Industeel

ArcelorMittal

MARS® 190

RHA steel (< 430 HB) for ballistic protection

MARS® 190 has been studied for vehicle structures (main battle tanks, armour personal carriers...), stationary protection (buildings, sentry boxes, observation posts...) and targets.
MARS® 190 has a very great adaptability, combining easy workability even in thick thicknesses, with good ballistics properties against all ammunitions.

Standards

INDUSTEEL : MARS® 190

MARS® 190 satisfies requirements of following specifications :

→ France	NF A 36-800-CLA
→ Germany	TL 2350 – 0000 Hardness G, H, K, L
→ UK	Stan 95-24 Class 1 and 2, Stan 95-13
→ US	MIL DTL 12560 CL 1.2.3

Chemical analysis - Weight %

C	S	P	Si	Mn	Ni	Cr	Mo	V
≤ .30	≤ .005	≤ .012	≤ .4	≤ 1.20	≤ 1.8	≤ 1.5	≤ .6	≤ .10

Chemical composition depends on thickness range (particularly Ni and Cr contents) and, possibly, on customer's specification

Mechanical properties

Plate thickness (t)		Usual hardness range (HB)	KCV -40° Transverse to rolling direction	
mm	*Inch*		J	*ft.lbs*
≤ 12	*≤ .47"*	352 - 388	≥ 20	*≥ 15*
12 < t ≤ 35	*.47 < t ≤ 1.38*	331 - 375	≥ 24	*≥ 18*
35 < t ≤ 60	*1.38 < t ≤2.36*	302 - 341	≥ 32	*≥ 24*
60 < t ≤ 85	*2.36 < t ≤ 3.30*	262 - 331	≥ 36	*≥ 26*
85 < t ≤120	*3.30 < t ≤ 4.72*	248 - 285	≥ 56	*≥ 41*
120 < t ≤150	*4.72 < t ≤ 6*	241 - 277	≥ 64	*≥ 47*

In table, are put typical values which may vary in terms of customer or specification requirements.

Heat treatment

MARS® 190 is a quenched and high tempered armour steel (≥500°C / 930°F)

Ballistic properties

Generalities

Threat	V_o (m/s)	Distance (m)	Obliquity	Thickness for protection	
				mm	inch
7,62mm ordinary x 51 .30 ball x 51	830 ±10	30	0°	9	*.35*
7,62mm P80 x 51 .30 AP x 51	830 ±10	30	0°	16.5	*.65*
12,7mm P Mle 47x99 .50 AP X 99	875 ±10	100	0°	26	*1.02*
14,5mm API B32 x114	1000	100	0° 30° 60°	39 24 12	*1.54* *.94* *.47*
20mm OPT x 139	1100	200	30° 60°	46 22	*1.81* *.87*
25mm APDST x 137	1345	300	45° 60°	47 34	*1.85* *1.34*
35mm APDST x 228	1385	300	45° 70°	65 33	*2.56* *1.30*

According to 4569 STANAG AEP-55 / Volume 1 / Edition C / Version 1 (April 2014)

Level	KE Threat		Required thickness for protection (mm-inches)	
	Calibre and projectile type	V proof (±20m/s)	MARS®190	
3	7.62 mm x 51 AP WC (8.4g core)	930	23 *(.906")*	**23 *(.906")***
	7.62mm x 54 API B32 (10g core)	854	20 *(.787")*	
2	7.62mm x 39 API BZ (7.8g core)	695	13,5 *(.531")*	
1	7.62mm x 51 NATO (9.7g)	833	10,5 *(.413")*	**10,5 *(.413")***
	5.56mm x 45 NATO SS109 (4g)	900	7,6 *(.299")*	
	5.56 x 45M 193 Ball (3.56 g)	937	9,5 *(.374")*	

2	20mm FSP	630	**15 *(.591")***

Processing

Cutting

Standard thermal cutting techniques (oxygas, plasma, laser) can be used without any special precautions (pre or post-heating) for thicknesses up to 75 mm (*3"*)

Forming

MARS® 190 can be cold bent – The rough cut edges have to be ground prior to cold forming

For 90°
t=thickness

Bending radius	≥ 5 t
V die opening	≥ 12 t

Hot forming can be performed according to process ① or ②; nevertheless, consult us before because temperatures vary according to thickness.

① Heating at 900/950°C (*1650/1740°F*), mandatory to make a new quality treatment including quenching + tempering.

② Heating at 450/550°C (*840/1020°F*) – air cooling after forming.

Welding

MARS® 190 can be weld assembled without any pre-heating or stress-relieving. The edges of cut parts or plates must be ground to remove any traces of oxide or surface defects.

In each case, the processes used must be lead to an austeno-ferritic alloy weld deposit. Electric arc welding with the 20-10-3 austeno-ferritic welding rod with basic coating is recommended for this purpose.

MIG welding using wire type 18-8 Mo can also be performed.

The following precautionary steps warrant the quality of the joints :

→ Be sure that plate temperature is not below 10°C (*50°F*).
Oven-drying of the welding rods (generally *350°C/660°F*), then stored at 150°C (*300°F*) before welding.

→ Ignition on an overlength rather than on the joint itself.

→ Short arc to optimize the protection of the welding-rod coating.

Sizes and Tolerances

Sizes

MARS® 190 is supplied as tailor made mill plates, and standard sizes.

Thickness range	4-150mm (*.157"-6"*)

For target application, we can supply plates up to 600mm (*23.6"*) thick
(see our specific brochure on Targets).

Medium and thick plates (30-100mm / 1.2" - 4")

Tolerances on thickness

(Possibility of lower tolerances on request)

Thickness		Tolerance for width ≤ 2000mm (≤ 79")		Tolerance for 2000 < width ≤ 2500mm (79" < w ≤ 98")	
mm	*inch*	mm	*inch*	mm	*inch*
≤ 20	*≤.79*	1	*.04*	1,2	*.047*
> 20 to 35	*> .79 to 1.38*	1,2	*.047*	1,4	*.055*
> 35 to 50	*> 1.38 to 1.97*	1,6	*.063*	1,8	*.071*
> 50 to 80	*>1.98 to 3.15*	2	*.079*	2,2	*.087*
> 80 to 150	*> 3.15 to 5.91*	2,2	*.087*	2,4	*.094*

Tight tolerances

± 0,2 mm / ± .008"

Thickness	Maximum width mm (")
4,0 to 6,1mm *.157 to .243"*	1500 (*59"*)
6,2 to 8,0 mm *.244 to .315"*	2000 (*79"*)
8,1 to 10 mm *.316" to .323"*	1500 (*59"*)

Flatness

Our products are delivered as standard with a flatness of less than or equal to 3mm/m (1/8" in every 40").

Parts - Kit offer

Following customers requests, we can supply MARS® 190 parts : laser or oxygas/plasma cut (depending on thickness), formed, welded, machined, painted options... Please, contact us for your specific project.

For target applications, MARS® 190 parts can be supplied with holes or handles for manutention (see our specific brochure on Targets).

For any information

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transforming tomorrow

Parts in 80mm (3.15") thickness realized according to customer request : piling, welding, machining, shotblasting, varnishing