Material specification

This overview contains only standard spring materials.
German and English standards refer to the closest comparable qualities. Terms: T = wire, S = rod, B = strip.

Standard | Oljehärdat | Stainless | Acidproof | Antimagnetic acidproof | Heat resistant acidproof

SS-ref. or works ref.	DIN-ref works ref.	BS-ref.	Form	Range of work. temp. °C	Type of material
SS1774-04	17223 B	BS 5216 grade 2/3	T	-40 - + 120	Standard material
SS1774-05	17223 C/D	BS 5216 grade 4/5	T	-40 - + 120	Music wire
SS1774-06	17223 kl. II	BS 5215 grade 5	T	-40 - + 120	Music wire with increased tensile strength
SS1770	1.1231 Ck 67	BS 5770 CHST 70	B	-40 - + 120	Standardmaterial
SS2090	67SiCr5	BS 970-2 251 A58	T S B	-40 - + 150	Alloyed standard material
SS2230	1.8159 50CrV4	BS 970-2 735 A/H 51	T S B	-40 - + 225	Alloyed material for high temperatures and stresses. Good relaxation limit.
Oteva 60	17223 T2 VD CrV	BS 2803 730 A65 HD	T	-60 - + 200	Standard valve spring
Stato 70	17223 T2 FD SiCr	BS 2803 685 A55 HS	T	-60 - + 250	High class spring wire
Oteva 70	17223 T2 VD SiCr	BS 2803 685 A55 HD	T	-60 - + 250	High class ultrasonic tested valve spring wire
SS2331	1.4310 X12CrNi177	BS 2056 302 S26	T B	-150 - + 250	Stainless standard material. allows extra high loads for Dt < 2,0 mm
11R51	-	-	T B	-150 - + 300	Stainless material with increased tensile strenth and relaxation limit. "Half" acidproof
SS2388	1.4568 X7CrNiAl177	BS 2056 301 S82	T B	-200 - + 350	Stainless material for high loads with excellent relaxation resistance
SS2347-04	1.4401 X5CrNiMo1810	316S16	T B	-200 - + 300	Acidproof standard material
Titanium alloys	-	-	TSB	-200 - + 150	High corrosion resistant light weight material
SS5428-07	2.1020 CuSn 6	BS 2870 Pb 103	T B	-200 - + 80	Phosphor bronze. Antimagnetic and corrosion resistant. For low loads.
Beryllium-copper	2.1247 CuBe	BS 2873/ 2870 CB101	T B	-200 - + 150	Berylliumcopper. Antimagnetic and corrosion resistant with excellent spring characteristics.
Hastelloy C276	-	-	T S B	-100 - + 500	High corrosion- and high teperature resistant material
Inconel X-750					
Spring temp	-	-	T S B	-200 - + 370	High temerature materials with good
No 1 temp	-	-	T S B	-200 - + 540	corrosion resistance
Nimonic 90	2.4969		T B	-100 - + 600	High temerarure material with good corrosion resistance
Inconel 718	2.2668	-	T B	-200 - + 550	High temerarure material with good corrosion resistance

Material specification

Chemical analysis %

SS-ref works ref	C	Si	Mn	P<	S<	Cr	Mo	Ni	V	Al	Ti	Cu	Co	Fe	Others
SS1774	0,70	0,25	0,75	0,03	0,03	-	-	-	-	-	-	-	-	-	-
SS1770	0,69	0,25	0,75	0,03	0,03	-	-	-	-	-	-	-	-	-	-
SS2090	0,55	1,75	0,80	0,03	0,03	0,30	-	-	-	-	-	-	-	-	-
SS2230	0,51	0,28	0,90	0,03	0,03	1,05	-	-	0,15	-	-	-	-	-	-
Oteva 31	0,70	0,25	0,75	0,03	0,02	-	-	-	-	-	-	-	-	-	-
Oteva 60	0,70	0,25	0,75	0,03	0,02	0,50	-	-	0,10	-	-	-	-	-	-
Stato 70	0,55	1,40	0,75	0,03	0,03	0,70	-	-	-	-	-	-	-	-	-
Oteva 70	0,55	1,40	0,70	0,03	0,03	0,70	-	-	-	-	-	-	-	-	-
SS2331	<0,1	<1,0	<2,0	0,04	0,03	17,0	-	8,0	-	-	-	-	-	-	-
11R51	<0,1	<1,0	<2,0	0,04	0,03	17,0	0,7	8,0	-	-	-	-	-	-	-
SS2388	<0,1	<1,0	<1,0	0,04	0,03	17,0	-	7,1	-	1,13	-	-	-	-	-
SS2347	<0,07	<1,0	<2,0	0,04	0,03	17,5	2,25	12,0	-	-	-	-	-	-	-
Hastelloy C	<0,02	<0,08	<1,0	0,04	0,03	15,5	16,0	57,0	0,03	-	-	-	<2,5	5,0	W 4,0
SS5428	-	-	-	0,40	-	-	-	-	-	-	-	Rest	-	-	Sn 7,0
CuBe 250	-	-	-	-	-	-	-	0,2	-	-	-	Rest	0,2	-	Be 1,95
Inco X750	<0,08	<0,5	<1,0	-	-	15,5	-	<70	-	0,70	2,5	<0,5	-	7,0	Nb 0,95
Nimonic 90	0,09	<1,0	<1,0	-	0,015	19,5	-	Rest	-	1,40	2,35	-	<0,2	16,5	<2,0
Titanium alloy		-	-	-	-	-	-	-	4,0	6,20	Rest	-	-	<0,3	-

Other technical information

SS-ref or works ref	Elast.module (E) N/mm^2	Shearing (G) N/mm^2	Density kg/dm^3	Dimensionrange wire Ø	Strip t	Rod Ø
SS1774-04	208.500	80.400	7,85	0,10 - 14,0	-	-
SS1774-05	208.500	80.400	7,85	0,10 - 12,0	-	-
SS1774-06	208.500	80.400	7,85	0,10 - 10,0	-	-
SS1770	208.500	80.400	7,85		0,1 - 10,0	-
SS2090	208.500	80.400	7,85	8,0 - 20,0	5,0 - 15,0	10,0 - 30,0
SS2230	208.500	80.400	7,85	8,0 - 20,0	1,0 - 10,0	10,0 - 65,0
Oteva 60	206.000	81.500	7,85	0,50 - 9,0	-	-
Stato 70	206.000	81.500	7,85	0,50 - 9,0	-	-
Oteva 70	206.000	81.500	7,85	0,50 - 9,0	-	-
SS2331	190.000	73.000	7,90	0,10 - 12,0	0,10 - 3,00	-
11R51	190.000	73.000	7,90	0,10 - 10,0	0,10 - 1,50	-
SS2388	195.000	75.000	7,90	0,10 - 8,0	0,10 - 3,00	-
SS2347-04	185.000	71.000	8,00	0,10 - 10,0	-	-
Hastelloy C	205.000	73.300	8,89	0,10 - 10,0	0,10 - 10,0	6,0 - 150,0
SS5428-07	106.000	41.000	8,90	0,20 - 7,0	0,10 - 3,50	-
CuBe 250	135.000	47.000	8,90	0,50 - 1,30	0,15 - 3,0	-
Inconel X750	215.000	80.000	8,25	0,50 - 9,0	0,50 - 4,0	10,0 - 150,0
Nimonic 90	213.000	82.700	8,28	0,50 - 6,0	0,20 - 3,0	15,0 - 150,0
Titanleg.	106.000	40.000	4,45	0,10 - 10,0	0,10 - 10,0	6,0 - 150,0
Inco 718	204 900	77 200	8,22	0,50 - 15,0	0,50 - 10,0-	-

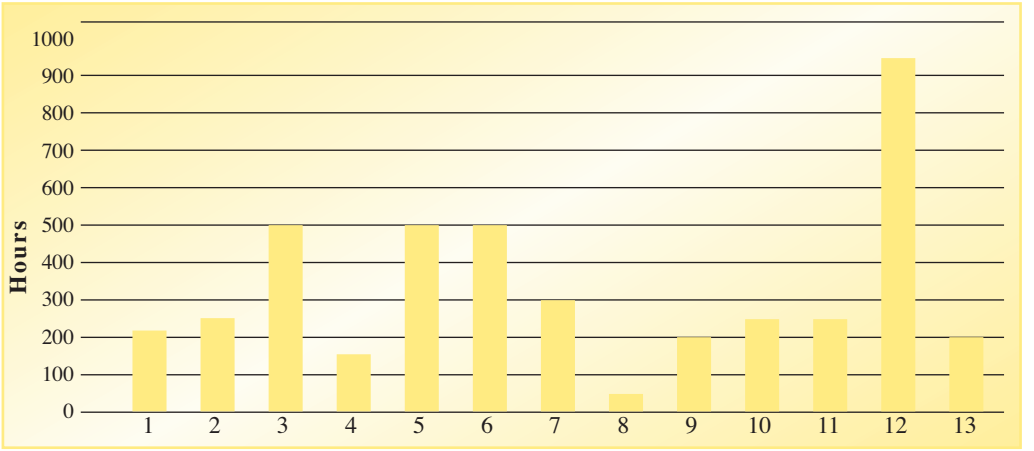
Values for E and G-modules are applicable at 20° C
Most of above mentioned materials are also available in square- or rectangular cross sections.
As the stock is limited, it often takes larger quantities to start production.

Surface treatments - specifications

Type of surface treatment	Appearance	Thickness of coating, micron	Risk of hydro-gen brittleness	Wear resistance
Electro-galvanazing	Silver semi matt/bright	8 - 12	Yes	Fair
Zinc coated wire	Greyish matt	20 - 30	No	Good
Bezinal zinc coating	Grey semi bright	20 - 30	No	Fair
Mechaical galvanizing	Grey matt	12 - 25	No	Fair
Nickel-plated, electrical	Silver/bright silver	5 - 10	Yes	Good
Nickel-plated, chemical	Bright silver	5 - 10	Yes	Good
Chromium-plated	Silver/bright silver	8 - 12	Yes	Very good
Tin-plated	Matt silver/silver	8 - 1	Yes	Fair
Silver-plated	Bright silver	4 - 10	Yes	Fair
Gold-plated	Gold matt / bright	2 - 5	Yes	Fair
Phosphating	Grey matt / semi bright	10 - 15	No	Fair
Black oxidization	Bright black	0,5 - 2	No	Fair
Electrolytic polishing	Silver ultra bight	0	No	Good
Painting	Various	50 - 150	No	Fair
Epoxy varnish	Various	50 - 100	No	Good
Delta-seal	Grey matt	8 - 12	No	Good
Delta-tone	Various	8 - 12	No	Very good
Tefloncoating	Large selection	15 - 100	No	Very good

Corrosion resistance to salt spray test

It is not possible to give a general comparison of the corrosion resistances of different coatings, as the result very much depends on the thickness of the coating whether it is homogenious, its adhesion, its porosity or combinations of all of these etc. If the material has been pre-treated, this also influences the result. The values in the diagram below must therefore only be regarded as general values.



1. El. galv + yellow chrome. >12 microns
2. Zinc coated wire
3. Bezinal zinc coated wire
4. Mech. galv + yellow chrome. >12 microns
5. El. nickel-plating
6. Chem. nickel-plating 15 microns
7. Tin-plated > 12 icrons
8. Black oxide + oiled
9. Painting incl. zinc priming coat
10. Epoxy varnish incl. phosphating
11. Delta-Seal
12. Delta-Magni
13. Teflon incl. phosphating

Zinc coatings
Electro-galvanizing is the most popular surface treatment of springs and gives a smooth and even coat. To obtain an improved resistance against corrosion, the springs are also additionally treated with bright chrome (FZB) or yellow chrome (FZG). There is a risk, however, of hydrogen brittleness. An alternative to electro-galvanizing is also mechanical galvanizing (also called Rotalyt), which minimises hydrogen brittleness. The coating is mechanically applied by letting zinc powder, glass balls and the components to be coated rotate in a tumbler. The balls act as carriers of the powder and are removed after the treatment duration.

Surface treated wire
Surface treated wire is in many cases a very good and price competitive alternative for stainless material when the wgt/component is large and the demands for corrosion resistance are moderate. With the material already having been "hot dip galvanized" and post-annealed before production, there is no risk for hydrogen brittleness. The only drawback tends to be the narrow choice of coated wire, which is largely restricted to zinc coated SS1774 and zinc/aluminium (Bezinal) coated SS1774.

Nickel-plating
Used for decorative and corrosion protective purposes. It should not be used on springs where the wire is exposed to large angular rotations, as the nickel plate is very hard and will crack under load. Nickel-plating is often used for the first coating prior to tin, silver gold etc.

Chromium-plating
Chrome with nickel coating beneath can be polished to a very bright apperance and is therefore primarily used for decorative purposes. The surface is very hard and wear-resistant. It should not be used for springs with large loads.

Tin-plating
Used primarily to facilitate welding. Tin-plate also gives a good protection against corrosion. Nickel-plating is often chosen as the pre-treatment.

Silver-plating / gold-plating
Used for decorative and corrosion protection purposes and for components used in the electrical and electronic industry. Electrolytic silver-plating is chosen for a lot of applications due to its excellent electrical conductivity.

Phosphating
Phosphating is used for decorative purposes. It gives a low corrosion protection and is usually finished by oiling. Phosphating is also a primary treatment used prior to varnishing, where the phosphate coating prevents corrosion and gives a good adhesion.

Black oxidation
Used for decorative purposes and consists of an iron oxide layer which does not protect against corrosion. Usually oiled afterwards.

Electrolytic polish
This surface treatment, which polishes and gives a smooth surface, is only carried out on stainless and acidproof materials, primarily used for decorative purposes, due to the resultant surface being bright. The surface finish increases the springs relaxation limit.

Painting
A large variety of varnishes, prime coatings and zinc chromium colours are available, used mainly on heavier springs. Usually not suitable for springs with no space between the coils.

Epoxy varnish
A very good surface treatment for springs. The varnish is applied by spraying an electrostatically charged powder on the components, which are the then furnace heated. The resultant surface gets being even and very hard.

Delta-Seal
An organic surface treatment method where zinc particles are applied on the surface, which gives a good basic protection against corrosion. Delta-Seal is the pre-treatment for Delta-Magni.

Delta-Magni
A surface treatment system consisting of the organic pre-treatment Delta-Seal and the non-organic Delta-Tone. A high-class corrosion protection, especially suited for springs where there is no risk of hydrogen brittleness at all.

Teflon
A suitable and surface corrosion treatment where low friction, good isolation and chemical resistance properties are demanded. Working temperature -190 - + 260° C

Hydrogen brittleness
Hydrogen inclusion in steel can lead to the steel breaking at a much lower tensile than normal, even though the steel under short cycle tests, e.g. impact tests, shows normal values of strength. This phenomenon is called hydrogen brittleness. Hydrogen inclusion occurs in all instances where hydrogen can develop on the surface of the steel. Surface treatment processes, where soaking in non oxidised acids, cathodic cleaning and cathodic coating etc., can cause brittleness, especially on oil hardened spring wire and leaf springs which have been hardened after shaping/forming.
The tendency to become brittle decreases as the tensile limit and hardness decreases. Normally, there is no brittleness in steel with tensile limits <1000 n/mm2 and hardness below 30 Vickers.

To a great extent, the hydrogen can be removed by heat treatment (saoking) according to:

Thickness of component	< 3 mm	170°C	5 hours
Thickness of component	< 12 mm	190-210°C	4 hours