

# DI-MC 460

## Weldable fine-grained structural steel, thermomechanically rolled

Material data sheet, edition April 2016<sup>1</sup>

DI-MC 460 is a thermomechanically rolled, fine-grained structural steel with minimum yield strength of 460 MPa in its delivery condition ex works (referring to the lowest thickness range). It fulfils the chemical and mechanical requirements of EN 10025-4.

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 despite the application of higher-strength steels.

### Product description

#### Designation and range of application

DI-MC 460 can be delivered in two qualities as follows:

- Basic quality (B) with minimum impact values at -20 °C: **DI-MC 460 B**  
Material No. 1.8827 - S460M in accordance with EN 10025-4
- Low-temperature quality (T) with minimum impact values at -50 °C: **DI-MC 460 T**  
Material No. 1.8838 - S460ML in accordance with EN 10025-4.

DI-MC 460 can be delivered in thickness from 8 to 150 mm according to the [dimensional program](#) (EN 10025-4 defines the properties only up to a thickness of 120 mm).

#### Chemical composition

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

DI-MC 460	C	Si	Mn	P	S	Nb	V	Al	Ti	Cr	Ni	Mo	Cu	N
B	≤0.13	≤0.60	≤1.70	≤0.020	≤0.003	≤0.05	≤0.08	≥0.02	≤0.02	≤0.30	≤0.60	≤0.20	≤0.40	≤0.01
T														

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

Overview carbon equivalents<sup>a</sup>:

Plate thickness t [mm]	DI-MC 460 B/T typical CET [%]	DI-MC 460 B/T typical CEV [%]	DI-MC 460 B/T max. CEV [%]	See EN 10025-4 max. CEV [%]
t ≤ 16	0.27	0.38	0.40	0.45
16 < t ≤ 40	0.27	0.38	0.40	0.46
40 < t ≤ 63	0.25	0.39	0.41	0.47
63 < t ≤ 120	0.25	0.39	0.41	0.48
120 < t ≤ 150	0.26	0.40	0.43	-

<sup>a</sup> CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15 ; CET = C + (Mn + Mo)/10 + (Cr + Cu)/20 + Ni/40

### Delivery condition

Thermomechanically rolled (short designation M).

### Mechanical 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	460	540 - 720	17
16 < t ≤ 40	440		
40 < t ≤ 63	430	530 - 710	
63 < t ≤ 80	410	510 - 690	
80 < t ≤ 100	400	500 - 680	
100 < t ≤ 150	385	490 - 660	

Optionally it is possible to order DI-MC 460 in the whole thickness range (up to 120 mm) with constant minimum yield strength of 460 MPa, as well as a constant tensile strength range (540 MPa – 720 MPa) (see option 1).

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

DI-MC 460	Specimen direction	Impact Energy KV <sub>2</sub> [J] at test temperature of					
		0 °C	-10 °C	-20 °C	-30 °C	-40 °C	-50 °C
B	longitudinal/transverse	47/27	43/24	40/20			
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. One individual value may be below the minimum average value specified, provided that it is not less than 70 % of that value. Subsize specimens are admitted for

plate thickness  $\leq 12$  mm, the minimum specimen width is 5 mm. The minimum impact energy will be decreased proportionally.

## Option

- 1) Yield strength of 460 MPa, as well as a tensile strength of 540 MPa – 720 MPa independent of plate thickness (only possible for thickness up to 120 mm).

The following max. CEV values apply for  $t > 40$  mm:

40 mm $< t \leq 63$ mm:	CEV $\leq 0.43$
63 mm $< t \leq 120$ mm:	CEV $\leq 0.44$

- 2) The impact properties and the tensile properties shall be verified for each mother plate.

## 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 mother plate are possible on request (see option 2). The test pieces are taken and prepared according to part 1 and 4 of EN 10025.

The tensile test is carried out on specimens of gauge length  $L_0 = 5.65 \cdot \sqrt{S_0}$  respectively  $L_0 = 5 \cdot d_0$ , in accordance with EN ISO 6892- 1. The impact test will be carried out on Charpy-V-specimens in accordance with EN ISO 148-1 using a 2 mm striker. Unless otherwise agreed, the test will be performed according to EN ISO 148-1 at a temperature of -20 °C for basic quality B and at -50 °C for low-temperature quality T on longitudinal test pieces.

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 460 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 Dillinger brochure "DI-MC Technical Information".

## **Cold forming**

DI-MC 460 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 in general 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 degrees we recommend consulting 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 treatment. Therefore hot forming is not permitted.

## **Flame cutting and welding**

DI-MC 460 can be flame cut in all thickness ranges without preheating due to its low hardenability. Plasma and laser cutting can also be carried out without preheating for typical thickness.

DI-MC 460 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. The choice of the appropriate preheating temperature depends on the construction, plate thickness, welding heat input, chosen welding process, welding filler materials and base materials (basic quality B and low-temperature quality T). From experience, an appropriate choice of these parameters allows omitting the preheating up to a plate thickness of 50 mm. To avoid hydrogen-induced cold cracking, only filler materials which add very little hydrogen to the base metal, may be used (up to 5 ml/100 g DM according to ISO 6390).

The low content of carbon and other alloy elements leads to favourable 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.

## **Heat treatment**

Welded joints of DI-MC 460 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 4 hours (even if multiple operations are carried out). For differing heat treatment requirements we recommend consulting us prior to ordering.

## **Flame straightening**

For flame straightening, working recommendations are given in the Dillinger brochure “DI-MC Technical Information”. For thermomechanically rolled steel the report CEN/TR 10347 recommends the same maximum flame straightening temperature as for normalized steel.

## General technical delivery requirements

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

## Tolerances

Unless otherwise agreed, tolerances are in accordance with 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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