

CREUSABRO® 8000^(P)

A high performance wear resistant steel

CREUSABRO 8000 is a high performance wear resistant steel, exhibiting a wear resistance of 50% higher than that of conventional 500 HB water quenched steel.

CREUSABRO 8000 is using an innovative concept, based on a unique combination of chemical analysis and heat treatment procedures (oil quenching). This confers to the steel an improved wear resistant by the contribution of :

- a very fine distribution of chromium and molybdenum microcarbides reinforcing the microstructure with the same principal as composite materials.
- a very efficient work hardening capability in service, coming from a metallurgic effect called TRIP effect (**T**Ransformation Induced by **P**lasticity).

In addition to its high wear resistance, CREUSABRO 8000 still maintains a very good aptitude to processing, far much better than that of 500 HB water quenched. CREUSABRO 8000 offers consequently the best possible optimization of an exceptional wear resistance and a very acceptable workability.

Application markets of CREUSABRO 8000 are : mines, quarries, cement industries, steel making, publics works...

STANDARD

CREUSABRO 8000

CHEMICAL ANALYSIS

Guaranted values (Weight %)

C	Mn	Ni	Cr	Mo	S
≤ 0,28	≤ 1,60	≈ 0,40	≤ 1,60	≥ 0,20	≤ 0,002

MECHANICAL PROPERTIES

Hot mechanical properties (indicative values)

Indicative values (As delivered)

Hardness HB	YS 0.2 MPa (KSI)	UTS MPa (KSI)	EI. %	KCVL-20°C (-4°F) J/Cm ²	E GPa
470	1250 (181)	1630 (236)	12	55	205

Guaranted values (As delivered)

Hardness : 430/500 HB

Toughness : KCVL -20°C (-4°F) ≥ 40 J/cm²

® Trademark registered by USINOR INDUSTRIEL

(P) Grade patented by USINOR INDUSTRIEL

PHYSICAL PROPERTIES

METALLURGICAL CONCEPT

YS MPa (KSI)			UTS MPa (KSI)		
200°C (392°F)	400°C (752°F)	500°C (932°F)	200°C (392°F)	400°C (752°F)	500°C (932°F)
1080 (156)	880 (127)	520 (75)	1650 (239)	1250 (181)	900 (130)

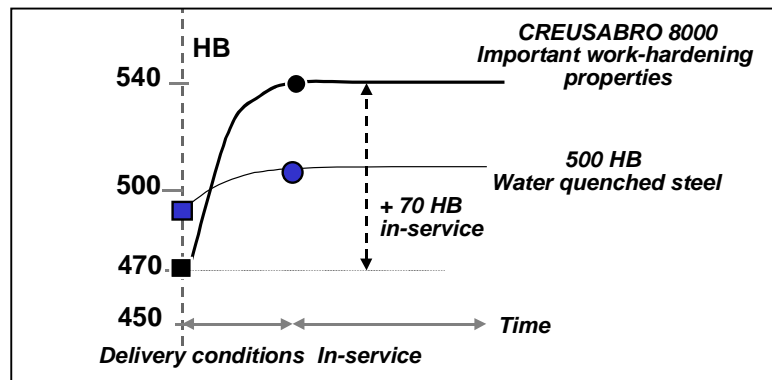
Density at +20°C (68°F) : 7,85 kg/dm³

Expansion coefficient (x 10⁻⁶.°C⁻¹)

20/100°C 68/212°F	20/200°C 68/392°F	20/300°C 68/572°F	20/400°C 68/732°F	20/500°C 68/932°F
11.2	12.0	12.5	13.2	13.8

Abrasion resistance is not exclusively connected to the hardness of the steel in the as delivered condition. Its components, its structure strongly influence its performances. Chemical balance and manufacturing processes of CREUSABRO 8000 confer a metallurgical structure to the steel which participates strongly to the improvement of its wear resistance through following properties.

In service work hardening thanks to TRIP effect



When entering in service, CREUSABRO 8000 takes profit of a surface hardening of about 70 HB, whatever the applied strain level is (impact, pressure...)

"TRIP effect" : TRansformation Induced by Plasticity.

CREUSABRO 8000 , due to its initial structure containing retained austenite, has the capability to work-harden in service under the action of local plastic deformations.

These plastic deformations create an hardening by transformation of retained austenite into very hard fresh martensite.

TRIP effect also participates to the delay of chip removal from the steel under the action of abrasive particles.

The steel consequently becomes harder and remains very resistant to the wear by chip removal.

Fine dispersion of micro carbides

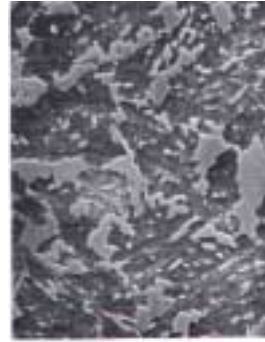
The fine structure of CREUSABRO 8000 is obtained by a fine dispersion of micro-carbides.

This structure is just the opposite of the rough acicular lamellar structure, typical of 500HB water quenched steels.

Cracking along lamellas leads easily to the chip removal effect under the action of abrasive.

This effect is strongly reduced in CREUSABRO 8000 which has not this lamellar structure.

Moreover, this fine dispersion of carbides is like an internal reinforcement for the steel. It comes in addition to the work-hardening effect to delay the chip removal effect in service.



CR 8000 Microstructure



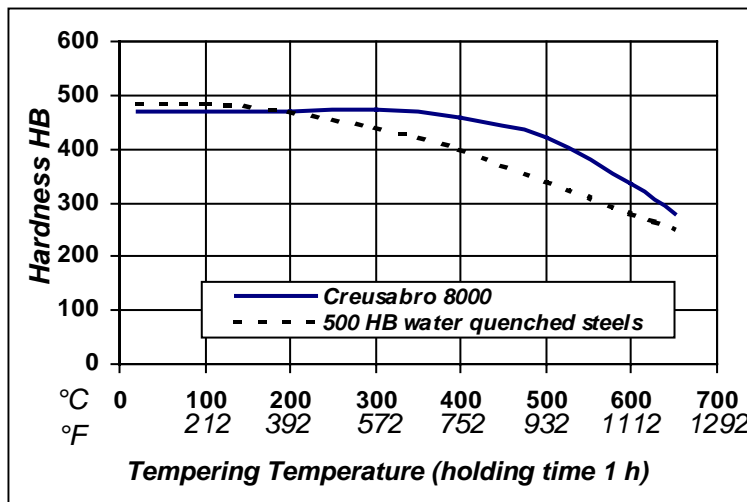
500 HB Water quenched Microstructure

Summarize

Water quenched 500HB Conventional route Passive material	Creusabro 8000 Innovative route Active material
<ul style="list-style-type: none"> ▪ Low alloy steel ▪ Water quenching ↓ ▪ 100% martensitic lamellar structure 	<ul style="list-style-type: none"> ▪ Specific additions of alloying elements ▪ Controlled cooling (heat treatment) ↓ ▪ Structure : martensite + retained austenite + micro-carbides → Transformation of retained austenite into fresh martensite under abrasive effect → Fine micro-carbides, homogeneously dispersed
Wear resistance just connected to delivered hardness, crack propagation along lamellas	Resistance to wear and chip removal effect , due to combined actions of hardness, TRIP effect, and micro-carbides.

Chemical analysis of CREUSABRO 8000, and specially its chromium and molybdenum contents, confers to the steel a high softening resistance in hot conditions, much better than that of 500HB water quenched steels.

PROPERTIES AT HIGH TEMPERATURE



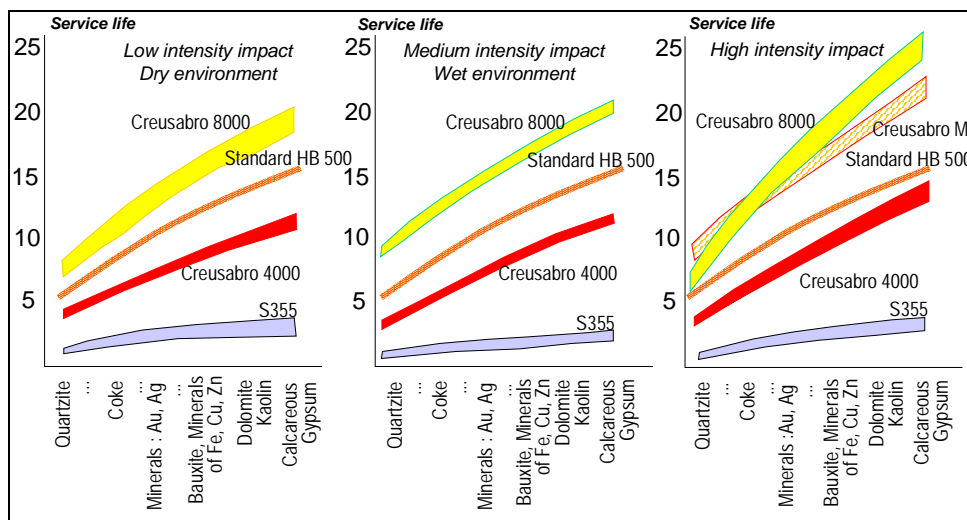
Softening resistance according to tempering temperature

This property allows to process the steel in hot conditions (450/500°C – 842/932°F), hot forming for example, and to cool it down by air without inducing any significant drop of hardness (about 30 HB max).

The resistance of CREUSABRO 8000 allows its use in hot conditions where pieces are heated up to 300°C (572°F) max.

SERVICE LIFE

Whatever service conditions are, the specific metallurgical concept of CREUSABRO 8000 leads to an improvement of its performances, compared to other grades available on the market.



Comparative service life ; reference is the service life of S355 steel in quartz environment (= value 1)

FIELD-TESTS

Many fields tests were performed, which confirm the high performances of CREUSABRO 8000 compared to 500HB water quenched steels.

Environments (abrasive materials)	Application	thickn. Piece	Service life (compared to 500 HB steel)
Mines (gold ore)	External lining plates of a loading bucket	30 mm	+ 100%
Foundry (hot agglomerate)	Extracting plates	12 mm	+ 36%
Steelmaking (iron ore + coal)	Vertical lining plates of an exhausting chute of a unloading crane	15 mm	+ 35%
Fertilizers industry	Crushing hammers	15 mm	+ 58%
Agglomerated wood production (wood chip)	Pipe elbow pneumatic transportation of chips	12 mm	+ 38%
Glass industry (calcin)	Deflective plates at the end of a conveyor belt	15 mm	+ 69%
Quarry (granite)	Side armour plates of jaw crusher chamber	40 mm	+ 50%

PROCESSING

Cutting

All classical thermal processes (gas-plasma-laser) can be used. Plasma/laser processes are specially recommended. They provide a better precision and cutting aspect and so induce a thinner Heat Affected Zone (HAZ).

Whatever process (thermal) is used, following conditions are sufficient to avoid cold cracking :

Plate temperature	Thicknesses ≤ 40 mm (1,57")	Thicknesses > 40mm (1,57")
≥ 10°C (+50°C)	No preheating	Preheating : 150°C (302°F)
< 10°C (+50°C)	All thicknesses : Preheating 150°C (302°F)	

Water jet cutting can be used.

Shearing of thin plates is not recommended.

Machining

Drilling must 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) eventually coated (TiN) shall significantly improve drilling performances in case of long series.

Quality	Ø Mm (inch)	Drilling speed (m/min)	Revolution speed (rev./min)	Feed (mm/rev.)
HSSCO AR 2.9.1.8 (M42)	10 (0.39")	4-6	125-190	0.07
	20 (0.79")		65-95	0.10
	30 (1.18")		40-65	0.12
Carbide K20	10 (0.39")	18-22	575-700	0.07
	20 (0.79")		285-350	0.10
	30 (1.18")		190-235	0.12

Milling shall also 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)

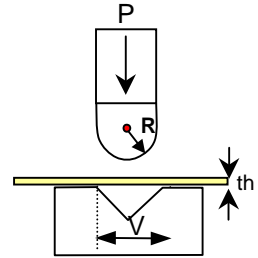
Quality	Depth mm (inch)	Cutting speed (m/min)	Feed (mm/tooth)
HSSCO AR 12.0.5.5 (T15)	1 (0.04")	10-12	0.08
	4 (0.16")	8-10	0.12
	8 (0.31")	5-8	0.12

Forming

Cold forming can be done as far as following conditions are met :

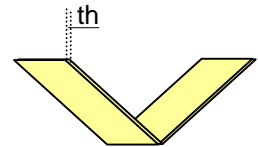
- edge preparation by grinding to remove flame cutting heterogeneities
- minimum internal bending radius (table below)
- plate temperature at 10°C (50°F) minimum

Internal bending radius (min.)	
- Bend \perp to longitudinal rolling direction	$R \geq 5 \text{ th}$
- Bend \parallel to longitudinal rolling direction	$R \geq 6 \text{ th}$
Die opening V (mini)	$V \geq 14 \text{ th}$



According above parameters, bending strength depends on bending length, piece thickness, die opening...

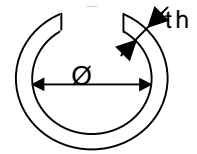
Thickness (mm – inch)	Bending strength per meter (Tons/m)
10 (0.39)	200
20 (0.78)	430



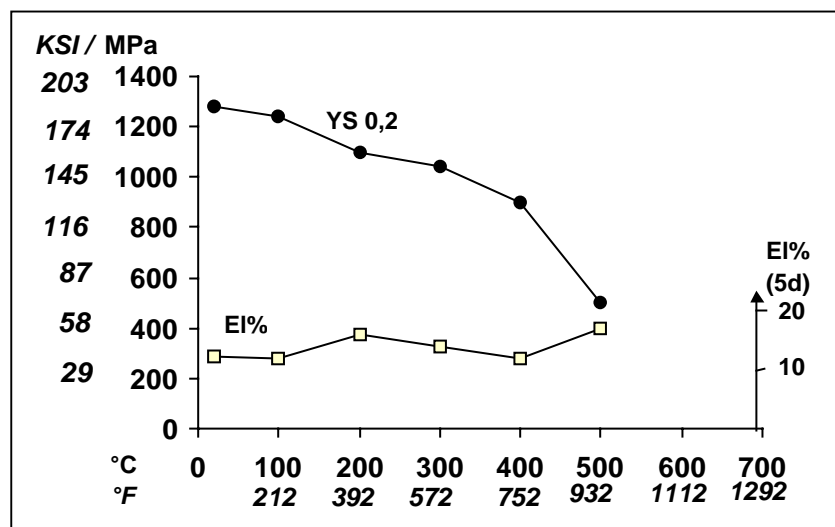
Above table gives indicative power needed to bend for a die opening of 14 times the thickness.

Rolling shall be performed in following conditions.

$\varnothing_i \geq 40 \text{ th}$ (temperature of the piece $\geq 10^\circ\text{C} - 50^\circ\text{F}$)



CREUSABRO 8000 can be formed at a temperature of 450/500°C (842/932°F) without any further heat treatment. At this temperature, forming requires lower power than at room temperature, proportionally to the reduction of its yield strength YS 0,2.



APPLICATIONS

Welding

CREUSABRO 8000 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	A81309 E514/3B	DIN 1913 Class E5143/B10	AWS 5-1 Class E7016 or 7018
Semi-automatic under gas	A81311 GS2	DIN 8559 SG2	AWS A5-18 Class ER70S4 or ER 70S6
	A81350 TGS 51BH TGS 47BH	DIN 8559 SGB1 CY 4255	AWS-5-20 Class ER 71T5

For welds subjected to wear, ask us for the best choice of welding consumables.

Welded areas shall be clean, free of grease, water, oxides,...

Electrodes and flux shall be stoved according to supplier's recommendations.
 Following preheating conditions shall be respected (for welded structure without excessive stresses).

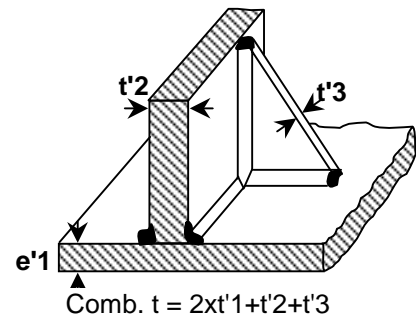
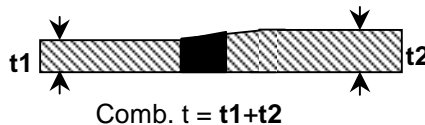
Welding processes	Heat input (kJ/cm)	Pre and post heating conditions Combined thickness (mm)								
		10	20	30	40	50	60	70	80	90
1 Stick manual arc welding	15/20									
2 Semi-automatic under gas	15									
	30									
3 Submerged arc welding	20									
	30									

Without pre-heating

Pre-post heating at 100°C (212°F)

Pre-post heating at 150°C (302°F)

Combined thickness calculation



- Quarries – Publics works
Cutting blades, bucket liners, internal crushing liners, screens, dumpers bodies,
- Mines

DIMENSIONAL PROGRAM

Cutting equipments, liners, buckets, chains conveyors, pales and bottom of mixing machines...

- *Cement plants*
Drying trommels, shovels, hoopers, coolers, granulators, separators, crushers...
- *Steel plants*
Unloading buckets, skips, guiding plates, hoopers...

mm → th ↓	1500 x 3000 4.92' x 9.8'	2000 x 6000 6.56' x 19.7'	2500 x 8000 8.2' x 26.2'	Others sizes
4 (.16")	xx			Please, consult
5/50 (.20/1.96)	x	xx	xx	
>50 (1.96)	Please, consult			

xx Optimum sizes
x acceptable sizes

Indicative dimensional program –
Other dimensions available on request, including plate width up to 4100 mm

NOTE :

1. This technical data and information represents our best knowledge at the time of printing. However, it may be subject to some slight variations due to our ongoing research programme on abrasion resistant grades.

We therefore 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 is only for the purpose of description, and may only be considered as guarantees when our company has given written formal approval.

Further information may be obtained from the following address.

2. Creusabro 8000 : Application range.

Creusabro 8000 has been developed specifically for its abrasion resistance. Customer's usage of CREUSABRO 8000 for any other purposes, not directly resulting from its abrasion resistance, is his own prerogative but won't, in any way, engage USINOR INDUSTRIEL's responsibility. In addition to the recommendations given in this document, Customer will have to follow the Industry standard quality rules for any processing operation performed on this material.

For any information : USINOR INDUSTRIEL

56 Rue Clemenceau
71202 LE CREUSOT CEDEX - FRANCE
Sales Tel +33 3 85 80 58 04
Fax +33 3 85 80 55 00

Development Tel +33 3 85 80 55 37 / 51 62
Fax +33 3 85 80 55 00