



DILLINGER HÜTTE GTS

DILLIMAX 460

HIGH STRENGTH FINE GRAINED STRUCTURAL STEEL
QUENCHED AND TEMPERED

Material Data Sheet Edition June 1997

DILLIMAX 460 is a high strength quenched and tempered, fine grained structural steel with a minimum yield strength of 460 N/mm² in its delivered condition (referring to the lowest thickness range), whose mechanical properties are achieved by water quenching followed by tempering.

DILLIMAX 460 fulfils the requirements of EN 10 137. It is preferentially used for welded steel structures within mechanical constructions, plant constructions and structural steel works, such as machines for structural engineering, conveying plants, hoists, cranes, flood gates, bridges and frameworks.

Product description

Designation and range of application

The steel can be delivered in three grades:

- **basic (B)** with minimum impact values down to -20°C (-4°F): **DILLIMAX 460 B**
Steel number 1.8908 - S460Q according to EN 10 137

- **high toughness (T)** with minimum impact values down to -40°C (-40°F): **DILLIMAX 460 T**
Steel number 1.8906 - S460QL according to EN 10 137

- **extra tough (E)** with minimum impact values down to -60°C (-76°F): **DILLIMAX 460 E**
Steel number 1.8916 - S460QL1 according to EN 10 137

DILLIMAX 460 B and T can be delivered in thicknesses from 6 to 150 mm (1/4 to 6 inches) according to the dimensional program, grade 460 E up to 120 mm (4 3/4 inches) thickness. Dimensions, which deviate from the usual dimensional program for this type of steel, may be possible on request.

Chemical composition

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

DILLIMAX 460	C	Si	Mn	P	S	Cr	Ni	Mo	V+Nb
B,T,E	≤.16	≤.50	≤1.60	≤.020	≤.010	≤.40	≤1.00	≤.40	≤.08

The steel is fine grained through sufficient aluminium content.

Delivery condition

Water quenched and tempered according to EN 10 137.

DILLIMAX 460

Mechanical and technological properties in the delivery condition

Tensile test at ambient temperature - transverse test specimens -

Plate thickness t mm (inches)	Tensile strength R_m N/mm ² (ksi)	Minimum yield strength R_{eH} ¹⁾ N/mm ² (ksi)	Minimum elongation	
			A_5 %	$A_{2in.}$ ²⁾ %
≤ 50 (2)	550 - 720 (80 - 104)	460 (67)	17	18
> 50 (2) ≤ 100 (4)	550 - 720 (80 - 104)	440 (64)	17	18
> 100 (4) ≤ 150 (6)	500 - 670 (72 - 97)	400 (58)	17	18

1) If not apparent, the yield strength $R_{p0.2}$ is measured.

2) These values apply if tested according to ASTM A370.

The values in brackets are only for information.

Impact test on Charpy-V-specimens

DILLIMAX 460	Specimen direction	Impact energy A_v in Joules (ft.-lb.) at test temperature			
		0°C (32°F)	-20°C (-4°F)	-40°C (-40°F)	-60°C (-76°F)
Basic (B)	longitudinal / transverse	40/30 (30/22)	30/27 (22/20)	–	–
High toughness (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)

The specified values are minimum values; they are the average of 3 specimens, whereby the lowest individual value may not be less than 70% of the specified minimum. The values in brackets are only for information. For plate thicknesses below 10 mm the test on Charpy-V-specimens will be performed with reduced width. Therefore, the minimum value of the impact energy will be reduced in proportion to the reduction of the specimen's cross section.

Technological bend test

Formability of the transverse specimen subjected to the technological bend test:

bending angle 180°; mandrel diameter ≥ 1 x specimen thickness

Testing

Tensile and impact tests, and on request bend tests, will be performed according to EN 10 137. Tests on every heat treated plate may be possible on request.

The specimens for the tensile test are prepared according to EN 10 137. Testing is carried out on specimens of gauge length $l_0 = 5.65\sqrt{S_0}$ or $l_0 = 5d_0$, in accordance with EN 10 002-1. Tensile tests according to ASTM A370 may be agreed.

The impact test will be carried out on Charpy-V-specimens in accordance with EN 10 045-1. Unless otherwise agreed, the test will be performed at the lowest temperature of the corresponding grade on transverse test specimens taken as follows:

- for plate thicknesses ≤ 40 mm: close to the surface
- for plate thicknesses > 40 mm: 1/4 of the plate thickness

Unless otherwise agreed, the test results are documented in a certificate 3.1 B in accordance with EN 10 204.

Identification of plates

The plates are at least marked by stamp with the following information:

- heat number
- plate number
- steel designation (DILLIMAX 460 B, T or E)
- the manufacturer's brand

In addition, the plates are stencilled with DILLIMAX 460 B, T or E.

Fabricating properties

The entire fabrication and application techniques are of fundamental importance for the reliability of products manufactured with these steels. The fabricator should ensure that his calculation, design and manufacturing methods are suitable for the intended application, are state of the art and, that they correspond with the properties of the material.

The customer is responsible for the selection of the material. The recommendations of the Stahl-Eisen-Werkstoffblatt 088 or ECSC Information Circular No. 2 should be observed.

Cold forming

Cold forming means forming below the maximum allowable stress relief temperature (560°C / 1040°F). DILLIMAX 460 can be cold formed with regard to its high yield strength. Flame cut or sheared edges in the bending area should be grinded before cold forming. Cold forming is always related to a hardening of the steel and to a decrease in toughness. This change in the mechanical properties can, as a rule, 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 treatment may be necessary to restore the original mechanical properties. In this case we recommend you to consult us prior to ordering.

Hot forming

Hot forming means forming at temperatures above the maximum allowable stress relief temperature (560°C / 1040°F). The original quenched and tempered condition will thereby be altered. As a result, a new quenching and tempering treatment is always necessary after hot forming. It should be noted that when applying a new quenching and tempering treatment, it is not always possible to obtain the same properties as with the original hot forming at the mill, because of different hot forming equipment, for example. In this respect we recommend you to contact us prior to ordering, in all cases where hot forming is required. However, it is the fabricator's responsibility to obtain the required values of the steel through an appropriate heat treatment.

Welding and flame cutting

DILLIMAX 460 is characterized by a low carbon content or a low carbon equivalent, respectively. This results in a low hardness, a low sensitivity to hydrogen induced cold cracking and, in a good toughness in the heat affected zone. Experience has shown that good properties can be reached in the weld area, if the welding parameters are chosen in such a manner that the cooling time $t_{8/5}$ lies between 8 and 35 seconds.

The raised yield strength of the base material must be taken into account, when the filler materials are chosen. A stress relief heat treatment after welding can change the properties of the weld metal by increased temperature and annealing time. The yield strength is generally reduced, thus. If a post-weld heat treatment is planned during or after the manufacturing, this must be already considered when selecting the filler materials.

For general welding instructions, please consult the SEW 088 or ECSC Information Circular No. 2.

Heat treatment

If a stress relieving has to be considered because of constructional regulations, constructive reasons or because it is necessary for the fabrication, please consult us. The properties of structural components can be altered by a stress relief heat treatment.

Tolerances

Unless otherwise agreed, the tolerances will be in accordance with EN 10 029, with class A for thickness and, table 4, steel group H, for the maximum flatness deviation. Smaller flatness deviations may be possible on request.

Surface quality

Unless otherwise agreed, the specifications will be in accordance with EN 10 163, class A2.

General Note

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

Detailed instructions for flame cutting, welding, machining and, about the structural properties of the DILLIMAX are provided in the brochure "DILLIMAX - HIGH STRENGTH STEEL".