

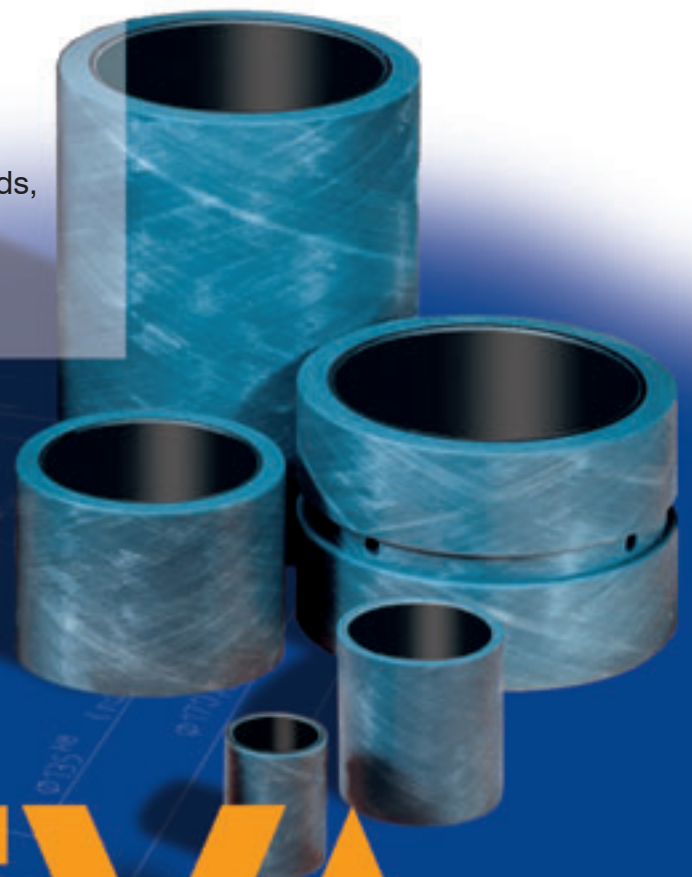
deva.tex[®]

Maintenance-free, self-lubricating bearings

Technischer Service

Our bearing service

- ✓ Profit from more than **60 years of experience in self-lubricating sliding bearings.**
- ✓ Make use of our extensive **material and application** expertise spanning a **very wide range of industries.**
- ✓ Let **our application engineering team assist you in the:**
 - selection of the bearing materials,
 - design, purpose-built to your requirements,
 - assembly and installation,
 - calculation of estimated life time.
- ✓ Benefit from the latest **material developments,** tested using **state of the art facilities.**
- ✓ Ask for a simulation of your **bearing application on our test rigs.**
- ✓ Let us **analyse your bearing problem by FEM.**
- ✓ Expect the highest quality standards, certified to **DIN ISO 9001:2000, ISO/TS 16949:2002 and DIN EN ISO 14001.**



World class bearings from **DEVA®** save time and money.

deva.tex® Technical Manual – Contents

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Introduction

Contemporary designs represent an enormous challenge for modern-day bearing materials. Zero maintenance is often expected under severe to extreme conditions as well as under maximum loads. The constant pressure on costs also calls for increasing uptime of machinery and equipment and uncompromising standards of operational reliability.

deva.tex[®] materials are suitable for applications involving sustained high static and dynamic loads, relatively low sliding speeds and rotary, angular, axial or linear motion. They are also suitable for applications where conventional lubrication is not possible or permissible, or where other properties are required such as durability and resistance to operational and environmental influences or special conditions (e.g. impact load, abrasive stress, etc).

Courtesy of
MVB Magdeburger
Verkehrsbetriebe.



1 Material properties

deva.tex® is a self-lubricating, glass-fibre reinforced composite bearing material which is produced using a special winding technology. The base material guarantees high strength, while the sliding layer contains special non-abrasive fibres and solid lubricants which ensure excellent tribological properties even in damp environments or in the event of edge loads. The solid lubricants were developed to give extremely low coefficients of friction and wear rates in dry-running conditions.

deva.tex®

- is available as a precision bearing with inner diameter H8/D8/E8, or as a standard bearing with inner diameter D11, or as a sliding plate. The required precision standard depends on the application.
- can be machined to the required inner or outer diameter.

- requires no additional lubrication.
- allows maintenance-free operation.
- can accommodate high static and dynamic loads.
- has extremely low friction and wear rates in dry-running conditions.
- has low swelling rates in liquids.
- is suitable for rotating, oscillating and linear movements.
- withstands temperatures up to 160 °C (cylindrical bearings) or 80 °C (sliding plates).
- can be used in seawater (certification for rudder bearings DNV and GL).
- can be used in corrosive environments.
- is non-sensitive to impact loads and shock loads.
- is non-sensitive to vibrations.
- is suitable for micro-movements.
- can be used in a vacuum.

Material properties

Material structure

2 Material structure

deva.tex® is a bearing material consisting of two layers. The inner layer is a sliding layer containing a special type of fibre in an epoxy resin matrix with structurally embedded solid lubricants, designed to ensure good

tribological properties. The external layer of **deva.tex®** material is characterised by a glass-fibre reinforced epoxy resin matrix which guarantees a maximum bearing load capacity.

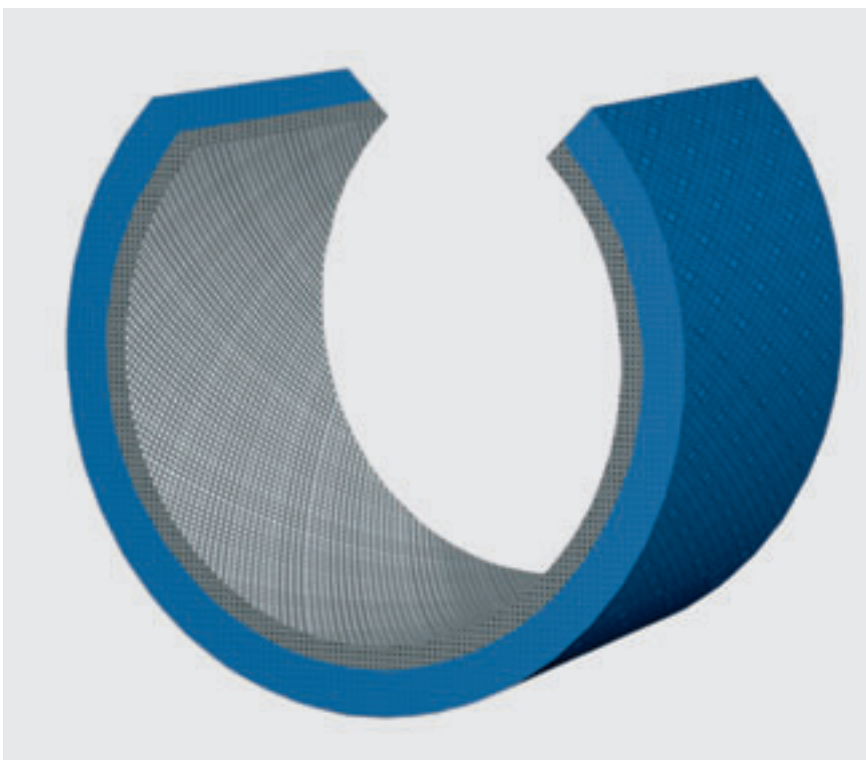


Figure 2.1 – Diagram of deva.tex® structure

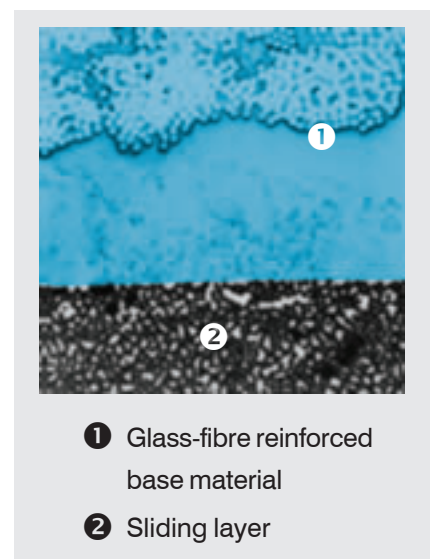


Figure 2.2 – Microsection of deva.tex®

3 Materials

3.1 Composition and properties

deva.tex®	Composition and properties ¹⁾			
	Mechanical and physical properties (min.)			
	Density	Linear coefficient of thermal expansion	Thermal conductivity factor	Compressive strength
Symbol	ρ	α_1	λ	δ
Unit	g/cm ³	10 ⁻⁶ /K	W/mK	MPa
Cyl. bearings	2	13	0.4	415
Sliding plates	2	13	0.4	200

¹⁾ Current properties and values can be found in the DEVA® material data sheets, which are available on request.

Table 3.1.1 – Composition and sliding layer properties of deva.tex®

deva.tex®	Bearing properties									
	max. permissible load		max. sliding speed	max. $\bar{p}U$ -value	Temperature range ¹⁾		Friction coefficient ²⁾	Friction coefficient ²⁾	Min. shaft hardn.	Shaft surface finish
	stat.	dyn.	dry	dry	max.	min.	dry	in water		optimal
Symbol	$\bar{p}_{stat/max}$	$\bar{p}_{dyn/max}$	U_{max}	$\bar{p}U_{max}$	T_{max}	T_{min}	f	f		R_a
Unit	MPa	MPa	m/s	MPa × $\frac{m}{s}$	°C	°C			HB	μm
Cyl. bearings	220	120	0.3	1.8	160	-100	0.03 – 0.12	0.03 – 0.12	180	0.2 – 0.8
Sliding plates	100	60	0.3	1.0	80	-100	0.05 – 0.12	0.05 – 0.12	180	0.2 – 0.8

Additional lubrication with most lithium-soap, mineral-oil based greases or silicone greases is permissible.

¹⁾ Values do not apply in continuous operation.

²⁾ The stated sliding friction coefficients are not guaranteed properties. They have been determined on our test rigs using field-proven parameters that do not necessarily reflect the actual application of our products and their service environment. We offer customer-specific friction and wear tests on request.

Table 3.1.2 – deva.tex® bearing properties

3.2 Chemical resistance

deva.tex® sliding bearings are highly resistant to corrosive environments. Table 3.2.1 provides an overview of their possible applications in various media

at room temperature. Their suitability for use with other media and chemicals should be checked in a resistance test according to DIN 50905 or ASTM D543.

Chemical substance	Conc. in %	Resistant	Non resistant
Acids			
Boric acid	10	○	
Citric acid	10	○	
Ethanoic acid	10	○	
Hydrochloric acid	10	○	
Sulphuric acid	10	○	
Arsenic acid	10		○
Carbonic acid	10		○
Hydrofluoric acid	10		○
Nitric acid	10		○
Bases			
Ammonium hydroxide		○	
Calcium hydroxide		○	
Magnesium hydroxide		○	
Potassium hydroxide		○	
Sodium hydroxide		○	
Ammonia			○
Alcohols			
Amyl alcohol		○	
Ethyl alcohol		○	
Ethylene glycol		○	
Hydroxy acetone		○	
Isopropanol		○	
Isopropylcarbinol		○	
Methanol		○	
Propanol		○	
Allyl alcohol			○
Butyl alcohol			○
Gases			
Acetylene		○	
Butane		○	
Carbon dioxide		○	
Ether		○	
Hydrogen		○	
Natural gas		○	
Nitrogen		○	
Ozone		○	
Propane		○	
Sulphur dioxide		○	
Bromide			○
Chlorine gas			○
Fluorine			○

Chemical substance	Conc. in %	Resistant	Non resistant
Fuels			
Diesel		○	
Kerosene		○	
Petroleum		○	
Solvents			
Acetone		○	
Methyl ethyl ketone		○	
Naphtaline		○	
Toluol		○	
Benzene			○
Methyl chloride			○
Trichloroethane			○
Oils			
Cottonseed oil		○	
Crude oil		○	
Gear oil		○	
Hydraulic oil		○	
Linseed oil		○	
Motor oil		○	
Salts			
Ammonium chloride		○	
Ammonium nitrate		○	
Ammonium sulphate		○	
Calcium chloride		○	
Iron chloride		○	
Magnesium carbonate		○	
Magnesium chloride		○	
Magnesium sulphate		○	
Sodium acetate		○	
Sodium bisulphate		○	
Sodium carbonate		○	
Sodium nitrate		○	
Zinc sulphate		○	
Miscellaneous			
Calcium oxide		○	
Formaldehyde		○	
Freon		○	
Water 20°C		○	
Water 100°C			○

Table 3.2.1 – Chemical properties of deva.tex®

4 Mating materials

deva.tex[®] sliding materials require the use of a mating material with a hardness of at least 180 HB. In the case of abrasive environments, a hardened mating surface should be used. The surface roughness when using **deva.tex**[®] should ideally be $R_a = 0.2$ to $0.8 \mu\text{m}$ (obtained by grinding). Rougher surfaces may also be acceptable depending on the operating conditions.

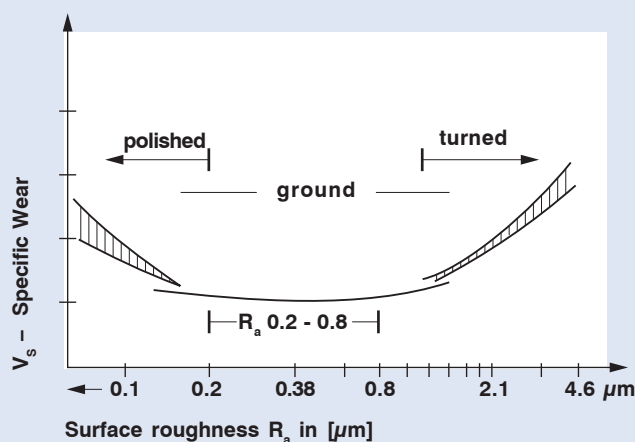
The corrosion resistance required from the mating material should be determined according to the relevant operating conditions. The adjacent table provides an overview of some possible mating materials.

Mating materials for standard applications				
Material number	DIN designation	Comparable standards		
		USA AISI	GB B.S. 9 70	F AFNOR
1.0543	St 60-2	Grade 65	55C	A60-2
1.0503	C45	1045	080M46	CC45
1.7225	42CrMo4	4140	708M40	42CD4

Mating materials for corrosive environments				
Material number	DIN designation	Comparable standards		
		USA AISI	GB B.S. 9 70	F AFNOR
1.4021	X 20Cr13	420	420S37	Z20C13
1.4057	X 22CrNi17	431	432S29	Z15CN16.02
1.4112	X 90CrMoV18	440B		(Z70CV17)
1.4122	X 35CrMo17			

Mating materials for seawater applications				
Material number	DIN designation	Comparable standards		
		USA AISI	GB B.S. 9 70	F AFNOR
1.4460	X 8CrNiMo275329			
1.4462	X2CrNiMoN22-5-3	UNS531803	318513	Z3CND24-08
2.4856	Inconel 625			

Table 4.1 – Recommended mating materials



Model representation
(based on various tests and studies)

Figure 4.1 – Influence of mating material surface roughness on the microwear of composite

5 Fits

Recommended fitting and tolerance ranges

	Fit	
	Standard	Precision
Housing bore	H7	H7
Bearing bore (after installation)	D11	D8, E8 ¹⁾ H8 ¹⁾
Shaft	h8	h7 d7, e7

¹⁾ Exception for diameter ≤ 40 mm : Quality IT9

Table 5.1 – Fits and tolerances

- **deva.tex®** is pressed into the housing with an interference fit by means of screw press, hydraulic press or press mandrel. Tapping or driving into place is not permissible.
- The standard housing bore is H7.
- Average roughness of housing:
 $R_a = 3.2 \mu\text{m}$.
- The housing should be provided with a 20 - 40° chamfer for easier installation.
- Higher precision standards (IT7 or better) can be achieved by machining the bearing bore after installation. For this purpose, **deva.tex®** can be produced with a machining allowance.
- **deva.tex®** precision bearings with inside diameters of 150 mm and above can also be installed by supercooling in liquid nitrogen.

6 Design

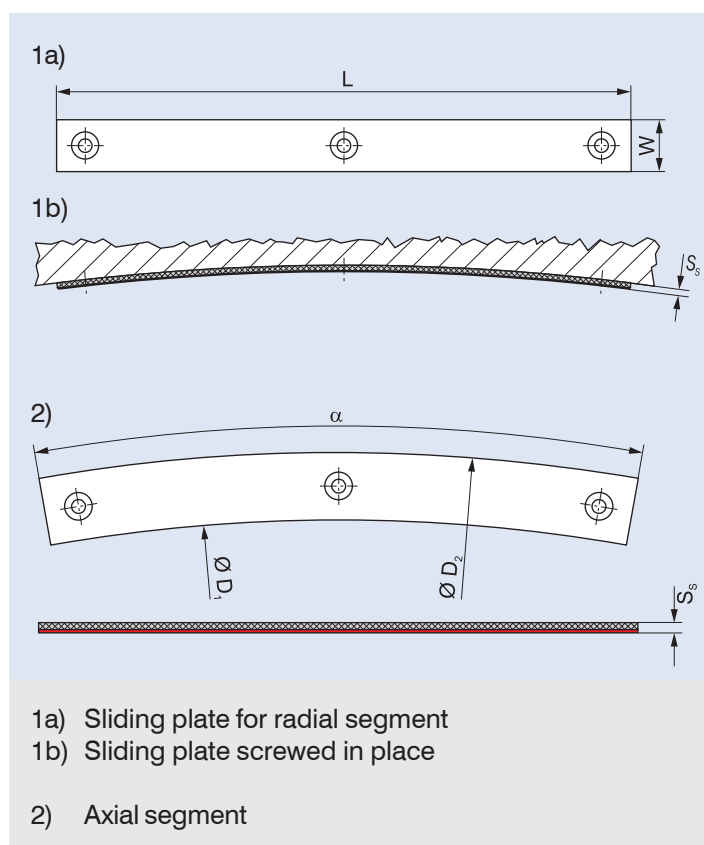


Figure 6.1 – deva.tex® radial and axial segments

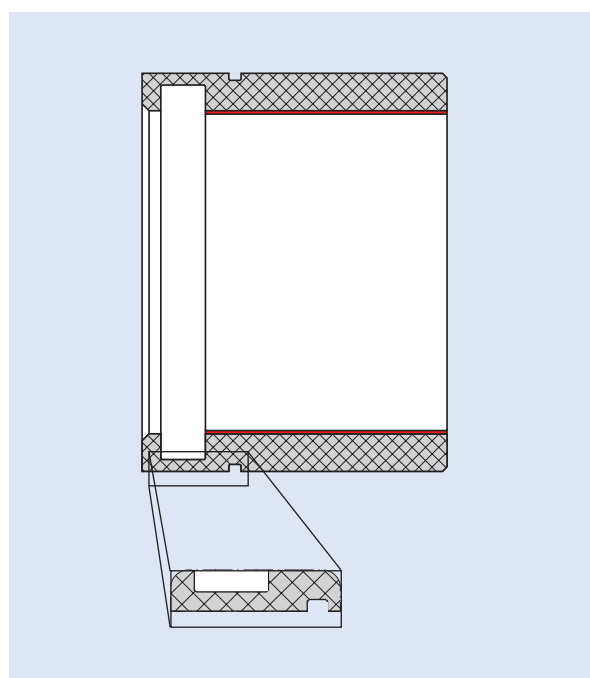


Figure 6.2 – deva.tex® guide vane bearing, water turbine

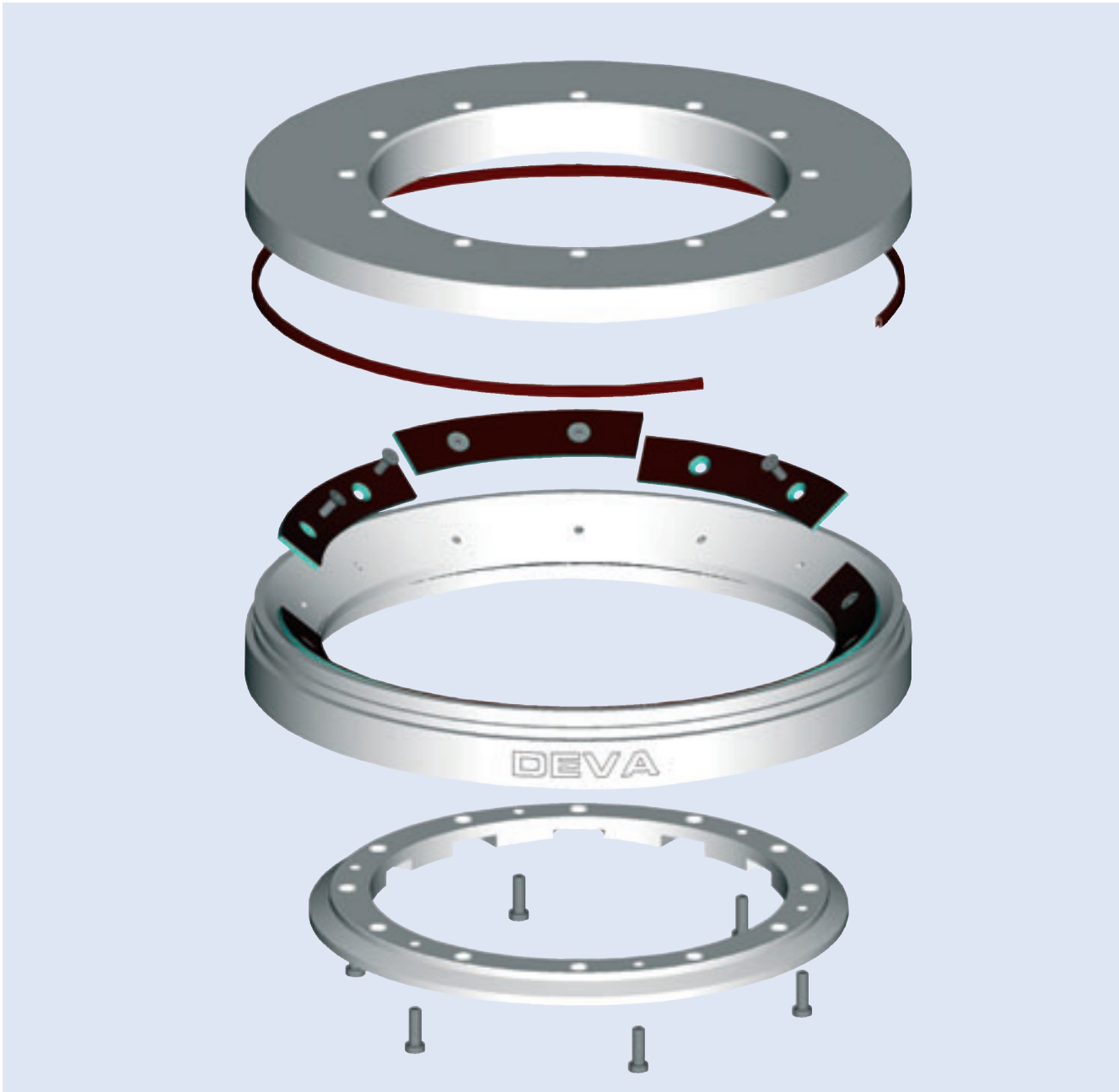


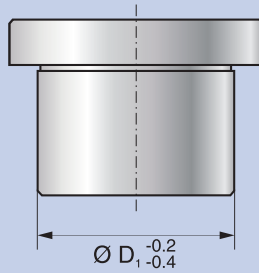
Figure 6.3 – deva.tex® rotary sliding connection in railway vehicles

7 Installation of deva.tex®

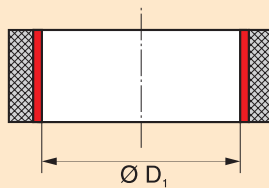
7.1 Installation of cylindrical deva.tex® bearings

Installation of deva.tex® bearings by press-fitting

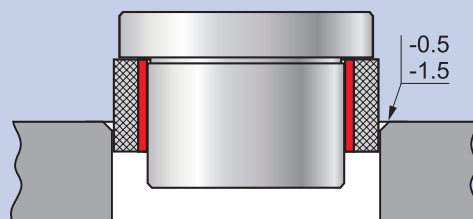
Press-fit mandrel



deva.tex® bearing



Housing



Housing with bearing

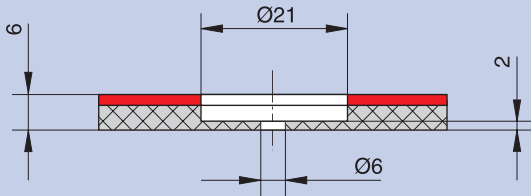


Figure 7.1.1 – Press-fitting of deva.tex® bearings

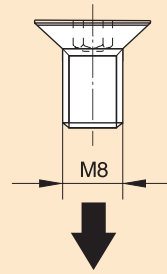
7.2 Installation of deva.tex® sliding plates

Installation of deva.tex® sliding plates with countersunk screws and fixing devices

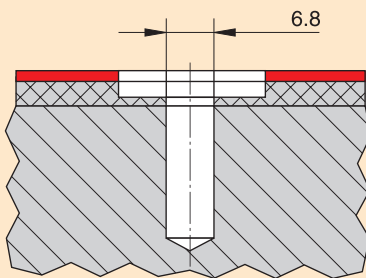
As-delivered dimensions of deva.tex®:



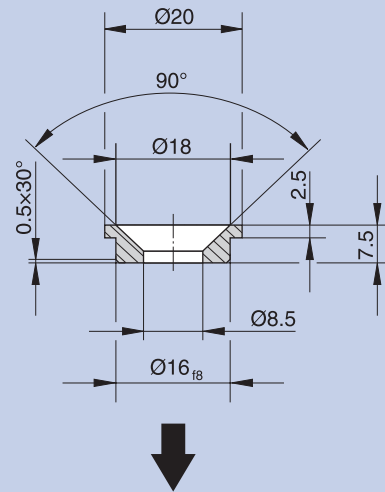
Countersunk screw (EN ISO 10642):



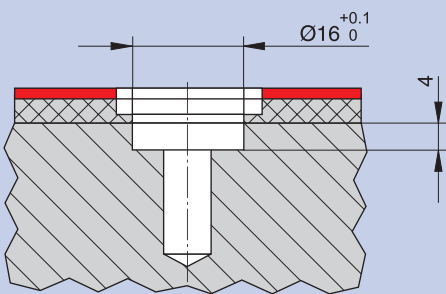
1. Drill tap hole:



Fixing clamp:



2. Apply with cylindrical counter bore:



deva.tex® sliding plate after installation:

3. Machining of metric thread:

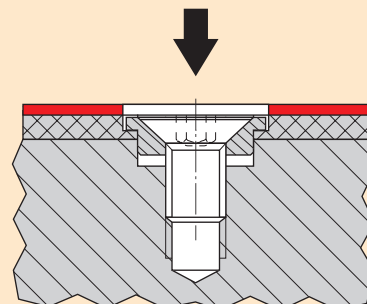
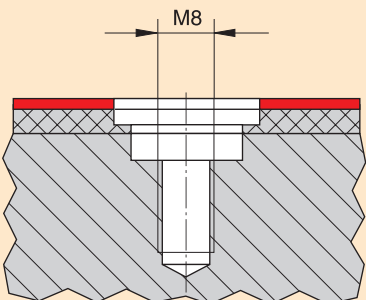
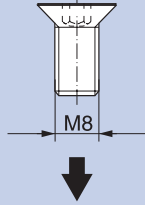


Figure 7.2.1 – Installation of deva.tex® sliding plates with countersunk screws and fixing clamp

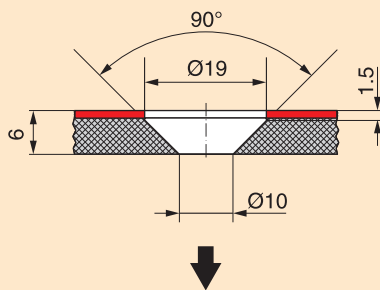
Installation of deva.tex® sliding plates with M8 countersunk screws

Preparation:

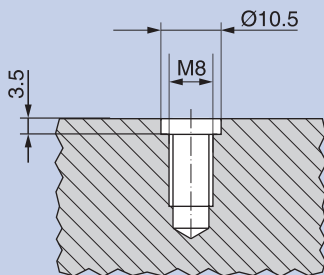
Countersunk screw M8 according to EN ISO 10642



deva.tex®

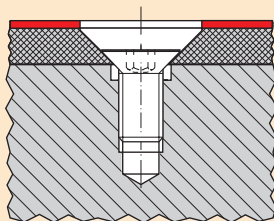


Base material



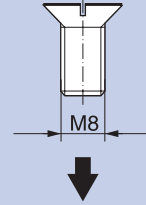
Installation:

deva.tex® after installation

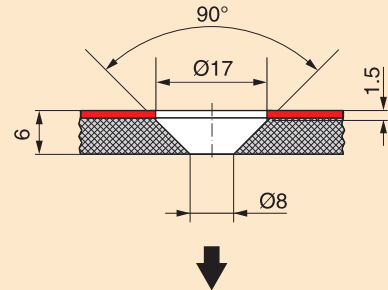


Preparation:

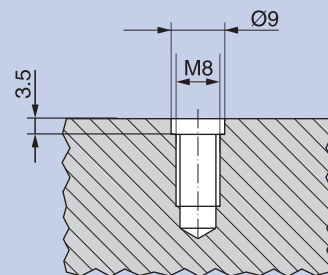
Countersunk screw M8 according to ISO 2009



deva.tex®

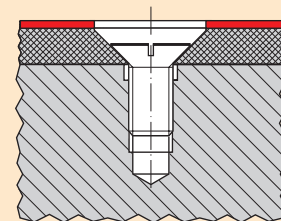


Base material



Installation:

deva.tex® after installation



Mounting:

During mounting, secure the screws with metal adhesive, e.g. LOCTITE 306.
The operating temperature limits and manufacturer's details must be observed.

Figure 7.2.2 – Installation of deva.tex® sliding plates with countersunk screws

Installation of deva.tex® sliding plates with adhesive

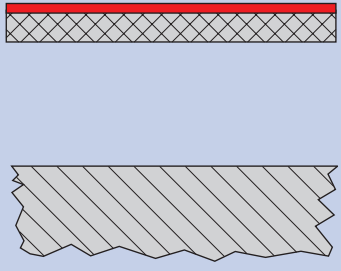
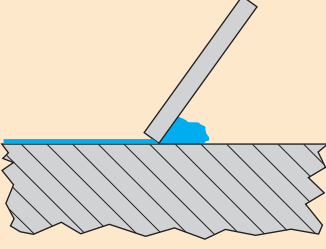
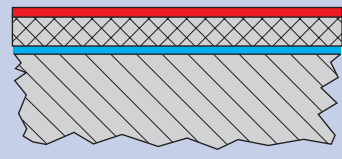
<p>Preparation: Roughen the surfaces to be joined (e.g. with emery paper, grain size 120). Clean surfaces thoroughly.</p> 	<p>Application of adhesive: Apply the adhesive using a toothed spatula (0.5 - 1 mm).</p> 	<p>Mounting: Join surfaces by applying slight pressure and leave to set.</p> 
<p>Recommended adhesive (observe manufacturer's directions): Loctite 496 or 3425</p>		

Figure 7.2.3 – Installation of deva.tex® sliding plates with adhesive

8 Recommended dimensions

8.1 Dimension table for deva.tex® cylindrical bearings

Nominal dimensions					
D ₁ ¹⁾	D ₂ ¹⁾	B ₁	D ₁ ¹⁾	D ₂ ¹⁾	B ₁
16	20	15	80	90	80
16	20	20	80	90	90
20	24	15	80	90	100
20	24	20	85	95	65
20	24	25	85	95	85
22	26	15	85	95	100
22	26	20	85	95	105
22	26	25	90	105	70
25	30	20	90	105	80
25	30	25	90	105	90
25	30	30	90	105	110
25	30	40	90	105	120
28	34	20	95	110	75
28	34	30	95	110	95
28	34	35	95	110	100
28	34	40	95	110	115
30	36	25	100	115	80
30	36	30	100	115	90
30	36	35	100	115	100
30	36	40	100	115	120
35	41	30	100	115	130
35	41	35	110	125	85
35	41	40	110	125	100
35	41	50	110	125	110
40	48	20	110	125	120
40	48	30	110	125	135
40	48	40	120	135	90
40	48	50	120	135	100
45	53	35	120	135	120
45	53	45	120	135	130
45	53	50	120	135	150
45	53	55	130	145	100
45	53	60	130	145	120
50	58	30	130	145	130
50	58	40	130	145	150
50	58	50	130	145	160
50	58	60	140	155	100
55	63	40	140	155	110
55	63	50	140	155	120
55	63	55	140	155	130
55	63	70	140	155	140
60	70	40	140	155	150
60	70	45	140	155	170
60	70	50	150	165	100
60	70	60	150	165	120
60	70	75	150	165	130
65	75	50	150	165	150
65	75	60	150	165	180
65	75	65	160	180	120
65	75	80	160	180	130
70	80	40	160	180	150
70	80	55	160	180	160
70	80	70	160	180	180
70	80	85	180	200	120
75	85	50	180	200	140
75	85	60	180	200	180
75	85	75	180	200	200
75	85	90	180	200	220
80	90	60	200	220	180
80	90	70	200	220	200

Further sizes available on request. All dimensions in mm.
¹⁾ Machining allowance for precision bearings on request.

Table 8.1.1 – Dimension table for deva.tex® cylindrical bearings

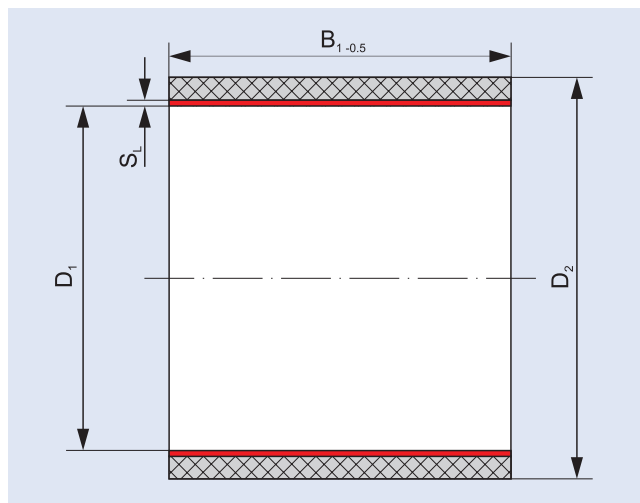


Figure 8.1.1 – Drawing of deva.tex® cylindrical bearings

The Sliding layer consists of wound fibre with embedded solid lubricant. Machined surface for precision bearings. Deburring by friction grinding. Lead-in chamfer can be produced by mechanical machining. Due to residual stresses, measurement of roundness and tolerances can only be performed after installation into housing or ring gauge.

Standard dimensions for sliding layer thicknesses

D ₁	S _L
≤ 50	0.6
≤ 100	1.0
≤ 200	1.5
≤ 300	2.0
≤ 400	2.75
≤ 500	3.5

All dimensions in mm.

Table 8.1.2 – Sliding layer thicknesses of deva.tex® cylindrical bearings

Special dimension

Minimum wall thickness: Wall thickness = $D_2 \times 0.03 + 0.7$

Possible sliding layer thicknesses

D ₁	S _L
≤ 100	max. 1.5
≤ 200	max. 3.0
≥ 200	max. 3.5

All dimensions in mm.

Table 8.1.3 – Special dimensions for deva.tex® cylindrical bearings

8.2 deva.tex® sliding plates

Dimensions of standard sliding plate

L ¹⁾	W ¹⁾	S _s ¹⁾	S _L
965 ±0.1	245 ±0.1	6.0 ^{+0.1} _{-0.05}	1.5

¹⁾ Further sizes available on request. All dimensions in mm.

Table 8.2.1 – Dimension table of deva.tex® sliding plates

Dimensions of special sliding plates

S _s	S _L
5	1
8	1.5
10	2

All dimensions in mm.

S_s = Wall thickness

S_L = Sliding layer thickness

Table 8.2.2 – Sliding layer thicknesses of deva.tex® sliding plates

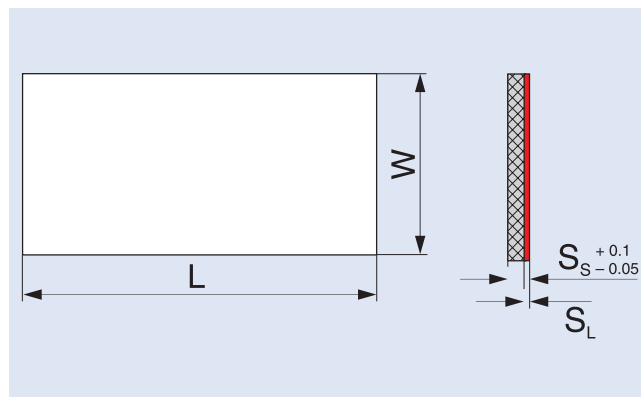


Figure 8.2.1 – Drawing of deva.tex® sliding plates

9 Order specifications for deva.tex®

Order specification for deva.tex® standard cylindrical bearings

Order designation (example):	1KB	D	100	115	100	V9
Tolerance zone ¹⁾ e.g. ▶ D (standard) = D11						
Inner diameter D ₁						
Outer diameter D ₂						
Length						
V9 = standard						

¹⁾ The tolerances of the inner diameter is the tolerance after installation into a housing bore H7.

Order specification for deva.tex® precision cylindrical bearings

Order designation (example):	1KB	E	100	115	100	V8
Tolerance zone ¹⁾ e.g. ▶ E = E8, D = D8, H = H8 (Exception: Inner diameter ≤ 40 mm quality IT9)						
Inner diameter D ₁						
Outer diameter D ₂						
Length						
V8 = Precision						

¹⁾ The tolerances of the inner diameter is the tolerance after installation into a housing bore H7.

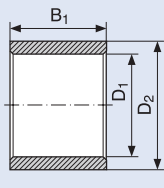
Order specification for deva.tex® sliding plates

Order designation (example):	1KE	06	245	965
Thickness S _s (Example S _s = 6 mm)				
Width W (Example W = 245 mm)				
Length L (Example L = 965 mm)				

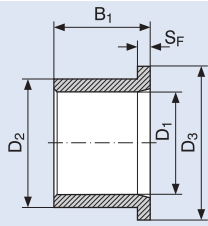
10 Data relevant to the design of DEVA® bearings

Description of application: _____

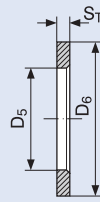
Project / No. _____ New design Existing design



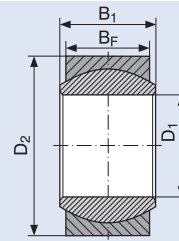
Plain bearing



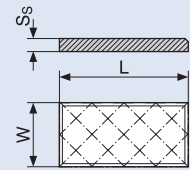
Flanged bearing



Thrust washer



Spherical bearing
 Floating bearing Fixed bearing



Sliding plate

Shaft rotates

Bearing rotates

Angular motion

Axial motion

	Item 1	Item 2	Item 3
Quantity			
Dimensions (in mm)			
Inner diameter $D_1(D_5)$			
Outer diameter $D_2(D_6)$			
Bearing width B_1			
Outer ring width B_F			
Flange outer dia. D_3			
Flange thickness S_F			
Wall thickness S_T			
Plate length L			
Plate width W			
Plate thickness S_s			

Loading	Item 1	Item 2	Item 3
Static	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dynamic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Alternating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Radial load in kN			
Axial load in kN			
Surface pressure			
Radial in MPa			
Axial in MPa			

Mating material	Item 1	Item 2	Item 3
Material No./type			
Hardness in HB/HRC			
Roughness R_a in μm			

Lubrication	Item 1	Item 2	Item 3
Dry running	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Permanent lubrication	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Medium lubrication	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Medium			
Lubricant			
Assembly lubrication	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hydrodyn. lubrication	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dynamic viscosity			

Motion	Item 1	Item 2	Item 3
Speed in rpm			
Sliding speed in m/s			
Stroke length in mm			
Double strokes/min			
Angle α°			
Frequency in n/min			

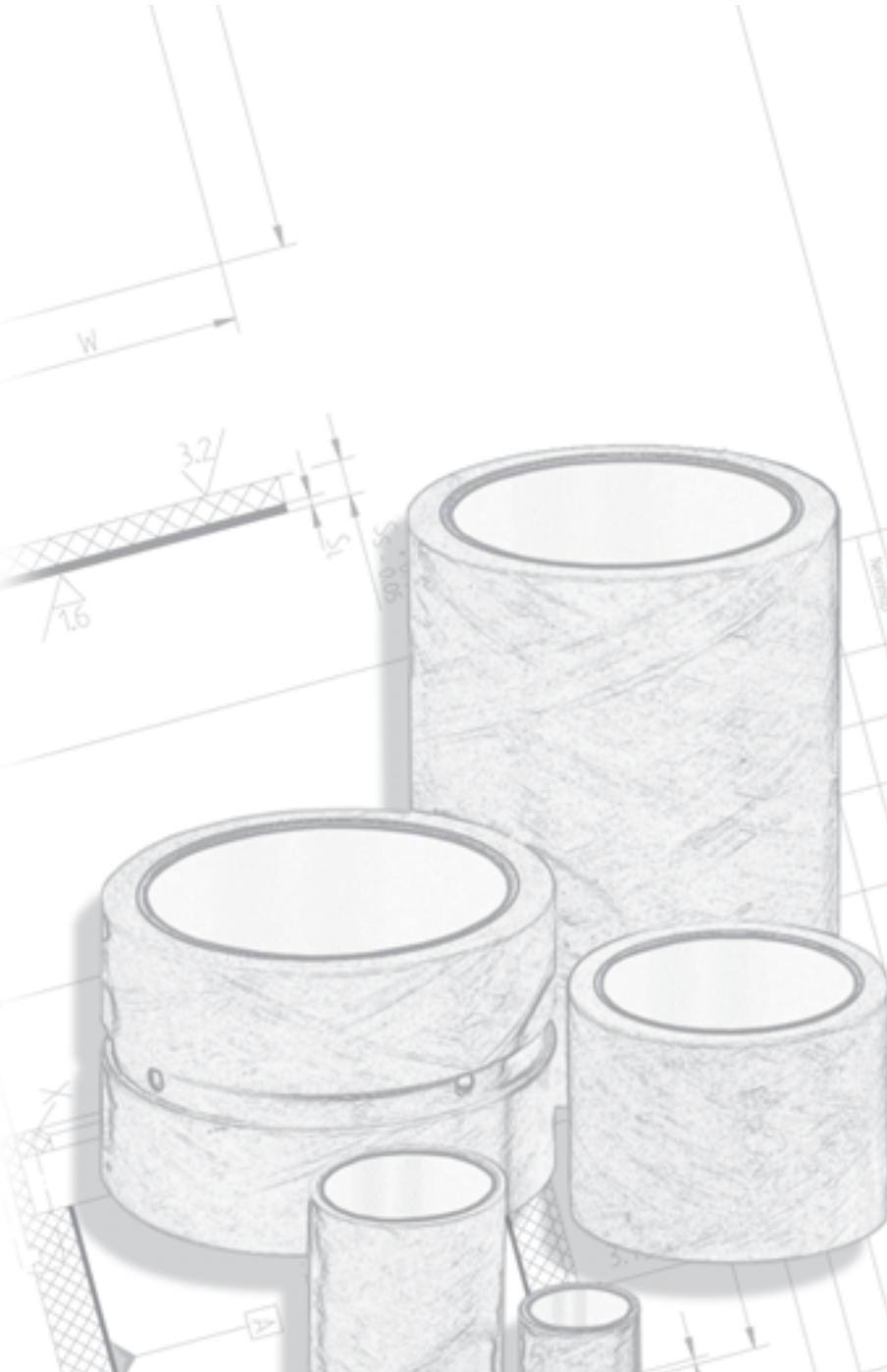
Operating time	Item 1	Item 2	Item 3
Continuous operation			
Intermittent operation			
Duty cycle	%/h	%/h	%/h
Days/years			
Frictional distance in km			

Fits and tolerances	Item 1	Item 2	Item 3
Shaft			
Bearing holder			

Environm. conditions	Item 1	Item 2	Item 3
Temperature at bearing	°C	°C	°C
Contact medium			
Other influences			

Lifetime	Item 1	Item 2	Item 3
Desired operating time	h	h	h
Permissible wear	mm	mm	mm

Company address / contact



Typ	DN-Nr.	DN	DN	DN	DN	DN	DN	DN	DN
1 und 2 sind in der Tabelle aufgeführt	3	6	30	50	400	0.5	0.8	1.2	2000
3 bis 10 sind in der Tabelle aufgeführt	0.1	0.1	0.2	0.3	0.5	0.8	1.2	2000	2000

FEDERAL-MOGUL DEVA

Gleitlager

Material: C 270000
 Zeichnung: 01003
 Zeichnung: 1KB105111
 D-35260 GERMANY

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.

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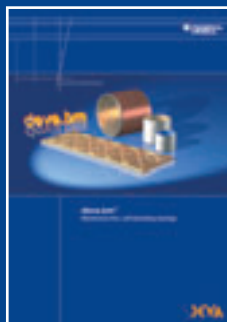
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New perspective on
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Federal-Mogul Deva GmbH

Postfach 1160 · D-35251 Stadtallendorf · Schulstrasse 20 · D-35260 Stadtallendorf

Phone +49 (0)6428 701-0 · Telefax +49 (0)6428 701-108

info@deva.de · www.deva.de