Koyo®

Roll neck bearings for rolling mill

JTEKT CORPORATION

JTEKT
Koyo TOYODA

CAT. NO. B2013E-1



Operating environment of bearings for rolling mill



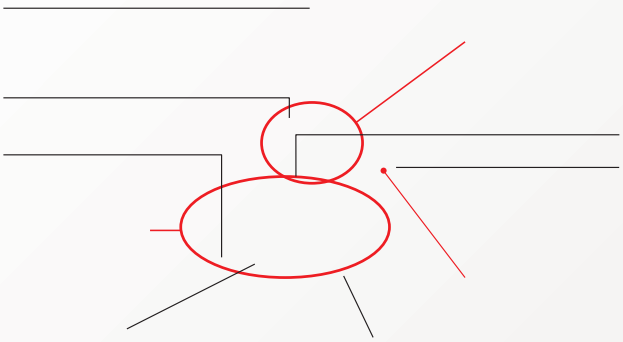
Roll neck bearings



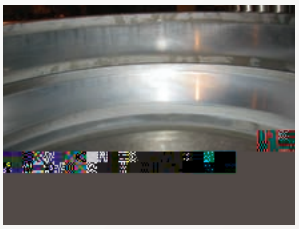
Prevention of the intrusion of water and scale

High-performance seal

JTEKT dramatically extended bearing life by completely preventing the intrusion of rolling mill water and/or scale into the bearing, which is the major cause of failure through the use of enhanced seals. Moreover, maintenance interval has been also lengthened by maintaining high sealing performance. This product was developed by collaboration of JTEKT and Koyo Sealing Techno Co.,Ltd. in JTEKT group.



The tables below show the appearance status and application history of bearing with high-performance seal adopted. Low water content in the grease and little to no rust generation is proof of excellent sealing performance.

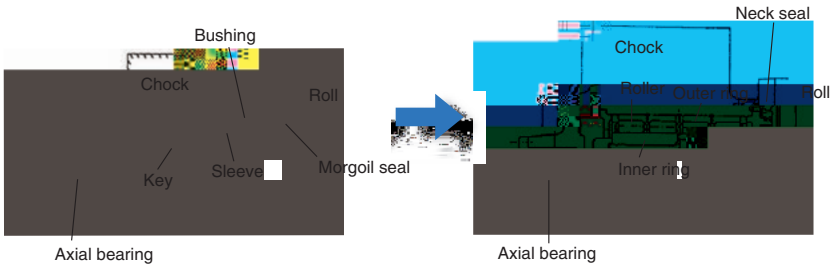
		
		

Post-use appearance of bearing with high-performance seal

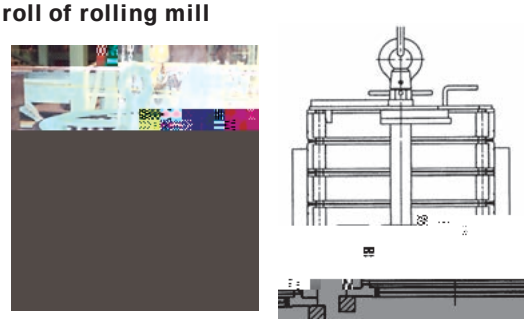
Application history of bearing with high-performance seal

Replacing oil film bearing with rolling bearing

In 1972, JTEKT adopted four-row cylindrical roller bearings for new cold tandem mill tandem back-up rolls (BUR) at first in Japan. Since then, JTEKT has supplied bearings for BUR to many steel manufacturers all over the world. Since JTEKT carried out the modification design and delivered rolling bearings for the modification of the plate mill by replacing the oil film bearing of the back-up roll with the rolling bearing in 1984, JTEKT has completed about twenty-seven projects (maximum record in Japan) until 2014 and has contributed to offer highly-precise products for rolling mills.

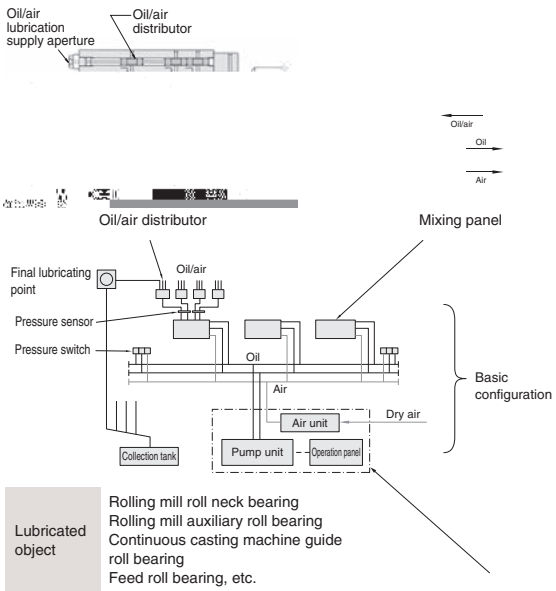


Replacement of oil film bearing with rolling bearing for back-up roll of rolling mill



Lifting tool for rolling bearing assembly

Oil / air lubrication for steelmaking equipment



Lubricated object	Rolling mill roll neck bearing Rolling mill auxiliary roll bearing Continuous casting machine guide roll bearing Feed roll bearing, etc.
Tank capacity	From 250 to 2 000 L
Number of	q 1 0 Tm (Num2 0 m 3.345 0 4.771 256.362 c7 11.199 0.318 re f q 1 0.318 re f q d2 c7 11 f q d2 c7 1ng)Tj 0 -1.25 T6 328.03q 174 0 Tm

Main unit

Handling bearings



Precautions before opening the package and installing bearings

(1) Do not open the bearing packaging or wrapping until right before you install the bearing.
(2) Make the work area where you will install the bearing as clean as possible, and prevent foreign materials such as trash, dust, and iron powder from adhering to the bearing.
(3) When removing a sealed type bearing from its wooden box, exercise sufficient caution to prevent the oil seal attached to the seal cover from being damaged.
(4) Handle the bearing gently and do not subject it to impacts or shocks.
(5) Thoroughly clean the roll neck and the chock to ensure that no trash or other foreign material is affixed to them.
(6)



Bearing assembly (3)

Bearing failures, causes and countermeasures

Failures	Characteristics

1 Flaking

Flaking caused by excessive axial load



(Cones of four-row tapered roller bearing)

Damages Flaking on bearing raceway surface generated on only rows receiving axial load

Causes

1) Crossed work rolls causing excessive axial load
   - Roll neck diameter is smaller than the standard one.
   - Chock side liner is worn.
   - Inaccuracy of mill stand.
   - Rigidity of the chock is poor.
   - Corrosion on liner or clearance generated between the liner and the chock.
   - Failure of the keeper plate.

Countermeasures

1) Keep the correct locations of the chock and work roll.



(Cup raceway of four-row tapered roller bearing)

Damages Flaking generated and developed from raceway end face

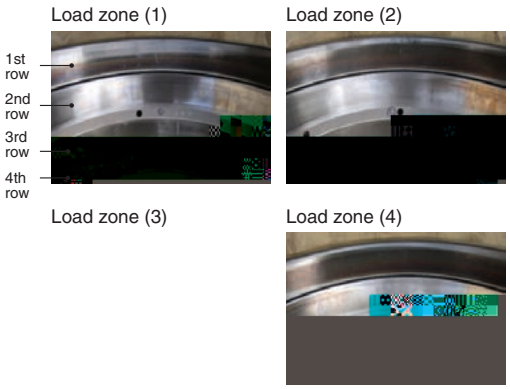
Causes

1) Looseness of chock cover/excessive axial clearance.
   (As the axial clearance is increased, the loading range becomes narrower, partial load acts, and edge load is generated on the cup raceway.)
2) Excessive axial clearance is generated because of the mixed use of other bearing spacer or cup.

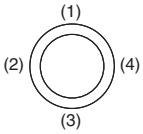
Countermeasures

1) Adjust shims, select thickness of shims, measure a gap, and tighten bolts correctly.
2) Use parts of the same number.

Flaking caused by improper mounting



(Cup raceway of four-row tapered roller bearing)



Damages Flaking on raceway surface with slanted contact

Causes

1) It occurs when the chock is fixed inappropriately and slantingly.
   - Failure of keeper plate
     Removal, looseness, damage, deformation, bend, unequal tightening, unequal wear, improper parallelism.
   - Damaged, deformed, or bent chock flange.

Countermeasures

1) Find the cause of damage by periodic inspection of the chock and stand.

Bearing failures, causes and countermeasures

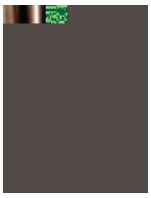
Flaking at corroded start point

Flaking on raceway surface started from corroded (rusted) portion

1) After the bearing was used, it has been left for a long period with moisture mixed in grease.
2) Improper rust preventive treatment after the bearing was washed.
3) Worn or damaged seal lips.
4) Corrosion on the raceway is generated due to the clearance between the roll neck and the sleeve, and flaking occurs with rust.

1) Improve seal maintenance and sealing method. Periodically check for wear or damage on the seal lips.
2) Fit the “O” ring between the roll neck and the sleeve.
3) Immediately after the bearing is removed from the chock, change grease.
4) After washing the bearing, remove kerosene and water completely.

Flaking on nicks (scratch) start point

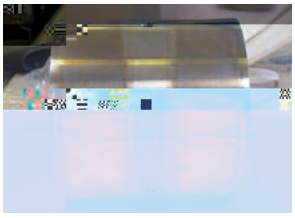


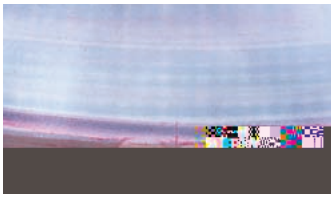
(Rolling contact surface of four-row cylindrical roller bearing)

Flaking on rolling contact surface with nicks start point

1) Inappropriate handling
   · Mounting / dismounting bearing to / from chock.
   · Replacing roll.

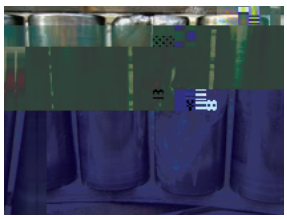
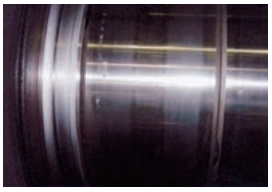
1) Proper handling jig (use of a copper hammer).
2) Prevention of impact load when replacing roll (use of soft material).
3) Improvement in mounting method.
4) Change in raceway chamfering.





Flaking on raceway surface

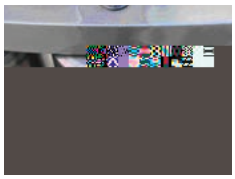
1) Low viscosity oil lubrication (improper lubrication).

Failures	Characteristics	
2 **Cracking Chipping**	 (Rolling contact surface of four-row cylindrical roller bearing)	**Damages** Cracking on rolling elements
		Causes 1) Application of load greater than bearing load rating (Load resistance of roller by use of pin type cage) 2) Secondary factor in case of damaged pin of cage (For a reversible mill, pins are broken due to fatigue caused by rapid acceleration and deceleration) 3) Other factors · Ingress of water due to faulty sealing. · Increase of axial clearance of bearing, causing application of partial and excessive load.
		1) Optimal design of bearing considering load and operating conditions (Examination of optimal cage type) 2) Reviewing sealing method and design of strength of cover.
	 (Inner ring raceway of four-row cylindrical roller bearing)  (Inner ring raceway of four-row cylindrical roller bearing)	Grinding burn or crack on inner ring raceway surface
		1) After fitting an inner ring into the roll neck, grinding burn occurs during grinding with the inner ring and the roll. 2) Crack occurs because rollers rolling on the raceway surface of which strength (hardness) is decreased due to grinding burn.
		1) Reviewing grinding conditions Grain size of grinding stone, grinding stone cutting amount, cutting pressure, grinding fluid amount, etc.
	 (Inner ring of spherical roller bearing)  (Fractured section of inner ring)	Axial crack occurs on bore surface of inner ring and raceway surface.
		1) Excessive interference between inner ring and shaft. 2) Great fit stress due to excessive difference in temperature of inner ring and that of shaft.
		1) Appropriate fit conditions of inner ring and shaft. 2) Appropriate difference in temperature by checking load, rotation, and temperature conditions. (appropriate fit)
	 (Cone bore surface of four-row tapered roller bearing)	Circumferential crack occurs on bore surface and raceway surface of cone.
		1) Step wear occurs on the shaft (roll neck), and the cone overrides the shaft, causing great bore surface stress.
		1) Provide circumferential groove for the roll neck. 2) When using a bearing with different chamfers for a roll, make the chamfers identical.

Bearing failures, causes and countermeasures



(Rolling contact surface of double-row tapered roller bearing)



(Roller large end face of double-row tapered roller bearing)



(Cone of double-row tapered roller bearing)

Discoloration, deformation, and melting caused by heating in bearing

1) Improper lubrication (insufficient or degraded lubricant)
2) Ingress of water due to faulty sealing
3) Excessive axial load
4) Heat generated by creep of cone
5) Ingress of dusts or foreign matters
6) Excessively small bearing internal clearance

1) Reviewing sealing type and conditions
2) Reviewing lubricating method and lubricant, and checking lubricated condition
3) Check for axial load
4) Reviewing bearing (type, size, etc.)
5) Reviewing clearance
6) Confirming operating conditions



(Cone assembly of four-row tapered roller bearing)

Grease including large quantity of water mixed in

1) Operated at high temperature ⇒ Grease is carbonized.
2) Ingress of water due to improper sealing or wear or damage of seal lip (In this example, 20% or more of water is mixed in grease.)

1) Find the cause of high temperature.

2) Checking wear or damage of seal lip. Find the cause of and countermeasure against the improper sealing.



(Cone assembly of double-row tapered roller bearing)



(Cup of double-row tapered roller bearing)

Foreign matter attachment and corrosion occur because of ingress of a great deal of foreign matters (scale and water for rolling).

1) Ingress of water due to improper sealing or wear or damage of seal lip

1) Checking wear or damage of seal lip. Find the cause of and countermeasure against the improper sealing.

Seizure and adhesion of raceway, roller, and cage

1) Varied factors including improper lubrication, improper operation, and ingress of foreign matters occur, causing damages.

1) Checking improper operation
2) Checking lubricating conditions
3) Checking de1 j 1 5 Tw30(oreig30 0 m 22 qN 0 0 m 0 0 l

Technical data

Table 1-1 Recommended fits for roll neck metric series four-row tapered roller bearing

Table 1-2 Recommended fits for roll neck inch series four-row tapered roller bearing

Double cone and roll neck (shaft)							Cup and chock (housing)							
Nominal bore diameter d (1/25.4)		Single bore diameter deviation Δ_d μ		Roll neck diameter deviation μ		Minimum allowable roll neck diameter wear μ	Nominal outside diameter D (1/25.4)		Single outside diameter deviation Δ_D μ		Chock bore diameter deviation μ		Maximum allowable chock bore (wear) μ	Maximum roundness μ
over	up to	upper	lower	upper	lower		over	up to	upper	lower	upper	lower		
76.2 (3.0)	**101.6** (4.0)	+ 25	0	– 75	–100	–250	–	**304.8** (12.0)	+ 25	0	+ 75	+ 50	+150	150
101.6 (4.0)	**127.0** (5.0)	+ 25	0	–100	–125	–300	**304.8** (12.0)	**609.6** (24.0)	+ 51	0	+150	+100	+300	150
127.0 (5.0)	**152.4** (6.0)	+ 25	0	–125	–150	–350	**609.6** (24.0)	**914.4** (36.0)	+ 76	0	+225	+150	+450	150
152.4 (6.0)	**203.2** (8.0)	+ 25	0	–150	–175	–400	**914.4** (36.0)	**1 219.2** (48.0)	+102	0	+300	+200	+600	300
203.2 (8.0)	**304.8** (12.0)	+ 25	0	–175	–200	–450	**1 219.2** (48.0)	**1 524.0** (60.0)	+127	0	+375	+250	+750	350
304.8 (12.0)	**609.6** (24.0)	+ 51	0	–200	–250	–600	**1 524.0** (60.0)		+127	0	+450	+300	+750	350
609.6 (24.0)	**914.4** (36.0)	+ 76	0	–250	–325	–800								
914.4 (36.0)	**1 219.2** (48.0)	+102	0	–300	–400	–800								
1 219.2 (48.0)		+127	0	–375	–475	–800								

Table 1-3 Recommended fits for roll neck four-row cylindrical roller bearing (inner ring interference fit)

Inner ring and roll neck (shaft)						Outer ring and chock (housing)					
Nominal bore diameter d		Single plane mean bore diameter deviation Δ_d μ		Roll neck diameter deviation μ		Nominal outside diameter D		Single plane mean outside diameter deviation Δ_D μ		Chock bore diameter deviation μ	
over	up to	upper	lower	upper	lower	over	up to	upper	lower	upper	lower
80	**120**	0	– 20	+ 59	+ 37 (p6)	**120**	**150**	0	– 18	+ 40	0 (H7)
120	**180**	0	– 25	+ 68	+ 43 (p6)	**150**	**180**	0	– 25	+ 40	0 (H7)
180	**250**	0	– 30	+ 79	+ 50 (p6)	**180**	**250**	0	– 30	+ 46	0 (H7)
250	**280**	0	– 35	+126	+ 94 (r6)	**250**	**315**	0	– 35	+ 52	0 (H7)
280	**315**	0	– 35	+130	+ 98 (r6)						
315	**355**	0	– 40	+144	+108 (r6)	**315**	**400**	0	– 40	+ 75	+ 18 (G7)
355	**400**	0	– 40	+150	+114 (r6)						
400	**450**	0	– 45	+166	+126 (r6)	**400**	**500**	0	– 45	+ 83	+ 20 (G7)
450	**500**	0	– 45	+172	+132 (r6)						
500	**560**	0	– 50	+194	+150 (r6)	**500**	**630**	0	– 50	+ 92	+ 22 (G7)
560	**630**	0	– 50	+354	+310 (s6)						
630	**710**	0	– 75	+390	+340 (s6)	**630**	**800**	0	– 75	+160	+ 80 (F7)
710	**800**	0	– 75	+430	+380 (s6)						
800	**900**	0	–100	+486	+430 (s6)	**800**	**1 000**	0	–100	+176	+ 86 (F7)
900	**1 000**	0	–100	+526	+470 (s6)						
1 000	**1 120**	0	–125	+588	+520 (s6)	**1 000**	**1 250**	0	–125	+203	+ 98 (F7)
1 120	**1 250**	0	–125	+646	+580 (s6)						
						1 250	**1 400**	0	–160	+235	+110 (F7)
						1 400	**1 600**	0	–160	+345	+220 (E7)

[Remark] The table above shows general values. JTEKT determines recommended fit on a case by case basis according to bearing materials and operating conditions to prevent the inner ring from creeping. Consult with JTEKT when referring to this table.

Table 1-4 Recommended fits of bearing types for support of axial loading

Bearing type	Inner ring and roll neck (shaft)	Outer ring and chock (housing)	
	Shaft tolerance range class	Mounted to chock	Mounted to sleeve

2. Tolerances

2-1. Four-row cylindrical roller bearings

Table 2-1 Tolerances of roller set bore diameter and roller set outside diameter of interchangeable bearings

Unit : μ

Table 2-2 (1) Radial bearing tolerances (tapered roller bearings excluded) = JIS B 1514-1 =

(2) Inner ring (running accuracy and width)

Unit : μ

Nominal bore diameter d		Radial runout of assembled bearing inner ring K			S	Single inner ring width deviation Δ_B						Single inner ring width deviation Δ_B						Inner ring width variation V_B		
		class 0	class 6	class 5	class 5	class 0		class 6		class 5		class 0		class 6		class 5		class 0	class 6	class 5
over	up to	max.			max.	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	max.		
120	**150**	30	18	8	10	0	– 250	0	– 250	0	– 250	0	–500	0	–500	0	–380	30	30	8
150	**180**	30	18	8	10	0	– 250	0	– 250	0	– 250	0	–500	0	–500	0	–380	30	30	8
180	**250**	40	20	10	11	0	– 300	0	– 300	0	– 300	0	–500	0	–500	0	–500	30	30	10
250	**315**	50	25	13	13	0	– 350	0	– 350	0	– 350	0	–500	0	–500	0	–500	35	35	13
315	**400**	60	30	15	15	0	– 400	0	– 400	0	– 400	0	–630	0	–630	0	–630	40	40	15
400	**500**	65	35	*20*	*18*	0	– 450	0	– 450	*0*	*– 450*	–	–	–	–	–	–	50	45	*18*
500	**630**	70	40	*25*	*25*	0	– 500	0	– 500	*0*	*– 500*	–	–	–	–	–	–	60	50	*20*
630	**800**	80	*50*	*30*	*30*	0	– 750	*0*	*– 750*	*0*	*– 750*	–	–	–	–	–	–	70	*60*	*23*
800	**1 000**	90	*60*	*40*	*40*	0	–1 000	*0*	*–1 000*	*0*	*–1 000*	–	–	–	–	–	–	80	*60*	*35*
1 000	**1 250**	100	*70*	*50*	*50*	0	–1 250	*0*	*–1 250*	*0*	*–1 250*	–	–	–	–	–	–	100	*60*	*45*
1 250	**1 600**	120	–	–	–	0	–1 600	–	–	–	–	–	–	–	–	–	–	120	–	–
1 600	**2 000**	140	–	–	–	0	–2 000	–	–	–	–	–	–	–	–	–	–	140	–	–

S

Table 2-2 (2) Radial bearing tolerances (tapered roller bearings excluded)

(3) Outer ring (outside diameter)

Unit : μ

[Applicable tolerance for tapered roller bearings]

Type of tapered roller bearings			Applicable tolerance[1)]
Double-row · Four-row	Metric series	45200, 45300, 46200 (A), 46300 (A) 46T30200JR, 46T32200JR, 46T30300JR, 46T32300JR 37200, 47200, 47300	Class 0 of BAS 1002 (Refer to Table 2-3 on page 30)
	Inch series	[LM377449D/LM377410, 67388/67322D EE127094D/127138/127139D etc.]	Class 4 of ABMA 19 (Refer to Table 2-4 on page 31)
	The others	45T···, 46T···, 47T···, 2TR···, 4TR···	Special tolerances for required are used in many cases. Consult with JTEKT.

Table 2-4 Tolerances and permissible values for inch series tapered roller bearings = ABMA 19 =

(1) Cone

Unit : μ

Applied bearing type	Nominal bore diameter *d*, (1/25.4)		Deviation of a single bore diameter Δ_d							
			Class 4		Class 2		Class 3		Class 0	
	over	up to	upper	lower	upper	lower	upper	lower	upper	lower
All types	–	**76.2** (3.0)	+ 13	0	+13	0	+13	0	+13	0
	76.2 (3.0)	**266.7** (10.5)	+ 25	0	+25	0	+13	0	+13	0
	266.7 (10.5)	**304.8** (12.0)	+ 25	0	+25	0	+13	0	+13	0
	304.8 (12.0)	**609.6** (24.0)	+ 51	0	+51	0	+25	0	–	–
	609.6 (24.0)	**914.4** (36.0)	+ 76	0	–	–	+38	0	–	–
	914.4 (36.0)	**1 219.2** (48.0)	+102	0	–	–	+51	0	–	–
	1 219.2 (48.0)	–	+127	0	–	–	+76	0	–	–

(2) Cup

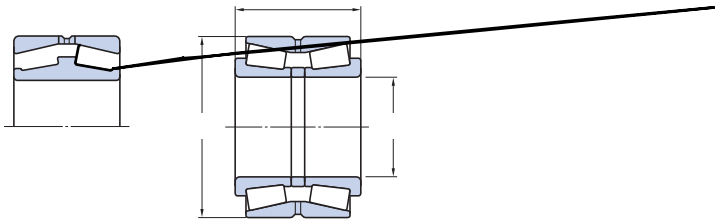
Unit : μ

Applied bearing type	Nominal outside diameter *D*, (1/25.4)		Deviation of a single outside diameter Δ_D							
			Class 4		Class 2		Class 3		Class 0	
	over	up to	upper	lower	upper	lower	upper	lower	upper	lower
All types	–	**266.7** (10.5)	+ 25	0	+25	0	+13	0	+13	0
	266.7 (10.5)	**304.8** (12.0)	+ 25	0	+25	0	+13	0	+13	0
	304.8 (12.0)	**609.6** (24.0)	+ 51	0	+51	0	+25	0	–	–
	609.6 (24.0)	**914.4** (36.0)	+ 76	0	+76	0	+38	0	–	–
	914.4 (36.0)	**1 219.2** (48.0)	+102	0	0	2	0			

(4) Assembled bearing width and overall width

Unit : μ

Applied bearing type	Nominal bore diameter d, (1/25.4)		Nominal outside diameter D, (1/25.4)		Deviation of the actual bearing width and overall width of cones/cups Δ_T, Δ_W							
					Class 4		Class 2		Class 3		Class 0	
	over	up to	over	up to	upper	lower	upper	lower	upper	lower	upper	lower
Double-row	–	**101.6** (4.0)	–	–	+ 406	0	+ 406	0	+ 406	– 406	+ 406	– 406
	101.6 (4.0)	**266.7** (10.5)	–	–	+ 711	– 508	+ 406	– 203	+ 406	– 406	+ 406	– 406
	266.7 (10.5)	**304.8** (12.0)	–	–	+ 711	– 508	+ 406	– 203	+ 406	– 406	+ 406	– 406
	304.8 (12.0)	**609.6** (24.0)	–	**508.0** (20.0)	–	–	+ 762	– 762	+ 406	– 406	–	–
	304.8 (12.0)	**609.6** (24.0)	**508.0** (20.0)	–	–	–	+ 762	– 762	+ 762	– 762	–	–
	609.6 (24.0)		–	–	+ 762	– 762	–	–	+ 762	– 762	–	–
Double-row (TNA type)	–	**127.0** (5.0)	–	–	–	–	+ 254	0	+ 254	0	–	–
	127.0 (5.0)		–	–	–	–	+ 762	0	+ 762	0	–	–
Four-row	Total dimensional range		–	–	+1 524	–1 524	+1 524	–1 524	+1 524	–1 524	+1 524	–1 524



Large size bearing technology development center

At JTEKT, we continue to develop our operations as a global system supplier that can solve the problems of our customers and that can provide our customers with new products based on our accumulated knowledge and having high added value.



Regarding large bearings used in the field of industrial machinery, up to now it was common to perform theoretical examinations, to perform basic evaluations, and to have these bearings evaluated by our customers with using the bearings on actual equipment. As a result, issues such as unexpected problems and extended development time occurred.

At JTEKT, we have established the Large Size Bearing Technology Development Center and we have begun work at this center, which enables us to perform evaluations in which the environments closely resemble those of the actual machines.

The data that we accumulate here will be put to use in improving the accuracy of our CAE analysis (simulation analysis), in greatly reducing the development time of future products, and in developing new products with high added value.



■ Test devices for bearings used in steelmaking equipment

In order to closely approximate the use conditions of actual machinery, this test equipment enables evaluations with spraying water for rolling and under high temperatures. This enables us to proceed with the development of new products having even higher reliability by giving consideration to bearings and oil seals as a complete package.

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