Alleima

Chromflex™
Strip steel
Datasheet

Chromflex™ is a family of hardened and tempered martensitic chromium steels characterized by:

- High strength combined with good shape
- High standard of surface finish
- Close dimensional tolerances
- Freedom from internal stresses
- Low content of non-metallic inclusions

Each of the four grades in the Chromflex™ family has its own distinguishing characteristics:

Alleima® 7C27Mo2	Very high fatigue strength
Alleima® 13C26	Good edge grinding properties and excellent wear resistance
Alleima® 12C27	Good edge properties and high toughness for heavy gauges
Alleima® 6C27	Good blanking and forming properties

Chemical composition (nominal) %

Alleima	C	Si	Mn	Cr	Mo
7C27Mo2	0.38	0.40	0.55	13.5	1.0
13C26	0.68	0.40	0.60	12.9	-
12C27	0.60	0.40	0.40	13.5	-
6C27	0.32	0.15	0.30	13.7	-

Specifications

Alleima	ASTM	EN	W.-Nr	SS
6C27	420	1.4028	1.4007	2304

Applications

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Chromflex™ has a lot of different applications in various branches of industry. Examples are:

Industry	Applications
Precision engineering	Solenoid springs, parts for electric shavers
Food processing	Knives and slaughterhouse bandsaws
Textile manufacturing	Reeds for weaving machines
Building	Cement grinders, trowels, measuring tapes and rules
Domestic and hobby purposes	Knives and spatulas
Surgery	Bone saws
Paper and printing industry	Creping and printing doctor blades

Contact us for more information on where Alleima Chromflex™ can be used.

Dimensions

Thickness

Alleima® 6C27: max. 2.50 mm (0.0984 in.)
Alleima® 7C27Mo2: max. 3.00 mm (0.118 in.)
Alleima® 13C26: max. 1.00 mm (0.0394 in.)
Alleima® 12C27: >1.00 - 3.00 mm (0.118 in.)

Width

Thickness		Min. width		Max. width	
mm	in.	mm	in.	mm	in.
0.076- 0.10	0.003- 0.0039	8	0.32	160	6.3

0.10- 0.15

0.0039- 0.0059

8

0.32

240

9.5

0.15- 0.30

0.0059- 0.0118

8

0.32

300

11.8

0.30- 0.50

0.0118- 0.0195

10

0.39

300

11.8

0.50- 0.75

0.0195- 0.0295

15

0.59

340

13.4

0.75- 1.20

0.0295- 0.0468

20

0.79

340

13.4

1.20- 3.00

0.0468 - 0.118
1
30
1.18
365
14.4

Other sizes can be discussed from case to case.

Tolerances

The standard width and thickness tolerances are B1 and T1. Other tolerances on request. Contact us for more information about tolerances.

Conditions and forms of supply

Chromflex™ is supplied as strip steel in the hardened and tempered condition in coils, or on plastic spools, depending on weight and size. Straight lengths, up to 4 meters (13 ft.), can also be supplied.

Bending

Table 6 below shows average values for the least bending radius, r min . These figures refer to strip with a nominal tensile strength as per tables 4 and 5. The bending tests were carried out according to Swedish Standard SS 11 26 26 method 3, i.e. in a 90° veer block with a 25 mm (1 in.) die opening, the blanked test pieces being 35 mm (1.38 in.) wide and turned so that their burr edge was facing inwards in the bend.
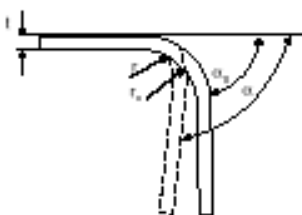
Material thickness		Least bending radii					
		Alleima® 7C27Mo2		Alleima® 13C26		Alleima® 6C27	
mm	in.	I I	_I_	I I	_I_	I I	_I_
0.25	0.010	5t	4t	6t	5t	5t	3t
0.50	0.020	6t	5t	7t	5t	5t	3t
1.00	0.039	12t	10t	-	-	6t	4t

I I = bending parallel to the rolling direction
_I_ = bending at right angles to the rolling direction
t = strip thickness

Bending calculations (springback)

Radius of the punch, $r = k \cdot r_1$

Angle of the V-die $\alpha = \dfrac{\alpha_1}{k}$

k = springback factor, see fig. 5
r_1 = bending radius after springback
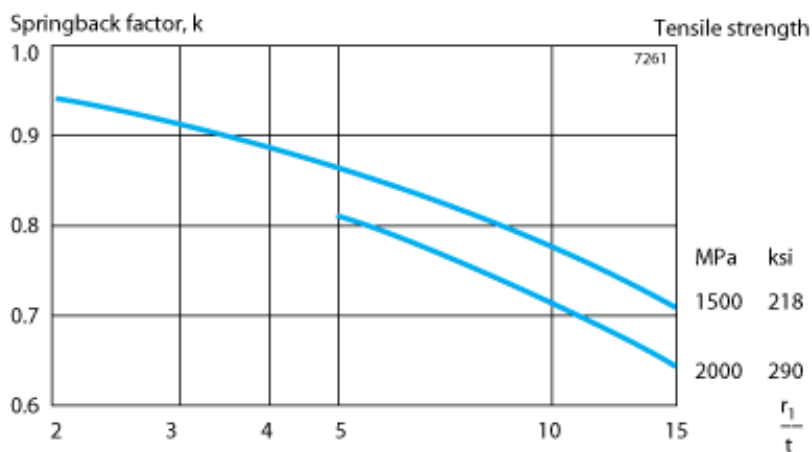α_1 = bending angle after springback

Figure 5. Springback factor. Since the springback also is dependent on the bending method, the tool design, the setting of the press and other factors, the final choice of tool angle and punch radius must be made on the basis of practical trials.

Table 6 below shows average values for the least bending radius, r min . These figures refer to strip with a nominal tensile strength as per tables 4 and 5. The bending tests were carried out according to Swedish Standard SS 11 26 26 method 3, i.e. in a 90° veer block with a 25 mm (1 in.) die opening, the blanked test pieces being 35 mm (1.38 in.) wide and turned so that their burr edge was facing inwards in the bend.

Mechanical properties (nominal value)

Metric units at 20ᵒC

Thickness mm	Alleima® 7C27Mo2	Alleima® 13C26	Alleima® 6C27
	Tensile strength R_m, MPa *)		
0.03 - 0.50	1800	1900	1600
(0.50) - 1.00	1800	1800	1600
(1.00) - 2.00	1700	-	1500
(2.00) - 2.50	-	-	1500
	Proof strength, $R_{p0.2}$, MPa		
0.03 - 0.50	1450	1550	1300
(0.50) - 1.00	1450	1450	1300
(1.00) - 2.00	1350	-	1200
(2.00) - 2.50	-	-	1200
	Elastic limit, 0.01%, MPa		
0.03 - 0.50	1250	1300	1050
(0.50) - 1.00	1250	1200	1050
(1.00) - 2.00	1200	-	1000

			1000

	Modulus of elasticity, MPa		
0.03 - 2.50	210 000 for all steels		

*) The manufacturing tolerance is ± 100 MPa

English units at 68ºC

Thickness in.	Alleima® 7C27Mo2	Alleima® 13C26	Alleima® 6C27
	Tensile strength R_m, psi *)		
0.0012 - 0.0197	261000	276000	232000
(0.0197) - 0.0394	261000	261000	232000
(0.0394) - 0.0787	196000	-	218000
(0.0787) - 0.0984	-	-	218000
	Proof strength, $R_{p0.2}$, psi		
0.0012 - 0.0197	210000	225000	189000
(0.0197) - 0.0394	210000	210000	189000
(0.0394) - 0.0787	196000	-	174000
(0.0787) - 0.0984	-	-	174000
	Elastic limit 0.01%, psi		
0.0012 - 0.0197	181000	189000	152000
(0.0197) - 0.0394	181000	174000	152000
(0.0394) - 0.0787	174000	-	145000
(0.0787) - 0.0984	-	-	145000
	Modulus of elasticity, psi		
0.0012 - 0.0984	30 500 000 for all steels		

*) The manufacturing tolerance is ± 14 500 psi

Other mechanical properties on request.

Impact energy

Figure 1 shows impact energy as a function of temperature. The figures on which the curves are based are determined in a Schopper miniature testing machine. Specimens have been extracted parallel to the rolling direction, which means impact at right angles to the rolling direction.
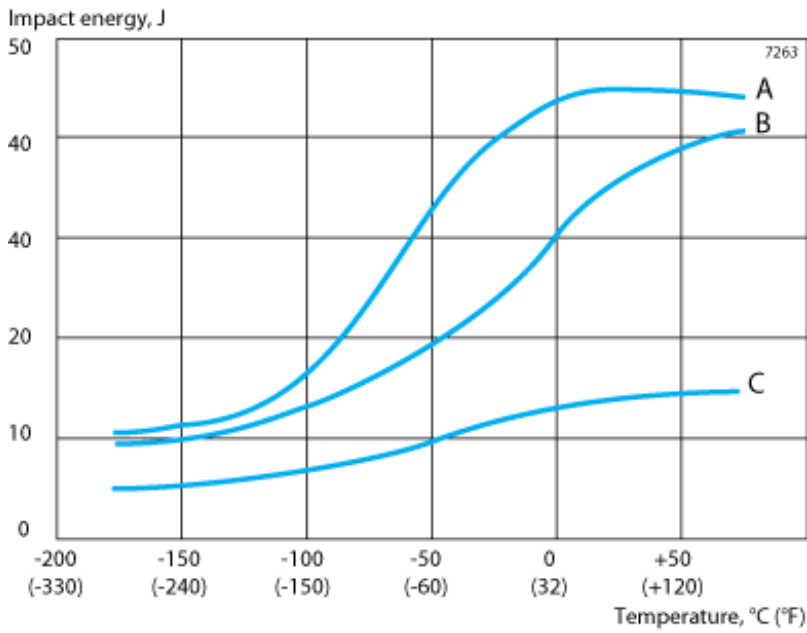
Figure 1.
Impact energy as a function of temperature
A = Alleima® 6C27. Tensile strength 1600 MPa (232000 psi)
B = Alleima® 7C27Mo2. Tensile strength 1800 MPa (261000 psi)
C = Alleima® 13C26. Tensile strength 1900 MPa (276000 psi)

Fatigue strength

The fatigue limit is defined as the stress at which 50% of the test specimens withstand minimum 2×10^6 load cycles.

Reversed bending stress (mean stress = 0)

Figure 2 shows a Wöhler S-N curve for Alleima® 7C27Mo2. The corresponding curves for Alleima 13C26 and 6C27 are about 10% lower.
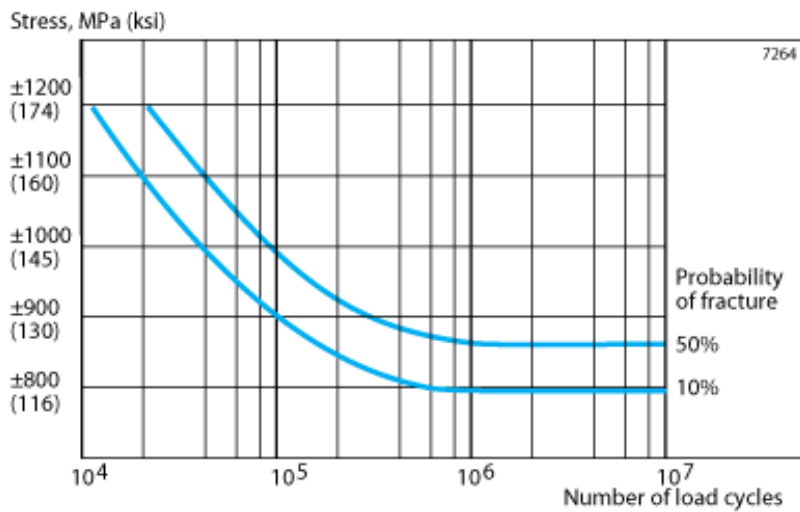

Figure 2. Wöhler S-N curve for Alleima® 7C27Mo2, tensile strength 1800 MPa (261000 psi), max. thickness 1.00 mm (0.0394 in.). Thicker materials have a somewhat lower fatigue strength. The diagram shows that Alleima® 7C27Mo2 with a maximum thickness of 1.00 mm (0.0394 in.) has a fatigue limit of 860 MPa (125000 psi).

Fluctuating tensile stress (minimum stress = 0)

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The fatigue limit of Alleima® 7C27Mo2, tensile strength 1800 MPa (261000 psi) and a maximum thickness of 1.00 mm (0.0394 in.) is 650 ± 650 MPa (94000 ± 94000 psi). Strip thicker than 1.00 mm (0.0394 in.) has a fatigue limit which is about 10% lower. The corresponding figures for Alleima® 13C26, and 6C27 are about 10% lower.

Relaxation

The materials have been relaxation tested both at room temperature and at elevated temperature. Figures 3 and 4 show the results obtained with Alleima® 7C27Mo2. The relaxation of Alleima® 13C26 and Alleima® 6C27 is roughly on the same level.
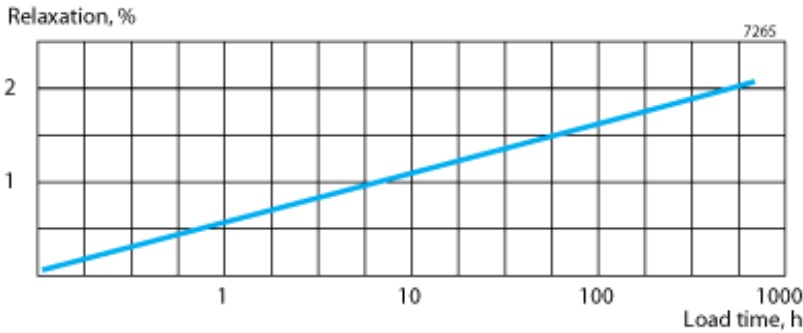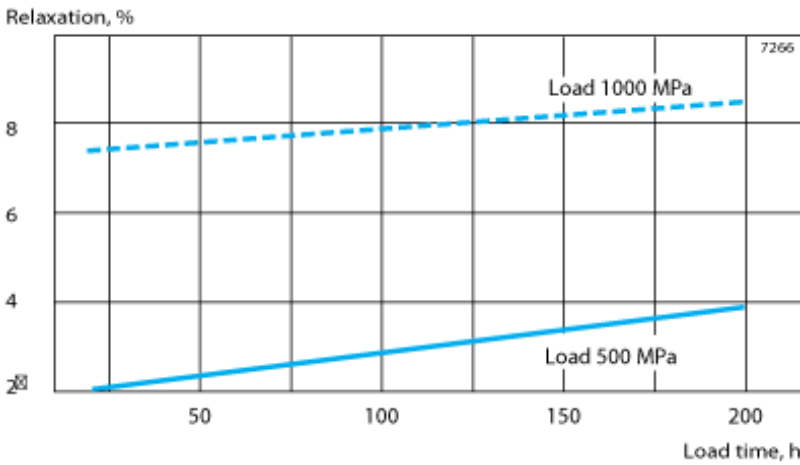

Figure 3.
Relaxation as a function of time at 20 °C (68 °F). Load 1100 MPa (160000 psi). Tensile strength 1700 MPa (247000 psi).

Relaxation as a function of time at 250°C (480°F). Tensile strength 1700 (247000 psi).

Physical properties

The physical properties of a steel are related to a number of factors, including alloying elements, heat treatment and manufacturing route, but the data presented below can generally be used for rough calculations.

Density

g/cm^3	7.7
lb/in.^{3}	0.27

Thermal expansion per °C, x10^{-6}

from 20°C	to 100°C	10.6

	to 200°C	11.1
	to 300°C	11.4

Thermal expansion per °F, x10⁻⁶

from 68°F	to 210°F	5.9
	to 390°F	6.2
	to 570°F	6.3

Thermal conductivity

at	20°C, W/(m * °C)	24
	68°F, Btu/(ft * h * °F)	14

Specific heat capacity

mean value for	50–100°C, J/(kg * °C)	460
	120–210°F, Btu/(lb * °F)	0.11

Blanking

General

Accurate, stable dies and presses are needed to ensure optimum blanking results. A lubricant should be used to reduce tool wear.

Clearance between punch and die

A clearance equaling 4–10% of the strip thickness will give low-level burrs and long tool life and will produce edges with a narrow shear zone and a wide break zone. If the die is tapered, the clearance can be reduced by about half without significantly reducing the life of the die.

The best way of preventing slugs or blanked items riding up with the punch is to fit the punch with a spring-loaded ejector pin. This method is not feasible with slender punches. In cases of this kind, a die without a taper, i.e. with a straight section starting from the edge of the tool, can be used instead. The straight section should be at least 5 times the strip thickness and at least 3 mm (0.118 in.) long.

Tools

Tool grades such as AISI D2 and D4 with a hardness of about HRC 63 are suitable for blanking except in the case of thick material, slender tool sections and small corner radii, for which we recommend AISI M2 high speed steel hardened and tempered to about HRC 63.

AISI M2 for the punch and AISI D4 for the die is often a suitable tool combination. For blanking in long runs we recommend carbide tools, unless the strip is too hard or thick or the shape of the workpiece unsuitable. Further recommendations can be given on request.

The corner radii should be at least 0.25 times the thickness and on no accounts less than 0.25 mm (0.010 in.), while the diameter of the punch should be at least twice the thickness.

Photo-etching

Photo-etching is an alternative to blanking and offers the following important advantages:

- Design freedom
  Parts can be designed simply with the best possible function in mind.
- Freedom from stresses
  Flat parts, free from stresses, can be manufactured.
- Lower costs
  Inexpensive 'tools' reduce the total cost for small and medium size production series.
- Short lead time, high flexibility
  'Photo tools' can be manufactured in a very short time. Design changes and modifications are easily done.

Materials

Chromflex ™ is an ideal material for photo-etching. The material is hardened and tempered in a unique vertical furnace. The strip steels are almost entirely free from surface oxides and internal stresses and furthermore have a very good flatness and surface finish combined with excellent mechanical properties. What is more, the structure and hardness of Chromflex™ provide a favorable etching edge.

Laser cutting

This method has advantages similar to photo-etching and is particularly suitable for thick materials. As laser cutting involves heating and melting of the material, it may result in reduced toughness on the cut edge. The toughness is restored by a simple heat treatment. Recommendations can be given on request.

Welding

Generally speaking, martensitic chromium steels are difficult to weld because they harden in air. Welds of adequate functional stability can, however, be obtained under controlled conditions. Resistance welding in the form of butt- and flashwelding is used, for example, in the manufacture of endless strip.

The welding current and upset force are greater than those required for butt- and flashwelding carbon steel. A perfect weld demands careful preparation of the joint, the removal of oxide and other impurities and clean clamps. The welding operation should be followed by tempering, 760-780°C (1400-1435°F) for 45 sec., in order to reduce hardness peaks and homogenize the structure.

For butt welding of thin strip we recommend micro plasma laser or electron beam welding followed by tempering at 600°C (1110°F), 2-3 minutes, or at 650°C (1200°F), 15 sec.

The weld should be cooled to room temperature before the tempering operation. To obtain a perfect weld, accurate joint preparation (straight, even edges) followed by cleaning of the edges, is required. Alleima can assist to develop welding procedures in particular cases.

Alleima