Cylindrical Roller Bearings SL04 in Rope Sheaves

SCHAEFFLER

Foreword

Construction machinery and conveying equipment are being designed as increasingly compact while their power levels are continually increasing. This increase in power density places increasingly high demands on the rolling bearings used.

This is particularly true for rope sheaves made from plastic or steel, since these must transmit very high power levels with high operational security under a wide variety of environmental and operating conditions.

The rolling bearings used are subject to very high demands in terms of functional security, rating life and environmental durability.

Rolling bearings are now used in preference if they have high load carrying capacity, are extremely reliable, have a very long rating life and are very easy to fit.

Technical and economic leadership

For applications in rope sheaves, Schaeffler offers two series of bearings giving major customer benefits. Cylindrical roller bearings with annular slots are available in the light series SL04..-PP and in the dimension series 50 as a heavy series SL0450..-PP for higher loads.

The full complement rope sheave bearings are locating bearings and have the following essential characteristics:

- very high rigidity
- high load carrying capacity, since they can support moderate axial forces in both directions as well as high radial forces
- annular slots in the outer ring for the support of retaining rings
- specially matched initial lubrication
- seals on both sides for protection of the raceway system
- the anti-corrosion coating system Corrotect.

Global competence

The central factors responsible for the global success of rope sheave bearings are extremely high quality standards in all processes and our ability to transform specific customer requirements quickly and accurately into cost-effective solutions. Thanks to the positive experience gained in numerous practical applications, it has been possible to make technical improvements on an ongoing basis.

Advice on the selection of bearings and the design of rope sheave bearing arrangements is available worldwide from application engineers and the engineering service of Schaeffler.

An addition to ...

This publication TPI 237, Cylindrical Roller Bearings SL04 in Rope Sheaves, is a supplement to Catalogue HR 1, Rolling Bearings. This Technical Product Information essentially covers the subjects relating to rope sheave bearing arrangements in construction machinery that are not described in Catalogue HR 1, Rolling Bearings.

⚠️ In the design of a bearing arrangement for rope sheaves, the relevant information in Catalogue HR 1, Rolling Bearings must always be observed.

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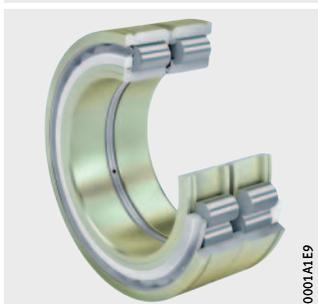
Double row
Sealed on both sides

SL0450..-PP,
SL04..-PP

0001AA93

With Corrotect coating

SL0450..-PP-RR,
SL04..-PP-RR

0001A1E9

Full complement cylindrical roller bearings with annular slots

Features

Rope sheave bearings are full complement cylindrical roller bearings with annular slots and are designed as locating bearings. These bearings are very rigid and can support moderate axial forces in both directions as well as high radial forces. They are particularly suitable for compact designs. The bearings comprise solid outer and inner rings with ribs, rib-guided cylindrical rollers and sealing rings.

The outer rings have annular slots for retaining rings. The inner rings are axially split, 1 mm wider than the outer rings and held together by a sheet metal ring.

Cylindrical roller bearings with annular slots are available in the light series SL04..-PP and in the dimension series 50 as SL0450..-PP.

Anti-corrosion coating system Corrotect

In order to ensure long operating life and high functional security of rope sheave bearings, coatings matched to the application are indispensable. With its modular coating concept, Schaeffler offers dedicated solutions for the prevention of corrosion and wear. By reducing friction, the coatings contribute to energy efficiency in the form of lower energy consumption.

Many of the coatings available in the market are, however, not always suitable and can, if used incorrectly, lead to safety problems. For many years, Schaeffler has successfully supplied cylindrical roller bearings SL04 with the suffix RR for rope sheave applications with the Cr(VI)-free thin layer coating Corrotect.

Corrotect is a zinc/iron coating with a high level of anti-corrosion protection and a coating thickness of $0,5\ \mu m$ to $3\ \mu m$. The effectiveness of the coating has been proved not only in the salt spray test to DIN EN ISO 9227 but also through practical experience in many different customer applications.

Bearings with the Corrotect coating are recommended for rope sheave applications. The thin layer coating technology allows the complete coating of bearings without any negative effect on dimensional deviations. The anti-corrosion coating system delays the development of corrosion beneath the seal lips and prevents their premature wear. It also prevents contact corrosion between the rolling elements and raceway even after long stationary periods.

Further information

- The Schaeffler modular coating concept is described in TPI 186, Higher Performance Capacity Through the Use of Coatings
- Enquiries: Surface.Technology@schaeffler.com.

Full complement cylindrical roller bearings with annular slots

Sealing

In the case of rope sheave bearings, the rolling element system is protected against contamination and moisture by polyurethane sealing rings on both sides. The seals have low friction and are particularly resistant to climate and temperature.

Where environmental condition are particularly critical, sealing of the bearings can be improved further by means of additional seals such as V-rings in the adjacent construction.

Lubrication

Cylindrical roller bearings SL04..-PP are supplied greased as standard.

All the greases used are highly suitable, in terms of moisture resistance and high load carrying capacity, for application in rope sheave bearings operating at low to moderate speeds.

If you have any questions on the subject of lubrication, the specialists in our Tribology Department will be pleased to assist you. Please consult the Schaeffler engineering service.

Standard greasing

Standard greasing is carried out using a lithium complex soap grease with a mineral oil base in accordance with GA08. This grease corresponds to DIN 51825 with an operating temperature range of −20 °C to +140 °C. The grease is also known under the former designations SM03 and L271.

Specially matched initial lubrication

Due to increasing requirements and expanded operating conditions for rope sheave bearing arrangements, specially adapted greases are used more and more frequently.

In practical applications, the principal requirements relate to operation in the low temperature range.

For many years, rope sheave bearings have therefore been lubricated using a grease in accordance with GA22, a lithium soap grease with an ester oil base. The greases to DIN 51825 are suitable for an operating temperature range of −40 °C to +80 °C.

They are characterised in particular by very low friction, especially in the low temperature range. Greases in accordance with GA22 are also known under the former designation L091 and L254.

Relubrication

Cylindrical roller bearings SL04 can be relubricated via the inner or outer ring. For this purpose, both bearing rings have an integral circumferential lubrication groove and axial lubrication holes.

It is recommended that catalogue bearings lubricated with a grease in accordance with GA08 should be relubricated using the grease Arcanol LOAD150. In the case of bearings with an initial greasing in accordance with GA22, relubrication can be carried out using a lithium soap grease to DIN 51825 KE2K−50 or DIN 51825 KEHC2K−50 and a base oil viscosity at +40 °C of $\nu = 15$ mm^2/s or $\nu = 22$ mm^2/s.

Operating temperature	As restricted by the grease and the seal material, the following applies:	

Operating temperature As restricted by the grease and the seal material, the following applies:
- −20 °C to +80 °C with standard greasing
- −40 °C to +80 °C with greasing using GA22.

Suffixes Suffixes for available designs: see table.

Available designs

Suffix	Description	Design
D	Outer ring profile developed further, with an enlarged load-bearing area and optimised edge transitions	Standard
PP	Seal on both sides	
P	Seal on one side	Special design, available by agreement only
−	Without seals	
RR	Corrosion-resistant design, with Corrotect coating on outer ring and inner ring	
C3	Radial internal clearance larger than Normal (Group N; CN)	
C4	Radial internal clearance larger than Group 3 (C3)	
C5	Radial internal clearance larger than Group 4 (C4)	
GA22	Bearing greased with lithium soap grease GA22 for expanded temperature range	
2NR	Supplied with two loose-packed retaining rings WRE	
2WR	Supplied with two loose-packed retaining rings WR	

Designation structure Cylindrical roller bearings of the light series SL04 state the bore diameter as part of the designation. Bearings of the heavy series SL0450 include a bore code in the designation, *Figure 1*.

Rope sheave bearings SL04 can be requested and ordered in different versions, *Figure 1*.

① Design
② Bore diameter
③ Bore code
④ Seals on both sides
⑤ With Corrotect coating
⑥ Radial internal clearance
⑦ Two retaining rings WRE supplied loose
⑧ Application-specific grease class

SL045034-PP-RR-C5-2NR
① ③ ④ ⑤ ⑥ ⑦

SL04170-PP-RR-C3-GA22
① ② ④ ⑤ ⑥ ⑧

Figure 1
Structure of the designation

0001A A76
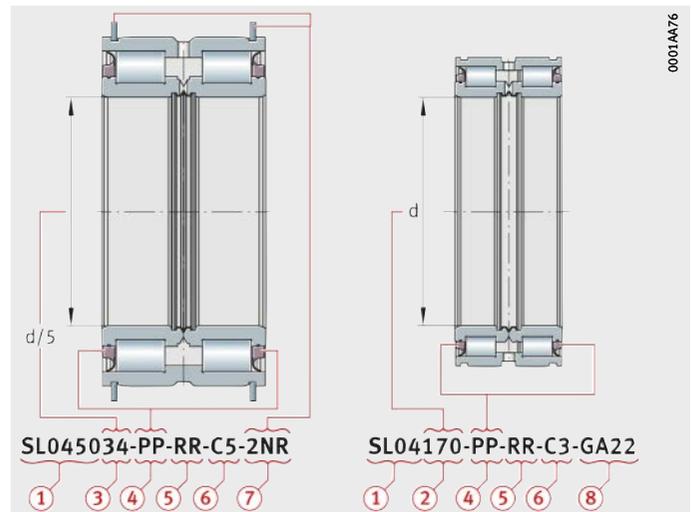
Full complement cylindrical roller bearings with annular slots

Design and safety guidelines

Static load safety factor

In addition to dimensioning on the basis of the fatigue limit life, it is advisable to check the static load safety factor S_0.

The static load safety factor indicates the security against impermissible permanent deformations in the bearing:

$$S_0 = \frac{C_0}{P_0}$$

S_0 —
Static load safety factor
C_0 (C_{0a}, C_{0r})   N
Basic static axial or radial load rating, see dimension table
P_0 N
Equivalent static bearing load.

Equivalent static load

The equivalent static load P_0 is a calculated value.

P_0 induces the same load at the centre point of the most heavily loaded contact point between the rolling element and raceway as the combined load occurring in practice.

For bearings under static loading, the following applies:

$$P_0 = F_{0r}$$

P_0 N
Equivalent static bearing load
F_{0r} N
Radial static bearing load.

Dynamic load carrying capacity and life

The fatigue behaviour of the material determines the dynamic load carrying capacity of a rolling bearing.

The dynamic load carrying capacity is described in terms of the basic dynamic load rating and the basic rating life L_{10} in accordance with DIN ISO 281.

The basic dynamic load rating C (C_a, C_r) applies to rotating rolling bearings.

The fatigue life is dependent on:
- the load
- the operating speed
- the statistical probability of the first appearance of failure.

Basic rating life

The basic rating life L_{10} is determined as follows:

$$L_{10} = \left(\frac{C_r}{P_r} \right)^{10/3}$$

L_{10} 10^6 revolutions
The basic rating life in millions of revolutions is the life reached or exceeded by 90% of a sufficiently large group of apparently identical bearings before the first evidence of material fatigue develops

C_r N
Basic radial dynamic load rating, see dimension tables

P_r N
Equivalent dynamic bearing load under radial load.

Equivalent dynamic load

The equivalent dynamic bearing load P is a calculated value. This value is constant in magnitude and direction; it is a radial load in the case of radial bearings.

A load corresponding to P will give the same rating life as the combined load occurring in practice.

For bearings under dynamic loading, the following applies:

$$P = F_r$$

Axial load carrying capacity

Cylindrical roller bearings with annular slots can support axial forces in one or both directions as well as radial forces.

The axial load carrying capacity is dependent on:

- ▪ the size of the sliding surfaces between the ribs and the end faces of the rolling elements
- ▪ the sliding velocity at the ribs
- ▪ the lubrication on the contact surfaces.

Ribs subjected to load must be supported across their entire height.

The permissible axial load $F_{a\,per}$ must not be exceeded, in order to avoid impermissibly high temperatures.

The axial limiting load $F_{a\,max}$ according to the equation must not be exceeded, in order to avoid impermissible pressure at the contact surfaces.

The ratio $F_a/F_r \leqq 0{,}4$ must be observed. Continuous axial loading without simultaneous radial loading is not permissible.

Full complement cylindrical roller bearings with annular slots

Permissible and maximum load

The axial load $F_{a\,per}$ and the limiting load $F_{a\,max}$ of bearings in the standard version are calculated as follows.

Permissible axial load

$$F_{a\,per} = k_S \cdot k_B \cdot d_M^{1,5} \cdot n^{-0,6} \leqq F_{a\,max}$$

Axial limiting load

$$F_{a\,max} = 0,075 \cdot k_B \cdot d_M^{2,1}$$

$F_{a\,per}$ N
Permissible axial load

$F_{a\,max}$ N
Axial limiting load

k_S −
Factor dependent on the lubrication method, see table

k_B −
Bearing factor, see table

d_M mm
Mean bearing diameter $(d + D)/2$, see dimension tables

n min^{-1}
Operating speed.

Factor k_S for the lubrication method

Lubrication method, heat dissipation	Factor k_S	
	from	to
Standard greasing, no heat dissipation by the lubricant	1,5	3

Bearing factor k_B

Series	Factor k_B
SL0450	17
SL04	10

Further information

Online calculation using BEARINX Easy RopeSheave:
- ▪ Precise, user-friendly calculation of rope sheave bearing arrangements can be carried out using the free of charge BEARINX calculation module Easy RopeSheave, see page 26
- ▪ http://bearinx-online-easy-ropesheave.schaeffler.com.

Design of bearing arrangements	Rope sheave bearings are normally subjected to circumferential load on the outer ring. The outer ring must therefore have a press fit.	

Design of bearing arrangements

Rope sheave bearings are normally subjected to circumferential load on the outer ring. The outer ring must therefore have a press fit.

Joint pressures between $p_{min} = 2 \ N/mm^2$ and $p_{max} = 25 \ N/mm^2$ have proved effective both in tests and in practical applications.

The decisive factors in this case are as follows:

- There is circumferential load on the outer ring
- Oblique tension occurs, leading to axial and tilting moment loads
- The axial loads occurring cannot be securely transmitted by the retaining rings. Transmission of the axial loads is only possible if sufficient joint pressure is present.
- At the possible operating temperatures of −40 °C to +80 °C, the modulus of elasticity of plastic rope sheaves leads to differences in behaviour:
  - temperatures above +20 °C lead to significant expansion
  - temperatures below +20 °C lead to significant contraction.

! Due to the operating conditions present in rope sheave bearing arrangements, an interference fit between the outer ring and rope sheave is absolutely critical in order to achieve correct bearing function and load transmission.

The joint pressure must be between $p_{min} = 2 \ N/mm^2$ and $p_{max} = 25 \ N/mm^2$.

In addition, selection of the correct internal clearance is of decisive importance, see page 15.

Surface quality

For rope sheave bearings, the following roughness values are recommended for the bearing seating surfaces, see table.

Surfaces of shaft and housing bore

Diameter of bearing seat d (D) mm		Roughness	
over	incl.	Shaft	Housing bore
20	300	Rz 4	Rz 16

Full complement cylindrical roller bearings with annular slots

Axial location

The annular slots in the bearing outer ring allow simple axial positioning of the rope sheave by means of retaining rings, *Figure 2*. Retaining rings WRE or rings to DIN 471 are suitable for this purpose. The retaining rings are not included in the scope of delivery. In the case of the design 2NR, each bearing is supplied with two retaining rings WRE packed loose.

! The split inner ring must be axially secured, *Figure 2*. The fasteners must not be subjected to axial load.

If housing tolerances are present or several rope sheaves are arranged adjacent to each other, axial clearance may occur between the inner rings. This must be prevented by means of design measures. This can be achieved, for example, by means of spacer rings.

① Retaining ring

Figure 2
Axial location of outer and inner ring, support of ribs
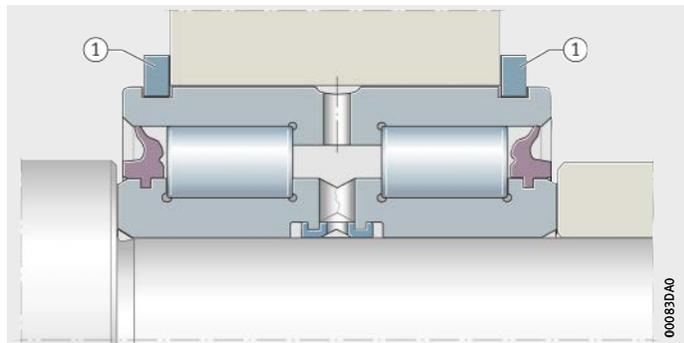
Support of sealing rings

The sealing rings must be supported to a sufficient height, so that they are not pressed out during lubrication of the bearings, *Figure 3*. The dimension d_2 must be observed, see dimension tables.

① Sealing ring
② Spacer ring
(alternatively shaft shoulder)

Figure 3
Support of sealing rings

d_2
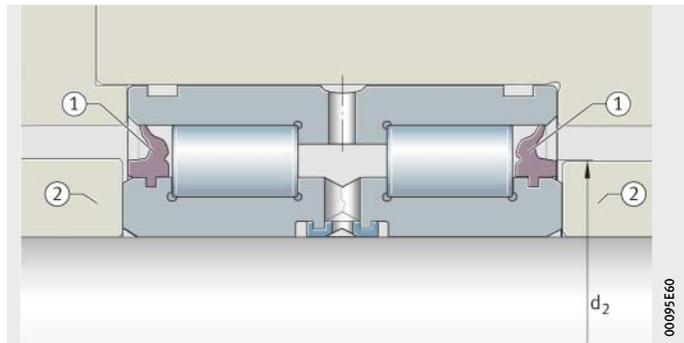
Mounting and dismounting of rope sheave bearings

Before the bearing is pressed into the rope sheave, it is recommended that the bearing seating surfaces should be lightly oiled or alternatively rubbed or sprayed with dry lubricant. In order to prevent bearing damage and inaccurate seating of the bearings, pressing in should be carried out on a suitable device with control of force and travel, *Figure 4*.

! During mounting and dismounting of the bearings, the mounting forces must never be directed through the rolling elements, sealing rings or the fasteners on the split inner ring.

Figure 4
Mounting with control of force and travel

Thermal mounting and dismounting

In order to facilitate the pressing-in operation, the rope sheave can be heated. Appropriate tools for steel rope sheaves are available from Schaeffler.

Further information

◻ Comprehensive information on mounting and dismounting is given in Catalogue HR 1, Rolling Bearings, and the Catalogues MH 1, Mounting Handbook (Mounting of rotary bearings) and IS 1, Mounting and Maintenance of Rolling Bearings.

# Full complement cylindrical roller bearings with annular slots

Guidelines for mounting

During the mounting of cylindrical roller bearings SL04, mounting forces should be applied only to the bearing ring to be mounted, *Figure 5*.

⚠️ Mounting forces must not be directed through the cylindrical rollers, *Figure 6*. During dismounting of the bearings, the dismounting forces must not be directed through the fasteners on the split inner ring.
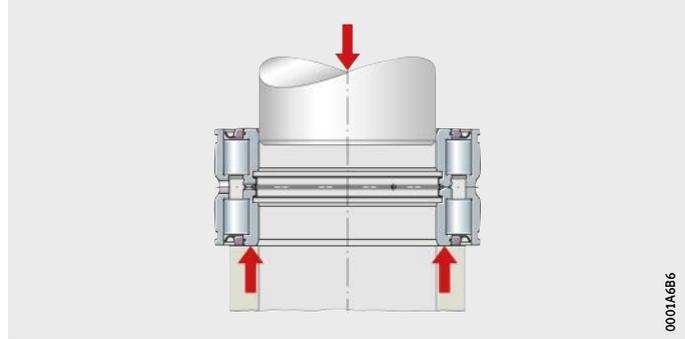
Figure 5
Application of mounting forces
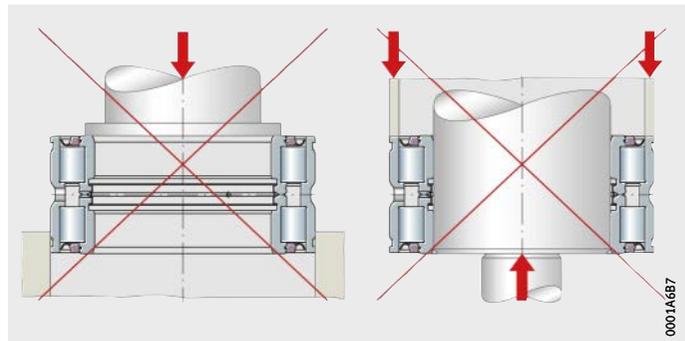
Figure 6
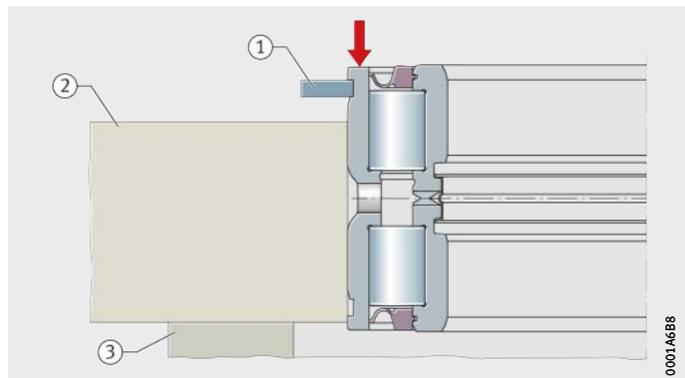Impermissible mounting or dismounting methods

Mounting with a premounted retaining ring

If bearings with a premounted retaining ring are pressed into the rope sheave, this must be always carried out with monitoring of force (or alternatively with monitoring of travel), *Figure 7*.

① Retaining ring
② Rope sheave
③ Surface for support of mounting forces

Figure 7
Mounting
with a premounted retaining ring

| | Accuracy | The dimensional and running tolerances of the bearings correspond to tolerance class Normal (P0) in accordance with ISO 492 (DIN 620). |

Accuracy

The dimensional and running tolerances of the bearings correspond to tolerance class Normal (P0) in accordance with ISO 492 (DIN 620).

Shaft and housing fits

For the shaft fit, the tolerance class g6 Ⓔ is always recommended. The recommended housing fits are dependent on the material of the rope sheave, see table.

Housing fits

Bore of rope sheave D		Material of rope sheave	
mm		Tolerance class[1]	
from	to	Steel	Plastic
–	130	P7	−0,4% to −0,5% (guide values)
130	460	R7	

[1] The envelope condition Ⓔ applies here.

Radial internal clearance

The radial internal clearance groups correspond to ISO 5753-1 (DIN 620-4), see table. The recommended internal clearance is dependent on the material of the rope sheave, see table.

Recommended internal clearance group

Bore d		Material of rope sheave	
mm		Internal clearance class	
from	to	Steel	Plastic
–	85	Group N (CN) or Group 3 (C3)	Group 5 (C5)
90	–	Group 3 (C3)	

Radial internal clearance

Bore	Radial internal clearance							
d	Group N		Group 3		Group 4		Group 5	
mm	μm		μm		μm		μm	
over	incl.	min.	max.	min.	max.	min.	max.	min.	max.
–	24	20	45	35	60	50	75	65	90
24	30	20	45	35	60	50	75	70	95
30	40	25	50	45	70	60	85	80	105
40	50	30	60	50	80	70	100	95	125
50	65	40	70	60	90	80	110	110	140
65	80	40	75	65	100	90	125	130	165
80	100	50	85	75	110	105	140	155	190
100	120	50	90	85	125	125	165	180	220
120	140	60	105	100	145	145	190	200	245
140	160	70	120	115	165	165	215	225	275
160	180	75	125	120	170	170	220	250	300
180	200	90	145	140	195	195	250	275	330
200	225	105	165	160	220	220	280	305	365
225	250	110	175	170	235	235	300	330	395
250	280	125	195	190	260	260	330	370	440
280	315	130	205	200	275	275	350	410	485
315	355	145	225	225	305	305	385	455	535
355	400	190	280	280	370	370	460	510	600

Rope sheave bearings

Cylindrical roller bearings
with annular slots
Full complement, sealed
Locating bearings
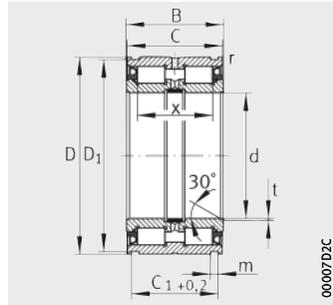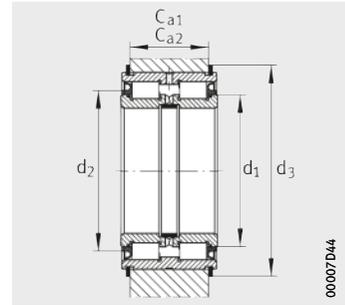
SL0450..-PP,
SL04..-PP

Mounting dimensions

Dimension table · Dimensions in mm											
Designation[1]	Mass	Dimensions									
	m	d	D	B	C	C_1	D_1	m	r	t	x
	$\approx$ kg					+0,2			min.		
SL045004-PP	0,2	**20**	42	30	29	24,7	40,2	1,8	0,3	0,5	22,5
SL045005-PP	0,24	**25**	47	30	29	24,7	45,2	1,8	0,3	0,5	22,5
SL045006-PP	0,37	**30**	55	34	33	28,2	53	2,1	0,3	0,5	25,5
SL045007-PP	0,48	**35**	62	36	35	30,2	60	2,1	0,3	0,5	27,5
SL045008-PP	0,56	**40**	68	38	37	32,2	65,8	2,7	0,6	0,8	28,5
SL045009-PP	0,7	**45**	75	40	39	34,2	72,8	2,7	0,6	0,8	30,5
SL045010-PP	0,76	**50**	80	40	39	34,2	77,8	2,7	0,6	0,8	30,5
SL045011-PP	1,18	**55**	90	46	45	40,2	87,4	3,2	0,6	1	36
SL045012-PP	1,26	**60**	95	46	45	40,2	92,4	3,2	0,6	1	36
SL045013-PP	1,33	**65**	100	46	45	40,2	97,4	3,2	0,6	1	36
SL045014-PP	1,87	**70**	110	54	53	48,2	107,1	4,2	0,6	1	42
SL045015-PP	1,96	**75**	115	54	53	48,2	112,1	4,2	0,6	1	42
SL045016-PP	2,71	**80**	125	60	59	54,2	122,1	4,2	0,6	1,5	48
SL045017-PP	2,83	**85**	130	60	59	54,2	127,1	4,2	0,6	1,5	48
SL045018-PP	3,71	**90**	140	67	66	59,2	137	4,2	0,6	1,5	54
SL045019-PP	3,88	**95**	145	67	66	59,2	142	4,2	0,6	1,5	54
SL045020-PP	3,95	**100**	150	67	66	59,2	147	4,2	0,6	1,5	54
SL045022-PP	6,57	**110**	170	80	79	70,2	167	4,2	0,6	1,8	64
SL045024-PP	7,04	**120**	180	80	79	71,2	176	4,2	0,6	1,8	64
SL045026-PP	10,5	**130**	200	95	94	83,2	196	4,2	0,6	1,8	77
SL04130-PP	7,5	**130**	190	80	79	71,2	186	4,2	0,6	1,8	64
SL045028-PP	11,1	**140**	210	95	94	83,2	206	5,2	0,6	1,8	77
SL04140-PP	8	**140**	200	80	79	71,2	196	4,2	0,6	1,8	64
SL045030-PP	13,3	**150**	225	100	99	87,2	221	5,2	0,6	2	80
SL04150-PP	8,4	**150**	210	80	79	71,2	206	5,2	0,6	1,8	64
SL045032-PP	16,6	**160**	240	109	108	95,2	236	5,2	0,6	2	89
SL04160-PP	8,8	**160**	220	80	79	71,2	216	5,2	0,6	1,8	64

[1] Improved outer ring profile of rope sheave bearings SL04 available by agreement,
for example SL045020-D-PP.

[2] For snap rings WRE.

[3] For retaining ring to DIN 471.

Mounting dimension					Basic load ratings		Fatigue limit load	Limiting speed	Snap ring WRE	Retaining ring to DIN 471
C_{a1}[2]	C_{a2}[3]	d_1	d_2	d_3[2]	dyn. C_r	stat. C_{0r}	C_{ur}	n_G grease		
$-0,2$	$-0,2$				N	N	N	min^{-1}		
21,5	21	30,55	34	47	41 500	51 000	6 900	4 000	WRE42	42×1,75
21,5	21	35,35	39	52	46 000	60 000	8 100	3 600	WRE47	47×1,75
25	24	40,6	44	60	50 000	67 000	9 500	3 000	WRE55	55×2
27	26	46,1	50	67	63 000	88 000	12 400	2 600	WRE62	62×2
28	27	51,4	55	75	80 000	111 000	16 000	2 400	WRE68	68×2,5
30	29	57	61	82	97 000	139 000	19 900	2 200	WRE75	75×2,5
30	29	61,8	66	87	102 000	151 000	21 700	2 000	WRE80	80×2,5
35	34	68,6	73	99	120 000	186 000	25 500	1 800	WRE90	90×3
35	34	73,7	79	104	125 000	201 000	27 500	1 700	WRE95	95×3
35	34	78,8	84	109	130 000	215 000	29 500	1 600	WRE100	100×3
43	40	84,5	91	119	175 000	275 000	36 000	1 400	WRE110	110×4
43	40	89,95	97	124	201 000	315 000	42 000	1 400	WRE115	115×4
49	46	97,1	105	137	210 000	340 000	45 000	1 300	WRE125	125×4
49	46	103,9	112	142	219 000	365 000	47 500	1 200	WRE130	130×4
54	51	109,3	118	152	305 000	510 000	69 000	1 100	WRE140	140×4
54	51	113,35	122	157	315 000	530 000	71 000	1 100	WRE145	145×4
54	51	117,35	128	162	330 000	550 000	73 000	1 000	WRE150	150×4
65	62	131,55	143	182	395 000	680 000	89 000	900	WRE170	170×4
65	63	140,9	153	196	410 000	740 000	94 000	900	WRE180	180×4
77	75	156,75	170	216	540 000	960 000	122 000	800	WRE200	200×4
65	63	150,55	160	206	430 000	790 000	99 000	800	WRE190	190×4
77	73	165,4	181	226	610 000	1 100 000	139 000	750	WRE210	210×4
65	63	159,95	170	216	445 000	840 000	104 000	750	WRE200	200×4
81	77	175,7	192	245	710 000	1 260 000	156 000	700	WRE225	225×5
65	61	174,4	185	226	465 000	920 000	111 000	700	WRE210	210×5
89	85	189	207	260	740 000	1 360 000	165 000	650	WRE240	240×5
65	61	184,05	196	236	480 000	970 000	116 000	700	WRE220	220×5

Rope sheave bearings

Cylindrical roller bearings
with annular slots
Full complement, sealed
Locating bearings
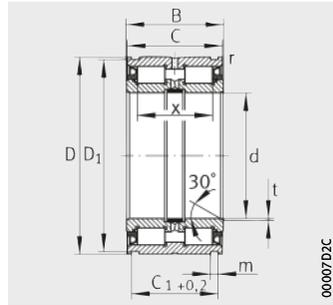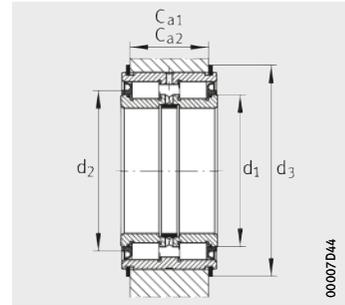
SL0450..-PP,
SL04..-PP

Mounting dimensions

Dimension table (continued) · Dimensions in mm

Designation[1]	Mass	Dimensions									
	m	d	D	B	C	C_1	D_1	m	r	t	x
	$\approx$kg					+0,2			min.		
SL045034-PP	22,6	**170**	260	122	121	107,2	254	5,2	0,6	2	100
SL04170-PP	9,3	**170**	230	80	79	71,2	226	5,2	0,6	1,8	64
SL045036-PP	30,1	**180**	280	136	135	118,2	274	5,2	0,6	2	112
SL04180-PP	9,8	**180**	240	80	79	71,2	236	5,2	0,6	1,8	64
SL045038-PP	31,5	**190**	290	136	135	118,2	284	5,2	0,6	2	112
SL04190-PP	12,7	**190**	260	80	79	73,2	254	5,2	0,6	1,8	64
SL045040-PP	40,8	**200**	310	150	149	128,2	304	6,3	0,6	2	126
SL04200-PP	13,2	**200**	270	80	79	73,2	264	5,2	0,6	1,8	64
SL045044-PP	52,5	**220**	340	160	159	138,2	334	6,3	1	2	132
SL04220-PP	19,5	**220**	300	95	94	83,2	294	5,2	1	2	72
SL045048-PP	56	**240**	360	160	159	138,2	354	6,3	1	2	132
SL04240-PP	21	**240**	320	95	94	83,2	314	6,3	1	2	72
SL045052-PP	84,5	**260**	400	190	189	162,2	394	6,3	1,1	3	150
SL04260-PP	22,5	**260**	340	95	94	83,2	334	6,3	1	3	75
SL045056-PP	90	**280**	420	190	189	163,2	413	7,3	1,1	3	150
SL045060-PP	126	**300**	460	218	216	185,2	453	7,3	1,1	3	170
SL04300-PP	25,5	**300**	380	95	94	83,2	374	6,3	1	3	75

[1] Improved outer ring profile of rope sheave bearings SL04 available by agreement,
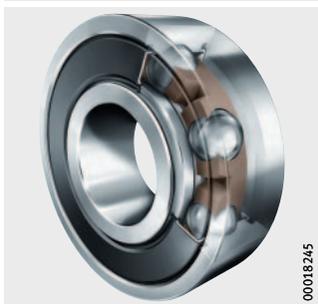for example SL045034-D-PP.

[2] For snap rings WRE.

[3] For retaining ring to DIN 471.

Mounting dimension					Basic load ratings		Fatigue limit load	Limiting speed	Snap ring WRE	Retaining ring to DIN 471
C_{a1} [2]	C_{a2} [3]	d_1	d_2	d_3 [2]	dyn. C_r	stat. C_{0r}	C_{ur}	n_G grease		
$-0,2$	$-0,2$				N	N	N	min^{-1}		
99	97	200,7	220	282	960 000	1 750 000	212 000	600	WRE260	260×5
65	61	193,9	206	250	490 000	1 030 000	120 000	650	WRE230	230×5
110	108	217,8	239	302	1 140 000	2 130 000	255 000	550	WRE280	280×5
65	61	203,1	216	260	500 000	1 080 000	125 000	600	WRE240	240×5
110	108	225,65	248	312	1 160 000	2 210 000	260 000	550	WRE290	290×5
65	63	217,55	231	282	520 000	1 160 000	131 000	550	WRE260	260×5
120	116	243,05	267	336	1 350 000	2 600 000	300 000	500	WRE310	310×6
65	63	227,15	241	292	540 000	1 210 000	136 000	550	WRE270	270×5
130	126	259,85	286	366	1 570 000	3 050 000	350 000	480	WRE340	340×6
75	73	248,7	264	322	700 000	1 550 000	174 000	480	WRE300	300×5
130	126	279,25	305	386	1 630 000	3 300 000	370 000	440	WRE360	360×6
75	71	271,7	287	346	740 000	1 700 000	186 000	480	WRE320	320×6
154	150	304,95	336	426	2 380 000	4 700 000	520 000	400	WRE400	400×6
75	71	292,7	310	366	840 000	1 990 000	215 000	440	WRE340	340×6
154	149	320,95	354	453	2 600 000	5 200 000	570 000	380	WRE420	420×7
176	171	346,85	375	493	3 000 000	5 800 000	620 000	340	WRE460	460×7
75	71	328	346	406	900 000	2 250 000	234 000	380	WRE380	380×6

Single row
With lip seals

60..-2RSR,
62..-2RSR

00018245

Deep groove ball bearings

Applications In the case of rope sheave applications with small loads, such as rope sheaves in elevators, deep groove ball bearings can also be used.

Features Single row deep groove ball bearings are versatile, self-retaining bearings with solid outer rings, inner rings and ball and cage assemblies. They are of a simple design, robust in operation and easy to maintain. They are available in open and sealed designs. Due to the raceway geometry and the use of balls, deep groove ball bearings can support axial forces in both directions as well as radial forces.

Sealing Open bearings are suitable for high to very high speeds.

Deep groove ball bearings with the suffix 2Z have gap seals on both sides and are suitable for high speeds. Bearings with the suffix 2RSR have lip seals on both sides made from nitrile butadiene rubber NBR and are suitable for moderate speeds.

By agreement, we can supply bearings with non-contact seals on both sides (suffix 2BRS). The frictional behaviour of these bearings is equally as favourable as that of bearings with seals of type Z. If the inner ring is stationary and the outer ring rotates, the lubricant loss is less than that in bearings with seals of type Z.

Lubrication Open bearings can be lubricated with grease or oil. Deep groove ball bearings with gap or lip seals on both sides are greased with a high quality grease and are lubricated for life.

Anti-corrosion protection For rope sheave applications requiring high levels of anti-corrosion protection, we offer corrosion-resistant deep groove ball bearings in sealed and open designs, see TPI 64, Corrosion-resistant Products.

Radial internal clearance The radial internal clearance corresponds to internal clearance groups in accordance with ISO 5753-1 (DIN 620-4). The corresponding values must be observed.

Further information
- The technical principles for the various deep groove ball bearings can be found in our Catalogues HR 1, Rolling Bearings and GL 1, Large Size Bearings.
- Up to a shaft diameter of $d = 90$ mm, deep groove ball bearings of Generation C are also suitable, see TPI 165, Deep Groove Ball Bearings Generation C, on the Internet at www.fag-generationc.info.

Product overview   Spherical roller bearings

Cylindrical bore
Design E1
Open

223..-E1

00084D8E

Sealed

WS223..-E1-2RSR

00084D9A

Spherical roller bearings

Features	Spherical roller bearings are double row, self-retaining units comprising solid outer rings with a concave raceway, solid inner rings and barrel rollers with cages.
	The symmetrical barrel rollers orient themselves freely on the concave outer ring raceway. As a result, shaft flexing and misalignment of the bearing seats are compensated.
X-life	Spherical roller bearings of the X-life design have improved kinematics and optimised surfaces, are made from higher performance materials and do not have a rigid central rib. As a result, the basic dynamic and static load ratings and, under identical operating conditions, the basic rating life of the bearings are significantly improved. In certain applications, this means that a smaller bearing arrangement can be designed.
	Where spherical roller bearings are used in rope sheaves, two bearings per rope sheave are necessary. If larger tolerances are present, please contact us.
	X-life spherical roller bearings have the suffix E1.
Radial and axial load carrying capacity	Spherical roller bearings can support axial loads in both directions and high radial loads. They are designed for very high load carrying capacity and, since they have the maximum possible number of large and particularly long barrel rollers, are also suitable for the heaviest loads.
	Due to the narrow osculation between the rollers and raceways, uniform stress distribution is achieved in the bearing.
Sealing	Spherical roller bearings of the standard version are supplied without seals.
	Spherical roller bearings sealed on both sides have the suffix 2RSR.
Lubrication	Open spherical roller bearings can be lubricated with oil or grease. Sealed spherical roller bearings are lubricated as standard with a grease to DIN 51502.
	In the standard version, bearings with the designation WS have a circumferential groove and three lubrication holes in the outer ring.
Operating temperature	Spherical roller bearings are dimensionally stable up to +200 °C.
	Open spherical roller bearings with metal cages can be used at operating temperatures from −30 °C to +200 °C.
	Due to their greasing and seals, sealed spherical roller bearings can be used from −20 °C to +100 °C. Spherical roller bearings 240..-2VSR-H40 and 241..-2VSR-H40 can be used up to +180 °C.
Radial internal clearance	The radial internal clearance corresponds to internal clearance groups in accordance with ISO 5753-1 (DIN 620-4). The corresponding values must be observed.
Further information	▪ TPI 218, Sealed Spherical Roller Bearings ▪ Catalogue HR 1, Rolling Bearings.

Single row

302, 303, 313, 320, 322,
323, 323..-A, 323..-B, 329,
330, 331, 332, T, K

0001AB22
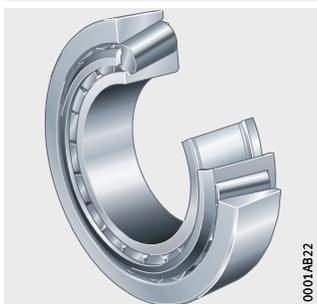
**Integral
tapered roller bearings**

Sealed on one side

JK0S

0001AB2D

Tapered roller bearings

Features
Tapered roller bearings comprise solid inner and outer rings with tapered raceways and tapered rollers in a window cage.

The bearings are available in the following designs:
- standard version
- open variant matched in pairs
- integral tapered roller bearing JK0S sealed on one side.

Open bearings are not self-retaining. As a result, the inner ring with the rollers and the cage can be mounted separately from the outer ring.

Metric and inch size bearings are available. Designs with a K in the designation have inch dimensions. For new designs, however, bearings in metric sizes should always be used in preference.

! Tapered roller bearings are not suitable for plastic rope sheaves.

For application in steel rope sheaves, one pair of tapered roller bearings, preferably in an O arrangement, must be used in each case. Please contact us.

Radial and axial load carrying capacity
Tapered roller bearings can support axial loads in one direction as well as high radial loads.

They must normally be axially adjusted against a second bearing fitted in a mirror image arrangement.

Integral tapered roller bearings
Tapered roller bearings JK0S are ready-to-fit units sealed on one side and are predominantly fitted in pairs in an O arrangement. They are not separable and do not require regreasing.

No setting of axial internal clearance required
There is no need to set the axial internal clearance of the bearing pair of integral tapered roller bearings. It is determined by the very closely toleranced projection (dimension u) between the inner and outer ring when the inner rings are clamped using a shaft nut or shaft end cover.

In order to achieve the correct axial clearance after mounting, the outer rings have a tight fit.

In the case of integral tapered roller bearings fitted in pairs in an O arrangement, a suitable slot is formed on the outer ring for the snap ring BR. The snap ring must be ordered separately.

Sealing
Integral tapered roller bearings JK0S have a lip seal on one side.

Lubrication
Integral tapered roller bearings JK0S are filled with a high quality grease.

Operating temperature
Bearings with a lip seal can be used at operating temperatures from −30 °C to +110 °C, restricted by the grease and sealing ring material.

Cages
In the case of integral tapered roller bearings JK0S, the cages are made from glass fibre reinforced polyamide 66.
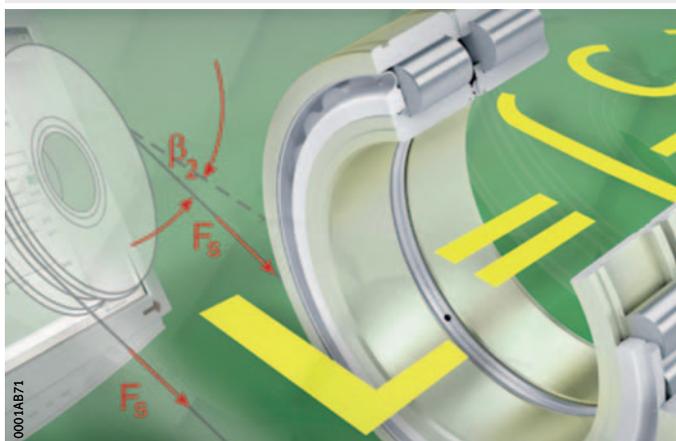
Further information
- Catalogue HR 1, Rolling Bearings and
  TPI 151, Integral Tapered Roller Bearings JK0S.

Calculation of rope sheave bearing arrangements

Easy RopeSheave

BEARINX-online Easy RopeSheave

Calculation of rope sheave bearing arrangements

In order to ensure the correct use of products, Schaeffler offers the necessary support in partnership with the customer, from the very first design idea to delivery of the products. A key component in design advisory work is the design of the rolling bearings. The optimum design of products gives Schaeffler customers a competitive advantage. To this end, Schaeffler has been successfully using calculation programs for many years.

BEARINX-online

Through the use of BEARINX, specific bearing loads can be calculated in detail, represented and documented taking account of operating and environmental conditions. The contact pressure on each individual rolling element is included in the process.

BEARINX takes account of factors including the following:

- the non-linear elastic deflection behaviour of rolling elements
- elasticity of the bearing rings
- displacements in contact angle induced by load
- the actual contact pressure taking account of the misalignment and profiling of rolling elements.

Calculation module Easy RopeSheave

There is a separate BEARINX-online module for rope sheave bearing arrangements, which can be used for the precise calculation of rope sheaves arranged adjacent to each other, *Figure 1*.

In addition to the existing BEARINX-online software, the new module Easy RopeSheave is a logical addition to the Easy range of proven calculation programs.

Easy RopeSheave can be used to calculate the static load safety factor and basic rating life of single or multiple rope sheave bearing arrangements. Easy RopeSheave has access to the Schaeffler bearing database. It is possible to integrate cylindrical roller bearings, ball bearings or tapered roller bearings without difficulty.

① Rope sheave with cylindrical roller bearing SL04
② A maximum of 8 rope sheaves can be calculated using the module
③ Plastic rope sheaves with integrated steel bush

Figure 1
View in BEARINX, rope sheaves arranged adjacent to each other
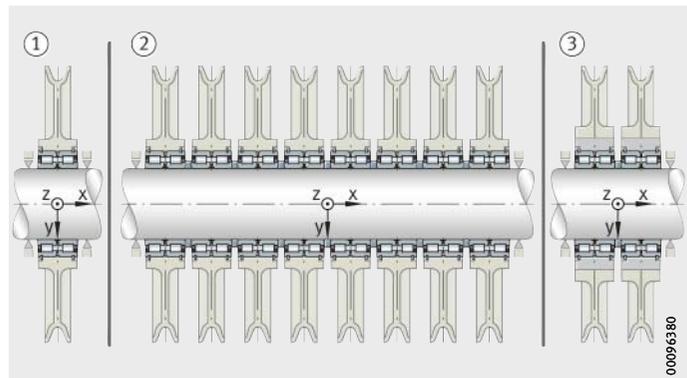
BEARINX-online Easy RopeSheave

<table>
<tr><td>Influencing factors typical for the application</td><td>The following influencing factors typical for the application are taken into consideration:</td></tr>
</table>

Influencing factors typical for the application | The following influencing factors typical for the application are taken into consideration:
■ location of the bearing on the shaft
■ material of the rope sheave
■ integration of a bush between the bearing and plastic rope sheave
■ operating temperature range
■ possible deformations of adjacent components (shaft or rope sheave).

User-friendly interface

Data can be inputted quickly and easily thanks to the self-explanatory menu navigation, *Figure 2*. From the starting point of preconfigured rope sheave bearing arrangements representative of practical use and free selection of bearings and arrangement, the required rope sheave system can be quickly identified and loaded with the necessary parameters, *Figure 3* and *Figure 4*, page 29.

All the necessary operating data can be inputted separately, with navigation by means of user-friendly menus:
■ bearing type
■ bearing size
■ internal clearance
■ geometrical data
■ material data for the rope sheave
■ static and dynamic loads
■ active directions
■ speeds.
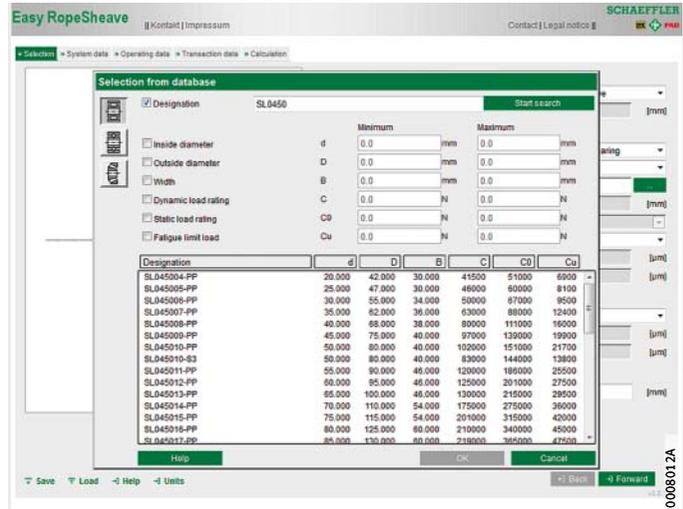
Figure 2
Bearing selection from the database
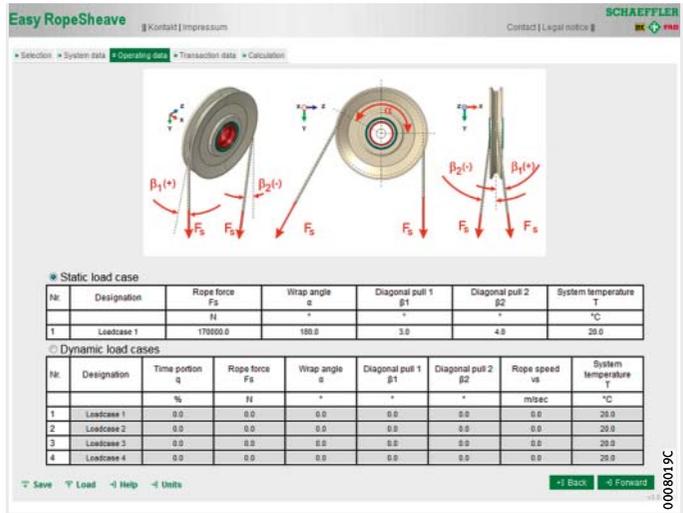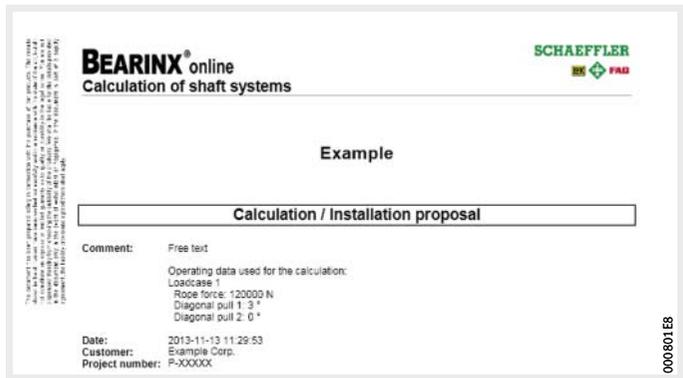
Figure 3
Input of operating data

Figure 4
Results view

Data interchange with Schaeffler

All input data can be stored. As a result, relevant modifications can be quickly made to an existing application case without the need for duplicated input of data. Furthermore, the stored file can be exchanged with the Schaeffler engineering service in order to achieve an optimum bearing design.

The BEARINX-online modules run on the powerful calculation servers at Schaeffler. Once calculation has been successfully carried out, the customer receives an e-mail containing the most important results together with the input file and a PDF results document as an attachment.

Registration for the calculation program

http://bearinx-online-easy-ropesheave.schaeffler.com

The module BEARINX-online Easy RopeSheave is available only in an online format and can be used free of charge.

Initial registration takes only a short time and you can then start your calculation work straight away.

Applications in rope sheaves

Applications in rope sheaves

Rope sheave bearings SL04
in the Liebherr crawler crane LR 11350

The Liebherr crawler crane LR11350 is, fitted with a crawler track, one of the largest lattice boom cranes in the world, *Figure 1*. Thanks to its modular design principle, the crawler crane can be dismantled into individual components for economical transport. The individual components are transported on separate low loaders to the installation site, where they can be reassembled quickly and easily. The crawler crane LR11350 can be fitted with various boom systems and a derrick system.

The rope sheave bearings SL04 fitted in the crawler crane give reliable transmission of heavy loads under all weather conditions.

Figure 1
Rope sheaves
in the Liebherr crawler crane

Requirements Rope sheaves are used in crawler cranes and mobile cranes mainly as return and guide elements for ropes as well as for transmission of rope loads. The rope sheaves used are now made predominantly from plastic such as moulded polyamide.

The use of plastic rope sheaves represents a further challenge for the bearings fitted. The differences in coefficient of thermal expansion between the plastic rope sheave, the steel bearing and steel shaft require precise consideration and selection of the mounting fits and internal clearance.

In the selection of bearings, the important factors are not only good weather resistance but also low maintenance, ease of mounting and high static and dynamic load carrying capacities of the bearings.

In order to obtain a rope sheave system with the lowest possible maintenance requirements, rope sheave bearing arrangements must fulfil the following requirements:

- high load safety factor and operating life
- effective sealing throughout the operating life
- relubrication facility
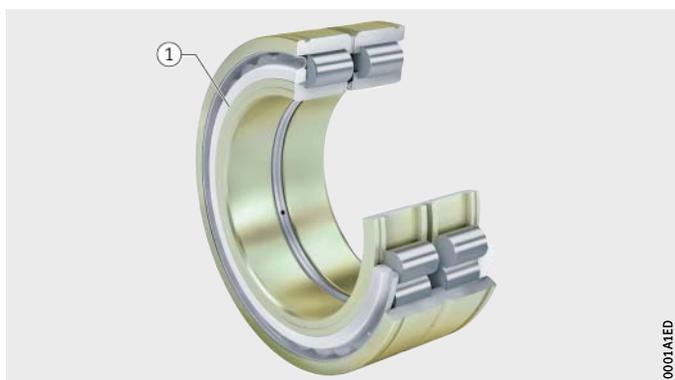- protection against corrosion.

Design solution

Under the operating conditions in the crawler crane, where the bearings are continually subjected to high loads and temperature fluctuations, cylindrical roller bearings with Corrotect coating offer an optimum bearing arrangement for the rope sheaves. The rope sheave bearings SL04260-PP-RR-C5-GA22 fitted in the crawler crane LR 11350 are fitted on both sides with robust sealing rings and a high performance grease for high media resistance. Selection of the correct mounting fits and internal clearance gives a reliable bearing solution.

Mounting fit and internal clearance

Outside diameter D	Shaft fit	Housing fit Rope sheave		Internal clearance	
mm		min.	max.	ISO 5753-1	DIN 620-4
340	g6	338,3	338,64	Group 5	C5

Anti-corrosion coating system Corrotect

Corrotect is an extremely thin, electroplated zinc-iron coating free from Cr(VI) that is used to protect rolling bearings against corrosion.

The anti-corrosion protection gives a significant increase in operating life compared to uncoated parts. The decisive factors are that formation of rust under the seal lip is prevented, premature wear of the seal lip is prevented and that contamination and water cannot penetrate the bearing.

Figure 2
Cylindrical roller bearing with anti-corrosion protection and seals

Products used

① SL04260-PP-RR-C5-GA22

Rope sheave bearings SL04
in the crane vessel Hermod

The two cranes on the Hermod working in tandem can lift up to 8 100 t at an outreach of 39 m. At minimum outreach, the auxiliary hoists are capable of each lowering 600 t to a depth of 3 000 m below the working deck. The rope sheave bearings SL04 fitted in the crane jib give reliable transmission of heavy loads under the challenging offshore weather conditions, *Figure 1*.

Figure 1
Rope sheave bearings
in the crane vessel Hermod

Requirements

Rope sheaves are used as return and guide elements for the support rope, *Figure 2*, page 35. Depending on the type, they are arranged either singly or in multiples alongside each other as an assembly. They are manufactured mainly from a special steel and are extremely robust with good wear resistance. The sheaves are mainly subjected to radial load due to the wrap of the support rope. However, axial forces and tilting moments may also occur due to oblique tension of the rope as a result of the crane design.

In the selection of bearings, the important factors are not only good weather resistance but also low maintenance, ease of mounting and high static and dynamic load carrying capacities of the bearings.

In order to obtain a rope sheave system with the lowest possible maintenance requirements, rope sheave bearing arrangements must fulfil the following requirements:
- long operating life
- effective sealing throughout the operating life
- relubrication facility
- protection against corrosion.

Figure 2
Rope sheave bearings
in the example of a hook block
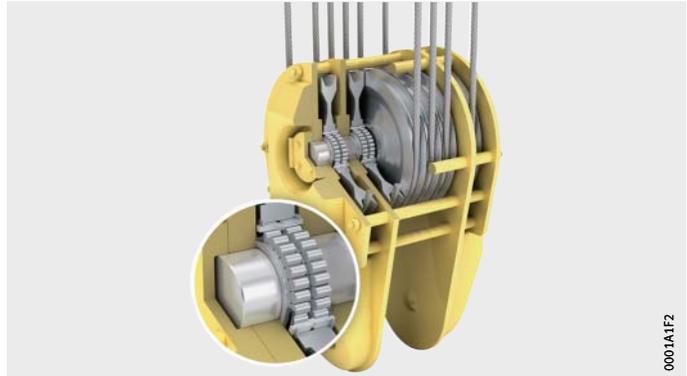
Design solution

In an environment as challenging as that of a crane vessel, where bearings are continually exposed to corrosive salt water, extreme temperature fluctuations and UV radiation, cylindrical roller bearings with Corrotect coating offer an optimum solution for rope sheave bearing arrangements. The bearings used in the crane vessel Hermod are narrower than the basic type of rope sheaves SL045052-PP-RR and are fitted with special seals for high media resistance. Selection of the correct mounting fit gives a reliable bearing solution, *Figure 3*.

**Anti-corrosion coating
system Corrotect**

Corrotect is an extremely thin, electroplated zinc-iron coating free from Cr(VI) that is used to protect rolling bearings against corrosion.

The anti-corrosion protection gives a significant increase in operating life compared to uncoated parts. The decisive factors are that formation of rust under the seal lip is prevented, premature wear of the seal lip is prevented and that contamination and water cannot penetrate the bearing.

Figure 3
Cylindrical roller bearing with
anti-corrosion protection and seals
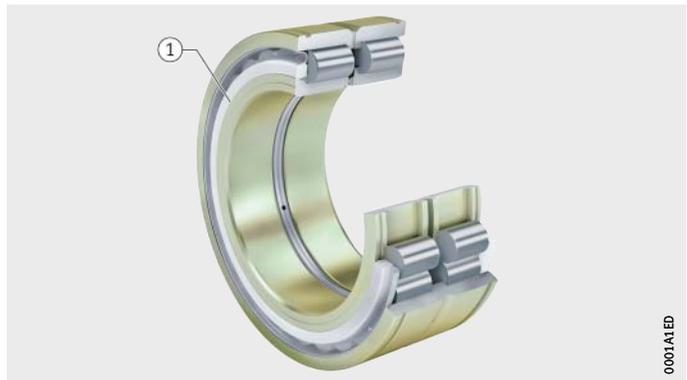
Products used

① Cylindrical roller bearing SL04, special version

Rope sheave bearings SL04 in a Liebherr hook block

The Liebherr crawler crane LR 13000 has a maximum load carrying capacity of 3 000 t at an outreach of 12 m and is one of the most powerful crawler cranes of conventional design in the world.

The hook block in such a crane forms the connection between the hoist rope and the load to be lifted. The hook block has a lower part and an upper part. Depending on the model, the lower part has one or two hooks that can be rotated and tilted. It is connected by means of bolts to the upper part, which is attached via the hoist rope to the crane boom by means of rope sheaves using the block and tackle principle.

The modular design of hook block for this crawler crane has a mass of 111 t, *Figure 1*. The pulley sets are connected with a gimbal facility via a hook crossbeam and compensate the different running behaviour of the winches where there are differences in the number of pulleys.

① Hook crossbeam
② Pulley set
③ Rope sheave
④ Upper part
⑤ Lower part
⑥ Hook

Figure 1
Modular design of hook block
in fully assembled state

Requirements

A hook block is exposed to weather conditions such as sun and rain as well as high and low temperatures. The bearings in the pulley sets are subjected to high radial loads and moderate axial loads.

For a long operating life, the bearings must be robust and reliable. In order to support the full load carrying capacity of the system, the hook block must accommodate 30 rope sheaves in a modular concept.

Design solution

One of the challenges in relation to this hook block is the restricted space available due to the large number of steel rope sheaves. A special design of double row, full complement cylindrical roller bearing was therefore developed on the basis of a rope sheave bearing SL04. This has a particularly small section width and offers a high dynamic load carrying capacity in a reduced cross-section.

The bearing makes optimum use of the design envelope, is sealed on both sides and is lubricated with a low temperature grease to DIN 51825-KE2K–50. The grease has a particularly low frictional torque.

The cylindrical roller bearing can be relubricated via the inner ring and outer ring. All surfaces of the bearing rings are protected against corrosion by means of the anti-corrosion coating system Corrotect, including the raceways and seal running surfaces.

Due to the tight fit of the bearing in the rope sheave necessary for this application and the wide range of operating temperatures, the bearing requires a radial internal clearance Group 3 (C3) in accordance with ISO 5753-1 (DIN 620-4), see table, page 15.

The bearing has annular slots in the outer ring for the fitting of retaining rings that give precise positioning of the rope sheave on the bearing. The bearing is used at multiple points in the modular hook block system and in all other rope sheaves, *Figure 2*.

Bearing data on cylindrical roller bearing

Design characteristic	Bearing data
Basic dynamic load rating C	1 650 kN
Basic static load rating C_0	4 000 kN
Radial internal clearance	Group 3 (C3)
Mounting fits	
Shaft tolerance	g6
Bore tolerance	R7
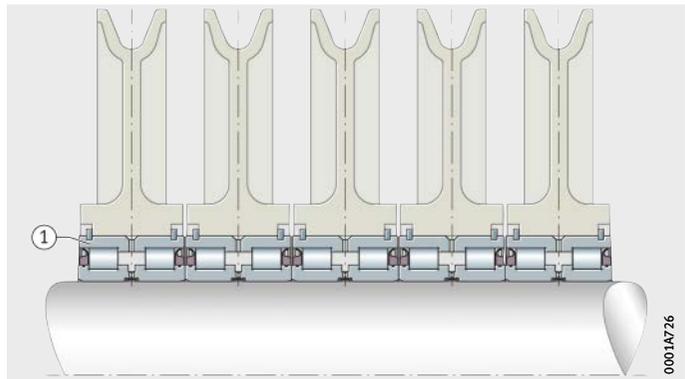
Figure 2
Rope sheave bearing arrangements

Products used

① Full complement double row cylindrical roller bearing F-554987 (special version)

Design brief for rope sheave bearing arrangement

Customer

Application data

Machine
(such as harbour crane, crane vessel, mobile crane) _____

Application (such as hook block, boom head) _____

Environmental influences

Lower operating temperature _____ °C

Upper operating temperature _____ °C

Contamination (such as dust, water) _____ –

Corrosive media (such as moisture,
salt water atmosphere, UV radiation, ozone, petrol, oil) _____ –

Design data

Rope sheave

Diameter of groove base _____ mm

Bore diameter _____ mm

Fit of bore diameter (rope sheave, finished part) _____ mm

Material
- ▢ Modulus of elasticity
  at minimum operating temperature _____ N/mm^2

- ▢ Modulus of elasticity at +20 °C _____ N/mm^2
- ▢ Modulus of elasticity
  at maximum operating temperature _____ N/mm^2

- ▢ Poisson's ratio _____ –

- ▢ Density _____ kg/cm^3

- ▢ Coefficient of thermal expansion _____ K^{-1}

With integrated steel bush

- ▢ Outside diameter _____ mm

- ▢ Fit of outside diameter (steel bush) _____ mm

- ▢ Bore diameter (plastic rope sheave) _____ mm

- ▢ Fit of bore diameter (plastic rope sheave) _____ mm

Bearing

Bearing designation

Number per rope sheave _____ piece

Spacing of bearings (bearing centre/bearing centre) _____ mm

Shaft

Outside diameter _____ mm

Fit _____ mm

Length (support spacing) _____ mm

Number of rope sheaves per shaft _____ piece

Load data

Load data for calculation of static load safety factor S_0

▪ Maximum rope tension (test load) _____ kN

▪ Wrap angle _____ °

▪ Maximum oblique tension 1 (+/−) _____ °

▪ Maximum oblique tension 2 (+/−) _____ °

Load case data for rating life calculation

Mean load in load case	1	2	3	4	
▪ Time proportion					%
▪ Rope tension					kN
▪ Wrap angle					°
▪ Oblique tension 1 (+/−)					°
▪ Oblique tension 2 (+/−)					°
▪ Rope velocity					m/min

Additional comments

_____

_____

▪ Appendices (e.g. drawing) _____

▪ Created on _____

▪ Contact _____

Notes

Notes