13RM19 Data Sheet
Strip Steel

Zapp is Certified according to ISO 9001

13RM19 is a stainless spring steel combining high mechanical strength with a non-magnetic structure. This combination of properties has previously been found mainly in expensive Co-Ni-base or Cu-Be alloys. Corrosion resistance is comparable to ASTM 301.

13RM19 also possesses good fatigue properties and excellent ductility, which makes it a most suitable choice for springs and other high-strength applications where ferromagnetic materials cannot be used.

13RM19 main characteristics:
_ Non-magnetic structure in all conditions
_ High mechanical strength in the cold rolled condition. Strength can be further increased by tempering, without any effect on the non-magnetic structure.
_ High elastic limit and energy storing capacity in the cold rolled and tempered condition which is important for spring applications.

Service temperature: up to 250 °C (480 °F)

Standards

- EN Number: 1.4369
- EN Name: X11CrNiMnN19-8-6

Chemical Composition (Nominal) %

C	Si	Mn	P	S	Cr	Ni
0.11	0.8	6.0	≤ 0.030	≤ 0.015	18.5	7.0

Others: N=0.25

Forms of Supply

Strip steel can be supplied in coils, bundles, on plastic spools or in lengths. The edges can be either slit, deburred or smoothly rounded. Please contact us for more information.

Tolerances

The thickness and width tolerances are ± tolerances to the nominal size. The normal tolerance classes for most of our strip products are T2 and B1. Tighter tolerances as well as other tolerance limits can be offered upon request.

Conditions and dimensions

13RM19 is supplied in the cold rolled or solution annealed (bright annealed or annealed and pickled) condition.

Condition	Tensile strength, R_m		Thickness	
	MPa	ksi	mm	in.
Annealed	850	123	0.03 – 4.0	0.0012 - 0.16
Cold rolled	1,100	160	0.025 – 3.2	0.001 - 0.13
Cold rolled	1,300	189	0.02 – 2.8	0.0008 - 0.11
Cold rolled	1,500	218	0.015 – 1.9	0.0006 - 0.075
Cold rolled	1,600	232	0.015 – 0.9	0.0006 - 0.035

Widths: 2 – 345 mm (0.08 – 13.6 in.)

Mechanical Properties

Static strength

Nominal values at 20 °C (68 °F)

Condition[1)]	Tensile strength, R_m		Proof strength, $R_{p0.2}$[a)]		Elongation, $A_{11,3}$
	MPa	ksi	MPa	ksi	%
A	850	123	470	68	45
C	1,100	160	975	142	12
CT	1,130	164	1,020	148	11
C	1,300	189	1,150	167	10
CT	1,350	196	1,220	177	8
C	1,500	218	1,350	196	3
CT	1,650	239	1,500	218	2
C	1,600	232	1,440	209	2
CT	1,800	261	1,630	237	1

1) A = Annealed, C = Cold rolled, CT = Cold rolled and tempered, 480 °C (896 °F)/2 h. See further under section 'Heat treatment'.

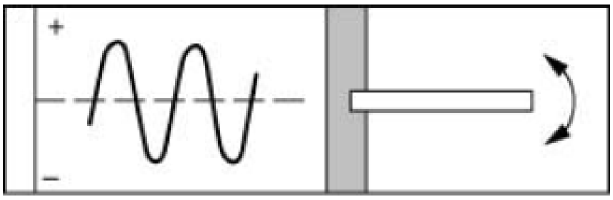
a) $R_{p0.2}$ corresponds to 0.2 % offset yield strength. 1 MPa = 1 N/mm²

Fatigue Strength

Nominal values at 20 °C (68 °F) in a normal dry atmosphere. The fatigue limit is defined as the stress at which 50 % of the specimens withstand a minimum of 2 million load cycles.

Reversed Bending Stress

Average stress = 0
Bending transversal to rolling direction.

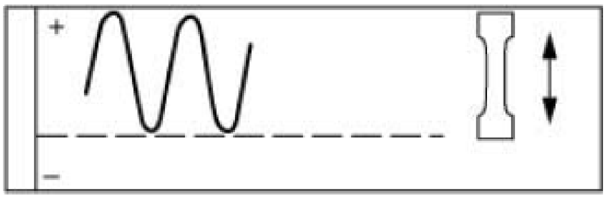


Comparison made for different thicknesses and tensile strength levels.

Tensile strength, R_m		Thickness		Fatigue limit	
MPa	ksi	mm	in.	MPa	ksi
1,600	232	0.40	0.016	± 605	± 88
1,800	261	0.20	0.008	± 680	± 99
1,800	261	0.40	0.016	± 635	± 92

Fluctuating Tensile Stress

Minimum stress = 0
Specimens parallel to rolling direction.



Comparison made for different thicknesses and tensile strength levels.

Tensile strength, R_m		Thickness		Fatigue limit	
MPa	ksi	mm	in.	MPa	ksi
1,600	232	0.40	0.016	500 ± 500	73 ± 73
1,800	261	0.40	0.016	535 ± 535	78 ± 78

Physical Properties

The physical properties of a steel relate to a number of factors, including alloying elements, heat treatment and manufacturing route, but the following data can generally be used for rough calculations. These values refer to cold rolled material, at a temperature of 20 °C (68 °F) unless otherwise stated.

Density: 7.9 g/cm^3 (0.29 lb/in.^{3})

Resistivity: 0.7 μΩm (27.6 μΩin.)

Modulus of elasticity: 190,000 MPa (27,600 ksi)

Thermal expansion **means values in temperature ranges (x10^{-6})**

Temperature, °C	per °C	Temperature, °F	per °F
30 – 100	16.5	85 – 200	9.0
30 – 200	17.0	85 – 400	9.5
30 – 300	18.0	85 – 550	10

Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
20	15	68	8.5
100	16	200	9.0
300	19	600	11.0

Magnetic Properties

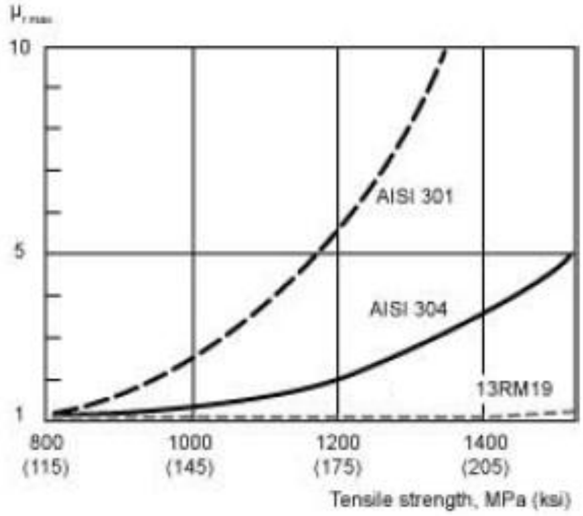
From a magnetic point of view, materials can be divided into three groups, para-, dia- and ferromagnetic materials. In many practical cases, para- and diamagnetic materials will, however, interact strongly with the magnetic fields. In some cases, the ferro-magnetic properties are desired, while in other situations no interaction with a magnetic field can be accepted.

The magnetic properties of a material are expressed as the magnetic susceptibility, c, or often as the magnetic permeability m0 = 1 + c. By definition, the magnetic susceptibility is placed at 0 for vacuums, from which it follows that m =1. The magnetic permeability for a certain material is expressed as m_r , which is its relative permeability versus vacuum. Further, as m may vary with the magnetic field strength, the maximum value of $m_{r\,max}$ is often given as a representative value of the material.

Most types of high strength steel are ferromagnetic in spring hard conditions. The spring properties are achieved by hardening, e.g. carbon and chromium steels, or by cold rolling e.g. ASTM 301 (EN 1.4310). The origin of the properties is the martensitic structure. Higher alloyed steels e.g. ASTM 316, besides being more expensive, suffer from difficulties in reaching a high strength by cold working. If high strength is needed, together with a nonmagnetic (para-magnetic) material, the option has traditionally been expensive Copper-Beryllium or Cobalt base alloys.

13RM19 is alloyed in such a way that the structure is very stable against a martensitic transformation but still allows a strong work hardening effect at deformation. Therefore, it is possible to obtain mechanical properties similar to ASTM 301, but maintain a non-magnetic structure. The low permeability is not influenced by a tempering operation. 13RM19 also remains completely non-magnetic down to extremely low temperatures.

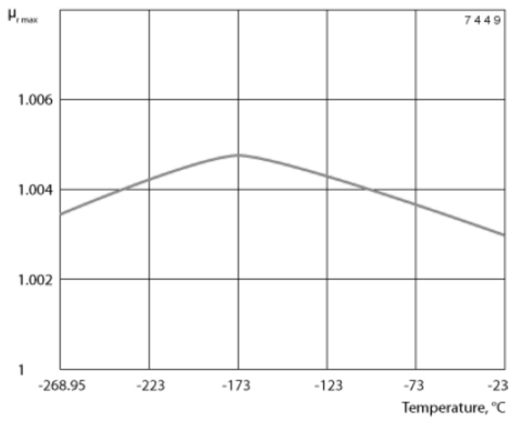
The following diagram shows typical values for the maximum relative magnetic permeability for 13RM19, compared to ASTM 301 and 304.



Typical values at 20 °C (68 °F)

Condition	Tensile strength, R_m		Maximum $\mu_{r\,max}$
	Mpa	ksi	
A	850	123	1.003
C	1,300	189	1.005
CT	1,350	196	1.005
C	1,600	232	1.03
CT	1,800	261	1.03

13RM19 remains non-magnetic down to very low temperatures. The diagram below shows the magnetic permeability down to 4.2 K (-268.95 °C) for material in the annealed condition.



Corrosion Resistance

13RM19 has a corrosion resistance comparable to that of ASTM 301/304. The high nitrogen content is known to be beneficial for resistance to pitting and crevice corrosion. However, all austenitic steels of this type are susceptible to stress corrosion cracking (SCC) when in contact with chloride solutions at elevated temperatures.

Heat Treatment

The strength of cold rolled steel can be increased by a tempering operation at 480 °C (896 °F) for 2 hours. For cold rolled 13RM19 with a tensile strength above about 1,400 MPa, an increase in tensile strength of about 100 – 200 MPa (14.5 – 29 ksi) can be expected. Further information on the nominal tempering effect can be seen under the 'Mechanical properties' section. This heat treatment is also beneficial for relaxation and fatigue resistance.
Tempering is normally carried out by the customer after forming. To avoid discoloration, parts should be carefully cleaned before heat treatment.
Tempering in open air furnaces gives a harmless brownish oxide on the surface.

Welding

13RM19, like most austenitic stainless steels, has good weldability. Welding, however, introduces excess heat into the material closest to the weld that breaks down the structure formed by cold working. As a consequence, this will decrease the mechanical properties of the welded area. The lowest practical heat input, < 1.0 kJ/mm, and interpass temperature for multipass welding, < 100 °C (210 °F), is recommended.
In most cases, the TIG (GTAW) method is preferable. It can be used either autogenously (without filler metal) or with filler metal. In both cases, pure argon (99,99 %) should be used as the shielding gas. If a low loss of nitrogen is essential, Argon with 1 – 2 % Nitrogen can be used instead.
When filler metal is used, please call us for further information. Due to the high carbon content of 13RM19, there is also a risk of carbide precipitation at the grain boundaries of the material in the heat affected zone (HAZ), which may decrease the corrosion resistance of the material in certain environments.

Bending

The values given below have been obtained by bending according to Swedish standard SS 11 26 26 method 3 (in a 90 ° V-block with a 25 mm die opening, a sample of 35 mm width, turned so that the burrs of the blanked edges face into the bend). They can be used as guidance for the smallest recommended bending radius.

Nominal tensile strength, R_m	Thickness (t)	Min. bending radius	
MPa	mm	⊥	//
1,300	0.25	0.5 t	-
1,300	0.50	0.5 t	4 t
1,500	0.25	1.5 t	3.5 t
1,500	0.50	1.5 t	6 t

⊥ Bend transverse to the rolling direction

// Bend parallel to the rolling direction

Applications

The combination of high strength and non-magnetic behavior makes 13RM19 very suitable for springs and other high strength components in the electronic and computer industries.

Typical products where 13RM19 can be used to advantage are printers, springs in generators, magnetic instrument housings, components in measuring instruments, zipper parts and other components that require non-magnetic properties. The grade is also used in surgical tools and other equipment for open architecture magnets in which surgery is performed simultaneously with magnetic resonance imaging.

The high strength also makes 13RM19 suitable as a cable armoring material for high voltage cables, where transmission losses must be kept low.

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