



# S500G1+M/G2+M

## HIGH STRENGTH FINE GRAINED STRUCTURAL STEEL THERMOMECHANICALLY ROLLED

### Material data sheet Edition March 2013<sup>1)</sup>

S500G1+M/G2+M is a thermomechanically rolled, fine-grained structural steel. Due to its chemical composition, this material has a low carbon equivalent and hence excellent weldability. It is predominantly used in steel structures with high demands on weight reduction, weldability and safety, e.g. offshore structures and platforms.

### Product description

#### Designation and range of application

S500G1+M is based on the NORSOK Standard MDS – Y55, Rev. 5. S500G2+M is based on the NORSOK Standard MDS – Y50, Rev. 5 which includes through-thickness testing according to option 13 of EN 10225.<sup>2)</sup>

Steel plates ordered according to this data sheet can be offered up to 100 mm thickness.

The steel can be ordered with prequalified weldability. The tests were performed according to EN 10225, Annexes E (as welded condition), F and G.

#### Chemical composition

For the ladle and product analysis the following limiting values in % are applicable:

C	Si	Mn	P	S	Cr	Mo	Ni	Al	Cu	N	Nb	Ti	V
≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	≤	≤
0.14	0.15 - 0.55	1.80	0.020	0.010	0.25	0.25	0.70	0.015 - 0.055	0.40	0.010	0.040	0.025	0.050

Cr+Mo+Ni+Cu	Nb+V	Nb+V+Ti	P <sub>cm</sub> <sup>a)</sup>
≤	≤	≤	≤
1.20	0.09	0.11	0.22

<sup>a)</sup>  $P_{cm} = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B$

If prequalified steel is ordered, the chemical composition corresponds to the alloy concept used for the qualifications. Deviations are only permitted within the qualified range defined in EN 10225 (option 18).

#### Delivery condition

Thermomechanically rolled and, if necessary, accelerated cooled and tempered (M).

<sup>1)</sup> The current version of this material data sheet can be also found on <http://www.dillinger.de>.

<sup>2)</sup> The NORSOK Standard applies for thicknesses up to 75 mm.



## Mechanical properties in the delivery condition

### Tensile test at room temperature – transverse test specimens –

Plate thickness t [mm]	Tensile strength $R_m$ [MPa]	Yield strength $R_{p0.2}$ [MPa]	Yield to tensile strength ratio	Minimum elongation $A_5$ [%]
$10 \leq t \leq 75$	600 - 700	500 - 600	$\leq 0.90$	17
$75 < t \leq 100$	575 - 700	480 - 600	$\leq 0.90$	17

### Through-thickness testing<sup>3)</sup>:

Quality class Z35 in accordance with EN 10164 for the reduction of area.

Through thickness tensile strength at room temperature:

Plate thickness t [mm]	Through thickness tensile strength [MPa]
$25 \leq t \leq 75$	Minimum 80% of the specified minimum tensile strength
$75 < t \leq 100$	

### Impact test on Charpy-V-test specimens – transverse test specimens –

Test temperature [°C]	Impact values $A_v$ [Joule]
-40	60

The specified value is the minimum value for the average of 3 tests. One individual value may be below the minimum average value specified, provided that it is not less than 70 % of that value.

The test pieces are taken from the following positions:

- Sub-surface with one face of a specimen located within 2 mm from a rolled surface
- For plate thickness below 12 mm: test pieces width reduced width. The minimum impact value is decreased proportionally.
- For plate thicknesses above 40 mm: additional test pieces from the mid-thickness

## Testing

Mechanical tests are carried out in accordance with NORSOK Standard MDS – Y50/55 and EN 10225.

The following options as specified in EN 10225 can be ordered:

- Option 10: Tests in PWHT condition
- Option 12: Strain ageing testing

Unless otherwise agreed, ultrasonic testing is carried out in accordance with EN 10160, class  $S_0/E_1$  for S500G1+M and class  $S_1/E_2$  for S500G2+M.

Unless otherwise agreed, the test results are documented in an inspection document 3.1 in accordance with EN 10204.

<sup>3)</sup> Through-thickness testing is carried out only for S500G2+M.



## Identification of plates

Unless otherwise agreed, the marking is carried out with low stress steel stamps with at least the following information:

- Steel grade (S500G1+M or S500G2+M)
- Heat number
- Number of mother plate and individual plate
- The manufacturer's symbol
- Authorized inspection representative's sign

## Processing

The properties of the steel may be impaired if the conditions for the forming and welding operations are not properly chosen. For the reliability of products manufactured from this steel, the user and the fabricator have to ensure that the construction is appropriate for the service conditions. The design and the processing parameters must fit to the material. The customer is responsible for the selection of the material. The recommendations of EN 1011 (=ISO/TR 17671) and CEN/TR 10347 should be considered.

### Cold forming

Cold forming means forming below the maximum allowable stress relief temperature of 580 °C. S500G1+M/G2+M has excellent cold forming properties. With regard to the higher yield strength the steel needs approximately  $\frac{1}{3}$  higher bending forces compared to S355 of the same thickness. Flame cut edges have sufficient toughness to allow cold forming. Cutting defects shall be ground flush in the bending area before cold forming to avoid strain concentration.

Cold forming is always related to a work hardening of the steel and to a decrease in toughness. For intense cold deformation the loss in toughness can be partly recovered through a heat treatment in the temperature range of 550 – 580 °C. In this case we recommend to consult us prior to ordering. If plates are cold formed, the material properties in the final condition can be determined by testing the strain aged condition.

### Hot forming

Hot forming means forming at temperatures above the maximum allowable stress relief temperature of 580 °C. Hot forming is not allowed for thermomechanically rolled steel, because the particular microstructure would be altered and can not be restored by a subsequent heat treatment.

In case of forming by induction heating, preliminary tests are needed to prove that the material and the time-temperature-cycle fit to each other.

### Flame Cutting

Flame cutting can be done without preheating. The hardness at the flame cut edge is moderate thanks to the low hardenability of the steel.

### Welding

S500G1+M/G2+M is characterized by a low carbon content and low carbon equivalents. This results in a low heat affected zone (HAZ) hardness, a low sensitivity to hydrogen induced cold cracking and a good toughness in the HAZ. Experience has shown that for best properties the weld cooling time  $t_{8/5}$  should be between 10 and 30 seconds. The welding parameters shall be chosen accordingly. In the weldability tests heat inputs up to 4.5 kJ/mm corresponding to  $t_{8/5}$ -times of 45 up to 50 seconds were also successfully applied.

According to ISO/TR 15608 the steel belongs to Group 2.2 "Thermomechanically treated steel ... with a specified minimum yield strength > 460 MPa".



The welding consumables shall comply with the tensile properties of the steel and allow a post weld heat treatment if applicable. Good results were obtained using a wire with 1.3 % Mn, 1.2 % Ni, 0.4 % Mo. Higher alloy contents in the weld would raise the sensitivity of the weld metal for cold cracking so that higher preheat/interpass temperatures would become necessary and one could not fully profit from the low sensitivity of the steel itself.

### Heat treatment

If a heat treatment has to be carried out for reasons of stress relieving, in order to reduce work hardening, or if it is requested by the applicable standards, this treatment shall be performed at 550 – 580 °C. Higher temperatures and holding times exceeding 4 hours could affect the mechanical properties of the material.

### General technical delivery requirements

Unless otherwise agreed, the general technical delivery requirements in accordance with EN 10021 apply.

### Tolerances

Unless otherwise agreed, the tolerances will be in accordance with EN 10029, with class A for thickness and class N, steel group H for the maximum flatness deviation. Smaller flatness deviations may be possible on request.

### Surface quality

Unless otherwise agreed, the provisions in accordance with EN 10163-2, class A3 are applicable

### General note

If particular requirements are demanded and not covered in this material data sheet, please contact us with the specifications for our review and agreement prior to ordering.

The information in this data sheet is a product description. This data sheet is updated as occasion demands. The latest version is available from the mill or as download at <http://www.dillinger.de>.

### Contact

For your local representative  
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