DILLIMAX 1100

High strength fine grained structural steel, quenched and tempered

Material data sheet, edition April 2020[1]

DILLIMAX 1100 is a high strength quenched and tempered, fine grained structural steel with a minimum yield strength of 1 100 MPa (160 ksi)[2] in its delivery condition.
DILLIMAX 1100 is preferentially used for steel components if weight shall be reduced to a considerable extent, e.g. hoisting devices and cranes.

Product description

Designation and range of application

DILLIMAX 1100 can be delivered in thicknesses from 8 (0.3 in.)[2] to 40 mm (1.6 in.)[2] and in the following maximum widths:

Plate thickness t [mm] (in.)[a]	Width [mm]
8.0 (0.3) < t ≤ 9.5 (0.4)	2 500
9.5 (0.4) < t ≤ 40 (1.6)	3 050

[a] The approximately converted values in brackets are for information only.

Chemical composition

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

C	Si	Mn	P	S	Cr	Ni	Mo	Ti	V+Nb	B
≤ 0.18	≤ 0.50	≤ 1.60	≤ 0.018	≤ 0.005	≤ 2.00	≤ 3.5	≤ 0.70	≤ 0.01	≤ 0.10	≤ 0.004

The steel is fine grained through sufficient aluminium content.
Typical carbon equivalents CEV[b]/CET[c] are:

Thickness t [mm] (in.)[a]	CEV[b] [%]	CET[c] [%]
20 (0.8)	0.66	0.39
30 (1.2)	0.77	0.37

[a] The approximately converted values in brackets are for information only.
[b] CEV = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15
[c] CET = C + (Mn+Mo)/10 + (Cr+Cu)/20 + Ni/40

[1] The current version of this material data sheet can be also found on www.dillinger.de.
[2] The approximately converted values in brackets are for information only.

Delivery condition

Water quenched and tempered.

Mechanical properties in the delivery condition

Tensile test at ambient temperature – transverse test pieces –

Plate thickness t [mm] (in.)[a]	Tensile strength R_m [MPa] (ksi)[a]	Minimum yield strength R_{eH}[b] [MPa] (ksi)[a]	Minimum elongation A_5 [%]	Minimum elongation $A_{2in.}$[c] [%]
t ≤ 20 (0.8)	1 200 – 1 500 (175 – 220)	1 100 (160)	10	11
20 (0.8) < t ≤ 40 (1.6)			8	9

[a] The approximately converted values in brackets are for information only.
[b] If not apparent, the yield strength $R_{p0.2}$ is measured instead.
[c] These values apply if tested according to ASTM A370.

Impact test on Charpy-V-specimens

Specimen direction	Impact energy KV_2 [J] (ft.-lb.)[a] at test temperature
longitudinal/transverse	30/27 (22/20) at -40 °C (-40 °F)

[a] The approximately converted values in brackets are for information only.

An extra tough grade with guaranteed Charpy values at -60 °C (-76 °F) may be agreed on request.
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. For plate thicknesses below 12 mm, the test can be carried out on Charpy-V test pieces with reduced width; the minimum width must be 5 mm. The minimum impact value will be decreased proportionally.

Testing

Tensile and impact tests will be performed according to EN 10025-6 once per heat and 60 t.
Tests on every heat treatment unit may be possible on request. The test pieces are taken and prepared according to parts 1 and 6 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. Tensile tests according to ASTM A370 may be agreed. The impact test will be carried out on longitudinal Charpy-V-specimens in accordance with EN ISO 148-1 using a 2 mm striker.
Unless otherwise agreed, the test results are documented in an inspection 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 (e.g. DILLIMAX 1100)
- 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 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 of the EN 1011 (welding) and CEN/TR 10347 (forming) as well as recommendations regarding job safety in accordance with national rules should be observed.

Cold forming

DILLIMAX 1100 can be cold formed below 200 °C (390 °F) taking into account its high yield strength. Flame cut or sheared edges in the bending area should be ground before cold forming. It is also advisable to round the plate edge slightly on the outside of the bend coming under tension stress during bending.
Cold forming is related to a hardening of the steel and to a decrease in toughness. In contrast to lower yield strength steels DILLIMAX 1100 can not be heat treated to reduce the strain hardening effects.
After higher cold forming amounts or if prescribed by regulations, a new quenching and tempering treatment may become necessary to restore the required mechanical properties. In this case, we recommend you to consult the steel producer prior to ordering.
During the processing, the necessary safety measures have to be taken, so that nobody will be exposed to a danger by a possible fracture of the work piece during the forming process.

The following geometries can usually be achieved by cold forming without the formation of surface defects (t is the plate thickness):

Position of bending line to rolling direction	Minimum bending radius		Minimum die width	
	t < 20 mm	t ≥ 20 mm	t < 20 mm	t ≥ 20 mm
Transverse direction	4 t	5 t	12 t	14 t
Longitudinal direction	5 t	6 t	14 t	16 t

Hot forming

If the temperature of 220 °C (428 °F) is exceeded, the initial tempering will be altered so that the mechanical properties are affected.

Flame cutting and welding

Due to its high yield strength, DILLIMAX 1100 requires special care during plate processing.
For flame cutting, the following minimum preheating temperatures are recommended: 75 °C (165 °F) for plate thickness up to 20 mm (0.8 in.) and 125 °C (260 °F) for thicker plates.
For general welding instructions, please consult the EN 1011. So far, no welding consumables are available that produce tensile properties matching the base material. Thus, fully loaded joints must be avoided by an appropriate design.
Minimum preheating, interpass and working temperature shall be limited to a range from 150 °C (302 °F) up to 200 °C (390 °F).
In order to ensure that the tensile strength of the weld metal fulfils the requirements of the base metal, the heat input and interpass temperature must be limited during welding. Experience has shown that the welding conditions should be chosen so that the cooling time $t_{8/5}$ does not exceed 12 seconds. This is applicable when using suitable filler materials of a corresponding yield strength class.
To avoid hydrogen-induced cold cracking, only filler materials, which add very little hydrogen to the base metal, may be used. Therefore, shielded arc welding should be preferred. For manual arc welding, electrodes with basic coating (type HD < 5 ml/100 g in accordance with ISO 3690) and dried according to the manufacturer's instructions should be used. With increasing plate thickness, increasing hydrogen charge and restraint of the weld, a soaking for hydrogen effusion immediately after welding is recommended. The temperature for this treatment shall be in the range of 180 °C (355 °F) up to 220 °C (428 °F). To reduce hydrogen to an uncritical rate, we recommend the following holding times in the temperature range of 180 °C (355 °F) up to 220 °C (428 °F): 1 hour for welding joint thickness of up to 20 mm (0.8 in.), 2 hours for welding joint thickness of up to 30 mm (1.2 in.) and 4 hours for welding joint thickness of up to 40 mm (1.6 in.).
A stress relief heat treatment is not possible and flame straightening is generally not permitted because these operations would reduce the tensile properties of the steel. Only in areas of the component where a local softening can be tolerated, straightening by flame or by inductive heating may be applied (in agreement with the design department).

General technical delivery requirements

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

Tolerances

Unless otherwise agreed, the tolerances will be in accordance with EN 10029, with class A for thickness and table 4, steel group H, for the maximum flatness deviation. Smaller flatness deviations may be possible on request prior to order (see specification DILLIMAX TL for telescopic booms).

Surface quality

Unless otherwise agreed, the specifications will be in accordance with EN 10163-2, class B3.

Ultrasonic testing

If not agreed otherwise, DILLIMAX 1100 fulfils the requirements of class S_1E_1 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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