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DI-MC 460

Weldable fine grained structural steel, thermomechanically rolled

Material data sheet, edition June 2023[1]

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 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**
  Applicable in the sense of S460M in accordance with EN 10025-4
- **Low temperature quality (T)** with minimum impact values at -50 °C: **DI-MC 460 T**
  Applicable in the sense of S460ML in accordance with EN 10025-4

DI-MC 460 can be delivered in thickness from 8 to 160 mm according to the dimensional programme.
For DI-MC 460, under the designations DI-MC 460 B/S460M and DI-MC 460 T/S460ML a CE-marking is applied in thicknesses up to 150 mm, unless otherwise agreed.
For DI-MC 460, under the designations DI-MC 460 B/S460M and DI-MC 460 T/S460ML, the „marque NF–Acier“ can be applied up to 150 mm, if agreed.

Chemical composition

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

	C	Si	Mn	P	S	Nb	V	Al	Ti	Cr	Ni	Mo	Cu	N
max.	0.13	0.60	1.70	0.020	0.003	0.05	0.08	-	0.02	0.30	0.60	0.20	0.40	0.010
min.	-	-	-	-	-	-	-	0.020	-	-	-	-	-	-

[1] The current version of this material data sheet can be found on www.dillinger.de

Overview carbon equivalents:

Plate thickness t [mm]	DI-MC 460 B/T typical CET[a] [%]	DI-MC 460 B/T typical CEV[b] [%]	DI-MC 460 B/T max. CEV[b] [%]	See EN 10025-4 max. CEV[b] [%]
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	0.37	0.39	0.47
63 < t ≤ 80	0.25	0.37	0.39	0.48
80 < t ≤ 100	0.25	0.38	0.41	0.48
100 < t ≤ 120	025	0.40	0.42	0.48
120 < t ≤160	0.26	0.41	0.43	0.48

[a]CET = C + (Mn + Mo)/10 + (Cr + Cu)/20 + Ni/40
[b]CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15

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_{eH}[a] [MPa]	Tensile strength R_m [MPa]	Minimum elongation A_5 [%]
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 ≤160	385	490 - 660	

[a] If not apparent, the yield strength Rp0.2 is measured instead.

Optionally it is possible to order DI-MC 460 in the thickness range up to 150 mm with a minimum yield strength of 460 MPa, as well as a tensile strength range of 540 MPa (see option 1).

Impact test on Charpy-V-specimens

DI-MC 355	Specimen direction	Impact energy KV_2 [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. Undersize specimens are admitted for plate thickness ≤ 12 mm, the minimum specimen width is 5 mm. The minimum impact energy will be decreased proportionally.

Options

1) Yield strength of 460 MPa, as well as a tensile strength of 540 MPa independent of plate thickness (up to 150 mm). In these cases, the following max. CEV values apply for t > 40 mm:
   40 mm < t ≤ 63 mm: CEV ≤ 0.43 %
   63 mm < t ≤ 150 mm: CEV ≤ 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 according to table 5 of EN 10025-4, 60 t and thickness range as specified in table 'Tensile test at ambient temperature – transverse test specimens –'. 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 $L_o = 5.65 \cdot \sqrt{S_o}$ respectively $L_o = 5 \cdot d_o$, 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 on longitudinal test pieces at a temperature of -20 °C for the basic quality B and at -50 °C for the low temperature quality T.
Unless otherwise agreed, the test results are documented in a certificate 3.1 in accordance with EN 10204.

Identification

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

- The steel designation (DI MC460B S460M or DI MC460T S460ML)
- The heat number
- The number of mother plate and individual plate
- The manufacturer's sign
- The inspection representative's sign

Processing

The entire processing and application techniques are of fundamental importance to the reliability of the parts and assemblies 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 processing instructions.

Cold forming
With regard to its high toughness, DI-MC 460 can generally be well cold formed, i.e. 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 Warm
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. 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, even for high plate thicknesses (> 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 ($t_{8/5}$) 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 air. The holding time should not exceed 4 hours (even if multiple operations are carried out). For particular heat treatment requirements we recommend consulting us prior to ordering.

Flame straightening
For flame straightening, working recommendations are given in the processing instructions. 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.

Ultrasonic testing

Unless otherwise agreed, DI-MC 460 meets the requirements of class S1E1 in accordance with EN 10160.

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.

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