

CREUSABRO[®] 4800^(P)

Advanced technology in wear

CREUSABRO[®] 4800^(P) is a wear resistant steel offering up to 50% extra in service life compared with a 400 HB water quenched steel.

CREUSABRO[®] 4800^(P) combines several modern metallurgical concepts which, depending on thickness, use different combinations of an enriched chemical analysis (Cr, Mo, Ti...) and controlled quenching rate.

Creusabro[®] 4800^(P) is designed to provide the optimum combination of wear resistance controlled hardness and ease of processing. Rather than using just a high hardness level, it achieves this aim by using proven and controlled metallurgical mechanisms, which are more complex but more efficient than the simple effect of hardness alone.

- Work-hardening and Cr Mo micro-carbides, the basic CREUSABRO[®] concept ,
- TRIP⁽¹⁾ effect originally developed with CREUSABRO[®] 8000,
- Reinforcement of the structure with Titanium carbides.

The limited as delivered hardness of Creusabro[®] 4800^(P) makes processing operations like cutting, machining and forming no more difficult than processing 400HB water quenched steel.

Creusabro[®] 4800^(P) is ideal for applications in mines and quarries, cement and the Steelmaking industries, public works and agricultural machinery. It is suitable for all types of abrasion, sliding or impact, dry or wet media including high temperature abrasion up to 350°C.

⁽¹⁾ TRansformation Induced by Plasticity

STANDARD

CREUSABRO[®] 4800^(P)

CHEMICAL ANALYSIS

Guaranteed values (Weight %)

| C | S | P | Mn | Ni | Cr | Mo | Ti |
|--------|---------|---------|--------|--------|--------|--------|---------|
| ≤ 0,20 | ≤ 0,005 | ≤ 0,018 | ≤ 1,60 | ≈ 0,20 | ≤ 1,90 | ≤ 0,40 | ≤ 0,200 |

MECHANICAL PROPERTIES

Typical values (as supplied)

| Hardness HB | YS MPa | UTS MPa | E % | KCVL-20°C J/Cm ² | Elasticity modulus GPa |
|-------------|--------|---------|-----|-----------------------------|------------------------|
| 370 | 900 | 1200 | 12 | 45 | 205 |

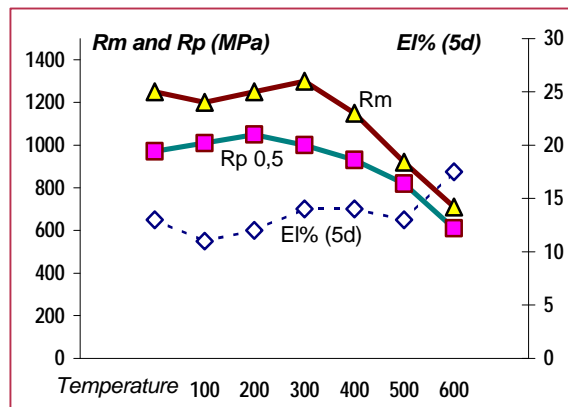
Guaranteed values (as supplied)

Hardness : 340/400 HB

[®] Trademark

^(P) Patented grade

Mechanical properties at high temperature (Typical values)



PHYSICAL PROPERTIES

Expansion coefficient - average ($\times 10^{-6} \cdot ^\circ\text{C}^{-1}$)

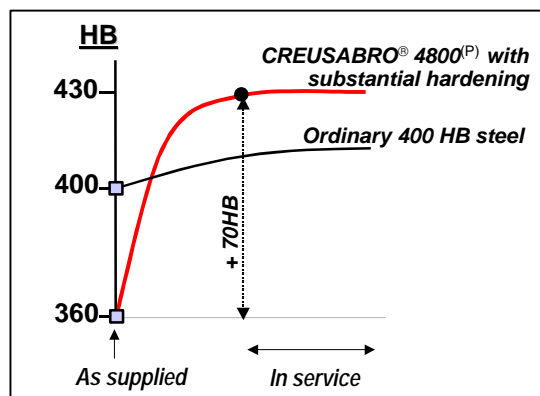
| 20/100°C | 20/200°C | 20/300°C | 20/400°C | 20/500°C | 20/600°C |
|----------|----------|----------|----------|----------|----------|
| 12,4 | 13,1 | 13,9 | 14,4 | 14,7 | 15,0 |

METALLURGICAL CONCEPT

Abrasion resistance is not exclusively associated with the hardness of the steel in the supplied condition. Its composition and structure strongly influence the actual performance in service. The chemical composition and the manufacturing processes applied to CREUSABRO® 4800^(P) develop a metallurgical structure, which contributes strongly to the improvement of its wear resistance through the following effects.

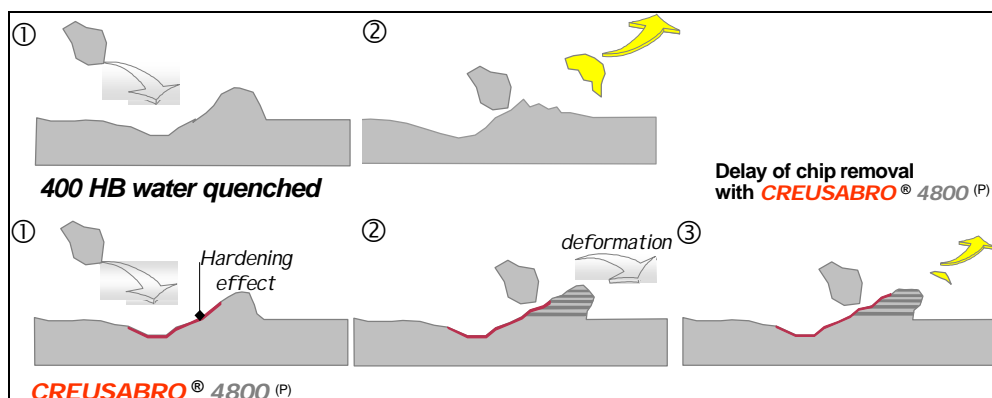
Work hardening in service

When entering in service, CREUSABRO® 4800^(P) takes profit of a surface hardening of about 70 HB whatever the applied strain level is (impact, pressure....)



Delay of chip removal

Creusabro® 4800^(P) has the advantage of a higher capacity for plastic deformation caused by impact s. This extra-ductility induces a delay in the chip removal ensuring a slower wear rate (weight loss) than on 400HB water quenched steels.



Titanium carbides

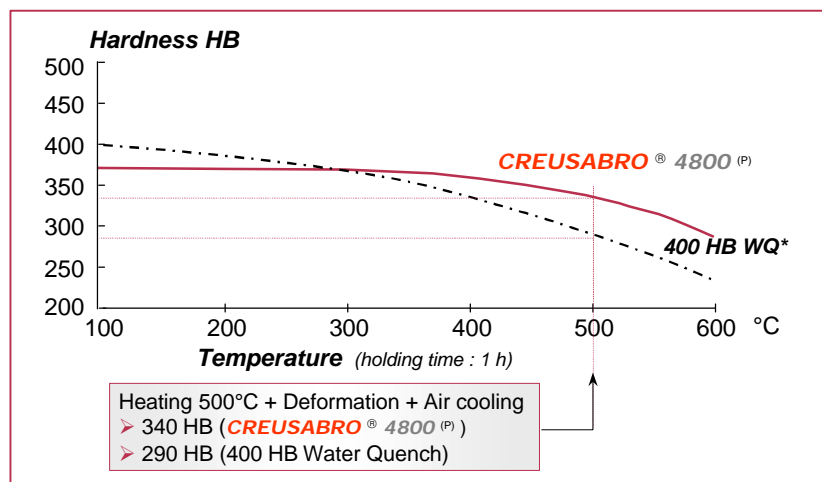
In addition to the fine and homogeneous distribution of chromium and molybdenum carbides (respectively 1500 HV and 1800 HV) common to CREUSABRO® steels. Creusabro® 4800^(P) is a new generation steel in the field of wear resistance steels with a significant addition of Titanium resulting in the formation of a structure with very hard and fines particules of titanium carbide, TiC reaching a hardness level of 3200 Hv. These carbides give to the steel an increased wear resistance..

Summary

| | | |
|-----------------|---|---|
| Wear resistance | 400HB water quenched Conventional route Passive material | CREUSABRO® 4800^(P) Innovative route Active material |
| | Just connected to supplied hardness PASSIVE STEEL | Combining <ul style="list-style-type: none"> ▪ In service hardening ▪ TRIP Effect ▪ Microcarbides + Titanium effect REACTIVE STEEL |
| Process | <ul style="list-style-type: none"> ▪ Low alloyed steel (C, Mn, B) ▪ Water quenching | <ul style="list-style-type: none"> ▪ Specific addition of alloying elements (Cr, Mo, B, Ti...) ▪ Controlled cooling rate |
| Structure | <ul style="list-style-type: none"> ▪ 100% martensitic structure | <ul style="list-style-type: none"> ▪ Structure : bainite/martensite + retained austenite + micro-carbides → Transformation of retained austenite into fresh martensite under abrasive effect → Fine micro-carbides homogeneously dispersed + Very hard Titanium carbides |

PROPERTIES AT HIGH TEMPERATURE

CREUSABRO® 4800^(P) chemical composition, Chromium and Molybdenum contents principally give a high resistance to softening in hot conditions, much better than that of 400 HB water quenched steel.

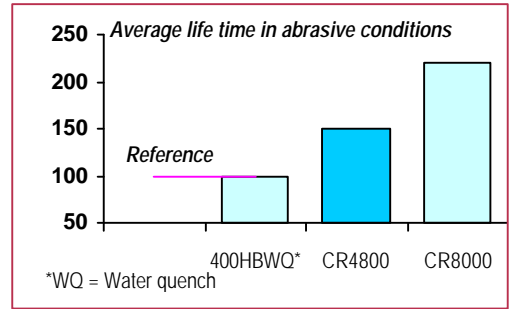


These properties enable the steel to be processed in the hot condition (450/500°C). Forming of thick plates, for example, followed by a slow cooling without inducing any significant drop of hardness.

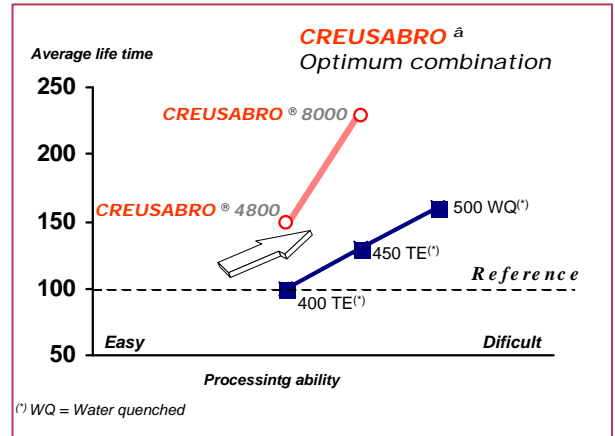
Hot resistance of CREUSABRO® 4800^(P) allows its use in hot environments where pieces are heated up to 350°C

SERVICE LIFE

CREUSABRO® 4800^(P) metallurgical concept improves its wear resistance compared to other anti-abrasion grades available in the market, and in all service conditions.



Creusabro® 4800^(P) benefits from the optimum compromise between wear resistance and ease of processing.



PROCESSING

Cutting

All classical thermal processes (oxygen-plasma-laser) can be used. Plasma/Laser processes are specially recommended, they provide a better precision and cutting aspects and produce a narrower Heat Affected Zone (HAZ).

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

| Plate temperature | Thickness ≤ 60mm (2.4") | Thickness >60mm (2.4") |
|-------------------|--|----------------------------|
| ≥ 10°C (50°F) | No preheating | Preheating : 150°C (302°F) |
| < 10°C (50°F) | All thicknesses : Preheating 150°C (302°F) | |

Water jet cutting can be used.

Machining

Drilling can 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 | 0.07 |
| | 10 | 13 – 17 | 415 – 540 | 0.09 |
| | 15 | 12 – 15 | 255 – 320 | 0.10 |
| | 20 | 11 – 14 | 175 – 220 | 0.12 |
| | 25 | 9 – 12 | 115 – 150 | 0.15 |
| | 30 | 8 - 10 | 85 - 105 | 0.20 |

Indicative parameters

Milling shall be done with HSSCO tools (AR.6.5.2.5. according to AFNOR, M35 according to AISI or AFNOR AR.12.0.5.5 / AISI T15).

Lubrication with soluble oil.

| Tools | Depth (mm) | Cutting speed (m/min) | Feed (mm/tooth) |
|--------------------------------------|------------|-----------------------|-----------------|
| HSSCO AR 12.0.5.5 (T15) | 1 | 12 - 15 | 0.08 |
| | 4 | 10 - 12 | 0.10 |
| | 8 | 7 - 9 | 0.15 |

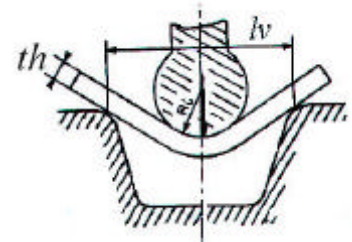
Forming

Cold forming of CREUSABRO® 4800^(P) can be done without any problem when the following conditions are met :

- No marks or scratches in shaped zones, mainly on external face ;
- Beveling by grinding of edge angle specially on extended skin – Eventually grinding to remove cutting heterogeneities ;
- Minimum internal bending radius (table below) ;
- Plate temperature > 10°C (50°F)

■ Bending

| | |
|---|----------------|
| Internal bending radius (min.) ⊥ Direction | $r_i \geq 3th$ |
| // Direction | $r_i \geq 4th$ |
| Die opening V (mini) | $V \geq 12th$ |



- The strength necessary to bend depends on UTS and plate thickness as well as bended length and die opening V.

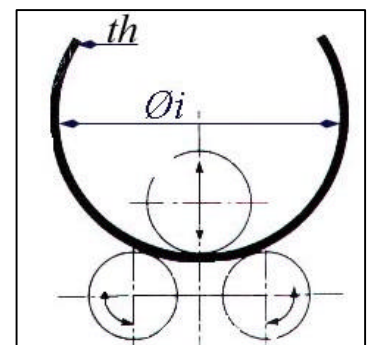
Indicative values, for die opening $V = 12th$ (V bending)

| th plates (mm) | Bending strength L = 1 m ton/m |
|----------------|--------------------------------|
| 5 | 70 |
| 10 | 130 |
| 20 | 250 |

- Spring back : allow for a tight bending angle to compensate spring back effect.
Example : for $r_i / th = 5$, anticipate an angular correction of about 10° .
- Safety : Due to high elastic energy of the steel it is advice not to stand in front of the machine, but at the side.

- **Rolling** has to be done using the following conditions

$\varnothing_i \geq 30 th$ (plate temperature > 10°C)
The force necessary to roll a plate will be about double that of a S355 type steel.



■ CREUSABRO® 4800^(P) can be hot formed at a temperature of 450/500°C without any further heat treatment. At this temperature the force necessary to deform the plate will be lower than at room temperature, and the deformation capability of the steel will be higher (smaller forming radius).

It is possible to deform a CREUSABRO® 4800^(P) plate thicknesses $th \leq 20\text{mm}$ within temperature range 870/1000°C followed by air cooling without affecting steel properties. This process is particularly interesting to reduce bending / rolling forces and to increase the deformation capability of the steel.

Welding

CREUSABRO® 4800^(P) can be welded by all traditional welding processes : manual, semi-automatic under gas, automatic under fluxes.
For welds non exposed to wear, the following welding rods can be used.

| Processes | AFNOR | DIN | AWS |
|-----------------------------|--------------------------------|------------------------------|--|
| Manual Stick electrode | A81-309 E51 4/3 B | DIN 1913 Class E51 43 B10 | AWS 5-1 Class E7016 or 7018 |
| Semi-automatic Under gas | A81311 GS2 | DIN 8559 SG2 | AWS A-5-18 Class ER70S4 ou 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...

Electrodes and flux shall be stoved according to supplier recommendations.
Following preheating conditions shall be met (weld without excessive stresses).

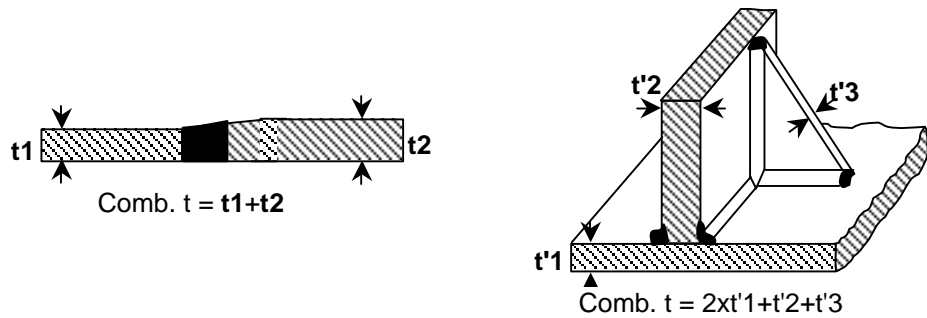
| Welding process | Heat input (kJ/Cm) | Pre and post-heating conditions Combined thickness (mm) | | | | | | | |
|----------------------------------|--------------------|--|----|----|----|----|----|----|--|
| | | 30 | 40 | 50 | 60 | 70 | 80 | 90 | |
| 1 Semi-automatic under gas | 15 | | | | | | | | |
| | 30 | | | | | | | | |
| 2 Manual welding Stick electrode | 10 | | | | | | | | |
| | 20 | | | | | | | | |
| 3 Automatic under solid flux | 20 | | | | | | | | |
| | 30 | | | | | | | | |

□ Without preheating

■ Pre-post heating at 75°C

■ Pre-post heating at 125°C

Combined thickness calculation



APPLICATIONS

- *Quarries – Public works*
Blades, bucket liners, chutes, liner plates, crusher lateral stiffeners, screens, dumper bodies and trommels, ...
- *Mines*
Extraction equipment, conveyor bottom plates, hoppers, helical gravity and screw conveyors, skips, ventilators, discharge plates, ...
- *Cement plants*
Wheel excavators buckets, crusher lateral shield, clinker chutes, buckets, ventilators, dust separators, bagging machines...
- *Steel plants*
Guiding plates, hoppers, chutes, discharge plates, scrap containers / charging boxes, ...

DIMENSIONAL PROGRAM

Thicknesses 3mm to 150 mm

Standard sizes 1 500 x 3 000 mm
2 000 x 6 000 mm
2 500 x 8 000 mm

Flatness 5mm/m

Indicative dimensional program
Other dimensions available on request.

NOTA :

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® 4800^(P) : Application range.

CREUSABRO® 4800^(P) has been developed specifically for its abrasion resistance.

Customer's usage of CREUSABRO® 4800 for any other purposes, not directly resulting from its abrasion resistance, is his own prerogative but won't, in any way, engage INDUSTRIEEL'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 all information : INDUSTRIEEL

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