12.12 SPECIAL ROLLER BEARINGS

- Hybrid bearings
- Electrically insulated bearings
- Split bearings
- Other special bearings

HYBRID BEARINGS

Hybrid bearings have races made of bearing steel and rolling elements made of silicon nitride (Si_3N_4). Hybrid bearings feature excellent electrical insulation properties that apply mainly in the area of electric motors. Silicon nitride rolling elements prevents passage of current through the bearings which protects also the bearing rings against damage by electric current.

Silicon nitride has also significantly lower density than steel which takes effects mainly at high revolutions by reduction of centrifugal forces which reduces tension of outer ring. This has positive effect to the durability of high rpm bearings. It also reduces inertial forces which takes effect mostly in sudden changes of revolution frequency. Lower inertial forces of rolling elements load cage partitions significantly less, comparing to the standard steel elements.

Silicon nitride has higher elasticity module than bearing steel. This takes effect in contact area by lower contact surface resulting in reduction of rolling and sliding friction. Along with lower weight of ceramic elements and lower centrifugal forces, friction can be reduced at high revolutions. Friction in bearing is closely related to the service temperature of bearing. The lower the friction factor in the bearing, the lower the service temperature. Hybrid bearings are therefore suitable for applications with high revolution frequencies.

Hybrid bearings are capable of operation at low service viscosity since in contact of hybrid rings and silicon nitride elements no abrasion occurs. Hybrid bearings are suitable also in operations where bearings operate at very big dynamic stress, or when bearings are greased only with a very thin lubrication film. Hybrid bearings are used in locations where vibrations act, or where bearings perform oscillation movements only.

Silicon nitride also features lower thermal ductility; bearing is thus less sensitive to temperature changes.

Availability of hybrid bearings has to be discussed with the supplier.

Hybrid ball bearings

Single row hybrid ball bearings are among the most frequently used hybrid bearings which find their application in electric motors. Their construction is very easy and they are able to transfer radial and axial load in both directions.

Hybrid ball bearings are made in dimensions with bore diameter between 10 to 120 mm. Bearings with bigger dimensions can be made upon customer's request. Hybrid bearings for electric motors are made in rows 60, 62 and 63 as uncovered bearings. Standard design is of normal accuracy P0; upon request hybrid bearings can be supplied in accuracy P6 and P5.

Bearing rings are made of the same steel as the one used for all-steel bearings. In standard version bearing are made in dimension stabilisation S0 for operation up to the temperatures of 150 °C. Upon request bearings can be supplied with dimension stabilisation S1 for operation up to the temperatures of 200 °C. In other cases consult the technical and consultancy services of ZKL.



Fig. 12.12.1

Main dimensions

As standard, hybrid ball bearings are made according to dimensional plan ISO 15.

Radial clearance

Radial clearances of hybrid ball bearings are the same as clearances of all-steel bearings and comply with ISO 5753. For use in electric and traction motors, bearings with radial clearance C3 are used most of the time.

Misalignment

Hybrid ball bearings do not suit compensation of misalignment. Depending on radial clearance, bearing dimensions and forces acting on bearing, admissible tilting of bearing ranges between 2 to 10 angular minutes. Tilting of inner race against outer ring causes excessive noise and reduces service life of bearing.

Cages

Hybrid ball bearings are mostly made with metal cages. Some applications utilise polyamide cages that only suit in temperatures to 120 °C. Standard cages are in the same design as for common ball bearings, are stated in chapter 7.4:

- Two-piece riveted steel plate cage guided by balls (is not designated)
- Two-piece riveted massive brass age cage guided on the external race (MA)
- Single-piece polyamide cage reinforced with fibre glasses guided by balls (TNG).

Minimum load

Hybrid ball bearings are more resistant to damage of raceways caused by slippage in sufficient loading. Comparing to common steel bearings, they can provide reliable run with lower minimum load. Therefore these bearings also suit locations where very small or variable load acts on bearings.

Axial load rating

Bearing must not be exposed to purely axial load exceeding 50 % C_{0r}. Small bearings and light rows must not be exposed to axial load exceeding 25 % C_{0r}. If the above stated values are exceeded, the service life of bearing reduces dramatically.

Equivalent dynamic and static load of bearing

Equivalent dynamic and static load of bearing is calculated same as for common all-steel ball bearing, see chapter Single row ball bearings.

Designation of hybrid ball bearings

Hybrid ball bearings have the same designation system as standard all-steel ball bearings. Use of ceramics on bearing components is characterised with an additional "C" character before the bearing designation, e.g.: C 6213MA.

Hybrid cylindrical roller bearings

Hybrid cylindrical roller bearings are located where bearings are loaded with big radial load and where hybrid ball bearings can no longer be used due to the their lower dynamic load capacity. Hybrid cylindrical roller bearings are made in standard dimensions complying with ISO 15. Hybrid cylindrical roller bearings are made in designs with two-piece massive brass cage guided on outer ring (MA), another cage design has to be consulted with the supplier.

Hybrid cylindrical roller bearings have the same designation system as standard all-steel roller bearings with the only difference of having the „C" character before the designation of the bearing, e.g.: C NU312MA. Availability and details on these bearings are available at the technical and consultancy services of ZKL.

ELECTRICALLY INSULATED BEARINGS

Bearings in electric motors and generators, together with related equipment might get damages due to passage of electric current that participates in damaging the raceways of rings and rolling elements, causing fast degradation of the lubricant used.

Bearings are supplied with insulating ceramic spray application (Al_2O_3) on the outer ring surface; the aluminium oxide thickness is 0.15 mm. Bearings insulated in the above described manner are capable of resisting to DC voltage up to 1000 V. The spray application is coated thermally on the outer surface of the outer ring, and complies with the requirements for surface hardness and adhesion to the surface the spray is applied on.

These bearings have an additional designation TM01, e.g.: NU1012M TM01. In the designation means

TM . . . . . bearing with thermal insulation spray application (always in combination with a par of characters for the layer characteristics)

0 . . . . . Al_2O_3 spray application with minimum resistance of 50 MΩ at DC voltage of 1000 V

1 . . . . . ceramic spray application on the outer ring surface (2 on inner race, 3 on both races).

Mostly used are single row ball bearings and single row cylindrical roller bearings. Bearings insulated with aluminium oxide have the same dimensions and design as standard bearings. Dimensions of ball and cylindrical roller bearings with Al_2O_3 layer correspond with the ISO 15 dimensional plan. The availability of electrically insulated bearings has to be consulted with the supplier.

Standard design is that of normal accuracy P0; upon request the bearings can be supplied even in higher accuracy P6 and P5. The bearings are made in normal radial clearance or, upon request, in bigger radial clearances C3 and C4. Radial clearances are stated in tables 7.17a for single row ball bearings and 7.19 for single row cylindrical roller bearings.

Electrically insulated bearings are made mostly with a two--piece massive brass cage guided on rolling elements, or with a two-piece steel plate cage guided on rolling elements. In some cases, especially in smaller bearings, a single-piece plastic cage reinforced with fibre glass is used.

Other properties of electrically insulated bearings are identical to those of common bearings; detailed information on these bearings is available in individual chapters on single row ball bearings and single row cylindrical roller bearings.

The table section states the most common electrically insulated bearings. Please consult delivery of bearings of different dimensions and types with the supplier.



Fig. 12.12.2

SPECIAL ZKL BEARINGS

Besides standardised bearings in basic and different designs stated in this catalogue, ZKL supplies also special roller bearings. They usually feature non-standardised dimensions and cannot be included in standardised series. Production of special bearings often utilises different materials. These bearings are purposefully designed for applications in machines and equipment where the construction does not allow use of standardised bearings. The dimensions and basic parameters of the bearings are stated in the table section.

OTHER SPECIAL BEARINGS

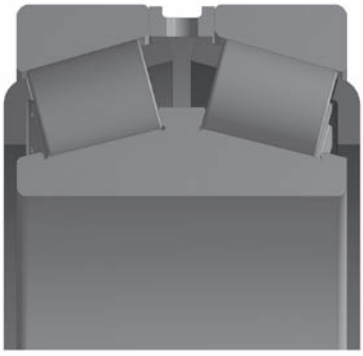
ZKL manufactures additional type and dimensional series of bearings, parameters of which are not listed in this catalogue. More detailed information about special ZKL bearings is available in professional company publications. Use of special roller bearings is mainly recommended in more demanding cases of location, and supplies of bearings, their locations and assembly should be consulted with the supplier. Further information on special roller bearings is available at the ZKL technical and consultancy services.



Fig. 12.12.3

Multi row roller bearings

They are used to capture extremely big radial forces with limited build-up dimensions, mainly in smelting industry for location of rolling mill rollers. Rings of these bearings are provided with lubrication holes to ensure supply of lubricant in all roller rows.



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Single row and double row tapered roller bearings

They are used mainly in automotive industry and in heavy machinery.

Double and four row tapered roller bearings

They are used to locate rolling mill rollers and rollers of other plants in steel rolling mills. They are manufactured with axial clearance the size of which is determined upon the service conditions.

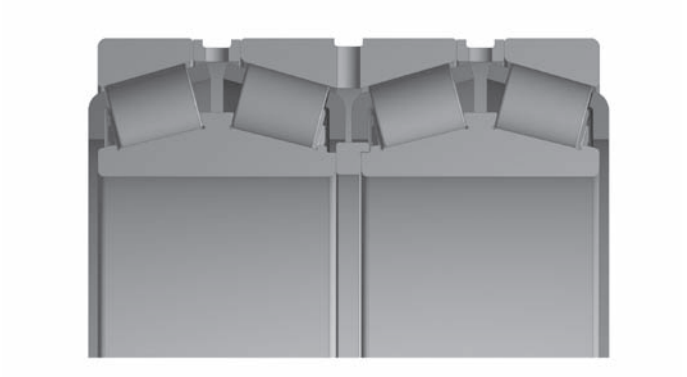


Fig. 12.12.5

Crossed roller bearings

In standard design, crossed roller bearings are compact two ring bearings with cross arrangement of rollers in raceway between the inner and outer ring. In majority of cases, rollers are separated with plastic separators or alternatively with a massive or segment cage. The contact angle of raceway is usually 45°. The bearings are supplied with clearance or prestress, depending on the use. Bearing rings are provided with bores for fixing bolts. Inner space is protected with rubber sealing to prevent excessive leak of grease from the bearing and penetration of impurities inside the bearing.

It is manufactured with outer diameter between 300 to 1 600 mm, and with inner or outer gearing or – more precisely – without gearing for location of building and earth-moving machinery, robots and manipulators, machine tools, mining combine harvesters, stamp plates, wind power plants, rotary furnaces and mill mixers.



Fig. 12.12.6

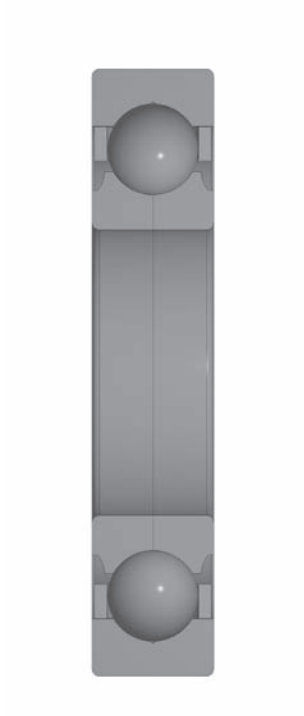


Fig. 12.12.7

Large size ball bearings with four-point contact and double row ball bearings with angular contact

Bearings suitable for continuously rotating plants and also for machines with cyclic operation character of medium sizes, such as excavators and cranes. To ensure higher revolution frequency, bearings with massive or segment cage are made. They have a relatively low friction torque. The rigidity of location with the use of ball bearings is lower than that of bearings with crossed rollers. Usually they have a contact angle of 45º. They are manufactured with outer diameter ranging between 300 and 1600 with inner or outer gearing or – more precisely – without gearing.

Double direction cylindrical roller and tapered thrust bearings

They are used to capture big radial forces in rolling mill rollers' locations, and also where high rigidity in axial direction is required, mainly in locations of carousel desks.

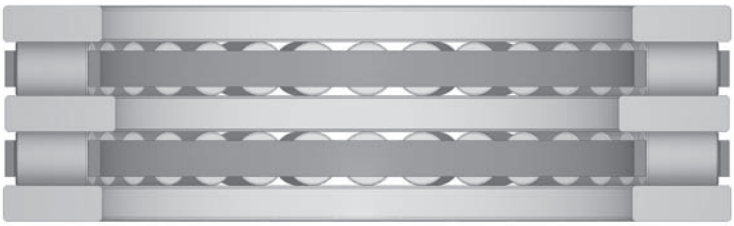
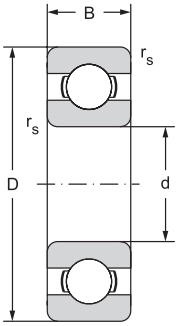
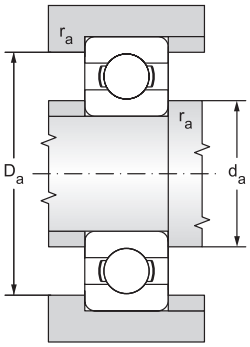


Fig. 12.12.8

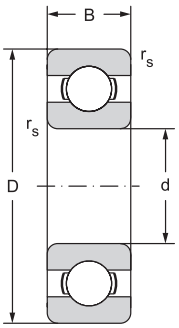


12.12.1

Main dimensions				Basic load rating		Fatique load limit
d	D	B	r_s	dynamic C_r	static C_{or}	P_u
mm				kN		kN
10	26	8,0	0,3	4,56	1,96	0,089
	30	9,0	0,6	6,05	2,51	0,114
12	28	8,0	0,3	5,09	2,36	0,107
	32	10,0	0,6	6,91	3,10	0,141
15	32	9,0	0,3	5,59	2,87	0,130
	35	11,0	0,6	7,72	3,75	0,170
17	35	10,0	0,3	6,00	3,27	0,149
	40	12,0	0,6	9,53	4,73	0,215
20	42	12,0	0,6	9,37	4,97	0,226
	47	14,0	1,0	12,77	6,55	0,298
25	47	12,0	0,6	10,07	5,81	0,264
	52	15,0	1,0	14,03	7,94	0,361
30	55	13,0	1,0	13,24	8,25	0,375
	62	16,0	1,0	19,44	11,19	0,508
35	62	14,0	1,0	15,96	10,33	0,469
	72	17,0	1,1	25,66	15,23	0,692
40	68	15,0	1,0	16,82	11,49	0,522
	80	18,0	1,1	32,63	19,89	0,904
	90	23,0	1,5	40,76	24,17	1,099
45	75	16,0	1,0	21,10	15,30	0,695
	85	19,0	1,1	32,68	20,33	0,924
	100	25,0	1,5	52,80	31,72	1,442
50	80	16,0	1,0	21,72	16,65	0,757
	90	20,0	1,1	35,07	23,23	1,056
	110	27,0	2,0	61,75	37,75	1,716
55	90	18,0	1,1	28,22	21,32	0,969
	100	21,0	1,5	43,35	29,40	1,336
	120	29,0	2,0	71,00	44,70	2,032

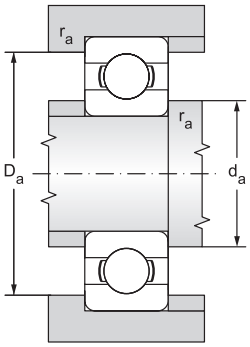


Limiting speed for lubrication with		Bearing designation	Abutment and fillet dimensions			Weight
grease	oil		d_a min	D_a max	r_a max	~
min^{-1}			mm			kg
28000	33000	**C 6000**	12,0	24,0	0,3	0,018
25000	30000	**C 6200**	14,0	26,0	0,6	0,031
25000	30000	**C 6001**	14,0	26,0	0,3	0,022
22000	27000	**C 6201**	16,0	28,0	0,6	0,037
21000	25000	**C 6002**	17,0	30,0	0,3	0,030
20000	24000	**C 6202**	19,0	31,0	0,6	0,044
20000	24000	**C 6003**	19,0	33,0	0,3	0,040
18000	21000	**C 6203**	21,0	36,0	0,6	0,073
17000	20000	**C 6004**	24,0	38,0	0,6	0,070
15000	18000	**C 6204**	25,0	42,0	1,0	0,11
14000	17000	**C 6005**	28,0	43,0	0,6	0,082
12000	15000	**C 6205**	30,0	47,0	1,0	0,13
12000	14000	**C 6006**	34,0	50,0	1,0	0,12
11000	13000	**C 6206**	35,0	57,0	1,0	0,20
10600	12600	**C 6007**	39,5	57,0	1,0	0,15
9400	11000	**C 6207**	42,0	65,0	1,0	0,28
9400	11000	**C 6008**	44,0	63,0	1,0	0,19
8400	10000	**C 6208**	47,0	73,0	1,0	0,35
7900	9400	**C 6308**	47,0	81,0	1,5	0,63
8400	10000	**C 6009**	49,0	70,0	1,0	0,24
7900	9400	**C 6209**	52,0	78,0	1,0	0,40
7100	8400	**C 6309**	52,0	91,0	1,5	0,83
7900	9400	**C 6010**	54,0	75,0	1,0	0,26
7100	8400	**C 6210**	57,0	83,0	1,0	0,46
6300	7500	**C 6310**	60,0	100,0	2,0	1,06
7100	8400	**C 6011**	60,0	84,0	1,0	0,38
6700	7900	**C 6211**	62,0	91,0	1,5	0,60
5600	6700	**C 6311**	65,0	110,0	2,0	1,38



12.12.1

Main dimensions				Basic load rating		Fatique load limit
d	D	B	r_s	dynamic C_r	static C_{or}	P_u
mm				kN		kN
60	110	22,0	1,5	52,85	35,79	1,627
	130	31,0	2,1	81,50	52,10	2,368
65	120	23,0	1,5	57,21	40,01	1,819
	140	33,0	2,1	92,60	59,60	2,676
70	125	24,0	1,5	62,00	43,80	1,991
	150	35,0	2,1	104,00	63,10	2,735
75	130	25,0	1,5	66,18	49,31	2,214
	160	37,0	2,1	114,00	76,40	3,204
80	140	26,0	2,0	72,20	53,10	2,301
	170	37,0	2,1	122,85	86,23	3,506
85	150	28,0	2,0	83,30	63,68	2,670
	180	41,0	3,0	132,51	96,07	3,794
90	160	30,0	2,0	96,20	70,80	2,878
	190	43,0	3,0	144,00	108,00	4,149
95	170	32,0	2,1	108,00	81,00	3,199
	200	45,0	3,0	152,44	117,37	4,393
100	180	34,0	2,1	123,00	92,60	3,557
	215	47,0	3,0	174,00	141,00	5,107
105	190	36,0	2,1	132,93	104,83	3,924
110	200	38,0	2,1	144,00	117,00	4,272
120	215	40,0	2,1	144,00	117,00	4,109



Limiting speed for lubrication with		Bearing designation	Abutment and fillet dimensions			Weight
grease	oil		d_a min	D_a max	r_a max	~
min^{-1}			mm			kg
6000	7100	**C 6212MA**	67,0	101,0	1,5	0,77
5300	6300	**C 6312MA**	72,0	118,0	2,0	1,72
5300	6300	**C 6213MA**	72,0	111,0	1,5	1,00
5000	6000	**C 6313MA**	76,0	128,0	2,0	2,10
5300	6300	**C 6214MA**	77,0	116,0	1,5	1,07
4700	5600	**C 6314MA**	81,0	138,0	2,0	2,54
5000	6000	**C 6215MA**	82,0	122,0	1,5	1,18
4200	5000	**C 6315MA**	86,0	148,0	2,0	3,06
4700	5600	**C 6216MA**	90,0	130,0	2,0	1,40
4000	4700	**C 6316MA**	91,0	158,0	2,0	3,63
4200	5000	**C 6217MA**	95,0	140,0	2,0	1,80
3800	4500	**C 6317MA**	98,0	166,0	2,5	4,20
4000	4700	**C 6218MA**	100,0	150,0	2,0	2,16
3500	4200	**C 6318MA**	103,0	176,0	2,5	4,95
3800	4500	**C 6219MA**	107,0	158,0	2,0	2,60
3300	4000	**C 6319MA**	109,0	186,0	2,5	5,72
3500	4200	**C 6220MA**	112,0	169,0	2,0	3,13
3200	3800	**C 6320MA**	113,0	201,0	2,5	7,07
3300	4000	**C 6221MA**	117,0	178,0	2,0	3,74
3200	3800	**C 6222MA**	122,0	188,0	2,0	4,37
3000	3500	**C 6224MA**	132,0	203,0	2,0	5,15