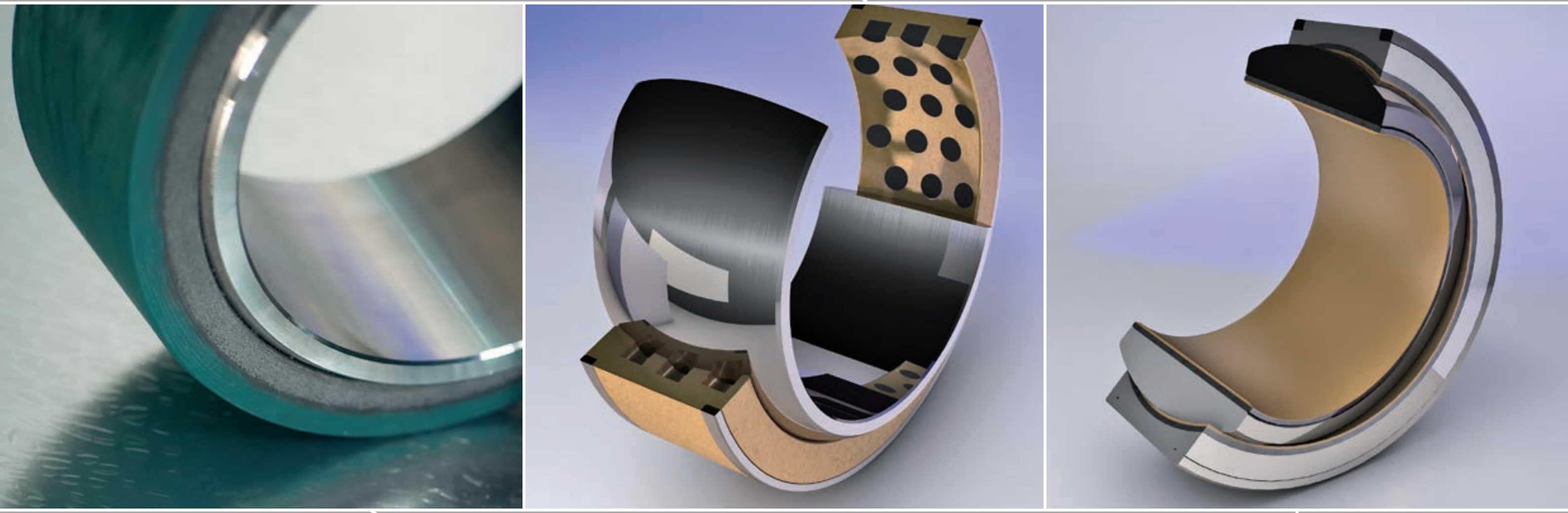
FEDERAL-MOGUL POWERTRAIN

DEVA

World Class Bearing Technology



DEVA® spherical bearings

Spherical bearings

Bearings that allow tilting movements beside rotation and oscillation due to spherical sliding surfaces

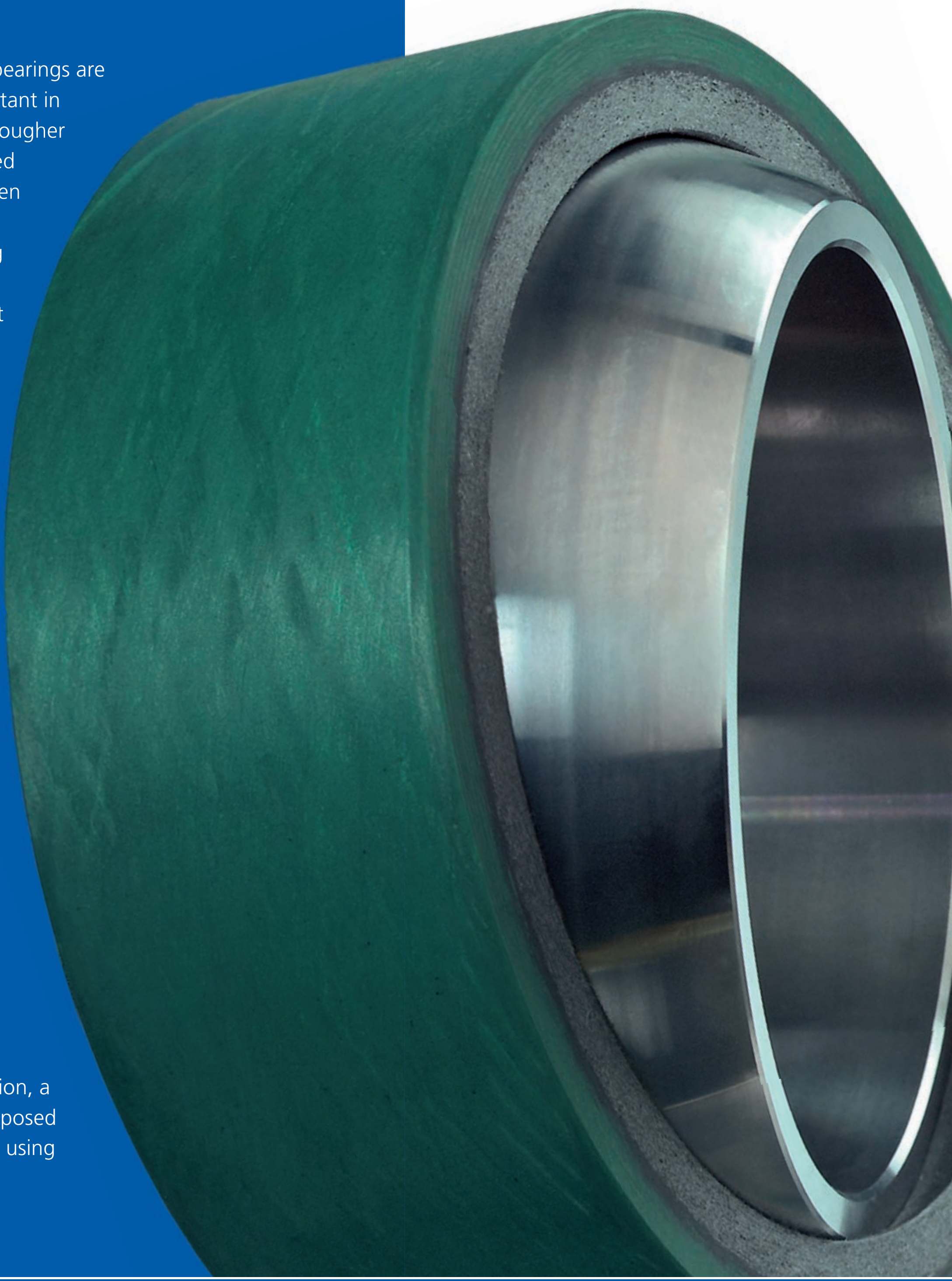
Maintenance-free spherical bearings are becoming increasingly important in industrial applications. Ever tougher requirements are being placed on machinery and plants when it comes to availability and maintenance. Self-lubricating spherical bearings of the **DEVA**® system offer the best conditions for maintenance-free operation.

Spherical bearings with spherical sliding surfaces are ready-to-install machine elements used primarily for oscillating rotating and tilting movements in high-load applications.

As they offer the possibility for spatial adjustment in all directions, alignment errors, skewed shaft positions, and shaft deflection are compensated.

Use of adjustable spherical bearings can eliminate premature failures from high edge loads caused by conventional sliding bearing bushings.

For maintenance-free operation, a number of requirements are posed which are sufficiently met by using **DEVA** spherical bearings.



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Material systems of DEVA® spherical bearings

The maintenance-free, high-performance friction materials of the **DEVA** product range require no external lubrication and ensure a long reliable service life.
For the selection of maintenance-free spherical bearings from the **DEVA** system, the function, use-case, design, and the requirements posed to the overall system are indisputable.

Four **DEVA** material systems are available for the manufacturing of spherical bearings. In principle, each of these material systems can be used for many areas of application. Our application engineers are available to consult on the best technological and economical material variants for your application.

DEVA material systems for spherical bearings

deva.glide®

- Enabling of maintenance-free operation by solid lubricant reservoirs evenly distributed in the friction material on a macro level
- High dynamic and static loading capacity
- Constant low wear and friction coefficients without stick-slip
- Insensitive to dirt, corrosion, and impact stress
- Can be used within a large temperature range (-100°C to + 250°C)
- Fit for use in seawater
- Maximum dimensional stability in liquids
- Manufacturability even in very large dimensions
- Electrical conductivity, no electrostatic charge effects, very good thermal conductivity
- Can also be used with conventional lubrication
- Machinable

deva.metal®

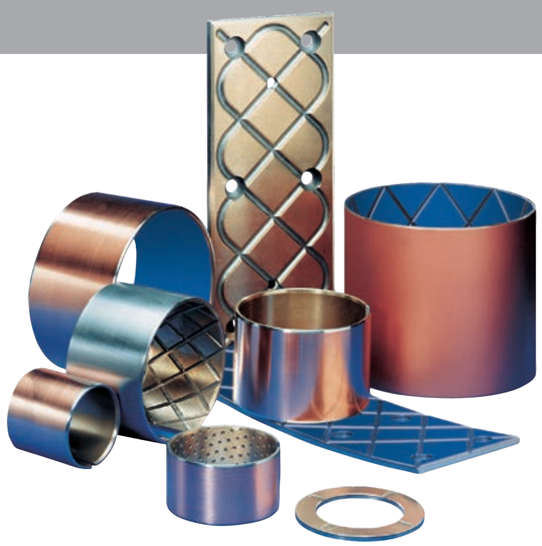
- Enabling of maintenance-free operation through uniformly micro-distributed solid lubricants embedded in the base matrix
- Good lubricant distribution even in case of micro-movement
- High dynamic and static loading capacity
- Constant low wear and friction coefficients without stick-slip
- Insensitive to dirt
- Design also intended for use in seawater
- Use in corrosive environments
- Maximum dimensional stability in liquids
- Can be used across a very wide temperature range (-200°C to + 800°C)
- Electrical conductivity, no electrostatic charge effects, very good thermal conductivity
- Can also be used with conventional lubrication
- Machinable

deva.bm®

- Enabling of maintenance-free operation through uniformly micro-distributed solid lubricants embedded in the base matrix
- Good lubricant distribution even in case of micro-movement
- High dynamic and static loading capacity
- Constant low wear and friction coefficients without stick-slip
- Insensitive against dirt, corrosion, and impact load
- Available for use in seawater
- Maximum dimensional stability in liquids
- Can be used across a wide temperature range (-150°C to + 280°C)
- Electrical conductivity, no electrostatic charge effects, very good thermal conductivity
- Can also be used with conventional lubrication
- Machinable

deva.tex®

- High dynamic and static loading capacity
- Excellent damping properties
- Very robust under impact load
- Good lubricant distribution even in case of micro-movement
- Consistently very low wear rates
- Constant friction coefficients without stick-slip
- Good chemical resistance
- Excellent sliding properties in seawater
- Swelling behavior < 0.1%
- Temperature range - 40 °C to 160 °C
- Machinable



1.1 deva.glide®

Material structure

deva.glide materials consist of high-wear-resistant cast bronze alloys with solid lubricant plugs evenly distributed in the sliding surface in a macro level pattern. The plugs are arranged to optimally supply the sliding surfaces with solid lubricant, adapted to the specific movement. The material's high density ensures a high load bearing ability which is combined with the good dirt particle embedding ability in the lubricant plugs.
In the technical dry run, **deva.glide** is provided with a running-in film that already permits a transfer of solid lubricant to the mating material at first contact.

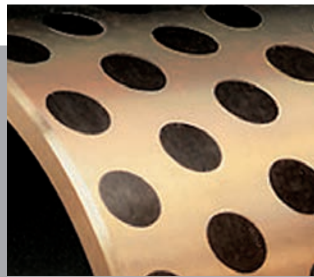
Solid lubricants

In the **deva.glide** material system solid lubricants are used that provide optimum film formation, adhesion, surface affinity, and corrosion resistance. **deva.glide** is available with two standard solid lubricants.

- dg12 Graphite, additives
- dg16 PTFE, additives

The highly pure, natural graphite used is not chemically pretreated. Due to its indifferent behavior, no electrolytic and chemical activity takes place.

Material systems of DEVA® spherical bearings



1.2 deva.metal®

Material structure

deva.metal has a metallic base matrix with uniformly distributed, embedded solid lubricant. The composition of the metallic matrix determines the physical, mechanical and chemical properties of an alloy and is thus the foundation of the material selection.
Alloys based on bronze, iron, nickel, nickel-copper, nickel-iron and stainless steel are available.

Solid lubricants

The percentage and properties of the solid lubricant fundamentally have an influence on the sliding behavior of a **deva.metal** alloy. Across the base materials listed, the following solid lubricants are used:

- Graphite C
- Molybdenum disulfide MoS_2
- Tungsten disulfide WS_2
- Special solid lubricants

1.3 deva.bm®

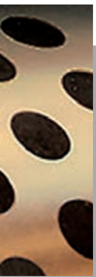
Material structure

deva.bm is excellently suited for low friction or minimum wear rate requirements due to the special properties of the matrix/lubricant system.
deva.bm is a self-lubricating, compound friction material composite, consisting of a steel back with a sliding layer of **deva.metal** applied in a special roll-sinter process.

Solid lubricants

Low friction in **deva.bm** is provided by the solid lubricant which is homogeneously embedded in the bronze matrix. This is either graphite in various particle shapes and sizes or PTFE.

To support the running-in phase in a pure dry run, a running-in layer made of graphite (dg22) or PTFE (dg26) can also be applied.



1.4 deva.tex®

deva.tex is excellently suited for extremely low friction and minimum wear rate requirements, especially for use in corrosive environments and in applications with serious shock stress.

Material structure of deva.tex® 552

deva.tex 552 is a two-layer composite sliding material consisting of an external, highly stable support layer made of continuously wound glass fibers embedded in epoxy resin, and an internal sliding layer made of special fibers containing lubricant; these fibers are embedded in the epoxy resin. With graphite, a highly efficient solid lubricant is added to the resin.
The material selection of **deva.tex 552** thus fulfills the demand for a highly loadable, self-lubricating bearing material that has low wear in both dry and moist environments.

Types of spherical bearings

Maintenance-free, self-lubricating **DEVA®** spherical bearings are available in various basic types:

- Radial spherical bearings
- Axial spherical bearings / calotte bearings
- Special designs

2.1 Radial spherical bearings

Radial spherical bearings with spherical sliding surfaces can be moved in all directions and are used for high radial loads. Limited axial loading combined with radial forces are permissible. In this context the ratio between axial and radial load must be observed.

Bearing design: fixed bearing – floating bearing

In case of multiple shaft bearings, only one bearing (fixed bearing) may guide the shaft in the longitudinal direction and take up any axial forces due to manufacturing tolerances, tension-free installation and heat expansion; all other bearings (floating bearings) must be able to move freely or adjust in the longitudinal direction.

Principle of the fixed / floating bearings

Fixed bearings

In fixed bearings, the outer ring is fixed in the housing and the inner ring is fixed on the shaft. Both the tilting and turning movement take place on the spherical surface.

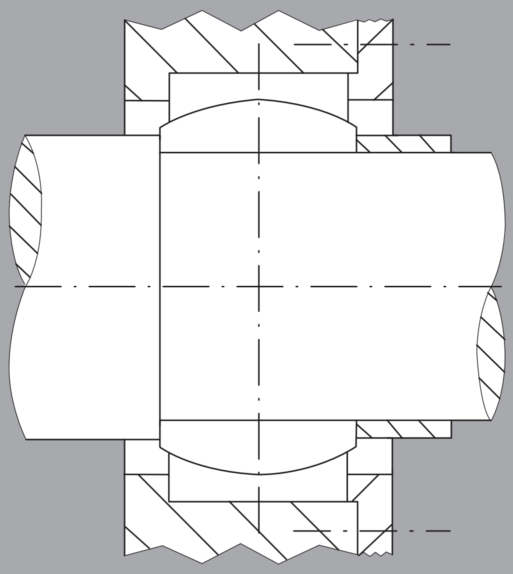


Fig. 2.1.1

Floating bearings

The outer ring of the floating bearing is fixed in the housing. The tilting movement takes place on the spherical surface, the rotational movement is on the inside diameter with simultaneous axial movement of the shaft also possible.

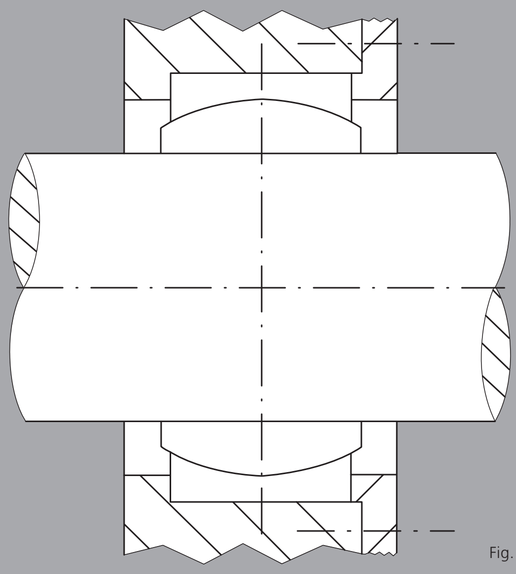


Fig. 2.1.2

2.1.1 Radial fixed bearing in the DEVA® material systems

Fixed bearings made of deva.glide®

The fixed bearing consists of an internally enclosed ball made of stainless steel and an axially divided external ring made of **deva.glide**, connected by stainless steel retaining rings shrunken onto both sides.

Fig. 2.1.1.1

Fixed bearings made of deva.metal®

The spherical bearing consists of a complete inner ball made of heat-treated steel* and an axially divided external ring made of **deva.metal**, connected by stainless steel retaining rings shrunken onto both sides. For dimensions up to 50 mm, lock washers or tube springs can be used for mounting.

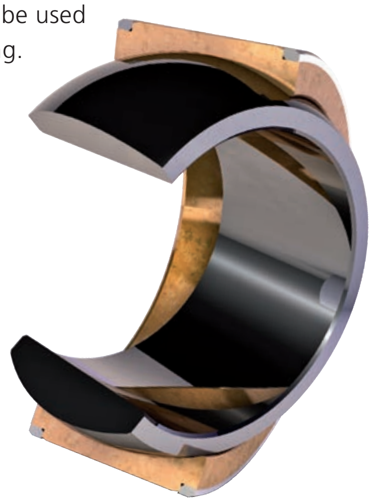


Fig. 2.1.1.2

* Steel quality depending on the respective application conditions, e.g. stainless steel, heat-resistant steel

Fixed bearings made of deva.bm®

The spherical bearing consists of a complete inner ball and an axially divided external ring*, connected by steel* retaining rings shrunken onto both sides or by lock washers. The ball surface of the external ring is lined with a mechanically fixed sliding layer made of **deva.bm**.

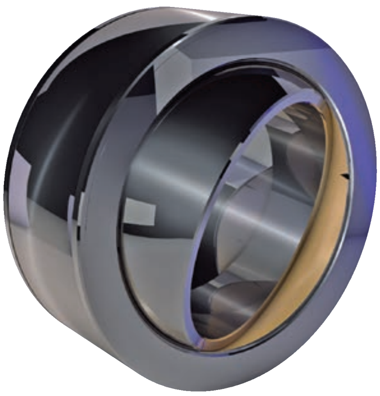


Fig. 2.1.1.3

* Steel quality depending on the respective application conditions, e.g. stainless steel, heat-resistant steel

Fixed bearings made of deva.tex®

The spherical bearings consist of a complete inner stainless steel ball and an enclosed external ring made of **deva.tex® 552**.

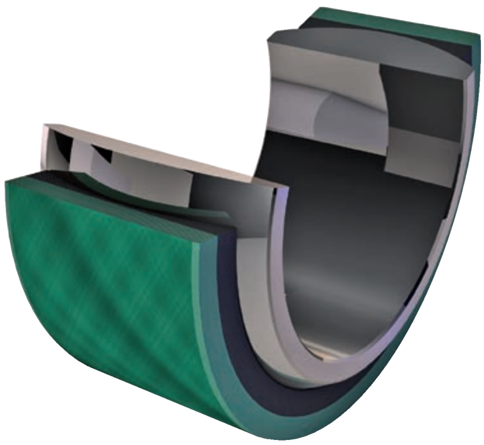


Fig. 2.1.1.4

2.1.2 Radial floating bearing in the DEVA® material systems

Floating bearings made of deva.glide®

The spherical bearings consist of a complete inner ball made of **deva.glide** and an axially divided external ring made of stainless steel, connected by stainless steel retaining rings shrunken onto both sides. The lubricating plugs are inserted evenly into the ball bore and along the outer diameter.

Fig. 2.1.2.1

Floating bearings made of deva.metal®

The spherical bearings consist of a complete inner ball made of **deva.metal** and an axially divided external ring made of heat-treated steel*, connected by steel retaining rings shrunken onto both sides. For dimensions up to 50 mm, lock washers or tube springs can be used for mounting.

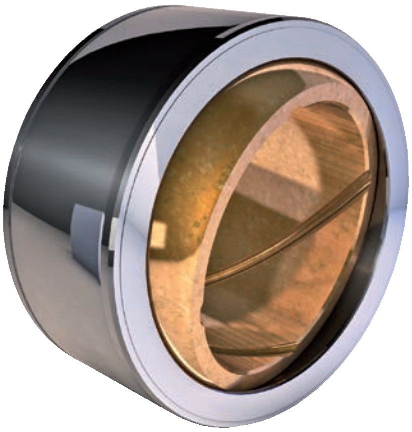


Fig. 2.1.2.2

* Steel quality depending on the respective application conditions, e.g. stainless steel, heat-resistant steel

Floating bearings made of deva.bm®

The design is analogous to that of the fixed bearings with additionally inserted **deva.bm** sliding bearing bushing in the ball bore. For design reasons, a dimensional adaptation (thicker ball wall thicknesses) is required.

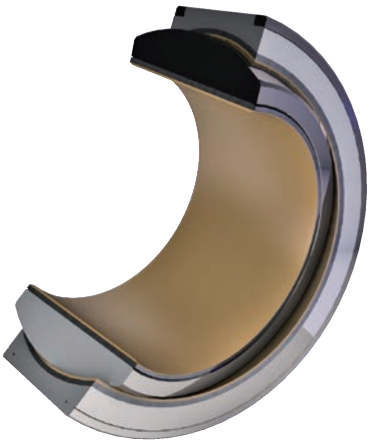


Fig. 2.1.2.3

* Steel quality depending on the respective application conditions, e.g. stainless steel, heat-resistant steel

Floating bearings made of deva.tex®

The design is analogous to that of the fixed bearings with additionally inserted **deva.tex** sliding bearing bushing in the ball bore. For design reasons, a dimensional adaptation (thicker ball wall thicknesses) is required.

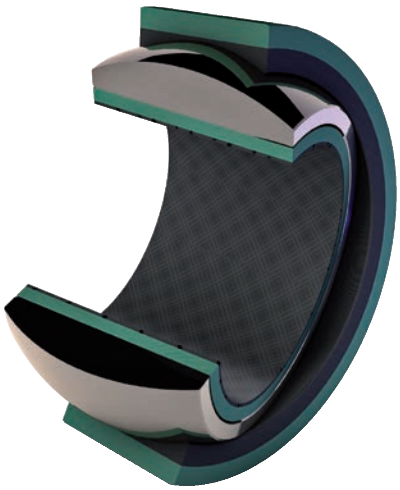


Fig. 2.1.2.4

2.2 Axial spherical bearings

Axial spherical bearings with spherical sliding surfaces can be moved in all directions and are used for axial loads. Limited radial loading combined with radial forces are permissible. In this context the ratio between radial and axial load must be considered.

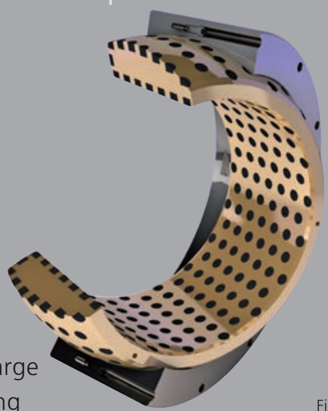
Design example

deva.bm®

Fig. 2.2.1

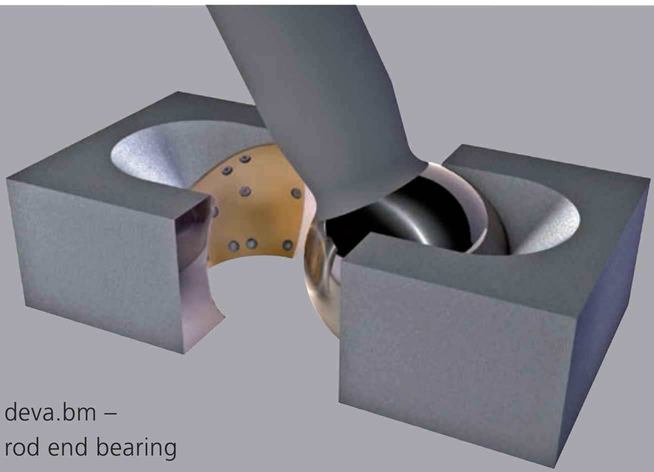
2.3 Examples for special designs of DEVA® spherical bearings

Asymmetrical spherical bearings



deva.glide® –
asymmetrical large
spherical bearing

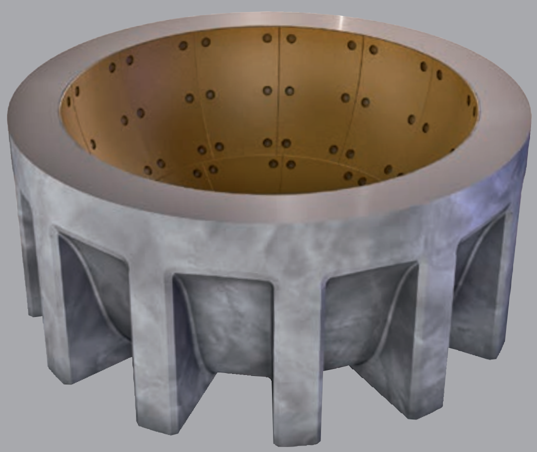
Fig. 2.3.1



deva.bm –
rod end bearing

Fig. 2.3.2

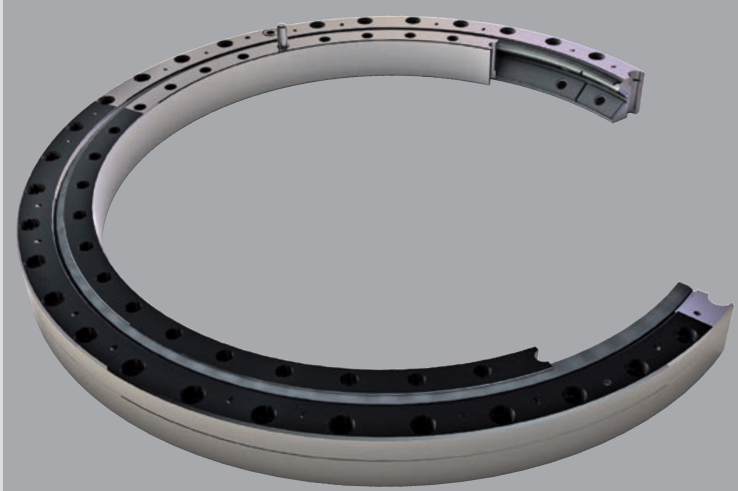
Calotte bearing



deva.bm –
calotte bearing
with sliding
layer lining

Fig. 2.3.3

Boogie bearing system



deva.tex® –
boogie bearing
system

Fig. 2.3.4

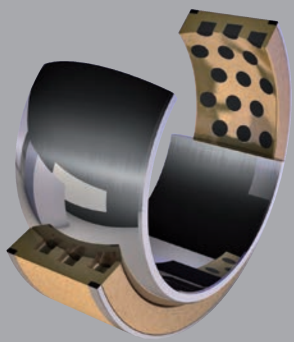
2.4 Selection of materials

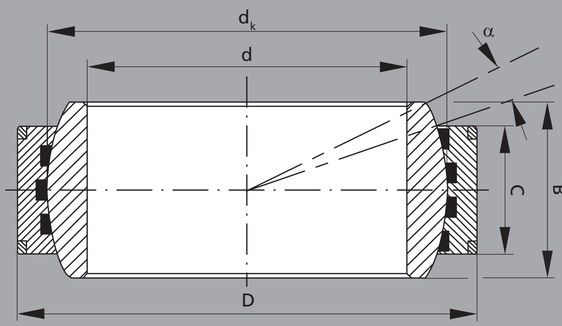
The material selection and the respective design form are especially based on the individual operating conditions and absolute bearing dimensions. The material properties can be found in the respective technical manuals.

All listed sliding pairs have characteristic features that make them suited for individual applications. To select a suitable sliding pair and formulation of technical design, please consult our application engineer department.

Table of dimensions for the DEVA® spherical bearings

3.1 Dimensions and load capacities for deva.glide® spherical bearings, FIXED BEARING version





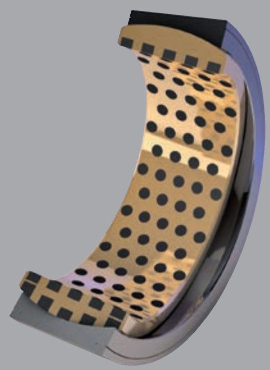
Fixed bearings deva.glide

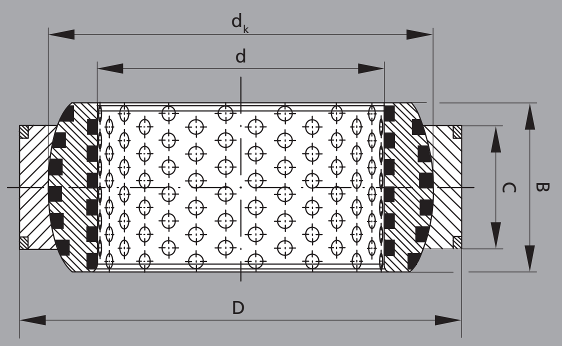
Dimensions and load capacities for deva.glide spherical bearings — Table 3.1.1

Dimensions					Load capacities			
					dg02.12		dg03.12	
d [mm]	d_k [mm]	D [mm]	B [mm]	C [mm]	C_{dyn} [kN]	C_{stat} [kN]	C_{dyn} [kN]	C_{stat} [kN]
100	130	150	70	55	715	1251	1287	2145
110	140	160	70	55	770	1348	1386	2310
120	160	180	85	70	1120	1960	2016	3360
140	180	210	90	70	1260	2205	2268	3780
160	200	230	105	80	1600	2800	2880	4800
180	225	260	105	80	1800	3150	3240	5400
200	250	290	130	100	2500	4375	4500	7500
220	275	320	135	100	2750	4813	4950	8250
240	300	340	140	100	3000	5250	5400	9000
260	325	370	150	110	3575	6256	6435	10725
280	350	400	155	120	4200	7350	7560	12600
300	375	430	165	120	4500	7875	8100	13500
320	380	440	160	135	5130	8978	9234	15390
340	400	460	160	135	5400	9450	9720	16200
360	420	480	160	135	5670	9923	10206	17010
380	450	520	190	160	7200	12600	12960	21600
400	470	540	190	160	7520	13160	13536	22560
420	490	560	190	160	7840	13720	14112	23520
440	520	600	218	185	9620	16835	17316	28860
460	540	620	218	185	9990	17483	17982	29970
480	565	650	230	195	11018	19281	19832	33053
500	585	670	230	195	11408	19963	20534	34223
530	620	710	243	205	12710	22243	22878	38130
560	655	750	258	215	14083	24644	25349	42248
600	700	800	272	230	16100	28175	28980	48300
630	740	850	300	260	19240	33670	34632	57720
670	785	900	308	260	20410	35718	36738	61230
710	830	950	325	275	22825	39944	41085	68475
750	875	1000	335	280	24500	42875	44100	73500
800	930	1060	355	300	27900	48825	50220	83700
850	985	1120	365	310	30535	53436	54963	91605
900	1040	1180	375	320	33280	58240	59904	99840
950	1100	1250	400	340	37400	65450	67320	112200
1000	1160	1320	438	370	42920	75110	77256	128760

For dimensions d < 100 mm, designs in **deva.metal**® are especially recommended.
The basic load ratings are used for the preliminary determination of the bearing.
The preliminary dimensioning cannot replace the further calculation of the bearing.
It is recommended that the application engineer department of Federal-Mogul DEVA is consulted after each preselection.
Special dimensions are possible.
Values for static and dynamic load capacity of further bronze alloys dg01, dg04 and dg05 can be provided on request.

3.2 Dimensions and load capacities for deva.glide® spherical bearings, FLOATING BEARING version





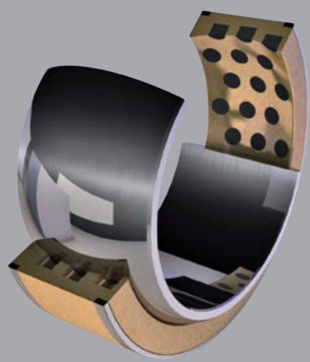
Floating bearings deva.glide

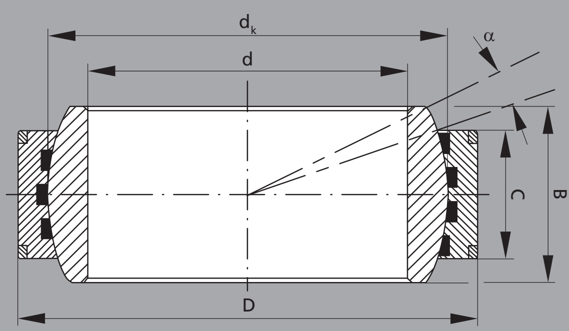
Dimensions and load capacities for deva.glide spherical bearings — Table 3.2.1

Dimensions					Load capacities			
					dg02.12		dg03.12	
d [mm]	d_k [mm]	**D** [mm]	**B** [mm]	**C** [mm]	C_{dyn} [kN]	C_{stat} [kN]	C_{dyn} [kN]	C_{stat} [kN]
100	140	160	70	55	700	1225	1260	2100
110	160	180	85	70	935	1636	1683	2805
120	180	210	90	70	1080	1890	1944	3240
140	200	230	105	80	1470	2573	2646	4410
160	225	260	105	80	1680	2940	3024	5040
180	250	290	130	100	2340	4095	4212	7020
200	275	320	135	100	2700	4725	4860	8100
220	300	340	140	100	3080	5390	5544	9240
240	325	370	150	110	3600	6300	6480	10800
260	350	400	155	120	4030	7053	7254	12090
280	375	430	165	120	4620	8085	8316	13860
300	380	440	160	135	4800	8400	8640	14400
320	400	460	160	135	5120	8960	9216	15360
340	420	480	160	135	5440	9520	9792	16320
360	450	520	190	160	6840	11970	12312	20520
380	470	540	190	160	7220	12635	12996	21660
400	490	560	190	160	7600	13300	13680	22800
420	520	600	218	185	9156	16023	16481	27468
440	540	620	218	185	9592	16786	17266	28776
460	565	650	230	195	10580	18515	19044	31740
480	585	670	230	195	11040	19320	19872	33120
500	620	710	243	205	12150	21263	21870	36450
530	655	750	258	215	13674	23930	24613	41022
560	700	800	272	230	15232	26656	27418	45696
600	740	850	300	260	18000	31500	32400	54000
630	785	900	308	260	19404	33957	34927	58212
670	830	950	325	275	21775	38106	39195	65325
710	875	1000	335	280	23785	41624	42813	71355
750	930	1060	355	300	26625	46594	47925	79875
800	985	1120	365	310	29200	51100	52560	87600
850	1040	1180	375	320	31875	55781	57375	95625
900	1100	1250	400	340	36000	63000	64800	108000
950	1160	1320	438	370	41610	72818	74898	124830

For dimensions d < 100 mm, especially designs in **deva.metal®** are available. The basic load ratings are used for the preliminary determination of the bearing.
The preliminary dimensioning does not replace the further calculation of the bearing.
It is recommended that the application engineer department of Federal-Mogul DEVA is consulted after each preselection.
Special dimensions are possible.
Values for static and dynamic load capacity of further bronze alloys dg01, dg04 and dg05 can be provided on request.

3.3 Dimensions and load capacities for deva.glide® spherical bearings, FIXED BEARING version (high load version)





Fixed bearings deva.glide
(high load version)

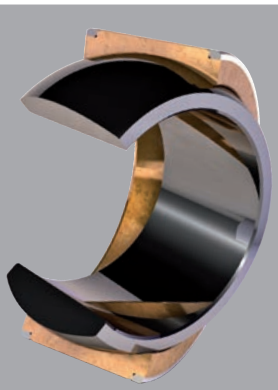
Dimensions based on DIN-ISO 12240-1 - Series H. To increase the radial and axial bearing capacity with the lowest possible construction space, this bearing form is designed with a geometrically expanded external ring. The resulting larger projected axial surface permits higher axial load components. Especially in steel construction for hydraulic structures (e.g. radial segments), these sliding bearings offer ideal properties for a safe and long-term operation.

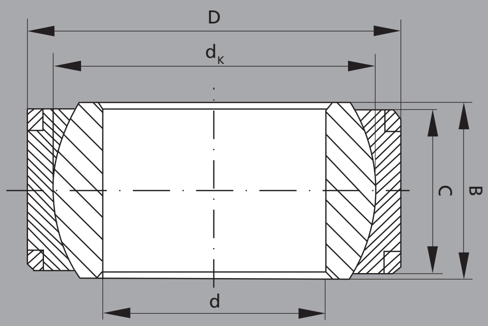
Dimensions and load capacities for deva.glide spherical bearings — Table 3.3.1

Dimensions					Load capacities			
					dg02.12		dg03.12	
d [mm]	d_k [mm]	D [mm]	B [mm]	C [mm]	C_{dyn} [kN]	C_{stat} [kN]	C_{dyn} [kN]	C_{stat} [kN]
300	390	430	212	200	7800	13650	14040	23400
320	414	460	230	218	9025	15794	16245	27076
340	434	480	243	230	9982	17469	17968	29946
360	474	520	258	243	11518	20157	20733	34555
380	494	540	272	258	12745	22304	22941	38236
400	514	580	280	265	13621	23837	24518	40863
420	534	600	300	280	14952	26166	26914	44856
440	574	630	315	300	17220	30135	30996	51660
460	593	650	325	308	18264	31963	32876	54793
480	623	680	340	320	19936	34888	35885	59808
500	643	710	355	335	21541	37696	38773	64622
530	673	750	375	355	23892	41810	43005	71675
560	723	800	400	380	27474	48080	49453	82422
600	773	850	425	400	30920	54110	55656	92760
630	813	900	450	425	34553	60467	62195	103658
670	862	950	475	450	38790	67883	69822	116370
710	912	1000	500	475	43320	75810	77976	129960
750	972	1060	530	500	48600	85050	87480	145800
800	1022	1120	565	530	54166	94791	97499	162498
850	1112	1220	600	565	62828	109949	113090	188484
900	1142	1250	635	600	68520	119910	123336	205560
950	1242	1360	670	635	78867	138017	141961	236601
1000	1312	1450	710	670	87904	153832	158227	263712

The preliminary dimensioning does not replace the further calculation of the bearing.
It is recommended that the application engineer department of Federal-Mogul DEVA is consulted after each preselection.
Special dimensions are possible.
Values for static and dynamic load capacity of further bronze alloys dg01, dg04 and dg05 can be provided on request.

3.4 Dimensions for deva.metal® spherical bearings, FIXED BEARING version



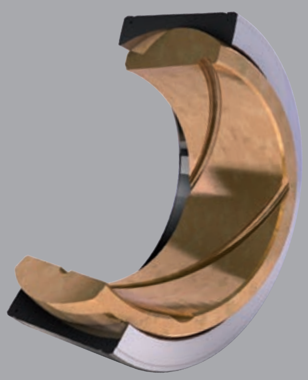


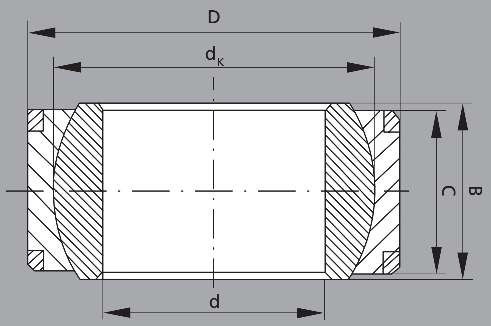
Fixed bearings deva.metal

Dimensions for deva.metal spherical bearings				Table 3.4.1
Dimensions				
d [mm]	**d$_K$** [mm]	**D** [mm]	**C** [mm]	**B** [mm]
25	35	42	19	20
30	42	48	21	22
35	47	55	24	25
40	53	62	27	28
50	66	75	33	35
60	80	90	42	44
70	94	105	47	49
80	110	120	53	55
90	119	130	58	60
100	134	150	68	70
110	140	160	73	75

Intermediate sizes upon request.

3.5 Dimensions for deva.metal® spherical bearings, FLOATING BEARING version



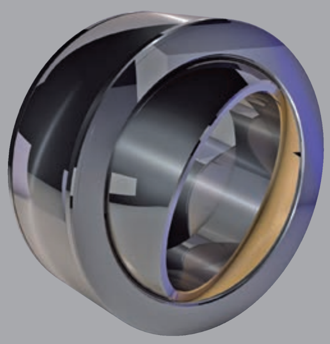


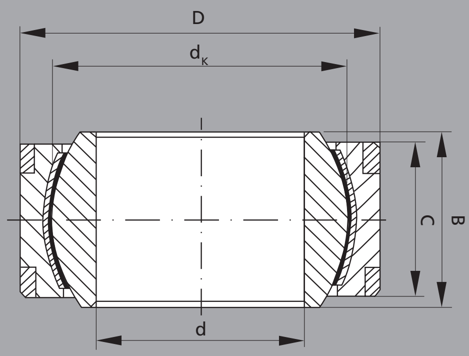
Floating bearings deva.metal

Dimensions for deva.metal spherical bearings				Table 3.5.1
d [mm]	**d_k** [mm]	**D** [mm]	**C** [mm]	**B** [mm]
25	35	42	19	20
30	42	48	21	22
35	47	55	24	25
40	53	62	27	28
50	66	75	33	35
60	80	90	42	44
70	94	105	47	49
80	110	120	53	55
90	119	130	58	60
100	134	150	68	70
110	140	160	73	75

Intermediate sizes upon request.

3.6 Dimensions for deva.bm® spherical bearings, FIXED BEARING version



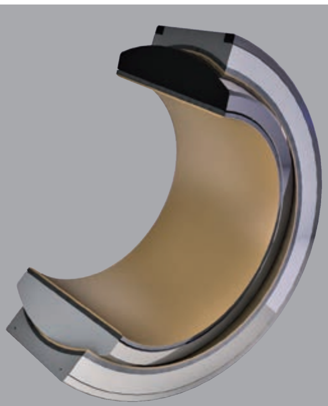


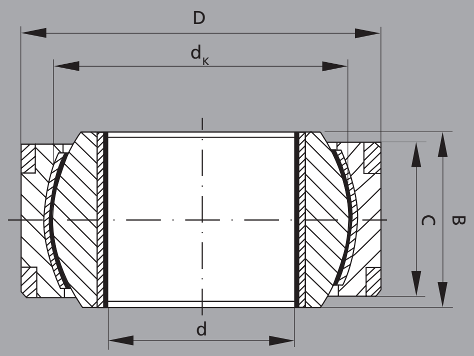
Fixed bearings deva.bm

Dimensions for deva.bm spherical bearings				Table 3.6.1
Dimensions				
d [mm]	**d_k** [mm]	**D** [mm]	**C** [mm]	**B** [mm]
20	29	35	14	16
25	35,5	42	18	20
30	40,7	48	20	22
35	47	55	23	25
40	53	62	26	28
50	66	75	33	35
60	80	90	42	44
70	92	105	47	49
80	105	120	53	55
90	115	130	58	60
100	130	150	68	70
120	160	180	81	85
140	180	210	86	90
160	200	230	100	105
180	225	260	100	105
200	250	290	125	130

Intermediate sizes upon request.

3.7 Dimensions for deva.bm® spherical bearings, FLOATING BEARING version



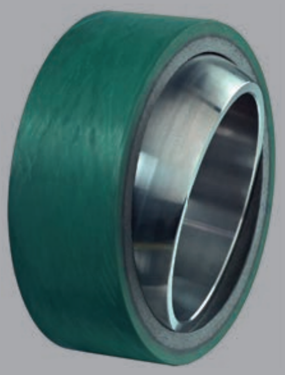


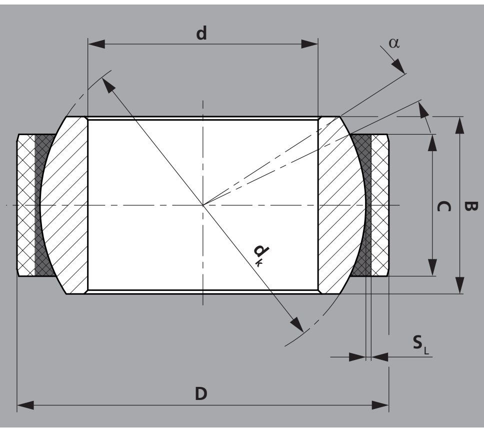
Floating bearings deva.bm

Dimensions for deva.bm spherical bearings				Table 3.7.1
Dimensions				
d [mm]	d_k [mm]	**D** [mm]	**C** [mm]	**B** [mm]
20	29	35	14	16
25	35,5	42	18	20
30	40,7	48	20	22
35	47	55	23	25
40	53	62	26	28
50	66	75	33	35
60	80	90	42	44
70	92	105	47	49
80	105	120	53	55
90	115	130	58	60
100	130	150	68	70
120	160	180	81	85
140	180	210	86	90
160	200	230	100	105
180	225	260	100	105
200	250	290	125	130

Intermediate sizes upon request.

3.8 Dimensions for deva.tex® spherical bearings, FIXED BEARING version





Fixed bearings deva.tex

Dimensions and load capacities for deva.tex® 552 spherical bearings — Table 3.8.1

Dimensions							Load capacities	
d [mm]	**D** [mm]	**B** [mm]	**C** [mm]	d_K [mm]	$S_{L\,min}$ [mm]	**α** [°]	C_{stat} [kN]	C_{dyn} [kN]
25	42	20	16	35.5	1.0	7	102.2	51.1
30	47	22	18	40.7	1.0	6	131.9	65.9
35	55	25	20	47	1.0	6	169.2	84.6
40	62	28	22	53	1.0	7	209.9	104.9
45	68	32	25	60	1.0	7	270.0	135.0
50	75	35	28	66	1.0	6	332.6	166.3
60	90	44	36	80	1.5	6	518.4	259.2
70	105	49	40	92	1.5	6	662.4	331.2
80	120	55	45	105	1.5	6	850.5	425.3
90	130	60	50	115	1.5	5	1035.0	517.5
100	150	70	55	130	1.5	6	1287.0	643.5
110	160	70	55	140	1.5	6	1386.0	693.0
120	180	85	70	160	1.5	6	2016.0	1008.0
140	210	90	70	180	1.5	7	2268.0	1134.0
160	230	105	80	200	2.0	8	2880.0	1440.0
180	260	105	80	225	2.0	6	3240.0	1620.0
200	290	130	100	250	2.0	7	4500.0	2250.0
220	320	135	100	275	2.0	8	4950.0	2475.0
240	340	140	100	300	2.0	8	5400.0	2700.0
260	370	150	110	325	2.0	7	6435.0	3217.5
280	400	155	120	350	2.5	6	7560.0	3780.0
300	430	165	120	375	2.5	7	8100.0	4050.0

Further sizes available on request.

The outer ring becomes slightly out of round due to cutting. The roundness of the outer ring is restored once it is fitted in the housing bore produced in accordance to the specifications. Measurements taken of the outside diameter of the unfitted bearing cannot be used as the actual values for the outside diameter.

Design properties

d = Inner diameter (bore diameter of inner steel ball) for shaft j6
D = Outer diameter for housing H7
B = Width of steel ball
C = Width of **deva.tex** 552 ring
d_K = Sphere diameter
S_L = Minimum sliding layer thickness
α = Tilt angle transverse to the bearing axis

Advice for assembly: The cut position of **deva.tex 552** ring should be perpendicular to the applied force F.

In case of applied loads close to the material limit values (dynamically and statically) the sliding layers front-faces (grey-black colored) should be partly covered by the housing or flange to prevent it against creeping.

Bearing design

4.1 Fitting guidelines for DEVA® spherical bearings

For the perfect selection of the fit, several factors play a role; for example, the design or function of the bearing (fixed or floating bearing version) absolutely must be taken into consideration.

Floating bearings offer the possibility to take up the axial and radial sliding movement between the shaft and housing bore. A corresponding running clearance should be provided here.

In the case of the fixed bearing, the sliding movement should occur only between the spherical sliding surfaces. Sliding movements along the shaft or in the housing bore must be excluded. The safest conditions are achieved with a tight fit.

Since large spherical bearings are usually installed under difficult conditions, a tight fit is not always possible. In this case the sliding bearings are mounted with the smallest possible clearance between the shaft and housing bore and must be sufficiently secured against turning and axial movement using axially acting brace mechanisms (such as holding flanges). For the dimensioning of these parts, the occurring forces in the axial direction and the direction of rotation must be taken into consideration.

It should be considered that spherical bearings are subjected to constant elastic deformation, which can lead to relative micro-movements. In this case the design should include mechanical safety devices.

4.2 Recommended tolerances for spherical bearings

Tolerances for spherical bearings — Table 4.2.1

	Fixed bearing	Fixed bearing (heavy-weight version)	Floating bearing
Internal Ø of ball	DIN ISO 12240-1	DIN ISO 12240-1	D8
Shaft	j6 / h7	h7 / g7	h7
Housing	H7 / K7	G7 / H8	H7 / K7
Outer Ø of ball ring	h7	DIN ISO 12240-1	h7
Outer Ø of ball ring, deva.tex®	k8 / r8		

These fitting suggestions exemplify under which conditions sufficient clearance exists in the installed state. There are naturally a number of reasons that lead to the selection of other fits (e.g. applications in a higher temperature range).

The values contained in the table are suggestions. Especially in the case of low-force installation fit, the external ring of a floating bearing and the external and internal rings of a fixed bearing must be secured against torsion.

4.3 Constructive arrangement

For the installed maintenance-free spherical bearing, sufficient protection must be provided against axial and radial torsion.

Since a permanent installation fit usually does not suffice, suitable design measures must be taken. Due to the bearing design, floating bearing positions have to be designed in such a way that sufficient axial movement between the ball and shaft is possible and that the external ring is permanently fixed to the bearing support. In the case of fixed bearing positions, the ball is also axially attached to the shaft on both sides.

It is easiest to support the external rings in the housing bore on a shoulder and clamp them axially on the other side using a screwed-on washer through front contact pressure (Fig. 4.3.1).

The width of the housing bore has to be designed smaller than the minimum width of the external ring of the spherical bearing.

Alternatively two retaining rings mounted on both sides can also sufficiently fix the external ring of the spherical bearing (Fig. 4.3.2).

When axial forces occur, the additional stress in the construction design of the retaining rings must be taken into consideration as well as in the determination of the screw size and number of screws required.

The ball of the fixed bearing design is generally set by supporting the ball on a shaft shoulder and an end disc provided on the end of the shaft (Fig. 4.3.3). Clamping using distance sleeves on both sides is also possible (Fig. 4.3.4).

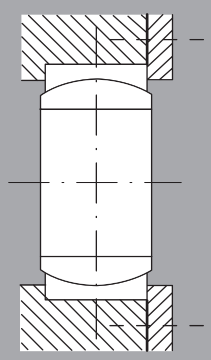


Fig. 4.3.1

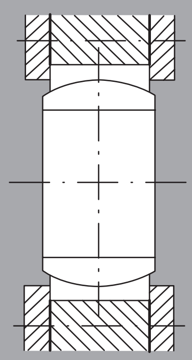


Fig. 4.3.2

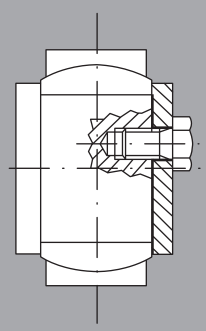


Fig. 4.3.3

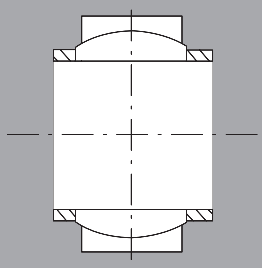


Fig. 4.3.4

Mounting

5.1 General information

To be able to utilize all advantages of spherical bearings a few important notices must be observed to optimize function and service life. Only in this way a good function and sufficient service life can be guaranteed.

Spherical bearings should be removed from the packaging directly before installation and not washed with trichloroethylene, perchloroethylene, gasoline, or other solvents.

Large spherical bearings are best transported using eyebolts for suspension when screwed into the front sides of internal or extern rings.

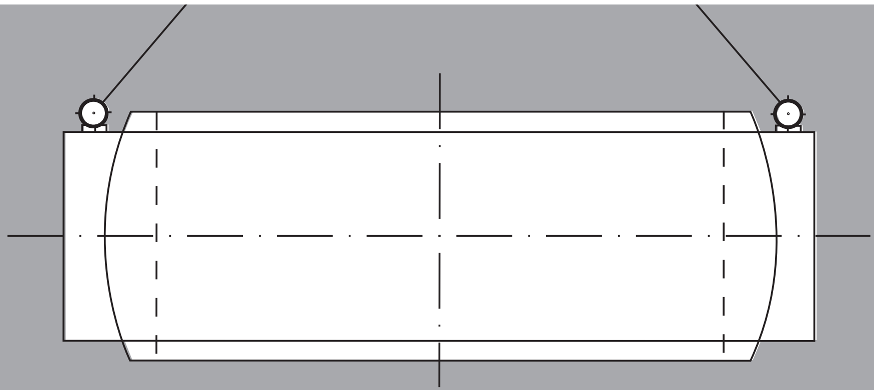


Fig. 5.1.1

Before mounting the spherical bearing, all installation parts (housing, shaft) must be checked for dimensional precision and the identity of the specified fitting recommendation must be determined. Any deviations may lead to malfunctions.

5.2 Installation

A precise, centric positioning of the spherical bearing is the basic precondition for perfect installation.

Accordingly, the housing bores and shaft ends should be chamfered 10° to 20° in axial direction.

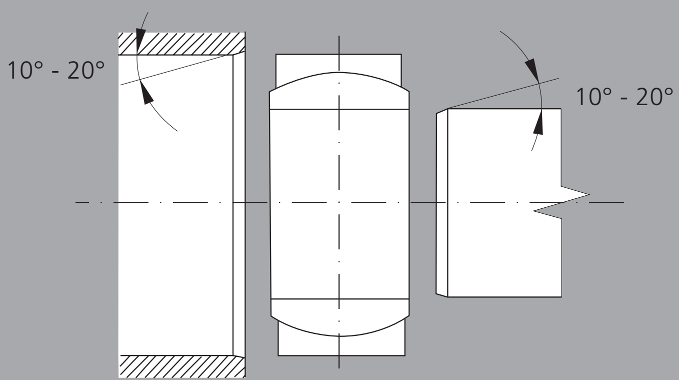


Fig. 5.2.1

For the installation of spherical bearings with cover (press-fit), an installation sleeve or tube used with a hydraulic press as the mounting force transducer provides the optimal fit of the spherical bearings. Impact damage, for example caused by installing the bearing with hammer and mandrel, must be avoided in any case.

This is particularly the case for spherical bearing types with external or internal rings made of **deva.metal®** produced in a sinter process.
Damage to the precision bearing parts can lead to serious malfunctions. Installing a spherical bearing into a housing should be done via the outer ring.

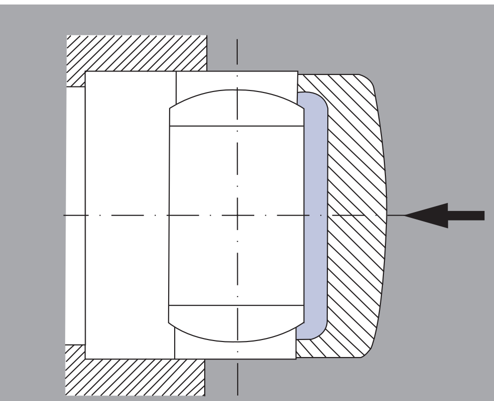


Fig. 5.2.2

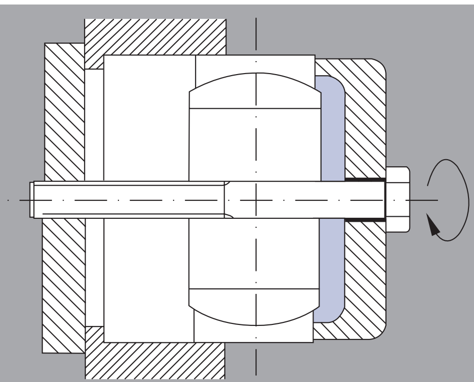


Fig. 5.2.3

Spherical bearing installation on a shaft or a bolt should be done via the inner ring.

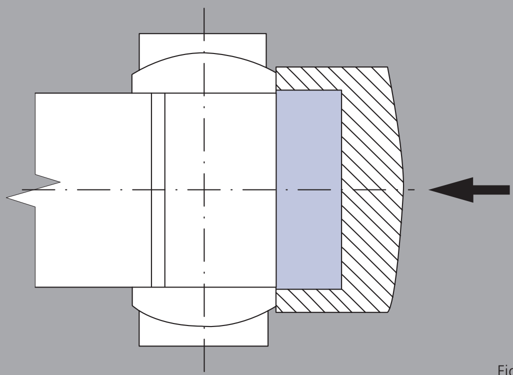


Fig. 5.2.4

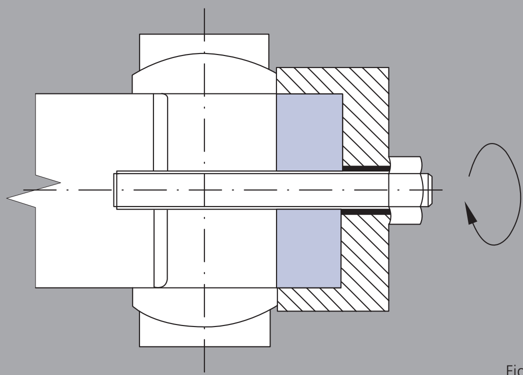


Fig. 5.2.5

Spherical bearings with axially divided external rings must be installed in such a way that the direction of load does not run through the separation joints.

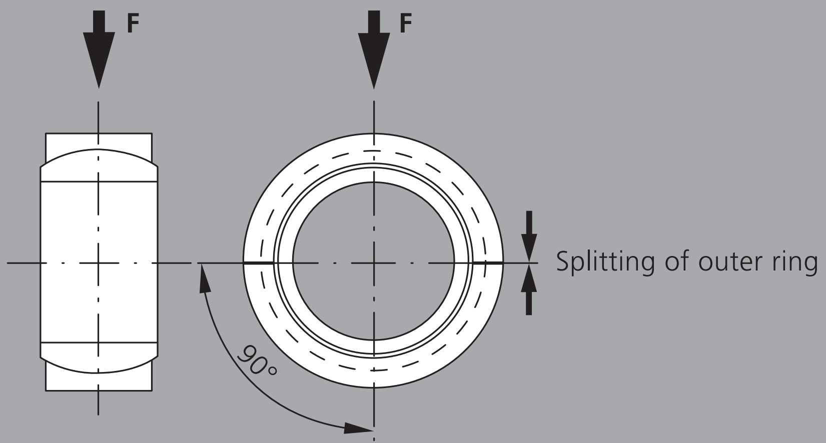


Fig. 5.2.6

Loading capacity and service life

The operating conditions are taken into consideration in the design and dimensioning of spherical bearings.

For this reason, the respective operating conditions should be precisely checked in the drafting stage. A technical data sheet can be found in the appendix for a specification of the precise operating data. The information entered in the data sheet by the designer or user is used as the basis of the calculation by our application engineers at Federal-Mogul DEVA. Within the scope of a free technical suggestion and offer, our application engineering department is available to consult with you.

If desired, the service life can be estimated. This is based on test rig experiments under laboratory conditions and should thus be seen as a reference point.

6.1 Loads

For the preselection, the occurring bearing forces are decisive. For the selection of the spherical bearing design, the respective direction of load must be taken into consideration.

Constant loads that act on a radial spherical bearing in a sole radial manner and on axial spherical bearings in a sole axial and centric manner can be used directly as the basis of the design.

If axial and radial load components occur at the same time, the combined load must be accordingly taken into consideration in the design. The ratio between the axial load $\mathbf{F_A}$ and the radial load $\mathbf{F_R}$ in the case of a radial spherical bearing should generally not exceed $\mathbf{F_A}/\mathbf{F_R} = 0.25$.

For spherical bearings with a spherical sliding surface the pressure in the sliding surface – in the case of floating bearings as well in the bore sliding surface – has to be calculated. The load carrying capacity of the spherical bearing is based on the respectively defined sliding bearing material and the permissible surface pressures or basic load ratings listed in our technical manuals.

In addition, the service life depends on the number of swivel movements or rotating speeds.

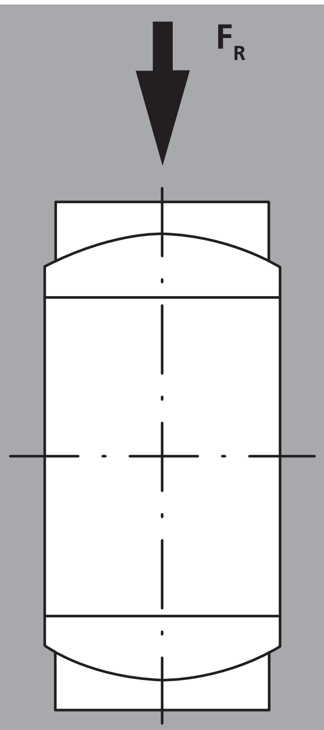


Fig. 6.1.1

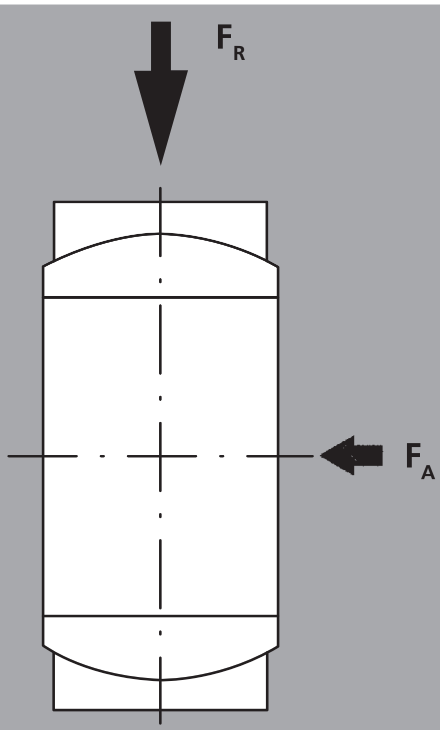


Fig. 6.1.2

6.2 Determination of the equivalent load value **P** in case of a combined load of radial and axial forces

This method is required if the spherical bearings are loaded radially and axially at the same time.
This effect of combined attacking forces is thus reduced to a single force.

The value **P** is determined using the following equations:

for radial spherical bearings

$$P = Y \times F_R$$

P = equivalent bearing load [kN]
F_R = radial bearing load [kN]
F_A = axial bearing load [kN]
Y = factor for the axial load of radial spherical bearings

The **Y** factor is always greater than or equal to 1 and can be determined in the diagram.

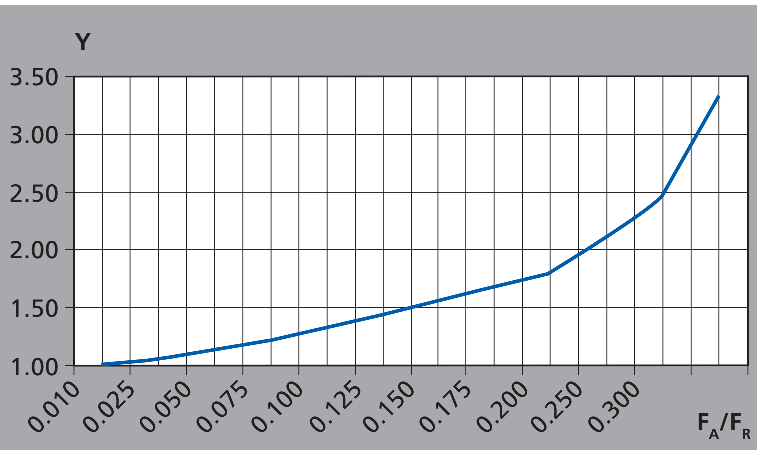


Fig. 6.2.1

6.3 Bearing pressure

To determine the size of the bearing and the prerequisite for a sufficient service life, the specific surface pressure in the sliding plane must be adapted to the respective application conditions.
To simplify matters, the project bearing surface is taken as the bearing sliding surface:

- For fixed bearings:
  Outer ball diameter × external ring width
- For floating bearings:
  Also: hole diameter × width of ball.

Constant bearing forces that radially act on a radial spherical plain bearing can be used directly as a basis for the calculation (F_R = **P**).
Under consideration of the combined load stress, only the equivalent load (**P**) should be calculated and used for the design.

$$p = P / A_{proj} < p_{zul}$$

The determination of the permissible bearing pressure of a spherical plain bearing requires a precise estimation of the respectively occurring specific application conditions.

6.4 Load coefficients

The static and dynamic load figures are the measure for loadability.

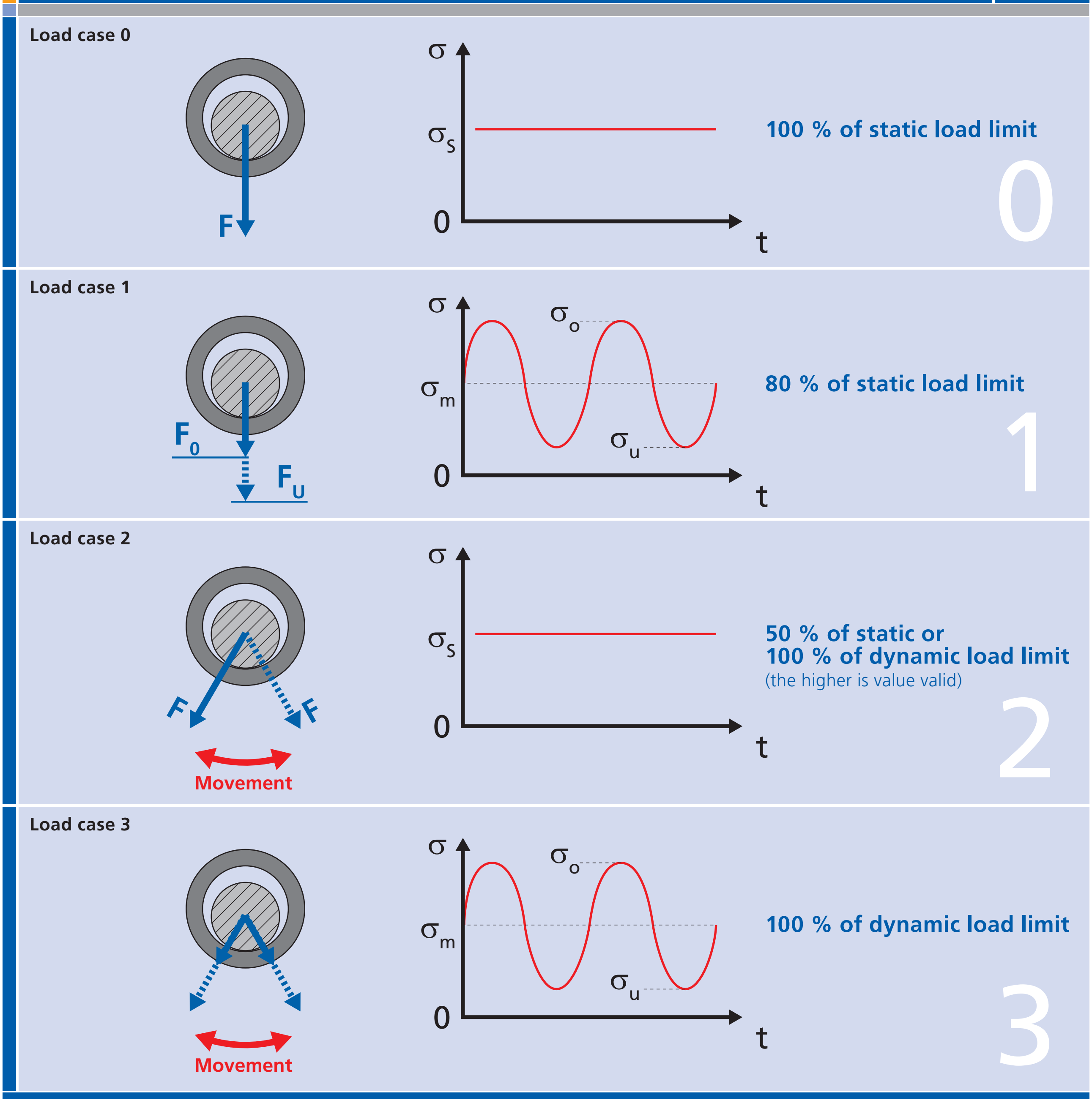
The material-specific load values are determined by Federal-Mogul DEVA and are therefore not comparable with the basic load values of other manufacturers.

The basic load values listed in the tables of dimensions only refer to applications with products from the **deva.glide**® material system.

6.5 Design considerations of fatigue aspects

DEVA differentiates load cases (0 to 3) regarding the character of load stressing a bearing. This is to consider fatigue influences in case of dynamic pressure. The percentage values are referring to the limit values described in the material data sheet or technical handbooks.

Load cases 0-3 — Figure 6.5.1



6.6 Predimensioning

To determine the required bearing size, the dynamic basic load limit rating has to be compared with the actual bearing load.

The permissible equivalent bearing load and resulting maximum specific bearing pressure depend on the desired operating time and the sliding and frictional distances covered during operation (6.6 Determination of the sliding distance).

For safe use, a ratio of **C/P** > 1 is required depending on the frequency of movement. The greater the ratio – the longer the service life.

After the dimensioning and selection of a spherical bearing type, we recommend that you contact our application engineering department. For the evaluation of all effective operating parameters, the included questionnaire should be filled in and sent to Federal-Mogul DEVA.

Note:
The basis of the calculation only refers to applications for radial spherical bearings made of **deva.glide®** for swiveling/tilting movements and ambient temperature. Influences from the sliding speed and frictional energies are not taken into consideration and should be checked by a separate calculation procedure if necessary.

6.7 Determination of the sliding distance

To estimate the expected service life, the permissible wear abrasion caused by micro-abrasion in the sliding system during movement must be determined for self-lubricating friction materials. Permissible wear abrasion results from the frequency of movement of the bearing and the connected wearing or sliding distances under load.

The sliding distance per time unit results from the number and size of the swiveling motion (angular movements from one end position to the other) and the distance covered on the sliding plane.

General information
This document shall help the experienced user to make a preselection of the suitable bearing dimension.

Sliding bearings are tribological systems, which represent a highly complex network.

In general, the question of the "duty cycle influence" (reference of the calculated friction distance to the ratio between operating time and overall service life) or secondary influences like shock, vibration, dust, exposure to corrosive media should be taken into consideration in the design.

Media, etc. should be taken into consideration in the design.

Federal-Mogul DEVA has extensive practical experience that we take into consideration for the benefit of our customers when selecting the design.

Application examples

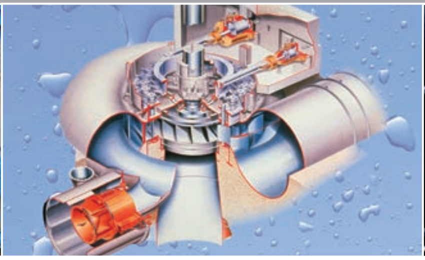
Buildings



Marine and Offshore



Hydropower


Data for the design of DEVA® spherical bearings

Questionaire 8.1

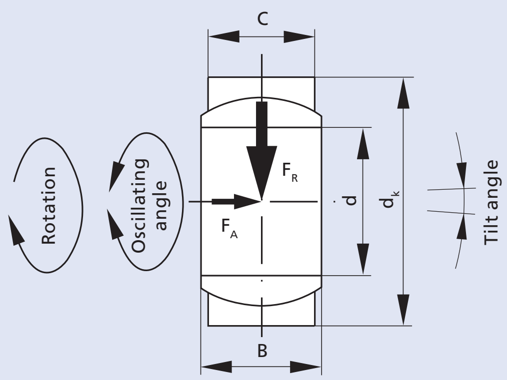
Description of application

☐ New design
☐ Existing design
Project No.

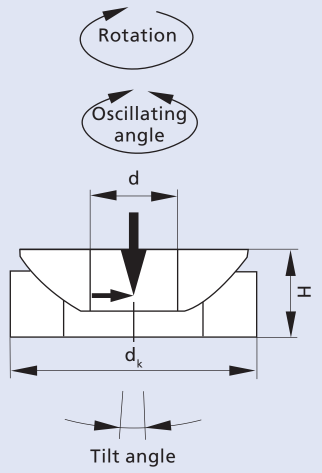
	Item 1	Item 2	Item 3
Quantity			
Bearing type	Item 1	Item 2	Item 3
Radial spherical (FLOATING)	☐	☐	☐
Radial spherical (FIXED)	☐	☐	☐
Axial bearing	☐	☐	☐
Dimensions [mm]	Item 1	Item 2	Item 3
Inner diameter d			
Outer diameter d_k			
Width inner ring C			
Width outer ring B			
Total height (Axial bearing) H			
Loading radial and axial spherical [kN]	Item 1	Item 2	Item 3
Radial load dynamic F_R			
Axial load dynamic F_A			
Radial load static F_R			
Axial load static F_A			
Movement	Item 1	Item 2	Item 3
Rotational speed [rpm]			
Rotating angle [°]			
No. of cycles [min./h/day]			
Tilt angle [°]			
Operating time	Item 1	Item 2	Item 3
Continuous operation			
Intermittent operation			
Operation time [h/day]			
Days/year			
Environmental conditions	Item 1	Item 2	Item 3
Bearing temperature			
Contact medium			
Other influences			
Limits/fits/tolerances	Item 1	Item 2	Item 3
Shaft			
Bearing housing			
Lifetime	Item 1	Item 2	Item 3
Desired operating time [h]			
Permissible wear [mm]			

Company	
Company name	
Address	
Contact person	
Phone	
Fax	
Cell-phone	
E-mail	

Radial spherical bearings (FLOATING/FIXED)



Axial bearing

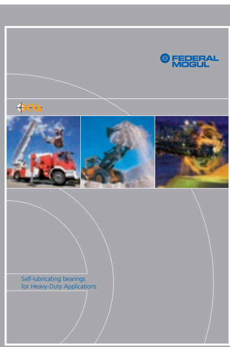


12.11

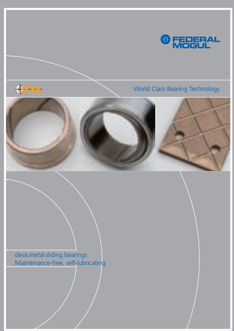
Portfolio

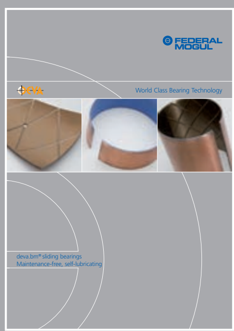

DEVA in the steel industry


DEVA in marine/offshore


DEVA in heavy-duty

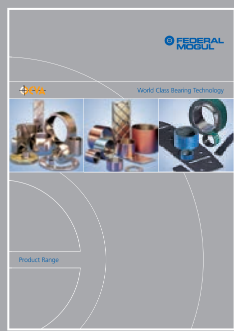
Industry solutions


deva.metal®


deva.bm®


deva.glide®


deva.tex®


Product range

Product information

Disclaimer

The present technical documentation has been prepared with care and all the information verified for its correctness. No liability, however, can be accepted for any incorrect or incomplete information. The data given in the documentation 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.

The sliding friction and wear values stated by us or appearing in catalogues and other technical documentation do not constitute a guarantee of the specified properties. They have been determined in our test facilities under conditions that do not necessarily reflect the actual application of our products and their service environment or permit comprehensive simulation in relation to them.

We provide guarantees only after written agreement of the test procedures and parameters and of all the relevant characteristics which the product is required to have.

All transactions conducted by DEVA® are subject, in principle, 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 process of development. DEVA® reserves the right to amend the specification or improve the technological data without prior notice.

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FEDERAL-MOGUL
POWERTRAIN

DEVA

Federal-Mogul DEVA GmbH
Schulstraße 20
35260 Stadtallendorf/ Germany

Phone +49 6428 701-0
Fax +49 6428 701-108

www.deva.de

www.federalmogul.com

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