

Steel

# XAR®

Product information for wear-resistant steels



thyssenkrupp

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## Profile

XAR® steels from thyssenkrupp are wear-resistant steels with excellent workability. XAR® stands for eXtra Abrasion Resistant. Hardnesses of 300 to 600 HBW and plate thicknesses from 4.0 to 100 mm make these the steel of choice for a wide range of applications that must withstand moderate wear to extreme abrasion. We additionally offer special grades with exceptionally high toughness for high-impact applications as well as heat-resistant grades for use in high-temperature environments up to 400°C.

Modern, low carbon equivalent alloying concepts that are optimally matched to the thickness range ensure good cutting and welding characteristics along with good through-hardening even at greater plate thicknesses.

These steels are ideal for designs and components subject to wear, such as:

- Parts of demolition and earth-moving machinery
- Tipper bodies
- Handling and crushing equipment
- Scrap presses
- Agricultural machinery

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## Available steel grades

XAR® steels are available as cut-to-length and four-high mill plate with nominal hardnesses between 300 and 600 HBW in the dimensions specified under “Available dimensions”.

XAR® family overview			
	Material number	Special feature	Delivery form
<b>Name of steel grade</b>			
XAR® 300	1.8704	Hot-formable	Four-high mill
XAR® HT		High guaranteed toughness for impact wear and through-hardening	Four-high mill
XAR® 400	1.8714	Guaranteed toughness and through-hardening	Four-high mill and cut-to-length
XAR® 400HR		Hot-formable, heat resistant up to 400 °C	Four-high mill
XAR® 400W		Heat resistant up to 400 °C with good toughness	Four-high mill
XAR® 450	1.8722	Guaranteed toughness and through-hardening	Four-high mill and cut-to-length
XAR® 500	1.8734	High abrasion resistance, guaranteed through-hardening	Four-high mill
XAR® 600	1.8735	Extreme abrasion resistance, guaranteed through-hardening	Four-high mill

## Comments

Permissible tolerances are determined according to DIN EN 10051 for cut-to-length plates and DIN EN 10029 for four-high mill plates.

Four-high mill plates are supplied with a maximum flatness tolerances in accordance with DIN EN 10029, Table 4, steel group H, cut-to-length plates according to DIN EN 10029, Table 5, steel group H. Smaller flatness tolerances can be agreed upon on ordering.

DIN EN 10163 applies for the surface quality requirements of cut-to-length and four-high mill plates. On the basis of a special agreement, four-high mill plates can be supplied blasted or descaled or descaled and primed. Cut-to-length plates are only available with an as-rolled surface and untrimmed.

If not otherwise agreed upon the order, the terms of DIN EN 10021 shall apply for supply.

## Available dimensions

### Cut-to-length plates

Name of steel grade	Thickness from_to in mm	Maximum width in mm
XAR® 400	4.0–8.0*	1,500
XAR® 450	4.0–8.0*	1,600

Length: Minimum 2,000 mm, maximum 16,000 mm.

\*Not all width/thickness combinations are available. Further dimensions on request..

### Four-high mill plates

Name of steel grade	Thickness from_to in mm	Maximum width in mm
XAR® 300	6.0–50.0	3,500
XAR® HT	40.0–100.0	3,300
XAR® 400	4.0–100.0	3,300
XAR® 400HR	4.0–25.0	3,300
XAR® 400W	4.0–40.0	3,300
XAR® 450	4.0–100.0	3,300
XAR® 500	4.0–100.0	3,300
XAR® 600	4.0–50.0	3,300

Length: Minimum 6,000 mm (shorter lengths to min. 4,000 mm on request), maximum 14,800 mm. Not all width/thickness combinations are available.

## Technical characteristics

### Delivery condition

XAR® HT, 400, 400W, 450, 500, 600: Hardened, quenched and tempered or thermomechanically rolled with accelerated cooling.

XAR® 300 and XAR® 400HR: As rolled, normalized or air-hardened.

See also the section “Heat treatment”.

### Chemical composition

Name of steel grade	Mass fraction in ladle analysis									Typical carbon equivalents (t = 15 mm)	
	C [%] max.	Si [%] max.	Mn [%] max.	P [%] max.	S [%] max.	Cr [%] max.	Mo [%] max.	B [%] max.	Ni [%] max.	CE [%]	CET [%]
XAR® 300	0.22	0.65	1.50	0.020	0.010	1.20	0.30	0.005	–	0.70	0.42
XAR® HT	0.20	0.60	1.60	0.020	0.010	1.00	0.70	0.005	–	0.58	0.38
XAR® 400	0.20	0.80	1.50	0.020	0.010	1.00	0.50	0.005	1.50	0.42	0.28
XAR® 400HR	0.20	0.50	1.80	0.020	0.010	1.90	0.50	0.005	1.00	0.83	0.46
XAR® 400W	0.26	0.80	1.30	0.020	0.010	1.20	0.60	0.005	–	0.60	0.40
XAR® 450	0.22	0.80	1.50	0.020	0.010	1.30	0.50	0.005	1.50	0.46	0.32
XAR® 500	0.28	0.80	1.50	0.020	0.010	1.00	0.50	0.005	1.50	0.60	0.40
XAR® 600	0.40	0.80	1.50	0.020	0.010	1.50	0.50	0.005	1.50	0.78	0.53

CE [%] =  $C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$

CET [%] =  $C + (Mn + Mo)/10 + (Cr + Cu)/20 + Ni/40$

The steel has a fine-grained microstructure. The nitrogen is bound as nitrides with Al as well as Nb or Ti where appropriate.

## Mechanical properties

Name of steel grade	Hardness	Impact energy		Yield strength	Tensile strength	Elongation	
	[HBW]	CVN Min. [J]	CVN typ. [J] at -40°C	CVN typ. [J] at -20°C	R <sub>p0.2</sub> typ. [MPa]	R <sub>m</sub> typ. [MPa]	A typ. [%]
XAR® 300	≥270 (6–20 mm)	–	–	–	700	1,030	12
	≥240 (>20–50 mm)	–	–	–	700	1,030	12
XAR® HT	310–370	50 J at -40°C (40–70 mm)	70	–	960	1,000	14
		40 J at -40°C (>70 mm)	70	–	900	960	14
XAR® 400	370–430	27 J at -20°C (6–35 mm)	45	–	1,000	1,250	10
XAR® 400HR	340–440 (4–<20 mm)	–	–	27	900	1,200	12
	320–440 (20–25 mm)	–	–	27	900	1,200	12
XAR® 400W	360–430	–	30	–	1,100	1,250	10
XAR® 450	420–480	27 J at -20°C (6–35 mm)	40	–	1,200	1,400	10
XAR® 500	470–530	–	–	30	1,300	1,600	9
XAR® 600	>550	–	–	20	1,700	2,000	8

The Brinell hardness is determined according to DIN EN ISO 6506. The hardness is measured approx. 1 mm beneath the surface of the plate. A core hardness of ≥90% of the minimum hardness is guaranteed for XAR® HT, 400, 450, 500 and 600. The core hardness is calculated as the average of three measurements in the area of the centre of the plate.

The notch impact tests according to DIN EN ISO 148-1 are performed on longitudinal samples from the area of the product surface (except for XAR® HT: ¼t). The minimum values represent an average of three samples, whereby no single value may be less than 70% of the prescribed

minimum value. For thicknesses under 10 mm, the impact energy value stated in the table decreases in proportion to the sample width (product thickness). No notch impact tests are performed on products less than 6 mm. Typical values apply for plate thicknesses from 10–25 mm (except XAR® HT: 70 mm).

Tensile testing is performed on transverse samples at room temperature according to DIN EN ISO 6892-1, method B. Typical values apply for a plate thickness of 15 mm (except XAR® HT: 50 and accordingly 80 mm).

## Number of tests

If not otherwise agreed upon the order, the following scope of testing shall apply for acceptance inspections:

Scope of testing		
	Hardness	Notched bar impact test (1 set = 3 specimens)
<u>Name of steel grade</u>		
XAR® 300	Min. 1 x per heat	
XAR® HT	Min. 1 x per 40t of a heat	Min. 1 x per 40t of a heat
XAR® 400	6–35 mm: Min. 1 x per 40t of a heat < 6 mm and > 35 mm: Min. 1 x per heat	6–35 mm: Min. 1 x per 40t of a heat
XAR® 400HR	Min. 1 x per heat	
XAR® 400W	Min. 1 x per heat	
XAR® 450	6–35 mm: Min. 1 x per 40t of a heat < 6 mm and > 35 mm: Min. 1 x per heat	6–35 mm: Min. 1 x per 40t of a heat
XAR® 500	Min. 1 x per heat	
XAR® 600	Min. 1 x per heat	

## Notes on use and working

The following notes can only address a few key points. More detailed recommendations are contained in the brochure “XAR® Abrasion-resistant Steels – Processing Recommendations” and, more generally, in the publication “STAHL-EISEN-Werkstoffblatt 088”. Our Technical Customer Service is happy to support you in matters relating to working. The processor/ fabricator must assure himself, that his design and work methods are appropriate for the material, conform to the state of the art and are suitable for the intended purpose. The choice of material is the responsibility of the customer.

### Cold forming

XAR® steels are suitable for cold bending under consideration of their high hardness. Under favorable conditions (e.g. deburred and notch-free edges, slow forming, lubrication of die edge), crack-free forming is possible with the following minimum bending radii and die widths:

Minimum bending radii and die widths for cold forming

	Nominal thickness [mm]	r/t ⊥	r/t	W/t ⊥	W/t
<b>Name of steel grade</b>					
XAR® 300	t ≤ 8	2.5	3.0	8.5	10.0
XAR® 400	8 < t ≤ 20	3.0	4.0	10.0	10.0
XAR® 400HR	t > 20	4.5	5.0	12.0	12.0
XAR® 450	t ≤ 8	4.0	4.5	10.0	12.0
	8 < t ≤ 15	4.5	5.0	12.0	12.0
	t > 15	5.0	6.0	12.0	14.0
XAR® 500	t ≤ 8	5.0	6.0	12.0	13.0
	t > 8	On request			
XAR® 600	On request				

⊥ = bending line perpendicular to rolling direction; || = bending line in rolling direction; W = maximum die width;  
r/t = radius/nominal thickness

### Machining

In spite of their high wear resistance, XAR® steels can be satisfactorily machined using suitable machine tools equipped with sharp carbide tools. The feed rate and cutting speed are to be adjusted according to the hardness of the steel.

### Hot forming

XAR® 300 and XAR® 400HR are suitable for hot forming. The functional properties are retained in hot forming in the temperature range from 850 to 1,000 °C with subsequent air cooling. However, other XAR® steels are not suitable for hot forming, as they lose their as-delivered properties when heated above 250 °C (XAR® 400W: over 400 °C).

### Heat treatment

XAR® plates generally receive their high hardness after austenitizing with subsequent quenching in special facilities and, where appropriate, annealing below Ac1. Direct hardening after rolling is comparable to conventional hardening. To avoid loss of hardness, the steel may not be heated above 250 °C (XAR® 400W: not above 400 °C).

Unlike the other steels of the XAR® family, XAR® 300 and XAR® 400HR receive their properties through normalizing at 880 to 950 °C or through normalizing rolling with subsequent air cooling. At thin product thicknesses and in special cases, these two steels can require delayed cooling or tempering. Properly conducted subsequent heating (tempering) up to 550 °C with subsequent air cooling does not alter the steel's properties profile. When heating to temperatures above 550 °C, however, a subsequent normalization in the temperature range 880 to 950 °C is required.

### Thermal cutting

The optimized analysis concepts with low carbon equivalent (see "Chemical composition") ensure good cutting and welding properties. Depending on the plate thickness, the following methods can be used for thermal cutting of XAR® steels: plasma cutting, laser cutting, oxy-fuel cutting. Our processing recommendations contain information on recommended preheating temperatures. Those working the steel must decide at their own discretion which additional precautions must be applied to avoid cracking in thermal cutting and welding under the given design and fabrication conditions.

### Welding

XAR® steels are suitable for both manual and automated welding under consideration of generally accepted good engineering practice. Information on welding may be found in DIN EN 1011 parts 1 and 2 in our processing recommendations and online in our welding calculator ProWeld.



## Sample applications



Special mill grades are supplied subject to the special conditions of thyssenkrupp. Other delivery conditions not specified here will be based on the applicable specifications. The specifications used will be those valid on the date of issue of this product information brochure.

### General information

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