भारतीय मानक

Indian Standard

IS 17458 (Part 1) : 2024
ISO 22705-1 : 2021

स्प्रिंग — माप और परीक्षण मानदंड

भाग 1 अतप्त निर्मित बेलनाकार कुंडलिनी संपीड़न स्प्रिंग

Springs — Measurement and Test Parameters

Part 1 Cold Formed Cylindrical Helical Compression Springs

ICS 21.160

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Springs and Suspension Systems Sectional Committee, TED 34

NATIONAL FOREWORD

This Indian Standard (Part 1) which is identical to ISO 22705-1 : 2021 'Springs — Measurement and test parameters — Part 1: Cold formed cylindrical helical compression springs' issued by International Organization for Standardization (ISO), was adopted by the Bureau of Indian Standards on the recommendation of the Springs and Suspension Systems Sectional Committee and approval of the Transport Engineering Division Council.

This standard is one of the part of standards on the springs measurement and test parameters. Other part of this standard is:

Part 2 Cold formed cylindrical helical extension springs

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminologies and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and
b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. The Bureau of Indian Standards shall not be held responsible for identifying any or all such patent rights.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off it shall be done in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'

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Indian Standard

SPRINGS — MEASUREMENT AND TEST PARAMETERS

PART 1 COLD FORMED CYLINDRICAL HELICAL COMPRESSION SPRINGS

1 Scope

This document specifies the measurement and test methods for the general characteristics of cold formed helical compression springs made from round wire, excluding dynamic testing.

2 Normative references

There are no normative references in this document.

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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

[SOURCE: ISO 26909:2009, 1.1]

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

Note 1 to entry: In the narrow sense, a compression spring indicates a helical compression spring.

[SOURCE: ISO 26909:2009, 1.2]

3.1.3
coil spring
coil-shaped spring

[SOURCE: ISO 26909:2009, 3.11]

3.1.4
helical compression spring
compression spring made of wire of circular cross-section, wound around an axis with spaces between its coils

[SOURCE: ISO 26909:2009, 3.12, modified — limited to wires with circular cross-section]

3.1.5
cold formed spring
spring formed at ambient temperature

[SOURCE: ISO 26909:2009, 1.12]

3.1.6
active coils
total number of coils less the inactive coils

Note 1 to entry: This is the number of coils used in computing the total deflection of a spring.

[SOURCE: ISO 26909:2009, 5.70, modified — extended to all inactive coils]

3.1.7
test parameter
parameter with a tolerance for which there is an immediate conclusion after the test (within tolerance or out of tolerance)

Note 1 to entry: Test can be performed without measurement (i.e. with GO/NO-GO gauges).

3.2 Symbols and abbreviated terms

Table 1 includes the symbols and abbreviated terms used throughout this document.

Table 1 — Symbols and abbreviated terms

Symbols	Units	Designations
D_e	mm	outside diameter of spring
$D_{e,max}$	mm	maximum outside diameter of spring
$D_{e,min}$	mm	minimum outside diameter of spring
D_i	mm	inside diameter of spring
$D_{i,max}$	mm	maximum inside diameter of spring
$D_{i,min}$	mm	minimum inside diameter of spring
d	mm	diameter of wire
d_{max}	mm	maximum diameter of wire
d_{wire}	mm	actual wire diameter
e_1	mm	perpendicularity
e_2	mm	parallelism
F	N	spring load or force
F_c	N	spring load at solid length, L_c
F_{max}	N	maximum specified spring load
F_{min}	N	minimum specified spring load
F_n	N	spring load for the minimum test length, L_n
F_1, F_2,...	N	specified spring loads for the specified spring lengths, L_1, L_2,...
L_c	mm	solid length
L_{max}	mm	maximum specified spring length
L_{min}	mm	minimum specified spring length
L_n	mm	minimum acceptable test length for F_n
L_0	mm	free length
$L_{0,max}$	mm	maximum free length
$L_{0,min}$	mm	minimum free length
L_1, L_2,...	mm	specified spring lengths for the spring loads, F_1, F_2,...

Table 1 *(continued)*

Symbols	Units	Designations
n	–	active coils
n_t	–	total number of coils
p	mm	spring pitch
$R=\frac{\Delta F}{\Delta L}=\frac{\Delta F}{\Delta s}$	N/mm	spring rate (see Annex A)
s	mm	deflection of spring
s_c	mm	deflection of spring for the solid length, L_c
s_h	mm	deflection of the spring (stroke) between two loads, ΔF
s_n	mm	maximum test spring deflection for the spring load, F_n
s_1, s_2,...	mm	specified spring deflections for the specified spring loads, F_1, F_2,...
u	mm	distance between the coils

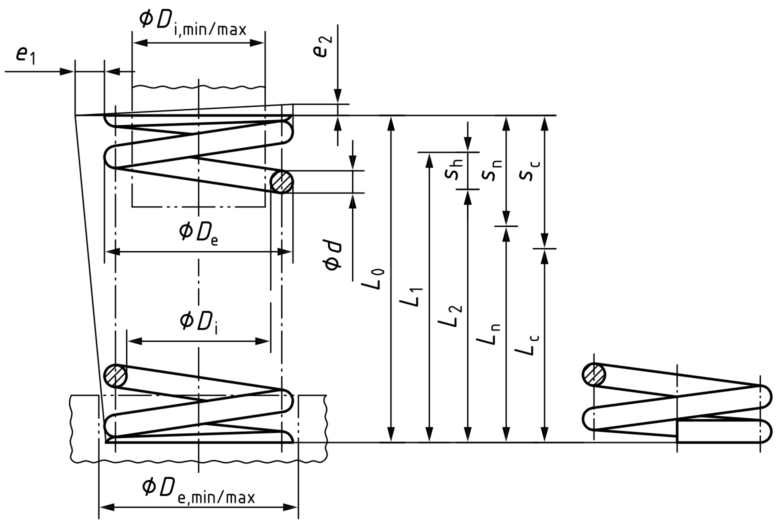


Figure 1 — Symbols for helical compression springs

4 Environmental conditions

The spatial distribution and equipment of the facility shall permit a reliable implementation of the measurements and tests. Measurements and tests should be carried out at ambient temperature in a normal workshop environment. Special tests (e.g. in air-conditioned rooms or other special environments) shall be agreed upon between the manufacturer and the customer. Measuring and testing equipment should be subject to regular inspection.

5 Qualifications of the person(s) performing the work

The measurements and tests shall be carried out by a person who has been instructed/trained in the use of the measuring and testing equipment, as well as regarding methods and test requirements.

The qualifications or additional knowledge and skills should be documented in appropriate qualification or training documents, depending on the requirements.

6 Geometries of guiding and supporting devices

If guiding and supporting devices (e.g. test pins, guide sleeves, ring grooves) are used, the properties (e.g. geometry, material) shall be agreed upon between the manufacturer and the customer to include special cases such as snapping end coils, buckling or bulging. The alignment of guiding and supporting devices is aimed to improve the reproducibility of the measurements.

7 Measuring and testing equipment

Suitable measuring equipment shall be selected. Measuring equipment shall conform to ISO standards, if such are available (e.g. ISO 3611 and ISO 13385-1).

If there is a customer requirement, the methods and measuring equipment shall be agreed on separately.

8 Measurement and test parameter for technical cold formed cylindrical compression springs

8.1 Free length (L_0)

8.1.1 General

The free length L_0 is a measurement and test parameter.

8.1.2 Type of characteristic

L_0 is the length across the entire spring body when no load is applied and only when both ends are ground (see Figure 2); other cases should be agreed upon between the manufacturer and the customer.

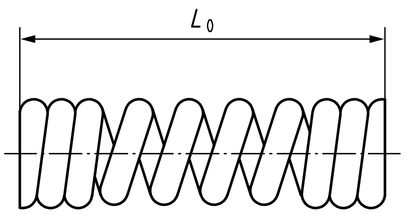


Figure 2 — Free length (L_0) where both ends are closed and ground

8.1.3 Measuring and/or testing equipment

The following measuring equipment can be used:

— micrometer gauge;

— calliper;

— dial gauge/indicating calliper;

— electronic measuring sensor;

— manual/automatic force gauge;

— optical measuring instruments/protractor/measurement microscope/camera systems.

The following testing equipment can be used:

— attributive gauges (GO/NO-GO gauges).

8.1.4 Conditions of measurement and testing

The free length L_0 shall be evaluated at ambient temperature as delivered.

8.1.5 Method of measurement and testing

a) Variable measurement

The measurement can be carried out without contact using optical procedures, capacitive or electrically by contact (with minimal force) or by contact with the measuring surfaces (at a known/unknown measuring force). Preferably, the measurement should be carried out over the entire face (see Figure 3). If this is not possible, then a second measurement can be carried out with a 90° offset. In this case, it shall be clarified whether the maximum value, the minimum value or the average value is to be specified.

When there is a spring self-weight effect, the measurement of free height should be agreed upon between the manufacturer and the customer.

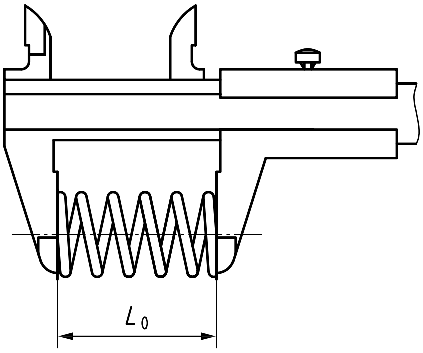
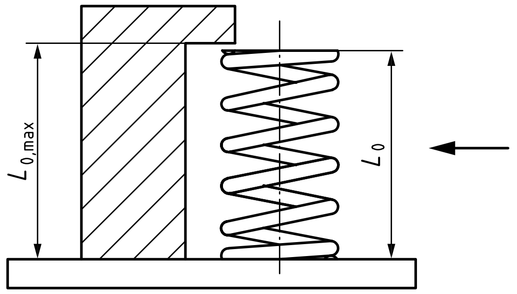


Figure 3 — Method of measurement of the free length (L_0) with calliper (example)

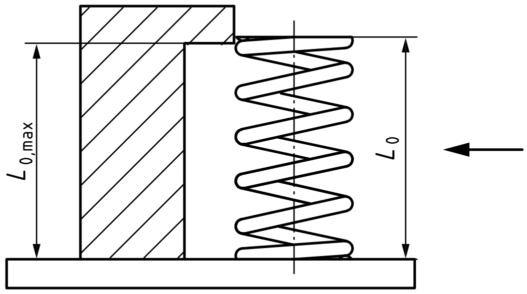
If the customer specifies a setting length for the test spring, the setting conditions for the test spring shall be agreed upon between the manufacturer and the customer.

Unless otherwise specified, springs that are not pre-set shall only be measured after the spring load test. If no spring load or force is specified, measurement can be done without any preliminary test.

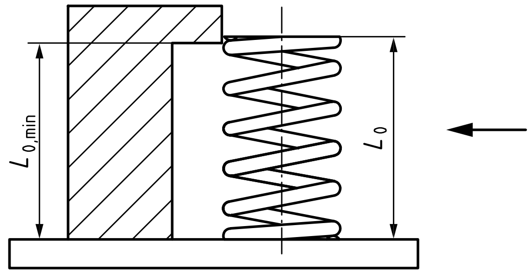
b) Attributive testing (with GO/NO-GO gauges, see Figure 4)



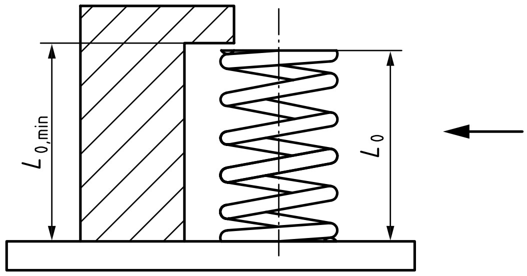
a) Tolerance upper limit check with gauge ($L_0 \leq L_{0,max}$) (GO/within tolerance)



b) Tolerance upper limit check with gauge ($L_0 > L_{0,max}$) (NO GO/out of tolerance)



c) Tolerance lower limit check with gauge ($L_0 \geq L_{0,min}$) (NO GO/within tolerance)



d) Tolerance lower limit check with gauge ($L_0 < L_{0,min}$) (GO/out of tolerance)

Figure 4 — Method of testing the free length (L_0) with gauges (examples)

8.1.6 Test location on the product

The test direction is in the axial direction to the finished spring. When measuring equipment is used that induces a measuring force, then the applied force should not deflect the spring.

When optical measuring equipment (camera systems) is used, the measurement axis is perpendicular to the spring axis.

8.2 Outside diameter (D_e)

8.2.1 General

The outside diameter D_e is a measurement and test parameter.

8.2.2 Type of characteristic

D_e is the value of the outside diameter through the whole spring body (see Figure 5).

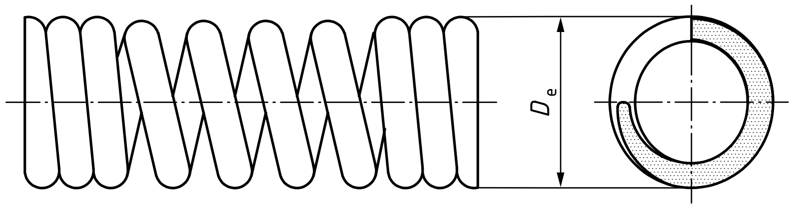


Figure 5 — Outside diameter (D_e)

8.2.3 Measurement and/or testing equipment

The following standard measuring equipment can be used:

— micrometer gauge;

— calliper;

— dial gauge.

Alternatively, optical measuring equipment can be used.

In this case, the following testing equipment can be used:

— test sleeve;

— special gauge (part-based);

— snap gauge.

The shape and dimension of all testing equipment shall be agreed upon between the manufacturer and the customer.

8.2.4 Conditions of measurement and testing

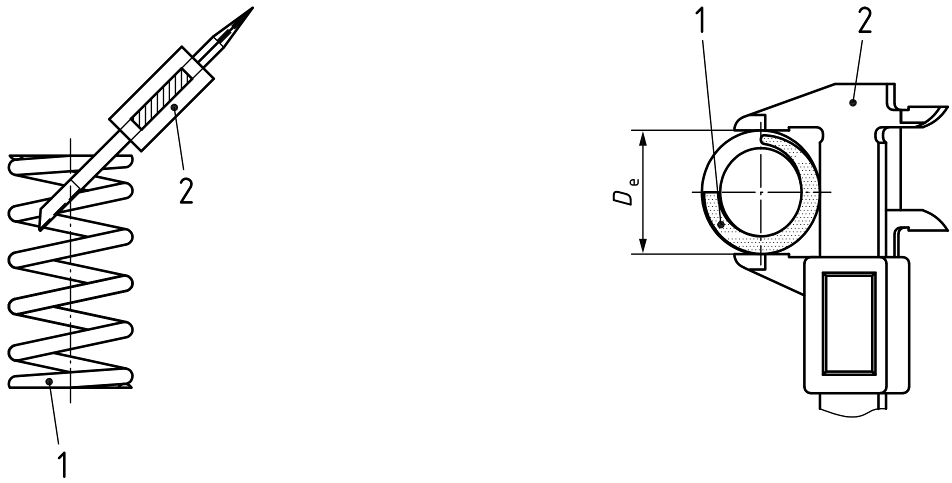
The outside diameter D_e shall be evaluated at ambient temperature as delivered.

In special cases, tests for coated and set springs should be agreed upon between the manufacturer and the customer.

8.2.5 Method of measurement and testing

a) Variable measurement (e.g. calliper)

The measurement is performed at several locations on the product, at least at the beginning, in the centre (Figure 6 and Figure 7) and at the end of the spring. The measurement at the end is performed in two perpendicular directions of the spring, except if the useful length of the calliper jaws is greater than the free length of the spring. Each measured value shall be within the tolerance. The maximum value shall be documented.

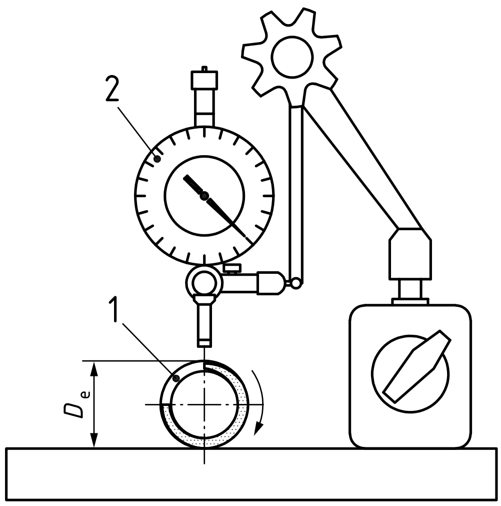


Key

1 spring

2 calliper

Figure 6 — Method of measurement of the outside diameter (D_e) with calliper (example)



Key

1 spring

2 dial gauge

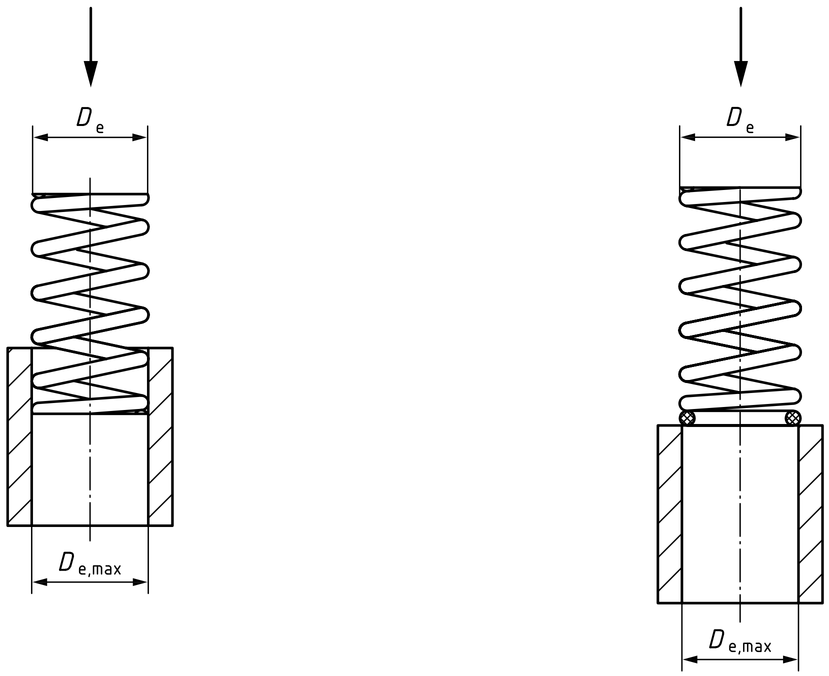
Figure 7 — Method of measurement of the outside diameter (D_e) with dial gauge (example)

b) Attributive testing (with test sleeve as GO/NO-GO gauge, see Figure 8)

The spring shall fall through the test sleeve due to its own weight at $D_{e,max}$ (see Figure 8a).

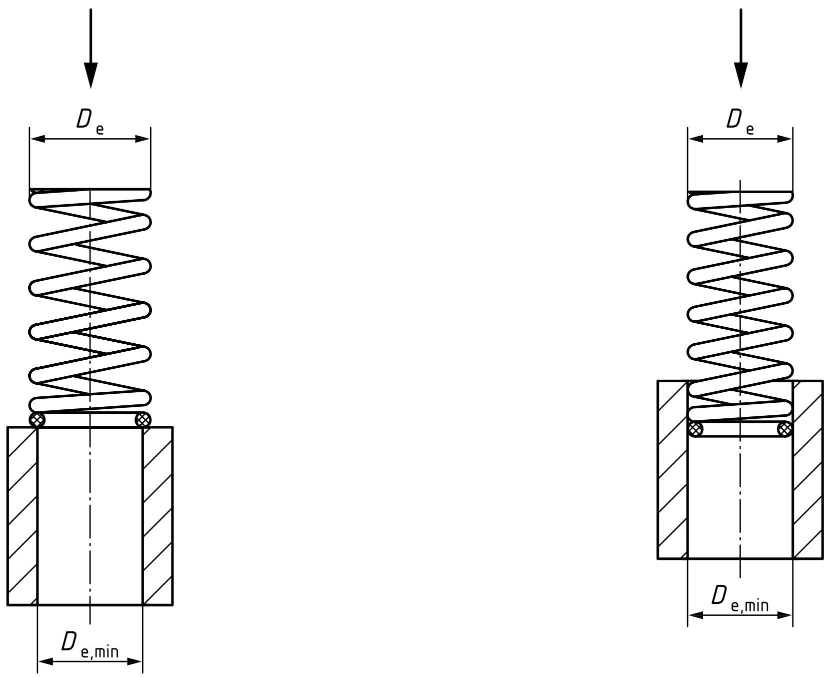
The spring shall not fall through the test sleeve due to its own weight at $D_{e,min}$ (see Figure 8c).

For the purpose of testing geometrical deviations (enveloping circle, curvature), a test sleeve with the length and diameter for cylindrical springs may be agreed upon between the manufacturer and the customer.



a) Tolerance upper limit check with test sleeve ($D_e \leq D_{e,max}$) (GO/within tolerance)

b) Tolerance upper limit check with test sleeve ($D_e > D_{e,max}$) (NO GO/out of tolerance)



c) Tolerance lower limit check with test sleeve ($D_e \geq D_{e,min}$) (NO GO/within tolerance)

d) Tolerance lower limit check with test sleeve ($D_e < D_{e,min}$) (GO/out of tolerance)

Figure 8 — Method of testing of the outside diameter (D_e) with test sleeve (examples)

8.2.6 Test location on the product

a) Variable measurement (e. g. calliper)

The measurement is performed at several locations on the product, at least at the beginning, in the centre and at the end of the spring with no load applied. The whole spring body should be measured.

b) Attributive testing (e. g. GO/NO-GO gauge)

The test is carried out over the entire length of the spring. The test sleeve length shall correspond to at least the clearance between 2 and a maximum of 4 coils.

8.3 Inside diameter (D_i)

8.3.1 General

The inside diameter D_i is a measurement and test parameter.

8.3.2 Type of characteristic

D_i is the minimum value of the inside diameter through the whole spring body (see Figure 9).

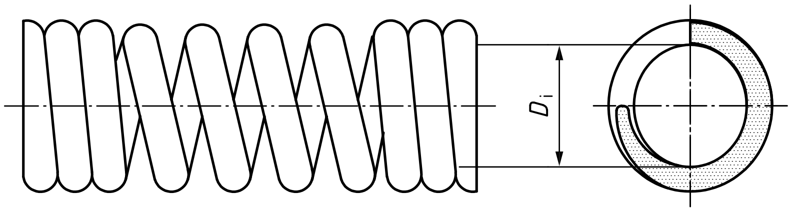


Figure 9 — Inside diameter (D_i)

8.3.3 Measuring and/or testing equipment

The following measuring equipment can be used:

— calliper.

Alternatively, a micrometer screw or optical measuring equipment can be used.

The following testing equipment can be used:

— test pin;

— special gauge (part-based), e. g. GO/NO-GO gauge.

The shape and dimension of all testing equipment shall be agreed upon between the manufacturer and the customer.

8.3.4 Conditions of measurement and testing

The inside diameter D_i shall be evaluated at ambient temperature as delivered.

In special cases, tests for coated and set springs should be agreed upon between the manufacturer and the customer.

8.3.5 Method of measurement and testing

a) Variable measurements (e.g. calliper)

Take two measurements per end (in perpendicular directions at each end) of the spring (see Figure 10), unless the length of the calliper jaws is greater than the free length of spring (in this case, take only two measurements in perpendicular directions). The minimum value shall be documented.

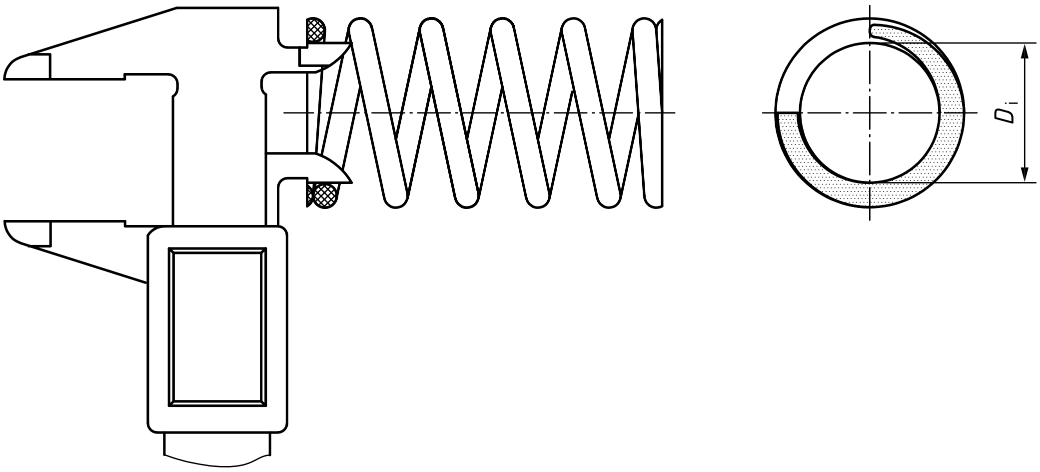


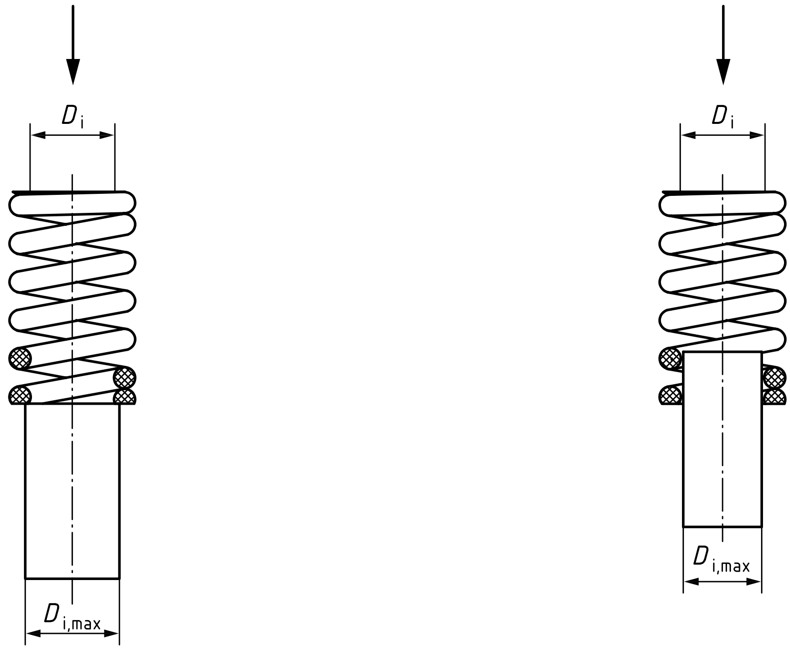
Figure 10 — Method of measurement of the inside diameter (D_i) with calliper (example)

b) Attributive testing (with test pin as GO/NO-GO gauge, see Figure 11)

The spring shall fall over the test pin due to its own weight at $D_{i,min}$ (see Figure 11c).

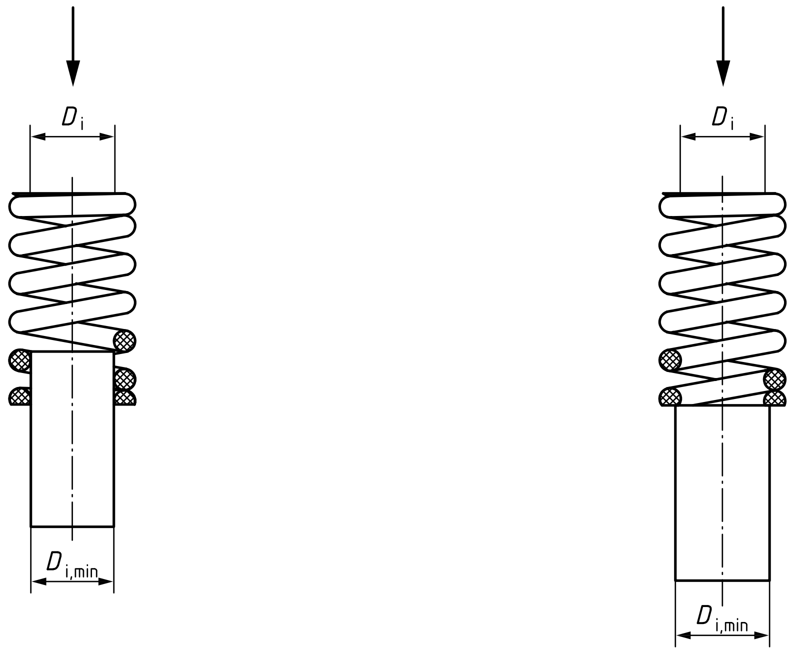
The spring shall not fall over the test pin due to its own weight at $D_{i,max}$ (see Figure 11a).

Both of the above-mentioned criteria shall be met, regardless of which side of the spring is attached to the test pin.



a) Tolerance upper limit with test pin ($D_i \leq D_{i,max}$) (NO GO/within tolerance)

b) Tolerance upper limit with test pin ($D_i > D_{i,max}$) (GO/out of tolerance)



c) Tolerance lower limit with test pin ($D_i \geq D_{i,min}$) (GO/within tolerance)

d) Tolerance lower limit with test pin ($D_i < D_{i,min}$) (NO GO/out of tolerance)

Figure 11 — Method of testing the inside diameter (D_i) with test pin (examples)

8.3.6 Test location on the product

a) Variable measurement

The measurement is carried out at the beginning and at the end of the spring.

In the spring centre, the inside diameter of the spring, D_i, can only be determined using Formula 1.

$$D_i = D_e - 2 \times d_{wire}$$

where

D_i is the inside diameter of the spring

D_e is the outside diameter of the spring

d_{wire} is the real wire diameter after the forming process (coiling/winding)

b) Attributive gauges (GO/NO GO-gauges)

The test is carried out over the entire length of the spring (L_0).

For the purpose of testing geometrical deviations (enveloping circle, curvature), a test gauge can be agreed upon between the manufacturer and the customer.

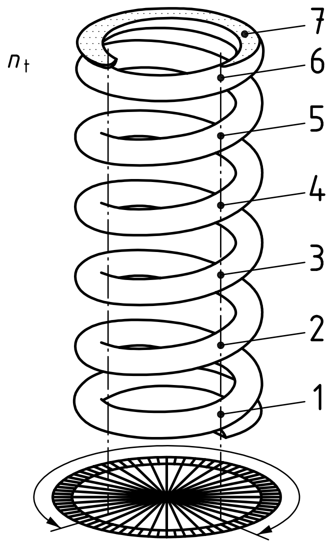
8.4 Total number of coils (n_t), number of active coils (n) and coil direction

8.4.1 General

The total number of coils and the coil direction are test parameters. The number of active coils is a theoretical calculation value.

8.4.2 Type of characteristic

The total number of coils n_t is the number of wire rotations/coils around the spring axis (see Figure 12).



Key

1 coil number 1

2 coil number 2

3 coil number 3

4 coil number 4

5 coil number 5

6 coil number 6

7 0,75 of a full coil (determined by the scale)

Figure 12 — Total number of coils (n_t)

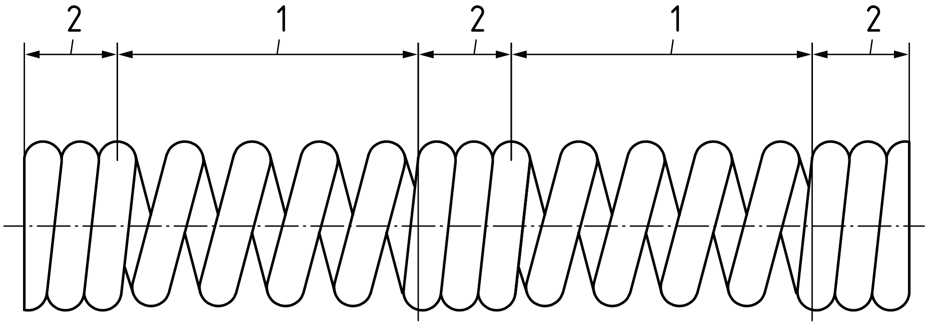
The number of active coils, n, is a theoretical calculated value that cannot be measured geometrically. The number of active coils can only be counted approximately.

The number of active coils, n, is the total number of coils, n_t, less the number of inactive coils (see Figure 13).

Definition of inactive coils:

a) with the end coil in contact, the number of turns is determined from the end of the wire to the last contact point with the subsequent coil.

b) with the coils contacting in the spring body between the end coils, the number of coils in each case is determined from the first to the last contact point of two adjacent (consecutive) coils.



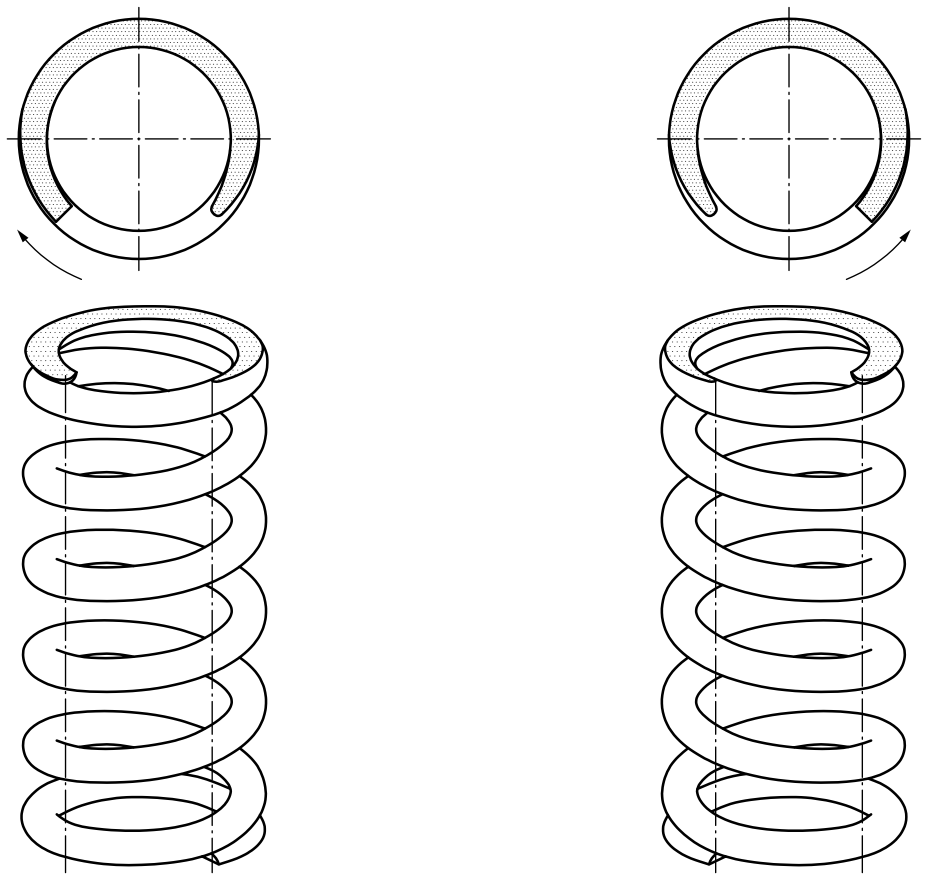
Key

1 active coils

2 inactive coils

Figure 13 — Number of active coils (*n*)

Depending on the winding direction during the coiling process, the spring can be coiled clockwise or counterclockwise (see Figure 14).



a) clockwise (right-handed) b) counterclockwise (left-handed)

Figure 14 — Coil direction

8.4.3 Measuring and/or testing equipment

The following testing equipment can be used:

— visual inspection;

— test template;

— optical test.

8.4.4 Conditions of measurement and testing

The total number of coils n_t shall be evaluated at ambient temperature as delivered.

8.4.5 Method of measurement and testing

All tests are carried out on the unloaded spring.

Total number of coils, n_t:

The wire coil rotations shall be counted from one end of the wire (spring end) to the other. Therefore, the end of the wire in each case is the maximum point in the run-off direction of rotation (see Figure 12).

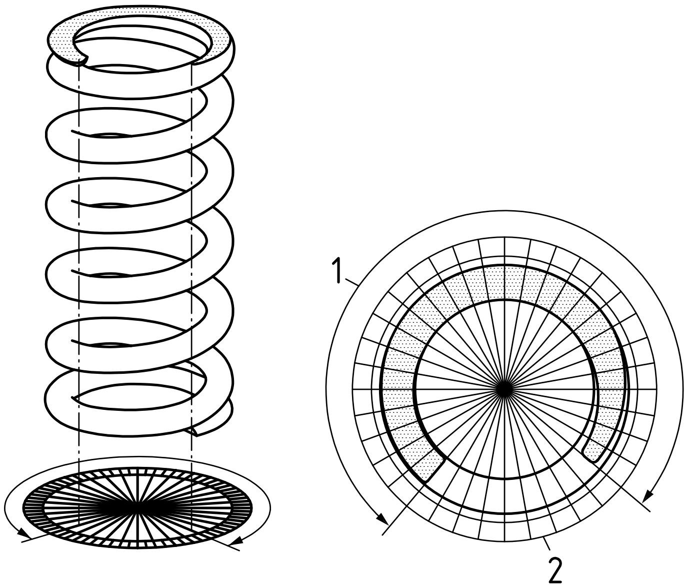
In case of open flat ends, and with open coils in the spring body, $n = n_t$.

Depending on the spring holding condition, there are cases of $n \neq n_t$.

The coil direction can be clockwise (right-handed) or counterclockwise (left-handed) (see Figure 14).

8.4.6 Test location on the product

The entire spring body shall be considered (see Figure 15).



Key

1 0,75 of a full coil

2 angle scale

Figure 15 — Method of measurement of the total number of coils (n_t) with test template (example)

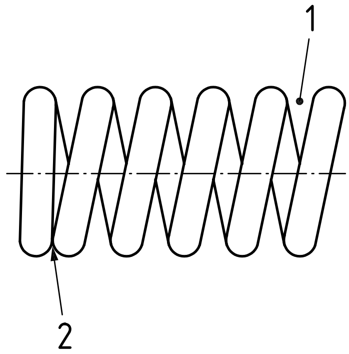
8.5 Applied end coils

8.5.1 General

The contacting end coils are a test parameter.

8.5.2 Type of characteristic

This is the condition of the spring ends. The end coils can be in contact (closed) or not (open) (see Figure 16). A minor gap is permissible if it is not relevant to the spring behaviour and cannot result in spring locking.



Key

1 open

2 closed

Figure 16 — End coils

8.5.3 Measuring and/or testing equipment

The following testing equipment can be used:

— visual inspection;

— optical test.

8.5.4 Conditions of measurement and testing

The contacting end coils shall be evaluated at ambient temperature as delivered.

8.5.5 Method of measurement and testing

The test is carried out on the unloaded spring.

The number of turns from the wire end to the last contact point of two adjacent (consecutive) coils shall be determined.

8.5.6 Test location on the product

The respective end coils of the spring shall be considered.

8.6 Solid length (L_c)/solid force (F_c)

8.6.1 General

The solid length L_c is a measurement and test parameter.

The solid force F_c is the theoretical spring force at solid length, which is not used during measurement and testing.

If the number of coils is open for production margin, this shall be taken into consideration or agreed upon when indicating the solid dimension.

8.6.2 Type of characteristics

The solid length L_c is the length of the spring, when the spring is loaded between two parallel test surfaces, in which all coils have contact in at least one point (see Figure 17).

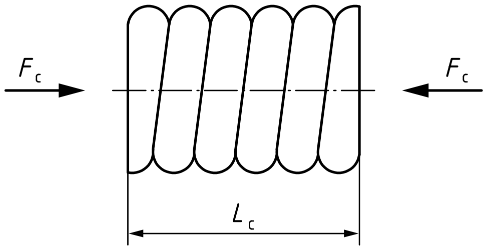


Figure 17 — Solid length (L_c)

8.6.3 Measuring and/or testing equipment

The following measuring and testing equipment can be used:

— spring load tester (manual or powered);

— calliper;

— dial gauge;

— block gauge;

— optical test.

8.6.4 Conditions of measurement and testing

The solid length L_c is evaluated at ambient temperature as delivered.

8.6.5 Method of measurement and testing

The spring shall not exceed a defined solid length, L_c, i.e. the solid length, L_c, shall be less than or equal to a specified value.

Measurement method for the determination of solid length, L_c:

The spring shall be compressed until all coils contact each other in at least one point (see Figure 18).

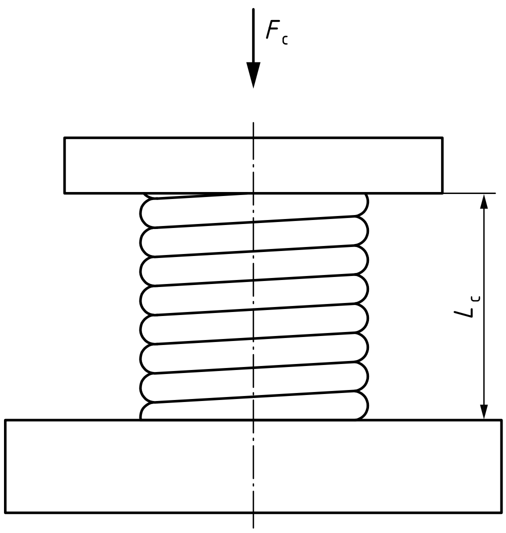


Figure 18 — Method of testing the solid length (L_c) with a spring load tester (example)

A test force shall be agreed upon with the customer upon request.

Geometries of guiding and supporting devices (for example, test pins, guide bushings, ring groove) may be agreed upon between the manufacturer and the customer to include special cases such as snapping end coils, buckling or bulging.

8.6.6 Test location on the product

The entire spring body shall be considered.

The two highest points are measured in axial direction.

8.7 Spring load (*F*)

8.7.1 General

The spring load F is a measurement and test parameter.

8.7.2 Type of characteristic

F_1, F_2,... are the assigned spring loads to the lengths of the loaded spring L_1, L_2,... or the assigned deflections s_1, s_2,....

The spring load is an axial force in the direction of compression (see Figure 19).

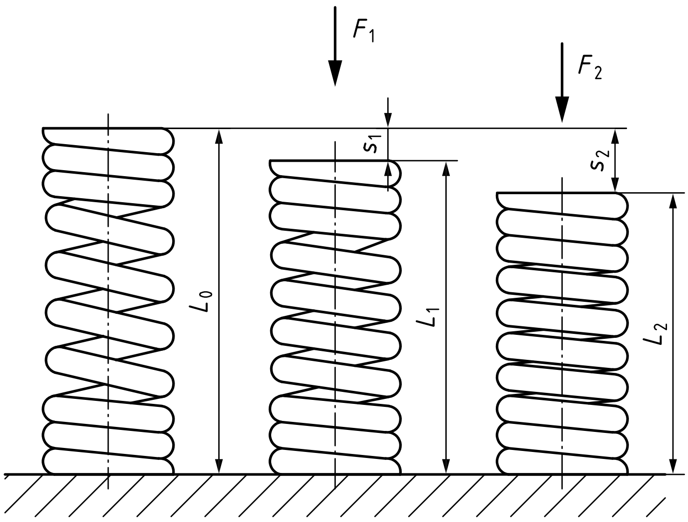


Figure 19 — Spring load (*F*)

8.7.3 Measuring and/or testing equipment

In order to test the force, a suitable, calibrated force and test gauge shall be used, which has been checked regularly between the calibrating intervals and adjusted to the required tolerance. This can be:

— a spring load tester (manual or powered);

— force measuring sensors (relationship between deformation and force) in part-specific test equipment;

— a beam balance (balancing weights).

8.7.4 Conditions of measurement and testing

The spring load F is evaluated at ambient temperature as delivered.

8.7.5 Method of measurement and testing

Unless otherwise specified, springs that are not preset are measured under force between two parallel plates, first at L_{min} (F_{max}), then unloaded and then measured by decreasing deflections to L_{max} (F_{min}). The spring is relieved between the individual measurements.

If the manufacturer considers the use of a test pin to be required for the spring force test, then it shall be used.

When testing with a test pin, the spring shall fall over the test pin due to its own weight at $D_{i,min}$.

If the customer specifies a setting length for the test spring, the setting conditions for the test spring shall be agreed upon between the manufacturer and the customer.

Geometries of guiding and supporting devices (e.g. test pins, guide bushings, ring groove) may be agreed upon between the manufacturer and the customer to include special cases such as snapping end coils, buckling, bulging, etc.

8.7.6 Test location on the product

The entire spring body shall be considered.

8.8 Spring pitch (p)/distance between the coils

8.8.1 General

The spring pitch/distance between the coils is a measurement.

The (functional) spring characteristic with the corresponding tolerances should be defined, rather than specifying the spring pitch/distance between the coils (u).

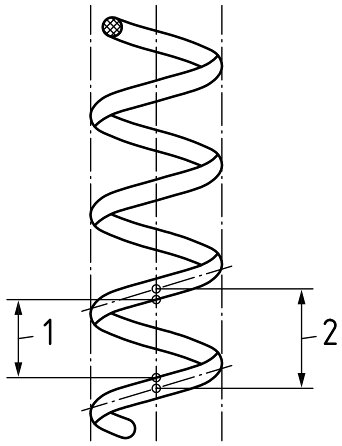
8.8.2 Type of characteristic

The spring pitch p is the distance between two consecutive coils in the neutral axis.

The spring pitch (p) can be calculated by adding the distance between coils (u) to the diameter of wire (d):

$$p = d + u$$

Figure 20 illustrates the difference between distance between coils and spring pitch.



Key

1 distance between coils, *u*

2 spring pitch, *p*

Figure 20 — Difference between spring pitch (*p*) and distance between the coils

8.8.3 Measuring and/or testing equipment

The following measuring equipment can be used:

— calliper (with the corresponding dimension);

— optical measuring instruments/protractors.

The resolution of the measuring equipment shall be observed.

8.8.4 Conditions of measurement and testing

The spring pitch *p* is evaluated at ambient temperature as delivered.

8.8.5 Method of measurement and testing

The measurement can be performed without contact (optical) or with minimal force application (manual check).

The measurement should be performed perpendicular to the spring axis.

8.8.6 Test location on the product

Coils to be defined between the manufacturer and the customer.

Furthermore, the measuring point should be precisely defined, since there are partly different distances between the coils in the spring.

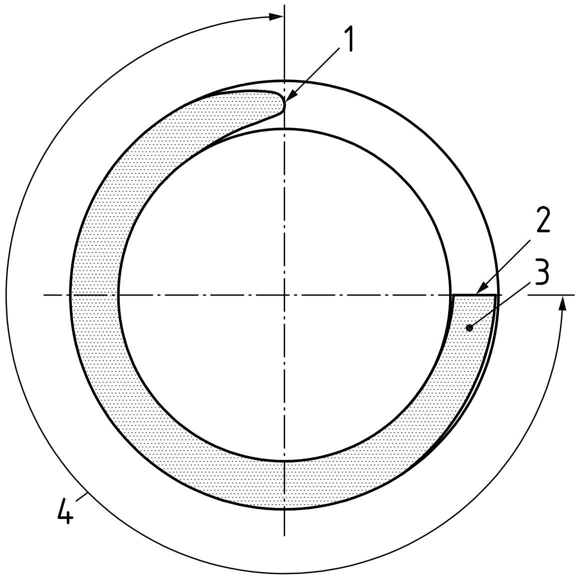
8.9 Ground surface/angle

8.9.1 General

The ground surface is a measurement and test parameter, for which the angle between the beginning and the end of the ground surface is indicated in degrees (see Figure 21 and Figure 22).

8.9.2 Type of characteristic

The inspected properties are the ground surfaces of the coil ends.



Key

1 end of grinding surface

2 end of coil

3 ground surface

4 grinding angle

Figure 21 — Applied and ground spring ends

8.9.3 Measuring and/or testing equipment

The following testing equipment should be used:

— visual inspection;

— template;

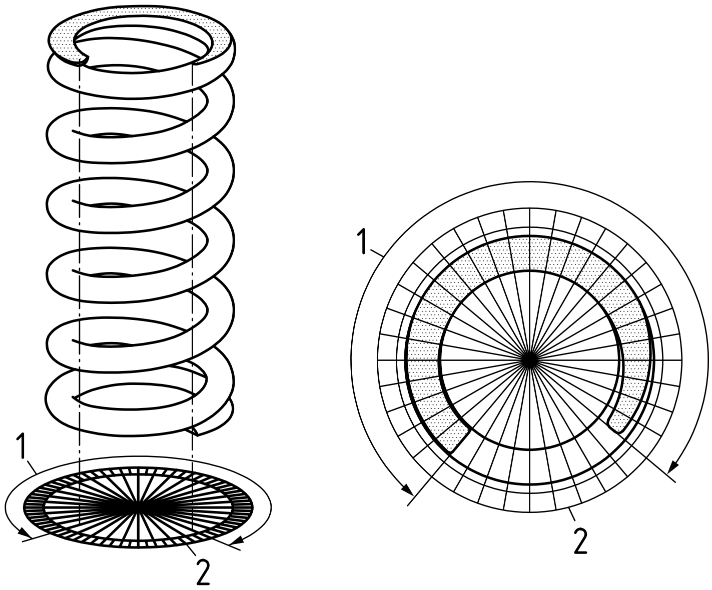
— projector;

— protractor.

The following measuring equipment should be used:

— projector with reflected light and protractor.

If the ground angle is determined by using a template, see Figure 22.



Key

1 ground angle

2 angle scale

Figure 22 — Method of testing the ground angle with a template (example)

8.9.4 Conditions of measurement and testing

The ground surface is evaluated at ambient temperature as delivered.

8.9.5 Method of measurement and testing

Visual inspection: ground surface.

Profile projector: ground angle with reflected light and protractor.

8.9.6 Test location on the product

The test is performed at the ground end coils of the spring.

8.10 Perpendicularity (e_1)

8.10.1 General

The perpendicularity e_1 at contacting and ground coil ends.

The perpendicularity, e_1, is a measurement and test parameter.

8.10.2 Type of characteristic

Perpendicularity, e_1 is the variation of squareness from the vertical spring axis in mm.

Figure 23 illustrates the characteristic of the perpendicularity, e_1.

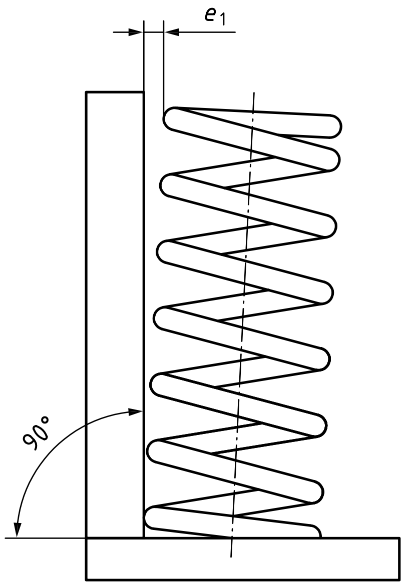


Figure 23 — Perpendicularity (e_1)

8.10.3 Measuring and/or testing equipment

The following measuring and testing equipment can be used:

— profile projector;

— height gauge or fixture with dial gauge;

— 3D camera systems (optical measuring system);

— steel square and feeler or pin gauge;

— protractor.

Special test procedures shall be agreed upon between the manufacturer and the customer.

8.10.4 Conditions of measurement and testing

The perpendicularity e_1 is evaluated at ambient temperature as delivered. The test is only applicable for closed and ground springs.

8.10.5 Method of measurement and testing

The perpendicularity, e_1, is determined at both spring ends. The larger of the two measurement values shall be used.

a) e_1 feeler gauge or dial gauge or pin gauge:

The ground spring is held, ground end against a flat surface, and lower coil against a square, while turned until the maximum offset between the lower and upper coil diameter is reached (check). The conformity to a maximum e_1 acceptable value is then determined using a feeler gauge.

b) e_1 profile projector:

The measurement is carried out using the coordinate system of the profile projector, without stops or devices. After orientation on the flat surface (glass plate) of the profile projector, the spring is turned to its maximum perpendicularity. This can be in the X and Y direction. The measured distance between the centres of the first and of the last coil diameter is e_1 (depending on the light incidence of the profile projector, applied perpendicular to a magnet).

c) e_1 camera systems:

The e_1 measurement is similar to that using the dial gauge; however, the measurement values are determined optically. The measurement using optical measuring instruments is device-dependent and shall be described or agreed upon with the customer on a case-by-case basis.

8.10.6 Test location on the product

The test location is on the applied and ground end coils.

8.11 Parallelism (e_2)

8.11.1 General

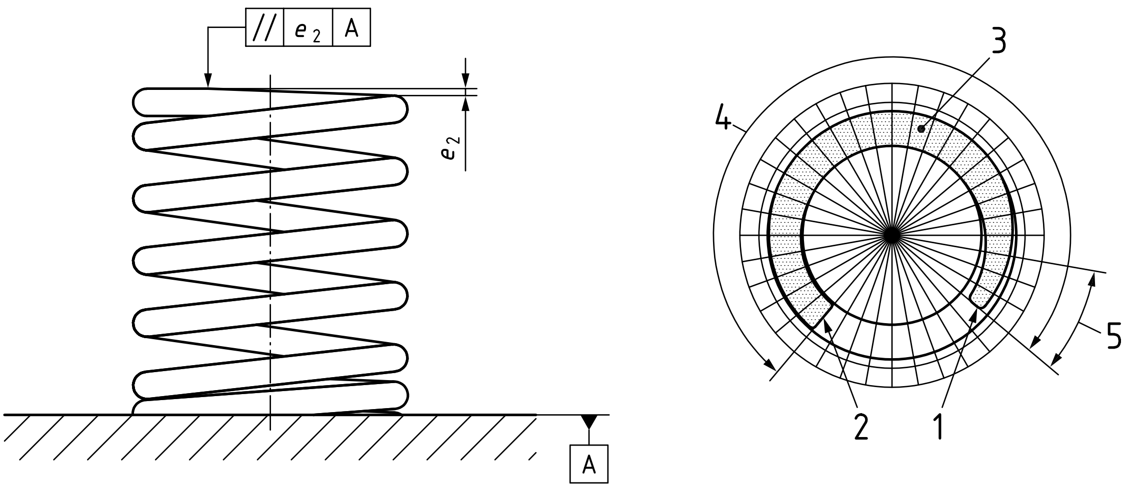
Parallelism e_2 at contacting and ground end coils.

Parallelism, e_2, is a measuring and test parameter.

8.11.2 Type of characteristic

Parallelism, e_2, is the variation of parallelism of the spring bearing surface in mm.

Figure 24 illustrates the characteristic of parallelism, e_2.



Key

1 end of grinding surface

2 end of coil

3 ground surface

4 ground angle

5 not considered area for e_2

Figure 24 — Parallelism (e_2)

8.11.3 Measuring and/or testing equipment

The following measuring and testing equipment can be used:

— profile projector;

— height gauge or fixture with dial gauge;

— 3D camera systems (optical measuring system);

— load testing machine and feeler or pin gauge.

Special test procedures shall be agreed upon between the manufacturer and the customer.

8.11.4 Conditions of measurement and testing

Parallelism e_2 is evaluated at ambient temperature as delivered. The test is only applicable for closed and ground springs.

8.11.5 Method of measurement and testing

Parallelism, e_2, is determined at both spring ends. The larger of the two measurement values shall be used. To determine e_2, measurements should not be taken within the first 30° of the ground surface (see Figure 24, Key 5).

a) e_2 dial gauge:

The value e_2 shall be measured using a height gauge or a fixture with a dial gauge. For this purpose, the measuring device is positioned on the ground surface of the end coil and the difference between the minimum and maximum value is determined as the spring is turned around the spring axis.

The force applied on the dial gauge shall not deflect the spring. If possible, the measuring head of the dial gauge should be guided in the radius of the spring when turning the spring.

b) e_2 profile projector:

For e_2, the spring shall be horizontally placed on the glass plate and secured against rolling. The alignment is made by means of the coordinate system. Therefore, one coil end is aligned perpendicularly to the glass plate. The difference between the maximum and the minimum value of the plane surface of the spring end is e_2.

c) e_2 camera systems:

The e_2 measurement is similar to that using the dial gauge. However, the measurement values are determined optically. The measurement using optical measuring instruments is device-dependent and shall be described or agreed upon with the customer on a case-by-case basis.

d) e_2 feeler or pin gauge:

A spring shall be placed between two parallel surfaces, which have a clearance of L_0 to this spring. The greatest distance between the top plate and the spring can now be determined with the feeler gauge.

8.11.6 Test location on the product

The test location is on the ground spring bearing surfaces.

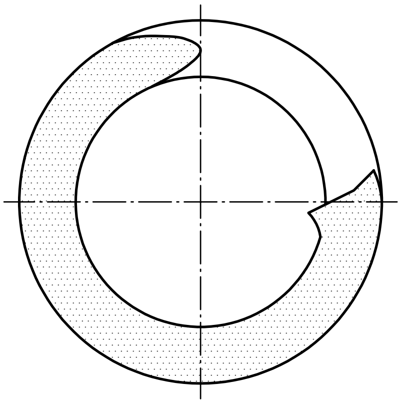
8.12 Shear-off burr

8.12.1 General

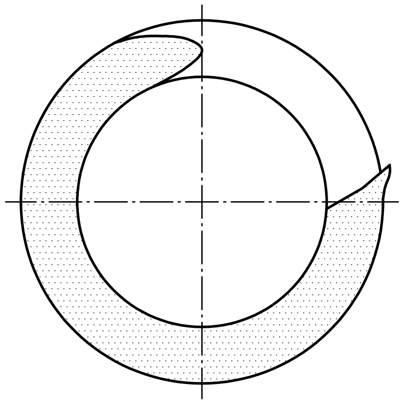
The shear-off burr is a test parameter.

8.12.2 Type of characteristic

The inspected property is the burr resulting from cutting off at both ends of the spring and on the inside and/or outside (see Figure 25).



a) inside



b) outside

Figure 25 — Shear-off burr

8.12.3 Measuring and/or testing equipment

The shear-off burr cannot be measured. Evaluation is carried out by test. This test is the assessment of the sharp edge (subjective evaluation).

The following testing equipment can be used:

— test pin and test sleeve;

NOTE The test pin/test sleeve is used to determine the burr projection regarding D_e or D_i or the exceedance/undercut of the minimum or maximum tolerance only.

— magnifying glass;

— projector;

— stereoscopic microscope;

— camera.

Unless otherwise agreed between customer and manufacturer, assessment is performed with the naked eye.

8.12.4 Conditions of measurement and testing

The shear-off burr is evaluated at ambient temperature as delivered.

8.12.5 Method of measurement and testing

One of the following test methods shall be applied:

— visual inspection;

— magnifying glass;

— projector test;

— microscope;

— camera test.

The shear-off burr should be taken into account when testing with a test pin or sleeve. The shear-off burr shall not exceed/undercut the tolerances of the inside and outside diametres.

8.12.6 Test location on the product

Tests are carried out at the points where the wire is cut off/sheared.

Annex A
(informative)

Calculation of spring rate (R)

A.1 General

The spring rate, R, (N/mm) is a parameter and is determined by calculation.

Instructions regarding force and length measurement shall be observed.

A.2 Type of characteristic

$$R=\frac{\Delta F}{\Delta L}=\frac{\Delta F}{\Delta s}=\frac{F_2-F_1}{L_1-L_2}=\frac{F_2-F_1}{s_2-s_1}$$

ΔF is the increase in force corresponding to a reduction in length ΔL or the increase in deflection Δs.

The spring rate calculation is between two points only and does not define the whole travel of the spring. Furthermore, the rate of a compression spring will not be constant, in particular close to the free or solid lengths.

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