BS ISO 7902-2:1998

BSI Standards Publication

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

Part 2: Functions used in the calculation procedure

National foreword

This British Standard is the UK implementation of ISO 7902-2:1998.

The UK participation in its preparation was entrusted to Technical Committee MCE/12, Plain bearings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

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

Part 2:
Functions used in the calculation procedure

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

Partie 2: Fonctions utilisées pour le calcul

Reference number
ISO 7902-2:1998(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 7902-2 was prepared by Technical Committees 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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Hydrodynamic plain journal bearings under steady-state conditions — Circular cylindrical bearings —

Part 2:
Functions used in the calculation procedure

1 Scope

This part of ISO 7902 specifies the values of the basic functions used in the calculation procedure for oil-lubricated circular cylindrical hydrodynamic bearings under conditions of full lubrication.

The values are given for the assumptions and boundary conditions given in ISO 7902-1. The values necessary for the calculation may be determined from the tables of bearing characteristics, the graphs and from the equations.

The descriptions of the symbols used and calculation examples are given in ISO 7902-1.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7902. At the time of publication, the editions indicated were 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 editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3448:1992, *Industrial liquid lubricants — ISO viscosity classification.*

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

3 Tables of basic bearing characteristics

Tables 1 to 30 give

— the attitude angle, β,

— The Sommerfeld number, So,

— the specific coefficient of friction, taking account of the unloaded area of lubricant film, f'/ψ,

— the specific coefficient of friction in the loaded area of the lubricant film, f/ψ,

— The coefficient of lubricant flow rate, parameter Q_3^*, due to generation of the internal pressure, as a function of angular span, Ω, relative eccentricity ε and relative bearing width B/D,

for various values of ε, Ω and B/D.

Table 1 — Values of the basic characteristics for Ω = 360° and B/D = 1,5

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	72,523 6	0,427 3	7,599 2	4,968 4	0,047 7
0,4	62,658 8	1,000 5	3,603 5	2,658 2	0,093 5
0,6	51,969 2	1,972 4	2,227 2	1,669 5	0,136 1
0,8	38,160 1	4,682 4	1,365 3	1,073 6	0,175 9
0,9	27,961	10,138 2	0,921 8	0,760 4	0,193 9
0,925	24,618 4	13,825 6	0,790 6	0,667 8	0,198
0,95	19,800 7	22,044	0,617 3	0,535 9	0,201
0,975	13,597 1	48,842 9	0,404	0,358 6	0,203 6

Table 2 — Values of the basic characteristics for Ω = 360° and B/D = 1,25

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	73,342 7	0,341	9,497 8	6,201 6	0,044 4
0,4	62,653 3	0,815 5	4,380 8	3,245 7	0,087 6
0,6	51,390 1	1,671 5	2,583 7	1,925 7	0,128 7
0,8	37,247 4	4,210 7	1,485 5	1,128 5	0,167 9
0,9	27,270 1	9,462 1	0,967 8	0,794 9	0,186 0
0,925	23,958 6	13,083 9	0,819 7	0,690 0	0,190 1
0,95	19,304 5	21,127 1	0,633 2	0,548 4	0,193 6
0,975	13,315 4	47,533 2	0,409 7	0,363 1	0,195 9

Table 3 — Values of the basic characteristics for Ω = 360° and B/D = 1

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	74,208	0,249 2	12,958	8,448 9	0,039 4
0,4	62,574 4	0,611	5,786 8	4,272 1	0,078 5
0,6	50,454 5	1,318 2	3,210 2	2,376 1	0,116 4
0,8	36,027 8	3,595 5	1,691 5	1,276 6	0,153 3
0,9	26,368 5	8,520 3	1,045 7	0,853 7	0,170 8
0,925	23,072 6	12,034 2	0,868 2	0,727 5	0,174 8
0,95	18,639 2	19,799	0,659 9	0,569 6	0,178 3
0,975	12,938 8	45,572 1	0,419 3	0,371	0,180 8

Table 4 — Values of the basic characteristics for Ω = 360° and B/D = 0,75

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	75,022	0,158 4	20,390 9	13,237 2	0,325 5
0,4	62,258 4	0,399 3	8,760 6	6,183	0,065
0,6	49,355 4	0,915 5	4,516 7	3,316 1	0,097 2
0,8	34,514 4	2,784 8	2,106 7	1,571 2	0,129 2
0,9	25,188 7	7,161 4	1,197 9	0,969 6	0,144 7
0,925	21,882 3	10,461 1	0,962 7	0,801	0,148 3
0,95	17,739 3	17,736 3	0,711 9	0,611 4	0,151 6
0,975	12,426 4	42,382 9	0,438 4	0,386 9	0,153

Table 5 — Values of the basic characteristics for Ω = 360° and B/D = 0,5

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	75,818 8	0,778 8	41,264 1	26,832 2	0,023 3
0,4	61,762 8	0,202 6	17,087 5	12,010 1	0,046 8
0,6	47,970 3	0,499 5	8,083 7	5,856 1	0,070 3
0,8	32,965 3	1,74	3,226 7	2,369 8	0,093 8
0,9	23,503 7	5,157 9	1,576 8	1,260 4	0,105 4
0,925	20,317 1	7,916 8	1,205	0,992	0,108 2
0,95	16,529 2	14,175 7	0,844 9	0,719 8	0,110 7
0,975	11,716 4	36,438	0,487	0,415	0,112 8

Table 6 — Values of the basic characteristics for Ω = 360° and B/D = 0,25

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	75,852 2	0,020 9	153,245 2	99,557 1	0,012 3
0,4	61,484 3	0,056	61,556 7	41,887 9	0,024 6
0,6	47,407 6	0,146	27,106 5	18,705 8	0,036 8
0,8	31,289 6	0,605 3	8,857 7	6,396 1	0,049 2
0,9	21,531 5	2,203 7	3,435 6	2,697 2	0,055 3
0,925	18,530 6	3,670 7	2,399 4	1,942 4	0,056 8
0,95	15,078	7,346 6	1,493 1	1,254 6	0,058 2
0,975	10,779 2	22,666 5	0,714 9	0,563 2	0,059 5

Table 7 — Values of the basic characteristics for Ω = 180°C and B/D = 1,5

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	66,676 7	0,378 1	8,571 8	4,556 5	0,038 5
0,4	54,239 5	0,871 1	4,097 2	2,442 4	0,062 8
0,6	44,217 1	1,752 8	2,449 6	1,680 3	0,075 5
0,8	32,582	4,353 1	1,418 2	1,139 1	0,075
0,9	24,256	9,698 7	0,916 1	0,796	0,067 5
0,925	21,517 7	13,445 1	0,784 6	0,678 2	0,063 2
0,95	18,655 7	20,525 9	0,642 3	0,549 5	0,058 9
0,975	12,665 2	47,276 1	0,405 9	0,370 1	0,050 1

Table 8 — Values of the basic characteristics for Ω = 180° and B/D = 1,25

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	67,708 5	0,310 6	10,415 5	5,514 6	0,036 9
0,4	55,202 7	0,732 6	4,843 1	2,866 6	0,061 5
0,6	44,364 2	1,531 2	2,774 4	1,893 1	0,074 8
0,8	32,449 1	3,981 9	1,529 6	1,224 8	0,074 7
0,9	24,033 7	9,227 9	0,964 3	0,822	0,068 2
0,925	21,247	12,858 4	0,810 6	0,707 5	0,064 2
0,95	18,433	19,947 1	0,654 9	0,558 9	0,060 1
0,975	12,347 1	46,753 5	0,406 6	0,370 6	0,050 7

Table 9 — Values of the basic characteristics for Ω = 180° and B/D = 1

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	69,018 2	0,232 8	13,868 3	7,306 8	0,033 8
0,4	56,409 3	0,560 1	6,286 1	3,687 3	0,057 5
0,6	44,589	1,244 8	3,365 2	2,279 7	0,072 9
0,8	32,368 1	3,451 4	1,731 2	1,379 9	0,073 5
0,9	23,770 1	8,403 7	1,039	0,906 1	0,067 9
0,925	20,898 1	11,940 5	0,857 4	0,744 6	0,064
0,95	18,135 1	18,577 5	0,691	0,589 4	0,060 1
0,975	11,901 7	45,771	0,409 4	0,375 4	0,051 3

Table 10 — Values of the basic characteristics for Ω = 180° and B/D = 0,75

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	70,534 9	0,151 3	21,282 4	11,151 3	0,028 9
0,4	57,855 8	0,381	9,166 3	5,320 7	0,051 3
0,6	45,012 4	0,888 3	4,632 8	3,107 8	0,066
0,8	32,312 8	2,698 7	2,154	1,705	0,069 8
0,9	23,336 7	7,137 5	1,188	1,032 2	0,064 9
0,925	20,438 4	10,425 2	0,954 6	0,827 8	0,061 7
0,95	17,579 3	16,746 5	0,746 9	0,639	0,058
0,975	11,294 8	43,512 8	0,420 4	0,380 1	0,051 3

Table 11 — Values of the basic characteristics for Ω = 180° and B/D = 0,5

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	72,293 9	0,074 7	43,011 7	22,402 8	0,021 3
0,4	58,192 8	0,200 2	17,289 7	9,961	0,039 4
0,6	45,697 1	0,49	8,228 4	5,451 8	0,052 2
0,8	31,575 6	1,722 2	3,249 8	2,550 2	0,057 3
0,9	22,246	5,167 6	1,566 6	1,335 2	0,054 7
0,925	19,751 4	7,843 6	1,210 4	1,039	0,053
0,95	16,593 5	13,852	0,862	0,741 9	0,050 8
0,975	10,769 1	38,055	0,460 1	0,412	0,045 1

Table 12 — Values of the basic characteristics for Ω = 180° and B/D = 0,25

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	73,936 4	0,019	169,077 7	87,621 5	0,011
0,4	59,674 3	0,053 7	64,035 4	36,513 5	0,021 4
0,6	45,563 1	0,146 5	27,014 5	16,989 1	0,029 5
0,8	30,521 4	0,605 4	8,852 2	6,047 2	0,033 9
0,9	21,448 2	2,172 5	3,482 1	2,703 6	0,033 4
0,925	19,517 5	3,461 7	2,543	2,011 9	0,033 2
0,95	14,938 5	7,348 5	1,491 6	1,260 3	0,032 1
0,975	9,461 7	23,426 6	0,683 7	0,566 8	0,029 9

Table 13 — Values of the basic characteristics for Ω = 150° and B/D = 1,5

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	61,770 3	0,305 8	10,574 2	4,767 8	0,328 8
0,4	47,933 7	0,738	4,793 3	2,489	0,044 5
0,6	39,850 8	1,554 7	2,718 1	1,659 9	0,052 1
0,8	30,215 2	4,061 6	1,490 5	1,108 2	0,050 1
0,9	23,445 9	9,207 3	0,961 8	0,771 2	0,043 7
0,925	20,432	13,050 8	0,794 9	0,655 1	0,040 3
0,95	17,262	20,569 9	0,630 1	0,525	0,036 5
0,975	12,396	46,556 5	0,408 3	0,35	0,032 5

Table 14 — Values of the basic characteristics for Ω = 150° and B/D = 1,25

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	62,776 5	0,258 8	12,478 4	5,604	0,028 3
0,4	48,877 3	0,637 4	5,528 2	2,850 1	0,044 5
0,6	40,280 1	1,380 6	3,038 3	1,843 6	0,052 6
0,8	30,231 1	3,747 2	1,598 7	1,184 4	0,050 9
0,9	23,432 6	8,690 6	1,008 3	0,800 2	0,044 7
0,925	20,295 4	12,474 1	0,823 2	0,680 5	0,041 3
0,95	17,159 2	19,833 7	0,647 4	0,542 5	0,037 5
0,975	12,298 7	45,382 6	0,415 4	0,370 5	0,033 4

Table 15 — Values of the basic characteristics for Ω = 150° and B/D = 1

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	64,170 8	0,202 2	15,945 9	7,122 8	0,026 8
0,4	50,190 4	0,509 9	6,875 9	3,51	0,043 4
0,6	41,135 1	1,143 4	3,631 8	2,175 7	0,052 6
0,8	30,244 5	3,296 7	1,789 7	1,318 9	0,051 1
0,9	22,963 4	8,078 7	1,067 7	0,886 2	0,045
0,925	20,115	11,598 6	0,871 9	0,748 8	0,041 9
0,95	16,946 5	18,783 7	0,674 1	0,563 6	0,038 3
0,975	12,184 4	43,302 6	0,429 4	0,376	0,033 9

Table 16 — Values of the basic characteristics for Ω = 150° and B/D = 0,75

ε	β	So	f'/ψ	f/ψ	Q_3^*
0,2	65,961 1	0,136 7	23,553 7	10,449 6	0,023 8
0,4	51,996 3	0,356 1	9,782 7	4,927 4	0,04
0,6	42,117 4	0,837 2	4,891 8	2,887 7	0,05
0,8	30,636 7	2,606 8	2,211	1,615 4	0,049 7
0,9	22,669 5	6,943 8	1,211 4	1,000 8	0,044 3
0,925	19,853 4	10,166 2	0,970 4	0,815 5	0,041 5
0,95	16,681 2	16,940 9	0,730 2	0,608	0,038 2
0,975	11,904 4	40,595 3	0,448 8	0,380 9	0,033 7

Table 17 — Values of the basic characteristics for Ω = 150° and B/D = 0,5

ε	β	So	f '/ψ	f/ψ	Q_3^*
0,2	67,982 1	0,070 6	45,488 2	20,028 9	0,018 4
0,4	54,289 6	0,189 9	18,209 7	9,021 1	0,032 3
0,6	43,007 8	0,477 5	8,429 1	4,915 2	0,041 2
0,8	30,304 7	1,692 7	3,295 1	2,378 5	0,043 1
0,9	22,185 9	5,033 5	1,601 8	1,293	0,040 2
0,925	19,66	7,583 4	1,246	1,022	0,038 5
0,95	16,378 1	13,255 2	0,894 6	0,738 3	0,036 1
0,975	11,467 3	34,970 3	0,501 2	0,424 5	0,031 7

Table 18 — Values of the basic characteristics for Ω = 150°C and B/D = 0,25

ε	β	So	f '/ψ	f/ψ	Q_3^*
0,2	70,141 7	0,018 5	173,657 4	75,891 2	0,009 9
0,4	56,480 4	0,052 9	65,001 8	31,701 1	0,018 5
0,6	43,946 4	0,144 7	27,351	15,684 6	0,024 8
0,8	29,809 3	0,600 8	8,914 3	6,343 3	0,026 9
0,9	21,215 2	2,153 9	3,509	2,611 2	0,025 9
0,925	18,326 8	3,587 1	2,450 4	1,911 4	0,025 1
0,95	15,853 8	6,827 2	1,603 5	1,270 1	0,024 4
0,975	10,791 7	21,429 5	0,751	0,631 5	0,022 1

Table 19 — Values of the basic characteristics for Ω = 120° and B/D = 1,5

ε	β	So	f '/ψ	f/ψ	Q_3^*
0,2	56,676 3	0,219 6	14,682 2	5,394 3	0,019 5
0,4	42,036 2	0,553 6	6,325 8	2,743 3	0,028 4
0,6	34,566 2	1,267 2	3,269 2	1,713 3	0,033 5
0,8	27,097 3	3,610 8	1,632 3	1,085 8	0,030 8
0,9	21,230 1	8,726 1	0,988 9	0,768	0,025 4
0,925	19,173 2	12,258 2	0,826 4	0,667 3	0,023 5
0,95	16,245 9	19,760 5	0,642	0,514 8	0,020 9
0,975	12,526 3	42,612 1	0,437 5	0,353 7	0,018 1

Table 20 — Values of the basic characteristics for Ω = 120°C and B/D = 1,25

ε	β	So	f '/ψ	f/ψ	Q_3^*
0,2	58,210 3	0,184 8	17,438 2	6,371 7	0,019 1
0,4	42,953	0,486 9	7,176 7	3,091 1	0,028 7
0,6	35,068 9	1,144 9	3,602 3	1,873 2	0,033 8
0,8	27,206 7	3,366 5	1,738 2	1,151 4	0,031 3
0,9	21,216 3	8,307 8	1,030 4	0,798 4	0,026 3
0,925	19,068 1	11,786 9	0,852 6	0,691 1	0,024 3
0,95	16,196 2	19,095 2	0,659 4	0,530 5	0,022 3
0,975	12,497 1	41,177 5	0,448 8	0,375 1	0,018 9

Table 21 — Values of the basic characteristics for Ω = 120° and B/D = 1

ε	β	So	f '/ψ	f/ψ	Q_3^*
0,2	59,398 7	0,153	21,036 9	7,650 6	0,018 8
0,4	44,128 5	0,407 5	8,550 6	3,649 7	0,028 8
0,6	35,883 7	0,977 9	4,191 5	2,157 8	0,033 6
0,8	27,36	3,009 4	1,923 7	1,266 5	0,031 6
0,9	21,254 9	7,658 1	1,104 3	0,852 5	0,027
0,925	18,998 1	11,022 2	0,900 7	0,728 2	0,025 1
0,95	16,145 2	18,053 6	0,689 4	0,541 8	0,022 5
0,975	12,470 2	39,792 4	0,460 6	0,389 6	0,019 7

Table 22 — Values of the basic characteristics for Ω = 120° and B/D = 0,75

ε	β	So	f '/ψ	f/ψ	Q_3^*
0,2	61,304 5	0,110 2	29,196 2	10,540 9	0,017 5
0,4	45,817 9	0,301	11,530 2	4,858 3	0,027 7
0,6	37,124 9	0,747 1	5,437 2	2,756 5	0,032 8
0,8	27,997 8	2,440 1	2,333 6	1,518 5	0,031 8
0,9	21,183 6	6,656 1	1,245 4	0,956 1	0,027 3
0,925	18,901 5	9,760 2	0,996 9	0,766 5	0,025 5
0,95	15,968 8	16,405 7	0,744	0,590 5	0,022 9
0,975	12,355 1	37,152 8	0,484 9	0,401	0,020 2

Table 23 — Values of the basic characteristics for Ω = 120° and B/D = 0,5

ε	β	So	f '/ψ	f/ψ	Q_3^*
0,2	63,707 2	0,061 1	52,602	18,817 3	0,014 4
0,4	48,359 7	0,171 3	20,155 6	8,330 5	0,023 8
0,6	39,012 5	0,444 6	9,021 4	4,469 2	0,029 5
0,8	27,961	1,641 3	3,377 6	2,166 4	0,029 7
0,9	20,901 3	4,956 1	1,614 8	1,227 2	0,026 3
0,925	18,945 4	7,410 6	1,265 9	0,962 4	0,025
0,95	15,685 6	13,250 3	0,887 8	0,691 3	0,022 7
0,975	11,904 8	31,950 5	0,548 1	0,436 5	0,019 9

Table 24 — Values of the basic characteristics for Ω = 120° and B/D = 0,25

ε	β	So	f '/ψ	f/ψ	Q_3^*
0,2	66,239 9	0,016 9	190,023 5	67,326 8	0,008 2
0,4	51,432	0,050 7	67,705 1	27,357	0,014 8
0,6	41,159 6	0,138 7	28,511 7	13,726 9	0,019
0,8	28,646 6	0,589 2	9,077 7	5,683 1	0,019 9
0,9	20,788 5	2,124 4	3,552 3	2,517 7	0,018 5
0,925	17,974 1	3,548 5	2,472 8	1,878 2	0,017 6
0,95	14,837 7	7,037 8	1,551 2	1,195 1	0,016 5
0,975	11,015 9	20,770 2	0,773 9	0,609 1	0,015 3

Table 25 — Values of the basic characteristics for Ω = 90° and B/D = 1,5

ε	β	*So*	f'/ψ	f/ψ	Q_3^*
0,2	53,340 2	0,117 6	27,355	7,627 6	0,011 4
0,4	37,166 5	0,330 1	10,503 4	3,54	0,015 9
0,6	28,916 7	0,864 2	4,688 1	1,975 8	0,017 4
0,8	23,203 7	2,881 7	1,974 6	1,104 1	0,015 1
0,9	18,831 5	7,636 6	1,089	0,748 7	0,012 5
0,925	17,184 5	11,026 1	0,886 5	0,623 5	0,011 5
0,95	14,926 5	18,268 3	0,673 1	0,509 7	0,010 5
0,975	11,529 4	40,891 4	0,443 2	0,354 1	0,009 7

Table 26 — Values of the basic characteristics for Ω = 90° and B/D = 1,25

ε	β	*So*	f'/ψ	f/ψ	Q_3^*
0,2	54,116 5	0,106 9	30,061 7	8,360 5	0,011 5
0,4	37,610 1	0,307 4	11,266	3,786	0,016 1
0,6	29,198 4	0,800 8	5,05	2,114 5	0,017 8
0,8	23,378 2	2,719	2,084 4	1,160 5	0,015 8
0,9	18,857	7,317 6	1,130 4	0,775 2	0,013 1
0,925	17,239 6	10,598 2	0,917 2	0,645 1	0,012 1
0,95	14,908	17,588 5	0,694 2	0,519	0,011
0,975	11,511 7	39,939 2	0,451 3	0,360 1	0,009 9

Table 27 — Values of the basic characteristics for Ω = 90° and B/D = 1

ε	β	*So*	f'/ψ	f/ψ	Q_3^*
0,2	55,814 5	0,089 3	35,979 2	9,946 3	0,011 2
0,4	38,693 2	0,266	13,010 3	4,335	0,016 3
0,6	29,800 6	0,710 5	5,676 2	2,356 7	0,018 3
0,8	25,653 6	2,477 4	2,274	1,257 6	0,016 5
0,9	19,043	6,803	1,206 2	0,823 3	0,013 8
0,925	17,202 1	10,011 5	0,962 6	0,673 5	0,012 6
0,95	14,919 6	16,815 8	0,720 6	0,537 7	0,011 5
0,975	11,480 1	38,478 5	0,464 5	0,369 9	0,010 3

Table 28 — Values of the basic characteristics for Ω = 90° and B/D = 0,75

ε	β	*So*	f'/ψ	f/ψ	Q_3^*
0,2	56,944 4	0,072 4	44,358 3	12,206 8	0,010 9
0,4	40,269 7	0,209 4	16,497 3	5,433 2	0,016 3
0,6	30,87	0,574 6	6,988 6	2,863 8	0,018 5
0,8	24,152 3	2,093 3	2,664 9	1,456 8	0,017 1
0,9	18,953 4	6,057 6	1,336	0,906 4	0,014 3
0,925	17,165 1	9,020 4	1,053 1	0,737 3	0,013 2
0,95	14,823 7	15,375 7	0,775 9	0,578	0,011 7
0,975	11,44	36,078 4	0,488	0,387 8	0,010 3

Table 29 — Values of the basic characteristics for Ω = 90° and B/D = 0,5

ε	β	*So*	f'/ψ	f/ψ	Q_3^*
0,2	59,758	0,043 6	73,56	20,031 8	0,009 6
0,4	42,706 3	0,132	26,098 7	8,439 3	0,015 1
0,6	32,766	0,373 1	10,686 6	4,276 1	0,017 6
0,8	24,867 7	1,468 5	3,733 8	2,000 8	0,016 8
0,9	19,130 2	4,626 1	1,705 4	1,141 8	0,014 3
0,925	17,137 3	7,140 5	1,294 2	0,870 4	0,013 2
0,95	14,715 4	12,688 2	0,913 6	0,675 2	0,011 8
0,975	11,271 1	31,525 5	0,543 8	0,430 8	0,010 3

Table 30 — Values of the basic characteristics for Ω = 90° and B/D = 0,25

ε	β	*So*	f'/ψ	f/ψ	Q_3^*
0,2	62,837 4	0,013 7	234,859 2	63,203 8	0,006 1
0,4	46,171 9	0,043 5	79,019 7	24,894 2	0,010 3
0,6	35,874 7	0,127 6	30,956 5	11,918 6	0,012 9
0,8	26,275 4	0,562 6	9,484	4,901 4	0,013
0,9	19,422 4	2,082 7	3,610 3	2,286	0,011 4
0,925	17,290 7	3,434	2,545 1	1,695 8	0,010 8
0,95	14,552 2	6,800 3	1,598 9	1,109 3	0,009 9
0,975	10,663	20,280 2	0,787 3	0,587 5	0,008 7

4 Graphs of basic bearing characteristics

Figures 1 to 50 graphically represent the functions β, So, f'/ψ, f/ψ and Q_3^*.

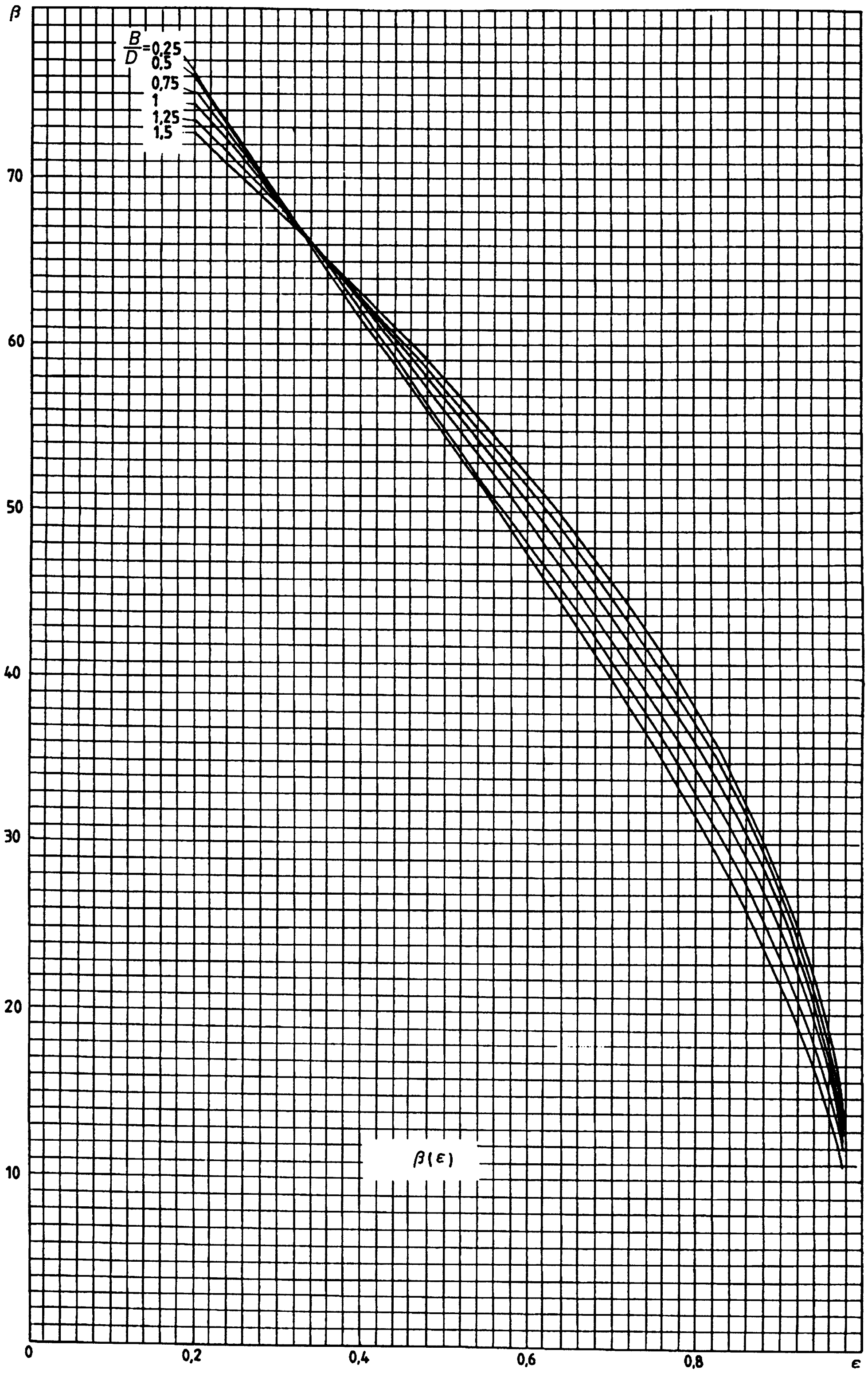

Figure 1 — Attitude angle β as a function of relative eccentricity ε for Ω = 360°

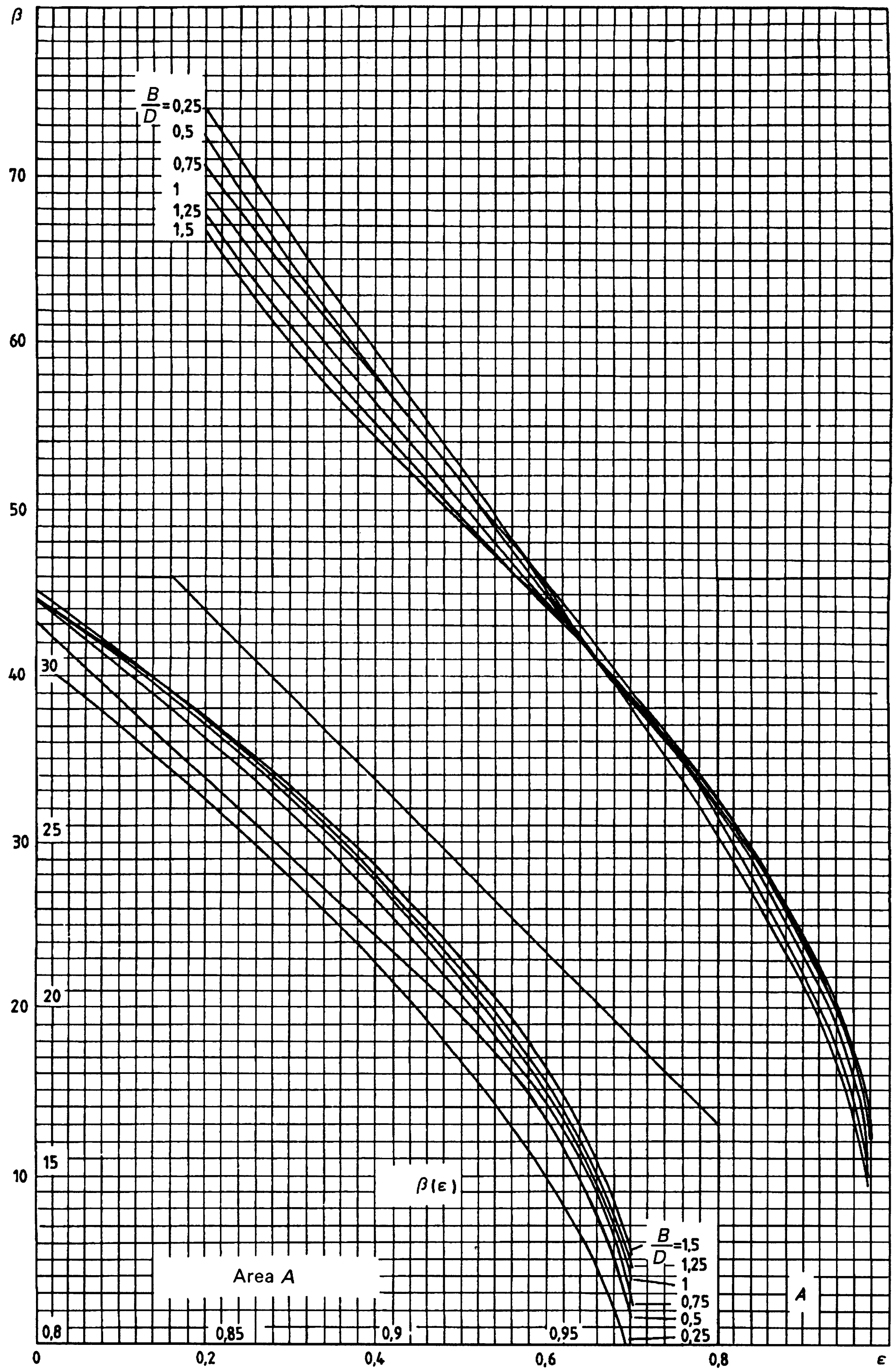

Figure 2 — Attitude angle β as a function of relative eccentricity ε for Ω = 180°

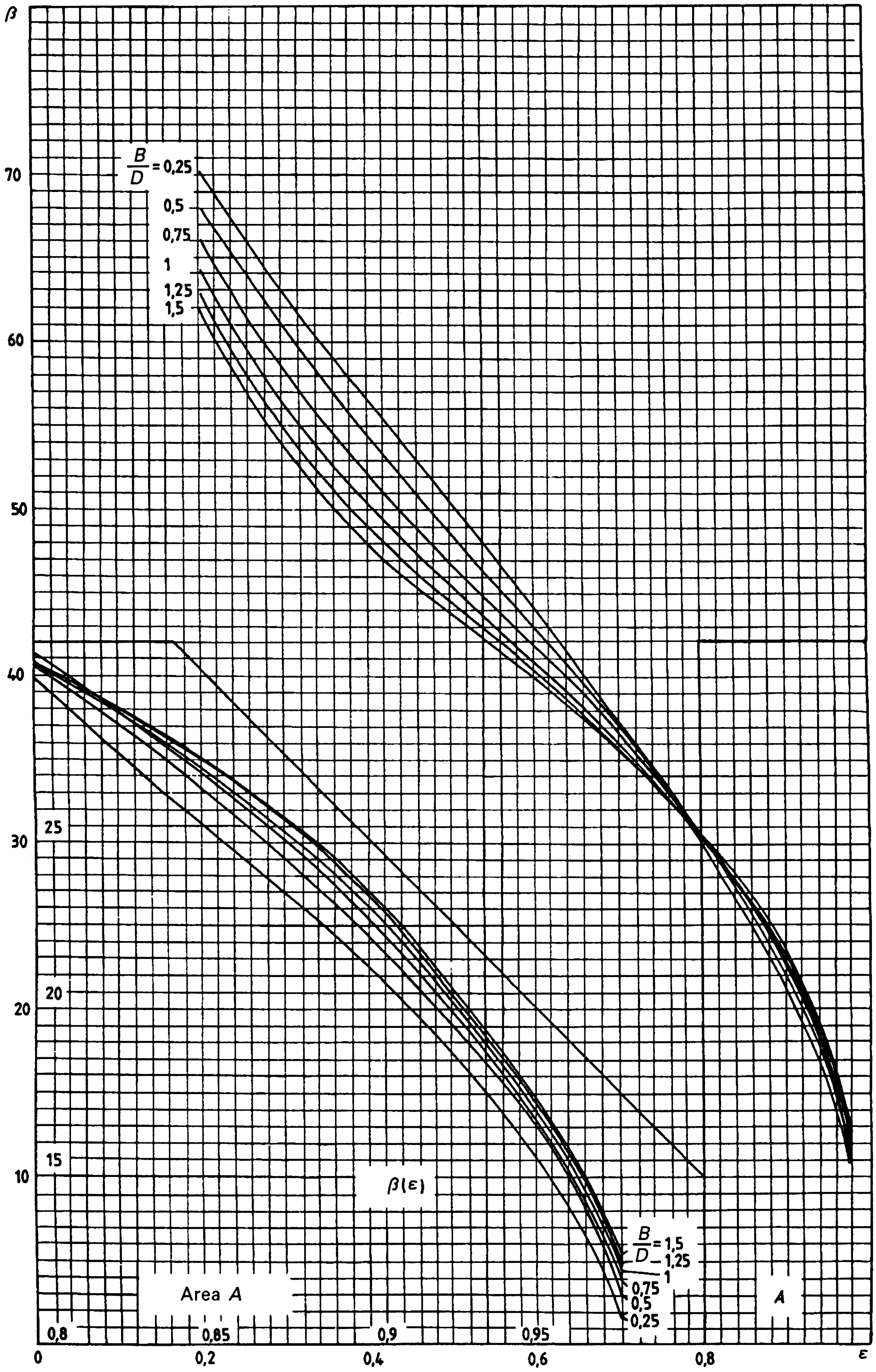

Figure 3 — Attitude angle β as a function of relative eccentricity ε for $\Omega = 150°$

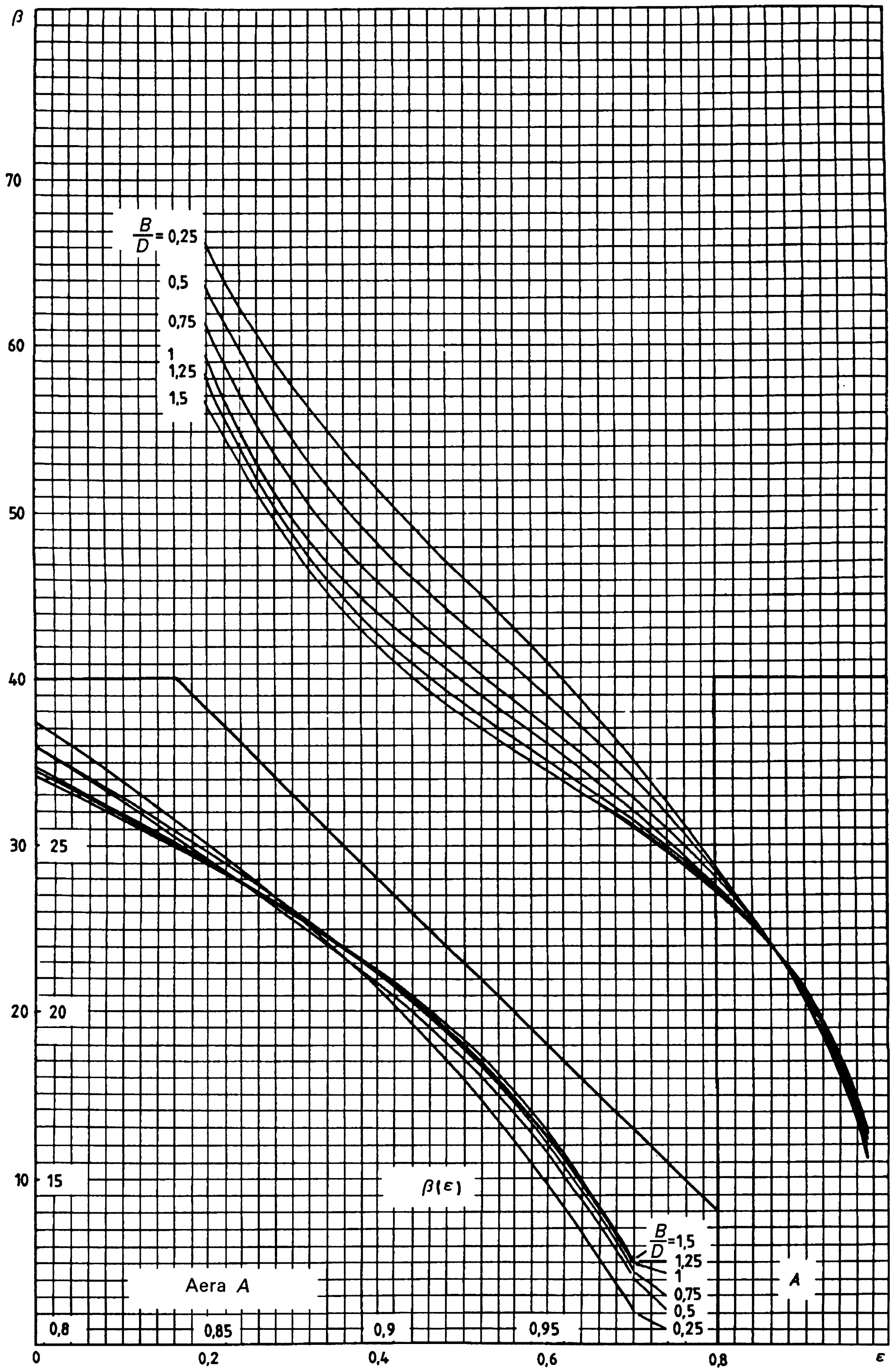

Figure 4 — Attitude angle β as a function of relative eccentricity ε for Ω = 120°

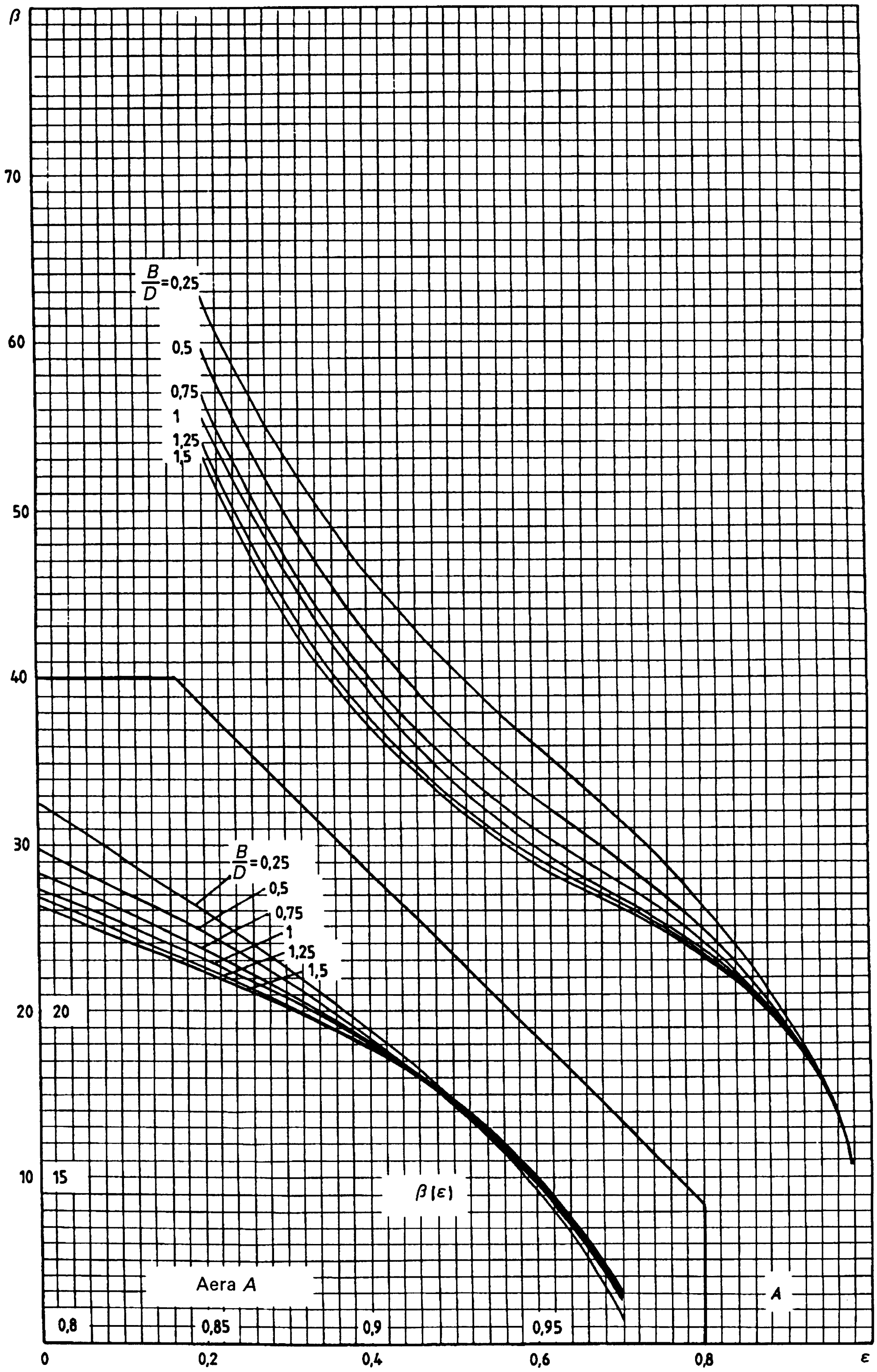

Figure 5 — Attitude angle β as a function of relative eccentricity ε for Ω = 90°

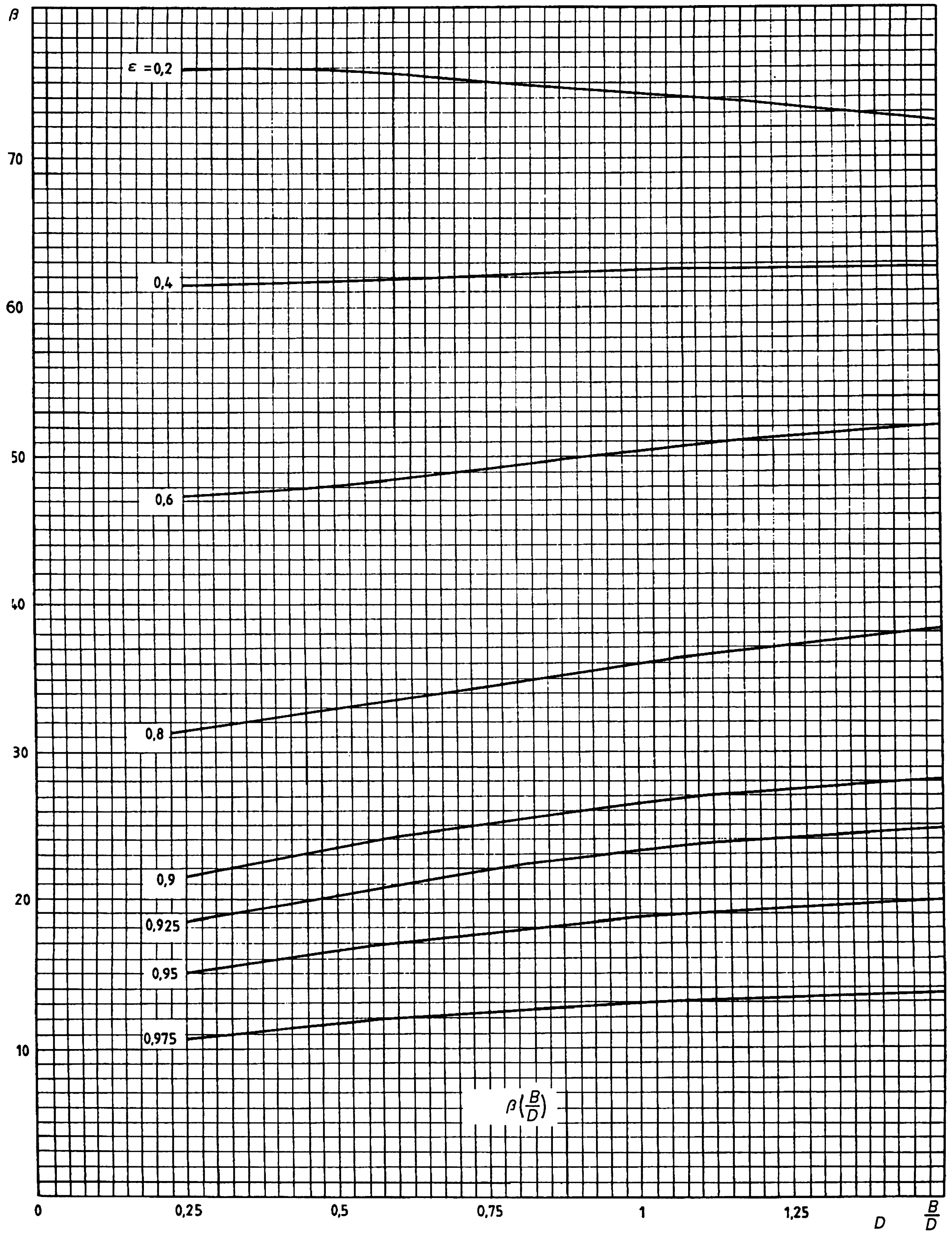

Figure 6 — Attitude angle β as a function of relative bearing width B/D for $\Omega = 360°$

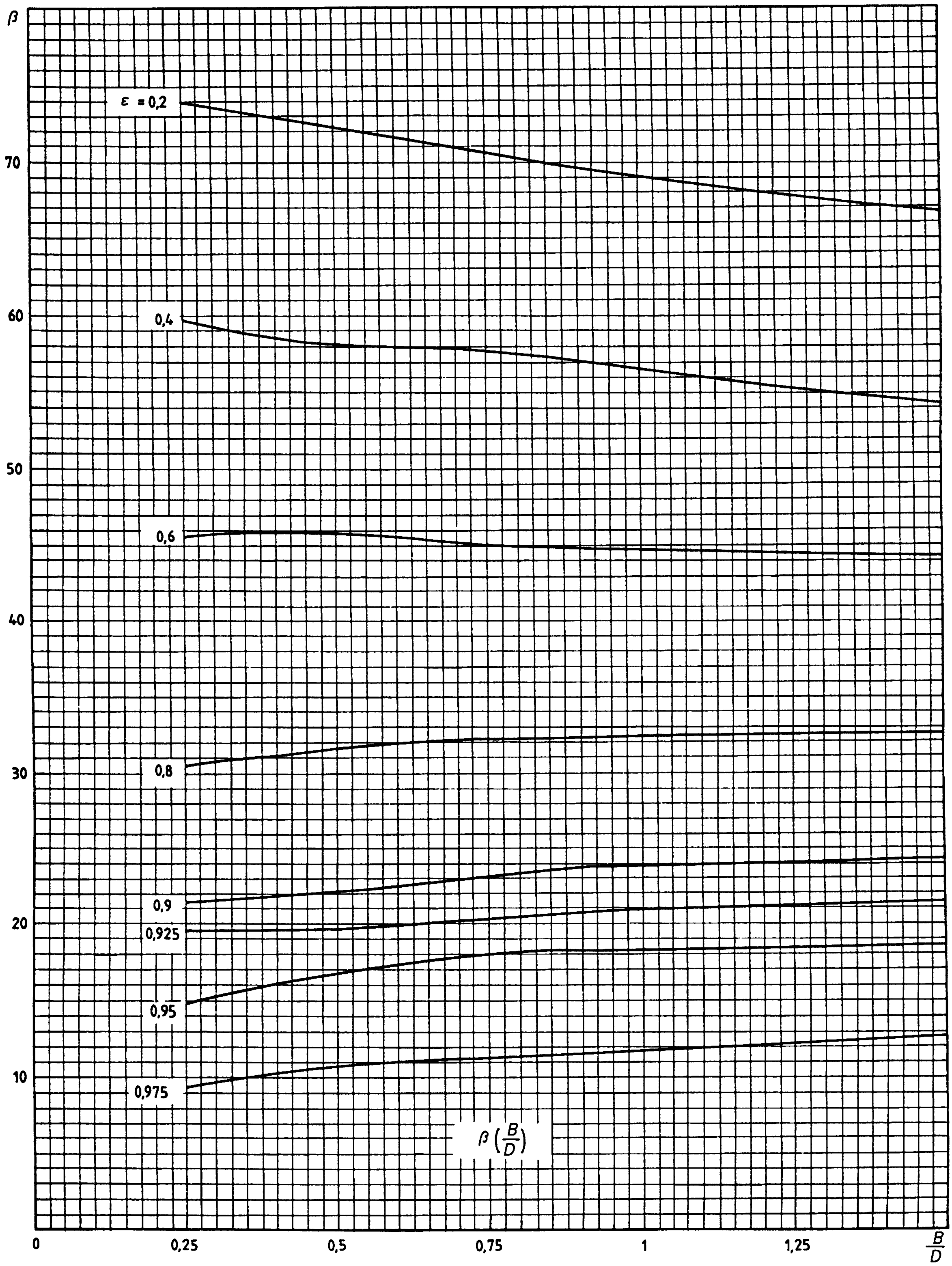

Figure 7 — Attitude angle β as a function of relative bearing length B/D for $\Omega = 180°$

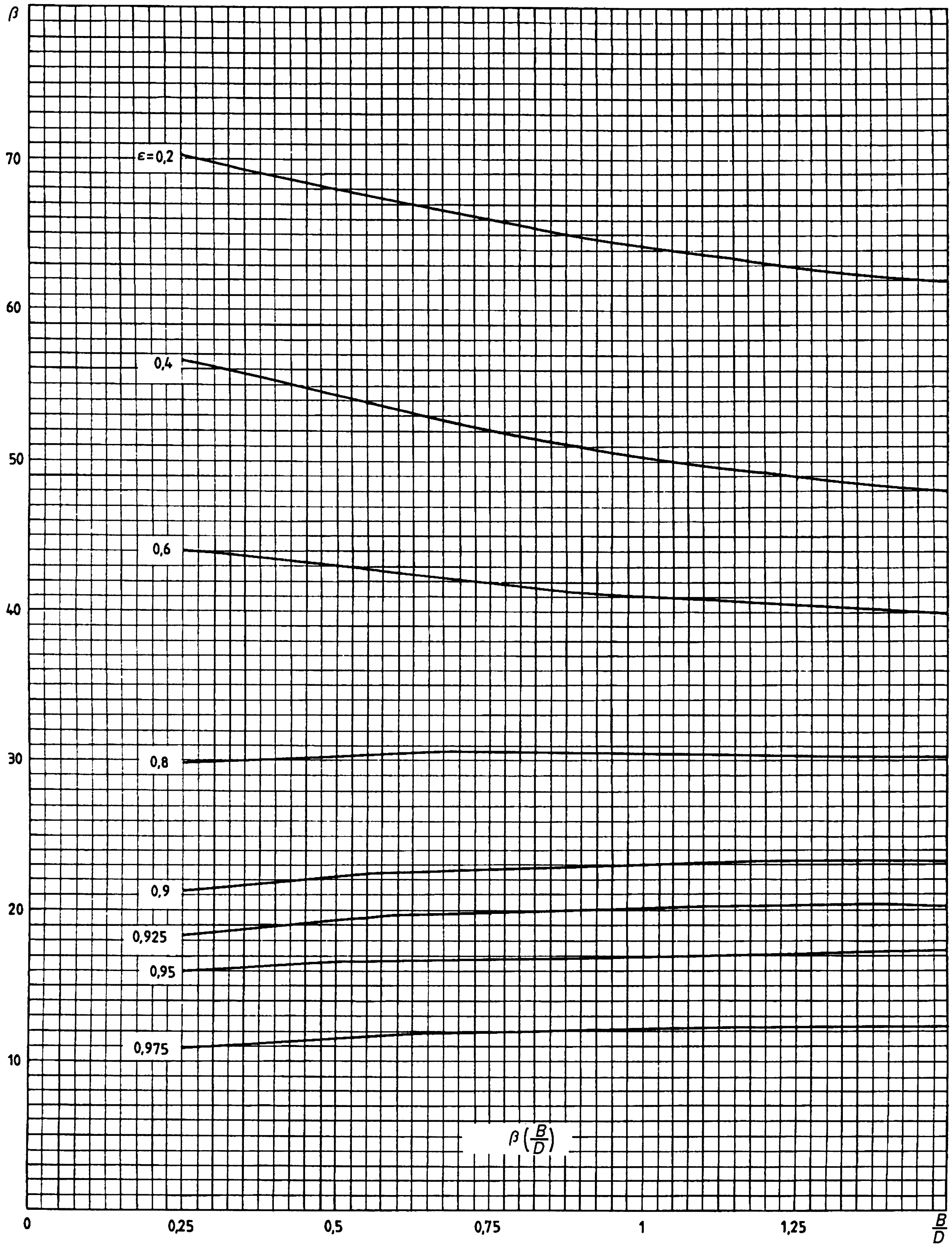

Figure 8 — Attitude angle β as a function of relative bearing length B/D for $\Omega = 150°$

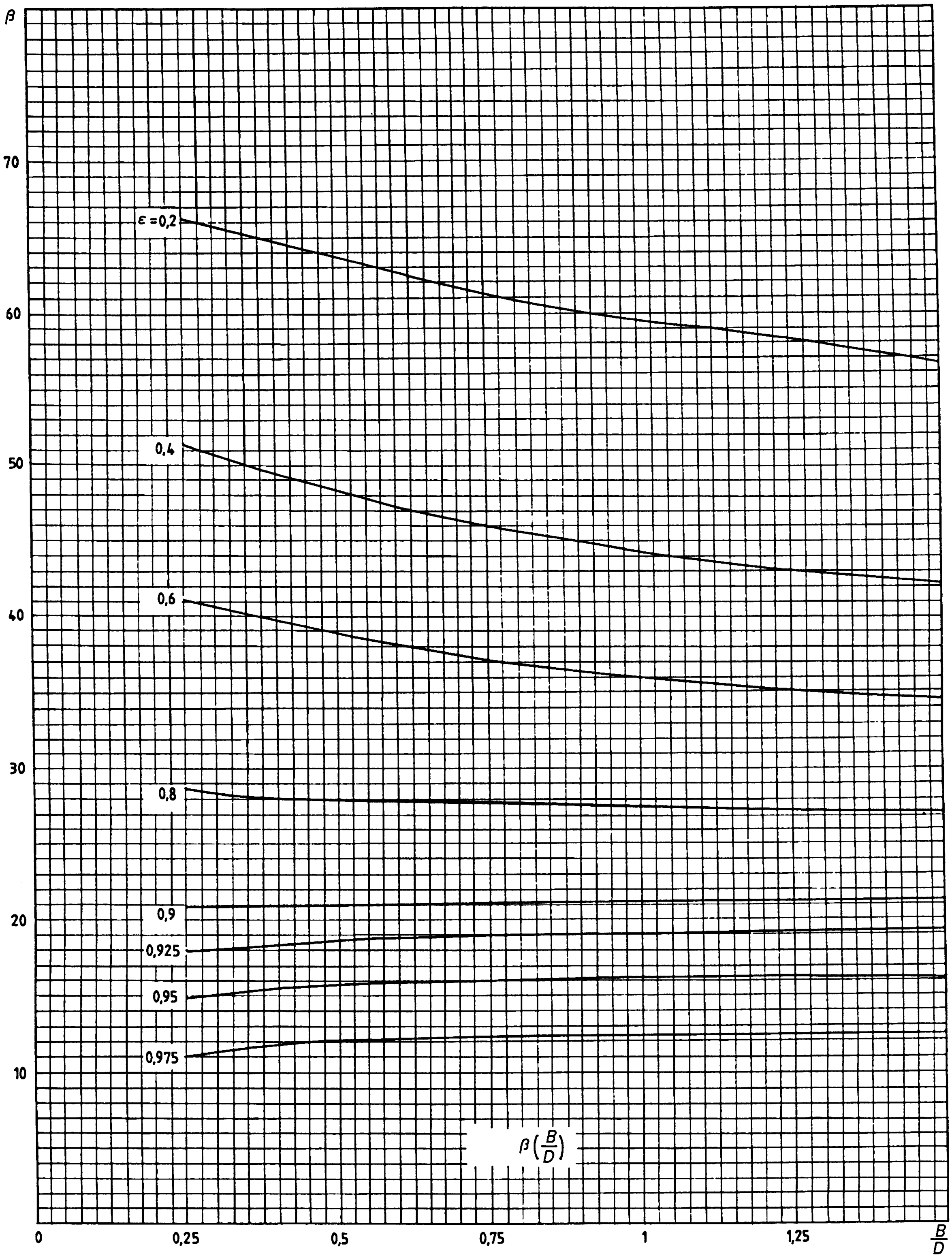

Figure 9 — Attitude angle β as a function of relative bearing width B/D for $\Omega = 120°$

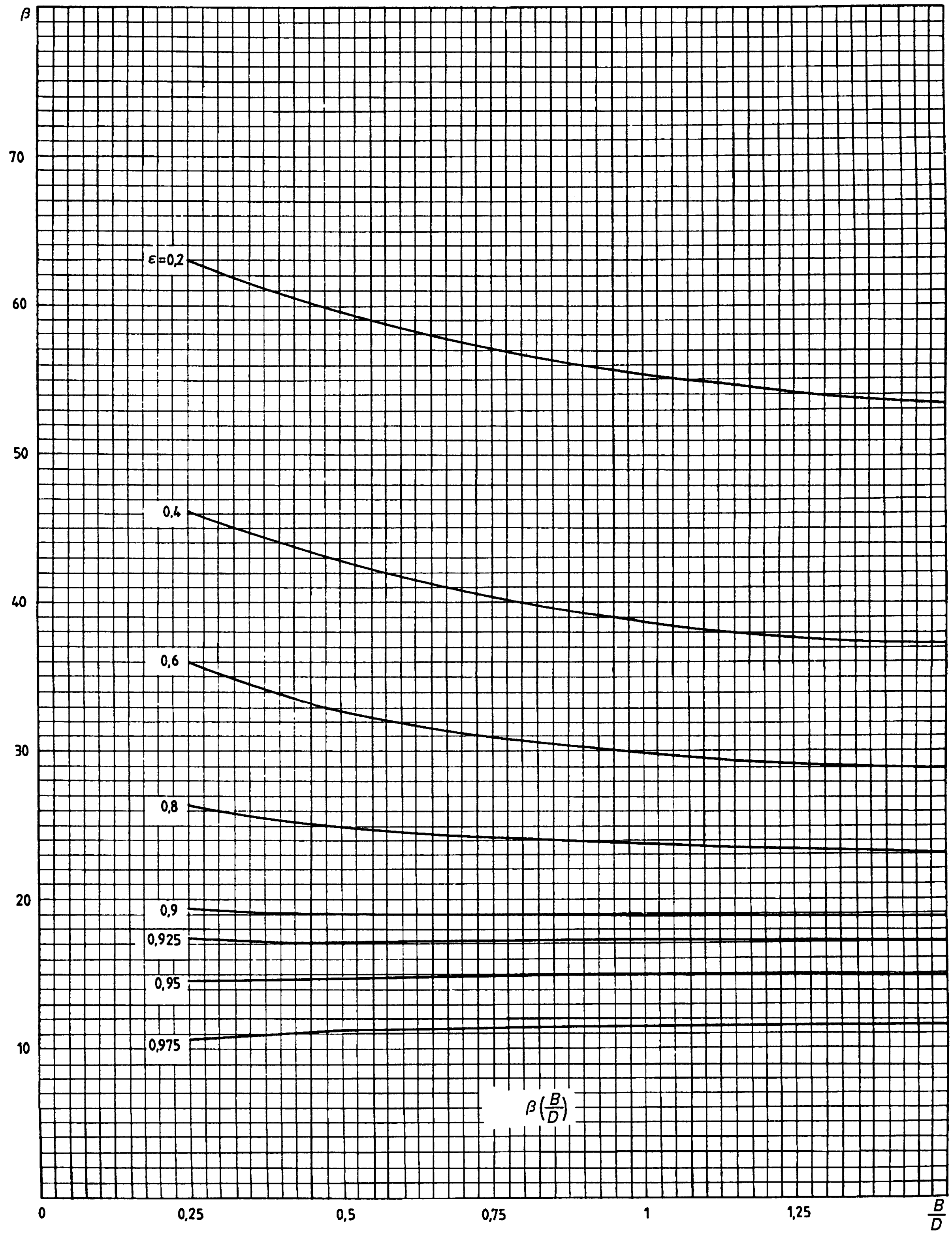

Figure 10 — Attitude angle β as a function of relative bearing width B/D for $\Omega = 90°$

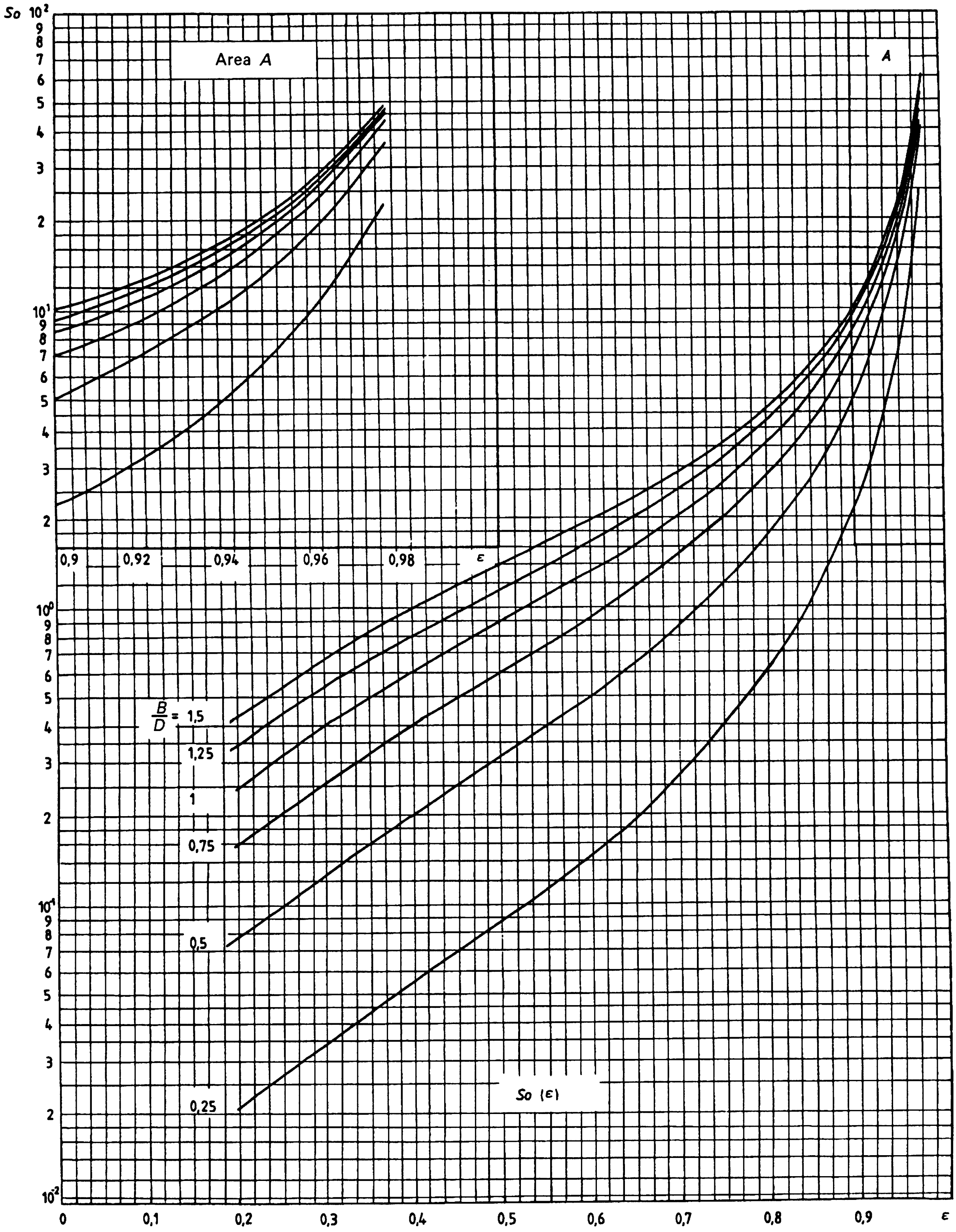

Figure 11 — Sommerfeld number *So* as a function of relative eccentricity *ε* for *Ω* = 360°

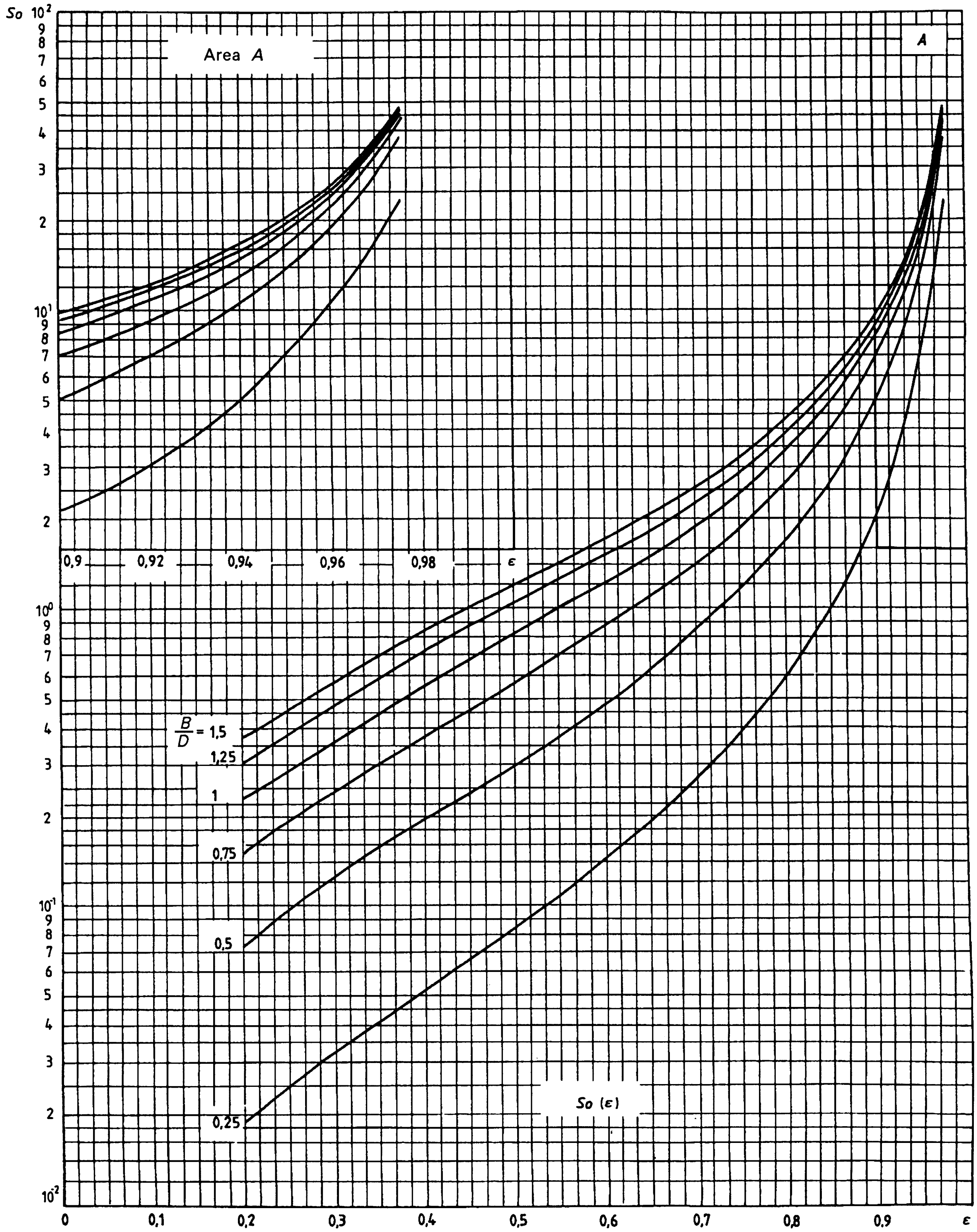

Figure 12 — Sommerfeld number *So* as a function of relative eccentricity *ε* for *Ω* = 180°

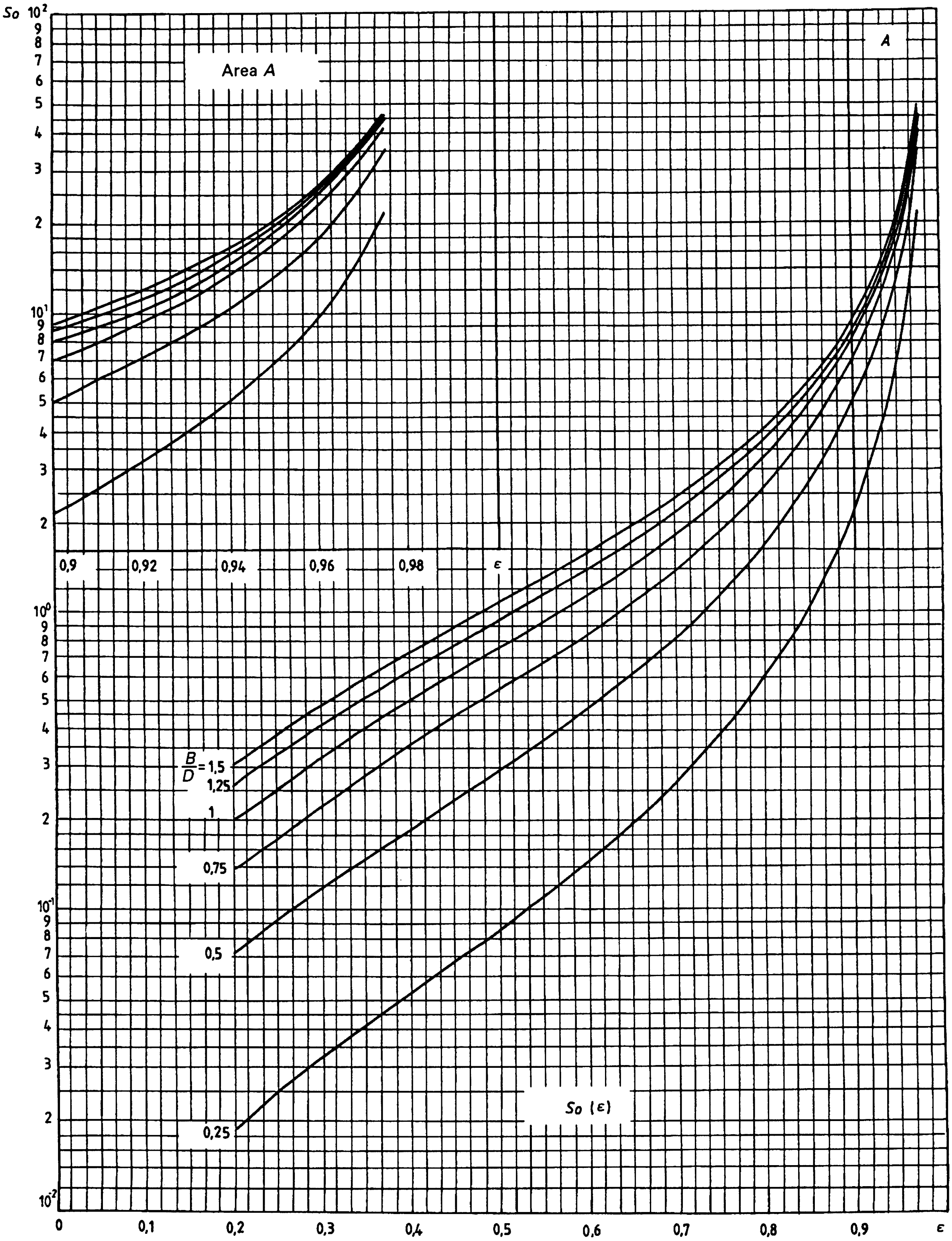

Figure 13 — Sommerfeld number So as a function of relative eccentricity ε for $\Omega = 150°$

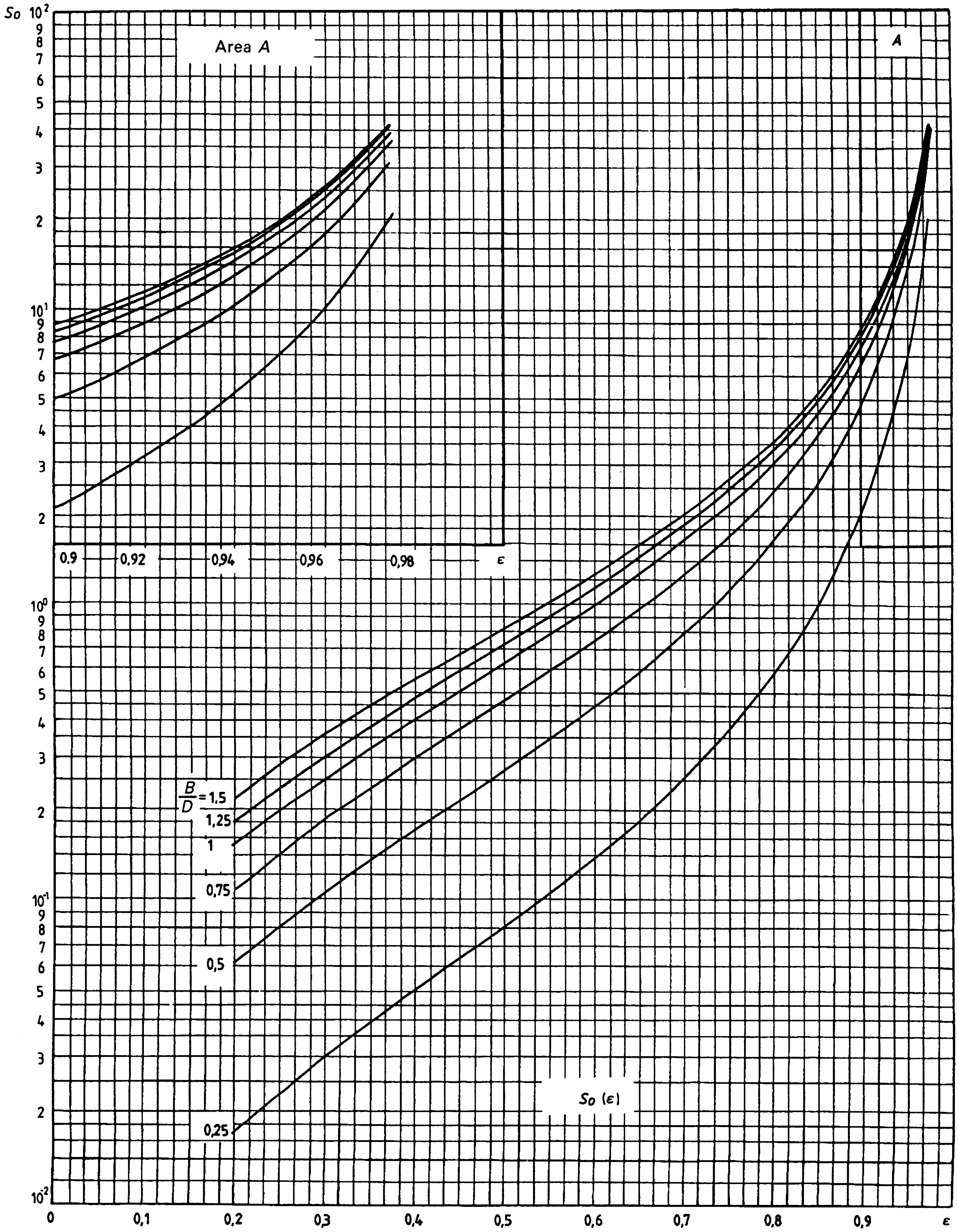

Figure 14 — Sommerfeld number *So* **as a function of relative eccentricity** *ε* **for** *Ω* **= 120°**

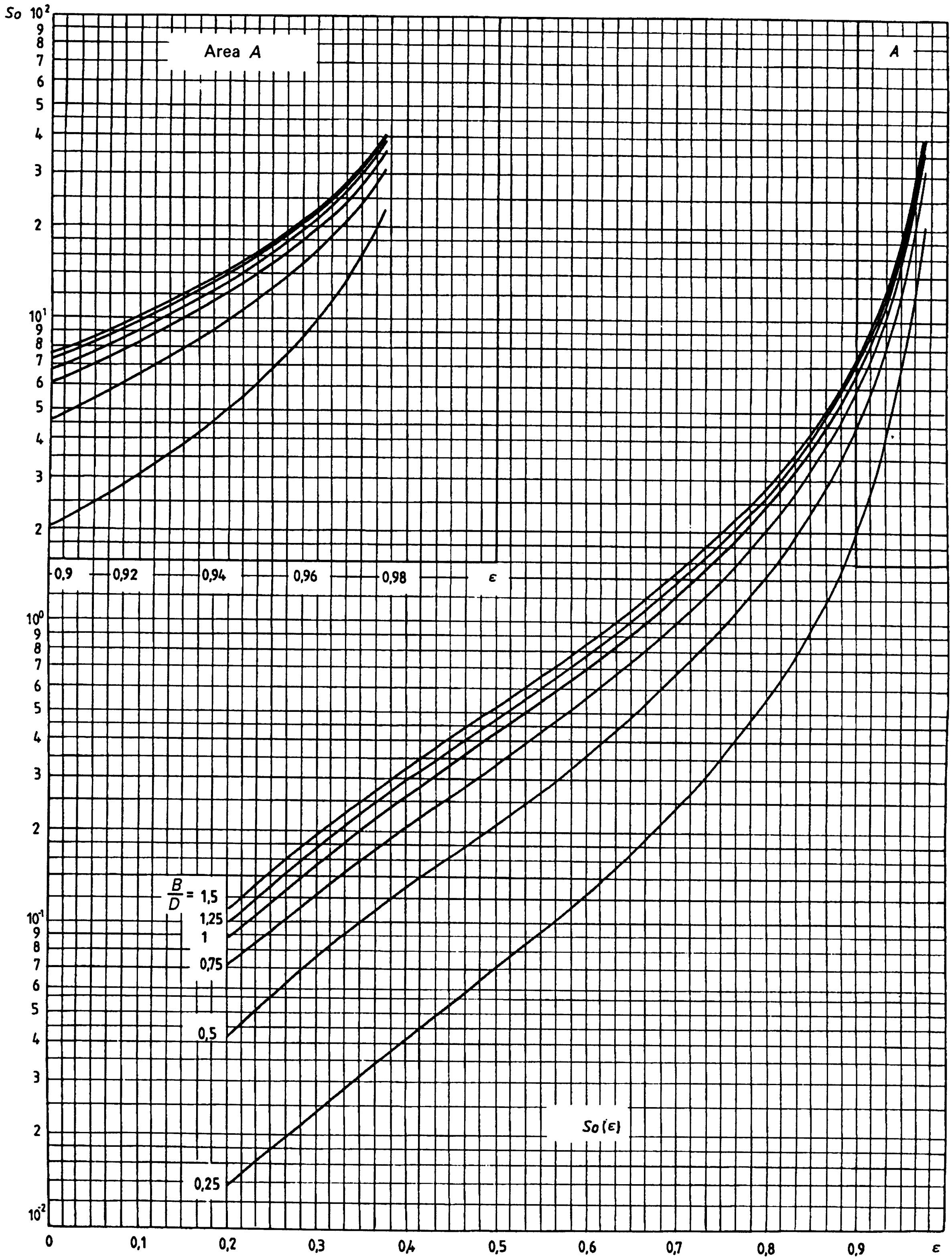

Figure 15 — Sommerfeld number So as a function of relative eccentricity ε for $\Omega = 90°$

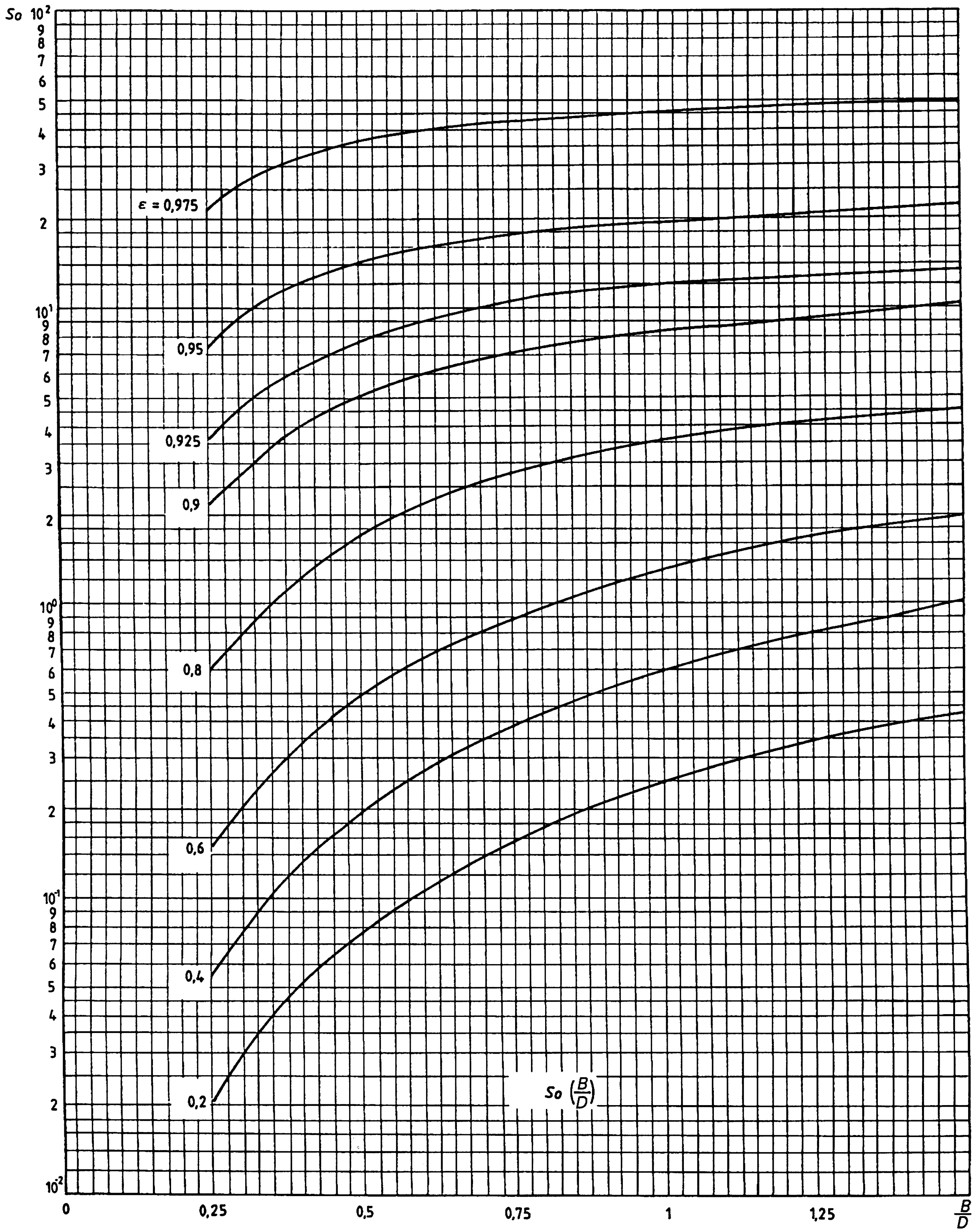

Figure 16 — Sommerfeld number *So* as a function of relative bearing width *B*/*D* for Ω = 360°

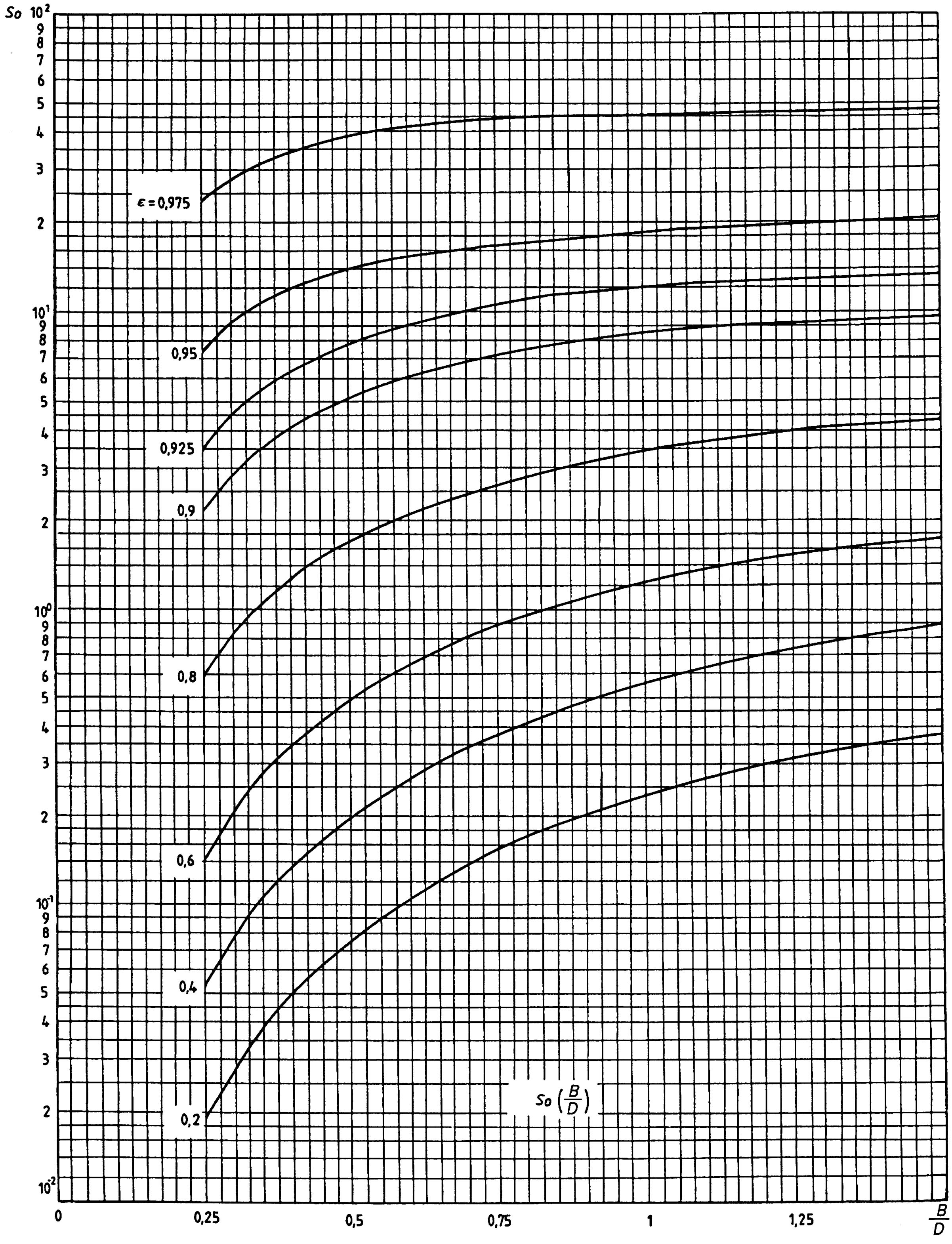

Figure 17 — Sommerfeld number *So* as a function of relative bearing width *B*/*D* for Ω = 180°

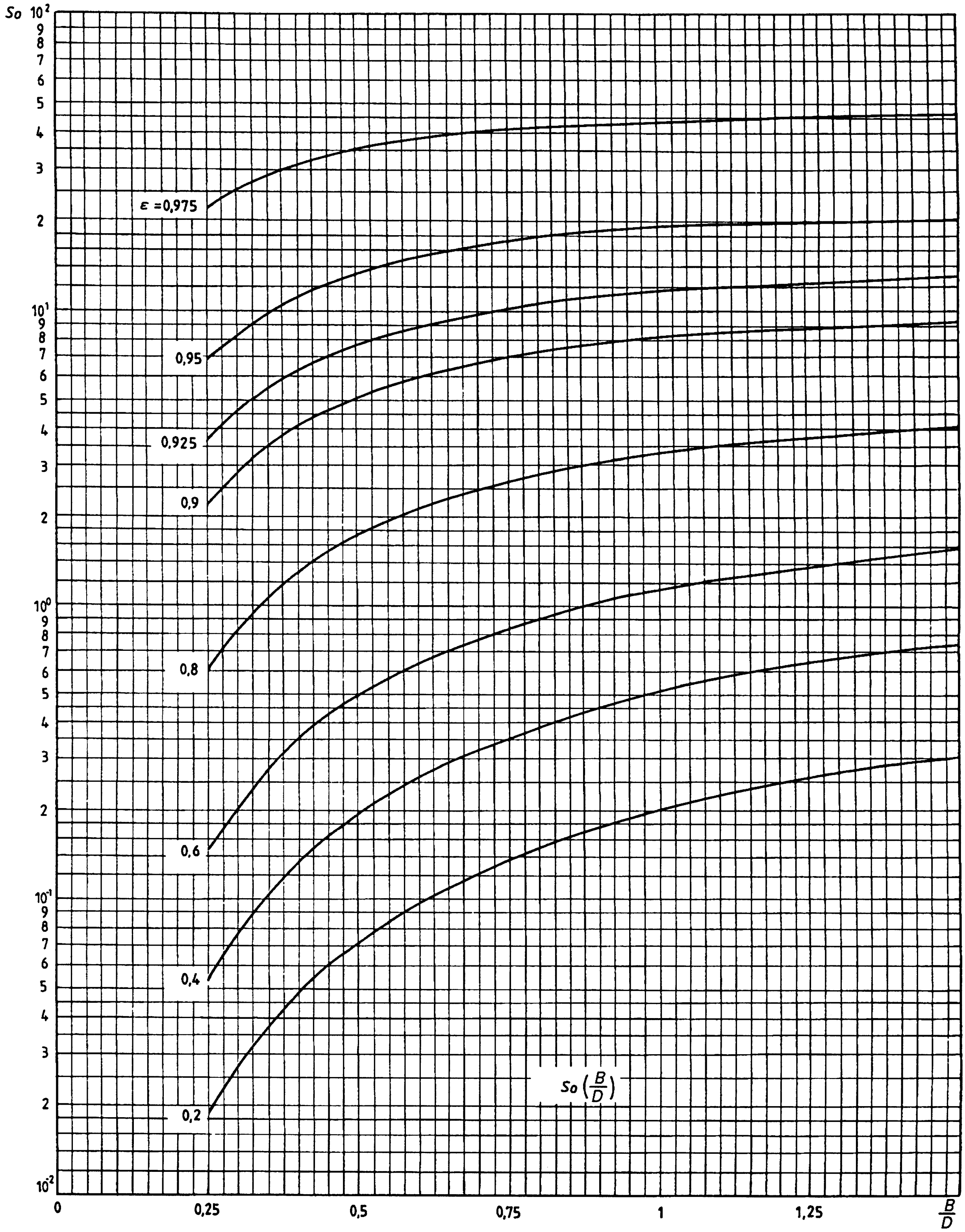

Figure 18 — Sommerfeld number *So* as a function of relative bearing width *B*/*D* for *Ω* = 150°

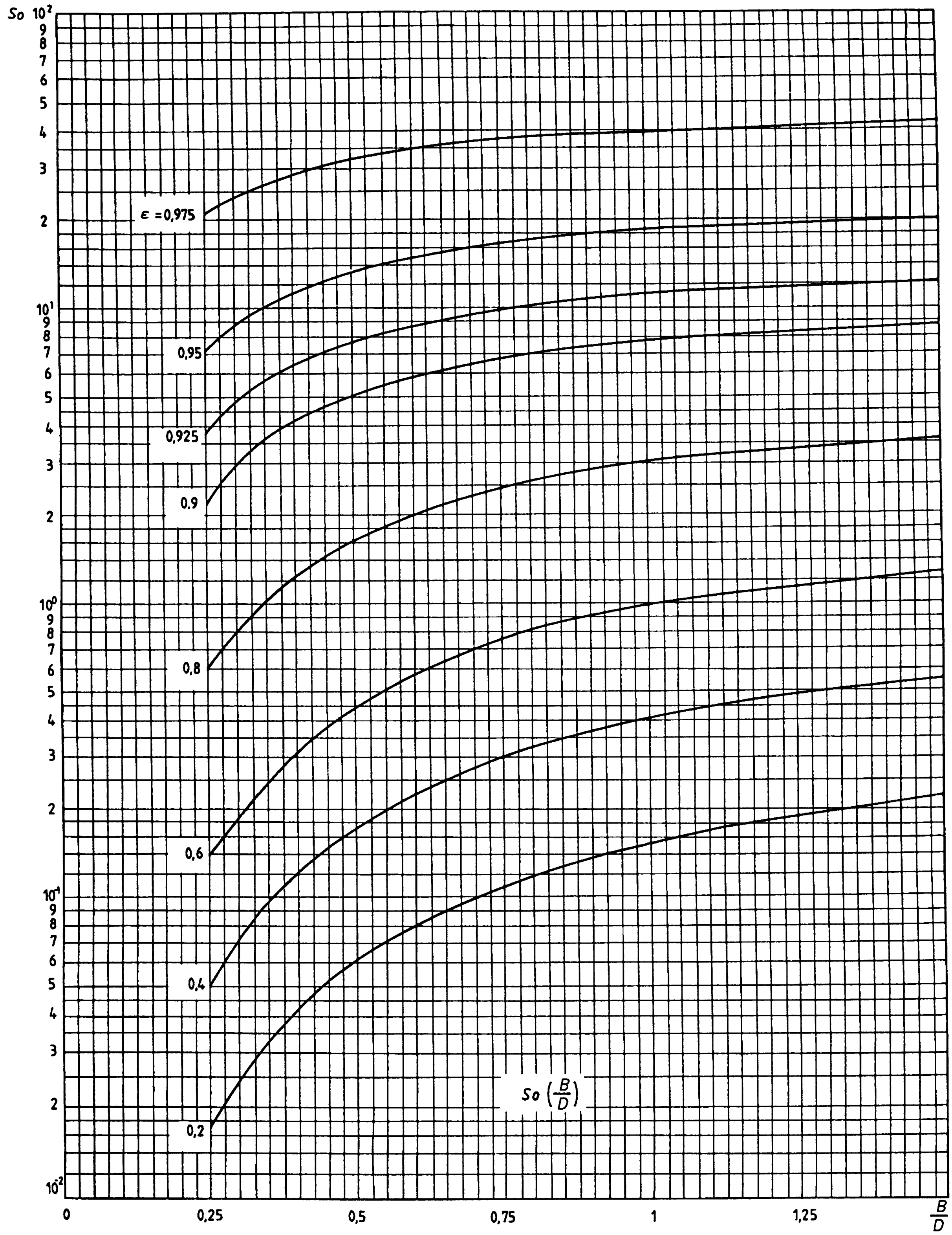

Figure 19 — Sommerfeld number So **as a function of relative bearing width** B/D **for** $\Omega = 120°$

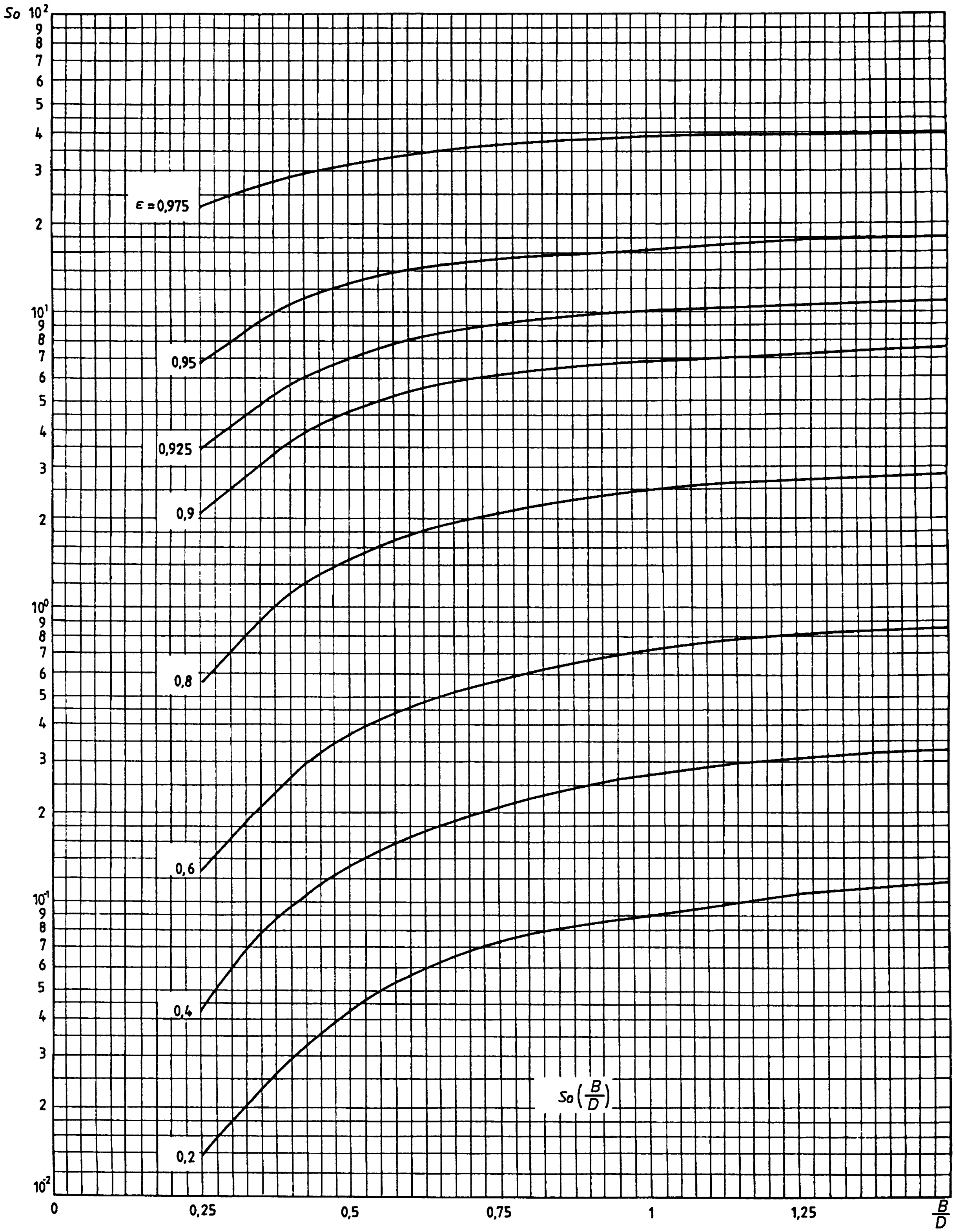

Figure 20 — Sommerfeld number *So* **as a function of relative bearing width** *B/D* **for** Ω **= 90°**

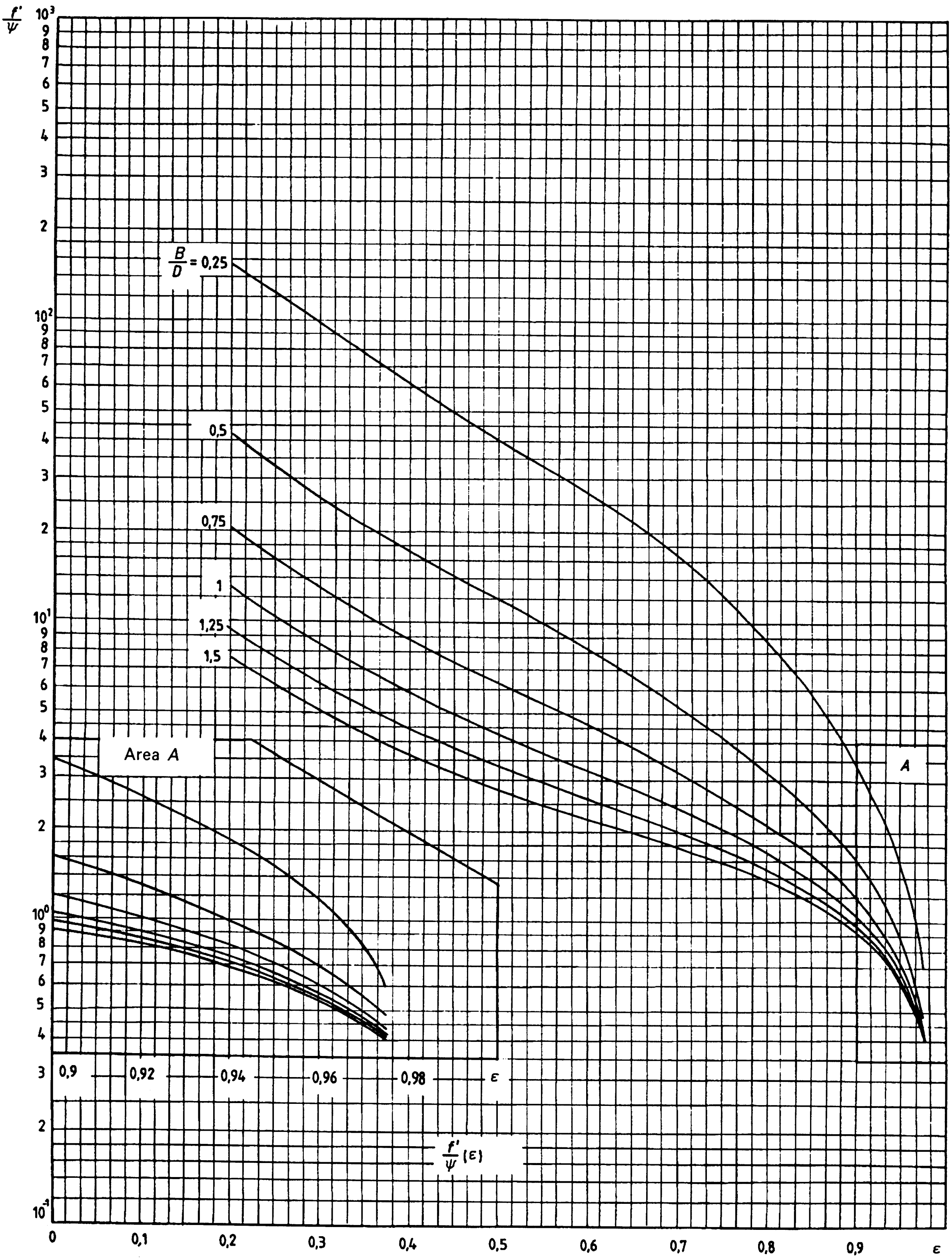

Figure 21 — Specific coefficient of friction f'/ψ as a function of relative eccentricity ε for Ω = 360°

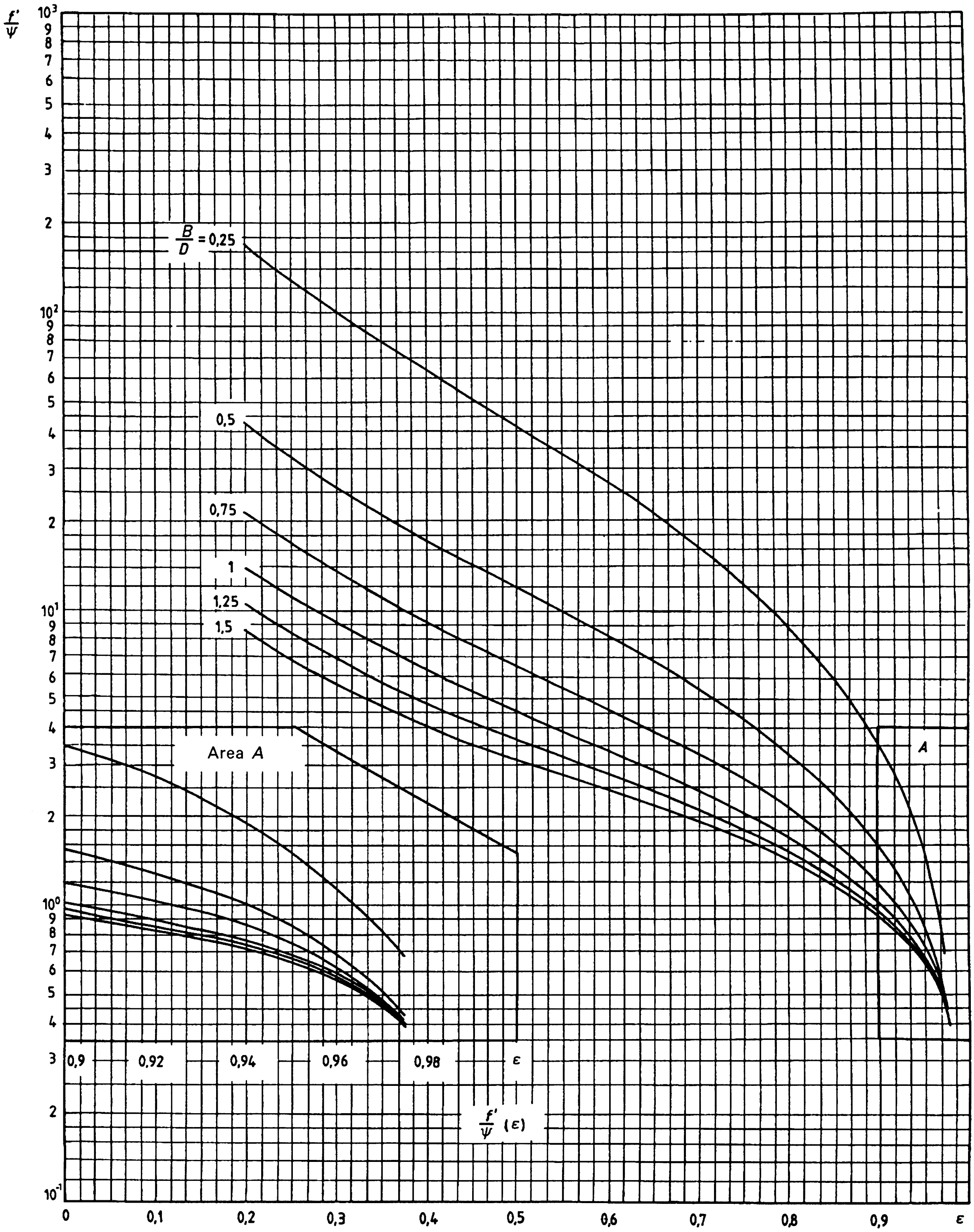

Figure 22 — Specific coefficient of friction f'/ψ as a function of relative eccentricity ε for Ω = 180°

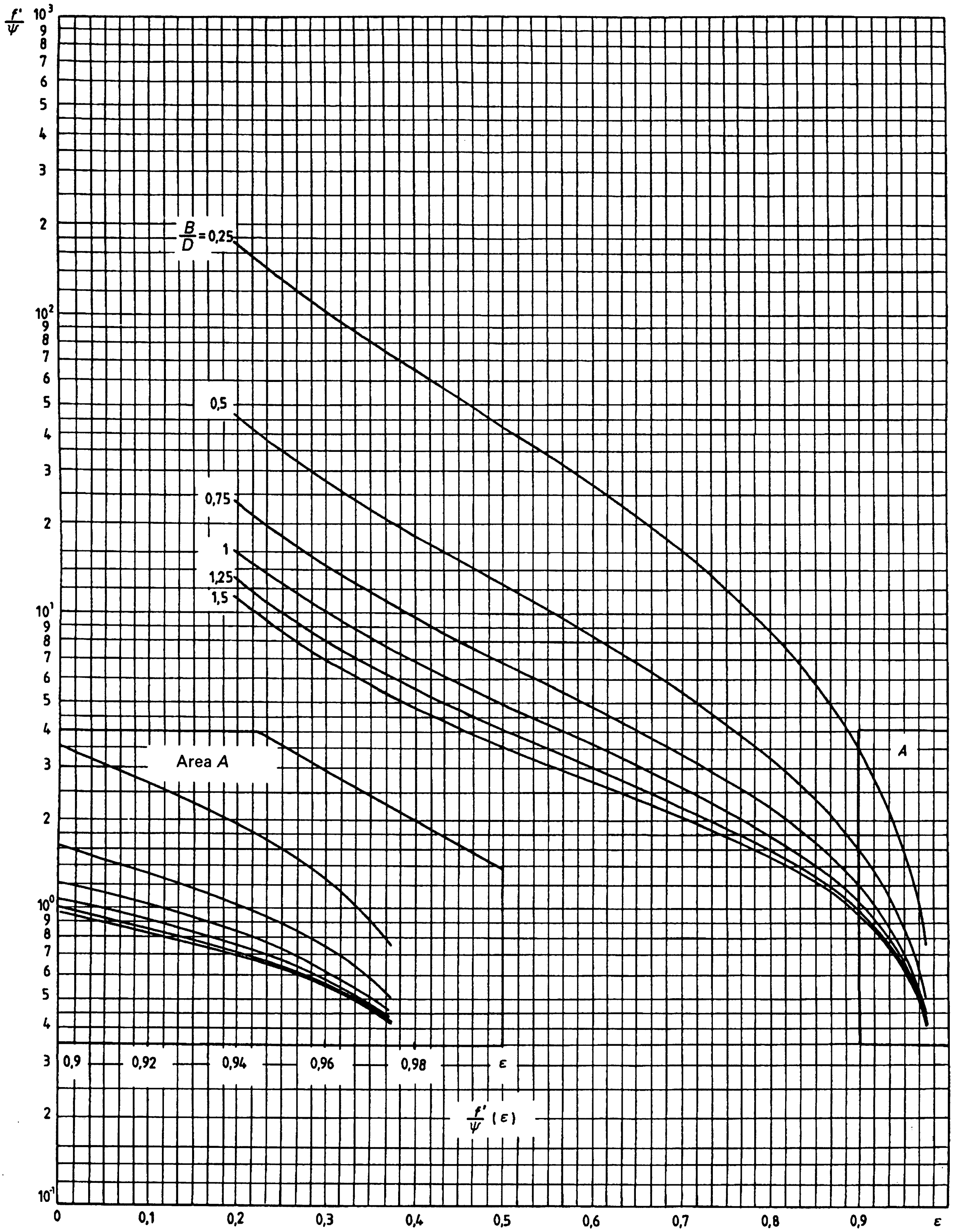

Figure 23 — Specific coefficient of friction f'/ψ as a function of relative eccentricity ε for $\Omega = 150°$

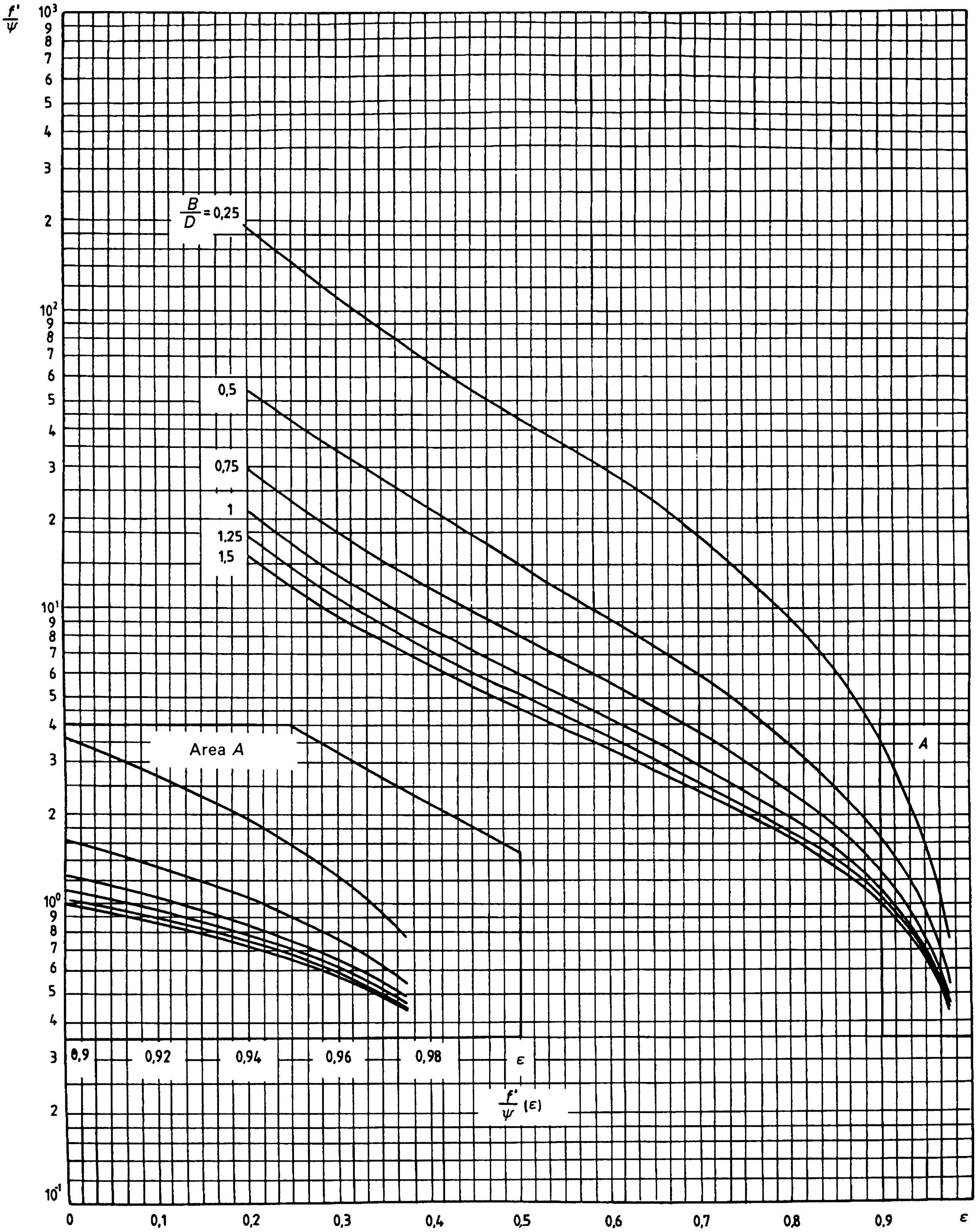

Figure 24 — Specific coefficient of friction f'/ψ as a function of relative eccentricity ε for $\Omega = 120°$

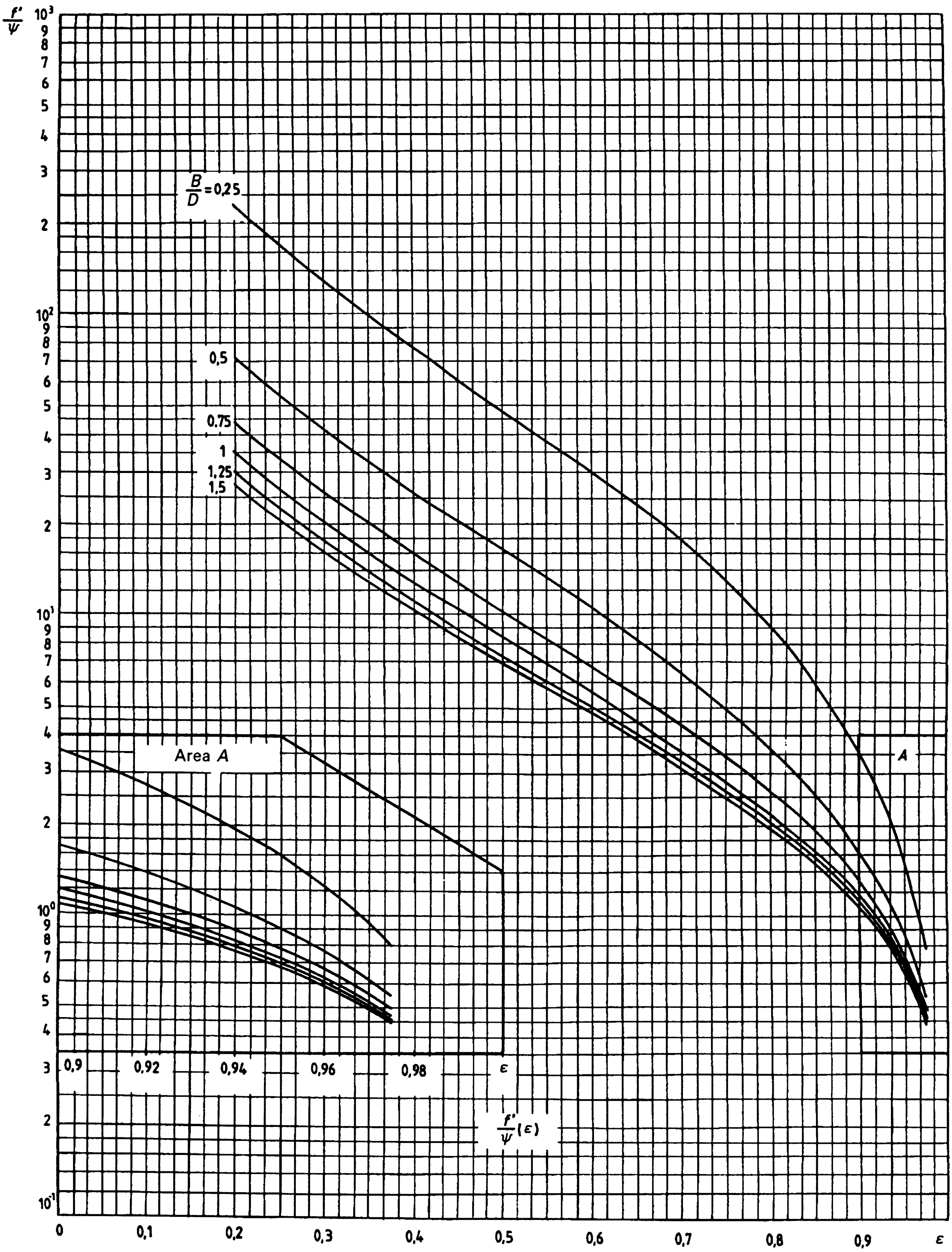

Figure 25 — Specific coefficient of friction f'/ψ as a function of relative eccentricity ε for $\Omega = 90°$

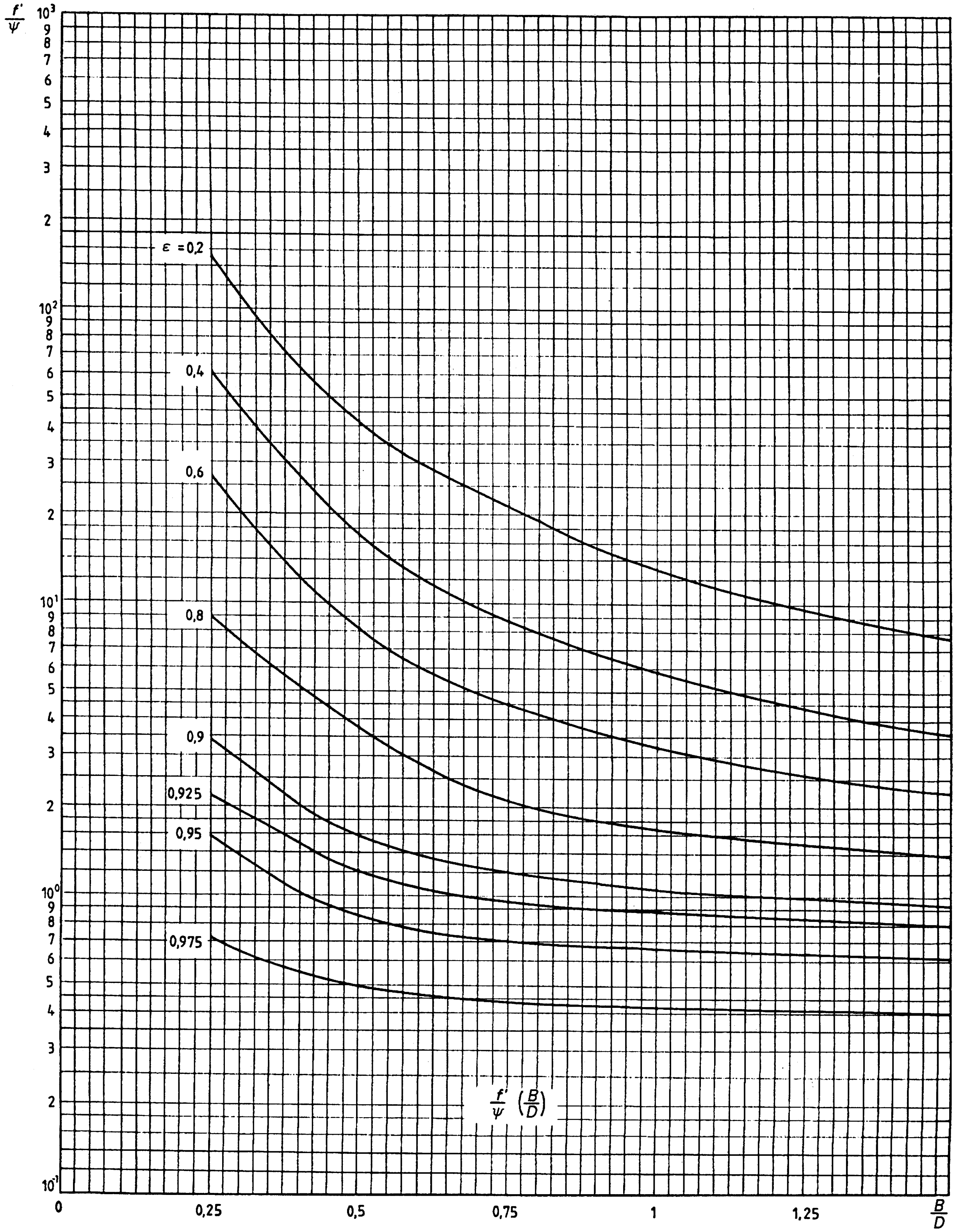

Figure 26 — Specific coefficient of friction f'/ψ as a function of relative bearing width B/D for $\Omega = 360°$

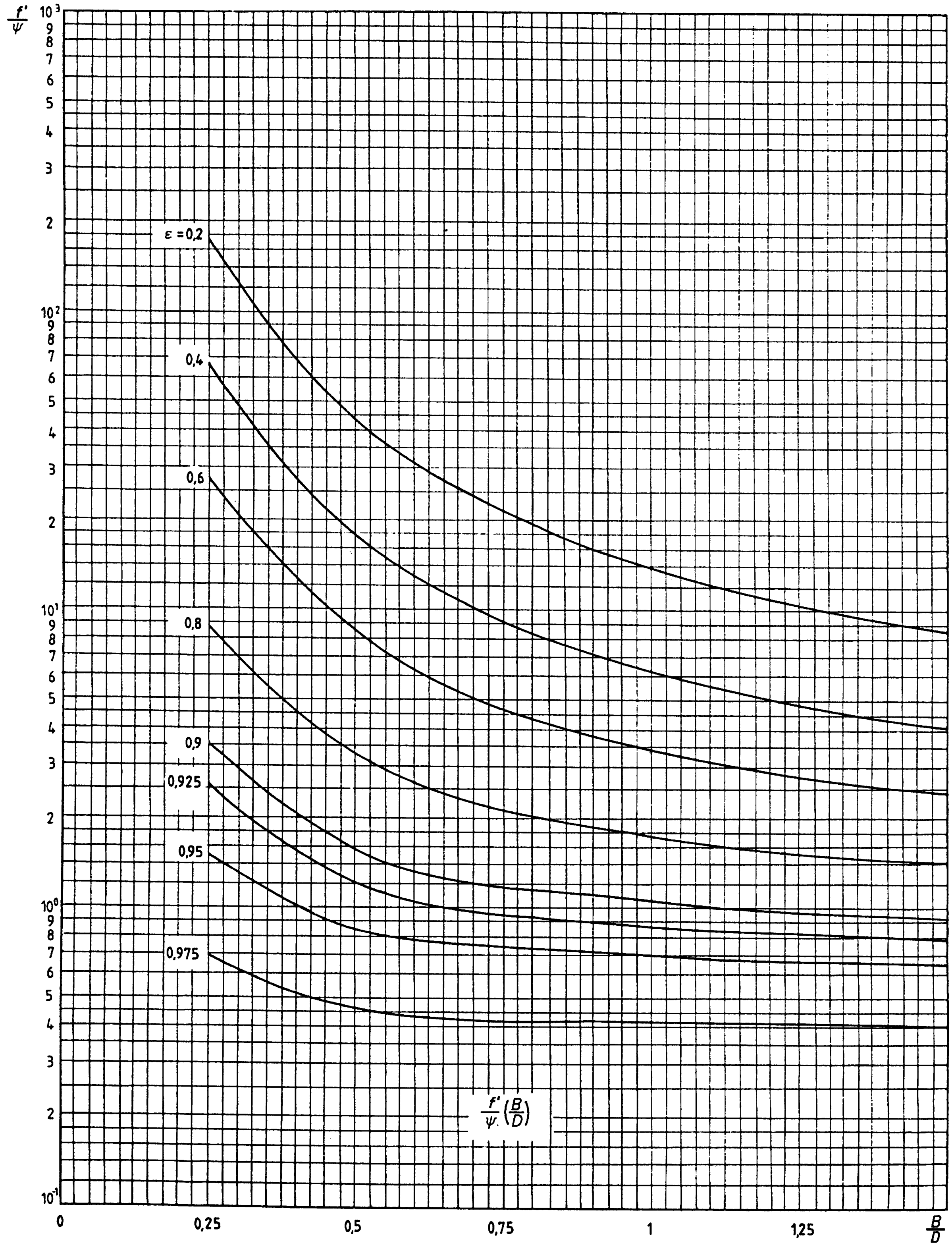

Figure 27 — Specific coefficient of friction f'/ψ as a function of relative bearing width B/D for $\Omega = 180°$

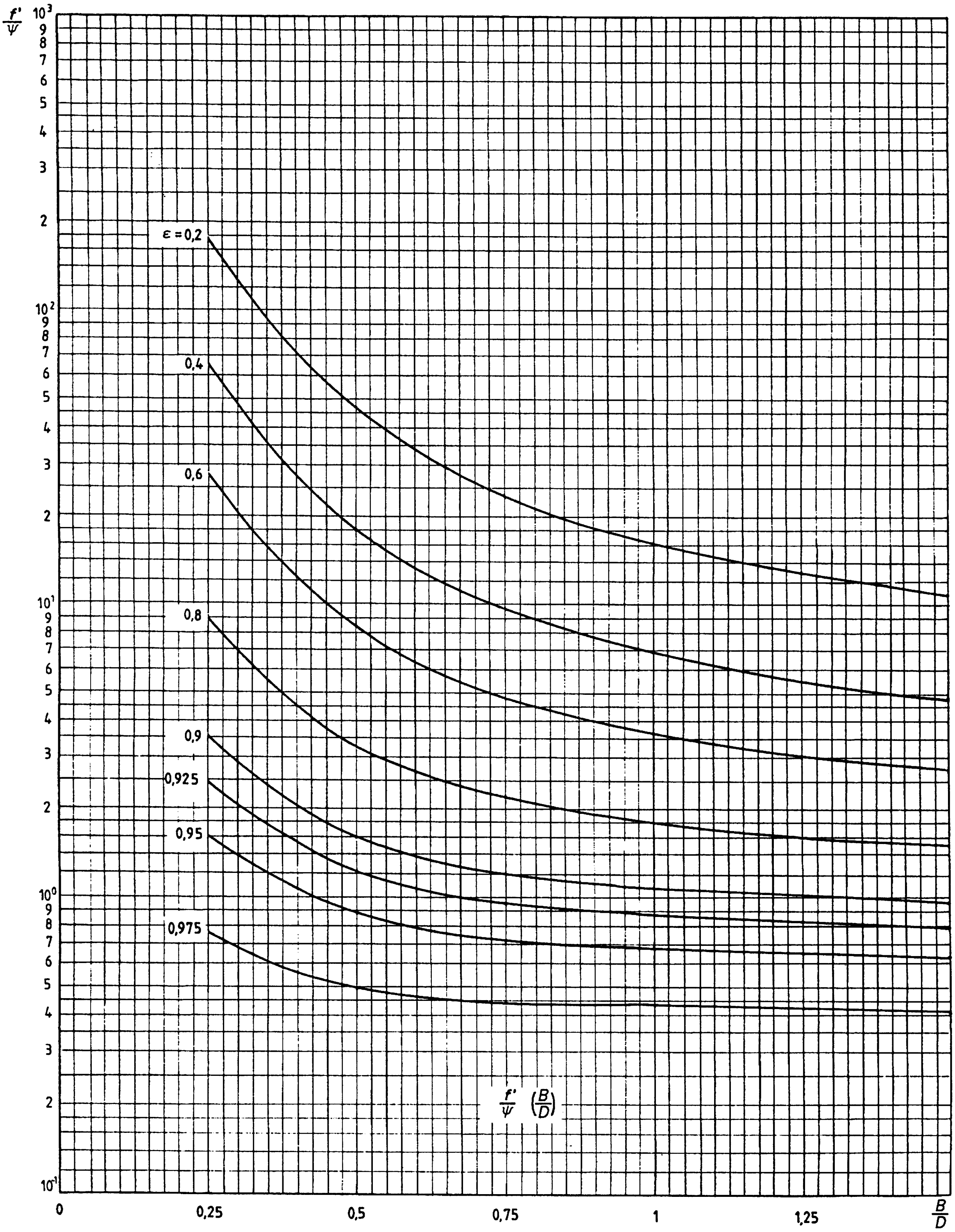

Figure 28 — Specific coefficient of friction f'/ψ as a function of relative bearing width B/D for $\Omega = 150°$

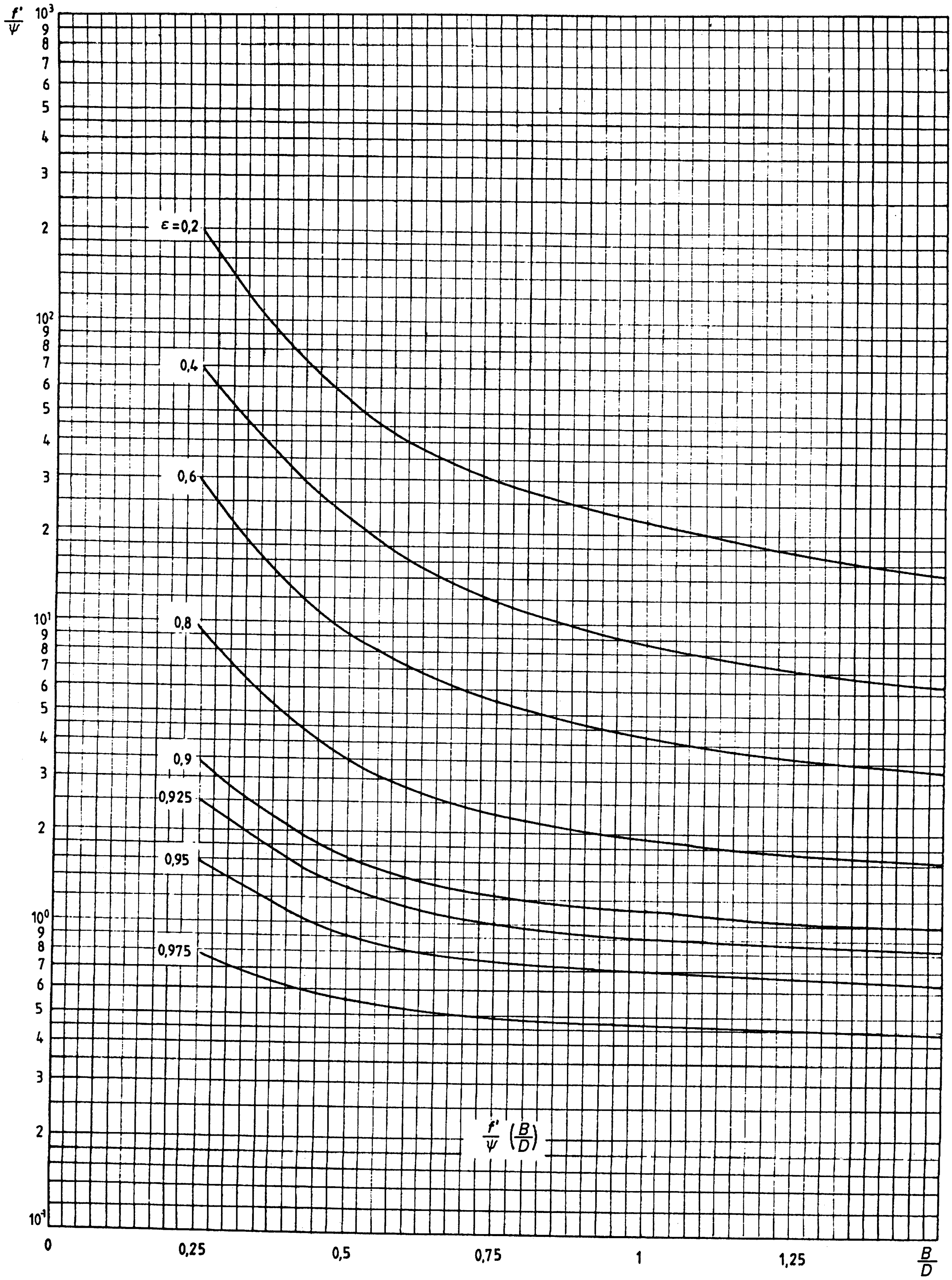

Figure 29 — Specific coefficient of friction f'/ψ as a function of relative bearing width B/D for $\Omega = 120°$

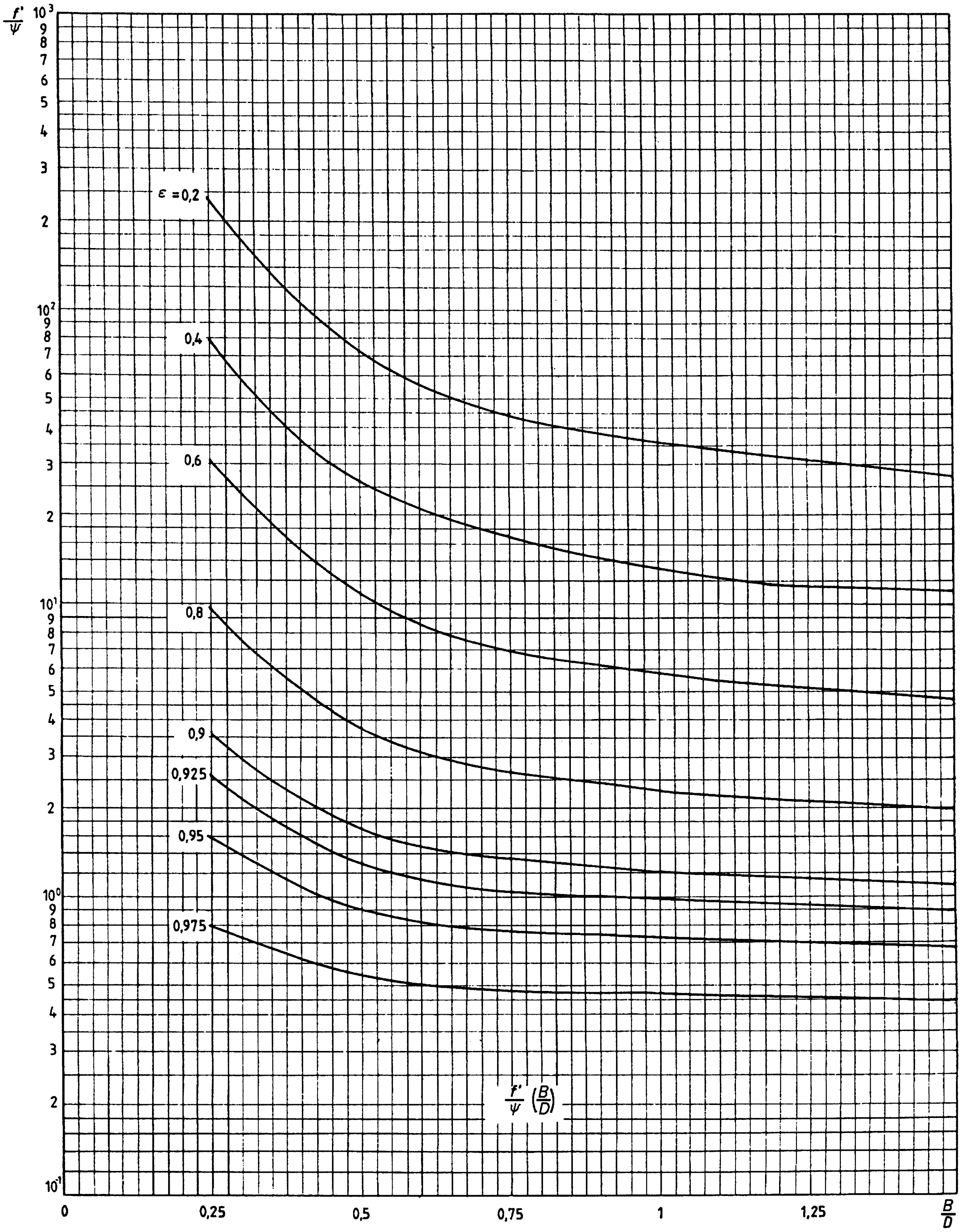

Figure 30 — Specific coefficient of friction f'/ψ as a function of relative bearing width B/D for $\Omega = 90°$

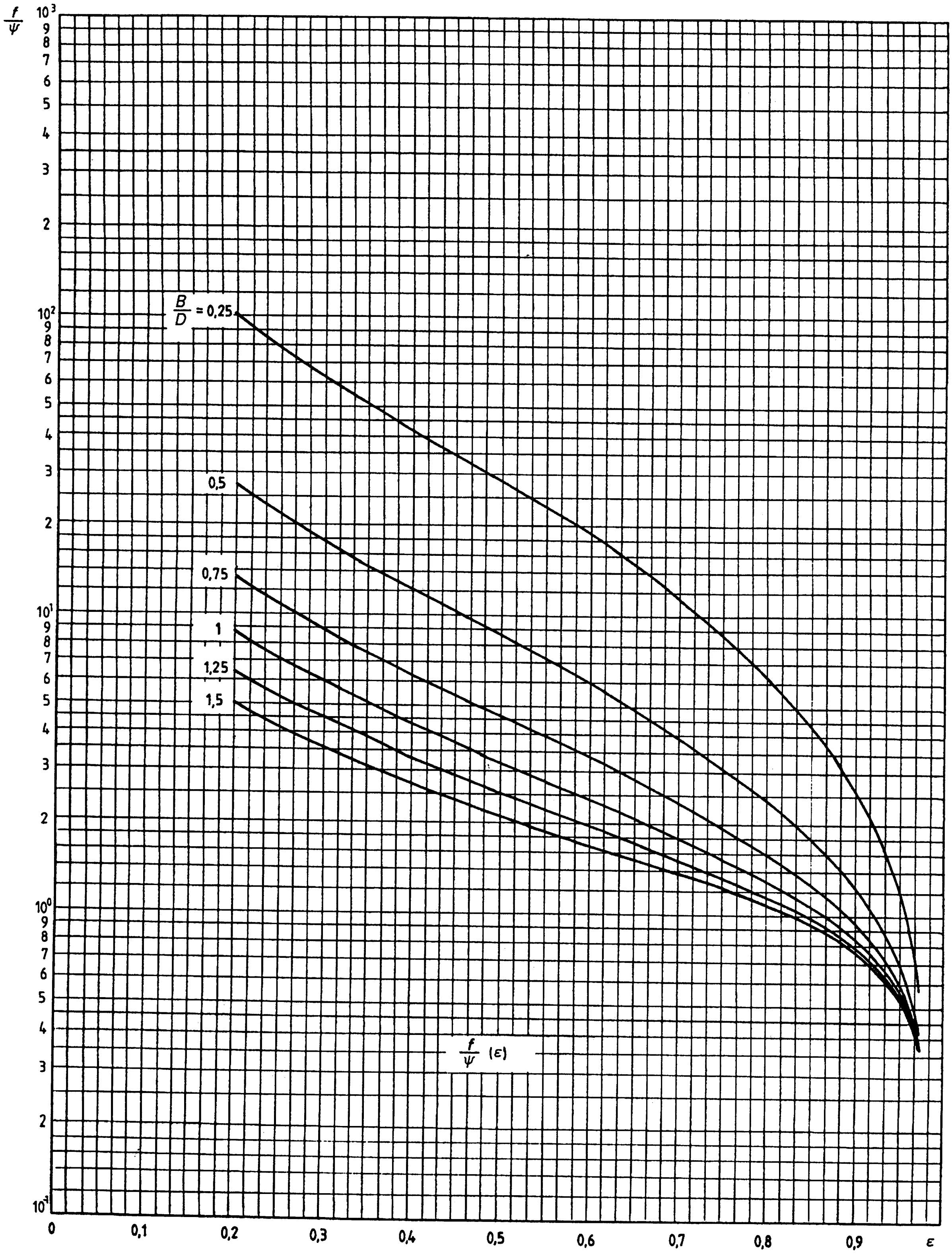

Figure 31 — Specific coefficient of friction f/ψ as a function of relative eccentricity ε for $\Omega = 360°$

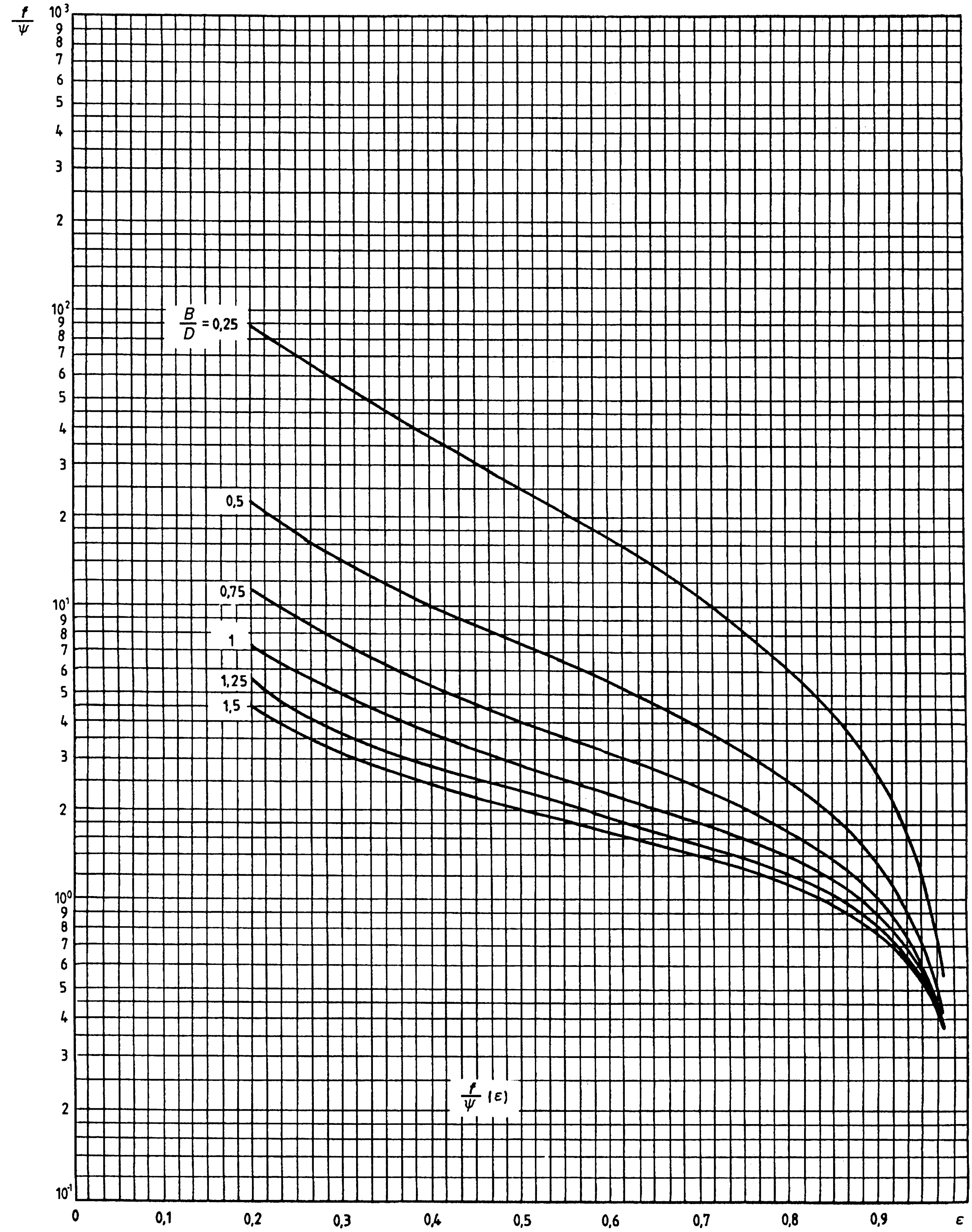

Figure 32 — Specific coefficient of friction f/ψ as a function of relative eccentricity ε for $\Omega = 180°$

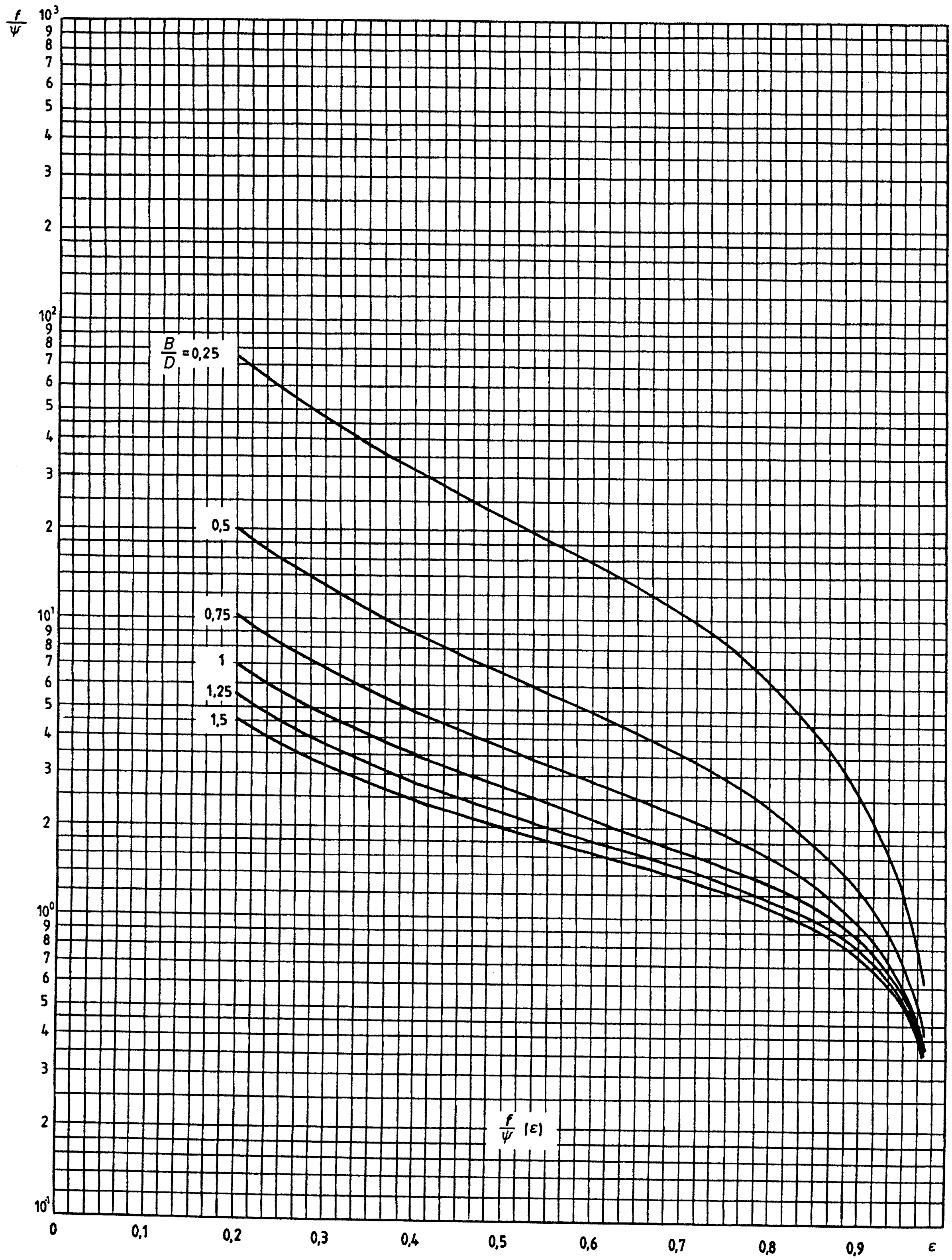

Figure 33 — Specific coefficient of friction f/ψ as a function of relative eccentricity ε for $\Omega = 150°$

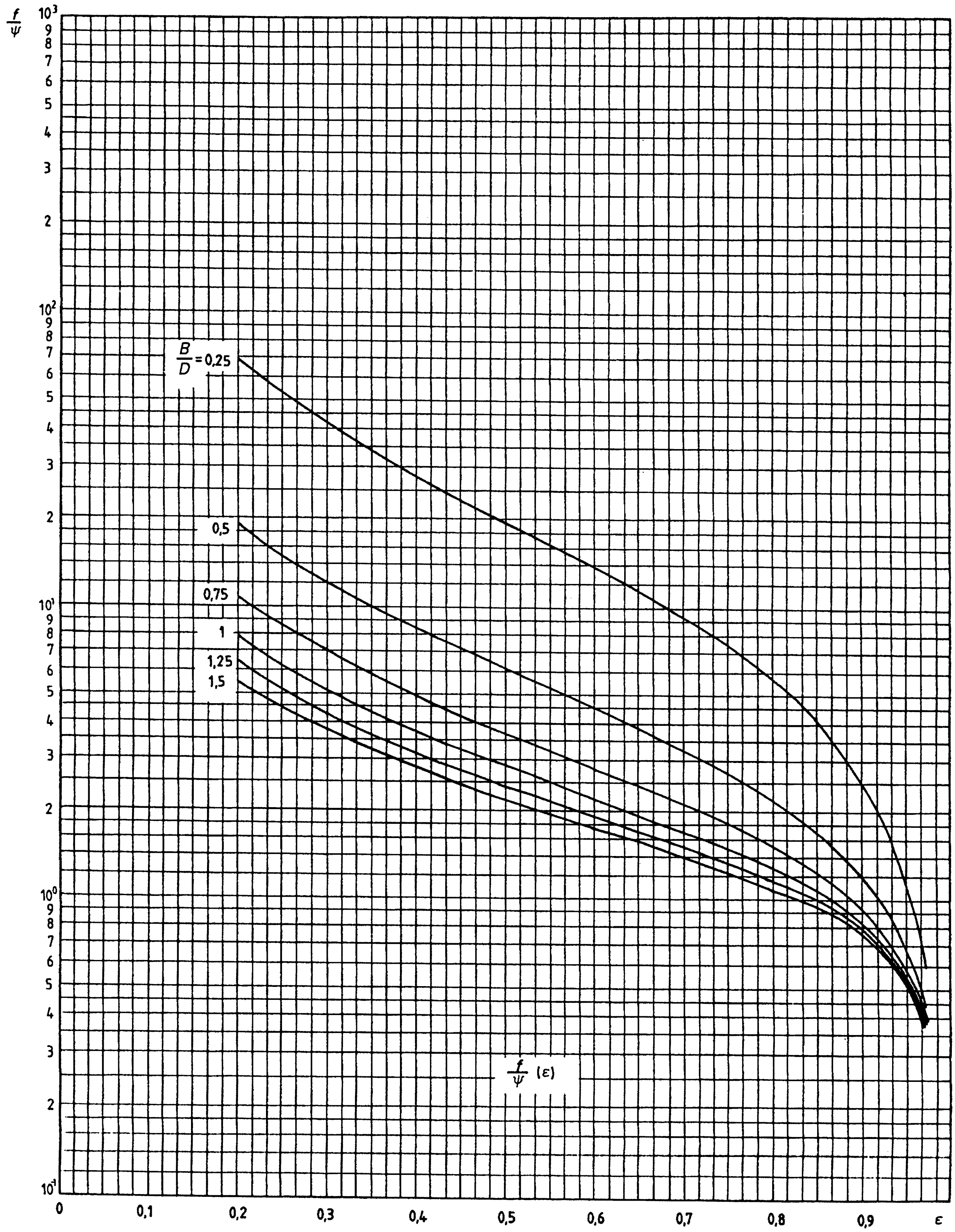

Figure 34 — Specific coefficient of friction f/ψ as a function of relative eccentricity ε for $\Omega = 120°$

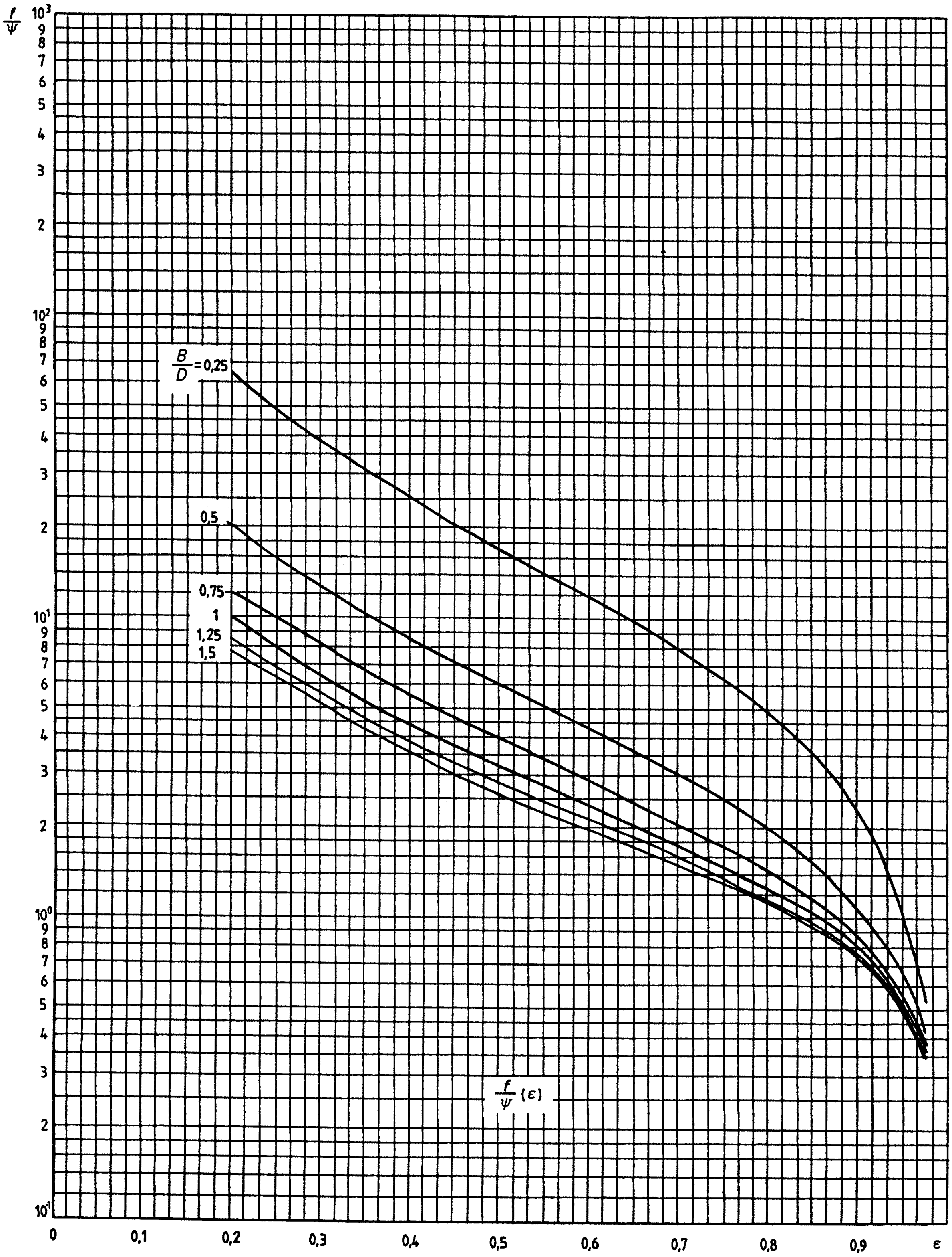

Figure 35 — Specific coefficient of friction f/ψ as a function of relative eccentricity ε for $\Omega = 90°$

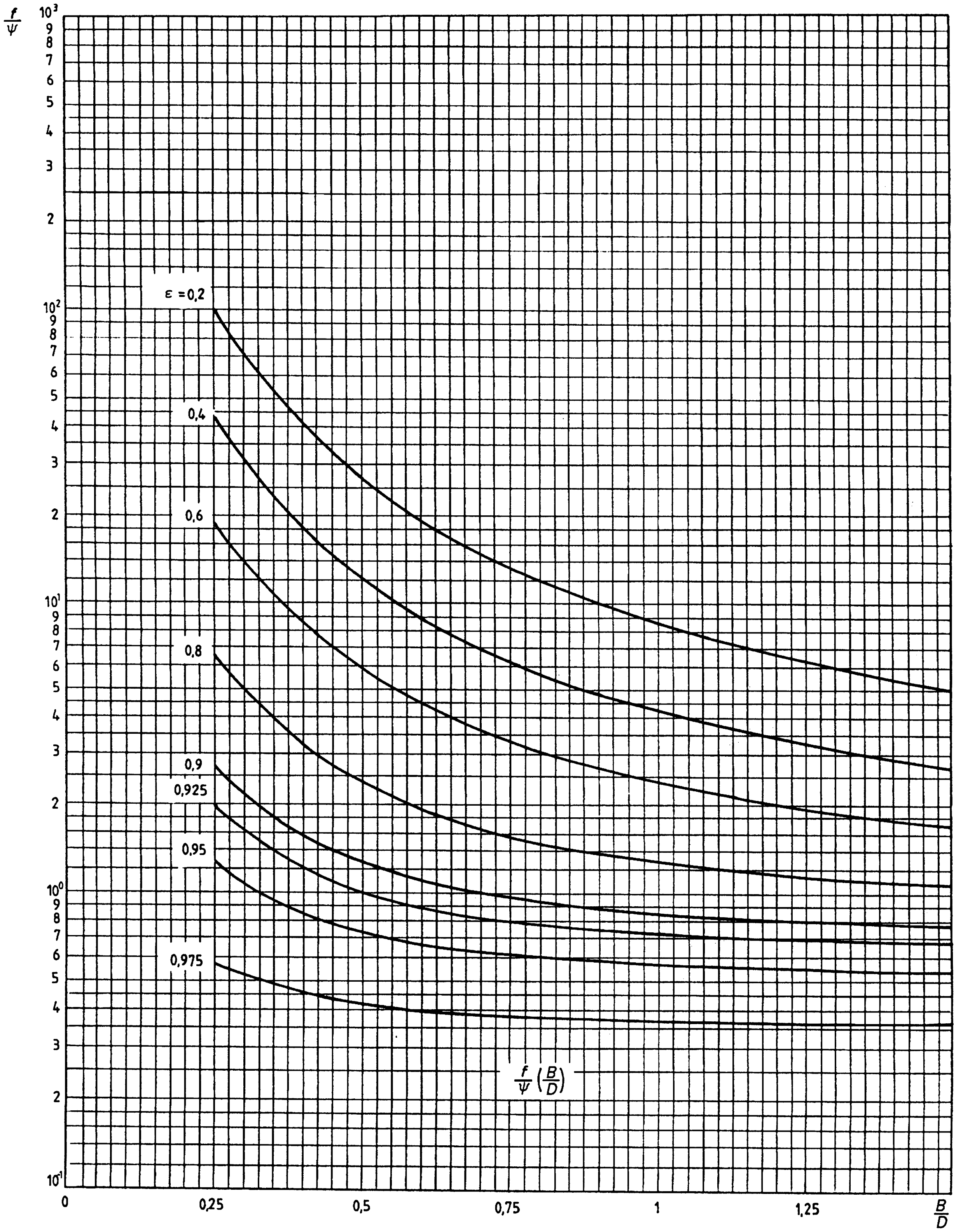

Figure 36 — Specific coefficient of friction f/ψ as a function of relative bearing width B/D for $\Omega = 360°$

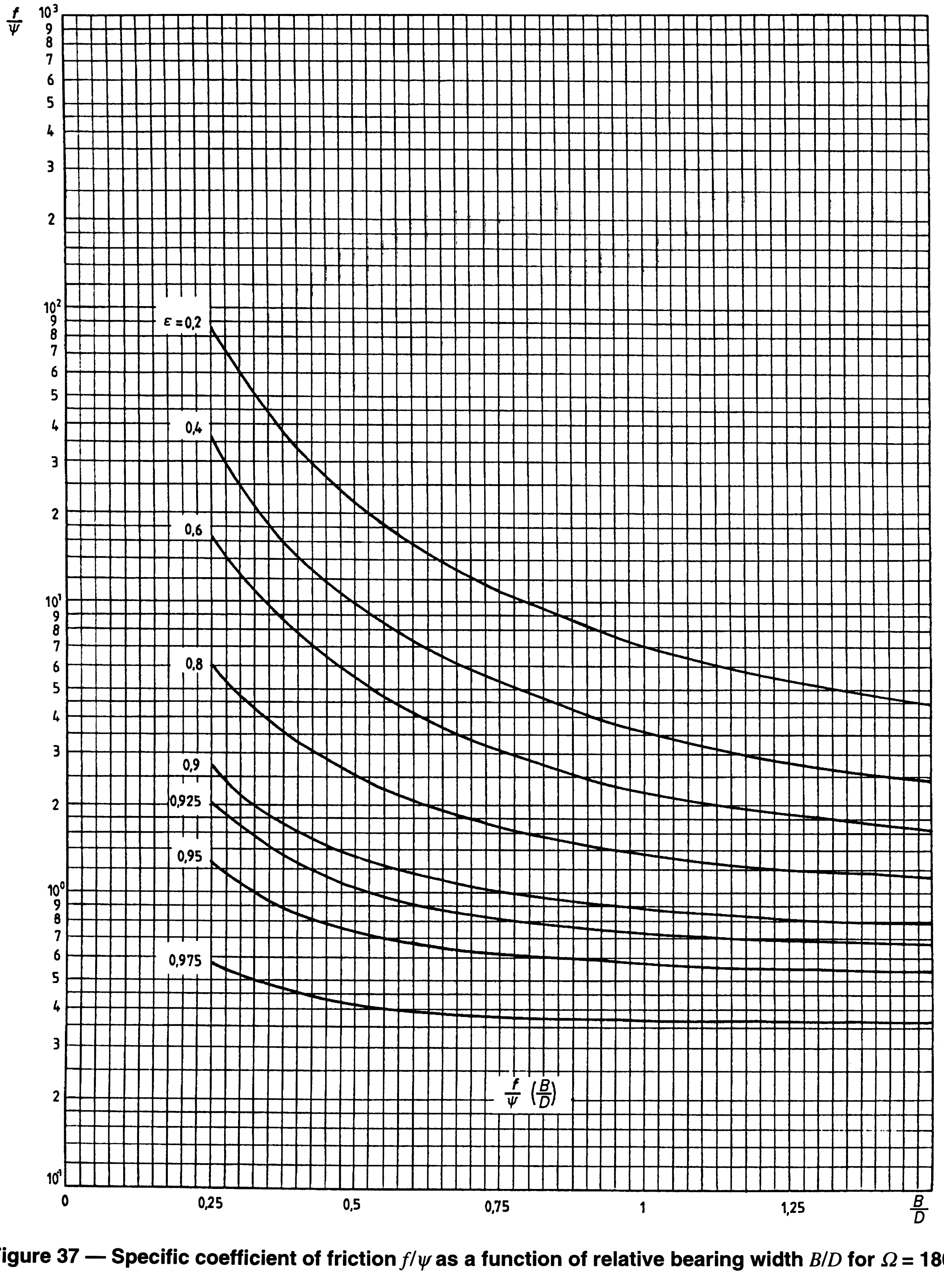

Figure 37 — Specific coefficient of friction f/ψ as a function of relative bearing width B/D for $\Omega = 180°$

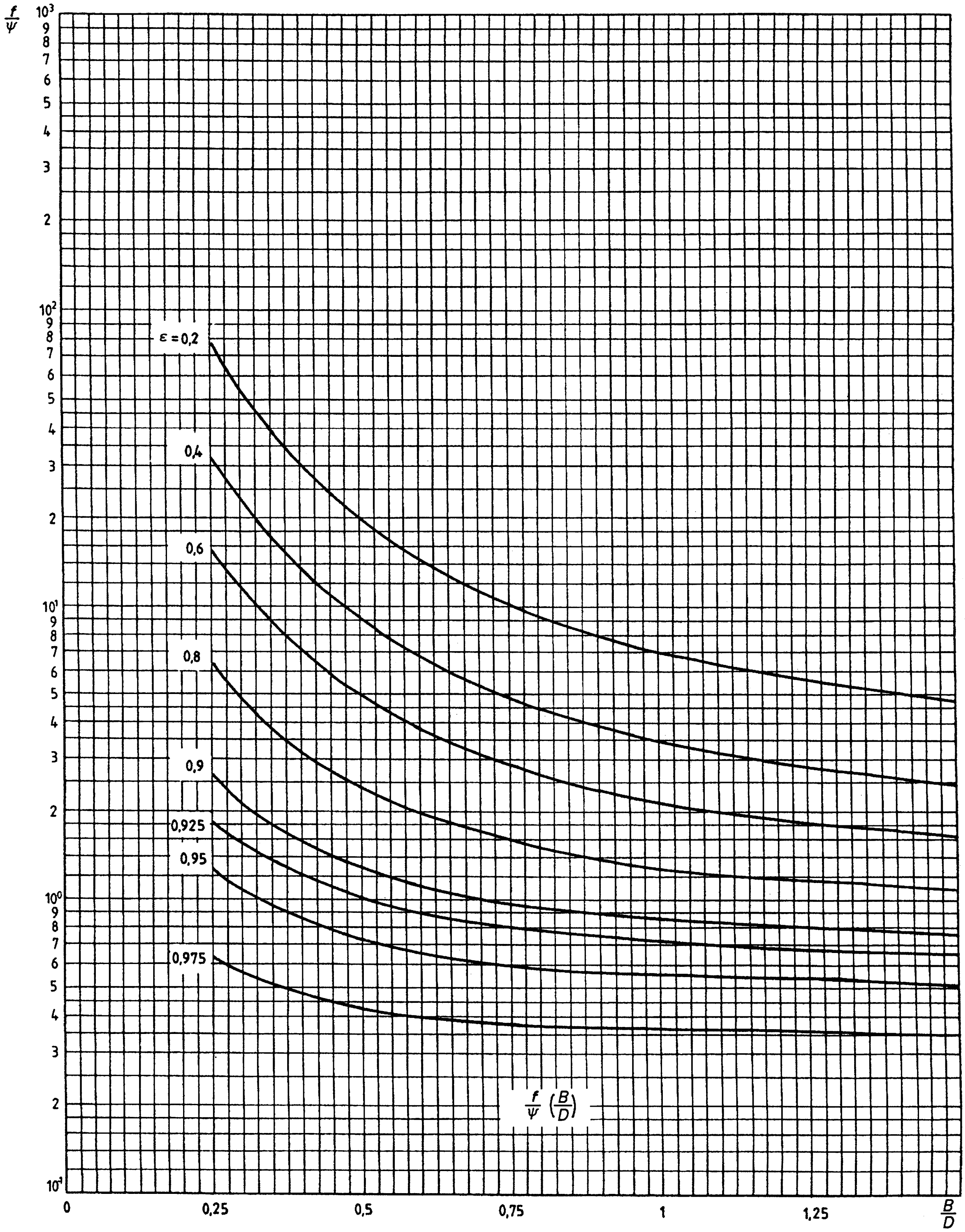

Figure 38 — Specific coefficient of friction f/ψ as a function of relative bearing width B/D for $\Omega = 150°$

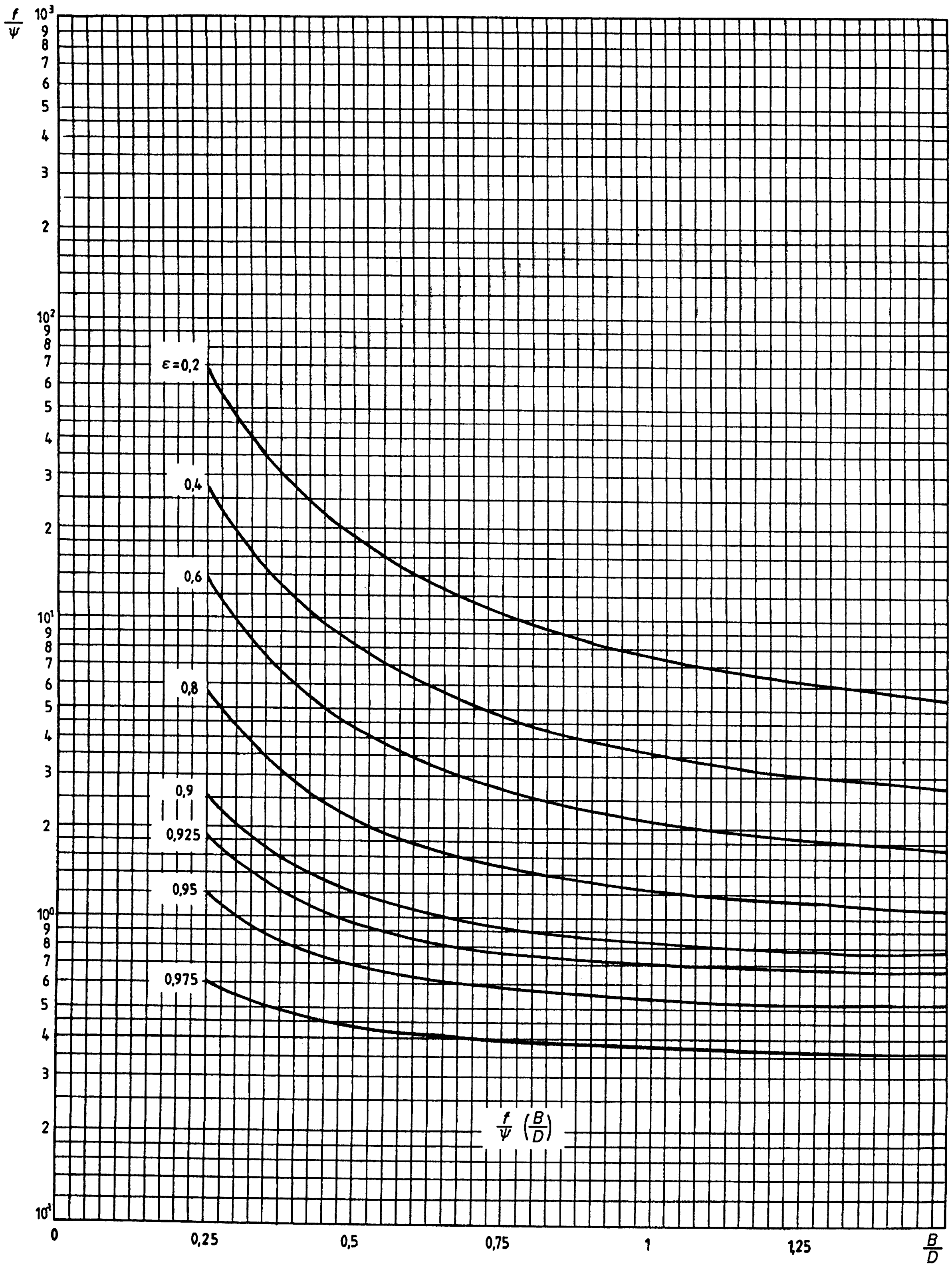

Figure 39 — Specific coefficient of friction f/ψ as a function of relative bearing width B/D for $\Omega = 120°$

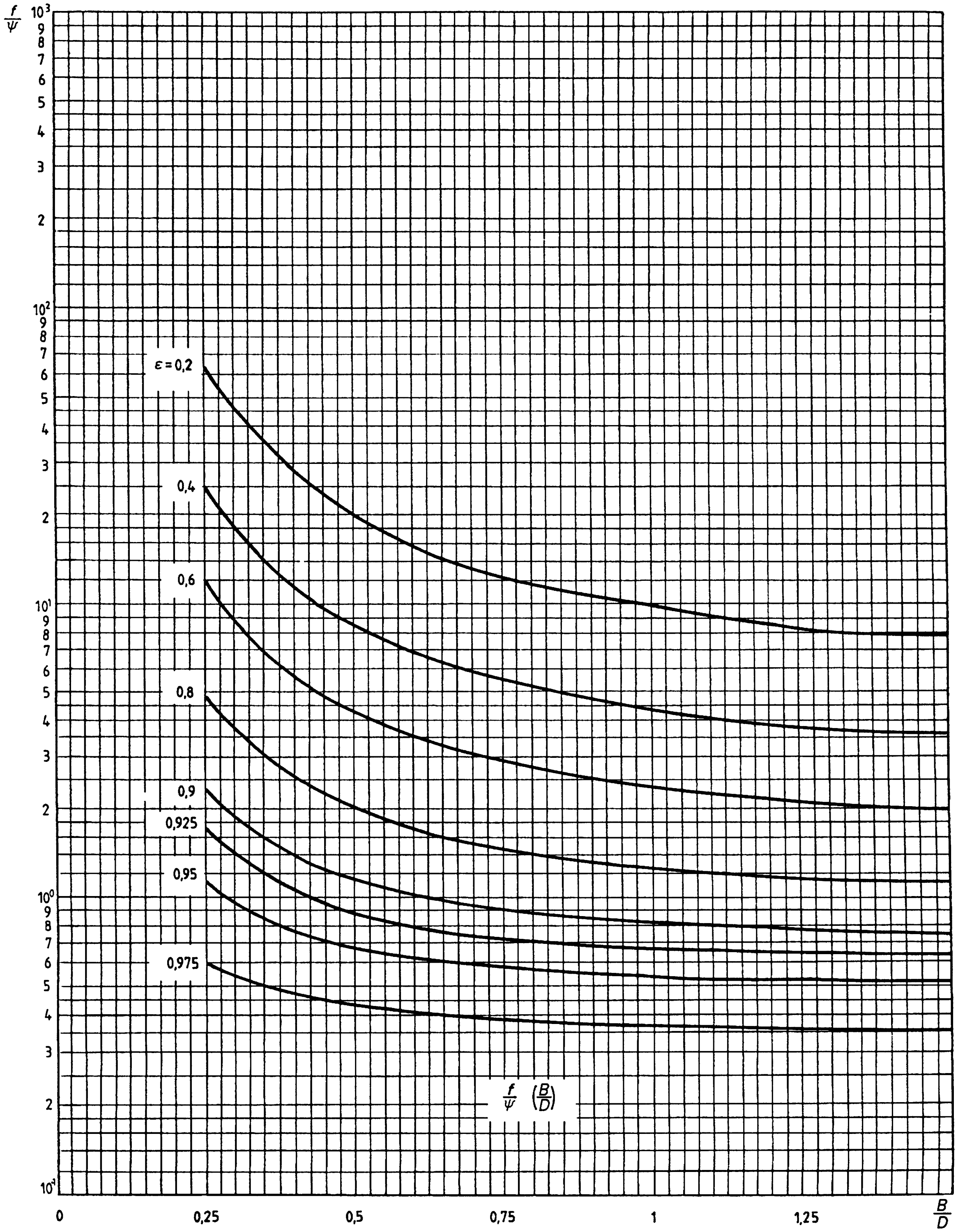

Figure 40 — Specific coefficient of friction f/ψ as a function of relative bearing width B/D for $\Omega = 90°$

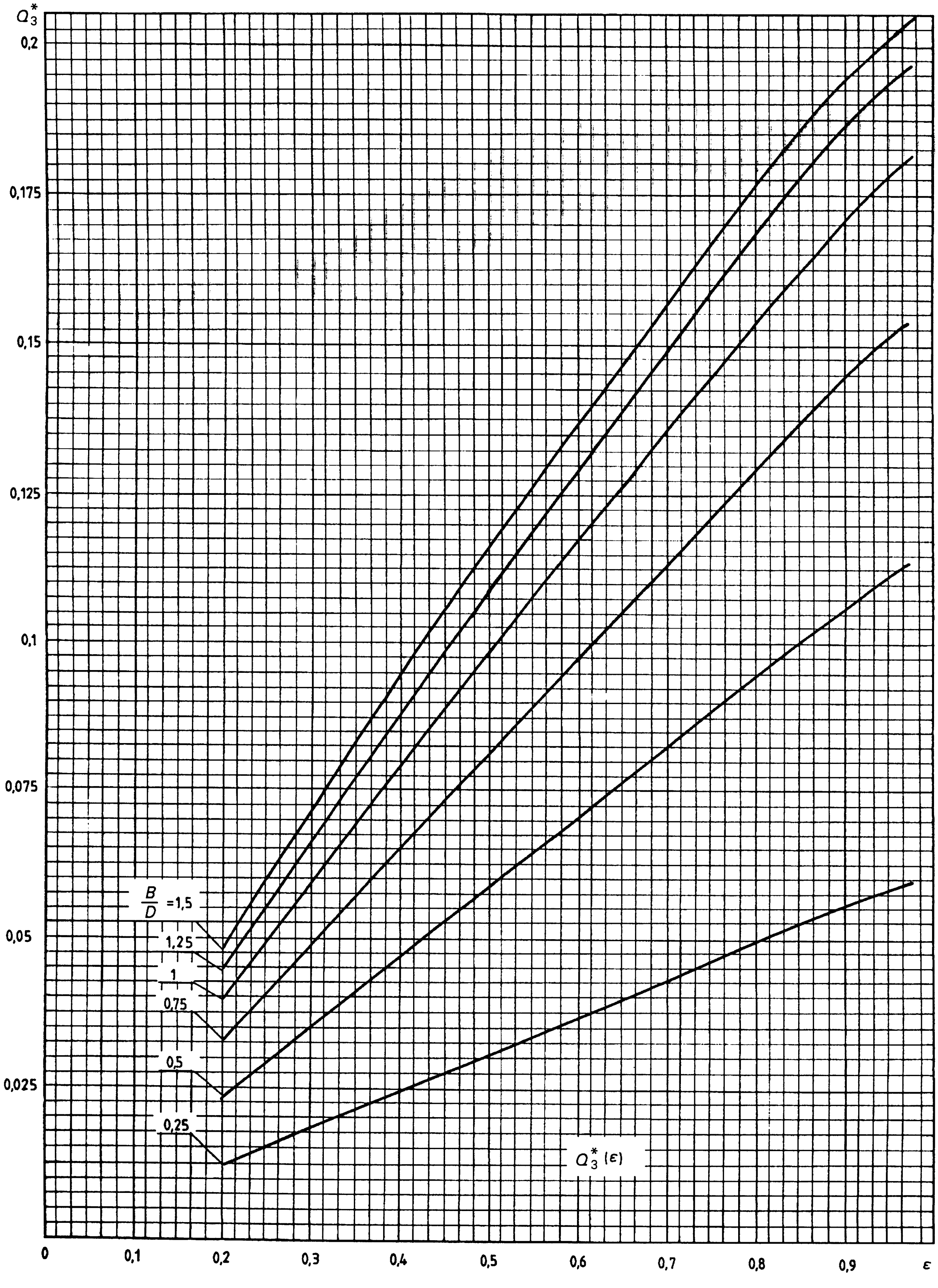

Figure 41 — Lubricant flow parameter Q_3^* as a function of relative eccentricity ε for $\Omega = 360°$

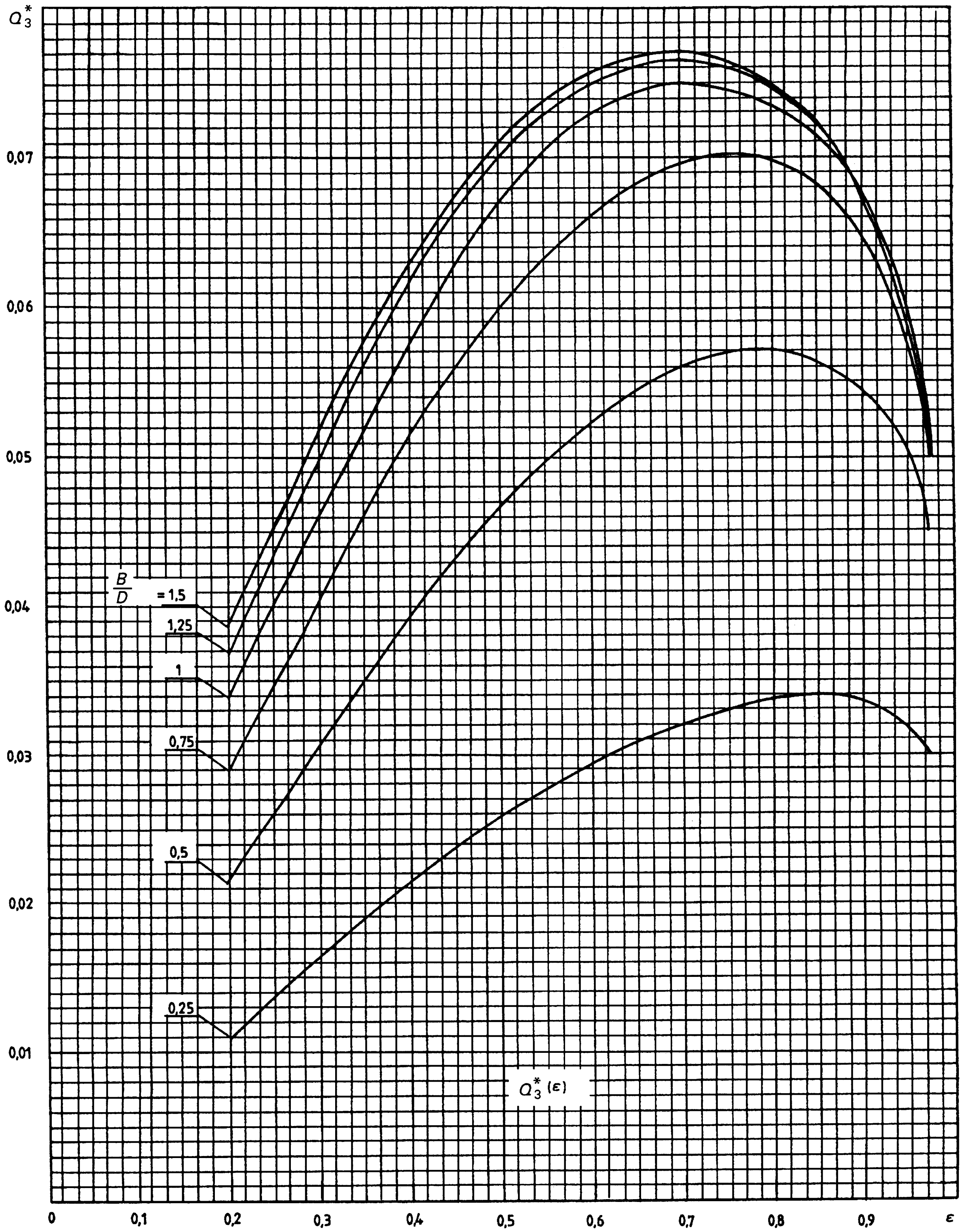

Figure 42 — Lubricant flow parameter Q_3^* as a function of relative eccentricity ε for $\Omega = 180°$

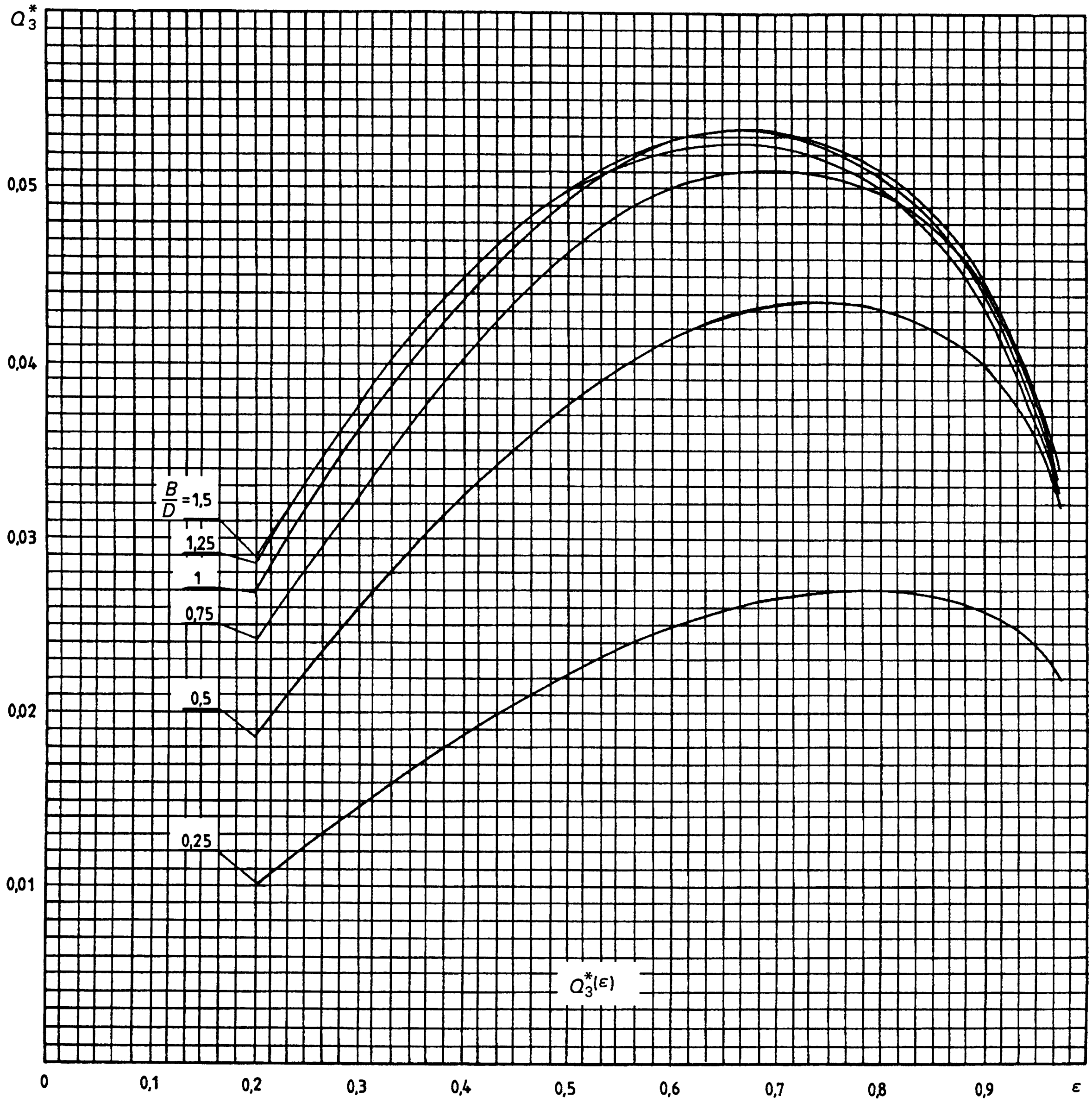

Figure 43 — Lubricant flow parameter Q_3^* as a function of relative eccentricity ε for Ω = 150°

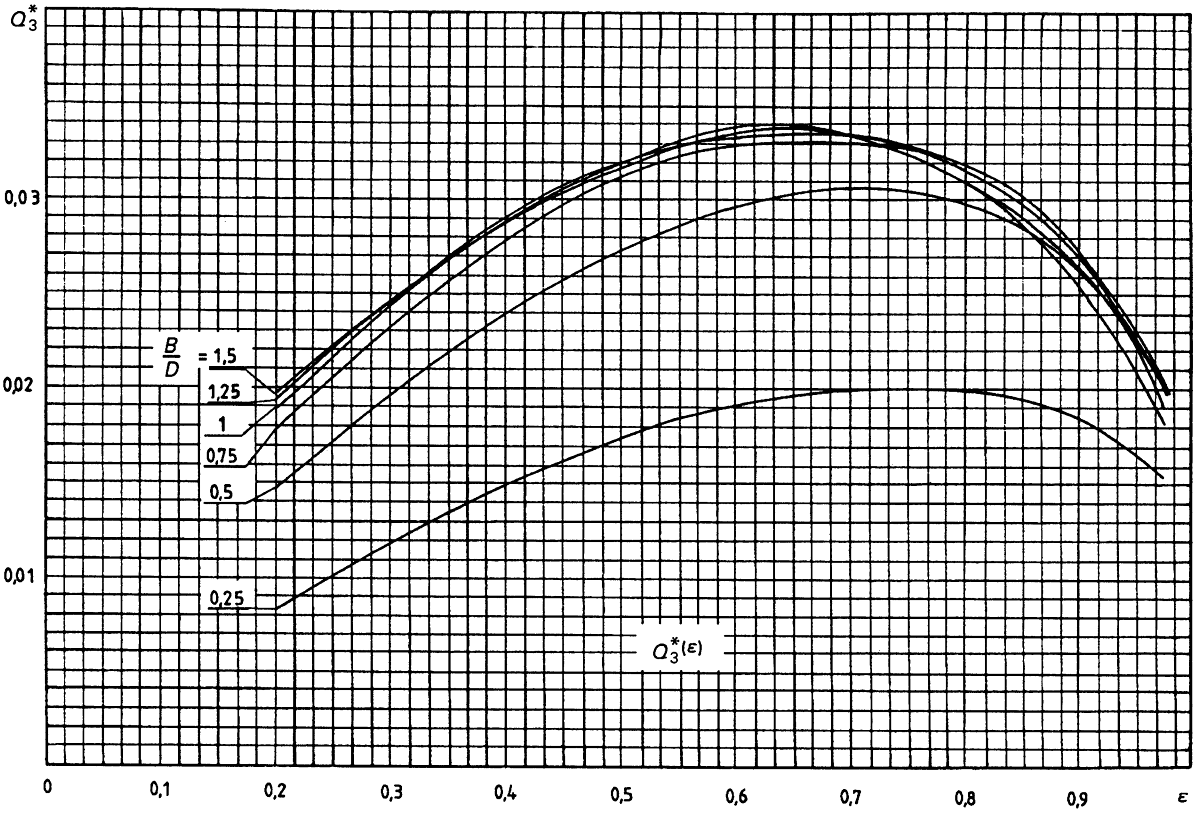

Figure 44 — Lubricant flow parameter Q_3^* as a function of relative eccentricity ε for Ω = 120°

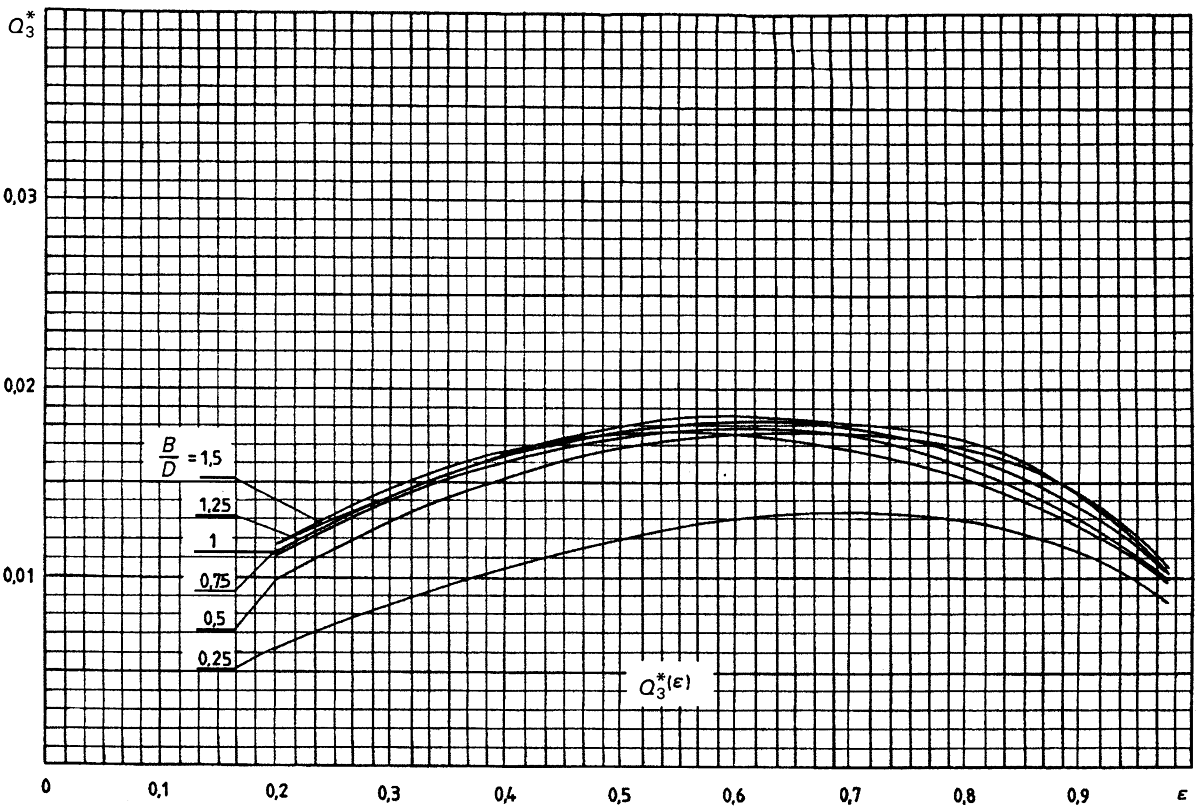

Figure 45 — Lubricant flow parameter Q_3^* as a function of relative eccentricity ε for Ω = 90°

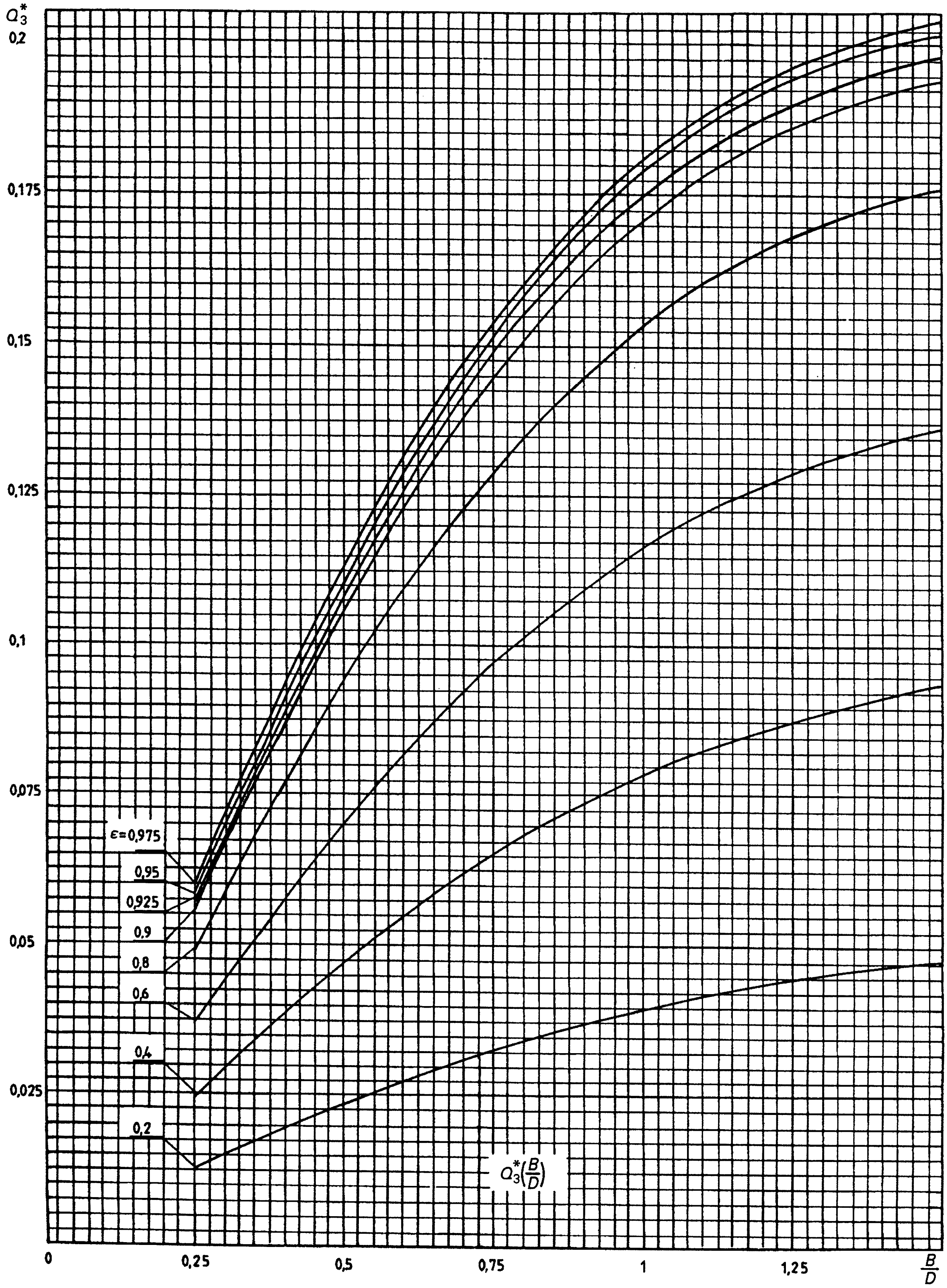

Figure 46 — Lubricant flow parameter Q_3^* as a function of relative bearing width B/D for $\Omega = 360°$

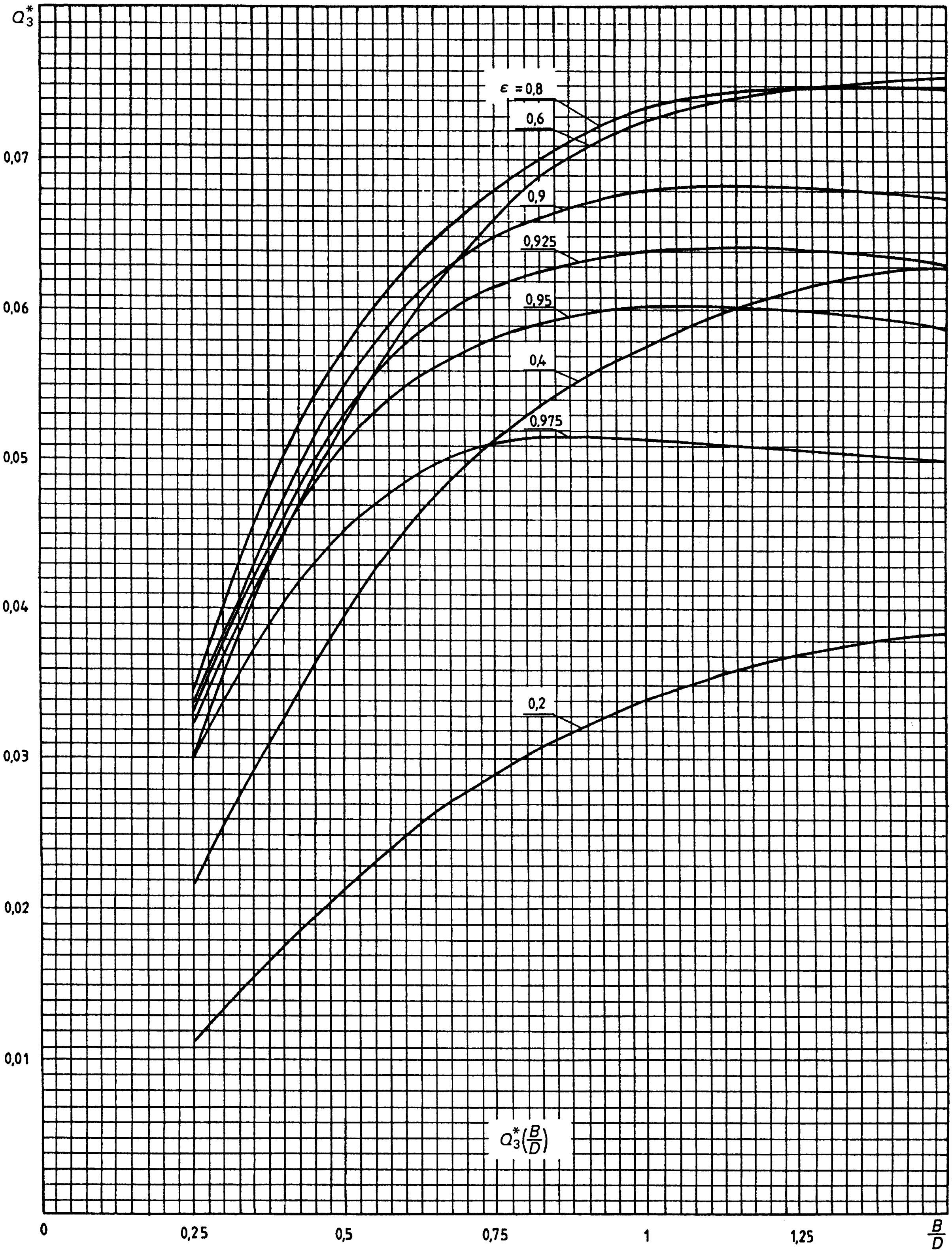

Figure 47 — Lubricant flow parameter Q_3^* as a function of relative bearing width B/D for Ω = 180°

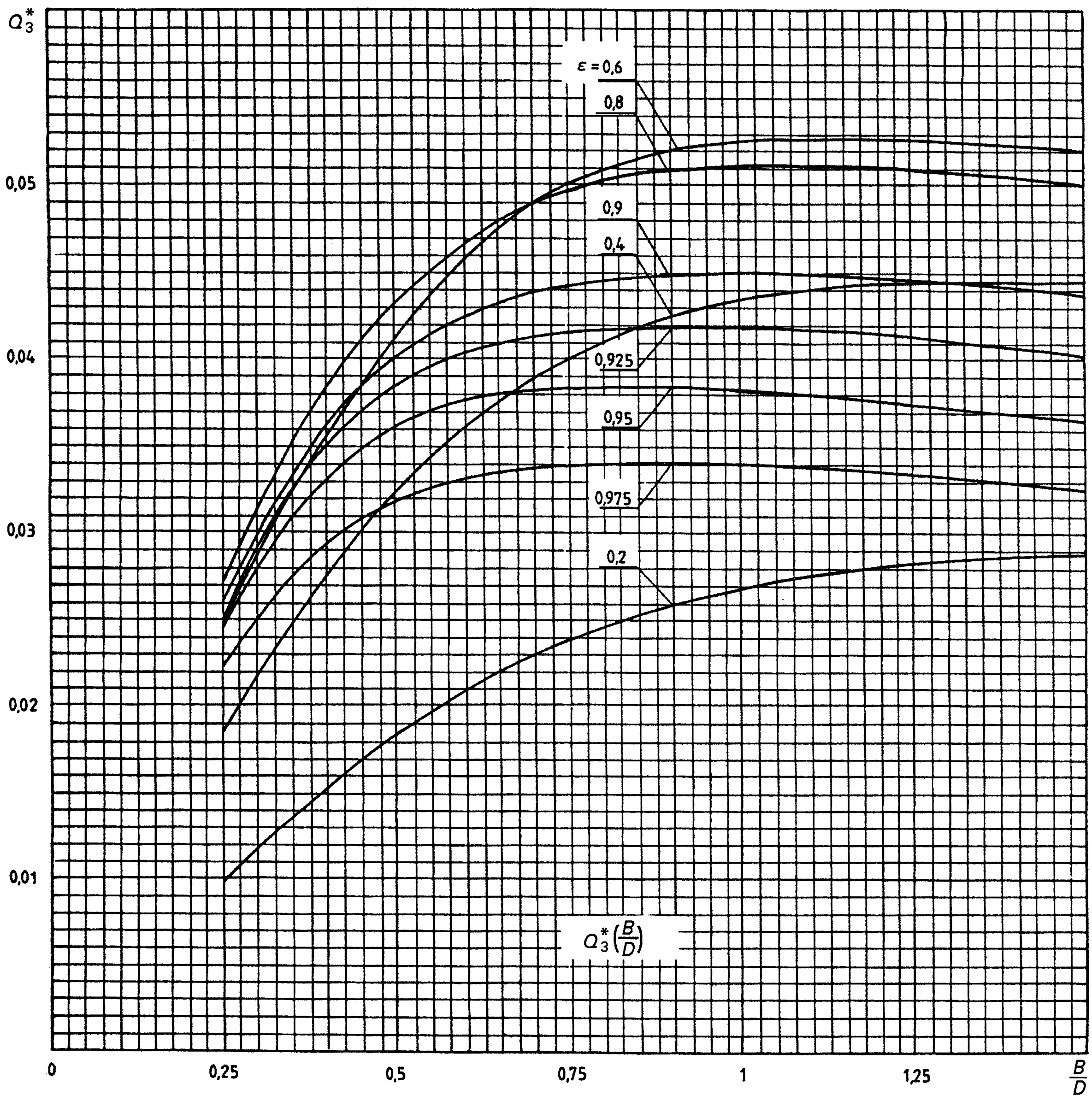

Figure 48 — Lubricant flow parameter Q_3^* as a function of relative bearing width B/D for $\Omega = 150°$

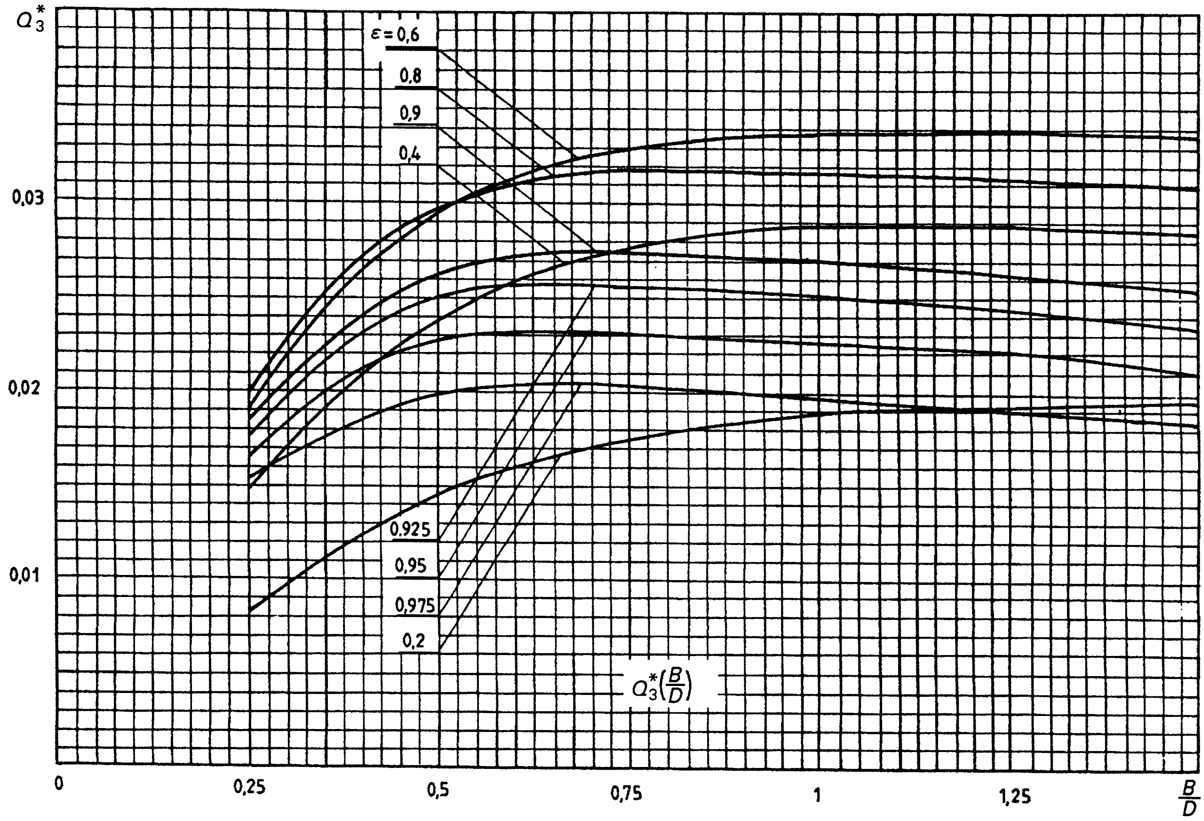

Figure 49 — Lubricant flow parameter Q_3^* as a function of relative bearing width B/D for Ω = 120°

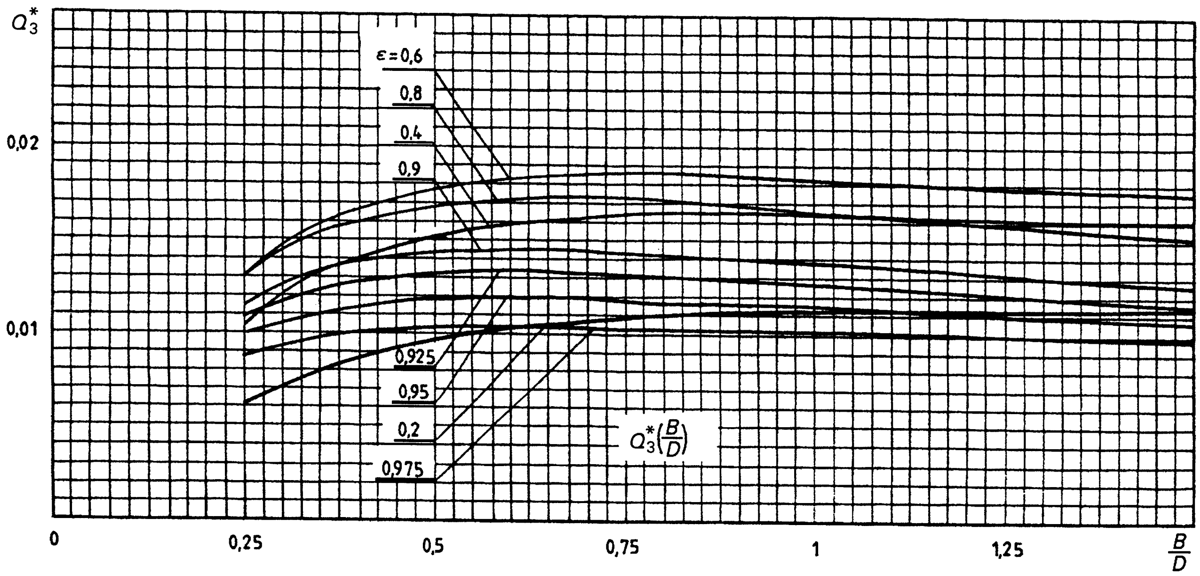

Figure 50 — Lubricant flow parameter Q_3^* as a function of relative bearing width B/D for Ω = 90°

5 Friction power loss in the lubricant film as a function of the design of the lubricant feed elements

5.1 If the lubricant fills only the loaded area of the bearing then the friction force F_f in the lubricant film is given by the following equation, independently of the design of the lubricant feed elements.

$$F_\mathrm{f} = \frac{\eta_\mathrm{eff}\,\omega_\mathrm{h}}{\psi_\mathrm{eff}} DB\xi = \frac{\eta_\mathrm{eff}\,\omega_\mathrm{h}}{\psi_\mathrm{eff}} DB \frac{f}{\psi_\mathrm{eff}} So \qquad \text{... (1)}$$

5.2 If the lubricant fills the whole of the lubricant clearance gap, i.e. both the loaded and unloaded areas, then with the lubricant fed through the lubricating holes and longitudinal (axial) grooves (with no lubricating pockets and circumferential grooves), the friction force in the lubricant film F_f' is given by

$$F_\mathrm{f}' = \frac{\eta_\mathrm{eff}\,\omega_\mathrm{h}}{\psi_\mathrm{eff}} DB\xi' = \frac{\eta_\mathrm{eff}\,\omega_\mathrm{h}}{\psi_\mathrm{eff}} DB \frac{f'}{\psi_\mathrm{eff}} So \qquad \text{... (2)}$$

5.3 If the lubricant fills the whole of the lubricant clearance gap and the design of the lubricant feed elements provides for lubricating holes and circumferential grooves (see ISO 7902-1:1998, figure A.3), then the friction force in the lubricant film F_f' is found from the formula given in [1]:

$$F_\mathrm{f}' = \frac{\eta_\mathrm{eff}\,\omega_\mathrm{h} BD}{\psi_\mathrm{eff}} \left[\frac{f'}{\psi_\mathrm{eff}} So - \frac{b_\mathrm{P}}{B} \left(\frac{\Omega_\mathrm{P}}{2\sqrt{1-\varepsilon^2}} - \frac{\psi_\mathrm{eff} D}{2h_\mathrm{P}} \xi_\mathrm{P} \right) - \frac{b_\mathrm{G}}{B} \left(\frac{\Omega_\mathrm{G}}{2\sqrt{1-\varepsilon^2}} - \frac{\psi_\mathrm{eff} D}{2h_\mathrm{G}} \xi_\mathrm{G} \right) \right] \qquad \text{... (3)}$$

Here, the friction power loss in the pocket and the grooves is taken correspondingly by the coefficients, ξ_P and ξ_G:

$$\xi_\mathrm{P} = 0{,}5\,\Omega_\mathrm{P} \left(4 + 0{,}001\,2\,Re_\mathrm{P}^{0{,}94}\right)$$

$$\xi_\mathrm{G} = 0{,}5\,\Omega_\mathrm{G} \left(4 + 0{,}001\,2\,Re_\mathrm{G}^{0{,}94}\right)$$

where Re_P and Re_G are the Reynolds numbers of the lubricant flow in the pocket and the grooves respectively:

$$Re_\mathrm{P} = \frac{\rho\omega_\mathrm{h} h_\mathrm{P} D}{2\eta_\mathrm{eff}}$$

$$Re_\mathrm{G} = \frac{\rho\omega_\mathrm{h} h_\mathrm{G} D}{2\eta_\mathrm{eff}}$$

Frictional power losses in the bearing are given by equations (6) and (7) in ISO 7902-1:1998.

6 Lubricant flow rate resulting from feed pressure

The lubricant flow rate resulting from feed pressure is given by equation (9) in ISO 7902-1:1998.

$$Q_p = \frac{D^3 \psi_\mathrm{eff}^3 p_\mathrm{en}}{\eta_\mathrm{eff}} Q_p^*$$

where Q_p^* is given by equations (4) to (8).

For the sake of simplification, the attitude angle β has only been taken into account approximately.

6.1 Lubricant feed through the lubrication hole located opposite to direction of load

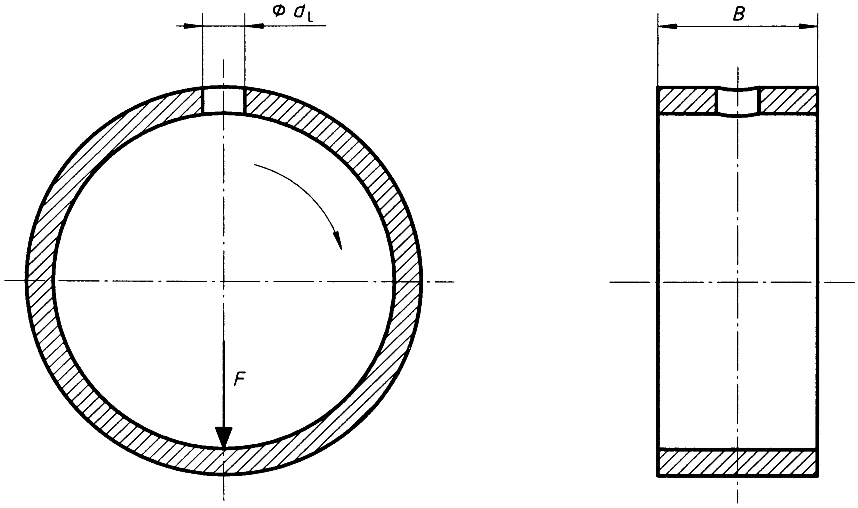

Figure 51

$$Q_p^* = \frac{\pi}{48} \frac{(1+\varepsilon)^3}{\ln\left(\frac{B}{d_L}\right) q_L} \qquad \text{. . . (4)}$$

where $q_L = 1{,}204 + 0{,}368(d_L/B) - 1{,}046(d_L/B)^2 + 1{,}942(d_L/B)^3$

6.2 Lubrication feed through the lubrication hole located at 90° to direction of load

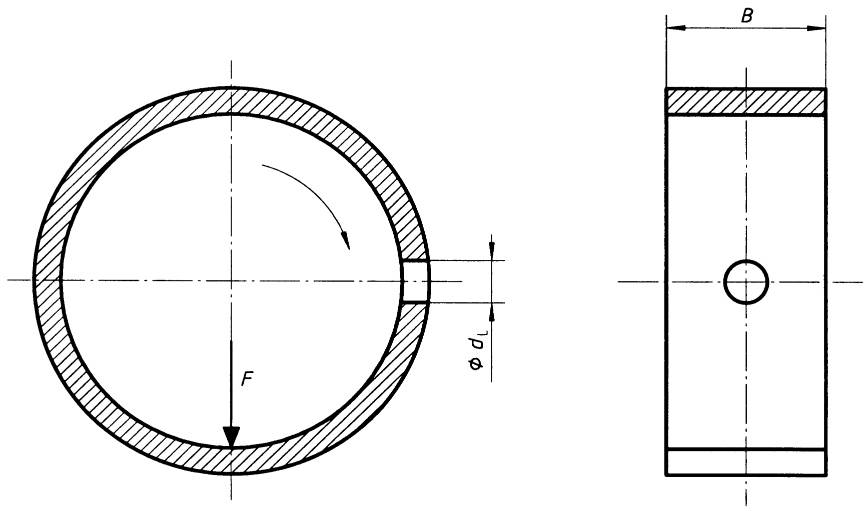

Figure 52

$$Q_p^* = \frac{\pi}{48} \frac{1}{\ln\left(\frac{B}{d_L}\right) q_L} \qquad \text{. . . (5)}$$

where q_L is as given in equation (4).

6.3 Lubrication feed through two lubrication holes located at 90° to direction of load

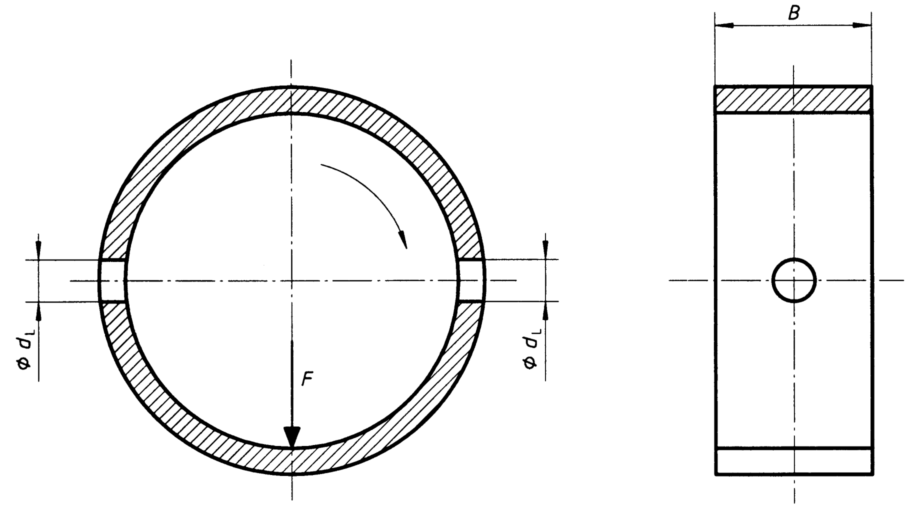

Figure 53

$$Q_p^* = \frac{\pi}{48} \frac{2}{\ln\left(\frac{B}{d_L}\right) q_L} \quad \ldots (6)$$

where q_L is as given in equation (4).

6.4 Lubrication feed through circumferential groove (full groove)

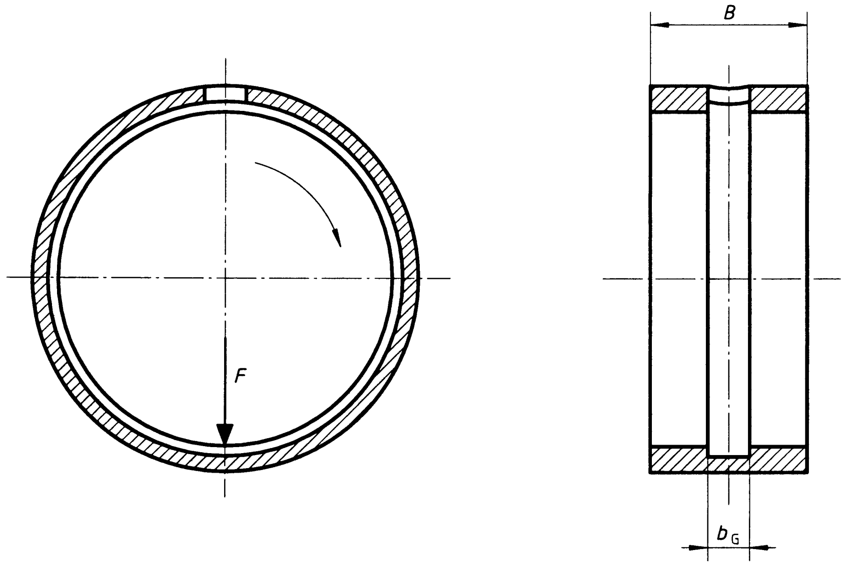

Figure 54

$$Q_p^* = \frac{\pi}{24} \frac{1 + 1{,}5\varepsilon^2}{\left(\frac{B}{D}\right)} \frac{B}{B - b_G} \quad \ldots (7)$$

6.5 Lubricant feed through circumferential groove (partial groove)

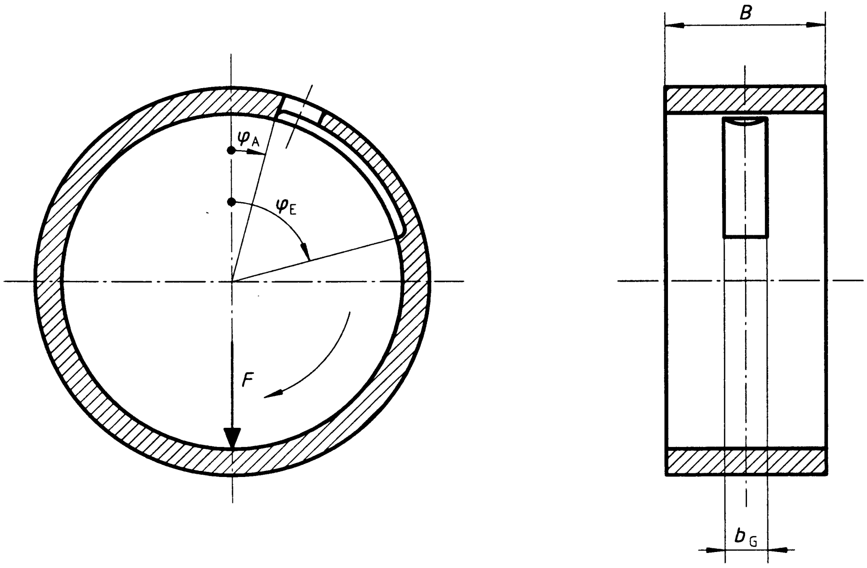

Figure 55

$$Q_p^* = \frac{1}{48} \frac{\left(\overset{\frown}{\varphi}_E - \overset{\frown}{\varphi}_A\right)\left(1 + 1{,}5\varepsilon^2\right) + \left(3\varepsilon + \varepsilon^3\right)\left(\sin\varphi_E - \sin\varphi_A\right) + 0{,}75\varepsilon^2\left(\sin^2\varphi_E - \sin^2\varphi_A\right) - \frac{\varepsilon^3}{3}\left(\sin^3\varphi_E - \sin^3\varphi A\right)}{\frac{B - b_G}{D}}$$

. . . (8)

For $\overset{\frown}{\varphi}_E = 90°$ and $\overset{\frown}{\varphi}_A = -\,90°$ (180° groove) equation (8) reduces to

$$Q_p^* = \frac{1}{48} \frac{\pi\left(1 + 1{,}5\varepsilon^2\right) + 6\varepsilon + 1{,}33\varepsilon^3}{\frac{B - b_G}{D}}$$

6.6 Lubricant feed through lubrication pocket, located opposite to direction of load

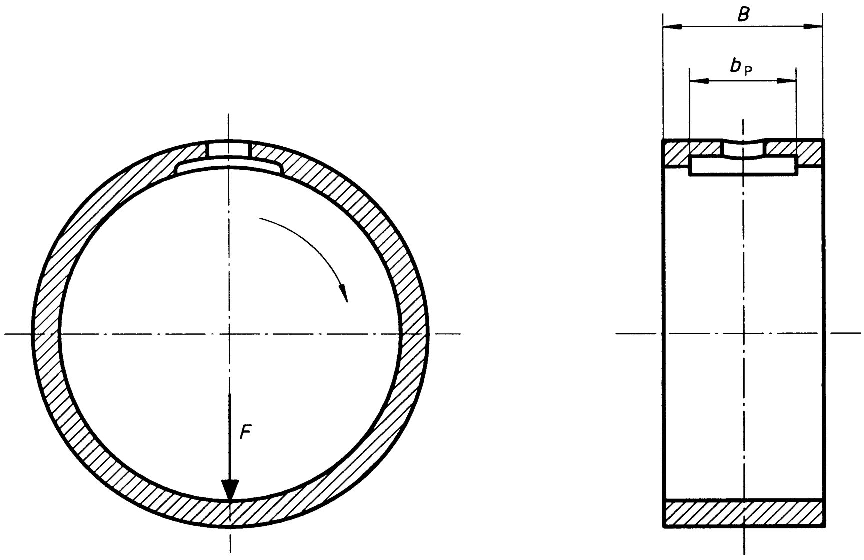

Figure 56

$$Q_p^* = \frac{\pi}{48} \frac{(1+\varepsilon)^3}{\ln\left(\frac{B}{b_P}\right) q_P} \qquad \text{. . . (9)}$$

where $q_P = 1{,}188 + 1{,}582\left(\frac{b_P}{B}\right) - 2{,}585\left(\frac{b_P}{B}\right)^2 + 5{,}563\left(\frac{b_P}{B}\right)^3$

valid for $0{,}05 \leqslant \left(\frac{b_P}{B}\right) \leqslant 0{,}7$

6.7 Lubricant feed through lubrication pocket located at 90° to direction of application load

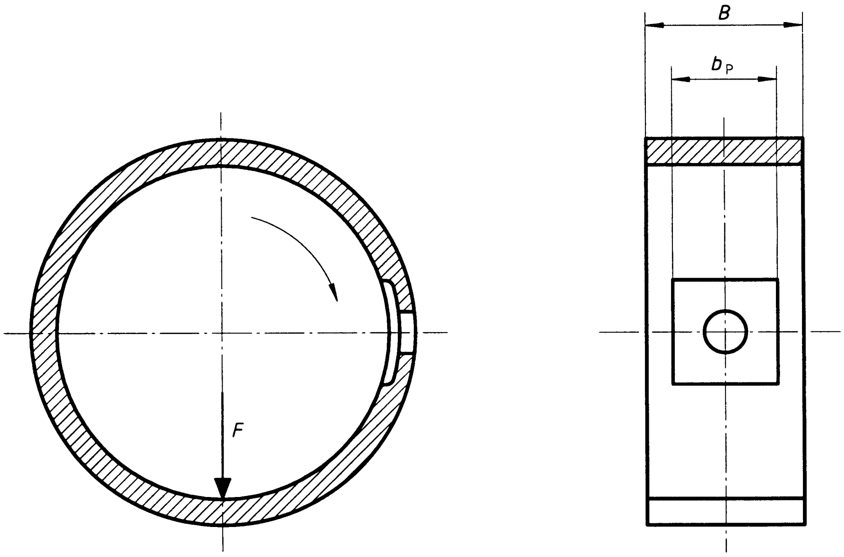

Figure 57

$$Q_p^* = \frac{\pi}{48} \frac{1}{\ln\left(\frac{B}{b_P}\right) q_P} \qquad \text{. . . (10)}$$

where q_P is as given in equation (9).

6.8 Lubricant feed through two lubrication pockets at ± 90° to direction of load

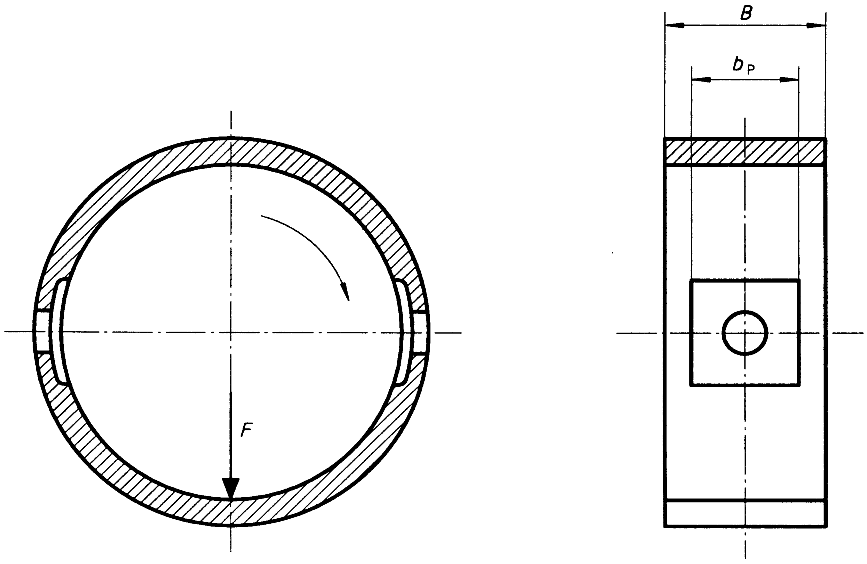

Figure 58

$$Q_p^* = \frac{\pi}{48} \frac{2}{\ln\left(\frac{B}{b_P}\right)} q_P \qquad \ldots (11)$$

where q_P is as given in equation (9).

7 Effective dynamic viscosity η_{eff} of the lubricant as a function of effective bearing temperature T_{eff}

If the relationship between dynamic viscosity and temperature is not known, either from parameters supplied by the lubricant manufacturers or by measurement, it can be determined at a given ISO viscosity class and a given viscosity index in accordance with ISO 3448.

For the viscosity index VI = 100, the dependency of the effective dynamic viscosity η_{eff} of the lubricant from the effective bearing temperature T_{eff} can be determined from figure 59.

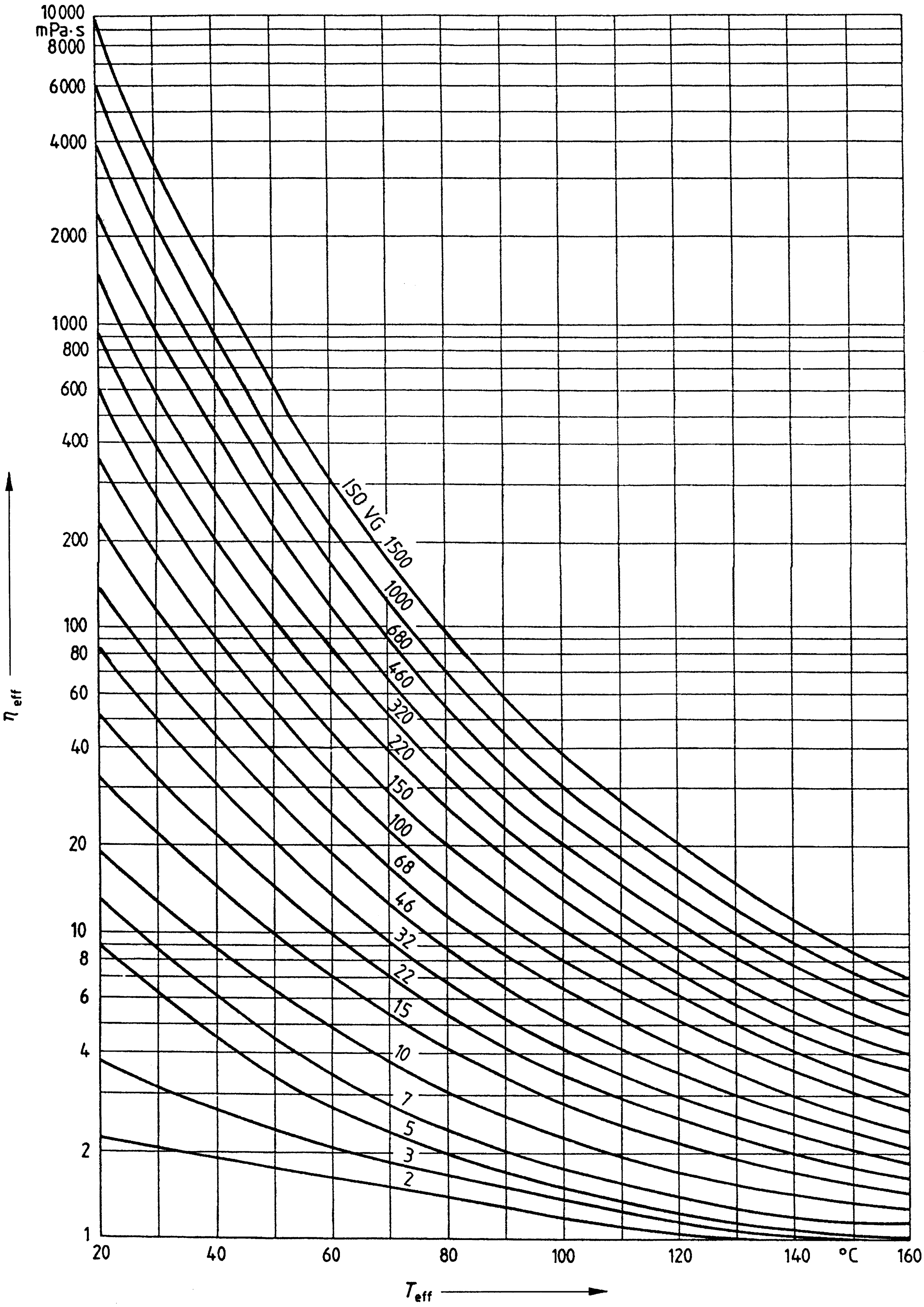

Figure 59 — Effective dynamic viscosity η_{eff} as a function of the effective bearing temperature T_{eff} for lubricants complying with ISO 3448, with VI = 100 **and** ρ = 900 kg/h

Annex A
(informative)

Bibliography

[1] CONSTANTINESCU, V. Basic Relationships in Turbulent Lubrication and their Extension to Include Thermal Effects. *Transactions of the* ASME, Series, F, No. 2, **95**, 1973, pp. 35-43.

ICS 21.100.10

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