11R51 Datasheet
Spring Wire

Zapp is Certified according to ISO 9001

11R51 is an austenitic stainless steel alloyed with molybdenum. The grade is characterized by high tensile strength and high resistance to corrosion, fatigue and relaxation.

Compared to most other steels of ASTM 302 type (for example 12R10/ T302),
11R51 offers:
_ Higher tensile strength and tempering effect
_ Higher relaxation resistance, especially at elevated temperatures
_ Higher fatigue strength
_ Better corrosion resistance, through the addition of molybdenum

Service temperature: -200 to 300 °C (-330 to 570 °F).

Standards
_ UNS: S30151
_ ISO: X9CrNi18-8
_ EN Number: 1.4310
_ EN Name: X10CrNi18-8

Product Standards	
EN	10270-3
ISO	6931-1
ASTM	A 313/A 313M

Chemical Composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo
0.08	1.5	1.8	≤ 0.025	≤ 0.010	17.0	7.5	0.7

Forms of Supply

Surface finishes	Size range, mm
Coated	0.20 - 8.50
Nicoat A (nickel coating)	0.22 - 2.50
Bright	0.15 - 0.80
Nicoat B (nickel coating + bright)	0.18 - 0.80
Mechanically polished	0.40 - 6.00
Flat wire	
Width	0.50 - 7.00
Thickness	0.05 - 4.00
W/t	< 25

Delivery Forms
Standard delivery forms are:

_ Coils with weight up to 150 kg
_ Spools of various types with wire weight up to 1,000 kg
_ Compact coils with weight up to 1,200 kg
_ Straightened lengths up to 4 m

Physical Properties

Density: 7.9 g/cm^3, 0.29 lb/in^3

Specific heat capacity	
500 J/kg °C	in the temperature range 50 – 100 °C
0.12 Btu/lb °F	in the temperature range 120 – 210 °F

Thermal conductivity

Temperature, °C	W/m °C	Temperature °F	Btu/ft h °F
20	15	68	9
100	16	210	9
200	18	390	10.5
300	19	570	11.5

Resistivity

Temperature, °C	µΩm	Temperature °F	µΩin.
20	0.90	70	35.0
100	0.95	210	37.0
200	1.00	390	39.0
300	1.05	570	41.5

Thermal expansion[1]

Temperature °C	per °C	Temperature °F	per °F
20 – 100	17.0	68 – 210	9.5
20 – 200	17.5	68 – 390	9.5
20 - 300	18.5	68 - 570	10.0

[1] Mean values in temperature ranges (x10 $^{-6}$)

Permeability

μ_{max}: about 35

Shear Modulus, MPa (ksi)

As delivered: approx. 71,000 (10,295)
Tempered: approx. 73,000 (10,585)

Modulus of Elasticity, MPa (ksi)

As delivered: approx.185,000 (26,825)
Tempered: approx. 190,000 (27,550)
The strength will decrease by 3 – 4 % per 100 °C (180 °F) increase in service temperature.

Mechanical Properties

Mechanical properties in the 'as delivered' condition
Tensile strength and proof strength, MPa (ksi)

Wire diameter		Nominal, R_m[1]		Nominal $R_{p0.2}$	
mm	in.	MPa	ksi	MPa	ksi
0.15 – 0.20	0.0059 - 0.0079	2,530	367	2,150	312
> 0.20 – 0.30	> 0.0079 - 0.012	2,470	358	2,100	305
>0.30 – 0.40	> 0.012 - 0.016	2,420	351	2,060	299
> 0.40 – 0.50	> 0.016 - 0.020	2,365	343	2,010	292
> 0.50 – 0.65	> 0.020 - 0.026	2,310	335	1,960	284
> 0.65 – 0.80	> 0.026 - 0.031	2,260	328	1,920	278
> 0.80 – 1.00	> 0.031 - 0.039	2,200	319	1,870	271
> 1.00 – 1.25	> 0.039 - 0.049	2,150	312	1,830	265
> 1.25 – 1.50	> 0.049 - 0.059	2,100	305	1,785	259
> 1.50 – 1.75	> 0.059 - 0.069	2,040	296	1,730	251
> 1.75 – 2.00	> 0.069 - 0.079	1,990	289	1,690	245
> 2.00 – 2.50	> 0.079 - 0.098	1,880	273	1,600	232
> 2.50 – 3.00	> 0.098 - 0.118	1,830	265	1,555	225
> 3.00 – 3.50	> 0.118 - 0.138	1,775	257	1,510	219
> 3.50 – 4.25	> 0.138 - 0.167	1,720	249	1,460	212
> 4.25 – 5.00	> 0.167 - 0.197	1,670	242	1,420	206
> 5.00 – 6.00	> 0.197 - 0.236	1,610	233	1,370	199
> 6.00 – 7.00	> 0.236 - 0.276	1,560	226	1,330	193
> 7.00 – 8.50	> 0.276 - 0.335	1,505	218	1,280	186
Flat wire		800 - 2,400	123 - 348	0.85*Rm	0.85 * ksi
Other strength levels		On request			

[1] tolerance on tensile strength ± 7.0 % in acc. with EN 10270-3 grade 1.4310 HS

The tensile strength can be increased by 150 - 300 MPa (22 - 44 ksi) by tempering. The tensile strength variation between spools/coils within the same production lot is ±50 MPa (7 ksi) maximum. The proof strength in the tempered condition is approx. 90 % of the tempered tensile strength. The tensile strength values are guaranteed and are measured directly after production. During storage, the strength will increase marginally due to ageing. Depending on the storage conditions, ageing can increase the strength by 0 - 80 MPa (0 - 12 ksi).

Straightened Lengths

After straightening the strength is approx. 7 % lower.

Strength Data

The strength data below are based on laboratory tests. The data apply at 20 °C (68 °F) in normal, dry atmosphere, unless otherwise stated. They are not guaranteed values but shall be taken as recommendations in the choice of wire gauge, stress level, etc. A description of the testing procedure will be found, together with explanations under following items:

The diagrams are valid for springs with the spring index 10 (mean diameter of spring/wire diameter).

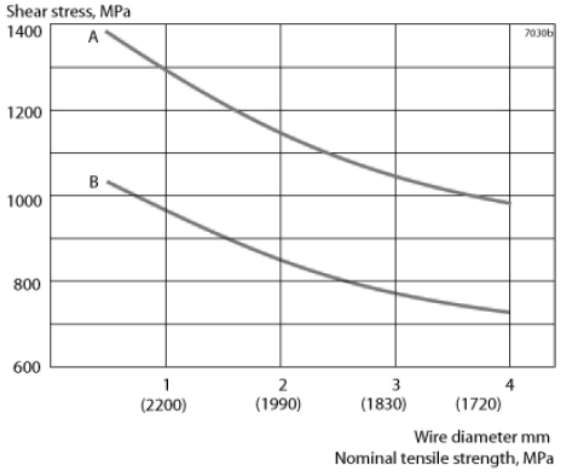

Figure 1. Setting limit, curve A, and maximum permissible shear stress, curve B, as a function of the wire diameter. The setting limit is defined as the shear stress at which the relaxation is 2% after a load time of 24 hours. Curve B lies 25 % below curve A.

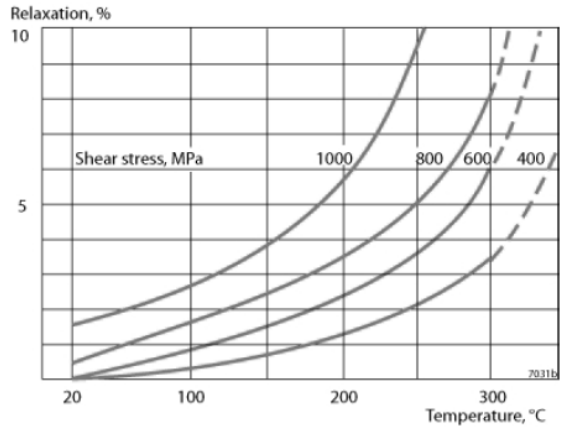

Figure 2. Relaxation (load loss) at various shear stresses as a function of service temperature. This diagram refers to a wire diameter of 1.0 mm.

Heat Treatment

By tempering springs at 425 °C (780 °F)/0.5 - 4 h, the tensile strength will increase by about 150 - 300 MPa (20 - 45 ksi). If a shorter tempering time is used the tempering effect will be lower. In continuous conveyor furnaces, where the holding time at temperature is very short (min. 3 minutes), the temperature can be increased to about 475 ° (780 °F).
In the 'as delivered' condition the ratio of proof strength/tensile strength is about 0.85. After tempering the ratio will be about 0.90.
Note that tension springs coiled with initial tension must not be tempered at the same high temperature as other types of spring. We recommend batch tempering at 250 °C (480 °F)/0.5 - 3 h, or continuous tempering in a conveyor furnace with a holding time of 3 - 5 minutes at about 300 °C (570 °F).

Bending

The minimum bending radius should not be less than half the wire diameter. The wire surface should be free from any tooling damage, since slight imperfections in the surface can lead to fracture even at large bending radii.

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