Industeel

Creusabro® 8000



Creusabro® 8000 : a high performance wear and impact resistant steel

Creusabro® 8000 is a high performance wear resistant steel, exhibiting a wear resistance 50% higher than conventional 500HB water quenched steel, combined with excellent weldability and very acceptable workability. Rather than relying exclusively on a high hardness level, properties of **Creusabro® 8000** are improved as a result of the combination of an enriched alloying content (chromium, nickel, molybdenum and titanium) and specific heat treatment procedures.

The moderate hardness of **Creusabro® 8000** in the as delivered condition makes processing operations like cutting, machining and forming easier and far better than ordinary water quenched steels.

When in service, **Creusabro® 8000** strongly improves its wear resistance by a surface hardening effect of about +70 HB under the action of local plastic deformations caused by impact with rocks or pressure by the abrasive particles.

Creusabro® 8000 is ideal for applications in mines and quarries, cement and steelmaking industries, public works and agricultural machinery. In the toughest industries such as mining and earth moving, the higher resistance to wear and impact abrasion translates into increased service life of wearparts and components made of **Creusabro® 8000** against conventional water quenched steels. As a result, significant costs saving benefits are achieved to plant maintenance budgets.

The grade is suitable for all types of abrasion, sliding or impact, dry or wet environments, including operating temperatures up to 450°C.

Properties

Standards

Creusabro® 8000 is a proprietary and exclusive grade developed by Industeel.

There exists no engineering standard for plates intended for wear resistant applications.

Chemical Analysis - % Weight (Max. values).

C	S	P	Mn	Ni	Cr	Mo
≤ 0.28	≤ 0.005	≤ 0.018	≤ 1.6	≤ 1.0	≤ 1.9	≤ 0.40

Mechanical Properties (Indicative values).

Hardness (HB)	Y S MPa (ksi)	UTS MPa (ksi)	Elongation 5.65 %	KCVL - 20°C/-4°F J (ft.lb)	Elasticity modulus GPa
470	1250 (181)	1630 (236)	12	50 [1] (37)	205

Guaranteed values (as supplied) Hardness **430 - 500 HB**, KCVL[1] -20°C **27J** (20ft-lb)

(1) thicknesses 20-100mm

Physical Properties

Density at +20°C (68°F) = 7.85kg/dm^3

Expansion coefficient - average (10-6/°C)

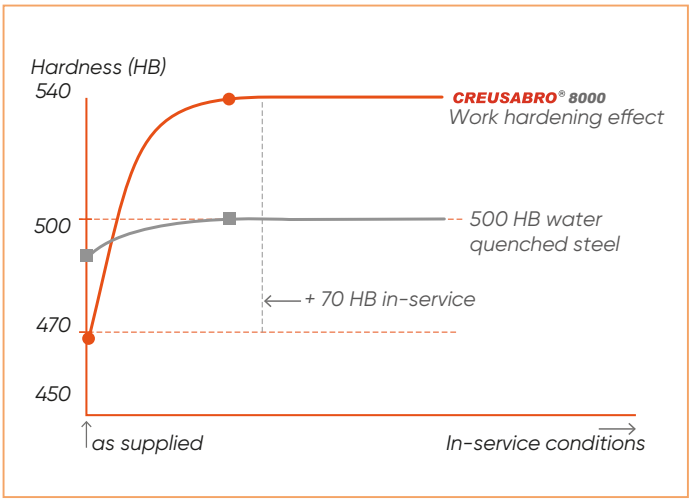
20/100°C (68/212°F)	20/200°C (68/392°F)	20/300°C (68/572°F)	20/400°C (68/752°F)	20/500°C (68/932°F)
11.2	12.0	12.5	13.2	13.8

Metallurgical Concept

Wear resistance depends not only on the hardness of the steel in the as delivered state, but also on the other properties, such as crack resistance, work hardening, strength, ductility, softening resistance, etc. The performance in service of given wear resistant steel is strongly influenced by the microstructure obtained after thermal processing. In the case of **Creusabro® 8000** , a significant improvement of the wear resistance in service is mainly due to the following properties:

«TRIP effect»: TRansformation Induced by Plasticity

Due to its initial structure not fully martensitic (a mix of martensite, bainite and retained austenite), **Creusabro® 8000** has the ability to work-harden when submitted to local plastic deformation in service. Plastic deformation induces a surface hardening phenomenon by transformation of retained austenite into fresh and very hard martensite while the material remains ductile underneath, makes it a most effective to withstand both abrasion and heavy impact in service.



In addition, the super ductility of the retaine austenite contributes to improve the lifetime in service by allowing larger micro shearing and thus delays the ultimate tearing of metal particles from the surface of the material exposed to the abrasive.

Fine dispersion of micro carbides

The fine microstructure of **Creusabro® 8000** is a result of a specific chemical composition combined with a controlled cooling rate. Such a microstructure differs from the rough acicular lamellar structure which is typical of the fully martensitic steels (conventional 500 HB water quenched steels). Moreover, the fine and homogeneous dispersion of micro carbides significantly contributes to improve th e reinforcement of the matrix by improving the sliding wear resistance in service.



Creusabro® 8000
microstructure

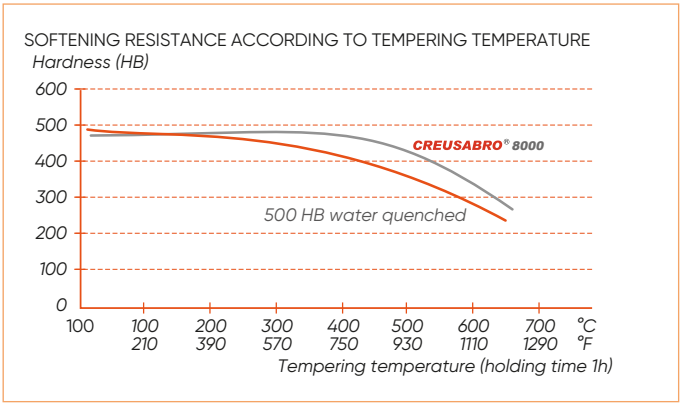


500 HB Water quenched microstructure

500 HB water quenched steel Conventional route Passive steel	Creusabro® 8000 Alternative route Active steel
- Restricted alloy elements (mainly C, Mn, B) - Drastic water quenching - Fully martensitic structure	- Specific chemical composition - Controlled cooling - Martensite + bainite + retained austenite - Perfect balance: high wear resistance + improved workability - Wear resistance in service is a combination of: - work-hardening (TRIP effect) - Presence of micro-carbides (chromium, molybdenum, titanium) - Delayed tearing of metal particles (super-ductility of the retained austenite).
Wear resistance in service is a result of the hardness in the as delivered state. It is an answer for common applications	**Creusabro® 8000** is an answer for specific applications.

Properties At High Temperature

Chemical composition of Creusabro® 8000, and especially chromium, molybdenum and titanium contents, confers a high softening resistance to the material. Such a quality allows using **Creusabro® 8000** in hot service conditions, at a maximum of 450°C (840°F) while conventional 500 HB water quenched steels are limited to 250°C (480°F). It is also possible to process the steel at high temperature 500-550°C (930-1020°F) (hot forming: bending, rolling) followed by a slow air cooling without any significant drop of hardness (about 30-50 HB).



Yield Strength		
200°C (392°F)	400°C (752°F)	500°C (932°F)
1080 (156)	880 (127)	520 (75)

UTS		
200°C (392°F)	400°C (752°F)	500°C (932°F)
1650 (236)	1250 (181)	900 (130)

Service life

Whatever the service conditions, the original metallurgical concept of **Creusabro® 8000** confers to the material an improvement of its performance in terms of wear resistance and workability, compared to other conventional 500 HB water quenched steels. **Creusabro® 8000** is particularly suitable for extreme applications, when severe abrasion conditions are combined with huge impact, heat or moderate corrosion.

Field tests

Many tests were performed in different areas of industries which confirm the high performance of **Creusabro® 8000** compared to 500 HB water quenched steels.

Service life versus 500 HB steels			
Areas of industries	Application	Thickn. Piece	Service life
Mines (gold ore)	Wear parts - External liner of bucket excavator	30 mm (1.2")	+ 100%
Foundry (handling hot agglomerate)	Extracting plates	12 mm (.47")	+ 36%
Iron making (iron ore + coal)	Wear parts - Internal chute liner	15 mm (0.6")	+ 35%
Fertilizer industry	Crushing hammers	15 mm (0.6")	+ 58%
Wood industry	Pneumatic chip handling (pipe elbows)	12 mm (.47")	+ 38%
Glass recycling (calcin)	Belt conveyor (guide plate)	15 mm (0.6")	+ 69%
Quarry (granite)	Wear parts (internal side of a jaw crusher)	40 mm (1.6")	+ 50%

Delivery conditions

Sizes - Tolerances

Product - Thickness	Width	Length	Flatness tolerance
COILS - 3,17 to 6 mm (.124"- 0.24")	1500 (4.92")	Consult us	3 mm/m (.118")
PLATES - 5 to 100 mm (.20"- 4")	2000 (6.56")	6000 (19.7")	5 mm/m (.20")
	2500 (8.2")	6000 (19.7")	
	2500 (8.2")	8000 (26.2")	

Other sizes - please consult

Plate processing

Cutting

All classical thermal processes (oxygen - plasma - laser) can be used. Plasma and laser processes are especially recommended, to obtain better precision and cutting aspect and to minimize the extend of the Heat Affected Zone (HAZ). Whatever process (thermal) is used, following conditions are sufficient to avoid any cold cracking:

Plate temperature	Thickness ≤ 40 mm (1.57")	Thickness > 40 mm (1.57")
≥ 10°C (50°F)	No preheating	Preaheating 150°C (302°F)
< 10°C (50°F)	All thicknesses: preheating 150°C (302°F)	

Water jet cutting also can be used.
Shearing of thin plates is not recommended.

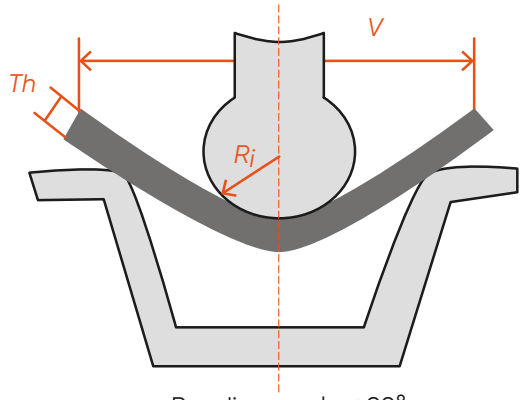
Forming

Cold forming can be done under the following appropriate conditions:

> edge preparation by grinding to remove flame cutting heterogeneities
> minimum internal bending radius (table below)
> Plate temperature > 10°C (50°F).

internal bending radius (min.) th=thickness

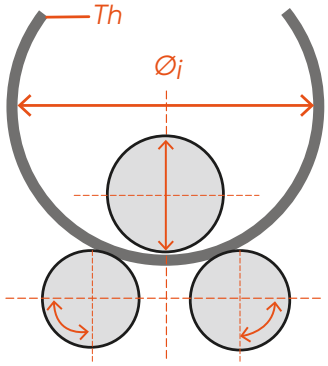
⊥ to rolling direction	ri ≥ 5 th
// to rolling	ri ≥ 6 th
Die opening V (mini)	V ≥ 14 th



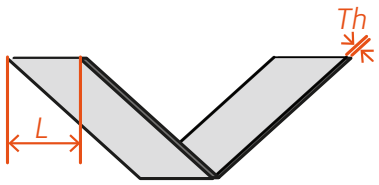
Bending angle ≤ 90°
th=thickness

According previous parameters, bending strength depends on bending length, thickness, die opening... Table here after gives indicative power needed to bend for a die opening of 14 times the thickness.

Th plates (mm)	Bending strength L = 1 m (ton/m)
10	200
20	430



Rolling shall be performed in following conditions:
ØI ≥ 40 th
(temperature of the piece ≥ 10°C - 50°F)



Machining

Drilling shall be done with high speed steels HSSCO type (ex. AR 2.9.1.8. according AFNOR, M42 according to AISI) taper shank. Carbide tip drills (K10 or K20 according to ISO) and possibly coated (TiN) shall significantly improve drilling performances in case of medium to large production.

Tool	Ø mm	Drillingspeed (m/min)	Revolution Speed (rev/min)	Feed mm/rev
HSSCO AR.2.9.1.8 (M42)	10	4 -6	125-190	.007
	20		65-95	.10
	30		40-65	.12
Carbide K20	10	18-22	575-700	.007
	20		285-350	.10
	30		190-235	.12

Milling

Shall be done with HSSCO tools (AR.6.5.2.5. according to AFNOR, M35 according to AISI or AR.12.0.5.5/T15). A better efficiency will be obtained with carbide tips P10/P30 (rough machining) or K10/K20 (finishing).

Quality	Depth mm (inch)	Cutting speed (rev/mm)	Feed (mm/tooth)
HSSCO AR 12.0.5.5 (T1 5)	1 (.04")	10-12	0.08
	4 (.16")	8 - 10	0.12
	8 (.31")	5 - 8	0.12

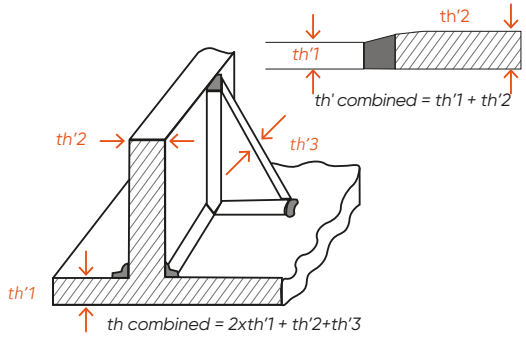
Welding

Creusabro® 8000 (ISO/TR 15608 class 3.3) can be welded with all classical processes: manual, semi-automatic under gas protection, automatic under flux. For welds non subjected to wear, following welding products can be used:

Processes	AFNOR	DIN	AWS
Manual coated electrode	A81-309 E51 4/3 B	DIN 1913 Class E514/3B10	AWS 5-1 Class E7016 or 7018
Semi - automatic Under gas	A81311 GS2	DIN 8559 SG2	AWS A-5-18 Class ER70S4 or ER 70S6
	A81350 TGS 51BH TGS 47BH	DIN 8559 SGB1 CY 4255	AWS-5-20 Class ER 71T5

For welds exposed to wear, please ask for advice on the choice of welding products and processes and parameters. Welded area must be free of grease, water, oxides... As best practice, we recommend a minimum preheat of 120°C (250°F) to ensure the joint is dry. Electrodes and flux shall be stoved according to supplier recommendations. Following preheating conditions can be used when welding in a dry controlled environment and provided the weld joint is not subject to excessive stress.

COMBINED THICKNESS CALCULATION



Heat input (kj/cm)	Combined thickness mm (inch)								
	10 .39	20 .78	30 1.18	40 1.57	50 1.96	60 2.36	70 2.75	80 3.14	90 3.54
Semi - automatic under gas	15/20								
Semi-auto. under gas	15/30								
Submerged arc welding	20/30								

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



Applications

Creusabro® 8000 can be used with success in a wide range of application - as example:

> Bucket liners for excavator, shovel, loader, dozer, ...
> Cutting edges, stiffeners... for different types of buckets
> Truck tray body liners
> Wear parts for primary and secondary crushers
> Vibratory feeder liners
> Chute liners
> Hopper liners
> Screens
> Trommels
> Pipe elbows
> Cyclones
> Deflectors
> Grinder liners (SAG Mill)
> Demolition tools (recycling)
> Pipes for dredging
> Blade liners for heavy duty fans
> ...



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