

Plain bearings — Quality control techniques and inspection of geometrical and material quality characteristics

Committees responsible for this British Standard

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- Association of Bronze and Brass Founders
- British Plastics Federation
- British Powder Metal Federation
- Copper Development Association
- Institution of Diesel and Gas Turbine Engineers
- Institution of Mechanical Engineers
- Society of Motor Manufacturers and Traders Ltd.

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National foreword

This British Standard has been prepared under the direction of the Machinery and Components Standards Policy Committee. It is identical with ISO 12301:1992 *Plain bearings — Quality control techniques and inspection of geometrical and material quality characteristics*, published by the International Organization for Standardization (ISO).

Cross-references

International Standard	Corresponding British Standard
ISO 286-1:1988	BS 4500 <i>ISO limits and fits</i> Section 1.1:1990 <i>Specification for bases of tolerances, deviations and fits</i> (Identical)
ISO 2178:1982	BS 5411 <i>Methods of test for metallic and related coatings</i> Part 11:1984 <i>Measurement of coating thickness of non-magnetic metallic and vitreous or porcelain enamel coatings on magnetic basis metals: magnetic method</i> (Identical)
ISO 2795:1991	BS 4480 <i>Plain bearings: metric series</i> Part 1:1992 <i>Sintered bushes. Dimensions and tolerances</i> (Identical)
ISO 3543:1981	BS 5411 <i>Methods of test for metallic and related coatings</i> Part 12:1981 <i>Beta backscatter method for measurement of thickness</i> (Identical) BS 4480 <i>Plain bearings: metric series</i>
ISO 3546:1976	Part 4:1979 <i>Dimensions, tolerances and methods of checking wrapped bushes</i> (Identical)
ISO 3548:1978	Part 5:1979 <i>Dimensions, tolerances and methods of checking thin-walled half bearings</i> (Identical) BS 7585 <i>Metallic multilayer plain bearings</i>
ISO 4386-1:1992	Part 1:1992 <i>Method for non-destructive ultrasonic testing of bond</i> (Identical)
ISO 4386-2:1982	Part 2:1992 <i>Method for destructive testing of bond for bearing metal layer thickness ≥ 2 mm</i> (Identical)
ISO 4386-3:1992	Part 3:1992 <i>Method for non-destructive die penetrant testing</i> (Identical) BS 4480 <i>Plain bearings: metric series</i>
ISO 6525:1983	Part 6:1984 <i>Specification for dimensions and tolerances of ring type thrust washers made from strip</i> (Identical)
ISO 6526:1983	Part 7:1984 <i>Specification for dimensions and tolerances of pressed bimetallic half thrust washers</i> (Identical)
ISO 6864:1984	Part 8:1984 <i>Specification for dimensions, tolerances and methods of checking of thin-walled flanged half bearings</i> (Identical)

The Technical Committee has reviewed the provisions of ISO 468:1982, ISO 1880:1979, ISO 4384-1:1982, ISO 4384-2:1982, ISO 6524:1983 and ISO 6691:1989, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. A related British Standard for ISO 468:1982 is BS 1134-1:1988.

Textual errors. When adopting the text of the International Standard, the textual errors listed below were discovered. They have been marked in the text and have been reported to ISO in a proposal to amend the text of the International Standard.

In **A.1.5**, insert ($a_{\min} = 0,040$ mm) at the end of line 1.

In **A.1.6**, lines 2 and 4, insert “diametral” before “deformation”.

In line 3, in the formula for $\varepsilon_{\min}$ change “ T_a ” and substitute “ $a_{\min}$ ”.

As a result of this change:

$$\varepsilon_{\min} = \frac{2}{\pi} (E_{\text{red}} + a_{\min}) = \frac{2}{\pi} (0,039 + 0,040) = 0,050 \text{ mm}$$

In line 5, as $\varepsilon_{\min}$ has now become 0,050 mm:

$$\varepsilon_{\max} = \frac{2}{\pi} \times T_a + (T_{d_H} + \varepsilon_{\min}) = \frac{2}{\pi} \times 0,030 + (0,019 + 0,050) = 0,088 \text{ mm}$$

In **A.1.7**, line 6, as $\varepsilon_{\min}$ has now become 0,050 mm:

$$\sigma_{\text{tan, min}} = \frac{\Phi}{d_H} + \varepsilon_{\min} = \frac{1,93 \times 10^5}{64} \times 0,050 = 151 \text{ N/mm}^2$$

In line 7, as $\varepsilon_{\max}$ has now become 0,088 mm:

$$\sigma_{\text{tan, max}} = \frac{\Phi}{d_H} + \varepsilon_{\max} = \frac{1,93 \times 10^5}{64} \times 0,088 = 265 \text{ N/mm}^2$$

In line 9, as $\sigma_{\text{tan, min}}$ has now become 151 N/m² and $\sigma_{\text{tan, max}}$ has likewise become 265 N/mm²:

$$\bar{F}_{\text{tan}} = \frac{\sigma_{\text{tan, min}} + \sigma_{\text{tan, max}}}{2} \times A_{\text{eff}} = \frac{151 + 265}{2} \times 43,75 = 9100 \text{ N}$$

In **A.2.5**, insert ($a_{\min} = 0,05$ mm) at the end of the line 1.

In **A.2.6**, lines 2 and 4, insert “diametral” before “deformation”.

In line 3, in the formula for $\varepsilon_{\min}$ delete “ T_a ” and substitute “ $a_{\min}$ ”.

As a result of this change:

$$\varepsilon_{\min} = \frac{2}{\pi} (E_{\text{red}} + a_{\min}) = \frac{2}{\pi} (0,065 + 0,050) = 0,073 \text{ mm}$$

In line 5, as $\varepsilon_{\min}$ has now become 0,073 mm:

$$\varepsilon_{\max} = \frac{2}{\pi} + T_a + (T_{d_H} + \varepsilon_{\min}) = \frac{2}{\pi} \times 0,030 + (0,022 + 0,073) + 0,114 \text{ mm}$$

In **A.2.7**, in line 6, as $\varepsilon_{\min}$ has now become 0,073 mm:

$$\sigma_{\text{tan, min}} = \frac{\Phi}{d_H} \times \varepsilon_{\min} = \frac{1,75 \times 10^5}{110} \times 0,073 = 116 \text{ N/mm}^2$$

In line 7, as $\varepsilon_{\max}$ has now become 0,114 mm:

$$\sigma_{\text{tan, max}} = \frac{\Phi}{d_H} \times \varepsilon_{\max} = \frac{1,75 \times 10^5}{110} \times 0,114 = 181 \text{ N/mm}^2$$

In line 9, as $\sigma_{\text{tan, min}}$ has now become 116 N/mm² and $\sigma_{\text{tan, max}}$ has likewise become 181 N/mm²:

$$\bar{F}_{\text{tan}} = \frac{\sigma_{\text{tan, min}} + \sigma_{\text{tan, max}}}{2} \times A_{\text{eff}} = \frac{116 + 181}{2} \times 183,4 = 27\,235 \text{ N}$$

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 36, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This International Standard specifies quality control techniques and inspection of the geometrical and material quality characteristics of the following types of plain bearing:

- metallic thin-walled half-bearings, as specified in ISO 3548;
- metallic thin-walled flanged bearings, as specified in ISO 6864;
- metallic thick-walled half-bearings (with and without flange) which are manufactured as halves but which are not necessarily interchangeable and have the ratio $s_{\text{tot}}: D_o \geq 0,11$;
- wrapped bushes, as specified in ISO 3547;
- unsplit metallic bushes (with and without flange) made from solid and multilayer materials and with outside diameters up to 230 mm, as specified in ISO 4379;
- thermoplastic bushes (with and without flange) with inside diameters up to and including 200 mm;
- ring-type thrust washers and pressed bimetallic half-thrust washers, as specified in ISO 6525 and ISO 6526, respectively;
- plain bearings made from sintered material, as specified in ISO 2795.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 286-1:1988, *ISO system of limits and fits — Part 1: Bases of tolerances, deviations and fits*.

ISO 468:1982, *Surface roughness — Parameters, their values and general rules for specifying requirements*.

ISO 1880:1979, *Instruments for the measurement of surface roughness by the profile method — Contact (stylus) instruments of progressive profile transformation — Profile recording instruments*.

ISO 2178:1982, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*.

ISO 2795:1991, *Plain bearings — Sintered bushes — Dimensions and tolerances*.

ISO 3543:1981, *Metallic and non-metallic coatings — Measurement of thickness — Beta backscatter method*.

ISO 3547:1976, *Plain bearings — Wrapped bushes — Dimensions, tolerances and methods of checking*.

ISO 3548:1978, *Plain bearings — Thin-walled half bearings — Dimensions, tolerances and methods of checking*.

ISO 4378-1:—, *Plain bearings — Terms, definitions and classification — Part 1: Design, bearing materials and their properties*¹⁾.

ISO 4379:—, *Plain bearings — Copper alloy bushes*²⁾.

ISO 4384-1:1982, *Plain bearings — Hardness testing of bearing metals — Part 1: Compound materials*.

ISO 4384-2:1982, *Plain bearings — Hardness testing of bearing metals — Part 2: Solid materials*.

ISO 4386-1:1992, *Plain bearings — Metallic multilayer plain bearings — Part 1: Non-destructive ultrasonic testing of bond*.

ISO 4386-2:1982, *Plain bearings — Metallic multilayer plain bearings — Part 2: Destructive testing of bond for bearing metal layer thicknesses ≥ 2 mm*.

ISO 4386-3:1992, *Plain bearings — Metallic multilayer plain bearings — Part 3: Non-destructive penetrant testing*.

ISO 6524:1983, *Plain bearings — Methods of dimensional control — Peripheral length checking of thin-walled half bearings*.

ISO 6525:1983, *Plain bearings — Ring type thrust washers made from strip — Dimensions and tolerances*.

¹⁾ To be published. (Revision of ISO 4378-1:1983)

²⁾ To be published. (Revision of ISO 4379:1978)

ISO 6526:1983, *Plain bearings — Pressed bimetallic half thrust washers — Features and tolerances.*

ISO 6691:1989, *Thermoplastics for plain bearings — Classification and designation.*

ISO 6864:1984, *Plain bearings — Thin-walled flanged half bearings — Dimensions, tolerances and methods of checking.*

ISO 12306:—, *Plain bearings — Measurement of wall thickness of thin-walled half-bearings and thin-walled unsplit or wrapped bushes*³⁾.

ISO 12307:—, *Plain bearings — Checking the outside diameter of wrapped bushes*³⁾.

3 Definitions

For the purposes of this International Standard, the definitions of technical terms relating to plain bearings given in ISO 4378-1 and the following definitions of terms relating to quality and measurement apply.

3.1

quality of plain bearing

condition which renders a plain bearing fit to fulfil given requirements. The given requirements are generally dependent upon the intended use

3.2

quality control techniques

the method, equipment and procedure by means of which the quality of a plain bearing is assessed

3.3

quality characteristic

characteristic by means of which the quality of a plain bearing is judged

3.4

inspection

checking of one or more quality characteristics of a plain bearing with applicable requirements

3.5

uncertainty of measurement

the uncertainty of measurement, u , can be calculated using the following formula:

$$u = \pm t \sigma$$

where

t is the stochastic variable according to Student's t distribution; $t = 2$ and corresponds to a statistical uncertainty in measurement $P = 95\%$, for which the probability of exceeding the value $(1 - P) = 0,05$ or 5% ;

σ is the standard deviation.

NOTE 1 The uncertainty of measurement is normally included in the tolerance given.

3.6

measuring points [lines]

agreed points [lines] established to facilitate agreement on testing

NOTE 2 The establishment of measuring points [lines] does not preclude the need to comply with dimensional specifications in other areas.

3.7

tolerance

range of acceptable measurements between the upper specified limit and the lower specified limit

4 Symbols and units

For the purposes of this International Standard, the symbols and units are as given in Table 1.

³⁾ To be published.

Table 1

Symbol	Parameter	SI Unit
a	Crush height (nip)	mm
Δa	Measured change in a	mm
a_c	Distance between measuring lines	mm
a_E	Distance between gauge faces	mm
a_{fl}	Distance between flanges	mm
A_{eff}	Effective cross-section	mm ²
B	Width	mm
B_{Δ}	Joint displacement	mm
d_c	Diameter of the checking block bore	mm
d_H	Housing diameter	mm
D_{fl}	Flange diameter	mm
D_{fs}	Diameter measured across the joint in the free state; free spread diameter	mm
D_i	Inside diameter	mm
D_o	Outside diameter	mm
E_{red}	Elastic reduction	mm
F_c	Checking load	N
F_{pin}	Checking load (measuring pin)	N
F_{tan}	Tangential load of bearing as fitted	N
h_{Δ}	Joint face taper	mm
H	Height	mm
r	Repeatability	μm
s_1	Steel thickness	mm
s_2	Bearing lining thickness	mm
$s_{2, red}$	Bearing lining thickness, reduced	mm
s_{fl}	Flange thickness	mm
s_{tot}	Wall thickness (total)	mm
T	Tolerance	mm
u	Uncertainty of measurement	mm
$x_1, x_2, \dots, x_i$	Individual measured values	mm
ϵ_{max}	Maximum deformation in compression	mm
ϵ_{min}	Minimum deformation in compression	mm
σ_{tan}	Tangential strength	N/mm ²
Φ	Stress	N/mm ²

5 Summary of defined quality characteristics

A summary of defined quality characteristics is given in Table 2 for the convenience of users of this International Standard, as a guide indicating which defined quality characteristics are relevant to each type of bearing.

The sequence of the characteristics listed in Table 2 does not determine their importance. The manufacturer and user shall agree on priorities for the quality characteristics which, from their points of view, are required to assure reliability and life-time of the product.

NOTE 3 A key explaining the meaning of signs used in Table 2 is provided at the bottom of the table.

Table 2

Relevant clause/sub-clause No.	Quality characteristic	Type of plain bearing						
		Thin-walled half-bearing	Thick-walled half-bearing	Wrapped bush	Unsplit metallic bush	Thermoplastic bush	Sintered bush	Thrust washer (ring and half)
6	Geometrical quality characteristics							
6.1	Wall thickness, s_{tot}							
6.1.1	Line measurement	+	+	+	+	+	—	—
6.1.2	Point measurement	+	+	+	+	+	+	+
6.2	Outside diameter, D_o	—	+	+	+	+	+	+
6.3	Inside diameter, D_i	—	+	+	+	+	+	+
6.4	Width, B	+	+	+	+	+	+	—
6.5	Locating features	+	+	+	+	+	—	+
6.6	Lubricant feed and distribution features	+	+	+	+	+	—	+
6.7	Surface conditions	+	+	+	+	+	—	+
6.8	Crush height, a	+	—	—	—	—	—	—
6.9	Free spread	+	+	—	—	—	—	—
6.10	Straightness of sliding surface	+	—	—	—	—	—	—
6.11	Joint face taper, h_{Δ}	+	—	—	—	—	—	—
6.12	Back contact	+	—	—	—	—	—	—
6.13	Joint displacement, B_{Δ}	—	—	+	—	—	—	—
6.14	Height of thrust half-washer, H	—	—	—	—	—	(+)	+
6.15	Flatness	—	—	—	—	—	(+)	+
6.16	Flange diameter, D_{fl}	+	+	+	+	+	+	—
6.17	Distance between flanges, a_{fl}	+	+	+	+	+	—	—
6.18	Flange thickness, s_{fl}	+	+	+	+	+	+	—
6.19	Perpendicularity (squareness) of flange	+	+	+	+	+	(+)	—
6.20	Geometric deviations							
6.20.1	Cylindricity	—	(+)	—	+	—	(+)	—
6.20.2	Run-out of thrust face	—	(+)	—	+	+	(+)	—
6.20.3	Coaxiality and concentricity	—	+	—	+	+	+	—

Table 2

Relevant clause/sub-clause No.	Quality characteristic	Type of plain bearing						
		Thin-walled half-bearing	Thick-walled half-bearing	Wrapped bush	Unsplit metallic bush	Thermoplastic bush	Sintered bush	Thrust washer (ring and half)
7	Material quality characteristics							
7.1	Metallic solid material							
7.1.1	Hardness	—	+	—	+	—	—	—
7.1.2	Material composition	—	+	—	+	—	—	—
7.1.3	Material structure	—	+	—	+	—	—	—
7.2	Multilayer metallic material							
7.2.1	Overlay properties	+	+	+	—	—	—	+
7.2.2	Lining properties	+	+	+	—	—	—	+
7.2.3	Backing properties	+	+	+	—	—	—	+
7.2.4	Adhesion (bond) of adjacent layers	+	+	+	—	—	—	+
7.3	Plastic layer material							
7.3.1	Overlay properties	—	—	+	—	—	—	(+)
7.3.2	Lining properties	—	—	+	—	—	—	(+)
7.3.3	Backing properties	—	—	+	—	—	—	(+)
7.3.4	Adhesion (bond) of adjacent layers	—	—	+	—	—	—	(+)
7.4	Thermoplastic material (solid)							
7.4.1	Material composition	—	—	—	—	+	—	—
7.4.2	Material structure	—	—	—	—	+	—	—
7.5	Sintered material							
7.5.1	Material composition	—	—	—	—	—	+	—
7.5.2	Material structure	—	—	—	—	—	+	—
Key Plus sign indicates that the characteristic is generally applicable to all types of bearings. Plus sign in parentheses indicates that this characteristic is not always applicable. Minus sign indicates that the characteristic is not relevant for the corresponding type of bearing.								

6 Geometrical quality characteristics

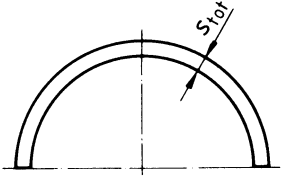
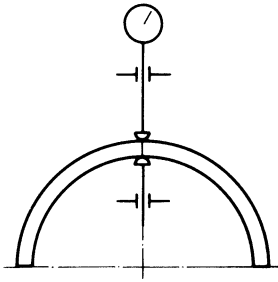
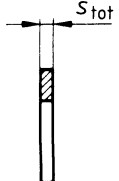
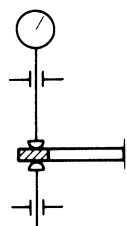
In order to assess plain bearing quality, important dimensional quality characteristics are specified in this clause.

Unless otherwise stated, the dimensions in the tables and figures are given in millimetres.

6.1 Wall thickness, s_{tot}

See Table 3.

Table 3

Applicability	Definition of geometrical characteristic to be measured	Test method/measuring principle	Test equipment
Metallic thin-walled half-bearing	See Figure 1 and ISO 12306.  Figure 1	In accordance with ISO 12306. (See Figure 2) NOTE This test method is also applicable when measuring joint face bore relief.  Figure 2	Device for measuring wall thickness (see also ISO 12306).
Metallic thick-walled half-bearing	See Figure 1 and ISO 12306.	Measured normal to the back surface in the radial direction using the spherical faces of the measuring pins, in accordance with ISO 12306. (See Figure 2.)	Device for measuring wall thickness.
Wrapped bush	See Figure 1 and ISO 12306.	In accordance with ISO 12306. (See Figure 2) NOTE Depending on the manufacturing process, the back of the wrapped bush may show slight hollows. The wall thickness shall, therefore, be measured outside these hollows, i.e. on the "bearing areas" (see ISO 3547). In the cases $D_i < 8$ or $D_i > 150$, the test method shall be subject to agreement between the manufacturer and user.	Device for measuring wall thickness (see also ISO 12306).
Unsplit metallic bush	See Figure 1 and ISO 12306.	In accordance with ISO 12306. (See Figure 2) NOTE The wall thickness may also be determined by obtaining the difference between the outside and inside diameters ($D_o - D_i$) (see 6.2 and 6.3).	Device for measuring wall thickness (see also ISO 12306).
Thermoplastic bush	See Figure 1 and ISO 12306.	In accordance with ISO 12306. (See Figure 2)	Device for measuring wall thickness.
Sintered bush	See Figure 1 and ISO 12306.	In accordance with ISO 12306. (See Figure 2)	Device for measuring wall thickness (see also ISO 12306).
Thrust washer	Axial distance between the two faces of the washer (see Figure 3)  Figure 3	Measured parallel to the axial direction using the spherical faces of the measuring pins (see Table 4).  Figure 4	Device for measuring wall thickness.