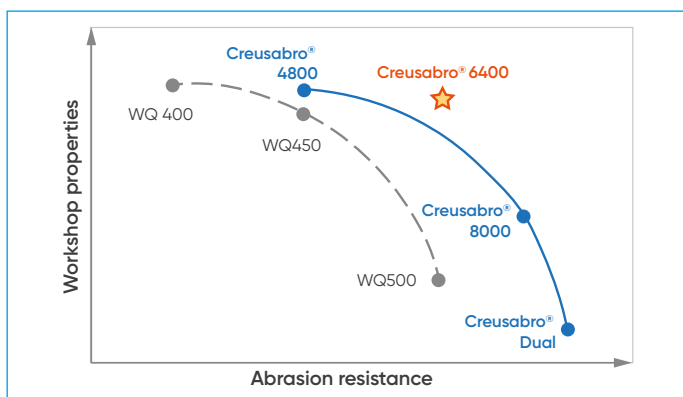


Industeel

Creusabro® 6400



Creusabro® 6400 : the best combination between wear resistance and formability



Creusabro® 6400 has been developed to meet all situation where improved wear resistance is required keeping the same formability and easy process-ability in the workshop as classical 450 HB plates.

Creusabro® 6400 is designed without compromise on toughness, and a hardening effect allowing comparison with 500/550 HB martensitic steels.

Metallurgical concept

Besides the 4800 and 8000 grades, **Creusabro® 6400** is genuinely different than classical low alloyed martensitic abrasion resistant plates. The original chemical composition and the soft quenching rates used in the mill fabrication process develop a uniform through-hardened plate having a multiphase microstructure with retained austenite. This unique metallurgical combination enhances the capacity of surface exposed to wear to increase its hardness up to +70 HB under the action of local plastic deformations caused by impact with rocks or pressure by the abrasive particles. This is known as TRIP-effect (Transformation Induced Plasticity).

Properties

Standards

Creusabro® 6400 is a proprietary grade and registered trademark developed by Industeel. There exists no product standard plates intended for wear resistant applications.

Chemical Analysis – Ladle analysis in weight % (Max. values).

C	S	P	Mn	Ni	Cr	Mo
≤ 0.22	≤ 0.003	≤ 0.02	≤ 4.2	≤ 0.25	≤ 0.25	≤ 0.2

Mechanical Properties

	Hardness (HBW)	Tensile properties			CVN-impact longitudinal -20°C
		YS 0.2% (MPa)	UTS (MPa)	Total Elong. (%)	
Typical	450 ⁽²⁾ → 530 ⁽³⁾	1000	1450	12	50
Specification	400 – 480 ⁽¹⁾	–	–	–	> 27 ⁽⁴⁾

(1) HBW Brinell hardness measured according to ASTM A370, on a milled or ground surface below the decarburized layer typically 0,2–3 mm depending on plate thickness; (2) as-delivered; (3) after work-hardening; (4) for plates up to 30 mm only. Impact testing not performed by the manufacturer; no test value reported in the mill certificate.

Plate processing

Cutting

Waterjet cutting is the most recommended method as it avoids the formation of a Heat Affected Zone (HAZ). This absence of HAZ reduces the risk of cracking.

The thermal processes of oxy-fuel cutting, plasma and laser cutting can also be used. Among these techniques, plasma and laser cutting are highly recommended to achieve greater precision, improved cutting quality and to minimize the extent of the HAZ. The hot cutting conditions to avoid hydrogen cracking are specified below:

Plate temperature	Thickness ≤ 40 mm	Thickness > 40 mm
≥ 10 °C	No preheating	Preheating 200°C (392 °F)
< 10 °C	All thickness: preheating 200°C (392 °F)	–

Plate thickness (mm)	Maximum flame cutting speed (mm/min)
5	–
10	–
40	220
50	190
70	170
100	140

Machining

Drilling could be done with high speed tools, HSSCO type. (ex. AR 2.9.1.8 according to AFNOR, M42 according to AISI) Lubrication with soluble oil diluted to 20%.

Tool	Ø mm	Cutting speed (m/min)	Revolution Speed (rev/min)	Feed mm/rev
HSSCO AR.2.9.1.8 (M42)	5	15 – 20	950 – 1250	.07
	10	13 – 17	415 – 540	.09
	15	12 – 15	255 – 320	.10
	20	11 – 14	175 – 220	.12
	25	9 – 12	115 – 150	.15
	30	8 – 10	85 – 105	.20

Milling could be done with cutting tool with insert F40 m. Lubrication with soluble oil.

Tool	Depth (mm)	Cutting speed (m/min)	Feed tooth
F40M Ø 12mm	1-5	70-200	.12-.35

Indicative parameters

Forming

Cold forming of **Creusabro® 6400** can be done without any problem when the following conditions are met:

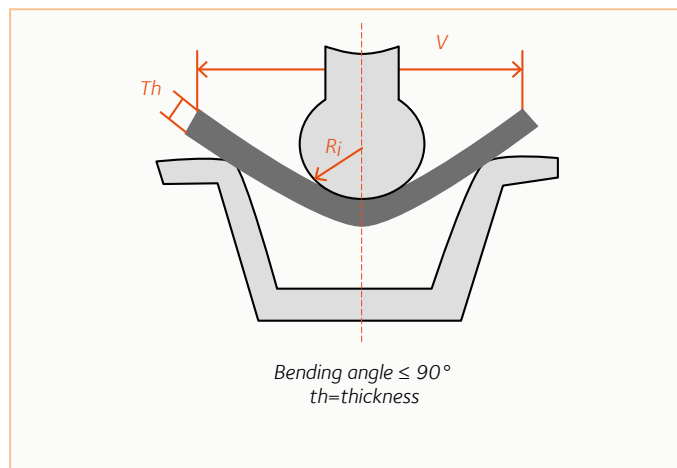
- > No marks or scratches in shaped zones, mainly on external face
- > Bevelling by grinding of edge angle both on extended and compressed skin. If required grinding to remove cutting heterogeneities
- > Minimum internal bending radius (table below),
- > Plate temperature > 10°C (50°F).

Bending properties

Recommended minimum bending radius and die opening are summarized in the following table.

Creusabro® 6400 is a highly hardening steel (up to 550 HB), therefore grinding the heat affected zone is mandatory. More severe radius can be reached under specific preparation (consult us).

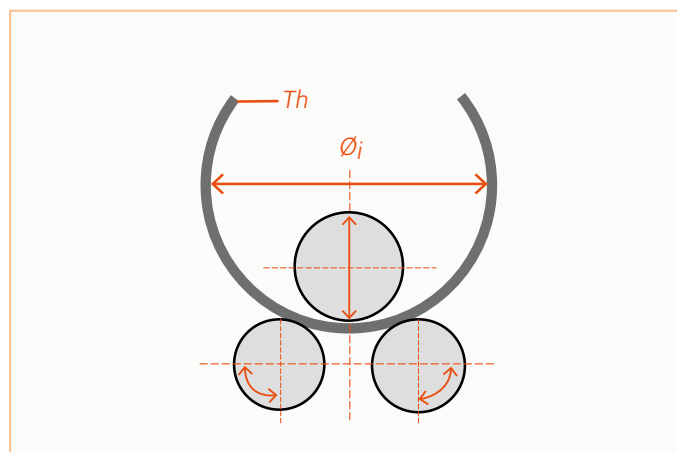
	Min Internal bending radius Ri	Min die opening V
Perpendicular to the plate rolling direction	3.5 t	14 t
Parallel to the plate rolling direction	4.5 t	16 t



Bending

The required power to bend the **Creusabro® 6400** mainly depends on bending length, thickness and die opening. Some indicative values for V = 14 t are proposed in the table below.

Plate thickness (mm)	Bending strength L = 1 m (ton/m)
5	80
10	150
20	300
30	460



Welding

		combined thickness (mm)							
	Heat input (kj/cm)	20	30	40	50	60	70	80	90
Semi-auto under gas (solid, flux or metal cored)	10								
	20								
Semi-auto. under gas	10								
	15								
Submerged arc welding	20								
	40								

- Without pre - heating
- Pre - postheating at 75°C (167°F)
- Pre - postheating at 125°C (257°F)

	SMAW	GMAW	FCAW	wire	flux
BOHLER	FOX EV 50	Pipeshield X 56	diamondspark 53 RC	Union S 2 Si	UV 418 TT
	EN ISO 2560-A : E 42 5 B 4 2 H5	EN ISO 14341-A : G 42 5 M21 2Si	EN ISO 17632-A : T 46 5 P M21 1 H5	EN ISO 14171-A : S 42 5 FB S2Si H5	-
	AWS A5.1 : E7018-1H4R	AWS A5.18 : ER70S-3	AWS A5.20 : E71T-1M/T-9M/T-12M JH4	AWS A5.17 : F7A6-EM12K	-
ESAB	OK 55.00	OK AristoRod 12.62	Dual Shield Prime 71 LT H4	autrod 13.40	OK Flux 10.62
	EN ISO 2560-A : E 46 5 B 3 2 H5	EN ISO 14341-A : G 46 4 M21 2Ti	EN ISO 17632-A : T 42 4 P M21 1 H5	EN ISO 14171-A : S3Ni1Mo	-
	AWS A5.1 : E7018-1H4R	AWS A5.18 : ER70S-2	AWS A5.20 : E71T-1C/1M/9C-J/9M-J-H4	SFA/AWS A5.23 : EF3	-
LINCOLN	Baso G	SUPRAMIG ULTRA	FLUXOFIL 464M	L50M	Lincolnweld 842-H
	EN ISO 2560-A : E 42 5 B 32 H5	EN ISO 14341-A : G50 5 M21 4Si1	EN ISO 17634-A : T 46 4 P M21 1 H5	EN ISO 14171-A : S3Si	-
	AWS A5.1 : E7018-1 H4R	AWS A5.18 : ER70S-6	AWS A5.20 : E71T-1M-JH4	AWS A5.17 : EH12K	

Dimensional program

The thicknesses range of **Creusabro® 6400** extends from 5 to 100 mm, available from standard plate sizes, typically 6000, 8000 or 12000 mm long and 2000 or 2500 mm width. Tailored dimensions are available upon inquiry within the limits given in the following table.

Thickness (mm)			Min Width (mm)	Max Width (mm)	Min Length (mm)	Max Length (mm)	Max unit plate weight (t)
5	to	5.99	1 200	2 000	4 000	13 000	12.5
6	to	8.99		2 500			
9	to	11.99		2 500		14 000	
12	to	24.99		3 000			
25	to	40		3 000			
41	to	100	1 500	3 000	3 000	10 000	20

Delivery conditions

Creusabro® 6400 is supplied in "as rolled" condition up to 35 mm, in "as quenched" condition after. The plates are produced by low CO2 process in Belgium and France from electric arc furnace, ladle refining and vacuum degassing. The use of scrap recycling and medium manganese content instead of expensive alloying elements such as molybdenum or nickel contribute to reducing the consumption of energy and critical raw materials.

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Technical data and information are to the best of our knowledge at the time of editing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.