

Thermomechanically rolled fine-grained steels

Technical terms of delivery for heavy plates



Thermomechanically rolled fine-grained steels



alform®

Steel grades

- alform plate 355 M
- alform plate 420 M
- alform plate 460 M
- alform plate 500 M
- alform plate 550 M

More information you will also find in our technical terms of delivery for high-strength and ultra-high-strength thermomechanically rolled fine-grained steels.

Subject to change pursuant to further development.
The current version is available at www.voestalpine.com/grobblech.

alform®

The steel grades of the alform® series are thermomechanically rolled, weldable and bendable fine-grained structural steels. Plates made of these steels combine the good toughness properties of the thermomechanically rolled fine-grained steels according to EN 10025-4 with the excellent cold forming properties of the cold forming steels according to EN 10149-2.



The alloying concept provides very low carbon contents and low carbon equivalents, which aims in very good weldability. In particular, the high-strength grades (alform plate 500 M and alform plate 550 M) provide special advantages in areas, where weight savings are of great importance. The steel grades of the alform® series are used in steel construction, bridge building and the manufacture of penstocks, vehicles and cranes.

The technical terms of delivery apply for plate thicknesses from 8 to 100 mm depending on steel grade.

Steel grades

Steel grades

Steel grades	Designation according to EN 10149-2	Designation according to EN 10025-4
alform plate 355 M	S 355 MC	S 355 ML
alform plate 420 M	S 420 MC	S 420 ML
alform plate 460 M	S 460 MC	S 460 ML
alform plate 500 M	S 500 MC	—
alform plate 550 M	S 550 MC	—

Table 1:
Steel grades

Production process

alform® steels are produced via LD-route and are cast as fully killed steel.

Chemical composition

Heat analysis

Guaranteed values

Steel grades	mass in %											
	C max.	Si max.	Mn max.	P ¹⁾ max.	S ¹⁾ max.	Nb ²⁾ max.	V ²⁾ max.	Ti ²⁾ max.	Cr max.	Ni max.	Cu max.	Mo max.
alform plate 355 M	0.10	0.40	1.60	0.012	0.003	0.05	0.05	0.02	0.30	0.30	0.30	0.10
alform plate 420 M	0.10	0.40	1.70	0.012	0.003	0.05	0.05	0.02	0.30	0.30	0.30	0.20
alform plate 460 M	0.10	0.40	1.70	0.012	0.003	0.05	0.05	0.02	0.30	0.70	0.30	0.20
alform plate 500 M	0.10	0.40	2.00	0.012	0.003	0.09	0.05	0.02	0.50	0.70	0.30	0.50
alform plate 550 M	0.10	0.40	2.00	0.012	0.003	0.09	0.05	0.02	0.50	0.70	0.30	0.50

Table 2:
Chemical
composition

¹⁾ The standard EN 10025-4 would permit significantly higher values: P max. 0.025; S max. 0.020

²⁾ The total of Nb, V and Ti must not exceed 0.22%.

Different elements are not alloyed.

Carbon equivalent

Standard values for carbon content and carbon equivalent

Steel grades	mass in %			
	C	CEV ²⁾	CET ³⁾	PCM ⁴⁾
alform plate 355 M	0.04	0.33	0.20	0.13
alform plate 420 M	0.04	0.33	0.20	0.13
alform plate 460 M	0.04	0.36	0.22	0.15
alform plate 500 M ¹⁾	0.05	0.43	0.27	0.17
alform plate 550 M	0.06	0.44	0.29	0.19

Table 3:
Carbon
equivalent

¹⁾ Carbon equivalents for alform plate 500 M in thicknesses > 60 mm have to be agreed individually.

²⁾ CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15, according to IIW

³⁾ CET = C + (Mn + Mo)/10 + (Cr + Cu)/20 + Ni/40, according to SEW 088

⁴⁾ PCM = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5*B, according to API 5L

As-delivered condition

The plates are delivered in a thermomechanically rolled condition with accelerated cooling.

Mechanical properties

The values of yield strength, tensile strength, fracture elongation and impact energy are guaranteed for thicknesses from 8 to 100 mm depending on steel grade.

The values of bending test are guaranteed for thicknesses from 8 to 20 mm.

Mechanical properties in as-delivered condition

Steel grades	Plate-thickness ¹⁾ mm	Yield strength YS ²⁾ MPa, min. Thickness mm				Tensile strength UTS ²⁾ MPa Thickness mm		
		8 ≤ 16	> 16 ≤ 40	> 40 ≤ 63	> 63 ≤ 100	8 ≤ 40	> 40 ≤ 63	> 63 ≤ 100
alform plate 355 M	8 - 100	355	345	335	325	470 - 630	450 - 610	440 - 600
alform plate 420 M	8 - 100	420	400	390	380	520 - 680	500 - 660	480 - 650
alform plate 460 M	8 - 100	460	440	430	410	540 - 720	530 - 710	510 - 690

Table 4:
Mechanical
properties

Steel grades	Plate-thickness ¹⁾ mm	Yield strength YS ²⁾ MPa, min. Thickness mm			Tensile strength UTS ²⁾ MPa Thickness mm		
		8 ≤ 30	> 30 ≤ 50	> 50 ≤ 80	8 ≤ 30	> 30 ≤ 50	> 50 ≤ 80
alform plate 500 M	8 - 80	500	480	460	570 - 750	550 - 750	550 - 750
alform plate 550 M	8 - 50	550	530	-	600 - 760	570 - 730	-

¹⁾ Larger thicknesses on request.

²⁾ Tensile test in accordance with EN 10002 on transverse samples.

Notch impact energy and bending

Steel grades	Plate-thickness ¹⁾ mm	Fracture elongation $L_0 = 5,65 \sqrt{S_0}$ mind. %	Notch impact energy ¹⁾ at -50 °C min. J	Bending test ²⁾ bending angle 180° Mandrel diameter s = plate thickness	Admissible minimum inner radius 90°-edging s = plate thickness
alform plate 355 M	8 - 100	22	27	0.5 s	1.0 s
alform plate 420 M	8 - 100	19	27	0.5 s	1.5 s
alform plate 460 M	8 - 100	17	27	1.0 s	1.5 s
alform plate 500 M	8 - 80	16	27	1.0 s	2.0 s
alform plate 550 M	8 - 50	16	27	1.5 s	2.0 s

Table 5:
Notch impact
energy and
bending

¹⁾ Notch impact bending test in accordance with EN 10045 on Charpy-V longitudinal samples at -50 °C.

The mean value from 3 individual samples must reach the specified requirements. No individual value may be below 70% of the guaranteed mean value. For thicknesses < 10 mm, samples similar to Charpy-V with dimensions of 10 x 7.5 mm are tested. The guaranteed value is reduced in proportion to the sample cross-section.

Quality test

Test unit

Unless otherwise agreed upon ordering, 40 t of a heat or a smaller portion is used as test unit for the mechanical properties. The test unit must consist of plates with the same steel grade and the same thickness range for the yield strength according to table 4.

Scope of testing

Quality testing includes tensile test and notch impact test. The notch impact test is carried out on longitudinal samples at $-50\text{ }^{\circ}\text{C}$. A different sample position or testing temperature must be agreed upon ordering. Bending test is applied on request. The heat analysis is provided as proof of the chemical composition.

Tolerances and surface finish

Unless otherwise agreed, tolerances according to EN 10029 (thickness tolerance according to class A, flatness tolerance according to class N), and surface finish according to EN 10163-A1 are valid.

Marking

In general, marking consists of the:

- voestalpine symbol
- Steel grade designation
- Heat number
- Plate number

Material testing certificate

Type of certificate according to EN 10204 must be agreed upon ordering.

Processing guidelines

Cold forming

alform® plate steels provide good cold forming properties. On condition that cut edges have been ground very smooth and that the bending process is done professionally a minimum bending radius without cracks for 90°- bending is guaranteed according to table 5. In general, the resulting bending radius on the plate is smaller than the die-radius. The proper die-radius is to be chosen by the processor; as minimum die-radius we recommend minimum inner radius plus 0.5 x plate thickness.

Hot forming

Heavy plates of alform® plate steel grades are in thermomechanically rolled condition and are intended for cold forming. In case of hot forming necessary, reheating for short time up to maximum 580 °C is possible.

Welding

General information

As a result of their low carbon equivalents, alform® plate steel grades provide excellent weldability. The production process permits the achievement of the high yield point of these grades with clearly reduced alloying content and hence very low carbon equivalents. This has the effect of providing a low hardening tendency in the heat-affected zone (HAZ) and a high cold cracking resistance.

The generally valid and accepted rules for the welding of low-alloyed, high-strength fine-grained structural steels according to EN 1011-2 and STAHL-EISEN Werkstoffblatt (SEW) 088 must be observed.



Weld preparation, thermal cutting

Weld preparation can be done by machining or thermal cutting. In the case of the latter, preheating is not required at a workpiece temperature above + 10 °C. The weld edges must be dry and clean prior to welding.

Welding process

All standard automatic and manual welding processes can be employed, particularly shielded metal arc, inert gas shielded and submerged arc welding.

Filler materials and welding conditions (preheating, welding parameters)

The selection of the filler materials should result in a weld that matches the mechanical-technological properties of the base metal. For reasons of cold cracking prevention, the hydrogen content of the weld metal should be very low ($HD < 4 \text{ ml/100g WM}$) during processing of these higher-strength steel grades.

In the case of dry weld edges, preheating is not required at a workpiece temperature of above +10 °C and a hydrogen content of $HD < 4 \text{ ml/100 g WM}$. For welding with basic coated electrodes and welding powder (electric arc welding manual, submerged arc welding) with a hydrogen content of $HD > 4 \text{ ml/100 g WM}$ preheating up to 60 - 70 °C is recommended for plate thicknesses > 20 mm. These fillers must be subjected to secondary drying according to manufacturer instructions. Welding conditions, which lead to cooling times $t_{8/5}$ of 5 - 15 seconds, have proven effective.

Dimensions

alform plate 355 M, alform plate 420 M, alform plate 460 M

Thickness (mm)																										
100																										
95																										
90																										
85																										
80																										
75																										
70																										
65																										
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Width (mm)		1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500	2,600	2,700	2,800	2,900	3,000	3,100	3,200	3,300	3,400	3,500	3,600	3,700	3,800	

Maximum length: 18,700 mm

The maximum length is 17,000 mm for thicknesses of $8 < 9$ mm and widths of $\geq 3,450 - 3,800$ mm.

The maximum length is 17,000 mm for thicknesses of $9 < 10$ mm and widths of $> 3,650 - 3,800$ mm.

Different dimensions on request.

Dimensions

alform plate 500 M

Thickness (mm)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				</
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Maximum length: 18,700 mm

The maximum length is 17,000 mm for thicknesses of $8 < 9$ mm and widths of $\geq 3,450 - 3,800$ mm.

The maximum length is 17,000 mm for thicknesses of $9 < 10$ mm and widths of $> 3,650 - 3,800$ mm.

Different dimensions on request.

Dimensions

alform plate 550 M

[illegible]

Maximum length: 18,700 mm

The maximum length is 17,000 mm for thicknesses of $8 < 9$ mm and widths of $\geq 3,450 - 3,800$ mm.

The maximum length is 17,000 mm for thicknesses of $9 < 10$ mm and widths of $> 3,650 - 3,800$ mm.

Different dimensions on request.

Technically more advanced. Successful together.

voestalpine Steel Division – the partner you can trust.

High-quality materials are the basis for our products. We strive to be the best partner for our customers and want to provide them with the best-possible solutions. We focus our expertise on two aspects:

The personal aspect, with dedicated and highly competent employees

The technical aspect, with high-quality methods, products and services

The companies in the voestalpine Steel Division and their employees understand partnership to be the following:

- Understanding for their customers' business
- Expertise and reliability
- Responsibility for satisfactory project completion
- Partnerships based on trust

Many years of successful partnerships with our customers prove our point.

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ONE STEP AHEAD.