DILLIMAX 550

High strength fine grained structural steel

Quenched and tempered

Material data sheet, edition September 2016[1]

DILLIMAX 550 is a high strength quenched and tempered, fine grained structural steel with a minimum yield strength of 550 MPa (80 ksi)[2] in its delivery condition (referring to the lowest thickness range). Its mechanical properties are achieved by water quenching followed by tempering.
DILLIMAX 550 is preferentially used by the customers for welded steel structures within mechanical constructions, plant constructions, structural steel works and hydropower, such as machines for structural engineering, conveying plants, hoists, cranes, flood gates, bridges, frameworks and penstocks.

Product description

Designation and range of application

DILLIMAX 550 can be delivered in 3 qualities:

- Basic (B) with minimum impact values down to -20 °C (-4 °F)[2]: **DILLIMAX 550 B**
  Steel number 1.8904 - S550Q according to EN 10025-6
- Tough (T) with minimum impact values down to -40 °C (-40 °F)[2]: **DILLIMAX 550 T**
  Steel number 1.8926 - S550QL according to EN 10025-6
- Extra tough (E) with minimum impact values down to -60 °C (-76 °F)[2]: **DILLIMAX 550 E**
  Steel number 1.8986 - S550QL1 according to EN 10025-6

DILLIMAX 550 B can be delivered in thicknesses from 6 to 200 mm (¼ to 8 in.)[2] and the qualities T and E in thicknesses from 6 to 150 mm (¼ to 6 in.)[2], according to the dimensional program. Dimensions, which deviate from the usual dimensional program, may be possible on request.

Chemical composition

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

DILLIMAX 550	C	Si	Mn	P	S	Cr	Ni	Mo	V+Nb	B
B, T, E	≤ 0.18	≤ 0.50	≤ 1.70	≤ 0.018	≤ 0.005	≤ 1.00	≤ 1.00	≤ 0.60	≤ 0.08	≤ 0.004

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

The steel is fine grained through sufficient aluminium content.

Limiting and auxiliary data for the carbon equivalent CEV[3]:

DILLIMAX 550	B, T			B	E		
Thickness [mm] Thickness [in.][a]	t ≤ 40 t ≤ 1½	40 < t ≤ 100 ½ < t ≤ 4	100 < t ≤ 150 4 < t ≤ 6	150 < t ≤ 200 6 < t ≤ 8	t ≤ 40 t ≤ 1½	40 < t ≤ 100 ½ < t ≤ 4	100 < t ≤ 150 4 < t ≤ 6
CEV (max.)	0.45	0.54	0.63	0.67	0.45	0.63	0.67
CEV (auxiliary data)	0.43	0.51	0.60	0.63	0.43	0.60	0.63

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

Lower carbon equivalent values may be agreed on request.

Delivery condition

Water quenched and tempered according to EN 10025-6.

Mechanical properties in the delivery condition

Tensile test at ambient temperature – transverse test specimens –

Plate thickness t [mm] (in.)[a]	Quality	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 ≤ 50 (2)	B, T, E	640 – 820 (93 – 119)	550 (80)	16	17
50 (2) < t ≤ 100 (4)	B, T, E	640 – 820 (93 – 119)	530 (77)		
100 (4) < t ≤ 150 (6)	B, T, E	590 – 770 (86 – 112)	490 (71)		
150 (6) < t ≤ 200 (8)	B	560 – 770 (81 – 112)	460 (67)		

[a] The approximately converted values in brackets are for information only.
[b] If not apparent, the yield strength $Rp_{0.2}$ is measured instead.
[c] These values apply if tested according to ASTM A370

Impact test on Charpy-V-specimens

DILLIMAX 550	Specimen direction	Impact energy KV_2 [J] (ft.-lb.)[a] at test temperature			
		0 °C (32 °F)[a]	-20 °C (-4 °F)[a]	-40 °C (-40 °F)[a]	-60 °C (-76 °F)[a]
Basic (B)	Longitudinal/transverse	40/30 (30/22)	30/27 (22/20)	-	-
Tough (T)	Longitudinal/transverse	50/35 (37/26)	40/30 (30/22)	30/27 (22/20)	-
Extra tough (E)	Longitudinal/transverse	60/40 (44/30)	50/35 (37/26)	40/30 (30/22)	30/27 (22/20)

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

[3] CEV = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15

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 (0.5 in) the test can be carried out on Charpy-V test specimens with reduced width; the minimum width must be 5 mm (0.2 in). The minimum impact value will be decreased proportionally.

Tensile test perpendicular to the product surface at ambient temperature

Improved deformation properties perpendicular to the product surface according to EN 10164 (quality classes Z15, Z25 or Z35) or corresponding standards can be agreed by order.

Testing

Tensile and impact tests will be performed according to EN 10025-6 once per heat and 40 t. Tests on every heat treated plate may be possible on request.

The test pieces are taken and prepared according to part 1 and 6 of EN 10025. The tensile test is carried out on specimens of gauge length $L_o = 5.65 \cdot \sqrt{So}$ respectively $L_o = 5 \cdot do$, in accordance with EN ISO 6892-1. Tensile tests according to ASTM A370 may be agreed.

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 at the lowest temperature of the corresponding quality on transverse test pieces.

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 with low stress steel stamps with at least the following information:

- steel grade (DILLIMAX 550 B, T or E)
- heat number
- number of mother plate and individual plate
- the manufacturer’s symbol
- authorized 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 fort he intended use. The customer is responsible for the selection of the material. The recommendations in accord-

ance with EN 1011-2 (welding) und CEN/TR 10347 (forming) should be observed. The national rules regarding job safety are mandatory.
Detailed instructions for flame cutting, welding, machining and for the structural properties of DILLIMAX are provided in the technical information “MAKE SAVINGS WITH HIGH STRENGTH STEELS – DILLIMAX”.

Cold forming

Cold forming means forming below the maximum allowable stress relief temperature (560 °C/1 040 °F).
DILLIMAX 550 can be cold formed with regard to its high yield strength. Flame cut or sheared edges in the bending area should be ground before cold forming.
Cold forming is 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. For larger cold forming amounts or if prescribed by regulations, a new quenching and tempering heat treatment may be necessary to restore the original mechanical properties. Depending on the relevant design code this can result in the need of larger bending radiuses than indicated in the chart. For larger cold forming amounts 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):

	Minimum bending radius	Minimum die width
Transverse direction	2 t	7 t
Longitudinal direction	3 t	9 t

Hot forming

If the temperature of 560 °C (1 040 °F) is exceeded, the initial tempering will be altered so that the mechanical properties are affected. To regain the initial properties new quenching and tempering become necessary. However, water quenching of a formed work piece or component will often be less effective than the original quenching in the plate mill so that the fabricator may not be able to re-establish the properties required and therefore hot forming may not be suitable. In this respect, we recommend you to contact the steel producer prior to ordering in all cases where hot forming is required.
Finally, it is the fabricator’s responsibility to obtain the required values of the steel through an appropriate heat treatment.

Flame cutting and welding

Due to its high yield strength, DILLIMAX 550 requires special care during plate processing. For flame cutting, the following minimum preheating temperatures are recommended: 25 °C (77 °F) for plate thickness up to 20 mm (0.8 in), 50 °C (122 °F) for plate thickness up to 50 mm (2 in), 100 °C (212 °F) for plate thickness up to 100 mm (4 in), 150 °C (302 °F) for plate thickness up to 200 mm (8 in) and 180 °C (356 °F) for thicker plates. For general welding instructions, please consult the EN 1011. 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 20 seconds. This is applicable when using suitable filler materials of a corresponding yield strength class.

The high yield strength of the base material must be taken into account when choosing the filler materials. It should be considered that increased heat input leads to lower tensile properties in the weld metal. If a stress relieving heat treatment is planned during or after plate processing, this must also be considered when selecting the filler materials. 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.

Heat treatment

The properties of structural components can be altered by a stress relief heat treatment. A stress relief heat treatment can be performed at a maximum temperature of 560 °C (1 040 °F) and maximum holding time of 60 minutes without significant impairment of the properties. It has to be specified prior to ordering if higher stress relieving temperatures or longer holding times have to be applied. The verification of appropriate stress relieving temperatures for a delivered plate may be possible on request.

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.

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 specification, 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 material data sheet is a product description. This data sheet is updated at occasion demands.
The latest version is available from the mill or as download at http://www.dillinger.de.

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