DB

Maintenance-free Bearings

Technical Manual

1 Introduction

Increasing competition has resulted in engineers demanding ever more reliable and maintenance-free bearings.

DB bearings are particularly suitable for applications where hydrodynamic lubrication is not possible; for example, in applications with high specific loads or with long dwell periods under static loading, with low sliding speed, angular or axial movement or when it is not permitted or practicable to use lubricants.

GGB's application engineering team is available to assist designers with:

- Material selection
- Design, either standard items or bearings according to your individual needs
- Assembly
- Calculation of estimated bearing life

✓ GGB have more than 60 years of experience with self-lubricating bearings and make use of the latest material developments supported by modern test facilities.

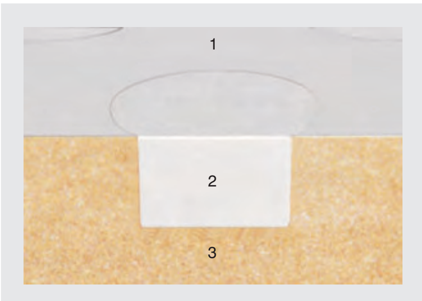
✓ GGBs' products are manufactured to the highest quality standards, certified by QS 9000 / VDA.

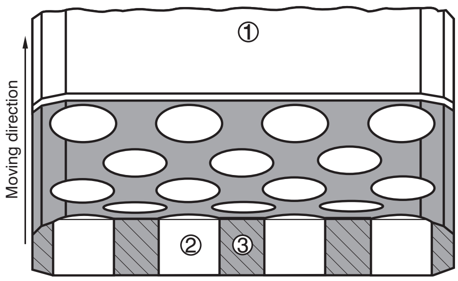
1.1 DB structure

DB consists of:

- a high quality bronze support
- solid lubricant inserts in the bronze support
- a running-in film of solid lubricant

The bronze alloy and the lubricant are selected according to the operating conditions and the application environment of the bearing. There are four standard **DB** alloys. The lubrication inserts are arranged such that the lubricant is optimally distributed over the sliding surface throughout the life of the bearing.





1 Sliding surface with running-in film

2 Solid lubricant insert

3 Support (bronze)

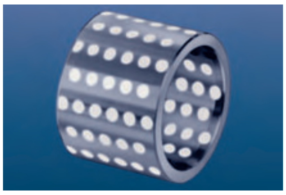
1.2 DB properties

- **DB** allows maintenance-free operation
- High load capacity
- Excellent performance under high load and intermittent operation
- New graphite-free, white solid lubricant
- Low friction coefficient, less than for bearings with graphite based solid lubricants
- Negligible stick-slip effect
- Long life time, longer than for bearings with graphite, due to low wear rate

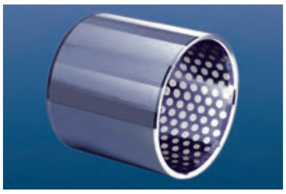
Properties	Units	DB-A	DB-B	DB-C	DB-D
Max. static load $\bar{p}$	N/mm^2	60	80	150	200
Max. dynamic load $\bar{p}$	N/mm^2	30	50	80	100
Max. sliding speed	Um/s	0.5			
Max. temperature	°C	200	250	320	350
Min. temperature	°C	- 50			
Friction coefficient f - dry		0.05 - 0.18			
Min. shaft hardness	HB	180		300	
Shaft surface finish Ra (ground)	µm	0.2 - 0.8			

1.3 Applications

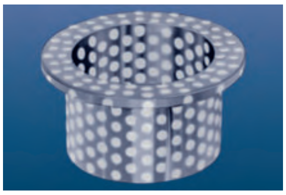
Hydromechanical equipment, large valves, civil engineering construction (supports for bridges and other structures), offshore industry, iron foundries and steel works, heavy machinery, cranes and conveyors, mining machinery, construction and earth-moving machinery etc.



Cylindrical bushes



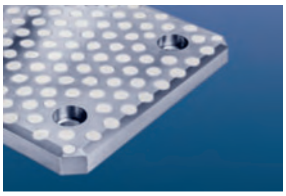
Cylindrical bushes



Flanged bushes

Thrust washers

Self-aligning bearings

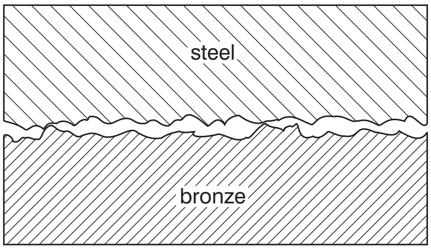


Slide plates

All bearings are provided with a running-in film, which is not shown.

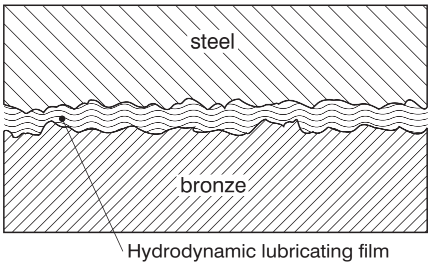
Unlubricated operation

When two unlubricated surfaces rub against each other, friction and wear results due to plastic deformation, local cold welding and shearing of asperity contacts on both surfaces.



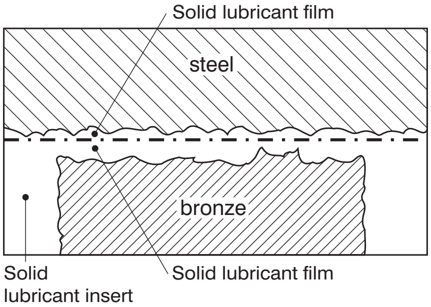
Operation with hydrodynamic lubrication

During operation with oil or other fluid lubrication, when the sliding speed is sufficiently high, a fluid film, separating both surfaces, may be built up. However this separation is not maintained under start up and run down conditions, as for example occurs with intermittent operation.



Operation with solid lubricant

In **DB** bearings separation of the bearing and mating surfaces is ensured by the solid lubricant, which occupies the spaces between the asperity peaks of both surfaces.



DB bearings always have a lubricating film on the sliding surface, with or without movement, thus ensuring that there is always low friction and wear. This is also true under high static loads - the lubricating film is maintained, thus providing secure operation whenever necessary. As soon as relative movement between the bearing and mating surface occurs, more solid lubricant is available where it is required at the sliding surface.

In certain applications therefore, for example under intermittent operation, **DB** bearings offer better performance than conventionally lubricated bearings. Conventional lubricants such as oil or grease can be expelled from the contact zone during long dwell periods under high load, leaving an unlubricated bearing for the next movement, which consequently, will show a high static friction coefficient. The solid lubricant of **DB** is not removed under these conditions and, therefore, the material does not present such increases of static friction during the subsequent movement.

If particles of wear debris or unavoidable dirt enter the bearing, they become embedded in the soft lubricant pockets, where they remain, and thereby displace an equal volume of solid lubricant to the bearing contact area.

2.1 DB solid lubricants

The white, graphite free solid lubricants used in **DB** bearings, are the result of extensive laboratory testing and subsequently confirmed by numerous successful applications. The new lubricants offer lower wear rates and longer bearing lives than conventional graphite based lubricants.

The solid lubricant is produced under pressure, to form a homogeneous, fully compacted material, which is inserted into the holes or pockets in the bronze support. The pockets are arranged to overlap in the sliding direction, to ensure the optimum transfer of lubricant to the mating surface. There is no electrolytic or chemical reaction between the lubricant, the support and the counterface material, when **DB** is used in contact with water.

2.2 Running-in film DB

To assist the running-in process, **DB** bearings are supplied with a thin film of solid lubricant over the sliding surface. It is applied after the solid lubricant has been inserted into the pockets and the surface has been finish machined.

The running-in film has a thickness of about 15 - 20 µm.
It should not be removed!
In the event of damage to the running-in film during assembly, spray cans of lubricant are available for on-site repair.

Some of the film is transferred to the mating surface during the first movements. This process characterises the start of a transition period, which continues until the solid lubricant is released from the pockets.

This material transfer is favored by the specific load and provides:

- low and constant friction coefficient
- negligible stick - slip effect
- full load capacity of the bearing, from the beginning

3 Order Specifications

Order designation (example):	**DB-**	**D**	**16**	**26**
Type of bearing (Bronze with solid lubricant inserts)				
Base material (**A** - **E**, see item 4.1)				
Solid lubricant **12** = black - up to 350°C **16** = white - up to 180°C				
Running-in film **22** = black - up to 350°C **26** = white - up to 180°C				

4 Technical data

4.1 DB bronze alloys

DB grade	ASTM		DIN		Composition		Mechanical properties (min)					Application
	Standard	Alloy No.	Standard	Alloy No.	ASTM % of weight	DIN % of weight	Density kg/dm³	Yield strength N/mm²	Tensile strength N/mm²	5% elong. %	Hardness HB	
DB-A	Industrial bronze											Simple applications
DB-B	B 584 B 271 B 505	C93200	1705	2.1090.01 2.1090.03 2.1090.04	Cu 81-85 Sn 6.3-7.5 Zn 2-4 Pb 6-8 Ni <1 Sb <0.35	Cu 81-85 Sn 6-8 Zn 3-5 Pb 5-7 Ni <2 Sb <0.3	8.8	120 130 120	240 270 270	15 13 16	65 75 70	Standard material for most applications
DB-C	B 584 B 148 B 271 B 505	C95500	1714	2.0975.01 2.0975.02 2.0975.03 2.0975.04	Cu >78 Al 10-11.5 Ni 3-5.5 Fe 3-5 Mn <3.5	Cu >76 Al 8.5-11 Ni 4-6.5 Fe 3.5-5.5 Mn <3	7.6	270 300 300 300	600 600 700 700	12 14 13 13	140 150 160 160	Material for extremely high loads with maximum corrosion resistance
DB-D	B 584 B 271 B 22 B 505	C86300	1709	2.0598.01 2.0598.02 2.0598.03 2.0598.04	Cu 60-66 Al 5-7.5 Fe 2-4 Mn 2.5-5 Zn 22-28 Ni <1	Cu 60-67 Al 3-7 Fe 1.5-4 Mn 2.5-5 Zn - rest Ni <3	8.2	450 480 480 480	750 750 750 750	8 8 5 5	180 180 190 190	Material for extremely high loads without corrosion attack
DB-E	For applications where standard **DB** alloys are not suitable, we are able to supply special materials											

4.2 Assembly and tolerances

DB bushes are assembled by pressing or "shrink-fitting", with an interference between the outer diameter of the bush and the housing bore.

Dimension (for bearing bore ≤ 300 mm)	**Tolerance**	**Surface finish (µm)**
Housing bore	H7	3.2
Bush outer Ø	s6	3.2
Bearing bore (before assembly)	E8	1.2
Bearing bore (after assembly)	H10	1.2
Shaft Ø	c8 / d8	0.2 - 0.8
Concentricity bearing bore / bush outer Ø	IT9	

For bearing bores >300 mm tolerances should be specified by Glacier Garlock Bearings' applications engineering team, according to the conditions of each application.

4.3 Counterface material

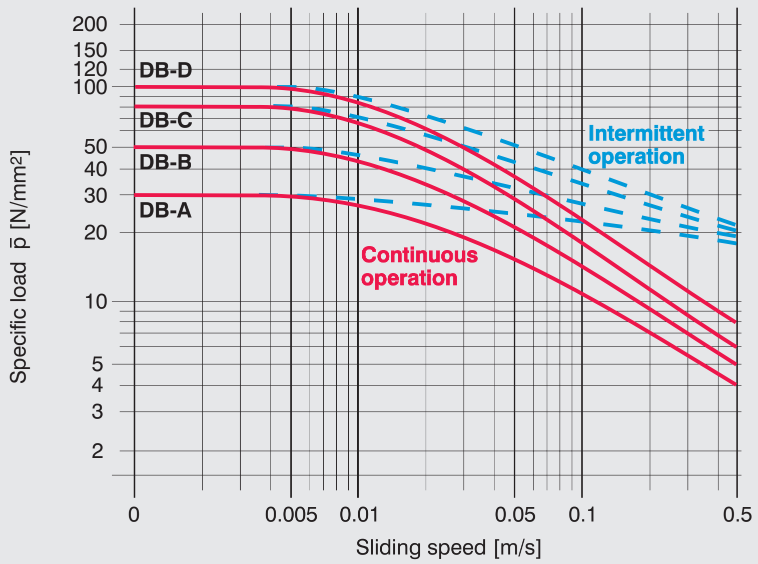
The counterface material (shaft) must have appropriate characteristics, such as: hardness, surface finish and corrosion resistance. When a not standard **DB** alloy is used, the hardness of the shaft should exceed that of the bronze by at least 100 HB.

DB bearing design

The bearing size is determined and after which the bearing life is estimated.

Size

The bearing size depends mainly on the load [N], the sliding speed [m/s] and the operation type [continuous or intermittent]. From the last two data the specific load is determined from the following graph.



Continuous operation $\begin{cases} \text{Operation period} > 5 \text{ min} \\ 1 \leq \dfrac{\text{Operation period } (< 5 \text{ min}) \times 5}{\text{Standstill period}} \end{cases}$ $< 1 \Big\}$ Intermittent operation

This graph is the result of simulations on a test rig.
Sliding path (Rkm) = 0.5 km, shaft Ø 70 mm, material: 1.4057, ground Ra 0.2 - 0.8 µm, HB 235

The specific load is defined as the load divided by the projected area of the bearing. From the specific load, the required bearing size can then be determined.

Life time estimation

Having established the bearing size, the estimated bearing operating life can be determined and compared with the required life.

The life time of a **DB** bearing depends mainly on the following factors:

Specific load	[N/mm²]	1)
Sliding speed	[m/s]	
Type of operation	[continuous or intermittent]	
Friction heat ($\bar{p}U$-factor)	[N/mm² x m/s = W/mm²]	2)
Lubrication		
Coefficient of friction	[f]	
Movement frequency	[Rkm = sliding path in km]	3)
Type of load	[static or dynamic]	4)
Load direction	[stationary or rotating relative to bush]	
Counterface material		
Temperature	[°C]	
Bearing size (diameter)	[mm]	
Countermaterial roughness	[µm]	
Alignment		
Other factors, such as: housing design, dirt, presence of fluids, corrosion, presence of chemical substances, countermaterial hardness, impacts, radiation		

Note:

1) Factors taken into account by means of the load / speed graph

2) These two factors are necessary in order to determine the specific wear, in µm / Rkm (Rkm = sliding path in km), by means of a graph

3) Rkm multiplied by the specific wear is the estimated wear on the end of the life time, which must be equal or less than the maximum admissible wear

4) Factors taken into account by means of estimated life time correction coefficients

Type of operation

Intermittent operation is more favorable than continuous in terms of frictional heat dissipation.

Friction heat

The frictional heat is proportional to the $\bar{p}U$-factor, and can be calculated by the expression:

$$Q = f\bar{p}U \ [W/mm^2]$$

Friction coefficient

The friction coefficient is extremely low. For calculation purposes it is recommended to assume a friction coefficient between 0.10 and 0.12 for **DB** bearings. The friction coefficient depends on many factors. Under high loads and with some humidity, for example, the value can be 0.06, whilst under reduced loads and high temperatures it can reach 0.15.

Type of load

DB bearings show optimum performance under steady unidirectional loads. Wear occurs only in a localised area of the sliding surface, with an arc of contact created between bearing and shaft, thereby decreasing the contact pressure.

Under dynamic loads, the bearing performance also depends on the fatigue resistance of the material and the bearing life is reduced.

Load direction

The most favourable operating conditions for **DB** journal bearing are with a rotating or oscillating shaft and the load direction constant relative to the bearing. Under these conditions the arc of contact increases as wear occurs and the contact pressure falls.

If the load direction changes relative to the bearing, then as wear proceeds the arc of contact reduces and the contact pressure increases and the bearing life is reduced.

Corrosion

Corrosion resistance depends mainly on the bearing alloy. There are no adverse electrolytic potential differences between the bearing alloy and the solid lubricant, nor between the solid lubricant and the counterface material. The presence of the solid lubricant also prevents fretting corrosion occurring between the bearing and counterface materials.

Chemical products

GGB can advise on the compatibility of **DB** bearings with chemical products. However, in general, it is recommended to test the selected bearing material in contact with the particular product to confirm the suitability for the application.

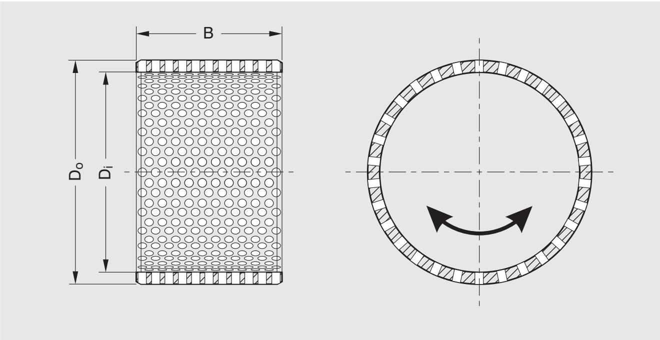
Product information

GGB warrants the products described in this document to be free from defects in material and workmanship. The data given in the document are intended as an aid for assessing the suitability of the material. They are derived from our own research as well as generally accessible publications. They do not constitute a guarantee of the specified properties.
Unless expressly agreed in writing, GGB does not guarantee the described products to be suitable for any special purposes or specific operating conditions.
GGB accepts no liability for losses, damage or costs arising in any way from direct or indirect use of these products.
All transactions conducted by GGB are subject to our terms of sale and delivery as indicated in our offers, product brochures and price lists. Copies are available on request.
Our products are subject to a constant development process. GGB reserves the right to amend the specification or improve the technological data without prior notice.

6 Forms and dimensions

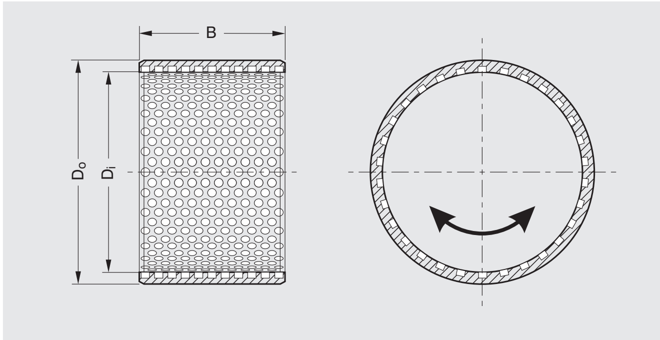
Radial bearings

Our standard D_i <500 mm
Special version $D_i \geq 500$ mm



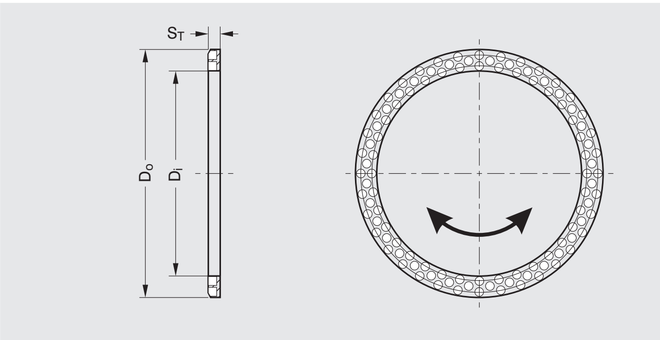
Radial bearings

Our standard $D_i \geq 500$ mm
Special version D_i <500 mm



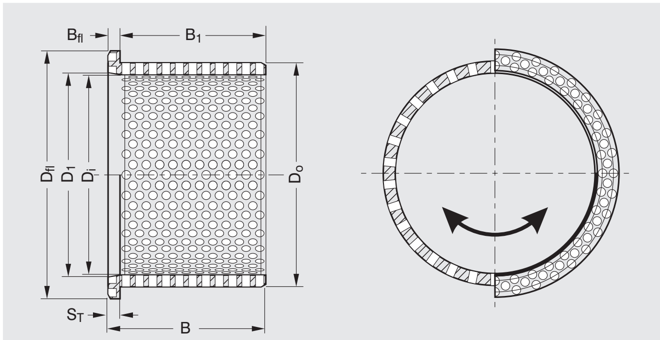
Axial bearings / Thrust washers

Our standard D_i >150 mm
Special version $D_i \leq 150$ mm

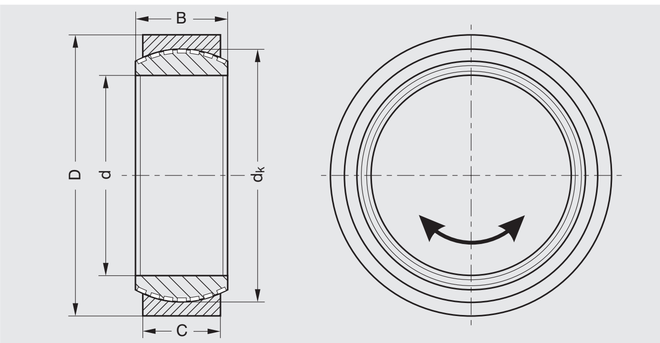


Combined radial and axial bearings

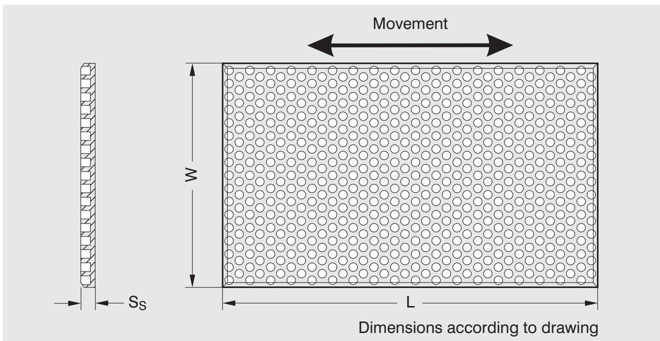
Our standard $D_i \leq 150$ mm (flanged bush)
Our standard D_i >150 mm (cyl. bush and thrust washer)



Spherical bearings



Sliding plates



All bearings are provided with a running-in film, which is not shown for optical reasons.

DB bearings are not stock material. They are produced according to our clients' requirements. It is possible to provide most special designs according to drawings, for example: special dimensions and tolerances, forms which are not in the following table, such as axial and radial segments, half-shells etc. For reasons of economy, however, we recommend the use of the types and sizes shown on the following table.

The arrangement of the solid lubricant pockets is defined by our application engineering team, according to the movement direction and other operating conditions.

Radial bearings					Flanged bushes - Thrust washers					
Diameter mm		Length B mm			Diameter mm				Flange thickn.	Length mm
		1.0 x D_i	0.75 x D_i	1.25 x D_i						
D_i	D_o	recom.	min	max	D_i	D_1	D_o	D_{fl}	B_{fl} / S_T	B
10	15	10	7	13	10		15	20	2,5	
12	18	12	9	15	12		18	22	3,0	
14	20	14	10	18	14		20	25	3,0	
15	20	15	11	19	15		20	26	3,0	
16	22	16	12	20	16		22	28	3,0	
20	26	20	15	25	20		26	32	3,0	
22	28	22	16	28	22		28	34	3,0	
25	32	25	18	32	25		32	38	3,5	
28	35	28	21	35	28		35	42	3,5	
30	38	30	22	38	30		38	45	4,0	
35	44	35	26	44	35		44	50	4,5	
40	50	40	30	50	40		50	60	5,0	
45	55	45	33	56	45		55	70	5,0	
50	60	50	35	65	50		60	80	5,0	
55	65	55	40	70	55		65	85	5,0	
60	70	60	45	75	60		70	90	5,0	
65	76	65	45	80	65		76	95	5,5	
70	82	70	50	85	70		82	100	6,0	
75	88	75	55	90	75		88	105	6,5	
80	95	80	60	100	80		95	110	7,5	
85	100	85	60	105	85		100	115	7,5	
90	105	90	65	115	90		105	120	7,5	
95	110	95	70	120	95		110	130	7,5	
100	115	100	75	125	100		115	140	7,5	
110	125	110	80	140	110		125	150	7,5	
120	135	120	90	150	120		135	160	7,5	
140	160	140	100	175	140		160	180	10,0	
150	170	150	110	185	150		170	190	10,0	
180	200	180	135	225	180	185	200	230	10,0	
200	220	200	150	250	200	205	220	250	10,0	
225	250	225	170	280	225	230	250	275	12,5	
250	275	250	190	315	250	255	275	300	12,5	
280	310	280	210	350	280	285	310	340	15,0	
300	330	300	225	375	300	305	330	360	15,0	
350	380	350	260	435	350	355	380	420	15,0	
400	435	400	300	500	400	405	435	480	17,5	
450	490	450	340	560	450	455	490	530	20,0	
500	540	500	375	625	500	510	540	600	20,0	
550	590	550	415	690	550	560	590	650	20,0	
600	640	600	450	750*	600	610	640	720	20,0	
650	700	650	490	815*	650	660	700	780	25,0	
700	750	700	525	875*	700	710	750	840	25,0	
750	800	750*	560	940*	750	760	800	900	25,0	
800	850	800*	600	1000*	800	810	850	960	25,0	
850	900	850*	640	1060*	850	860	900	1020	25,0	
900	950	900*	675	1125*	900	910	950	1080	25,0	
950	1000	950*	710*	1200*	950	960	1000	1140	25,0	
1000	1060	1000*	750*	1250*	1000	1010	1060	1200	30,0	
1200	1260	1200*	900*	1500*	1200	1210	1260	1440	30,0	

Flanged bush (rows without D_1)

Cylindrical bush and thrust washer (rows with D_1)

Length B = B_1 + B_{fl} / S_T where B_1 = bush length and B_{fl} / S_T = flange or washer thickness

Spherical bearings					
	Diameter mm			Length mm	
	d	d_k	D	B	C
Short bearing	100	130	150	70	55
	110	140	160	70	55
	120	160	180	85	70
	140	180	210	90	70
	160	200	230	105	80
	180	225	260	105	80
	200	250	290	130	100
	220	275	320	135	100
	240	300	340	140	100
	260	325	370	150	110
	280	350	400	155	120
	300	375	430	165	120
Long bearing	320	380	460	230	218
	340	400	480	243	230
	360	420	520	258	243
	380	450	540	272	258
	400	470	580	280	265
	420	490	600	300	280
	440	520	630	315	300
	460	540	650	325	308
	480	565	680	340	320
	500	585	710	355	335
	530	620	750	375	355
	560	655	800	400	380
	600	700	850	425	400
	630	740	900	450	425
	670	785	950	475	450
	710	830	1000	500	475
	750	875	1060	530	500
	800	930	1120	565	530
	850	985	1220	600	565
	900	1040	1250	635	600
	950	1100	1360	670	635
	1000	1160	1450	710	670

* Subdivided in length (2 x 0.5) for technical reasons