INTERNATIONAL STANDARD

ISO 7902-3

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Hydrodynamic plain journal bearings under steady-state conditions — Circular cylindrical bearings —

Part 3:
Permissible operational parameters

Paliers lisses hydrodynamiques radiaux fonctionnant en régime stabilisé — Paliers circulaires cylindriques —

Partie 3: Paramètres opérationnels admissibles

Reference number
ISO 7902-3:1998(E)

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.

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.

International Standard ISO 7902-3 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 4, *Methods of calculation of plain bearings*.

ISO 7902 consists of the following parts, under the general title *Hydrodynamic plain journal bearings under steady-state conditions — Circular cylindrical bearings*:

— *Part 1: Calculation procedure*

— *Part 2: Functions used in the calculation procedure*

— *Part 3: Permissible operational parameters*

Annex A of this part of ISO 7902 is for information only.

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Introduction

In order to attain sufficient operational reliability of circular cylindrical plain journal bearings when calculated in accordance with ISO 7902-1, it is essential that the calculated operational parameters h_{min}, T_{B} or T_{ex} and $\bar{p}$ do not lie above or below the permissible operational parameters h_{lim}, T_{lim} and $\bar{p}_{\mathrm{lim}}$. The permissible parameters represent geometrically and technologically dependent operational limits within the plain bearing tribological system. They are empirical values which still enable sufficient operational reliability even for minor influences (see ISO 7902-1).

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1 Scope

This part of ISO 7902 specifies empirical permissible values for h_{lim}, T_{lim} and $\bar{p}_{\text{lim}}$.

The empirical values stated can be modified for certain applications, for example if information supplied by the manufacturer is to be taken into account. The descriptions of the symbols and calculation examples are given in ISO 7902-1.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 7902. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7902 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7902-1:1998, *Hydrodynamic plain journal bearings under steady-state conditions — Circular cylindrical bearings — Part 1: Calculation procedure*.

3 Operational parameters to avoid wear

3.1 The aim of keeping above the minimum permissible lubrication film thickness h_{lim} is to retain complete lubrication of the plain bearing in order to attain least possible wear and low susceptibility to faults. The lubricant should be free of contaminating particles, otherwise increased wear, scoring and local overheating can result, thus impairing correct functioning of the plain bearing. If necessary, appropriate filtering of the lubricant should be provided for.

3.2 The minimum permissible lubrication film thickness h_{lim}, as a characteristic parameter for the transition to mixed friction (see ISO 7902-1:1998, 6.6), can be determined from the following equation:

$$h_{\text{lim}} = Rz_{\text{B}} + Rz_{\text{J}} + \frac{1}{2}By + \frac{1}{2}y + h_{\text{wav,eff}} \quad \ldots (1)$$

This takes into account

— the sum of the mean peak-to-valley heights of bearing and shaft at the ideal location (line X-X) [$Rz_B + Rz_J$]

— the misalignment (line Y-Y) within the bearing length [1/2 By]

— the mean deflection (line Z-Z) [1/2 y]

3.3 If wavy geometrical deviations occur in the sliding surfaces (bearing or shaft) in the circumferential direction, they are taken into account during the determination of h_{lim} by the effective waviness $h_{wav,eff}$ for the most unfavourable shaft position. In this case, $h_{wav,eff}$ is the effective waviness of the bearing under static loading or the effective waviness of the shaft under rotating loading, respectively.

The effective waviness $h_{wav,eff}$ and the maximum permissible effective waviness $h_{wav,eff,lim}$ at a given operating point (ε or h_{lim}) can be determined using figure 2 if roughnesses, deformations and tilt positions are known.

3.4 In accordance with equation (1), the following applies:

$$h_{lim} = m + h_{wav,eff}$$

where

$$m = Rz_B + Rz_J + \frac{1}{2} By + \frac{1}{2} y$$

$$h_{wav,eff} = \frac{E}{G} a$$

With a given minimum lubricant film thickness h_{min} the maximum permissible effective waviness amplitude is determined from

$$h_{wav,eff,lim} = h_{min} - m$$

The maximum permissible absolute waviness, $h_{wav,eff,lim}$, is determined from

$$h_{wav,lim} = \frac{G}{E} h_{wav,eff,lim}$$

3.5 An example of the determination of $h_{wav,eff}$, h_{lim}, $h_{wav,eff,lim}$ and $h_{wav,lim}$ (from figure 2) is as follows.

Given quantities:

$B/D = 0,5$

$C/2 = 85 \times 10^{-6}$ m

$m = 6 \times 10^{-6}$ m

$h_{wav} = 5 \times 10^{-6}$ m

$i = 6$

$h_{min} = 8,5 \times 10^{-6}$ m

$$\varepsilon = 1 - \frac{h_{min}}{C/2} = 0,9$$

With B/D = 0,5, figure 2 gives E = 0,86.

With i = 6 and ε = 0,9, figure 2 gives G = 1,85.

Hence

$$h_{\text{wav,eff}} = \frac{0{,}86}{1{,}85} \times 5 \times 10^{-6}\ \text{m} = 2{,}32 \times 10^{-6}\ \text{m}$$

and

$$h_{\text{lim}} = 6 \times 10^{-6}\ \text{m} + 2{,}32 \times 10^{-6}\ \text{m} = 8{,}32 \times 10^{-6}\ \text{m}$$

Since $h_{\text{min}} > h_{\text{lim}}$, $h_{\text{min}} = 8{,}5 \times 10^{-6}$ m is permissible.

$$h_{\text{wav,eff,lim}} = 8{,}5 \times 10^{-6}\ \text{m} - 6 \times 10^{-6}\ \text{m} = 2{,}5 \times 10^{-6}\ \text{m}$$

$$h_{\text{wav,lim}} = \frac{1{,}85}{0{,}86} \times 2{,}5 \times 10^{-6}\ \text{m} = 5{,}38 \times 10^{-6}\ \text{m}$$

3.6 In general, deviations of form are irregular. For the determination of $h_{\text{wav,eff}}$, the waves in the sliding surface area under load are significant.

For running-in processes under low load and sliding velocity, it is possible to allow a lower minimum film thickness owing to the smoothing and adjusting of the sliding surfaces. If necessary, a bearing material having a good running-in ability shall be used.

Table 1 gives empirical permissible values for h_{lim}, in which a mean peak-to-valley height of $Rz_{\text{J}} \leqslant 4$ µm for the shaft, minor geometrical errors of the sliding surfaces, careful assembly and adequate filtering of the lubricant are assumed.

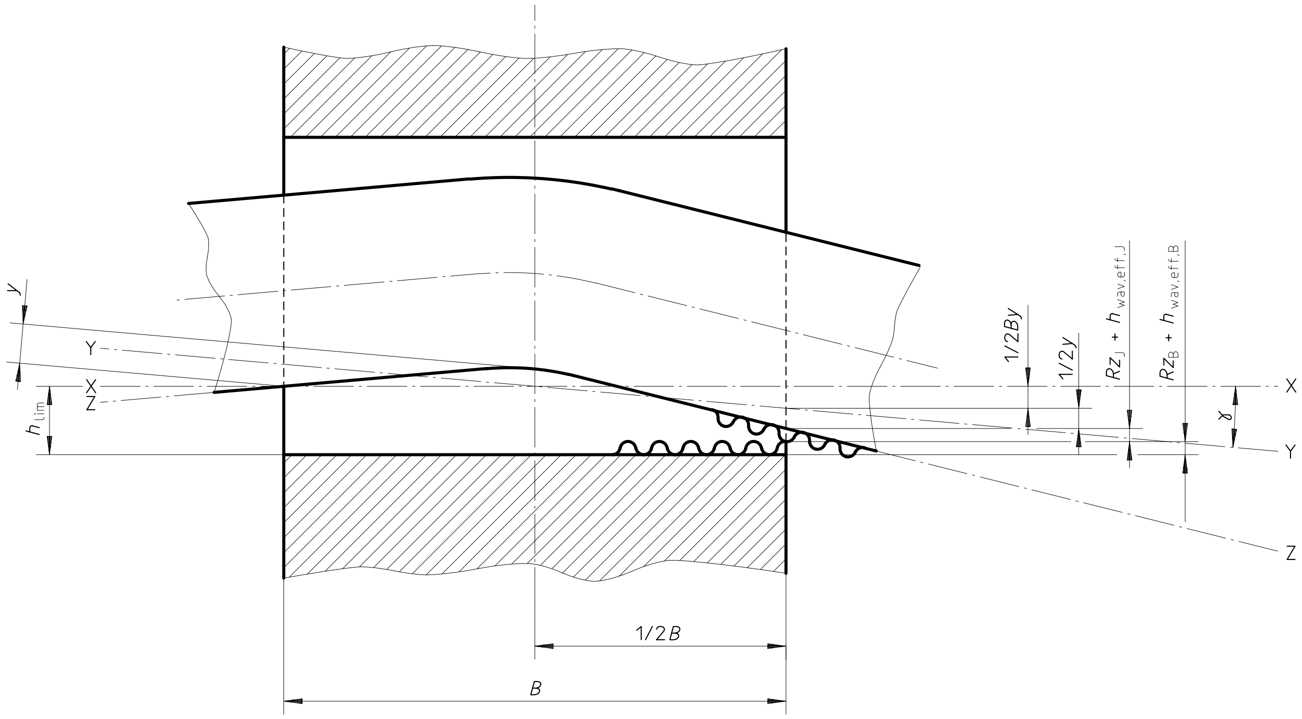


Figure 1 — Minimum permissible lubrication film thickness when no running-in process is allowed

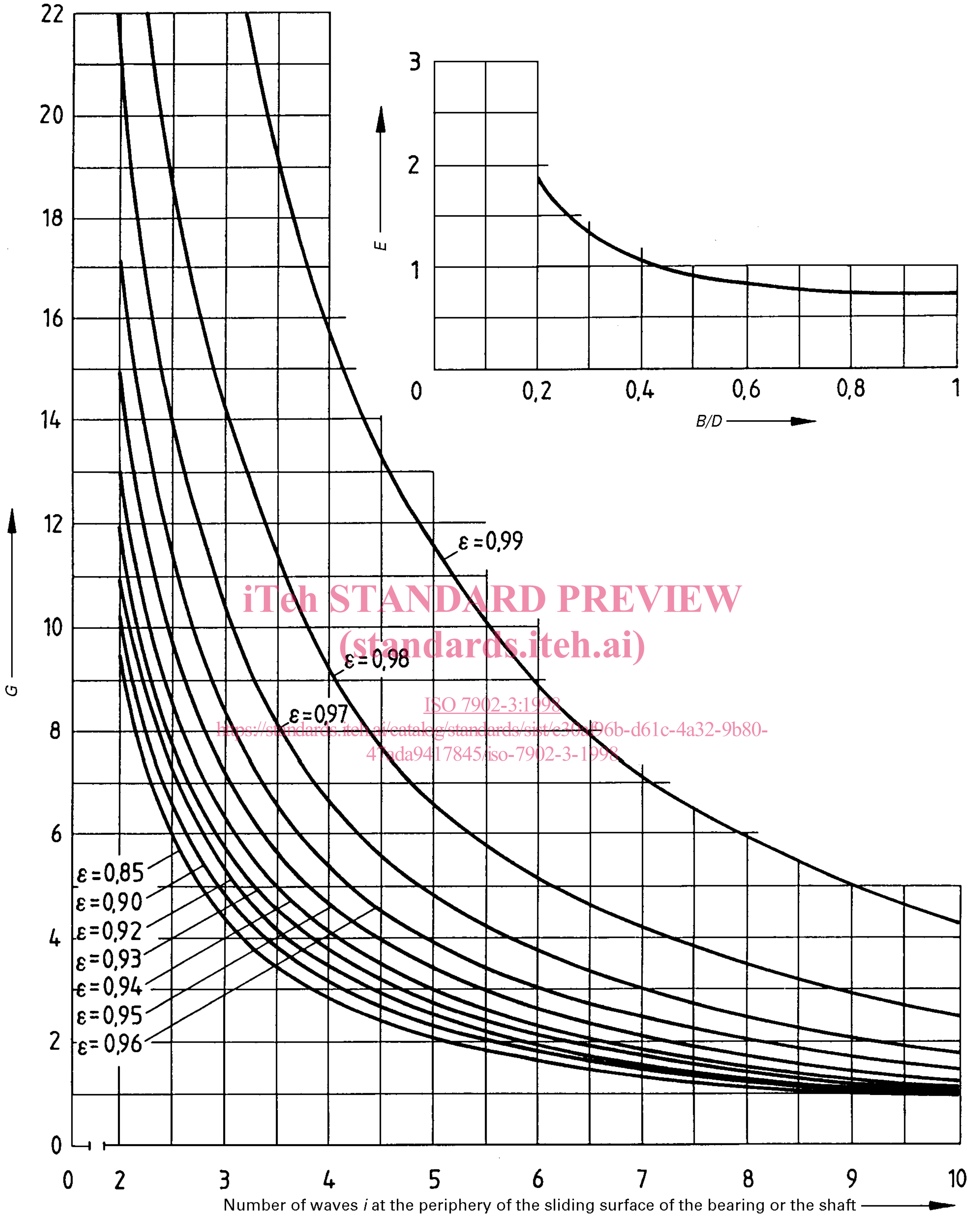
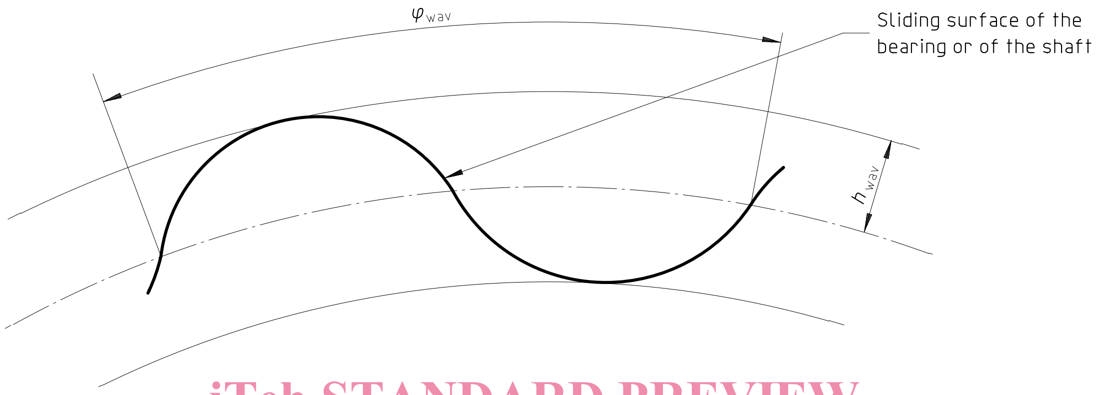


Figure 2 — Determination of the effective waviness $h_{wav,eff}$ and the maximum permissible effective waviness $h_{wav,eff,lim}$

Table 1 — Empirical permissible values for the minimum permissible least lubricant film thickness, h_{lim}

Minimum permissible thicknesses in micrometres

Shaft diameter, D_J mm	Sliding velocity of shaft, U_J m/s				
	$U_J \leqslant 1$	$1 < U_J \leqslant 3$	$3 < U_J \leqslant 10$	$10 < U_J \leqslant 30$	$30 < U_J$
$24 < D_J \leqslant 63$	3	4	5	7	10
$63 < D_J \leqslant 160$	4	5	7	9	12
$160 < D_J \leqslant 400$	6	7	9	11	14
$400 < D_J \leqslant 1\,000$	8	9	11	13	16
$1\,000 < D_J \leqslant 2\,500$	10	12	14	16	18



Number of waves wav

Figure 3 — Absolute waviness amplitude, h_{wav}, period of waviness, φ_{wav} and number of waves, i, of the sliding surface

4 Operational parameters to avoid excessive mechanical loading

The maximum permissible specific bearing load, $\bar{p}_{lim}$, is the result of the requirement that a deformation of the sliding surfaces may not result in impairment of correct functioning and the formation of cracks. In addition to the composition of the bearing material, there are many other decisive influencing factors, such as the method of manufacture, the material structure, the thickness of bearing material and the geometry and type of bearing liner backing. Independently of these, a check shall be made as to whether the bearing is subjected to the full load when starting. If the specific bearing load during starting, $\bar{p}$, is greater than 2,5 N/mm² to 3 N/mm², it may be necessary to provide relief by pressurized oil (auxiliary hydrostatic device). Otherwise wear can occur on the sliding surfaces. Table 2 gives empirical values for $\bar{p}_{lim}$.

Table 2 — Empirical values for the maximum permissible specific bearing load, $\bar{p}_{lim}$

1)	$\bar{p}_{lim}$ 2) 3) MPa
Pb and Sn alloys	5 (15)
Cu-Pb alloys	7 (20)
Cu-Sn alloys	7 (25)
Al-Sn alloys	7 (18)
Al-Zn alloys	7 (20)

1) ISO 4381, ISO 4382-1, ISO 4382-2 and ISO 4383.

2) The values in parentheses have, up to now, been realized for general mechanical engineering applications only in isolated instances, and are, in exceptional cases, permitted if there are special operational conditions, for example at very low sliding speeds.

3) 1 MPa = 1 N/mm²