SANDVIK

SANDVIK 9RU10 STRIP STEEL

DATASHEET

Sandvik 9RU10 is a precipitation hardening, austenitic stainless steel of the 17Cr-7Ni PH type, with a high tempering effect and good structural stability. The grade is characterized by:

- High tempering effect, up to 400 MPa
- Low relaxation at high stresses and elevated temperatures
- Higher fatigue strength
- Very small distortion during tempering
- High service temperatures

Service temperature: up to 350°C (660°F)

Sandvik 9RU10 is suitable for complex, formed springs with high demands on spring force and service life. It is also suitable for use at elevated temperatures.

STANDARDS

- ASTM: 631
- UNS: S17700
- EN Number: 1.4568
- EN Name: X 7 CrNiAl 17-7
- SS: 2388

CHEMICAL COMPOSITION (NOMINAL) %

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni
0.08	0.5	0.9	≤0.030	≤0.015	16.5	7.5

Others: Al=1.0

FORMS OF SUPPLY

Sandvik 9RU10 is supplied, as standard, in the cold rolled condition. Strip steel can be supplied in coils, bundles, on plastic spools or in lengths. The edges can be either slit, deburred or smoothly rounded.

Dimensions

The following range of thicknesses and widths can be supplied as standard. Please contact Sandvik if other dimensions are required.

Thickness, mm	Width, mm	Thickness, in.	Width, in.
0.015 - 3.00*	2 - 360	.0006 - .118	.079 - 14.2

Thickness, mm	Width, mm	Thickness, in.	Width, in.

* Depending on requested tensile strength.

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.

Stock standard

The following combinations of tensile strength and thickness are available from stock. Other combinations can be supplied on request.

Condition	Tensile strength, R_m		Thickness
	MPa	ksi	mm
Cold rolled	1300	189	0.20/0.50/1.5/2.0
Cold rolled	1500	218	0.75/ 0.80
Cold rolled	1700	247	0.

MECHANICAL PROPERTIES

Static strength

Nominal values at 20°C (68°F)

Condition[1)]	Tensile strength		Proof strength		Elongation
	Rm		$R_{p0,2}$[a)]		$A_{11,3}$
	MPa	ksi	MPa	ksi	%
C	1300	190	1150	165	12
CT	1550	225	1400	203	6
C	1500	220	1400	203	6
CT	1800	273	1650	240	2
C	1700	245	1650	240	2
CT	2050	295	1950	285	1

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

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

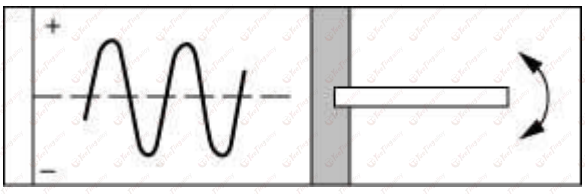
Fatigue strength

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

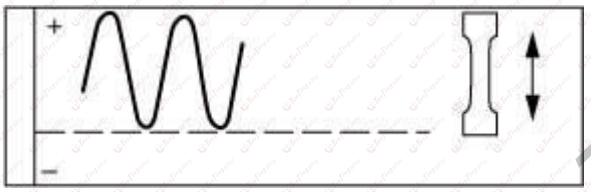
Bending transversal to rolling direction.



Comparison made for different thicknesses and tensile strength levels.

Tensile strength	Fatigue limit		Fatigue limit		
Rm	MPa		ksi		
	Thickness, mm		Thickness, in.		
MPa	0.50	0.75	ksi	0.020	0.030
1300	-	± 405	189	-	± 58.8
1500	± 555	-	218	± 80.5	-
1700	± 610	± 525	247	± 88.5	± 76.2
1900	± 620	-	276	± 90.0	-

Fluctuating tensile stress
Minimum stress = 0
Specimens parallel to rolling direction.



Comparison made for different thicknesses and tensile strength levels.

Tensile strength	Fatigue limit		Fatigue limit		
Rm	MPa		ksi		
	Thickness, mm		Thickness, in.		
MPa	0.50	0.75	ksi	0.020	0.030
1300	-	340 ± 340	189	-	49.3 ± 49.3
1500	390 ± 390	360 ± 360	218	56.6 ± 56.6	52.2 ± 52.2
1700	425 ± 425	410 ± 410	247	61.7 ± 61.7	59.5 ± 59.5
1900	445 ± 445	435 ± 435	276	64.6 ± 64.6	63.1 ± 63.1

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/cm³ (0.29 lb/in³) Resistivity 0.9 µΩm (35.5µΩin.) Modulus of elasticity
´as delivered´: approx 180 000 MPa (26 100 ksi) tempered: approx 190 000 MPa (27 550 ksi)

Shear modulus
as delivered: approx 70 000 MPa (10 150 ksi)

Specific heat capacity 500J/kg °C (in the temperature range 50-100°C)

Thermal expansion 1)

Temperature, °C	per °C	Temperature, °F	per °F
from 20 - 100	13	from 68 - 200	7
from 20 - 200	13.5	from 68 - 400	7.5
from 20 - 300	14	from 68 - 550	8

1) mean values in temperature ranges (x10^{-6})

Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
20	15	68	8.5
100	15	210	8.5
300	19	570	11

CORROSION RESISTANCE

It is very important to avoid corrosion in spring applications so as not to impair spring properties. Sandvik 9RU10 is an austenitic stainless steel and has sufficient corrosion resistance in most spring applications. The corrosion resistance is almost the same as ASTM 304 and, compared to other low alloyed spring steels, Sandvik 9RU10 has superior performance. 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

Sandvik 9RU10 is a precipitation hardenable steel and, compared to standard austenitic stainless spring steels e.g. type AISI 301, has a more pronounced tempering (ageing) effect. Consequently, it can be supplied with a comparatively low tensile strength in order to provide good forming properties, but still reach a high tensile strength after forming, by a simple heat treatment. Tempering also improves fatigue and relaxation resistance and, furthermore, it will decrease the internal stresses present in the spring after forming.

For maximum increase in mechanical strength, tempering of Sandvik 9RU10 should be carried out at 480°C (900°F) for 1 hour. It will give a significant increase in strength for initial tensile strengths above approximately 1300 MPa (189 ksi). This increase can be between 150-400 MPa (22-58 ksi) and is higher the greater is the initial tensile strength. Because of its high structural stability in the precipitation hardened condition, the good spring properties are also retained at elevated temperatures, up to about 350°C (662°F).

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

Sandvik 9RU10, 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 a shielding gas.

When filler metal is used, Sandvik 19.9.L or Sandvik 19.9.LSi is recommended. Note that the weld metal will not be able to precipitation harden in this case.

Due to the high carbon content of Sandvik 9RU10, 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	Thickness	Min. bending radius as function of thickness *)	
Rm	t		
MPa	mm	⊥	//
1300	0.25	1 t	4 t
1300	0.50	1 t	6 t
1300	0.75	1 t	7 t
1300	1.0	1 t	7 t
1500	0.25	1.5 t	7 t
1500	0.50	1.5 t	7.5 t
1500	0.75	1.5 t	8 t
1700	0.25	3 t	10 t
1700	0.50	4 t	11 t

*)⊥ Bend transverse to the rolling direction
// Bend parallel to the rolling direction

APPLICATIONS

Sandvik 9RU10 is a most suitable grade for springs or other high strength components. It has good spring properties including corrosion resistance, mechanical strength and fatigue resistance, making it an excellent material in most situations. The greatest benefit can be found in applications where low relaxation properties are required even at elevated temperatures. Due to the high ageing effect of this precipitation hardenable grade, high strength can also be reached for complicated shapes or heavy gauge components.

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