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Hot formed helical compression springs — Technical specifications

Ressorts de compression hélicoïdaux formés à chaud — Spécifications techniques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 11891 was prepared by Technical Committee ISO/TC 227, *Springs*.

Hot formed helical compression springs — Technical specifications

1 Scope

This International Standard specifies the materials, shapes, spring characteristics, tolerances, manufacturing requirements and test methods for common helical compression springs, which are made from hot coiled round section steel bar, and then quenched and tempered (hereinafter simply “springs”).

The following limit values apply to springs conforming to this International Standard:

— free length: ≤ 900 mm;

— spring index: 3 to 12;

— slenderness ratio: 0,8 to 4;

— active coils: ≥ 3;

— spring pitch: < 0,5D;

— wire diameter: 8 mm to 60 mm;

— mean diameter of coil: ≤ 460 mm.

This International Standard is not applicable to coil springs with special performance requirements, such as railway and automotive suspensions.

2 Normative references

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

ISO 643, *Steels — Micrographic determination of the apparent grain size*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 18265, *Metallic materials — Conversion of hardness values*

ISO 26909, *Springs — Vocabulary*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.2 Symbols and units

For the purposes of this document, the symbols and units given in Table 1 apply.

Table 1 — Symbols and units

Symbol	Parameter	Unit
D	mean diameter of coil	mm
D_e	outside diameter of spring	mm
d	diameter of wire	mm
d_{max}	maximum diameter of wire (or bar)	mm
F	spring load	N
L_c	solid length	mm
L_0	free length	mm
n_t	total coils	—
R	spring rate	N/mm
s	deflection	mm
e_1	perpendicularity	mm
e_2	parallelism	mm

4 Material

4.1 Adoption of material

Unless otherwise agreed by the purchaser and the supplier, springs should be made from the material conforming to ISO 683-14.

4.2 Diameter and tolerance of bars

4.2.1 Hot rolled bars

The tolerances of the dimensions and shapes of specified hot rolled bars should be according to ISO 1035-4, unless otherwise agreed between the purchaser and the supplier.

4.2.2 Bars with cold-worked surface

Tolerances of the dimensions and shapes of cold-worked surface bars (i.e. with cold-drawn, turned, peeled, ground or a combination thereof) specified should be as specified in Table 2, unless otherwise agreed between the purchaser and the supplier.

Table 2 — Tolerances of steel bars with cold-worked surface

Dimensions in millimetres

Diameter	Tolerance
$8 \leq d < 12{,}5$	± 0,06
$12{,}5 \leq d < 26$	± 0,08
$26 \leq d < 48$	± 0,10
$48 \leq d \leq 60$	± 0,15

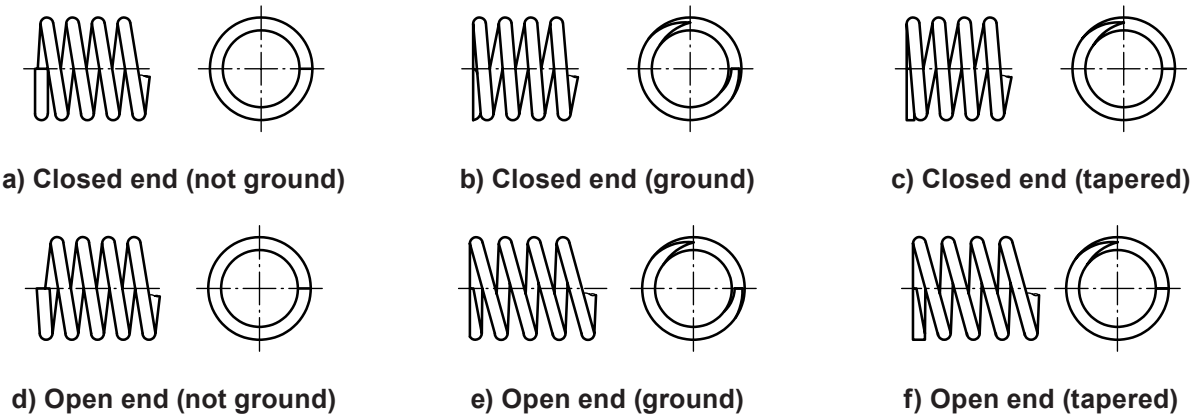
5 Spring construction

5.1 Direction of helix

Normally, the direction of helix should be right-hand (clockwise). If several springs are to be nested together, the direction of helix alternates by spring, with the outside spring usually being in the right-hand direction. If the direction of helix of the spring is requested to be left-hand, this requirement shall be indicated on the design drawing.

5.2 Types of coil end

The usual types of spring coil end are illustrated in Figure 1. If only one type is indicated on the drawings, this type shall apply to both ends of the spring; a combination of two coil ends, e.g. the coil end in Figure 1 a) and the coil end in Figure 1 b), is possible.



a) Closed end (not ground) b) Closed end (ground) c) Closed end (tapered)

d) Open end (not ground) e) Open end (ground) f) Open end (tapered)

Figure 1 — Types of coil end

6 Spring characteristics

6.1 General

The length at a specified load or the load at a specified length should be agreed between the purchaser and the supplier according to 6.2 or 6.3.

6.2 Length at a specified load

If the length at a specified load is required, the deflection under the specified load should be within the range of 20 % and 80 % of the nominal total deflection. If two or more lengths are required, it should be agreed between the purchaser and the supplier.

6.3 Load at a specified length

If the load at a specified length is required, the deflection which corresponds to the specified length should be within the range of 20 % to 80 % of the nominal total deflection. If two or more loads are required, it should be agreed between the purchaser and the supplier.

6.4 Spring rate

The axial spring rate is the force required to deflect a spring by one unit of length. The axial spring rate should be calculated by dividing the difference of loads by the difference of deflections taken at two loaded points located at 30 % to 70 % of the total deflection.

7 Tolerances of spring dimensions and characteristics

7.1 General

Three limiting tolerance grades should be applied to spring dimensions and characteristics. These grades should be selected independently for each parameter as follows (in 7.2 to 7.9). The calculated tolerances should be rounded according to ISO 80000-1.

7.2 Free length

Whenever the spring characteristics are specified, the free length, L_0, is for information only. Whenever the spring characteristics are not specified, the tolerances should be $\pm x$ % of L_0 (free length), subject to the minimum absolute value in Table 3.

Table 3 — Tolerances on the free length

Dimensions in millimetres

Grade	Grade 1	Grade 2	Grade 3
Tolerances	± 1,5 % of L_0, min. ± 2,0	± 2 % of L_0, min. ± 3,0	± 3 % of L_0, min. ± 4,0

7.3 Diameter of coils

For the diameter of coils, D, the outside diameter or inside diameter should be specified according to the uses of the springs. Tolerances should be $\pm x$ % of D (mean diameter), subject to the minimum absolute value in Table 4.

Table 4 — Tolerances on the outside diameter or inside diameter of coils

Dimensions in millimetres

Grade	Grade 1	Grade 2	Grade 3
Tolerance	± 1,25 % of D, min. ± 2,0	± 2,0 % of D, min. ± 2,5	± 2,75 % of D, min. ± 3,0

7.4 Total coils

Whenever the spring characteristics are specified, the tolerance on total coils is for reference only. Whenever spring characteristics are not specified, the tolerance on total coils should be approximately ±1/4 turn.

7.5 Perpendicularity

Except for springs with end types a and d (see Figure 1), perpendicularity should be measured for both ends, or perpendicularity plus parallelism for one end (see 9.3.2, Figure 2). Whenever the spring is standing on any end for measurement, the measured result should meet the requirements of this specification, unless otherwise agreed.

For springs with end types b, c, e and f, the perpendicularity should not be more than the limit specified in Table 5.

Table 5 — Tolerances for perpendicularity

Dimensions in millimetres

Grade	Grade 1	Grade 2	Grade 3
$L_0 \leq 500$	2,6 % of L_0	3,5 % of L_0	5 % of L_0
$L_0 > 500$	3,5 % of L_0	5 % of L_0	7 % of L_0

7.6 Parallelism

If perpendicularity for both ends is specified, parallelism shall not be required. For heavy-weight springs, one-end perpendicularity plus parallelism may be specified (see 9.3.3, Figure 3). Normally the parallelism of the two ends is not required for springs with end types a, d (see Figure 1). For springs with end types b, c, e and f, the parallelism should not be more than the limit specified in Table 6.

Table 6 — Tolerances for parallelism

Dimensions in millimetres

Grade	Grade 1	Grade 2	Grade 3
Tolerance	2,6 % of D_e	3,5 % of D_e	5 % of D_e

7.7 Irregularity of pitch

For a spring of uniform pitch, whenever 80 % of the total deflection has been compressed, the active coils shall not come into contact with each other.

7.8 Solid length

In general, the solid length is not specified. The maximum solid length of springs, L_c, for specified end types can be calculated using Formulae (1) and (2)[8]:

a) for spring end type b, e:

$$L_c \leq (n_t - 0{,}3) \cdot d_{max} \quad (1)$$

b) for spring end type a, d:

$$L_c \leq (n_t + 1{,}1) \cdot d_{max} \quad (2)$$

c) the solid length for springs with end type c and f should be agreed between the purchaser and the supplier.

7.9 Tolerances on spring characteristics

7.9.1 General

In general, there are three grades of tolerance based on spring characteristics for different applications.

7.9.2 Tolerances on length at a specified load

Tolerance should be $\pm x$ % of s (deflection), subject to the minimum absolute value in Table 7.

Table 7 — Tolerances on length at a specified load

Dimensions in millimetres

Grade	Grade 1	Grade 2	Grade 3
Tolerance	± 5 % of s, min. ± 2,5	±10 % of s, min. ± 5,0	±15 % of s, min. ± 7,5

7.9.3 Tolerances on load at a specified length

Tolerances should be $\pm x$ % of F (spring load), subject to the minimum absolute value in Table 8.

Table 8 — Tolerances on load at a specified length

Units in newtons

Grade	Grade 1	Grade 2	Grade 3
Tolerance	± 5 % of F, min. ± 2,5 R	± 10 % of F, min. ± 5 R	±15 % of F, min. ± 7,5 R

7.9.4 Tolerances on spring rate

Tolerances should be ± 10 % of axial spring rate, R. For high accuracy application, ± 5 % R may be specified. Other tolerances should be agreed between the purchaser and the supplier.