International Standard 4386/1

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Plain bearings — Metallic multilayer plain bearings — Part 1 : Non-destructive ultrasonic testing of bond for bearing metal layer thicknesses ⩾ 2 mm

Paliers lisses — Paliers lisses métalliques multicouches — Partie 1 : Détection, par la méthode ultrasonique, des défauts d'adhérence du matériau antifriction d'épaisseur ⩾ 2 mm

First edition — 1982-02-01

UDC 669.018.24-419 : 620.179.16 **Ref. No. ISO 4386/1-1982 (E)**

Descriptors : bearings, plain bearings, bearing alloys, bonding, tests, mechanical tests, non-destructive tests, ultrasonic tests, test results, adhesion.

Price based on 4 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4386/1 was developed by Technical Committee ISO/TC 123, *Plain bearings,* and was circulated to the member bodies in January 1979.

It has been approved by the member bodies of the following countries :

Chile	Italy	Romania
Czechoslovakia	Korea, Rep. of	South Africa, Rep. of
Egypt, Arab Rep. of	Libyan Arab Jamahiriya	Sweden
France	Netherlands	United Kingdom
Germany, F.R.	New Zealand	USA
India	Poland	USSR

The member body of the following country expressed disapproval of the document on technical grounds :

Australia

Printed in Switzerland

Plain bearings — Metallic multilayer plain bearings — Part 1 : Non-destructive ultrasonic testing of bond for bearing metal layer thicknesses ⩾ 2 mm

1 Scope and field of application

This part of ISO 4386 specifies an ultrasonic testing method for the determination of bond defects between the bearing metal and the backing. The test can be performed on metallic multilayer plain bearings consisting of backings with good sound transmission properties (for example steel, cast iron) and lined with bearing metal based on lead and tin with layer thicknesses ⩾ 2 mm.

In the transitional area between groove and land as well as at oil ducts, the test can only be performed under certain conditions because of the attendant pulse distortion.

Within the meaning of this part of ISO 4386, the ultrasonic method only permits a qualitative evaluation of the bonding and not a quantitative determination of the bond strength as specified in ISO 4386/2.

This part of ISO 4386 only describes the pulse-echo method in which the probe is applied from the bearing metal side. The case where the probe is applied from the backing side as well as the method of transmission are to be treated analogously.

The sound energy reflected by the bond surface area between the bearing metal and the backing serves for the determination of the quality of the bonding.

2 Symbols

The following symbols are used in this part of ISO 4386 :

IS : input signal
BE : bond echo
WE : back-wall echo
RE : reference echo

3 Test equipment

3.1 Ultrasonic test device : Pulse echo ultrasonic flaw detection equipment using rectified A scope presentation shall be used for the test. The equipment shall be fitted with a calibrated attenuator reading in decibels, and adjustable time base ranges. Suppression and swept gain functions are to be turned off.

3.2 Probes : In normal circumstances, probes of a standard design with a crystal diameter from 10 to 30 mm shall be used although a smaller probe my be used for small diameter bearings.

A compressional wave probe, frequency 2 MHz, crystal diameter in the range mentioned, shall be used where separation of input signal and bond echo is obtained. Probes of higher frequency or twin crystal probes should be used if such separation cannot be obtained.

3.3 Time base range : The time base range is adjusted so that at least two bond echoes are obtained from a suitable reference block. This reference block shall consist of a layer of bearing metal part of which is correctly bonded and part of which is incorrectly bonded on a backing material. The materials used in the reference block and the thicknesses shall be the same as in the bearing to be inspected.

4 Preparation

4.1 Preparation of the test surface (sliding surface)

4.1.1 Condition of the test surface

The test surface should have a surface roughness of $R_a = 5$ µm.

4.1.2 Cleaning of test surface

After machining, dirt and oil must be removed using suitable cleaning agents. When necessary the surface my be dried using cleaning paper or rags.

4.2 Ultrasonic scanning

The plain bearings shall be tested using either contact scanning with light machine oil as a couplant, or using immersion scanning. Small diameter bearings may be difficult to inspect by contact scanning as uniform coupling may be difficult to achieve on the curved surface.

5 Test classes

The test may be carried out according to one of three classes of increasing severity.

5.1 Class 1

Complete coverage of the edge zones of the sliding surface at flange sides and joint areas; point-type coverage of the bearing surface.

5.2 Class 2

Complete coverage of the flange surfaces, 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).

5.3 Class 3

Complete coverage of the flange areas and sliding surface line-by-line with the probe. In order to cover all points, it is tested with an overlap of the lines of 20 % of the crystal diameter.

6 Testing

6.1 Back-wall echo testing

The bond shall always be checked using one of the bond-echo and back-wall echo comparison methods if these are permitted by the geometry of the multilayer plain bearing and by the material of the backing. The alternative methods are as follows.

6.1.1 Testing according to the relative strength of the bond and back-wall echoes

When using probes in accordance with 3.2, the bond is good when the echo from the bond surface area (bond-echo) is equal to or less than the back-wall echo (see figure 1).

If the bond-echo is greater than the back-wall echo, then the bond between bearing metal and backing is not adequate. If, further, there is no back-wall echo and the bond-echo is repeated (at least three repeat echoes), then no bond is present (see figure 2). During the evaluation, both these results are treated as representing bond defects. If areas with porosity within the bearing metal border on defective areas, then these are regarded as defects due to the uncertainty of evaluation of the bond.

In the case of very thick-walled smaller backings or when using twin-crystal probes, the back-wall echo can become smaller than the bond-echo because of a sound beam divergence or a sound wave weakening, even though the bond is good. In cases of doubt, the ratio between the levels of the two echoes of a perfect and a missing bond are to be determined by means of a reference piece, (steel and bearing material).

6.1.2 Testing according to the reduction in height of the back-wall echo

The test equipment will be calibrated using a standard steel test block and set up on the plain bearing to be tested so as to obtain at least two back echoes, the first echo being set to 80 % screen height. The horizontal magnification should be adjusted to conveniently represent the total wall thickness which should be marked with screen indicators. Bond or backing material defects are then indicated by the position of intermediate echoes occurring before the first back-wall echo. The severity of the defects is then assessed by the reduction in height of the back-wall echo (see figures 3 and 4). An echo of 50 % screen height or less is deemed to indicate a significant defect during assessment of the bearing according to 7.2.

6.2 Testing without a back-wall echo

The bond is evaluated using a reference echo from a reference piece of approximately the same thickness and the same material as the bearing metal lining. The reference echo is adjusted to 80 % of the screen height (see figures 5 and 7). The bond is good, when the first bond-echo is less than the reference echo (see figure 6). A bond defect is present when the first echo from the bond zone is equal to the reference echo (see figure 8).

If areas with porosity within the bearing metal border on defective areas, then these are regarded as defects due to the uncertainty of evaluation of the bond.

7 Evaluation

When evaluating the test results according to this part of ISO 4386, bond defects equal to or larger than half the crystal diameter are normally estimated.

7.1 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 the determination of the transition line between bond and no bond.

Isolated point-type defects are marked with a value equal to half the crystal diameter.

If the distance between two or more defects is less than 10 mm, then these are regarded as one continuous defect.

A length/width ratio of up to 1 : 4 is permissible for individual defects.

7.2 Permissible defects

See the table.

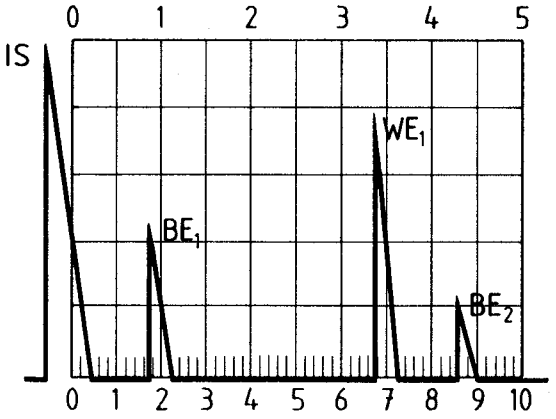

Figure 1 — Good bond

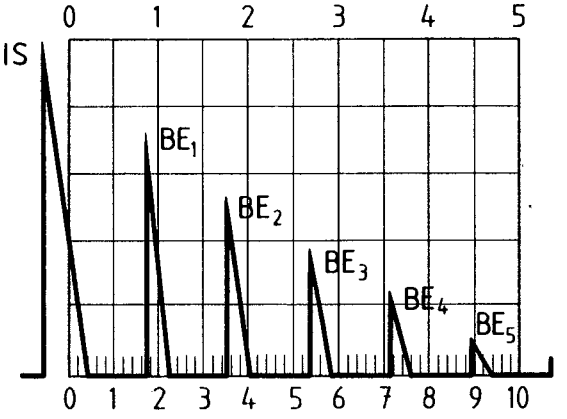

Figure 2 — No bond

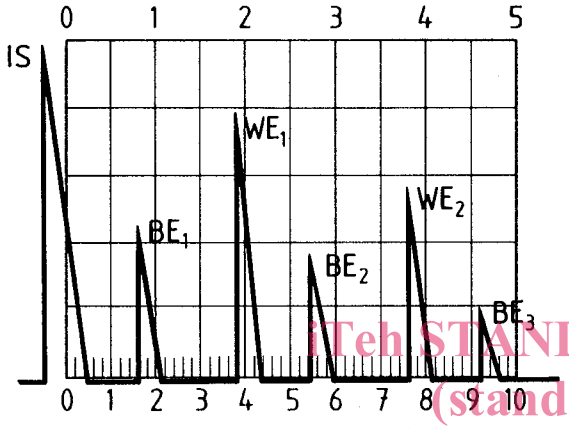

Figure 3 — Good bond

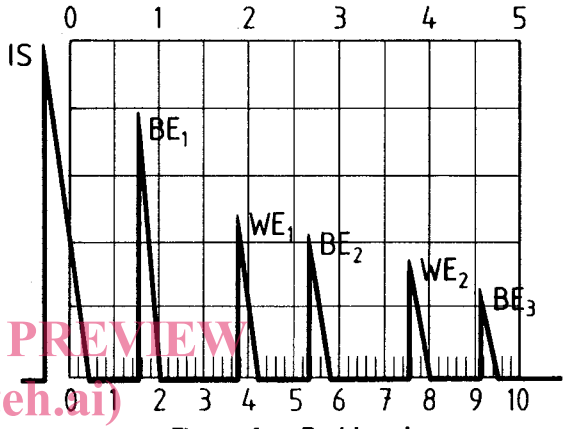

Figure 4 — Bad bond

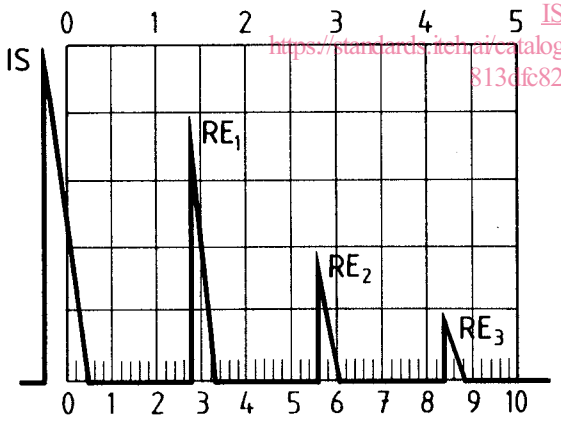

Figure 5 — Adjustment of the reference echo

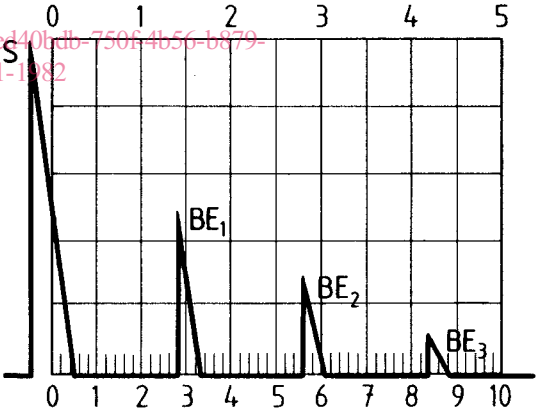

Figure 6 — Good bond

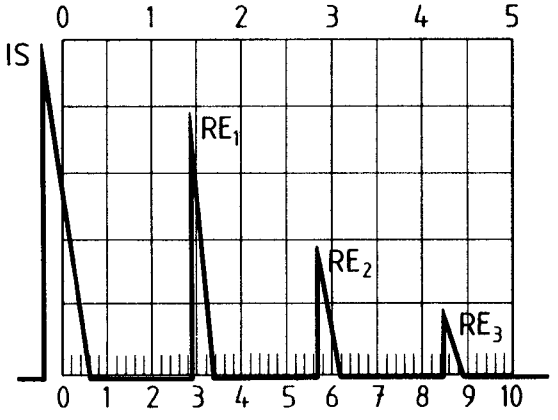

Figure 7 — Adjustment of the reference echo

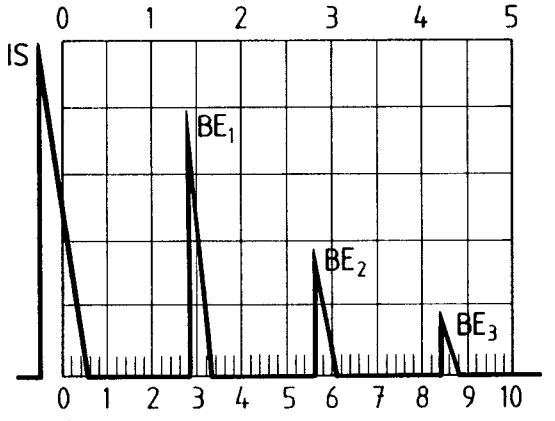

Figure 8 — Bad bond

8 Designation

With reference to this part of ISO 4386, the test class and the defect group are to be indicated in the following order, for example test class 2, defect group C :

Test ISO 4386-2C

9 Test report

A test report on the result of the test is to be drawn up; however in the case of test classes 1 and 2; this is only done by agreement.

In the test report the following are to be indicated :

a) a reference to this part of ISO 4386;

b) dimensions and materials of the plain bearing;

c) layer thickness of the bearing metal for the test;

d) test equipment;

e) type and size of probe, transmitting power;

f) test frequency;

g) amplification, test range;

h) reference piece (dimensions and materials);

j) bearing manufacturer, date of test;

k) testing techniques according to 6.1.1, 6.1.2 or 6.2.

If defects are found, then the exact position of the defects shall be indicated in a drawing of the sliding surface and this drawing included with the test report.

Table

Defect group	Permissible single defects 1) mm² max.	Permissible total defect of the sliding surface 2) % max.	Permissible defect in the edge zone related to the respective edge length 3) % max.	but not exceeding mm max.
A	0	0	0	0
B	2 *b*	1	1	5
C	2 *b*	2	2	10
D	4 *b*	5	4	20
E	6 *b*	10	6	40
F	6 *b*	15	8	60

1) *b* in millimetres represents the width of the bearing in the case of journal bearings and the width of the segment or ring in the case of thrust bearings.

2) For bearing liners of journal bearings, the bearing surface is $(D/2)\ \pi\ b$, for tilting pad thrust bearings the pad surface, and for ring thrust bearings the ring surface minus oil grooves divided by the number of wedge surfaces.

3) The transition from the joint face to the plane face must be free from defects of up to half of the permissible defect length.