

alform[®]

Superior solutions in high-strength
and ultra-high-strength TM steel

2016/17 edition



Martin Klein, Materials specialist

voestalpine Steel Division
www.voestalpine.com/alform

voestalpine

ONE STEP AHEAD.



Find out more about high-strength
and ultra-high-strength TM steels by visiting us at
www.voestalpine.com/alform





Superior solutions in high-strength and ultra-high-strength TM steel

Efficient light-weight design and highest performance

Successful light-weight design requires the utilization of high-strength and ultra-high-strength steels. The innovative thermomechanically (TM) rolled steel grades **alform®** and **alform® x-treme** made by voestalpine lead to comprehensive weight reduction and provide exceptional advantages in processing.

With their reduced material thicknesses and excellent weldability, our **alform®** steels provide cost savings from procurement to manipulation and processing.

Advantages over other steel grades

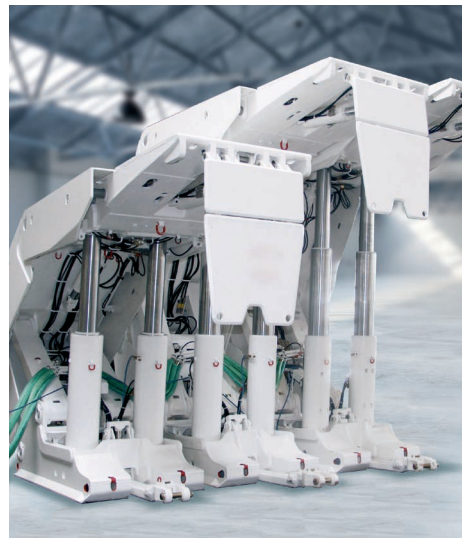
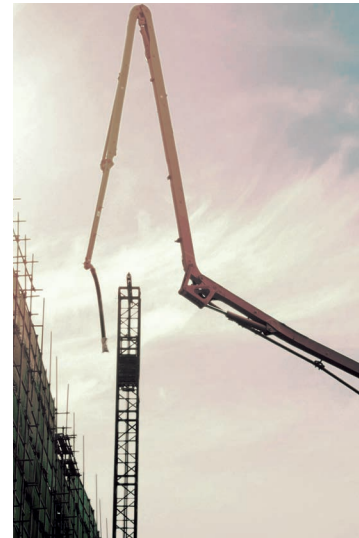
This graphic shows the potential savings achieved by implementing ultra-high-strength steels, for example, in a bending beam under static load.



Rectangular section 120 mm x 80 mm x thickness, longitudinally welded, V seam, bending moment 50 kNm

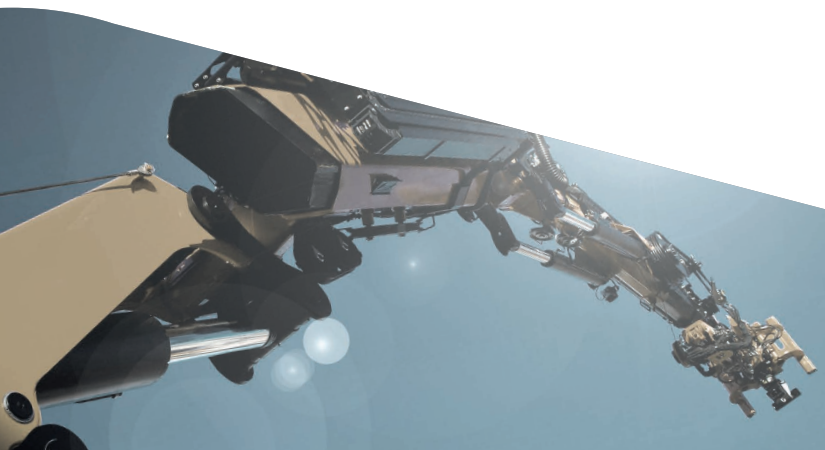
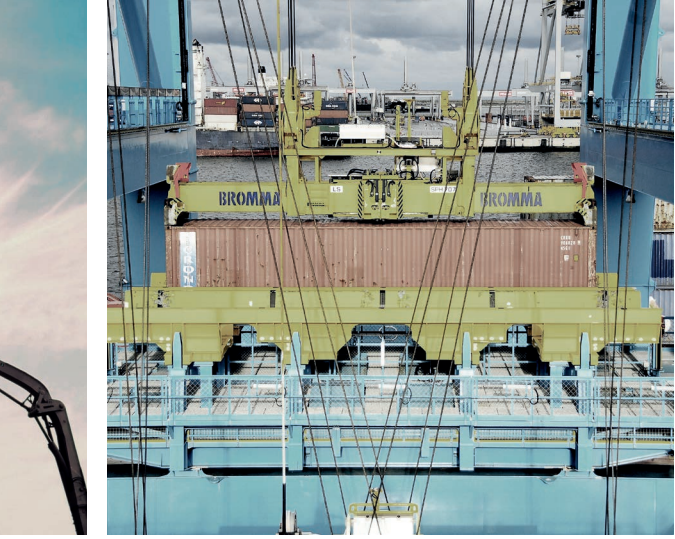
- Weight and volume reduction
- Best cuttability
- Very good cold formability
- Outstanding weldability
- Excellent toughness
- Perfect flatness
- Clean surface

Higher lifting and load capacity based on innovative light-weight design



Our **alform**[®] steel grades are excellently suited to applications in railcars, knuckle-boom cranes, spreaders, concrete pumps, agricultural and forestry machinery, mobile cranes, long-wall mining systems, trailers, push-off trailers and much more.





alform® service



alform® efficiency



alform® welding system

The alform[®] partner 2016/2017



Herbert Eibensteiner, Chairman of the Management Board of the voestalpine Steel Division,
and Herbert Ortner, PALFINGER Chairman of the Management Board.

PALFINGER stands for the world's most innovative, reliable and economical hoisting solutions found on commercial vehicles and in maritime applications. We set quality standards in our industries with technological expertise and experienced employees. Sustainability and responsible utilization of resources are at the center of our activities. High flexibility, production expertise and a worldwide sales and service network secure our decisive competitive advantage and provide our customers with LIFETIME EXCELLENCE.

As a multinational group of companies with headquarters in Salzburg, Austria, the PALFINGER Group operates 36 manufacturing and assembly locations in 20 different countries.

“As a world market leader in the highly technological mobile and offshore crane segment, we need steel with the best properties. In cooperation with our reliable partner of many years, voestalpine, we will continue to secure the success of our innovative products.”

Herbert Ortner
PALFINGER Chairman of the Management Board



alform® service

PALFINGER

LIFETIME EXCELLENCE



alform® efficiency



alform® welding system



Best processing properties

Extreme performance

The **alform**[®] grades are thermomechanically rolled, weldable, bendable, fine-grained structural steels. They combine the toughness properties of thermomechanically rolled fine-grained structural steels with the excellent bendability of cold-forming steels.



Weight and volume reduction

The reduced material thickness leads to light weight and smaller volume, which is a cost-saving advantage of all our **alform**[®] steel grades.



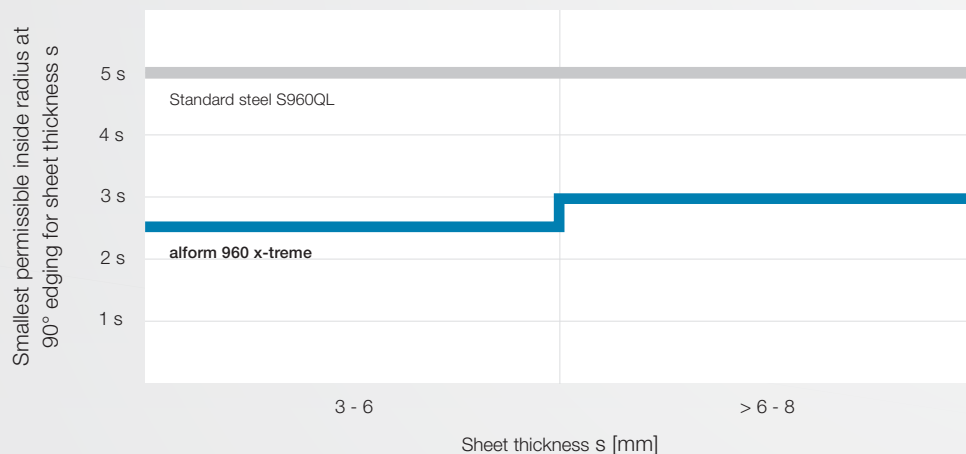
Best cuttability

The production technologies used in making high-strength and ultra-high-strength **alform**[®] steel grades are designed to minimize residual stresses and to avoid distortions during thermal cutting. The low carbon content and homogeneous surface make these high-strength and ultra-high-strength **alform**[®] steel grades suitable for all conventional cutting methods.



Very good cold formability

The homogeneous and fine-grained microstructure lends our **alform**[®] steel grades their decidedly improved forming behavior with more than twice the minimum yield strength than that of conventional structural steels.



Note

High-strength and ultra-high-strength **alform**[®] steel grades allow a significantly smaller bending radius than conventional constructional steels. You will find more detailed information on guaranteed minimum radii in the respective **alform**[®] data sheets.



Outstanding weldability

The combination of thermomechanical rolling and micro-alloying makes it possible to achieve very low carbon content. The excellent weldability of high-strength and ultra-high-strength **alform®** steels is based on the low carbon content and the tempering-resistant base materials.

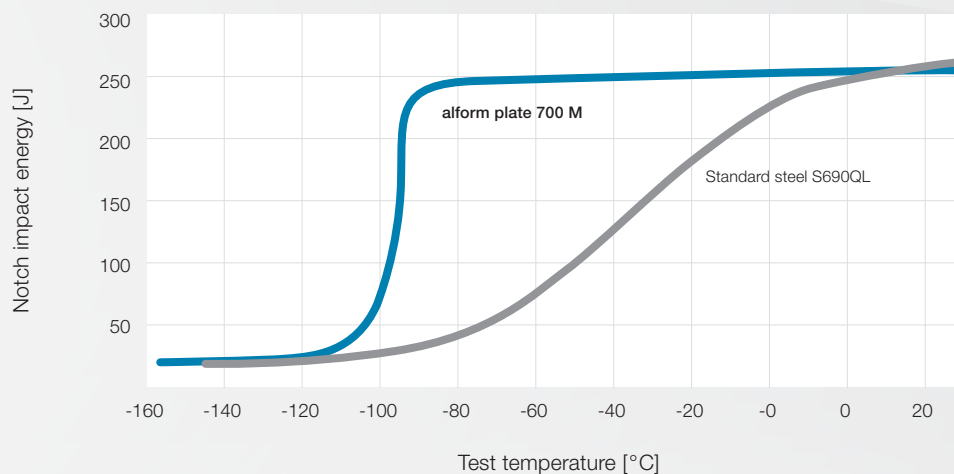
These properties lead to the following advantages:

- Broad welding range
- Lower maximum hardness in the heat affected zone
- Reduced tendency to temper softening in heat affected zone
- Reduced susceptibility to cold cracking



Excellent toughness

During the development of our **alform®** steel grades, special emphasis was placed on the requirements of the crane building industry. Thermomechanical rolling and accelerated cooling lend our **alform®** steel grades a fine-grained structure and excellent toughness that make it possible for us to enter into agreements that exceed the applicable standards.



Perfect flatness

Excellent flatness is achieved through precisely controlled rolling processes in combination with modern leveling units and production-route-based temper softening. Freedom from inner tension is highly advantageous during cutting and further processing and achieves optimized dimensional accuracy of the manufactured components.



Clean surface

A uniform layer of scale forms on the sheet surface following hot rolling in our process route. The natural protective layer acts against corrosion during transport and can easily be removed through sand blasting.



Thermomechanical rolling

For outstanding mechanical properties

Properties

We are the specialists in thermomechanical rolling with accelerated cooling. This process leads to a fine-grained structure that provides high strength, high toughness levels and good cold formability.

Rolling process

Our heavy plates (produced on reversing four-high rolling stands) and hot-rolled strips (cross-cut after rolling) are precision-rolled while ensuring that the temperature and forming processes are perfectly coordinated with each other. Both heavy plates and steel strips are accelerated-cooled directly after hot rolling.

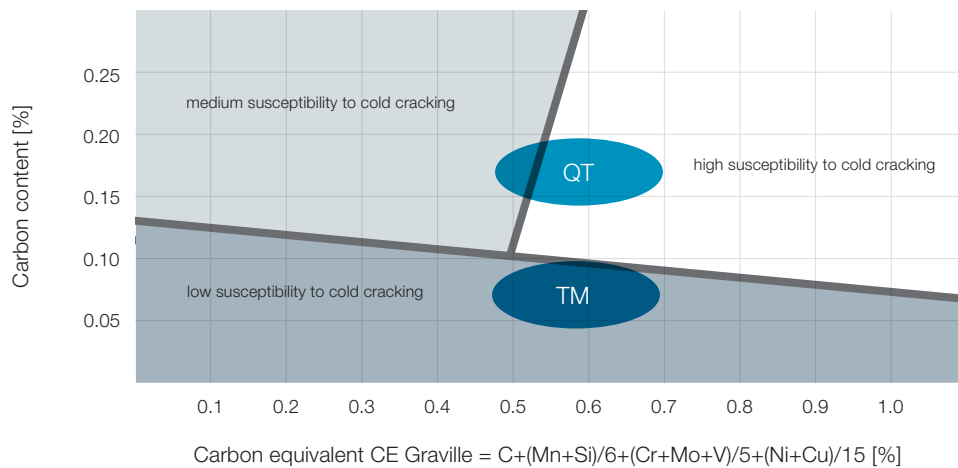
Temper annealing

The composition and microstructure of the steel grades are finely tuned to achieve the desired material properties, even after final annealing.

Surfaces and thickness tolerances

Our direct processes permit the use of modern alloying strategies with low carbon content and provide good surface characteristics by avoiding furnace scale and narrow thickness tolerances.

Comparison of thermomechanical rolling (TM) and quenched and tempered (QT)



Different material grades are characterized by a variety of welding behaviors. Three ranges with different levels of susceptibility to cold cracking are differentiated according to Graville in dependence on carbon content and carbon equivalent.

When compared with conventional quenched and tempered steels, thermomechanically rolled **alform**[®] steel grades achieve especially low carbon content at minimum yield strengths ranging from 700 to 960 MPa. For this reason, our **alform**[®] steel grades do not tend as readily to harden in the heat-affected zone (HAZ) and have low susceptibility to cold cracking. The benefits are achieved by means of a modern analysis strategy, thermomechanical rolling and accelerated cooling.









To the video:
Thermomechanical (TM) rolling





alform® product range

Available dimensions

		Thickness [mm]	Max. width [mm]	Max. length [mm]
alform 700 M / ME 		2.0 < 2.5	1,250	14,000
		2.5 < 3.0	1,380	
		3.0 < 3.5	1,500	
		3.5 ≤ 12.0	1,620	
		> 12.0 ≤ 15.0	1,500	
alform plate 700 M 		8.0 ≤ 15.0	3,000	18,700
		> 15.0 ≤ 20.0	3,500	18,700
		> 20.0 ≤ 50.0	3,800	18,700
		> 50.0 ≤ 60.0	3,800	16,000
alform 900 x-treme 		3.0 < 4.0	1,300	14,000
		4.0 < 7.5	1,620	
		7.5 ≤ 8.0	1,600	
alform plate 900 M x-treme 		8.0 ≤ 30.0	2,500	16,000
alform 960 x-treme 		3.0 < 4.0	1,200	14,000
		4.0 < 4.5	1,500	
		4.5 < 7.5	1,620	
		7.5 ≤ 8.0	1,600	
alform plate 960 M x-treme 		8.0 ≤ 25.0	2,500	16,000
alform 1100 x-treme 		4.0 < 5.0	1,300	14,000
		5.0 ≤ 7.0	1,500	
		> 7.0 ≤ 8.0	1,430	
alform plate 1100 M x-treme 		15.0 ≤ 25.0	2,500	16,000



cut-to-length sheets made of hot-rolled strip

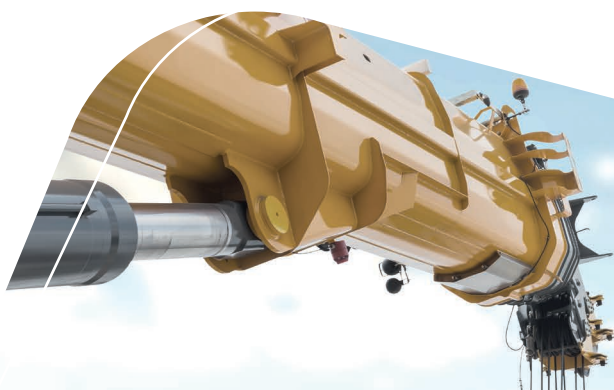


Heavy plates








Note

The different production routes for cut-to-length sheets made of hot-rolled strip and heavy plate result in specific product advantages that are described in greater detail in the respective data sheets.








Cut-to-length sheets made of hot-rolled strip

Mechanical properties

Tensile test	Sheet thickness [mm]	Yield strength R_{eH} [MPa]	Tensile strength R_m [MPa]	Elongation [%] min.	
				A_{80}	A_5
alform 700 M 	2 ≤ 15	≥ 700 ¹⁾	750 – 930	11	14
alform 700 ME 	2 ≤ 12	≥ 700 ¹⁾	750 – 930	11	14
alform 900 x-treme 	3 ≤ 8	≥ 900	940 – 1,100	-	10
alform 960 x-treme 	3 ≤ 8	≥ 960	980 – 1,150	-	10
alform 1100 x-treme 	4 ≤ 8	≥ 1,100	1,160 – 1,350	-	8

1) The yield strength may be lower by 20 M_{Pa} for thicknesses > 8 mm.
Longitudinal tensile test; minimum values for R_{eH} and R_m also apply in cross direction.





Notch impact energy Edging radii	Sheet thickness [mm]	Notch impact energy A_v [Joule]				Edging radii R_i min. at 90° edging Location of bending edge in direction of rolling (s = sheet thickness)	
		Test temperature of -20 °C		Test temperature of -40 °C ²⁾		longitudinal	transverse
alform 700 M 	2 < 3	-	-	-	-	0.8 s	0.8 s
	3 ≤ 6	40	-	-	-	1.2 s	1.2 s
	> 6 ≤ 15	40	-	-	-	1.6 s	1.6 s
alform 700 ME 	2 < 3	-	-	-	-	0.8 s	0.8 s
	3 ≤ 6	40	-	27	-	1.2 s	1.2 s
	> 6 ≤ 12	40	-	27	-	1.6 s	1.6 s
alform 900 x-treme 	3 ≤ 6	40	30	30	27	2.5 s	2.5 s
	> 6 ≤ 8	40	30	30	27	3.0 s	3.0 s
alform 960 x-treme 	3 ≤ 6	40	30	30	27	2.5 s	2.5 s
	> 6 ≤ 8	40	30	30	27	3.0 s	3.0 s
alform 1100 x-treme 	4 < 6	40	30	30	27	3.5 s	-
	> 6 ≤ 8	40	30	30	27	5.0 s	-





2) Transverse values at -40 °C only guaranteed upon agreement and when ordered as such.
Notch impact energy can be measured from a sheet thickness of ≥ 3 mm upon request.
Notch impact energy tests on thicknesses < 6 mm do not comply with Euronorm standards.



Heavy plates

Mechanical properties

Tensile test	Sheet thickness [mm]	Yield strength $R_{p0.2}$ [MPa]	Tensile strength R_m [MPa]	Elongation [%] min.	
				A_{80}	A_5
alform plate 700 M 	8 ≤ 15	700	770 – 1,050	-	10
	> 15 ≤ 50	680	770 – 1,050	-	12
	> 50 ≤ 60	650	770 – 1,050	-	12
alform plate 900 M x-treme 	8 ≤ 30	900	940 – 1,100	-	11
alform plate 960 M x-treme 	8 ≤ 25	960	980 – 1,150	-	10
alform plate 1100 M x-treme 	15 ≤ 20	1,100	1,120 – 1,300	-	8
	> 20 ≤ 25	1,080	1,100 – 1,300	-	8

Notch impact energy Edging radii	Sheet thickness [mm]	Notch impact energy A_v [Joule]				Edging radii R_i min. at 90° edging Location of bending edge in direction of rolling (s = sheet thickness)	
		Test temperature of -20 °C		Test temperature of -40 °C ¹⁾		longitudinal	transverse
		longitudinal	transverse	longitudinal	transverse		
alform plate 700 M 	8 ≤ 15	-	-	40	30	4 s	3 s
	> 15 ≤ 50	-	-	40	30	4 s	3 s
	> 50 ≤ 60	-	-	30	27	4 s	3 s
alform plate 900 M x-treme 	8 ≤ 30	-	-	30	27	5 s	4 s
alform plate 960 M x-treme 	8 ≤ 25	-	-	30	27	5 s	4 s
alform plate 1100 M x-treme 	15 ≤ 25	-	-	27	24	6 s	5 s

1) Transverse values at -40 °C only guaranteed upon agreement and when ordered as such.



Note

The excellent toughness of **alform plate 700 M** and **alform 700 ME** is of special interest.



More than just a quality product When solutions are in demand

With our material and processing expertise, we have been the reliable partner to our customers in the machinery industry for many years and provide innovative product solutions in addition to our full service for best-possible support and process performance.



alform® service



alform® technical support

Our large pool of technical experts will be happy to assist you in all matters of concern, whether it be help with the adjustment of your production facilities, technical consultation in selecting the correct product or any other issues.



alform® in-house welding competence

We are continuously improving our outstanding expertise in the most modern welding processes in the course of research projects that we carry out with economic and scientific partners. We use the most modern welding machines, robots and a thermal welding simulator to conduct practical welding tests for punctual measurement of microstructures and other properties.



voestalpine Steel & Service Center

We offer you customized solutions in collaboration with our own logistics company. Our well stocked warehouse of sample parts in Linz allows short-term sample deliveries for welding and bending trials. Our state-of-the-art stock logistics make it possible for us to quickly meet your requirements and supply small lots and cut shapes upon request.





More than just successful light-weight design Innovations that save costs

Our experience and continued research activities make it possible for us to develop innovative steel grades that help you more effectively meet your challenges in the future. State-of-the-art technologies in manufacturing and processing help reduce your costs and provide a decisive competitive advantage for your operations.

alform® efficiency

Short processing times

The excellent flatness and surface of our **alform®** steel grades ensure higher productivity through significantly increased cutting speeds and reduced downtimes as a result of optimized work processes.

Reduction of revision work

The homogeneous properties of our materials lead to reproducible processing results, thus guaranteeing optimized dimensional accuracy, and revision work is eliminated almost entirely.

Reduction of transport and logistics costs

Our **alform®** steel grades make lower material thicknesses possible. This leads to a reduction in transport weights and procurement volumes. Means of transport and hoisting devices can be smaller, and additional fuel costs can be saved.



alform® efficiency



alform® welding system



More than just perfect weld joints System solution in a new dimension

alform® welding system is the world's first custom-matched system of steels and consumables for high-strength and ultra-high-strength welded structures. This opens up an entirely new dimension of our alform® steels with respect to material expertise.

alform[®] welding system

Exceptional strength

The optimized system of tempering-resistant steel grades and adapted filler metals guarantees strength values in the welded joint across a wide range of parameters. These values meet the demands of the respective base materials.

Operational reliability

The steel grades and welding consumables in the system allow weld seams (heat-affected zone and filler metals) with excellent toughness. The excellent values guarantee high operating safety at low temperatures under complex loading conditions.

Best product quality

The **alform[®] welding system** stands for consistently high product quality in the base material and welding consumables. The proven system solution guarantees optimized component property profiles. Reduced costs and increased manufacturing reliability are achieved through the extended welding range. Highly professional consulting for your applications with comprehensive processing expertise perfectly round off the package.



If you're reading this, your successful future has already begun.

Together with us, you are always one step ahead because we offer more than optimized products made of high-quality material.

- If you are looking for customized solutions, we will be pleased to work with you on the creation of new products and services.
- If you are looking for new ideas on materials, technologies and services, we want to help you find them.
- If you are looking for a fair and reliable partner, you are at the right place. We know that we can only be successful together with our customers when they benefit as much as we do from our partnership.
- Our customers take advantage of the most widely used technology: Two thirds of the steel produced worldwide is made using the LD process, and we're rather proud of that.

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