SLOVENSKI STANDARD
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Vijačne valjaste vzmeti iz okrogle žice in palic - Izračun in načrtovanje - 1. del: Tlačne vzmeti

Cylindrical helical springs made from round wire and bar - Calculation and design - Part 1 : Compression springs

Zylindrische Schraubenfedern aus runden Drähten und Stäben - Berechnung und Konstruktion - Teil 1: Druckfedern

Ressorts hélicoïdaux cylindriques fabriqués à partir de fils ronds et de barres - Calcul et conception - Partie 1: Ressorts de compression

Ta slovenski standard je istoveten z: EN 13906-1:2013

ICS:

21.160	Vzmeti	Springs

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EUROPEAN STANDARD
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EN 13906-1

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ICS 21.160

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English Version

Cylindrical helical springs made from round wire and bar - Calculation and design - Part 1 : Compression springs

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (EN 13906-1:2013) has been prepared by Technical Committee CEN/TC 407 “Project Committee - 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of an identical text or by endorsement, at the latest by January 2014, and conflicting national standards shall be withdrawn at the latest by January 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13906-1:2002.

This European Standard has been prepared by the initiative of the Association of the European Spring Federation ESF.

This European Standard constitutes a revision of EN 13906-1:2002 for which it has been technically revised. The main modifications are listed below:

- updating of the normative references,
- technical corrections.

EN 13906 consists of the following parts, under the general title *Cylindrical helical springs made from round wire and bar — Calculation and design*:

- *Part 1: Compression springs;*
- *Part 2: Extension springs;*
- *Part 3: Torsion springs.*

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The revision of EN 13906 series have been initiated by the Association of the European Spring Federation – ESF – in order to correct the technical errors which are in the published standards and to improve them according to the state of the art. However, the revision of the figures is not take part of this work due to the lack of shared (mutual) data to update them. Nevertheless, the customers can have updated data from the manufacturers.

1 Scope

This European Standard specifies the calculation and design of cold and hot coiled cylindrical helical compression springs with a linear characteristic, made from round wire and bar of constant diameter with values according to Table 1, and in respect of which the principal loading is applied in the direction of the spring axis.

Table 1

Characteristic	Cold coiled compression spring	Hot coiled compression spring
Wire or bar diameter	$d \leq 20$ mm	8 mm $\leq d \leq$ 100 mm
Number of active coils	$n \geq 2$	$n \geq 3$
Spring index	$4 \leq w \leq 20$	$3 \leq w \leq 12$

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 10270-1, *Steel wire for mechanical springs — Part 1: Patented cold drawn unalloyed spring steel wire*

EN 10270-2, *Steel wire for mechanical springs — Part 2: Oil hardened and tempered spring steel wire*

EN 10270-3, *Steel wire for mechanical springs — Part 3: Stainless spring steel wire*

EN 10089, *Hot-rolled steels for quenched and tempered springs — Technical delivery conditions*

EN 12166, *Copper and copper alloys — Wire for general purposes*

EN ISO 2162-1:1996, *Technical product documentation — Springs — Part 1: Simplified representation (ISO 2162-1:1993)*

EN ISO 26909:2010, *Springs — Vocabulary (ISO 26909:2009)*

ISO 26910-1, *Springs — Shot peening — Part 1: General procedures*

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 26909:2010 and the following apply.

3.1.1
spring
mechanical device designed to store energy when deflected and to return the equivalent amount of energy when released

[SOURCE: EN ISO 26909:2010, 1.1]

3.1.2
compression spring
spring (1.1) that offers resistance to a compressive force applied axially

[SOURCE: EN ISO 26909:2010, 1.2]

3.1.3
helical compression spring
compression spring (1.2) made of wire of circular, non-circular, square or rectangular cross-section, or strip of rectangular cross-section, wound around an axis with spaces between its coils

[SOURCE: EN ISO 26909:2010, 3.12]

3.2 Symbols, units and abbreviated terms

Table 2 contains the symbols, units and abbreviated terms used in this European Standard.

Table 2 *(1 of 3)*

Symbols	Units	Terms
a_0	mm	gap between active coils of the unloaded spring
$D = \frac{D_e + D_i}{2}$	mm	mean diameter of coil
D_e	mm	outside diameter of spring
ΔD_e	mm	increase of outside diameter of the spring, when loaded
D_i	mm	inside diameter of spring
d	mm	nominal diameter of wire (or bar)
d_{max}	mm	upper deviation of d
E	N/mm² (MPa)	modulus of elasticity (or Young's modulus)
F	N	spring force
F_1, F_2 ...	N	spring forces, for the spring lengths L_1, L_2... (at ambient temperature of 20°C)
$F_{c\,th}$	N	theoretical spring force at solid length L_c NOTE The actual spring force at the solid length is as a rule greater than the theoretical force
F_K	N	buckling force
F_n	N	spring force for the minimum permissible spring length L_n
F_Q	N	spring force perpendicular to the spring axis (transverse spring force)
f_e	s^{-1} (Hz)	natural frequency of the first order of the spring (fundamental frequency)
G	N/mm² (MPa)	modulus of rigidity
k	-	stress correction factor (depending on D/d)
L	mm	spring length
L_0	mm	nominal free length of spring
L_1, L_2...	mm	spring lengths for the spring forces F_1, F_2...

Table 2 *(2 of 3)*

Symbols	Units	Terms
L_n	mm	minimum permissible spring length (depending upon S_a)
L_c	mm	solid length
L_K	mm	buckling length
m	mm	mean distance between centres of adjacent coils in the unloaded condition (pitch)
N	-	number of cycles up to rupture
n	-	number of active coils
n_t	-	total number of coils
R	N/mm	spring rate
R_m	N/mm² (MPa)	minimum value of tensile strength
R_Q	N/mm	transverse spring rate
S_a	mm	sum of minimum gaps between adjacent active coils at spring length L_n
s	mm	spring deflection
s_1, s_2 ...	mm	spring deflections, for the spring forces F_1, F_2 ...
s_c	mm	spring deflection, for the solid length, L_c
s_h	mm	deflection of spring (stroke) between two positions
s_K	mm	spring deflection, for the buckling force F_K (buckling spring deflection)
s_n	mm	spring deflection, for the spring force F_n
s_Q	mm	transverse spring deflection, for the transverse force F_Q
v_{St}	m/s	impact speed
W	Nmm	spring work,
$w = \frac{D}{d}$	-	spring index
η	-	spring rate ratio
λ	-	slenderness ratio
υ	-	seating coefficient
ξ	-	relative spring deflection
ρ	kg/dm³	density
τ	N/mm² (MPa)	uncorrected torsional stress (without the influence of the wire curvature being taken into account)
τ_1, τ_2 ...	N/mm² (MPa)	uncorrected torsional stress, for the spring forces F_1, F_2 ...
τ_c	N/mm² (MPa)	uncorrected torsional stress, for the solid length L_c

Table 2 *(3 of 3)*

Symbols	Units	Terms
τ_{kh}	N/mm² (MPa)	corrected torsional stress range, for the stroke s_h
τ_k	N/mm² (MPa)	corrected torsional stress (according to the stress correction factor k)
τ_{k1}, τ_{k2} ...	N/mm² (MPa)	corrected torsional stress, for the spring forces F_1, F_2 ...
$\tau_{kH\ (...)}$	N/mm² (MPa)	corrected torsional stress range in fatigue, with the subscript specifying the number of cycles to rupture or the number of ultimate cycles
τ_{kn}	N/mm² (MPa)	corrected torsional stress, for the spring force F_n
$\tau_{kO\ (...)}$	N/mm² (MPa)	corrected maximum torsional stress in fatigue, with the subscript specifying the number of cycles to rupture or the number of ultimate cycles
$\tau_{kU\ (...)}$	N/mm² (MPa)	corrected minimum torsional stress in fatigue, with the subscript specifying the number of cycles to rupture or the number of ultimate cycles
τ_n	N/mm² (MPa)	uncorrected torsional stress, for the spring force F_n
τ_{St}	N/mm² (MPa)	impact stress
τ_{zul}	N/mm² (MPa)	permissible static torsional stress

4 Theoretical compression spring diagram

The illustration of the compression spring corresponds to Figure 4.1 from EN ISO 2162-1:1996.

The theoretical compression spring diagram is given in Figure 1**.**

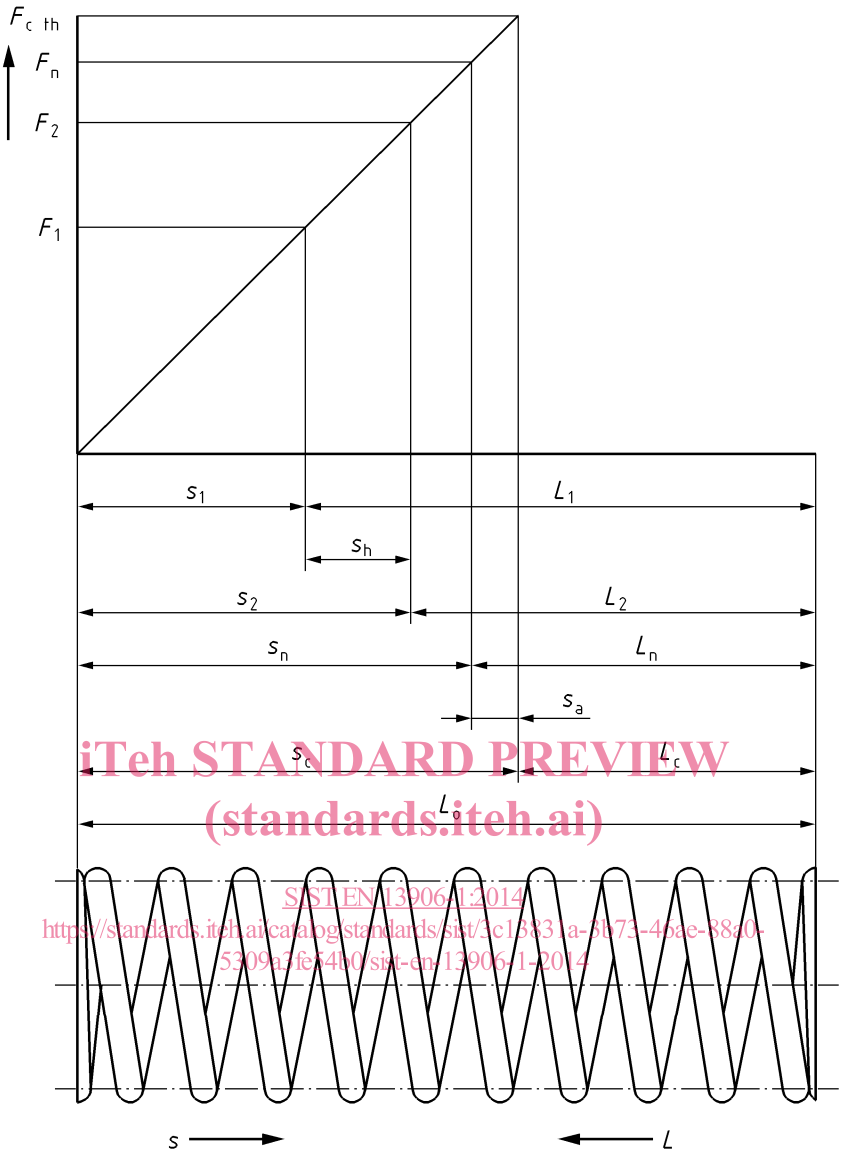

Figure 1 — Theoretical compression spring diagram

5 Design principles

Before carrying out design calculations for a spring, the requirements to be met shall be considered, particularly taking into account and defining:

- a spring force and corresponding spring deflection or two spring forces and corresponding stroke or a spring force, the stroke and the spring rate,
- loading as a function of time: is static or dynamic,
- in the case of dynamic loading the total number of cycles, N, to rupture,
- operating temperature and permissible relaxation,
- transverse loading, buckling, impact loading,
- other factors (e.g. resonance vibration, corrosion).

In order to optimise the dimensions of the spring by taking the requirements into account, sufficient working space should be provided when designing the product in which the spring will work.

6 Types of Loading

6.1 General

Before carrying out design calculations, it should be specified whether they will be subjected to static loading, quasi-static loading, or dynamic loading.

6.2 Static and/or quasi-static loading

A static loading is:

- a loading constant in time.

A quasi-static loading is:

- a loading variable with time with a negligibly small torsional stress range (stroke stress) (e.g. torsional stress range up to 0,1 × fatigue strength);
- a variable loading with greater torsional stress range but only a number of cycles of up to 10^4.

6.3 Dynamic loading

In the case of compression springs dynamic loading is:

Loading variable with time with a number of loading cycles over 10^4 and torsional stress range greater than 0,1 × fatigue strength at:

a) constant torsional stress range;

b) variable torsional stress range.

Depending on the required number of cycles N up to rupture it is necessary to differentiate the two cases as follows:

c) infinite life fatigue in which the number of cycles

  - $N \geq 10^7$ for cold coiled springs;
  - $N \geq 2 \times 10^6$ for hot coiled springs;

  In this case the torsional stress range is lower than the infinite life fatigue limit.

d) limited life fatigue in which

  - $N < 10^7$ for cold coiled springs;
  - $N < 2 \times 10^6$ for hot coiled springs.

  In this case the torsional stress range is greater than the infinite life fatigue limit but smaller than the low cycle fatigue limit.

In the case of springs with a time- variable torsional stress range and mean torsional stress, (set of torsional stress combinations) the maximum values of which are situated above the infinite fatigue life limit, the service life can be calculated as a rough approximation with the aid of cumulative damage hypotheses. In such circumstances, the service life shall be verified by means of a fatigue test.