

## S460ML

### Fine-grain structural steels, thermomechanically-rolled

Material no.	1.8838
analogic	DIN EN 10025-4
Tensile strength class	C

#### Usage

The series of thermomechanically-rolled fine-grain structural steels is characterised by a minimum yield strength of 275-460 N/mm<sup>2</sup>, by good weldability and high resistance to brittle cracking. They are used above all for highly stressed welded structures in the construction of bridges and steel structures.

The cryogenic grades S...ML are available for special applications at temperatures below -20 °C.

The user of these steel grades must make sure that his calculation, design and processing methods are appropriate for the material. The welding technique used must be suitable for the intended application and comply with the state-of-the-art.

The steel grades of this series offer excellent cold-forming properties. Cold-bordering, cold-flanging, coldbending and cod-folding are possible.

#### Bending radius

transverse	4 x e
parallel	5 x e

#### Chemical composition <sup>1)</sup>

(in percent by weight)

	min.	max.
C		0,16%
Si		0,60%
Mn		1,70%
P		0,025%
S		0,020% <sup>2)</sup>
N		0,025%
Al	0,020% <sup>3)</sup>	
Nb		0,05%
V		0,12%
Ti		0,05%
Cr		0,30%
Ni		0,80%
Mo		0,20%
Cu		0,55%
C <sub>E</sub>		0,43% <sup>4)</sup>

1) Heat analysis

2) A sulphur content of 0,007 % max. can be agreed in the order or all products with a thickness of ≤16 mm intended for railway construction.

3) The minimum value for the Al<sub>total</sub> content shall not apply if the steel contains sufficient quantities of nitrogen-fixing elements.

4) Max. carbon equivalent value:  $C_E = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15$ . When the steel is suitable for hot dip galvanizing, C<sub>E</sub> is raised by 0,20%.

The following limitation shall additionally apply to all steel grades: Ti ≤0,05 %, Nb ≤0,05 %, Mo ≤0,20 %. The total content of Chrome, copper and molybdenum is not bigger than 0,60%.

For the plate thickness above 16 mm the max. carbon equivalent value is 0,45% or 0,46% for steel grades S420M, S420ML, S460M and S460ML.

#### Mechanical properties <sup>1)</sup>

Nom. thick. e	Yield strength R <sub>eH</sub>
≤ 16 mm	≥ 460 MPa
> 16 mm	≥ 440 MPa

Nom. thick. e	Tensile strength R <sub>m</sub>
	540 – 720 MPa

Nom. thick. e	Total elongation A <sub>5</sub>
≥ 3 mm	≥ 17 %

The samples for the tensile test are taken at right angles to rolling direction unless the product width is opposed to this.

1) The tensile test values given in the table to longitudinal samples; in case of strip and sheet steel of widths of ≥600 mm they apply to transverse samples.

#### Notch impact energy <sup>1)</sup>

°C	Notch impact energy	
	longitud.	transverse
+20	≥ 63	≥ 40
0	≥ 55	≥ 34
-10	≥ 51	≥ 30
-20	≥ 47	≥ 27
-30	≥ 40	≥ 23
-40	≥ 31	≥ 20
-50	≥ 27	≥ 16

1) Average values of 3 samples; one individual value may fall short of the required minimum value by not more than 30%. The sample width shall equal the product thickness if the latter is between 5 and 10 mm, the tests being performed using samples which are similar to Charpy-V samples. The values specified in the table above are to be reduced proportionally to the sample width.

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### Available dimensions

Hot-rolled coils unpickled, mill edge

Thickn. in mm	Width in mm
2,00 – 2,24	900 – 1300
2,25 – 2,99	900 – 1350
3,00 – 3,99	900 – 1550
4,00 – 12,70	900 – 1650

Hot-rolled slit strip

Thickn. in mm	Width in mm
2,50 – 2,99	100 – 640
3,00 – 4,60	100 – 690
4,61 – 6,00	140 – 740

<=100 mm on request

### Welding

The fine-grain structural steel grades of this series can be perfectly welded both manually and using automatic equipment by means of all known welding processes, not least due to their reduced carbon content and the low carbon equivalent value.

In general, pre-heating prior to welding is not necessary due to the low tendency to cold-cracking. However, the quality of the weld joint depends on the welding process, the welding conditions and the selection of the correct filler metals. Gas welding should not be used.

The welding wires and electrodes approved in this strength category must be used as filler metals. Basic coated elec-

trodes are recommended for manual welding.

These fine-grain structural steel grades are not suitable for heat treatment above 580 °C. Stress relief annealing (530–580 °C) is required only if called for in the regulations or if manufacturing conditions make a reduction of the residual welding stresses appear useful. The holding time should be between 30 and 60 minutes.

### Condition of delivery, scope of testing and certificate

The provisions of EN 10025-4 shall apply for delivery and inspection. The products are thermomechanically-rolled and delivered with a corresponding reference.