SIST

SLOVENSKI STANDARD
SIST EN 16984:2017

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Krožnikaste vzmeti - Izračun

Disc springs - Calculation

Tellerfedern - Berechnung

Rondelles ressorts - Calculs

Ta slovenski standard je istoveten z: EN 16984:2016

ICS:

21.160 Vzmeti Springs

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EUROPEAN STANDARD
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EUROPÄISCHE NORM

EN 16984

November 2016

ICS 21.160

English Version

Disc springs - Calculation

Rondelles ressorts - Calculs

Tellerfedern - Berechnung

This European Standard was approved by CEN on 15 August 2016.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Page

European foreword

This document (EN 16984:2016) has been prepared by Technical Committee CEN/TC 407 “Cylindrical helical springs made from round wire and bar - Calculation and design”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

This European Standard has been prepared by the initiative of the Association of the European Spring Federation ESF and is based on the German Standard DIN 2092 “Disc springs — Calculation”, which is known and used in many European countries.

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1 Scope

This standard specifies design criteria and features of disc springs, whether as single disc springs or as stacks of disc springs. It includes the definition of relevant concepts as well as design formulae, and covers the fatigue life of such springs.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 16983:2016, *Disc springs - Quality specifications - Dimensions*

EN ISO 26909, *Springs - Vocabulary (ISO 26909)*

3 Terms, definitions, symbols, units and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 26909 apply.

NOTE Disc springs are annular coned elements that offer resistance to a compressive load applied axially. They may be designed as single disc springs or as disc springs stacked in parallel or in series, either singly or in multiples. They may be subjected to both static and fatigue loading, and may have flat bearings.

3.2 Symbols, units and abbreviated terms

For the purposes of this document, the following symbols, units and abbreviated terms apply

Table 1 — Symbols, units and abbreviated terms

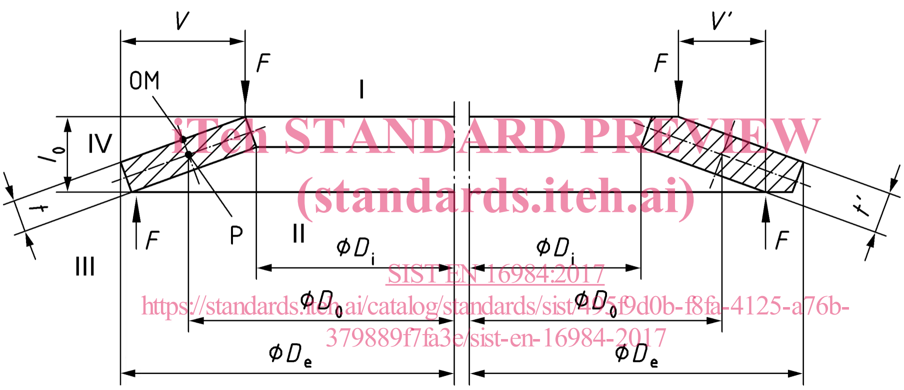
Symbol	Unit	Description
D_e	mm	Outer diameter of spring
D_i	mm	Inner diameter of spring
D_0	mm	Diameter of centre of rotation
E	MPa	Modulus of elasticity (see EN 16983:2016)
F	N	Spring load
F_1, F_2, F_3 ...	N	Spring loads related to spring deflections s_1, s_2, s_3...
F_c	N	Design spring load when spring is in the flattened position
F_{ges}	N	Spring load of springs stacked in parallel, related to spring deflection s_{ges}
$F_{ges\ R}$	N	Spring load of springs stacked in parallel, allowance being made for friction
F_t	N	Test load for length L_t or l_t
K_1, K_2, K_3, K_4		Constants (see 5.3)
L_0	mm	Length of springs stacked in series or in parallel, in

Symbol	Unit	Description
		the initial position
L_1, L_2, L_3 ...	mm	Lengths of loaded springs stacked in series or in parallel, related to spring loads F_1, F_2, F_3...
L_t	mm	Test length of springs stacked in series or in parallel
L_c	mm	Design length of springs stacked in series or in parallel, in the flattened position
N		Number of cycles to failure
R	N/mm	Spring rate
W	N mm	Energy capacity of spring
h_0	mm	Initial cone height of springs without flat bearings, $h_0 = l_0 - t$
h'_0	mm	Initial cone height of springs with flat bearings, $h'_0 = l_0 - t'$
i		Number of disc springs or packets stacked in series
l_0	mm	Free overall height of spring in its initial position
l_1, l_2, l_3 ...	mm	Length of loaded spring related to spring loads F_1, F_2, F_3...
L_t	mm	Test length of spring
n		Number of single disc springs stacked in parallel
P		Theoretical centre of rotation of disc cross section (see Figure 1)
s	mm	Deflection of single disc spring
s_1, s_2, s_3 ...	mm	Spring deflections related to spring loads F_1, F_2, F_3...
s_{ges}	mm	Deflection of springs stacked in series or in parallel, no allowance being made for friction. Recommended maximum value: $s_{ges} = 0{,}75\ (L_0 - L_c)$
t	mm	Thickness of single disc spring
t'	mm	Reduced thickness of single disc spring with flat bearings (group 3)
w_M, w_R		Coefficients of friction (see Table 3)
$\delta = \frac{D_e}{D_i}$		Ratio of outer to inner diameter
μ		Poisson’s ratio
σ	MPa	Design stress
$\sigma_{OM}, \sigma_{I}, \sigma_{II}, \sigma_{III}, \sigma_{IV}$	MPa	Design stresses at the points designated OM, I, II, III, IV (see Figure 1)
σ_o	MPa	Maximum design stress in springs subject to fatigue

Symbol	Unit	Description
		loading
σ_u	MPa	Minimum design stress in springs subject to fatigue loading
σ_h	MPa	Fatigue stress related to the deflection of springs subject to fatigue loading
σ_O	MPa	Maximum fatigue stress
σ_U	MPa	Minimum fatigue stress
$\sigma_H = \sigma_O - \sigma_U$	MPa	Permanent range of fatigue stress
V, V'	mm	Lever arms

4 Representation

4.1 Single disc spring



a) without flat bearings:
group 1
group 2

b) with flat bearings:
group 3

Figure 1 — Single disc spring (sectional view), including the relevant points of loading

4.2 Disc springs stacked in parallel

The stack consists of n single disc springs stacked in parallel.

Figure 2 — Packet - Disc springs stacked in parallel

4.3 Disc springs stacked in series

The stack consists of i single disc springs stacked in series.

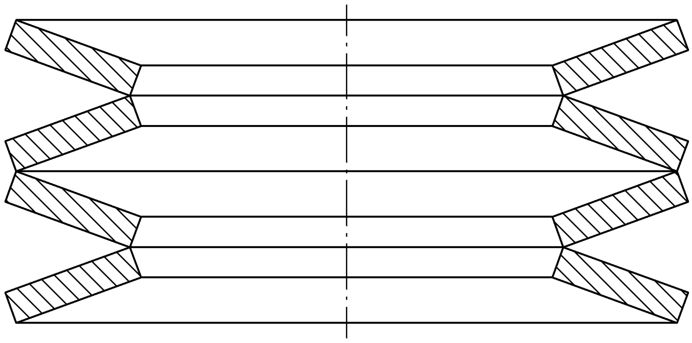


Figure 3 — Stack - Disc springs stacked in series

4.4 Disc spring diagram

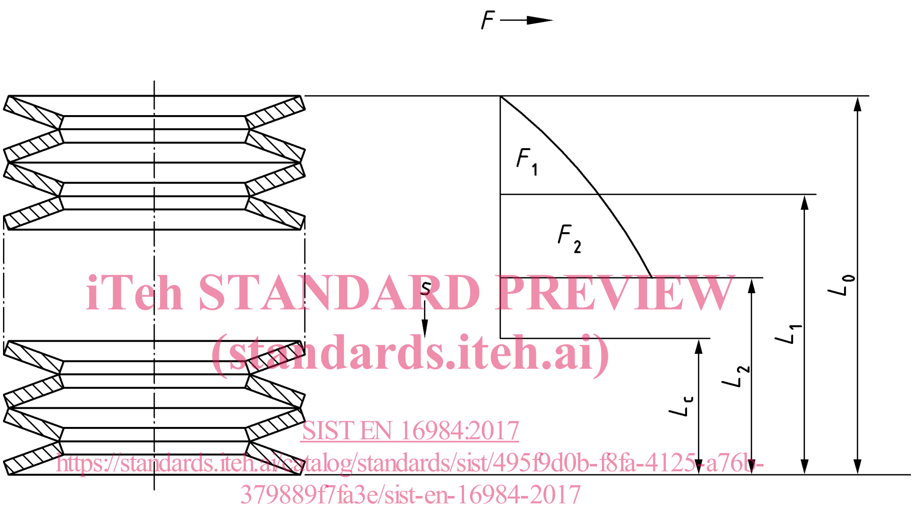


Figure 4 — Example of disc springs stacked in series

5 Design formulae for single disc springs

5.1 General

The following formulae apply to single disc springs with or without flat bearings, where $16 < D_e / t < 40$ or $1,8 < D_e / D_i < 2,5$, and which are made of materials as specified in EN 16983:2016.

In the case of other designs, it is recommended that the spring manufacturer should be consulted.

5.2 Test load

The test load of single disc springs or disc springs stacked in series, F_t, is designed for a deflection $s = 0,75\ h_0$. Single disc springs with flat bearings shall have the same test load for a test length L_t as ones without, where the principal dimensions D_e, D_i and l_0 are the same. Flat bearings have the effect of reducing the length of the lever arm. The increased load which results can be compensated by reducing the thickness of the disc spring. The load/deflection curve of such springs deviates from those without flat bearings, with the exception of the point at which the curves intersect, l_t.

Guideline values for the reduction in disc spring thickness as a function of dimensional series are given in Table 2.