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**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*



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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*

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# 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

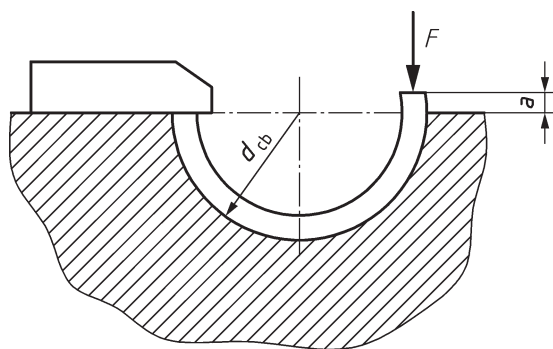
#### 3.2

##### **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  $\sigma_{\Delta}$  (see Annex E).

### 3.4

#### reproducibility

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            |
| $\Delta H_{cb}$ | 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            |
| $\Delta l$      | Deviation of the actual peripheral length of the checking block                                                       | mm            |
| $p_E$           | Elastic depression of the metering bar                                                                                | mm            |
| $R_a$           | Surface roughness                                                                                                     | $\mu\text{m}$ |
| $s_{cs}$        | 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            |
| $\delta$        | Empirical correction to compensate for the difference in elastic deflections under load between method A and method B | mm            |
| $\delta_x$      | Correction, estimated by calculation                                                                                  | mm            |
| $\sigma$        | 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           |

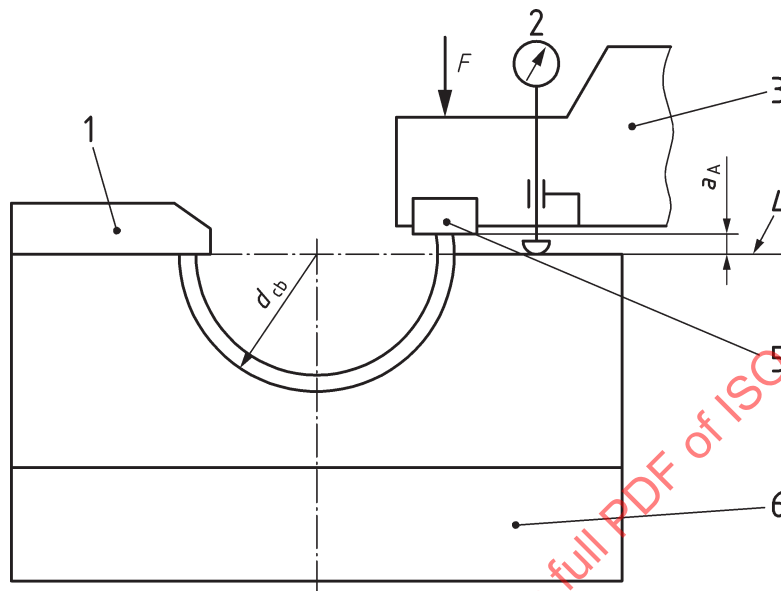
## 5 Purpose of checking

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).



$$a_A = (n/p)_A \quad (1)$$

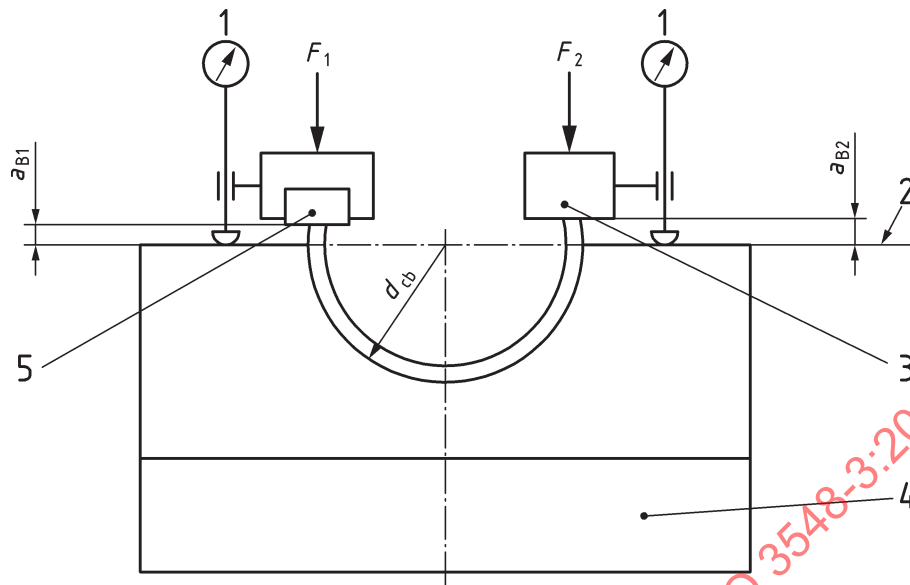
#### Key

- 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).



$$a_B = a_{B1} + a_{B2} = a$$

(2)

**Key**

- 1 dial gauge
- 2 datum
- 3 rigid metering bar<sup>a</sup>
- 4 checking block
- 5 pivoting toe piece
- <sup>a</sup> 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  $F = 6\,000\text{ N}$

Method B  $F_1 = 6\,000\text{ N}$

$F_2 = 6\,000\text{ N}$

**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,  $\delta$ , 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:

$$a_A = a_{B1} + a_{B2} + \delta \quad (3)$$

The value of  $\delta$  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  $\delta$  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  $\delta$  may be derived from the formula used in the mathematical analysis of belt friction, which gives:

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

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

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

[See also 16.5.]

**Table 3 — Selection of checking method**

| $D_{bs}$<br>mm          | Recommended checking method |
|-------------------------|-----------------------------|
| $D_{bs} \leq 200$       | A, B                        |
| $200 < D_{bs} \leq 500$ | B                           |

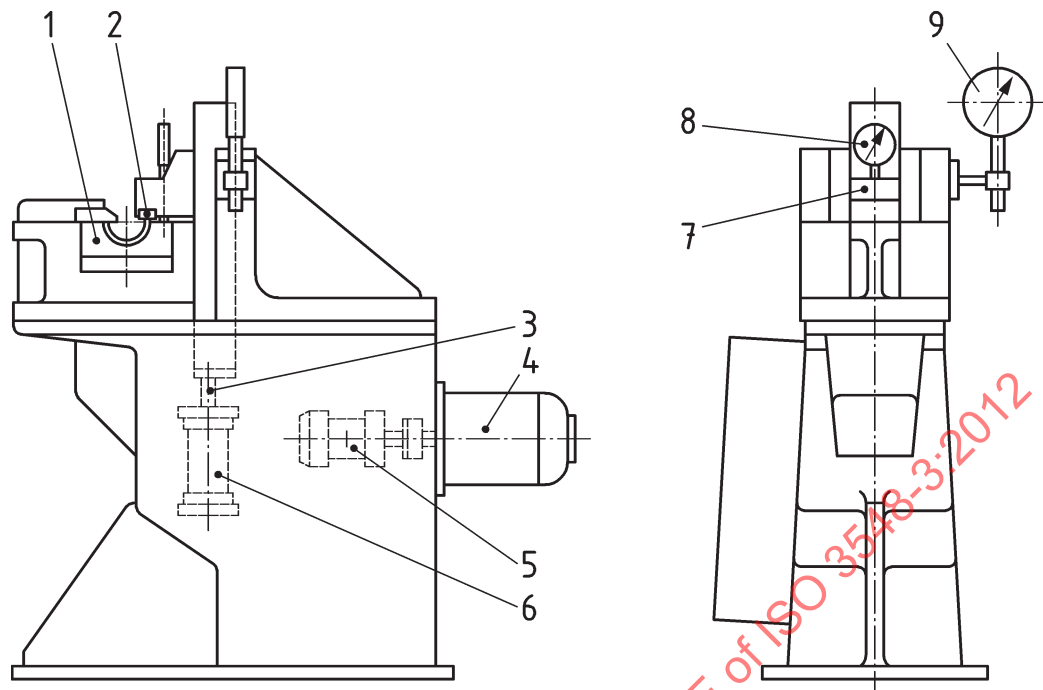
## 7.2 Designation of checking method

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

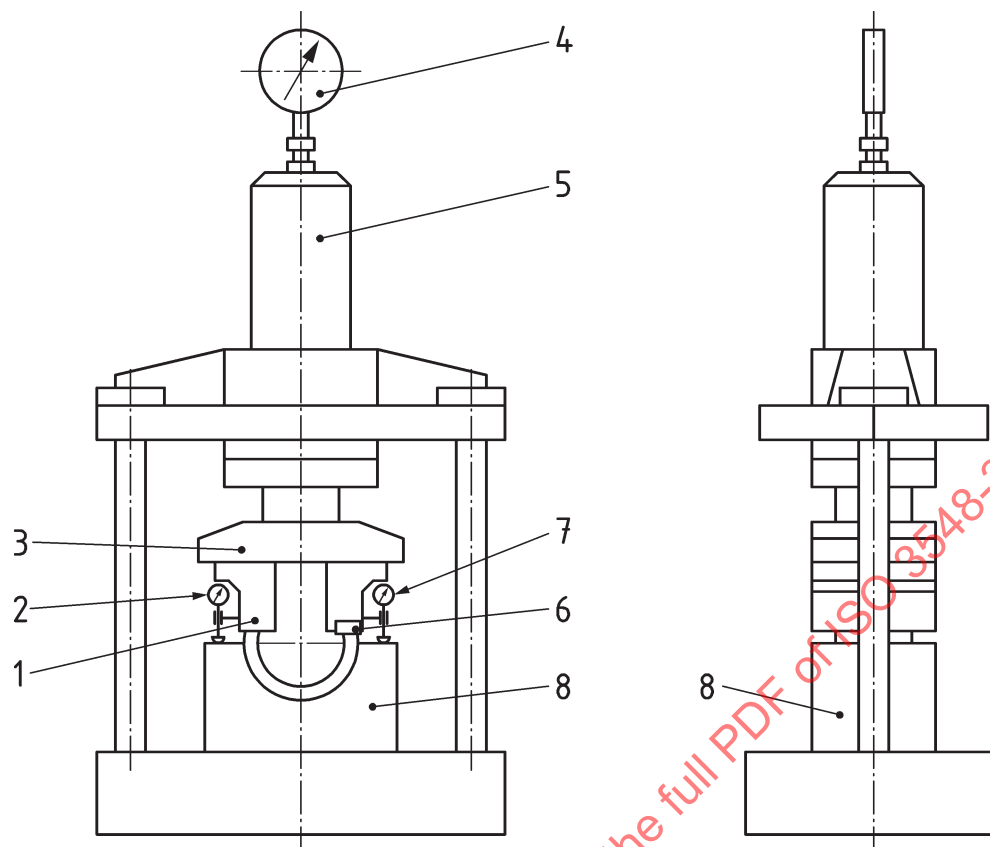
Figures 4 and 5 show typical measuring equipment for the measurement of the crush height by method A and by method B, respectively.

**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<sup>a</sup>
  - 2 dial gauge
  - 3 movable measuring gauge
  - 4 pressure gauge
  - 5 hydraulic ram
  - 6 pivoting toe piece
  - 7 dial gauge
  - 8 checking block
- <sup>a</sup> 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**

| $F$                        | Tolerance on $F$ |
|----------------------------|------------------|
| N                          | $\pm\%$          |
| $F \leq 2\,000$            | 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 occur. The speed of approach shall be  $10\text{ mm/s} \pm 2\text{ mm/s}$ .

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  $0,04\text{ mm}$  per  $100\text{ mm}$  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**

| $D_{bs}$                | Surface roughness<br>$R_a$ | Tolerance on flatness |
|-------------------------|----------------------------|-----------------------|
| mm                      | $\mu\text{m}$              | 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  $u \leq 1,2\text{ }\mu\text{m}$  ( $\pm 2\sigma$ ) with  $\sigma = 0,3\text{ }\mu\text{m}$ .

## 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.

It 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.

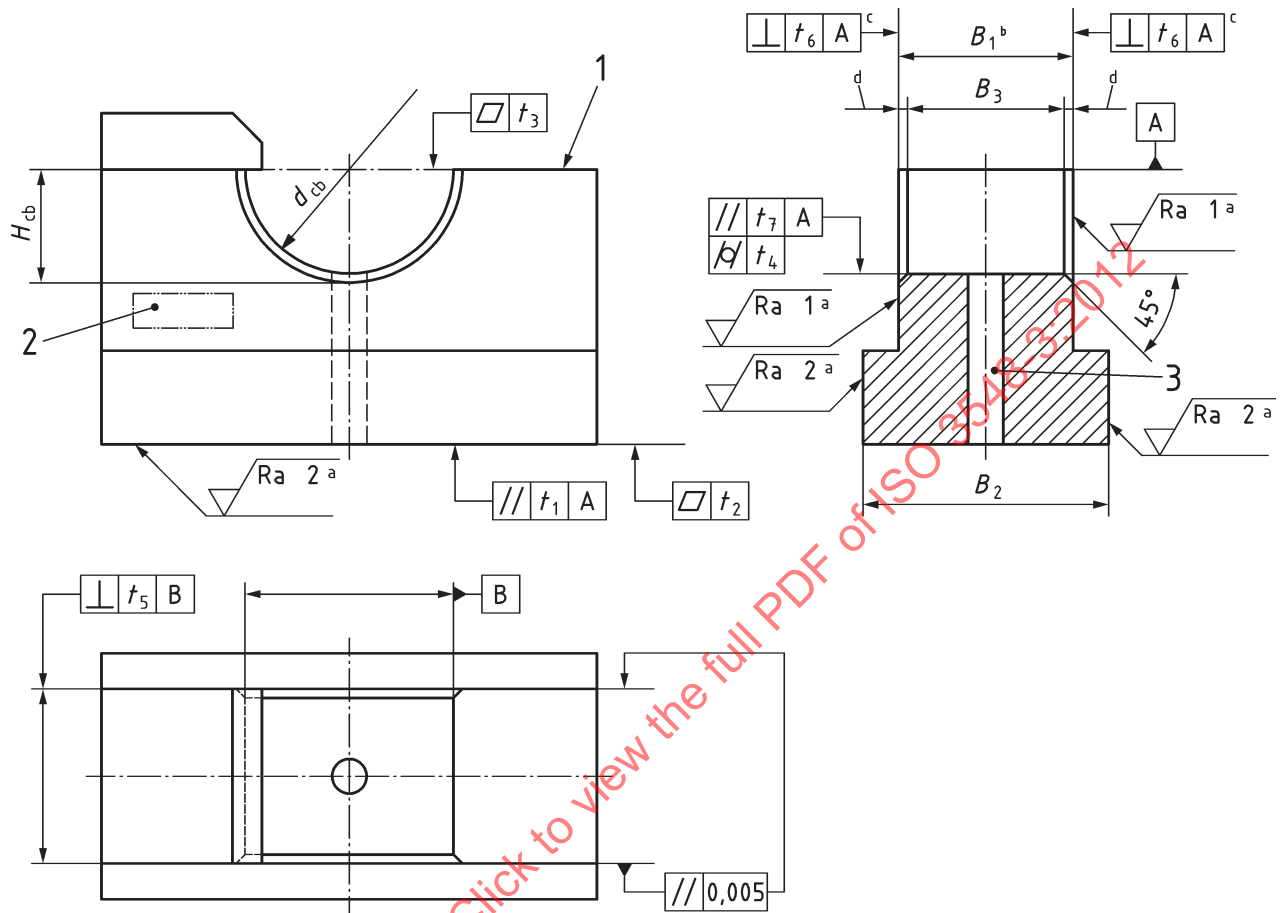
The checking block should preferably be of hardened steel and of rigid design and manufacturing so that the requirements of Clause 16 are met when the half bearing is tested under load.

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  $F_{cor,cb,s}$  (see 13.1 and 13.2.1)
- 2 field for marking of  $d_{cb,M}$ ,  $H_{cb,M}$  and  $F_{cor,cb}$  (or  $F_{cor,cb,s}$ )
- 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  $B_{max} + 1,2\text{ mm}$  with  $K_{1,max} = 0,4\text{ mm}$
- c Construction for flanged half bearing:  
 $B_1$ ; see Table 5;  
 $K_2 = h_{max} + 0,5\text{ mm}$ .
- 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<br>$D_{bs}$ | Tolerance on<br>$d_{cbm}$ | Surface roughness of<br>checking block bore<br>$R_a$ | Tolerance on<br>$H_{cbm}$ | Surface roughness of<br>the datum face<br>$R_a$ |
|------------------------------|---------------------------|------------------------------------------------------|---------------------------|-------------------------------------------------|
| mm                           | mm                        | $\mu\text{m}$                                        | mm                        | $\mu\text{m}$                                   |
| $D_{bs} \leq 75$             | $+0,0030$<br>0            | 0,2                                                  | $+0,0030$<br>0            | 0,3                                             |
| $75 < D_{bs} \leq 110$       | $+0,0040$<br>0            |                                                      | $+0,0035$<br>0            |                                                 |
| $110 < D_{bs} \leq 160$      | $+0,0050$<br>0            |                                                      | $+0,0040$<br>0            |                                                 |
| $160 < D_{bs} \leq 250$      | $+0,0060$<br>0            | 0,4                                                  | $+0,0045$<br>0            | 0,6                                             |
| $250 < D_{bs} \leq 340$      | $+0,0075$<br>0            | 0,6                                                  | $+0,0050$<br>0            | 1,0                                             |
| $340 < D_{bs} \leq 500$      | $+0,0100$<br>0            |                                                      | $+0,0060$<br>0            |                                                 |

## 11.2.2.2 Tolerances of form and orientation

It 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<br>$D_{bs}$ | Bearing without flange<br>$B_{3min}$ | Flanged bearing            | Surface roughness<br>$R_{a1}$ | Tolerances of form and orientation |       |       |       |       |       |       |
|------------------------------|--------------------------------------|----------------------------|-------------------------------|------------------------------------|-------|-------|-------|-------|-------|-------|
| mm                           | mm                                   | mm                         | μm                            | mm                                 |       |       |       |       |       |       |
|                              |                                      | $B_{1,min}$<br>$B_{1,max}$ |                               | $t_1$                              | $t_2$ | $t_3$ | $t_4$ | $t_5$ | $t_6$ |       |
| $D_{bs} \leq 75$             | $B_{max} + 0,4$                      | $z_{min} - 0,1$            | $z_{min} - 0,05$              | 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 | 0,004 | 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<br>$R_{a2}$ | Tolerance<br>on parallelism<br>$t_7$ |
|------------------|----------------|-------------------------------|--------------------------------------|
| mm               | mm             | $\mu\text{m}$                 | 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:

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

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

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

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

**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  $d_{\text{cbs}}$  and  $H_{\text{cbs}}$  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<br>$D_{bs}$ | Tolerance on<br>$d_{cbs}$ | Surface roughness of<br>checking block bore<br>$R_a$ | Tolerance on<br>$H_{cbs}$ | Surface roughness of<br>the datum<br>$R_a$ |
|------------------------------|---------------------------|------------------------------------------------------|---------------------------|--------------------------------------------|
| mm                           | mm                        | $\mu\text{m}$                                        | mm                        | $\mu\text{m}$                              |
| $D_{bs} \leq 75$             | $+0,008$<br>0             | 0,2                                                  | $+0,008$<br>0             | 0,3                                        |
| $75 < D_{bs} \leq 110$       | $+0,010$<br>0             |                                                      | $+0,009$<br>0             |                                            |
| $110 < D_{bs} \leq 160$      | $+0,012$<br>0             |                                                      | $+0,010$<br>0             |                                            |
| $160 < D_{bs} \leq 250$      | $+0,014$<br>0             | 0,4                                                  | $+0,010$<br>0             | 0,6                                        |
| $250 < D_{bs} \leq 340$      | $+0,017$<br>0             | 0,6                                                  | $+0,011$<br>0             | 1,0                                        |
| $340 < D_{bs} \leq 500$      | $+0,022$<br>0             |                                                      | $+0,012$<br>0             |                                            |

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

| Outside diameter<br>$D_{bs}$ | Bearing without flange<br>$B_{3min}$ | Flanged bearing |                  | Surface roughness<br>$R_{a1}$ | Tolerances of form and orientation |       |       |       |       |       |
|------------------------------|--------------------------------------|-----------------|------------------|-------------------------------|------------------------------------|-------|-------|-------|-------|-------|
| mm                           | mm                                   | mm              |                  | $\mu\text{m}$                 | 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 |
| $75 < D_{bs} \leq 110$       |                                      |                 |                  |                               | 0,010                              | 0,010 | 0,010 | 0,008 | 0,006 | 0,012 |
| $110 < D_{bs} \leq 160$      |                                      |                 |                  |                               |                                    |       |       |       |       |       |
| $160 < D_{bs} \leq 250$      |                                      |                 |                  |                               |                                    |       |       |       |       |       |
| $250 < D_{bs} \leq 340$      |                                      |                 |                  |                               | 0,014                              | 0,010 | 0,014 | 0,008 | 0,006 | 0,012 |
| $340 < D_{bs} \leq 500$      |                                      |                 |                  |                               |                                    |       |       |       |       |       |

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

| $B$              | $B_2$                   | Surface roughness<br>$R_{a2}$ | Tolerance on parallelism<br>$t_7$ |
|------------------|-------------------------|-------------------------------|-----------------------------------|
| mm               | mm                      | $\mu\text{m}$                 | 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,  $F_{\text{cor,cbs}}$** 

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<br>$d_{\text{cbs}}$ | Permissible difference<br>$ F_{\text{cor,cbs,new}} - F_{\text{cor,cbs,worn}} $ |
|---------------------------------------------|--------------------------------------------------------------------------------|
| mm                                          | mm                                                                             |
| $d_{\text{cbs}} \leq 75$                    | 0,012                                                                          |
| $75 < d_{\text{cbs}} \leq 110$              | 0,016                                                                          |
| $110 < d_{\text{cbs}} \leq 160$             | 0,020                                                                          |
| $160 < d_{\text{cbs}} \leq 250$             | 0,024                                                                          |
| $250 < d_{\text{cbs}} \leq 340$             | 0,030                                                                          |
| $340 < d_{\text{cbs}} \leq 500$             | 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,  $s_{\text{ms}}$  shall be equal to the total wall thickness,  $s_{\text{tot}}$ , of the standard half bearing to be checked plus 0,125 mm.

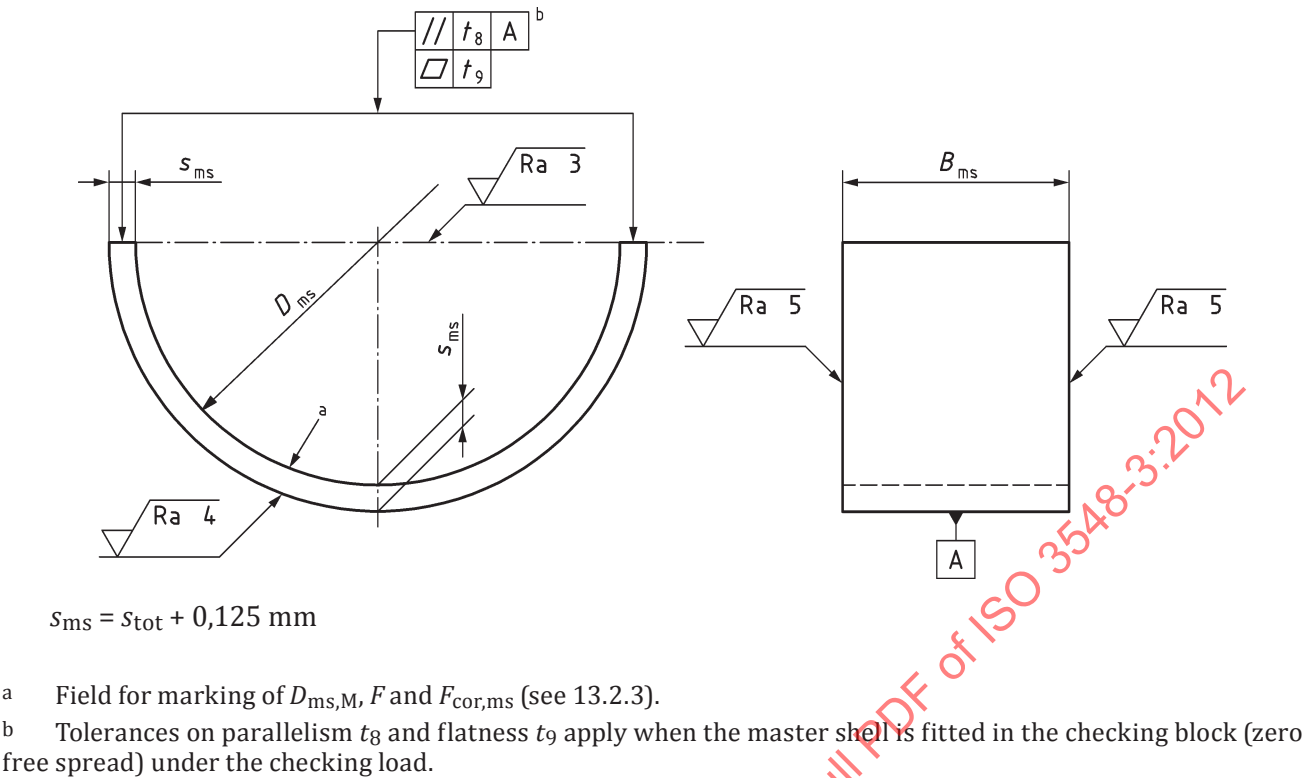


Figure 7 — Master shell

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).

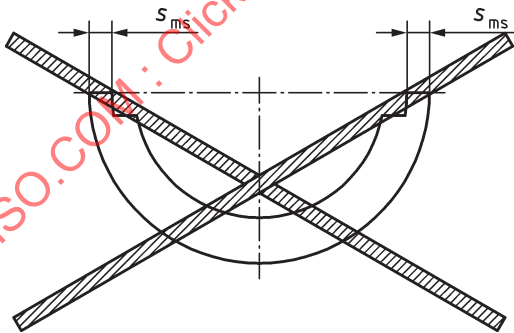


Figure 8 — Stepped master shell — Not suitable for checking bearings or uniform wall thickness

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           | $\mu\text{m}$     | $\mu\text{m}$ |
| $D_{ms} \leq 160$       | $\pm 0,10$   | $\pm 0,015$  | 0,2               | 2             |
| $160 < D_{ms} \leq 200$ | $\pm 0,15$   | $\pm 0,020$  |                   |               |

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

| Outside diameter<br>$D_{ms}$ | Surface roughness<br>$R_{a4}$ | Tolerance on parallelism<br>$t_8$ | Spread                                              | Tolerance on flatness<br>$t_9$ |
|------------------------------|-------------------------------|-----------------------------------|-----------------------------------------------------|--------------------------------|
| mm                           | $\mu\text{m}$                 | mm                                |                                                     | $\mu\text{m}$                  |
| $D_{ms} \leq 160$            | 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<br>$D_{ms}$ | Permissible difference<br>$ F_{cor,ms,new} - F_{cor,ms,worn} $ |
|------------------------------|----------------------------------------------------------------|
| 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):

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

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

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

The correction factor of the master checking block is therefore:

$$F_{\text{cor,cbm}} = l_{\text{cbm,M}} - l_{\text{cbm,th}} \quad (9)$$

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,  $a_{\text{cbm}}$ , and in a series checking block,  $a_{\text{cbs}}$ , under equal checking conditions (see Annex C):

$$F_{\text{cor,cbs}} = a_{\text{cbm,M}} - a_{\text{cbs,M}} \quad (10)$$

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

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

The correction factor,  $F_{\text{cor,cs}}$ , 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  $F_{\text{cor,cs}}$ .

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

The basis for the correction factor,  $F_{\text{cor,cs}}$ , 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,  $F_{\text{cor,cs}}$ , is equal to zero when the comparison shell is exactly adjusted to the peripheral length of the master checking block bore, the bore diameter,  $d_{\text{cbm}}$ , of which corresponds to the outside diameter,  $D_{\text{bs}}$ , 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 ( $F_{\text{cor,cb}}$  or  $F_{\text{cor,cbS}}$ ), the master shell ( $F_{\text{cor,ms}}$ ) or the comparison shell ( $F_{\text{cor,cs}}$ ).

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  $d_{cb,M}$  and  $H_{cb,M}$ , 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,  $\delta$ , 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  $d_{cb,th}$  and the distance from the bottom of the checking block to the datum plane,  $H_{cb,th}$ .

## 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 <sup>a</sup> | Case 2 <sup>b</sup> |               |
| 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             |
| <p>S: Same = physically the same</p> <p>I: Identical = in accordance with this part of ISO 3548, made to the same design, drawings and specifications</p> <p>D: Different = in accordance with this part of ISO 3548, but made to different design, drawings and specifications</p> <p><sup>a</sup> 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.</p> <p><sup>b</sup> 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.</p> |               |                     |                     |               |

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

| $D_{bs}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Repeatability<br>$\sigma_{\Delta B}$ | Reproducibility<br>$ \bar{x}_1 - \bar{x}_2 $<br>max. |                     | Reproducibility <sup>a</sup><br>$ \bar{x}_A - \bar{x}_B $<br>max. |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|------------------------------------------------------|---------------------|-------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                      | Case 1 <sup>b</sup>                                  | Case 2 <sup>c</sup> |                                                                   |
| mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | $\mu\text{m}$                        | $\mu\text{m}$                                        | $\mu\text{m}$       | $\mu\text{m}$                                                     |
| $D_{bs} \leq 75$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 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                                                                |
| <p><sup>a</sup> 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.</p> <p><sup>b</sup> 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.</p> <p><sup>c</sup> The same half bearings are checked in identical or in different checking blocks, with identical or different checking equipment by operators working in different places at different times.</p> |                                      |                                                      |                     |                                                                   |

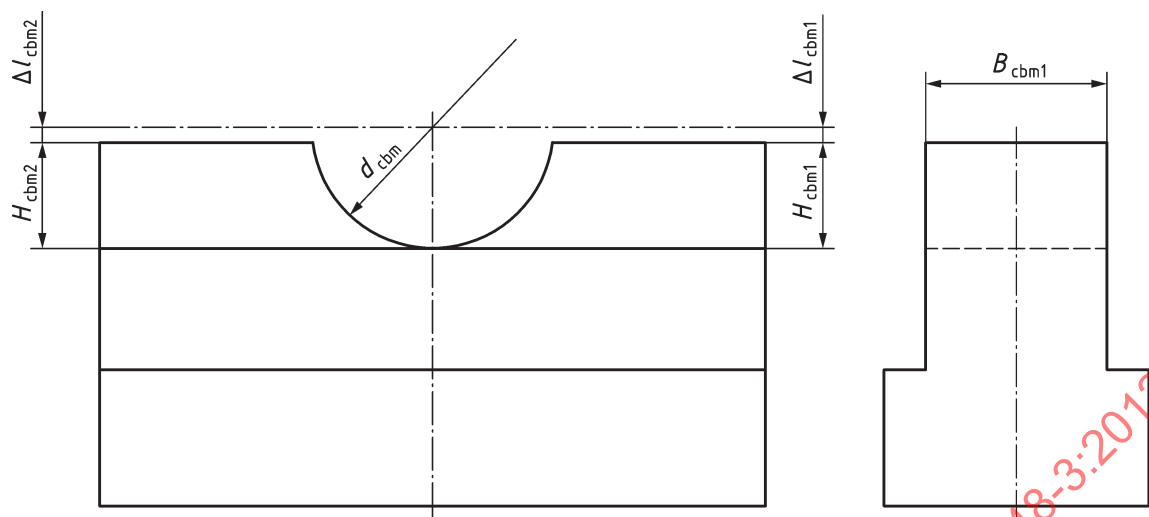
## Annex A (normative)

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

#### A.1 Calculation form

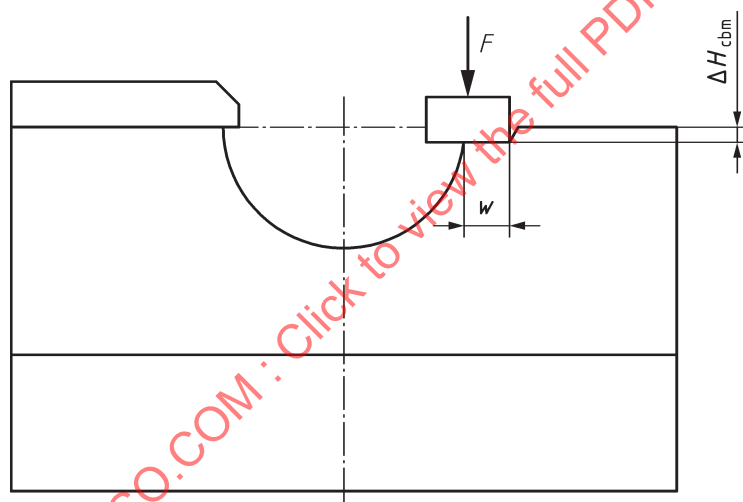
| Firm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Number of drawing                                                                                                                                                                      | Type of bearing                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| $d_{\text{cbm, th}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | $s_{\text{tot}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                   | $B_{\text{max}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm |
| $F = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> N                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | $B_{\text{cbm1}} \text{ or } B_{\text{cbm3, min}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm |                                                                                                                                                      |
| <b>1 Actual peripheral length before correction (see figure A.1)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                        |                                                                                                                                                      |
| $d_{\text{cbm, M}} \times \frac{\pi}{2} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times 1,570\,8 = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>2 Deviations <math>\Delta l_{\text{cbm1}}</math> and <math>\Delta l_{\text{cbm2}}</math> (take signs into account, see note under figure A.1)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                        |                                                                                                                                                      |
| $\Delta l_{\text{cbm1}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $\Delta l_{\text{cbm2}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                           |                                                                                                                                                      |
| $\Sigma \Delta l_{\text{cbm}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm $\longrightarrow$ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>3 Elastic variation of <math>H_{\text{cbm, th}}</math> (see figure A.2)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                        |                                                                                                                                                      |
| $\Delta H_{\text{cbm}} = \frac{H_{\text{cbm, th}} F}{5 \times 10^5 \times w B_{\text{cbm1}}} = \frac{$ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $= $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $= $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>4 Elastic depressions at the fixed stop and toe piece (see figure A.3)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                        |                                                                                                                                                      |
| $p_{\text{E1}} + p_{\text{E2}} = \frac{0,000\,03 F}{s_{\text{tot}} B} = \frac{0,000\,03 \times $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $= $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $= $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                          |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>5 Flexibility of the fixed stop under checking load <math>\Delta l_{\text{cbm}}</math> (see figure A.4)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                        |                                                                                                                                                      |
| $\Delta l_{\text{cbm}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>6 Measured peripheral length (after correction)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                        |                                                                                                                                                      |
| $l_{\text{cbm, M}} = \Sigma (1 \text{ to } 5) = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>7 Theoretical peripheral length</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                        |                                                                                                                                                      |
| $l_{\text{cbm, th}} = d_{\text{cbm, th}} \times \frac{\pi}{2} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times 1,570\,8 = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>8 Correction factor for master checking block</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                        |                                                                                                                                                      |
| $F_{\text{cor, cbm}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm $\longleftarrow$ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                        |                                                                                                                                                      |
| Determine steps 1, 2 and 5 by measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                        |                                                                                                                                                      |

Figure A.1 — Calculation form



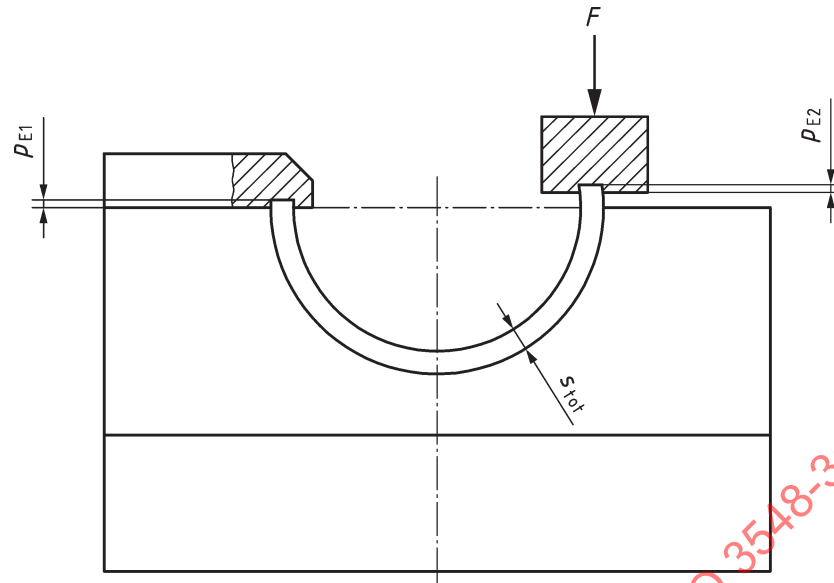
NOTE  $\Delta l_{cbm1} = H_{cbm1, M} - \frac{d_{cbm, M}}{2}$  and  $\Delta l_{cbm2} = H_{cbm2, M} - \frac{d_{cbm, M}}{2}$

Figure A.2



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

Figure A.3



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

Figure A.4

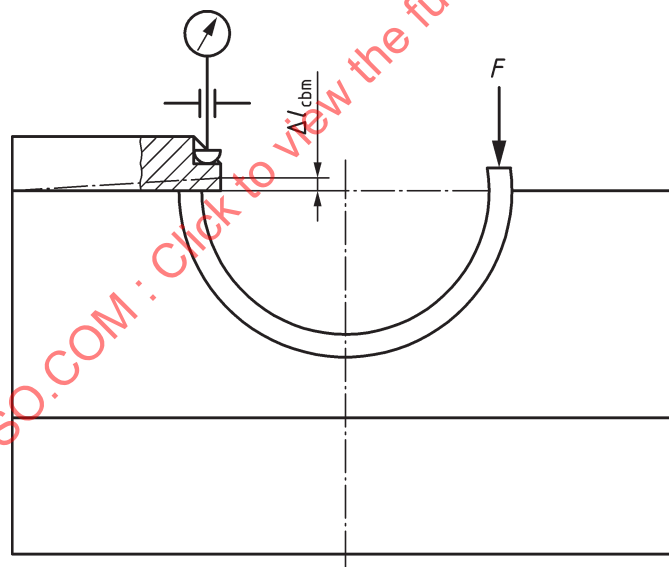


Figure A.5

## A.2 Numerical example

| Firm                                                                                                                                                                                                                                                                                                                                                                                                    | Number of drawing                                                                                                                                                                            | Type of bearing                                                                                                                                                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $d_{\text{cbm, th}} = $ <input type="text" value="5"/> <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="2"/> <input type="text" value="1"/> mm                                                                                                                                                                                                                   | $s_{\text{tot}} = $ <input type="text" value="1"/> <input type="text" value="9"/> <input type="text" value="5"/> <input type="text" value="0"/> mm                                           | $B_{\text{max}} = $ <input type="text" value="3"/> <input type="text" value="5"/> <input type="text" value="0"/> <input type="text" value="0"/> mm                                                                          |
| $F = $ <input type="text" value="5"/> <input type="text" value="8"/> <input type="text" value="0"/> <input type="text" value="0"/> N                                                                                                                                                                                                                                                                    | $B_{\text{cbm1}} \text{ or } B_{\text{cbm3, min}} = $ <input type="text" value="3"/> <input type="text" value="5"/> <input type="text" value="0"/> <input type="text" value="0"/> mm         |                                                                                                                                                                                                                             |
| 1 Actual peripheral length before correction (see figure A.1)                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| $d_{\text{cbm, M}} \times \frac{\pi}{2} = $ <input type="text" value="5"/> <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="2"/> <input type="text" value="2"/> $\times 1,570\,8 = $                                                                                                                                                                             |                                                                                                                                                                                              | <input type="text" value="8"/> <input type="text" value="5"/> <input type="text" value="6"/> <input type="text" value="4"/> <input type="text" value="2"/> <input type="text" value="9"/> mm                                |
| 2 Deviations $\Delta l_{\text{cbm1}}$ and $\Delta l_{\text{cbm2}}$ (take signs into account, see note under figure A.1)                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| $\Delta l_{\text{cbm1}} = $ <input type="text" value="-"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="1"/> mm                                                                                                                                                                                                               |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| $\Delta l_{\text{cbm2}} = $ <input type="text" value="+"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> mm                                                                                                                                                                                                               |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| $\Sigma \Delta l_{\text{cbm}} = $ <input type="text" value="-"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="1"/> mm                                                                                                                                                                                                         | <input type="text" value="-"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="1"/> <input type="text" value="0"/> mm |                                                                                                                                                                                                                             |
| 3 Elastic variation of $H_{\text{cbm, th}}$ (see figure A.2)                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| $\Delta H_{\text{cbm}} = \frac{H_{\text{cbm, th}} F}{5 \times 10^5 \times w B_{\text{cbm1}}} = \frac{$ <input type="text" value="2"/> <input type="text" value="7"/> <input type="text" value="2"/> <input type="text" value="6"/> <input type="text" value="0"/> $\times $ <input type="text" value="5"/> <input type="text" value="8"/> <input type="text" value="0"/> <input type="text" value="0"/> |                                                                                                                                                                                              | $= $ <input type="text" value="-"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="9"/> mm                           |
| $= \frac{500\,000 \times $ <input type="text" value="1"/> <input type="text" value="0"/> $\times $ <input type="text" value="3"/> <input type="text" value="5"/> <input type="text" value="0"/> <input type="text" value="0"/>                                                                                                                                                                          |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| 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 $ <input type="text" value="5"/> <input type="text" value="8"/> <input type="text" value="0"/> <input type="text" value="0"/>                                                                                                                                                                            |                                                                                                                                                                                              | $= $ <input type="text" value="+"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="2"/> <input type="text" value="5"/> mm                           |
| $= \frac{$ <input type="text" value="1"/> <input type="text" value="9"/> <input type="text" value="5"/> <input type="text" value="0"/> $\times $ <input type="text" value="3"/> <input type="text" value="5"/> <input type="text" value="0"/> <input type="text" value="0"/>                                                                                                                            |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| 5 Flexibility of the fixed stop under checking load $\Delta l_{\text{cbm}}$ (see figure A.4)                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                              | <input type="text" value="+"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="2"/> mm                                                               |
| 6 Measured peripheral length (after correction)                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| $l_{\text{cbm, M}} = \Sigma (1 \text{ to } 5) = $ <input type="text" value="+"/>                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                              | <input type="text" value="8"/> <input type="text" value="5"/> <input type="text" value="6"/> <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="5"/> mm                                |
| 7 Theoretical peripheral length                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| $l_{\text{cbm, th}} = d_{\text{cbm, th}} \times \frac{\pi}{2} = $ <input type="text" value="5"/> <input type="text" value="4"/> <input type="text" value="5"/> <input type="text" value="2"/> <input type="text" value="1"/> $\times 1,570\,8 = $                                                                                                                                                       |                                                                                                                                                                                              | <input type="text" value="-"/> <input type="text" value="8"/> <input type="text" value="5"/> <input type="text" value="6"/> <input type="text" value="4"/> <input type="text" value="1"/> <input type="text" value="3"/> mm |
| 8 Correction factor for master checking block                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                              |                                                                                                                                                                                                                             |
| $F_{\text{cor, cbm}} = $ <input type="text" value="+"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="4"/> mm                                                                                                                                                                                                                  | <input type="text" value="+"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="0"/> <input type="text" value="4"/> <input type="text" value="2"/> mm |                                                                                                                                                                                                                             |
| Determine steps 1, 2 and 5 by measurement.                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                              |                                                                                                                                                                                                                             |

Figure A.6 — Calculation form

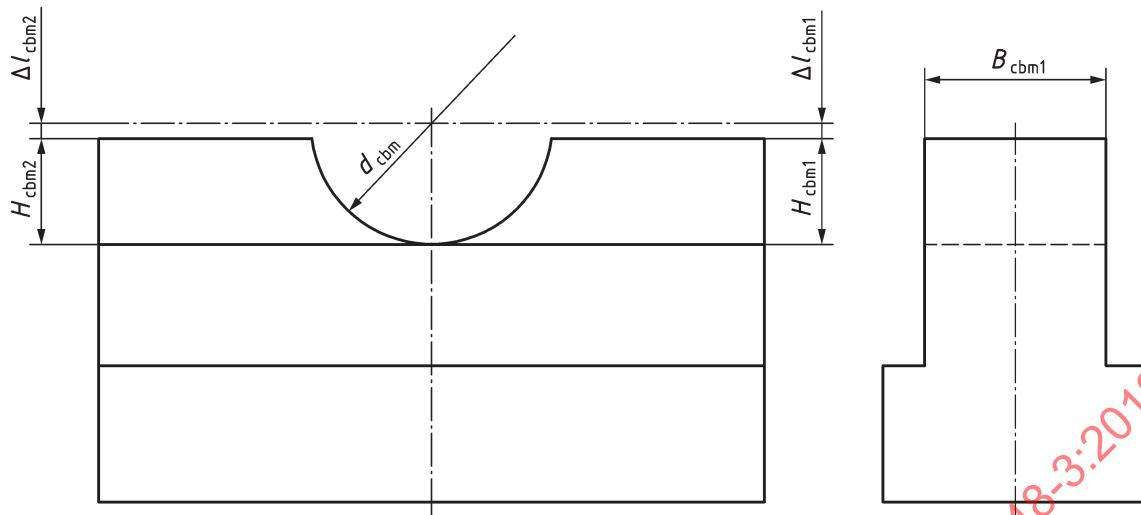
## Annex B (normative)

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

#### B.1 Calculation form

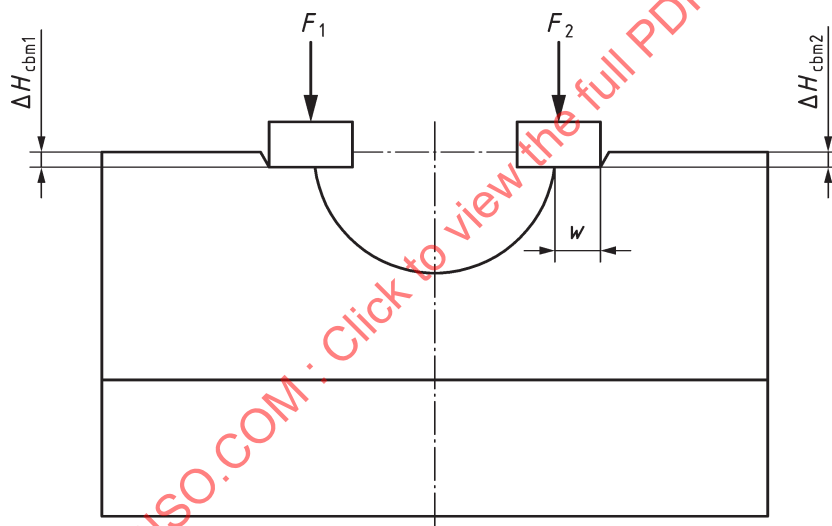
| Firm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Number of drawing                                                                                                                                                                      | Type of bearing                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| $d_{\text{cbm, th}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | $s_{\text{tot}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                   | $B_{\text{max}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm |
| $F = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> N                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $B_{\text{cbm1}} \text{ or } B_{\text{cbm3, min}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm |                                                                                                                                                      |
| <b>1 Actual peripheral length before correction (see figure B.1)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                        |                                                                                                                                                      |
| $d_{\text{cbm, M}} \times \frac{\pi}{2} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times 1,570\,8 = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>2 Deviations <math>\Delta l_{\text{cbm1}}</math> and <math>\Delta l_{\text{cbm2}}</math> (take signs into account, see note under figure B.1)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                        |                                                                                                                                                      |
| $\Delta l_{\text{cbm1}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | $\Delta l_{\text{cbm2}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                           |                                                                                                                                                      |
| $\Sigma \Delta l_{\text{cbm}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm $\longrightarrow$ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>3 Elastic variation: <math>\Delta H_{\text{cbm}} = \Delta H_{\text{cbm1}} + \Delta H_{\text{cbm2}}</math> (see figure B.2)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                        |                                                                                                                                                      |
| $\Delta H_{\text{cbm}} = \frac{H_{\text{cbm, th}} F}{2,5 \times 10^5 \times w B_{\text{cbm1}}} = \frac{$ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $}{250\,000 \times $ <input type="text"/> <input type="text"/> $\times $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $= $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>4 Elastic depressions at both toe pieces (see figure B.3)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                        |                                                                                                                                                      |
| $p_{\text{E1}} + p_{\text{E2}} = \frac{0,000\,03 F}{s_{\text{tot}} B} = \frac{0,000\,03 \times $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $}{$ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $= $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                        |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>5 Measured peripheral length (after correction)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                        |                                                                                                                                                      |
| $l_{\text{cbm, M}} = \Sigma (1 \text{ to } 4) = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>6 Theoretical peripheral length</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                        |                                                                                                                                                      |
| $l_{\text{cbm, th}} = d_{\text{cbm, th}} \times \frac{\pi}{2} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> $\times 1,570\,8 = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                        |                                                                                                                                                      |
| <b>7 Correction factor for master checking block</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                        |                                                                                                                                                      |
| $F_{\text{cor, cbm}} = $ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm $\longleftarrow$ <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> mm                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                        |                                                                                                                                                      |
| Determine steps 1 and 2 by measurement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                        |                                                                                                                                                      |

Figure B.1 — Calculation form



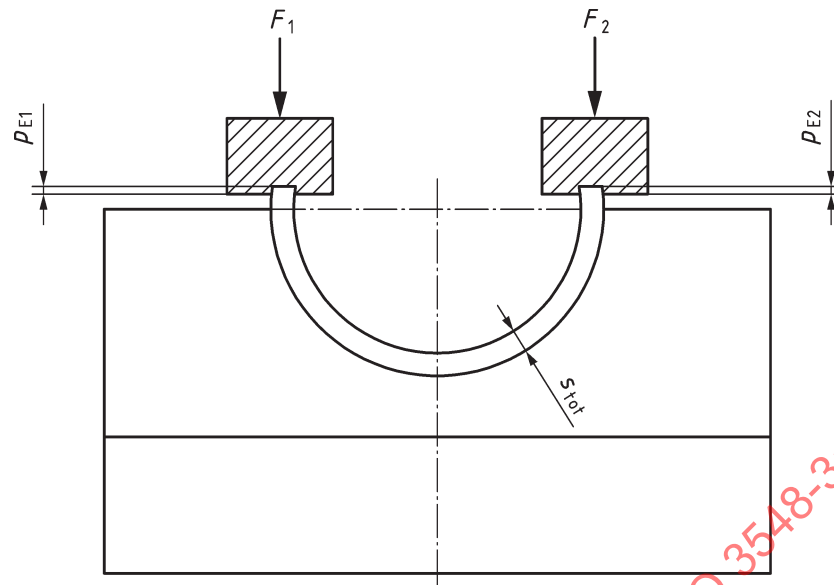
NOTE  $\Delta l_{cbm1} = H_{cbm1, M} - \frac{d_{cbm, M}}{2}$  and  $\Delta l_{cbm2} = H_{cbm2, M} - \frac{d_{cbm, M}}{2}$

Figure B.2



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

Figure B.3



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

Figure B.4