INTERNATIONAL STANDARD

ISO 12130-2

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Plain bearings — Hydrodynamic plain tilting pad thrust bearings under steady-state conditions —

Part 2:
Functions for calculation of tilting pad thrust bearings

Paliers lisses — Butées hydrodynamiques à patins oscillants fonctionnant en régime stationnaire —

Partie 2: Fonctions pour le calcul des butées à patins oscillants

Reference number
ISO 12130-2:2001(E)

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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 3.

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 part of ISO 12130 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12130-2 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 4, *Methods of calculation of plain bearings*.

ISO 12130 consists of the following parts, under the general title *Plain bearings — Hydrodynamic plain tilting pad thrust bearings under steady-state conditions*:

— *Part 1: Calculation of tilting pad thrust bearings*

— *Part 2: Functions for calculation of tilting pad thrust bearings*

— *Part 3: Guide values for the calculation of tilting pad thrust bearings*

Introduction

The functions of the following type are necessary for the calculation of oil-lubricated tilting-pad thrust bearings in accordance with ISO 12130-1, assuming hydrodynamic conditions with full lubrication. They are based on the premises and boundary conditions there specified. The values necessary for the calculation can be determined by means of the given equations as well as from diagrams and tables. The equations are approximations of the numerically-determined values traced as curves in accordance with [1]. The explanation of the symbols as well as examples for the calculation are included in ISO 12130-1.

On account of the premises laid down in ISO 12130-1:2001 clause 3, items g) and k), the following definitions are not applicable to the calculation of thrust bearings with centrally supported tilting-pads ($a_F^* = 0,5$) which, under the premises there indicated, have no hydrodynamic load-carrying capacity. For the determination of the characteristic values of such bearings it is necessary to consider at least the deformations of the tilting-pads which occur during operation (compare e.g. [2] and [3]).

Plain bearings — Hydrodynamic plain tilting pad thrust bearings under steady-state conditions —

Part 2:
Functions for calculation of tilting pad thrust bearings

1 Scope

This part of ISO 12130 specifies the derivation of mathematical functions to be applied when calculating tilting pad thrust bearings.

This part of ISO 12130 is not applicable to heavily loaded tilting pad thrust bearings.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 12130. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 12130 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 12130-1, *Plain bearings — Hydrodynamic plain tilting pad thrust bearings under steady-state conditions — Part 1: Calculation of tilting pad thrust bearings*

3 Functions for the tilting-pad thrust bearing

3.1 General

For an explanation of symbols see ISO 12130-1.

3.2 Characteristic value of load-carrying capacity F^* as a function of the relative bearing width B/L and the relative minimum lubricant film thickness h_{min}/C_{wed}

Approximation of the curves of Figure 1 (range of application: $0{,}2 \leqslant \frac{h_{min}}{C_{wed}} \leqslant 2$).

$$F^* = 5\left(\frac{h_{min}}{C_{wed}}\right)^2 \times \left[\ln \frac{1+\left(h_{min}/C_{wed}\right)}{h_{min}/C_{wed}} - \frac{2}{1+2\times\frac{h_{min}}{C_{wed}}}\right] \times \frac{A^* + B^*\left[1-\frac{1}{h_{min}/C_{wed}}\right] + C\left[1-\frac{1}{h_{min}/C_{wed}}\right]^2}{1+a\left[\frac{1}{B/L}\right]^2}$$

$$a = \frac{10}{\left(1+2\frac{h_{min}}{C_{wed}}\right)^2} \times \left\{\left[\frac{h_{min}}{C_{wed}} + \left(\frac{h_{min}}{C_{wed}}\right)^2\right]^2 + \frac{1-2\left[\frac{h_{min}}{C_{wed}} + \left(\frac{h_{min}}{C_{wed}}\right)^2\right]}{12\left[\left(1+2\frac{h_{min}}{C_{wed}}\right)\times\ln\frac{1+\left(h_{min}/C_{wed}\right)}{h_{min}/C_{wed}} - 2\right]}\right\}$$

$$A^* = 1{,}168\,6 - 0{,}329\,45\times\left(\frac{B}{L}\right) + 0{,}222\,67\times\left(\frac{B}{L}\right)^2 - 0{,}046\,51\times\left(\frac{B}{L}\right)^3$$

$$B^* = -0{,}100\,95 + 0{,}197\,43\times\left(\frac{B}{L}\right) - 0{,}131\,36\times\left(\frac{B}{L}\right)^2 + 0{,}028\,703\times\left(\frac{B}{L}\right)^3$$

$$C^* = -0{,}004\,879\,1 + 0{,}008\,601\times\left(\frac{B}{L}\right) - 0{,}005\,401\,5\times\left(\frac{B}{L}\right)^2 + 0{,}001\,127\,8\times\left(\frac{B}{L}\right)^3$$

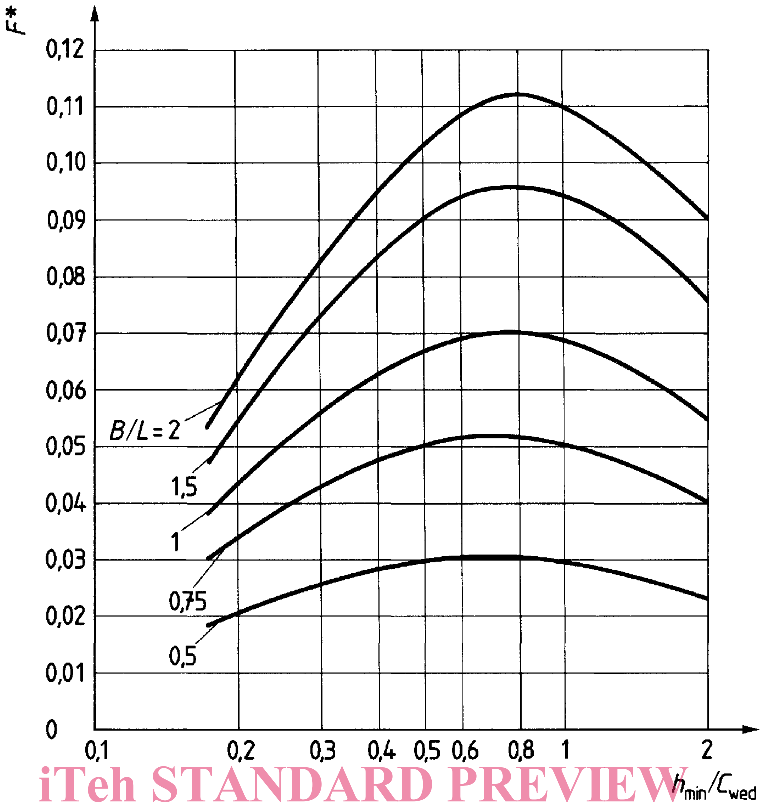

Figure 1 — Characteristic value of load-carrying capacity F^* as a function of the relative bearing width B/L and the relative minimum lubricant film thickness h_{min}/C_{wed}

Table 1 — Values to Figure 1 $F^* = f\,(B/L, h_{min}/C_{wed})$

h_{min}/C_{wed}	B/L				
	2	1,5	1	0,75	0,5
2	0,089 95	0,077 21	0,055 75	0,040 39	0,022 88
1	0,109 6	0,094 57	0,068 94	0,050 37	0,028 92
0,667	0,109 5	0,094 97	0,069 97	0,051 58	0,030 05
0,50	0,103 2	0,090 01	0,067 01	0,049 83	0,029 45
0,333	0,087 19	0,076 88	0,058 36	0,044 09	0,026 76
0,25	0,072 85	0,064 87	0,050 11	0,038 37	0,023 82
0,2	0,061 27	0,055 05	0,043 20	0,033 45	0,021 17

3.3 Characteristic value of friction f^* as a function of the relative bearing width B/L and the relative minimum lubricant film thickness h_{min}/C_{wed}

Approximation of the curves of Figure 2 (range of application: $0{,}2 \leqslant \frac{h_{min}}{C_{wed}} \leqslant 2$).

$$f^* = \frac{6}{5}\left\{ 4 \times \frac{h_{min}}{C_{wed}} \times \ln \frac{1 + \left(h_{min}/C_{wed}\right)}{h_{min}/C_{wed}} - \frac{6 \times \frac{h_{min}}{C_{wed}}}{1 + 2 \times \frac{h_{min}}{C_{wed}}} \right\} \times \left\{ 1 + \alpha \left[\frac{1}{B/L} \right]^2 \right\} A^*$$

$$a = \frac{10}{\left(1 + 2 \times \frac{h_{min}}{C_{wed}}\right)} \left\{ \left[\frac{h_{min}}{C_{wed}} \right]^2 + \frac{1 - 2 \times \left[\frac{h_{min}}{C_{wed}} \right]}{12 \left[\left(1 + 2 \times \frac{h_{min}}{C_{wed}}\right) \times \ln \frac{1 + \left(h_{min}/C_{wed}\right)}{h_{min}/C_{wed}} - 2 \right]} \right\}$$

$$A^* = -0{,}214\,59 + 0{,}880\,71 \left(\frac{B}{L}\right) - 0{,}297\,60 \left(\frac{B}{L}\right)^2 + 0{,}037\,91 \left(\frac{B}{L}\right)^3$$

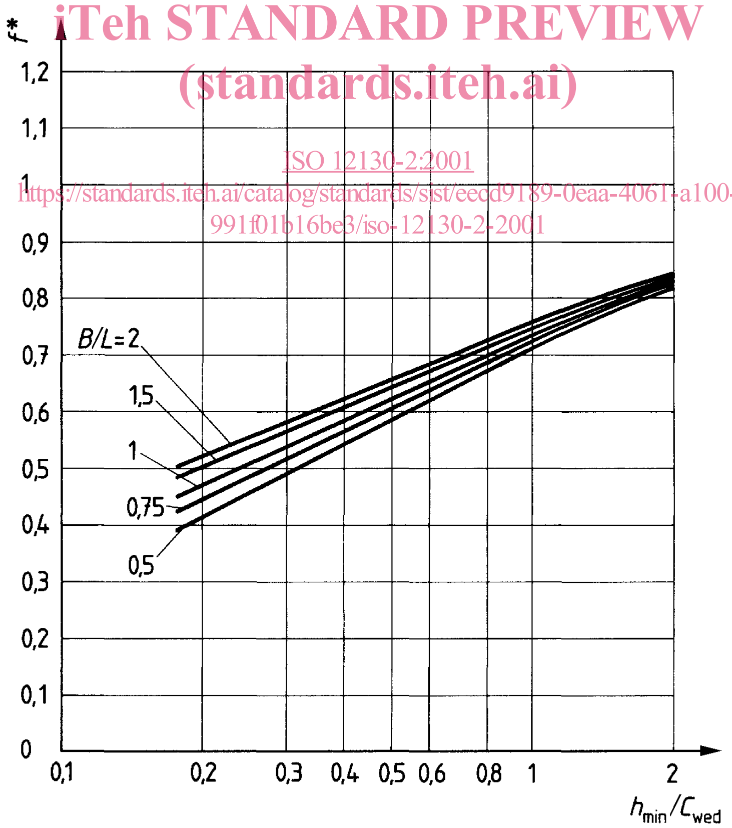

Figure 2 — Characteristic value of friction f^* as a function of the relative bearing width B/L and the relative minimum lubricant film thickness h_{min}/C_{wed}

Table 2 — Values to Figure 2 $f^* = f\,(B/L, h_{min}/C_{wed})$

h_{min}/C_{wed}	B/L				
	2	1,5	1	0,75	0,5
2	0,833 4	0,830 2	0,824 9	0,821 0	0,816 7
1	0,748 0	0,740 4	0,727 6	0,718 3	0,707 6
0,667	0,693 0	0,682 1	0,663 3	0,649 5	0,633 4
0,5	0,652 5	0,639 3	0,616 3	0,599 1	0,678 8
0,333	0,592 9	0,577 4	0,549 6	0,528 2	0,502 2
0,25	0,548 1	0,532 1	0,502 6	0,479 1	0,450 0
0,2	0,511 5	0,496 0	0,466 3	0,442 0	0,411 3

3.4 Relative lubricant flow rates Q_1^* and Q_3^* as a function of the relative bearing width B/L and the relative minimum lubricant film thickness h_{min}/C_{wed}

Approximation of the curves of Figures 3 and 4 (range of application: $0{,}2 \leqslant \dfrac{h_{min}}{C_{wed}} \leqslant 2$).

$$Q_i^* = \frac{1+\left(h_{min}/C_{wed}\right)}{1+2\times\dfrac{h_{min}}{C_{wed}}}\times\left\{A_i + B_i\times\left[1-\frac{1}{h_{min}/C_{wed}}\right]\right\}$$

with constants A_i and B_i

for $Q_i^* = Q_1^*$:

$$A_i = 1{,}549\,4 - 0{,}344\,48\left(\frac{B}{L}\right) + 0{,}072\,457\left(\frac{B}{L}\right)^2$$

$$B_i = -0{,}572\,08 + 0{,}370\,91\left(\frac{B}{L}\right) - 0{,}079\,18\left(\frac{B}{L}\right)^2$$

for $Q_i^* = Q_3^*$:

$$A_i = 2\left[0{,}358\,6 - 0{,}240\,57\left(\frac{B}{L}\right) + 0{,}052\,129\left(\frac{B}{L}\right)^2\right]$$

$$B_i = 2\left[-0{,}276\,82 + 0{,}186\,07\left(\frac{B}{L}\right) - 0{,}040\,081\left(\frac{B}{L}\right)^2\right]$$