INTERNATIONAL STANDARD

ISO 16249

First edition
2013-04-01

Springs — Symbols

Ressorts — Symboles

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Reference number
ISO 16249:2013(E)

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Published in Switzerland

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Foreword

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The committee responsible for this document is ISO/TC 227, *Springs*.

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Introduction

Several spring symbols related to cylindrical helical compression springs specified in ISO 2162-2 have been quoted according to this International Standard.

In this International Standard, existing spring symbols that have been used globally and customarily among several nations or regions are adopted without major alteration.

Existing spring symbols that have been used locally or in a limited nation/region have been redesigned in a logical way according to a particular rule for creating new spring symbols.

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Springs — Symbols

1 Scope

This International Standard specifies general principles for the creation of symbols of physical quantities, coefficients, and parameters for metal springs. It specifies the presentation of basic characters, subscripts, and application symbols for use in the field of helical compression springs, helical extension springs, helical torsion springs, flat springs, and leaf springs with attention to technical product documentation, especially for describing and ordering.

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.

ISO 26909, *Springs — Vocabulary*

ISO 80000-1, *Quantities and units — Part 1: General*

ISO 80000-4, *Quantities and units — Part 4: Mechanics*

3 Terms and definitions

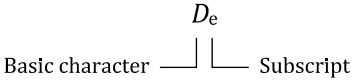
For the purposes of this document, the terms and definitions given in ISO 26909 and the following apply.

3.1
basic character
main part of spring symbols representing physical quantities, coefficients, and parameters of springs

3.2
subscript
second part of spring symbols that follows basic characters in order to modify the physical quantities, coefficients, and parameters with respect to properties, feature, numbering, etc.

3.3
application symbol
combination of basic character and subscript

EXAMPLE Application symbol



4 Composition of spring symbols

4.1 General

Simple spring symbols consist of basic characters alone. Subscripts may be added to these basic characters to create more complex symbols.

Quantities and units used are specified in accordance with ISO 80000-1 and ISO 80000-4.

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For the purpose of international applicability, all basic characters and subscripts should be derived from English words, and designations used in technical literature up to the time of publication of this International Standard are adopted as far as possible. Wide conformity of the symbols for springs has been attempted.

The characters that are permitted to be used for spring symbols are Latin letters (upper case or lower case), Greek letters (upper case or lower case), and Arabic numbers.

NOTE 1 As there is a risk of confusion with the Arabic number 0, the following Latin letters have not been specified: *O* (upper case letter), *o* (lower case letter).

NOTE 2 As there is a risk of confusion with Latin letters, the following Greek letters have not been specified: *A*, *B*, *E*, *Z*, *H*, *I*, *K*, *κ*, *M*, *N*, *O*, *o*, *P*, *T*, *Y* and *X*.

4.2 Basic characters

Basic characters consist of one upper case letter or lower case letter written in Latin or Greek alphabet.

The letter should be derived from the corresponding spring term or designation in English.

Variables shall be in italic typeface.

EXAMPLES D for coil diameter, τ for torsional stress

4.3 Subscripts

Subscripts consist of one, two or three letters, digits, or letter/digit combinations of Latin letters, Greek letters or Arabic numbers.

EXAMPLE 1 D_{e} (e: one letter)

EXAMPLE 2 A_{L0} (*L0*: two letters)

EXAMPLE 3 d_{max} (max: three letters)

Subscripts should be as short as possible. A single letter/digit is preferable; however, when the symbol of a single letter/digit overlaps with an existing symbol or if it is difficult to describe the meaning with a single letter/digit, two or three letters/digits are acceptable.

EXAMPLE 4 A_M (*M*: one letter taken from “moment”)

EXAMPLE 5 d_{max} (max: three letters taken from “maximum”)

The letters should be derived from the corresponding spring terms or designation in English.

Subscripts that represent physical quantities shall be printed in italic typeface. Others shall be printed in roman typeface. Subscripts of Arabic numbers should be printed in roman typeface. However, running numbers are generally printed in italic typeface.

EXAMPLE 6 A_{L0} (*L0*: free length: italic type)

EXAMPLE 7 l_{A} (A: length at leg A: roman type)

EXAMPLE 8 L_1 (*1*: running number: italic type)

Up to two sets of subscripts are permitted in one spring symbol. In this case, they shall be separated by means of a comma (,) but without a space between them.

EXAMPLE 9 $r_{\mathrm{w,A}}$ (w,A: effective working radius of leg A)

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5 Creation of new spring symbols

5.1 General

New spring symbols created in the future should follow the rules described below. The composition of the symbols should conform to Clause 4.

5.2 Latin letters and Greek letters for basic characters

Latin letters for basic characters are used when describing coefficients or quantities measured by devices or instruments, e.g. length, diameter, and load (including mean value).

Greek letters for basic characters are used when describing the quantities calculated, e.g. stress, deflection, and amount of loss.

5.3 Upper case letters and lower case letters for basic characters

Upper case letters for basic characters are used when describing quantities of the whole spring shape or function.

EXAMPLES 1 L for spring length, D for diameter of coil, F for spring load

Lower case letters for basic characters are used when describing quantities of spring materials or partial dimensions.

EXAMPLES 2 d for diameter of wire, l for straight length at coil end

5.4 Latin letters and Greek letters for subscripts

Basic Latin letters and Greek letters shall be used for subscripts.

When subscripts are abbreviated terms, they shall be in Latin typeface only.

5.5 Upper case letters and lower case letters for subscripts

In the case of subscripts consisting of a single character, upper case letters should be used basically.

When a subscript consists of a single character and the upper case letter of this character is already used for an existing symbol, the lower case letter may be used.

When an upper case letter is used as a basic character, the corresponding subscript should be the upper case letter.

When a lower case letter is used as a basic character, the corresponding subscript should be the lower case letter.

In the case of subscripts consisting of two or three characters, lower case letters should be used basically.

6 Basic character and subscript components of spring symbols

6.1 Basic character components

Basic characters are shown in Table 1.

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Table 1 — List of basic characters

No.	Symbol	Parameter	Compression	Extension	Torsion	Flat	Leaf
1.1	*A*	permissible variation	X	X	X	X	X
1.2	*b*	width or breadth	—	—	—	X	X
1.3	*C*	camber	—	—	—	—	X
1.4	*D*	spring diameter	X	X	X	—	—
1.5	*d*	wire diameter	X	X	X	—	—
1.6	*E*	modulus of elasticity	—	—	X	X	X
1.7	*e*	perpendicularity	X	—	—	—	—
		parallelism	X	—	—	—	—
1.8	*F*	spring load or force	X	X	X	X	X
1.9	*f*	frequency	X	X	X	X	X
1.10	*G*	modulus of rigidity	X	X	—	—	—
1.11	*H*	spring height	—	—	—	—	X
1.12	*L*	spring length	X	X	X	—	—
1.13	*l*	leg length	—	—	X	—	—
		beam length	—	—	—	X	—
		span length	—	—	—	—	X
1.14	*M*	moment or spring torque	—	—	X	X	—
1.15	*m*	hook opening	—	X	—	—	—
1.16	*N*	number of cycles	X	X	X	X	X
1.17	*n*	number of coils	X	X	X	—	—
		number of leaves	—	—	—	—	X
1.18	*p*	pitch	X	—	—	—	—
1.19	*R* See Annex A	spring rate	X	X	X	X	X
1.20	*r*	radius	—	X	X	X	—
1.21	*s*	spring deflection	X	X	—	X	X
1.22	*T*	temperature	X	X	X	X	X
1.23	*t*	thickness of beam or leaf	—	—	—	X	X
1.24	α	position angle when unloaded only	—	—	X	—	—
		torsional angle or working angle	—	—	X	—	—
1.25	Δ	amount of change	X	X	X	X	X
1.26	σ	bending stress	—	—	X	X	X
1.27	τ	torsional stress	X	X	—	—	—

6.2 Subscript components

Subscripts are shown in Table 2.

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Table 2 — List of subscripts

No.	Symbol	Parameter	Compression	Extension	Torsion	Flat	Leaf
2.1	A	eye A	—	—	—	—	X
		leg A	—	—	X	—	—
2.2	B	coiling body	—	X	X	—	—
		eye B	—	—	—	—	X
		leg B	—	—	X	—	—
2.3	c	solid	X	—	—	—	—
2.4	*D*	diameter of coil or diameter of spring	X	X	X	—	—
2.5	d	mandrel or inner guide	X	—	X	—	—
2.6	E	eye	—	—	—	—	X
2.7	e	external or outside	X	X	X	—	—
		natural	X	X	X	X	X
2.8	*F*	spring load or force	X	X	X	X	X
2.9	H	hook	—	X	—	—	—
2.10	*h*	deflection between two positions	X	X	X	—	—
2.11	i	inside or inner	X	X	X	—	—
		initial	—	X	—	—	—
2.12	*L0*	free length	X	X	—	—	—
2.13	*M*	moment or spring torque	—	—	X	—	—
2.14	max	maximum	X	X	X	X	X
2.15	min	minimum	X	X	X	X	X
2.16	n	maximum test point	X	X	X	—	—
2.17	R	required	X	X	X	X	X
2.18	ST	straight	—	—	—	—	X
2.19	t	total	X	—	—	—	—
2.20	w	effective working	—	—	X	—	—
2.21	0	free condition or unloaded	X	X	X	X	X
2.22	1	measuring position of perpendicularity	X	—	—	—	—
	1	running number (specified position)	X	X	X	X	X
2.23	2	measuring position of parallelism	X	—	—	—	—
	2	running number (specified position)	X	X	X	X	X

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7 Application symbols for helical compression springs

Application symbols for helical compression springs are shown in Table 3, and some sample symbols are shown in Figures 1 and 2.

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Table 3 — List of application symbols for helical compression springs

No.	Symbol	Unit	Parameter
3.1	A_D	mm	permissible variation of mean coil diameter, D
3.2	A_F	mm	permissible variation of spring load, F
3.3	A_{L0}	mm	permissible variation of spring free length, L_0
3.4	D [a]	mm	mean diameter of spring (see Figure 1)
3.5	D_d	mm	mandrel diameter (inner guide)
3.6	D_e [a]	mm	outside (external) diameter of spring (see Figure 1)
3.7	D_i [a]	mm	inside diameter of spring (see Figure 1)
3.8	d [a]	mm	diameter of wire
3.9	d_{max} [a]	mm	maximum diameter of wire
3.10	e_1	mm	perpendicularity (see Figure 2)
3.11	e_2	mm	parallelism (see Figure 2)
3.12	F	N	spring load or force
3.13	F_c	N	spring load at solid length, L_c (see Figure 1)
3.14	F_n [a]	N	spring load for the minimum test length, L_n (see Figure 1)
3.15	$F_1, F_2, \ldots$ [a]	N	specified spring loads for the specified spring lengths, $L_1, L_2, \ldots$ (see Figure 1)
3.16	f [a]	Hz, s^{-1}	load cycle frequency
3.17	f_e [a]	Hz, s^{-1}	natural frequency
3.18	G [a]	N/mm^2, MPa	modulus of rigidity
3.19	L_c [a]	mm	solid length (see Figure 1)
3.20	L_n [a]	mm	minimum acceptable test length for F_n (see Figure 1)
3.21	L_0 [a]	mm	free length (see Figure 1)
3.22	$L_1, L_2, \ldots$ [a]	mm	specified spring lengths for the specified spring loads, $F_1, F_2, \ldots$ (see Figure 1)
3.23	N [a]	—	number of repetition times to spring failure
3.24	N_R	—	required number of repetition times for testing
3.25	n [a]	—	active coils
3.26	n_t [a]	—	total number of coils
3.27	p	mm	spring pitch (see Figure 1)
3.28	R See Annex A	N/mm	spring rate
3.29	s	mm	deflection of spring
3.30	s_c	mm	deflection of spring for the solid length, L_c (see Figure 1)
3.31	s_h [a]	mm	deflection of spring (stroke) between two loads (see Figure 1)
3.32	s_n	mm	maximum test spring deflection for the spring load, F_n (see Figure 1)
3.33	$s_1, s_2, \ldots$	mm	specified spring deflections for the specified spring loads, $F_1, F_2, \ldots$ (see Figure 1)
3.34	T [a]	°C	working temperature
3.35	ΔD_e [a]	mm	enlargement of outside diameter of spring when loaded
3.36	τ	N/mm^2, MPa	torsional stress
3.37	τ_c [a]	N/mm^2, MPa	torsional stress for the solid length, L_c (see Figure 1)

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Table 3 *(continued)*

No.	Symbol	Unit	Parameter
3.38	τ_n	N/mm^2, MPa	maximum torsional stress for the spring load, F_n (see Figure 1)
3.39	τ_1, τ_2, … [a]	N/mm^2, MPa	torsional stresses for the specified spring loads, F_1, F_2, … (see Figure 1)
[a] Given in ISO 2162-2:1993, 5.3.			

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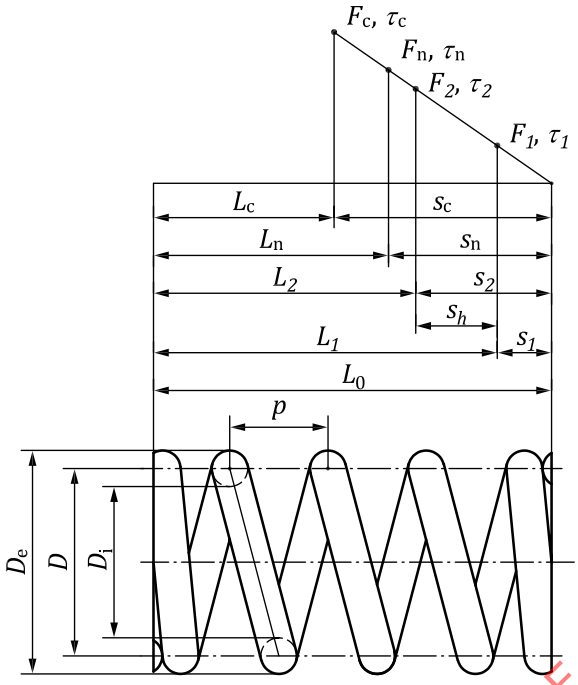
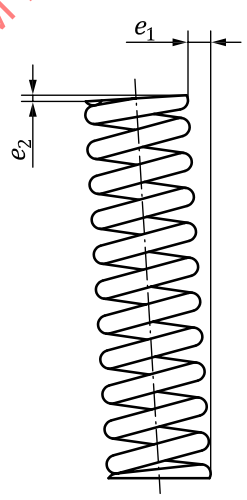


Key

D, D_e, D_i	a variety of diameters of spring
F_c, F_n, F_1, F_2	spring loads
L_c, L_n, L_0, L_1, L_2	spring lengths
p	spring pitch
s_c, s_h, s_n, s_1, s_2	deflections of spring
τ_c, τ_n, τ_1, τ_2	torsional stresses

Figure 1 — Symbols for helical compression spring



Key

e_1 perpendicularity

e_2 parallelism

Figure 2 — Symbols of perpendicularity and parallelism

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8 Application symbols for helical extension springs

Application symbols for helical extension springs are shown in Table 4, and some sample symbols are shown in Figure 3.

Table 4 — List of application symbols for helical extension springs

No.	Symbol	Unit	Parameter
4.1	A_D	mm	permissible variation of mean coil diameter, D
4.2	A_F	mm	permissible variation of spring load, F
4.3	A_{L0}	mm	permissible variation of spring free length, L_0
4.4	D	mm	mean diameter of spring (see Figure 3)
4.5	D_e	mm	outside (external) diameter of spring (see Figure 3)
4.6	D_i	mm	inside diameter of spring (see Figure 3)
4.7	d	mm	diameter of wire
4.8	d_{max}	mm	maximum diameter of wire
4.9	F	N	spring load or force
4.10	F_i See Annex A	N	initial tension spring load (see Figure 3)
4.11	F_n	N	spring load for the maximum test length, L_n (see Figure 3)
4.12	$F_1, F_2, \ldots$	N	specified spring loads for the specified spring lengths, $L_1, L_2, \ldots$ (see Figure 3)
4.13	f	Hz, s^{-1}	load cycle frequency
4.14	G	N/mm^2, MPa	modulus of rigidity
4.15	L_B	mm	spring coiling body length when unloaded (see Figure 3)
4.16	L_H	mm	spring hook length (see Figure 3)
4.17	L_n	mm	maximum acceptable test spring length measured between hook inner radii for F_n (see Figure 3)
4.18	L_0	mm	free length measured between hook inner radii (see Figure 3)
4.19	$L_1, L_2, \ldots$	mm	specified spring lengths measured between hook inner radii for the specified spring loads, $F_1, F_2, \ldots$ (see Figure 3)
4.20	m	mm	hook opening (see Figure 3)
4.21	N	—	number of repetition times to spring failure
4.22	N_R	—	required number of repetition times for testing
4.23	n	—	number of coils
4.24	R See Annex A	N/mm	spring rate
4.25	r	mm	bending radius (see Figure 3)
4.26	s	mm	deflection of spring
4.27	s_h	mm	deflection of spring (stroke) between two loads (see Figure 3)
4.28	s_n	mm	maximum test spring deflection for the spring load, F_n (see Figure 3)
4.29	$s_1, s_2, \ldots$	mm	specified spring deflections for the specified spring loads, $F_1, F_2, \ldots$ (see Figure 3)
4.30	T	°C	working temperature
4.31	τ	N/mm^2, MPa	torsional stress

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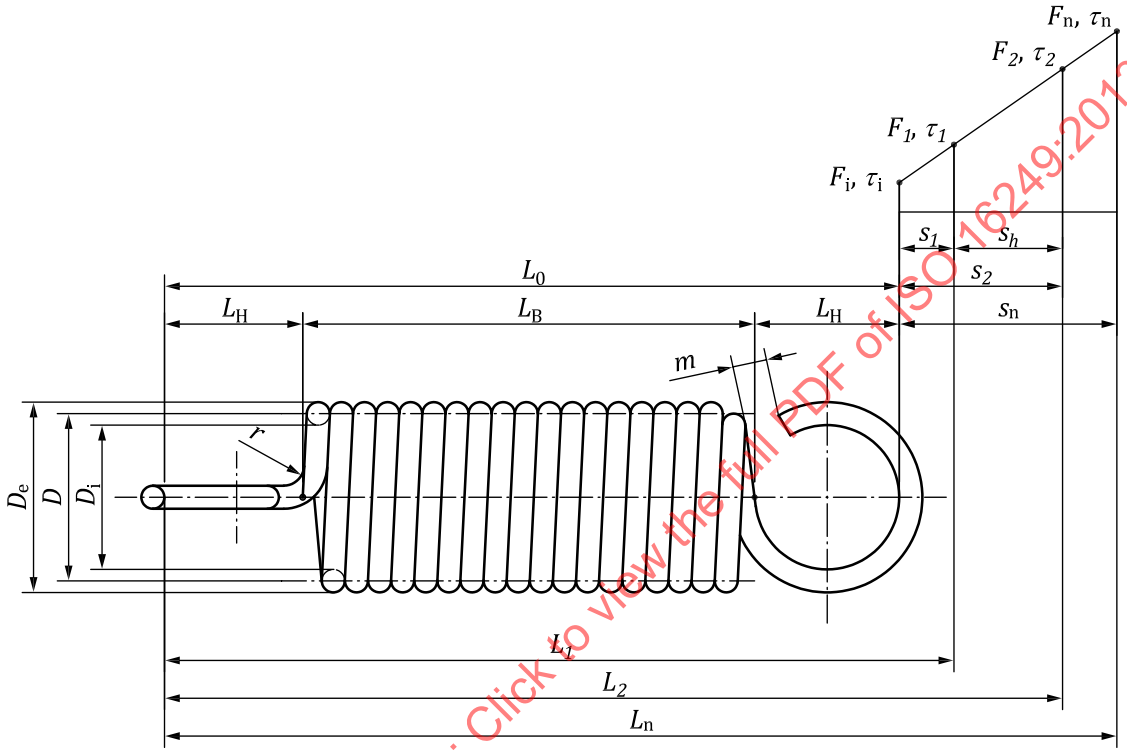
Table 4 *(continued)*

No.	Symbol	Unit	Parameter
4.32	τ_i See Annex A	N/mm², MPa	initial torsional stress (see Figure 3)
4.33	τ_n	N/mm², MPa	maximum torsional stress for the spring load, F_n (see Figure 3)
4.34	τ_1, τ_2, ...	N/mm², MPa	torsional stresses for the specified spring loads, F_1, F_2, ... (see Figure 3)



Key

D, D_e, D_i	a variety of diameters of spring
F_i, F_n, F_1, F_2	spring loads
L_n, L_0, L_1, L_2	spring lengths measured between hook inner radii
L_B	spring coiling body length when unloaded
L_H	spring hook length
m	hook opening
r	bending radius
s_h, s_n, s_1, s_2	deflections of spring
τ_i, τ_n, τ_1, τ_2	torsional stresses

Figure 3 — Symbols for helical extension spring

9 Application symbols for helical torsion springs

Application symbols for helical torsion springs are shown in Table 5, and some sample symbols are shown in Figures 4, 5, and 6.

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Table 5 — List of application symbols for helical torsion springs

No.	Symbol	Unit	Parameter
5.1	A_D	mm	permissible variation of mean coil diameter, D
5.2	A_M	N · mm	permissible variation of spring torque or moment at the specified angle
5.3	D	mm	mean diameter of spring (see Figure 6)
5.4	D_d	mm	mandrel diameter (inner guide) (see Figure 6)
5.5	D_e	mm	outside (external) diameter of spring (see Figure 6)
5.6	D_i	mm	inside diameter of spring (see Figure 6)
5.7	d	mm	diameter of wire
5.8	d_{max}	mm	maximum diameter of wire
5.9	E	N/mm², MPa	modulus of elasticity
5.10	F	N	spring load or force
5.11	F_A	N	spring load at leg A (see Figure 6)
5.12	F_B	N	spring load at leg B (see Figure 6)
5.13	F_n	N	spring load for the maximum test torsional angle and related leg length (see Figure 5)
5.14	$F_1, F_2, \ldots$	N	specified spring loads for the specified moments, $M_1, M_2, \ldots$ (see Figure 5)
5.15	f	Hz, s^{-1}	load cycle frequency
5.16	L_B	mm	body length in axis direction (excluding legs) when unloaded (see Figure 5)
5.17	l	mm	length of leg (without considering working effect)
5.18	l_A	mm	length of leg A (without considering working effect)
5.19	l_B	mm	length of leg B (without considering working effect)
5.20	l_w	mm	effective working length of leg
5.21	$l_{w,A}$	mm	effective working length of leg A (see Figure 6)
5.22	$l_{w,B}$	mm	effective working length of leg B (see Figure 6)
5.23	$l_1, l_2, \ldots$	mm	length of legs (without considering working effect)
5.24	M	N · mm	spring torque or moment (see Figure 6)
5.25	M_{max}	N · mm	maximum spring torque, which occurs occasionally in practice, in test, or during assembly of the torque
5.26	M_n	N · mm	spring torque for the maximum test torsional angle and related leg length
5.27	$M_1, M_2, \ldots$	N · mm	spring torques for the specified spring loads, $F_1, F_2, \ldots$
5.28	N	—	number of repetition times to spring failure
5.29	N_R	—	required number of repetition times for testing
5.30	n	—	number of coils
5.31	R_M See Annex A	N · mm/rad, N · mm/degree	angular spring rate (increase of spring torque per unit angular deflection)
5.32	r	mm	bending radius
5.33	r_w	mm	effective working radius of leg
5.34	$r_{w,A}$	mm	effective working radius of leg A (see Figures 5 and 6)
5.35	$r_{w,B}$	mm	effective working radius of leg B (see Figures 5 and 6)
5.36	T	°C	working temperature

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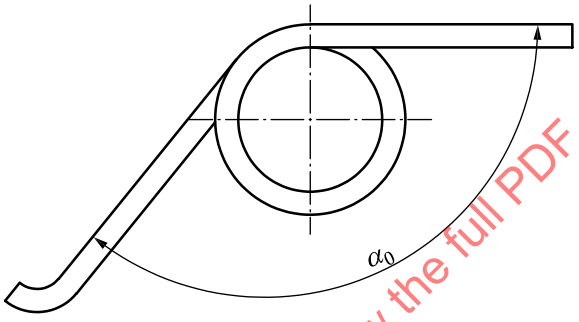
Table 5 *(continued)*

No.	Symbol	Unit	Parameter
5.37	α_h	rad, degree	deflection of torsional angle (stroke) between two positions (see Figure 5)
5.38	α_n	rad, degree	maximum permissible test torsional angle (see Figure 5)
5.39	α_0	rad, degree	position angle between two legs when unloaded (see Figure 4)
5.40	$\alpha_1, \alpha_2, \ldots$	rad, degree	torsional angles for the specified spring torques, $M_1, M_2, \ldots$ (see Figure 5)
5.41	ΔD	mm	change in mean diameter of spring or decrement of mean diameter of spring when loaded
5.42	σ	N/mm^2, MPa	bending stress (see Figure 6)
5.43	σ_n	N/mm^2, MPa	bending stress for the specified spring torque, M_n
5.44	$\sigma_1, \sigma_2, \ldots$	N/mm^2, MPa	bending stresses for the specified spring torques, $M_1, M_2, \ldots$



Key

α_0 position angle between two legs when unloaded

Figure 4 — Symbol for helical torsion spring when unloaded

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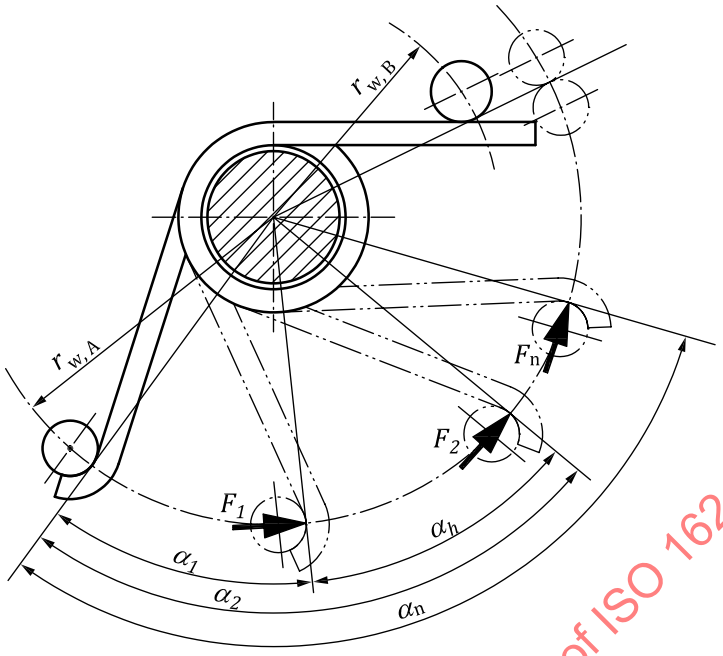

Key

F_n, F_1, F_2	spring loads
$r_{w,A}$, $r_{w,B}$	effective working radii of leg
α_h	deflection of torsional angle (stroke) between two positions
α_1, α_2, α_n	torsional angles (working angles)

Figure 5 — Symbols for helical torsion spring when loaded

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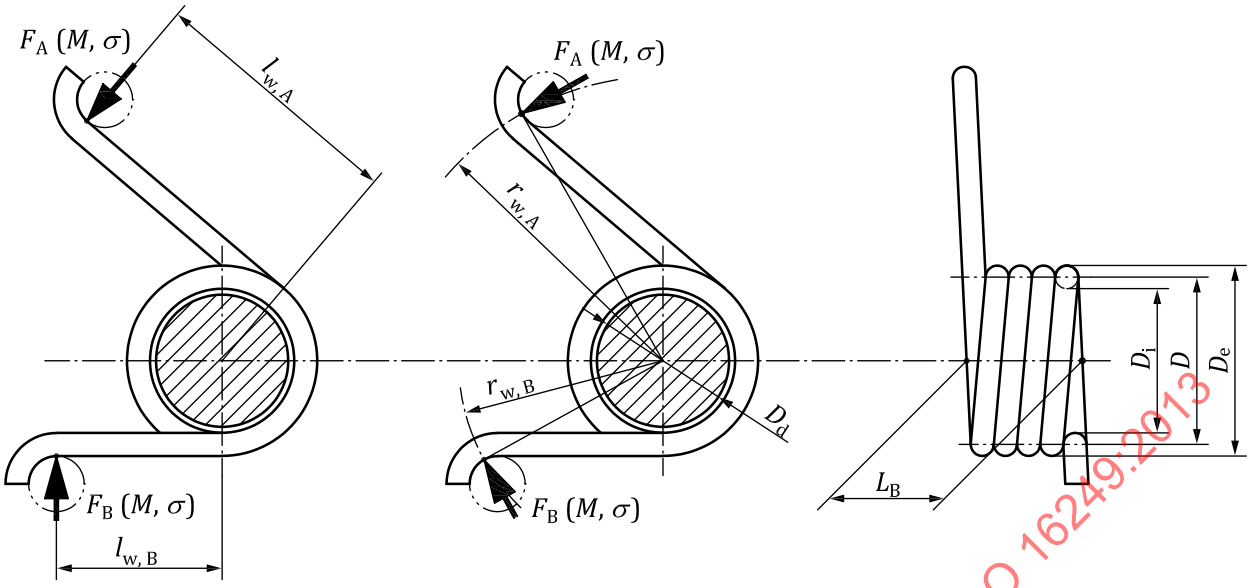

Key

D, D_e, D_i	a variety of diameters of spring
D_d	mandrel diameter (inner guide)
F_A, F_B	spring loads
L_B	body length in axis direction (excluding legs) when unloaded
$l_{w,A}$, $l_{w,B}$	effective working lengths of leg
M	spring torque or moment
$r_{w,A}$, $r_{w,B}$	effective working radii of leg
σ	bending stress

Figure 6 — Symbols for helical torsion spring related effective working length or radius of leg

10 Application symbols for flat springs

Application symbols for flat springs are shown in Table 6, and some sample symbols are shown in Figure 7.

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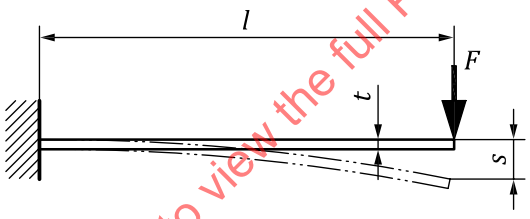
Table 6 — List of application symbols for flat springs

No.	Symbol	Unit	Parameter
6.1	b	mm	width or breadth of beam
6.2	E	N/mm^2, MPa	modulus of elasticity
6.3	F	N	spring load or force (see Figure 7)
6.4	l	mm	length of beam (see Figure 7)
6.5	M	N · mm	bending moment or spring torque
6.6	N	—	number of repetition times to spring failure
6.7	N_R	—	required number of repetition times for testing
6.8	R See Annex A	N/mm	spring rate
6.9	r	mm	bending radius
6.10	s	mm	deflection of beam (see Figure 7)
6.11	t	mm	thickness of beam (see Figure 7)
6.12	σ	N/mm^2, MPa	bending stress



Key

F spring load or force
l length of beam
s deflection of beam
t thickness of beam

Figure 7 — Symbols for flat spring

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11 Application symbols for leaf springs

Application symbols for leaf springs are shown in Table 7, and some sample symbols are shown in Figure 8.

Table 7 — List of application symbols for leaf springs

No.	Symbol	Unit	Parameter
7.1	b	mm	width or breadth of leaf
7.2	C	mm	camber (see Figure 8)
7.3	C_0	mm	camber when unloaded
7.4	E	N/mm^2, MPa	modulus of elasticity
7.5	F	N	total spring load (see Figure 8)
7.6	F_A	N	spring load at eye A (see Figure 8)
7.7	F_B	N	spring load at eye B (see Figure 8)

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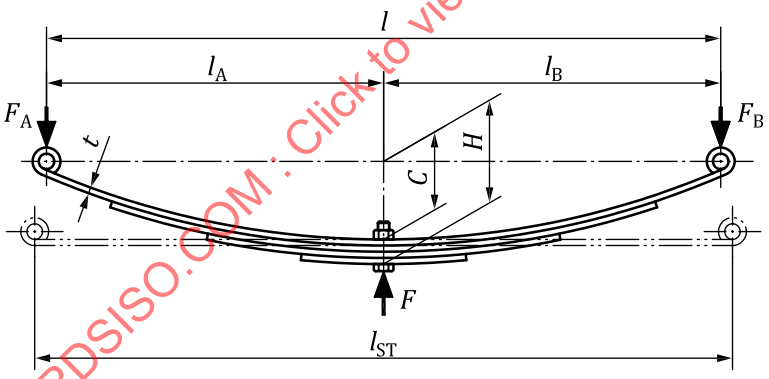
Table 7 *(continued)*

No.	Symbol	Unit	Parameter
7.8	f	Hz, s^{-1}	load cycle frequency
7.9	f_e	Hz, s^{-1}	natural frequency
7.10	H	mm	spring height (see Figure 8)
7.11	H_0	mm	spring height when unloaded
7.12	l	mm	length of span between eye A and eye B (see Figure 8)
7.13	l_A	mm	length of span between eye A and centre (see Figure 8)
7.14	l_B	mm	length of span between eye B and centre (see Figure 8)
7.15	l_{ST}	mm	straight span (see Figure 8)
7.16	l_0	mm	length of span between eye A and eye B when unloaded
7.17	N	—	number of repetition times to spring failure
7.18	N_R	—	required number of repetition times for testing
7.19	n	—	total number of leaves
7.20	R See Annex A	N/mm	spring rate
7.21	s	mm	deflection of beam
7.22	t	mm	thickness of leaf (see Figure 8)
7.23	σ	N/mm^2, MPa	bending stress



Key

C	camber
F	total spring load
F_A, F_B	spring loads at eye A or eye B
H	spring height
l	length of span between eye A and eye B
l_A, l_B	lengths of span between eye A and centre, eye B and centre
l_{ST}	straight span
t	thickness of leaf

Figure 8 — Symbols for leaf spring

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