials and machining.

ROUND CORNER SQUARE BAR

Square bars or billets are mainly used for drop-forged components in the automotive industry. They offer uniform structure and very good surface properties, with no sharp edges.

HOT-ROLLED FLAT BAR

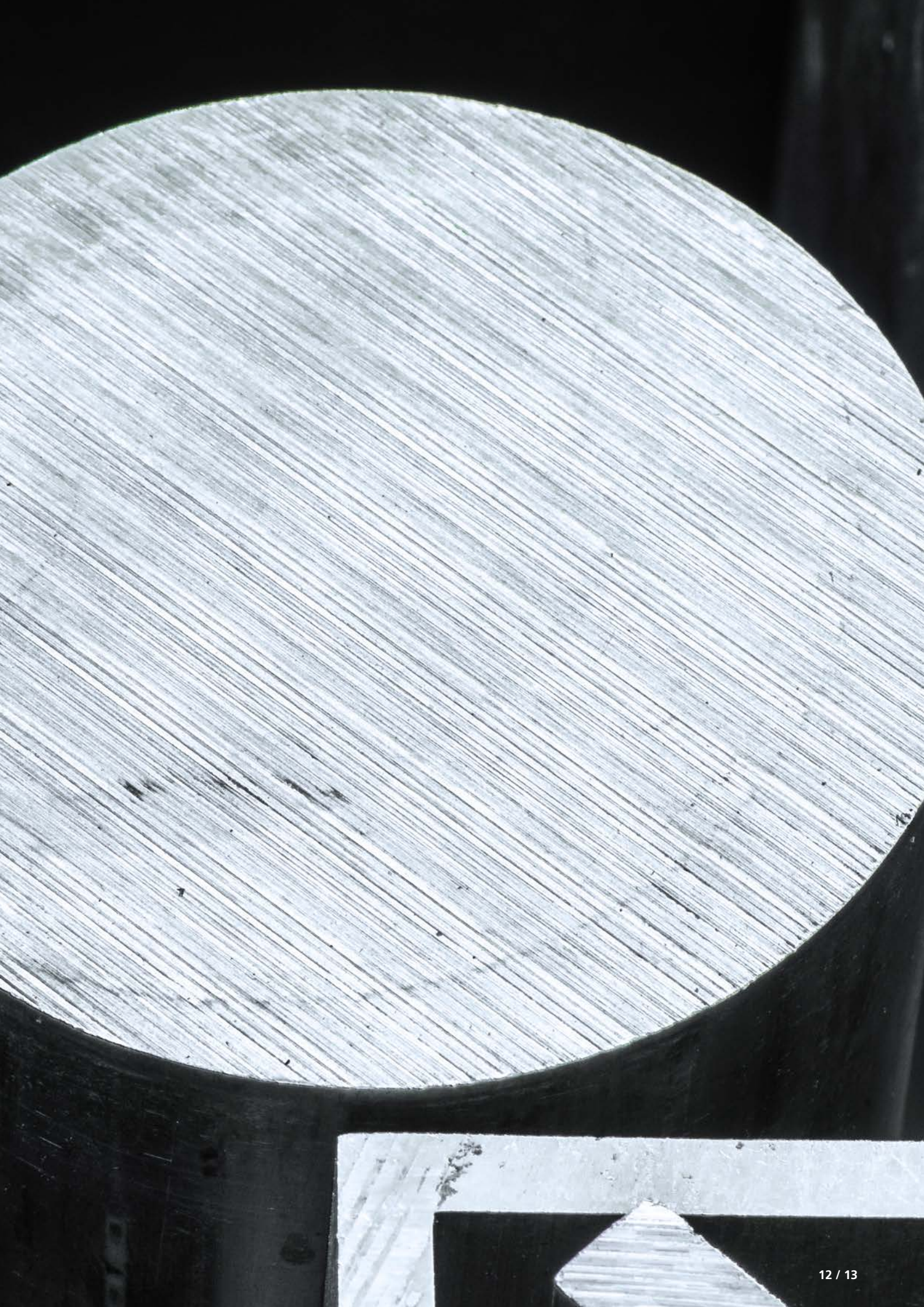
Ovako's flat bars, made either from structural steel, spring steel or boron steel, are developed for applications requiring high strength, good bendability and weldability. With low levels of non-metallic inclusions and optimal hardenability, our flat bar also offers good impact toughness and high yield strength.

HOT-ROLLED SPECIAL PROFILES BAR

Available in symmetrical or asymmetrical shapes, these can reduce production steps. Even basic profiles, such as flats with welding chamfers and rounded corners, often deliver significant cost savings compared to materials that require machining or gas cutting. Widths range from 15 mm to 300 mm, with thicknesses from 5 mm to 60 mm.

HOT-ROLLED ROUND AND SQUARE BAR

Available in diameters from 13 mm to 230 mm, and in many different sizes. Characterized by close tolerances, excellent straightness as well as roundness, good surfaces and low decarburization. Ideally suited for forging and machining.



Select your M-Steel, put our resources to work

Which type of M-Steel® can best optimize your process? Naturally, our round and square bar products are available in a wide range of standard dimensions. But we can also tailor the process to suit your needs. Or provide it cut-to-length to fit the specific requirements of your machining center.

Making high-quality M-Steel products is only part of our job. Just as important is our collaboration with you to get a better understanding of your technical requirements. Our ability to finely control purity, hardenability, heat treatment and machinability is the key to successful M-Steel production.

The difference is knowledge
We encourage customers to tap into our comprehensive know-how and experience gained from different applications and production methods. We aim to optimize steel performance for every application, and to come up with entirely new, cost-efficient material solutions. Our home base is Northern Europe, with three steelmaking plants and five rolling mills – many of which have histories going back 300 years. We also have a well-developed logistics chain and a network of sales offices around the globe.

25 mm to 200 mm
Our main focus for M-Steel is high-quality, low-alloyed engineering steels, with bar sizes from 25 mm to 200 mm and square bars up to 150 mm. We also supply, flat and profile bar as well as tubes and rings. M-Steel can be produced in a wide variety of steel grades. The table below provides an overview of typical M-Steel specifications for some of our most common steel grades.

TYPICAL ENGINEERING STEELS FOR M-TREATMENT

		TYPICAL ANALYSIS						
EN-standard* (Ovako standard)	Special feature	C	Si	Mn	Cr	Mo	Ni	Other
CASE-HARDENING STEEL								
16MnCr5	Alloyed steel suitable for heat treatment and carburizing.	0.2	0.2	1.2	1			
16NiCr54	Good toughness, controlled hardenability, good machinability.	0.2	0.2	0.6	0.8		1	
20NiCrMo2-2	Suitable for high-performance carburizing and carbonitriding components.	0.2	0.3	0.9	0.6	0.2	0.5	
20MnCr5	Alloyed steel for parts with a required core tensile strength and good wear resistance.	0.2	0.2	1.3	1.2			
GENERAL STRUCTURAL STEEL								
11SMn30	Will substitute leaded free-cutting steels.	0.1	0.2	1.2				S
19MnVS6 (280M)	Excellent toughness, hardenability and strength.	0.2	0.4	1.5				V
20Mn5F		0.2	0.4	1.3				S
30MnVS6	Microalloyed cold-heading steel.	0.3	0.5	1.4				V
C45E	Steel suitable for cold working and quenching and tempering.	0.5	0.3	0.7				
S355J0	A microalloyed construction steel with increased sulfur content. Excellent machinability and weldability.	0.1	0.4	1.3				S
S355J2		0.1	0.4	1.3				S
S355J2 (550M and 520M)	Improved machinability and mechanical properties compared to regular S355J2. Better impact strength and tensile strength.	0.1	0.3	0.8				V
QUENCHING AND TEMPERING STEEL								
21CrMoV5-7F	Steel suitable for nitriding.	0.2	0.3	0.6	1.4	0.7		V
25CrMo4	Steel suitable for cold heading.	0.3	0.2	0.9	1.1	0.2		
34CrMo4	Alloyed steel suitable for heat treatment. Excellent toughness.	0.3	0.3	0.8	1.1	0.2	1.3	
34CrNiMo6	Outstanding combination of toughness, strength and weldability.	0.3	0.2	0.7	1.4	0.2		
42CrMo4	Continuous casting	0.4	0.3	0.8	1.1	0.2		
7CrV5	Suitable for welding. Does not require post-welding heat treatment.	0.1	0.3	1	4			Nb

*Designation followed by F is not an official EN standard grade but named according to the rules in EN 10027.

Steel Navigator: your shortcut to finding the right steel

Our Steel Navigator is a digital platform that lets you search for and identify the optimal steel grade for your appltion. It consists of three parts: Material data sheets covering more than 200 steel grades; a Heat Treatment Guide and our M-Steel Calculator where you can calculate and compare standard grades against our M-treated grades.

Material data sheets
With Ovako's Steel Navigator, you can quickly pull up material data sheets for a specific steel group, quality, type of process, product or chemical composition. Naturally, you will find our attribute brands, such as IQ-Steel®, BQ-Steel®, M-Steel® and our subzero SZ-Steel®, wear-resistant WR-Steel®. But we also include engineering steels from other manufacturers.

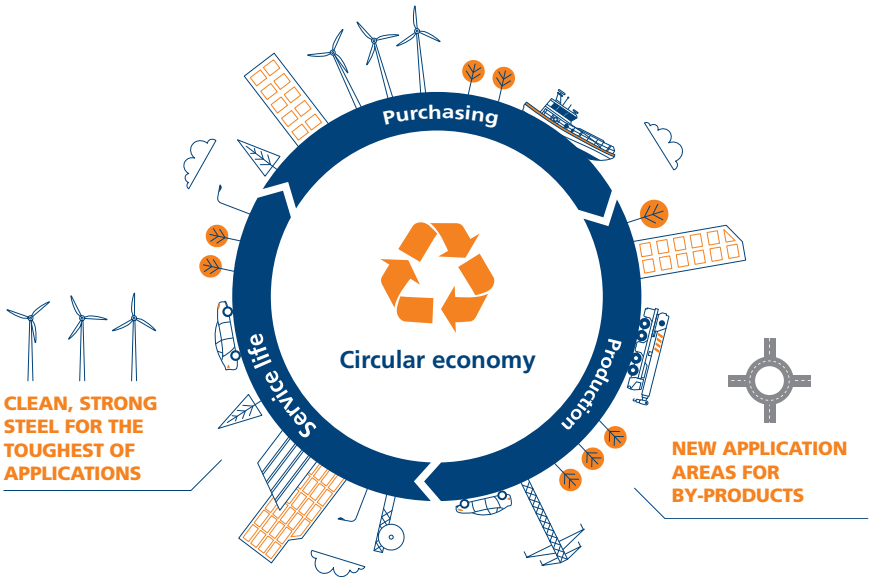
Heat Treatment Guide
Our digital Heat Treatment Guide helps you save time and money by predicting how a specific steel composition will perform after treatment. And our web-based steel selection tools let you explore hundreds of high-quality steel products to find the right match for any application.

M-Steel Calculator
The M-Steel Calculator lets you calculate and compare cutting speeds, chip stream, surface quality and other key variables for M-Steel and conventional steel grades. It provides a quick overview of the potential gains with M-Steel, as well as suggestions for the optimal grade for your needs.

Find out more at
steelnavigator.ovako.com

Environmental benefits

All Ovako products are manufactured with recycled steel and a Nordic energy mix that contributes to an extremely low CO_2 footprint. This means our products are world-leading in their low cradle-to-gate carbon footprint. As a result of our sourcing and production methods, your M-Steel products have already contributed to significantly lower CO_2 emissions when they arrive at your facilities. It's part of our focus on building a more sustainable steel cycle together with our customers – for a better engineering future.



Ovako develops high-tech steel solutions for, and in cooperation with, its customers in the bearing, transport and manufacturing industries. Our steel makes our customers' end products more resilient and extends their useful life, ultimately resulting in smarter, more energy-efficient and more environmentally-friendly products.

Our production is based on recycled scrap and includes steel in the form of bar, tube, rings and pre-components. Ovako has around 2,700 employees in more than 30 countries. Ovako is a subsidiary of Sanyo Special Steel and a member of Nippon Steel Corporation group, one of the largest steel producers in the world with more than 100,000 employees globally.

For more information, please visit us at www.ovako.com, www.sanyo-steel.co.jp and www.nipponsteel.com.

CONTACT US

www.ovako.com/en/contact/