A54 - Durabor® - Quenchable boron steels

Quenchable boron steels are used in applications requiring good wear resistant properties.

A54

Properties

Quenchable boron steels represent a breakthrough in heat treatment technology. These steels use boron as a hardening agent. The melting and refining process, together with thermomechanical treatment by controlled hot rolling, allow ArcelorMittal quenchable boron steel to attain a remarkable degree of hardness and a very uniform microstructure, resulting in excellent mechanical loading performance after heat treatment of the finished part.

A54

Advantages

After heat treatment

Their extreme hardness after heat treatment makes these grades particularly suitable for applications requiring high wear/abrasion resistance. Their use allows significant weight saving (up to 50% compared with an HSLA grade) in structural and automotive components. The specific advantage of ArcelorMittal quenchable boron steels is their suitability for water quenching, making the process more environmentally friendly (less effluent treatment) than that used for conventional carbon steels. Their hardening performance is excellent with both liquid and gas quenching.

ArcelorMittal offers the following quenchable boron grades: Durabor® 20MnB5, Durabor® 22MnB5, Durabor® 28MnB5, Durabor® 30MnB5, Durabor® 33MnCrB5 and Durabor® 38MnB5 and equivalent EN ISO 683-2:2018 grades. Please contact us for other grades which are under development.

Properties can be tailored to specific requirements. Additional grades may be available on request. Contact our commercial teams for further information.

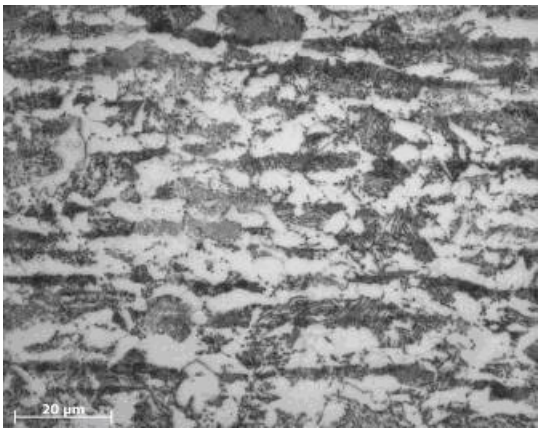
The choice of grade will depend on:

- The required hardness of the finished part
- The abrasion resistance required
- The severity of the forming process envisaged

All the grades in the Durabor® boron steel range can be hot or cold formed.

As supplied

In spite of their moderate hardness and mechanical properties, boron grades exhibit remarkably good abrasion resistance in their delivery condition, thanks to their composite microstructure consisting of a hard pearlite phase embedded in ferrite. They are therefore very cost-effective solutions for applications requiring good abrasion resistance.



Durabor® 30MnB5

Ferrite-pearlite structure

A54

Applications

Quenchable boron steels are used in applications requiring good wear resistant properties. The main applications for these steel grades after heat treatment are agricultural machinery (discs, plough shares), machinery for public works and mining, cutting equipment, tubes for automotive safety parts etc. A popular application for untreated steel is concrete mixer drums.

A54

Recommendations for use

TRC characterisation of Durabor® 22MnB5

The recommended austenitising temperature is 880 °C. The temperature at the beginning of the quenching process (i.e. at the maximum cooling rate) is 750 °C. Ac_3 temperature is 860 °C, for a heating rate of 5 °C/s. Ac_1 temperature is 750 °C, and M_s (Martensitic Start) starting temperature is 400 °C.

In a tensile test, after austenitisation for 5 minutes at 850 °C followed by water quenching, the structure of the sample obtained is entirely of the martensite type. In the same test performed at 840 °C, a few islands of residual ferrite can be observed, regularly distributed.

TRC characterisation of Durabor® 30MnB5

The recommended austenitising temperature is 830 °C to 850 °C. The temperature at the beginning of the quenching process (i.e. at the maximum cooling rate) is 730 °C. The TRC diagrams are available on request.

Forming

Durabor® 20MnB5, Durabor® 22MnB5, Durabor® 28MnB5, Durabor® 30MnB5, Durabor® 33MnCrB5 and Durabor® 38MnB5 can be hot or cold formed.

A54

Heat treatment

Typical mechanical properties of a 6 mm specimen in the rolling direction before and after quenching are indicated below.

	Delivery condition			Quenched			
Grade	R_e (MPa)	R_m (MPa)	A (%)	Hardness HRC	R_e (MPa)	R_m (MPa)	A (%)
Durabor® 20MnB5 and EN ISO 683-2:2018	350	520	27	45	1100	1450	11
Durabor® 22MnB5						1500	10
Durabor® 28MnB5	420	620	26	49	1200	1650	9
Durabor® 30MnB5 and EN ISO 683-2:2018	440	660	25	50		1700	8
Durabor® 33MnCrB5 and EN ISO 683-2:2018	495	750	20	54	1300	2000	7
Durabor® 38MnB5	480	760	18	55			

Changing up from grade Durabor® 30MnB5 to Durabor® 38MnB5 makes it possible to increase hardness by about 10% on the quenched parts. Abrasion tests show that this translates into a dramatic improvement of 40% of the wear resistance.

A54

Surface quality

The boron grades are available in A unexposed surface quality only.

A54

Fatigue resistance

Fatigue resistance is determined after heat treatment and quenching. Durabor® 22MnB5 steel 2.65 mm thick has been fatigue-tested by cyclical tensile loading with a load ratio of Rs = 0.1 after different heat treatments. Specimens were austenitised at 950°C for 5 minutes.

Specimen heated for 5 minutes at 950°C followed by:	Endurance limit sD (MPa)	Spread (sigma) (MPa)	Maximum stress sD (MPa)
Water quenching	253	5	562
Oil quenching	260	6	578
Water quenching + heat treatment at 200°C for 20 minutes	293	26	651

sD = (smax - smin)/2

Remark:

The fatigue resistance of ArcelorMittal's boron quenchable steels is between 40 and 60% higher than S355MC AM FCE low alloy grade. It can be reduced by over 30% if total decarburisation is carried out.

A54

Brand correspondence

	EN 10083-3:2006	NF A 36102	DIN 1654 Teil 4	BS970 Part 1	UNI 3756	UNE 36034	J1268	UNS
20MnB5 EN ISO 683-2:2018	20MnB5	20MnB5RR	20B2	174H20				
Durabor® 20MnB5	*20MnB5*	*20MnB5RR*	*20B2*	*174H20*				
Durabor® 22MnB5	*20MnB5*	*20MnB5RR*	*22B2*	*174H20*	*21B3*	*21B3/20MnB5*	*10B21/15B21*	*H15211*
Durabor® 28MnB5	*28MnB5*	*28MnB5RR*	*28B2*					
30MnB5 EN ISO 683-2:2018	30MnB5	30MnB5RR	28B2				15B30	H15301
Durabor® 30MnB5	*30MnB5*	*30MnB5RR*	*28B2*				*15B30*	*H15301*
33MnCrB5 EN ISO 683-2:2018	33MnCrB5							
Durabor® 33MnCrB5	*33MnCrB5*							
39MnB5 EN ISO 683-2:2018	38MnB5							
Durabor® 38MnB5	*38MnB5*							

Grades in italics: not included in the standard

A54

Dimensions

Mill finish

Thickness (mm)	20MnB5 EN ISO 683-2:2018, Durabor® 20MnB5		Durabor® 22MnB5		Durabor® 28MnB5		30MnB5 EN ISO 683-2:2018, Durabor® 30MnB5		33MnCrB5 EN ISO 683-2:2018, Durabor® 33MnCrB5		39MnB5 EN ISO 683-2:2018, Durabor® 38MnB5	
	Min width	Max width	Min width	Max width	Min width	Max width	Min width	Max width	Min width	Max width	Min width	Max width
1.50 ≤ th < 1.70	800	1020	-	-	-	-	-	-	-	-	-	-
1.70 ≤ th < 1.80			685	1015			685	1065				
1.80 ≤ th < 2.00		1250			800	1250			800	1250		
2.00 ≤ th < 2.30		1350		1265		1350		1265		1350		
2.30 ≤ th < 2.40	600	1450			600		600				600	1250
2.40 ≤ th < 2.50				1460				1460				1370
2.50 ≤ th < 2.60						1400				1450		
2.60 ≤ th < 2.80												
2.80 ≤ th < 3.00		1550				1475			800			
3.00 ≤ th < 3.40				1650		1550		1650		1550		1575
3.40 ≤ th < 4.00		1575				1575						
4.00 ≤ th < 4.50				1850				1850				
4.50 ≤ th < 5.00				1950				1950				
5.00 ≤ th < 8.00				2150				2150				
8.00 ≤ th < 12.70	800				800		685				800	
12.70 ≤ th < 14.00									1000			
14.00 ≤ th < 15.00		1370	685			1370						1370
15.00 ≤ th < 15.50				-	-		800	1370				
15.50 ≤ th < 16.00									-	-		

Pickled

Thickness (mm)	20MnB5 EN ISO 683-2:2018, Durabor® 20MnB5		Durabor® 22MnB5		Durabor® 28MnB5		30MnB5 EN ISO 683-2:2018, Durabor® 30MnB5		33MnCrB5 EN ISO 683-2:2018, Durabor® 33MnCrB5		39MnB5 EN ISO 683-2:2018, Durabor® 38MnB5	
	Min width	Max width	Min width	Max width	Min width	Max width	Min width	Max width	Min width	Max width	Min width	Max width
1.50 ≤ th < 1.70	800	1020	-	-	-	-	-	-	-	-	-	-
1.70 ≤ th < 1.80			660	1050			660	1050				
1.80 ≤ th < 2.00		1250			800	1250			800	1250		
2.00 ≤ th < 2.30		1300		1260		1300		1250		1300		
2.30 ≤ th < 2.40	600	1310			600	1310						
2.40 ≤ th < 2.50				1450				1280				
2.50 ≤ th < 2.80		1400				1400						
2.80 ≤ th < 3.00		1475				1475						
3.00 ≤ th < 3.20		1525		1630		1525					-	-
3.20 ≤ th < 3.60		1550				1550						
3.60 ≤ th < 4.00		1500				1500						
4.00 ≤ th < 4.50				1830				1100				
4.50 ≤ th < 5.00				1930								
5.00 ≤ th < 6.00				2130								
6.00 ≤ th < 6.20	800	1300		1550	800	1300		-				
6.20 ≤ th < 7.00	-	-			-	-			-	-		
7.00 ≤ th < 8.00				1280								

A54

Chemical composition

These grades receive a globularisation treatment of the manganese sulphides. The efficiency of boron is ensured by the addition of elements that bind nitrogen.

	C (%)	Mn (%)	P (%)	S (%)	Si (%)	Al (%)	Ti (%)	B (%)	Cr (%)
20MnB5 EN ISO 683-2:2018	0.170 - 0.230	1.10 - 1.40	≤ 0.025	≤ 0.035	≤ 0.40	-	-	0.0008 - 0.0050	-
Durabor® 20MnB5	**0.190** - 0.230	**1.15 - 1.35**	≤ **0.020**	≤ **0.005**	**0.15 - 0.35**	≥ **0.020**	**0.020 - 0.050**	**0.0015 - 0.0045**	-
Durabor® 22MnB5	0.200 - 0.250	1.10 - 1.40	≤ 0.025	≤ **0.008**	0.15 - 0.35	≥ **0.020**	**0.020 - 0.060**	0.0020 - 0.0050	-
Durabor® 28MnB5	0.260 - 0.300	1.20 - 1.40	≤ 0.020	≤ 0.005	0.20 - 0.30	≥ 0.015	0.020 - 0.050	0.0020 - 0.0050	-
30MnB5 EN ISO 683-2:2018	0.270 - 0.330	1.15 - 1.45	≤ 0.025	≤ 0.035	≤ 0.40	-	-	0.0008 - 0.0050	-
Durabor® 30MnB5	0.270 - 0.330	1.15 - 1.45	≤ 0.025	≤ **0.004**	**0.20 - 0.30**	≥ **0.020**	**0.020 - 0.050**	**0.0010 - 0.0040**	-
33MnCrB5 EN ISO 683-2:2018	0.300 - 0.360	1.20 - 1.50	≤ 0.025	≤ 0.035	≤ 0.40	-	-	0.0008 - 0.0050	0.30 - 0.60
Durabor® 33MnCrB5	0.300 - 0.380	1.20 - **1.45**	≤ **0.020**	≤ **0.030**	≤ **0.35**	≥ **0.015**	**0.020 - 0.050**	**0.0010 - 0.0040**	**0.40 - 0.50**
39MnB5 EN ISO 683-2:2018	0.360 - 0.420	1.15 - 1.45	≤ 0.025	≤ 0.035	≤ 0.40	-	-	0.0008 - 0.0050	-
Durabor® 38MnB5	**0.360 - 0.400**	**1.20 - 1.40**	≤ **0.020**	≤ **0.005**	**0.20 - 0.35**	≥ **0.020**	**0.020 - 0.050**	**0.0020** - 0.0050	-

Grades in italics: not included in the standard

Values in bold: tighter than the standard

Any questions?
Ask them via our contact form on https://industry.arcelormittal.com/getintouch