

ArcelorMittal Europe
Long Products



ArcelorMittal

Bars and Rods



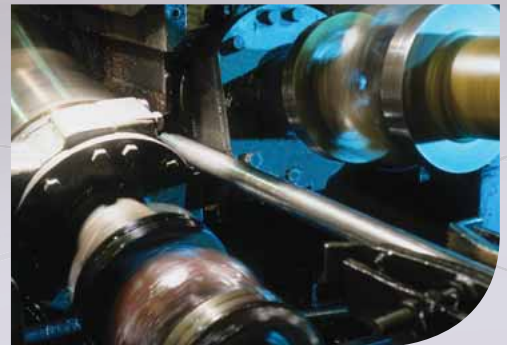
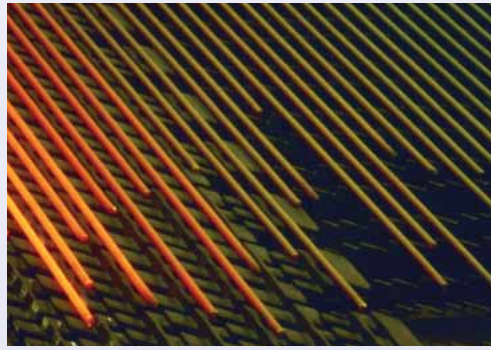


Table of contents

Products & applications

Alloyed spring	6
Bearing.....	8
Cold heading	9
Chains	10
Drawing and cold rolling	11
Forging.....	13
Free cutting.....	15
Prestressed concrete	17
Steel cord, hose wire, bead wire.....	18
Welding.....	19

Quality range	20
----------------------------	-----------

Production units

Duisburg.....	23
Gandrange	24
Hamburg	25
Sonasid	26
Sosnowiec.....	27
Veriña.....	28
Warszawa.....	29
Zenica.....	30

Life cycle assessment.....	31
-----------------------------------	-----------

Product development.....	32
---------------------------------	-----------

Product range.....	34
---------------------------	-----------

Trademarks: ArcelorMittal is the owner of the following trademark applications or registered trademarks: "Freefrom", "Solam" and "Usimax".

Photography copyrights: ArcelorMittal Image Library; Goodyear Dunlop Tires Operations EMEA; La robe à l'eau; Shutterstock - ssuaphotos; Siemens Wind Power; © Philippe Stroppa; © Studio Pons; Air liquide; Sidergas; Italfil; Roosevelt de Paula Almado; Siegenia-Aubi; wide.lu.; courtesy of Hendrickson Commercial Vehicle Systems Europe; courtesy of FLT KRASNIK - PBF; Fotolia; Gyusko-Photo / Shutterstock.com.

Care has been taken to ensure that the information in this publication is accurate, but this information is not contractual. Therefore ArcelorMittal and any other ArcelorMittal Group company do not accept any liability for errors or omissions or any information that is found to be misleading. As this document may be subject to change at any time, please consult the latest information in the "Documentation" part of barsandrods.arcelormittal.com website.

copyright 2018 ArcelorMittal.

Dear Customer,

ArcelorMittal Europe has a long and rich tradition of producing bars and wire rod in its locations in Germany, France, Spain, Poland, Bosnia Herzegovina and Morocco. These plants are at the forefront of technical innovation and provide best-in-class customer service. They offer a wide spectrum of wire rod as well as SBQ and forging billet, products covering the full range of final applications.

In recent years, our European plants have made major investments in state-of-the-art equipment: a new bar mill and new SBQ finishing capacities in Warsaw, a new wire rod mill and updated billet/bloom casters in Duisburg, a new finishing line in Gandrange, a rebar in coil production line in Zenica and a new vacuum degassing station. Furthermore, the wire rod rolling mills of Sosnowiec, Hamburg and Veriña are upgraded.

All this with the aim to significantly improve the capability and the quality of our products and support the development of our customers in the most demanding market segments. Bars and rods find applications in every major market segment – construction, infrastructure, automotive, mechanical engineering, yellow goods and energy. ArcelorMittal Europe offers a unique combination of industrial, technical and sales resources fully committed to supporting you in your endeavour to offer the best products to your customers. Our commitment to reducing the company's carbon footprint is another key element in our development strategy, enabling our customers to develop lighter and more cost-effective designs. Our product range is continuously evolving to meet the needs of the industry. The highly experienced technicians in our mills and in our research & development centres are looking forward to working with you to meet your specific needs – now and in the future.

End of 2016, the organisation of ArcelorMittal Europe - Long Products was changed from a regional setup to a product wise set up. With the creation of the Business Division Bars and Rods, we ensure a One face to the customer policy with the target to improve service and customer partnering.

Best Regards,



Lutz Bandusch
Chief Executive Officer

Business Division Bars & Rods
ArcelorMittal Europe – Long Products

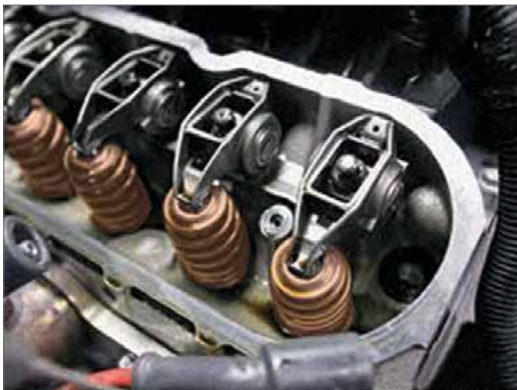
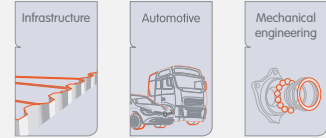


Mike Haller
Chief Marketing Officer

Alloyed spring

Key properties

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



Springs are produced from medium or high carbon steels with a very high yield strength obtained by heat treatment after processing.

Yield strength is the essential property of the elastic behaviour of the spring as it allows the part formed with these grades 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.

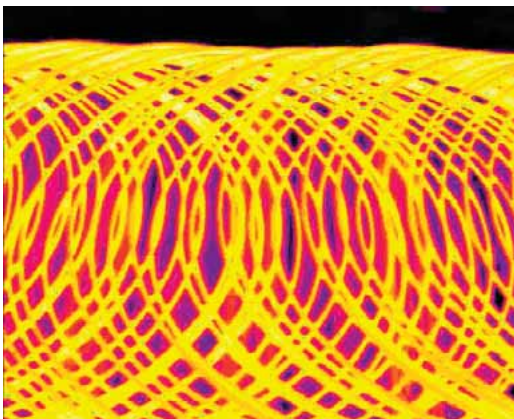
The torsional fatigue loads of the spring require high levels of cleanliness, surface quality and very low decarburisation to increase fatigue resistance.

Hardenability is obtained by very precise chemistry shaping the Jominy curve.

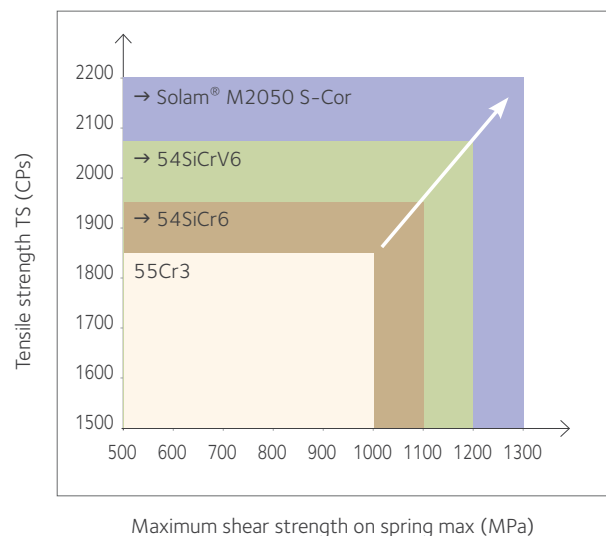
Superclean grades are obtained by a specific production process and are used for transmission, clutch and valve springs.

Advanced steel grade SOLAM® M2050 S-Cor, 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.

**Very high cooling homogeneity
obtained in Duisburg wire rod mill**



**Grade evolution for spring with
high mechanical properties**





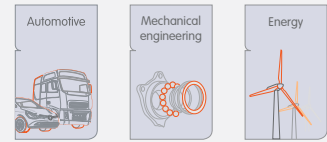
Typical steel grades (acc. to EN 10089)

		C	Si	Mn	P	S	Cr	Ni	Mo	V
		%	%	%	%	%	%	%	%	%
Name	Material No.	-	-	-	max.	max.	-	-	-	-
38Si7	1.5023	0.35-0.42	50-1.80	1.50-0.80	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
52CrMoV4	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	0.7-1.00	0.025	0.025	0.7-1.00	-	-	-
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	-	-	-

Bearing

Key properties

- Steel cleanliness
- Steel homogeneity
- Hardness



Bearing steels are exposed to fatigue and high contact loads. Final hardness can be obtained by through-hardening, case hardening or inductive heat treatment.

The most common bearing grades for through-hardening are 100Cr6 families. Those grades combine the advantages of carbon and chromium to achieve heat treatment efficiency and final mechanical properties. Since such grades require annealing before transformation, thermo-mechanical rolling for fine grain size distribution represents an advantage in terms of reducing annealing time.

Steel production requires expertise and strong process control: to achieve high performance, the heat treatment has to be very homogeneous throughout the part. Grade and structure homogeneity is therefore key in order to avoid any segregation during casting or decarburisation in reheating operations.

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.

The final heat treatment of 100Cr6 grades gives possibilities for either bainitic or martensitic final structure depending on the trade-off required between toughness and hardness. The grade is thus alloyed with molybdenum and/or manganese to favour bainite and/or martensite.

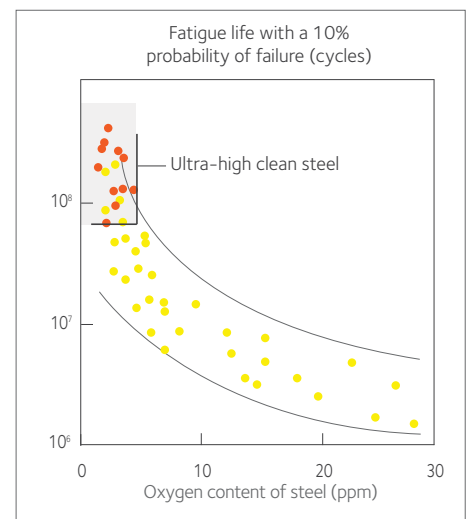
The same considerations on homogeneity and inclusions apply to C55 and C70 for induction hardening.

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

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

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

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

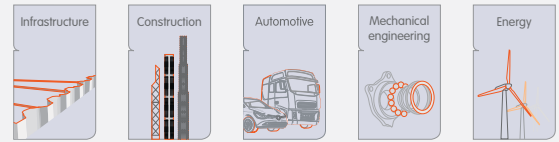


fatigue life and oxygen content

Cold heading

Key properties

- Cold ductility and final mechanical properties
- Microstructure homogeneity
- Surface quality



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.

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

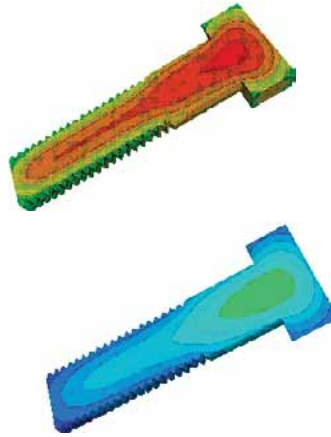
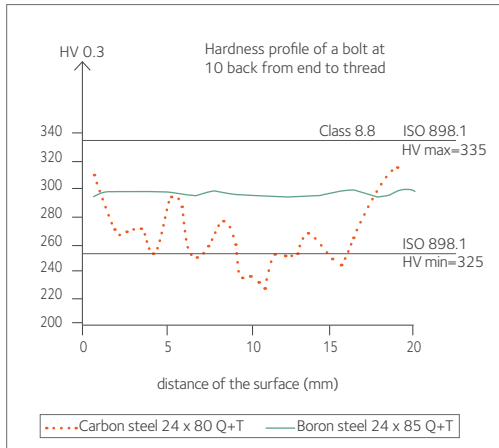
ductility prior to processing and the final properties obtained after quenching and tempering (Q&T).

Specific solutions using FREEFORM™ grades have been developed. For example, for engine bolts (range from M6 to M14), the grade FREEFORM™ 1500 H2 provides ultimate tensile strength above 1500 MPa while maintaining a good hydrogen resistance. The Q&T process can be also adjusted to reach fastener classes of 12.9 or 14.9. Bainitic grades have also been developed.

Typical steel grades (EN 10263)

Name	Material No.	Class								C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Al %	V %	B ppm
		4.6	5.6	6.8	8.8	9.8	10.9	12.9												
C4C	1.0303	X	X	X					0.02-0.06	max. 0.10	0.25-0.40	max. 0.02	max. 0.025	-	-	-	0.02-0.06	-	-	
C8C	1.0213	X	X	X					0.06-0.10	max. 0.10	0.25-0.45	max. 0.02	max. 0.025	-	-	-	0.02-0.06	-	-	
C10C	1.1214	X	X	X					0.08-0.12	max. 0.10	0.30-0.50	max. 0.025	max. 0.025	-	-	-	min. 0.02	-	-	
C15C	1.1234	X	X	X					0.13-0.17	max. 0.10	0.35-0.60	max. 0.025	max. 0.025	-	-	-	min. 0.02	-	-	
C20C	1.0411	X	X	X					0.18-0.22	max. 0.10	0.70-0.50	max. 0.025	max. 0.025	-	-	-	0.02-0.06	-	-	
C22	1.0402	X	X	X					0.20-0.24	max. 0.15	0.40-0.60	max. 0.015	max. 0.015	-	-	-	-	-	-	
6MnB6					X				0.06-0.10	0.05-0.40	1.30-1.60	max. 0.025	max. 0.025	max. 0.30	-	-	-	-	-	10-20
17MnB4	1.5520				X				0.15-0.20	max. 0.30	0.90-1.20	max. 0.025	max. 0.025	max. 0.30	-	-	-	-	-	8-50
20MnB4	1.5525				X	X	X		0.18-0.23	max. 0.30	0.90-1.20	max. 0.025	max. 0.025	max. 0.30	-	-	-	-	-	8-50
23MnB4	1.5535				X	X	X		0.20-0.25	max. 0.30	0.90-1.20	max. 0.025	max. 0.025	max. 0.30	-	-	-	-	-	8-50
28B2	1.5510				X	X	X		0.25-0.30	max. 0.30	0.60-0.90	max. 0.025	max. 0.025	max. 0.30	-	-	-	-	-	8-50
30MnB4	1.5526				X	X	X		0.27-0.32	max. 0.30	0.80-1.10	max. 0.025	max. 0.025	max. 0.30	-	-	-	-	-	8-50
32CrB4	1.7076							X	0.30-0.34	max. 0.30	0.60-0.90	max. 0.025	max. 0.025	0.90-1.20	-	-	-	-	-	8-50
38B2	1.5515							X	0.35-0.40	0.15-0.30	0.60-0.90	max. 0.025	max. 0.025	max. 0.30	-	-	-	-	-	8-50
36CrB4	1.7077							X	0.34-0.38	max. 0.30	0.70-1.00	max. 0.025	max. 0.025	0.90-1.20	-	-	-	-	-	8-50
30CrMoB1								X	0.28-0.32	max. 0.30	0.80-1.10	max. 0.015	max. 0.015	0.15-0.30	-	0.08-0.15	0.02-0.06	-	-	8-50
27MnSiV6	1.5232								0.25-0.30	0.15-0.80	1.20-1.60	max. 0.025	0.02-0.06	-	-	-	-	-	0.08-0.20	-
34CrMo4	1.7220							X	0.30-0.37	max. 0.30	0.60-0.90	max. 0.025	max. 0.025	0.90-1.20	-	0.15-0.30	-	-	-	-
34CrNiMo6	1.6582							X	0.30-0.38	max. 0.30	0.50-0.80	max. 0.025	max. 0.025	1.30-1.70	1.40-1.70	0.15-0.30	-	-	-	-
41CrS4	1.7039							X	0.38-0.45	max. 0.30	0.60-0.90	max. 0.025	0.02-0.04	0.90-1.20	-	-	-	-	-	-

20MnB5 screw: hardness profile, thermal simulation



Courtesy of Gévelot



Chains

Key properties

- Toughness
- Elongation
- Weldability
- Toughness



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.

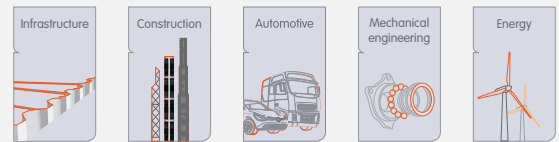
Typical steel grades

Name	Material No.	C	Si	Mn	P	S
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

Drawing and cold rolling

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%.

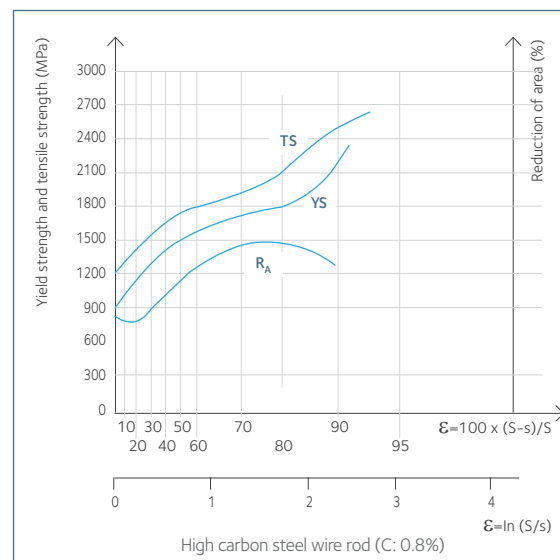
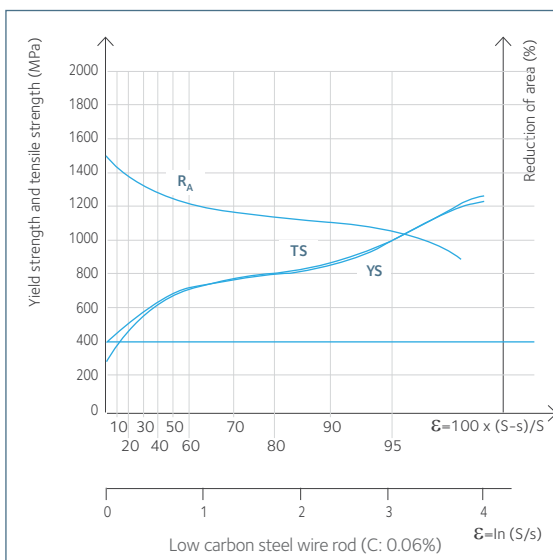
Carbon content is the first parameter for obtaining the final mechanical properties defined by international standards (EN, ASTM, JIS,...). For a wider range of properties, alloying elements such as boron, titanium, vanadium or chromium can be added.

The second parameter is strain hardening, induced by the drawing or rolling process.

Specific customers' requirements influence steel production standards to meet expected surface quality and ability for descaling or ultimate coating.

Some cold drawn products can be also obtained from bars, such as piston rods or camshafts.

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





© Stegenia-Alubi

Typical steel grades (according to EN 16120)

Name	Material No.	C	Si	Mn	P	S	Cr	Ni	Cu	Al	TS*
		%	%	%	%	%	%	%	%	%	MPa
		–	–	–	max.	max.	max.	max.	max.	max.	–
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

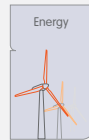
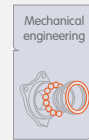
* For 5.5 mm wire rod, typical value

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.

Typical steel grades (mostly EN 10083)

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	-

To be noticed that some carbon grades are also included in the EN 10083: steels for quenching and tempering and available from C22 to C60.

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)

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	-	-
16MnCr5	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)

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	0.020-0.060	0.08-0.20	0.01-0.02
38MnVS6	1.1303	0.34-0.41	0.15-0.80	1.20-1.60	0.020-0.060	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

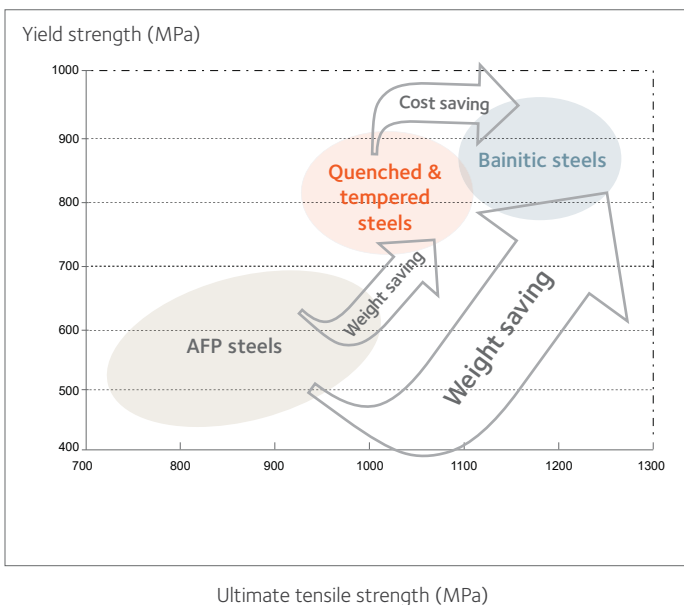
Bainitic steels are designed for applications that require both high mechanical properties and process cost reductions, compared with Q+T grades. Very high strength can be achieved (UTS > 1100 MPa) without heat treatment: controlled cooling after forging steers the austenite transformation into the bainitic 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

Designation	Material No.	C %	Mn %	Cr %	UTS %
Solam™ B1100	1.7960	max. 0.2	max. 1.9	max. 1.5	> 1100 MPa
Solam™ B1150IH		max. 0.4	max. 1.8	max. 0.8	> 1150 MPa



Comparison of mechanical & quenchability properties of AFP, Q+T and bainitic grades



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.

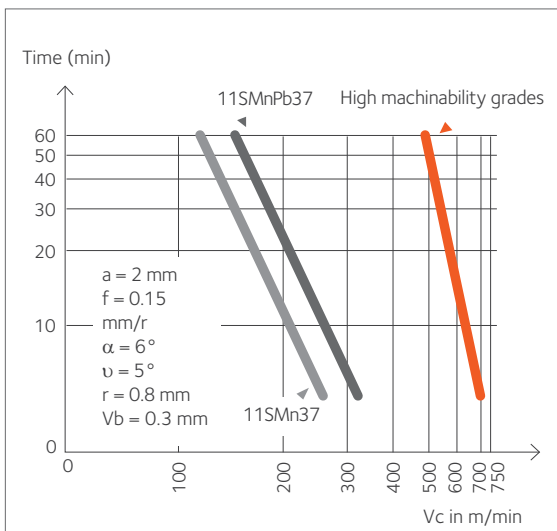
Very high mechanical properties can require alloying elements, heat treatment such as quenching and tempering, or surface treatment such as inductive hardening or case hardening.

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.

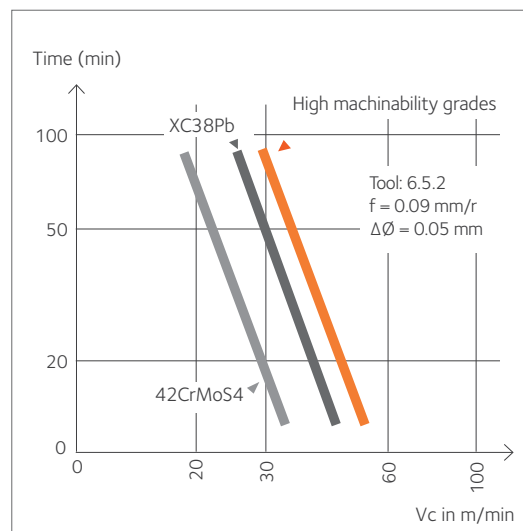
Sulphur influences inclusion morphology and improves tool life but sometimes at the expense of fatigue. Special steel grades have been developed for improved fatigue requirements while keeping high machinability levels. The family of steels is named Usimax™ and is available in as drawn Bright Bars in various diameters.



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



Low carbon grades



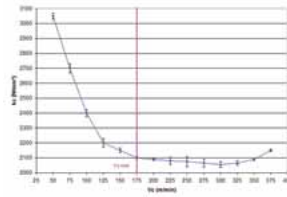
Medium carbon grades

Machinability evaluation: matching tool and material



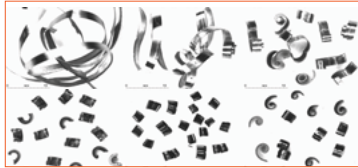
Workpiece

KISTLER 9121 table

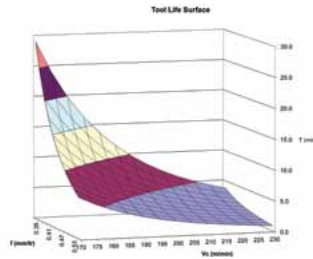


Cutting forces measurement

V_c : Cutting speed m/min
 K_c : Specific energy N/mm²
 T = Time (min)
 f = feed (mm/revolution)



Chips characterisation



Tool life surface

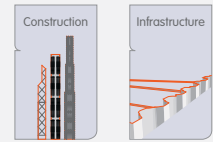
Typical steel grades (mostly per EN 10087)

		C	Si	Mn	P	S	Pb
Name	Material No.	%	%	%	%	%	%
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

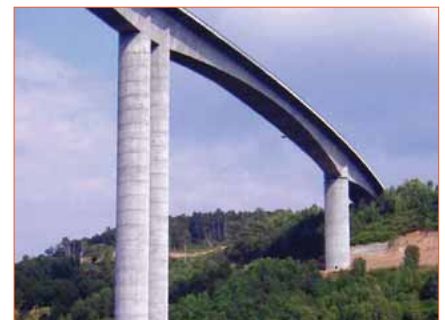
- Tensile strength related to high carbon content and micro alloying
- Steel cleanliness
- Microstructure homogeneity
- Surface quality



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.

Special know-how is required for prestressed concrete wire rod production and drawing because of the carbon content, alloying elements and the final mechanical properties required.



Typical steel grades

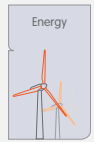
Name	C	Si	Mn	Cr	V	TS* (MPa)		
	%	%	%	%	%	Ø 6.5	Ø 10	Ø 15
C80	0.78-0.82	0.15-0.25	0.60-0.70	max. 0.10	max. 0.02	1200	1150	1020
C82+Cr	0.80-0.84	0.15-0.25	0.65-0.75	0.07-0.25	max. 0.02	1280	1200	1150
C82+Cr+V	0.80-0.84	0.15-0.30	0.70-0.80	0.07-0.25	0.03-0.06	-	1250	1200

* Typical value

Steelcord, hose wire, bead wire

Key properties

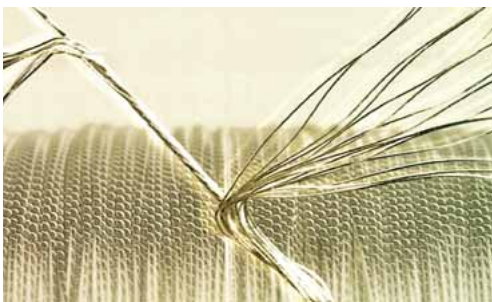
- Grade analysis
- Steel cleanliness
- Microstructure homogeneity
- Surface quality



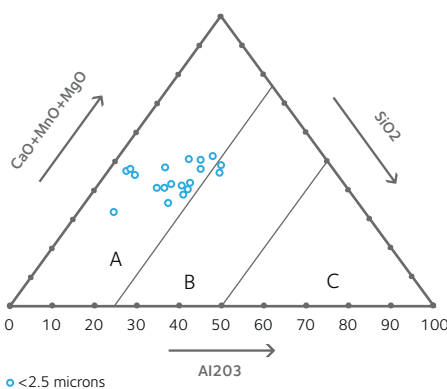
Courtesy of Goodyear Dunlop Tires Operations EMEA

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.

For the steel producer these are the most demanding high carbon product.



Typical inclusion distribution analysis by ternary diagram on steel cord



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

To achieve small drawn diameters, steel cleanliness is tightly controlled and inclusions are strictly monitored in terms of chemistry, density and size.

Surface quality is the final success factor for achieving very fine drawing quality, enabling surface treatments such as brass plating to be applied.

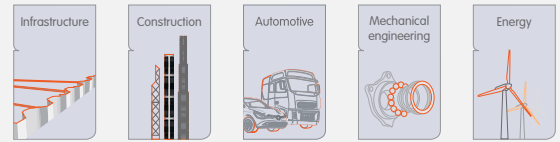
Typical steel grades

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	0.65 - 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

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...

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





Courtesy of Air liquide



Courtesy of Sidergas



Courtesy of Italfil

Standard steel grades

Name	Standard	Applications	C	Si	Mn	P	S	Cr	Ni	Mo	Cu
			%	%	%	%	%	%	%	%	%
			-	-	-	max.	max.	max.	max.	max.	max.
SG1	ISO 14341	Shielded arc welding	0.06-0.10	0.50-0.70	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	0.05-0.15	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

Name	Standard	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	0.750	-	-	-	-
2C1MV	ISO 24598	0.120	0.120	0.80	-	2.60	-	0.30	1.00	0.022	-
CrMo91	ISO 24598	0.120	0.60	1.00	-	9.00	0.500	0.20	1.00	0.065	0.045

Quality range Bars & Rods

	Duisburg (Germany)	Gandrange (France)	Hamburg (Germany)	Sonasid (Morocco)
Alloyed spring				
Alloyed spring	✓	✓	✓	
Superclean	✓			
Bearing	✓	✓	✓	
Chains	✓	✓	✓	
Cold heading	✓	✓	✓	
Drawing and cold rolling				
Low carbon	✓	✓	✓	✓
Medium carbon	✓	✓	✓	
High carbon	✓	✓	✓	
Forging				
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 concrete reinforcement and geotechnical

	Duisburg	Gandrange	Hamburg	Sonasid
Rebar				✓
Mesh			✓	✓
Threaded bars				
Krybar				

Certifications

	Duisburg	Gandrange	Hamburg	Sonasid
IATF-16949	✓	✓		
ISO 9001	✓	✓	✓	✓
ISO 14001	✓	✓	✓	✓
OHSAS 18001	✓	✓	✓	✓
ISO 50001	✓	✓	✓	
BES 6001				

Sosnowiec (Poland)	Veriña (Spain)	Warszawa (Poland)	Zenica (Bosnia Herzegovina)	
				Alloyed spring
✓	✓	✓		Alloyed spring
				Superclean
		✓		Bearing
✓	✓	✓		Chains
✓	✓	✓		Cold heading
				Drawing and cold rolling
✓	✓	✓	✓	Low carbon
✓	✓	✓	✓	Medium carbon
✓	✓	✓	✓	High carbon
				Forging
		✓		Carbon steels
		✓		Steels for quenching and tempering
		✓		Case hardening steel
		✓		Micro-alloyed steel
		✓		Bainitic steel for forging
				Free-cutting
	✓			Leaded
✓	✓	✓		Unleaded
✓	✓			Prestressed concrete
✓	✓			Steel cord
				Welding
✓	✓		✓	Non-alloyed
				Alloyed

bars

Sosnowiec	Veriña	Warszawa	Zenica	
		✓	✓	Rebar
✓			✓	Mesh
				Threaded bars
		✓		Krybar

Sosnowiec	Veriña	Warszawa	Zenica	
✓		✓		IATF-16949
✓	✓	✓	✓	ISO 9001
✓	✓	✓	✓	ISO 14001
✓	✓	✓	✓	OHSAS 18001
✓	✓	✓		ISO 50001
✓	✓	✓		BES 6001

Bars and rods production units



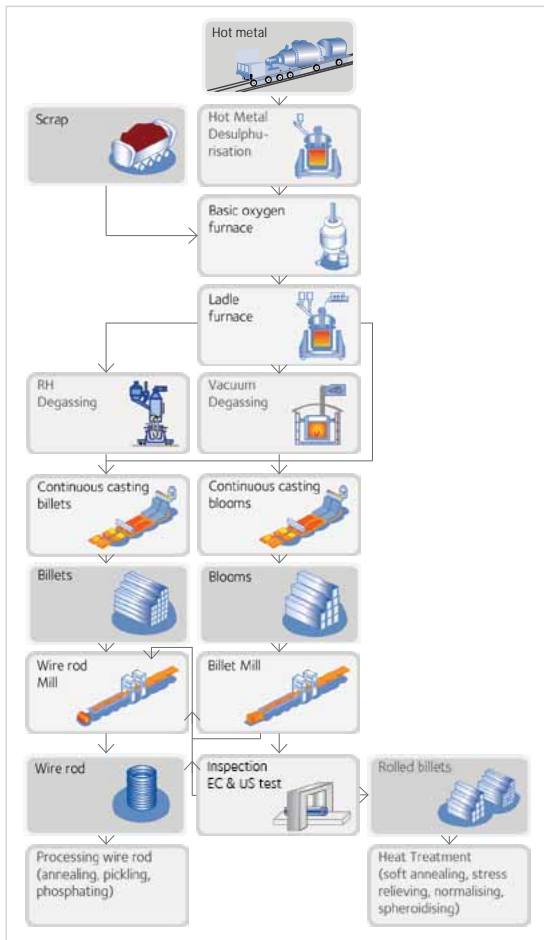
ArcelorMittal Duisburg

Vohwinkelstraße 107; D-47137 Duisburg



ArcelorMittal Duisburg plant is located in the Ruhr region in north-west Germany. ArcelorMittal Duisburg works to develop new applications and new products for the automotive, energy and mechanical industries.

The billet mill produces high quality billets and SBQ for the forging industry. The new wire rod mill supplies the automotive market with cold heading, spring grades, bearing and other special wire rod grades.



Facilities

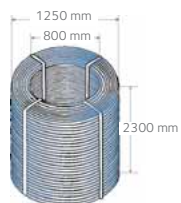
- ▶ Steel plant:
 - Two oxygen converters (TBM process)
 - Ladle furnace
 - Steel ladle vacuum treatment: circulation degasser (RH) and tank degasser (VD), as per metallurgical need
 - Steel conditioning (Argon & Nitrogen stirring)
 - 1 Bloom caster with soft reduction
 - 1 Billet caster
- ▶ Billet rolling mill:
 - Reversing breakdown and finishing stand
- ▶ Inspection line for bars & billets:
 - Conditioning with ultrasonic and surface testing (TOM)
 - Annealing (up to 9 m in length): soft annealing, normalising
 - Dimension control
 - Surface grinding (including robot)
- ▶ Wire rod rolling mill:
 - High speed single-strand, 28 stands including pre-block
 - Thermo-mechanical rolling including loop
 - 104 m long Stelmor line
- ▶ Wire rod processing (annealing, pickling, phosphating) upon request

Casted semis

- ▶ Blooms (mm): 385 x 265 length (m): 4.3 - 12.3
- ▶ Blooms (mm²): 320 length (m): 4.3 - 12.3
- ▶ Billets (mm²): 160 length (m): 12 - 16 (<12 m on request)

Finished products

- ▶ Wire rod (mm): 5.5 to 25 (steps of 0.5 mm)



Coil length (mm) (max.): 2300

Coil weight (t) (max.): 3
(2t, 2.5t on request)

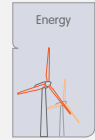
- ▶ Bars (mm²): 63 to 200 (round corner square)
- ▶ Bars (mm): 100 to 170



Length: 5-16 meters (3-5 m upon request)
Strapping: 6 steel bands
Labelling: content upon request
Bundle weight (t) (max.): 10

ArcelorMittal Gandrange

Boîte postale 3; F-57360 Amnéville



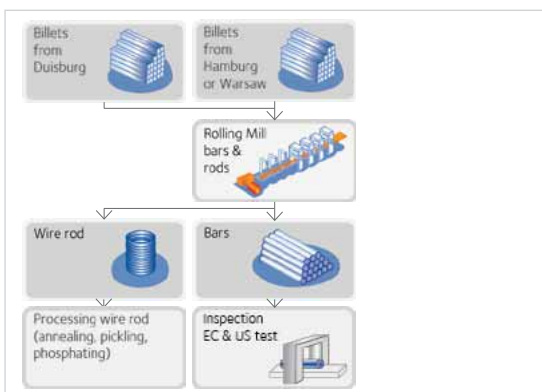
ArcelorMittal Gandrange plant is located in the Lorraine region in north-east France.

The production facilities of Gandrange consist of a hot rolling mill producing bars and wire rod (round and hexagon) in a wide range of grades and dimensions.

This combined mill also has a state-of-the-art sizing block and a new integrated bar conditioning line with surface and ultrasonic testing.

Strongly positioned in the field of bar and wire rod products, the site works to develop new applications and new products for the automotive, energy and mechanical industries (forging, cold heading, bright drawing...).

The site has high flexibility in steel input with semis provided by Duisburg, Hamburg and Warsaw.

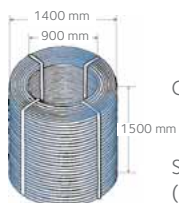


Facilities

- ▶ Bar & wire rod rolling mill:
 - Furnace with tight temperature control
 - Sizing block
 - On-line dimensional control
 - On-line surface control
 - Garrett coiling for wire rod
- ▶ Inspection line for bars:
 - Multi-roll straightener
 - Sawing and chamfering devices (45° or 60° from 0.2 to 4mm)
 - Surface control (Circoflux)
 - Ultrasonic control device
- ▶ Wire rod processing (annealing, pickling, phosphating) upon request

Finished products

- ▶ Wire rod (mm): ● 15 - 52 (steps of 0.1 mm)
- 14.3 - 42.5 (hexagons)



Coil length (mm) (max.): 1500

Standard coil weight (t) (max.): 2.5
(other coil weights available upon request)

- ▶ Bars (mm): ● 15 - 103 (steps of 0.1 mm)
- 14.3 - 70.4 (hexagons)

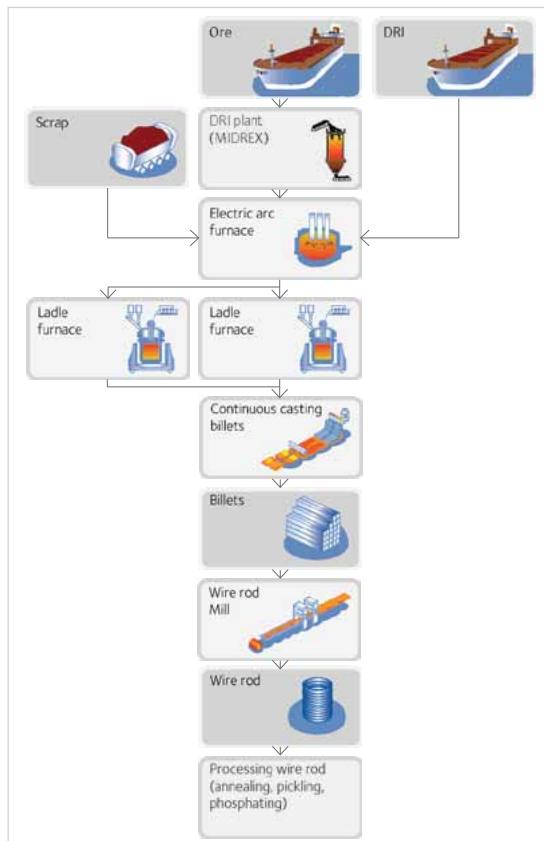
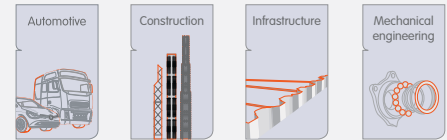


Length (m): 5 - 16
Strapping: 4 - 8 steel bands
Labelling: 2 per bundle

Bundle weight (t) (max.): 1.5 - 8

ArcelorMittal Hamburg

Dradenastraße 33; D-21129 Hamburg



ArcelorMittal Hamburg plant is located at Germany's largest sea port which is an important logistical advantage. The production site of Hamburg consists of an electric arc furnace, two ladle furnaces, a continuous caster and a 2-strand wire rod mill.

Thanks to its direct reduction plant (DRI), the steel shop is able to produce high quality at an optimum cost. The scrap and DRI mix is modified according to customer technical requirements.

ArcelorMittal Hamburg is acknowledged as a global leader in high-quality wire rod production. It is also a pioneer in melt shop productivity and energy efficiency.

Facilities

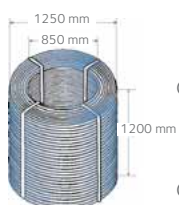
- ▶ DRI: Direct reduction plant
- ▶ Steel plant:
 - Electric arc furnace
 - 2 ladle furnaces
 - 7-strand billet caster
- ▶ Wire rod rolling mill:
 - High speed 2-strand
 - 26 stands including pre-block and no-twist Morgan block
- ▶ Wire rod processing (annealing, pickling, phosphating) upon request

Casted semis

- ▶ Billets (mm²): ■ 120; 125; 130; 140 lengths (m): 5 - 16

Finished products

- ▶ Wire rod (mm): ● 5.5 - 16

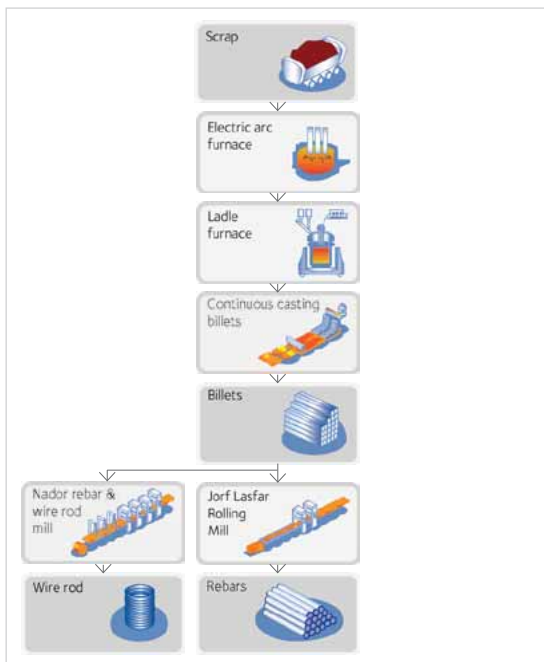
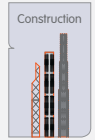


Coil length (mm) (max.): 1200

Coil weight (t) (max.): 1.5; 1.7
 -> from 2018, Coil weight (t) (max.): 2

ArcelorMittal Sonasid

Jorf Lasfar; P.O.Box 856 and 857 El Jadida; Jorf Lasfar
Nador; P.O.Box551; Route National N°2. km 18; El Aaroui; Nador



The two plants of ArcelorMittal Sonasid are located in the north and west of Morocco. Sonasid is the leading supplier of rebar and wire rod in North Africa.

The production sites of Sonasid consist of one electric arc furnace, one continuous caster, one wire rod and one bar mill.

Sonasid principally produces steel bars and rods. These products include reinforcing bars for construction, billets and wire rods.

Facilities

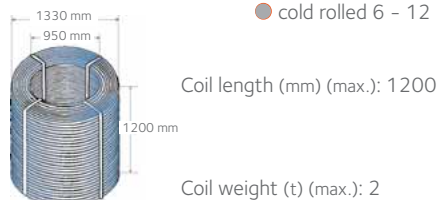
- ▶ Steel plant: Jorf Lasfar
 - Shredder
 - Electric arc furnace
 - Ladle furnace
 - 5-strand billet caster
- ▶ Wire rod rolling mill: Nador
 - 2-strand wire rod mill
- ▶ Bar rolling mill: Jorf Lasfar
 - 3-strand slitting rebar rolling mill

Casted semis

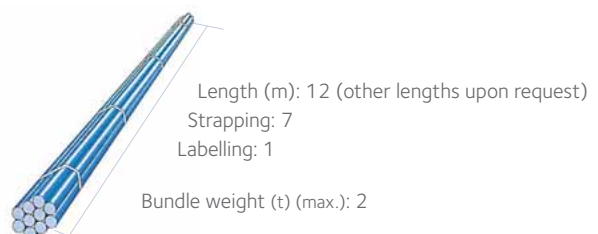
- ▶ Billets (mm²): 130; 140 length (m): 12 - 13

Finished products

- ▶ Wire rod (mm): 5.5 - 16
- ▶ Rebar in wild coils (mm):
 - hot rolled 6 - 16
 - cold rolled 6 - 12

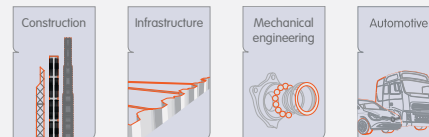


- ▶ Rebar (mm): 8 - 40



ArcelorMittal Sosnowiec

Ul. Niwecka 1; P- 41-200 Sosnowiec



ArcelorMittal Sosnowiec plant consists of a modern wire rod mill.

Billets sourced from the integrated plant in Dąbrowa Gornicza are subject of advanced metallurgical routing including a ladle furnace, vacuum degassing and a continuous caster (modernised in 2013).

Sosnowiec is a leading supplier of high quality wire rod and has the knowledge and expertise to produce wire rod for demanding applications.

With its strong position in carbon grades including prestressed concrete, welding and cold heading quality, the site develops grades for the most demanding applications in the automotive industry.

Facilities

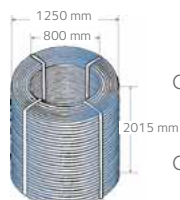
- ▶ Upstream: Dąbrowa Górnicza
 - Coke oven
 - Sintering plant
 - Blast furnace
- ▶ Steel plant: Dąbrowa Górnicza
 - Oxygen converter
 - Ladle furnace
 - RH degassing
- ▶ Wire rod rolling mill: Sosnowiec
 - High speed 2-strand SMS (Morgan)/Danieli WR (2006)
 - 110 m long, Stelmor cooling conveyor

Casted semis

- | | | | |
|--------------------------------------|----------------------|-----------------------------------|------------------------|
| ▶ Blooms (mm): 400 x 280 ; 300 x 280 | length (m): 4.2 - 12 | ▶ Billets (mm ²): 130 | length (m): 8.5 - 13.5 |
| ▶ Blooms (mm): 220 x 190 | length (m): 5 - 13.5 | ▶ Billets (mm ²): 140 | length (m): 8 - 13.5 |
| | | ▶ Billets (mm ²): 160 | length (m): 7 - 13.5 |

Finished products

- ▶ Wire rod (mm): 5.5 - 21

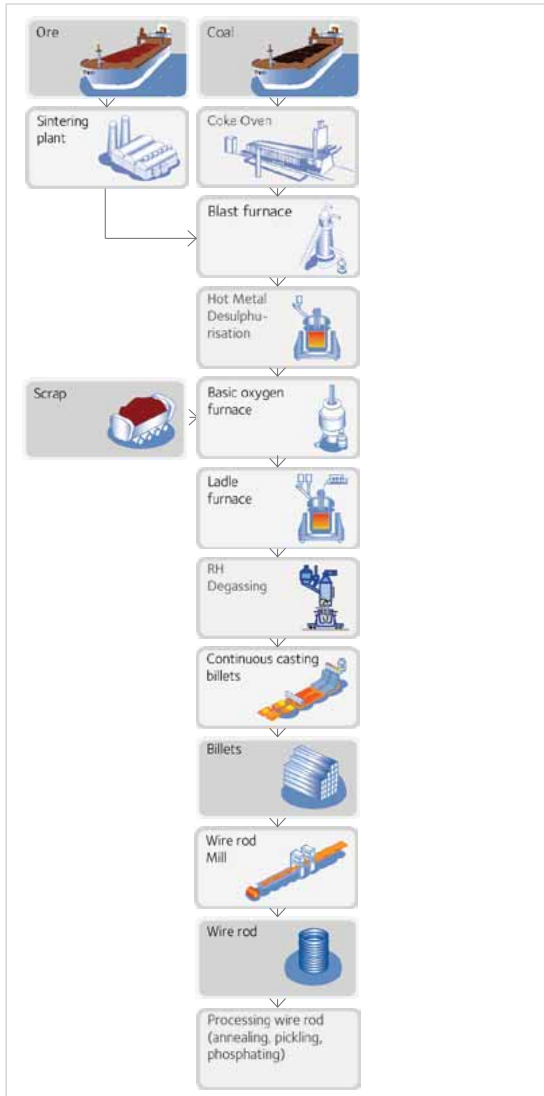
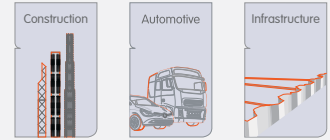


Coil length (mm) (max.): 2015

Coil weight (t) (max.): 2.4

ArcelorMittal Veriña

ArcelorMittal Asturias (Gijón); Veriña de Abajo; E-33200 Gijón



ArcelorMittal Veriña plant is located in the Asturias region in north-west Spain in a strategic location with port services close to the factory.

The Gijón site consists of a steel plant with two oxygen converters, secondary metallurgy (including two ladle furnaces and an RH degasser), a bloom caster and a billet caster, as well as a wire rod mill and a rail mill.

The site produces high quality wire rod for the most demanding applications (steelcord, cold heading, springs, etc.).

Gijón is the only Spanish producer of high-speed rail and head hardened rail. Both products are subject to the most stringent quality and reliability requirements.

Facilities

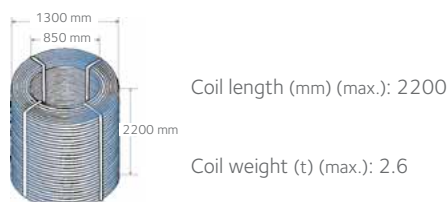
- ▶ Upstream:
 - Coke oven
 - Sintering plant
 - Blast furnaces
- ▶ Steel plant:
 - Oxygen converter
 - RH degassing
 - Two ladle furnaces
 - Kiss system to avoid slag carriover from the ladle to the tundish
 - 6-strand billet caster
- ▶ Wire rod rolling mill:
 - High speed 2-strand
 - 32 stands including pre block and reducing sizing mill
 - Zumbach Gauge monitoring (rod tolerance and ovality control)
 - Eddy current equipment for surface control of defects along the coil length
- ▶ Wire rod processing (annealing, pickling, phosphating) upon request

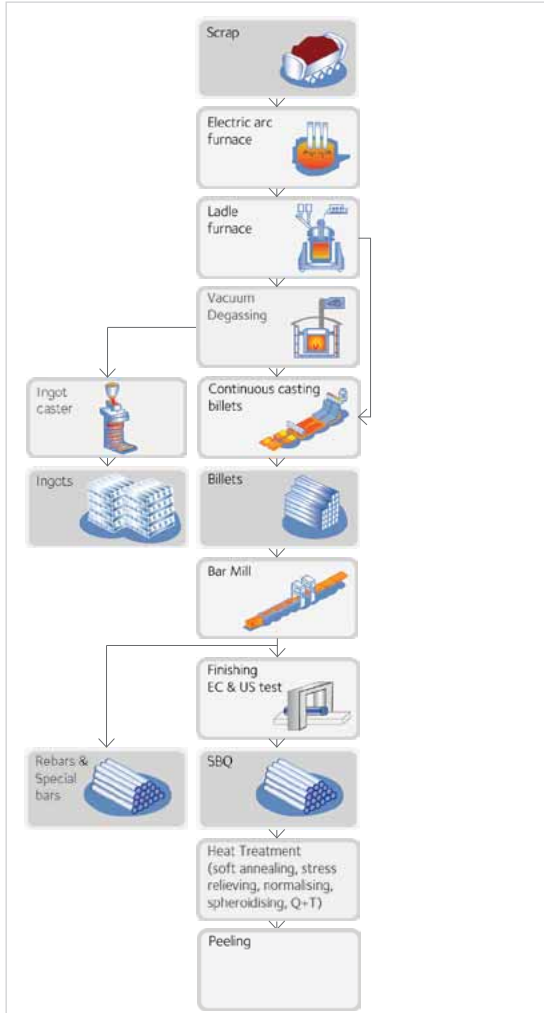
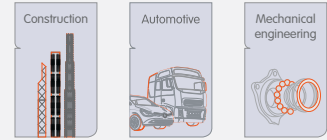
Casted semis

- ▶ Billets (mm²): ■ 150 length (m): 15 (<15 m on request)

Finished products

- ▶ Wire rod (mm): ● 5 - 23





ArcelorMittal Warszawa plant is located at the northern edge of Warsaw.

Warszawa production site consists of an electric arc furnace, a ladle furnace, vacuum degassing, an ingot caster, a continuous caster, a bar mill and finishing lines.

Warszawa produces special quality bars from 20 to 80 mm and rebars from 10 to 40 mm.

Facilities

- ▶ Steel plant:
 - Electric arc furnace with eccentric bottom tapping
 - Ladle furnace
 - Vacuum degassing
 - 4 strand billet caster
- ▶ Bar rolling mill:
 - 18 stands in continuous system roll line
- ▶ Finishing line:
 - Straightening machines
 - Milling and chamfering devices
 - Surface control (Circograph, Circoflux)
 - Ultrasonic control device
 - Antimixing control - spectrotest devices
 - Packaging, marking
- ▶ Bar processing:
 - Heat treatment: soft annealing, normalising, isothermal, spheroidising and stress relieving treatments, quenching and tempering
 - Peeling

Casted semis

- ▶ Blooms (mm²): ■ 220 length (m): 4 - 9
- ▶ Billets (mm²): ■ 140; 160 length (m): 4 - 14.8

Finished products

- ▶ Bars (mm): ● 20 - 80
- ▶ Rebar (mm): ● 10 - 40
- ▶ Krybar (mm): ● 12 - 32

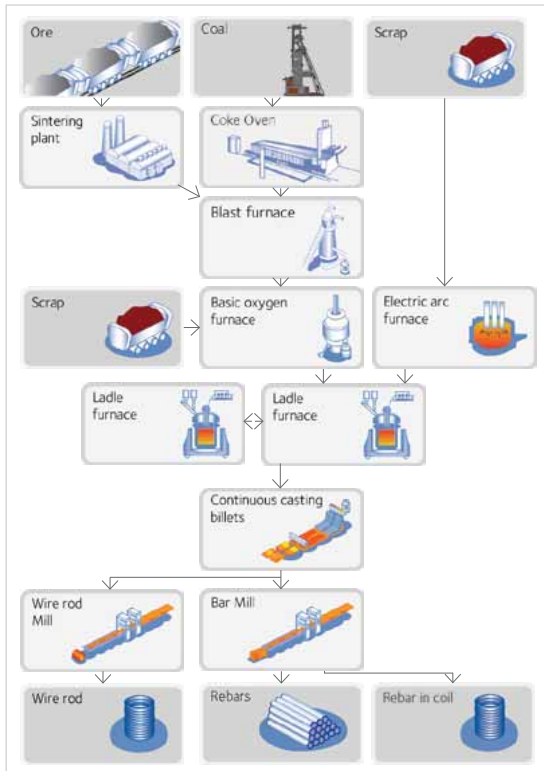
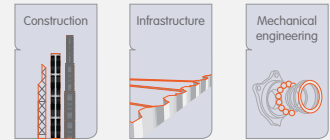


Length (m): 12 - 15
 Strapping: min. 3 steel bands
 Labelling: customer specifications (min. 2)

Bundle weight (t) (max.): 10

ArcelorMittal Zenica

Bulevar Kralja Tvrtka I, no. 17; 72000 Zenica



ArcelorMittal Zenica plant is located in the Zenica-Doboj canton in the centre of Bosnia and Herzegovina.

Zenica production site consists of an integrated plant with a liquid phase (coke oven, sintering plant, blast furnace), a steel plant and two rolling mills. The ore is supplied by the nearby Prijedor Mine.

The plant is unique with facilities including both integrated route and electric arc furnace.

→ Investment in rebar coil (2016).

Facilities

- ▶ Upstream:
 - Coke plant
 - Sintering plant
 - Blast furnace
- ▶ Steel plant:
 - Oxygen converter
 - Basic oxygen furnace
 - Ladle furnace
 - 6-strand continuous caster
- ▶ Wire rod rolling mill
- ▶ Rebar rolling mill
- ▶ Finishing: Mesh plant

Casted semis

- ▶ Billets (mm²): ■ 120; 130 length (m): 12

Finished products

- ▶ Wire rod (mm): ● 5.5 - 12



Coil length (mm) (max.): 1250
Coil weight (t) (max.): 1.3



Coil height (mm) (max.): 700
Coil weight (t) (max.): 1.5

- ▶ Rebar in bar (mm): ● 8 - 32



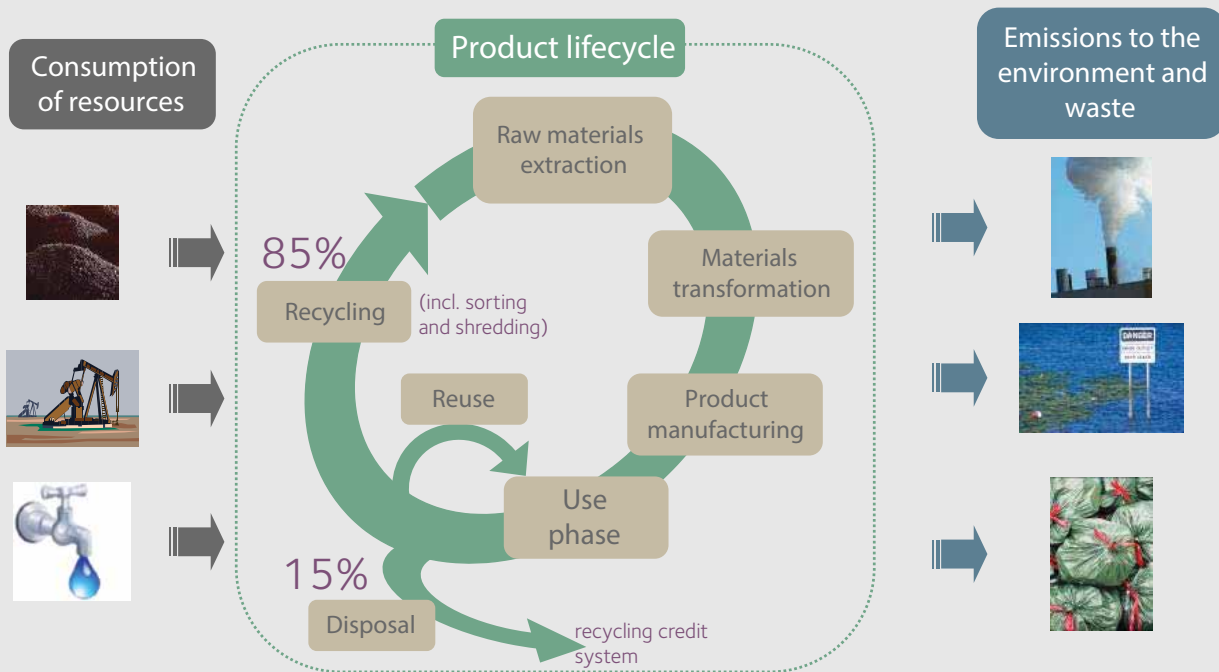
Length (m) (max.): 12
Strapping: double 4.2 mm/
5.5 mm double wire on 7 places
Labelling: 2 per bundle

Bundle weight (t) (max.): 2.5

Sustainable development

LCA: Life Cycle Assessment

“Analysis of the potential environmental burdens of a product or service in its production, use phase and disposal (end of life).” [ISO standard]



Life Cycle Assessment (LCA) is an important tool to assess and quantify the potential environmental footprint of products along the entire lifecycle in order to help industry improve efficiency where it matters most and contributing to sustainable development.

Steel rebar is the lowest grade of steel products, often produced locally using small scale electric arc furnace (EAF) mills. As such, the steel used in rebars is a permanent material: rebars can be recycled into new rebars, without losing quality or functionality. On the one hand, by using EAF route we ensure that our rebars have a high content of recycled material. On the other hand, 85% of the rebars are currently recycled at the end of their life*.

Through EAF route, the high proportion of recycled steel used allows to save CO₂ emissions as well as natural resources. Taking into account the entire lifecycle, the usage of scrap allows saving 1.4t direct CO₂ emissions per tonne of rebar produced. Additionally, with EAF route, more than 95% of dust emissions as regard to heavy metals such lead, zinc and nickel are also saved.

* European Commission Technical Steel Research, Sansom, M. and Meijer, J.: Life-cycle assessment (LCA) for steel construction, European Commission technical steel research, 2001 - 12

Since October 2016 an Environmental Product Declaration (EPD) for ArcelorMittal rebars is available at <http://ibu-epd.com/>. An Environmental Product Declaration provides transparent and comparable information on the life-cycle environmental impact of a product in accordance with EN15804. The declaration is independently verified by Institut Bauen und Umwelt (IBU) – the Institute of Construction and the Environment – which is specialised in the sustainability labeling of construction products and materials.

2.26 mt

tonnes of steel recycled representing 42% of ArcelorMittal Europe - Long Products bars & rods production**

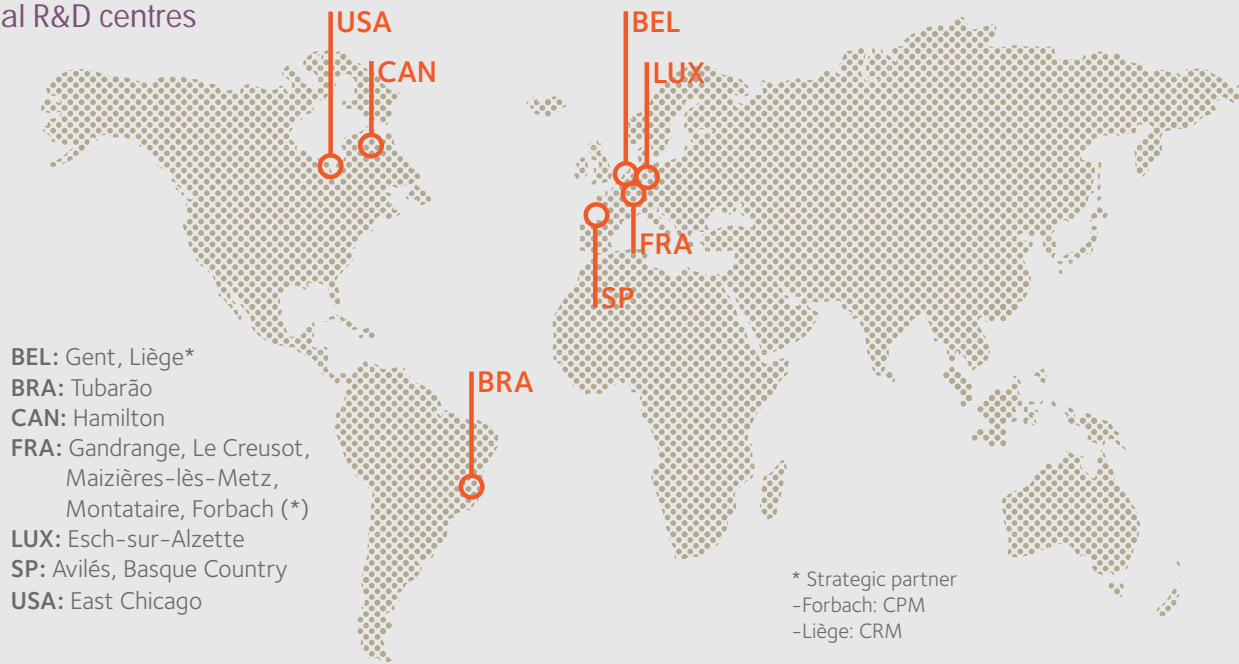
3.06 mt

tonnes of CO₂ saved from steel we recycled

**Bars & rods production in 2017: 5.36 million t.

Product & process development

Global R&D centres



BEL: Gent, Liège*
BRA: Tubarão
CAN: Hamilton
FRA: Gandrange, Le Creusot, Maizières-lès-Metz, Montataire, Forbach (*)
LUX: Esch-sur-Alzette
SP: Avilés, Basque Country
USA: East Chicago



ArcelorMittal's product development approach is based on long term co-development agreements. From Global Research & Development Centres at group level to European plants, our experts are committed to invent new steel products and to improve steel processing and engineering. Our research and development teams provide also support to our customers to establish a sound knowledge on the key expectations from our products, such as cleanliness, structure homogeneity, mechanical characteristics, machinability, corrosion resistance, etc.

Beyond this, research and development mission is to invent new steel solutions to address future segment needs, and move the technical borders between our plants and the customer's ones. Some of them are already currently used by our customers : bainitic grades for forging (Solam®), high plasticity and high strength grades for cold heading (FreeForm®), high machinability grades.



We are also permanently developing models, describing in details the overall steel production process, from the liquid metallurgy to hot rolling and cold forming, connecting microstructural behaviour, thermo-mechanical process to steel product or part performance. Final thermal treatments simulations help our partners to reach very high process control and increase its robustness. Specific pilot plants for casting, rolling, drawing, surface and heat treatments complement numerical simulations by providing material for physical evaluation. Drawability and machinability are specific areas of research and development with 3 dedicated pilot benches for drawing, as well as specific and instrumented lathe and machining centre.



Our labs are equipped with the most recent technologies :

- For macro/micro characterisation (Field Emission Gun SEM, macro-probe, torsion & fatigue machines, Charpy&Brugger impact test, Jominy bench, dilato-plastometer, corrosion chambers...)
- Specific surface expertise can be provided for wires : surface morphology, composition, aptitude for coating
- US analysis can be made in our new tank for cleanliness expertises
- In our Pilots, dedicated to simulate exiting or new processes (drawing, rolling process, heat treatment, 3D printing)
- A specific workshop is dedicated to machining optimisation with 2 new equipments: Lath and Machining centre.
- In addition, we support instrumentation of process in the ArcelorMittal Europe Long Products plants (Thermal camera, pyrometers, force sensors...). Moreover, our customers can rely on the expertise of ArcelorMittal's Global R&D Centres based in Europe, as well as on our international network of experts available on every continent, to manage the world's largest steel product portfolios.



Global R&D

Over 1.400 full-time researchers in 12 Labs, spending in 2017 amounting to \$278 million of which 33% is dedicated to Auto.

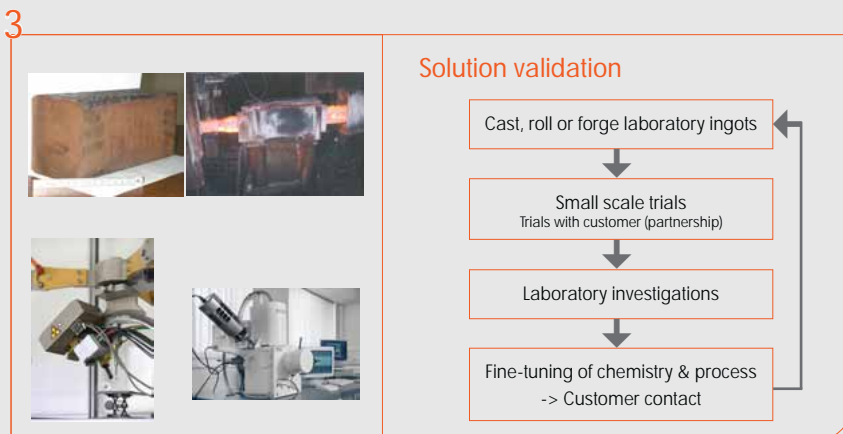
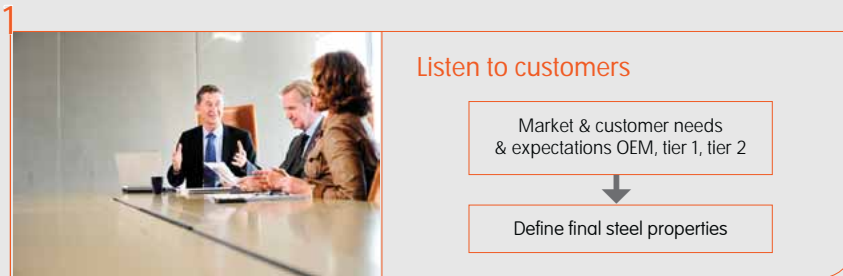
Missions

- Pro-active approach of future needs in automotive industry
- Innovative solutions taking advantage of Flat & Long synergies
- Development of products, steel solutions and processes from their pre-design phase through their implementation and lifetime at our customers and at our plants
- Assistance to plants for complex technical issues










Activities


- Broad, comprehensive portfolios and programmes addressing business needs
- Expanding Worldwide network of research sites in Europe & America
- Partnerships with focused engineering schools & universities research sites





4 steps to go from customer needs to industrialisation








Product range Bars & Rods

Semis		Duisburg (Germany)	Gandrange (France)	Hamburg (Germany)	Sonacid (Morocco)
Steel production	Steel origin	Iron ore		Scrap/DRI	Scrap
	Steel plant	BOF		EAF	EAF
	Vacuum degassing	✓			
	Electro-magnetic stirring	✓		✓	
	Casted semis (mm)	 385 x 265  160 ²  320 ²		 120 ²  125 ²  130 ²  140 ²	 130 ²  140 ²

Wire rod		Wire rod	Wire rod	Wire rod	Wire rod	
Wire rod rolling	Finished products		 			
	Dimensions (mm) (min.)	5.5	15 14.3	5.5	5.5	
	Dimensions (mm) (max.)	25	52 42.5	16	16	
	Coil presentation	Coil forming	Loop Cooling Conveyor	Garrett	Stelmor	Stelmor
		Coil weight (t) (max.)	3	2.5	1.5; 1,7; 2 starting from 2018	2
		Coil length (mm) (max.)	2300	1500	1200	1200
	On-line inspection	Surface control	✓	✓	✓	
		Dimensions gauge	✓	✓	✓	
Processing wire rod		on request	on request	on request		




Bars		Round Corner Square	Special Bar Quality	Special Bar Quality			
Bar rolling	Finished products			 			
	Dimensions (mm) (min.)	63 ²	100	15 14.3			
	Dimensions (mm) (max.)	200 ²	170	103 70.4			
	Conditioning	Bundle weight (t) (max.)	10		8		
		Bundle length (m) (max.)	16		16		
	On-line inspection	Surface control			✓		
Dimensions gauge				✓			
Inspection & Finishing	Off-line inspection	Surface control	✓	✓			
		US	✓	✓			
	Heat treatment	Q+T					
		Annealing	✓				
Peeling				on request			

Rebars		Sonacid		Warszawa	Zenica	
Finished products		in wild coils	in bars	in bars	in coils	in bars
Diameter (mm)		6-16	8-40	10-40	6-25	8-32
Conditioning	Bundle weight (t) (max.)		2	10		2.5
	Bundle length (m) (max.)		12	12		12
	Coil weight (t) (max.)	2			1.5	
	Coil length (mm) (max.)	1200			700	

Sosnowiec (Poland)	Veriña (Spain)	Warszawa (Poland)	Zenica (Bosnia Herzegovina)	Semis	
Iron ore	Iron ore	Scrap	Iron ore	Steel origin	
BOF	BOF	EHF	BOF	Steel plant	
✓	✓	✓		Vacuum degassing	
✓	✓	✓		Electro-magnetic stirring	
 220 x 190; 300 x 280 400 x 280  130 ² ; 140 ² ; 160 ²	 150 ²	 140 ² 160 ² 220 ²	 120 ² 130 ²	Casted semis (mm)	
				Steel production	

Wire rod	Wire rod		Wire rod	Wire rod	
●	●		●	Finished products	
5.5	5		5.5	Dimensions (mm) (min.)	
21	23		12	Dimensions (mm) (max.)	
Stelmor	Stelmor		Stelmor	Coil forming	Coil presen- tation
2.4	2.6		1.3	Coil weight (t) (max.)	
2015	2200		1250	Coil length (mm)(max.)	On-line inspec- tion
✓	✓			Surface control	
✓	✓			Dimensions gauge	
	✓			Processing wire rod	

		Special Bar Quality		Bars	
		●		Finished products	
		20		Dimensions (mm) (min.)	
		80		Dimensions (mm) (max.)	
		10		Bundle weight (t) (max.)	Condi- tioning
		15		Bundle length (m) (max.)	
		✓		Surface control	On-line inspec- tion
		✓		Dimensions gauge	
		✓		Surface control	Off-line inspec- tion
		✓		US	
		✓		Q+T	
		✓		Annealing	Heat treat- ment
		on request		Peeling	
				Inspection & Finishing	

Belval (Luxembourg)	Hunedoara (Romania)	other Semis	
Scrap	Scrap	Steel origin	
EHF	EHF	Steel plant	
	✓	Vacuum degassing	
 270 x 155	 270 x 240; 310 x 280  180; 200; 250; 270; 310	Casted semis (mm)	
		Steel production	

Sales offices

European countries

Austria, Germany, the Netherlands, Switzerland

Vohwinkelstraße 107
47137 Duisburg - Germany
T: +49 203 606 66400
F: +49 203 606 66332
constantin.vonlivosius@arcelormittal.com
joachim.scheibe@arcelormittal.com

Belgium, France, Luxembourg

66, rue de Luxembourg
4221 Esch-sur-Alzette - Luxembourg
T: +352 53 13 34 32
F: +352 53 13 45 34 61
xavier.monfort@arcelormittal.com

Bosnia and Herzegovina, Albania, Croatia, FYROM, Kosovo, Montenegro, Slovenia, Serbia

Kralja Tvrtka I no.17,
72 000 Zenica - Bosnia & Herzegovina
T: +38732 467 051
F: +38732 467 065
akshaya.gujral@arcelormittal.com
salesamz@arcelormittal.com

Bulgaria

Antim I street no. 26, floor 1, office 6
1303 Sofia - Bulgaria
T: +359 2 87 09 028
F: +359 2 87 05 226
georgi.genov@arcelormittal.com

The Czech Republic, Hungary, Slovakia

Francouzská 6167
CZ-708 00 Ostrava-Poruba
T: +420 724 416 781
Jan.Abrahamcik@arcelormittal.com
Janusz.Muszynski@arcelormittal.com

Denmark, Finland, Iceland, Norway, Sweden

Västmannagatan 6
11124 Stockholm - Sweden
T: +46 8 534 809 40
michael.wild@arcelormittal.com

Estonia, Latvia, Lithuania

Koorma 5a
74004 Muuga - Estonia
T: +37251979170
erki.saar@arcelormittal.com

Greece & Cyprus

9. Saki Karagiorga Str.
166 75 Glyfada - Greece
T: +30 21 09 604 279
F: +30 21 09 611 824
aleksandar.rankovic@arcelormittal.com

Italy

Viale Brenta, 27/29
20139 Milano - Italy
T: +39 02 80650 234
F: +39 02 80650 250
angelo.agnelli@arcelormittal.com
marco.manfredini@arcelormittal.com

Poland

ul. Niwiecka 1
41-200 Sosnowiec - Poland
T: +48 32 736 11 17
F: +48 32 736 14 11
barbara.stefaniak@arcelormittal.com
janusz.muszynski@arcelormittal.com

ul. Kasprowicza 132
01-949 Warszawa - Poland
T: +48 22 835 80 10
T: +48 22 835 80 20
F: +48 22 835 81 93
mikolaj.wronski@arcelormittal.com
miroslaw.czub@arcelormittal.com
janusz.muszynski@arcelormittal.com

Romania

9 Intrarea Tudor Stefan 2nd Floor, AP.4
Sector 1. Bucharest 11655 - Romania
T: +40 31 40 54 792
F: +40 21 23 17 138
daniela.voicuagache@arcelormittal.com

Spain and Portugal

Ctr. Toledo. Km. 9,200
E-28021 Madrid - Spain
T: +34 91 797 23 00
elina.martin@arcelormittal.com
juan-carlos.hurtado@arcelormittal.com
T: +34 985 18 74 03
juan.demiguel@arcelormittal.com

The UK and Ireland

Fore 2, Huskisson Way,
Shirley, Solihull,
West Midlands
B90 4SS - United Kingdom
T: +44 121 713 6600
F: +44 121 733 1299
andrew.dejong@arcelormittal.com

Main other countries

CIS

Bolshaya Ordynka str., 44/4
119017 Moscow Russia
T: +7 495 666 2688
andrei.kurbatov@arcelormittal.com

Morocco

Twin Center, angle Bd Zerktouni et
Massira Al Khadra, Tour A 18^e étage,
Casablanca
T: (+212) 5 22 95 41 00
F: (+212) 5 22 95 86 43
a.baraka@sonasid.ma

NAFTA

1 S Dearborn Street
18th Floor
Chicago, IL. 60603
T +312 899 3937
r.ravi@arcelormittal.com

Other exports

Esentepe Mah. Buyukdere Cad.
Metrocity A Blok 171A Kat:16
Sisli 34394 Istanbul - Turkey
T: +90 212 317 4922
cansu.cobanoglu@arcelormittal.com
alper.ozdemir@arcelormittal.com

longeurope.barsandrods@arcelormittal.com

barsandrods.arcelormittal.com