

Hot rolled Steel Plates, Sheets and Coils

Structural steels

Optim MC

A high-strength steel grade that makes it possible to increase the payload of vehicles and lifting equipment, Optim MC makes equipment manufacturing more efficient thanks to good weldability, flangeability and lower unit weight. The properties of Optim MC promote environmentally friendly construction and sustainable development.

Applications

- frame structures of mobile vehicles
- surface structures of commercial vehicles
- frames and booms of forestry vehicles
- crane arms and other lifting equipment
- load handling equipment
- masts

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- **Description of steel and delivery condition**

Optim MC offers both strength and formability at the same time. The surface quality, dimensional and geometrical accuracy and uniformity of properties of this steel are all top class. Steel structures can be made lighter, which means that the payload of machines and equipment can be increased and fuel consumption reduced. The capital letter “M” indicates the thermo-mechanical rolling of these steel grades, which is their delivery condition. The capital letter “C” means that the steel is suitable for cold forming in compliance with EN 10149-1.

- **Corresponding standards**

Optim MC meets, and indeed exceeds, the requirements of EN standards. The steel grades are in accordance with EN 10149-2, table 1. The number in the brand name is the guaranteed yield strength value of the steel, table 2 and 3.

- **Product shapes**

Hot rolled strip products: Cut lengths, coils and slit strips. The products are also delivered pickled.

- **Materials testing**

Test pieces are taken and tested in accordance with EN 10149-1. Tensile and impact tests are carried out on test pieces taken longitudinally to the rolling direction, whereas the flanging test uses test pieces taken transversally. The flanging test is chosen as the test of formability as it very well reproduces bending under workshop conditions.

- **Inspection documents**

Inspection documents are in accordance with EN 10204-3.1.

- **Dimension and shape tolerances**

The dimension and shape tolerances conform with, and in part exceed, EN 10051 requirements. Guaranteed flatness for cut lengths is 3 mm/m.

- **Welding**

The welding of Optim MC is, in spite of its high strength, easier than the welding of conventional softer grades. As a result of thermomechanical treatment, carbon equivalent values are low in relation to its strength, table 4. In addition, weldability has been improved by selection of suitable alloying elements and by ladle treatment. In design and workshop practice this good weldability means that preheating is not necessary under normal conditions. Before welding it must be ensured that the surfaces of the weld run are both dry

and clean. The welding materials and methods must be of sufficiently low hydrogen. Materials must be stored and dried, if necessary, in accordance with the manufacturers instructions.

The weld material properties, strength etc. must, in the main, be the same as those of the base material (matching). There are, however, some exceptions to this general rule in the case of high strength steels. This is the case for the higher-strength Optim 500 MC – 700 MC steels, which means that consumables of a lower strength than the steel (undermatching) may be used, provided that the weld is situated in a less stressed part of the structure. A narrow zone of material softer than the base material may be formed in the welded joints of Optim MC steels. The softer zone is similar to that in quenched and tempered steel and does not usually affect the strength of the structure. The width of this zone can be limited by avoiding the use of unnecessarily high welding energy.

- **Forming**

Optim MC steels can easily be bent in the workshop. As a result of this, components previously made by welding can now be made by bending, which shortens the throughput time and so reduces costs. The Table 5 indicates the smallest bending radius depending on plate thickness.

Successful utilization of the excellent formability requires the use of good workshop techniques. This requirement becomes more important the higher the strength of the steel is. Worn tools, insufficient lubrication, scratches on the surface of the steel as well as edge burrs will all reduce the quality of the forming. Plates taken from cold storage must be allowed to warm up to room temperature before being formed.

- **Heat treatment**

The applications of Optim MC steel do not usually require any heat treatment after fabrication. If relieving of residual stresses is required the thermomechanically rolled Optim MC steels may be stress-relieved at the temperature of 530–580°C as shown in Table 6. Heating the steel to temperatures higher than 580°C may reduce its strength, and for this reason hot working or normalizing are prohibited.

- **Cutting**

Optim MC steels can be cut easily using thermal methods such as flame, plasma and laser cutting. When cutting mechanically, attention must be paid to the stiffness of the equipment, the blade condition and clearance, and the supporting of the work piece.

Plates taken from cold storage must be allowed to warm up to room temperature before being cut.

• **Hot-dip galvanizing**

The good galvanizing characteristics of Optim MC steel is mainly the result of the optimisation of its chemical composition. By control of the galvanizing parameters it is possible to produce a smooth, bright and durable coating. The target coating thickness is achieved by control of immersion time and temperature.

• **Further information**

The following data sheets are related to the subject: Coil products production programme, Pickled strip products, Dimensional and shape tolerances, Welding, Thermal cutting and flame straightening, Flanging and forming, Mechanical cutting.

• **Corresponding standards**

Table 1

	EN 10149-2
Optim 500 MC	S500MC
Optim 550 MC	S550MC
Optim 600 MC	S600MC
Optim 650 MC	S650MC
Optim 700 MC	S700MC

• **Mechanical properties and thickness ranges**

Table 2

	Thickness mm	Yield strength R _{eH} or R _{p0.2} MPa Minimum	Tensile strength R _m MPa	Elongation %		Impact strength	
				Minimum A ₈₀ ¹⁾	A ₅	t °C	Longitudinal minimum KV J
Optim 500 MC	2.0 – 12.0	500	560 – 690	14	18	-20	40
Optim 550 MC	2.2 – 10.0	550	600 – 750	13	17	-20	40
Optim 600 MC	2.2 – 10.0	600	650 – 810	12	16	-20	40
Optim 650 MC	2.5 – 10.0	650	700 – 860	12	15	-20	40
Optim 700 MC	3.0 – 10.0	700 ²⁾	750 – 930	–	15	-20	40 ³⁾

The yield strength and tensile strength are tested in longitudinal direction to the rolling direction, but guaranteed both in longitudinal and transverse direction. Elongation is tested longitudinally. Impact strength is determined using the Charpy V test, size of the test piece is 10 x 10 mm. For thickness less than 10 mm the width of the test piece is equal to the strip thickness and, correspondingly, the guaranteed values are lower in direct proportion such that for 5 mm a value of 2/3 of the value in the table is guaranteed. Impact tests are not carried out on thickness of less than 5 mm, but the impact strength is guaranteed.

¹⁾ Elongation A₈₀ is used for thickness below 3 mm.

²⁾ For thickness (8) - 10 mm the minimum yield strength can be 20 MPa lower.

³⁾ For thickness (8) - 10 mm the minimum impact strength value is 27 J.

• **Chemical composition**

Table 3

	Content % (ladle analysis)					
	C Maximum	Si Maximum	Mn Maximum	P Maximum	S Maximum	Al Minimum
Optim 500 MC	0.10	0.20	1.50	0.020	0.010	0.015
Optim 550 MC	0.10	0.20	1.70	0.020	0.010	0.015
Optim 600 MC	0.10	0.20	1.90	0.020	0.010	0.015
Optim 650 MC	0.10	0.20	2.00	0.020	0.010	0.015
Optim 700 MC	0.10	0.20	2.00	0.020	0.010	0.015

In addition, niobium (Nb), vanadium (V), molybdenum (Mo), titanium (Ti) or boron (B) may be used as alloying elements either singly or in combination.

• **Carbon equivalent (CEV)**

Table 4

	CEV average	CEV maximum
Optim 500 MC	0.32	0.36
Optim 550 MC	0.33	0.38
Optim 600 MC	0.40	0.41 ¹⁾
Optim 650 MC	0.35	0.41
Optim 700 MC	0.37	0.41

¹⁾ In the thickness range of 2.2 – 4.6 mm CEV maximum is 0.45.

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

• **Minimum permissible bending radius, bending angle 90°**

Table 5

	Thickness mm								
	≤ 2,5	(2,5) – 3	(3) – 4	(4) – 5	(5) – 6	(6) – 7	(7) – 8	(8) – 10	(10) – 12
	Minimum permissible inside bending radius mm								
Optim 500 MC	2.0	2.5	3.0	4.0	4.5	7.0	8.0	10.0	12.0
Optim 550 MC	2.0	2.5	3.5	4.5	5.5	8.0	9.0	11.0	–
Optim 600 MC	2.5	2.5	3.5	5.0	7.0	9.0	10.0	12.0	–
Optim 650 MC	2.5	3.0	4.0	6.0	8.0	10.0	12.0	14.0	–
Optim 700 MC	–	3.5	5.0	6.0	8.0	12.0	14.0	16.0	–

No limitations on bending direction.

• **Heat treatment recommendations**

Table 6

Heat treatment	Temperature °C	Treatment time and manner of cooling
Stress relieving	530 – 580 (target 560)	2 minutes / millimetre thickness, minimum 30 minutes. Slow cooling in the furnace.

Too high temperature and long treatment time may weaken mechanical properties.

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