Industeel

ArcelorMittal

Creusabro® M

12-14%Mn austenitic manganese hot rolled steel plate

Creusabro® M is the genuine fine-grained 12-14%Mn austenitic manganese steel (Hadfield steel) hot-rolled plate.

12-14% Mn austenitic manganese steel shows an outstanding hardening capacity under stress recognized for a long time. As delivered, Creusabro® M exhibits a moderate hardness of 180 to 240 HB combined with high ductility and impact energy absorption capacity. When exposed to high pressure or impact loads in service, Creusabro® M work hardens considerably on its surface up to 600 HB, while remaining not brittle in the bulk.

As a result, Creusabro® M exhibits high resistance to abrasive wear, where external conditions cause extensive work hardening of the wear component's surface. Creusabro® M has found many applications in crushing and earthmoving equipment, in railways and in the shot blasting industry.

The second essential property is that Creusabro® M is a non-magnetic steel.

STANDARDS

Creusabro® M is a proprietary grade and registered trademark developed by Industeel. There exists no product standard for austenitic manganese steel hot-rolled plates (wrought) intended for wear resistant applications. The alternative names for this steel are the nearest approximations according to different steel grade designation* or castings product standards.

DIN*	1.3401	JIS G5131	Grade SCMnH1; H2; H3
EN*	X120Mn12, X120Mn13	CNS 3830	Grade SCMnH1; H2; H3
AFNOR*	Z120M12	GOST 21357	Grade 110G13L
ASTM A128	Grade A; Grade B2	CSN 417618	Grade 17618
ISO 13521	Grade GX120Mn13	Others	Hadfield steel, "manganese steel", 12% Mn steel, 13% Mn steel...

CHEMICAL ANALYSIS - % WEIGHT

	C	S	P	Mn	Si	Cr	Mn/C
Min	1.10			12	0.3		10
Max	1.30	0.01	0.03		0.5	1.5	

MECHANICAL PROPERTIES

	Hardness (HBW)	Tensile properties			CVN-impact +20°C (J)
		YS 0.2% (MPa)	UTS (MPa)	Total Elong. (%)	
Specification	180 – 240 (1)				
Typical	210 → 600 (2)	400	900	40	200

(1)as-delivered after quenching (940-1000°C, 1724-1832°F); According to UIC 893 specification upon request.
(2)surface hardness after work-hardening.

HIGH WEAR RESISTANCE

The outstanding strain hardening capacity of 12-14%Mn austenitic manganese steel has been recognized for a long time. When exposed to high pressure or impact loads in service, **Creusabro® M** steel work hardens considerably on its surface up to 600 HB.

The work hardening of the surface layer is rapidly produced and continuously rejuvenated by the high pressure or impact loads in service.

For specific components or application, explosive surface hardening can be considered.

EXCEPTIONAL CRACK RESISTANCE

With CVN-impact energies well above 100 J and no ductile-to-brittle transition, **Creusabro® M** maintains good toughness required for key components operating in difficult environment.

If cracking of the work hardened surface layer occurs, the crack propagation would quickly be prevented by the tougher core.

With a tensile strength to yield strength ratio ("yield ratio") greater than 2, parts and components made of **Creusabro® M** can quickly transfer exceptional stress concentration from external shocks and effectively prevent part damage.

HOT ROLLED FINE STRUCTURE

Austenitic manganese steel is probably more widely used as castings but, due to its fine-grained structure and virtually defect-free microstructure (porosities, cracks, inclusions...) compared to the cast forms, **Creusabro® M** hot-rolled steel has higher resistance to sudden failure or fatigue cracking that could result to the destruction of structural parts during the operation of machinery and equipment.

GALLING RESISTANCE / SELF-LUBRICATION

Another unique and original feature of austenitic manganese steel is its self-lubricating properties. For example, key components of railway wagons, pins and bushing connecting sets of mining shovels made of **Creusabro® M** don't need to add oil.

MAGNETIC PROPERTIES

The second essential property is that high-manganese steel, after appropriate heat treatment, is a non-magnetic steel.

PROPERTIES AT HIGH TEMPERATURE

The grade is not suitable for continuous operating temperatures above 300°C. Exposure to higher temperatures lead to embrittlement by carbide precipitation. In the 450 – 750°C temperature range, embrittlement occurs after only a few minutes.

PHYSICAL PROPERTIES

The property values below refer to Hadfield's manganese steel in the properly heat-treated condition.

T (°C)	20° C	100°C	200 °C	400°C	500°C
Density (g/cm³)	7.87				
Young Modulus E (GPa)	190				
Thermal conductivity (W·m-1.K-1)	13	14.6	16.3	19.3	21.8
Electric resistivity Ohm.mm²/m	0.68				
Specific heat capacity J/(kg.K)	500	519	565	607	704
Thermal expansion 10^6 m/(m.K)		18.1	19.4	21.7	23.9
Magnetic permeability	1.002				

Notes: The thermal expansion of manganese steel is 1.5 to 2 times that of low alloyed carbon steel
The thermal conductivity of manganese steel is approximately 3 times lower than that of low alloyed carbon steel.

DELIVERY CONDITIONS

DELIVERY CONDITION

Creusabro® M is produced from electric arc furnace, ladle refined and vacuum degassed. Creusabro® M is supplied in the "as-quenched" condition. This final heat treatment (solution annealing followed by quenching) warrants virtually carbide-free microstructure that gives the characteristic properties of Hadfield steel.

Despite all due care during manufacture to avoid surface decarburization, a surface layer of approximately 0.2 mm depending on thickness could be present in the delivery condition.

DIMENSIONAL PROGRAM

The thicknesses range of **Creusabro® M** extends from 5 to 110 mm.

Thickness mm	5 -6	7 -8	9 -60	60 - 110
Casting	CC. Slabs	CC. Slabs	CC. Slabs	Ingots
Rolling	Quarto	Quarto	Quarto	Quarto
Width (mm)	1200 - 2000	1200 - 2500	1200 – 3000	1200 - 3250
Length (mm)	4000 - 13000	4000 - 13000	4000 - 13000	3000 - 10000
Max plate weight (t)	20	20	20	15

MANUFACTURING TOLERANCES

Dimensions and shape

Unless otherwise specified, tolerances on dimensions and shape are determined according to EN 10029. Tighter manufacturing tolerances for flatness are also available as per the following table.

Nominal Thickness (mm)	Thickness Tolerance (mm)	Flatness tolerances (mm) per 2000 mm	
	EN 10029 Class A(1)	EN 10029 Class N - steel type H	Industeel
5 -(8)	- 0.4 / +11	17	8
8 - (15)	- 0.5 / + 1.2	15	8
15 – (25)	- 0.6 / + 1.3	14	8
25 – (40)	- 0.8 / + 1.4	13	8
40 – (80)	- 1.0 / + 1.8	12	8
80 – 100	- 1.0 / + 2.2	12	8

(1) if class B, C , D or specific tolerances are required, it shall be indicated at the time of enquiry and order.
(2) After prior agreement at the time of enquiry and order.

Surface

Creusabro® M plates are delivered in accordance to EN 10163-2 Class A, Sub-class 1. The plate may be delivered with shot blast surface.

PLATE PROCESSING

The grade is processed by usual methods taking into account its aptitude for work-hardening, high coefficient of expansion, and low thermal conductivity.

Thermal **cutting** is possible using oxy-acetylene with iron powder addition or improved using plasma or laser cutting which result in a cleaner quality of cut.

Forming, by press-brake bending or rolling techniques, is easy at room temperature. Avoid forming directly on zones previously work-hardened, (e.g. sheared edges), carry out grinding of these areas.

PLATE PROCESSING

Shearing can be easily achieved with sufficiently powerful machines and freshly sharpened blades. When crossed cutting is necessary, intermediate local grinding is required on edges (already work-hardened).

Milling using carburized high-speed steel tools of HSSCO type (AISI grade M42) or carbide tipped tools (ISO grade K10) combined with large depths of cut produce the best results. During the machining of manganese, it is important to continuously remove the work-hardened zone with the next cut. Strong clamping, sharp tools and a stiff machine are required to with stand the high cutting forces and prevent any vibration.

Drilling using super carburized cobalt alloy high speed steel bits of HSSCO type (AFNOR grade 2-9-1-8, AISI grade M42), with reinforced shape, 130° point angle, long twist, low cutting speed (2-3 m/min.), high feed, lubrication using soluble oils.

Welding using standard procedures shall be carried out taking into account: high coefficient of expansion, low thermal conductivity, risk of carbide precipitation above 300°C (572°F).

To avoid the embrittlement of the base metal, welding is performed with no preheating, low heat-input E < 20 KJ/cm and interpass temperature lower than 100°C with water cooling, if necessary between each pass.

For heterogeneous welds (most common practice):

- For manual arc welding, typical recommended fillers are 18Cr8Ni6Mn or 20Cr10Ni3Mo (class A5.4E307 or 5.4E308Mo per AWS).
- For semi-automatic welding under gas, the same type of deposit is used in solid wire – class A5.2ER 307 or A5.9ER 308 Mo per AWS or coated wire – class A5.22E 307T or A5.22E 308 Mo T per AWS

For homogeneous welds, typical 13Mn3NiMo (class A5.13E FeMn per AWS) work hardening filler metal is appropriate for manual welding. For semi-automatic welding coated wire of similar composition, with or without protective gas.

APPLICATIONS

Creusabro® M is suitable for applications involving wear by impact or pressure, including low operating temperatures down to -60°C.

Due to its high resistance to both impact loads and abrasive wear, Creusabro® M has found many applications in crushing and earthmoving equipment, in railways and in the shot blasting industry.

Hence, in demanding applications such as primary rock crushing austenitic manganese steels are widely used. The component never gets brittle.

Due to its wrought structure, Creusabro® M offers enhanced properties compared to standard cast Mn parts.

Examples of manganese wear plates (X120Mn12) for shot blasting cabinets

Examples of manganese wear plates for wagon bogies

Electromagnetic separator drum

Lifting magnets

CONTACT

Gilles Hauden
Gilles.Hauden@arcelormittal.com

https://industeel.arcelormittal.com

Industeel France
Le Creusot Plant
56 rue Clemenceau
F - 71202 Le Creusot Cedex