INTERNATIONAL STANDARD

ISO 3548-3

First edition
2012-12-01

Plain bearings — Thin-walled half bearings with or without flange —

Part 3:
Measurement of peripheral length

Paliers lisses — Demi-coussinets minces à collerette ou sans collerette —

Partie 3: Mesurage de la longueur développée

Reference number
ISO 3548-3:2012(E)

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Published in Switzerland

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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 3548-3 was prepared by Technical Committee ISO/TC 123, *Plain Bearings*, Subcommittee SC 5, *Quality analysis and assurance*.

This first edition of ISO 3548-3 cancels and replaces ISO 6524:1992, which has been technically revised.

ISO 3548 consists of the following parts, under the general title *Plain bearings — Thin walled half bearings with or without flange*:

— *Part 1: Tolerances, design features and methods of test*

— *Part 2: Measurement of wall thickness and flange thickness*

— *Part 3: Measurement of peripheral length*

Plain bearings — Thin-walled half bearings with or without flange —

Part 3:
Measurement of peripheral length

1 Scope

This part of ISO 3548 specifies, according to ISO 12301, the checking of the peripheral length of thin-walled half bearings with or without flange, and describes the necessary checking methods and measuring equipment.

Thin-walled half bearings are flexible and, in the free condition, do not conform to a cylindrical profile. This is one reason the peripheral length of the half bearings can only be measured under a constraining load by use of specialized measuring equipment.

In addition, measuring equipment different from that illustrated in this part of ISO 3548 can be used, provided the measuring accuracy of the equipment is consistent with the specifications given in Clause 17.

This part of ISO 3548 does not include measurement of the parting line taper.

This part of ISO 3548 applies to thin-walled half bearings, the specifications of which are given in ISO 3548-1.

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 3548-1, *Plain bearings — Thin-walled half bearings with or without flange — Tolerances, design features and methods of test*

ISO 12301, *Plain bearings — Quality control techniques and inspection of geometrical and material quality characteristics*

3 Terms and definitions

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

3.1
peripheral length
circumferential length, which runs from one parting line face to the other

3.2
crush height
a
value by which a half bearing, fitted in a checking block of bore diameter, d_{cb}, under a predetermined checking load, F, exceeds the defined peripheral length of the checking block bore See Figure 1.

NOTE In practice, the datum serves as a basis for measuring a (see Figure 1).

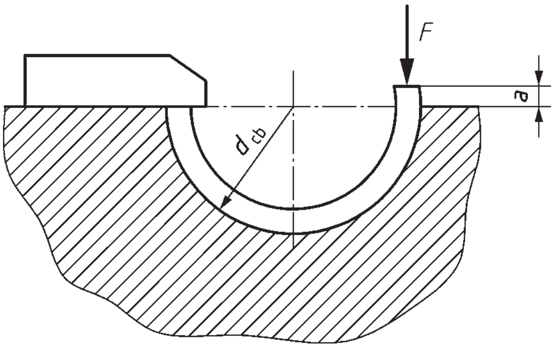


Figure 1 — Crush height, a

3.3
repeatability

closeness of agreement between successive results obtained with the same method on the same test piece, under the same conditions (same operator, same measuring equipment, same checking place and time intervals)

NOTE Repeatability is assessed from the standard deviation of repeatability σ_Δ (see Annex E).

3.4
reproducability

closeness of agreement between individual results obtained with the same method on the same test piece but under different conditions (identical or different operator, measurement equipment, checking place and times)

NOTE For the purposes of this part of ISO 3548, reproducibility is the difference between the two averages obtained from two sets of measuring equipment (see Annex E).

3.5
comparability

accuracy in the case of operators working in different checking places at different periods and each of them achieving individual results, one using method A and the other using method B, on the same plain bearing test piece in different checking blocks

NOTE Comparability is assessed from the difference between the two averages obtained from the two methods (see Annex E).

4 Symbols

For the purposes of this document, the following symbols apply.

Table 1 — Symbols and units

Symbol	Parameter	Unit
a_A or $a_{B1}+a_{B2}$	Crush height	mm
B	Width of the half bearing without flange	mm
B_1	Checking block width (construction for flanged half bearings)	mm
B_2	Checking block width	mm
B_3	Checking block width (construction for half bearings without flange)	mm
B_{ms}	Master shell width	mm
d_{cb}	Diameter of the checking block bore	mm
D_{bs}	Outside diameter of the half bearing to be checked	mm

Table 1 *(continued)*

Symbol	Parameter	Unit
D_{ms}	Outside diameter of the master shell	mm
E	Elasticity modulus	MPa
F	Friction coefficient in calculation of deflection under load	
$F = F_1 = F_2$	Checking load	N
F_{cor}	Correction factor	mm
H	Fillet radius between back and flange on flanged half bearing	mm
H_{cb}	Distance from the bottom of the checking block bore to the datum face	mm
ΔH_{cb}	Elastic deformation of the height of the checking block under load	mm
K_1	Checking block chamfer (construction for half bearings without flange)	mm
K_2	Checking block chamfer (construction for flanged half bearings)	mm
L	Peripheral length	mm
Δl	Deviation of the actual peripheral length of the checking block	mm
p_E	Elastic depression of the metering bar	mm
R_a	Surface roughness	µm
s_{cs}	Wall thickness of the comparison shell	mm
s_{ms}	Wall thickness of the master shell	mm
s_{tot}	Total wall thickness of the half bearing	mm
U	Uncertainty of measurement	
W	Width of the metering bar contact area	mm
Z	Distance between flanges of the flanged half bearing	mm
δ	Empirical correction to compensate for the difference in elastic deflections under load between method A and method B	mm
δ_x	Correction, estimated by calculation	mm
σ	Standard deviation	mm

The characteristic subscripts are given in Table 2.

Table 2 — Subscripts

Subscript	
bs	bearing to be checked
cb	checking block
cbm	master checking block
cbs	series checking block
cs	comparison shell
M	measured
ms	master shell
th	theoretical

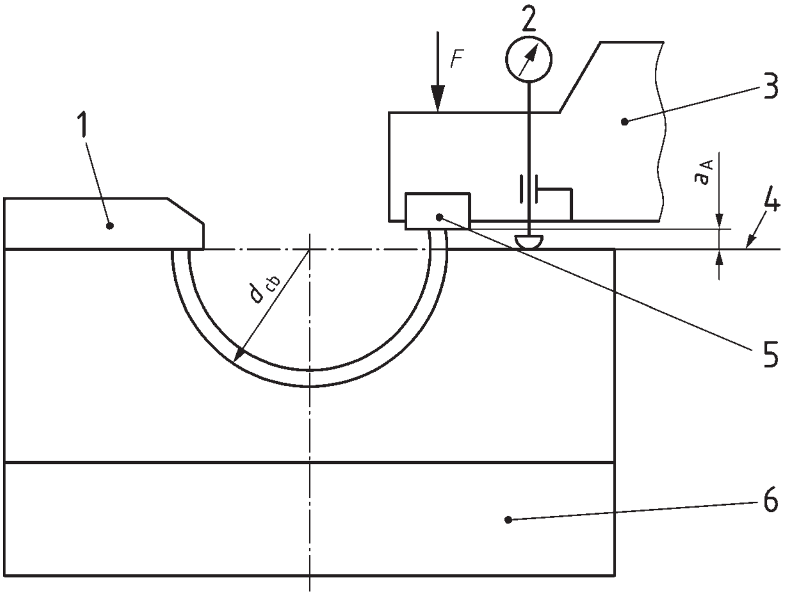
5 Purpose of checking

In order to ensure the required mounting compression (interference fit) for the half bearings in the housing bore, it is necessary to keep to the crush height tolerances as specified in ISO 3548-1 and ISO 12301.

6 Checking methods

6.1 Method A

The checking load, F, is directly applied via the measuring head with a pivoting metering bar to one parting line face of the half bearing while the other parting line face is in contact with a fixed stop (see Figure 2).



$$a_A = (n/p)_A \tag{1}$$

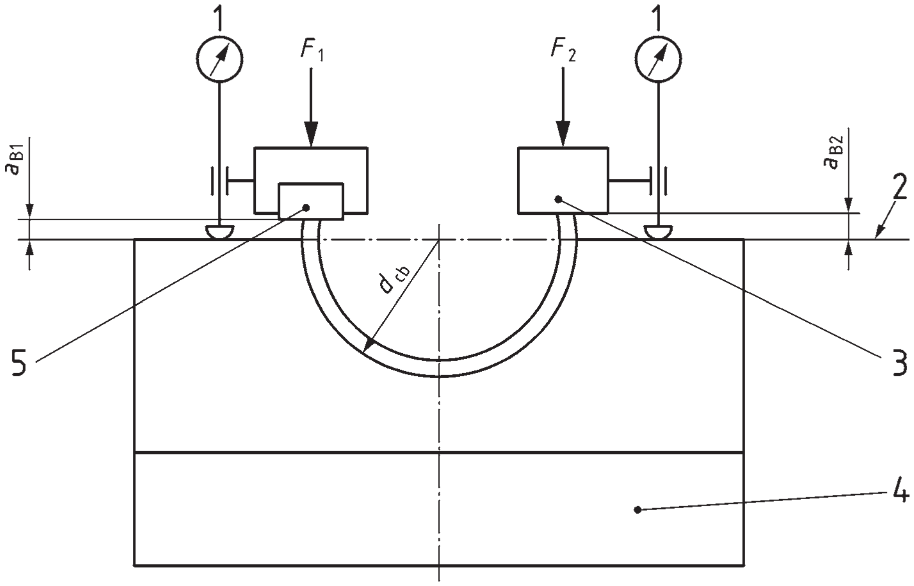
Key

1	fixed stop
2	dial gauge
3	movable measuring head
4	datum
5	metering bar
6	checking block

Figure 2 — Measuring principle of method A

6.2 Method B

The checking loads, F_1 and F_2, are applied via the measuring head and two metering bars to both parting line faces of the half bearing (see Figure 3).



$$a_B = a_{B1} + a_{B2} = a \qquad (2)$$

Key

1	dial gauge
2	datum
3	rigid metering bar[a]
4	checking block
5	pivoting toe piece
a	Bearings may also be checked using two pivoting metering bars.

Figure 3 — Measuring principle of method B

NOTE In the case of method A, the fixed stop exerts the required counterforce, which, in the case of method B, is applied directly by the measuring equipment via two metering bars.

EXAMPLE

Method A	F = 6 000 N
Method B	F_1 = 6 000 N
	F_2 = 6 000 N

7 Choice and designation of checking method

7.1 Choice of checking method

Recommendations for choosing either method A or method B, based on dimensions of the half bearings to be checked, are given in Table 3.

However, any size of bearing may be tested by either method by agreement between the manufacturer and user. In that case, a correction, δ, should be applied to compensate for the difference in deflections at parting line face(s) under load between method A and method B, and be such that:

$$a_A = a_{B1} + a_{B2} + \delta \tag{3}$$

The value of δ shall be determined empirically by actual measurements obtained on the two different types of equipment used. Since the detailed design of the checking feature shall be varied between different manufacturers, the value of δ established by one manufacturer cannot be transferred to another, who shall determine it separately. See example in Annex E.

For general guidance, the value of δ may be derived from the formula used in the mathematical analysis of belt friction, which gives:

$$\delta = \frac{d_{cb,m} \cdot F}{s_{ms} \cdot B_{ms}} \cdot \frac{1}{2Ef}\left(1 + e^{-f\pi} - 2e^{-f\pi/2}\right) \tag{4}$$

With a value of the friction coefficient f = 0,15, Formula (4) becomes:

$$\delta_x = 7 \cdot 10^{-7} \cdot \frac{d_{cb,m} \cdot F}{s_{ms} \cdot B_{ms}} \tag{5}$$

(See also 16.5.)

Table 3 — Selection of checking method

D_{bs} mm	**Recommended checking method**
$D_{bs} \leq 200$	A, B
$200 < D_{bs} \leq 500$	B

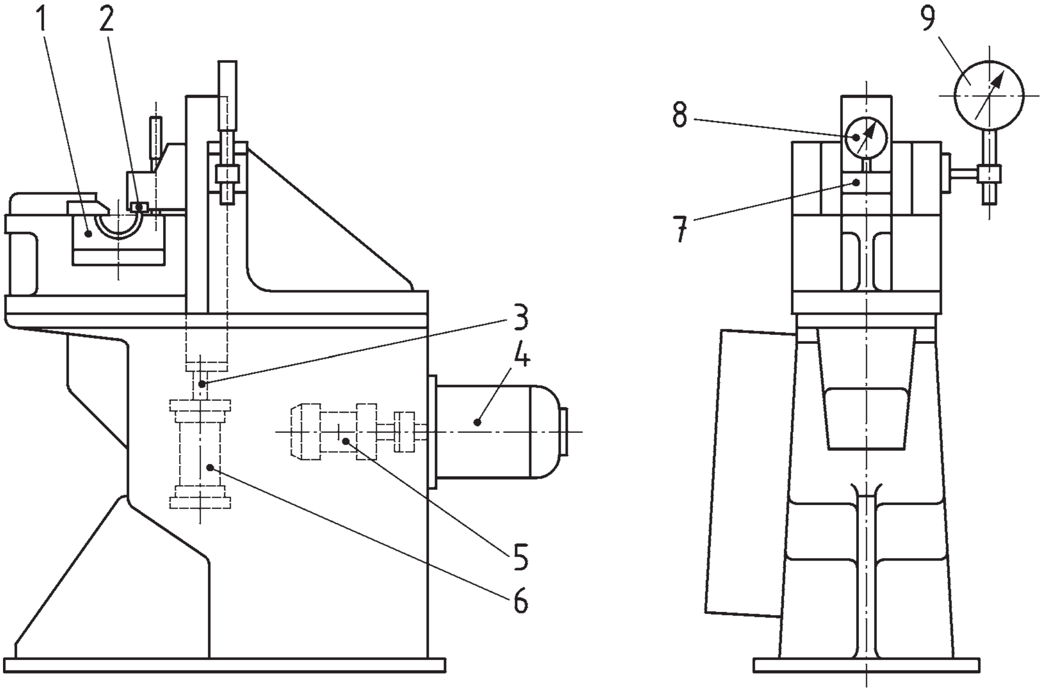
7.2 Designation of checking method

An example of the designation of method B for checking thin-walled half bearings with an outside diameter, D_{bs} of 340 mm is as follows:

Method ISO 3548-3-B-340

8 Measuring equipment

Figures 4 and 5 show typical measuring equipment for the measurement of the crush height by method A and by method B, respectively.

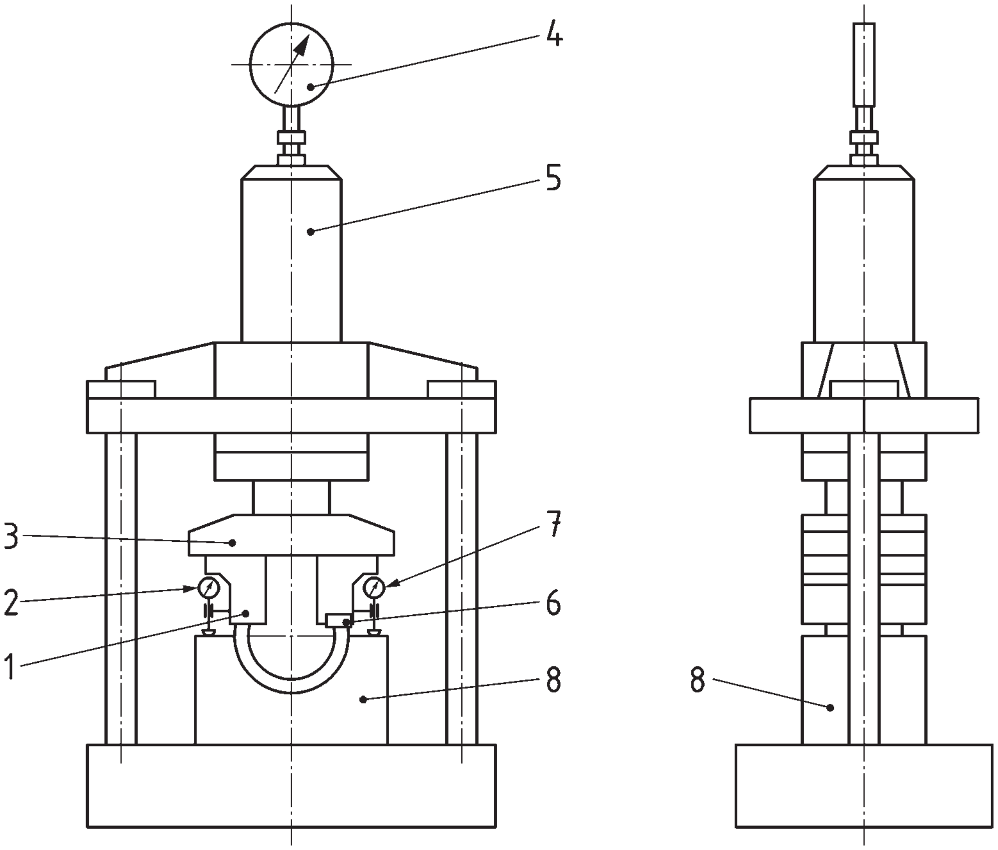


Key

1	checking block
2	pivoting metering bar
3	pressure adjustment valve
4	drive motor
5	oil pump
6	pressure cylinder
7	movable measuring head
8	dial gauge
9	pressure gauge

Figure 4 — Typical measuring equipment with one column, for method A

NOTE Figures 4 and 5 show hydraulically operated equipment. Pneumatically or mechanically operated equipment can also be used.



Key

1 rigid metering bar[a]
2 dial gauge
3 movable measuring gauge
4 pressure gauge
5 hydraulic ram
6 pivoting toe piece
7 dial gauge
8 checking block

[a] Bearings may also be checked using two pivoting metering bars.

Figure 5 — Typical measuring equipment with two columns, for method B

9 Measuring equipment requirements

9.1 General

The most important factors affecting the accuracy of the measuring equipment (and hence the measured crush height) are given in the following subclauses.

9.2 Tolerance on checking load setting

The permissible tolerances are given in Table 4.

Table 4 — Tolerance ranges for checking loads

F N	**Tolerance on F** ±%
$F \leq 2\,000$	1,25
$2\,000 < F \leq 5\,000$	1,00
$5\,000 < F \leq 10\,000$	0,75
$10\,000 < F \leq 50\,000$	0,50
$50\,000 < F$	0,25

9.3 Speed of approach of measuring head

The checking load, F, shall be applied to the parting line face(s) of the half bearing so that shock load shall not occurr. The speed of approach shall be 10 mm/s ± 2 mm/s.

For devices in which the speed of approach cannot be altered, the load shall be applied, released and applied a second time before the measurement is made.

9.4 Construction of measuring head

The measuring head shall be so designed and manufactured that it is accurately guided and moves normal to the datum of the checking block. The deviation from parallelism between the metering bar(s) in the measuring head and the supporting plane of the checking block shall not exceed 0,04 mm per 100 mm in a radial direction.

9.5 Accuracy of the measuring plane for metering bars

Specifications on the accuracy of the measuring plane of the metering bars are given in Table 5.

Table 5 — Tolerances of the measuring plane for metering bars

D_{bs} mm	**Surface roughness** R_a µm	**Tolerance on flatness** mm
$D_{bs} \leq 160$	0,2	0,001 5
$160 < D_{bs} \leq 340$	0,4	0,003 0
$340 < D_{bs} \leq 500$		0,004 0

9.6 Accuracy of the dial gauge

Uncertainty of measurement $u \leq 1{,}2$ µm ($\pm 2\sigma$) with $\sigma = 0{,}3$ µm.

10 Gauging tools for establishing the datum

10.1 General

The following equipment may be used for carrying out measurements:

- a master checking block (for reference measurements) (see Clause 11), or
- a series checking block (for series control in production) (see Clause 11), or
- a master shell (for series control in production) (see Clause 12).

It shall be used in three ways (as indicated in 10.2, 10.3 and 10.4) to establish the appropriate datum for setting the gauge.

10.2 Master checking block (used alone)

The master checking block is the comparison basis for the other checking blocks used for series control.

10.3 Series checking block used alone

The peripheral length of the bore of this type of checking block is determined by comparison with the master checking block.

lt is applied in series control without using a master shell or a comparison shell.

10.4 Series checking block with master shell

The peripheral length of the checking block bore is determined by the master shell or comparison shell, the peripheral length of which was determined in the master checking block.

This combination of gauging tools is applied in series control.

NOTE For series control, a checking block can also be used with a checking master, but this combination of gauging tools is not within the scope of this part of ISO 3548.

11 Checking block requirements

11.1 General

A typical block is shown in Figure 6. The gauging part has a bore diameter, d_{cb}, and height, H_{cb}, and holds the half bearings to be checked.

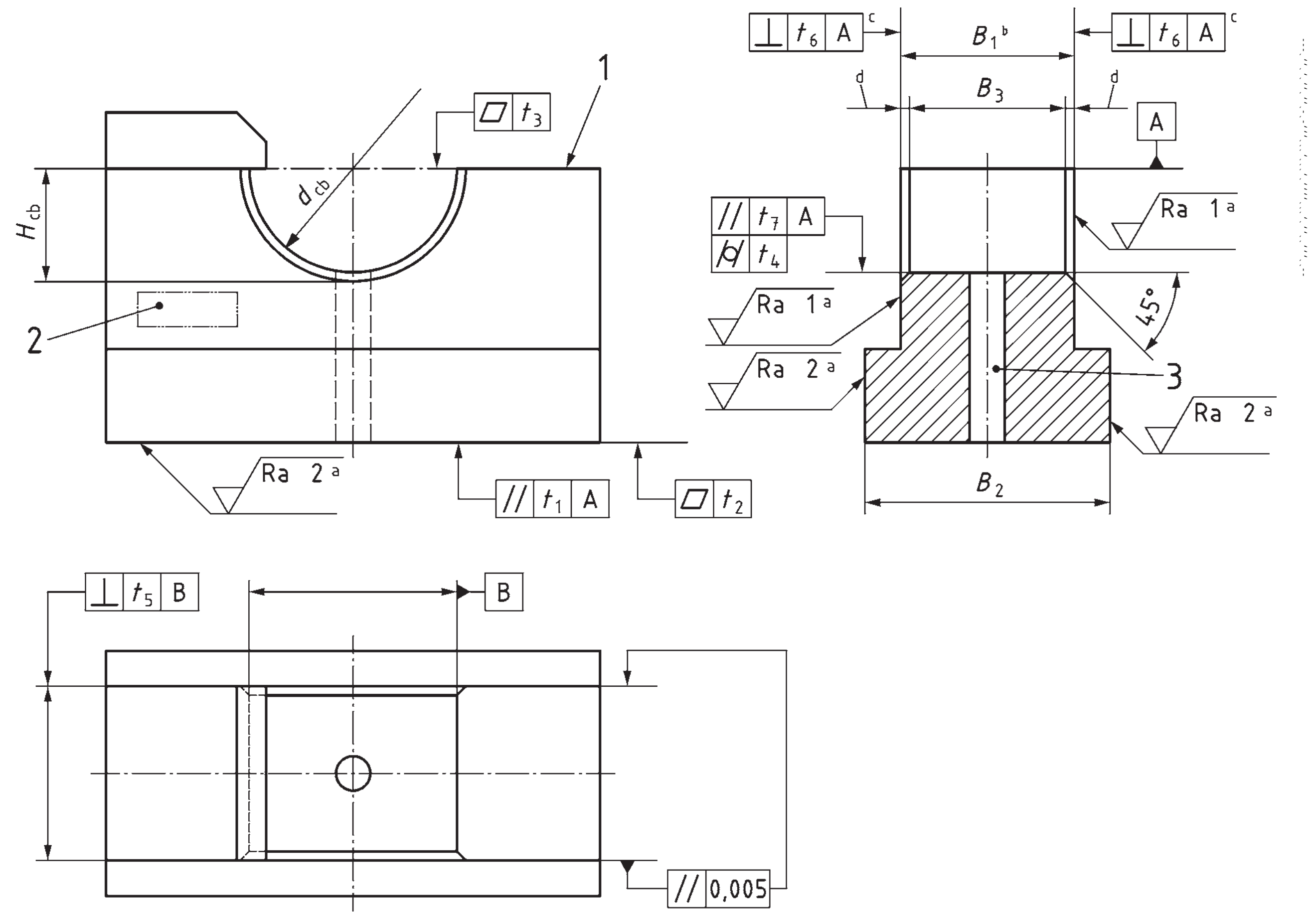
The checking block should preferably be of hardened steel and of rigid design and manufacturing so that the requirements of Clause 16 are met when the half bearing is tested under load.

The bore of the checking block shall not be chromium plated.

Recesses shall be cut into the checking block to accommodate the locating lip in the half bearings. They shall be 1 mm wider and deeper and 1,5 mm longer than the locating lips in the half bearings.

11.2 Reference tooling: master checking block — General

11.2.1 Reference tooling — Master checking block



Key

1 datum for $F_{cor,cb}$ and $F_{cor,cbs}$ (see 13.1 and 13.2.1)

2 field for marking of $d_{cb,M}$, $H_{cb,M}$ and $F_{cor,cb}$ (or $F_{cor,cbs}$)

3 ejector hole (optional)

[a] It is recommended that the values given in Table 5 and 6 be observed.

[b] Construction for half bearing without flange:

B_1 may correspond to B_2 or it may be adjusted to the width of the half bearing,

i.e. to B_{max} + 1,2mm with $K_{1,max}$ = 0,4 mm

[c] Construction for flanged half bearing:

B_1; see Table 5;

$K_2 = h_{max}$ + 0,5 mm.

[d] K_1 or K_2.

Figure 6 — Checking block

11.2.2 Manufacturing limits — General

11.2.2.1 Manufacturing limits

Manufacturing limits and specifications for the master checking block are given in Table 6.

Table 6 — Manufacturing limits and specifications for the master checking block

Outside diameter D_{bs}	Tolerance on d_{cbm}	Surface roughness of checking block bore R_a	Tolerance on H_{cbm}	Surface roughness of the datum face R_a
mm	mm	µm	mm	µm
$D_{bs} \leq 75$	+0,0030 0	0,2	+0,0030 0	0,3
$75 < D_{bs} \leq 110$	+0,0040 0		+0,0035 0	
$110 < D_{bs} \leq 160$	+0,0050 0		+0,0040 0	
$160 < D_{bs} \leq 250$	+0,0060 0	0,4	+0,0045 0	0,6
$250 < D_{bs} \leq 340$	+0,0075 0	0,6	+0,0050 0	1,0
$340 < D_{bs} \leq 500$	+0,0100 0		+0,0060 0	

11.2.2.2 Tolerances of form and orientation

lt is the responsibility of the manufacturer of the master checking block to achieve high quality regarding tolerances of form and orientation, the values of which are given in Tables 7 and 8.

Table 7 — Tolerances of form and orientation — No. 1

Outside diameter D_{bs}	Bearing without flange B_{3min}	Flanged bearing		Surface roughness R_{a1}	Tolerances of form and orientation					
mm	mm	mm		µm	mm					
		$B_{1,min}$	$B_{1,max}$		t_1	t_2	t_3	t_4	t_5	t_6
$D_{bs} \leq 75$	$B_{max} + 0,4$	z_{min} - 0,1	z_{min} - 0,05	1,2	0,002	0,002	0,002	0,002	0,002	0,005
$75 < D_{bs} \leq 110$										
$110 < D_{bs} \leq 160$										
$160 < D_{bs} \leq 250$					0,005	0,005	0,005	0,004	0,003	0,006
$250 < D_{bs} \leq 340$										
$340 < D_{bs} \leq 500$					0,007		0,007			

Table 8 — Tolerances of form and orientation — No. 2

B	B_2	**Surface roughness** R_{a2}	**Tolerance on parallelism** t_7
mm	mm	µm	mm
$B \leq 55$	60^{+2}_{0}	1,2	0,002
$55 < B \leq 80$	85^{+2}_{0}		0,003
$80 < B$	$B+5^{+2}_{0}$		0,004

11.2.2.3 Surface roughnesses R_{a1} and R_{a2}

See Tables 7 and 8.

11.2.2.4 Specifications for B_1, B_2 and B_3

See Tables 7 and 8.

11.2.3 Measuring accuracy of equipment used for establishing $d_{\text{cbm,M}}$ and $H_{\text{cbm,M}}$

Determination of $d_{\text{cbm,M}}$ and $H_{\text{cbm,M}}$ shall be carried out using measuring equipment with a tolerance of:

±0,001 mm for $d_{\text{cbm}} \leq 160$ mm;

±0,002 mm for $d_{\text{cbm}} > 160$ mm.

These values are necessary for calculating the correction factor, $F_{\text{cor,cbm}}$ (see 13.1), which is based on the peripheral length, determined from Formula (6):

$$l_{\text{cbm,M}} = d_{\text{cbm,M}} \cdot \frac{\pi}{2} + 2 \cdot \left(H_{\text{cbm,M}} - \frac{d_{\text{cbm,M}}}{2} \right) \tag{6}$$

11.2.4 Permissible wear limit

The tolerance specified in 11.2.2 for the master checking block shall not be exceeded through wear. If wear occurs within the specified tolerance range, it may be necessary to change the correction factor.

11.3 Series gauging tools

11.3.1 Series checking block used alone

Since the peripheral length of this checking block bore is determined by comparison with the master checking block (11.2), larger tolerances for d_{cbs} and H_{cbs} are acceptable.

11.3.2 Manufacturing limits, correction factor and permissible wear limit

11.3.2.1 Manufacturing limits

Manufacturing limits and specifications for the series checking block are given in Tables 9 to 11.

Table 9 — Manufacturing limits and specifications for the series checking block — No. 1

Outside diameter D_{bs}	**Tolerance on** d_{cbs}	**Surface roughness of checking block bore** R_a	**Tolerance on** H_{cbs}	**Surface roughness of the datum** R_a
mm	mm	µm	mm	µm
$D_{bs} \leq 75$	$^{+0{,}008}_{0}$	0,2	$^{+0{,}008}_{0}$	0,3
$75 < D_{bs} \leq 110$	$^{+0{,}010}_{0}$		$^{+0{,}009}_{0}$	
$110 < D_{bs} \leq 160$	$^{+0{,}012}_{0}$		$^{+0{,}010}_{0}$	
$160 < D_{bs} \leq 250$	$^{+0{,}014}_{0}$	0,4	$^{+0{,}010}_{0}$	0,6
$250 < D_{bs} \leq 340$	$^{+0{,}017}_{0}$	0,6	$^{+0{,}011}_{0}$	1,0
$340 < D_{bs} \leq 500$	$^{+0{,}022}_{0}$		$^{+0{,}012}_{0}$	

Table 10 — Manufacturing limits and specifications for the series checking block — No. 2

Outside diameter D_{bs}	**Bearing without flange** B_{3min}	**Flanged bearing**		**Surface roughness** R_{a1}	**Tolerances of form and orientation**					
mm	mm	mm		µm	mm					
		$B_{1,min}$	$B_{1,max}$		t_1	t_2	t_3	t_4	t_5	t_6
$D_{bs} \leq 75$	$B_{max} + 0{,}4$	z_{min} - 0,1	z_{min} - 0,05	1,2	0,004	0,004	0,004	0,004	0,004	0,010
$75 < D_{bs} \leq 110$										
$110 < D_{bs} \leq 160$										
$160 < D_{bs} \leq 250$					0,010	0,010	0,010	0,008	0,006	0,012
$250 < D_{bs} \leq 340$										
$340 < D_{bs} \leq 500$					0,014		0,014			

Table 11 — Manufacturing limits and specifications for the series checking block — No. 3

B	B_2	**Surface roughness** R_{a2}	**Tolerance on parallelism** t_7
mm	mm	µm	mm
$B \leq 55$	60^{+2}_{0}	1,2	0,004
$55 < B \leq 80$	85^{+2}_{0}		0,006
$80 < B$	$B + 5^{+2}_{0} 5 ^{+2}_{0}$		0,008

11.3.2.2 Correction factor, $F_{\mathrm{cor,cbs}}$

See 13.2.1.

11.3.2.3 Permissible wear limit

The limit of permissible wear of the series checking block is reached when the difference between the correction factor in original and worn conditions is equal to the values stated in Table 12.

Table 12 — Limit of permissible wear of the series checking block

Checking block diameter d_{cbs}	**Permissible difference** $\lvert F_{\mathrm{cor,cbs,new}} - F_{\mathrm{cor,cbs,worn}} \rvert$
mm	mm
$d_{\mathrm{cbs}} \leq 75$	0,012
$75 < d_{\mathrm{cbs}} \leq 110$	0,016
$110 < d_{\mathrm{cbs}} \leq 160$	0,020
$160 < d_{\mathrm{cbs}} \leq 250$	0,024
$250 < d_{\mathrm{cbs}} \leq 340$	0,030
$340 < d_{\mathrm{cbs}} \leq 500$	0,040

11.3.3 Series checking block with master shell or with comparison shell

11.3.3.1 Manufacturing limits

Manufacturing limits and specifications for the series checking block are given in Tables 9 to 11.

11.3.3.2 Correction factor

See 13.2.2.

11.3.3.3 Permissible wear limit

The limit of permissible wear of the series checking block is reached when the difference between the correction factor in original and worn conditions is equal to the values stated in Table 12.

12 Master shell and comparison shell requirements

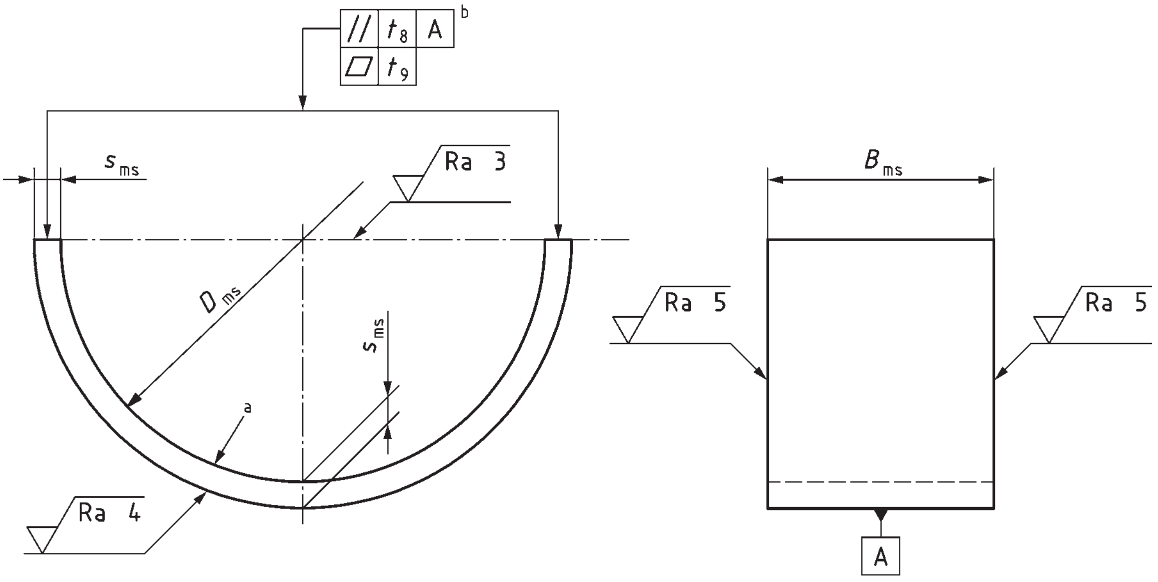
12.1 Master shell requirements

The basic dimensions of the master shell shall be corresponded to those of the half bearings to be checked (see Figure 7). The master shell shall have similar behaviour to the half bearing when it is fitted into the checking block.

NOTE This cylindrical master shell can also be used for checking flanged half bearings.

Master shells shall be made from hardened steel (58 HRC min.). Normally, master shells are only used up to 200 mm in diameter.

In order that a single master shell may be used for a group of parts down to 1 mm undersize, s_{ms} shall be equal to the total wall thickness, s_{tot}, of the standard half bearing to be checked plus 0,125 mm.



$s_{ms} = s_{tot} + 0{,}125$ mm

[a] Field for marking of $D_{ms,M}$, F and $F_{cor,ms}$ (see 13.2.3).

[b] Tolerances on parallelism t_8 and flatness t_9 apply when the master shell is fitted in the checking block (zero free spread) under the checking load.

Figure 7 — Master shell

The master shell shall be of similar geometry to that of the bearing being checked. Masters of a different geometry from that of the shell shall not be used since friction and elastic deformation may differ significantly from those of the bearing (see Figure 8).

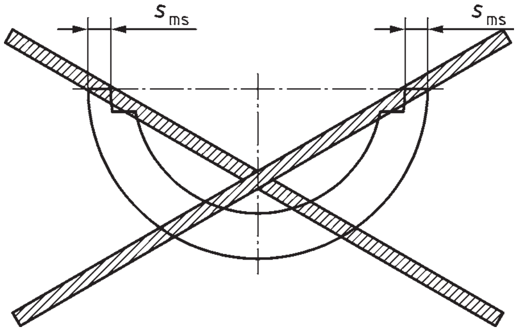


Figure 8 — Stepped master shell — Not suitable for checking bearings or uniform wall thickness

12.1.1 Manufacturing limits

Manufacturing limits and specifications for the master shell are given in Tables 13 and 14.

Table 13 — Manufacturing limits and specifications for the master shell — No. 1

Outside diameter	Tolerance on	Tolerance on	Surface roughness	
D_{ms}	B_{ms}	s_{ms}	R_{a3}	R_{a5}
mm	mm	mm	µm	µm
$D_{ms} \leq 160$	±0,10	±0,015	0,2	2
$160 < D_{ms} \leq 200$	±0,15	±0,020		

Table 14 — Manufacturing limits and specifications for the master shell — No. 2

Outside diameter D_{ms}	Surface roughness R_{a4}	Tolerance on parallelism t_8	Spread	Tolerance on flatness t_9
mm	µm	mm		µm
$D_{ms} \leq 160$	0,3	0,004	Within the limits of the half bearing to be checked	0,003
$160 < D_{ms} \leq 200$	0,5	0,006		

12.1.2 Correction factor, $F_{cor,ms}$

See 13.2.3

12.1.3 Permissible wear limit

The limit of the permissible wear of the master shell is reached when the difference between the correlation factor in original and worn conditions is equal to the values stated in Table 15.

Table 15 — Limit of the permissible wear of the master shell

Outside diameter D_{ms}	Permissible difference $\lvert F_{cor,ms,new} - F_{cor,ms,worn} \rvert$
mm	mm
$D_{ms} \leq 160$	0,030
$160 < D_{ms} \leq 200$	0,035

12.2 Comparison shell requirements

For economic reasons, the crush height of the half bearings may be determined using comparison shells rather than master shells.

Comparison shells shall be made from stainless steel or cold or hot worked tool steel. In special cases, a normal production bearing may also be used.

The relative manufacturing limits shall be agreed upon between the manufacturer and customer.

13 Correction factors

13.1 Reference tooling: master checking block correction factor, $F_{\text{cor,cbm}}$

The measured peripheral length of the master checking block bore, $l_{\text{cbm,M}}$, is given by Formula (7) (see 11.2.3):

$$l_{\text{cbm,M}} = d_{\text{cbm,M}} \cdot \frac{\pi}{2} + 2 \cdot \left(H_{\text{cbm,M}} - \frac{d_{\text{cbm,M}}}{2} \right) \tag{7}$$

The theoretical peripheral length of the master checking block bore, $l_{\text{cbm,th}}$, is given by Formula (8) (see 11.2.3):

$$l_{\text{cbm,th}} = d_{\text{cbm,th}} \cdot \frac{\pi}{2} \tag{8}$$

The correction factor of the master checking block is therefore:

$$F_{\text{cor,cbm}} = l_{\text{cbm,M}} - l_{\text{cbm,th}} \tag{9}$$

The other factors to be taken into consideration, and their determination and calculation are given in Annex A (for method A) and Annex B (for method B).

The basis for the correction factor, $F_{\text{cor,cbm}}$, is the datum of the master checking block (see Figures 2 and 3).

13.2 Series control tooling

13.2.1 Correction factor for series checking block used alone, $F_{\text{cor,cbs}}$

The correction factor, $F_{\text{cor,cbs}}$, is the difference between the crush height of a half bearing measured in a master checking block, a_{cbm}, and in a series checking block, a_{cbs}, under equal checking conditions (see Annex C):

$$F_{\text{cor,cbs}} = a_{\text{cbm,M}} - a_{\text{cbs,M}} \tag{10}$$

When setting the dial gauge, the correction factor, $F_{\text{cor,cbs}}$, of the series checking block only shall be taken into consideration.

The basis for the correction factor, $F_{\text{cor,cbs}}$, is the datum of the series checking block.

13.2.2 Correction factor for series checking block with master shell

The correction factor, $F_{\text{cor,cbs}}$, of the series checking block should not be taken into consideration when carrying out measurements; it is only to check the wear limit of the series checking block.

When setting the dial gauge, the correction factor, $F_{\text{cor,ms}}$, of the master shell only (see 13.2.3) shall be taken into consideration.

13.2.3 Master shell correction factor, $F_{\text{cor,ms}}$

The correction factor, $F_{\text{cor,ms}}$, is the amount by which a master shell fitted in a master checking block bore, under a predetermined checking load, deviates from the theoretical peripheral length of the master checking block bore.

Annex D shall be used for determining the correction factor $F_{\text{cor,ms}}$.

When setting the dial gauge, the correction factor of the master shell, $F_{\text{cor,ms}}$, shall be taken into consideration.

The basis for the correction factor, $F_{\mathrm{cor,ms}}$, is the parting line of the master shell, the peripheral length of which shall be measured in a master checking block, in accordance with 13.1.

NOTE The correction factor, $F_{\mathrm{cor,ms}}$, is equal to zero when the master shell is exactly adjusted to the peripheral length of the master checking block bore, the bore diameter, d_{cbm}, of which corresponds to the outside diameter, D_{bs}, of the half bearing to be checked.

13.2.4 Comparison shell correction factor, $F_{\mathrm{cor,cs}}$

The correction factor, $F_{\mathrm{cor,cs}}$, is the amount by which a comparison shell fitted in a master checking block bore, under a predetermined checking load, deviates from the theoretical peripheral length of the master checking block bore.

Annex D shall be used for determining the correction factor $F_{\mathrm{cor,cs}}$.

When setting the dial gauge, the correction factor of the comparison shell, $F_{\mathrm{cor,cs}}$, shall be taken into consideration.

The basis for the correction factor, $F_{\mathrm{cor,cs}}$, is the parting line of the comparison shell, the peripheral length of which shall be measured in a master checking block, in accordance with 13.1.

NOTE The correction factor, $F_{\mathrm{cor,cs}}$, is equal to zero when the comparison shell is exactly adjusted to the peripheral length of the master checking block bore, the bore diameter, d_{cbm}, of which corresponds to the outside diameter, D_{bs}, of the half bearing to be checked.

13.3 Marking

The correction factor calculated shall be engraved on each of the gauging tools.

13.4 Reference setting

In cases of dispute, the setting shall be made in accordance with the determined correction factor in a master checking block (see 13.1). The method shall be agreed between the manufacturer and customer.

14 Typical checking procedure

14.1 Place the checking block in the measuring equipment, line it up and secure it against lateral movement.

14.2 Set the checking load in accordance with the specifications.

14.3 Under the specified checking load, lower the pivoting metering bar (for method A) or the metering bars (for method B) vertically on to the parting line of the master shell, or of the comparison shell.

In the case of method A, adjust the dial gauge to the full value of the correction factor engraved on either the checking block ($F_{\mathrm{cor,cb}}$ or $F_{\mathrm{cor,cbs}}$), the master shell ($F_{\mathrm{cor,ms}}$) or the comparison shell ($F_{\mathrm{cor,cs}}$).

In the case of method B, adjust both dial gauges to one-half of the correction factor (see Figure 3).

14.4 Place the half bearing to be checked (see also Clause 15) in the checking block and apply the checking load via the measuring head.

14.5 Determine the crush height variation of the half bearing, in the case of method A, by reading off the dial gauge directly or, in the case of method B, by adding the partial crush height variations recorded on the two dial gauges.

14.6 The measuring temperature shall be between 20 °C and 25 °C when using the master block, but series checking may take place at room temperature if both the measurement equipment and the half bearings being checked are at the same temperature.

14.7 When carrying out reference measurements, the value of the crush height is the average of three measurements taken at a temperature of 20 °C.

15 Conditions of the half bearings to be checked

The joint and back faces of the half bearing shall be free of foreign matter, grease and any damage, and shall be at the same temperature as the checking block being used.

16 Measuring errors

16.1 Errors due to measuring equipment

These errors are due to

- an incorrect position of the checking block (longitudinal or transversal direction),
- the checking block being incorrectly fixed in the measuring equipment,
- an incorrect setting of the checking load,
- an excessive speed of approach of the load,
- the pivoting metering bar being too tight or having too much clearance, or
- damage or wear of the metering bar(s).

16.2 Errors due to the checking block

These errors are due to

- the difference in temperature between the half bearing and checking block,
- damage or wear of the checking block,
- the recess for locating lips being too large,
- the locating lip fouling the notch in the checking block,
- the bore of the checking block being chromium plated,
- the fixed stop (for method A) not covering the total parting line face of the bearing,
- the fixed stop (for method A) deflecting too much and/or being poorly attached,
- damage or wear of the fixed stop,
- the checking block width, B_3, being smaller than the bearing width in the case of bearings without flange, or
- the checking block width, B_1 or B_3, for flanged bearings being too large, so that bearings are in contact with the checking block at the fillet radius between back and flange (K_1 or K_2 incorrect).

16.3 Errors due to the correction factor

These errors are due to

- an incorrect reading when measuring $d_{\mathrm{cb,M}}$ and $H_{\mathrm{cb,M}}$, or
- an error in calculating the correction factor.

16.4 Errors due to the half bearing

These errors are due to

- grease, dirt or damage on the outside diameter or parting line, or
- the parting line taper being excessive.

16.5 Error due to the choice of checking method

An error may arise if the correction, δ, is not considered when the half bearing is tested by a method other than the method specified on the bearing drawing (see 7.1 and E.3).

17 Accuracy of methods used

This clause gives a statistical approach to evaluate the accuracy of the methods used by determining the repeatability and reproducibility of the measurement results and by comparing results obtained with methods A and B.

17.1 Checking conditions

See Table 15.

17.2 Limits

The values given in Table 16 are a basis for interpreting the test results.

17.3 Calculation

Details of the methods of calculation and the interpretation of the test results of repeatability, reproducibility and comparability are given in Annex E.

18 Specifications on bearing drawings

The following should be specified in the drawing, represented graphically or otherwise, for the measurement of the peripheral length:

a) the recommended checking method (A or B) (see Clause 7);

b) the checking load;

c) the crush height;

d) diameter $d_{\mathrm{cb,th}}$ and the distance from the bottom of the checking block to the datum plane, $H_{\mathrm{cb,th}}$.

19 Specifications for the control of the checking means

19.1 The gauging tools shall be checked regularly; significant damage shall be refurbished and any dimensional changes to the gauging tools shall be engraved on them.

19.2 The measuring equipment shall be checked as to its accuracy, at specified time intervals (with regard to statistical methods).

Table 16 — Specifications for the control of the checking means — No. 1

Date	Repeatability	Reproducibility		Comparability
		Case 1[a]	Case 2[b]	
Half bearings	S	S	S	S
Measuring equipment	S	S or I	I or D	D
Checking block	S	S	I or D	D
Operator	S	S or D	D	D
Checking place	S	S or D	D	D
Checking time	Short period	D	D	D

S: Same = physically the same

I: Identical = in accordance with this part of ISO 3548, made to the same design, drawings and specifications

D: Different = in accordance with this part of ISO 3548, but made to different design, drawings and specifications

[a] The same half bearings are checked in the same checking block with the same checking equipment, or with an identical one (in which the checking block can be mounted), by a single operator or different operators working in the same or in different places at different times.

[b] The same half bearings shall be checked in identical or in different checking blocks with identical or different checking equipment by operators working in different places at different times.

Table 17 — Specifications for the control of the checking means — No. 2

D_{bs}	Repeatability $\sigma_{\Delta B}$	Reproducibility $\lvert\bar{x}_1-\bar{x}_2\rvert$ max.		Reproducibility[a] $\lvert\bar{x}_A-\bar{x}_B\rvert$ max.
		Case 1[b]	Case 2[c]	
mm	µm	µm	µm	µm
$D_{bs} \leq 75$	1,1	3	8	10
$75 < D_{bs} \leq 160$	1,4	4	9	14
$160 < D_{bs} \leq 340$	2,2	6	16	24
$340 < D_{bs} \leq 500$	2,8	8	18	30

[a] In order to achieve these values, especially for thicker bearings, a good contact between the metering bar (fixed stop) and the bearing joint faces is of prime importance.

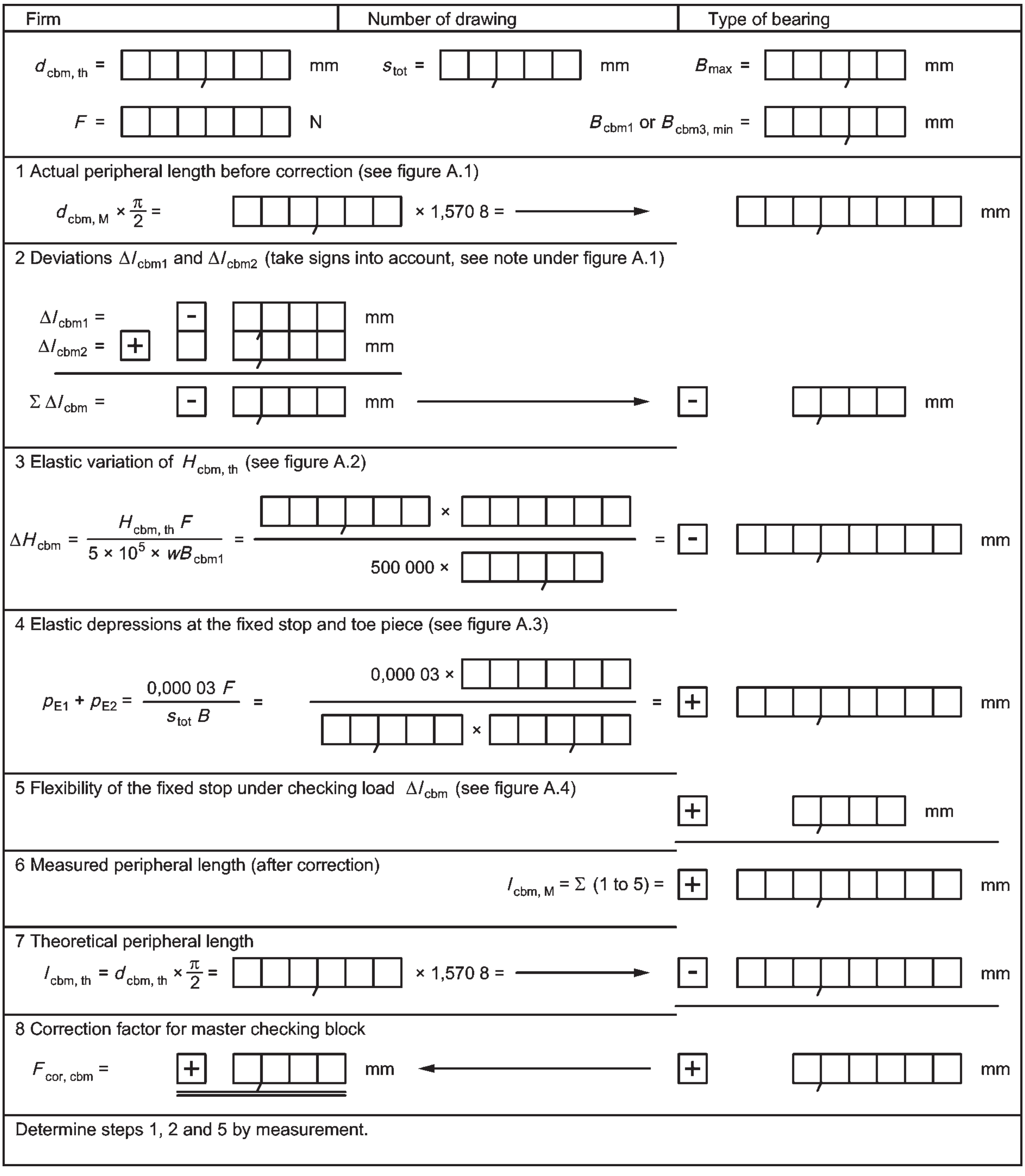
[b] The same half bearings are checked in the same checking block with the same checking equipment, or with an identical one (in which the chacking block can be mounted), by a single operator or different operators working in the same or in different places at different times.

[c] The same half bearings are checked in identical or in different chacking blocks, with identical or different checking equipment by operators working in different places at different times.

Annex A
(normative)

Determination of the correction factor of the master checking block — Method A

A.1 Calculation form



Firm | Number of drawing | Type of bearing

$d_{\text{cbm, th}}$ = mm s_{tot} = mm B_{max} = mm

F = N B_{cbm1} or $B_{\text{cbm3, min}}$ = mm

1 Actual peripheral length before correction (see figure A.1)

$d_{\text{cbm, M}} \times \frac{\pi}{2} =$ × 1,570 8 = → mm

2 Deviations Δl_{cbm1} and Δl_{cbm2} (take signs into account, see note under figure A.1)

Δl_{cbm1} = − mm

Δl_{cbm2} = + mm

$\Sigma\, \Delta l_{\text{cbm}}$ = − mm → − mm

3 Elastic variation of $H_{\text{cbm, th}}$ (see figure A.2)

$$\Delta H_{\text{cbm}} = \frac{H_{\text{cbm, th}}\, F}{5 \times 10^5 \times wB_{\text{cbm1}}} = \frac{ \times }{500\,000 \times } = -$$ mm

4 Elastic depressions at the fixed stop and toe piece (see figure A.3)

$$p_{\text{E1}} + p_{\text{E2}} = \frac{0{,}000\,03\, F}{s_{\text{tot}}\, B} = \frac{0{,}000\,03 \times }{ \times } = +$$ mm

5 Flexibility of the fixed stop under checking load Δl_{cbm} (see figure A.4)   + mm

6 Measured peripheral length (after correction)

$l_{\text{cbm, M}} = \Sigma$ (1 to 5) = + mm

7 Theoretical peripheral length

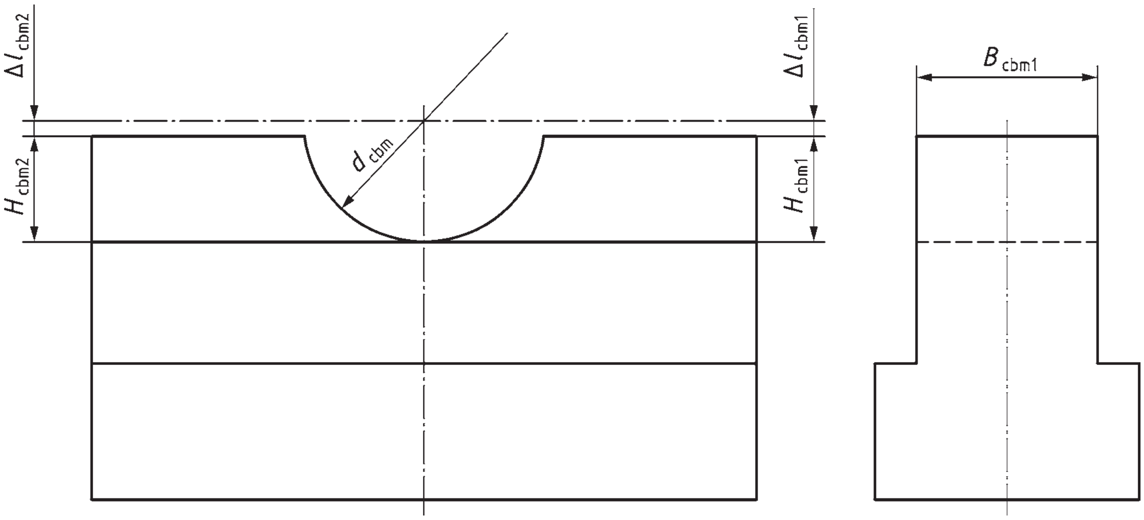
$l_{\text{cbm, th}} = d_{\text{cbm, th}} \times \frac{\pi}{2} =$ × 1,570 8 = → − mm

8 Correction factor for master checking block

$F_{\text{cor, cbm}}$ = + mm ← + mm

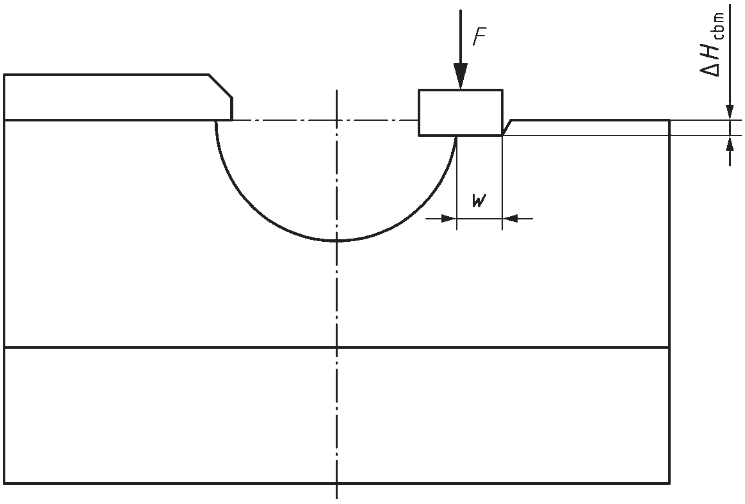
Determine steps 1, 2 and 5 by measurement.

Figure A.1 — Calculation form



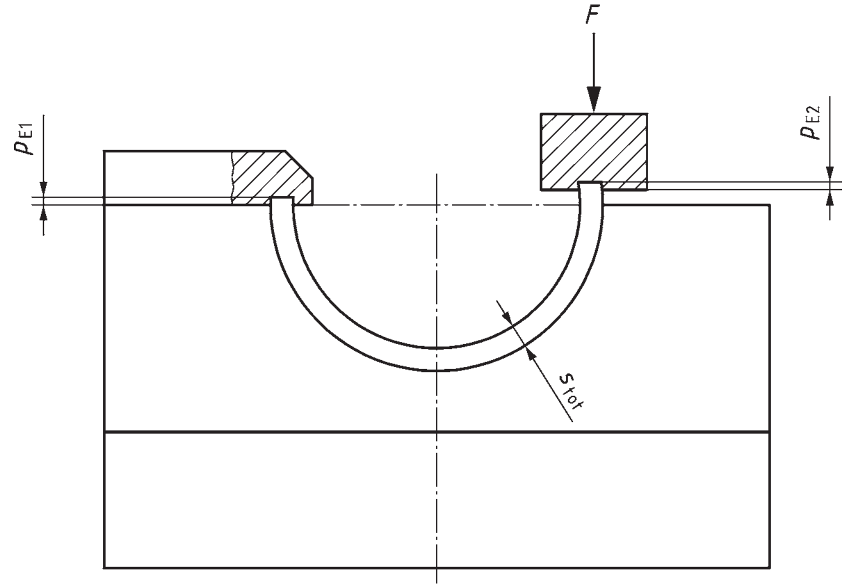
NOTE $\Delta l_{cbm1} = H_{cbm1,\,M} - \frac{d_{cbm,\,M}}{2}$ and $\Delta l_{cbm2} = H_{cbm2,\,M} - \frac{d_{cbm,\,M}}{2}$

Figure A.2



NOTE w is the width of the toe piece contact area, in millimetres.

Figure A.3



NOTE p_{E1} und p_{E2} are negligible if the measuring planes of the toe piece and the fixed stop are coated with hard carbide.

Figure A.4

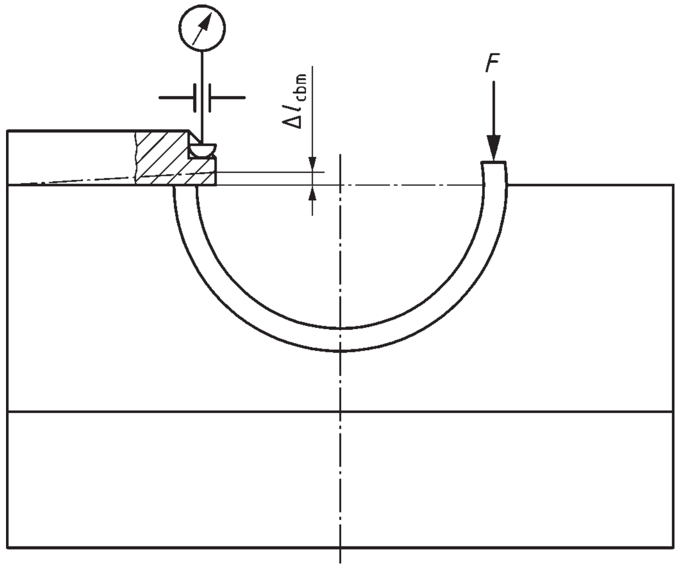
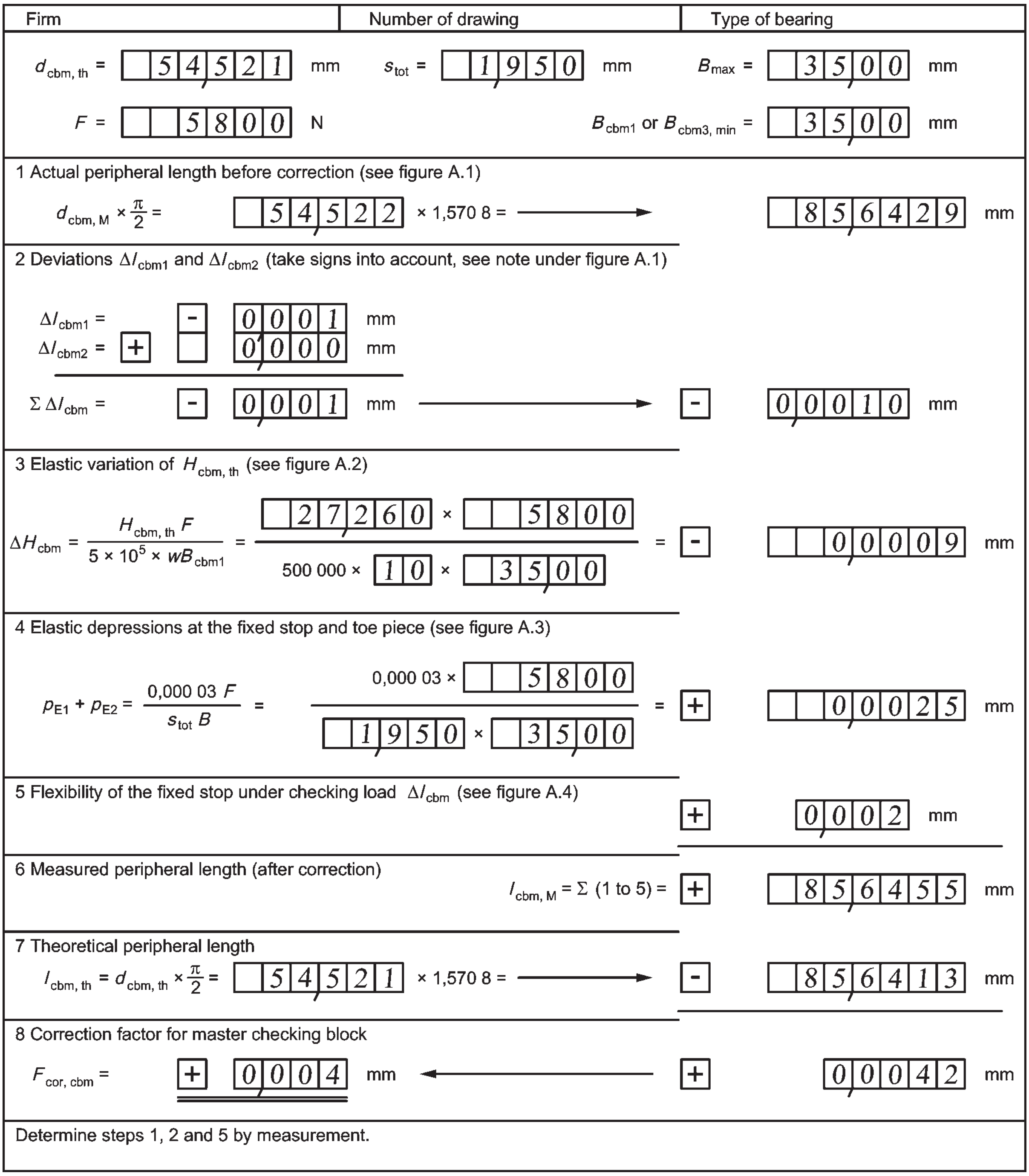


Figure A.5

A.2 Numerical example



Firm	Number of drawing	Type of bearing

$d_{\mathrm{cbm,\,th}}$ = 54,521 mm

s_{tot} = 1,950 mm

B_{max} = 35,00 mm

F = 5800 N

B_{cbm1} or $B_{\mathrm{cbm3,\,min}}$ = 35,00 mm

1 Actual peripheral length before correction (see figure A.1)

$d_{\mathrm{cbm,\,M}} \times \frac{\pi}{2}$ = 54,522 × 1,570 8 = → 85,6429 mm

2 Deviations Δl_{cbm1} and Δl_{cbm2} (take signs into account, see note under figure A.1)

Δl_{cbm1} = - 0,001 mm

Δl_{cbm2} = + 0,000 mm

$\Sigma \Delta l_{\mathrm{cbm}}$ = - 0,001 mm → - 0,0010 mm

3 Elastic variation of $H_{\mathrm{cbm,\,th}}$ (see figure A.2)

$\Delta H_{\mathrm{cbm}} = \frac{H_{\mathrm{cbm,\,th}}\,F}{5 \times 10^5 \times wB_{\mathrm{cbm1}}} = \frac{27,260 \times 5800}{500\,000 \times 10 \times 35,00}$ = - 0,0009 mm

4 Elastic depressions at the fixed stop and toe piece (see figure A.3)

$p_{\mathrm{E1}} + p_{\mathrm{E2}} = \frac{0,000\,03\,F}{s_{\mathrm{tot}}\,B} = \frac{0,000\,03 \times 5800}{1,950 \times 35,00}$ = + 0,0025 mm

5 Flexibility of the fixed stop under checking load Δl_{cbm} (see figure A.4) + 0,002 mm

6 Measured peripheral length (after correction)

$l_{\mathrm{cbm,\,M}} = \Sigma$ (1 to 5) = + 85,6455 mm

7 Theoretical peripheral length

$l_{\mathrm{cbm,\,th}} = d_{\mathrm{cbm,\,th}} \times \frac{\pi}{2}$ = 54,521 × 1,570 8 = → - 85,6413 mm

8 Correction factor for master checking block

$F_{\mathrm{cor,\,cbm}}$ = + 0,004 mm ← + 0,0042 mm

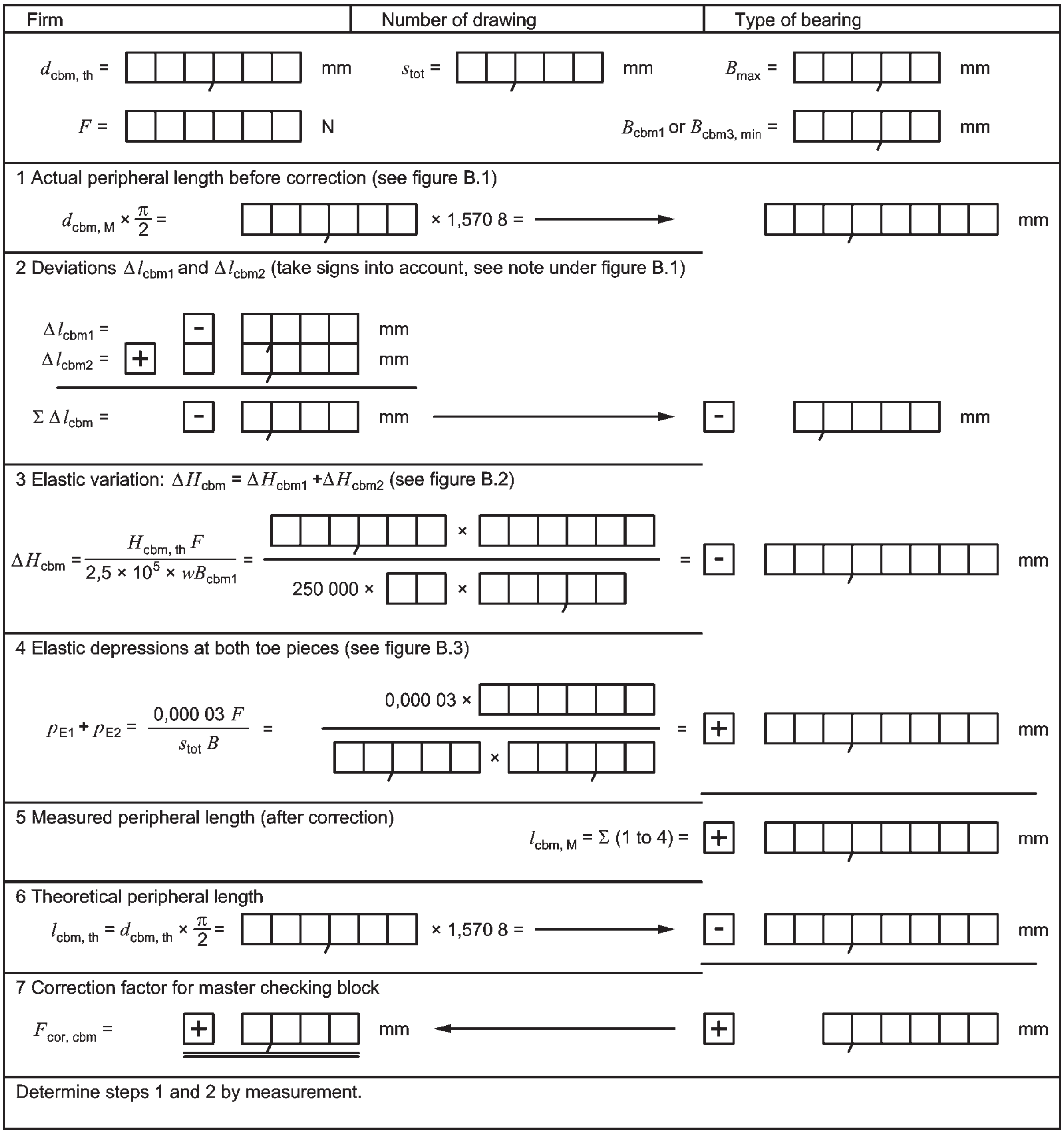
Determine steps 1, 2 and 5 by measurement.

Figure A.6 — Calculation form

Annex B
(normative)

Determination of the correction factor of the master checking block — Method B

B.1 Calculation form



Firm	Number of drawing	Type of bearing

$d_{\text{cbm, th}} =$ mm $\quad s_{\text{tot}} =$ mm $\quad B_{\max} =$ mm

$F =$ N $\quad B_{\text{cbm1}}$ or $B_{\text{cbm3, min}} =$ mm

1 Actual peripheral length before correction (see figure B.1)

$d_{\text{cbm, M}} \times \frac{\pi}{2} = \quad \times 1{,}570\,8 = \longrightarrow$ mm

2 Deviations Δl_{cbm1} and Δl_{cbm2} (take signs into account, see note under figure B.1)

$\Delta l_{\text{cbm1}} = \boxed{-}$ mm

$\Delta l_{\text{cbm2}} = \boxed{+}$ mm

$\Sigma \Delta l_{\text{cbm}} = \boxed{-}$ mm $\longrightarrow \boxed{-}$ mm

3 Elastic variation: $\Delta H_{\text{cbm}} = \Delta H_{\text{cbm1}} + \Delta H_{\text{cbm2}}$ (see figure B.2)

$$\Delta H_{\text{cbm}} = \frac{H_{\text{cbm, th}}\,F}{2{,}5 \times 10^5 \times wB_{\text{cbm1}}} = \frac{\quad \times \quad}{250\,000 \times \quad \times \quad} = \boxed{-} \text{ mm}$$

4 Elastic depressions at both toe pieces (see figure B.3)

$$p_{\text{E1}} + p_{\text{E2}} = \frac{0{,}000\,03\,F}{s_{\text{tot}}\,B} = \frac{0{,}000\,03 \times \quad}{\quad \times \quad} = \boxed{+} \text{ mm}$$

5 Measured peripheral length (after correction)

$l_{\text{cbm, M}} = \Sigma$ (1 to 4) $= \boxed{+}$ mm

6 Theoretical peripheral length

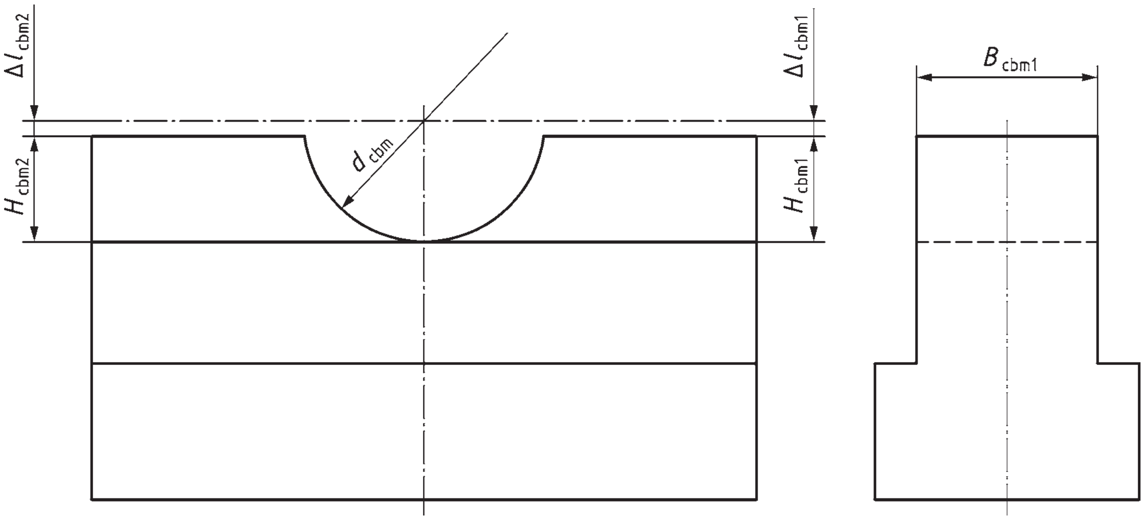
$l_{\text{cbm, th}} = d_{\text{cbm, th}} \times \frac{\pi}{2} = \quad \times 1{,}570\,8 = \longrightarrow \boxed{-}$ mm

7 Correction factor for master checking block

$F_{\text{cor, cbm}} = \boxed{+}$ mm $\longleftarrow \boxed{+}$ mm

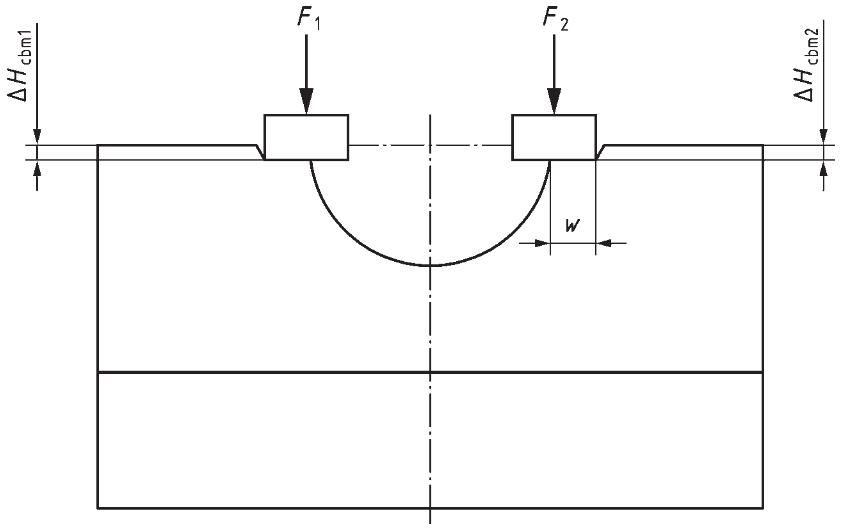
Determine steps 1 and 2 by measurement.

Figure B.1 — Calculation form



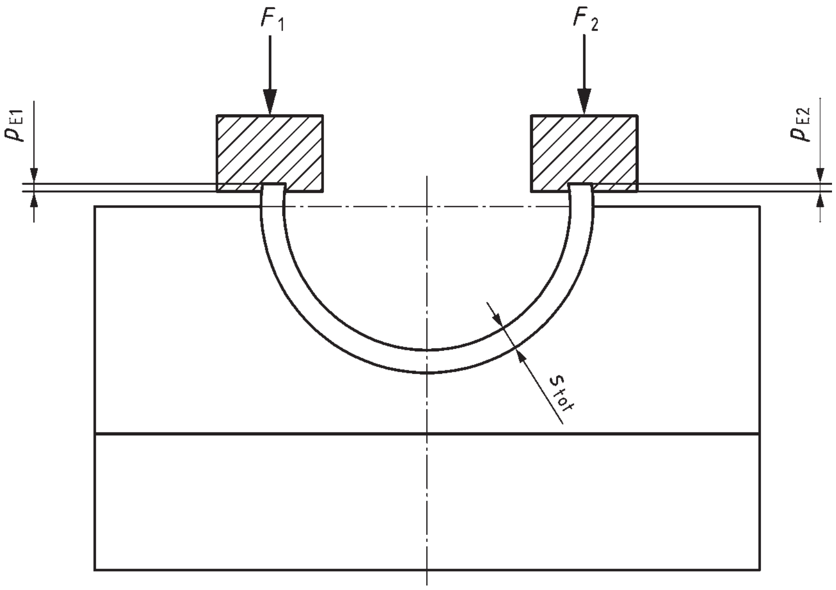
NOTE $\Delta l_{\text{cbm1}} = H_{\text{cbm1, M}} - \frac{d_{\text{cbm, M}}}{2}$ and $\Delta l_{\text{cbm2}} = H_{\text{cbm2, M}} - \frac{d_{\text{cbm, M}}}{2}$

Figure B.2



NOTE w is the width of the toe piece contact area, in millimetres.

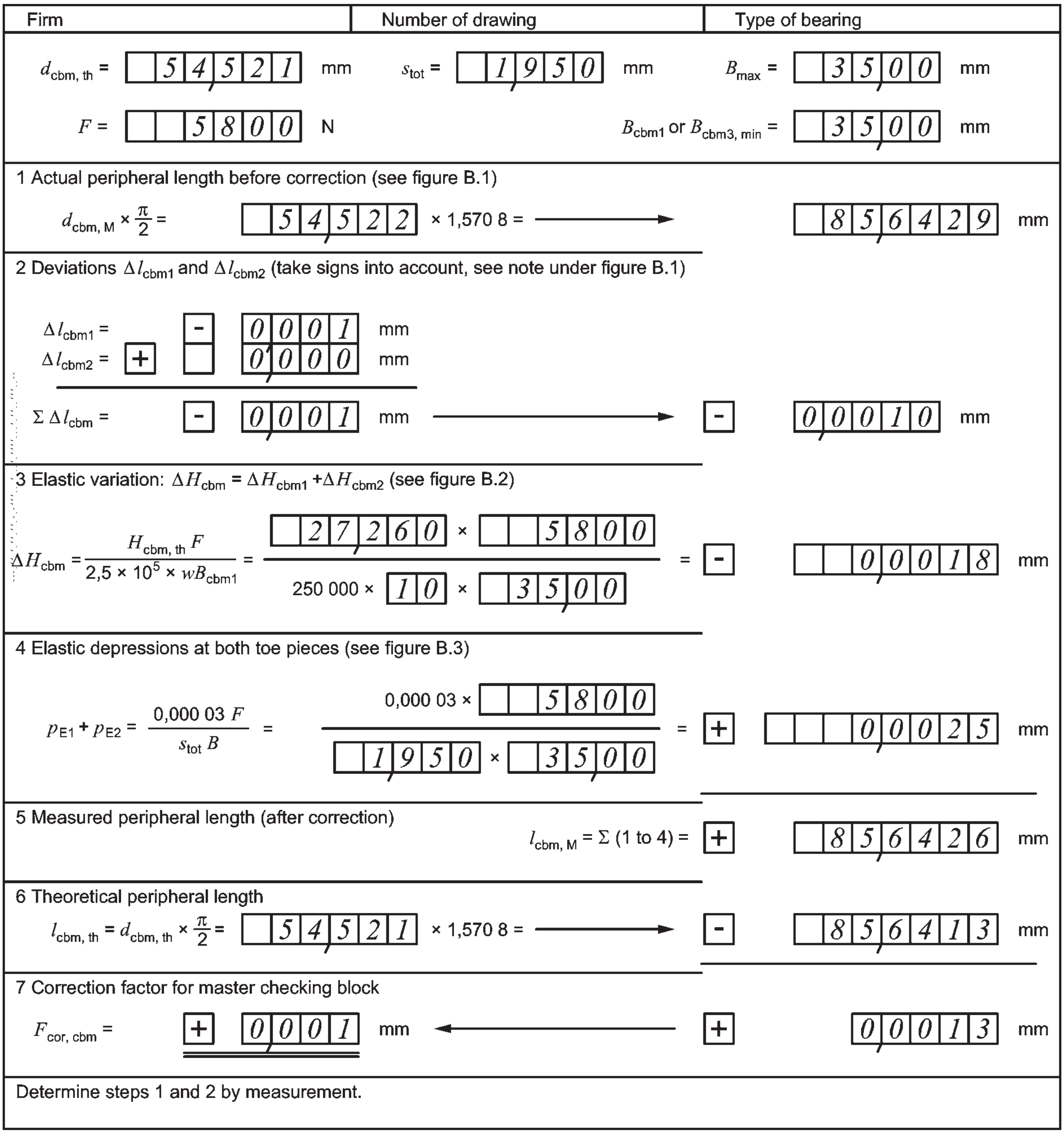
Figure B.3



NOTE p_{E1} und p_{E2} are negligible if the measuring planes of the toe piece and the fixed stop are coated with hard carbide.

Figure B.4

B.2 Numerical example



Firm	Number of drawing	Type of bearing

$d_{\text{cbm, th}}$ = 54,521 mm s_{tot} = 1,950 mm $B_{\max}$ = 35,00 mm

F = 5800 N B_{cbm1} or $B_{\text{cbm3, min}}$ = 35,00 mm

1 Actual peripheral length before correction (see figure B.1)

$d_{\text{cbm, M}} \times \frac{\pi}{2}$ = 54,522 × 1,570 8 = → 85,6429 mm

2 Deviations Δl_{cbm1} and Δl_{cbm2} (take signs into account, see note under figure B.1)

Δl_{cbm1} = − 0,001 mm

Δl_{cbm2} = + 0,000 mm

$\Sigma \Delta l_{\text{cbm}}$ = − 0,001 mm → − 0,0010 mm

3 Elastic variation: $\Delta H_{\text{cbm}} = \Delta H_{\text{cbm1}} + \Delta H_{\text{cbm2}}$ (see figure B.2)

$$\Delta H_{\text{cbm}} = \frac{H_{\text{cbm, th}}\, F}{2{,}5 \times 10^5 \times wB_{\text{cbm1}}} = \frac{27{,}260 \times 5800}{250\,000 \times 10 \times 35{,}00} = -\ 0{,}0018 \text{ mm}$$

4 Elastic depressions at both toe pieces (see figure B.3)

$$p_{\text{E1}} + p_{\text{E2}} = \frac{0{,}000\,03\, F}{s_{\text{tot}}\, B} = \frac{0{,}000\,03 \times 5800}{1{,}950 \times 35{,}00} = +\ 0{,}00025 \text{ mm}$$

5 Measured peripheral length (after correction)

$l_{\text{cbm, M}} = \Sigma$ (1 to 4) = + 85,6426 mm

6 Theoretical peripheral length

$l_{\text{cbm, th}} = d_{\text{cbm, th}} \times \frac{\pi}{2}$ = 54,521 × 1,570 8 = → − 85,6413 mm

7 Correction factor for master checking block

$F_{\text{cor, cbm}}$ = + 0,001 mm ← + 0,0013 mm

Determine steps 1 and 2 by measurement.

Figure B.5 — Calculation form

Annex C
(normative)

Determination of the correction factor of the series checking block used alone

C.1 Determination of peripheral length value in master checking block

C.1.1 Fit the master checking block in the measuring equipment.

C.1.2 Adjust the checking load, F, in accordance with the specifications.

C.1.3 Lower the measuring head with the metering bar on to the datum plane of the master checking block.

C.1.4 Set the correction factor, $F_{\mathrm{cor,cbm}}$, of the master checking block on the dial gauge under checking load F.

C.1.5 Place the half bearing in the master checking block.

C.1.6 Apply the checking load, F, on the parting line(s) of the half bearing.

C.1.7 Read the result, $a_{\mathrm{cbm,M}}$, off the dial gauge.

C.2 Determination of peripheral length value in series checking block

C.2.1 Fit the series checking block in the measuring equipment.

C.2.2 Set the same checking load, F, as in C.1.2.

C.2.3 Lower the measuring head with the metering bar on to the datum plane of the series checking block.

C.2.4 Set the dial gauge to zero under checking load F.

C.2.5 Fit the same half bearing used in C.1.5 in the series checking block.

C.2.6 Apply the checking load, F, on the parting line face(s) of half bearing.

C.2.7 Read the result, $a_{\mathrm{cbs,M}}$, on the dial gauge.

C.3 Determination of correction factor

The difference between the two peripheral length value readings in C.1.7 and C.2.7 is the correction factor given by Formula (C.1):

$$F_{\mathrm{cor,cbs}} = a_{\mathrm{cbm,M}} - a_{\mathrm{cbs,M}} \tag{C.1}$$

The $F_{\mathrm{cor,cbs}}$ value is to be set on the dial gauge to a plus or minus indication.

For example if $a_{\text{cbm,M}}$ = + 40 µm and $a_{\text{cbs,M}}$ = + 45 µm, then

$F_{\text{cor,cbs}}$ = 40 – 45 = −5 µm

and the dial gauge is set to −5 µm.

Annex D
(normative)

Determination of the correction factor of the master shell or comparison shell

D.1 Peripheral length of master shell

The peripheral length of the master shell should be approximately equal to that of the half bearing to be checked.

D.2 Calibration of master shell and determination of correction factor, $F_{\text{cor,ms}}$

D.2.1 Fit the master checking block in the measuring equipment.

D.2.2 Adjust the checking load, F, in accordance with the specifications.

D.2.3 Lower the measuring head with the metering bar on to the datum plane of the master checking block.

D.2.4 Set the correction factor, $F_{\text{cor,cbm}}$, of the master checking block on the dial gauge under checking load, F, and keep it unaltered until checking is completed.

D.2.5 Remove the measuring head with the metering bar from the master checking block.

D.2.6 Place the master shell in the master checking block.

D.2.7 Apply the checking load, F, on the parting line(s) of the master shell.

D.2.8 Read the measuring result off the dial gauge; this is the correction factor, $F_{\text{cor,ms}}$, of the master shell.

D.2.9 Engrave the correction factor, $F_{\text{cor,ms}}$, on the master shell.

D.3 Peripheral length of comparison shell

The peripheral length of the comparison shell should be approximately equal to that of the half bearing to be checked

D.4 Calibration of comparison shell and determination of correction factor $F_{\text{cor,cs}}$

D.4.1 Fit the master checking block in the measuring equipment.

D.4.2 Adjust the checking load, F, in accordance with the specifications.

D.4.3 Lower the measuring head with the metering bar on to the datum plane of the master checking block.

D.4.4 Set the correction factor, $F_{\text{cor,cbm}}$, of the master checking block on the dial gauge under checking load, F, and keep it unaltered until checking is completed.

D.4.5 Remove the measuring head with the metering bar from the master checking block.

D.4.6 Place the comparison shell in the master checking block.

D.4.7 Apply the checking load, F, on the parting line(s) of the comparison shell.

D.4.8 Read the measuring result off the dial gauge; this is the correction factor, $F_{\mathrm{cor,cs}}$, of the comparison shell.

D.4.9 Engrave the correction factor, $F_{\mathrm{cor,cs}}$, on the comparison shell.

Annex E
(normative)

Tests and calculation of repeatability, reproducibility and comparability

E.1 Calculation of standard deviation of repeatability

E.1.1 Take and number 24 half bearings ($n = 24$)

E.1.2 Place the first bearing in the checking block and measure it. Measure the remaining 23 bearings.

E.1.3 In accordance with the checking conditions given in Table 14, place the first bearing in the checking block to carry out a second measurement. Measure the remaining 23 bearings.

E.1.4 Determine the difference, Δl_i, between the first and the second measurement of the individual bearings with correct signs.

E.1.5 Calculate the standard deviation, σ_Δ:

$$\sigma_\Delta = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n}(\Delta l_i)^2 - \frac{1}{n}\left(\sum_{i=1}^{n}\Delta l_i\right)^2\right]} \tag{E.1}$$

The repeatability of the checking method used is considered correct if

$\sigma_\Delta \le \sigma_{\Delta\mathrm{B}}$ (see Table 15).

NOTE σ_Δ is an estimate of the true standard deviation σ.

E.2 Assessment of reproducibility

The test is carried out as specified in E.1.1 and E.1.2, with a first set of measuring equipment, and then with a second set of measuring equipment, in accordance with the checking conditions given in Table 14.

Calculate the mean value with each set of measuring equipment:

$$\overline{x}_1 = \frac{\sum_{i=1}^{n} x_{1i}}{n} = \frac{1}{24}\sum_{1}^{24} x_{1i} \tag{E.2}$$

and

$$\overline{x}_2 = \frac{\sum_{i=1}^{n} x_{2i}}{n} = \frac{1}{24}\sum_{1}^{24} x_{2i} \tag{E.3}$$

The reproducibility of the method used is considered correct, if

$\left|\overline{x}_1 - \overline{x}_2\right| \le$ the values given in Table 15.

E.3 Assessment of comparability

E.3.1 Test the accuracy of method A with method B as follows.

E.3.2 Calculate $\overline{x_{\mathrm{A}}}$ (or $\overline{x_{\mathrm{B}}}$) as specified in E.2.

E.3.3 Calculate $\acute{}\overrightarrow{x_{\mathrm{A}}}$ (or $\acute{}\overrightarrow{x_{\mathrm{B}}}$), the value of the crush height measured with method B transposed to method A (or, reciprocally, with method A to method B):

$$\vec{x}_{\mathrm{A}} = \bar{x}_{\mathrm{B}} + \delta \tag{E.4}$$

$$\vec{x}_{\mathrm{B}} = \bar{x}_{\mathrm{A}} - \delta \tag{E.5}$$

where

$\overline{x_{\mathrm{B}}}$ (or $\overline{x_{\mathrm{A}}}$)	are calculated as specified in E.2;
δ	is determined by the bearing manufacturer from the particular conditions of friction in the equipment.

E.3.4 Calculate $\left|\bar{x}_{\mathrm{A}} - \vec{x}_{\mathrm{A}}\right|$ (or $\left|\bar{x}_{\mathrm{B}} - \vec{x}_{\mathrm{B}}\right|$).

The comparability is considered correct, if the result is less than the value given in Table 15.

For example, twenty-four half bearings with an outside diameter of 100 mm are to be checked.

The recommended method of checking is method A (see Table 1), which is specified on the drawing. Nevertheless, the manufacturer decides to apply method B.

The manufacturer measures the 24 bearings using method B and determines $\overline{x_{\mathrm{B}}}$ in micrometres (µm):

$$\bar{x}_{\mathrm{B}} = \frac{\sqrt{\left(a_{\mathrm{B1}} + a_{\mathrm{B2}}\right)}}{24} = 35$$

The manufacturer determines empirically the correction, δ, to be applied, for example 7 µm [to be compared with the approximate value as given in Clause 7,

$$\tilde{\delta} = 0{,}7 \cdot 10^{-6} \cdot \frac{100 \cdot 9\,000}{2{,}25 \cdot 40} = 7$$

in micrometres(µm)],

and determines $\vec{x}_{\mathrm{A}}$:

$$\vec{x}_{\mathrm{A}} = 35 + 7 = 42$$

in micrometres.

When the customer receives the half bearings, he/she carries out an acceptance test with the recommended method A and finds a mean peripheral length value, $a_{\mathrm{A,mean}}$, of

$$a_{\mathrm{A,mean}} = +50\mu\mathrm{m} = \overline{x}_{\mathrm{A}} \qquad \text{(E.6)}$$

Hence

$$\left| \overline{x}_{\mathrm{A}} - \vec{x}_{\mathrm{A}} \right| = 50 - 44 = 6$$

in micrometres (µm).

Since 6 < 14 (see Table 15), the accuracy is correct.

ICS 21.100.10

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