durostat®

Wear-resistant steels

Technical terms of delivery for heavy plates

voestalpine Grobblech GmbH
www.voestalpine.com/grobblech

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ONE STEP AHEAD.

durostat®

Wear-resistant steels

durostat®

Steel grades

- durostat 400
- durostat 450
- durostat 500
- durostat B2

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

durostat 400, durostat 450, durostat 500

The steel grades durostat 400, durostat 450 and durostat 500 are wear-resistant special steels with hardness of approx. 400 HB, 450 HB resp. 500 HB. These steels provide high levels of resistance to mechanical wear and are specially suitable for components exposed to heavy abrasion, e.g. loading devices, shovels of wheel loaders, bodies of trough tipping wagons, conveyors, excavator components, road machines, screens and crushers.

The technical terms of delivery apply for plate thicknesses from 8 - 100 mm for durostat 400, for plate thicknesses from 8 - 30 mm for durostat 450 and for plate thicknesses from 10 - 30 mm for durostat 500.

Steel grades

Steel grades

Steel grades
durostat 400
durostat 450
durostat 500

Table 1: Steel grades

Production Process

The steel grades durostat 400, durostat 450 and durostat 500 are produced via the LD-route.

Chemical composition

Heat analysis

Table 2: Chemical composition

Guaranteed values

Steel grades	mass in %									
	C	Si	Mn	P	S	$Al_{tot.}$	Cr	Mo	B	Ti
	max.	max.	max.	max.	max.	min.	max.	max.	max.	max.
durostat 400	0.18	0.60	2.10	0.025	0.010	0.020	1.00	0.50	0.005	0.050
durostat 450	0.22	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

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

Carbon equivalent

Table 3: Carbon equivalent

Standard values

Steel grades	mass in %	
	CEV[1)]	CET[2)]
durostat 400	0.47	0.30
durostat 450	0.68	0.43
durostat 500	0.53	0.41

[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 450	410 - 490
durostat 500	460 - 540

Mechanical properties

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

Table 4: Mechanical properties

Steel grades	Yield strength MPa	Tensile strength MPa	Fracture elongation $L_0 = 5{,}65 \sqrt{S_0}$ %
durostat 400	1,000	1,250	10
durostat 450	1,100	1,400	9
durostat 500	1,200	1,550	8

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, durostat 450 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

Table 5: Minimum bending radii

Position of the bending edge to the rolling direction	smallest permitted bending radius		
	durostat 400	durostat 450	durostat 500
Longitudinal	4 x plate thickness	5 x plate thickness	5 x plate thickness
Transverse	3 x plate thickness	4 x plate thickness	4 x plate thickness

Heat treatment

In order to maintain its hardness, durostat 400, durostat 450 and durostat 500 may not be heated above 200 °C.

Welding

General information

Due to their chemical composition, plates of durostat 400, durostat 450 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 ml/100 g WM.

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

Table 6: Recommended filler materials

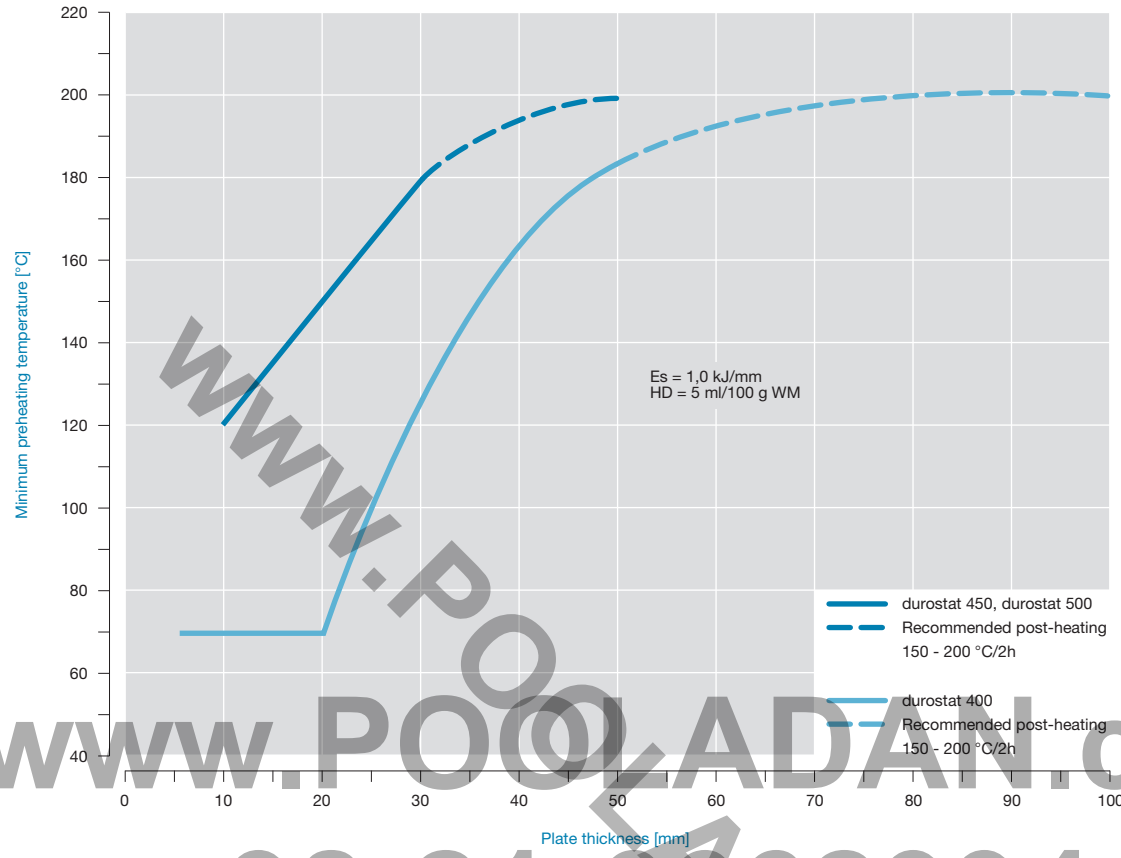
Electrodes	Inert gas welding wire
E 7018-1 (e. g. Böhler FOX EV 50)	ER 80 S-G (e. g. Böhler DMO-IG)
E 7018-1 (e. g. Böhler FOX EV 50)	ER 80 S-G (e. g. Böhler DMO-IG)
for welded joints of higher strength	
E 10018-G (M) (e. g. Böhler FOX EV 75)	ER 110 S-G (e. g. Böhler X70-IG)

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. UTP DUR 400 or UTP DUR 600) or equivalent inert gas welding wires.

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, durostat 450 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													
8													
Width (mm)		1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500	

Maximum length: 13,200 mm

Different dimensions on request.

Dimensions

durostat 450

Thickness (mm)													
30													
25													
20													
15													
10													
8													
Width (mm)		1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500	

Maximum length: 13,200 mm

Different dimensions on request.

Dimensions

durostat 500

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

Maximum length: 13,200 mm

Different dimensions on request.

durostat B2

durostat B steels are heat-treatable steels delivered in as-rolled condition for components in agri-cultural machines (e.g. ploughs and harrows), cutting edges for front-end loaders or brick-molding boxes.

The technical terms of delivery apply for plate thicknesses from 8 - 50 mm.

Steel grades

Table 1: Steel grades

Steel grades
durostat B2

Production process

durostat B2 steels are produced via the LD-route.

Chemical composition

Heat analysis

Guaranteed values

Table 2: Chemical composition

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

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)

Table 3: Mechanical properties

Steel grades	Yield strength MPa	Tensile strength MPa	Fracture elongation $L_0 = 5{,}65 \sqrt{S_0}$ %	Hardness HB
durostat B2	400	650	20	200

Achievable hardness (following quenching in water)

Table 4: Achievable hardness

Steel grades		Hardness HB
durostat B2		approx. 500

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

Table 5: Heat treatment

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

Welding

General information
The high hardness of approx. 500 HB 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

Table 6: Recommended filler materials

Welding	Electrodes	Inert gas welding wire
before hardening	E 7018-1 (e. g. Böhler FOX EV 50)	ER 80 S-G (e. g. Böhler DMO-IG)
after hardening	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)

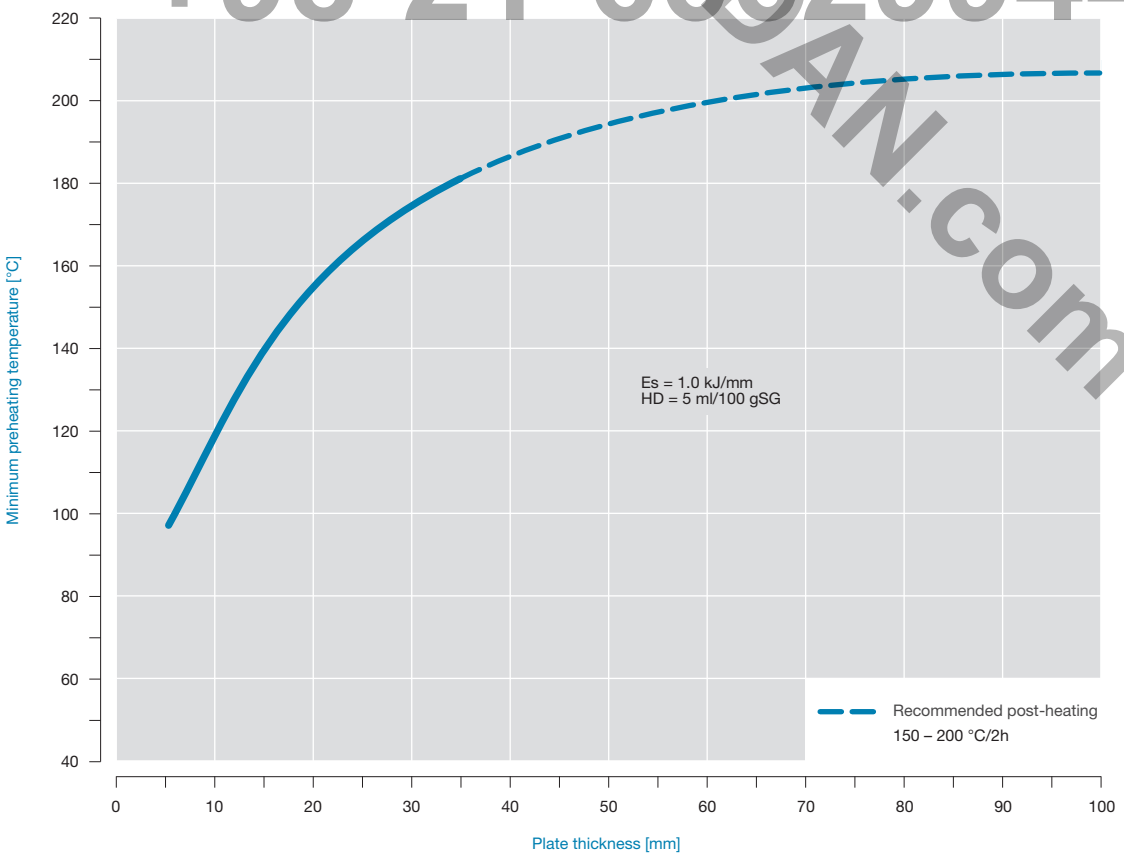
If the design requires that the welds have the same wear-resistance as the base material, the top layers can be welded with wear-resistant electrodes (e.g. UTP DUR 400 or UTP DUR 600) or equivalent inert gas welding wires. For reasons of cold cracking prevention, the hydrogen content in the weld material should be very low (HD ≤ 5 ml/100 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 °C / 2 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)													
50													
45													
40													
35													
30													
25													
20													
15													
10													
8													
Width (mm)		1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500	

Maximum length: 18,700 mm

Different dimensions on request.

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High-quality materials are the basis for our products. We strive to be the best partner for our customers and want to provide them with the best-possible solution. We focus our expertise on two aspects:
The personal aspect, with dedicated and highly competent employees
The technical aspect, with high-quality methods, products and services

The companies in the voestalpine Steel Division and their employees understand partnership to be the following:

- Understanding for their customers' business
- Expertise and reliability
- Responsibility for satisfactory project completion
- Partnerships based on trust

Many years of successful partnerships with our customers prove our point.

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

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