

# DI-MC 690

**High strength fine grained structural steel, thermomechanically rolled**

**Material data sheet, edition February 2017<sup>1</sup>**

**DI-MC 690** is a high strength thermomechanically rolled, fine grained structural steel with a minimum yield strength of 690 MPa in its delivery condition ex works.

DI-MC 690 is preferentially used by the customers for welded steel structures within hydraulic steelworks such as penstocks.

## Product description

### Designation and range of application

DI-MC 690 can be delivered in two qualities as follows:

- Basic quality (B) with minimum impact values at  $-20\text{ °C}$  : **DI-MC 690 B**
- Low-temperature quality (T) with minimum impact values at  $-40\text{ °C}$  : **DI-MC 690 T**

DI-MC 690 plates can be delivered in the following dimensions:

- thickness: 20 to 40 mm
- width: 2,000 to 4,000 mm
- length:  $\leq 15,000$  mm

### Chemical composition

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

DI-MC 690	C	Si	Mn	P	S	Ni	Cu	Mo	Cr	B	Nb+V+Ti
B, T	$\leq 0.10$	$\leq 0.60$	$\leq 2.00$	$\leq 0.020$	$\leq 0.003$	$\leq 1.00$	$\leq 0.50$	$\leq 0.50$	$\leq 0.80$	$\leq 0.005$	$\leq 0.15$

The steel is fully killed and fine grain treated.

Auxiliary data for CEV, CET and Pcm :

Plate thickness t [mm]	typical CEV <sup>a)</sup>	typical CET <sup>b)</sup>	typical Pcm <sup>c)</sup>
20 to 40	0.47	0.26	0.19

<sup>a)</sup>  $CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$ , <sup>b)</sup>  $CET = C + (Mn + Mo)/10 + (Cr + Cu)/20 + Ni/40$

<sup>c)</sup>  $Pcm = C + Si/30 + (Mn + Cu + Cr)/20 + Mo/15 + Ni/60 + V/10 + 5B$

<sup>1</sup> The current version of this material data sheet can be found on <http://www.dillinger.de>

## Delivery condition

Thermomechanically controlled process (TMCP, short designation M) <sup>d)</sup>.

<sup>d)</sup> Thermomechanical rolling can include processes with an increasing cooling rate with or without tempering.

## Mechanical and technological properties in the delivery condition

### Tensile test at ambient temperature - longitudinal test specimens

Minimum yield strength $R_{eH}$ <sup>a)</sup> [MPa]	Tensile strength $R_m$ [MPa]	Minimum elongation $A_5$ [%]
690	770 - 940	12

<sup>a)</sup> If  $R_{eH}$  is not apparent, the yield strength  $R_{p0.2}$  is measured instead.

### Impact test on Charpy-V-specimens

DI-MC 690	Specimen direction	Impact Energy $KV_2$ [J] at test temperature of	
		-20 °C	-40 °C
B	longitudinal / transverse	47 / 40	-
T	longitudinal / transverse	-	47 / 40

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.

Optionally it is possible to order DI-MC 690 with additional impact testing at 0 °C with a minimum average value of 100 J (single value 70 J).

### Bend test

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

bending angle 180 °; mandrel diameter  $\geq 4 \times$  specimen thickness

A smaller mandrel diameter can be agreed on request.

## Testing

Tensile and impact tests, and on request bend tests, are carried out once per heat and 40 t. Tests on every mother plate are possible on request.

The tensile test is carried out on flat rectangular specimens of gauge length  $L_0 = 5.65 \cdot \sqrt{S_0}$  or  $L_0 = 5 \cdot d_0$  in accordance with EN ISO 6892-1.

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 according to EN ISO 148-1 at a temperature of -20 °C for basic quality B and at -40 °C for low-temperature quality T in longitudinal direction close to the surface.

The bend test will be carried out according to EN ISO 7438.

Unless otherwise agreed, the test results are documented in a 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 (DI-MC 690 B or T)
- 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 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 should be observed.

### Cold forming

DI-MC 690 (only the unwelded plate) can be cold formed at temperatures below 580 °C taking into account its high yield strength. Irregularities in the bend area of the flame cut (cratering, blow-out, deep drag lines) should be ground smooth before cold forming, in order to avoid stress concentration.

Cold forming is always related to a hardening of the steel and to a decrease in toughness. If a heat treatment of unwelded cold formed parts becomes necessary, please contact us prior to the ordering.

### Hot forming

Hot forming is not allowed for thermomechanically rolled steel, because the particular microstructure would be altered. Consequently the forming of DI-MC 690 at temperatures above 580 °C without a significant deterioration of its mechanical properties is not possible and so shall not be applied.

### Flame cutting and welding

Due to its high yield strength, the processing of DI-MC 690 requires special care.

DI-MC 690 needs no preheating for flame cutting.

For general welding instructions, please follow the recommendations of EN 1011.

DI-MC 690 has a low carbon content and a low carbon equivalent, which leads to a low hardness increase and a decreased susceptibility to cold cracking. Nevertheless preheating may be necessary to avoid cracks in the weld metal, due to the sensitivity of high strength filler materials. Thus only welding consumables adding very little hydrogen to the weld shall be used. 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) should be used after drying according to the manufacturer's instructions. Heat treatment for hydrogen effusion (soaking) immediately after welding is recommended in case of increasing plate thicknesses and high restraint welds.

The high yield strength of the base material must also be taken into account while selecting the filler materials. In order to ensure that the tensile strength of the weld metal fulfils the requirements of the base material, the heat input and interpass temperature must be limited during welding. This is applicable when using suitable filler materials of a corresponding yield strength class. DI-MC 690 is suitable for a post-weld stress relieving of welded structural components up to 580 °C. The holding time should not exceed 1.5 hours (even if multiple operations are carried out). Cooling rate after PWHT should not be lower than 75 °C/h for temperatures above 300 °C.

## Heat treatment

If a stress relieving has to be considered because of design codes, constructive reasons or because it is necessary during the fabrication, the above mentioned conditions can be applied. The properties of structural components can be altered by a stress relief heat treatment.

## 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 agreed on request.

## Surface quality

Unless otherwise agreed, the technical data sheet will be in accordance with EN 10163, class A2. Higher requirements may be agreed on request.

## General Note

If particular 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 technical data sheet is a product description. This material data sheet is updated at irregular intervals. The current version is available from the mill or as download at

[www.dillinger.de/downloads](http://www.dillinger.de/downloads).

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