Dimensions and quality of conical disc springs

DIN 2093

Tellerfedern; Maße und Qualitätsforderungen

Supersedes September 1990 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Contents

Dimensions in mm

1 Scope and field of application

This standard specifies requirements for the materials, dimensions, tolerances, and permissible stresses for conical disc springs. It includes graphs showing the permissible relaxation and the endurance life of such springs, as a function of stress.

The minimum requirements specified here are intended to ensure the proper performance of conical disc springs, and may also be applied to non-standardized springs.

The three series specified here represent groups of spring sizes which have met with general acceptance in practice.

Conical disc springs are not intended to be used with bolt/nut assemblies to counteract the effect of setting (as are DIN 6796 conical spring washers, for example).

2 Concept

Conical disc springs ('springs', for short) are annular coned elements that offer resistance to a compressive force applied axially. They may be designed as single discs or as discs stacked in parallel or in series, either singly or in multiples. They may be subjected to both static and fatigue loading, and may have ground end surfaces ('ground ends', for short).

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3 Symbols and units

Symbol	Unit	Term
D_e	mm	Outside diameter of spring
D_i	mm	Inside diameter of spring
D_0	mm	Mean coil diameter
E	N/mm²	Modulus of elasticity
F	N	Spring load of a single disc (with or without ground ends)
ΔF	N	Relaxation
L_0	mm	Length of springs stacked in series or in parallel, in the initial position
L_c	mm	Design length of springs stacked in series or in parallel, in the flattened position
N		Number of cycles to failure
h_0	mm	Initial cone height of springs without ground ends (equal to free overall height, l_0, minus t)
i		Number of discs stacked in series, singly or in multiples
l_0	mm	Free overall height of spring in its initial position
s	mm	Deflection of single disc
$s_1, s_2, s_3 \dots$	mm	Deflections associated with the spring loads designated $F_1, F_2, F_3 \dots$
t	mm	Thickness of single disc
t'	mm	Reduced thickness of single disc in the case of springs with ground ends (group 3)
μ		Poisson's ratio
σ	N/mm²	Design stress
$\sigma_{II}, \sigma_{III}, \sigma_{0M}$	N/mm²	Design stresses at the points designated 0M, I, II, III and IV (see figure 1)
σ_h	N/mm²	Mean fatigue stress associated with the deflection of springs subject to fatigue loading
σ_O	N/mm²	Maximum fatigue stress
σ_U	N/mm²	Minimum fatigue stress
$\sigma_H = \sigma_O - \sigma_U$	N/mm²	Range of stress

4 Classification

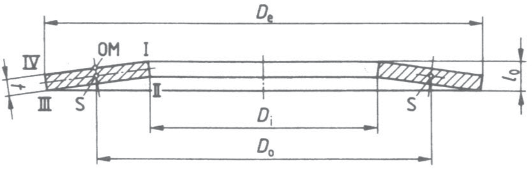
This standard makes a distinction among three groups of springs, in accordance with table 1.

Table 1

Group	Thickness of single disc, t	Single disc with ground ends
1	Less than 1,25	No
2	From 1,25 to 6	No
3	Over 6 up to 14	Yes

5 Dimensions and designation

Conical disc spring of group 1 or 2



Conical disc spring of group 3

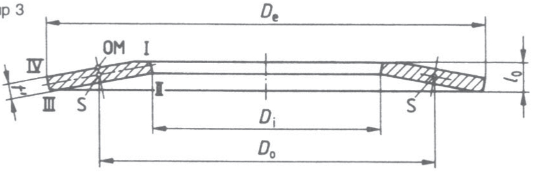


Figure 1: Cross section of a single disc, including the relevant points of loading

Designation of a conical disc spring of spring series A with an outside diameter, D_e, of 40 mm:

Conical disc spring DIN 2093 – A 40

Where a particular manufacturing process is required for group 2 springs (cf. table 10), the designation shall be amended as follows.

In the case of springs produced by turning (G):

Conical disc spring DIN 2093 – A 40 G

In the case of springs produced by stamping (F):

Conical disc spring DIN 2093 – A 40 F

Table 2: Conical disc springs of series A (with $\frac{D_e}{t} \approx 18$; $\frac{h_0}{t} \approx 0{,}4$, $E = 206\,000$ N/mm², and $\mu = 0{,}3$)

Group	D_e h12	D_i H12	t or (t') 1)	h_0	l_0	F N	s (where $s \approx 0{,}75\,h_0$)	$l_0 - s$	σ_{0M} 2) $\frac{N}{mm^2}$	σ_{II} 3) σ_{III} $\frac{N}{mm^2}$
1	**8**	4,2	0,4	0,2	0,6	210	0,15	0,45	– 1200	1220*
	10	5,2	0,5	0,25	0,75	329	0,19	0,56	– 1210	1240*
	12,5	6,2	0,7	0,3	1	673	0,23	0,77	– 1280	1420*
	14	7,2	0,8	0,3	1,1	813	0,23	0,87	– 1190	1340*
	16	8,2	0,9	0,35	1,25	1 000	0,26	0,99	– 1160	1290*
	18	9,2	1	0,4	1,4	1 250	0,3	1,1	– 1170	1300*
	20	10,2	1,1	0,45	1,55	1 530	0,34	1,21	– 1180	1300*
2	**22,5**	11,2	1,25	0,5	1,75	1 950	0,38	1,37	– 1170	1320*
	25	12,2	1,5	0,55	2,05	2 910	0,41	1,64	– 1210	1410*
	28	14,2	1,5	0,65	2,15	2 850	0,49	1,66	– 1180	1280*
	31,5	16,3	1,75	0,7	2,45	3 900	0,53	1,92	– 1190	1310*
	35,5	18,3	2	0,8	2,8	5 190	0,6	2,2	– 1210	1330*
	40	20,4	2,25	0,9	3,15	6 540	0,68	2,47	– 1210	1340*
	45	22,4	2,5	1	3,5	7 720	0,75	2,75	– 1150	1300*
	50	25,4	3	1,1	4,1	12 000	0,83	3,27	– 1250	1430*
	56	28,5	3	1,3	4,3	11 400	0,98	3,32	– 1180	1280*
	63	31	3,5	1,4	4,9	15 000	1,05	3,85	– 1140	1300*
	71	36	4	1,6	5,6	20 500	1,2	4,4	– 1200	1330*
	80	41	5	1,7	6,7	33 700	1,28	5,42	– 1260	1460*
	90	46	5	2	7	31 400	1,5	5,5	– 1170	1300*
	100	51	6	2,2	8,2	48 000	1,65	6,55	– 1250	1420*
	112	57	6	2,5	8,5	43 800	1,88	6,62	– 1130	1240*
3	**125**	64	8 (7,5)	2,6	10,6	85 900	1,95	8,65	– 1280	1330*
	140	72	8 (7,5)	3,2	11,2	85 300	2,4	8,8	– 1260	1280*
	160	82	10 (9,4)	3,5	13,5	139 000	2,63	10,87	– 1320	1340*
	180	92	10 (9,4)	4	14	125 000	3	11	– 1180	1200
	200	102	12 (11,25)	4,2	16,2	183 000	3,15	13,05	– 1210	1230*
	225	112	12 (11,25)	5	17	171 000	3,75	13,25	– 1120	1140
	250	127	14 (13,1)	5,6	19,6	249 000	4,2	15,4	– 1200	1220

1) The values specified for t are nominal values. In the case of group 3 springs, the values given in parentheses apply for t' (reduced thickness). Limit deviations for thickness are specified in subclause 6.2.

2) Design (compressive) stresses at the point designated 0M, i.e. on the conical surface of the spring.

3) The values specified apply for the largest tensile stresses on the lower edges of the spring. The values specified with an asterisk (*) apply to the point designated II, those without an asterisk, to the point designated III.

In the case of springs with ground ends (cf. group 3 in clause 4), the desired spring load, F (where s is equal to approximately 0,75 h_0), is to be obtained by reducing the thickness of single discs, t, which then gives the value t'. In the case of spring series A and B, t' shall be equal to approximately 0,94t, and in the case of spring series C, it shall be equal to approximately 0,96t.

Table 3: Conical disc springs of series B (with $\frac{D_e}{t} \approx 28$; $\frac{h_0}{t} \approx 0{,}75$, $E = 206\,000$ N/mm², and $\mu = 0{,}3$)

Group	D_e h12	D_i H12	t or (t') 1)	h_0	l_0	F (where $s \approx 0{,}75\,h_0$) N	s	$l_0 - s$	σ_{OM} 2) N/mm²	σ_{II} 3) σ_{III} N/mm²
1	**8**	4,2	0,3	0,25	0,55	119	0,19	0,36	– 1140	1330
	10	5,2	0,4	0,3	0,7	213	0,23	0,47	– 1170	1300
	12,5	6,2	0,5	0,35	0,85	291	0,26	0,59	– 1000	1110
	14	7,2	0,5	0,4	0,9	279	0,3	0,6	– 970	1100
	16	8,2	0,6	0,45	1,05	412	0,34	0,71	– 1010	1120
	18	9,2	0,7	0,5	1,2	572	0,38	0,82	– 1040	1130
	20	10,2	0,8	0,55	1,35	745	0,41	0,94	– 1030	1110
	22,5	11,2	0,8	0,65	1,45	710	0,49	0,96	– 962	1080
	25	12,2	0,9	0,7	1,6	868	0,53	1,07	– 938	1030
	28	14,2	1	0,8	1,8	1 110	0,6	1,2	– 961	1090
2	**31,5**	16,3	1,25	0,9	2,15	1 920	0,68	1,47	– 1090	1190
	35,5	18,3	1,25	1	2,25	1 700	0,75	1,5	– 944	1070
	40	20,4	1,5	1,15	2,65	2 620	0,86	1,79	– 1020	1130
	45	22,4	1,75	1,3	3,05	3 660	0,98	2,07	– 1050	1150
	50	25,4	2	1,4	3,4	4 760	1,05	2,35	– 1060	1140
	56	28,5	2	1,6	3,6	4 440	1,2	2,4	– 963	1090
	63	31	2,5	1,75	4,25	7 180	1,31	2,94	– 1020	1090
	71	36	2,5	2	4,5	6 730	1,5	3	– 934	1060
	80	41	3	2,3	5,3	10 500	1,73	3,57	– 1030	1140
	90	46	3,5	2,5	6	14 200	1,88	4,12	– 1030	1120
	100	51	3,5	2,8	6,3	13 100	2,1	4,2	– 926	1050
	112	57	4	3,2	7,2	17 800	2,4	4,8	– 963	1090
	125	64	5	3,5	8,5	30 000	2,63	5,87	– 1060	1150
	140	72	5	4	9	27 900	3	6	– 970	1110
	160	82	6	4,5	10,5	41 100	3,38	7,12	– 1000	1110
	180	92	6	5,1	11,1	37 500	3,83	7,27	– 895	1040
3	**200**	102	8 (7,5)	5,6	13,6	76 400	4,2	9,4	– 1060	1250
	225	112	8 (7,5)	6,5	14,5	70 800	4,88	9,62	– 951	1180
	250	127	10 (9,4)	7	17	119 000	5,25	11,75	– 1050	1240

For 1), 2), and 3), see table 2.

In the case of springs with ground ends (cf. group 3 in clause 4), the desired spring load, F (where s is equal to approximately $0{,}75\,h_0$), is to be obtained by reducing the thickness of single discs, t, which then gives the value t'. In the case of spring series A and B, t' shall be equal to approximately $0{,}94t$, and in the case of spring series C, it shall be equal to approximately $0{,}96t$.

Table 4: Conical disc springs of series C (with $\frac{D_e}{t} \approx 40$; $\frac{h_0}{t} \approx 1{,}3$, $E = 206\,000$ N/mm², and $\mu = 0{,}3$)

Group	D_e h12	D_i H12	t or (t') [1]	h_0	l_0	F (where $s \approx 0{,}75\,h_0$) N	s	$l_0 - s$	σ_{OM} [2] N/mm²	σ_{II} [3] σ_{III} N/mm²
1	**8**	4,2	0,2	0,25	0,45	39	0,19	0,26	− 762	1040
	10	5,2	0,25	0,3	0,55	58	0,23	0,32	− 734	980
	12,5	6,2	0,35	0,45	0,8	152	0,34	0,46	− 944	1280
	14	7,2	0,35	0,45	0,8	123	0,34	0,46	− 769	1060
	16	8,2	0,4	0,5	0,9	155	0,38	0,52	− 751	1020
	18	9,2	0,45	0,6	1,05	214	0,45	0,6	− 789	1110
	20	10,2	0,5	0,65	1,15	254	0,49	0,66	− 772	1070
	22,5	11,2	0,6	0,8	1,4	425	0,6	0,8	− 883	1230
	25	12,2	0,7	0,9	1,6	601	0,68	0,92	− 936	1270
	28	14,2	0,8	1	1,8	801	0,75	1,05	− 961	1300
	31,5	16,3	0,8	1,05	1,85	687	0,79	1,06	− 810	1130
	35,5	18,3	0,9	1,15	2,05	831	0,86	1,19	− 779	1080
	40	20,4	1	1,3	2,3	1 020	0,98	1,32	− 772	1070
2	**45**	22,4	1,25	1,6	2,85	1 890	1,2	1,65	− 920	1250
	50	25,4	1,25	1,6	2,85	1 550	1,2	1,65	− 754	1040
	56	28,5	1,5	1,95	3,45	2 620	1,46	1,99	− 879	1220
	63	31	1,8	2,35	4,15	4 240	1,76	2,39	− 985	1350
	71	36	2	2,6	4,6	5 140	1,95	2,65	− 971	1340
	80	41	2,25	2,95	5,2	6 610	2,21	2,99	− 982	1370
	90	46	2,5	3,2	5,7	7 680	2,4	3,3	− 935	1290
	100	51	2,7	3,5	6,2	8 610	2,63	3,57	− 895	1240
	112	57	3	3,9	6,9	10 500	2,93	3,97	− 882	1220
	125	64	3,5	4,5	8	15 400	3,38	4,62	− 956	1320
	140	72	3,8	4,9	8,7	17 200	3,68	5,02	− 904	1250
	160	82	4,3	5,6	9,9	21 800	4,2	5,7	− 892	1240
	180	92	4,8	6,2	11	26 400	4,65	6,35	− 869	1200
	200	102	5,5	7	12,5	36 100	5,25	7,25	− 910	1250
3	**225**	112	6,5 (6,2)	7,1	13,6	44 600	5,33	8,27	− 840	1140
	250	127	7 (6,7)	7,8	14,8	50 500	5,85	8,95	− 814	1120

For [1], [2], and [3], see table 2.

In the case of springs with ground ends (cf. group 3 in clause 4), the desired spring load, F (where s is equal to approximately 0,75 h_0), is to be obtained by reducing the thickness of single discs, t, which then gives the value t'. In the case of spring series A and B, t' shall be equal to approximately 0,94t, and in the case of spring series C, it shall be equal to approximately 0,96t.

6 Tolerances

6.1 Tolerances on diameter

For all springs, tolerance class h12 shall apply for the outside diameter, D_e.

The coaxiality tolerance for the outside diameter, where D_e does not exceed 50, shall be 2 · IT 11 or, where D_e exceeds 50, it shall be 2 · IT 12.

Tolerance class H12 shall apply for the inside diameter, D_i.

6.2 Tolerances on thickness

Table 5

Group	t or t'	Limit deviations[4])
1	From 0,2 to 0,6	+ 0,02 − 0,06
	Over 0,6 to below 1,25	+ 0,03 − 0,09
2	From 1,25 to 3,8	+ 0,04 − 0,12
	Over 3,8 up to 6,0	+ 0,05 − 0,15
3	Over 6,0 up to 14,0	± 0,10

[4]) In the case of group 3 springs, the limit deviations specified apply to the reduced thickness, t' (cf. clauses 4 and 5).

6.3 Tolerances on free overall height, l_0

Table 6

Group	t	Limit deviations
1	Less than 1,25	+ 0,10 − 0,05
2	From 1,25 to 2,0	+ 0,15 − 0,08
	Over 2,0 up to 3,0	+ 0,20 − 0,10
	Over 3,0 up to 6,0	+ 0,30 − 0,15
3	Over 6,0 up to 14,0	± 0,30

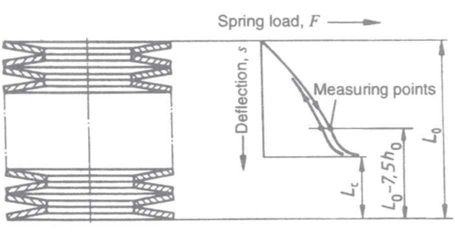


Figure 2: Measuring points for loading and unloading curves

7 Tolerances on spring load

7.1 Single discs

The static spring load, F, of a single disc in the initial position ($l_0 - s$) shall be determined for a spring in the loaded state, using a suitable lubricant. The flat plates between which the spring is to be compressed shall be hardened, ground, and polished.

Under normal circumstances, the values specified in table 7 shall apply.

Table 7

Group	t	Limit deviations for F, at $l_0 - 0{,}75\ h_0$, as a percentage
1	Less than 1,25	+ 25 − 7,5
2	From 1,25 to 3,0	+ 15 − 7,5
	Over 3,0 up to 6,0	+ 10 − 5
3	Over 6,0 up to 14,0	± 5

To comply with the specified tolerances, it may be necessary to exceed the tolerance values specified for l_0 (cf. table 6).

7.2 Springs stacked in series

Ten single discs stacked in series shall be used to determine the deviation in load between the loading curve and the unloading curve of springs stacked in series. The individual discs shall be centred about a mandrel in compliance with clause 16. The flat plates between which the spring is to be compressed shall be hardened, ground, and polished.

Prior to testing, the spring shall be compressed to twice its design load, F (where s is approximately 0,75 h_0).

At ($L_0 - 7{,}5\ h_0$), the spring load determined for the unloading curve shall make up at least the minimum percentages specified in table 8 of the spring load determined for the loading curve (cf. figure 2).

Table 8

Group	Minimum spring load (unloading), as a percentage, for spring series		
	A	B	C
1	90		85
2	92,5		87,5
3	95		90

Within certain tolerances, the form of the actual individual discs will deviate from the geometrically ideal form of the stack. Together with the effect of friction, this results in a load/deflection curve for the stack that differs from that established for the sum of the results for the individual discs (cf. subclause 7.4 of DIN 2092).

Stacks of springs shall normally be tested with the arrangement used in practice.

8 Play between spring and centring element

Means shall be provided to keep the spring in position, these being preferably internal, such as a mandrel. In the case of external positioning, a sleeve is preferred. The recommended amount of play between the spring and such a centring element is specified in table 9, as a function of the outside or inside diameter of the spring.

Table 9

D_i or D_e	Approximate play
Up to 16	0,2
Over 16 up to 20	0,3
Over 20 up to 26	0,4
Over 26 up to 31,5	0,5
Over 31,5 up to 50	0,6
Over 50 up to 80	0,8
Over 80 up to 140	1
Over 140 up to 250	1,6

9 Permissible set

See DIN 2092 for relevant concepts.

Following heat treatment, each spring shall be prestressed in such a manner that the values specified in table 7 are complied with when the spring is compressed to twice its design load, F (where s is equal to approximately 0,75 h_0).

In the case of springs subject to static loading, the guideline values for relaxation illustrated in figures 3 and 4 should not be exceeded.

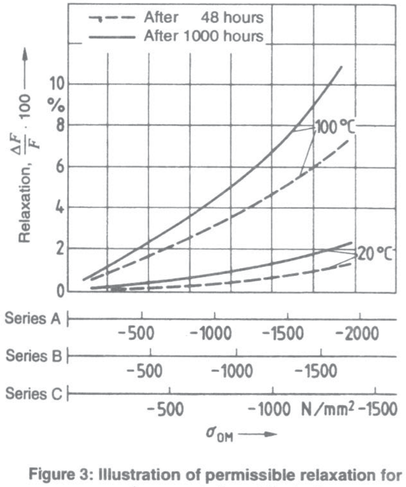


Figure 3: Illustration of permissible relaxation for springs made from Ck steel

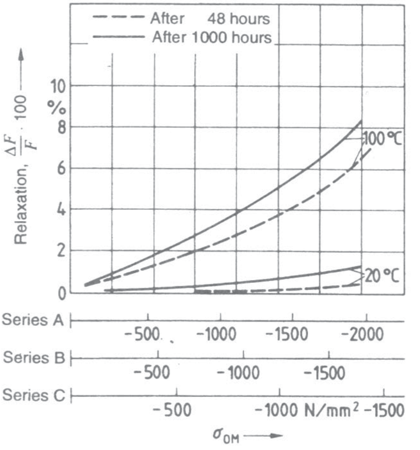


Figure 4: Illustration of permissible relaxation for springs made from high-grade chromium alloy steel or chromium-vanadium alloy steel in accordance with DIN 17 221 and DIN 17 222

Where the service temperature will exceed 100 °C, the spring manufacturer shall be consulted.

10 Stresses in springs subject to static loading or moderate fatigue conditions

In the case of springs made from DIN 17 221 or DIN 17 222 steel that are subject to static loading or to moderate fatigue conditions, the design stress at the point designated 0M (σ_{0M}), shall be approximately equal to the yield strength, R_e, of the material used (i.e. 1400 to 1600 N/mm²).

Where used at higher stresses, it is likely that the springs will suffer from creep or relaxation (cf. clause 9).

11 Stresses in springs subject to fatigue loading

11.1 Minimum initial deflection to avoid cracking

Springs subject to fatigue loading shall be designed and installed in such a way that the initial deflection, s_1, is from about 0,15 h_0 to 0,20 h_0, in order to avoid cracking at the upper inner edge (point I; cf. figure 1) as a result of residual stresses from the setting process.

11.2 Stresses

Figures 5 to 7 illustrate the endurance life of conical disc springs subject to fatigue loading that have not been shot peened. They specify guideline values for the range of stress, σ_H, as a function of the minimum stress, σ_U, at three different numbers of stress cycles, N, namely where N is less than or equal to $2 \cdot 10^6$, equal to 10^5, and equal to $5 \cdot 10^5$. Intermediate values for other numbers of stress cycles may be estimated based on this information.

The information given in figures 5 to 7 represents the results of laboratory testing using fatigue testing equipment capable of producing sinusoidal loading cycles and the statistical results obtained for a 99 % probability of endurance life. The test pieces were ten single discs with hardened surfaces, stacked in series, designed for use at ambient temperature, provided with an internal or external centring element with a smooth finish, having a minimum initial deflection, s_1, from about 0,15 h_0 to 0,20 h_0.

To ensure the expected endurance life of springs, they shall be protected from mechanical damage and other adverse conditions.

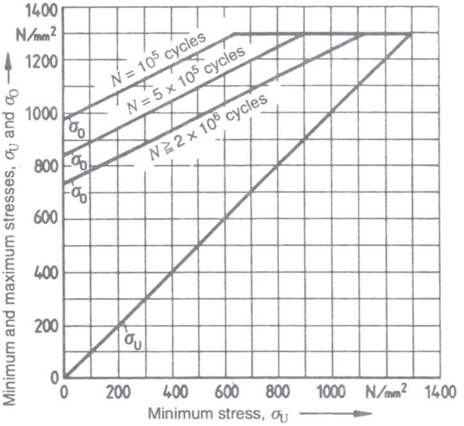


Figure 5: Graphical representation of endurance life of springs where t is less than 1,25 mm

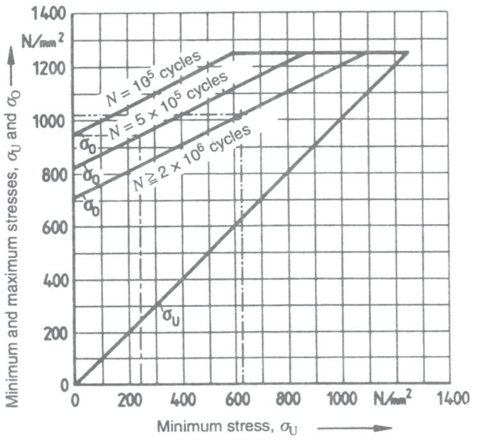


Figure 6: Graphical representation of endurance life of springs where 1,25 mm $\leq t \leq$ 6 mm (The dot-dash line illustrates the examples covered in subclauses 10.2.1 and 10.2.2 of DIN 2092.)

It should be noted that stress cycles in practice are generally not sinusoidal in form. Where additional types of loading (e.g. sudden dynamic loading or that which results from resonance) act on the spring, it may be assumed that their endurance life will be shorter. Where such is the case, the values given in the above figures shall be converted by

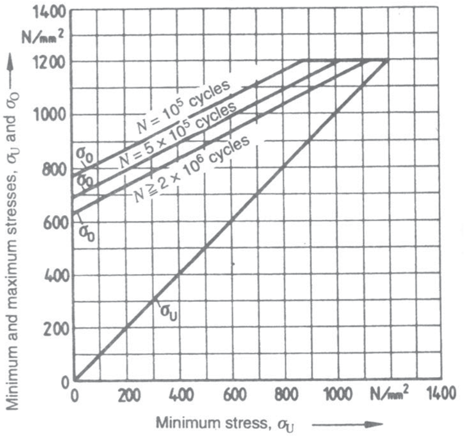


Figure 7: Graphical representation of endurance life of springs where 6 mm < t < 14 mm

appropriate factors of safety, the spring manufacturer being consulted where necessary.

> NOTE: Reliable information regarding the endurance life is not available for springs made from materials other than those specified here, for springs consisting of more than ten single discs stacked in series, for other arrangements of stacks of springs, nor for springs subjected to chemical or thermal effects, although some relevant information is usually obtainable from the spring manufacturer.

In the case of springs which exhibit a highly degressive load/deflection curve (springs of series C consisting of a large number of single discs stacked in series), an uneven distribution of total applied load from the single discs can be expected due to the friction between the discs and the centring element and to dimensional deviations. In this case, the end of the spring subject to deflection receives the higher portion of loading, which results in an endurance life that is shorter than can be read from figures 5 to 7.

12 Materials

Springs in accordance with this standard shall be made from high-grade steel with a modulus of elasticity, E, of 206 000 N/mm^2, as specified in either DIN 17 221 or DIN 17 222, it being noted that Ck steel shall only be used for the manufacture of group 1 springs.

> NOTE: Other materials shall be the subject of agreement (e.g. stainless steel for springs in accordance with DIN 17 224, copper alloys (spring bronze) in accordance with DIN 1777), since their moduli of elasticity and strength properties will likely be different. The values given for F and σ in tables 2 to 4 then cease to apply. It is therefore recommended to consult with the spring manufacturer.

13 Manufacturing process and surface quality

Table 10

Group	Manufacturing process	Surface roughness**), in μm, on	
		upper and lower surfaces	outer and inner edges
1	Stamped, cold formed, edges rounded	$R_a < 3,2$	$R_a < 12,5$
2*)	Stamped, cold formed, D_e and D_i turned, edges rounded	$R_a < 6,3$	$R_a < 6,3$
	Stamped, cold formed, edges rounded	$R_a < 6,3$	$R_a < 3,2$
3	Cold or hot formed, turned on all sides, edges rounded	$R_a < 12,5$	$R_a < 12,5$

*) Unless otherwise specified, the particular manufacturing process shall be up to the manufacturer (cf. clause 5).

**) The values specified do not apply to shot peened springs.

The surface shall be free from defects such as scars, cracks and the effects of corrosion.

14 Heat treatment and surface treatment

14.1 Heat treatment

After quenching and tempering, the spring shall not exhibit a depth of decarburization exceeding 3 % of its thickness.

To ensure good strength with as little relaxation as possible, the hardness of springs shall lie within the range of 42 to 52 HRC. For group 1 springs, the Vickers hardness is to be determined.

14.2 Shot peening

It is recommended that shot peening be carried out on springs subjected to severe loading, which enables the values given in figures 5 to 7 to be increased. This procedure shall be the subject of agreement.

14.3 Corrosion protection

Whether and which corrosion protection is to be provided shall be a function of the particular spring application. Suitable corrosion protection measures include phosphating, black finishing, and the application of protective metallic coatings such as zinc or nickel.

Electroplating processes using aqueous solutions that are currently available may not preclude the risk of hydrogen embrittlement. Springs with a hardness exceeding 40 HRC are more prone to the risk of hydrogen embrittlement than softer springs. Particular care shall therefore be taken when selecting the material, manufacturing process, heat treatment and surface treatment of springs (cf. DIN 50 969). Where springs are to be electroplated, it is recommended that the manufacturer be consulted, and that this procedure not be used for springs subject to fatigue loading.

15 Testing

Determination of the properties covered in subclauses 15.1 and 15.2 shall be the subject of agreement between purchaser and manufacturer.

15.1 Check of dimensions and other spring characteristics

The specifications given in DIN 267 Part 5 shall apply in addition to the characteristics and quality levels specified in table 11.

Table 11

Spring characteristics	AQL value
Major characteristics Spring load, F (where $s \approx 0,75\ h_0$) Outside diameter, D_e Inside diameter, D_i	1
Minor characteristics Free overall height in initial position, l_0 Spring thickness, t or t' Surface roughness, R_a	1,5

15.2 Hardness testing

Rockwell hardness testing shall be carried out as specified in DIN 50 103 Part 1, and Vickers hardness testing (for group 1 springs), as in DIN 50 133. The indentation shall be made on the upper surface of the spring, at a point that lies centrally between the inner and outer edges.

16 Other relevant requirements

Where possible, the centring element and the seat shall be made from case-hardened materials, with a case depth of about 0,8 mm, and have a hardness of 55 HRC. The surface of the centring element shall be smooth and, where possible, polished.

It shall be permitted to use unhardened centring elements where the spring is subject to static loading.

Standards referred to

DIN 267 Part 5	Fasteners; technical delivery conditions; acceptance inspection (modified version of ISO 3269:1984)
DIN 1777	Wrought copper alloy strip for springs; technical delivery conditions
DIN 2092	Design of conical disc springs
DIN 6796	Conical spring washers for bolt/nut assemblies
DIN 17 221	Hot rolled steel for springs suitable for quenching and tempering; technical delivery conditions
DIN 17 222	Cold rolled steel strip for springs; technical delivery conditions
DIN 17 224	Stainless steel wire and strip for springs; technical delivery conditions
DIN 50 103 Part 1	Rockwell hardness testing of metallic materials; C, A, B, F scales
DIN 50 133	Vickers hardness testing of metallic materials; HV 0,2 to HV 100
DIN 50 969	Heat treatment of chemically and/or electrochemically treated high-strength steel components to prevent hydrogen embrittlement

Other relevant standards

DIN 1016	Hot rolled steel sheet and strip; tolerances on size, form and mass
DIN 1544	Steel flat products; cold rolled steel strip; dimensions, limit deviations and form tolerances
DIN 8201 Part 1	Abrasives; classification and designation
DIN 50 942	Phosphating of metals; methods of test
DIN 59 200	Hot rolled wide steel flats; dimensions and tolerances on size, form and mass

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Amendments

In comparison with the September 1990 edition, the following amendments have been made.

a) In table 4, the value specified for D_i where D_e is equal to 50 has been corrected.

b) In table 5, the limit deviation specified for group 2 springs has been corrected.

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