

Wear-resistant steels

Technical terms of delivery

durostat®

Wear-resistant steels



DUROSTAT®

Steel grades

- DUROSTAT 400
- DUROSTAT 500
- DUROSTAT A2
- DUROSTAT B2

Subject to change pursuant to further development.
The current version is available in internet: www.voestalpine.com/grobblech

DUROSTAT 400, DUROSTAT 500

The steel grades DUROSTAT 400 and DUROSTAT 500 are wear-resistant special steels with hardness of approx. 400 HB resp. 500 HB. These steels provide high levels of resistance to mechanical wear, good cold forming properties and good weldability. Plates of these steels are used e.g. in crushers, screens, transport equipment, chutes, cutters, excavator parts and truck superstructures.



The technical terms of delivery apply for plate thicknesses from 6 - 100 mm for DUROSTAT 400 and for plate thicknesses from 10 - 50 mm for DUROSTAT 500.

Steel grades

Steel grades

Steel grades
DUROSTAT 400
DUROSTAT 500

Table 1:
Steel grades

Production Process

The steel grades DUROSTAT 400 and DUROSTAT 500 are produced via the LD-route.

Chemical composition

Heat analysis

Guaranteed values

Steel grades	mass in %									
	C max.	Si max.	Mn max.	P max.	S max.	Al _{tot.} min.	Cr max.	Mo max.	B max.	Ti max.
DUROSTAT 400	0.18	0.60	2.10	0.025	0.010	0.020	1.00	0.50	0.005	0.050
DUROSTAT 500	0.30	0.60	2.10	0.025	0.010	0.020	1.00	0.50	0.005	0.050

Table 2:
Chemical
composition

The steel is fine-grain melted and can contain microalloying elements such as Nb and V.

Carbon equivalent

Standard values

Steel grades	mass in %	
	CEV ¹⁾	CET ²⁾
DUROSTAT 400	0.47	0.30
DUROSTAT 500	0.53	0.41

Table 3:
Carbon
equivalent

¹⁾ $CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$, according to IIW

²⁾ $CET = C + (Mn + Mo)/10 + (Cr + Cu)/20 + Ni/40$, according to SEW 088

As-delivered condition

The high level of hardness is achieved by online accelerated cooling or conventional quenching.

Hardness

Hardness in as-delivered condition

Steel grades	Hardness HB
DUROSTAT 400	360 - 440
DUROSTAT 500	460 - 540

Mechanical properties

Standard values for as-delivered condition (for 20 mm plate thickness)

Steel grades	Yield strength N/mm ²	Tensile strength N/mm ²	Fracture elongation $L_0 = 5,65 \sqrt{S_0}$ %
DUROSTAT 400	1,000	1,250	10
DUROSTAT 500	1,200	1,550	8

Table 4:
Mechanical
properties

Quality test

Brinell hardness is measured according to ISO 6505 per heat and for every 40 t.
Hardness is measured approx. 1mm under the surface. The heat analysis is provided as proof of the chemical composition.

Tolerances and surface finish

Unless otherwise agreed, tolerances according to EN 10029 (thickness tolerance according to class A, flatness tolerance according to class N) and surface finish according to EN 10163-A1 are valid.

Marking

In general, marking consists of:

- voestalpine symbol
- Steel grade designation
- Heat number
- Plate number

Material testing certificate

Type of certificate according to EN 10204 must be agreed upon ordering.

Processing guidelines

Cold forming

DUROSTAT 400 and DUROSTAT 500 can be cold formed if the high hardness is taken into account. The prerequisite for cold forming is the proper preparation of the cut edges. Grinding of the flame- or shear-cut edges in the bending area is recommended. Due to the high level of hardness, bending must take place slowly and steadily.



Recommended minimum bending radii

Position of the bending edge to the rolling direction	smallest permitted bending radius	
	Durostat 400	Durostat 500
Longitudinal	4 x plate thickness	5 x plate thickness
Transverse	3 x plate thickness	4 x plate thickness

Table 5:
Minimum
bending radii

Heat treatment

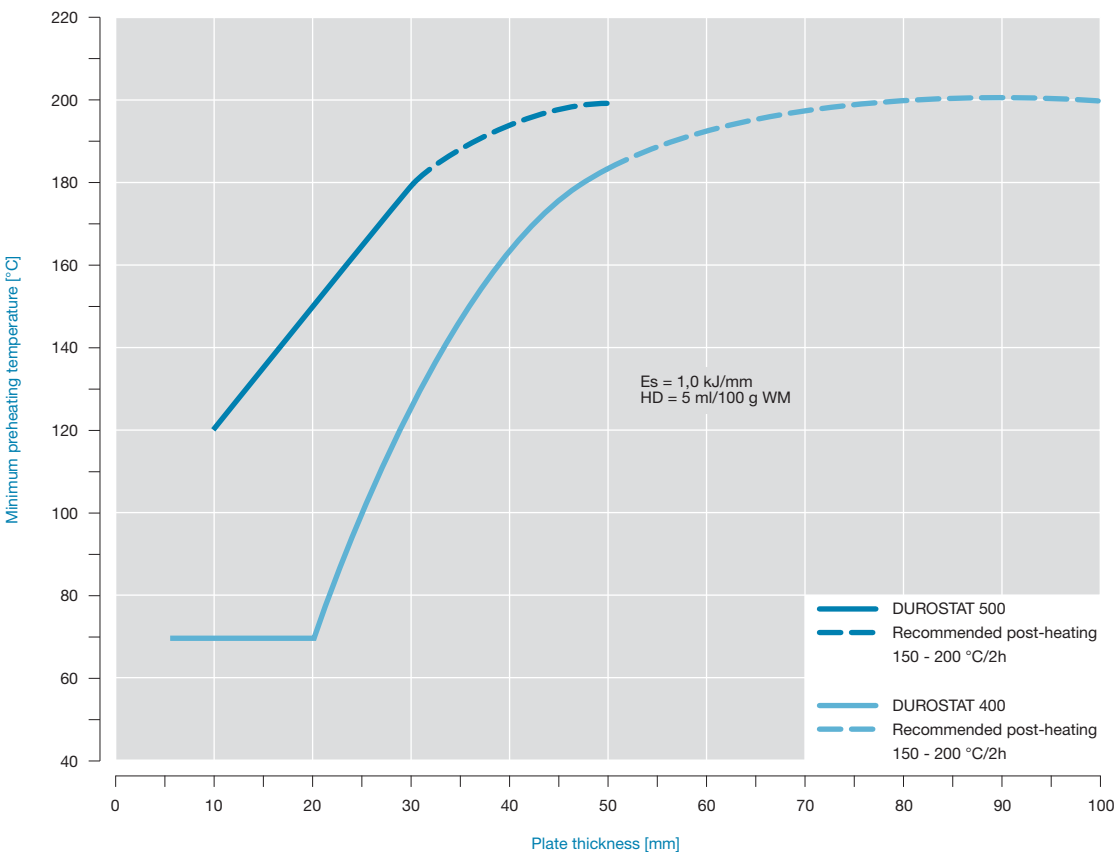
In order to maintain its hardness, DUROSTAT 400 and DUROSTAT 500 may not be heated above 200 °C.

Welding

Due to their chemical composition, plates of DUROSTAT 400 and DUROSTAT 500 are well-suited for welding. All tested fusion welding methods can be employed, but metal inert gas shielded arc welding has proved especially effective (low hydrogen input). For reasons of crack prevention, basic-coated electrodes with controlled hydrogen content should be used for manual electric arc welding. Prior to welding, the electrodes must be dried according to manufacturer instructions. The diffusible hydrogen content should be $HD \leq 5 \text{ ml}/100 \text{ g WM}$.

Where statics allow, soft filler with minimum strength should be employed. In order to minimise the risk of cold cracks, preheating according to picture 1 is recommended as well as postheating (150 - 200 °C/ 2 h) for preheating temperatures above 180 °C.

Recommended preheating temperature, DUROSTAT 400 and DUROSTAT 500



Picture 1:
Recommended
preheating
temperature

Dimensions

DUROSTAT 400

Thickness (mm)														
100														
95														
90														
85														
80														
75														
70														
65														
60														
55														
50														
45														
40														
35														
30														
25														
20														
15														
10														
6														
		1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500		Width (mm)

Maximum length: 12,000 mm

Different dimensions on request.

Dimensions

DUROSTAT 500

Thickness (mm)														
50														
45														
40														
35														
30														
25														
20														
15														
10														
		1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500		Width (mm)

Maximum length: 12,000 mm

Different dimensions on request.

DUROSTAT A2

DUROSTAT A2 provides a potential for high hardness and therefore high levels of resistance to mechanical wear. This steel is used for components subjected to high mechanical wear and abrasion: loading and transport equipment, excavator parts, machine components for road construction, preparation, crushing, silos.



The technical terms of delivery apply for plate thicknesses from 8 - 100 mm.

Steel grades

Steel grades

Steel grades
DUROSTAT A2

Table 1:
Steel grades

Production process

DUROSTAT A2 steels are produced via the LD-route.

Chemical composition

Heat analysis

Guaranteed values

Table 2:
Chemical
composition

Steel grade	mass in %						
	C max.	Si max.	Mn max.	P max.	S max.	Cr max.	V max.
DUROSTAT A2	0.75 to 0.85	0.65	2.10	0.030	0.025	0.60	0.20

As-delivered condition

The plates are delivered in as-rolled condition (hot-rolled, untreated), since usually heat treatment such as quenching or tempering is carried out on the finished parts.

Mechanical properties

Standard values for as-rolled condition (plate thickness 20 mm)

Table 3:
Mechanical
properties

Steel grades	Yield strength N/mm ²	Tensile strength N/mm ²	Fracture elongation $L_0 = 5,65 \sqrt{S_0}$ %	Hardness HB
DUROSTAT A2	650	1,050	10	320

Achievable hardness (following quenching in water)

Table 4:
Achievable
hardness

Steel grades	Hardness HRC
DUROSTAT A2	62 - 66

Quality test

The heat analysis is provided as proof of the chemical composition.

Tolerances and surface finish

Unless otherwise agreed, tolerances according to EN 10029 (thickness tolerance according to class A, flatness tolerance according to class N) and surface finish according to EN 10163- A1 are valid.

Marking

In general, marking consists of:

- voestalpine symbol
- Steel grade designation
- Heat number
- Plate number

Material testing certificate

Type of certificate according to EN 10204 must be agreed upon ordering.

Processing guidelines

Cold forming

DUROSTAT A2 can be cold formed only to a limited extent. Soft annealing creates more favourable conditions for this purpose. In such cases, subsequent normalising or quenching and tempering must be carried out to increase wear-resistance. Plate edges which are formed must be free of notches.

Hot forming and heat treatment

It is desirable that the final forming operation is carried out at normalising temperature. If this is not possible, then repeated normalising or quenching and tempering may be required.

Hot forming and heat treatment temperatures

Steel grade	Hot forming °C	Soft annealing °C	Quenching and tempering in water or oil °C
DUROSTAT A2	1,050 - 850	710 - 750	790 - 830

Table 5:
Heat
treatment

Welding and oxygen cutting

As a consequence of their high carbon content, these wear-resistant steels show a limited weldability. Therefore, their employment in welded structures should be avoided as far as possible.

Special measures are necessary in any case. Preheating to minimum 200 °C, postheating (200 °C / 3 hours) and the use of austenitic fillers are recommended.

The same preheating requirements apply for oxygen cutting.

Dimensions

DUROSTAT A2

Thickness (mm)															
100															
95															
90															
85															
80															
75															
70															
65															
60															
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35															
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25															
20															
15															
10															
8															
		1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500			Width (mm)

Maximum length: 12,000 mm

Different dimensions on request.

DUROSTAT B2

The grades of DUROSTAT B2 are boron alloyed, quenched and tempered steels, which are produced as fine-grain steels. The steels are mainly used for components of agricultural machines such as harrows and ploughs. Additional areas of use are wheel loader buckets, dump bodies or cut bars on front loaders.



The technical terms of delivery apply for plate thicknesses from 8 - 100 mm.

Steel grades

Steel grades

Steel grades
DUROSTAT B2

Table 1:
Steel grades

Production process

DUROSTAT B2 steels are produced via the LD-route.

Chemical composition

Heat analysis

Guaranteed values

Steel grades	mass in %									
	C max.	Si max.	Mn max.	P max.	S max.	Al _{tot.} min.	Cr max.	Ti max.	B min.	B max.
DUROSTAT B2	0.30	0.60	2.10	0.025	0.010	0.020	0.80	0.050	0.0005	0.0050

Table 2:
Chemical
composition

The steel is fine-grain melted and can contain microalloying elements such as Nb and V.

As-delivered condition

The plates are delivered in as-rolled condition (hot-rolled, untreated), since usually heat treatment such as quenching or tempering is carried out on the finished parts.

Mechanical properties

Standard values for as-rolled conditions (plate thickness 20 mm)

Steel grades	Yield strength N/mm ²	Tensile strength N/mm ²	Fracture elongation $L_0 = 5,65 \sqrt{S_0}$ %	Hardness HB
DUROSTAT B2	400	650	20	200

Table 3:
Mechanical
properties

Achievable hardness (following quenching in water)

Steel grades	Hardness HRC
DUROSTAT B2	48 - 52

Table 4:
Achievable
hardness

Quality test

The heat analysis is provided as proof of the chemical composition.

Tolerances and surface finish

Unless otherwise agreed, tolerances according to EN 10029 (thickness tolerance according to class A, flatness tolerance according to class N) and surface finish according to EN 10163-A1 are valid.

Marking

In general, marking consists of:

- voestalpine symbol
- Steel grade designation
- Heat number
- Plate number

Material testing certificate

Type of certificate according to EN 10204 must be agreed upon ordering.

Processing guidelines

Hot forming and heat treatment

DUROSTAT B steel plates can be hot formed and machined in untreated condition. Cold forming in as-rolled condition is only possible to a limited extent.

Hot forming and heat treatment temperatures

Steel grade	Hot forming °C	Quenching an tempering in	
		water °C	oil °C
DUROSTAT B2	1,100 - 800	870 - 900	900 - 930

Table 5:
Heat
treatment

Welding

General information

The high hardness of 48 - 52 HRC of DUROSTAT B2 steel grade is obtained by alloying boron. The chemical composition with a relatively low carbon content provides good weldability. Due to their high strength and good hardenability, DUROSTAT B2 grades require extra care during welding.

The generally valid and accepted rules for the welding of low-alloyed, higher-strength fine-grain structural steel according to EN 1011-2 and STAHL-EISEN Werkstoffblatt (SEW) 088 are to be observed.

Filler materials and welding conditions (preheating, welding parameters)

The selection of the fillers depends on the strength requirements made on the welded joint. The following filler materials have proved practically:

Recommended filler materials

Welding	Electrodes	Inert gas welding wire
before quenching	E 7018-1 (e.g. Böhler FOX EV 50)	ER 80 S-G (e.g. Böhler DMO-IG)
after quenching	E 7018-1 (e.g. Böhler FOX EV 50)	ER 80 S-G (e.g. Böhler DMO-IG)
for welded joints of higher strength		
	E 10018-G (M) (e.g. Böhler FOX EV 75)	ER 110 S-G (e.g. Böhler X70-IG)

Table 6:
Recommended
filler materials

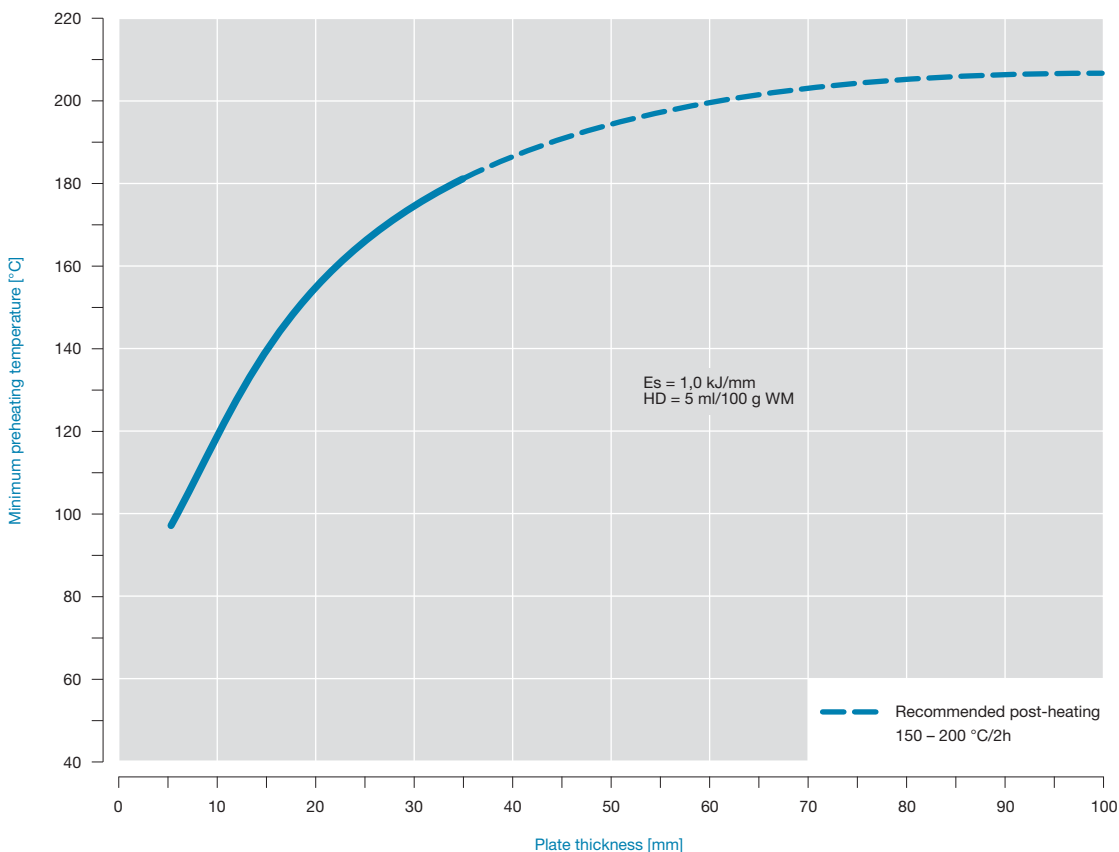
If the design requires that the welds have the same wear-resistance as the base material, the top layers can be welded with wear-resistant electrodes (e.g. Böhler FOX DUR 350 or FOX DUR 500) or equivalent inert gas welding wires. For reasons of cold cracking prevention, the hydrogen content in the weld material should be very low ($HD \leq 5 \text{ ml}/100 \text{ g WM}$). This is generally guaranteed by inert gas shielded welding with solid wire. Basic electrodes must be subjected to secondary drying according to manufacturers instructions in order to maintain this hydrogen criterion.

In order to prevent excessive hardening in the heat-affected zone and to obtain a high level of resistance against hydrogen-induced cracks, preheating according to picture 1 and postheating ($150 - 200 \text{ }^\circ\text{C} / 2 \text{ hours}$) for plate thicknesses above 30 mm is recommended.

For specific applications, the precise preheating temperature can be established according to SEW 088 or EN 1011-2 on the basis of the chemical composition of the plate to be processed and the selected welding parameters.

Welding parameters which lead to cooling times $t_{8/5}$ of 10 - 20 seconds, have proved effective. They result in optimum mechanical-technological properties (strength, toughness etc.) of the welds.

Recommended preheating temperature, DUROSTAT B2



Picture 1:
Recommended
preheating
temperature

Dimensions

DUROSTAT B2

Thickness (mm)														
100														
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90														
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8														
		1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500		Width (mm)

Maximum length: 12,000 mm

Different dimensions on request.

voestalpine Grobblech GmbH

voestalpine-Straße 3
4020 Linz, Austria
T. +43/50304/15-9440
F. +43/50304/55-9440
grobblech@voestalpine.com
www.voestalpine.com/grobblech

voestalpine

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