



DILLINGER HÜTTE GTS

# DI-MC 355

WELDABLE FINE-GRAINED STRUCTURAL STEEL, THERMOMECHANICALLY ROLLED

Material Data Sheet Edition August 2005

DI-MC 355 is a thermomechanically rolled, fine-grained structural steel with a constant minimum yield strength of 355 MPa in its delivery condition ex works, referring to the whole thickness range up to 120 mm. Due to its chemical composition, this material has a low carbon equivalent and hence excellent weldability. The steel is preferentially used by the customers in constructional steelwork, hydraulic steelwork and mechanical engineering, where exacting demands are placed on weldability.

## Product description

### Designation and range of application

DI-MC 355 can be delivered in two qualities as follows:

- Basic quality (B) with minimum impact values at  $-20\text{ }^{\circ}\text{C}$ : **DI-MC 355 B**  
Material No. 1.8823 - S355M in accordance with EN 10025-4
- Low-temperature quality (T) with minimum impact values at  $-50\text{ }^{\circ}\text{C}$ : **DI-MC 355 T**  
Material No. 1.8834 - S355ML in accordance with EN 10025-4.

DI-MC 355 can be delivered in thickness from 8 to 120 mm according to the dimensional program.

### Chemical composition

For the ladle analysis the following limiting values are applicable:

DI-MC 355	C	Si	Mn	P	S	N	Al	Nb	V	Ni	Cu	Mo	Cr	Ti
	≤	≤	≤	≤	≤	≤	≥	≤	≤	≤	≤	≤	≤	≤
Basic quality (B)	0.14	0.50	1.60	0.025	0.015	0.015	0.02	0.05	0.08	0.50	0.40	0.10	0.30	0.03
Low-temperature quality (T)				0.020	0.010									

Product analysis, permissible variations from the ladle analysis:

C	Si	Mn	P	S	N	Al	Nb	V	Ni	Cu	Mo	Cr	Ti
+0.02	+0.05	+0.10	+0.005	+0.005	+0.002	-0.005	+0.01	+0.02	+0.05	+0.05	+0.03	+0.05	+0.01

Maximum carbon equivalent CEV:

Plate thickness t [mm]	max. CEV [%]
t = 40	0.39
40 < t = 63	0.40
63 < t = 120	0.43

Typical values for CEV and Pcm:

	DI-MC 355 B		DI-MC 355 T	
	30 mm	80 mm	30 mm	80 mm
CEV	0.35 %	0.35 %	0.35 %	0.34 %
Pcm	0.18 %	0.18 %	0.18 %	0.17 %

$$\text{CEV} = \text{C} + \text{Mn}/6 + (\text{Cr} + \text{Mo} + \text{V})/5 + (\text{Ni} + \text{Cu})/15$$

$$\text{Pcm} = \text{C} + \text{Si}/30 + (\text{Mn} + \text{Cu} + \text{Cr})/20 + \text{Ni}/60 + \text{Mo}/15 + \text{V}/10 + 5\text{B}$$

### Delivery condition

Thermomechanically rolled, and if necessary, accelerated cooled (short designation TM or M).

### Mechanical and technological properties in the delivery condition

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

Plate thickness t [mm]	Minimum Yield Strength R <sub>eH</sub> [MPa]	Tensile Strength R <sub>m</sub> [MPa]	Minimum Elongation A <sub>5</sub> [%]
t ≤ 16	355	470 - 630	22
16 < t ≤ 40			
40 < t ≤ 63		450 - 610	
63 < t ≤ 100		440 - 600	
100 < t ≤ 120		430 - 590	

For plate thickness of more than 15 mm, the adherence to grades Z15, Z25 or Z35 in accordance with EN 10164 or comparable regulations, which are characterized by a minimum reduction of area on tensile specimens perpendicular to the plate surface, can be agreed when placing the order.

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

DI-MC 355	Specimen direction	Impact Energy A <sub>v</sub> [J] at test temperature of					
		0 °C	-10 °C	-20 °C	-30 °C	-40 °C	-50 °C
Basic quality (B)	Longitudinal / transverse	47/27	43/24	40/20			
Low-temperature quality (T)	Longitudinal / transverse	55/34	51/30	47/27	40/23	31/20	27/16

The specified minimum value is the average of 3 tests. Not more than one individual value is permitted to be below this minimum value; it has to be at least 70 % of this minimum average value. Subsize specimens are admitted for plate thickness = 12 mm, the minimum specimen width is 5 mm. The minimum impact energy will be decreased proportionally.

### Testing

Tensile test and impact tests are carried out once per heat, 40 t and thickness range as specified for the yield strength according to table 5 of EN 10025-4. Tests on every plate may be possible on request.

The specimens for the tensile test are prepared according to EN 10025-4. Testing is carried out in accordance with EN 10002-1 on specimens of gauge length  $L_0 = 5.65 \sqrt{S_0}$  or  $L_0 = 5d_0$ .

Unless otherwise agreed, the impact test will be performed according to EN 10045-1 at a temperature of -20 °C for basic quality B and at -50 °C for low-temperature quality T on Charpy-V- longitudinal test specimens taken as follows:

- for plate thickness < 40 mm: close to the surface
- for plate thickness ≥ 40 mm:  $\frac{1}{4}$  of the plate thickness.

Unless otherwise agreed, the test results are documented in a certificate 3.1 in accordance with EN 10204.

### Identification of plates

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

- steel grade (DI-MC 355 B or T)
- heat number
- number of mother plate and individual plate
- the manufacturer's symbol
- inspection representative's sign

## Processing

The entire processing and application techniques are of fundamental importance to the reliability of the products made from this steel. The user should ensure that his design, construction and processing methods are aligned with the material, correspond to the state-of-the-art that the fabricator has to comply with and are suitable for the intended use. The customer is responsible for the selection of the material. The recommendations in accordance with EN 1011 and SEW 088 should be observed. You find detailed information on processing in the brochure "DI-MC Technical Information" of Dillinger Hütte GTS.

### Cold forming

DI-MC 355 can generally be well cold formed with regard to its high toughness, i.e. formed at temperatures below 580 °C. Cold forming is always related to a hardening of the steel and to a decrease in toughness. This change in the mechanical properties can, as a rule, be partially recovered through a subsequent stress relief heat treatment. Flame cut or sheared edges in the bending area should be ground before cold forming. For larger cold forming amounts we recommend you to consult us prior to ordering.

### Hot forming

Hot forming, i.e. forming at temperatures above 580 °C, leads to changes in the original material condition. It is impossible to re-establish the same material properties that had been achieved during the original manufacture through a further heat treatment. Therefore hot forming is not permitted.

### Flame cutting and welding

DI-MC 355 can be flame cut in all thickness ranges without preheating due to its small tendency for hardness increase. Plasma and laser cutting can also be carried out without preheating for typical thickness'.

DI-MC 355 has an excellent weldability if the general technical rules are observed (EN 1011 has to be applied analogously). The risk of cold cracking is low, so that preheating is not necessary when welding. With greater plate thickness dispensing with preheating requires the use of filler materials and welding conditions that lead to a very low hydrogen transfer (up to 5 ml/100 g DM according to ISO 6390).

The low content of carbon and other alloy elements leads to favorable toughness properties in the heat-affected-zone, even with high heat inputs. Depending on the chosen welding process, welding filler material as well as toughness requirements in the heat affected zone, it permits cooling temperatures above the limiting values of 25 s as stated in EN 1011-2 and SEW 088.

DI-MC 355 T distinguishes itself from DI-MC 355 B by an even improved weldability, especially in the thickness range above 50 mm.

### Heat treatment

Welded joints of DI-MC 355 are usually used in welded condition. If a stress relief heat treatment is necessary, it is carried out in the temperature range between 530 and 580 °C with cooling in still air. The holding time should not exceed 150 minutes (even if multiple operations are carried out). For a holding time of more than 90 minutes the lower limit of the temperature range should be aimed at.

For flame straightening, special working recommendations have to be observed (see DI-MC Technical Information of Dillinger Hütte GTS).

## Tolerances

Unless otherwise agreed, tolerances are in accordance with EN 10029, with class A for the thickness.

## Surface quality

Unless otherwise agreed, the specifications will be in accordance with EN 10163, class A2.

## General note

If special requirements, which are not covered in this material data sheet, are to be met by the steel due to its intended use or processing, these requirements are to be agreed before placing the order.

The information in this data sheet is a product description. This data sheet is updated at irregular intervals. The current version is relevant. The latest version is available from the mill or as download at [www.dillinger.de](http://www.dillinger.de).

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