DIWETEN 460

Fine-grained structural steel with improved atmospheric corrosion resistance, thermomechanically rolled

Material data sheet, edition April 2016[1]

DIWETEN 460 is a higher strength structural steel with improved atmospheric corrosion resistance. Due to its chemical composition, this material develops a patina with increased resistance against the atmospheric corrosion in comparison with the normal structural steels. The improved atmospheric corrosion resistance property is defined by fulfilling the weather resistance index of I in accordance with ASTM G101.
DIWETEN 460 has minimum yield strength of 460 MPa in its delivery condition ex works (referring to the lowest thickness range). The thermomechanical rolling process allows using less alloying elements, leading to a lower carbon equivalent and hence an improved weldability compared to normalized weathering steels of the same strength. The steel can therefore especially be used in steel constructions for bridges and high-rise buildings where a higher strength weathering steel with good weldability is demanded. Special building-authority approvals (e.g. European Technical Approval) may have to be considered.

Product description

Designation and range of application

DIWETEN 460 can be delivered in two qualities as follows:

- Basic quality with minimum impact values at -20 °C: **DIWETEN 460 M**
  applicable in terms of S460K2W+M
- Low-temperature quality with minimum impact values at -50 °C: **DIWETEN 460 ML**
  applicable in terms of S460J5W+M

DIWETEN 460 can be delivered in thickness from 8 to 120 mm according to the dimensional program for thermomechanically rolled steels (table 2).

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
≤ 0.11	≤ 0.50	≤ 1.40	≤ 0.020	≤ 0.003	≤ 0.05	≤ 0.08	≥ 0.02	≤ 0.02	0.40-0.80	≤ 0.50	≤ 0.08	0.25-0.40	≤ 0.01

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

Overview carbon equivalents:

typical CET[a] [%]	typical CEV[b] [%]	max. CEV[b] [%]
0.28	0.47	0.49

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

In addition, the weather resistance index of I > 6.0 in accordance with ASTM G 101 is valid. I = 26.01 · (% Cu) + 3.88 · (% Ni) + 1.2 · (% Cr) + 1.49 · (% Si) + 17.28 · (% P) – 7.29 · (% Cu) · (% Ni) - 9.10 · (% Ni) · (% P) – 33.39 · (% Cu)**Fehler! Textmarke nicht definiert.**

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} [MPa]	Tensile strength R_m [MPa]	Minimum elongation A_5 [%]
t ≤ 16	460	530 - 710	17
16 < t ≤ 40	440		
40 < t ≤ 63	430		16
63 < t ≤ 80	410		15
80 < t ≤ 100	400		
100 < t ≤ 120	385	490 - 660	15

Impact test on Charpy-V-specimens

DIWETEN 460	Specimen direction	Impact Energy KV_2 [J] at test temperature of -20 °C	-50 °C
M	longitudinal	40	-
ML	longitudinal	-	27

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 ≤ 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 with respect to EN 10025-5 once per heat, 60 t and thickness range as specified for the yield strength (respectively on the thickest plate). Tests on every mother plate are possible on request.

The test pieces are taken and prepared according to part 1 and 5 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 at a temperature of -20 °C for the basic quality and at -50 °C for the low-temperature quality 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 (DIWETEN 460 M or ML)
- heat number
- number of mother plate and individual plate
- the manufacturer’s symbol
- inspection representative’s sign

Atmospheric corrosion resistance

Atmospheric corrosion resistance means that the steel - due to the chemical composition - presents a higher resistance against atmospheric corrosion in comparison to unalloyed steels because a protective coating on the surface is formed influenced by the weather, which protects the surface and decelerates the normal corrosion process. This property is defined by the weather resistance index $I > 6.0$ in accordance with ASTM G 101. Generally, the corrosion velocity decreases with increasing service life. Even after the formation of the patina, a total stop of the corrosion process is not achieved. However, the patina offers - in comparison to unalloyed steels - a better protection against atmospheric corrosion in industrial, city or rural atmosphere, which enables the application of uncoated steels under certain circumstances. Initial formation, time of development and protective effect of the patina on steels with improved atmospheric corrosion resistance are extremely depending on the constructional design and the atmospheric and environmental conditions in the respective case. In any case, usual constructional standards for the construction with steels with improved atmospheric corrosion resistance are to be observed, as i.e. the German guideline DASt 007 (delivery, fabrication and application of steels with improved atmospheric corrosion resistance).

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 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 1011-2, guideline DASt 007, SEW 088 as well as recommendations regarding job safety in accordance with national rules should be observed.

Cold forming

DIWETEN 460 can be cold formed as any comparable structural steel in accordance with EN 10025, 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

DIWETEN 460 has despite its higher strength and weathering property a good weldability if the general technical rules (see EN 1011) are respected. The fabrication by flame cutting and welding has to be carried out similarly to normalized structural steels of EN 10025 at the same strength and dimensions. However the hardenability of the steel is increased due to the Cu and Cr alloying. Owing to the low carbon content oxygen cutting, plasma and laser cutting can be carried out up to large thickness without preheating. The preheat conditions during welding have to be adapted to the slightly increased carbon equivalent compared to non-weathering thermomechanically rolled steels. If necessary, the corrosion resistance of the welding deposit has to be assured by selection of adequate weld metals or other anti-corrosion measures.

Heat treatment

Welded joints of DIWETEN 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.

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.

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