

Special structural steels for cold forming	Steel grade		Material No.	Material Specification
	TKSE-Short name	EN- Short name		
Heavy plates	<b>PERFORM 315</b>	<b>S315MC</b>	<b>1.0972</b>	660
	<b>PERFORM 355</b>	<b>S355MC</b>	<b>1.0976</b>	
	<b>PERFORM 380</b>	-	<b>1.0978</b>	
	<b>PERFORM 420</b>	<b>S420MC</b>	<b>1.0980</b>	
	<b>PERFORM 460</b>	<b>S460MC</b>	<b>1.0982</b>	
	<b>PERFORM 500</b>	<b>S500MC</b>	<b>1.0984</b>	
	<b>PERFORM 550</b>	<b>S550MC</b>	<b>1.0986</b>	
	<b>PERFORM 600</b>	<b>S600MC</b>	<b>1.8969</b>	
	<b>PERFORM 650</b>	<b>S650MC</b>	<b>1.8976</b>	
	<b>PERFORM 700</b>	<b>S700MC</b>	<b>1.8974</b>	
				February 2014

### Scope

This Material Specification applies to plates made of low carbon high strength steels with minimum yield strength values between 315 and 700 MPa in the thermomechanically rolled delivery condition. They offer improved formability and show favourable properties such as low tendency towards hardening and high cold cracking resistance at welding. Available are plates cut from hot strip in thicknesses equal or greater than 3 mm. Maximum widths and thicknesses are depending on the steel grade and the product (see paragraph "Available sizes"). The steels can also be ordered in accordance to EN 10149-2.

### Application

The steels are used for cold formed parts of different kinds such as truck frames, axle designs and other special profiles and shapes. The entire processing technique is of fundamental importance for the good performance of the products made of these steels. The processor must assure himself, that his calculation, designing and working conform with the material to be used, meet the latest requirements of technical progress, and are suited to the proposed application.

The selection of the material is up to the purchaser.

### Chemical Composition (heat analysis, %)

Steel grade	C	Si	Mn	P	S	Nb	V	Ti
<b>PERFORM 315</b>	≤ 0.10	≤ 0.15	≤ 1.30	≤ 0.025	≤ 0.010	≤ 0.05	≤ 0.08	-
<b>PERFORM 355</b>			≤ 1.50			≤ 0.06		
<b>PERFORM 380</b>			≤ 1.50			≤ 0.07		
<b>PERFORM 420</b>			≤ 1.60			≤ 0.10		
<b>PERFORM 460</b>			≤ 1.70			≤ 0.15		
<b>PERFORM 500</b>			≤ 1.80			≤ 0.08		
<b>PERFORM 550</b>		≤ 0.50	≤ 1.90			-		
<b>PERFORM 600</b>			≤ 2.00					
<b>PERFORM 650</b>		≤ 0.60	≤ 2.10			≤ 0.20		
<b>PERFORM 700</b>			≤ 2.10					

PERFORM-steels are fully killed fine-grained structural steels with an Al-content of 0.015 % minimum. The grades PERFORM 600, PERFORM 650 and PERFORM 700 may additionally contain molybdenum up to 0.50 % and boron up to 0.005 %. With regard to special aspects of processing a limitation of the Si-content to 0.03 % maximum for the grades up to PERFORM 500 can be ordered.

**State of delivery:** thermomechanically rolled, PERFORM 650 and PERFORM 700 in case additionally tempered.

**Mechanical properties** (longitudinal)

Steel grade	Minimum yield strength $R_{eH}$ *) MPa	Tensile strength $R_m$ MPa	Minimum elongation A %	Impact energy KV in J at a test temperature of - 20 °C	Bend test, mandrel diameter D (t=specimen thickness) (transversal)
<b>PERFORM 315</b>	315	390 - 510	24	40	0 t
<b>PERFORM 355</b>	355	430 - 550	23		0.5 t
<b>PERFORM 380</b>	380	450 - 590	23		
<b>PERFORM 420</b>	420	480 - 620	19		
<b>PERFORM 460</b>	460	520 - 670	17		
<b>PERFORM 500</b>	500	550 - 700	14		
<b>PERFORM 550</b>	550	600 - 760	14		
<b>PERFORM 600</b>	600	650 - 820	13		
<b>PERFORM 650</b>	650 **)	700 - 880	12		
<b>PERFORM 700</b>	700 **)	750 - 950	12		

\*) if continuous yielding occurs, the yield strength is determined as  $R_{p0,2}$

The tensile test in accordance to EN ISO 6892 is carried out by using longitudinal specimens. For PERFORM 650\*\*) and 700\*\*) in thicknesses > 8 mm the minimum yield strength is 630 MPa respectively 680 MPa. The bend test in accordance with ISO 7438 is performed by using transverse specimens.

The notched bar impact tests in accordance to EN ISO 148 are carried out by using longitudinal specimens. The values for the impact energy are minimum values obtained as the average of three specimens, no single value being less than 70 % of the value stated in the table. The values apply to plate thicknesses from 10 to 20 mm. For thicknesses below 10 mm the required minimum impact value is reduced proportionally to the specimen width (product thickness). On special agreement at time of ordering the tests can also be carried out at - 40 °C. The minimum average impact value in that case is 27 J.

No impact test is performed on products below 6 mm in thickness.

**Number of tests**

Unless otherwise agreed upon in the order, the tests listed below will be performed during inspection:

1 tensile test	1 specimen per 40 t from each heat
1 notched bar impact test (3 specimens)	1 set per 40 t from each heat.

**Available sizes****a) Plates cut from hot rolled wide strip** (minimum width 820 mm, trimmed)

<b>PERFORM 315 / 355 / 380 / 420</b>		<b>PERFORM 460 / 500</b>		<b>PERFORM 550 / 600 / 650 / 700</b>	
Standard dimensions		Standard dimensions		Standard dimensions	
Thickness, mm	Width, mm	Thickness, mm	Width, mm	Thickness, mm	Width, mm
3.00 - 3.49	≤ 1600	3.00 - 3.49	≤ 1500	3.00 - 3.39	≤ 1250
3.50 - 3.99	≤ 1700	3.50 - 3.99	≤ 1600	3.40 - 3.59	≤ 1400
4.00 - 4.59	≤ 1800	4.00 - 4.49	≤ 1700	3.60 - 3.79	≤ 1450
4.60 - 12.00	≤ 2000	4.50 - 4.99	≤ 1800	3.80 - 4.19	≤ 1500
12.01 - 15.00	850 - 1500*	5.00 - 10.00	≤ 2000	4,20 - 4,99	≤ 1550
				5.00 - 10.00	≤ 1600
* only PERFORM 315 / 355 / 380					

Lengths: 1000 - 12000 mm, Tolerances according to EN 10051.  
Other dimensions on special agreement

**b) Four high mill plates**

On special agreement at the time of order the steel grade PERFORM 380 can also be supplied as four-high mill plate with the following dimensions:

Thickness: 10 to 20 mm, widths: 1500 to 3000 mm.

Length: 4500 to 15000 mm (length min. 4000 mm after consultation), a minimum rolling length of 8000 is necessary.

Tolerances: According to EN 10029.

For the testing of tensile- and toughness properties transverse specimens are used.

**General processing information**

See EN 10149-2 chapter 7.5 "Technological Properties" and STAHL-EISEN-Werkstoffblatt 088.

Recommendations for welding are also given in EN 1011 part 1 and part 2 - Welding, Recommendation for welding of metallic materials -.

In addition to that it has to be noted, that at MAG and manual arc welding of the grades PERFORM 315 to PERFORM 550 at cooling times  $t_{8/5}$  from 5 to 20 s sufficient mechanical properties in the heat affected zone of the weld are achieved as experience shows. For the grades PERFORM 600, 650 and 700 the appropriate cooling times are from 5 to 15 s.

For those, who process this steel for the first time it is recommended to consult the steel supplier to take advantage of the experiences gathered so far.

**General information**

Unless otherwise agreed upon in the order, the delivery will be governed by the conditions outlined in EN 10021.

The admissible tolerances are based on EN 10051 for plates cut from coils and on EN 10029 for four-high mill plates.

The plates will be supplied with a maximum flatness tolerance according to EN 10029, table 4. Smaller flatness tolerances can be agreed according to EN 10029, table 5 at the time of ordering.

For surface quality requirements EN 10163 is applicable.

As per special agreement it is possible to supply plates pickled and oiled or descaled and primed.

**Publisher`s addresses**

EN-, ISO Standards

Beuth Verlag GmbH, Postfach, D-10772 Berlin

STAHL-EISEN-Werkstoffblätter

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ThyssenKrupp Steel Europe brochures

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"Processing of Special Structural Steels for Cold Forming, PERFORM"

"PERFORM Special Structural Steel Plates for Cold Forming - When strength and formability are needed"