INTERNATIONAL STANDARD

ISO 4386-2

Second edition
2012-10-15

Plain bearings — Metallic multilayer plain bearings —

Part 2: Destructive testing of bond for bearing metal layer thicknesses greater than or equal to 2 mm

Paliers lisses — Paliers lisses métalliques multicouches —

Partie 2: Détermination, par essai destructif, de l'adhérence du matériau antifriction d'épaisseur supérieure ou égale à 2 mm

Reference number
ISO 4386-2:2012(E)

Contents

Page

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 4386-2 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions*.

This second edition cancels and replaces the first edition (ISO 4386-2:1982), which has been technically revised.

ISO 4386 consists of the following parts, under the general title *Plain bearings — Metallic multilayer plain bearings*:

— *Part 1: Non-destructive ultrasonic testing of bond of thickness greater than or equal to 0,5 mm*

— *Part 2: Destructive testing of bond for bearing metal layer thicknesses greater than or equal to 2 mm*

— *Part 3: Non-destructive penetrant testing*

Introduction

Long years of experience with bond tests led to an adaptation of this part of ISO 4386. The test apparatus has been modified, to reduce the negative local bending stress influence on the specimen. The geometry of the test specimen has been modified to avoid negative influence due to tolerances. A description of the specimen machining sequence has been added to get a more uniform specimen. A subclause on the application for quality control has been added.

Plain bearings — Metallic multilayer plain bearings —

Part 2: Destructive testing of bond for bearing metal layer thicknesses greater than or equal to 2 mm

1 Scope

This part of ISO 4386 specifies a tensile test method for determination of the bond strength between the bearing metal and the backing. The test can be applied to multilayer plain bearings with bearing metals based on lead, tin, copper or aluminium. For tested layer thicknesses of ≥ 2 mm, a raw lining thickness of a minimum additional 1 mm is necessary.

The backings are from steel, cast steel or copper alloys. The bond strength test does not apply to bearings with cast iron backing.

The test applies to all thrust bearings and to journal bearings with an inner diameter of backing ≥ 90 mm.

The test can be used for comparative investigations into the influence on the bond strength of various processes and types of material. In addition, the test is suitable for production control and for process qualification of bearing production.

For non-destructive ultrasonic testing of the bond between bearing metal and backing for bearing metal layer thicknesses ≥ 2 mm, see ISO 4386-1.

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 4381, *Plain bearings — Tin casting alloys for multilayer plain bearings*

3 Principle

During the tensile testing carried out vertically to the bond surface, the bond strength R_{Ch}, in newtons per square millimetre, is the quotient of the maximum force, F_{max}, in newtons and the bond surface, A, in square millimetres, of the specimen (see Table 2).

NOTE The subscript “Ch” refers to the test method proposed by Chalmers.

$$R_{Ch} = \frac{F_{max}}{A} \quad (1)$$

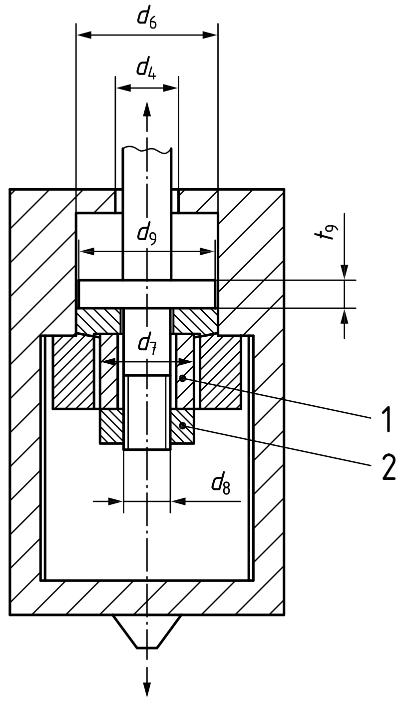
4 Test equipment

4.1 General

A calibrated tensile testing machine shall be used with apparatus in accordance with Table 1.

By means of careful adjustment of the apparatus, it shall be ensured that the force is acting vertically to the bond surface in order to avoid incorrect measurements.

4.2 Testing apparatus



Key

1 distance tube

2 nut

Figure 1 — Main dimensions of apparatus

NOTE Details not indicted in this part of ISO 4386 are expected to be chosen accordingly.

Table 1 — Dimensions and tolerances for test apparatus

Dimensions in millimetres

Type of specimen	Apparatus geometry data					
	d_4	d_6	d_7	d_8	d_9	t_9
	$^{+0,1}_{0}$	$^{+0,1}_{0}$	$^{0}_{-0,1}$	n.a.	n.a.	n.a.
T 100	8,1	19,8	15,9	M 8	19	4
T 200	12,1	29,1	23,9	M 12	28	4

5 Specimen

5.1 General

Tin casting alloys for multilayer plain bearings are specified in ISO 4381.

For selection of the type of specimen in the case of journal bearings, the inner diameter, d_1, of the bearing has to be considered.

Specimen T 100 is valid from the minimum diameter d_1 = 90 mm up to d_1 = 200 mm.

Specimen T 200 is valid for all diameters d_1 > 200 mm.

For the thrust bearings specimen, T 100 and T 200 may be used. Whenever possible, T 200 should be preferred.

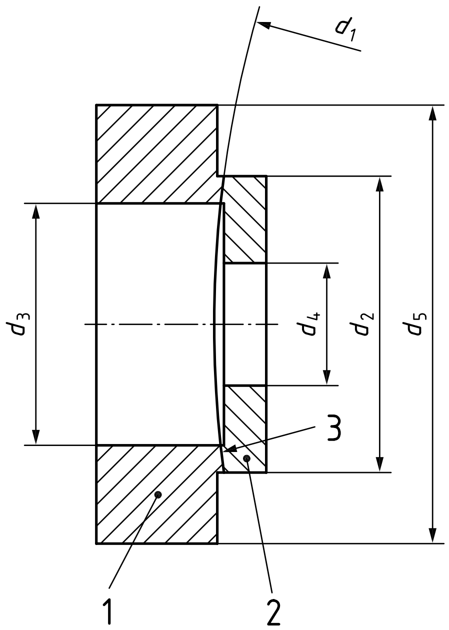
Both bearing metal faces shall be machined as a precondition for fixing the bearing metal layer on the test apparatus to avoid bending deformation of the bearing metal during test procedure. Use test apparatus in accordance with Table 1.

Specimens shall be manufactured in accordance with Table 2, Figure 2 and 5.1.

Table 2 — Dimensions and tolerances for specimens (see Figure 2)

Dimensions in millimetres

Type of specimen	Bond surface	Inner diameter of the backing of journal bearing	Specimen geometry data			
	A mm^2	d_1	d_2	d_3	d_4	d_5
			h8	H8	$^{+0,1}_{0}$	
T 100	100	90 - 200	19,60	16	8,1	29
T 200	200	> 200	28,85	24	12,1	38



Key

1 backing

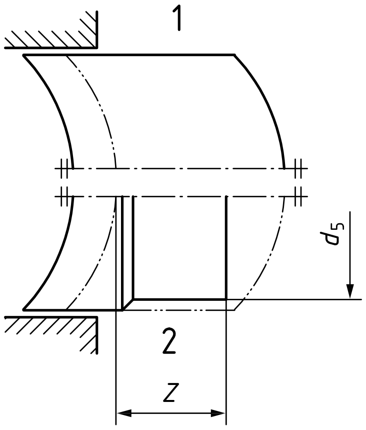
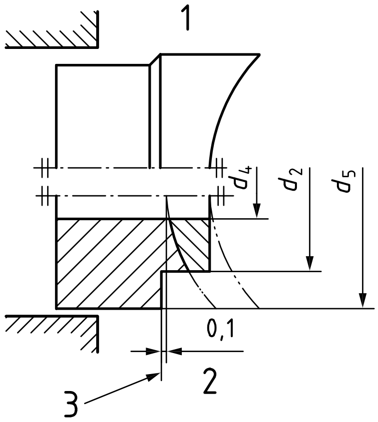
2 bearing metal

3 bond surface equal to test surface

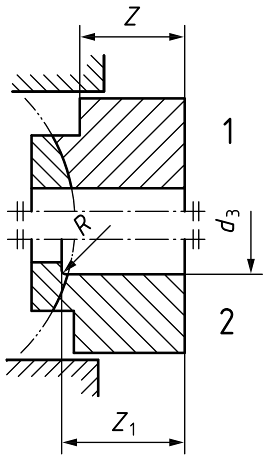
Figure 2 — Specimen (from a journal bearing) for bond testing

5.2 Specimen machining sequence

Specimen machining sequence

Step 1: a) tighten raw specimen with bearing metal towards chuck b) machine d_5 c) machine backing front plane to thickness *Z*		T 100	T 200
	Key 1 before machining 2 after machining **Figure 3 — Step 1**	$d_5 = 29$ $Z = 8 - 10$	$d_5 = 38$ $Z = 10 - 12$
Step 2: a) reverse specimen and tighten with back-ing towards chuck b) drill d_4 c) machine d_5 machine d_2 Machine the reference plane 0,1 mm deep into the steel, referred to the deepest point of bond surface d) machine bearing metal front face plane The raw lining thick-ness shall be min. 3 mm			
	Key 1 before machining 2 after machining 3 reference plane **Figure 4 — Step 2**	$d_4 = 8,1\ ^{+0,1}_{0}$ $d_5 = 29$ $d_2 = 19,60$ h8	$d_4 = 12,1\ ^{+0,1}_{0}$ $d_5 = 38$ $d_2 = 28,85$ h8

Specimen machining sequence

Step 3: a) reverse specimen and tighten with bearing metal towards chuck b) machine d_3 with depth Z_1 Radius R = 0,1 mm			
	Key 1 before machining 2 after machining **Figure 5 — Step 3**	d_3 = 16,0 H8 $Z_{1\,0}^{\,+0,1} = Z + 0,9$	d_3 = 24,0 H8 $Z_{1\,0}^{\,+0,1} = Z + 0,9$

6 Procedure

The apparatus, as shown in Figure 1, is mounted on the calibrated tensile testing machine. Subsequently, the specimen is locked into the apparatus, whereas the bearing metal surfaces are fixed to avoid local bending. For that purpose, hand tighten the nut (see Figure 1).

The force is steadily increased until the specimen fractures.

The increase in stress should be at about 10 N/mm^2·s.

The force of the specimen fracture is read from the testing machine.

7 Evaluation

7.1 General

With the aid of the force of failure, F_{max}, found necessary to tear the bearing metal away from the backing in the region of the bond surface, the bond strength, R_{Ch}, is to be determined according to Formula (1). Previous existing local bond defects on the surface of failure shall be noted.

The characteristic limiting value of layer thickness for the absolute bond strength is a property of the bearing metal. It is 6 mm for Pb and Sn alloys. For other than Pb and Sn alloys, the value shall be determined in a series of tests with different thicknesses of the bearing material layers. Above the limit, the results are independent of the layer thickness.

Absolute bond strength is given when the layer thickness is greater than or equal to the characteristic limiting value of thickness. The result is independent of the layer thickness of the bearing metal.

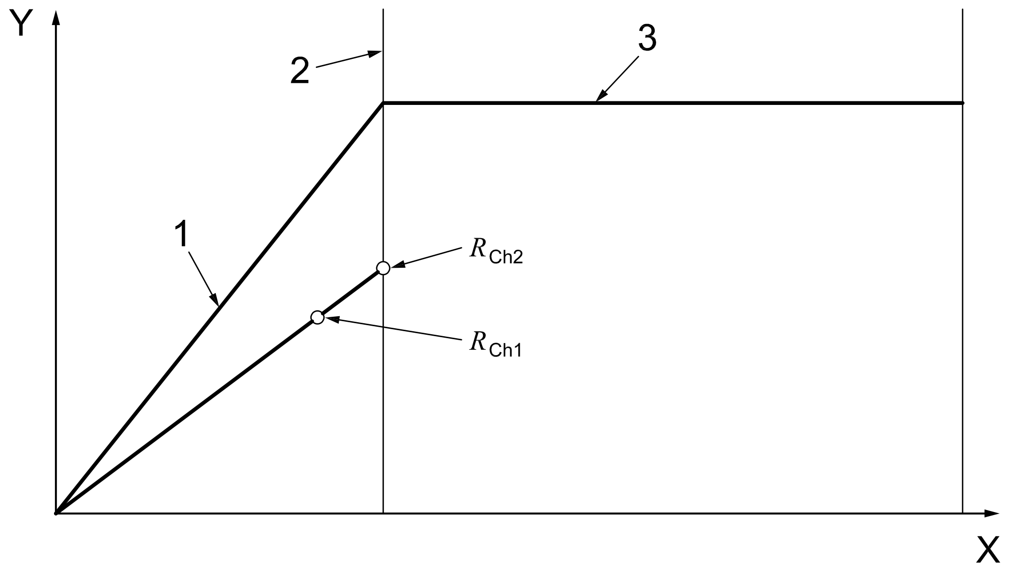
Relative bond strength is given when the layer thickness is less than the characteristic limiting value of thickness. For layer thicknesses below the limiting value of thickness, it has been established experimentally that the relative bond strength drops linearly to the value zero (see Figure 2).

The evaluation procedure is as follows:

a) layer thickness greater than or equal to characteristic limiting value of thickness: the value found is the absolute bond strength value;

b) layer thickness less than characteristic limiting value of thickness: the value found is the relative bond strength value and has to be converted into the value of the absolute bond strength as shown in Figure 2 (as an example).

All results of absolute bond strength shall be limited to the tensile strength, R_m, of the tested bearing metal.



Key

X thickness of bearing metal layer
Y bond strength
1 relative bond strength
2 limiting value
3 absolute bond strength
R_{Ch1} measured value in the range of the relative bond strength
R_{Ch2} value of the absolute bond strength determined graphically

Figure 6 — Principle curve of the bond strength as a function of the thickness of the bearing metal layer

7.2 Designation

With reference to this part of ISO 4386, the tensile test (represented by T) shall be indicated in the following order, for example a test surface of 200 mm^2 is designated as follows: **Test ISO 4386-2, 2009- T 200**

7.3 Test report

A test report on the result of the test shall be drawn up (by agreement) .

In the test report, the following shall be indicated:

a) reference to this part of ISO 4386, i.e. ISO 4386-2;

b) reference to the tested plain bearing;

c) dimensions, layer thickness and materials of the plain bearing;

d) type of specimen, for example T 200;

e) number of specimens;

f) for each specimen:

— maximum force applied until fracture of the specimen;

— relative and absolute bond strength determined;

— description of the condition of the fractured surface inclusive of detected local bond defects or porosities;

g) summary of a test series:

— mean value of absolute bond strength;

— maximum absolute bond strength;

— minimum absolute bond strength;

h) test personnel and date of test.

8 Application for quality control and process qualification

8.1 General

The bond strength depends on many influences, such as backing material quality, heat treatment of backing material, preparation of bond surface, bearing metal composition, casting temperature, backing temperature, backing geometry, cooling conditions, specimen machining tolerances and the test procedure itself.

Because of all these influences, in practice, bond strength results may vary. Less variation of results of a tested series is an indication for high uniformity in processing.

A sufficient number of specimens shall be taken from the test bearing. Specimens should be taken from the centre area of the bearing as well as from the area near the border and should be marked accordingly.

A test with a single specimen gives no quality indication. For a quality indication, the mean value of a series of tests shall be taken.

8.2 Quality control

Through this test procedure, usually the bearing will be destroyed. Therefore, this test procedure is not applicable to continuous quality control. In mass production, a single bearing can be immolated each time.

In single-part production, a separate bearing of the same materials and same geometry shall be produced in sequence with the original bearing, and specimens are to be taken from this separate bearing. Only this approach ensures comparable bond conditions on both bearings.

A mean value of absolute bond ≥ 0,6 R_{m} (tensile strength) of the bearing metal is a sufficient bond for plain bearings.

8.3 Process qualification

A process qualification can be carried out on a typical bearing of the production range.

The mean value of an absolute bond ≥ 0,8 R_{m} (tensile strength) of the bearing metal is a desirable bond for process qualification.

The associated processing data shall be documented and shall be used in the future for the tested bearing type. When dimensions, geometry or materials are to be modified, the process qualification shall be repeated under the new conditions.

NOTE 1 A frequent reason for low bond is a processing temperature that is too low due to local temperature losses.

If the recommended bond cannot be achieved, the heating and cooling conditions of the lining process shall be improved or a different lining process shall be chosen.

ICS 21.100.10
Price based on 8 pages