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DIWETEN 355+N

Fine grained structural steel with improved atmospheric corrosion resistance

Material Data Sheet, edition August 2023[1]

DIWETEN 355+N is a fine-grained structural steel[2], 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 non-alloyed structural steels.
DIWETEN 355+N has a minimum yield strength of 355 MPa in its delivery condition ex works (referring to the lowest thickness range).
DIWETEN 355+N fulfills the requirements of EN 10025-5. Compared to the respective steels only according to the standard, the steel has a better weldability due to its restricted chemical composition.
DIWETEN 355+N is used for instance in steel constructions like bridges and buildings.

Product description

Designation and range of application
DIWETEN 355+N can be delivered in thickness from 8 to 150 mm according to the dimensional programme.
DIWETEN 355+N is certified with impact test of -20 °C as DIWETEN 355+N / S355J2W+N resp.
DIWETEN 355+N / S355K2W+N or with impact test of -50 °C as DIWETEN 355+N / S355J5W+N.
The CE-marking certificate is issued in accordance with EN 10025-1, unless otherwise agreed in thicknesses up to 150 mm.

All DIWETEN steels can be supplied in thicknesses up to 150 mm with the „marque NF-Acier“.

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

C	Si	Mn	P	S	Nb	V	Al	Cr	Ni	Mo	Cu
≤ 0.16	0.20 - 0.50	1.00 - 1.45	≤ 0.020	≤ 0.005	≤ 0.040	≤ 0.08	> 0.020	0.37 - 0.60	≤ 0.40	≤ 0.10	0.25 - 0.40

[1] The current version of this material data sheet can be also found on: www.dillinger.de.
[2] Steels with fine grain structure with an equivalent index of ferritic grain size ≥ 6 determined in accordance with EN ISO 643.

Overview carbon equivalents:

Plate thickness t [mm]	DIWETEN 355+N CET[a] max. [%]	DIWETEN 355+N CEV[b] max. [%]	See EN 10025-5 CEV [%] max.
8 ≤ t ≤ 25	0.30	0.47	0.52
25 < t ≤ 150	0.33	0.50	0.52

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

At the time of the order, lower values of carbon equivalents can be agreed.

Delivery condition
Normalized or normalizing rolling in accordance with EN 10025-5 (short designation +N).

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	

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

Impact test on Charpy-V longitudinal specimens

DIWETEN 355+N	Test temperatur [°C]	min. Absorbed energy KV_2 [J]	
		Average value	Single value
S355J2W+N resp. S355K2W+N	-20	40	28
S355J5W+N	-50	27	19

The specified average value is the average of 3 tests. One individual value may be below the average value specified. For plate thicknesses ≤ 12 mm the test can be carried out on Charpy-V-test specimens with reduced width, the minimum width of the specimens being 5 mm. Then, the minimum impact value decreases proportionally to the section of the test specimen.

Weld bead bend test
For plate thickness > 30 mm, DIWETEN 355+N can be delivered with additional weld bead bend test in accordance with SEP 1390 (edition 1996) if specified at the time of the order (option 1).

Testing

Tensile and impact tests will be performed according to EN 10025-5 once per heat, 60 t and thickness range as specified for the yield strength. If agreed at the time of the order, the tests could be performed on each mother plate (option 2). The preparation of the test units occurs in accordance with EN 10025-1 and EN 10025-5. The tensile test is carried out in accordance with EN ISO 6892-1 on specimens of gauge length $L_o = 5.65 \cdot \sqrt{S_o}$ resp. $L_o = 5 \cdot d_o$. Unless otherwise agreed, the impact test is carried out 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) Weld bead bend test in accordance with SEP 1390 (Edition 1996)
2) Tensile and impact test are carried out on each mother plate according to EN 10025-5
3) Additional Charpy-V-test for thicknesses ≥ 40 mm in ¼ thickness, other test conditions according to EN 10025-5

Identification of plates

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

- The steel designations (e.g. DIWETEN355+N S355J2W+N, DIWETEN355+N S355K2W+N or DIWETEN355+N S355J5W+N)
- 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 DIWETEN 355+N - due to its chemical composition - presents an improved resistance against atmospheric corrosion because of the forming of an auto- protective layer on the base material depending on weather condition having a succession of dry and wet periods. This layer protects the surface and slows down the normal rust formation.
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 atmospheres, enabling 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 ("Lieferung, Verarbeitung und Anwendung wetterfester Baustähle") or the European Design Guide ECCS / CECM / EKS ("European design guide for the use of weathering steel in bridge construction") or the Cerema/UGE French information note "Aciers autopatinables, recommandations pour leur utilisation en structure des tabliers des ponts et passerelles ".

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 1011-2 and guideline DASt 007 as well as recommendations regarding job safety in accordance with national and European rules (i.e. ECCS-Design-Guide) should be observed.

Cold forming
Cold forming means forming below the maximum allowable stress relief temperature (generally < 580 °C). DIWETEN 355+N can be cold formed as any comparable structural steel in accordance with EN 10025. In case of higher cold forming ratios, i.e. edging on mechanical presses, it is advisable to consult the steel manufacturer prior to placing the order.

Hot forming
Hot forming means forming at temperatures above A_{C3} (~ 900 °C; austenitic phase). If possible, the hot forming has to be carried out at the normalizing temperature with following cooling in still air (see CEN/TR 10347).

Flame cutting and welding
DIWETEN 355+N has an excellent weldability under the condition that the general technical rules (see EN 1011) are observed. The fabrication by flame cutting and welding has to be carried out similarly to unalloyed structural steels of EN 10025-2 of the same strength and dimensions. However the hardenability of the steel is increased due to the Cu and Cr alloying. The preheat conditions must be adapted to the increased carbon equivalent. 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
Stress relieving at more than 580 °C or for over 1 h can lead to a deterioration of the mechanical properties of the steel grade. The maximum stress relief temperature should therefore be 560 °C. If intended to stress relief the products at higher temperatures or for longer times than mentioned above, it is recommended to contact Dillinger.

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 EN 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+N meets the requirements of class S_1E_1 in accordance with EN 10160.

General note

If particular requirements are demanded and not covered in this material data sheet, please contact us with the specifications for our review and agreement prior to ordering.

The information in this data sheet is a product description. This data sheet is updated as occasion demands. The latest version is available from the mill or as download at www.dillinger.de.

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