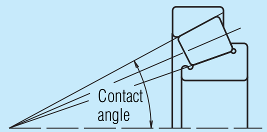
TAPERED ROLLER BEARINGS



Design, Types, and Features

Tapered roller bearings are designed so the apices of the cones formed by the raceways of the cone and cup and the conical rollers all coincide at one point on the axis of the bearing. When a radial load is imposed, an axial force component occurs; therefore, it is necessary to use two bearings in opposition or some other multiple arrangement.

Among the metric design tapered roller bearings with high load capacity (HR series), some bearings have the basic number suffixed by J to conform to the specifications of ISO for the cup back face raceway diameter, cup width, and contact angle. Therefore, the cone assembly and cup of bearings with the same basic number suffixed by J are internationally interchangeable.

For the cone assemblies and cups of inch design tapered roller bearings, except four-row bearings, the bearing numbers are approximately formulated as follws:

Example: M 2 727 49 D

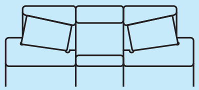
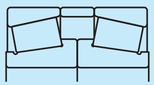
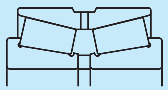
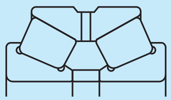
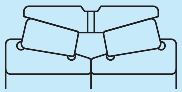
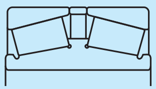
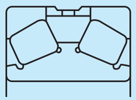
M	2	727	49	D
Load Limit Symbol	Contact Angle Symbol	Series No.	Design No.	Additional Symbol

For tapered roller bearings, besides single-row bearings, there are also various combinations of bearings as listed in Table 1.

The cages of tapered roller bearings are either pressed steel or pin type.

Regarding four-row tapered roller bearings for roll necks, refer to page B344.

Table 1 Design and Features of Combinations of Tapered Roller Bearings

Figure	Arrangement	Examples of Bearing No.	Features
	Back-to-back DB	HR32220JDB+KLR20	Two standard bearings are combined. The bearing internal clearances are adjusted by cone spacers or cup spacers. The cones and cups and spacers are marked with serial numbers and matching symbols. Components with the same serial number can be assembled referring to the matching symbols.
	Face-to-face DF	HR32220JDF+KR	
	KBE(TDO)	100KBE31+L	This type of bearing consists of a double cup and two cone assemblies and a cone spacer. The bearing internal clearance has already been set using the cone spacer, and parts must be combined according to the serial number and matching symbol. The double cup has an oil groove and holes. The KBE type can carry both radial and axial loads, so it can be used as a fixed-end bearing. This is also used frequently on the free end by relieving the shaft elongation/contraction between the cup and housing. This type is basically the same as the back-to-back combination (DB combination) with two single-row tapered roller bearings coupled using cone and cup spacers, but is easier to handle because of fewer parts. This type of bearing is recommended where rigidity is required and strong moments exist.
	KDE(TDO)	100KDE1801+L	This type of bearing is equivalent to the KBE type but with a steeper contact angle. This is used when the axial load is larger than the radial load. The bearing internal clearance has already been set using a cone spacer. The bearing must be assembled according to the serial number and matching symbols.
	KF(TNA)	100KF1701	This type of bearing has one double cup and two cone assemblies. The two cones are in contact face-to-face and there is no cone spacer. Since the bearing internal clearance has already been set, the various parts must be assembled by observing the serial number and matching symbols.
	KH(TDI)	110KH31+K	This type of bearing consists of a double cone assembly and two cups and a cup spacer. Since the bearing internal clearance has already been set using the cup spacer, the parts must be combined according to the serial number and matching symbols. The cup spacer has an oil groove and holes. Since the depth of the oil groove is limited, it is desirable to also provide an oil groove inside the housing.
	KDH(TDI)	100KDH2101+K	This type of bearing is a double-row tapered roller bearing with the rows facing inward but the contact angle is steeper than in the KH type. This consists of a double cone assembly, two cups, and a cup spacer. This is recommended when the axial load is larger than the radial load or an axial load only exists. In certain cases, a spring is provided between the housing shoulder and cup end face for preloading (without using a cup spacer).

Tolerances and Running Accuracy

Metric Design Tapered Roller Bearings.......................... Table 2.3 (Pages A20 to A23)
Inch Design Tapered Roller Bearings.............................. Table 2.4 (Pages A24 to A25)

Inch design tapered roller bearings of J-line (in the bearing tables, bearings preceeded by ▲) conform to the following tables. Symbols in the tables are described on page A15. Please contact NSK for details.

Table 2 Tolerances for Cones (Class K)

Units : μm

Nominal Bore Diameter d (mm)		Δ_{dmp}		V_{dp}	V_{dmp}	K_{ia}
over	incl	high	low	max.	max.	max.
80	**120**	0	− 20	20	15	30
120	**180**	0	− 25	25	19	35
180	**250**	0	− 30	30	23	50
250	**315**	0	− 35	35	26	60
315	**400**	0	− 40	40	30	70

Table 3 Tolerances for Cups (Class K)

Units : μm

Nominal Outside Diameter D (mm)		Δ_{Dmp}		V_{Dp}	V_{Dmp}	K_{ea}
over	incl	high	low	max.	max.	max.
80	**120**	0	− 18	18	14	35
120	**150**	0	− 20	20	15	40
150	**180**	0	− 25	25	19	45
180	**250**	0	− 30	30	23	50
250	**315**	0	− 35	35	26	60
315	**400**	0	− 40	40	30	70
400	**500**	0	− 45	45	34	80

Table 4 Tolerances for Effective Width of Cone Assemblies and Cups and Bearing Width (Class K)

Units : μm

Nominal Bore Diameter d (mm)		Cone Assembly Effective Width Deviation Δ_{T1s}		Cup Effective Width Deviation Δ_{T2s}		Bearing Width Deviation Δ_{Ts}	
over	incl	high	low	high	low	high	low
80	**120**	+ 100	− 100	+ 100	− 100	+ 200	− 200
120	**315**	+ 150	− 150	+ 200	− 100	+ 350	− 250
315	**400**	+ 200	− 200	+ 200	− 200	+ 400	− 400

Recommended Fits

Metric Design Tapered Roller Bearings ·······Table 3.2 (Page A35)
Table 3.4 (Page A36)

Inch Design Tapered Roller Bearings ··········Table 3.6 (Page A37)
Table 3.7 (Page A38)

Internal Clearances ·······································Table 3.13 (Page A43)

Metric Design Tapered Roller Bearings (Matched and Double-Row)
Inch Design Tapered Roller Bearings (Matched and Double-Row)

Dimensions Related to Mounting

The abutment and fillet dimensions for tapered roller bearings and listed in the bearing tables. Since the cages protrude frow the ring face of tapered roller bearings, please use care when designing shafts and housings.

When heavy axial loads are imposed, the shaft shoulder dimensions and strength must be sufficient to suport the cone rib.

Permissible Misalignment

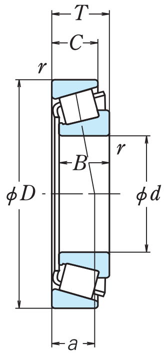
The permissible misalignment angle for single-row tapered roller bearings is approximately 0.0009 radian (3').

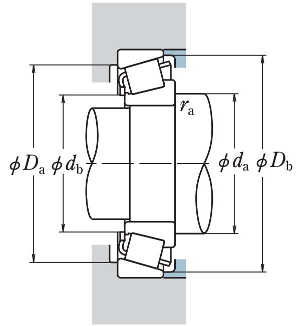
Precautions for Use of Tapered Roller Bearings

1. If the load of tapered roller bearings becomes too small, or if the ratio of the axial and radial loads for matched bearings exceeds 'e' (e is listed in the bearing tables) during operation, slippage between the rollers and raceways occurs, which may result in smearing. Especially with large bearings since the weight of the rollers and cage is high. If such load conditions are expected, please consult with NSK for selection of the bearings.
2. Confirm Abutment and Fillet Dimensions D_a and D_b at the time of the HR series adoption.

SINGLE-ROW TAPERED ROLLER BEARINGS

Bore Diameter 100 – 130 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	0	0.4	Y_1

Static Equivalent Load

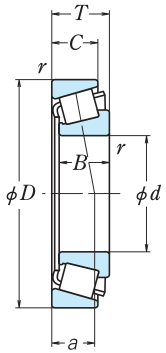
$P_0 = 0.5F_r + Y_0F_a$

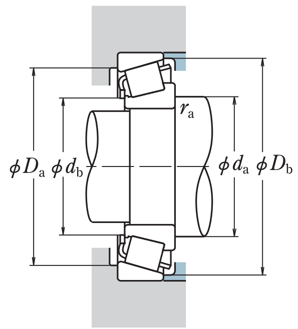
When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

The values of e, Y_1, and Y_0 are given in the table below.

Boundary Dimensions (mm)							Basic Load Ratings (kN)		Basic Load Ratings {kgf}		Bearing Numbers	Abutment and Fillet Dimensions (mm)						Eff. Load Centers (mm)	Constant	Axial Load Factors		Mass (kg)
d	D	T	B	C	CONE r min.	CUP r min.	C_r	C_{0r}	C_r	C_{0r}		d_a	d_b	D_a	D_b	CONE r_a max.	CUP r_a max.	a	e	Y_1	Y_0	approx.
100	140	25	25	20	1.5	1.5	117	205	12 000	20 900	**HR32920J**	112	106	131	136	1.5	1.5	24.2	0.33	1.8	1.0	1.18
	145	24	22.5	17.5	3	3	113	163	11 500	16 600	**T4CB100**	114	106	133	141	2.5	2.5	30.1	0.47	1.3	0.70	1.18
	150	32	32	24	2	1.5	176	294	17 900	30 000	**HR32020XJ**	115	106	138	146	2	1.5	32.5	0.46	1.3	0.72	1.95
	180	37	34	29	3	2.5	255	330	26 000	34 000	**HR30220J**	121	110	163	172	2.5	2	36.1	0.42	1.4	0.79	3.78
	180	49	46	39	3	2.5	325	450	33 000	46 000	**HR32220J**	122	110	161	174	2.5	2	41.5	0.42	1.4	0.79	5.05
	215	51.5	47	39	4	3	425	525	43 000	53 500	**HR30320J**	129	119	193	202	3	2.5	41.4	0.35	1.7	0.96	8.41
	215	77.5	73	60	4	3	565	755	57 500	77 000	**HR32320J**	130	114	190	206	3	2.5	53.2	0.35	1.7	0.96	12.7
105	145	25	25	20	1.5	1.5	119	212	12 100	21 600	**HR32921J**	117	111	136	141	1.5	1.5	25.3	0.34	1.8	0.96	1.23
	160	35	35	26	2.5	2	204	340	20 800	34 500	**HR32021XJ**	122	112	146	155	2	2	34.3	0.44	1.4	0.74	2.48
	190	39	36	30	3	2.5	280	365	28 500	37 500	**HR30221J**	127	116	172	182	2.5	2	38.1	0.42	1.4	0.79	4.52
	190	53	50	43	3	2.5	360	510	37 000	52 000	**HR32221J**	128	115	170	183	2.5	2	44.8	0.42	1.4	0.79	6.26
	225	53.5	49	41	4	3	455	565	46 500	57 500	**HR30321J**	136	124	202	212	3	2.5	43.2	0.35	1.7	0.96	9.52
	225	81.5	77	63	4	3	670	925	68 000	94 500	**HR32321J**	136	122	199	213	3	2.5	55.2	0.35	1.7	0.96	14.9
110	150	25	25	20	1.5	1.5	123	224	12 500	22 800	**HR32922J**	122	116	141	146	1.5	1.5	26.5	0.36	1.7	0.93	1.29
	170	38	38	29	2.5	2	236	390	24 000	40 000	**HR32022XJ**	128	117	156	165	2	2	35.9	0.43	1.4	0.77	3.09
	200	41	38	32	3	2.5	315	420	32 000	43 000	**HR30222J**	134	121	181	192	2.5	2	40.1	0.42	1.4	0.79	5.28
	200	56	53	46	3	2.5	400	565	40 500	57 500	**HR32222J**	135	121	179	193	2.5	2	47.2	0.42	1.4	0.79	7.35
	240	54.5	50	42	4	3	485	595	49 500	60 500	**HR30322J**	143	129	216	228	3	2.5	45.1	0.35	1.7	0.96	11
	240	84.5	80	65	4	3	675	910	68 500	93 000	**HR32322J**	144	127	213	229	3	2.5	58.5	0.35	1.7	0.96	17.1
120	165	29	29	23	1.5	1.5	161	291	16 400	29 700	HR32924J	133	126	155	161	1.5	1.5	29.2	0.35	1.7	0.95	1.8
	170	27	25	19.5	3	3	153	243	15 600	24 800	**T4CB120**	136	126	157	166	2.5	2.5	35.0	0.47	1.3	0.70	1.78
	180	38	38	29	2.5	2	242	405	24 600	41 000	**HR32024XJ**	138	127	165	175	2	2	39.7	0.46	1.3	0.72	3.27
	215	43.5	40	34	3	2.5	335	450	34 000	46 000	**HR30224J**	145	132	195	206	2.5	2	44.4	0.44	1.4	0.76	6.28
	215	61.5	58	50	3	2.5	440	635	44 500	65 000	**HR32224J**	146	131	192	208	2.5	2	52.0	0.44	1.4	0.76	9.0
	260	59.5	55	46	4	3	535	655	54 500	67 000	**HR30324J**	155	139	234	247	3	2.5	50.0	0.35	1.7	0.96	13.9
	260	90.5	86	69	4	3	770	1 060	78 500	108 000	**HR32324J**	155	137	230	248	3	2.5	62.4	0.35	1.7	0.96	21.8
130	180	32	32	25	2	1.5	200	365	20 400	37 500	**HR32926J**	145	138	168	174	2	1.5	31.4	0.34	1.8	0.97	2.46
	200	45	45	34	2.5	2	320	535	32 500	54 500	**HR32026XJ**	151	139	184	195	2	2	43.9	0.43	1.4	0.76	5.06
	230	43.75	40	34	4	3	375	505	38 000	51 500	**HR30226J**	157	146	210	220	3	2.5	45.8	0.44	1.4	0.76	7.25
	230	67.75	64	54	4	3	530	790	54 000	80 500	**HR32226J**	158	143	205	221	3	2.5	56.9	0.44	1.4	0.76	11.3
	280	63.75	58	49	5	4	650	820	66 000	83 500	**HR30326J**	167	149	252	265	4	3	52.7	0.35	1.7	0.96	16.6
	280	98.75	93	78	5	4	830	1 150	84 500	117 000	**32326**	172	150	248	269	4	3	69.2	0.36	1.7	0.92	26.6

Bore Diameter 140 – 190 mm





Dynamic Equivalent Load

$P = XF_r + YF_a$

$F_a/F_r \leq e$		$F_a/F_r > e$	
X	Y	X	Y
1	0	0.4	Y_1

Static Equivalent Load

$P_0 = 0.5F_r + Y_0F_a$

When $F_r > 0.5F_r + Y_0F_a$, use $P_0 = F_r$

The values of e, Y_1, and Y_0 are given in the table below.

Boundary Dimensions (mm) d	D	T	B	C	CONE r min.	CUP r min.	Basic Load Ratings (kN) C_r	(kN) C_{0r}	{kgf} C_r	{kgf} C_{0r}	Bearing Numbers	Abutment and Fillet Dimensions (mm) d_a	d_b	D_a	D_b	CONE r_a max.	CUP r_a max.	Eff. Load Centers (mm) a	Constant e	Axial Load Factors Y_1	Y_0	Mass (kg) approx.
140	190	32	32	25	2	1.5	206	390	21 000	39 500	**HR32928J**	155	148	178	184	2	1.5	33.6	0.36	1.7	0.92	2.64
	210	45	45	34	2.5	2	325	555	33 000	57 000	**HR32028XJ**	161	148	193	205	2	2	46.6	0.46	1.3	0.72	5.32
	250	45.75	42	36	4	3	390	515	40 000	52 500	**HR30228J**	169	154	228	240	3	2.5	48.9	0.44	1.4	0.76	8.74
	250	71.75	68	58	4	3	610	915	62 000	93 500	**HR32228J**	171	152	224	242	3	2.5	60.5	0.44	1.4	0.76	14.3
	300	67.75	62	53	5	4	740	945	75 500	96 500	**HR30328J**	178	150	269	284	4	3	55.7	0.35	1.7	0.96	21.1
	300	107.75	102	85	5	4	985	1 440	101 000	147 000	**32328**	185	161	265	288	4	3	76.4	0.37	1.6	0.88	33.9
150	210	38	38	30	2.5	2	281	520	28 600	53 000	**HR32930J**	168	160	196	203	2	2	36.5	0.33	1.8	1.0	4.05
	225	48	48	36	3	2.5	375	650	38 000	66 500	**HR32030XJ**	173	159	206	219	2.5	2	49.8	0.46	1.3	0.72	6.6
	270	49	45	38	4	3	485	665	49 000	67 500	**HR30230J**	180	164	245	258	3	2.5	51.3	0.44	1.4	0.76	11.2
	270	77	73	60	4	3	705	1 080	71 500	110 000	**HR32230J**	183	166	241	259	3	2.5	64.7	0.44	1.4	0.76	17.8
	320	72	65	55	5	4	825	1 060	84 500	108 000	**HR30330J**	192	178	288	301	4	3	60.0	0.35	1.7	0.96	25
	320	114	108	90	5	4	1 120	1 700	114 000	174 000	**32330**	198	173	282	306	4	3	81.5	0.37	1.6	0.88	41.4
160	220	38	38	30	2.5	2	296	570	30 000	58 000	**HR32932J**	178	170	206	213	2	2	38.7	0.35	1.7	0.95	4.32
	240	51	51	38	3	2.5	425	750	43 500	76 500	**HR32032XJ**	184	169	221	234	2.5	2	53.0	0.46	1.3	0.72	7.93
	290	52	48	40	4	3	470	610	47 500	62 000	**30232**	195	178	266	279	3	2.5	55.0	0.43	1.4	0.77	13.1
	290	84	80	67	4	3	795	1 120	81 000	125 000	**HR32232J**	195	177	259	278	3	2.5	70.5	0.44	1.4	0.76	22.7
	340	75	68	58	5	4	915	1 180	93 000	120 000	HR30332J	203	182	307	323	4	3	62.9	0.35	1.7	0.96	29.2
	340	121	114	95	5	4	1 210	1 770	123 000	181 000	**32332**	210	183	301	327	4	3	87.1	0.37	1.6	0.88	48.3
170	230	38	38	30	2.5	2	294	560	30 000	57 000	**HR32934J**	187	179	215	223	2	2	41.7	0.38	1.6	0.86	4.44
	260	57	57	43	3	2.5	505	890	51 500	90 500	**HR32034XJ**	196	180	239	253	2.5	2	56.6	0.44	1.4	0.74	10.6
	310	57	52	43	5	4	525	690	53 500	70 500	**30234**	207	189	282	297	4	3	59.8	0.43	1.4	0.77	16.1
	310	91	86	71	5	4	930	1 450	94 500	148 000	**HR32234J**	209	185	276	300	4	3	76.4	0.44	1.4	0.76	28
	360	80	72	62	5	4	1 010	1 310	103 000	134 000	**HR30334J**	214	194	325	342	4	3	67.3	0.35	1.7	0.96	36.4
	360	127	120	100	5	4	1 370	2 050	140 000	209 000	**32334**	222	194	319	346	4	3	91.3	0.37	1.6	0.88	57
180	250	45	45	34	2.5	2	350	685	36 000	69 500	**HR32936J**	201	189	231	242	2	2	53.9	0.48	1.3	0.69	6.56
	280	64	64	48	3	2.5	640	1 130	65 000	115 000	**HR32036XJ**	208	192	257	272	2.5	2	60.4	0.42	1.4	0.78	14.3
	320	57	52	43	5	4	520	695	53 000	70 500	**30236**	215	199	291	306	4	3	62.1	0.44	1.4	0.74	16.6
	320	91	86	71	5	4	960	1 540	98 000	157 000	**HR32236J**	219	199	285	307	4	3	78.8	0.45	1.3	0.73	29.8
	380	83	75	64	5	4	935	1 230	95 500	126 000	**30336**	230	209	343	360	4	3	72.4	0.36	1.7	0.92	39.3
	380	134	126	106	5	4	1 520	2 290	155 000	234 000	**32336**	232	205	336	364	4	3	96.6	0.37	1.6	0.88	66.8
190	260	45	45	34	2.5	2	365	715	37 000	73 000	**HR32938J**	210	199	241	252	2	2	55.3	0.48	1.3	0.69	6.83
	290	64	64	48	3	2.5	650	1 170	66 000	119 000	**HR32038XJ**	219	202	267	283	2.5	2	63.3	0.44	1.4	0.75	14.9
	340	60	55	46	5	4	580	790	59 000	80 500	**30238**	230	212	311	326	4	3	62.7	0.40	1.5	0.82	20.1
	340	97	92	75	5	4	1 110	1 770	113 000	181 000	**HR32238J**	231	209	305	327	4	3	80.5	0.44	1.4	0.76	35.2
	400	86	78	65	6	5	1 010	1 340	103 000	136 000	**30338**	243	222	362	380	5	4	76.1	0.36	1.7	0.92	46
	400	140	132	109	6	5	1 660	2 580	169 000	263 000	**32338**	249	220	355	385	5	4	102.7	0.37	1.6	0.88	78.9