OVAKO

WR-STEEL

WEAR RESISTANT STEEL GOES CARBON NEUTRAL

Creating a more sustainable future together with you

Imagine a range of steels that can extend the life of your equipment by many years. Resist abrasion and wear. Open engineering possibilities. Drive down the manufacturing costs of key components for agricultural, construction and mining. Now all made in a 100% carbon-neutral manufacturing process.

This is what we called WR-Steel®, or wear-resistant steel. It's not one type of steel, but a range of metallurgies in various hardness levels, dimensions and compositions. All designed to give you a wear-resistance advantage. And all rooted in a 500-year Ovako steelmaking legacy characterized by close collaboration with demanding industries and continuous investments in R&D. Together with you, our aim is to not only boost your productivity but safeguard your sustainable long-term success.

Applying sustainable thinking
Today, this means supporting your Environmental, Social and Governance (ESG) strategies. In particular, the focus is on accelerating decarbonization and working towards Net Zero emissions. This was (and is) a key driver behind our Carbon Neutral Now initiative, which means that all products from our three metallurgical workflows and nine production sites are manufactured in a certified, 100% carbon neutral process. Our WR-Steel is based on 97% recycled steel and made using fossil-free energy sources. To verify what we claim, we also provide our customers with Environmental Product Declaration (EPD) certificates.

Knowledge and support tools
With Ovako WR-Steel, you gain access to the broadest wear-resistant steel range in Europe. It covers three metallurgies (billets, blooms, ingots) multiple grades and hundreds of profiles. For guidance in finding the right steel, use our digital Steel Navigator, Wear Resistance Index, Heat Treatment Guide or simply reach out to our technical service team. Let's see how we can solve your real-life needs together.

KEY BENEFITS – LEADING TO PEACE OF MIND

– MORE CHOICE	Europe's broadest range of WR-Steel® grades and profiles
– SCIENTIFIC PROOF	Field and lab-tested for proven superior wear resistance
– CARBON NEUTRAL	100% carbon neutral manufacturing process
– EPD VERIFICATION	Environmental Product Declaration (EPD) for all hot-rolled products
– METHODOLOGY	Ovako Wear Index (strength, abrasive resistance, toughness)
– SUPPORT TOOLS	Ovako Steel Navigator and Heat Treatment Guide

We start with your need, not the steel

It's a fact. Wear is specific to the application and the environmental factors in that application. In other words, there is no "one-size-fits all" wear-resistant solution. If you want to extend the lifetime of a bolt-on edge, tooth, tine point, drill head or blade, you need to examine how the wear mechanisms act in real-life situations. That is why we start with your need, not the steel.

But first a bit of science. Our R&D team has identified four main wear mechanisms that occur at a microscopic level when hard, rough surfaces meet softer surfaces under force: Plowing, cutting, wedge formation and cracking. You don't need to be an expert on these (that's our job), but you should be aware of them. They will differ depending on the application and there can be a mix of them, with some being more dominant.

Abrasive wear in a wheel loader BOE
For example, in field tests of a bolt-on-edge (BOE) for the bucket of a wheel loader, the main source of wear on the bottom of the edge is severe abrasive wear. By contrast, the top of the edge is exposed to sliding abrasive wear, with extensive plowing, wedge formation and groove formation.

Wedge formation in a tine point
In yet another field test, we looked at a typical steel tine point – that is, the replaceable wear part in agricultural equipment (harrows, cultivators) that penetrates the soil and is exposed to wear. Here, most of the wear occurs across the width of the piece in the middle, with the main wear micro-mechanisms being micro-plowing, wedge formation, micro-cutting, groove formation and brittle facture.

Cutting in a drill head
Finally, we investigated a down-the-hole (DTH) drill head being used for rock drilling and mining. Here, on the side of the drill head, we noted that the surface had been attacked by sharp, undefined particles at random angles, leading to micro- and macro-cutting and mass removal. We also found brittle factures.

What all these field tests confirmed is that each application has different demands and that the relevant wear mechanisms change as well. So how can we use this knowledge to guide your selection in a more tailored way? We found the answer in the Ovako WR-Steel Wear Index (see page 7).

"Our starting point is always the real-life customer situation, understanding the wear mechanisms and then optimizing them for the best result."

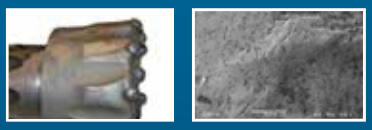
Patrik Ölund
Head of Group R&D Ovako

From real-life application to required WR-Steel properties

WEAR IN REAL APPLICATIONS

Bolt-on edge

Agricultural tine point



Down the hole (DTH) drill head

WEAR MECHANISM

Plowing occurs when an abrasive particle causes the softer material to shift sideways, forming a groove with ridges on either side.

Wedge formation is a combination of plowing and cutting, where pieces of grit burrow into the surface forming wedges that eventually detach.

Cutting is mainly found when abrasive particles impact the surface and act as tiny cutting tools that literally chip away at the surface.

Cracking, or brittle fracture, can happen when impacts by the abrasive material create highly concentrated stresses upon impact, leading to the formation of micro-cracks.

REQUIRED PROPERTIES

Strength

Abrasive resistance

Toughness

"Today's forestry machine operators also want to have a minimal impact on the climate. Our customers are calling for us to help them quantify their environmental performance. To achieve this, we are currently working to publish the independently verified carbon footprint of our forestry machine tracks."

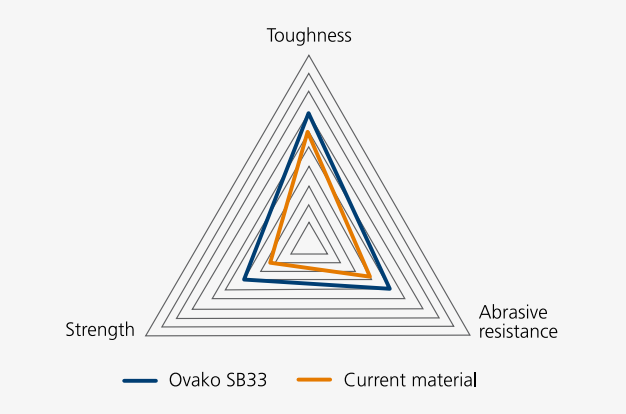
Urban Hadarsson, CEO of Olofsfors

How to specify the right grade with the Ovako wear index

Based on our field testing, we found that choosing the right wear resistant steel comes down to three key parameters: Strength, toughness and abrasive resistance. Each of these properties can be tested, measured and assigned a value – for your current material or a suitable Ovako WR-Steel grade. We call this the Ovako WR-Steel Wear Index.

Our Wear Index methodology allows us to guide you in finding the most cost-efficient grade, with the most important material properties, to increase service life in your application. In short, by screening and comparing materials, you get the optimal solution. The key mechanical properties are:

- Strength, as measured by hardness, resists the plastic deformation of plowing and cutting.
- Toughness, measured with Charpy-V testing, resists impact loading from abrasive.
- Abrasive resistance, a key property since materials with the same strength and toughness can show different wear resistance due to having different microstructures. Therefore, we developed our own in-house test method called the Ovako WR-drum to evaluate this.



WEAR INDEX IN ACTION: With the Ovako WR-drum test, we can assign a strength-abrasion-toughness (SAT) value to a customer's current material (orange) and then compare it to a relevant Ovako WR-Steel grade (blue).

Olofsfors prioritizes a fourth "property" – sustainability

Increasingly, there's also a fourth "property" we call "sustainability" – meaning that the WR-Steel grade is produced in an environmentally responsible way, contributing to ESG targets. This fourth property, in addition to other key properties in the Wear Index, was crucial to Olofsfors, a 250-year-old Nordic producer of steel tracks for forest machinery, that is striving to be more cost-efficient and sustainable.

"By optimizing our designs to simplify manufacturing, we have reduced the number of processing steps needed. Ovako's rolling mill is fully equipped to supply the right grades of steel at the tolerances we need for our tracks. As a result, we can make significant savings in production, and we pass those savings on to our customers."

Mats Frangén, Product Development, Olofsfors

Putting our ideas to the test

To support our customers, we continue to make advances in the lab testing of wear-resistant steel. By simulating the real-life situation and then evaluating the surfaces of the steel both visually and using SEM images, we can draw conclusions about the optimal composition and microstructure. It helps us to continuously improve our grades and develop the wear-resistant steels of the future.

One key test is the Ovako WR Abrasion Test Machine (ATM), or WR-Drum for short. Used at our R&D lab in Hofors, Sweden, it allows us to accurately simulate the dominant wear mechanisms. It can be done either by attaching steel samples on the edge of the drum or mixing the samples in with the abrasive media. The drum is loaded with a measured amount of abrasive media and spun at defined rotational speeds. It is also possible to control the angle between the sample and abrasive media as well as the temperature of the samples.

Strength and impact testing
When it comes to strength, this is determined with hardness measurements, while impact toughness is measured using a Charpy-V impact test. The combined results of the different tests give us what we call a "property zone." By this, we mean defined performance properties that can then be compared to the application needs for a certain component.

Finding the right "property zone"
For example, machining tools are not generally subject to impact, so strength is the main zone factor. By contrast, a rock tool requires a large property zone with impact resistance and abrasion resistance as the main factors.

An agricultural component, such as a tine, may need less impact resistance but still require high abrasive resistance. Together with field tests, we can then define the ideal grade or combination of properties of toughness, strength and abrasive wear.

"We test, study and evaluate the wear-service life of steel in different applications. This knowledge enables us to improve our products and develop the wear-resistant steels of the future."

Patrik Ölund
Head of Group R&D Ovako

Optimized for easier and more cost-efficient heat treatment

Consistency. Repeatability. Availability. Three words that sum up the demands of many of heat treatment shops. To meet them, we continue to invest in our own knowledge in this area and collaborate closely with customers to ensure trouble-free, cost-efficient performance. That also means securing a reliable supply chain in these challenging times.

Clearly, the heat treatment process is crucial to solving your customers' wear challenges. After all, it's the heating, quenching, and tempering of your steel that will determine the end properties. We want them to be perfect, batch after batch! That is why we continuously improve the microchemistry of our grades to ensure repeatable hardenability and improve machinability. We want to make sure you get the correct chemical composition, every time, and can shape and quench with low risk of microcracking – consistency is everything.

Near-net shape special profiles
The breadth of choice and flexibility of our range are other key advantages. You can choose from more than 700 variants of near-net-shape, hot-rolled flat bar or special profiles to eliminate or minimize time-consuming machining and other heat-treating steps. And with three metallurgical supply chains, we secure rapid availability for most heat-treatment specifications – from ingot- or continuous-cast routes (bloom and billet sizes are both available) – at a competitive performance profile.

Total integrated quality control
Tight quality control and tolerances are assured by a closely controlled production chain, from initial melt to final product. This is reinforced by regular, state-of-the-art, non-destructive testing. To learn more about different alloying elements influence steel hardness or strength, get our Heat Treatment Guide, available via our online Steel Navigator.

"We've tested other unhardened steels, but still find the consistency and quality of Ovako's WR-Steel grades, in very batch, to be in a class of its own. We also value the fact that they're constantly developing new grades that give us even more design freedom and ensure that we deliver premium parts to our customers."

Stefan Svanborg, CEO, Borox AB, Sweden*

*Founded in 1920, Borox is a family-owned Swedish business that is a leading European producer of wear parts for the construction equipment, quarrying and mining industries.

Raising the bar on productivity, efficiency and sustainability

Today, the engineering standards expected of a wear-resistant steel partner are getting tougher. The steel must contribute to cost-efficient production and high performance. At the same time, it needs to be innovative and produced in a sustainable way. But that's not all. The partner should preferably add materials expertise and support at every step. In other words, it's a delicate balancing act.

Fortunately, this is nothing new for us. Our customers are ambitious and leading the way in their industries. They set high standards and expect more than just high-quality steel. Whether its battling abrasion on a plow tine, redesigning a component to be lighter and stronger or meeting new sustainability standards, we are there to support you. If required, our own R&D team can collaborate with your engineers, metallurgists or heat-treatment specialists to find an optimal solution.

Aiming high with Kverneland

A good example of all these factors coming together is our longstanding partnership with Kverneland, a global Norwegian-based maker of plows and other agricultural equipment. Yes, their ambitions are high: they are on a mission to be the leading provider of intelligent and efficient farming systems that contribute to sustainable agriculture, serving the world's growing population.

Supporting sustainability goals

With sustainability high on the agenda, Kverneland was naturally happy that Ovako's steelmaking process has a 95% lower carbon footprint than the global average. Now we're taking that a step further with strong investments in switching from gas to fossil-free hydrogen in our heating of steel prior to rolling – going carbon-neutral in all our steel manufacturing processes. We use 97% recycled steel and 100% fossil-free electricity sources. In other words, strong support for their ESG strategy.

From lab to heat treatment to plowing

We also collaborate closely with Kverneland's metallurgists to ensure high consistency and repeatability in their heat treatment processes. By putting our heads together, we can ensure that every part of a plow is optimized for wear resistance and lighter weight, making pulling easier, reducing fuel consumption, and increasing service life. From micro-chemistry to lab testing and real-life analyses, it's possible to tailor the steel with high precision. Good news for the future of farming.

Meeting your wear challenge

Do you have a steel wear challenge right now? Do you believe that applying a combination of science, lab research and observing real-life wear mechanisms could help address this? If so, don't hesitate to get in touch with our team of wear-resistant experts. We'd love to hear from you.

"Ovako is easy to work with. They're close at hand, speak our language, and know our operation. One of the benefits of our relationship is that they perform theoretical testing, and we conduct the practical testing. Then we compare results, allowing us to come up with the best solution – and they're always open to change."

Odd Geir Arre, Procurement Manager, Kverneland, Norway*

***Founded in 1879, the Kverneland Group of Norway is today the world's leading manufacturer of farming equipment**

3 metallurgies. 55 grades. 680 profiles. All made in a carbon-neutral process.

What type of wear-resistant steel are you looking for? In what format? As one of Europe's largest suppliers of wear-resistant steel, we continue to expand our range of boron steel, quench and tempering steel and high-carbon through-hardening steel in various formats. Starting in 2022, we also we also began manufacturing all our steels in a 100% carbon neutral manufacturing process.

What is Carbon Neutral Now?
In 2022, we launched our Carbon Neutral Now initiative for the benefit of our customers, society and the world. Simply stated, it means that the CO_2 released into the atmosphere is now 100% balanced by an equivalent amount being removed – across all our operations.

Environmental Product Declaration (EPD)
Each of our hot-rolled products comes with an Environmental Product Declaration (EPD) in accordance with ISO 14025 and EN 15804: 2012+A2:2019, produced by RISE and verified by a third-party auditor. Based on these, we can deliver specific details for all downstream products and all different grades we produce through our Carbon Footprint Calculator.

Hot-rolled round bars
Our hot-rolled round bar is characterized by close tolerances, excellent straightness and roundness. Good surfaces and low decarburization. Diameters range from 13 mm to 200 mm in many sizes.

Hot-rolled flat bar
Our flat bar offers superior impact toughness, good surfaces, and high yield strength. Also excellent straightness, shape and tight tolerances, with low decarburization. Flats with welded chamfers and rounded corners often deliver high-cost savings compared to machining or gas cutting, which can weaken edges. Standard lengths are 6-meters, but they can range from 2.8 to 21 meters and be sawn to length, if needed. Widths range from 12 mm to 270 mm and thickness from 5 mm to 60 mm.

Hot-rolled special profile bar
Reduce machining costs and eliminate manufacturing steps by taking advantage of our hundreds of special profile bars in both symmetrical and asymmetrical shapes. Special profiles are rolled in widths ranging from 15 mm to 300 mm and thicknesses from 5 mm to 60 mm.

SPECIAL PROFILES IN STOCK

Single bevel

Profile	Size	Steel grade
P4-0036	150 x 16	SB 27M12CB
P4-0059	200 x 20	
P4-0060	200 x 25	
P4-0101	200 x 30	
P4-0061	250 x 25	
P4-0062	250 x 30	
P4-0063	270 x 30	
P4-0064	270 x 35	
P4-0231	300 x 30	
P4-0099	300 x 35	
P4-0100	300 x 40	

Arrowhead

Profile	Size	Steel grade
P4-0025	101 x 23	SB 27M12CB
P4-0003	151 x 32	
P4-0338	203 x 32	

Grouser bar

Profile	Size	Steel grade
P7-0019	30 x 16	SB 24M13B
P7-0020	40 x 22	SB 27M12CB
P4-0020	42 x 24	
P4-0019	50 x 27	
P4-0018	65 x 30	
P4-0017	68 x 37	
P4-0016	75 x 45	
P4-0355	89 x 43.5	

STANDARD BORON GRADES

Boron steel chemical composition

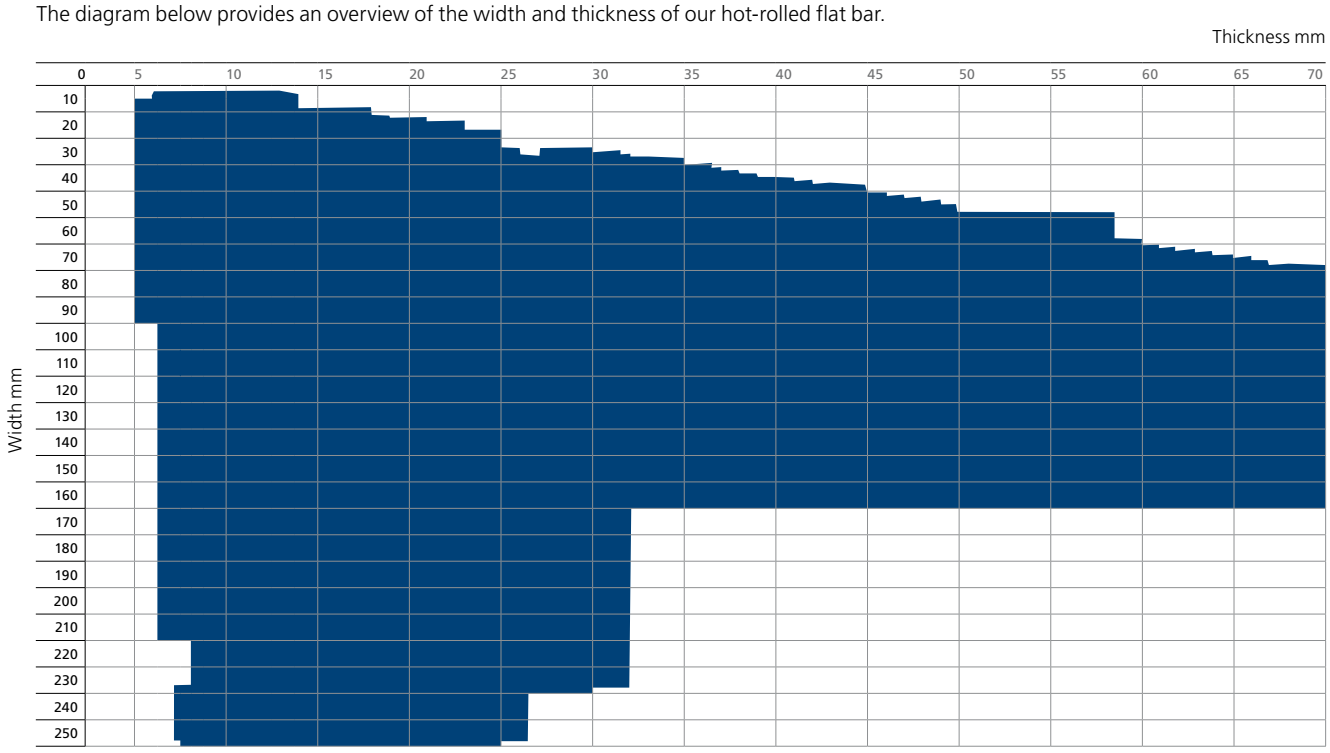
		Typical analysis				
Ovako standard	**EN-standard***	**C**	**Si**	**Mn**	**Cr**	**CEV**
SB17M10B		0.17	0.2	1.0	0.4	0.45
SB21M10B		0.21	0.2	1.0	0.2	0.4
SB24M13B	24MnB5*	0.24	0.3	1.3	0.2	0.5
SB27M12CB	27MnCrB5-2	0.27	0.2	1.2	0.5	0.6
SB30M12CB	30MnCrB5-2*	0.30	0.3	1.2	0.5	0.6
SB33M13CB	33MnCrB5-2	0.33	0.3	1.3	0.6	0.7
SB43M14B	43MnB6-3*	0.43	0.3	1.4		
** 495B	48CrMoNi4-10	0.48	0.2	1.8	0.6	1.1
** 803F / 100Cr6	100Cr6	0.97	0.3	0.3	1.4	

* EN-standard designation followed by "*" is not an official EN standard grade but named according to the rules in EN 10027. CEV = C + Mn/6 + (Ni + Cu)/15 + (Cr + Mo + V)/5

** Non boron grades, commonly used in finite wear critical applications

DIMENSIONS, HOT-ROLLED FLAT BAR

The diagram below provides an overview of the width and thickness of our hot-rolled flat bar.



Ovako develops clean, high quality engineering steel for customers in the bearing, transport, and manufacturing industries. Our steel enables products that are lightweight, resilient and climate smart. Our sustainability ambition is high. Our production is carbon neutral since January 2022 and is based on recycled steel and fossil-free electricity. We are a subsidiary of Sanyo Special Steel and a member of Nippon Steel Corporation, one of the largest steel producers in the world.

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

CONTACT US

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