भारतीय मानक
Indian Standard

IS 16478 (Part 1) : 2024
ISO 4386-1 : 2019

प्लेन बियरिंग्स — धात्विक बहुपरतीय प्लेन बियरिंग्स

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(पहला पुनरीक्षण)

Plain Bearings — Metallic Multilayer Plain Bearings

Part 1 Non-Destructive Ultrasonic Testing of Bond of Thickness Greater than or Equal to 0.5 mm

(First Revision)

ICS 21.100.10

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

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Bearing Sectional Committee, PGD 13

NATIONAL FOREWORD

This Indian Standard (Part 1) (First Revision), which is identical to ISO 4386-1 : 2019 'Plain bearings — Metallic multilayer plain bearings — Part 1: Non-destructive ultrasonic testing of bond of thickness greater than or equal to 0.5 mm' issued by the International Organization for Standardization (ISO), was adopted by the Bureau of Indian Standards on the recommendation of the Bearing Sectional Committee and approval of the Production and General Engineering Division Council.

This standard was first published in 2012. This revision has been undertaken to align it with the current version of ISO 4386-1.

In this revision, a new clause on terms and definitions has been added.

This standard has been published in three parts. The other parts in this series are:

Part 2	Destructive testing of bond for bearing metal layer thicknesses greater than or equal to 2 mm
Part 3	Non-destructive penetrant testing

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

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standard for which Indian Standard also exists. The corresponding Indian Standard which is to be substituted in its place is given below along with its degree of equivalence for the edition indicated.

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 4386-3 Plain bearings — Metallic multilayer plain bearings — Part 3: Non-destructive penetrant testing	IS 16478 (Part 3) : 2023/ISO 4386-3 : 2018 Plain bearings — Metallic multilayer plain bearings — Part 3: Non-destructive penetrant testing (*first revision*)	Identical

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*).' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Contents

Page

Indian Standard

PLAIN BEARINGS — METALLIC MULTILAYER PLAIN BEARINGS

PART 1 NON-DESTRUCTIVE ULTRASONIC TESTING OF BOND OF THICKNESS GREATER THAN OR EQUAL TO 0.5 MM

(First Revision)

1 Scope

This document specifies an ultrasonic testing method for determining bond defects between the bearing metal and the backing. The test can be performed on metallic multilayer plain bearings consisting of steel- or copper-based material backings lined with bearing metal based on lead and tin, with layer thicknesses greater than or equal to 0,5 mm. For cast iron backings, this document is applicable with restrictions.

The ultrasonic signal reflected by the bond interface between the bearing metal and the backing is used to determine bonding defects.

Ultrasonic testing is not possible on edge zones of sliding surface, flange sides, joint areas, oil holes, grooves, etc. in a range of less than half the diameter of the ultrasonic probe because of undefined reflections. The same applies to bearings with dovetail keying grooves at the bond. Ultrasonic testing of bond does not apply along the edges of the dovetails.

Evaluation of the bond on the visible transition from the backing to the bearing metal (on end faces or joint faces) is only practicable by the penetrant testing method specified in ISO 4386-3.

This document only describes in detail the pulse-echo method. Within the meaning of this document, the ultrasonic method only permits a qualitative evaluation of the bonding and not a quantitative determination of the bond strength. The ultrasonic bond test differs only between bond and bond defect.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Symbols

The following symbol is used in this document.

Ra Surface roughness

5 Test equipment

5.1 Ultrasonic instrument

Pulse-echo ultrasonic instrument using rectified A-scope presentation shall be used for the test. The instrument shall be fitted with a calibrated attenuator, reading in decibels, and adjustable time base ranges.

5.2 Probe

For the standard procedure, normal beam probes shall be chosen with size and frequency in relation to the thickness of the bearing layer, backing thickness and backing material. The typical range of diameters is from 24 mm for 2 MHz to 6 mm for 10 MHz probes. For layer thickness < 1 mm, testing with dual-element probes may be chosen.

5.3 Reference block

The time base range shall be adjusted, using a reference block corresponding to the thicknesses of the bearing to be inspected.

6 Preparation of test surface

The test surface shall have a surface roughness of $Ra \leq 5$ µm. After machining, remove dirt and oil using suitable cleaning agents.

7 Testing

7.1 General

Test plain bearings using either contact scanning, with light machine oil as a couplant, or using immersion scanning. Suppression and swept-gain functions shall be switched off. The preferred test is performed from the bearing metal side under consideration of the back-wall echo. Bearings with smaller diameters can be difficult to inspect by contact scanning from the bearing metal side because of limited access of the ultrasonic probe. In such a case, contact scanning from the back surface may be used.

7.2 Testing with a back-wall echo

General preconditions are:

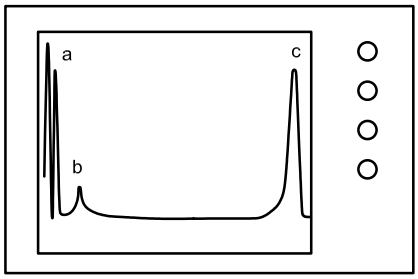
a) free access with the probe to the contact surface;

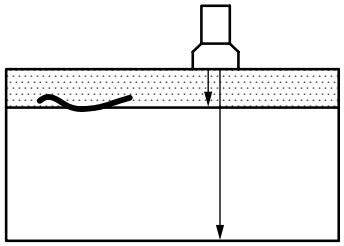
b) back-wall is always parallel to the bearing metal surface;

c) no hollow spaces within the backing material (drilled holes, channels, etc.).

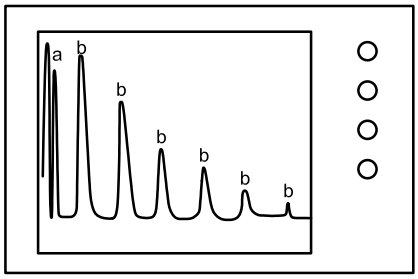
The time base range and sensitivity shall be adjusted so that at least the first back-wall echo is visible on the right-hand side of the screen at approximately 80 % of full screen height. In Figure 1, the bond echo (BE) is on the left-hand side of the screen near the input signal (IS). If in doubt about having the first back-wall echo (WE1) on the screen, use a reference block for adjustment.

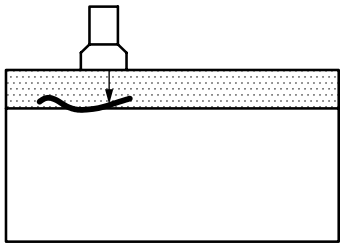
Bond defect is given when the back-wall echo breaks down and at the same time, the bond echo on the left-hand side of the screen increases and repeats multiple times (see Figure 1). The border of the detected defect area is on the middle of the probe diameter when the back-wall echo is reduced to its half height under the above-mentioned conditions.





a) Bond





b) Defective bond

Key

a Input signal (IS).

b Bond echo (BE).

c First back-wall echo (WE_1).

Figure 1 — Testing with a back-wall echo

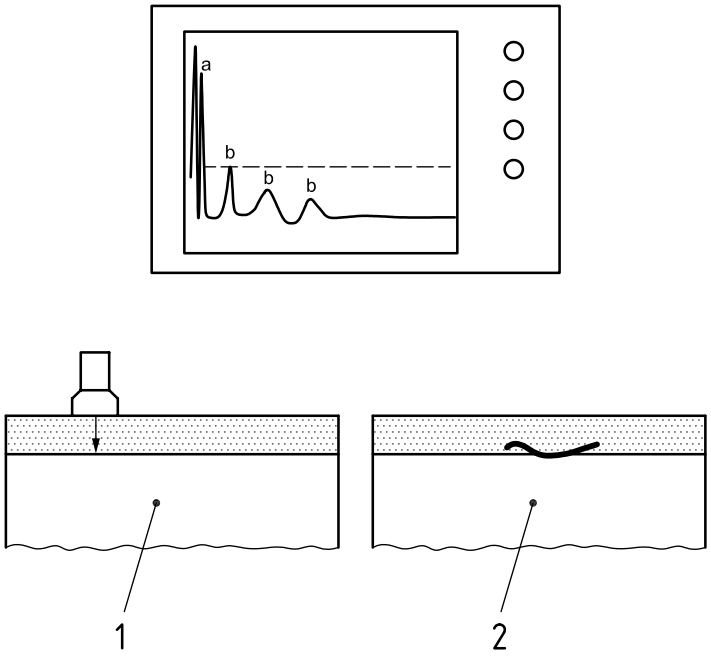
7.3 Testing without a back-wall echo

If the preconditions of 7.2 are not fulfilled, testing without back-wall echo becomes necessary.

Use a reference piece with good bond between similar backing material and similar bearing metal lining as the tested bearing. Adjust the reference bond echo to 20 % of full screen height; see Figure 2.

Bond is given when the echo signal of the tested plain bearing is similar to the adjusted reference bond echo; see Figure 3.

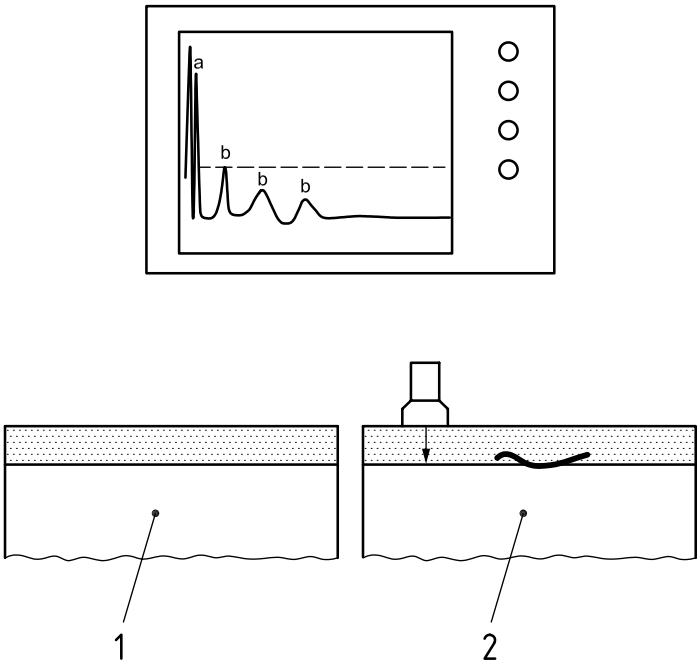
Defective bond is given when the bond echo on the plain bearing is significant above the reference bond height; see Figure 4.



Key

1 reference block
2 test object
a Input signal (IS).
b Reference echo (RE).

Figure 2 — Testing without a back-wall echo: display and adjustment of reference echo



Key

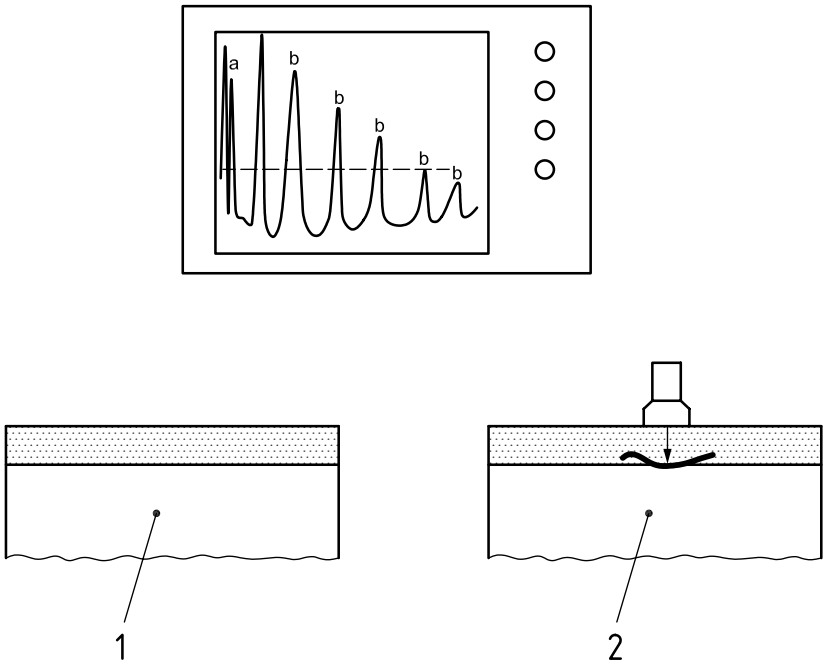
1 reference block

2 test object

a Input signal (IS).

b Bond echo (BE).

Figure 3 — Testing without a back-wall echo: display of bond



Key

1 reference block

2 test object

a Input signal (IS).

b Bond echo (BE).

Figure 4 — Testing without a back-wall echo: display of bond defect

8 Test classes

The test shall be carried out in accordance with one of the following three classes, which are of increasing severity.

— Class 1: complete coverage of the testable area of the edge zones of the sliding surface at flange sides and joint areas; point-type coverage of the sliding surface.

— Class 2: complete coverage of the testable area of the edge zones of the sliding surface at flange sides and joint areas. In addition, complete coverage of the area of maximum loading (for example, in the case of a radial bearing with a bearing force acting vertically downwards, this would be in the range from 60° to 120° with respect to the sliding surface).

— Class 3: complete coverage of the testable area of the flange areas and sliding surface line-by-line. In order to cover all points, testing is carried out with an overlap of the lines of 20 % of the probe diameter.

9 Defect groups

As a guideline, Table 1 shows five different defect groups. The applicable defect groups shall be agreed between the customer and the supplier in advance. Different defect groups should be defined for different regions of a bearing, depending on the kind, size and direction of the load (for example, defect group A for the high-loaded region and defect group B1 for the remaining regions of a journal bearing). Generally, defect group A should be reserved for high-loaded bearings and therefore the area of maximal loading.

Table 1 — Defect groups

Defect group	Maximum areal dimension of single defects	Maximum total defect
	mm^2	Percentage of bonding area[a] %
A	0	0
B1	$0{,}75b$[b]	1
B2	$2b$[b]	1
C	$2b$[b]	2
D	$4b$[b]	5

[a] The bonding area is the lined area of a journal bearing or a thrust plain bearing element.

[b] The width, *b*, in millimetres represents, in case of journal bearing, the functional cylindrical length and, in the case of thrust segments or rings, the distance between the inner and outer diameter. The summary of single defects may not exceed the maximum total defect size.

10 Evaluation

10.1 General

The tests should be carried out by operators educated for ultrasonic testing.

When evaluating the test results in accordance with this document, bond defects equal to or larger than half the probe diameter are normally estimated.

In case of any irregularities on bond surface of a bearing backing, the relevant area shall be collected and documented in the drawing before lining with bearing metal. This avoids misinterpretation during ultrasonic testing as a bond defect.

If the bond echo signal becomes diffuse and missing scanning contact can be excluded, this indicates porosities within the bearing metal. Such areas of porosity shall be regarded as defects due to the uncertainty of evaluation of the bond.

For inspection of the bearing, the following steps shall be considered.

a) After local repair work by a soldering procedure, the bond test shall be repeated in the respective area.

   On edge zones, the visible transition from the backing to the bearing metal shall be checked in accordance with non-destructive penetrant testing specified in ISO 4386-3.

b) Evaluation of defect distribution: detected bond defects on new lined bearings give additional information depending on their location and distribution.

   1) Single bond defects in the flange side edge zone or in the corner between flange side - joint side: these defects are typically based on local temperature losses during the casting procedure. Usually, these defects can be repaired by soldering procedure without any quality reduction.

   2) Single bond defects on sliding surface: if repair work by soldering can be carried out, bond strength is sufficient and quality is not reduced.

   3) Many bond defects distributed on sliding surface: many detected bond defects distributed on the total sliding surface and growing defects during the soldering procedure are indicators for low bond strength at all. Complete renewal of bearing metal lining is recommended.

10.2 Marking of defective areas

If possible, defective areas should be indicated by straight boundary lines. The location of the centre of the probe is decisive for determining the transition line between bond and no bond.

Isolated point-type defects shall be marked with a value equal to half the probe diameter.

If the distance between two or more defects is less than one tenth of the bearing width, *b*, these defects shall be regarded as one continuous defect.

10.3 Designation

With reference to this document, the test class and the defect group shall be indicated as follows:

Test ISO 4386-1 followed by test class number and defect group

EXAMPLE Test Class 2, defect group B1 is designated as follows: **Test ISO 4386-1- 2 B1**

Bibliography

[1] ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

[2] ISO 6280, *Plain bearings — Requirements and guidance on backings for thick-walled multilayer bearings*

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	2323 7617
Eastern	: 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	2367 0012 2320 9474
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg, Chandigarh 160019	265 9930
Southern	: C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113	2254 1442 2254 1216
Western	: Manakalya, 4th Floor, NTH Complex (W Sector), F-10, MIDC, Andheri (East), Mumbai 400093	283 25838

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