



## S355 / 420 / 460 MLO toughcore

### **Fracture mechanic – heat affected zone qualification up to 140 mm plate thickness to assure highest safety for offshore application**

Putting the focus on the entire supply chain from installation, exploration, transportation to storage, voestalpine Grobblech GmbH gives the answer to an upcoming market with a TMCP-based plate design, satisfying this demanding world.

The new generation of thermomechanically rolled (TMCP) steel is manufactured in a completely new and patented process that enables unique combinations of properties with respect to thickness, strength, excellent toughness even at lowest temperatures as well as best weldability.

toughcore® is characterized by its extremely high toughness even to the core as a result of the remarkably fine microstructure throughout the entire cross-section. The microstructure is refined even in half plate thickness by accelerated cooling and consecutive fast reheating during the rolling process.

toughcore® heavy plates are pre-qualified as per EN 10225 (2019) Annex B (Option 17) in the delivery condition as well as after simulated post weld heat treatment for heat inputs of 3.5 kJ/mm and 5 kJ/mm.

With its outstanding toughness over the entire cross-section, even at very high plates thickness, it creates higher safety standards and enhance the potential for the use of heavy plates for offshore construction, especially when used for arctic applications.

#### **Convincing advantages**

- » The answer for exploration of arctic regions and fulfilling requirements acc. to Arctic Class III up to 100 mm in particular
- » Superior toughness to the core assuring highest safety levels
- » Enhanced weldability
- » Welding Pre-qualification acc. EN 10225

## Chemical composition

Heat analysis in mass %

Steel grade	C max.	Si max.	Mn max.	P max.	S max.	Cr max.	Mo max.	B max.	Ti max.	Ni max.	Cu max.	Nb max.	N max.
S355 MLO toughcore	0.07	0.35	1.60	0.01	0.002	0.25	0.2 <sup>1)</sup>	0.0005	0.02	0.5	0.25	0.03	0.008
S420 MLO toughcore	0.08	0.35	1.60	0.01	0.002	0.25	0.3	0.0005	0.02	0.7	0.25	0.04	0.008
S460 MLO toughcore	0.08	0.35	1.70	0.01	0.002	0.25	0.3	0.0005	0.02	0.7	0.25	0.04	0.008

<sup>1)</sup> max. 0.08% up to incl. 75 mm

## Carbon equivalent

Steel grade	Plate thickness [mm]	CEV max.	Mass [%]	Pcm max.
S355 MLO toughcore	40 - 140	0.40 <sup>2)</sup>		0.2
S420 MLO toughcore	40 - 140	0.42		0.2
S460 MLO toughcore	40 - 140	0.43		0.2

<sup>2)</sup> max. 0.39% up to incl. 75 mm

## Mechanical properties: Notch impact energy

Notch impact energy in as-delivered condition

Steel grade	Plate thickness [mm]	Notch impact energy <sup>3)</sup> A, min / A min. [J] (¼ t)		Notch impact energy <sup>3)</sup> A, min / A min. [J] (½ t)	
		Test temperature		Test temperature	
		-80 °C	-65 °C	-60 °C	-45 °C
S355 MLO toughcore	40 ≤ 100	150 / 105	150 / 105	100 / 60	100 / 60
	> 100 ≤ 140	-	150 / 105	-	100 / 60
S420 MLO toughcore	40 ≤ 100	150 / 105	150 / 105	100 / 60	100 / 60
	> 100 ≤ 140	-	150 / 105	-	100 / 60
S460 MLO toughcore	40 ≤ 100	150 / 105	150 / 105	100 / 60	100 / 60
	> 100 ≤ 140	-	150 / 105	-	100 / 60

<sup>3)</sup> Notched impact bending test in accordance with EN ISO 148-1 on Charpy-V transversal samples  
Normative requirements acc. to EN 10225 at -40 °C min. 60/42J in 1/2t

## Mechanical properties: Tensile test

Standard values for as-delivered condition

Steel grade	Plate thickness [mm]	Yield strength $R_{p0.2}$ <sup>4)</sup> [MPa] min.		Tensile strength $R_m$ <sup>4)</sup> [MPa]	
		¼ t	½ t	¼ t	½ t
S355 MLO toughcore	40 ≤ 100	355	355	470 – 600	470 – 600
	> 100 ≤ 140	355	355	470 – 600	470 – 600
S420 MLO toughcore	40 ≤ 100	420 – 540	390 – 510	500 – 620	490 – 610
	> 100 ≤ 140	400 – 520	370 – 490	490 – 610	470 – 590
S460 MLO toughcore	40 ≤ 100	440 – 560	400 – 520	530 – 650	510 – 630
	> 100 ≤ 140	420 – 540	390 – 510	520 – 640	490 – 610

Steel grade	Uniform elongation $A_g$ <sup>4)</sup> [%]	Fracture elongation $L_0 = 5.65 \sqrt{S_0}$ <sup>4)</sup> A5 [%]		$R_{p0.2}$ / UTS max.
		L <sub>0</sub> = 5.65 √ S <sub>0</sub>	A5	
S355 MLO toughcore	10		25	0.90
S420 MLO toughcore	10		25	0.90
S460 MLO toughcore	10		25	0.90

<sup>4)</sup> Tensile test in accordance with EN ISO 6892-1 on transverse samples.

## Available dimensions

Maximum width per thickness; minimum width 1,500 mm

Steel grade	Plate thickness [mm]	Max. width [mm]	Max. length [mm]	As-delivered condition
S355 MLO toughcore	40 – 140	3,800	18,700	toughcore®
S420 MLO toughcore	40 – 140	3,800	18,700	toughcore®
S460 MLO toughcore	40 – 140	3,800	18,700	toughcore®

Additional dimensions upon request.

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