DIWETEN 355+M

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

Material data sheet, edition October 2020[1]

DIWETEN 355+M is a fine grained 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.
DIWETEN 355+M has minimum yield strength of 355 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 weathering steel with good weldability is demanded.

Product description

Designation and range of application

DIWETEN 355+M can be delivered in thicknesses from 8 to 150 mm according to the dimensional programme for thermomechanically rolled steels (table 2).

DIWETEN 355+M is certified as DIWETEN 355+M/S355K2W+M or with the order option 2 as DIWETEN 355+M/ S355J5W+M in thicknesses up to 150 mm. The CE-marking certificate is issued in accordance with EN 10025-1, unless otherwise 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
≤ 0.08	≤ 0.45	≤ 1.40	≤ 0.020	≤ 0.002	≤ 0.05	≤ 0.01	≥ 0.020	≤ 0.015	0.40 -0.60	≤ 0.50	≤ 0.08	0.25 -0.40	≤ 0.01

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

Overview carbon equivalents[a]:

Thickness t [mm]	CET [%] typical	CEV [%] typical	CEV [%] max.	EN 10025-5 CEV max. [%]
8 ≤ t ≤ 100	0.22	0.39	0.42	0.52
100 < t ≤ 150	0.23	0.40	0.45	0.52

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

In addition, the weather resistance I-index > 6.0 in accordance with ASTM G 101-04 (2015) 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)

Delivery condition

Thermomechanically rolled (short designation +M).

Mechanical properties

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	355	470 - 630	20
16 < t ≤ 40	345		
40 < t ≤ 63	335		19
63 < t ≤ 80	325		18
80 < t ≤ 100	315		
100 < t ≤ 150	295	450 - 600	18

[a] If not apparent, the yield strength $R_{p0.2}$ is measured instead.

Impact test on Charpy-V longitudinal specimens

	Test temperature	Absorbed energy KV_2 [J] Average of 3 tests	Single value
DIWETEN 355+M	- 20 °C	40	28
+ Option 2	- 50 °C	27	19

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.

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. Tests on every mother plate are possible on request. The test pieces are taken and prepared according to parts 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. Unless otherwise agreed, the impact test is carried out at -20 °C (at -50 °C for option 2) on longitudinal Charpy-V-specimens using a 2 mm striker in accordance with EN ISO 148-1. Unless otherwise agreed, the test results are documented in a certificate 3.1 in accordance with EN 10204.

Order options

1) Tensile and impact test on each mother plate,
2) Supplementary Charpy-V-test: absorbed energy KV_2 27 J at -50 °C as the average of 3 tests and minimum single value of 19 J, applicable in the sense of S355J5W+M.

Identification of plates

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

- The steel designation (DIWETEN 355+M S355K2W+M or DIWETEN 355+M S355J5W+M)
- The heat number
- The number of mother plate and individual plate
- The manufacturer's sign
- The 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 which protects the surface and decelerates the normal corrosion process is formed on the surface and influenced by the weather. 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 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 1011-2, guideline DASt 007, SEW 088 as well as recommendations regarding job safety in accordance with national rules should be observed.

Cold forming

DIWETEN 355+M can be cold formed, i.e. forming at temperatures below 580 °C, as any comparable structural steel in accordance with EN 10025. 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 355+M has despite its weathering property a good weldability if the general technical rules (see EN 1011) are respected.. 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 355+M 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.

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 10163-2, class A2.

Ultrasonic testing

Unless otherwise agreed, DIWETEN 355+M meets the requirements of class S_1E_1 according to 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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