

CREUSABRO® 4800^(P)

A high wear resistant steel

CREUSABRO® 4800^(P) is a high wear resistant steel, offering a 50% extra in service life compared to a conventional 400 HB water quenched.

Improved properties of CREUSABRO® 4800^(P) are the result of the combination of an enriched analysis (chromium, molybdenum and titanium) and specific heat treatment procedures.

More than hardness, the wear resistance of CREUSABRO® 4800^(P) is based on:

- a very fine distribution of chromium, molybdenum, and titanium 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" (TRansformation Induced by Plasticity).
- Reinforcement of the grain structure with titanium carbides.

Together with its high wear properties, CREUSABRO® 4800^(P) exhibits very good aptitude to processing. Especially, the limited hardness in delivery condition, strongly facilitates processing operations like cutting, machining and forming.

Application markets of CREUSABRO® 4800^(P) are: mines, quarries, cement industries, steel making, public works - It can be used in all environments, sliding, impact abrasion, in dry, wet or hot conditions (350°C max).

STANDARD CREUSABRO® 4800^(P)

CHEMICAL ANALYSIS

Guaranteed values (Weight %)

| C | Mn | Ni | Cr | Mo | S | Ti |
|--------|--------|--------|--------|--------|---------|--------|
| ≤ 0.20 | ≤ 1.60 | ≈ 0.20 | ≤ 1.90 | ≤ 0.40 | ≤ 0.005 | ≤ 0.20 |

MECHANICAL PROPERTIES

Indicative values (As delivered)

| Hardness | YS 0.2 | UTS | EI. | KCVL-20°C | E |
|----------|--------|------|-----|-------------------|-----|
| HB | MPa | MPa | % | J/Cm ² | GPa |
| 370 | 900 | 1200 | 12 | 45 | 205 |

Guaranteed values (As delivered)

Hardness: 340/400 HB

Toughness: KCVL -20°C ≥ 30 J/cm²

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(P) Grade patented by USINOR INDUSTRIEL

Hot mechanical properties (indicative values)

| Rp YS MPa | | | Rm UTS MPa | | |
|-----------|-------|-------|------------|-------|-------|
| 200°C | 400°C | 500°C | 200°C | 400°C | 500°C |
| 940 | 920 | 820 | 1220 | 1120 | 900 |

PHYSICAL PROPERTIES

Expansion coefficient (x 10⁻⁶.°C⁻¹)

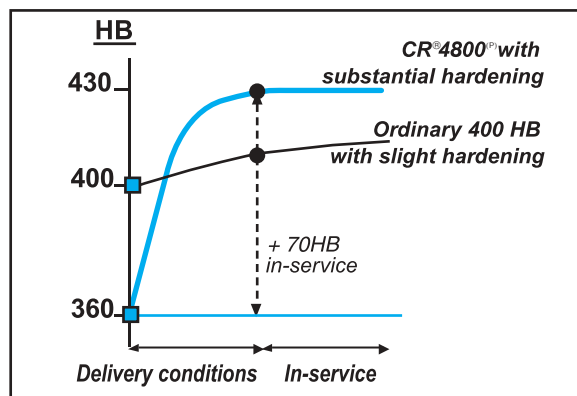
| 20/100°C | 20/200°C | 20/300°C | 20/400°C | 20/500°C |
|----------|----------|----------|----------|----------|
| 12.4 | 13.1 | 13.9 | 14.4 | 14.7 |

METALLURGICAL CONCEPT

Abrasion resistance is not exclusively connected to the hardness of the steel in delivered condition. Its components and its structure strongly influence its performance. Chemical balance and manufacturing processes of CREUSABRO® 4800^(P) impart a metallurgical structure to the steel which strongly improves its wear resistance through the following properties.

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

In service work hardening thanks to TRIP effect



“TRIP effect”: TRansformation Induced by Plasticity

CREUSABRO® 4800^(P), 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 a hardening effect by transformation of retained austenite into very hard fresh martensite.

TRIP effect also contributes 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 wear by chip removal.

Fine dispersion of micro carbides

The fine structure of CREUSABRO® 4800^(P) is obtained by a fine dispersion of micro-carbides.

This structure is just the opposite of the rough acicular lamellar structure typical of 400HB water quenched steels.

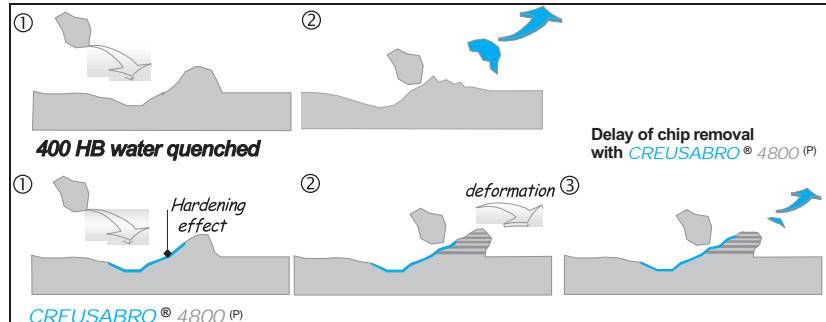
In water quenched steel, cracking along lamellas leads easily to the chip removal effect under the action of abrasion.

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 fine particles of titanium carbide, TiC reaching a hardness level of 3200 Hv. These carbides give to the steel an increased wear resistance.

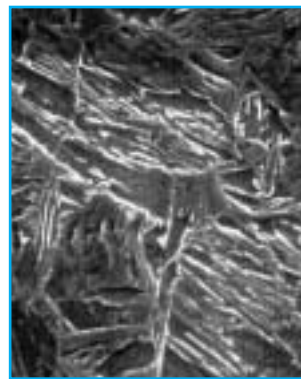
Delay of chip removal

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

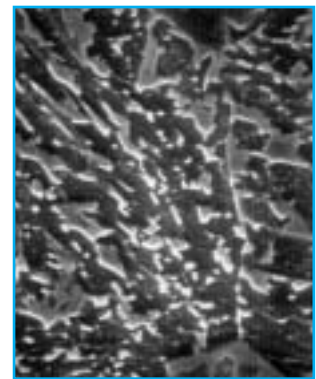


This effect is strongly reduced in CREUSABRO® 4800^(P) which does not have this lamellar structure.

More over, this fine dispersion of carbides reinforces the steel and works in combination with the work hardening effect to delay chip removal in service.



400 HB Water quenched
Microstructure



CR® 4800^(P) Microstructure

Summary

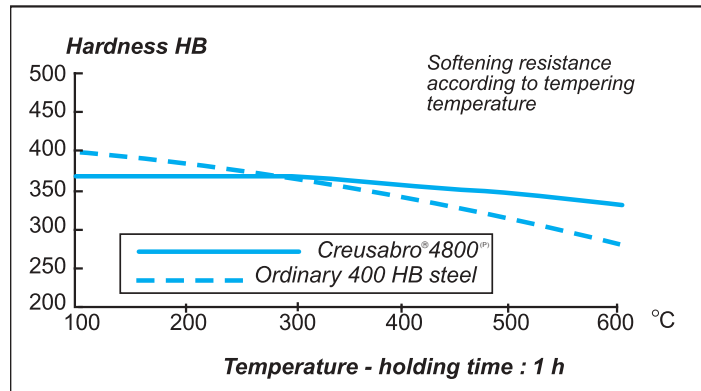
| | 400HB water quenched Conventional route Passive material | Creusabro® 4800 ^(P) Innovative route Active material |
|-----------------|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wear resistance | 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 additions of alloying elements (Cr, Mo, B, Ti...) Controlled cooling rate |
| Structure | <ul style="list-style-type: none"> 100% martensitic lamellar 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

Chemical analysis of CREUSABRO® 4800^(P), specifically its chromium and molybdenum contents, imparts a high softening resistance in hot conditions, much better than that of 400HB water quenched steel.

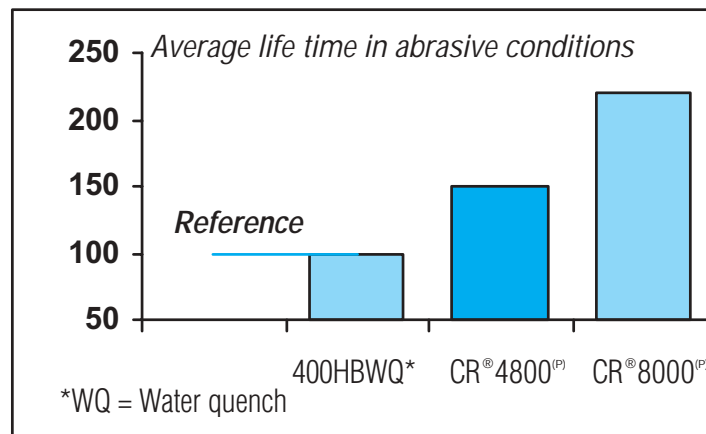
This property allows processing of the steel in hot conditions (450/500°C), hot forming for example, and cooling down in air without inducing any significant drop of hardness.

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

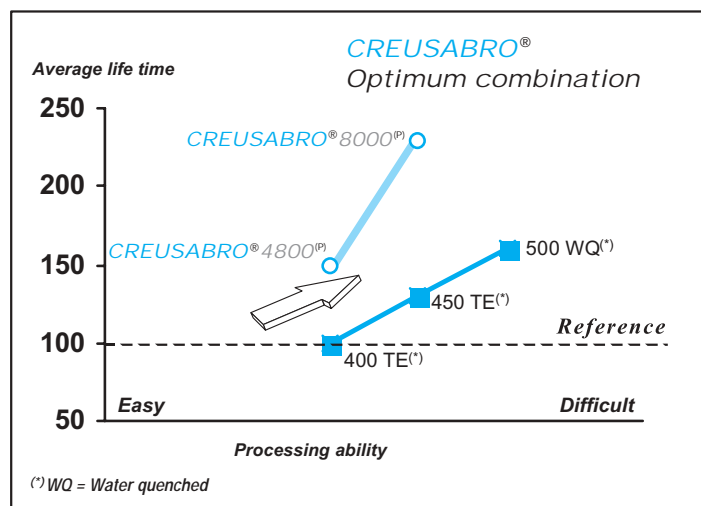


SERVICE LIFE

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 (gas-plasma-laser) can be used. Plasma/laser processes are especially recommended. They provide better precision and cutting aspects and induce a thinner Heat Affected Zone (HAZ).

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

| Plate temperature | Thicknesses ≤ 60 mm | Thicknesses > 60mm |
|-------------------|-----------------------------------|--------------------|
| ≥ 10°C | No preheating | Preheating: 150°C |
| < 10°C | All thicknesses: Preheating 150°C | |

Water jet cutting can be used.

Machining

Drilling and milling operations can be done by utilising Sandvik Coromant drills and inserts.

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 | ∅ mm | Cutting speed (m/min) | Revolution speed (rev/min) | Feed (mm/rev) |
|--------------|---------|--------------------------|-------------------------------|------------------|
| HSSCO | 5 | 15-20 | 950-1250 | 0.07 |
| AR.2.9.1.8 | 10 | 13-17 | 415-540 | 0.09 |
| (M42) | 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 |

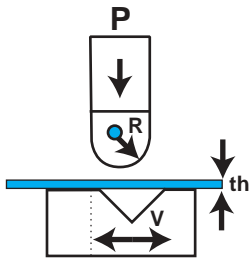
Indicative parameters

PROCESSING

Forming

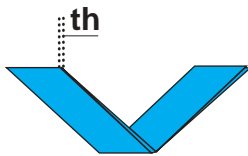
Cold forming can be done as long as the following conditions are met:

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



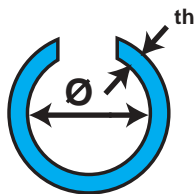
| | | |
|--------------------------------|--------------|----------------|
| Internal bending radius (min.) | ⊥ Direction | $r_i \geq 3rd$ |
| Internal bending radius (min.) | // Direction | $r_i \geq 4th$ |
| Die opening V (mini) | | $V \geq 12th$ |

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



| Thickness mm | Bending strength per meter (Tons/m) |
|--------------|-------------------------------------|
| 10 | 130 |
| 20 | 250 |

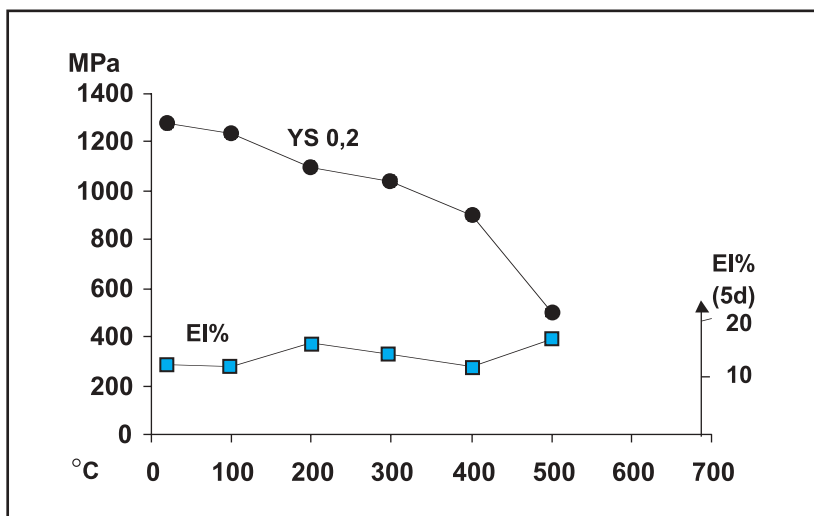
Above table gives indicative power needed to bend for a die opening of 12 times the thickness.



Rolling shall be performed in following conditions.

$\varnothing_i \geq 30 th$ (temperature of the piece $\geq 10^\circ\text{C}$)

CREUSABRO® 4800^(P) can be formed at a temperature of 450/500°C without any further heat treatment. At this temperature, forming require lower power than at room temperature, proportionally to the reduction of its yield strength YS 0,2.



For thickness up to 15mm, it is possible to perform hot forming within the range 870/1000°C followed by air cooling without impairing steel properties.

Welding

CREUSABRO® 4800^(P) 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 | AWS |
|--------------------------|------------------------------------------|
| Manual Coated electrode | AWS 5-1 Class E7016 or 7018 |
| Semi-automatic Under gas | AWS A-5-18 Class ER70S4 or ER 70S6 |
| | AWS-5-20 Class ER 71T5 |

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

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

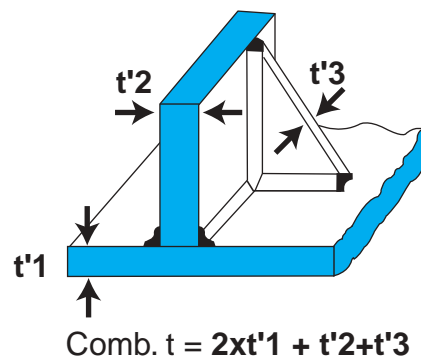
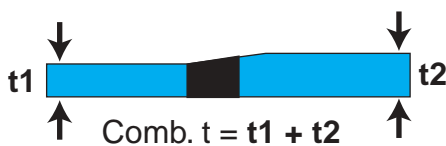
Electrodes and flux shall be stoved according to supplier's recommendations.

Following preheating conditions shall be respected (for welded structure without excessive stresses).

| Welding process | Heat input (kj/mm) | Pre/Postheating conditions: | | | | | | | |
|----------------------------------------------------|--------------------|-----------------------------|----|----|----|----|----|----|--|
| | | Combined thickness (mm) | | | | | | | |
| | | 30 | 40 | 50 | 60 | 70 | 80 | 90 | |
| 1 Solid wire with gas (GMAW) | 1.5 | | | | | | | | |
| | 3.0 | | | | | | | | |
| 2 Manual or flux cores wire welding (SMAW or FCAW) | 1.0 | | | | | | | | |
| | 2.0 | | | | | | | | |
| 3 Submerged arc welding (SAW) | 2.0 | | | | | | | | |
| | 3.0 | | | | | | | | |

Without pre-heating
 Pre-post heating at 75°C
 Pre-post heating at 125°C

Combined thickness calculation



APPLICATIONS

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

DIMENSIONAL PROGRAM

Thicknesses 5mm to 100 mm

Standard sizes 1500 x 3000 mm
 2000 x 6000 mm
 2500 x 7500 mm

Other dimensions available on request

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.

2. Creusabro® 4800^(P): Application range.

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

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.

Further information may be obtained from the following address.

**FOR FURTHER
INFORMATION
CONTACT YOUR
LOCAL SALES
REPRESENTATIVE**

Email: sales.steelau@sandvik.com

| | |
|-------------------|---------------------|
| ADELAIDE | 08 8243 7700 |
| BRISBANE | 07 3347 0500 |
| MELBOURNE | 03 9238 7200 |
| NEWCASTLE | 02 4924 2130 |
| PERTH | 08 9351 1500 |
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