ArcelorMittal Europe
Long Products

ArcelorMittal

Bars & Rods
Product offer

#2

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We welcome you to discover
our product offer in more detail.

Our company and our values can be
found in the B&R overview brochure #1.

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Message

from the Chief Marketing Officer and the Chief Executive Officer, Business Division Bars & Rods

Dear Customer and Partner,

We have a long tradition of producing Bars & Rods in our European mills, located in Germany, Poland, Spain, France, Bosnia Herzegovina and Morocco. Together with our colleagues in Americas, Eastern Europe, CIS and Southern Africa, and thanks to our global and unique products portfolio, **we offer a large range of solutions** to **meet your, as well as your customers' requirements**.

In Europe, our mills feasibilities are being continuously updated to match with the emerging trends in terms of environmental sustainability, and to satisfy your evolving needs with respect to new developments, higher services levels, and ensuring fit for purpose. The last revamping of Hamburg, Gijón and Sosnowiec wire rod mills in 2019 and of Zenica in 2018 are ensuring high-quality products for the highest demanding applications in the automotive, truck, mechanical appliances, yellow and green goods and construction sectors.

Our wide spread and dedicated Sales network, our R&D and product development teams, our Supply Chain and Quality teams in our mills are strongly involved in their daily tasks to be closer to you, to clearly understand your needs, to develop the right products, services and IT tools with **the unique objective to build a strong and intense partnership with you**.

Our common success is also driven by the challenging times we are facing. One aspect of this is the environmental sustainability. ArcelorMittal announced clearly and in a transparent way **its ambition to become carbon neutral in Europe by 2050**. We are inventing, developing, testing new technologies with the intermediate objective to reduce our CO_2 emission by 30% in 2030. Within the Bars & Rods perimeter, we are proud of our H2 pilot project in Hamburg.

This year we have also launched XCarb® which is designed to bring together all of ArcelorMittal's reduced, low and zero-carbon products and steelmaking activities, as well as wider initiatives and green innovation projects, into a single effort focused on achieving demonstrable progress towards carbon neutral steel.

Together, we are inventing the smarter steels of tomorrow and we are well positioned for a **sustainable long-term partnership** and to address together, both **local and global challenges**.

Yours faithfully,

Mike Haller & Lutz Bandusch

Sustainability

High standards of business ethics and governance have been fundamental at ArcelorMittal since the company was founded. Our business is committed to build solutions for sustainable development. We frame this in our 10 Sustainable Development outcomes, which act as a compass to describe the business we know we must become.
To structure our approach to achieving them, we focus on six themes: **product innovation, safety, social, environment, climate change, customer reassurance**.

Transparent Governance is obviously a guiding principle at ArcelorMittal, which means that we, as a company, fully comply with the external regulations and reporting requirements linked to a listed company which also includes regulatory compliances such as **Human Rights, Code of Business Conduct, Anti-corruption and Insider dealing**.

Reducing ArcelorMittal's carbon footprint is one of our most important goals: ArcelorMittal is strongly involved in developing technologies to make low-carbon steel a reality, and this underpins ArcelorMittal Europe's ambition to reduce carbon emissions **by 30% by 2030**.

ArcelorMittal is committed in **developing trusted standards protecting our environment**. Each ArcelorMittal European facility adheres to ISO 14001 standards. The company has recently taken a leading role in forming and committing to **ResponsibleSteel™**, the steel industry's first multi-stakeholder global certification initiative.

ResponsibleSteel™ includes a broad range of criteria in:

- Climate Change & Greenhouse Gas Emissions
- Water Responsibility & Biodiversity
- Human Rights and Labour Law
- Local Communities & Business Integrity

ResponsibleSteel™ objectives are:

- To establish single standard for the entire mine to metal value chain
- To develop standards on greenhouse gas emissions for steel
- To improve responsible sourcing in raw material
- To answer customers' expectations in providing certified products

Our 2030 roadmap is based on three distinct pathways:

1. **Clean power steelmaking** using clean power as the energy source for hydrogen-based steelmaking, and longer term for direct electrolysis steelmaking;
2. **Circular carbon steelmaking**, which uses circular carbon energy sources, such as waste biomass, to displace fossil fuels in steelmaking, thereby enabling low-emissions steelmaking;
3. **Fossil fuels with Carbon Capture and Storage**, where the current method of steel production is maintained but the carbon is then captured and stored or re-used rather than emitted into the atmosphere.

The 2050 roadmap with the ambition to be carbon neutral by this date, is based on potential improvements and a suite of breakthrough technologies. One of our main strengths is the breadth and flexibility of our €250 million research and demonstration programme.

In addition, our innovative approach supports three key underlying principles of low-emissions circular economy: smarter, circular, lower-emissions.

Inventing smarter steels for a better world

Product development

New product development is printed in ArcelorMittal Group DNA, and constantly completes the current offer.

Did you know that more than 30% of ArcelorMittal products in our brochure did not exist 20 years ago?

This is resulting from a combination of key factors including **hiring talented** and **innovative people**, providing to our people the ability **to listen to our customers' needs**, investing in **new process technologies** and producing **high performance steels**. Thanks to our extended product portfolio, we are recognised by our customers for always offering the most relevant product.

We are innovating thanks to a proven product development process.

1. **We capture** market trends and new challenges.
2. **We anticipate** the end customers' needs and expectations, through the competences of our sales and marketing force, our product development teams and researchers, our resident engineers and our customer service.
3. But sometimes, the single solution to fulfil new requirements is to develop a new product.
4. Our researchers' network can **propose breakthrough** ideas or progressive solutions. Our effectiveness in new products offer relies on highly competent researchers, on developed models to design products and simulate all our production processes, from the liquid metallurgy to finishing. We even develop adequate tools to simulate some of our customer's processes, with the objective to predict in use performance.
5. After the innovation concept proof at lab scale, **we offer the opportunity to conduct semi-industrial trials** making it possible to produce prototypes thanks to our numerous pilot facilities located in our research centres.
6. To cover specific Bars and Wires applications, **we are equipped** with drawing benches, surface treatment or bulk treatment simulators and instrumented lathes to optimise machinability of our products.
7. When industrialised, our products are manufactured and characterised according to a dedicated monitoring plan that guarantees the robustness of the properties of our products appreciated in high-end applications.

Towards carbon neutral steel with XCarb®

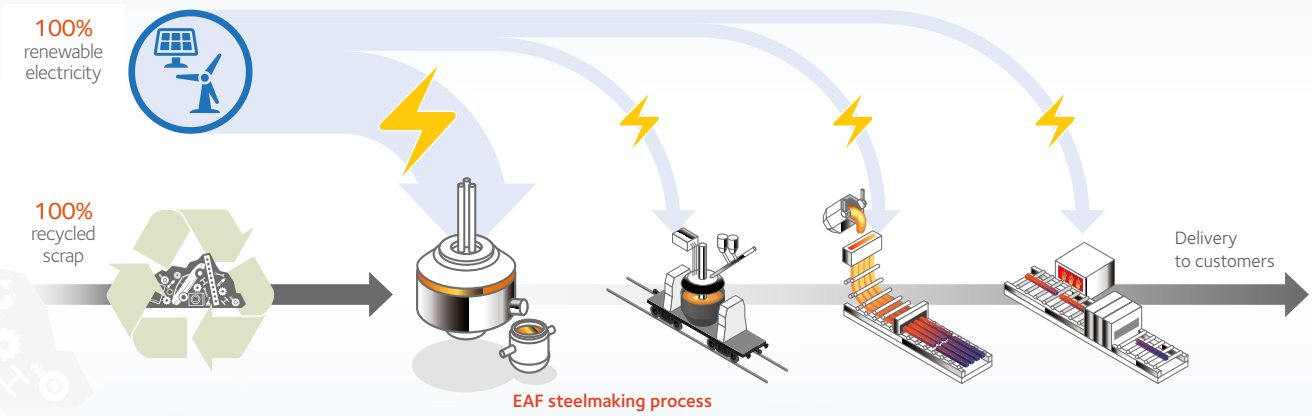
Our new brand, XCarb® is designed to bring together all of ArcelorMittal's reduced, low and zero-carbon products and steelmaking activities targeted at carbon-neutral steel by 2050.

Our first two XCarb® products are now ready for market:

XCarb® recycled and renewably produced applies to products made via the Electric Arc Furnace route using scrap steel and 100% renewable energy, giving our finished steel products an extremely low CO_2 footprint.

All of the electricity needed to transform the scrap into XCarb® recycled and renewably produced steels comes from renewable sources such as solar and wind power. The energy is provided by suppliers who are connected to the same grid as our production sites and whose projects are recent.

With XCarb® recycled and renewably produced, our steel products come now also with a 'Guarantee of Origin' certifying the renewable sources for the electricity.



XCarb® green steel certificates are designed for our steel products made from iron ore.

We have several decarbonisation initiatives underway in our steel making process which are resulting in significant CO_2 savings in our Scope 1 emissions . We can add up these savings and then pass them onto our customers in the form of a certificate, which has been verified by an independent auditor. When a customer buys an XCarb® certificate from us, they effectively 'own' the CO_2 saving and can report that saving as a reduction in their Scope 3 emissions as raw material. This approach is in accordance with the GHG Protocol Corporate Accounting and Reporting Standard.

With XCarb®, we aim to reduce the carbon footprint of our steel.

Products & applications

Our presence in every major segment and our capability to offer a unique combination of industrial, technical and commercial resources to support our customers' needs allows us to segment our product portfolio to better fulfil their demand. For each segment we provide High Added Value (HAV) bars and rods connecting our customers' needs to their customers requirements.

The HAV bars and rods supplied by ArcelorMittal Europe are segmented considering common key properties, application and quality requirements. Everywhere you look it is possible to see our steels.

- Our steel grades for **bearing** are providing clean and renewable energy (wind mill motors) and are present in all rotational parts you need;
- Our steels for **chains** are lifting heavy loads, anchoring boats, keeping people safe and moving vehicles in mud and snow;
- Our steels for **cold head quality** (CHQ) are fixing important parts in your car (wheels, engines), in wind towers, robots, infrastructure buildings and construction (bridges, rails, etc.);
- Our steels for **drawing** are present in your celebrations (cork wire), leisure (cable cars) and comfort at home (window parts);
- Our steels for **forging** are present in your car (engine, gear box), and growing your food (green and yellow goods parts);
- Our steels for **free cutting** are moving many parts of our daily routine, from home appliances to industrial machines;
- Our steels for **prestressed concrete** (PC) are shortening distances (bridges and railroads) and providing comfort on buildings and skyscrapers;
- Our steels for **steel cord** and **bead wire** are reinforcing the tyres for your car, buses and trucks. They are also present on conveyor belts at the airport and mines;
- Our steels for **springs** are providing comfort when you are driving your car (suspension, clutch and valve springs) or travelling (rails clips);
- Our steels for **welding** are building ships, equipment, tanks, pipelines, etc.

Bearing

Key properties

- Steel cleanliness
- Steel homogeneity

Bearings are produced from high carbon steel grades alloyed mainly with chromium which provides a very good wearing resistance and rolling fatigue strength. The most common bearing grades are 100Cr6 grades.

Steel production requires strict process set ups control in order to achieve product parameters requested by customers.

High fatigue loads require surface quality and low inclusion content. Two metallurgical treatments are available to achieve this. Aluminium killed steel follows a clean metallurgical process to obtain a very low oxygen content. Silicon killed steel produces grades with good deformability inclusions. The sizes of such inclusions are reduced during the rolling process.

In standard steel production, the reduction ratio is the final process required to enable a fine and homogeneous structure prior to transformation.

ArcelorMittal is able to provide steel with bainitic or martensitic final structure depending on the customers requesting. These grades are thus alloyed with molybdenum and/or manganese to favour bainite and/or martensite.

The same considerations on homogeneity and inclusions apply to C55 and C70 for induction hardening.

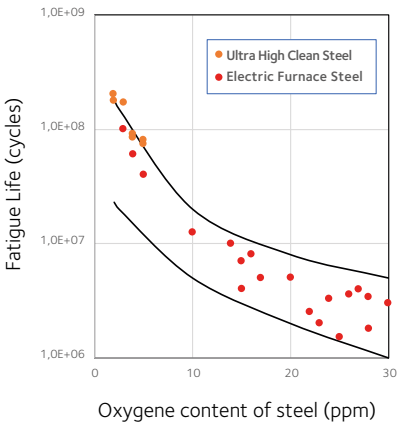
Typical throught-hardening bearing steel grade (ISO 683-17)

Name	**Material No.**	**C** (%)	**Si** (%)	**Mn** (%)	**Cr** (%)	**Mo** (%)
C56E2	1.1219	0.55	0.25	0.80	-	-
C70Mn4	1.1244	0.75	0.25	1.00	-	-

Typical induction-hardening bearing steel grade (ISO 683-17)

Name	**Material No.**	**C** (%)	**Si** (%)	**Mn** (%)	**Cr** (%)	**Mo** (%)
100Cr6	1.3505	1.00	0.25	0.35	1.50	-
100CrMo7	1.3537	1.00	0.25	0.35	1.80	0.25

Fatigue life and oxygene content



Chains

Key properties

- Toughness
- Elongation
- Weldability

Chains are produced by hot or cold forming and further quenching and tempering.

Precise alloying is required for weldability but also to reach the minimum notch impact energy required.

Typical Steel grades

Name	**Material No.**	**C** (%)	**Si** (%)	**Mn** (%)	**Cr** (%)	**Mo** (%)
15Mn3Al	1.0468	0.12-0.18	≤ 0.20	0.70-0.90	max. 0.025	max. 0.025
21Mn4Al	1.0470	0.18-0.24	max. 0.25	0.80-1.10	0.025	0.025
21Mn5	1.0495	0.18-0.24	max. 0.25	1.10-1.60	0.025	0.025
27MnSi5	1.0412	0.24-0.30	max. 0.25	1.10-1.60	0.025	0.025

Cold Heading Quality

Key properties

- Cold ductility and final mechanical properties
- Microstructure homogeneity

Screws, bolts, rivets, etc. are produced by cold heading: a process of high productivity using punch and dies to transform a steel wire rod at room temperature. A specific quenching and tempering process regularly follows cold heading in order to reach the final mechanical properties.

Ductility and strength required for cold heading are obtained by a wide range of low carbon, alloyed and boron grades produced according to international standards.

Typical Steel grades (EN 10263) *Non exhaustive list*

Name	Material No.	Class							C (%)	Si (%)
		4.6	5.6	6.8	8.8	9.8	10.9	12.9		
C4C	1.0303	×	×	×					0.02-0.06	max. 0.10
C8C	1.0213	×	×	×					0.06-0.10	max. 0.10
C10C	1.1214	×	×	×					0.08-0.12	max. 0.10
C15C	1.1234	×	×	×					0.13-0.17	max. 0.10
C20C	1.0411	×	×	×					0.18-0.22	max. 0.10
C22	1.0402	×	×	×					0.20-0.24	max. 0.15
6MnB6					×				0.06-0.10	0.05-0.40
17MnB4	1.5520				×				0.15-0.20	max. 0.30
20MnB4	1.5525				×	×	×		0.18-0.23	max. 0.30
23MnB4	1.5535				×	×	×		0.20-0.25	max. 0.30
28B2	1.5510				×	×	×		0.25-0.30	max. 0.30
30MnB4	1.5526				×	×	×		0.27-0.32	max. 0.30
32CrB4	1.7076							×	0.30-0.34	max. 0.30
38B2	1.5515							×	0.35-0.40	0.15-0.30
36CrB4	1.7077							×	0.34-0.38	max. 0.30
30CrMoB1								×	0.28-0.32	max. 0.30
27MnSiVS6	1.5232								0.25-0.30	0.15-0.80
34CrMo4	1.7220							×	0.30-0.37	max. 0.30
34CrNiMo6	1.6582							×	0.30-0.38	max. 0.30
41CrS4	1.7039							×	0.38-0.45	max. 0.30

ArcelorMittal developed the FREEFORM™ grades for special application such as engine bolts (range M6 to M14). The grade FREEFORM™ 1500 H2 provides ultimate tensile strength above 1500 MPa while maintaining a good hydrogen resistance.

Adjusting the QT process this grade can reach the requirement for classes 12.9 or 14.9.

The steel grade is accordingly alloyed with elements such as manganese, chromium, boron and molybdenum depending on the final class targeted (8.8, 9.8, 10.9, 12.9). The chemical analysis is a trade-off between the necessary ductility prior to processing and the final properties obtained after quenching and tempering (Q&T).

Typical Steel grades (EN 10263)

Non exhaustive list

Mn (%)	**P** (%)	**S** (%)	**Cr** (%)	**Ni** (%)	**Mo** (%)	**Al** (%)	**V** (%)	**B** (ppm)	Name
0.25-0.40	max. 0.02	max. 0.025	-	-	-	0.02-0.06	-	-	C4C
0.25-0.45	max. 0.02	max. 0.025	-	-	-	0.02-0.06	-	-	C8C
0.30-0.50	max. 0.025	max. 0.025	-	-	-	min. 0.02	-	-	C10C
0.35-0.60	max. 0.025	max. 0.025	-	-	-	min. 0.02	-	-	C15C
0.70-0.50	max. 0.025	max. 0.025	-	-	-	0.02-0.06	-	-	C20C
0.40-0.60	max. 0.015	max. 0.015	-	-	-	-	-	-	C22
1.30-1.60	max. 0.025	max. 0.025	max. 0.30					10-20	6MnB6
0.90-1.20	max. 0.025	max. 0.025	max. 0.30	-	-	-	-	8-50	17MnB4
0.90-1.20	max. 0.025	max. 0.025	max. 0.30					8-50	20MnB4
0.90-1.20	max. 0.025	max. 0.025	max. 0.30					8-50	23MnB4
0.60-0.90	max. 0.025	max. 0.025	max. 0.30					8-50	28B2
0.80-1.10	max. 0.025	max. 0.025	max. 0.30					8-50	30MnB4
0.60-0.90	max. 0.025	max. 0.025	0.90-1.20					8-50	32CrB4
0.60-0.90	max. 0.025	max. 0.025	max. 0.30					8-50	38B2
0.70-1.00	max. 0.025	max. 0.025	0.90-1.20					8-50	36CrB4
0.80-1.10	max. 0.015	max. 0.015	0.15-0.30		0.08-0.15	0.02-0.06		8-50	30CrMoB1
1.20-1.60	max. 0.025	0.02-0.06					0.08-0.20		27MnSiVS6
0.60-0.90	max. 0.025	max. 0.025	0.90-1.20		0.15-0.30				34CrMo4
0.50-0.80	max. 0.025	max. 0.025	1.30-1.70	1.40-1.70	1.15-0.30				34CrNiMo6
0.60-0.90	max. 0.025	0.02-0.04	0.90-1.20						41CrS4

Drawing and Cold Rolling Quality

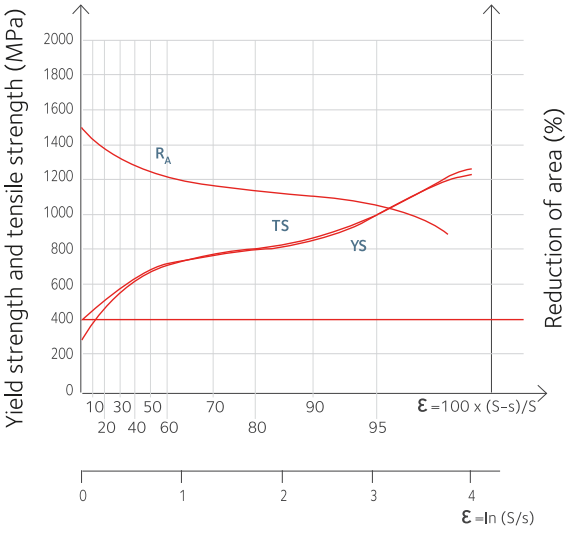
Key properties

- Grade analysis
- Microstructure homogeneity
- Surface quality and descaling ability

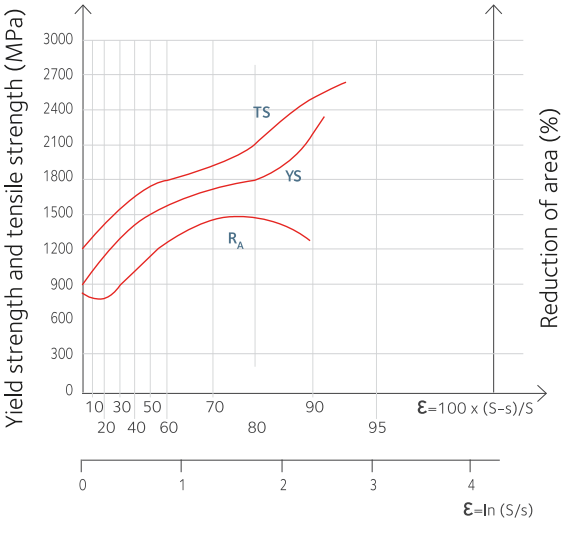
Carbon steel grades for wire rod and bars destined to cold drawing or cold rolling are classified in three families: low, medium and high carbon. The European standard EN 16120 for carbon grades defines a large range of grades with a carbon content from 0.03% to 1%.

Carbon content is the first parameter for obtaining the final mechanical properties defined by international standards (EN, ASTM, JIS,...). For a wider range of properties, alloying elements such as boron, titanium, vanadium or chromium can be added.

Evolution of tensile properties (yield strength, tensile strength, reduction of area) with strain hardening for low and high carbon grades



Low carbon steel wire rod (C:0.06%)



High carbon steel wire rod (C:0.8%)

The second parameter is strain hardening, induced by the drawing or rolling process which will provide the mechanical properties established by the customer. It also requires a strict surface quality, an appropriate scale and/or an ultimate coating.

Typical Steel grades (EN 16120) *Non exhaustive list*

Name	**Material No.**	**C** (%)	**Si** (%)	**Mn** (%)	**P** (%) max.	**S** (%) max.	**Cr** (%) max.	**Ni** (%) max.	**Cu** (%) max.	**Al** (%) max.	**TS*** (Mpa)
C2D1	1.1185	max. 0.03	max. 0.05	0.10-0.35	0.02	0.02	0.10	0.10	0.10	0.01	330
C3D1	1.1187	max. 0.05	max. 0.05	0.20-0.40	0.025	0.025	0.10	0.10	0.15	0.05	350
C4D1	1.1188	max. 0.06	max. 0.10	0.20-0.45	0.025	0.025	0.15	0.15	0.15	0.05	370
C4D	1.0300	max. 0.06	max. 0.30	0.30-0.60	0.035	0.035	0.20	0.25	0.30	0.01	370
C10D	1.0310	0.08-0.13	max. 0.30	0.30-0.60	0.035	0.035	0.20	0.25	0.30	0.01	420
C26D	1.0415	0.24-0.29	0.10-0.30	0.50-0.80	0.03	0.03	0.20	0.25	0.30	0.01	600
C15D2	1.1126	0.13-0.17	max. 0.30	0.30-0.50	0.02	0.025	0.10	0.10	0.15	0.01	490
C36D2	1.1145	0.34-0.38	0.10-0.30	0.50-0.70	0.02	0.025	0.10	0.10	0.15	0.01	700
C60D2	1.1228	0.58-0.62	0.10-0.30	0.50-0.70	0.02	0.025	0.10	0.10	0.15	0.01	930
C76D2	1.1253	0.74-0.78	0.10-0.30	0.50-0.70	0.02	0.025	0.10	0.10	0.15	0.01	1095
C82D2	1.1262	0.80-0.84	0.10-0.30	0.50-0.70	0.02	0.025	0.10	0.10	0.15	0.01	1150
C86D2	1.1265	0.84-0.88	0.10-0.30	0.50-0.70	0.02	0.025	0.10	0.10	0.15	0.01	1200
C88D2	1.0628	0.86-0.90	0.10-0.30	0.50-0.70	0.02	0.025	0.10	0.10	0.15	0.01	1225
C92D2	1.1282	0.90-0.94	0.10-0.30	0.50-0.70	0.02	0.025	0.10	0.10	0.15	0.01	1250

Forging

Quenched and tempered steels, case hardening steels, micro-alloyed steels, bainitic steels

Key properties

- Grade analysis for final mechanical properties along with quenchability
- Cleanliness in case of fatigue loads
- Surface quality

Carbon and carbon manganese steels

Carbon steel grades are the most common steels used for forging applications. Low carbon steels (carbon between 0.05 to 0.25%) are the easiest to cold form due to their soft and ductile nature. Medium carbon steels (carbon between 0.26 and 0.59%) are typically used in medium and large parts forgings. High carbon steels (carbon above 0.6 %) are used for applications in which high strength, hardness and wear resistance are necessary, such as wear parts, gear wheels, chains and brackets.

Quenched and tempered steels (Q+T)

Quenched and tempered steel grades are hardenable steels. They are alloyed with chromium and molybdenum for example, to favour transformation of austenite into martensite during the quenching process. The forging part is quenched in water, polymer or oil to obtain the required hardness. The tempering process enables the mechanical properties and toughness to be adjusted.

Typcial steel grades (mostly EN 10083) *Non exhaustive list*

Name	Material No.	C (%)	Si (%)	Mn (%)	Cr (%)	Mo (%)	Ni (%)	V (%)	B (ppm)
25CrMo4	1.7218	0.22-0.29	max. 0.40	0.60-0.90	0.90-1.20	0.15-0.30			
30MnB5	1.5531	0.27-0.33	max. 0.40	1.15-1.45					8-50
34CrNiMo6	1.6582	0.30-0.38	max. 0.40	0.50-0.80	1.30-1.70	0.15-0.30	1.30-1.70		
38Cr2	1.7003	0.35-0.42	max. 0.40	0.50-0.80	0.40-0.60				
41Cr4	1.7035	0.38-0.45	max. 0.40	0.60-0.80	0.90-1.20				
42CrMo4	1.7225	0.38-0.45	max. 0.40	0.60-0.90	0.90-1.20	0.15-0.30			
C45	1.0503	0.43-0.50	max. 0.40	0.50-0.80	max. 0.40	max. 0.10	max. 0.40		
50CrMo4	1.7228	0.46-0.54	max. 0.40	0.50-0.80	0.90-1.20	0.15-0.30			
51CrV4	1.8159	0.47-0.55	max. 0.40	0.70-1.10	0.90-1.20			0.10-0.25	

Case hardening steels

Case hardening steels are used for parts that require high surface wear resistance while retaining a soft core that absorbs stresses without cracking. After forging and machining, the outer layer is carburised and/or carbo-nitrided and then locally hardened by quenching. The grades are usually low-carbon steels to which suitable alloying elements have been added. A special characteristic of this kind of grade is the Jominy curve, which needs to be well controlled.

Typical steel grades (mostly EN 10084) *Non exhaustive list*

Name	Material No.	C (%)	Si (%)	Mn (%)	Cr (%)	Mo (%)	Ni (%)
C15	1.0401	0.12-0.10	max. 0.40	0.30-0.80			
17Cr3	1.7016	0.14-0.20	max. 0.40	0.60-0.90	0.70-1.00		
16MnCrS5	1.7139	0.14-0.19	max. 0.40	1.00-1.30	0.80-1.10		
18CrNiMo7-6	1.6587	0.15-0.21	max. 0.40	0.50-0.90	1.50-1.80	0.25-0.35	1.40-1.70
20NiCrMo2	1.6523	0.17-0.23	max. 0.40	0.65-0.95	0.35-0.70	0.15-0.25	0.40-0.70
20MnCr5	1.7147	0.17-0.22	max. 0.40	1.10-1.40	1.00-1.30		
25MoCr4	1.7325	0.23-0.29	max. 0.40	0.60-0.90	0.40-0.60	0.40-0.50	
27CrMo4	1.7218	0.22-0.29	max. 0.40	0.60-0.90	0.90-1.20	0.15-0.30	
27MnCr5	1.7147	0.23-0.29	max. 0.40	1.10-1.40	0.80-1.10		

Micro-alloyed steels (AFP)

Micro-alloyed steel grades allow the production of parts with higher strength, obtained without subsequent heat-treatment after forging. Typical additions include niobium, vanadium and titanium, which increases yield strength by precipitation hardening, while offering finer grain structures. These two outcomes increase the strength of the forged parts compared to conventional carbon steels.

Typical steel grades (mostly En 10267) *Non exhaustive list*

Name	Material No.	C (%)	Si (%)	Mn (%)	S (%)	V (%)	N (%)
19MnV6	1.1301	0.15-0.22	0.15-0.80	1.20-1.60	0.02-0.06	0.08-0.20	0.01-0.02
30MnVS6	1.1302	0.26-0.33	0.15-0.80	1.20-1.60	0.02-0.06	0.08-0.20	0.01-0.02
38MnVS6	1.1303	0.34-0.41	0.15-0.80	1.20-1.60	0.02-0.06	0.08-0.20	0.01-0.02
46MnVS6	1.1304	0.42-0.49	0.15-0.80	1.20-1.60	0.02-0.06	0.08-0.20	0.01-0.02
C70S6		0.66-0.73	0.15-0.35	0.40-0.90	0.02-0.07	max. 0.04	-

Bainitic steels

Bainitic steels are designed for applications that require both high mechanical properties and process cost reductions, compared with Q+T grades. Very high strength can be achieved (UTS > 1100 MPa) without heat treatment: controlled cooling after forging steers the austenite transformation into the bainitic region. The desired level of strength is reached by fine-tuning the alloying elements taking into account the customer's processes and the size of the part. Bainitic steels achieve higher mechanical properties than micro-alloyed grades as well as demonstrating uniform hardness throughout the steel.

Typical steel grades *Non exhaustive list*

Designation	Material No.	C (%)	Mn (%)	Cr (%)	UTS (%)
Solam® B1100	1.7960	max. 0.2	max. 1.9	max. 1.5	> 1100 MPa
Solam® B1150 IH		max. 0.4	max. 1.8	max. 0.8	>1150 Mpa

Free cutting

Key properties

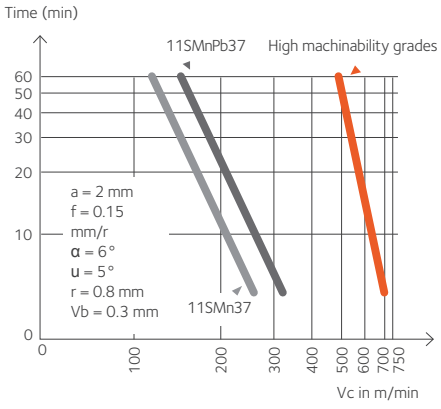
- Machinability
- Grade analysis
- Surface quality

The metallurgy of free cutting steels is first determined by their expected machinability. The second parameters to take into account are the final mechanical properties required.

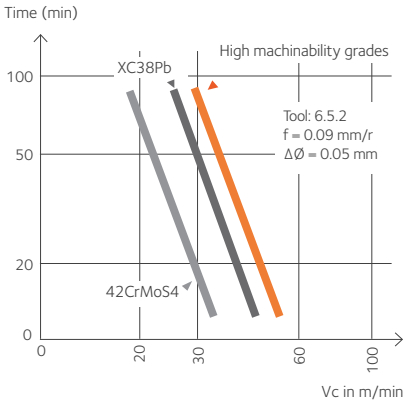
Very high mechanical properties can require alloying elements, heat treatment such as quenching and tempering, or surface treatment such as inductive hardening or case hardening.

Machining behaviour is obtained through specific alloying. Historically, lead (Pb) was the element used to improve machinability for its lubricating effect. Nowadays, lead-free grades have been developed using calcium, tellurium, bismuth, selenium, etc. Sulphur influences inclusion morphology and improves tool life but sometimes at the expense of fatigue. Special steel grades have been developed for improved fatigue requirements while keeping high machinability levels. The family of steels is named Usimax™ and is available in as drawn bright bars in various diameters.

Grades development for improved machinability for low and medium carbon grades Usimax™



Low carbon grades



Medium carbon grades

Typical steel grades (mostly per EN 10087)							*Non exhaustive list*
Name	**Material No.**	**C** (%)	**Si** (%)	**Mn** (%)	**P** (%)	**S** (%)	**Pb** (%)
11SMn30	1.0715	max. 0.14	max. 0.05	0.90-1.30	max. 0.11	0.27-0.33	–
11SMnPb30	1.0718	max. 0.14	max. 0.05	0.90-1.30	max. 0.11	0.27-0.33	0.20-0.35
11SMn37	1.0736	max. 0.14	max. 0.05	1.00-1.50	max. 0.11	0.34-0.40	–
11SMnPb37	1.0737	max. 0.14	max.0.05	1.00-1.50	max. 0.11	0.34-0.40	0.20-0.35
SAE1215	1.9704	max. 0.05	–	0.75-1.05	0.04-0.05	0.26-0.35	–
SAE12L14	1.0718	max. 0.15	–	0.85-1.15	0.04-0.05	0.26-0.35	0.15-0.35
C10Pb	-	0.06-0.12	max. 0.04	0.25-0.50	max. 0.045	max. 0.045	0.15-0.30
10S20	1.0721	0.07-0.13	max. 0.04	0.70-1.10	max. 0.06	0.15-0.25	–
10S20Pb	1.0722	0.07-0.13	max. 0.04	0.70-1.10	max. 0.06	0.15-0.25	0.20-0.35
16MnCrS5Pb	-	0.14-0.15	max. 0.40	1.00-1.30	max. 0.025	max. 0.035	0.20-0.35
35S20	1.0726	0.32-0.39	max. 0.04	0.70-1.10	max. 0.06	0.15-0.25	–
35SPb20	1.0756	0.32-0.39	max. 0.04	0.70-1.10	max. 0.06	0.15-0.25	0.15-0.25
36SMn14	1.0764	0.32-0.39	max. 0.04	1.30-1.70	max. 0.06	0.10-0.18	–
36SMnPb14	1.0765	0.32-0.39	max. 0.04	1.30-1.70	max. 0.06	0.10-0.18	0.15-0.25
38SMn28	1.0760	0.35-0.40	max. 0.04	1.20-1.50	max. 0.06	0.24-0.33	–
38SMnPb28	1.0761	0.35-0.40	max. 0.04	1.20-1.50	max. 0.06	0.24-0.33	0.15-0.25
44SMn28	1.0762	0.40-0.48	max. 0.04	1.30-1.70	max. 0.06	0.24-0.33	–
44SMn2Pb28	1.0763	0.40-0.48	max. 0.04	1.30-1.70	max. 0.06	0.24-0.33	0.15-0.25
46S20	1.0727	0.42-0.50	max. 0.04	0.70-1.10	max. 0.06	0.15-0.25	–
46SPb20	1.0757	0.42-0.50	max. 0.04	0.70-1.10	max. 0.06	0.15-0.25	0.15-0.25
C45Pb	-	0.42-0.50	max. 0.40	0.50-0.80	max. 0.045	max. 0.045	0.15-0.30

Prestressed concrete

Key properties

- Tensile strength related to high carbon content and micro alloying
- Steel cleanliness
- Microstructure homogeneity
- Surface quality

Wire rod for prestressed concrete has high carbon grades (typically over 0.75% C) that can be alloyed with chromium (up to 0.5 % Cr) and vanadium (up to 0.16% V) and is delivered in diameters up to 16 mm. Depending on the grades and diameters, tensile strength ranges from 1000 MPa to 1350 MPa.

Prestressed concrete wires are used in a wide range of building and civil structures allowing longer spanes, reduced structure thickness and saving material costs.

Typical steel grades *Non exhaustive list*

Name	**C** (%)	**Si** (%)	**Mn** (%)	**Cr** (%)	**V** (%)	**TS*** (MPa)		
						Ø 6.5	Ø 10	Ø 15
C80	0.78-0.82	0.15-0.25	0.60-0.70	max. 0.10	max. 0.02	1200	1150	1020
C82+Cr	0.80-0.84	0.15-0.25	0.65-0.75	0.07-0.25	max. 0.02	1280	1200	1150
C82+Cr+V	0.80-0.84	0.15-0.30	0.70-0.80	0.07-0.25	0.03-0.06	–	1250	1200

Steelcord, hose wire, bead wire

Key properties

- Grade analysis
- Steel cleanliness
- Microstructure homogeneity
- Surface quality

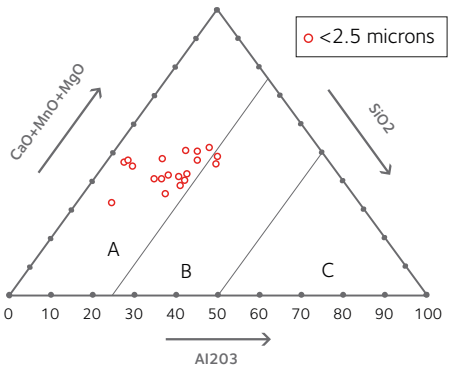
Steel for rubber reinforcement is a 5.5 mm hot rolled wire rod designed to be drawn down to 0.2 mm or less while reaching final mechanical properties over 4000 MPa. Similar steel grades can be used to cut silicon slices for solar panels.

The grades for tire cord application are devided according with its chemical composition: normal tensile (NT) high tensile (HT), super tensile (ST) and ultra tensile (UT)

ArcelorMittal has developed 0.9% carbon chromium alloyed grades to obtain high mechanical properties for thinner drawing to lighten tires and improve fuel efficiency.

Steel cleanliness, surface quality, homogeneous microstructure and chemical composition are strictly controlled during production process. These characteristics are very relevant for customers in order to get a good processability during drawing process.

Typical inclusion distribution analysis by ternary diagram on steel cord



Typical Steel grades *Non exhaustive list*

Name	C	Si	Mn	P	S	Cr
C60	0.55-0.65	0.15-0.30	0.40-0.80	max. 0.03	max. 0.03	
C70	065-0.75	0.15-0.30	0.40-0.80	max. 0.03	max. 0.03	
C80	0.75-0.88	0.15-0.30	0.40-0.80	max. 0.03	max. 0.03	
C90+Cr	0.90-0.95	0.15-0.30	0.10-0.40	max. 0.03	max. 0.03	0.10-0.30

Springs

Key properties

- Grade analysis: Si and Cr
- Steel cleanliness/superclean
- Microstructure homogeneity
- Surface quality

Springs are produced from medium to high carbon steels alloyed with elements “Si, V, Cr, Mn” which provide special final mechanical properties.

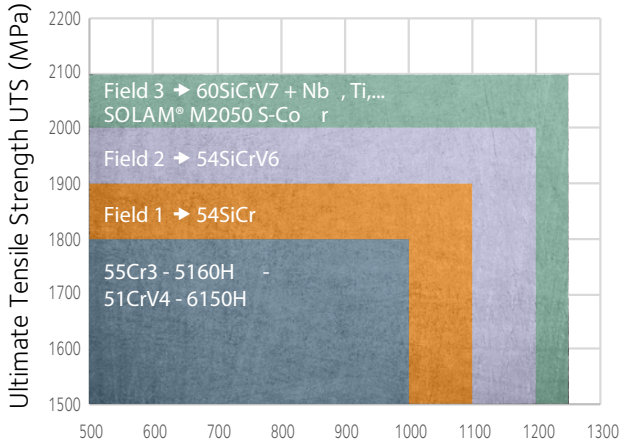
Yield strength is the essential property of the elastic behaviour as it allows the springs to return to its original shape after significant bending or twisting. The principal alloying elements used to achieve high yield strength are silicon, manganese, chromium and vanadium.

The torsional fatigue loads of the spring require high levels of cleanliness, surface quality and very low decarburisation to increase fatigue resistance. Hardenability is obtained by very precise chemistry shaping the Jominy curve.

ArcelorMittal also produces most of standards steels according to EN 10089 but we are also able to provide Superclean grades wich we obtain by a specific production process and we use for transmission, clutch and valve springs.

Advanced steel grade SOLAM® M2050 S-Cor, SOLAM® M2200S, specially developed for suspension springs reduces component weight by up to 20% by increasing mechanical properties (tensile strength of 2050 MPa) and improving fatigue resistance after corrosion as compared to the standard grade 54SiCrV6.

Evolution steel grades



Maximum shear stress on spring **tmax** (MPa)

Valve springs

Clutch springs

Suspension springs

Rail clips

Typical steel grades (acc. To EN 10089)										*Non exhaustive list*
Grade acc. EN 100271	**Material No.**	**C**(%)	**Si**(%)	**Mn**(%)	**P**(%) max.	**S**(%) max.	**Cr**(%)	**Ni**(%)	**Mo**(%)	**V**(%)
38Si7	1.5023	0.35-0.42	1.50-1.80	0.50-0.80	0.025	0.025				
51CrV4	1.8159	0.47-0.55	max. 0.40	0.70-1.10	0.025	0.025	0.90-1.20			0.10-0.25
51CRMoV4	1.7701	0.48-0.56	max. 0.40	0.70-1.10	0.025	0.025	0.90-1.20		0.15-0.30	0.10-0.20
52SiCrNi5	1.7117	0.49-0.56	1.20-1.50	0.70-1.00	0.025	0.025	0.70-1.00	0.50-0.70		
54SiCr6	1.7102	0.51-0.59	1.20-1.60	0.50-0.80	0.025	0.025	0.50-0.80			
55Cr3	1.7176	0.52-0.59	max. 0.40	0.70-1.00	0.025	0.025	0.70-1.00			
60Cr3	1.7177	0.55-0.65	max. 0.40	0.70-1.10	-	-	0.60-0.90			
60SiCrV7	1.8153	0.56-0.64	1.50-2.00	0.70-1.00	0.025	0.025	0.20-0.40			0.10-0.20
60CrMo3-3	1.7241	0.56-0.64	max. 0.40	0.70-1.10	0.025	0.025	0.70-1.00		0.25-0.35	
61SiCr7	1.7108	0.57-0.65	1.60-2.00	0.70-1.00	0.025	0.025	0.20-0.45			

Welding

Key properties

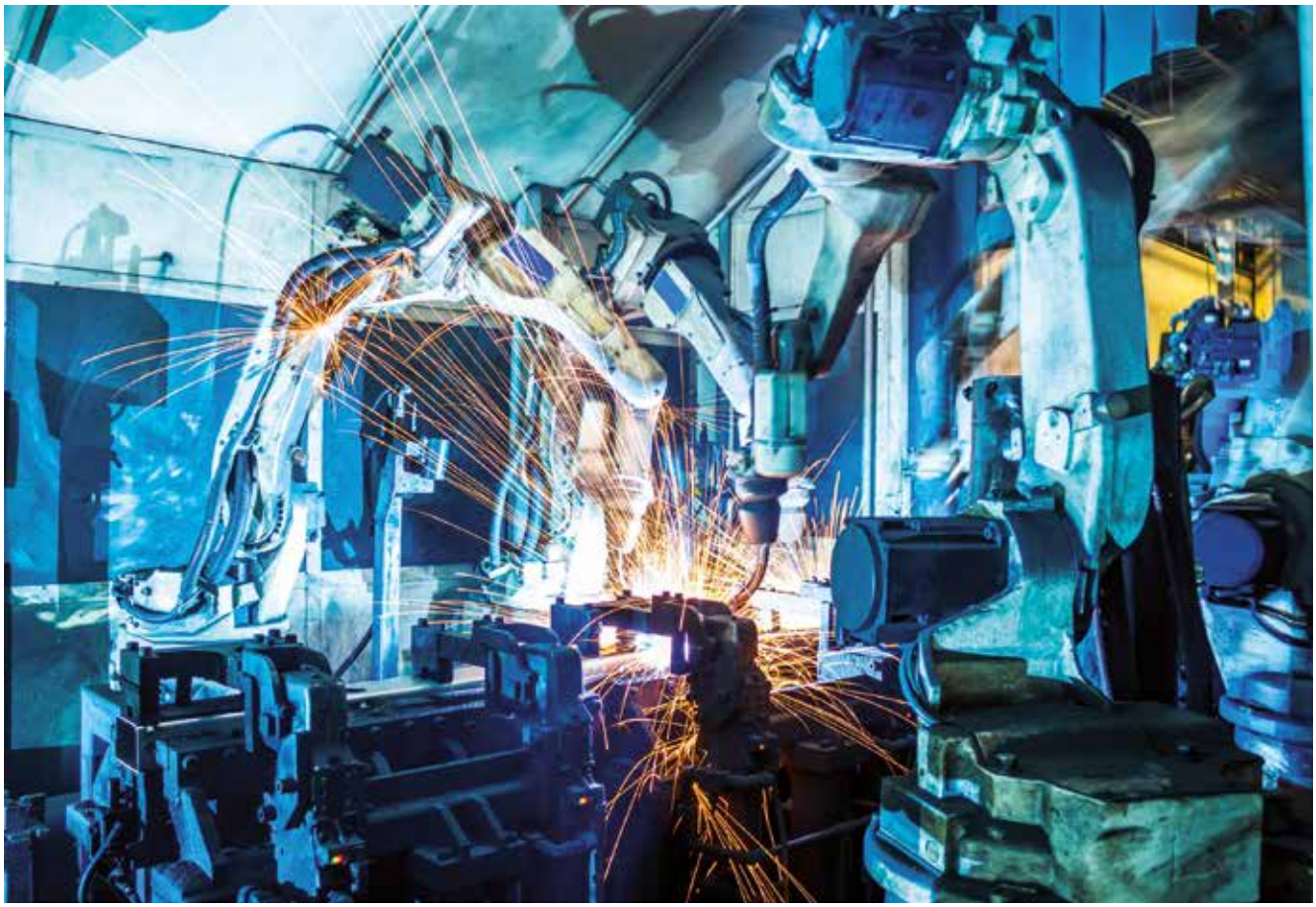
- Grade analysis
- Mechanical properties prior to drawing by controlled cooling

Steel welding grades are developed to guarantee coherent chemical and mechanical properties between the welded joint and the base metal.

The grade analysis is a determining factor, especially

1. in obtaining the required mechanical properties: carbon, manganese and alloying elements such as vanadium or niobium;
2. for toughness or corrosion resistance: nickel, chromium or molybdenum;
3. depending on the welding process and the protection used (shielding gas or flux): carbon, silicon, aluminium or titanium to limit the risk of welded joint oxidation;
4. residual content such as copper, chromium and tin... are tightly controlled to avoid cracks prompted by phosphorus, sulphur and hydrogen;
5. special processes have been developed to achieve
   a. ultra-low levels of residuals such as lead, bismuth
   b. alloyed grades with up to 9% chromium, nickel, molybdenum, etc.

All these metallurgical considerations explain the diversity of grades available for welding and which can only be partially covered by international standards.



Standard steel grades *Non exhaustive list*

Name	Standard	Applications	**C** (%)	**Si** (%)	**Mn** (%)	**P** (%) max.	**S** (%) max.	**Cr** (%) max.	**Ni** (%) max.	**Mo** (%) max.	**Cu** (%) max.
SG1	ISO 14341	Shielded arc welding	0.06-0.10	0.05-0.70	1.00-1.30	0.015	0.015	0.10	0.10	0.05	0.10
SG2	ISO 14341	Shielded arc welding	0.06-0.09	0.80-0.90	1.40-1.50	0.015	0.015	0.10	0.10	0.05	0.10
Sg3	ISO 14341	Shielded arc welding	0.06-0.09	0.85-1.00	1.60-1.70	0.015	0.015	0.10	0.10	0.05	0.10
S1	ISO 14171	Stick electrode	0.05-015	max. 0.15	0.35-0.60	0.025	0.025	0.10	0.10	0.05	0.10
S2	ISO 14171	Submerged arc welding	0.07-0.15	max. 0.15	0.80-1.30	0.025	0.025	0.10	0.10	0.05	0.10
S3Si	ISO 14171	Submerged arc welding	0.07-0.15	0.15-0.40	1.30-1.85	0.025	0.025	0.10	0.10	0.05	0.10
S2Mo	ISO 14171	Submerged arc welding	0.07-0.15	0.05-0.25	0.95-1.20	0.025	0.025	0.10	0.10	0.45-0.65	0.10
S3Mo	ISO 14171	Submerged arc welding	0.07-0.15	0.05-0.25	1.30-1.75	0.025	0.025	0.10	0.10	0.45-0.65	0.10

Alloyed steel grades *Non exhaustive list*

Name	Standart	**C** (%)	**Si** (%)	**Mn** (%)	**Cu** (%)	**Cr** (%)	**Ni** (%)	**V** (%)	**Mo** (%)	**Nb** (%)	**N** (%)
		typ	typ	typ	typ	max.	max.	typ	max.	max.	typ
CrMo5	ISO 24598	0,12	0.25	0.90		6.00			0.65		
Mn4Ni2CrMo	ISO 16834	0,12	0.80	1.80		0.50	2.50		0.50		
G2Ni2	ISO 14341	0,08	0.80	1.40			2.70				
CrMo2Si	ISO 21952	0,07	0.50	1.00		2.50			1.00		
SUNCC3	ISO 14171	0,10	0.30	1.00	0.50	0.30	0.75				
2C1MV	ISO 24598	0,12	0.12	0.80		2.60		0.30	1.00	0.022	
CrMo91	ISO 24598	0,12	0.60	1.00		9.00	0.50	0.20	1.00	0.065	0.045


ArcelorMittal

Our product offer from our European mills

QUALITY RANGE [1] Bars & Rods	Duisburg (DE)	Gandrange (FR)	Gijón (ES)	Hamburg (DE)	Sosnowiec (PL)	Warszawa (PL)	Zenica (BA)	Sonasid (MA)
Alloyed spring								
Alloyed spring	×	×	×	×	×	×		
Superclean	×							
Bearing	×	×		×		×		
Chains	×	×	×	×	×	×		
Cold heading	×	×	×	×	×	×		
Drawing and cold rolling								
Low carbon	×	×	×	×	×	×	×	×
Medium carbon	×	×	×	×	×	×	×	
High carbon	×	×	×	×	×		×	
Engineering steels[2]								
Carbon steels	×	×				×		
Steels for quenching and tempering	×	×				×		
Case hardening steel	×	×				×		
Micro-alloyed steel	×	×				×		
Bainitic steel	×	×				×		
Free-cutting								
Leaded	×	×	×			×		
Unleaded	×	×	×	×	×	×		
Prestressed concrete	×		×	×	×			
Steel cord			×	×	×			
Welding								
Non-alloyed	×		×	×	×		×	×
Alloyed	×			×				

QUALITY RANGE [1] concrete reinforcement and geotechnical bars	Duisburg (DE)	Gandrange (FR)	Gijón (ES)	Hamburg (DE)	Sosnowiec (PL)	Waszawa (PL)	Zenica (BA)	Sonasid (MA)
Rebar						×	×	×
Mesh	×	×	×	×	×		×	×
Krybar						×		

[1] *This is a non exhaustive list, please contact your sales manager for additional requests (cf pages 36, 37)*
[2] *Including qualities for forging/bright bars, requested in industry sectors*

Our European mill's capabilities

			Duisburg (DE)	Gandrange (FR)		Gijón (ES)
Semis						
	Vaccum degassing		×			×
	Electro-magnetic stirring		×			×
	Casted semis (mm)		▬ 400 x 280 ■ 160² ; 320²	*		■ 150²
Wire rod						
Wire rod rolling	Finished products		Wire Rod	Wire Rod		Wire rod
			●	●	⬣	●
	Dimensions (mm) (min.)		5.5	15	14.3	5.5
	Dimensions (mm) (max.)		25	52	42.5	23
	Coil presentation	Coil forming	Loop cooling Conveyor	Garett		Stelmor
		Coil weight (t) (max.)	1.5; 2; 2.5; 3	2.4 ; 2.7		2.6
		Coil length (mm) (max.)	2300	1500		2200
	Online in-spection	Surface control	×	×		×
		Dimensions gauge	×	×		×
	Processing wire rod		on request	on request		on request
Bars						
Bar rolling	Finished products		Round corner square	Special bar quality	Special bar quality	
			■	●	● ⬣	
	Dimensions (mm) (min.)		110²	115	15 14.3	
	Dimensions (mm) (max.)		180²	170	103 70.4	
	Conditioning	Bundle weight (t) (max.)	10		8	
		Bundle length (m) (max.)	16		16	
	Online in-spection	Surface control			×	
		Dimension gauge			×	
Inspection & Finishing	Offline inspection	Surface control	×		×	
		US	×		×	
	Heat treatment	Q+T	on request	on request		
		Annealing	on request	on request		
	Peeling			on request	on request	

* semis are supplied from ArcelorMittal Duisburg, Hamburg, Warszawa
** semis are supplied from ArcelorMittal Dabrowa

		Waszawa (PL)	Zenica (BA)		Sonasid (MA)	
Rebars						
	Finished products	in bars	in coils	in bars	in wild coils	in bars
	Diameter (mm)	10-40	8-25	8-32	5.5-16	8-40
Conditioning	Bundle weight (t) (max.)	2.5		2.5		2
	Bundle length (m) (max.)	18		12		15
	Coil weight (t) (max.)		2.1		2	
	Coil length (mm) (max.)		700		2050	

Hamburg (DE)	Sosnowiec (PL)	Warszawa (PL)	Zenica (BA)	Sonasid (MA)		
					Semis	
		×			Vaccum degassing	
×		×			Electro-magnetic stirring	
■ 125²;130²;140²	**	■ 140²; 160²; 220²	■ 120²; 130²; 150²	■ 130²;140²	Casted semis (mm)	
					Wire rod	
Wire rod	Wire rod		Wire Rod	Wire Rod	Finished products	Wire rod rolling
●	●		●	●		
5.5	5.5		5.5	5.5	Dimensions (mm) (min.)	
17	21		12	16	Dimensions (mm) (max.)	
Stelmor	Stelmor		Stelmor	Stelmor	Coil presentation: Coil forming	
1.5; 2	2.4		1.3	2	Coil presentation: Coil weight (t) (max.)	
1600 for 2t; 1200 for 1.5 t	2015		1250	1200	Coil presentation: Coil length (mm) (max.)	
×	×				Online inspection: Surface control	
×	×				Online inspection: Dimensions gauge	
on request	on request				Processing wire rod	
					Bars	
		Special bar quality		Hot rolled bars	Finished products	Bar rolling
		●		●		
		20		10	Dimensions (mm) (min.)	
		80		40	Dimensions (mm) (max.)	
		10		2	Conditioning: Bundle weight (t) (max.)	
		12		15	Conditioning: Bundle length (m) (max.)	
					Online inspection: Surface control	
		×			Online inspection: Dimension gauge	
		×			Offline inspection: Surface control	Inspection & Finishing
		×			Offline inspection: US	
		×			Heat treatment: Q+T	
		×			Heat treatment: Annealing	
		on request			Peeling	

* semis are supplied from ArcelorMittal Duisburg, Hamburg, Warszawa
** semis are supplied from ArcelorMittal Dabrowa

	Belval (LU)	Hunedoara (RO)	Dabrowa (PL)
Other Semis			
Vacuum degassing		×	×
Electro-magnetic stirring			×
Casted semis (mm)	■ 270 x 155	■ 270 x 240; 310 x 280	■ 220 x 190; 300 x 280; 400 x 280
		● 120-180; 200; 250; 270; 310	■ 130²; 140²; 160²

Our global presence

and colleagues in Americas and Southern Africa

North America

1	Contrecœur	●		●

Central America

2	Lazaro Cardenas	●	●	

South America

3	Monlevade	●		
3	Juiz de Foras	●	●	
4	Barra Mansa		●	●
4	Resende	●	●	
5	Piracicaba		●	
6	Acindar	●	●	●

South Africa

7	Newcastle	●	●	●

CIS

8	Kriviy Rih	●	●	

Our mills in Europe

Europe			
9	Gijón	●	
10	Gandrange	●	▬
11	Duisburg	●	▬
12	Hamburg	●	
13	Warsaw		▬ ▬
14	Sosnowiec	●	
15	Zenica	●	▬

North Africa			
16	Sonasid Nador	●	▬
17	Sonasid Jorf Lasfar		▬ ▬

●	Wire Rod, coils
▬	Rebars in bars
▬	Bars, Special quality bars

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covering your needs in Europe and beyond

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Aïn Sebâa, Casablanca
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14- Export other than NAFTA
Akatlar Mah. Yildirim Oguz Goker
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Notes

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Our **B&R Overview** brochure

Our **Product Offer** brochure

Our **Process Feasibility** brochure is on request. Please contact your sales office.