Industeel

ArcelorMittal

Mars® 600

Mars® 600: Ultra high-hardness steel (600 HB) for ballistic protection

Mars® 600 is an ultra high hard armor steel (600 HB) having both very high ballistic performances and integration possibilities similar to those of structural materials.

Mars® 600 is an innovative product from the Center Materials Research of Le Creusot, and Industeel rich expertise for over a quarter century on modern 600 HB materials.

Mars® 600 is a multipurpose 600HB with an impressive ballistic behavior in terms of deformation capacity, resistance to multi-impacts with workability (mainly bending) close to a 500HB steel.

Mars® 600 is the material of the future that will change designs meeting both light weight and integration requirements of manufacturers. Its greats properties suggest unlimited of use possibilities.

PROPERTIES

STANDARDS

INDUSTEEL: Mars® 600

Mars® 600 satisfies requirements of following specifications:

> France	NF A 36-800-1 THD4
> Germany	TL 2350-0000 Quality T
> UK	DEF STAN 95-24 Class 5
> USA	MIL 32 332 Class 1

CHEMICAL ANALYSIS - WEIGHT %

C	S	P	Si	Mn	Ni	Cr	Mo
.40 - .50	≤ .002	≤ .010	≤ 1.0	≤ 1.0	1.4 - 2.4	≤ .5	≤ .5

MECHANICAL PROPERTIES

As supllied	Hardness	Yield Strength		UTS		Elongation	Résilience KV-40° Sens travers	
	HB	MPa	ksi	MPa	ksi	5d(%)	J*	ft.lbs*
Minimum values	578 - 655	≥ 1300	189	≥ 2000	≥ 290	≥ 7	≥ 16	≥ 16
Typical valued	601	1450	210	2150	305	10	23	17

** Standard specimen: 10 x 10 mm*

HEAT TREATMENT

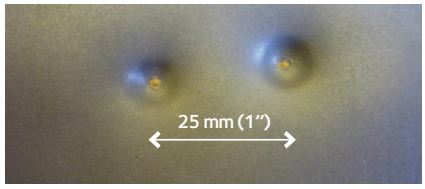
Mars® 600 is a quenched and low tempered armour steel. Mars® 600 may not be heated above 120°C (250°F) in order to maintain the guaranteed hardness

BALLISTIC PROPERTIES

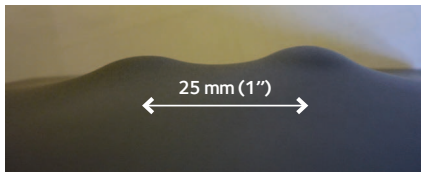
Mars® 600 used as solid plate (stand alone)

Application	Level	Obliquity	Thickness for protection**		Saving in weight in comparaison with 350 HB	Saving in weight in comparaison with 500 HB
Civil	EN 1522 FB4+	0°	3.9 -0 +0.4 mm*	.142"	40%	13%
	EN 1522 FB5	0°	5.2 -0 +0.4 mm	.205"	35%	13%
	EN 1522 FB6	0°	5.2 -0 +0.4 mm	.205"	35%	13%
	EN 1522 FB7	0°	11 -0 +0.5 mm*	.453"	50%	36%
Military	4569 stanag level 1	0°	7.2 -0 +0.4 mm*	.295"	30%	20%
	4569 stanag level 2	0°	8.5 -0 +0.4 mm	.335"	35%	30%

** thickness tolerance depends on width*



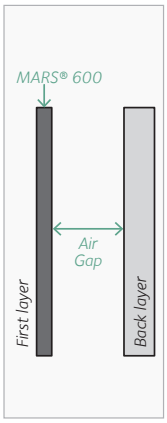
7,62 ordinaire x51 - Mars® 600 th 5.3 mm (.21")

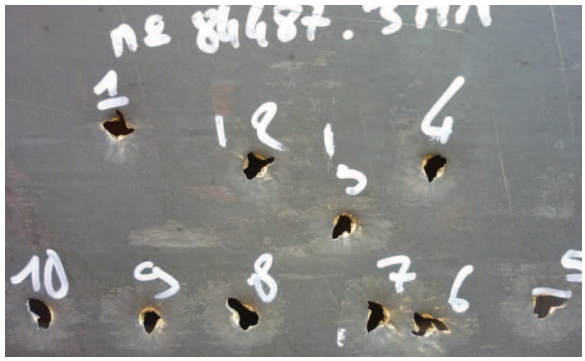


Shots to 890m/s (2920 ft/s)- 0°

Mars® 600 used as add-on-armor or as a first of double layers systems

Application	Level	i	Mars 600 Thickness	Air gap	Back layer Minimum thickness for protection		Saving in weight in comparison monolhitic solution 350 HB	Saving in weight in comparison monolhitic solution 500 HB
Civil	EN 1522 FB7	0°	5 mm	10 mm	6,5 mm	Mars® 240	28%	23%
Military	4569 stanag level2	0°	5 mm	10 mm	6,5 mm	Mars® 240	15%	10%
	4569 stanag level3 a	0°	5 mm	10 mm	8 mm	Mars® 190	30%	25%
	4569 stanag level4	0°	8.5 mm	30 mm	1 5 mm	Mars® 190	35%	30%





Mars® 600 first layer:excellent multi-hit capability, without any cracking

Projectiles cores destroyed by Mars® 600 hardness

DELIVERY CONDITIONS

SIZE AND TOLERANCES

Mars® 600 is supplied as tailor made mill plates, or standard sizes plates.

Sizes

Thickness range	3 - 15 mm (.118" - .6")

This thickness range is designed to reply to current market needs.
For other sizes, please contcat us.
Its extension to higher thicknesses is possible and will be according to needs.

Flatness - 3 mm /m (1/8 in every 40")

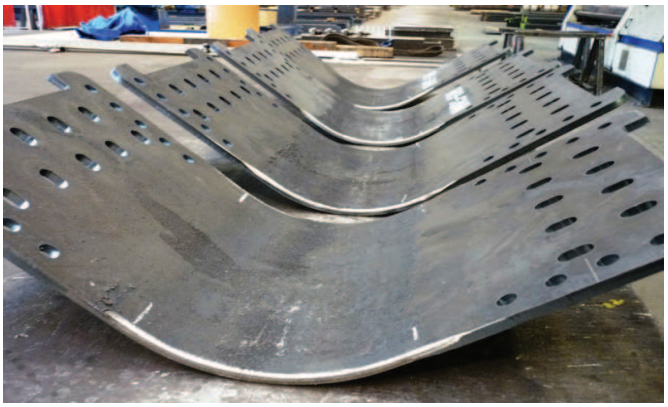
Typical values :
95% of plates are delivered with flatness ≤ 1,5 mm/m (.060" in every 40").
Our specificity: a flatness quenching machine, which procures a very low level of residual stresses in view to obtain an homogeneous ultra high hardness "quiet" material: deformations during cutting plates or parts are avoided, and flatness is conserved after cutting operations.

DIMENSIONAL PROGRAM

Mill	Thickness		Maximum width		Tolerances on thickness			
	(mm)	(inch)	(mm)	(inch)	(mm)		(inch)	
Tight Tolerances	3.0 to 4.0	.118 to .157	1250	49	- 0	+ 0.4	- 0	+.016
	4.0 to 5.9	.157 to .235	1500	59				
	6.0 to 10.0	.236 to .393	2000	79				
Standard Tolerances	5.0 to 12	.197 to 590	2000	79	- 0	+ 0.8	- 0	+.031
	6.0 to 12	.236 to 590	2500	98	- 0	+ 1.0	- 0	+ .039
	> 12	> .590	2000	79	- 0	+ 1.0	- 0	+ .039
			2500	98	- 0	+ 1.2	- 0	+ .047

PARTS - KIT OFFER

Mars® 600 is also supplied as cut parts by laser or waterjet (depending on thickness) up to finished complex parts and kits (formed, machined, painted options...): *contact us for your specific project*.



Mars® 600 - Cold bended parts thickness 8,5 mm (.34 ") Mandrel radius 120 mm (407")

PLATE PROCESSING

CUTTING AND DRILLING

We recommend laser. Standard thermal cutting techniques (oxygas, plasma) can be used . Our geometric recommendations: all reflex angles with radius ≥ thickness.

COLD FORMING

Considering its ultra high hardness material (600HB), forminghas to be realized with firstly personal safety precautions. Preparation of parts:

> Breaking angles of edges with a grinding wheel
> Ensure that there are no obvious defects (striated grinding lines for example)
> Preliminary trials on prototypes
> Bending with slow fall the first pieces
> Pinching to be used very carefully
> Dye penetrant test in the area in extension at east for the first pieces
> Minimal recommended temperature: 15 °C (60 °F)

Zoom on a bended part th 8.5 mm

Thickness (mm)	Bending line // Rolling direction	Bending line ⊥ Rolling direction
< 4 mm (.16")	R = 10 x ep	R = 8 x t
From 4 (.16") to < 6 mm (.24")	R = 12 x ep	R = 10 x t
From 6 (.24") to < 9 mm (.35")	R = 14 x ep	R = 1 2 x t

R = Minimum **mandrel** *radius - t = thickness of plate - Vé opening recommended : (Rx2) + (3xt)*

Bended samples (500x500 mm) in 4 and 5 mm thickness

WELDING

According to high level content of carbon, we initially recommended to contact us before welding realizations; Industeel will advise on the processes and parameters of your specific request.
Here after is a summary of general basis recommendations.

> Using austenitic 307 products (18.8) or 20.10.3
> No preheating is required except for hard configuration
> Weld on grinded and degreased parts
> Single pass
> Softening in HAZ to take into account at design stage
> keeping the heat input low to reduce HAZ sizeconception.

YOUR CONTACTS

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