

DILLIMAX 965

HIGH-STRENGTH STRUCTURAL STEEL (QUENCHED AND TEMPERED)

— **DILLIMAX 965** is a high strength quenched and tempered, fine grained structural steel with a minimum yield strength of 960 MPa in its delivery condition (referring to the lowest thickness range), which mechanical properties are achieved by water quenching followed by tempering.

— **DILLIMAX 965** fulfils the requirements of EN 10025-6. 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:

DILLIMAX 965 can be delivered in two qualities:

- **DILLIMAX 965 B¹**,
basic (B) with min. impact values down to -20 °C.
Steel number 1.8933 - S960Q according to EN 10025-6;
- **DILLIMAX 965 T**,
high toughness (T) with minimum impact values down to -40 °C.
Steel number 1.8933 - S960QL according to EN 10025-6;

DILLIMAX 965 can be delivered in thickness from 6 to 100 mm (¼ to 4 in.), according to the dimensional program. Dimensions which deviate from the usual dimensional program may be possible on request.

Chemical composition

C	Si	Mn	P	S	Cr	Ni	Mo	B	V + Nb
≤ 0.20	≤ 0.50	≤ 1.20	≤ 0.02	≤ 0.01	≤ 0.80	≤ 2.00	≤ 0.70	≤ 0.004	≤ 0.10

— The steel is fine grained through sufficient aluminium content. Furthermore, the limiting CEV² values indicated by prEN 10025-6 are respected. Lower carbon equivalent values can be guaranteed on request.

¹ On request with a minimum quantity.

² CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15.

Mechanical properties in delivery condition

— Delivery condition:

Water quenched and tempered according to EN 10025-6.

— Tensile test at ambient temperature – transverse test specimens:

Thickness (mm (in))	UTS (MPa)	Ys (MPa)	E (%)
≤ 50 (2)	980-1150	960	12
50-60 (2-2.4)	950-1120	930	12
60-100 (2.4-4)	900-1100	850	12

— Impact test on Charpy-V-specimens:

DILLIMAX 965	Specimen direction	Impact energy Av (J) (ft.-lb.) at test temperature		
		0 °C	-20 °C	-40 °C
Basic (B)	longitudinal / transverse	40 / 30	30 / 27	30 / 27
High toughness (T)	longitudinal / transverse	50 / 35	40 / 30	30 / 27

The specified minimum value is the average of 3 tests. Not more than one individual value is permitted to be below this minimum value, and no more than 30 %. For plate thickness below 10 mm, the test will be carried out on Charpy-V test specimens with reduced width. The minimum impact value will be reduced proportionally.

— 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 specimens for the tensile test are prepared according to EN 10025-6. Testing is carried out on specimens of v gauge length $l_0 = 5.65\sqrt{S_0}$ or $l_0 = 5d_0$, in accordance with EN 10002-1. Tensile tests according to ASTM A370 may be agreed.

The impact test will be carried out on Charpy-V-specimens in accordance with EN 10045-1. Unless otherwise agreed, the test will be performed at the lowest temperature of the corresponding quality on transverse test specimens taken as follows:

- for plate thickness ≤ 40 mm: close to the surface;
- for plate thickness > 40 mm: ¼ of the plate thickness.

Unless otherwise agreed, the test results are documented in a certificate 3.1 B in accordance with EN 10204.

— Surface quality:

Unless otherwise agreed, the specifications will be in accordance with EN 10163, class A2.

— Identification:

The marking of plates is carried out via steel stamps with at least the following information:

- the manufacturer's brand;
- steel designation (**DILLIMAX 965 B** or **T**);
- heat number;
- rolled plate number.

In addition, the plates are stencilled with **DILLIMAX 965 B** or **T**.

— 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.

³ If not apparent, the yield strength Rp0.2 is measured instead.

Processing information

— Hot forming:

Hot forming means forming at temperatures above the maximum allowable stress relief temperature (560 °C). 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 instance. 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.

— Cold bending:

Cold forming means forming below the maximum allowable stress relief temperature (560 °C). **DILLIMAX 965** 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. These changes in the mechanical properties can, as a rule, be partially neutralized through a subsequent stress relief heat treatment. For large 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. Cold forming of **DILLIMAX 965** should be carried out according to the following recommendations.

	Internal minimum radius	Die opening minimum
Transversal	3x th	9 x th
Longitudinal	4 x th	12 x th

— Welding and flame cutting:

Due to its high yield strength, **DILLIMAX 965** requires special care during plate processing. For general welding instruction, 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 10 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 in accordance with ISO 3690), and dried according to the manufacturer's instructions, should be used. For flame cutting, the following minimum preheating temperatures are recommended: 50 °C for plate thickness up to 25 mm, 100 °C for plates thickness up to 50 mm and 150 °C for thicker plates.

— Heat treatment:

If a stress relieving has to be considered because of constructional regulations, constructive reasons or because it is necessary for plate processing, please consult us. The properties of structural components can be altered by a stress relief heat treatment. Detailed instructions for flame cutting, welding, machining and, about the structural properties of the **DILLIMAX** are provided in the brochure *DILLIMAX-HIGH STRENGTH STEEL*.

General note

— If further informations are required, please request a copy of our technical guide.

Contact

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