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

Part 2:
Functions for the calculation of thrust pad bearings

Paliers lisses — Butées hydrodynamiques à patins géométrie fixe fonctionnant en régime stationnaire —

Partie 2: Fonctions pour le calcul des butées à segments

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 8, *Calculation methods for plain bearings and their applications*.

This third edition cancels and replaces the second edition (ISO 12131-2:2016), which has been technically revised.

The main changes are as follows:

— adjustments have been made to ISO/IEC Directives, Part 2:2021;

— typographical errors have been corrected.

A list of all parts in the ISO 12131 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Assuming hydrodynamic conditions with full lubrication, the functions of the type covered by this document are necessary for the calculation of oil-lubricated pad thrust bearings in accordance with ISO 12131-1. They are based on the premises and boundary conditions specified. The values necessary for the calculation can be determined by means of the given formulae, as well as from diagrams and tables. The formulae in this document are approximations of the numerically determined values traced as curves according to Reference [2]. The explanation of the symbols, as well as examples for the calculation, are included in ISO 12131-1.

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

Part 2: Functions for the calculation of thrust pad bearings

1 Scope

This document specifies functions for thrust pad bearings. It also covers the effect of dynamic viscosity on lubricant film temperature.

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 12131-1, *Plain bearings — Hydrodynamic plain thrust pad bearings under steady-state conditions — Part 1: Calculation of thrust pad bearings*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Symbols, terms and units

Symbols and units are defined in Table 1. The symbols not listed in Table 1 can be referenced in Table 1 of ISO 12131-1.

Table 1 — Symbols, terms and units

Symbol	Term	Unit
i (index)	Consecutive number	1
A_1, A_3, A_i, A^*	Auxiliary quantity	1
B_1, B_3, B_i, B^*	Auxiliary quantity	1
C^*	Auxiliary quantity	1
K_1	“thickness” of oil	Pa·s
K_2	Inherent viscosity-temperature dependence of oil	°C
K_3	Oil temperature for infinite viscosity	°C
VG	ISO Viscosity Grade	1
α	Auxiliary quantity	1
η_x	Constant coefficient	Pa·s

5 Functions for the thrust pad bearing

5.1 Load carrying capacity

Characteristic value of load carrying capacity, F_B^*, as a function of the relative bearing length, B/L, and the relative minimum lubricant film thickness, h_{min}/C_{wed} is defined by Formula (1) using the auxiliary quantities α, A^*, B^* and C^*.

Approximation of the curves of Figure 1 (range of application: $0{,}1 \le \frac{h_{min}}{C_{wed}} \le 10$).

$$F_B^* = 5 \times \left[\left(\frac{l_{wed}}{L}\right)^2 \times \left(\frac{h_{min}}{C_{wed}}\right)^2 \times \ln \frac{1 + h_{min}/C_{wed}}{h_{min}/C_{wed}} + \frac{\frac{l_{wed}}{L} \times \frac{1}{h_{min}/C_{wed}} \times \left(1 - \frac{l_{wed}}{L}\right)^2 - 2 \times \left(\frac{l_{wed}}{L}\right)^2 \times \left[2 \times \frac{h_{min}}{l_{wed}} + 3 \times \left(1 - \frac{l_{wed}}{L}\right)\right]}{4 + 2 \times \left(4 - 3\frac{l_{wed}}{L}\right) \times \frac{1}{h_{min}/C_{wed}} + 4 \times \left(1 - \frac{l_{wed}}{L}\right) \times \left(\frac{1}{h_{min}/C_{wed}}\right)^2} \right] \times \frac{A^* + B^* \times \left(1 - \frac{1}{h_{min}/C_{wed}}\right) + C^* \times \left(1 - \frac{1}{h_{min}/C_{wed}}\right)^2}{1 + \alpha \times \left(\frac{B}{L}\right)^{-2}} \times \left(\frac{1}{h_{min}/C_{wed}}\right)^2 \tag{1}$$

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

$$A^* = 1{,}2057 - 0{,}243\,44 \times \left(\frac{B}{L}\right) + 0{,}126\,25 \times \left(\frac{B}{L}\right)^2 - 0{,}021\,554 \times \left(\frac{B}{L}\right)^3$$

$$B^* = -0{,}256\,34 + 0{,}361\,14 \times \left(\frac{B}{L}\right) - 0{,}199\,58 \times \left(\frac{B}{L}\right)^2 + 0{,}038\,633 \times \left(\frac{B}{L}\right)^3$$

$$C^* = -0{,}010\,765 + 0{,}009\,350\,1 \times \left(\frac{B}{L}\right) - 0{,}002\,752\,7 \times \left(\frac{B}{L}\right)^2 + 0{,}000\,184\,46 \times \left(\frac{B}{L}\right)^3$$

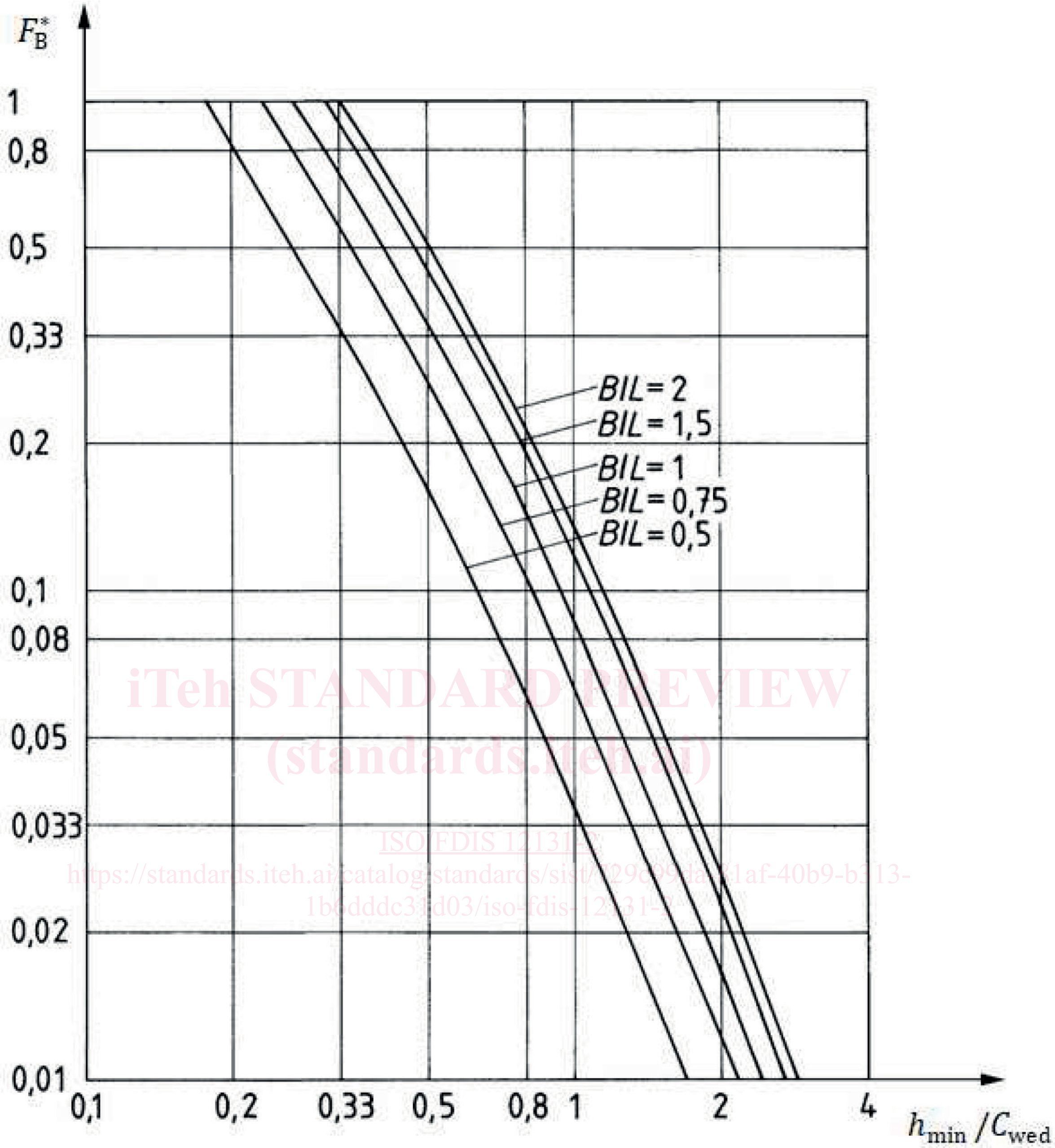

Figure 1 — Characteristic value of load carrying capacity for thrust pad bearings, F_B^*, as a function of the relative bearing width, B/L, and the relative minimum lubricant film thickness, h_{min}/C_{wed}, for l_{wed}/L = 0,75

Table 2 — Values to Figure 1 where $F_{\mathrm{B}}^{*} = f(B/L, h_{\mathrm{min}}/C_{\mathrm{wed}}, l_{\mathrm{wed}}/L = 0{,}75)$

$h_{\mathrm{min}}/C_{\mathrm{wed}}$	B/L				
	2	1,5	1	0,75	0,5
10	0,000 3	0,000 3	0,000 2	0,000 2	0,000 1
2	0,026 7	0,023 0	0,016 7	0,012 1	0,006 8
1	0,134 1	0,116 9	0,086 5	0,063 7	0,036 4
0,5	0,522	0,462 8	0,355 2	0,27	0,161 2
0,33	1,010 7	0,908 1	0,716 4	0,559 8	0,348 3
0,2	2,067 5	1,887 5	1,547 5	1,252 5	0,83
0,1	4,52	4,21	3,62	3,08	2,24

5.2 Friction for thrust pad bearings

Characteristic value of friction for thrust pad bearings, f_{B}^{*}, as a function of the relative bearing width, B/L, and the relative minimum lubricant film thickness, $h_{\mathrm{min}}/C_{\mathrm{wed}}$ is defined by Formula (2) using the auxiliary quantities α, A^{*} and B^{*}.

Approximation of the curves of Figure 2 (range of application: $0{,}1 \le \dfrac{h_{\mathrm{min}}}{C_{\mathrm{wed}}} \le 10$).

$$f_{\mathrm{B}}^{*} = \left[4 \times \frac{l_{\mathrm{wed}}}{L} \times \frac{h_{\mathrm{min}}}{C_{\mathrm{wed}}} \times \ln \frac{1 + h_{\mathrm{min}}/C_{\mathrm{wed}}}{h_{\mathrm{min}}/C_{\mathrm{wed}}} + \left(1 - \frac{l_{\mathrm{wed}}}{L}\right) - \frac{3 \times \dfrac{l_{\mathrm{wed}}}{L} \times \dfrac{h_{\mathrm{min}}}{C_{\mathrm{wed}}} \times \left\{ 2 \times \dfrac{h_{\mathrm{min}}}{C_{\mathrm{wed}}} + 3 \times \left(1 - \dfrac{l_{\mathrm{wed}}}{L}\right) \right\}}{2 \times \left(\dfrac{h_{\mathrm{min}}}{C_{\mathrm{wed}}}\right)^{2} + \left(4 - 3 \times \dfrac{l_{\mathrm{wed}}}{L}\right) \times \dfrac{h_{\mathrm{min}}}{C_{\mathrm{wed}}} + 2 \times \left(1 - \dfrac{l_{\mathrm{wed}}}{L}\right)} \right] \times \frac{6}{5} \times \left\{ 1 + \left(\frac{B}{L}\right)^{-2} \times \alpha \right\} \times A^{*} \times \frac{1}{\dfrac{h_{\mathrm{min}}}{C_{\mathrm{wed}}}} \times B^{*} \tag{2}$$

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

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

for $h_{\mathrm{min}}/C_{\mathrm{wed}} \ge 0{,}2$ is $B^{*} = 1$

for $h_{\mathrm{min}}/C_{\mathrm{wed}} < 0{,}2$ is $B^{*} = 1{,}125\,1 \times \left(\dfrac{B}{L}\right)^{-0{,}129\,39}$