

1 Structure and features

Koyo Insert Bearing Units are highly precise bearing units comprising grease sealed deep groove ball bearings and housings in various forms. The insert bearing units allow easy handling and installation by followings: direct installation to machines and equipment with some bolts, self-aligning, and greasing.

1.1 Structure

Koyo Insert Bearing Unit comprises the insert bearing for unit with spherical outside surface and the housing with spherical bearing seat (Fig. 1.1).

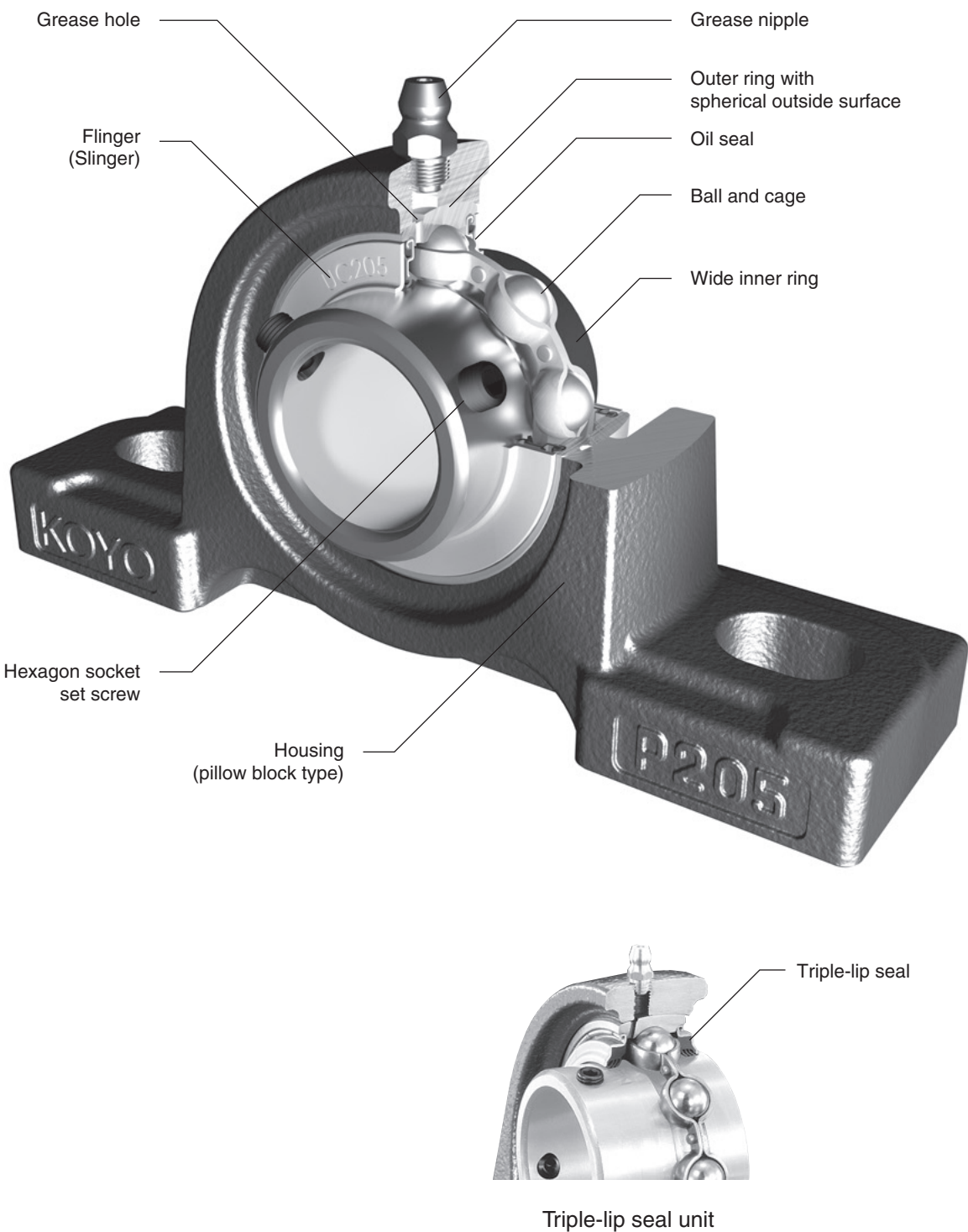


Fig. 1.1 Structure of insert bearing units (representative example)

1 Structure and features

1.2 Features

Koyo Insert Bearing Units, having many features, are available in various types. Select the bearing unit optimal for your purpose among the types with unique features.

1 Supreme load capacity and accuracy

Koyo Insert Bearings for unit, featuring the internal structure identical to single row deep groove ball bearings, bear axial load in both directions, as well as great radial load. The tolerance is equal to that of an standard bearing. They feature high rotation accuracy and high speed rotation.

2 Rational self aligning mechanism and optimal fit

Koyo Insert Bearing Units have self aligning mechanism by the spherical outside surface bearing and the housing with and spherical bearing seat. Because of this mechanism, deviation of the shaft center caused by warp of the shaft flexion of axis (shaft) or offset is automatically adjusted to eliminate abnormal load onto the bearing, leading to guarantee of original service life of the bearing.

Since the spherical outside surface of the bearing is ground and the spherical bearing seat of the housing is machined by a boring machine with high accuracy, optimal fitting of the bearing and the housing can be obtained, as well as superior aligning performance.

The allowable aligning angle of standard insert bearing unit is 3°, while that of insert bearing unit with cover is 1°.

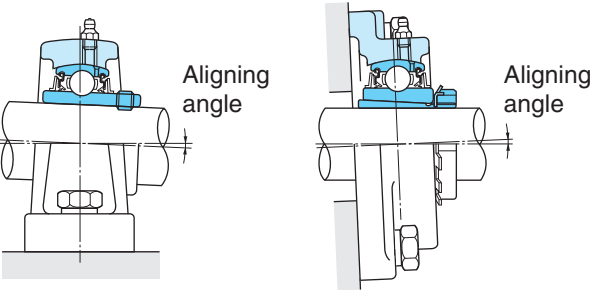


Fig. 1.2 Allowable aligning angle of insert bearing unit

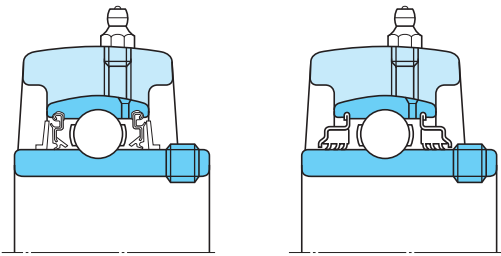
3 Superior sealing performance

Koyo Insert Bearing Units can prevent leak of grease in the bearing to the outside, as well as ingress of dusts and water from the outside into the inside of the bearing by the synergetic effect of the oil seal installed to the outer ring of the bearing and the flinger (slinger) installed to the inner ring of the bearing.

The oil seal is made of synthetic rubber featuring supreme oil proof. Its lip contacts with the inner ring of the bearing with optimal tension (radial load of lip).

When using in environments with many dusts or high humidity, the triple-lip seal unit (supplementary code : L3) or the unit with cover (supplementary code : C, CD, FC, FD) is optimal.

The triple-lip seal unit or unit with cover strongly prevents ingress of water and dusts from the outside, and guarantees a longer service life of the bearing.



Standard type Triple-lip seal type (Supplementary code : L3)

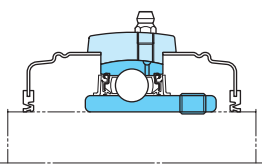
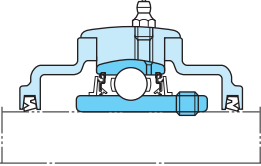
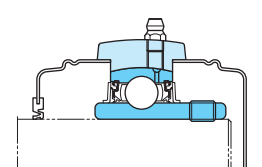
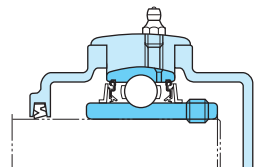
	Pressed steel cover type	Cast iron cover type
Open ends type	 (Supplementary code : C)	 (Supplementary code : C, FC)
Closed end type	 (Supplementary code : CD)	 (Supplementary code : CD, FCD)
Unit with cover		

Fig. 1.3 Sealing mechanism of insert bearing unit

#### 4 Simple greasing

Because of the grease nipple on the housing of Koyo Insert Bearing Unit, fresh grease can be easily supplied to the bearing being operated. If the bearing is used in severe environments that are exposed to many dusts or high humidity or that is high temperature, supply fresh grease at a regular interval. Then, the lubrication status of the bearing is kept to the best, and the service life of the bearing can be extended.

When greasing to the bearing unit with the centralized lubricating system, use the socket for lubricating installed to the grease nipple tapped hole on the housing.

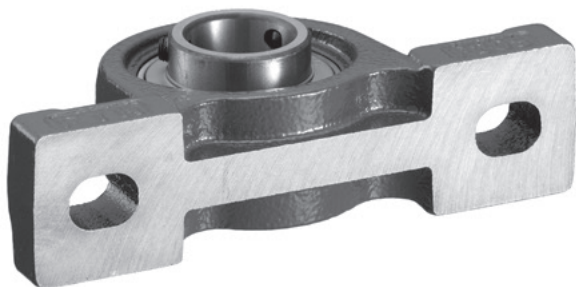
#### 5 Highly rigid and strong housing

Koyo Insert Bearing Unit housing is designed so that it is optimal for reduction of deformation due to centralization of stress and load. After the selection of good material, it is produced by highly advanced casting technique or press working technique.

Since any abnormal load onto the bearing is eliminated by the highly rigid and strong housing, the service life of the bearing can be extended. Baking finish on the surface of the housing keeps good surface status for a long time.

Koyo original solid base pillow block housings seat better and produce a more stable mounting configuration that significantly reduces vibration.

The support ribs have been eliminated to make more room for mounting bolts and washers, yet these housings are more than 30% stronger than before while also reducing housing weight. The new housing downward destruction strength means that the inserts break before the housings.



#### 6 Simple installation and handling

Koyo Insert Bearing Units of many types can be installed to any of machine or equipment with some bolts, and can be used in the status as it is. Clearance fit is used for the inner ring of bearing and the shaft, as a rule.

Therefore, Koyo Insert Bearing Unit does not need any work such as filling of lubricant or installation of sealing unit required for standard bearings. As a result, the total of manpower can be drastically reduced.

As for the fixing method of bearing to shaft, three methods, (1) set screw mounted to the cylindrical bore wide inner ring, (2) adapter installed to the tapered bore inner ring, and (3) eccentric locking collar installed to the cylindrical bore wide inner ring are available.

Fixing of bearing to shaft can be executed easily and securely by adopting any of these method.

#### 7 Various types

Koyo Insert Bearing Units are available in various types.

Reliability of machine or equipment used together with the units can be improved by selecting and using bearing units optimal for the purpose and operating conditions.

2 Unit number

2 Unit number

Nominal number of Koyo Insert Bearing Unit conform to JIS B1557, and comprise the bearing unit type number (comprising bearing type code and housing type code),

diameter series code, bore dia. number, supplementary code, and special code.

UC

P

207

J

L3

-----

UK

P

209

J

CD + H309X

-----

UC

F

209

J

L3

FD

D1K2

G6

A1

Housing special code  
(Table 2.8)

Bearing special code (Table 2.7)

Supplementary code (Table 2.6)

Fitting code (Table 2.5)

Bore dia. No. (Table 2.4)

Diameter series code (Table 2.3)

Housing type code (Table 2.2)

Bearing type code (Table 2.1)

Nominal bearing number	UC207L3
Nominal housing number	P207J

Nominal bearing number	UK209+H309X
Nominal housing number	P209JE1
Nominal pressed steel cover number	(Through type) C-9x40 (Closed type) D-9

Nominal bearing number	UC209L3D1K2G6
Nominal housing number	F209JA1E3
Nominal cast iron cover number	(Closed type) 209FD

[Remark] The above number shows an example of nominal number structure. It may depend on the bearing unit type.

Table 2.1 Bearing type code	
Bearing type code	Details
UC	Cylindrical bore, with set screws
UC-S6	Cylindrical bore, with set screws (stainless-series)
UK	Tapered bore (for adapter)
NA	Cylindrical bore, with eccentric locking collar
SB	Cylindrical bore, with set screws (light duty type)
SU	Cylindrical bore, with set screws ("compact" series)
SA	Cylindrical bore, with eccentric locking collar (light duty type)
SU-S6	Cylindrical bore, with set screws (stainless-series)
ER	Cylindrical bore, with set screws, cylindrical outer diameter, Lubricating mechanism
RB	Cylindrical bore, with set screws, cylindrical outer diameter

Table 2.2 Housing type code	
Housing type code	Details
P	Pillow block type
IP	Thick section pillow block type
PA	Tapped-base pillow block type
PH	Higher centerheight pillow block type
LP	Light duty pillow block type
P	Pillow block type ("compact" series)
SP	Pillow block type (stainless-series)
SPA	Tapped-base pillow (stainless-series)

Table 2.2 Housing type code (continued)	
Housing type code	Details
SP	Pillow block type (stainless-series)
PP	Cast steel pillow block type
F	Square-flanged type
FL	Rhombic-flanged type
FA	Adjustable rhombic-flanged type
FB	Three-bolt flange type
FC	Round-flanged type with spigot joint
FS	Square-flanged type
FL	Rhombic-flanged type ("compact" series)
SF	Square-flanged type (stainless-series)
SFC	Round-flanged type with spigot joint (stainless-series)
SFL	Rhombic-flanged type (stainless-series)
PF	Pressed steel round-flanged type
PFL	Pressed steel rhombic-flanged type
PFT	Pressed steel triangle-flanged type
T	Take-up type
ST	Take-up type (stainless-series)
TH	Section steel frame take-up type
TL	Light channel steel frame take-up type
TU	Channel steel frame take-up type
PTH	Pressed steel frame take-up type
NPTH	Pressed steel frame take-up type
C	Cartridge type
HA	Hanger type
RU-M	Rubber clamping ring type

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Table 2.3 Diameter series code

Diameter series code	Details
0	For light duty
2	For medium duty
X	For medium duty
3	For heavy duty

Table 2.4 Bore dia. number

Bore dia. No.	Details
8	Nominal bearing bore dia. 8 mm
00	Nominal bearing bore dia. 10 mm
01	Nominal bearing bore dia. 12 mm
02	Nominal bearing bore dia. 15 mm
03	Nominal bearing bore dia. 17 mm
04	(Bore dia. No.) × 5 = Nominal bearing bore dia. (mm)
or more	
01-8	– (bore dia. No.) /16 = nominal bearing bore dia. (inch) (in this case, 8/16 = 1/2 inch = 12.7 mm)

Table 2.5 Fitting code

Fitting code	Details
J	Tolerance class of spherical bore of the housing is J7 (not shown on the bearing that the spherical bore diameter exceeds 120 mm)
H	Tolerance class of spherical bore of the housing is H7 With integrated lock pin
K	Tolerance class of spherical bore of the housing is K7

Table 2.6 Supplementary code

Supplemen- tary code	Details
C	Cover, open type
D	Cover, closed type
FC	Cast iron cover, open type
FD	Cast iron cover, closed type
L2 <sup>1)</sup>	Double-lip seal type
L3 <sup>1)</sup>	Triple-lip seal type

Note 1) Standard specifications of codes L2 and L3 are as shown below.

Bearing No.	Applicable seal type
UC201 to UC205, UK205 NA201 to NA205	L2 (Double-lip seal)
UC206 to UC218, UK206 to UK218 NA206 to NA215	L3 (Triple-lip seal)
UCX05 to UCX17, UKX05 to UKX17	
UC307 to UC328, UK307 to UK328	

However, UC 206 - 18 to UC 206 - 20 are L2 [double-lip seal type]

[Remark] Please refer to “16 Parts and accessories” for cover details.

Table 2.7 Bearing special code

Item	Bearing special code	Details
Grease	None	Alvania No.2 or equivalents
	D1	SH44M
	D2	SH33M
	D9	Demnum L-200
Set Screw	None	Bullet Point
	G4	Pointed tip
	G6	With full dog point
Oil seal	None	Nitrile rubber
	K2	Silicone rubber
	K3	Non-contact type
Sealing Device	None	With oil seal and flinger (slinger) (UC, UK, NA, ER and RB types) With oil seal (SB, SA and SU types)
	P3	Without oil seal, flinger (slinger)
	P4	Without oil seal
	P11 <sup>1)</sup>	With integrated lock pin
Others	S3	Air handling fit, 100% noise check, the anti-rotation pin
	S5	For blower (oil seal : K3, inner clearance and bearing accuracy are specially controlled)
	S6	Stainless steel bearing
	S7	Plated bearing (for corrosion-resistance)

Note 1) Code P11 is unnecessary in the following cases.

Bearing Type	Bearing No.	Fitting code	Code
UC	313 or more	J	Not indication
UC200S6, SU000S6	All		
All	All	H	

2 Unit number

Table 2.8 Housing special code

Item	Housing special code	Details
Grease Nipple Thread Bore dia.	None	As shown in dimensional table
	A1	PT1/8 tube thread
	A2	PF1/8 tube thread
	A3	PT1/4 tube thread
	A4	PF1/4 tube thread
Grease Nipple Thread Bore Position	None	As shown in dimensional table
	B1	Right
	B2	Left
	B3	45°
	B5	30°
	B7	Both right and left
Machining	None	Standard type
	E1	Pressed steel cover mounting groove
	E3	Cast iron cover mounting groove (diameter series 2, X, 3)
	E4	Non-lubricating type
Material	None	Gray iron casting (FC200) or cold-reduced carbon steel sheets and strips (SPCC) Compact type is made of zinc alloy die-cast (ZDC2) Small stainless series is made of stainless cast steel type (SCS13)
	H4	Ductile iron (FCD450-10)
	H5	Rolled steel for general purpose (SS400)
Grease Nipple	None	A type
	N1	B type (67.5°)
	N2	C type (90°)



3 Types

3.1 Type list

Table 3.1 and Table 3.2 show the types of Koyo Insert Bearing Units and insert bearing for unit.

Koyo Insert Bearing Units are available in various types.

Table 3.1 Koyo Insert Bearing Units types

Type		Bearing bore dia. Surface (fixing to shaft)	Type code	Shaft dia.		Dimension table
				(inch)	(mm)	
1 Pillow block type	(1) Standard	Cylindrical bore (with set screws)	UCP	1/2 – 4	12 – 140	P.78
		Cylindrical bore (with eccentric locking collar)	NAP	1/2 – 2 15/16	12 – 75	P.84
			NAPK	1/2 – 2 15/16	12 – 75	P.86
		Tapered bore (with adapter)	UKP	3/4 – 4 1/2	20 – 125	P.88
	(2) Thick section type	Cylindrical bore (with set screws)	UCIP	1 1/2 – 4	40 – 140	P.94
		Tapered bore (with adapter)	UKIP	1 1/4 – 4 1/2	35 – 125	P.96
	(3) Tapped-base type	Cylindrical bore (with set screws)	UCPA	1/2 – 2	12 – 50	P.98
	(4) Higher centerheight type	Cylindrical bore (with set screws)	UCPH	1/2 – 2	12 – 50	P.100
	(5) Light duty type	Cylindrical bore (with set screws)	BLP	1/2 – 1 9/16	12 – 40	P.102
		Cylindrical bore (with eccentric locking collar)	ALP			
	(6) “Compact” series	Cylindrical bore (with set screws)	UP	N/A	10 – 30	P.104
	(7) Stainless-series	Cylindrical bore (with set screws)	UCSP-S6	N/A	12 – 65	P.106
			UCSPA-S6	N/A	12 – 50	P.108
			USP-S6	N/A	10 – 30	P.110
2 Square-flanged type	(1) Standard	Cylindrical bore (with set screws)	UCF	1/2 – 4	12 – 140	P.112
			UCF-E	1/2 – 3 7/16	12 – 85	P.118
		Cylindrical bore (with eccentric locking collar)	NANF	1/2 – 2 7/16	12 – 60	P.122
		Tapered bore (with adapter)	UKF	3/4 – 4 1/2	20 – 125	P.124
	(2) With spigot joint	Cylindrical bore (with set screws)	UCFS	1 – 4	25 – 140	P.130
		Tapered bore (with adapter)	UKFS	3/4 – 4 1/2	20 – 125	P.132
	(3) Stainless-series	Cylindrical bore (with set screws)	UCSF-S6	N/A	20 – 65	P.134
3 Rhombic-flanged type	(1) Standard	Cylindrical bore (with set screws)	UCFL	1/2 – 4	12 – 120	P.136
			UCFL-E	1/2 – 3 1/4	12 – 85	P.142
		Cylindrical bore (with eccentric locking collar)	NANFL	1/2 – 2 3/16	12 – 55	P.146
		Tapered bore (with adapter)	UKFL	3/4 – 4	20 – 110	P.148
	(2) Adjustable type	Cylindrical bore (with set screws)	UCFA	1/2 – 2 3/16	12 – 55	P.152
	(3) Three-bolt type	Cylindrical bore (with set screws)	UCFB	1/2 – 2	12 – 50	P.154
	(4) Light duty type	Cylindrical bore (with set screws)	BLF	1/2 – 1 7/16	12 – 35	P.156
		Cylindrical bore (with eccentric locking collar)	ALF			
	(5) “Compact” series	Cylindrical bore (with set screws)	UFL	N/A	8 – 30	P.158
		(6) Stainless-series	Cylindrical bore (with set screws)	UCSFL-S6	N/A	12 – 50
USFL-S6	N/A			10 – 30	P.162	
4 Round-flanged type with spigot joint	(1) Standard	Cylindrical bore (with set screws)	UCFC	1/2 – 4	12 – 100	P.164
			UCFCX-E	1 – 4	25 – 100	P.168
		Tapered bore (with adapter)	UKFC	3/4 – 3 1/2	20 – 90	P.170
	(2) Stainless-series	Cylindrical bore (with set screws)	UCSFC-S6	N/A	20 – 40	P.174
5 Pressed steel housing type	(1) Pillow block type	Cylindrical bore (with set screws)	SBPP	1/2 – 1 1/4	12 – 30	P.176
		Cylindrical bore (with eccentric locking collar)	SAPP			
	(2) Round-flanged type	Cylindrical bore (with set screws)	SBPF	1/2 – 1 7/16	12 – 35	P.178
		Cylindrical bore (with eccentric locking collar)	SAPF			
	(3) Rhombic-flanged type	Cylindrical bore (with set screws)	SBPFL	1/2 – 1 7/16	12 – 35	P.180
	Cylindrical bore (with eccentric locking collar)	SAPFL				
(4) Triangle-flanged type	Cylindrical bore (with set screws)	SBPFT	N/A	12 – 35	P.182	

3 Types

Table 3.1 Koyo Insert Bearing Units types (continued)

Type		Bearing bore dia. Surface (fixing to shaft)	Type code	Shaft dia.		Dimension table
				(inch)	(mm)	
6 Take-up type	(1) Standard	Cylindrical bore (with set screws)	UCT	$\frac{1}{2} - 4$	12 – 140	P.184
			UCT-E	$\frac{1}{2} - 3 \frac{7}{16}$	12 – 85	P.190
		Tapered bore (with adapter)	UKT	$\frac{3}{4} - 4 \frac{1}{2}$	20 – 125	P.194
	(2) Stainless-series	Cylindrical bore (with set screws)	UCST-S6	N/A	20 – 50	P.198
	(3) Section steel frame type	Cylindrical bore (with set screws)	UCTH	$\frac{1}{2} - 2 \frac{1}{2}$	12 – 65	P.200
	(4) Channel steel frame type	Cylindrical bore (with set screws)	UCTL	N/A	20 – 45	P.202
			UCTU	N/A	40 – 90	P.204
	(5) Pressed steel frame type	Cylindrical bore (with set screws)	SBPTH	N/A	12 – 25	P.208
			SBNPTH	N/A	12 – 25	P.210
7 Cartridge type		Cylindrical bore (with set screws)	UCC	$\frac{1}{2} - 4$	12 – 140	P.212
		Tapered bore (with adapter)	UKC	$\frac{3}{4} - 4 \frac{1}{2}$	20 – 125	P.216
8 Hanger type		Cylindrical bore (with set screws)	UCHA	$\frac{1}{2} - 3$	12 – 75	P.218
9 Rubber clamping ring type		Cylindrical bore (with set screws)	RU-M	N/A	20 – 30	P.220

Table 3.2 Types of insert bearing for Koyo Insert Bearing Unit

Type		Bearing bore dia. Surface (fixing to shaft)	Type code	Shaft dia.		Dimension table
				(inch)	(mm)	
Insert bearing for units	(1) Standard	Cylindrical bore (with set screws)	UC	$\frac{1}{2} - 4$	12 – 140	P.222
	(2) Standard	Tapered bore (with adapter)	UK	$\frac{3}{4} - 4 \frac{1}{2}$	20 – 125	P.234
	(3) Standard	Cylindrical bore (with eccentric locking collar)	NA	$\frac{1}{2} - 3$	12 – 75	P.230
	(4) Light duty	Cylindrical bore (with set screws)	SB	$\frac{1}{2} - 1 \frac{1}{2}$	12 – 40	P.222
	(5) Light duty	Cylindrical bore (with eccentric locking collar)	SA	$\frac{1}{2} - 1 \frac{9}{16}$	12 – 40	P.230
			SA-F	$\frac{1}{2} - 2 \frac{3}{16}$	12 – 55	
	(6) “Compact”	Cylindrical bore (with set screws)	SU	N/A	8 – 30	P.222
	(7) Stainless steel	Cylindrical bore (with set screws)	UC-S6	N/A	12 – 65	P.228
			SU-S6	N/A	10 – 30	
	(8) Cylindrical outside surface (with lubricating mechanism and snap ring)	Cylindrical bore (with set screws)	ER	$\frac{1}{2} - 2 \frac{7}{16}$	12 – 60	P.240
	(9) Cylindrical outside surface	Cylindrical bore (with set screws)	RB	$\frac{1}{2} - 1 \frac{9}{16}$	12 – 40	P.240
	(10) Adapter assembly		H2300X	$\frac{3}{4} - 5$	20 – 125	P.242

### 3.2 Types and features

Koyo Insert Bearing Units are available in various types by combinations of bearings and housings.  
Types and features of the Insert Bearing Units are shown below.

Remark) Descriptions of codes for unit with cover are shown in the table below. (common to all the types)

Diameter series	Code	Descriptions
2	C, CD	Pressed steel cover type
	FC, FCD	Cast iron cover type
X	C, CD	From X05 to X17 : pressed steel cover type X18 and X20 : cast iron cover type
	C, CD	Cast iron cover type

#### 1 Pillow block type units

##### 1 Pillow block type units



UCP



UKP

Cylindrical bore (with set screws)...Bearing **UC2 (X, 3)** series are used.

**UCP2 (X, 3)** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type  
**C, CD (FC, FCD)** : Pressed steel cover type or cast iron cover type

Cylindrical bore (with eccentric locking collar)  
...Bearing **NA2** series are used.

**NAP2, NAPK2** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type

Tapered bore (with adapter)...Bearing **UK2 (X, 3)** series are used.

**UKP2 (X, 3)** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type  
**C, CD (FC, FCD)** : Pressed steel cover type or cast iron cover type

NAP

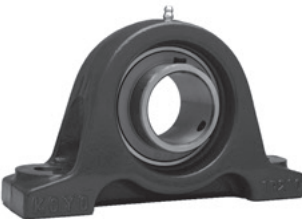
NAPK

This is the most typical type insert bearing unit. The rib at the bottom of the housing mounting section allows the highly strong structure which withstands against loads applied from all the directions.

The housing can be installed to a machine with two bolts. As for the tapered bore (UKP) type, nominal number of adapter assembly which follows the nominal number of unit should be added.

Applications : Transmission devices, general industrial equipment

##### 2 Thick section pillow block type units



UCIP



UKIP

Cylindrical bore (with set screws)...Bearing **UC2 (3)** series are used.

**UCIP2 (3)** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type  
**C, CD (FC, FCD)** : Pressed steel cover type or cast iron cover type

Tapered bore (with adapter)...Bearing **UK2 (3)** series are used.

**UKIP2 (3)** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type  
**C, CD (FC, FCD)** : Pressed steel cover type or cast iron cover type

This pillow block type unit is applicable for use with a great load. The thick and highly rigid housing is suitable to environment exposed to a great load, vibration, and impact. The mounting bolt holes are drilled, and the housing can be installed to the exact location with two bolts.

Applications : Crane, heavy object conveyor, quarrying plant, ships

3 Types

(1 Pillow block type units)

3 Tapped-base pillow block type unit



UCPA

Cylindrical bore (with set screws)...Bearing **UC2** series are used.  
**UCPA2** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type

This pillow block type unit is designed so that the mounting space is reduced. It is installed to machines with the two tapped holes on the housing mounting bottom.  
Applications : Roller conveyor, purpose with small mounting space

4 Higher centerheight pillow block type unit



UCPH

Cylindrical bore (with set screws)...Bearing **UC2** series are used.  
**UCPH2** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type

This unit, designed as the higher centerheight pillow block type unit, has high strength against impact load. It is suitable for the machine that the distance from the mounting bottom to the shaft center is long. The housing can be installed to machines with two bolts.  
Applications : Printing machine, spinneret

5 Light duty pillow block type unit



BLP

ALP

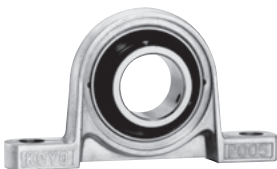
Cylindrical bore (with set screws)...Bearing **SB2** series are used.  
**BLP2**

Cylindrical bore (with eccentric locking collar)  
...Bearing **SA2** series are used.

ALP2

This pillow block type unit is designed for the aim of light-weight. The housing can be installed to machines with two bolts.  
Applications : Machinery for general purposes aiming at lightweight

6 “Compact” series pillow block type unit



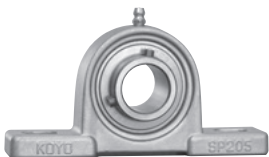
UP

Cylindrical bore (with set screws)...Bearing **SU0** series are used.  
**UP0**

**C, CD** : Rubber coating cover type

The small and lightweight pillow block type unit, comprising the insert bearing for unit for light load and the special light-weight alloy housing, needs not to be lubricated additionally.  
The housing can be installed to machines with two bolts.  
Applications : Machineries for light load

7 Stainless-series pillow block type units



UCSP-S6



USP-S6

Cylindrical bore (with set screws)  
Standard...Bearing **UC2-S6** series are used.  
**UCSP2-S6**  
C, CD : Pressed stainless steel cover type

Tapped base...Bearing **UC2-S6** series are used.  
**UCSPA-S6**  
C, CD : Pressed stainless steel cover type

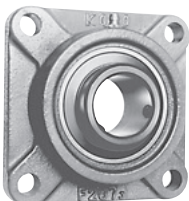
Compact...Bearing **SU0-S6** series are used.  
**USP0-S6**  
C, CD : Pressed stainless steel cover type

UCSPA-S6

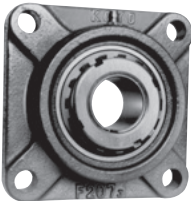
This superior anticorrosion pillow block type unit comprises the bearing and housing made of stainless steel. The unit is thinner than standard UCP series units, leading to downsizing of machinery. The housing can be installed to machines with two bolts.  
Applications : Food machinery, agricultural machinery

2 Square-flanged type units

1 Square-flanged type units



UCF, UCF-E



UKF

Cylindrical bore (with set screws)...Bearing **UC2 (X, 3)** series are used.  
**UCF2 (X, 3)** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type  
C, D (FC, FD) : Pressed steel cover type or cast iron cover type  
**UCF2 (X) -E** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type

Cylindrical bore (with eccentric locking collar)  
...Bearing **NA2** series are used.  
**NANF2** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type

NANF

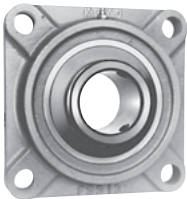
Tapered bore (with adapter)...Bearing **UK2 (X, 3)** series are used.  
**UKF2 (X, 3)** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type  
C, D (FC, FD) : Pressed steel cover type or cast iron cover type

This bearing unit comprises the insert bearing for unit and the housing with square flange. It is suitable to use on a vertical surface, such as the side of machinery.  
The housing can be installed to machines with four bolts.

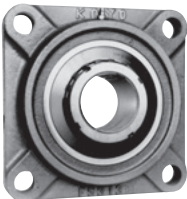
3 Types

(2 Square-flanged type units)

2 Square-flanged types with spigot joint



UCFS



UKFS

Cylindrical bore (with set screws)...Bearing **UC3** series are used.  
**UCFS3** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type  
**C, D** : Cast iron cover type

Tapered bore (with adapter)...Bearing **UK3** series are used.  
**UKFS3** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type  
**C, D** : Cast iron cover type

This bearing unit comprises the insert bearing for unit, square flange, and the housing with spigot joint on the mounting surface. The housing can be installed to a machine by fitting the spigot joint into the mounting hole of it, and using four bolts.  
The housing can be installed to the exact location by fitting the spigot joint into the mounting hole.  
Applications : Rotating drum, rotating roller, purposes excellent mounting accuracy is required


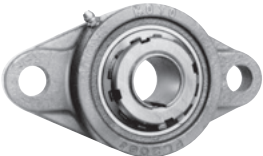
3 Stainless-series square-flanged type unit

UCSF-S6


Cylindrical bore (with set screws)...Bearing **UC2-S6** series are used.  
**UCSF2-S6**  
**C, D** : Pressed stainless steel cover type

In this superior waterproof and anticorrosion square-flanged type unit, bearing and housing are made of stainless steel. The unit is thinner than standard UCF series units, leading to downsizing of machinery. The housing can be installed to machines with four bolts.  
Applications : Food machinery, agricultural machinery

3 Rhombic-flanged type units

1 Rhombic-flanged type units	
 UCFL, UCFL-E	 UKFL
<p>Cylindrical bore (with set screws)...Bearing <b>UC2 (X, 3)</b> series are used.</p> <p><b>UCFL2 (X, 3)</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p><b>C, D (FC, FD)</b> : Pressed steel cover type or cast iron cover type</p> <p><b>UCFL2 (X) -E</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p>	
<p>Cylindrical bore (with eccentric locking collar) ...Bearing <b>NA2</b> series are used.</p> <p><b>NANFL2</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p>	
<p>Tapered bore (with adapter)...Bearing <b>UK2 (X, 3)</b> series are used.</p> <p><b>UKFL2 (X, 3)</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p><b>C, D (FC, FD)</b> : Pressed steel cover type or cast iron cover type</p>	
<p>This bearing unit comprises the insert bearing for unit and the housing with rhombic flange. It is suitable to use on a vertical surface, such as the side of machinery. Compared to the square-flanged type unit, it requires less mounting space, and the unit weight is also reduced.</p> <p>Since the pitches of the center of two mounting bolt holes on the rhombic-flanged type housing are the same as those of the center of bolt holes located opposite each other on the square-flanged housing, they are compatible.</p> <p>The housing can be installed to machines with two bolts.</p> <p>Applications : Roller conveyor, environment the mounting dimensions are small</p>	

2 Adjustable rhombic-flanged type unit

 UCFA	<p>Cylindrical bore (with set screws)...Bearing <b>UC2</b> series are used.</p> <p><b>UCFA2</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p>This rhombic-flanged type unit allows angle adjustment with a supporting point as the shaft center. Therefore, when the bearing unit is installed, fine adjustment of supporting location for the shaft center is enabled.</p> <p>Since the pitches of the center of mounting bolt holes on the housing are the same as those of the square-flanged type unit and rhombic-flanged type unit, they are compatible.</p> <p>The housing can be installed to machines with two bolts.</p>
---	---

3 Types

(3 Rhombic-flanged type units)

3 Three-bolt flange type unit



UCFB

Cylindrical bore (with set screws)...Bearing **UC2** series are used.  
**UCFB2** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type

The housing of this unit has the one-side rhombic flange, and the unit is suitable to use on a vertical surface and in a limited space, such as the side of machinery.  
The housing can be installed to machines with three bolts.

4 Light duty rhombic-flanged type units



BLF

ALF

Cylindrical bore (with set screws)...Bearing **SB2** series are used.  
**BLF2**

Cylindrical bore (with eccentric locking collar)  
...Bearing **SA2** series are used.

ALF2

This rhombic-flanged type unit is designed for the aim of lightweight. The housing can be installed to machines with two bolts.

5 “Compact” series rhombic-flanged type unit



UFL

Cylindrical bore (with set screws)...Bearing **SU0** series are used.  
**UFL0**

**C, D** : Rubber coating cover type

The small and lightweight rhombic-flanged type unit, comprising the insert bearing for unit for light load and the special lightweight alloy housing, needs not to be lubricated additionally.

The housing can be installed to machines with two bolts.  
Applications : Machineries for light load

6 Stainless-series rhombic-flanged type units



UCSFL-S6



USFL-S6

Cylindrical bore (with set screws)  
Standard...Bearing **UC2X (2) -S6** series are used.

**UCSFL2X (2) -S6**

**C, D** : Pressed stainless steel cover type

Compact...Bearing **SU0-S6** series are used.



**USFL0-S6**

**C, D** : Rubber coating cover type

This superior anticorrosion rhombic-flanged type unit comprises the bearing and housing made of stainless steel. The unit is thinner than standard UCFL series units, leading to downsizing of machinery.


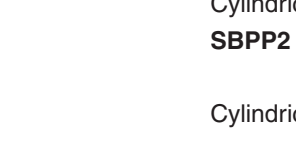
The housing can be installed to machines with two bolts.  
Applications : Food machinery, agricultural machinery

4 Round-flanged types with spigot joint

1 Round-flanged types with spigot joint	
	
UCFC, UCFC-E	UKFC
<p>Cylindrical bore (with set screws)...Bearing <b>UC2 (X)</b> series are used.</p> <p><b>UCFC2 (X)</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p><b>C, D (FC, FD)</b> : Pressed steel cover or cast iron cover type</p> <p><b>UCFCX-E</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p>Tapered bore (with adapter)...Bearing <b>UK2 (X)</b> series are used.</p> <p><b>UKFC2(X)</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p><b>C, D (FC, FD)</b> : Pressed steel cover or cast iron cover type</p> <p>This bearing unit comprises the insert bearing for unit, round flange, and the housing with spigot joint on the mounting surface. The housing can be installed to machines by fitting the spigot joint into the mounting hole of machinery, and using four bolts.</p> <p>The housing can be installed to the exact location by fitting the spigot joint into the mounting hole.</p> <p>Applications : Rotating drum, rotating roller, purposes excellent mounting accuracy is required.</p>	

2 Stainless-series round-flanged types with spigot joint
<p><b>UCSFC</b> is a four-Bolt Flange Cartridge Units that is made entirely out of stainless steel components for the highest level of corrosion resistance for a mounted bearing unit. It is also pre-filled with food grade grease for food processing applications.</p> <p>Duty: Standard</p> <p>UCSFC-S6</p>

5 Pressed steel housing type units

1 Pressed steel pillow block type unit	
	
SBPP	SAPP
<p>Cylindrical bore (with set screws)...Bearing <b>SB2</b> series are used.</p> <p><b>SBPP2</b></p> <p>Cylindrical bore (with eccentric locking collar)</p> <p>...Bearing <b>SA2</b> series are used.</p> <p><b>SAPP2</b></p> <p>This lightweight pillow block type unit for light load comprises the insert bearing for lightweight unit and the pressed steel plate housing.</p> <p>The housing can be installed to machines with two bolts.</p> <p>Applications : Light duty conveyor, environment exposed to light load and low speed rotation</p>	

3 Types

(5 Pressed steel housing type units)

2 Pressed steel round-flanged type units



SBPF

SAPF

Cylindrical bore (with set screws)...Bearing **SB2** series are used.  
**SBPF2**

Cylindrical bore (with eccentric locking collar)  
...Bearing **SA2** series are used.

SAPF2

This lightweight round-flanged type unit for light load comprises the insert bearing for lightweight unit and the pressed steel plate housing.

The housing can be installed to machines with three bolts.  
Applications : Light duty conveyor, environment exposed to light load and low speed rotation

3 Pressed steel rhombic-flanged type units



SBPFL

SAPFL

Cylindrical bore (with set screws)...Bearing **SB2** series are used.  
**SBPFL2**

Cylindrical bore (with eccentric locking collar)  
...Bearing **SA2** series are used.

SAPFL2

This lightweight rhombic-flanged type unit for light load comprises the insert bearing for lightweight unit and the pressed steel plate housing. Compared to the pressed steel round-flanged type unit, less mounting space is required.

The housing can be installed to machines with two bolts.  
Applications : Light duty conveyor, environment exposed to light load and low speed rotation

4 Pressed steel triangle-flanged type units

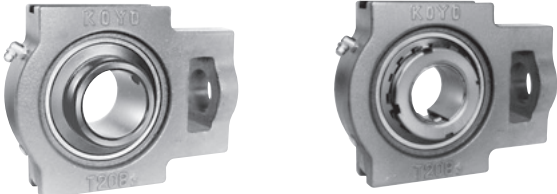
SBPFT


Cylindrical bore (with set screws)...Bearing **SB2** series are used.  
**SBPFT2**

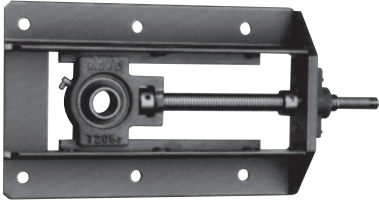
This lightweight triangle-flanged type unit for light load comprises the insert bearing for lightweight unit and the pressed steel plate housing.

The housing can be installed to machines with three bolts.  
Applications : Light duty conveyor, environment exposed to light load and low speed rotation

6 Take-up type units

1 Take-up type units	
	<p>Cylindrical bore (with set screws)...Bearing <b>UC2 (X, 3)</b> series are used.</p> <p><b>UCT2 (X, 3)</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p><b>C, CD (FC, FCD)</b> : Pressed steel cover or cast iron cover type</p> <p><b>UCT2 (X) -E</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p>
	<p>Tapered bore (with adapter)...Bearing <b>UK2 (X, 3)</b> series are used.</p> <p><b>UKT2(X, 3)</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p><b>C, CD (FC, FCD)</b> : Pressed steel cover or cast iron cover type</p>
	<p>The bearing unit comprises the insert bearing for unit and the housing with slide groove. This unit allows angle adjustment with a supporting point of the shaft center by moving the housing in radial direction along the slide groove.</p> <p>Applications : Belt conveyor, use the supporting point of the shaft center must be adjusted</p>

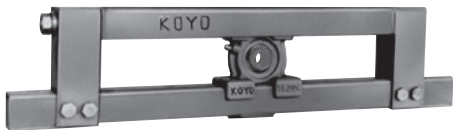
2 Stainless-series take-up type unit	
	<p>Cylindrical bore (with set screws)...bearing <b>UC2-S6</b> series are used.</p> <p><b>UCT2-S6</b></p> <p><b>C, CD</b> : Pressed stainless steel cover type</p>
	<p>This superior anticorrosion take-up type unit comprises the bearing and the housing made of stainless steel. The unit is thinner than standard UCT series units, leading to downsizing of machinery.</p> <p>Applications : Conveyor of food machinery, agricultural machinery</p>

3 Section steel frame take-up type unit	
	<p>Cylindrical bore (with set screws)...Bearing <b>UC2</b> series are used.</p> <p><b>UCTH2</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p><b>C, CD (FC, FCD)</b> : Pressed steel or cast iron cover type</p>
	<p>This unit comprises the take-up type unit, the section steel frame, adjuster bolt, and so on.</p> <p>This unit allows adjustment of the supporting point of the shaft center by moving the housing in radial direction with the adjuster bolt on the unit.</p> <p>The housing can be installed to machines with six bolts.</p> <p>Applications : Belt conveyor, use the supporting point of the shaft center must be adjusted</p>

3 Types

(6 Take-up type units)

4 Channel steel frame take-up type unit



UCTL

Cylindrical bore (with set screws)...Bearing **UC2 (3)** series are used.

**UCTL2** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type

**C, CD (FC, FCD)** : Pressed steel cover or cast iron cover type

**UCTU2 (3)** : Standard type, **L3 (L2)** : Triple-lip seal type or Double-lip seal type

**C, CD (FC, FCD)** : Pressed steel cover or cast iron cover type

This unit comprises the take-up type unit, the channel steel frame, adjuster bolt, and so on. This unit allows adjustment of the supporting point of the shaft center by moving the housing in radial direction with the adjuster bolt in the frame.

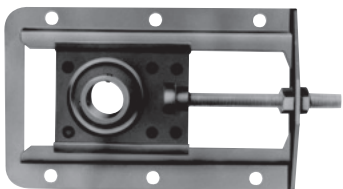
Since this unit is installed with the frame stood, the mounting space is reduced.

The TL lightweight type unit is made of light channel steel, and the TU highly rigid type unit is made of channel steel. The housing can be installed to machines with two or four bolts.

Tapered bore (with adapter) unit is also available (examples of nominal number : UKTL 207J-100, UKTU208J-500).

Applications : Belt conveyor, use the supporting point of the shaft center must be adjusted

5 Pressed steel frame take-up type unit



SBPTH

Cylindrical bore (with set screws)...Bearing **SB2** series are used.

**SBPTH2**


**SBNPTH2**


This unit comprises the pressed steel take-up type unit, the pressed steel frame, adjuster bolt, and so on. This unit allows adjustment of the supporting point of the shaft center by moving the housing in radial direction with the adjuster bolt in the frame.

Since the housing and the frame are made of pressed steel, the unit is compact and lightweight. The housing can be installed to machines with four or six bolts.


Applications : Small belt conveyor for lightload, use the supporting point of the shaft center must be adjusted

7 Other units

1 Cartridge type units	
	<p>Cylindrical bore (with set screws)...Bearing <b>UC2 (X, 3)</b> series are used.</p> <p><b>UCC2 (X, 3)</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p>Tapered bore (with adapter)...Bearing <b>UK2 (X, 3)</b> series are used.</p> <p><b>UKC2 (X, 3)</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p>This unit comprises the insert bearing for unit and the housing with the cylindrical outside surface. The housing, having the grounded cylindrical outer surface, can be fit to the cylindrical bore of a machine.</p> <p>The cartridge type unit, moving in axial direction, is used as the bearing for free side when a shaft is expanded or contracted.</p> <p>The cylindrical outside surface and the automatic aligning mechanism allow handling similar to standard automatic aligning type bearing.</p>

2 Hanger type unit	
	<p>Cylindrical bore (with set screws)...Bearing <b>UC2</b> series are used.</p> <p><b>UCHA2</b> : Standard type, <b>L3 (L2)</b> : Triple-lip seal type or Double-lip seal type</p> <p>The bearing unit comprises the insert bearing for unit and the housing with parallel thread for pipe on one side. The compact housing is installed to machinery with suspended with steel pipe.</p> <p>Applications : Intermediate bearing of screw conveyor</p>

8 Insert bearings for units

1 UC type bearing	
	<p>Cylindrical bore (with set screws)</p> <p><b>UC2 (X, 3)</b>...Standard type</p> <p><b>UC2 (X, 3) L3 (L2)</b>...Triple-lip seal type or Double-lip seal type</p> <p><b>UC2-S6</b>...Stainless steel series</p> <p>This grease sealed type deep groove insert bearing incorporates the outer ring with the spherical outside surface and lubricating mechanism and wide inner ring with cylindrical bore set screw. Two types, standard type (oil seal and flinger are included) and triple-lip seal type (supplementary code : L3), are available, depending on the type of sealing device.</p> <p>It can be fixed to shaft with two set screws on the inner ring. It is the most typical type in insert bearings for unit.</p> <p>The UC2-S6 series are superior waterproof and anticorrosive insert bearings for unit. The bearing is made of stainless steel, and the series are used for stainless-series units.</p> <p>As for the types and features of set screw for UC type bearing, see “14 Handling”.</p>

3 Types

(8 Insert bearings for units)

2 UK type bearing



Tapered bore (with adapter)  
**UK2 (X, 3)**...Standard type  
**UK2 (3) L3 (L2)**...Triple-lip seal type or Double-lip seal type

This grease sealed type deep groove ball bearing incorporates the outer ring with the spherical outside surface and lubricating mechanism and wide inner ring with tapered bore. Two types, standard type (oil seal and flinger are included) and triple-lip seal type (supplementary code : L3), are available, depending on the type of sealing device.  
It can be fixed to shaft with the adapter. The UK type bearing (with adapter) is optimal for use of long shaft.  
As for the UK type bearing, applicable adapter assembly number should be added to the bearing number.

3 NA type insert bearing



Cylindrical bore (with eccentric locking collar)  
**NA2**

This type is based on the UC type bearing having set screw, but equipped with the eccentric locking collar. The grease sealed type deep groove ball bearing incorporates the spherical outside surface outer ring with lubricating mechanism and the cylindrical bore, wide inner ring, and eccentric locking collar with eccentric section on one side. The sealing device is equipped with the oil seal and flinger.  
When fixing the bearing to shaft, fit the eccentric recessed section of the eccentric locking collar to the eccentric section of the inner ring, turn the eccentric locking collar to fix it to shaft, and tighten the set screw of the eccentric locking collar to shaft.

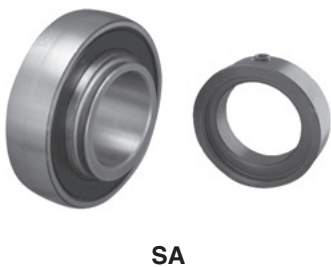
4 SB type bearing



Cylindrical bore (with set screws)  
**SB2**

This is the lightweight UC type bearing. The non-lubricating type grease sealed deep groove ball bearing incorporates the spherical outside surface outer ring and the wide inner ring with cylindrical bore set screw. When fixing it to shaft, use the two set screws on the inner ring.  
It is used for lightweight unit or pressed steel unit.

5 SA type bearing



Cylindrical bore (with eccentric locking collar)  
**SA2, SA2-F**

This type is based on the SB type bearing having set screw, but equipped with the eccentric locking collar. The non-lubricating type grease sealed type deep groove ball bearing incorporates the spherical outside surface outer ring and the cylindrical bore, wide inner ring, and eccentric locking collar with eccentric section on one side.  
When fixing the bearing to shaft, fit the eccentric recessed section of the eccentric locking collar to the eccentric section of the inner ring, turn the eccentric locking collar to fix it to shaft, and tighten the set screw of the eccentric locking collar to shaft.  
(SA-F type bearing has lubricating mechanism on outer ring.)  
It is used for lightweight unit or pressed steel unit.

6 SU type bearing (“compact” series)



SU

Cylindrical bore (with set screws)

**SU0...**Standard type

**SU0-S6...**Stainless steel

The bearing series intended for light load is suitable for downsizing and weight saving.

The non-lubricating type grease sealed deep groove ball bearing incorporates the spherical outside surface outer ring and the wide inner ring with cylindrical bore set screw. When fixing it to shaft, use the two set screws on the inner ring.

The SU0-S6 type bearing for unit, made of stainless steel, is superior in corrosion resistance, and used for stainless-series units.

7 ER type bearing



ER

Cylindrical bore (with set screws), cylindrical outside surface, lubricating mechanism, locating snap ring and snap ring groove

**ER2**

The grease sealed type deep groove ball bearing incorporates the spherical outside surface with lubricating mechanism and set screw, the wide inner ring with cylindrical bore set screw. When fixing it to shaft, use the two set screws on the inner ring.

It features lubricating mechanism, set screw (easy to locate bearing), clearance fit of inner ring and shaft (easy to install). Therefore, it can be used for various purposes in a similar way to standard bearings.

8 RB type bearing



RB

Cylindrical bore (with set screws), cylindrical outside surface

**RB2**

This bearing is based on the ER type bearing, but without the lubricating mechanism and locating snap ring and snap ring groove. The grease sealed deep groove ball bearing incorporates the spherical outside surface outer ring and the wide inner ring with cylindrical bore set screw. When fixing it to shaft, use the two set screws on the inner ring.

Since clearance fit may be used for installation of the inner ring to shaft (easy to install), it can be used for various purposes in a similar way to standard bearings.

3 Types

3.3 Unit for special use

To meet with requests for varied and special purposes, JTEKT supplies insert bearing series for special use with various features, as well as standard types. If you use insert bearing units under special environment or conditions, select optimal type among insert bearing units for special use.

JTEKT produces bearing units in various forms and specifications, other than units for special use. Contact JTEKT, if you need them.

1 Triple-lip seal unit (Double-lip seal unit) (supplementary code : L3 (L2))

Triple-lip seal has the structure in which the triple-lip oil seal is glued to the pressed steel shield plate with vulcanized adhesive. The triple-lip eliminates ingress of dusts and mud water into bearing to ensure long service life of the bearing even under severe environmental conditions.

Since the triple-lip seal is fit to the outer ring of the bearing, the triple-lip seal bearing unit can be handled in the same manner as the standard types. The triple-lip seal unit does not lead to uneven contact of the shaft with seal while the bearing is aligned unlike the unit with cover, and maintains stable sealing performance for a long time.

The triple-lip seal unit is the outstanding product that defects of conventional dust and water preventive unit are improved to realize energy-saving and low cost. The triple-lip seal is applicable to the UC type bearing and the UK type bearing.

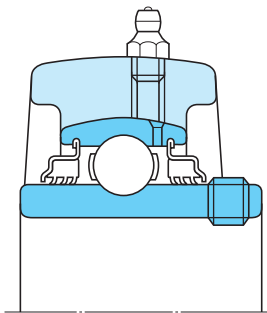


Fig. 3.1 Structure of triple-lip seal unit

2 Unit with cover (supplementary code : C, D, FC, FD)

The unit with cover is equipped with the standard type housing and the pressed steel cover or cast iron cover, and features the double sealing structure of bearing and housing. The unit ensures a long service life of bearing even under severe environmental conditions such as dusts and mud water.

The unit with cover is available in two types : open ends type C type, FC type, closed end type D type, and FD type (for pillow block type unit, CD type or FCD type).

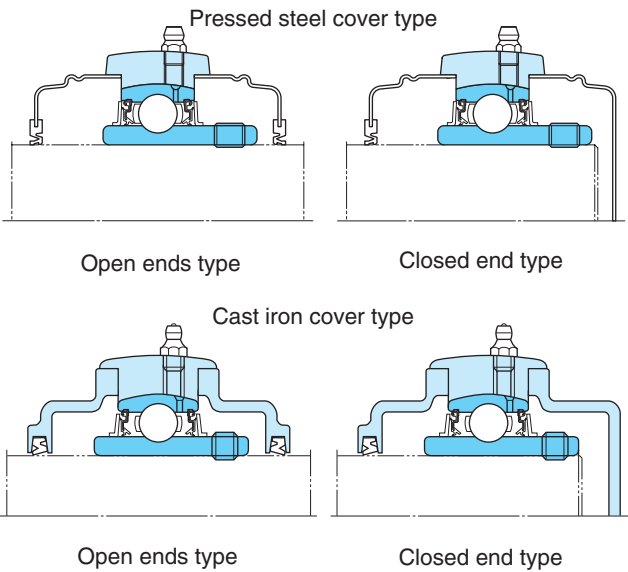


Fig. 3.2 Type and structure of unit with cover

3 Heat resistant unit (special code : D1K2) and Cold resistant unit (special code : D2K2)

The operating temperature range of a insert bearing unit depends on the performance of grease and oil seal (rubber) used for the bearing. The operating temperature range of Koyo Insert Bearing Unit (standard type) ranges from -20 °C to 100 °C.

If you use bearing units in the higher or lower temperature range beyond the operating temperature range of standard type, select the heat resistant (special code : D1K2) or the cold resistant unit (special code : D2K2).

Specifications of the heat resistant unit and the cold resistant unit are shown in Table 3.3.

Table 3.3 Specifications of heat resistant unit and cold resistant unit

Category	Special code	Operating temperature range (°C)	Grease	Oil seal rubber material	Bearing internal clearance	
					UC type	UK type
Standard	(no code)	-20 to 100	Alvania No. 2 or equivalence (lithium soap)	Nitrile	CN	C3
Heat resistant	D1K2	-40 to 180	SH44M (lithium soap)	Silicone	C4	C5
Cold resistant	D2K2	-50 to 120	SH33M (lithium soap)	Silicone	CN	C3

#### 4 High speed unit (special code : K3)

The high speed unit (special code : K3) is the product that has been developed for intention of high speed and less heat. For the high speed unit bearing, the non-contact type oil seal optimal for high speed rotation and low torque is used.

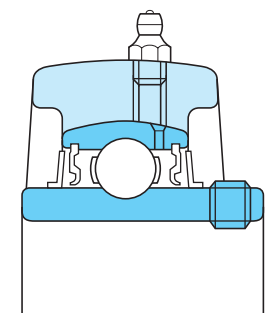
This unit is intended for the purposes high speed rotation, low torque, and less heat are required, such as textile machinery and printing machinery.

#### 5 Unit for blower (special code : S5)

The insert bearing unit for blower must meet requests for high speed rotation, less heat, less vibration, and low noise.

To meet with these requests for performance, JTEKT supplies the series of unit for blower (special code : S5) that the non-contact type oil seal is used, as well as improves the machining accuracy.

This unit is intended for the purposes high speed rotation, less heat, less vibration, low noise are required, such as a blower.



**Fig. 3.3 Structure of bearing unit for blower**

#### 6 “Compact” series unit

For downsizing of machinery in facilities, the set screw method facilitating installation of the shaft is adopted for this unit.

The unit comprises the compact bearing and the special alloy housing.

Since the cover surface is coated with rubber, it contacts close with the housing well, and features superior dustproof and waterproof performance.

Operating temperature range : Standard temperature

#### 7 Stainless-series unit (special code : S6)

The insert bearing units used for food machinery need waterproof performance.

For this purpose, JTEKT has released a series of Insert Bearing units of which bearings and housings are made of stainless steel in order to satisfy the required performance.

We can also provide bearing units packing grease applicable to use related to food certified by USDA (US Agriculture Department) H1.

Operating temperature range : From  $-20^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$

\* If you use this unit for machines splashed with water or in the environment that the operating temperature exceeds  $50^{\circ}\text{C}$ , it is recommended you use UC-S6 to be able to be lubricated for SU-S6.

4 Selection of unit

4 Selection of unit

4.1 Outline of selection

Koyo Insert Bearing Units are available in various types and series. Therefore, to select the bearing unit optimal for design of machinery, various factors including the structure of machinery, operating conditions, performance required

for bearing unit, specifications relative to the unit, market-ability, and economic efficiency, must be comprehensively taken into consideration. Service life of the bearing greatly depends on the quality of selection.  
Procedures of selection of standard insert bearing units are shown in **Table 4.1**.

Table 4.1 Procedures of selection of standard insert bearing units

Procedures of selection	Items to be examined	Operating conditions to be considered	Reference
1 Selection of type	<ul style="list-style-type: none"> <li>· Pillow block type</li> <li>· Flange type</li> <li>· Take-up type</li> <li>· Cartridge type</li> <li>· Hanger type</li> </ul>	Structure of machinery, mounting space, mounting dimensions	3 Types (P.13)
2 Selection of shaft dia. and dia. series	<ul style="list-style-type: none"> <li>· Bearing bore dia. : From 10 to 140 mm</li> <li>· Dia. series : 0, 2, X, 3</li> </ul>	Rating life of bearings required, load applied to bearings, rotational speed	5 Life of bearing (P.33) 6 Bearing load (P.38) 7 Allowable rotational speed (P.45)
3 Selection against atmosphere	<ul style="list-style-type: none"> <li>· L3 (L2) type</li> <li>· Cover type</li> <li>· Stainless steel series</li> <li>· For high speed use</li> <li>· For blower</li> </ul>	Environment (dusts, mud water, high humidity, chemicals), rotational speed	3 Types (P.13) (P.28) 7 Allowable rotational speed (P.45)
4 Selection against temperature	<ul style="list-style-type: none"> <li>· Heat resistant type</li> <li>· Cold resistant type</li> <li>· Measures against expansion and contraction of shaft</li> <li>· Grease supply</li> </ul>	Bearing temperature	3 Types (P.13) (P.28) 8 Operating temperature and bearing specifications (P.46) 10 Design of shaft and base (P.52) 14 Handling (P.66)
5 Selection of installing to shaft	<ul style="list-style-type: none"> <li>· Set screw</li> <li>· Adapter</li> <li>· Eccentric locking collar</li> </ul>	Rotational speed, load conditions, handling	3 Types (P.13) 14 Handling (P.66)
6 Selection of shafts	<ul style="list-style-type: none"> <li>· Dimensional tolerance</li> <li>· Adoption of shouldered shaft</li> <li>· Provision of set screw for shaft</li> <li>· Measures against expansion and contraction of shaft</li> </ul>	Rotational speed, load conditions, bearing temperature	3 Types (P.13) (P.28) 7 Allowable rotational speed (P.45) 10 Design of shaft and base (P.52) 14 Handling (P.66)
7 Selection of strength of housings	<ul style="list-style-type: none"> <li>· Cast iron</li> <li>· Cast steel</li> <li>· Pressed steel</li> </ul>	Load conditions, load directions, presence of impact	9 Strength of housing (P.47)
8 Selection of lubrication	<ul style="list-style-type: none"> <li>· Lubricating type</li> <li>· Non-lubricating type</li> <li>· Centralized lubricating type</li> <li>· Greasing interval</li> </ul>	Environment, importance of machine, bearing temperature, grease life	14 Handling (P.66)
9 Selection of maintenance and check	<ul style="list-style-type: none"> <li>· Periodic inspection</li> <li>· Grease supply</li> </ul>	Environment, importance of machine, bearing temperature, grease life	14 Handling (P.66)



4.2 Selection of type and specifications

Koyo Insert Bearing Units series are available in various types and specifications applicable to your purposes. Therefore, when selecting types and specifications of

bearing unit, structure of machine, operating conditions, and environment must be fully taken into consideration for comprehensive examination.

Outline of selection of insert bearing unit types and specifications are shown in **Table 4.2**.

Table 4.2 (1) Outline of selection of insert bearing unit types and specifications

○ : Acceptable or Yes, × : Unacceptable or No

Category	Performance required		Bearing specifications			Applicable housing
	Operating conditions	Fixing to shaft	Sealing structure	Type code	Lubrication	
Bearing	Standard	Set screw Adapter	Oil seal and flinger	UC UK	○	C, F, FA, FB, FC, FL, FS, HA, IP, P, PA, PH, T, TH, TL, TU
		Eccentric locking collar		NA	○	C, FC, NF, NFL, P, T
	Dustproof and waterproof	Set screw Adapter	Triple-lip seal	UC-L3 UK-L3	○	C, F, FA, FB, FC, FL, FS, HA, IP, P, PA, PH, T, TH, TL, TU
	Lightweight	Set screw	Oil seal	SA, SB	×	LF, LP, PF, PFL, PP, PTH, NPTH
	“Compact”	Set screw		SU		FL0, P0
	Anticorrosion	Set screw	Oil seal and flinger	UC-S6	○	SFL, SP
	Anticorrosion and compact		Oil seal	SU-S6	×	SFL0, SP0
	Heat resistant Cold resistant For high speed For blower	Set screw Adapter	Oil seal and flinger	UC UK	○	C, F, FA, FB, FC, FL, FS, HA, IP, P, PA, PH, T

Table 4.2 (2) Outline of selection of insert bearing unit types and specifications

Category	Performance required		Housing specifications				Applicable bearing
	Type	Operating conditions	Type code	Material	Presence of cover	Lubrication	
Housing	Pillow block type	Standard	P	Cast iron	○	○	UC (-L3 or -L2), UK (-L3 or -L2)
		Thick section (highly strong)	IP	Cast iron			
		Tapped-base	PA	Cast iron	×	○	UC (-L3 or -L2)
		Higher centerheight	PH			○	UC (-L3 or -L2)
		Light duty	LP			×	SB
		“Compact”	P0	Special light alloy	○	×	SU
		Anticorrosion	SP	Stainless steel		○	UC-S6
		Anticorrosion and compact	SP0	Stainless steel		×	SU-S6
	Flange type	Pressed steel	PP	Pressed steel	×	×	SB
		Square	F	Cast iron	○	○	UC (-L3 or -L2), UK (-L3 or -L2)
		With spigot joint (square)	FS				
		(round)	FC				
		Rhombic	FL	Cast iron	×	○	UC (-L3 or -L2)
		Shaft alignment (adjustable rhombic)	FA				
		Cantilever (deformed)	FB				
		Light duty (rhombic)	LF	Cast iron	×	×	SB
		“Compact” (rhombic)	FL0	Special light alloy	○	×	SU
		Anticorrosion (rhombic)	SFL	Stainless steel	○	○	UC-S6
		(round)	SFC	Stainless steel	○	○	UC-S6
		Anticorrosion and compact (rhombic)	SFL0	Stainless steel	○	×	SU-S6

4 Selection of unit

Table 4.2 (2) Outline of selection of insert bearing unit types and specifications

Category	Performance required		Housing specifications				Applicable bearing
	Type	Operating conditions	Type code	Material	Presence of cover	Lubrication	
Housing	Flange type	Pressed steel (round)	PF	Pressed steel	×	×	SB
		(rhombic)	PFL				
		(triangle)	PFT				
	Take-up type	Standard	T	Cast iron	○	○	UC (-L3 or -L2), UK (-L3 or -L2)
		Section steel frame type	TH	Cast iron	○	○	UC (-L3 or -L2)
		Channel steel frame type	TL	Cast iron	○	○	UC (-L3 or -L2), UK (-L3 or -L2)
			TU				
		Pressed steel frame type	PTH NPTH	Pressed steel	×	×	SB
	Cartridge type	Standard	C	Cast iron	×	○	UC (-L3 or -L2), UK (-L3 or -L2)
	Hanger type	Standard	HA	Cast iron	×	○	UC (-L3 or -L2)

4.3 Selection from a maintenance standpoint

Koyo Insert Bearing Units need not to be maintained or checked for standard purposes during operation, because of their structures. However, they must be periodically maintained or checked if they are used for important machines or under special environment.

Thus, it is important that intervals of periodic maintenance or check during operation are extended or insert bearing units optimal for purposes or operating conditions are selected in order to reduce the manpower required for maintenance and check.

For your purposes, various factors must be fully examined. In the environment exposed to vibration or impact, increase in safety factor of service life of the bearing, and strength of the housing must be fully examined. In the environment exposed to great axial load, use of shouldered shaft, in the environment exposed to dusts or mud water, use of the triple-lip seal type or covered type, in the environment exposed to high or low temperature, material of oil seal and grease type must be fully taken into consideration.

## 5 Life of bearing

If a insert bearing unit is installed to a machine or device and operated, vibration or noise from the unit may be increased or seizure may occur, after a certain period has passed, even under appropriate conditions. The period of bearing operation until the unit cannot be used due to these causes is called the life of insert bearing unit.

Life of a insert bearing unit is caused by two reasons, fatigue of bearing material (fatigue service life) and degradation of grease leading to faulty lubrication, and inability of continuous use. Each of them can be found as the rating life of bearing and grease life.

The life of insert bearing unit depends on the shorter one, between the rating life of bearing and grease life. Since the lubricating system is adopted for the Koyo Insert Bearing Unit, the grease life can be extended to the rating life of bearing by appropriate lubrication. If the bearing unit is used without lubrication, the shorter period, the rating life of bearing or grease life, is the life of the bearing unit.

However, a insert bearing unit is actually installed to a machine or device and operated, the unit cannot be used due to causes other than the rating life of bearing or grease service life (wear, dent, crack, seizure, etc.). They can be prevented by full examination of the selection, handling, installation, and lubrication of the insert bearing unit.

### 5.1 Basic rating life and basic rating load

#### 5.1.1 Basic rating life

While a bearing is rotated under load, the raceways surfaces of the inner and outer rings of bearing and the rolling surfaces of rolling element are exposed to load continuously. Thus, damages like scales appear on the raceway surfaces or rolling surfaces due to fatigue of material (flaking or peel-off). The total number of revolution until the damages appear is called as “(Fatigue) service life” of bearing. Fatigue service life of bearing may be greatly varied even if the bearings having the same structure, dimensions, materials, and machining methods, are operated under the same operating conditions.

To solve this problem, if a group of the same bearings are operated under the same conditions, the total number of revolution of 90% of the bearings without damage due to rotating fatigue (life of 90% reliability) is called as the “**Basic rating life of bearing**”.

#### 5.1.2 Basic rating load

Basic rating load indicates the withstanding strength against rolling fatigue of a bearing, that is to say, loading capacity. It is the pure radial load of a certain level and direction (for radial bearing) or central axial load (for thrust bearing) that a million times of rotations can be obtained as the basic rating life if the inner ring of bearing is rotated while the outer ring is stopped (or the outer ring is rotated while the inner ring is stopped).

They are called as the **basic dynamic radial load rating** ( $C_r$ ) for radial bearing or the **basic dynamic axial load rating** ( $C_a$ ) for axial bearings.

In the insert bearing for insert bearing unit, it is indicated as the basic dynamic radial load rating ( $C_r$ ), and the value is shown in the dimensional table.

### 5.2 Calculation of rating life

Relation between the basic rating life, basic dynamic load rating, and the dynamic equivalent load of the insert bearing for insert bearing unit can be indicated as the **Equation (5.1)**. If the insert bearing unit is used at a fixed rotational speed, it is convenient that the life is indicated as time, as shown in the **Equation (5.2)**.

(Total revolution)	$L_{10} = \left(\frac{C_r}{P_r}\right)^3$	(5.1)
(Time)	$L_{10h} = \frac{10^6}{60n} \left(\frac{C_r}{P_r}\right)^3$	(5.2)
Whereas,		
$L_{10}$	: Basic rating life	$10^6$ rotations
$L_{10h}$	: Basic rating life	h
$C_r$	: Basic dynamic load rating	N
$P_r$	: Dynamic equivalent load	N
	(see “6 Bearing load”)	
$n$	: Rotational speed	$\text{min}^{-1}$

Calculation of the basic rating life with using the life factor ( $f_h$ ) and the speed factor ( $f_n$ ) in the **Equation (5.2)** are shown below.

$L_{10h}$	$= 500 f_h^3$	(5.3)
Life factor	$f_h = f_n \cdot \frac{C_r}{P_r}$	(5.4)
Speed factor	$f_n = \left(\frac{10^6}{500 \times 60n}\right)^{1/3}$	
	$= (0.03n)^{-1/3}$	(5.5)

Values of  $f_n$ ,  $f_h$  and  $L_{10h}$  can be easily found by the nomogram of **Fig. 5.1**.

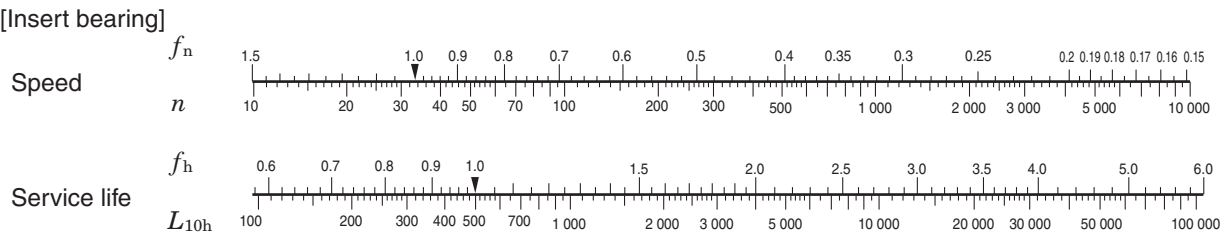


Fig. 5.1 Rotational speed (n) and its coefficients (fn), and service life coefficient (fh) and basic rating life (L10h)

5 Life of bearing

5.2.1 Correction of basic rating load  
for high temperature use

If a insert bearing unit is used at a high temperature, structure of bearing material is changed, leading to decreased hardness, and the basic dynamic load rating is reduced than that of the use at standard temperature. Once the structure of bearing material is changed, it will not be restored even if the temperature returns to standard level.

Therefore, when using a insert bearing unit at 150 °C or more, the basic rating load must be corrected by multiplying the basic dynamic load rating shown in dimensional table by the temperature factor shown in **Table 5.1**.

If the insert bearing unit has been used for a long period at 120 °C or more, fluctuations in dimensions of the bearing may be increased. If you use it under such conditions, contact JTEKT.

Table 5.1 Temperature factor

Bearing temperature, °C	125	150	175	200	250
Temperature factor	1	1	0.95	0.90	0.75

5.2.2 Modified rating life  $L_{nm}$

The life of rolling bearings was standardized as a basic rating life in the 1960s, but in actual applications, sometimes the actual life and the basic rating life have been quite different due to the lubrication status and the influence of the usage environment. To make the calculated life closer to the actual life, a corrected rating life has been considered since the 1980s. In this corrected rating life, bearing characteristic factor  $a_2$  (a correction factor for the case in which the characteristics related to the life are changed due to the bearing materials, manufacturing process, and design) and usage condition factor  $a_3$  (a correction factor that takes into account usage conditions that have a direct influence on the bearing life, such as the lubrication) or factor  $a_{23}$  formed from the interdependence of these two factors, are considered with the basic rating life. These factors were handled differently by each bearing manufacturer, but they have been standardized as a modified rating life in **ISO 281** in 2007. In 2013, **JIS B 1518** (dynamic load ratings and rating life) was amended to conform to the **ISO**.

The basic rating life ( $L_{10}$ ) shown in **Equation (5.1)** is the (fatigue) life with a dependability of 90 % under normal usage conditions for rolling bearings that have standard factors such as internal design, materials, and manufacturing quality. **JIS B 1518:2013** specifies a calculation method based on **ISO 281:2007**. To calculate accurate bearing life under a variety of operating conditions, it is necessary to consider elements such as the effect of changes in factors that can be anticipated when using different reliabilities and system approaches, and interactions between factors. Therefore, the specified calculation method considers additional stress due to the lubrication status, lubricant contamination, and fatigue load limit  $C_u$  (refer to P.36) on the inside of the bearing. The life that uses this life modification factor  $a_{ISO}$ , which considers the above factors, is called modified rating life  $L_{nm}$  and is calculated with the following **Equation (5.6)**.

$L_{nm} = a_1 a_{ISO} L_{10}$  ..... (5.6)

In this equation,

$L_{nm}$  : Modified rating life 10<sup>6</sup> rotations  
(This rating life has been modified for one of or a combination of the following: reliability of 90 % or higher, fatigue load limit, special bearing characteristics, lubrication contamination, and special operating conditions.)

$L_{10}$  : Basic rating life 10<sup>6</sup> rotations  
(reliability: 90 %)

$a_1$  : Life modification factor for reliability  
..... refer to section (1)

$a_{ISO}$  : Life modification factor  
..... refer to section (2)

[Remark] When bearing dimensions are to be selected given  $L_{nm}$  greater than 90 % in reliability, the strength of shaft and housing must be considered.

(1) Life modification factor for reliability  $a_1$

The term “reliability” is defined as “for a group of apparently identical rolling bearings, operating under the same conditions, the percentage of the group that is expected to attain or exceed a specified life” in **ISO 281:2007**. Values of  $a_1$  used to calculate a modified rating life with a reliability of 90 % or higher (a failure probability of 10 % or less) are shown in **Table 5.2**.

Table 5.2 Life modification factor for reliability  $a_1$

Reliability, %	$L_{nm}$	$a_1$
90	$L_{10m}$	1
95	$L_{5m}$	0.64
96	$L_{4m}$	0.55
97	$L_{3m}$	0.47
98	$L_{2m}$	0.37
99	$L_{1m}$	0.25
99.2	$L_{0.8m}$	0.22
99.4	$L_{0.6m}$	0.19
99.6	$L_{0.4m}$	0.16
99.8	$L_{0.2m}$	0.12
99.9	$L_{0.1m}$	0.093
99.92	$L_{0.08m}$	0.087
99.94	$L_{0.06m}$	0.080
99.95	$L_{0.05m}$	0.077

(Citation from **JIS B 1518:2013**)

(2) Life modification factor  $a_{ISO}$

a) System approach

The various influences on bearing life are dependent on each other. The system approach of calculating the modified life has been evaluated as a practical method for determining life modification factor  $a_{ISO}$  (ref. Fig. 5.2). Life modification factor  $a_{ISO}$  is calculated with the following equation. A diagram is available for each bearing type (radial ball bearings, radial roller bearings, thrust ball bearings, and thrust roller bearings). (Each diagram (Figs. 5.3 to 5.6) is a citation from JIS B 1518:2013.)

Note that in practical use, this is set so that life modification factor  $a_{ISO} \geq 50$ .

$$a_{ISO} = f\left(\frac{e_c C_u}{P}, \kappa\right) \dots\dots\dots (5.7)$$

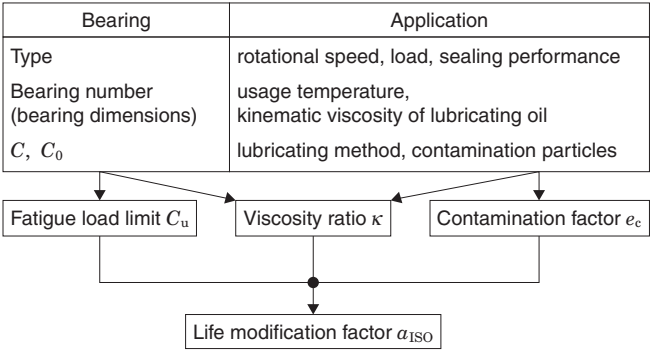


Fig. 5.2 System approach

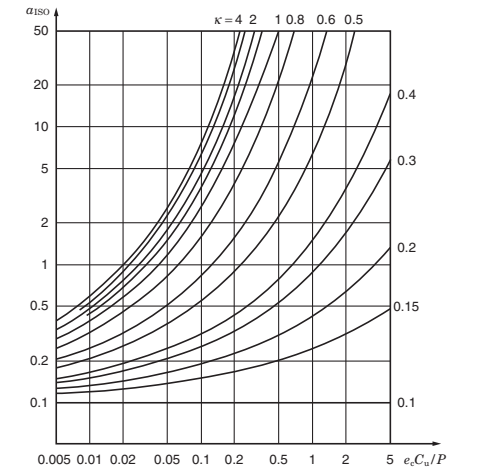


Fig. 5.3 Life modification factor  $a_{ISO}$   
(Radial ball bearings)

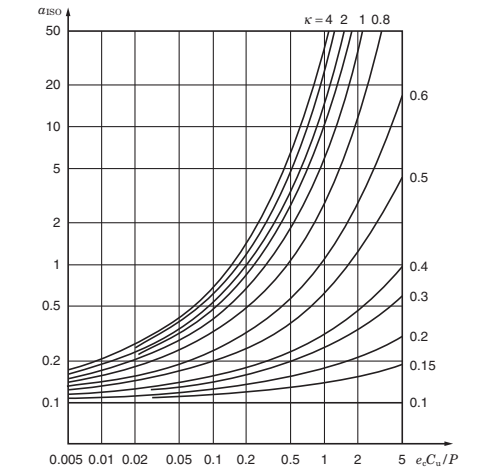


Fig. 5.4 Life modification factor  $a_{ISO}$   
(Radial ball bearings)

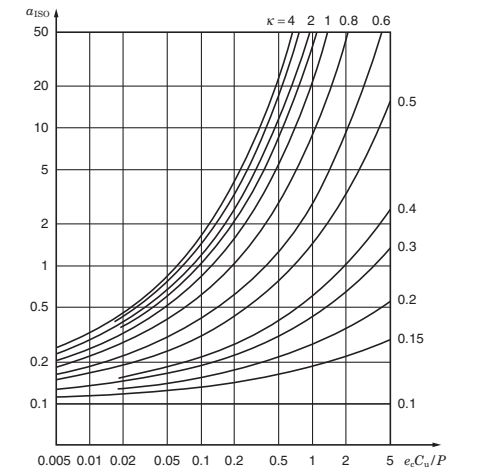


Fig. 5.5 Life modification factor  $a_{ISO}$   
(Thrust ball bearings)

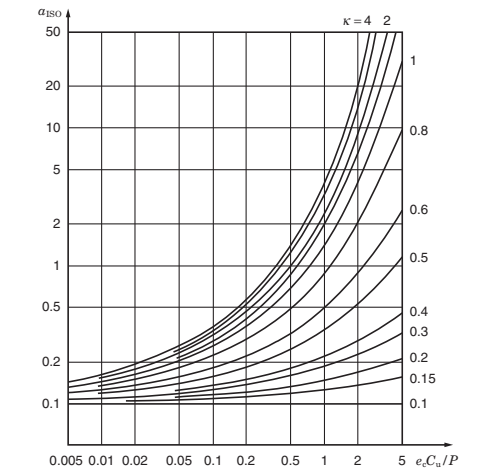


Fig. 5.6 Life modification factor  $a_{ISO}$   
(Thrust ball bearings)

(Figs. 5.3 to 5.6 Citation from JIS B 1518:2013)

5 Life of bearing

b) Fatigue load limit  $C_u$

For regulated steel materials or alloy steel that has equivalent quality, the fatigue life is unlimited so long as the load condition does not exceed a certain value and so long as the lubrication conditions, lubrication cleanliness class, and other operating conditions are favorable. For general high-quality materials and bearings with high manufacturing quality, the fatigue stress limit is reached at a contact stress of approximately 1.5 GPa between the raceway and rolling elements. If one or both of the material quality and manufacturing quality are low, the fatigue stress limit will also be low.

The term “fatigue load limit”  $C_u$  is defined as “bearing load under which the fatigue stress limit is just reached in the most heavily loaded raceway contact” in ISO 281: 2007. and is affected by factors such as the bearing type, size, and material.

For details on the fatigue load limits of special bearings and other bearings not listed in this catalog, contact JTEKT.

c) Contamination factor  $e_c$

If solid particles in the contaminated lubricant are caught between the raceway and the rolling elements, indentations may form on one or both of the raceway and the rolling elements. These indentations will lead to localized increases in stress, which will decrease the life. This decrease in life attributable to the contamination of the lubricant can be calculated from the contamination level as contamination factor  $e_c$ .

$D_{pw}$  shown in this table is the pitch diameter of ball/roller set, which is expressed simply as  $D_{pw} = (D + d)/2$ . ( $D$ : Outside diameter,  $d$ : Bore diameter)

For information such as details on special lubricating conditions or detailed investigations, contact JTEKT.

d) Viscosity ratio  $\kappa$

The lubricant forms an oil film on the roller contact surface, which separates the raceway and the rolling elements. The status of the lubricant oil film is expressed by viscosity ratio  $\kappa$ , the actual kinematic viscosity at the operating temperature  $\nu$  divided by the reference kinematic viscosity  $\nu_1$  as shown in the following equation.

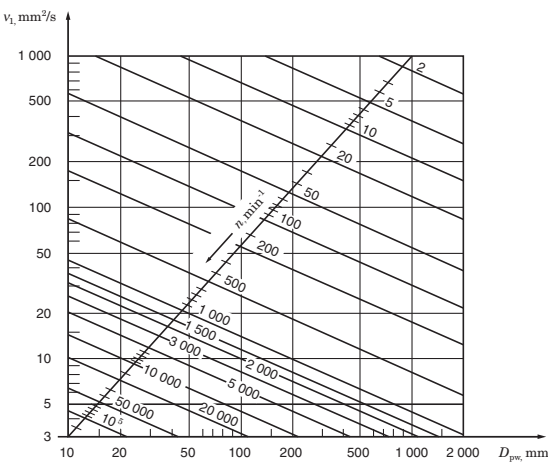
A  $\kappa$  greater than 4, equal to 4, or less than 0.1 is not applicable.

For details on lubricants such as grease and lubricants with extreme pressure additives, contact JTEKT.

$$\kappa = \frac{\nu}{\nu_1}$$

(5.8)

- $\nu$  : Actual kinematic viscosity at the operating temperature; the viscosity of the lubricant at the operating temperature
- $\nu_1$  : Reference kinematic viscosity; determined according to the speed and pitch diameter of ball/roller set  $D_{pw}$  of the bearing (ref. Fig. 5.7)



(Fig. 5.7 Citation from JIS B 1518:2013)  
Fig. 5.7 Reference kinematic viscosity  $\nu_1$

5.2.3 Service life of bearing system comprising two or more bearings

Even for systems which comprise two or more bearings, if one bearing is damaged, the entire system malfunctions. Where all bearings used in an application are regarded as one system, the service life of the bearing system can be calculated using the following equation,

Table 5.3 Values of contamination factor  $e_c$

Contamination level	$e_c$	
	$D_{pw} < 100 \text{ mm}$	$D_{pw} \geq 100 \text{ mm}$
Extremely high cleanliness: The size of the particles is approximately equal to the thickness of the lubricant oil film, this is found in laboratory-level environments.	1	1
High cleanliness: The oil has been filtered by an extremely fine filter, this is found with standard grease-packed bearings and sealed bearings.	0.8 to 0.6	0.9 to 0.8
Standard cleanliness: The oil has been filtered by a fine filter, this is found with standard grease-packed bearings and shielded bearings.	0.6 to 0.5	0.8 to 0.6
Minimal contamination: The lubricant is slightly contaminated.	0.5 to 0.3	0.6 to 0.4
Normal contamination: This is found when no seal is used and a coarse filter is used in an environment in which wear debris and particles from the surrounding area penetrate into the lubricant.	0.3 to 0.1	0.4 to 0.2
High contamination: This is found when the surrounding environment is considerably contaminated and the bearing sealing is insufficient.	0.1 to 0	0.1 to 0
Extremely high contamination	0	0

(Table 5.3 Citation from JIS B 1518:2013)

$$\frac{1}{L^e} = \frac{1}{L_1^e} + \frac{1}{L_2^e} + \frac{1}{L_3^e} + \dots \quad (5.9)$$

where :

$L$  : rating life of system

$L_1, L_2, L_3 \dots$  : rating life of each bearing

$e$  : constant

$e = 10/9 \dots$  ball bearing

$e = 9/8 \dots$  roller bearing

The mean value is for a system using both ball and roller bearings.

[Example]

When a shaft is supported by two roller bearings whose service lives are 50 000 hours and 30 000 hours respectively, the rating life of the bearing system supporting this shaft is calculated as follows, using **Equation (5.9)** :

$$\frac{1}{L^{9/8}} = \frac{1}{50\,000^{9/8}} + \frac{1}{30\,000^{9/8}}$$

$L \div 20\,000\text{ h}$

The equation suggests that the rating life of these bearings as a system becomes shorter than that of the bearing with the shorter life.

This fact is very important in estimating bearing service life for applications using two or more bearings.

5.2.4 Recommended service life of bearing

Excessively long life of insert bearing unit does not lead to economic operation. Setup of the recommended service life of bearing unit depending on the type of machine the insert bearing unit is used together and operating conditions is required.

Recommended service life of insert bearing unit empirically adopted is shown in **Table 5.4**.

Table 5.4 Recommended service life of insert bearing unit (reference)

Operating conditions	Application	Recommended service life, h
Operated in short period or intermittently	Home electric appliances, electric tool, agricultural machinery, hoist, etc.	4 000 – 8 000
Discontinuously but for a long period	Factory motor, general gear, etc.	12 000 – 20 000
Always operated for 8 hours or longer a day or operated continuously for a long period	General machinery, blower, etc.	20 000 – 30 000
Operated continuously for 24 hours, no fault is allowed	Electric power plant facility, mine drainage facility, etc.	100 000 –200 000

5.3 Grease life

Grease life of a insert bearing for insert bearing unit is influenced by the level of load, rotational speed of bearing, and operating temperature.

Grease life of a insert bearing for unit used under appropriate operating conditions can be found by the equation shown below.

$$\log L = 6.10 - 4.40 \times 10^{-6} d_m n - 2.50 \left( \frac{P_r}{C_r} - 0.05 \right) - (0.021 - 1.80 \times 10^{-8} d_m n) T \quad (5.10)$$

Whereas,

$L$  : Grease life

$d_m$  : Pitch dia. of ball set

$d_m = \frac{(D + d)}{2}$

$D$  : Nominal bearing outer dia.,

$d$  : Nominal bearing bore dia.

$n$  : Rotational speed of bearing

$P_r$  : Dynamic equivalent radial load (see “6 Bearing load”)

$C_r$  : Basic dynamic radial load rating of bearing

$T$  : Operating temperature of bearing

h

mm

min<sup>-1</sup>

N

N

°C

Applicable conditions for the **Equation (5.10)** are shown below.

- 1) Operating temperature of bearing :  $T$  °C
- To be applied if the following condition is satisfied :  
 $T \leq 100$
- If  $T$  is smaller than 50 ( $T < 50$ ),  
following condition should be applied :  $T = 50$ .

If  $T$  is larger than 100 ( $T > 100$ ), contact JTEKT.
- 2) Rotationl speed of bearing :  $d_m n$
- To be applied if the following condition is satisfied :  
 $d_m n \leq 30 \times 10^4$
- If  $d_m n$  is smaller than  $12.5 \times 10^4$  ( $d_m n < 12.5 \times 10^4$ ),  
following condition should be applied :  
 $d_m n = 12.5 \times 10^4$

If  $d_m n$  is larger than  $30 \times 10^4$  ( $d_m n > 30 \times 10^4$ ),  
contact JTEKT.
- 3) Load condition of bearing :  $\frac{P_r}{C_r}$
- To be applied if the following condition is satisfied :  
 $\frac{P_r}{C_r} \leq 0.2$
- If  $\frac{P_r}{C_r}$  is smaller than 0.05 ( $\frac{P_r}{C_r} < 0.05$ ),  
following condition should be applied :  $\frac{P_r}{C_r} = 0.05$

If  $\frac{P_r}{C_r}$  is larger than 0.2 ( $\frac{P_r}{C_r} > 0.2$ ), contact JTEKT.

Reference figure of grease life obtained by the **Equation (5.10)** is shown in **Fig. 5.8**.

5 Life of bearing

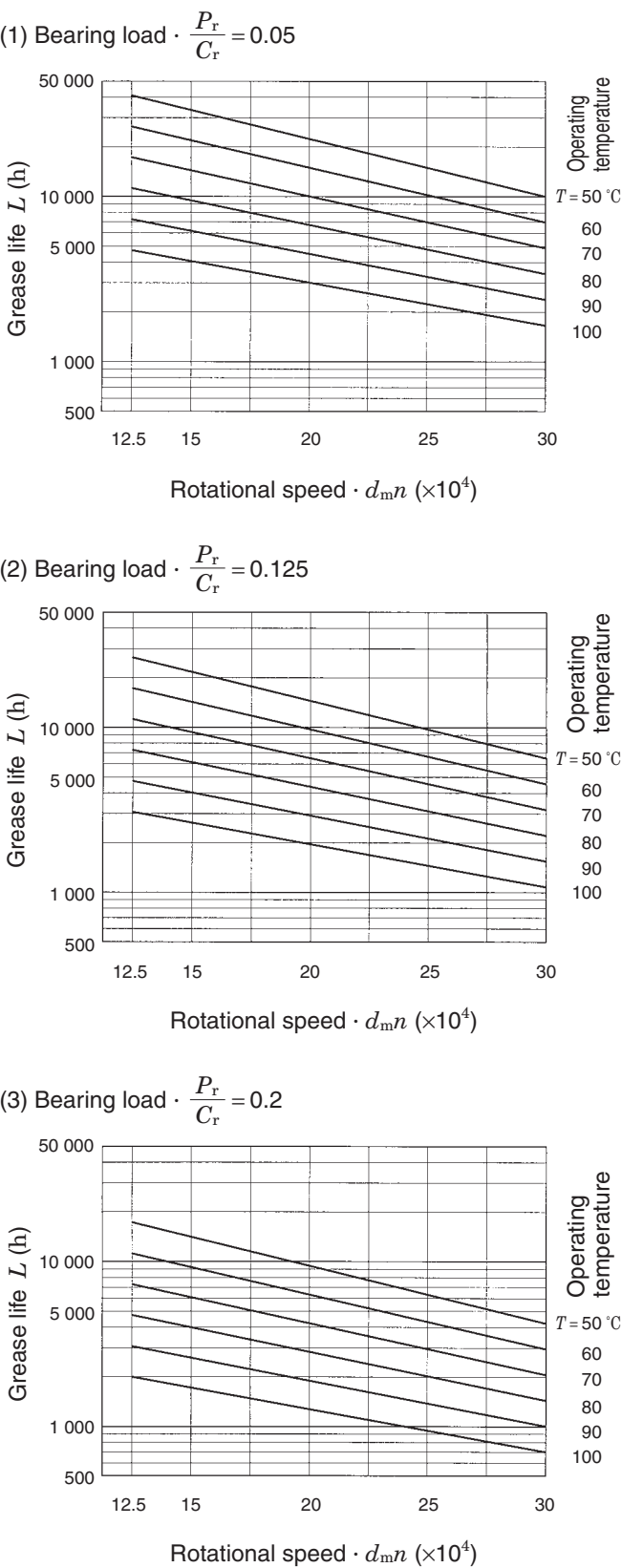


Fig. 5.8 Relation of grease life to bearing load, rotational speed, and operating temperature (reference)

6 Bearing load

As for the loads applied to a bearing, load caused by weight of object supported by the bearing, transmitting force of gears and belts, load generated in the machine operated are included. In many cases, these loads cannot be found out by simple calculation.

Because the loads are not fixed but fluctuated, and it is difficult to fix the level and direction of the fluctuations.

Therefore, in general, to find the loads applied to a bearing, the following steps are adopted : multiply the load to be able to be found theoretically by various factors obtained empirically.

6.1 Loads applied to bearing

6.1.1 Load factor

Even if radial load and axial load to be applied to a bearing can be found by standard dynamical calculation, loads actually applied to the bearing are greater than the calculated values because of vibration and impact generated while machine is being operated.

To find the loads actually applied to a bearing, multiply the theoretically found values by load factor.

$F = f_w \cdot F_c$  (6.1)

Whereas,	
$F$ : Load actually applied to bearing	N
$F_c$ : Theoretically calculated load	N
$f_w$ : Load factor (see Table 6.1)	

Table 6.1 Load factor  $f_w$

Operating conditions	Applications	$f_w$
Virtually no vibration or impact	Electric machines and instruments	1 – 1.2
Standard operation (weak impact)	Agricultural machines and blower	1.2 – 2
Great vibration and impact	Constructive machines and grinder	2 – 3

6.1.2 Loads in case of belt or chain transmission

As for belt transmission, theoretical load applied to the pulley shaft can be found by effective transmission force of belt. Actually, the effective transmission force must be multiplied by load factor ( $f_w$ ) obtained with taking vibration and impact generated while machine is being operated into consideration and belt factor ( $f_b$ ) with taking belt tension into consideration.

As for chain transmission, factor equivalent to the belt factor for belt transmission must be multiplied.

$$F_b = \frac{2M}{D_p} \cdot f_w \cdot f_b$$
$$= \frac{19.1 \times 10^6 W}{D_p \cdot n} \cdot f_w \cdot f_b \dots\dots\dots (6.2)$$

Whereas,

$F_b$  : Load actually applied to pulley shaft or sprocket shaft N

$M$  : Torque applied to pulley or sprocket mN · m

$W$  : Transmitted power kW

$D_p$  : Pitch circle dia. of pulley or sprocket mm

$n$  : Rotational speed min<sup>-1</sup>

$f_w$  : Load factor (see **Table 6.1**)

$f_b$  : Belt factor (see **Table 6.2**)

Table 6.2 Belt factor  $f_b$

Belt type	$f_b$
Toothed belt	1.3 – 2
V belt	2 – 2.5
Flat belt (with tension pulley)	2.5 – 3
Flat belt	4 – 5
Chain	1.2 – 1.5

6.1.3 Load in case of gear transmission

As for gear transmission, load in tangential direction ( $K_t$ ), load in radial direction ( $K_r$ ), and axial load ( $K_a$ ) are included as the theoretical loads applied to a gear. They can be dynamically found by transmission force and gear type.

The followings show the example of standard flat gear (as for flat gear, no axial load applied is expected.).

(1) Load applied to gear in tangential direction (tangential line force)

$$K_t = \frac{2M}{D_p} = \frac{19.1 \times 10^6 W}{D_p n} \dots\dots\dots (6.3)$$

(2) Load applied to gear in radial direction (separating force)

$$K_r = K_t \tan \alpha \dots\dots\dots (6.4)$$

(3) Synthetic load applied to gear

$$K_g = \sqrt{K_t^2 + K_r^2} = K_t \sec \alpha \dots\dots\dots (6.5)$$

Whereas,

$K_t$  : Load applied to gear in tangential direction (tangential line force) N

$K_r$  : Load applied to gear in radial direction (separating force) N

$K_g$  : Synthetic load applied to gear N

$M$  : Torque applied to gear mN · m

$D_p$  : Pitch circle dia. of gear mm

$W$  : Transmission power kW

$n$  : Rotational speed min<sup>-1</sup>

$\alpha$  : Pressure angle of gear deg

Note that the actual gear load must be found by multiplying the theoretical load by load factor ( $f_w$ ) obtained with taking vibration and impact generated while machine is being operated into consideration and gear factor ( $f_g$ ) with taking accuracy and finish of gear into consideration.

$$F_g = f_w \cdot f_g \cdot K_g \dots\dots\dots (6.6)$$

Whereas,

$F_g$  : Load actually applied to gear N

$K_g$  : Theoretically synthetic load applied to gear N

$f_w$  : Load factor (see **Table 6.1**)

$f_g$  : Gear factor (see **Table 6.3**)

Table 6.3 Gear factor  $f_g$

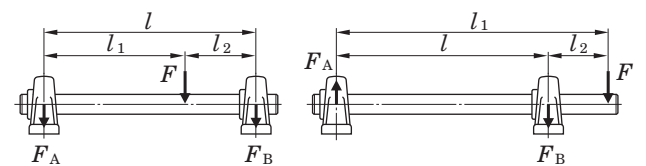
Gear type	$f_g$
Precision gear (both pitch error and tooth profile error should be 0.02 mm or less)	1 – 1.1
Standard gear (both pitch error and tooth profile error should be 0.1 mm or less)	1.1 – 1.3

6 Bearing load

6.2 Distribution of load to bearing

To distribute the load applied to the shaft system into the bearing which supports the shaft, find the radial component force of each load, and calculate the vector sum in accordance with the direction of load. **Fig. 6.1** shows the example of distribution of radial load.

In many cases, a bearing bears radial load as well as axial load, leading to synthetic loads. In such a case, convert it into dynamic equivalent load, and consider it as the bearing load.



$$F_A = \frac{l_2}{l} \cdot F \dots\dots\dots (6.7)$$
$$F_B = \frac{l_1}{l} \cdot F \dots\dots\dots (6.8)$$

Fig. 6.1 Distribution of load to bearing

6.3 Dynamic equivalent load

In many cases, a bearing is exposed to the synthetic load of radial load and axial load, and it is used under various conditions, including fluctuated load thus, the load actually applied to the bearing cannot be directly compared to the basic dynamic load rating.

In such a case, find the load running the bearing center in a fixed level and direction that allows the same bearing life as the actual bearing load and rotational speed. Then, compare it with the basic dynamic load rating.

The converted virtual load is called dynamic equivalent load (*P*).

6.3.1 Calculation of dynamic equivalent load

The dynamic equivalent radial load (*P<sub>r</sub>*) of a radial bearing (insert bearing for unit is included) that bears the synthetic load in a fixed level and direction can be found by the equation shown below.

$$P_r = XF_r + YF_a \dots\dots\dots (6.9)$$

Whereas,

<i>P<sub>r</sub></i> : Dynamic equivalent radial load	N
<i>F<sub>r</sub></i> : Radial load	N
<i>F<sub>a</sub></i> : Axial load	N
<i>X</i> : Radial load factor (see <b>Table 6.4</b> )	
<i>Y</i> : Axial load factor (see <b>Table 6.4</b> )	

Table 6.4 Radial load factor (*X*) and axial load factor (*Y*)

$\frac{f_0 F_a}{C_{0r}}$	<i>e</i>	$F_a / F_r \leq e$		$F_a / F_r > e$	
		<i>X</i>	<i>Y</i>	<i>X</i>	<i>Y</i>
0.172	0.19	1	0	0.56	2.30
0.345	0.22				1.99
0.689	0.26				1.71
1.03	0.28				1.55
1.38	0.30				1.45
2.07	0.34				1.31
3.45	0.38				1.15
5.17	0.42				1.04
6.89	0.44				1.00

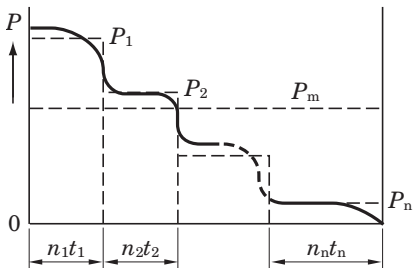
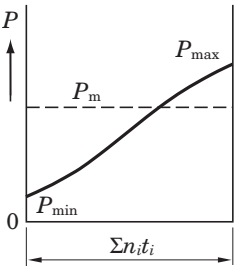
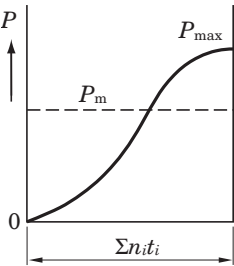
- [Remarks] 1. *C<sub>0r</sub>* (basic static radial load rating) and *f<sub>0</sub>* (factor) are shown in the dimensional tables.
2. If *f<sub>0</sub> F<sub>a</sub> / C<sub>0r</sub>* does not conform to the table above, find by interpolation.

### 6.3.2 Mean dynamic equivalent load in case of fluctuated load

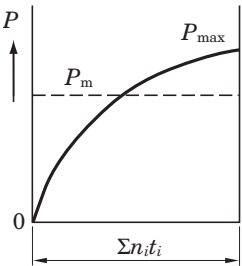
If level or direction of the load applied to a bearing is fluctuated, it is necessary to find the mean dynamic equivalent load to allow the same bearing life as that under actual fluctuated conditions.

Table 6.5 shows the method of finding the mean dynamic equivalent load under various fluctuated conditions.

Table 6.5 Calculation of mean dynamic equivalent load in case of fluctuated load

(1) Staged fluctuation

$P_m = \sqrt[p]{\frac{P_1^p n_1 t_1 + P_2^p n_2 t_2 + \dots + P_n^p n_n t_n}{n_1 t_1 + n_2 t_2 + \dots + n_n t_n}} \dots\dots\dots (6.10)$
(2) Stageless fluctuation

$P_m = \frac{P_{\min} + 2 P_{\max}}{3} \dots\dots\dots (6.11)$
(3) Sine curve fluctuation

$P_m = 0.68 P_{\max} \dots\dots\dots (6.12)$

### (4) Sine curve fluctuation (upper half of sine curve)



$P_m = 0.75 P_{\max} \dots\dots\dots (6.13)$

- Whereas,
- $P_m$  : Mean dynamic equivalent load N
  - $P_1$  : Dynamic equivalent load actuating for  $t_1$  hours at rotational speed of  $n_1$  N
  - $P_2$  : Dynamic equivalent load actuating for  $t_2$  hours at rotational speed of  $n_2$  N
  - ...
  - $P_n$  : Dynamic equivalent load actuating for  $t_n$  hours at rotational speed of  $n_n$  N
  - $P_{\min}$  : Minimum dynamic equivalent load N
  - $P_{\max}$  : Maximum dynamic equivalent load N
  - $\Sigma n_i t_i$  : Total rotating frequency for  $t_1$  to  $t_i$  hours

### 6.4 Basic static load rating and static equivalent load

#### 6.4.1 Basic static load rating

If a bearing is exposed to excessive static load or impact load even under extra low rotational speed, partial permanent deformation occurs to the contact surface of the raceway of bearing with the rolling element. The permanent deformation increases with the increase of load, and when it exceeds a fixed level, smooth rotation of the bearing is interfered.

Basic static load rating of a bearing is the static load to generate the calculated contact stress shown below at the center of contact surface of the raceway the maximum load is applied and the rolling element.

- (1) Self-aligning ball bearing ..... 4 600 MPa
- (2) Other ball bearings  
(insert bearing for unit is included) .... 4 200 MPa
- (3) Roller bearing ..... 4 000 MPa

The total permanent deformation of bearing raceway and rolling element to be generated under these contact stresses are 0.000 1 times of the diameter of rolling element.

In the insert bearing for unit, it is indicated as the **basic static radial load rating** ( $C_{0r}$ ), and the values are shown in the dimensional tables.

6 Bearing load

6.4.2 Static equivalent load

Static equivalent load is the virtual load converted into the level that allows the generation of the same contact stress at the contact face of the raceway of bearing and rolling element that are exposed to the maximum stress as the contact stress under the actual load conditions, when a bearing is stopped or rotated at extra low speed.

Static equivalent radial load ( $P_{0r}$ ) of the insert bearing for unit can be calculated by the equation below (use greater value).

$P_{0r} = 0.6 F_r + 0.5 F_a$	(6.14)
$P_{0r} = F_r$	(6.15)
Whereas,	
$P_{0r}$ : Static equivalent radial load	N
$F_r$ : Radial load	N
$F_a$ : Axial load	N

6.4.3 Safety factor

The static equivalent load allowed by a bearing depends on the basic static load rating of the bearing, and the limitation of use of bearing by the permanent deformation (partial dent) of the bearing depends on the performance required for the bearing or operating conditions.

Therefore, in order to examine the safety of the basic static load rating of the bearing, safety factor is defined taking conventional experiences into consideration.

$f_s = \frac{C_{0r}}{P_{0r}}$	(6.16)
Whereas,	
$f_s$ : Safety factor (see Table 6.6)	
$C_{0r}$ : Basic static radial load rating	N
$P_{0r}$ : Static equivalent radial load	N

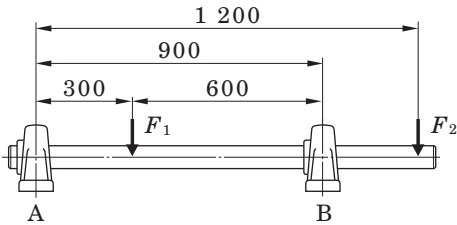
Table 6.6 Safety factor  $f_s$  (recommended)

Operating conditions		$f_s$ (Min.)
Being rotated	High rotating accuracy is required	2
	Standard operating conditions	1
	Impact	1.5
Not always being rotated ( sometimes oscillated )	Standard operating conditions	0.5
	Impact, unevenly distributed load	1

6.5 Example of applied calculation

Example 1 Distributing load

Find the load applied to the bearing A and bearing B, if the radial load  $F_1$  ( $F_1 = 1.5$  kN) and  $F_2$  ( $F_2 = 4.5$  kN) are applied.



- (1) Find the radial load  $F_{1A}$  applied to the bearing A by  $F_1$ , with **Equations (6.7) and (6.8)**.

$F_{1A} = \frac{600}{900} \times 1.5 = 1.0 \text{ (kN)}$

In a similar manner, find the radial load  $F_{2A}$  applied to the bearing A by  $F_2$ .

$F_{2A} = - \frac{1\,200 - 900}{900} \times 4.5 = -1.5 \text{ (kN)}$

[Remark] Negative load is the upward load.

Radial load  $F_A$  applied to the bearing A :

$F_A = F_{1A} + F_{2A} = 1.0 + (-1.5) = -0.5 \text{ (kN)}$

- (2) In a similar manner to (1), find the radial load  $F_B$  applied to the bearing B.

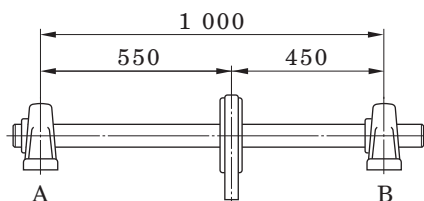
$F_{1B} = \frac{300}{900} \times 1.5 = 0.5 \text{ (kN)}$

$F_{2B} = \frac{1\,200}{900} \times 4.5 = 6.0 \text{ (kN)}$

$F_B = F_{1B} + F_{2B} = 0.5 + 6.0 = 6.5 \text{ (kN)}$

### Example 2 Calculating load by V-belt transmission

Find the load applied to the bearing A and bearing B when the shaft is driven by the V-belt, transmission power  $W$  is 7.5 kW ( $W = 7.5$  kW), rotational speed  $n$  is 300 min<sup>-1</sup> ( $n = 300$  min<sup>-1</sup>), effective diameter of pulley  $D_p$  is 300 mm ( $D_p = 300$  mm).



- (1) Find the load actually applied to the pulley shaft  $F_b$  with **Equation (6.2)**.

From **Table 6.1**, load factor  $f_w$  is 1.2 ( $f_w = 1.2$ ), and the belt factor  $f_b$  is 2.5 ( $f_b = 2.5$ ), from **Table 6.2**.

$$F_b = \frac{19.1 \times 10^6 W}{D_p \cdot n} \cdot f_w \cdot f_b$$

$$= \frac{19.1 \times 10^6 \times 7.5}{300 \times 300} \times 1.2 \times 2.5 = 4.78 \text{ (kN)}$$

- (2) Find the load actually applied to the bearing A and bearing B ( $F_A$  and  $F_B$ ) with **Equations (6.7)** and **(6.8)**.

$$F_A = \frac{450}{1000} \times 4.78 = 2.15 \text{ (kN)}$$

$$F_B = \frac{550}{1000} \times 4.78 = 2.63 \text{ (kN)}$$

### Example 3 Calculating dynamic equivalent radial load

Find the dynamic equivalent radial load  $P_r$  when the radial load  $F_r$ , 1.5 kN ( $F_r = 1.5$  kN), and the axial load  $F_a$ , 0.85 kN, ( $F_a = 0.85$  kN) are applied to the pillow block type unit UCP306J (bearing UC306).

- (1) Find the radial load factor ( $X$ ) and the axial load factor ( $Y$ ) with using the static radial load rating  $C_{0r}$  of UCP306J (bearing UC306), 15.0 kN ( $C_{0r} = 15.0$  kN), and **Table 6.4**.

$$\frac{f_0 F_a}{C_{0r}} = \frac{13.3 \times 0.85}{15.0} = 0.754, e = 0.264$$

$$\frac{F_a}{F_r} = \frac{0.85}{1.5} = 0.567 > e \text{ (0.264)}$$

Therefore,  $X = 0.56$ ,  $Y = 1.68$

- (2) Find the dynamic equivalent radial load  $P_r$  with **Equation (6.9)**.

$$P_r = XF_r + YF_a = 0.56 \times 1.5 + 1.68 \times 0.85$$

$$= 2.27 \text{ (kN)}$$

### Example 4 Calculating bearing life

Under the conditions shown in the **Example 3**, find the bearing life  $L_{10h}$  when a bearing is used for a blower of the rotational speed  $n$ , 1 000 min<sup>-1</sup>.

- (1) Select the load factor  $f_w$  is 1.2 ( $f_w = 1.2$ ) from **Table 6.1**, and find the bearing load  $P_r$ .

$$P_r = f_w \cdot F = 1.2 \times 2.27 = 2.72 \text{ (kN)}$$

- (2) The dynamic radial load rating of UCP306J (bearing UC306),  $C_r$ , is 26.7 kN ( $C_r = 26.7$  kN), and calculate the bearing life  $L_{10h}$  with the **Equation (5.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left( \frac{C_r}{P_r} \right)^3 = \frac{10^6}{60 \times 1000} \times \left( \frac{26.7}{2.72} \right)^3$$

$$\doteq 15\,800 \text{ (h)}$$

- (3) Calculate bearing life  $L_{10h}$  with the nomogram shown in **Fig. 5.1**.

When the rotational speed  $n$  is 1 000 min<sup>-1</sup> ( $n = 1\,000$  min<sup>-1</sup>), rotational factor  $f_n$  is 0.32 ( $f_n = 0.32$ ). next, find the life factor  $f_h$  by speed factor  $f_n$ , dynamic radial load rating of bearing  $C_r$ , and the bearing load  $P_r$ .

$$\text{Life factor } f_h = f_n \cdot \frac{C_r}{P_r} = 0.32 \times \frac{26.7}{2.72}$$

$$= 3.14$$

From life factor  $f_h$ , bearing life  $L_{10h} \doteq 16\,000$  hours.

### Example 5 Selecting insert bearing unit

If a bearing is operated under the following conditions, select the flange type unit (UCF) with at least two years (5 000 hours) or longer service life : rotational speed of shaft  $n$  is 1 500 min<sup>-1</sup> ( $n = 1\,500$  min<sup>-1</sup>), and radial load  $F_r$  is 5 kN ( $F_r = 5$  kN). The radial load  $F_r$  includes the load factor and gear factor.

- (1) From the nomogram shown in **Fig. 5.1**, when life time  $L_h$  is 5 000 h ( $L_h = 5\,000$  h), life factor  $f_h$  can be found as 2.16 ( $f_h \doteq 2.16$ ), and speed factor  $f_n$  can be found as 0.28 ( $f_n \doteq 0.28$ ) when the rotational speed  $n$  is 1 500 min<sup>-1</sup> ( $n = 1\,500$  min<sup>-1</sup>).

$$\text{Dynamic radial load rating } C_r = F_r \cdot \frac{f_h}{f_n} = 5 \times \frac{2.16}{0.28}$$

$$\doteq 38.6 \text{ (kN)}$$

- (2) Find the flange type unit that meets the following condition : dynamic radial load rating  $C_r$  is 38.6 kN ( $C_r = 38.6$  kN). As for the diameter series 2, UCF211J (dynamic radial load rating  $C_r$  is 43.4 kN ( $C_r = 43.4$  kN)) can be selected.

## 6 Bearing load

### Example 6 Selecting pillow block type unit for low speed

If a bearing is used for a dolly under the following conditions, select the pillow block type unit (UCP) with 10 000 hours service life : radial load  $F_r$  is 12 kN ( $F_r = 12$  kN), and rotational speed is  $8 \text{ min}^{-1}$ .

- (1) Find the required dynamic radial load rating  $C_r$  with using **Equations (5.4) and (5.5)**.

$$\text{Speed factor } f_n = (0.03n)^{-1/p} = (0.03 \times 8)^{-1/3} \doteq 1.61$$

$$\text{Life factor } f_h = \left(\frac{L_{10h}}{500}\right)^{1/p} = \left(\frac{10\,000}{500}\right)^{1/3} \doteq 2.71$$

$$\text{Dynamic radial load rating } C_r = P_r \cdot \frac{f_h}{f_n} = 12 \times \frac{2.71}{1.61} \\ \doteq 20.2 \text{ (kN)}$$

- (2) From **Table 6.6**, define safe factor  $f_s$  as 2 ( $f_s = 2$ ), and find the static radial load rating of bearing required  $C_{0r}$ .

$$C_{0r} = f_s \cdot P_r = 2 \times 12 = 24 \text{ (kN)}$$

- (3) The unit is used for a dolly, and vibration or impact may occur. Thus, select UCP308J ( $C_r = 40.7$  kN,  $C_{0r} = 24.0$  kN).

### Example 7 Calculating bearing life in case of use at high temperature

Find the bearing life if the heat resistant pillow block type unit (UCP215JD1K2) is operated under the following conditions : operating temperature is  $175^\circ\text{C}$ , radial load  $F_r$  is 4 kN ( $F_r = 4$  kN), and the rotational speed  $n$  is  $800 \text{ min}^{-1}$  ( $n = 800 \text{ min}^{-1}$ ). Note that the radial load  $F_r$  includes load factor and gear factor.

- (1) From **Table 5.1**, find the dynamic load rating  $C_r$  with in the case that a bearing is used at  $175^\circ\text{C}$ .

$$C_r = 67.4 \times 0.95 = 64.0 \text{ (kN)}$$

Find the bearing life  $L_{10h}$  with using **Equation (5.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left(\frac{C_r}{P_r}\right)^3 = \frac{10^6}{60 \times 800} \times \left(\frac{64.0}{4}\right)^3 \\ \doteq 85\,000 \text{ (h)}$$

- (2) If a bearing unit is operated at  $175^\circ\text{C}$ , grease is degraded faster, and it cannot be used without lubrication. Supply grease at intervals specified in **Table 14.4**.
- (3) If the shaft is extended excessively, install a bearing unit on the identical shaft on the fixed side (positioning of shaft), and install another bearing unit on the free side (see “10 Design of shaft and base”).

### Example 8 Calculating grease life

Find the grease life in the case that pillow block type unit UCP204J (bearing UC204) under the following conditions : radial load  $F_r$  is 1 kN ( $F_r = 1$  kN), and rotational speed  $n$  is  $800 \text{ min}^{-1}$  ( $n = 800 \text{ min}^{-1}$ ). Note that the radial load  $F_r$  includes load factor and belt factor. Operating temperature of the bearing should be  $40^\circ\text{C}$ .

Find the grease life  $L$  with using **Equation (5.10)**.

$$\log L = 6.10 - 4.40 \times 10^{-6} d_m n - 2.50 \left(\frac{P_r}{C_r} - 0.05\right) \\ - (0.021 - 1.80 \times 10^{-8} d_m n) T \\ = 6.10 - 4.40 \times 10^{-6} \times 12.5 \times 10^4 \\ - 2.50 \left(\frac{1}{12.8} - 0.05\right) \\ - (0.021 - 1.80 \times 10^{-8} \times 12.5 \times 10^4) \times 50 \\ = 4.542 \\ L \doteq 34\,800 \text{ (h)}$$

### Example 9 Calculating life of bearing unit in case of non-lubrication

Find the life of a bearing unit in the case that it is operated under the conditions shown in **Example 8**, but without lubrication.

- (1) Find the rating life of bearing  $L_{10h}$  with using **Equation (5.2)**.

$$L_{10h} = \frac{10^6}{60n} \cdot \left(\frac{C_r}{P_r}\right)^3 = \frac{10^6}{60 \times 800} \times \left(\frac{12.8}{1}\right)^3 \\ \doteq 43\,700 \text{ (h)}$$

- (2) Compare the grease life  $L$  shown in **Example 8** to the rating life of bearings  $L_h$ . Then, grease life  $L$  is shorter than the bearing rating life. Therefore, life of a bearing unit should be the same as the grease life  $L$ , 34 800 hours ( $L = 34\,800$  hours).

7 Allowable rotational speed

7.1 Allowable rotational speed

The rotational speed of a bearing is normally affected by friction heat generated in the bearing. If the heat exceeds a certain amount, seizure or other failures occur, thus causing rotation to be discontinued.

The allowable rotational speed is the highest speed at

which a bearing can continuously operate without generating such critical heat.

Allowable rotational speed of a insert bearing unit depends on the dimensions of the bearing, type of oil seal, and fitting conditions of bearing inner ring and shaft.

**Table 7.1** shows the standard allowable rotational speeds of insert bearing units.

Table 7.1 Allowable rotational speed of insert bearing units (standard value)

Unit : min<sup>-1</sup>

Bore diameter No.	UC type bearing, UC-S6 type bearing, UK type bearing, NA type bearing, ER, RB type bearing										SA type bearing SB type bearing	SU type bearing SU-S6 type bearing
	Standard type, cold resistant type (D2K2)			Triple-lip sealed (L3)			Heat resistant type (D1K2)	Heat resistant type (K3), for blower (S5)				
	Diameter series			Diameter series			Diameter series	Diameter series				
	2	X	3	2	X	3	2, X, 3	2	X	3		
8												10 000
00	—			—			—	—			—	10 000
01	5 800			2 300			3 800	8 700			6 800	8 000
02	5 800			2 300			3 800	8 700			6 800	6 600
03	5 800			2 300			3 800	8 700			6 800	5 800
04	5 800	—	—	2 300	—		3 800	8 700	—	—	5 800	5 000
05	5 100	4 300	4 600	2 100	960		3 000	7 700	6 400	6 700	5 100	4 000
06	4 300	3 700	3 900	960	830	—	2 500	6 400	5 500	5 800	4 300	3 300
07	3 700	3 300	3 400	830	750	770	2 100	5 500	5 000	5 100	3 700	—
08	3 300	3 100	3 100	750	690	690	1 900	5 000	4 600	4 600	3 300	
09	3 100	2 800	2 700	690	640	620	1 700	4 600	4 300	4 100	3 100	
10	2 800	2 500	2 400	640	570	550	1 500	4 300	3 800	3 700	2 800	
11	2 500	2 300	2 300	570	520	510	1 400	3 800	3 500	3 400		
12	2 300	2 200	2 100	520	490	470	1 300	3 500	3 200	3 100		
13	2 200	2 100	1 900	490	460	440	1 200	3 200	3 100	2 900		
14	2 100	2 000	1 800	460	440	410	1 100	3 100	2 900	2 700		
15	2 000	1 800	1 700	440	410	380	1 000	2 900	2 700	2 600		
16	1 800	1 700	1 600	410	380	360	940	2 700	2 600	2 400		
17	1 700	1 600	1 500	380	360	340	880	2 600	2 400	2 300		
18	1 600	1 500	1 400	360	340	320	830	2 400	2 300	2 100		
19	—	—	1 400	—	—	310	790	—	—	2 000		
20		1 300	1 300		300	280	750		2 000	1 900		
21		—	1 200		—	—	710		—	1 800		
22			1 100			250	680			1 700		
24			1 100			240	630			1 600		
26			1 000			220	580			1 500		
28			910			200	540			1 400		

[Remarks] 1. Allowable rotational speed of the units with covers is 80% of the value shown in the table above.

2. If a bearing unit is used with excessively loose fitting, allowable rotational speed must be corrected by multiplying it by the fitting factor *f<sub>c</sub>* shown in **Table 7.2**.

7 Allowable rotational speed

7.2 Correction of allowable rotational speed by fitting

For easier installation of a insert bearing unit to a shaft, clearance fit is used for a bearing inner ring and shaft, in general. Size of fitting clearance between the bearing inner ring and the shaft is related to the allowable rotational speed of the bearing unit. As the rotational speed is increased, the fitting clearance between the bearing inner ring and the shaft should be decreased.

**Table 7.2** shows the fitting factors to correct the allowable rotational speed depending on the types of fitting of the bearing inner ring to the shaft.

As for the bearings with set screws, allowable rotational speed must be corrected by multiplying the allowable rotational speed (standard value) by fitting factor, depending on the tolerance class of the shaft used. For the bearings with adapter, shafts of h8 or h9 tolerance class are recommended, while shafts of h5 or j5 tolerance class are recommended for the bearings with eccentric locking collar.

**Table 7.2    Fitting factor of insert bearing unit  $f_c$  (recommended)**

Type of insert bearing unit	Fitting factor $f_c$					
	Shaft tolerance class					
	h5, j5	j6	h6	h7	h8	h9
<b>With set screw</b>						
Standard type	—	1.0	1.0	0.8	0.5	0.2
Triple-lip seal type (Supplementary code L3)	—	—	—	1.0	1.0	0.9
Heat resistant type (Special code D1K2)	—	—	—	1.0	1.0	0.7
Cold resistant type (Special code D2K2)	—	—	—	1.0	1.0	0.7
For high speed (Special code K3)	—	1.0	0.8	0.6	—	—
For blower (Special code S5)	1.0	—	0.8	0.6	—	—
<b>With adapter</b>	—	—	—	—	1.0	1.0
<b>With eccentric locking collar</b>	1.0	—	—	—	—	—

8 Operating temperature and bearing specifications

8.1 Operating temperature range

Operating temperature range of a insert bearing unit depends on the type of grease used for the bearing, oil seal rubber material, and the internal clearance of the bearing.

Koyo Insert Bearing Units are available in heat resistant unit (special code : D1K2) and cold resistant unit (special code : D2K2) series, as well as standard types, to allow selection optimal for the operating temperature (see **Table 3.3**).

Even though the bearing unit suitable for temperature is used, grease must be fed in accordance with the specified standards, since grease life greatly depends on temperature.

8.2 Operating temperature and internal clearance of bearing

If the temperature of transmission heat to the shaft is high or hot steam enters the hollow bore of the shaft, difference between the temperatures of the bearing inner and outer rings is increased and the internal clearance of the bearing is decreased, leading to breakage at early stages of the bearing service life.

Decrease in the internal clearance of the bearing depending on the difference in the temperatures of the bearing inner ring and the bearing outer ring can be found by **Equation (8.1)**.

Under these conditions, decrease in the internal clearance must be calculated, and the internal clearance of bearing needs to be selected properly.

$$S_{t1} = \alpha \cdot D_e \cdot \Delta t \dots\dots\dots (8.1)$$

Whereas,

$$S_{t1}$$
 : Decrease in the internal clearance of bearing depending on the difference in the temperatures of the bearing inner ring and the bearing outer ring  
mm

$$\alpha$$
 : Line expansion factor of bearing steel  
12.5 × 10<sup>-6</sup>

$$D_e$$
 : Raceway dia. of bearing outer ring  
mm  
Diameter series 2, X.....  $D_e \div 0.92 D$   
Diameter series 3.....  $D_e \div 0.9 D$

$$D$$
 : Nominal bearing outer dia.  
mm

$$\Delta t$$
 : Difference in temperatures of bearing inner ring and outer ring  
°C

If a insert bearing unit is used at a high temperature, abnormal axial load may be applied to the bearing due to axial extension of the shaft caused by high temperature, leading to breakage at early stages of the bearing service life. This fact must be taken into consideration, as well as the internal clearance of the bearing for use of the bearing at a high temperature.

The shaft of free side unit or the unit needs to be able to be moved axially, as the countermeasure against this problem.

(See “10 Design of shaft and base”)

9 Strength of housing

The housing for Koyo Insert Bearing Unit reliably with-stands use under standard operating conditions, because of selection of good material and the highly tough design suitable to the load capacity of the bearing. However, if a great or impact loads occurs at a low rotational speed, strength of the bearing must be examined in advance, for the purpose safety is especially required.

Although the form of the housing is designed so that it is applicable to various purposes, destruction strength varies depending on the direction of load. Therefore, mounting direction of the bearing unit must be fully examined, as well as the strength of the housing.

At this time, setting of fixing device to support the hous- ing is required depending on the direction or level of load.

Rigidity of the base and flatness of the mounting surface give influence on the strength of the housing. Note that the load applied to the insert bearing unit is recommended to be basically examined by the calculation result of bearing life even if the strength of the housing is satisfied.

9.1 Strength of cast iron housing

Though gray cast iron has many superior features as machine parts material, it is fragile against impact load. Therefore, prior to use of it, level, direction, and property of load applied to it must be fully examined.

Allowable load of gray cast iron housing can be found by using static destruction strength of the housing, taking safety factor into consideration.

Table 9.1 shows the safety factor of gray cast iron prod- ucts against load, and Fig. 9.1 to Fig. 9.7 show the outline values of static destruction strength of pillow block type, flange type and take-up type housings.

Table 9.1 Safety factor of gray cast iron products (recommended)

Property of load	Safety factor of gray cast iron
Static load	4
With vibration	10
With impact	15

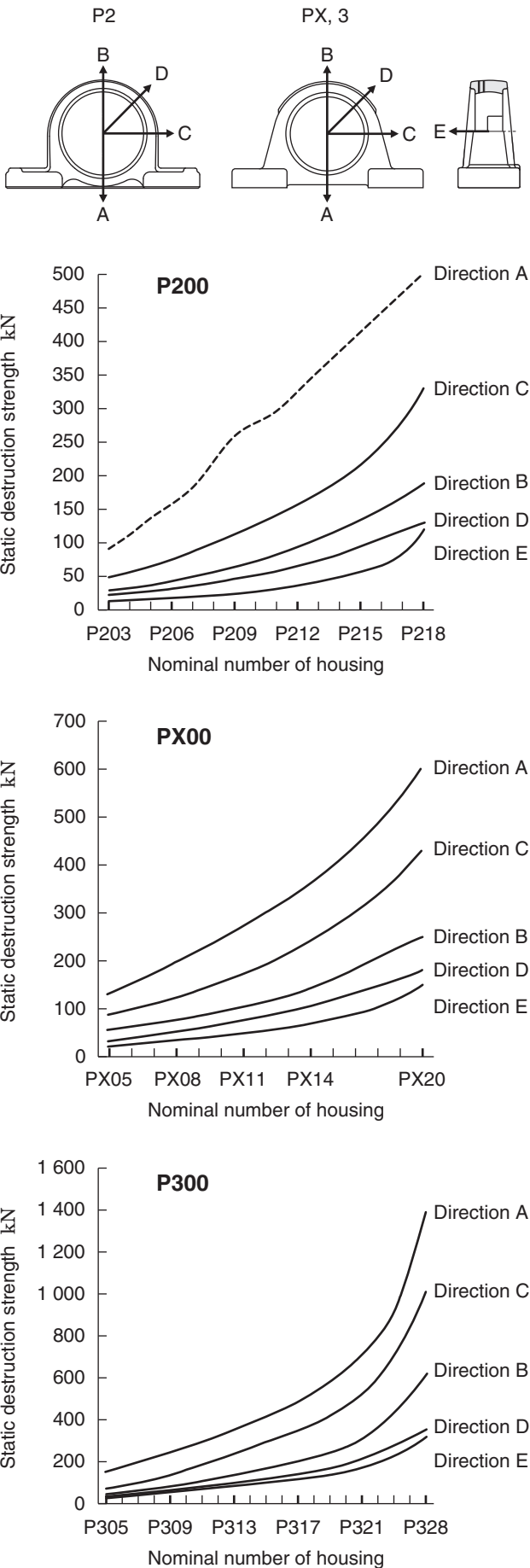


Fig. 9.1 Static destruction strength of pillow block type housing (P)

9 Strength of housing

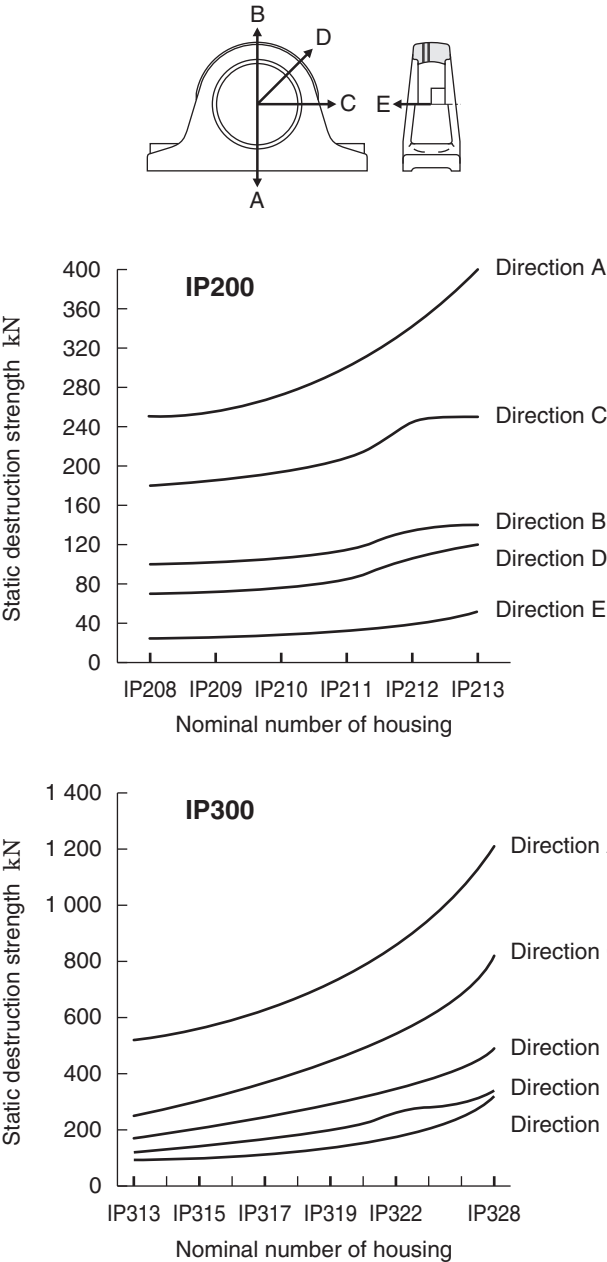


Fig. 9.2 Static destruction strength of thick section pillow block type housing (IP)

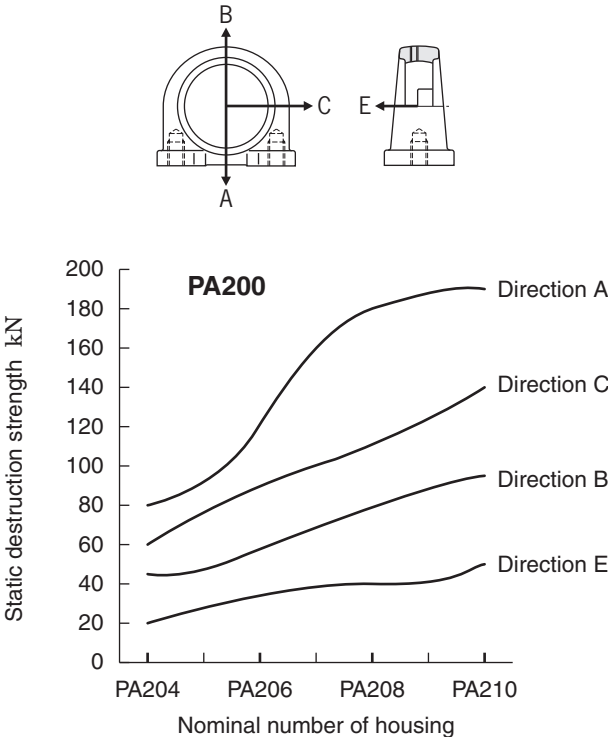


Fig. 9.3 Static destruction strength of tapped-base pillow block type housing (PA)

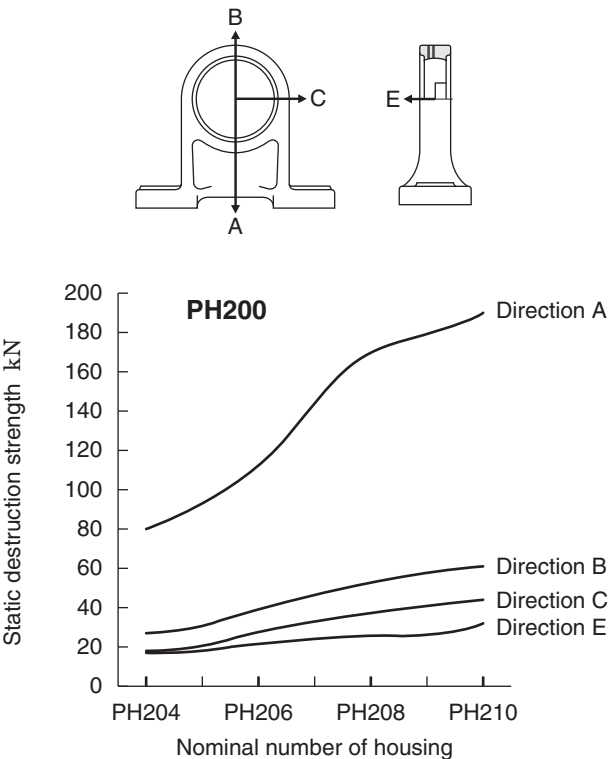


Fig. 9.4 Static destruction strength of higher centerheight pillow block type housing (PH)

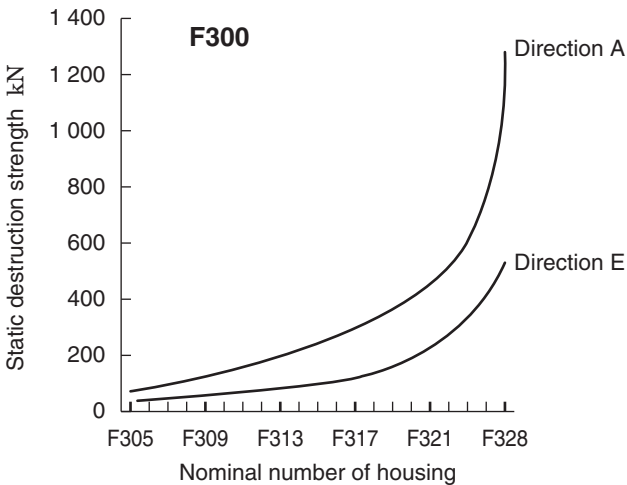
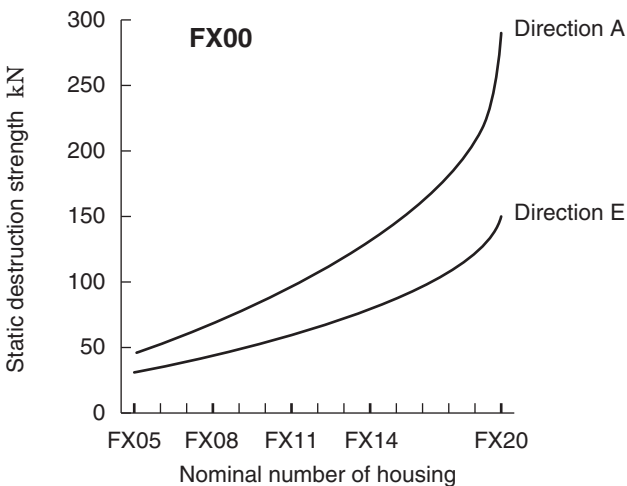
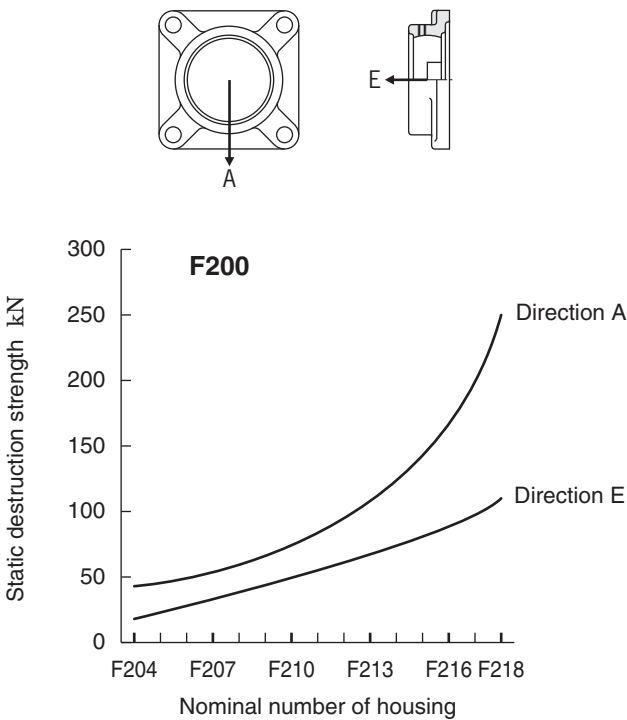


Fig. 9.5 Static destruction strength of square-flanged type housing (F)

9 Strength of housing

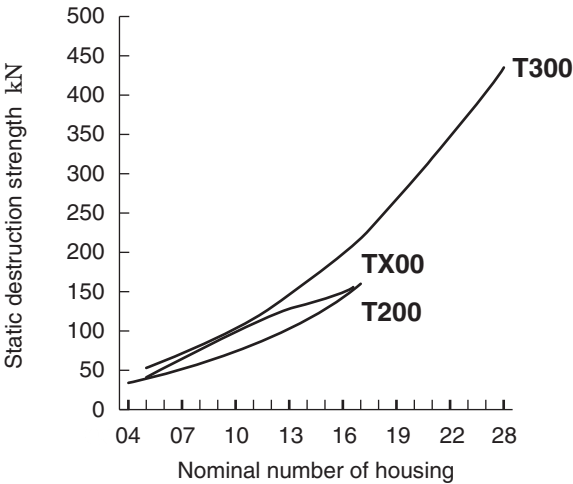
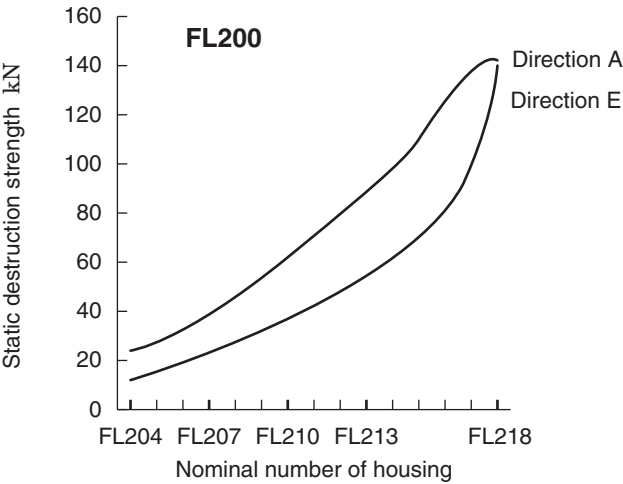
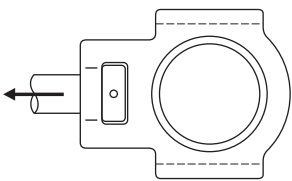
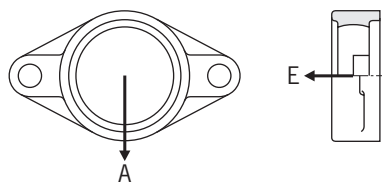


Fig. 9.7 Static destruction strength of take-up type housing (T)

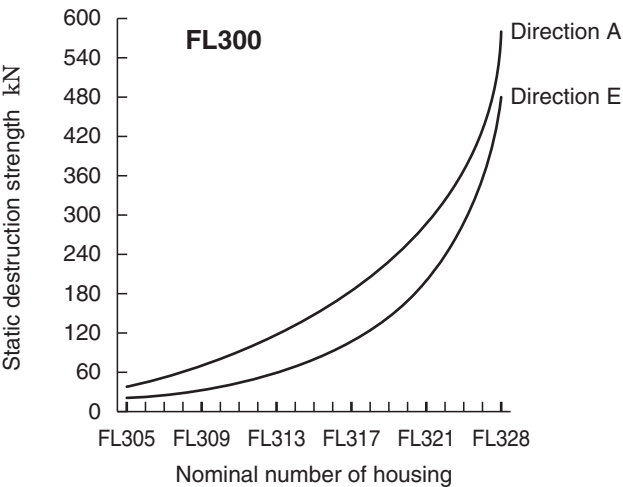
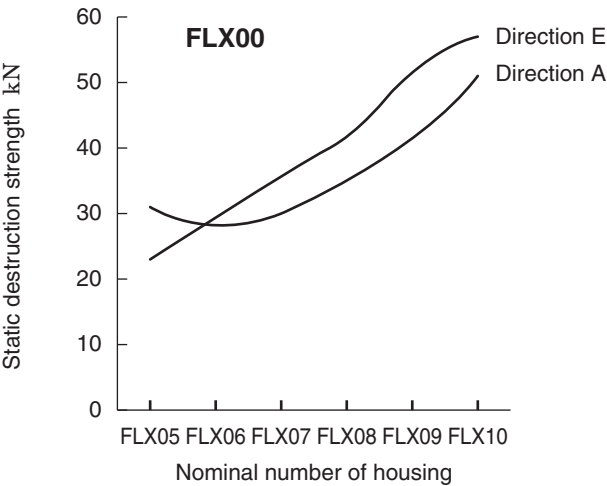


Fig. 9.6 Static destruction strength of rhombic-flanged type housing (FL)

### 9.2 Strength of steel housing

The precisely pressed steel housing is highly rigid, but great deformation occurs when load is applied until it is broken. Thus, allowable load of the pressed steel housing must be the value deformation of the housing caused by load does not influence on actual use.

Table 9.2 shows the allowable load of the pressed steel housing.

Table 9.2 Allowable load of pressed steel housing (recommended)

Load direction	Allowable load of pressed steel housing
Radial	Approx. 1/6 of basic dynamic radial load rating of bearing ( $C_r$ )
Axial	Approx. 1/18 of basic dynamic radial load rating of bearing ( $C_r$ )

### 9.3 Strength of stainless steel housing

To find the allowable load of a stainless steel housing, use the static destruction strength of a housing, taking safety factor into consideration.

Table 9.3 shows the safety factors for stainless steel products. As for the basic values of the static destruction strength of SP200, SPA200, SF200, SFL200, ST200 type housings, apply P200 of Fig. 9.1, PA200 of Fig. 9.3, F200 of Fig. 9.5, FL200 of Fig. 9.6 and T200 of Fig. 9.7. For the basic values of the static destruction strength of the SP000 and SFL000 type housings, see P000 of Fig. 9.8 and FL000 of Fig. 9.9 and multiply them by 1.5 respectively.

Table 9.3 Safety factor of stainless steel products

Property of load	Safety factor of stainless steel products
Static load	3
With vibration	5
With impact	10

### 9.4 Strength of “compact” series housing

The “compact” series housing is made of zinc alloy die-cast, but great deformation occurs when load is applied until it is broken.

Table 9.4 shows safety factor for zinc alloy die-cast, and Fig. 9.8 and 9.9 show the outline values of the static destruction strength of the zinc alloy die-cast housing.

Table 9.4 Safety factor of zinc alloy die-cast products

Property of load	Safety factor of die-cast products
Static load	8
With vibration	15
With impact	20

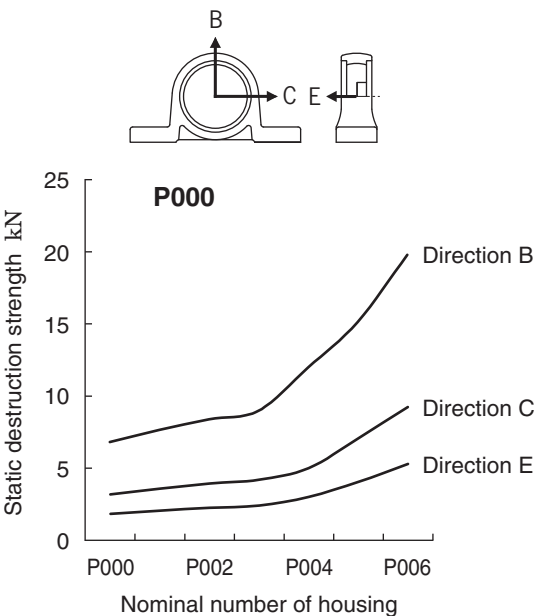


Fig. 9.8 Static destruction strength of “compact” housing (P)

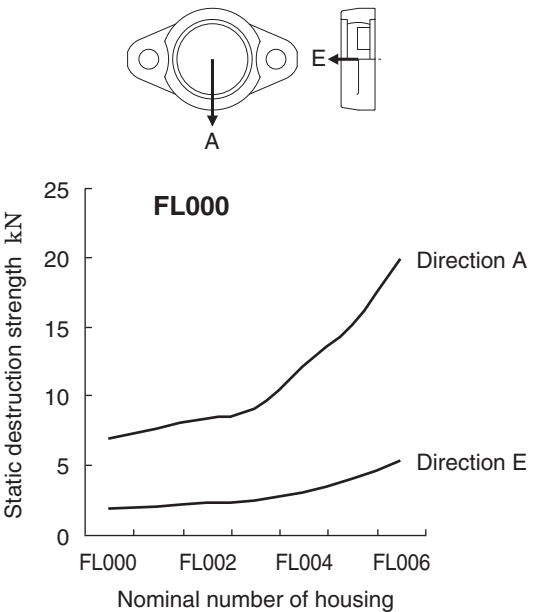


Fig. 9.9 Static destruction strength of “compact” housing (FL)

10 Design of shaft and base

10 Design of shaft and base

10.1 Design of shaft

For intrinsic performance of a insert bearing unit and maintenance of it for a long time, selection of the shaft optimal for operating conditions is important. Use the shaft with enough rigidity but free from bend, scratch, or burr.

10.1.1 Tolerance of shaft

(1) Tolerance of shaft used for cylindrical bore bearing with set screws

For the cylindrical bore bearing with set screws, use the shaft of the tolerance class leading to relatively loose fitting to simplify the mounting procedures. The fitting clearance between the bearing inner ring and the shaft should be decreased as the rotational speed of the shaft

is increased.  
Table 10.1 shows the guideline for the tolerance class of the rotational speed of the cylindrical bore bearing with set screws and the shaft used.  
If the cylindrical bore bearing with set screws is exposed to heavy load ( $P_r/C_r > 0.12$ ), vibration, or impact, use shaft of the tolerance class leading to relatively tight fitting to prevent creep or fretting to be occurred to the fitting surface of the bearing inner ring and the shaft.  
To use tight fitting of the cylindrical bore bearing with set screws, see Table 10.2 showing the guideline for the tolerance class of the shaft used.  
Table 10.3 shows the recommended deviation from circular and cylindrical forms of the shaft used.

Table 10.1 Tolerance of shaft used for cylindrical bore bearing with set screws (recommended)  
(clearance fitting or transition fitting)

Unit :  $\mu\text{m}$

Shaft diameter (mm)		Tolerance of shaft							
		j6		h6		h7		h8	
over	up to	upper	lower	upper	lower	upper	lower	upper	lower
6	10	+ 7	- 2	0	- 9	0	-15	0	-22
10	18	+ 8	- 3	0	-11	0	-18	0	-27
18	30	+ 9	- 4	0	-13	0	-21	0	-33
30	50	+11	- 5	0	-16	0	-25	0	-39
50	80	+12	- 7	0	-19	0	-30	0	-46
80	120	+13	- 9	0	-22	0	-35	0	-54
120	180	+14	-11	0	-25	0	-40	0	-63
Applicable rotational speed $dn^{1)}$		Over 120 000		Over 100 000, up to 120 000		Over 60 000, up to 100 000		up to 60 000	

Note 1)  $dn = d$  (bearing bore, mm)  $\times n$  (rotational speed,  $\text{min}^{-1}$ )

Table 10.2 Tolerance of shaft used for cylindrical bore bearing with set screws (recommended) (transition fitting or interference fitting)

Unit :  $\mu\text{m}$

Shaft diameter (mm)		Tolerance of shaft					
		k6		k7		m6	
over	up to	upper	lower	upper	lower	upper	lower
6	10	+10	+1	+16	+1	+15	+ 6
10	18	+12	+1	+19	+1	+18	+ 7
18	30	+15	+2	+23	+2	+21	+ 8
30	50	+18	+2	+27	+2	+25	+ 9
50	80	+21	+2	+32	+2	+30	+11
80	120	+25	+3	+38	+3	+35	+13
120	180	+28	+3	+43	+3	+40	+15

Table 10.3 Tolerance of shaft used for insert bearing units (recommended)

Unit :  $\mu\text{m}$

Shaft diameter (mm)		Deviation from circular and cylindrical forms
over	up to	
6	10	6
10	18	8
18	30	9
30	50	11
50	80	13
80	120	15
120	180	18

(2) Tolerance of shaft used for bearing for blower (cylindrical bore with set screws)

In the bearing for blower (special code S5), smaller internal clearance of bearing (C2) and once-class-higher bearing tolerance reduce vibration and noise during high-speed rotation.

Therefore, use of the shaft in the tolerance class shown in **Table 10.4** as the bearing for blower (cylindrical bore with set screws) used is recommended.

Table 10.4 Tolerance of shaft used for bearing for blower (cylindrical bore with set screws) (recommended)

Unit :  $\mu\text{m}$

Shaft diameter (mm)		Tolerance of shaft			
		h5		j5	
over	up to	upper	lower	upper	lower
10	18	0	- 8	+5	- 3
18	30	0	- 9	+5	- 4
30	50	0	-11	+6	- 5
50	80	0	-13	+6	- 7
80	120	0	-15	+6	- 9
120	180	0	-18	+7	-11

(3) Tolerance of shaft used for tapered bore bearing (with adapter)

Since the tapered bore bearing is fixed to a shaft with the adapter, the shaft in the tolerance class allowing relatively loose fitting should be selected, for easier mounting.

**Table 10.5** shows the tolerance of shaft used for the tapered bore bearing (with adapter).

Table 10.5 Tolerance of shaft used for tapered bore bearing (with adapter) (recommended)

Unit :  $\mu\text{m}$

Shaft diameter (mm)		Tolerance of shaft			
		h8		h9	
over	up to	upper	lower	upper	lower
18	30	0	-33	0	- 52
30	50	0	-39	0	- 62
50	80	0	-46	0	- 74
80	120	0	-54	0	- 87
120	180	0	-63	0	-100

(4) Tolerance of shaft used for cylindrical bore bearing with eccentric locking collar

As for the cylindrical bore bearing with eccentric locking collar, if the fitting clearance between the bearing inner ring and the shaft is great, the shaft may be installed with being tilted because of its structure.

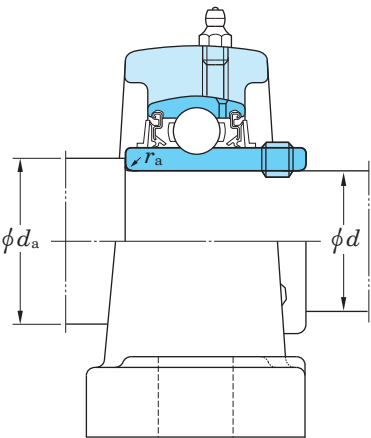
Therefore, for cylindrical bore bearing with eccentric locking collar, use of the shaft in the same tolerance class (h5 or j5) as that used with the bearing for blower (special code S5) is recommended (see **Table 10.4**).

10.1.2 Dimensions of shouldered shaft

When using the cylindrical bore bearing in the environment exposed to a great axial load, excessive vibration, or impact, adopt the shouldered shaft, and tighten the bearing inner ring with the nut.

**Table 10.6** shows the shoulder diameter and the fillet radius of the shouldered shaft.

Table 10.6 Shoulder diameter and fillet radius of shouldered shaft (recommended)



Unit : mm

Bore dia. No.	Nominal bearing bore dia. $d$	UC200, UCX00		UC300	
		Shoulder dia. $d_a$	Fillet radius $r_a$ (max.)	Shoulder dia. $d_a$	Fillet radius $r_a$ (max.)
01	12	17	0.6		
02	15	20	0.6		
03	17	22	0.6		
04	20	30	1	-	-
05	25	35	1	35	1
06	30	40	1	40	1
07	35	45	1	45	1.5
08	40	50	1	50	1.5
09	45	55	1	55	1.5
10	50	60	1	60	2
11	55	65	1.5	65	2
12	60	70	1.5	75	2
13	65	75	1.5	80	2
14	70	80	1.5	85	2
15	75	85	1.5	90	2
16	80	90	2	95	2
17	85	95	2	100	2.5
18	90	100	2	105	2.5
19	95	-	-	110	2.5
20	100	115	2	115	2.5
21	105	-	-	120	2.5
22	110			125	2.5
24	120			135	2.5
26	130			150	3
28	140			160	3

## 10 Design of shaft and base

### 10.1.3 Countermeasures against heat

In general, two or more insert bearing units are used for a shaft. If installation distance for the insert bearings is small or expansion and contraction of the shaft due to temperature are a little, install each of the bearing unit to the fixed side.

However, if installation distance is great and the shaft is exposed to heat, the shaft to be installed should be positioned with a bearing unit to be on the fixed side, and another bearing unit should be installed with it to be on the free side.

Because, if the shaft is exposed to heat, it is expanded in the axial direction, leading to a great axial load to the bearing, and it causes premature breakage of the bearing. Therefore, expansion of the shaft is absorbed by the bearing unit on the free side.

**Equation (10.1)** shows the relation of temperature increase to expansion of the shaft.

$$\Delta_\ell = \alpha \cdot \Delta_t \cdot l \dots\dots\dots (10.1)$$

Whereas,

 $\Delta_\ell$  : Expansion of shaft mm $\alpha$  : Linear expansion coefficient of shaft

in the case of standard steel  $11 \sim 12 \times 10^{-6}$

 $\Delta_t$  : Temperature increase  $^{\circ}\text{C}$ 

$l$  : Installation distance of unit mm

Countermeasures against great expansion of shaft as a result of exposure to heat are shown below.

**(1) Installation with full dog point set screw on the free side**

If the shaft is exposed to heat and expanded in axial direction, the bearing unit must be installed so that it or the shaft can freely move in axial direction.

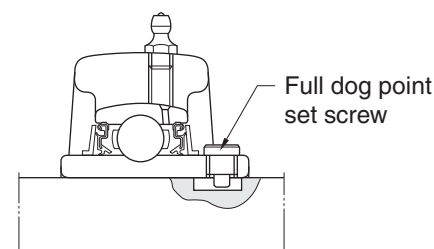
If the rotational speed is relatively slow, provide the shaft with key groove, attach the full dog point set screw (special code G6) to the bearing, and use it as the free side unit. Fit the tip on the dog point of the set screw to the key groove on the shaft to guide the move of the shaft in axial direction.

**Fig. 10.1** shows the structure example of bearing unit with key groove on shaft and full dog point set screw and use as free side unit. **Table 10.7** shows the dimensions of key groove for the full dog point set screw.

If a bearing unit is used as the free side bearing unit by adopting this method, h7 is recommended as the tolerance class of the shaft to be used.

If temperature of the shaft is higher than that in the bearing, the shaft in the tolerance class allowing a greater fitting clearance must be used.

If a bearing unit is used as the free side unit by adopting the above method, fretting corrosion may occur to the fitting surface between the bearing inner ring and the shaft. In order to prevent fretting corrosion, application of grease onto the bore surface of the bearing when the bearing unit is installed.

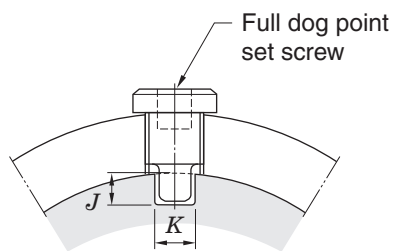


**Fig. 10.1** Use on free side with full dog point set screw

**Table 10.7 Dimensions of key groove for full dog point set screw (use on free side)**

Nominal size of set screw	Dimensions of key groove (mm)		Applicable nominal bearing number		
	<i>J</i>	<i>K</i> (Min.)	UC200	UCX00	UC300
M6 × 0.75	5	4	201–206	X05	305, 306
M8 × 1	6	6	207–209	X06–X08	307
M10 × 1.25	6.5	7	210–212	X09–X11	308, 309
M12 × 1.5	7	9	213–218	X12–X17	310–314
M14 × 1.5	7	10		X18	315, 316
M16 × 1.5	8	12		X20	317–319
M18 × 1.5	8	13			320–324
M20 × 1.5	8	15			325, 326

Allowable tolerance of key groove dimension "K" (Recommended value : 0~+0.2)



(2) Use of cartridge type unit on free side

In the environment the rotational speed is relatively high or the bearing unit is exposed to vibration, use of the cartridge type unit as the free side unit and move of the bearing unit between the mounting bore on a machine and the outside surface of the housing in axial direction are recommended.

Fig. 10.2 shows the example of structure of the cartridge type unit as the free side unit.

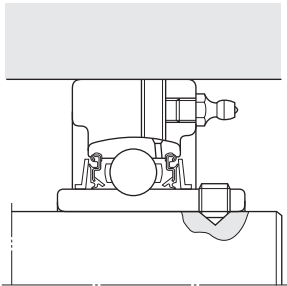


Fig. 10.2 Use of cartridge type unit on free side

If a insert bearing unit is exposed to heat, countermeasures against expansion of the shaft in axial direction as well as calculation of decrease in the internal clearance of the bearing to select the internal clearance of the bearing appropriately (see “8 Operating temperature and bearing specifications”).

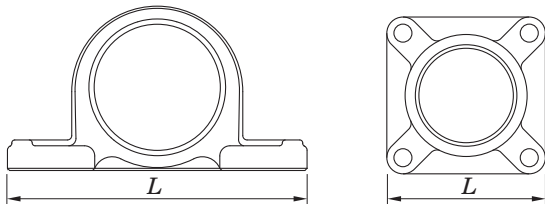
10.2 Design of base

10.2.1 Rigidity of base and flatness of mounting surface

If rigidity of the base that a insert bearing unit is to be installed is low or the flatness of the mounting surface is poor, vibration or abnormal noise may occur to the bearing unit during operation, leading to premature breakage or lower strength of the housing.

Therefore, the base that the insert bearing unit is to be installed must have enough rigidity, and the mounting surface must be finished with accuracy allowing elimination of deformation on the bearing or housing.

Fig. 10.3 shows the recommended values for flatness of the mounting surface of the base that the insert bearing unit is to be installed.



Max. :  $L / 1\,000\text{ mm}$

Fig. 10.3 Flatness of mounting surface of base (recommended)

10.2.2 Mounting bore of cartridge type unit

The cartridge type unit is directly fit to the cylindrical bore of the base.

Under the standard operating conditions, select H7 as the tolerance class of cylindrical hole on the base that the cartridge type unit is to be installed. For such purposes that the shaft and the bearing inner ring are hot, select G7 as the tolerance class of cylindrical bore on the base.

In the environment the bearing unit is exposed to vibration or impact, selection of the tolerance class allowing smaller fitting clearance between the cylindrical bore of the base and the bearing unit is recommended.

Table 10.8 shows the tolerance of cylindrical bore of the base that the cartridge type unit is to be installed.

Table 10.8 Tolerance of cylindrical bore for mounting cartridge type unit (recommended)

Unit :  $\mu\text{m}$

Nominal bore dia. of cylindrical bore (mm)		Tolerance of cylindrical bore			
		H7		G7	
over	up to	upper	lower	upper	lower
50	80	+30	0	+40	+10
80	120	+35	0	+47	+12
120	180	+40	0	+54	+14
180	250	+46	0	+61	+15
250	315	+52	0	+69	+17
315	400	+57	0	+75	+18

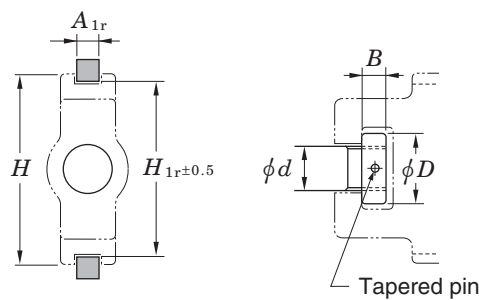
10.2.3 Dimensions relative to installation of take-up type unit

The take-up type unit is incorporated between the two guide rails on the base side, and enables adjustment of the support position with the shaft center by the adjuster bolt.

Table 10.9 shows the dimensions of the guide rail, adjuster bolt, and round nut to install the take-up type unit to the base.

10 Design of shaft and base

Table 10.9 Dimensions relative to installation of take-up type unit (recommended)



Unit : mm

Nominal housing No.	Dimensions of guide rail			Dimensions of adjuster bolt and round nut		
	A <sub>1r</sub>	H <sub>1r</sub>	H (Reference)	d	D	B
T204 T205	11	77	89	16	28	14
T206 T207	11	90	102	18	32	14
T208	15	103	114	24	42	16
T209 T210	15	103	117	24	42	16
T211 T212	20	131	146	30	55	20 27
T213 T214 T215	24	152	167	36	60	27
T216	24	166	184	36	60	27
T217	28	174	198	42	60	30
TX05 TX06	11	90	102	18	32	14
TX07	15	103	114	24	42	16
TX08 TX09	15	103	117	24	42	16
TX10 TX11	20	131	146	30	55	20 27
TX12 TX13 TX14	24	152	167	36	60	27
TX15	26	166	184	36	60	27
TX16 TX17	26	174	198	42	60	30

Unit : mm

Nominal housing No.	Dimensions of guide rail			Dimensions of adjuster bolt and round nut		
	A <sub>1r</sub>	H <sub>1r</sub>	H (Reference)	d	D	B
T305	11	81	89	22	32	12
T306 T307	15	91 101	100 111	24 26	36 40	14
T308 T309	16	113 126	124 138	28 30	45 50	16 18
T310	18	141	151	32	55	20
T311 T312	20	151 161	163 178	34 36	60 65	22 24
T313 T314 T315	24	171 181 193	190 202 216	38 40 40	65 80 80	26 28 28
T316	28	205	230	46	90	34
T317 T318	30	216 230	240 255	46 50	90 95	34 38
T319	32	242	270	50	95	38
T320 T321	32	262	290	52	100	40
T322	36	287	320	55	110	44
T324	42	322	355	60	120	50
T326 T328	47	352 382	385 415	65 70	130 140	55 60

10.3 Machining dimensions of holes for housing dowel pins

The pillow block type, square-flanged type, and rhombic-flanged type housing have the dowel pin seat. If accurate positioning of the housing is required, install it with the dowel pin.

As for the position of the pin for fixing the housing and pin diameter, see the **Supplementary 5** at the end of this catalogue.

## 11 Tolerances and internal clearance

Tolerances of a insert bearing unit is specified in JIS B 1558 (Rolling bearings - Insert bearings and eccentric locking collars) and JIS B 1559 (Rolling bearings - Cast and pressed housings for insert bearings). JTEKT produces products conforming to these standards.

### 11.1 Tolerances of bearing

Table 11.1 to Table 11.4 show the tolerance of a insert bearing for insert bearing unit.

Insert bearings for blower unit (special code S5) are produced with higher accuracy than standard types (see Table 11.3).

Table 11.5 shows the permissible values for chamfer dimensions of cylindrical bore bearing inner ring.

Table 11.2 Tolerances and permissible values of outer ring of insert bearing for insert bearing unit

Unit :  $\mu\text{m}$

Nominal bearing outer dia. $D$ (mm)		Mean outside diameter deviation $\Delta D_m$		Radial runout of assembled bearing outer ring $K_{ea}$
over	up to	upper	lower	max.
18	30	0	- 9	15
30	50	0	-11	20
50	80	0	-13	25
80	120	0	-15	35
120	150	0	-18	40
150	180	0	-25	45
180	250	0	-30	50
250	315	0	-35	60

[Remark] Values in Italics are prescribed in JTEKT standards.

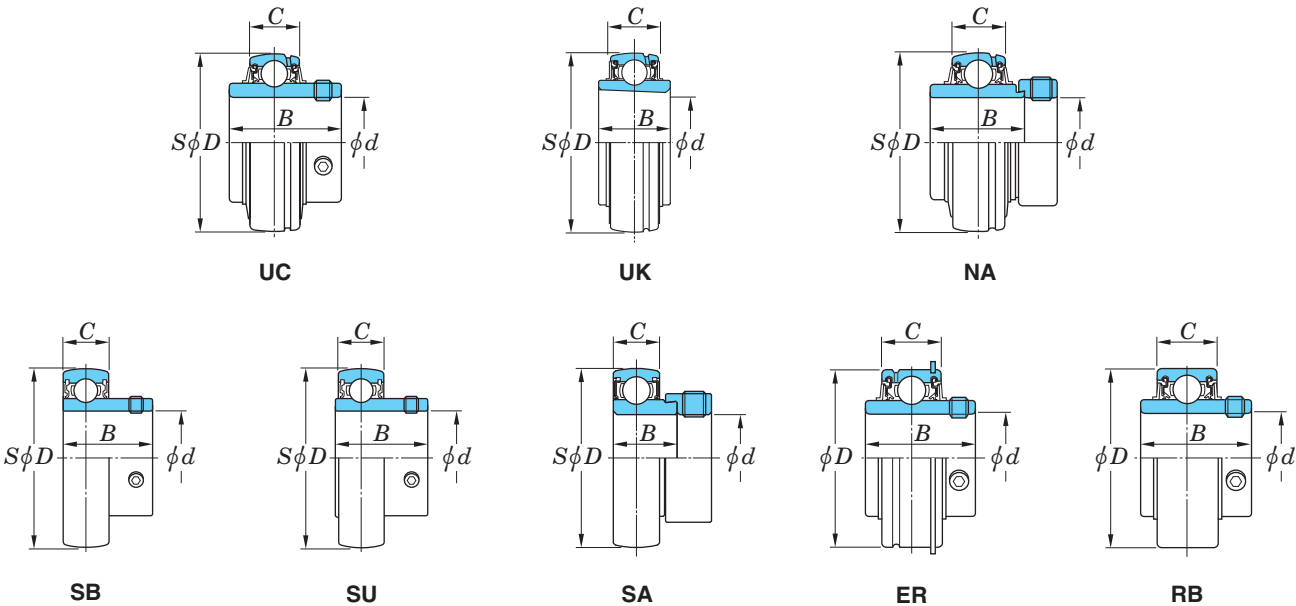


Table 11.1 Tolerances and permissible values of inner rings of insert bearings for insert bearing units

Unit :  $\mu\text{m}$

Nominal bearing bore dia. $d$ (mm)		Single plane mean bore diameter deviation $\Delta d_{mp}$		Single plane bore diameter variation $V_{dsp}$	Eccentricity deviation of eccentric surface of inner ring and eccentric locking collar $\Delta H_s$		Single inner (outer) ring width deviation $\Delta B_s$ ( $\Delta C_s$ )		Radial runout of assembled bearing inner ring $K_{ia}$
over	up to	upper	lower	max.	upper	lower	upper	lower	max.
-	10	+15	0	10	+100	-100	0	-120	10
10	18	+15	0	10	+100	-100	0	-120	15
18	31.75	+18	0	12	+100	-100	0	-120	18
31.75	50.8	+21	0	14	+100	-100	0	-120	20
50.8	80	+24	0	16	+100	-100	0	-150	25
80	120	+28	0	19	+100	-100	0	-200	30
120	180	+33	0	22	+100	-100	0	-250	35

[Remark] Values in Italics are prescribed in JTEKT standards.

11 Tolerances and internal clearance

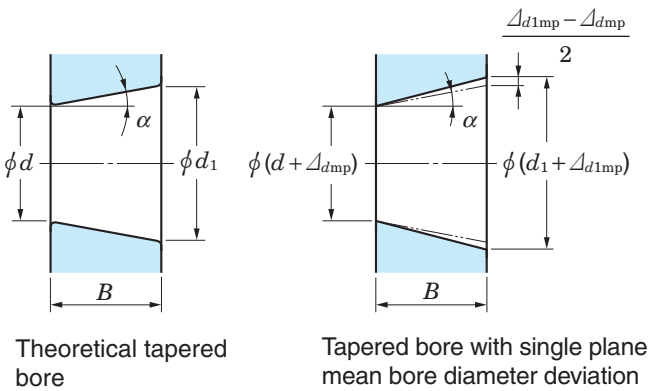
Table 11.3 Tolerances and permissible values of inner ring of insert bearing for blower unit (S5)

Unit :  $\mu\text{m}$

Nominal bearing bore dia. $d$ (mm)		Single plane mean bore diameter deviation $\Delta_{dmp}$		Single plane bore diameter variation $V_{dsp}$	Radial runout of assembled bearing inner ring $K_{ia}$
over	up to	upper	lower	max.	max.
10 <sup>1)</sup>	18	+13	0	6	7
18	31.75	+13	0	6	8
31.75	50.8	+13	0	10	10
50.8	80	+15	0	10	10
80	120	+18	0	14	13
120	180	+23	0	14	18

Note 1) 10 mm should be included in this category.

Table 11.4 Tolerances and permissible values for tapered bore of bearing



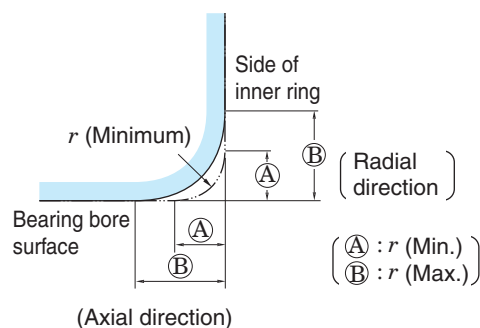
Unit :  $\mu\text{m}$

Nominal bearing bore dia. $d$ , mm		$\Delta_{dmp}$		$\Delta_{d1mp} - \Delta_{dmp}$		$V_{dsp}$ <sup>1)</sup>
over	up to	upper	lower	upper	lower	max.
18	30	+33	0	+21	0	13
30	50	+39	0	+25	0	16
50	80	+46	0	+30	0	19
80	120	+54	0	+35	0	22
120	180	+63	0	+40	0	40

Note 1) To be applied to all the radial planes of tapered bore

- [Remarks] 1. Applicable range
- Applicable to tapered bore of inner ring of tapered bore radial bearing that standard value of taper ratio is 1/12
2. Amount code
- $d_1$  : Standard diameter at theoretical large end of tapered bore  $d_1 = d + \frac{1}{12} B$
- $\Delta_{dmp}$  : Single plane mean bore diameter deviation at theoretical small end of tapered bore
- $\Delta_{d1mp}$  : Single plane mean bore diameter deviation at theoretical large end of tapered bore
- $V_{dsp}$  : Single plane bore diameter variation (a tolerance for the diameter variation given by a maximum value applying in any radial plane of the bore)
- $B$  : Nominal inner ring width
- $\alpha$  : 1/2 of nominal tapered angle of tapered bore
- $\alpha = 2^\circ 23' 9.4''$   
 $= 2.385\ 94^\circ$   
 $= 0.041\ 643\ \text{rad}$

Table 11.5 Permissible values for chamfer dimensions of inner ring of bearing with cylindrical bore



Unit : mm

r (Min.)	r (Max.)	
	Radial direction	Axial direction
0.6	1	2
1	1.5	3
1.1	2	3.5
1.5	2.3	4
2	3	4.5
2.1	4	6.5
2.5	3.8	6
3	5	8
4	6.5	9

[Remark] There shall be no specification for the accuracy of the shape of the chamfer surface, but its outline in the axial plane shall not be situated outside of the imaginary circle arc with a radius of  $r_{\min}$  or  $r'_{1\min}$  which contacts the inner ring side face and bore, or the outer ring side face and outside surface.

11.2 Tolerances of housing

As the tolerance of the housing for a insert bearing unit, tolerance of the diameter of spherical bearing seat fit to the bearing, and tolerance and permissible value of dimensions relative to installation of the housing are specified.

Table 11.6 shows the tolerance of diameter of the spherical bearing seat of housing. Usually, select tolerance class J7 that allows transition fitting of the housing and the bearing.

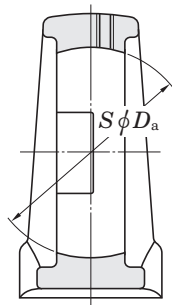
If priority should be given to operability in installation to a machine, select tolerance class H7 allowing clearance fitting. The unit conforming JIS of tolerance class H7 is equipped with the detent to the outer ring to prevent turning of the outer ring.

If rotating outer ring load occurs or the bearing is rotated while the shaft is stopped, select the tolerance K7 allowing interference fit.

Fig. 11.1 shows the representative example of dimensions relative to installation of the housing with tolerance and permissible value. Respective dimensional tables show the tolerance and permissible values of dimensions relative to installation of the housing.

Table 11.6 Tolerances of spherical bearing seat diameter of housing

Unit :  $\mu\text{m}$

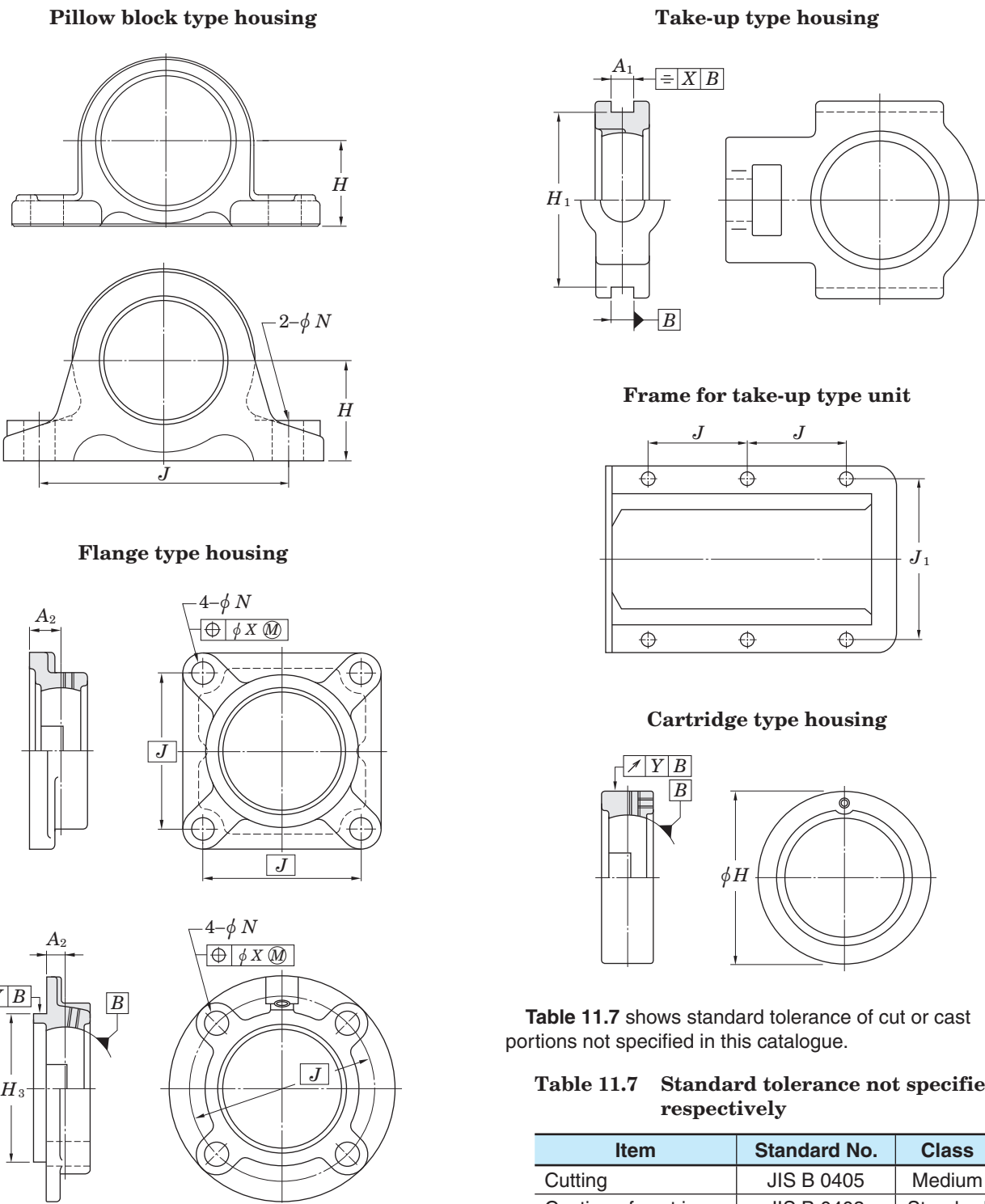


Nominal dia. of spherical bearing seat $D_a$ (mm)		Tolerance class H7		Tolerance class J7		Tolerance class K7	
		Deviation of spherical bearing seat dia. $\Delta_{Dam}$		Deviation of spherical bearing seat dia. $\Delta_{Dam}$		Deviation of spherical bearing seat dia. $\Delta_{Dam}$	
over	up to	upper	lower	upper	lower	upper	lower
18	30	+21	0	+12	- 9	+ 6	-15
30	50	+25	0	+14	-11	+ 7	-18
50	80	+30	0	+18	-12	+ 9	-21
80	120	+35	0	+22	-13	+10	-25
120	180	+40	0	+26	-14	+12	-28
180	250	+46	0	+30	-16	+13	-33
250	315	+52	0	+36	-16	+16	-36

[Remark] JTEKT generally applies class J to housing designs.  
Class H and class K can also be applied depeding on the application.

11 Tolerances and internal clearance

Fig. 11.1 Dimensions relative to installation of housing with tolerance and permissible value (representative example)



[Remark] Respective tolerances and permissible values for housing are shown in dimensional tables.

Table 11.7 shows standard tolerance of cut or cast portions not specified in this catalogue.

Table 11.7 Standard tolerance not specified respectively

Item	Standard No.	Class
Cutting	JIS B 0405	Medium
Casting of cast iron	JIS B 0403	Standard
Casting of cast steel	JIS B 0403	Standard

11.3 Bearing internal clearance

Insert bearing internal clearance for insert bearing unit is specified by the move at the time the inner ring or outer ring is moved in the radial direction (radial internal clearance). Value of internal clearance during operation (to be called operation clearance) gives a great influence on rolling fatigue life of the bearing, heat, noise, and vibration.

If the bearing inner ring is installed to the shaft with interference, the internal clearance of bearing must be fixed taking expansion of the bearing inner ring into consideration. If transmission heat to the shaft is high or hot steam runs through the hollow of the shaft, calculate the decrease of internal clearance, and appropriately select the internal clearance of bearing (see “8 Operating temperature and bearing specifications”).

Table 11.8 shows the internal clearance applicable to specifications of insert bearing for Koyo Insert Bearing Unit, and Table 11.9 shows the standard values of bearing internal clearance.

Table 11.8 Internal clearance applicable to types of insert bearing for insert bearing unit

Type	Applicable internal clearance	
	Bearing with cylindrical bore	Bearing with tapered bore
Standard type	CN	C3
Stainless steel type	C3	–
Heat resistant type (special code : D1K2)	C4	C5
Cold resistant type (special code : D2K2)	CN	C3
High speed type (special code : K3)	CN	C3
For blower (special code : S5)	C2	C3

[Remark] For the bearings that the internal clearance in this table is applied, no clearance code is indicated.

Table 11.9 Standard values for internal clearance of insert bearing for insert bearing unit

Unit : μm

Nominal bearing bore dia. d (mm)		Internal clearance											
		C2		CN		GN		C3		C4		C5	
over	up to	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper
6	10	0	7	2	13	–	–	8	23	14	29	20	37
10	18	0	9	3	18	10	25	11	25	18	33	25	45
18	24	0	10	5	20	12	28	13	28	20	36	28	48
24	30	1	11	5	20	12	28	13	28	23	41	30	53
30	40	1	11	6	20	13	33	15	33	28	46	40	64
40	50	1	11	6	23	14	36	18	36	30	51	45	73
50	65	1	15	8	28	18	43	23	43	38	61	55	90
65	80	1	15	10	30	20	51	25	51	46	71	65	105
80	100	1	18	12	36	24	58	30	58	53	84	75	120
100	120	2	20	15	41	28	66	36	66	61	97	90	140
120	140	2	23	18	48	33	81	41	81	71	114	105	160

[Remarks] 1. Radial internal clearance in this table conforms to JIS B 1558 (Rolling bearings - Insert bearings and eccentric locking collars).

2. Increase in radial internal clearance generated by measured load conforms to the table below. Smaller correction of C2 clearance is applicable to the lower clearance, while larger correction is applicable to the upper clearance.

Unit : μm

Nominal bearing bore dia. d (mm)		Measured load	Correction of clearance				
over	up to		C2	CN	GN, C3	C4	C5
2.5	18	24.5	3 – 4	4		4	
18	50	49	4 – 5	5		6	
50	280	147	6 – 8	8		9	

12 Materials

12 Materials

12.1 Materials of bearing

Insert bearings for insert bearing unit are made of the following materials : bearing rings (outer and inner rings) and rolling elements (balls) are made of steel, and cages are made of pressed steel.

These bearing materials need the features shown below.

- (1) Higher elastic limit is required, since high contact stress occurs partially.
- (2) Higher rolling fatigue strength is required, since great contact load occurs repeatedly.
- (3) Superior hardness
- (4) Superior wear resistance
- (5) Superior toughness against impact load
- (6) Superior stability of dimensions

As the material of bearing rings (outer and inner rings) and rolling elements (balls) of the insert bearing for Koyo Insert Bearing Unit, high carbon chromium bearing steel specified in JIS is used.

For more reliability of bearing, vacuum degassing is executed against high carbon chromium bearing steel to reduce non-metallic inclusion and included oxygen. After the materials of bearing are made into the specified form, quench-and-temper is executed until its hardness is 60HRC.

Table 12.1 shows the chemical components of high carbon chromium bearing steel. As the material of bearing rings and rolling elements of the insert bearings for stainless-series unit (special code : S6), stainless steel with superior corrosion resistance is used. Cages are made of cold-reduced carbon steel sheets and strips specified in JIS.

Table 12.2 shows the chemical compositions of cold-reduced carbon steel sheets and strips specified in JIS.

12.2 Materials of housing

A housing for insert bearing unit is mainly made of gray iron casting products, carbon steel casting products, structural steel, cold-reduced carbon steel sheets and strips.

Gray iron casting is the most popular as the material of housing for insert bearing unit, featuring absorption of vibration, damping superior to other materials, easy and varied forming by casting, appropriate strength, and excellent heat property.

Table 12.3 shows the mechanical properties of gray iron casting.

If superior strength is required for the housing for insert bearing unit, select carbon steel casting products with higher rupture strength, carbon steel casting, or general structural rolled steel with higher strength against impact.

For the material of housings of the “compact” series unit, zinc alloy die-cast is used, and corrosion-resistant cast steel products are used for housings of the stainless series unit. Cold-reduced carbon steel sheets and strips are used as the material of housings for the pressed steel unit.

Table 12.4 to 12.8 show the mechanical properties of these housing materials.

Spheroidal graphite iron casting (FCD450-10 of JIS G 5502) may be used, as well as these materials.

Table 12.1 Chemical compositions of high carbon chromium bearing steel (JIS G 4805)

Code	Chemical components (%)						
	C	Si	Mn	P	S	Cr	Mo
SUJ 2	0.95– 1.10	0.15– 0.35	0.50 or less	0.025 or less	0.025 or less	1.30– 1.60	0.08 or less
SUJ 3	0.95– 1.10	0.40– 0.70	0.90– 1.15	0.025 or less	0.025 or less	0.90– 1.20	0.08 or less

Table 12.2 Chemical compositions of cold-reduced carbon steel sheets and strips (SPCC) (JIS G 3141)

Code	Chemical components (%)						
	C	Si	Mn	P	S	Ni	Cr
SPCC	0.15 or less	–	0.60 or less	0.100 or less	0.035 or less	–	–
SPCD	0.10 or less	–	0.50 or less	0.040 or less	0.035 or less	–	–

Table 12.3 Mechanical properties of gray iron casting (FC200) (JIS G 5501)

Type code	Tensile strength N/mm <sup>2</sup>	Hardness HB
FC200	200 or more	223 or less

Table 12.4 Mechanical properties of general structural rolled steel (SS400) (JIS G 3101)

Type code	Yielding point or bearing force N/mm <sup>2</sup>			Tensile strength MPa	Thickness of steel mm	Tensile test piece	Elonga- tion %	Bendability		
	Thickness of steel mm							Bending angle	Inside dia.	Test piece
	incl. 16	Over 16 incl. 40	Over 40							
SS400	245 or more	235 or more	215 or more	400— 510	Over 5, 16 max.	No.1A	17 or more	180°	1.5 times of thickness	No.1
					Over 16, 40 max.	No.1A	21 or more			
					Over 40	No.4	23 or more			

Table 12.5 Mechanical properties of zinc alloy die-cast (ZDC02) (JIS H 5301) (Reference)

Code	Tensile strength MPa	Elonga- tion %	Impact MJ/m <sup>2</sup>	Hard- ness HB
ZDC2	285	10	1.4	82

Table 12.6 Mechanical properties of corrosion-resistant cast steel (SCS14) (JIS G 5121)

Type code	Bearing force MPa	Tensile strength MPa	Elonga- tion %	Hard- ness HB
SCS14	185 or more	440 or more	28 or more	183 or less

Table 12.7 Mechanical properties of cold-reduced carbon steel sheets and strips (SPCC) (JIS G 3141)

Type code	Tensile strength MPa	Elongation %
SPCC	270 or more	34 or more
SPCD	270 or more	36 or more

Table 12.8 Mechanical properties of ductile cast iron (FCD450-10) (JIS G 5502)

Type code	Tensile strength N/mm <sup>2</sup>	Elongation %
FCD	450 or more	10 or more

12.3 Materials of parts and accessories

Table 12.9 shows materials of parts and accessories of a insert bearing unit.

Table 12.9 Materials of parts and accessories of insert bearing units

Designations	Materials	Code	Standard code
Oil seal (standard type)	Nitrile rubber	NBR	—
Oil seal (heat resistant, cold resistant)	Silicone rubber	VMQ	—
Flinger (slinger)	Cold-reduced carbon steel sheets and strips	SPCC	JIS G 3141
Stainless steel Flinger (slinger)	Cold rolled stain-less steel plate and steel strip	SUS304-CP, SUS304-CS	JIS G 4305
Pressed steel cover	Cold-reduced carbon steel sheets and strips	SPCD	JIS G 3141
Pressed stainless steel cover	Cold rolled stain-less steel plate and steel strip	SUS304-CP, SUS304-CS	JIS G 4305
Cast iron cover	Gray casting iron products	FC200	JIS G 5501
Hexagon socket set screw	Chrome molybde-num steel	SCM435	JIS G 4053
Stainless steel hexagon socket set screw	Stainless bar steel	SUS304	JIS G 4303
Adapter sleeve for bearing	Mechanical struc-tural carbon steel	S17C	JIS G 4051
Lock nut for bearing	Mechanical struc-tural carbon steel	S17C	JIS G 4051
Washer for bearing	Cold-reduced carbon steel sheets and strips	SPCC	JIS G 3141
Eccentric locking collar	Mechanical struc-tural carbon steel	S17C	JIS G 4051
Grease nipple	Free-cutting steel	SUM24L	JIS G 4804

13 Performance

13 Performance

13.1 Friction torque of bearing

Friction torque of a insert bearing for insert bearing unit is the synthesis of rolling friction between the rolling elements (balls) and the bearing rings (outer and inner rings), sliding friction between the rolling elements and the cages, agitating resistance of lubricants, and friction resistance of oil seal.

Greatness of friction torque is influenced by the type, dimensions, load, and rotational speed of bearing, and lubricating conditions.

For the insert bearing unit, oil seals with especially superior dustproof performance are adopted to improve sealing performance of the bearing. Thus, friction resistance of the oil seal greatly depends on the friction torque of the bearing.

Friction torque of the insert bearing for insert bearing unit can be found by the Equations below.

$$M = M_p + M_k \dots\dots\dots (13.1)$$
$$M_p = \mu \cdot P \cdot \frac{d}{2} \dots\dots\dots (13.2)$$

Whereas,

$M$ : Friction torque of bearing	mN · m
$M_p$ : Friction torque of sections changed by load	mN · m
$M_k$ : Friction torque of sections changed by rotational speed	mN · m
$\mu$ : Friction coefficient (0.001 5 to 0.002)	
$P$ : Load applied to bearing	N
$d$ : Nominal bearing bore dia.	mm

Note that the agitating resistance of lubricants and the friction resistance of oil seal are difficult to be calculated, since they are fluctuated by rotational speed.

Fig. 13.1 shows the result of measurement of friction torque of the typical insert bearing unit.

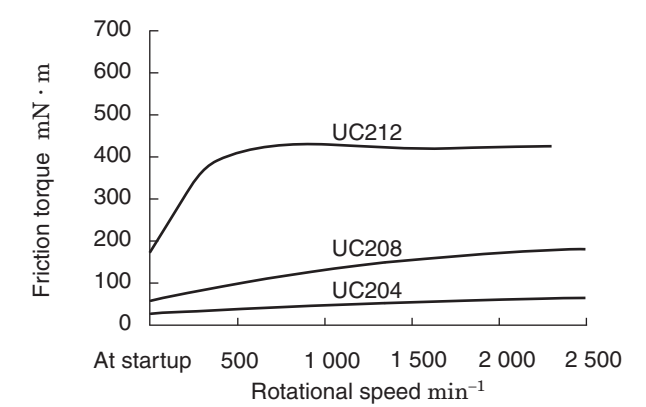


Fig. 13.1 Example of measurement result of insert bearing unit

13.2 Increase in temperature of bearing

Increase in temperature of the insert bearing for insert bearing unit is indicated as heat energy converted from the friction torque in the bearing during operation. Temperature of the bearing during operation increases in proportion to the greatness of friction torque and rotational speed (friction torque increases in proportion to the greatness of load).

Increase in temperature of the insert bearing for insert bearing unit depends on the heating value generated by friction in the bearing and that discharged outside from the surface of the bearing and housing. Therefore, increase in temperature of the insert bearing for insert bearing unit is influenced by the environmental conditions of the location that the insert bearing unit is installed (quality of heat radiation environment).

Temperature of the insert bearing unit is increased gradually after the startup of operation, and reaches the maximum level after one or two hours, if no abnormality occurs. Then, it is decreased a little, and enters the steady-state (see Fig. 13.2).

In this manner, if the operating conditions are not changed, bearing temperature is virtually constant, and therefore, measurement of temperature and assumption of the status of bearing are enabled.

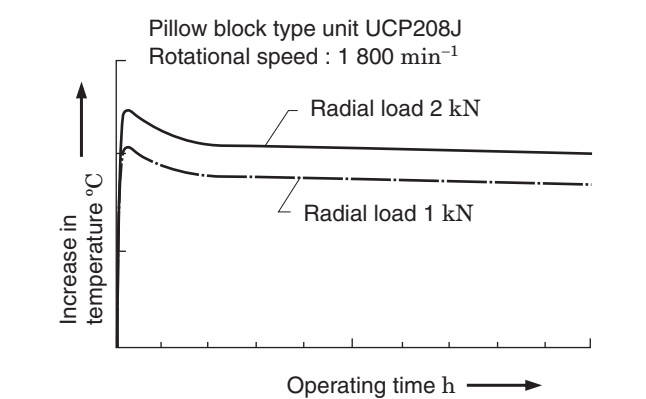


Fig. 13.2 Example of temperature measurement during operation of pillow block type unit

Increase in temperature during operation of the insert bearing unit depends on the type of oil seal used for the bearing as well as friction torque.

Increase in temperature of the triple-lip seal type (supplementary code L3) is greater than the standard type, and that of the non-contact seal type (special code K3, S5) is smaller than the standard type.

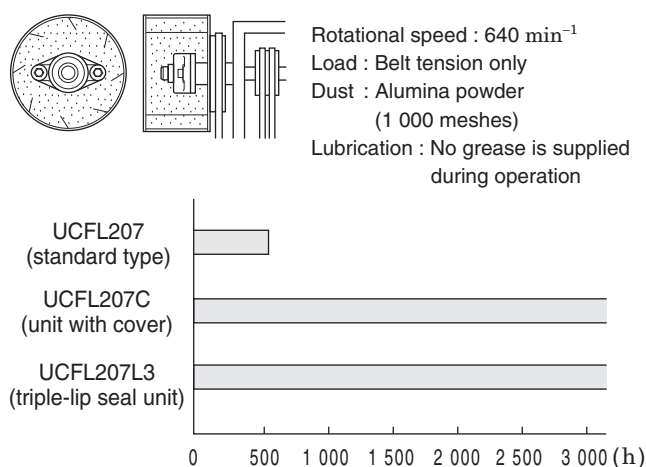
The bearing units for high speed and blower are equipped with the non-contact type oil seals for high speed use and reduction of heat, vibration, and noise.

### 13.3 Dustproof and waterproof performance

JTEKT executes various tests to check dustproof and waterproof performance of the insert bearing unit. Representative test results are shown below.

#### 13.3.1 Dust sprinkle rotating test (dust preventive performance)

Use the drum type dust sprinkle rotating test machine for this test. Directly sprinkle dusts onto the insert bearing unit while it is being operated, and then, judge the dust preventive performance of the product.



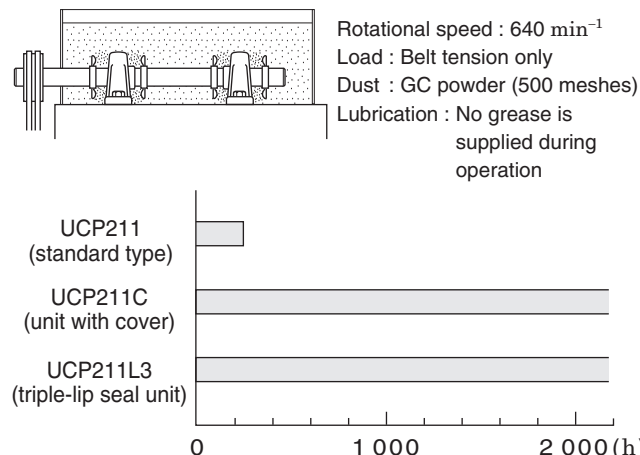
**Fig. 13.3 Example of result of dust sprinkle rotating test (dust preventive performance)**

In the case of the standard type, abnormal noise occurred about 500 hours after operation was started, and ingress of dusts was recognized.

On the other hand, no abnormality was found in the triple-lip seal type (supplementary code L3) and the covered type (supplementary code C) even after about 3 000 hours after operation was started, and superior dust proof performance was recognized.

#### 13.3.2 Dust bury rotating test (dust preventive performance)

Bury the insert bearing unit into dusts, and run it with the impeller installed to the shaft while stirring dusts, and judge the dust preventive performance of the product. This test is executed under the severest conditions among the operating conditions of the insert bearing unit.



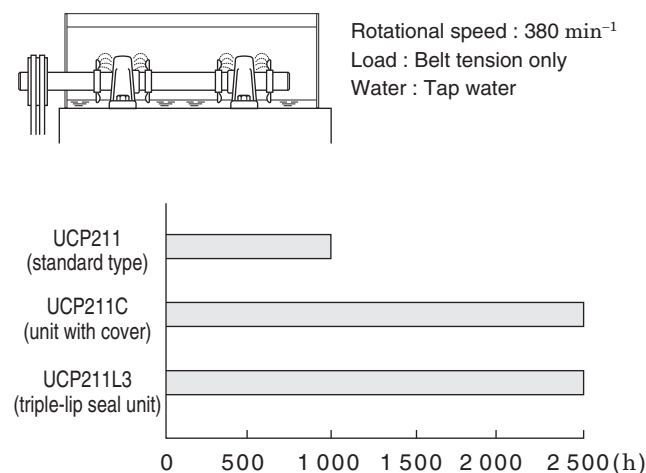
**Fig. 13.4 Example of result of dust bury rotating test (dust preventive performance)**

In the case of the standard type, abnormal noise occurred about 200 hours after operation was started, and ingress of dusts was recognized.

On the other hand, no abnormality was found in the triple-lip seal type (supplementary code L3) and the covered type (supplementary code C) even after about 2 000 hours after operation was started, and superior dust preventive performance was recognized.

#### 13.3.3 Waterproof performance test

In this test, water is splashed directly impellers installed on the shaft.



**Fig. 13.5 Example result of waterproof performance test**

In the case of the standard type, rust was found on the balls and raceway surface (outer and inner rings) about 1 000 hours after operation was started.

On the other hand, rust of equal level to the standard type was found in the triple-lip seal type (supplementary code L3) and the covered type (supplementary code C) after about 2 500 hours after operation was started.

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14 Handling

The most significant feature of the insert bearing unit is simplicity of handling and installation. However, if handling or installation is wrong, premature breakage may occur to the insert bearing unit.

Therefore, handle and install it appropriately for genuine performance of the insert bearing unit.

14.1 Installation

14.1.1 Installation of unit with set screws

When installing the unit to the shaft with the set screws, it is enough to tighten the two set screws of the bearing inner ring with the specified torque.

However, if the environment is exposed to impact or vibration, the shaft is rotated in normal and reverse directions, or the machine is started and stopped frequently and repeatedly, grind the surface of the shaft where the set screw contacts with a file so that the flat seat (Fig. 14.1) or drilled seat (Fig. 14.2) is provided. It improves the tightening effect of the set screw substantially.

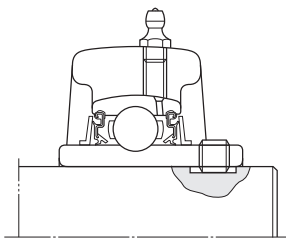


Fig. 14.1 Flat seat provided for shaft (for improvement in set screw tightening effect)

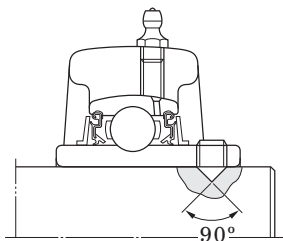


Fig. 14.2 Drilled seat provided for shaft (for improvement in set screw tightening effect)

If the environment is exposed to a great axial load or excessive vibration, use the shouldered shaft, and tighten the bearing inner ring with the nut (Fig. 14.3).

As for the dimensions of the shouldered shaft, see “10 Design of shaft and base”.

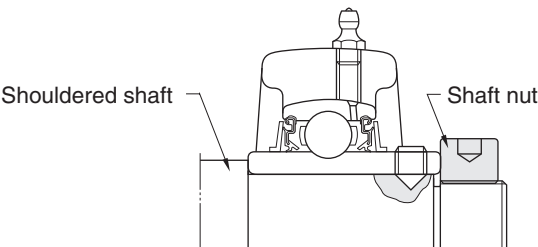





Fig. 14.3 Example of installation with using shouldered shaft and nut

The standard Koyo Insert Bearing Unit is equipped with the Bullet Point set screw featuring secure tightening to shaft. Other set screws are also available depending on your purposes and operating conditions (see Table 14.1).

Table 14.1 Set screw of insert bearing for unit

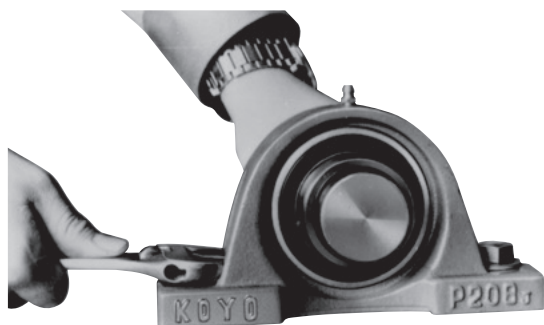
Designations (code)	Details
Bullet Point (no indication) 	The tip of the Bullet Point set screw has a ball shape, and it is designed to firmly grip the shaft by expanding its threads outward against the threads of the inner ring of the bearing as it is tightened. When shock or vibration are problems, the Bullet Point set screw can remain affixed to the shaft longer than other set screw styles including double point, ball point, or others.
Pointed (G4) 	The cone point set screw has a 90° angle and fits a drilled cone seat in the shaft. It allows correct positioning on the shaft and prevents shaft movement in an axial direction.
Full dog point cap (G6) 	The full dog point set screw fits into the key groove in the shaft and allows for expansion and contraction of the shaft.

Procedures for installation of the insert bearing unit with set screw are shown below.

- (1) Inspect the unit to ensure that the rigidity of the base, flatness of the mounting surface, variation of tolerance of the shaft meet the standards. Check for bend, flaw, or brr on the shaft.
- (2) Make sure that the tip of the set screw does not exceed the bearing bore diameter surface.
- (3) Fit the bearing unit to the shaft, and place it to the specified position. To fit it to the shaft with tight fitting, press-fit the bearing unit to the shaft with a press, cold-fit by cooling the shaft, or shrink-fit the bearing unit by warming it with air bath (100 °C or less).  
Avoid hitting the side of the bearing inner ring with a hammer to press-fit the bearing to the shaft.
- (4) Place the bearing unit to the specified position on the base, and fix it with bolts (Fig. 14.4).

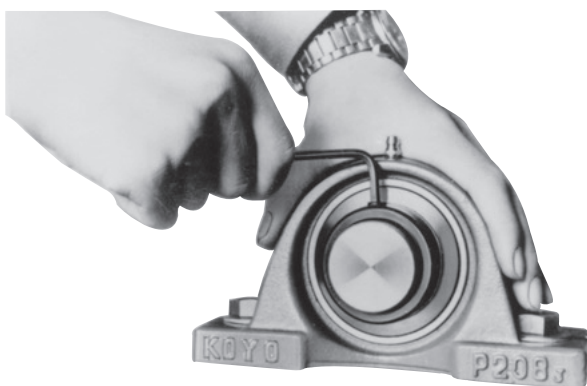
Tighten the mounting bolt of the housing with the specified torque by a torque wrench. As for the tighten-

ing torque of the mounting bolt, see the **Supplementary table 2** at the end of this catalogue.



**Fig. 14.4 Fixing insert bearing unit to base**

- (5) Tighten the set screws (two) of a bearing inner ring with the specified tightening torque evenly (**Fig. 14.5**).  
As for the tightening torque of the set screw, see the **Supplementary table 3** at the end of this catalogue.



**Fig. 14.5 Tightening of set screw**

- (6) Turn the shaft with your hands, and tighten the set screws (two) of another bearing inner ring with the specified torque.  
(7) At last, turn the shaft with your hands, and check for abnormality in turning status of the bearing.

#### 14.1.2 Installation of unit with adapter

To install the bearing with tapered bore to the shaft, set the adapter assembly (sleeve, locknut and washer) between the bearing bore diameter and the shaft. The bearing can be securely fixed even in the environment exposed to excessive vibration or impact.

If tightening of the locknut is loose, fitting to the shaft may be loosened during operation, and slippage occurs to the fitting surface, leading to wear on the shaft or parts. On the contrary, if tightening of the locknut is excessive, the bearing inner ring is expanded, and internal clearance of the bearing is too small, causing abnormal heat or premature breakage. Therefore, pay close attention to installation of the bearing with adapter.

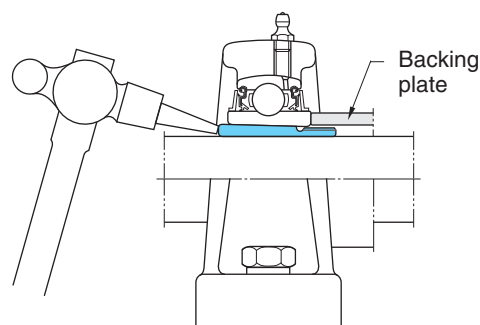
Procedures for installation of the insert bearing unit with adapter assembly are shown below.

- (1) Inspect the unit to ensure that the rigidity of the base, flatness of the installing surface, and variation of tolerance of the shaft meet the standards. Check for bend, flaw, or burr on the shaft.
- (2) Fit the adapter sleeve to the shaft, and move the adapter sleeve to the installing position of the bearing unit.

If the fitting is too tight to insert the adapter sleeve, put a screwdriver into the cutout of the adapter sleeve, and expand the cutout for easier fitting.

- (3) Fit the bearing unit to the shaft.

Then, place the cylindrical backing plate to the whole side of the bearing inner ring that the locknut is to be attached, and tap all around the large diameter side end face to fit the bore diameter surface of the bearing inner ring to the tapered surface of the adapter sleeve closely (**Fig. 14.6**).



**Fig. 14.6 Fitting adapter sleeve to bearing with tapered bore**

- (4) Fit the washer and locknut to the adapter sleeve, and tighten the locknut with your hands.
- (5) Place the bearing unit to the specified position of the base, and fix it with the bolts.

Tighten the mounting bolt of the housing with the specified torque by a torque wrench.

As for the tightening torque of the set screw, see the **Supplementary table 2** at the end of this catalogue.

- (6) Tighten the locknut of the adapter.

When tightening the locknut, tighten it with a wrench for tightening, or place a jig onto the cutout of the locknut outer surface, and tap the jig with a hammer and turn the locknut by 1/4 to 1/3 turn (**Fig. 14.7**).

As for the tightening torque of the locknut, see the **Supplementary table 4** at the end of this catalogue.

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**Fig. 14.7 Tightening locknut**

(7A) For the pillow block type unit, loosen the mounting bolts on a housing, adjust the position of the bearing unit in the axial direction while turning the shaft by your hands, and then, tighten the mounting bolt on the housing with the specified torque again.

(7B) For the flange type unit, positions of the bearing and housing in the axial direction must be fit completely. Therefore, pay close attention and tighten the locknut to prevent any error of the position of bearing inner ring.

(8) Bend the outer tab on a washer that fits to the position of cutout on the outer surface of the locknut, and lock the locknut (**Fig. 14.8**).



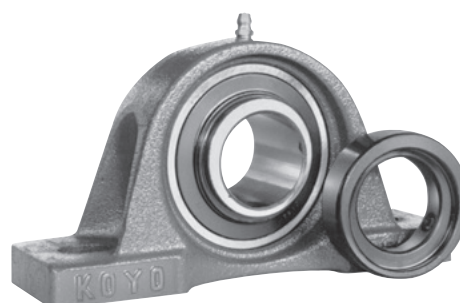
**Fig. 14.8 Bending outer tab of washer**  
(Locking locknut)

(9) At last, turn the shaft with your hands, and check for abnormality in the rotating status of the bearing.

### 14.1.3 Installing unit with eccentric locking collar

When installing the bearing to the shaft with the eccentric ring, fit the eccentric section of the end outside surface of the bearing inner ring to the eccentric recessed section provided on the eccentric locking collar, turn the eccentric locking collar, and tighten the set screw of the eccentric locking collar to fix the bearing to the shaft.

Since the rotating force of the shaft increases the tightening force of the eccentric ring to the shaft, the unit with eccentric locking collar allows secure fixing of the bearing (**Fig. 14.9**).



**Fig. 14.9 Insert bearing unit with eccentric locking collar**

Procedures for installation of the insert bearing unit with eccentric locking collar are shown below.

(1) Inspect the unit to ensure that the rigidity of the base, flatness of the mounting surface, and variation of tolerance of the shaft meet the standards. Check for bend, flaw, or burr on the shaft.

(2) Fit the bearing unit to the shaft, and place it on the specified position.

(3) Install the bearing unit to the specified position of the base, and fix it with the bolts.

Tighten the mounting bolts for the housing with the specified torque with a torque wrench.

For the tightening torque of the mounting bolt, see the **Supplementary table 2** at the end of this catalogue.

(4) Fit the eccentric section of the bearing inner ring to the eccentric recessed section provided on the eccentric locking collar, turn the eccentric locking collar in the shaft turning direction, and tighten the set screw of the eccentric locking collar with the specified torque (**Fig. 14.10**).

For the tightening torque of the set screw, see the **Supplementary table 3** at the end of this catalogue.



**Fig. 14.10 Installing eccentric locking collar**

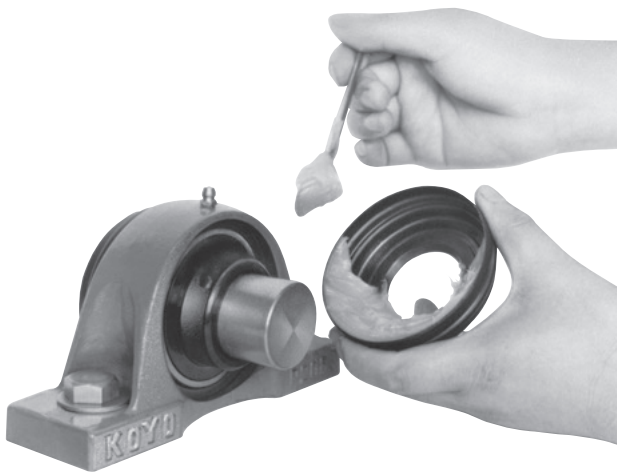
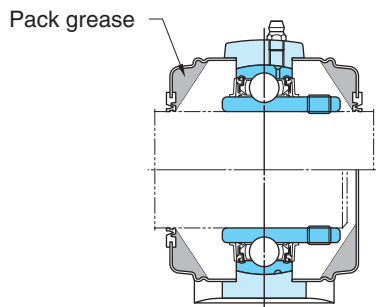
- (5) Turn the shaft with your hands. Then, fix the eccentric locking collar of another bearing unit to the bearing inner ring, and tighten the set screw of the eccentric locking collar with the specified torque.
- (6) At last, turn the shaft with your hands, and check for abnormality in the rotating status of the bearing.

#### 14.1.4 Installing unit with cover

Covers for insert bearing unit are available in four types, pressed steel, cast iron, stainless and rubber coated. Install both the covers at last after installation of the bearing and housing is complete.

Procedures for installation of the insert bearing unit with cover are shown below.

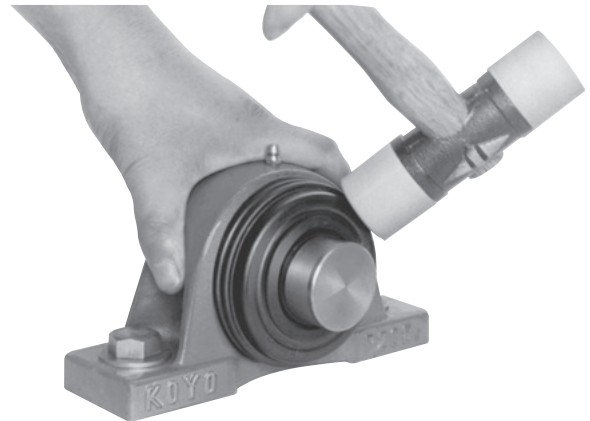
- (1) Apply grease all around the seal lip of the cover, and pack the internal space of the cover with grease (approximately 1/3 to 1/2 of the space capacity) (**Fig. 14.11**).



**Fig. 14.11 Packing grease in internal space and seal lip of cover**

- (2) Put a cover through the shaft, and then, fit the bearing unit to the shaft.
- (3) Fit the cover through the shaft to the cover groove on the housing, and fix it.
- (4A) For the pressed steel cover, tap all around the cover evenly with a synthetic resin hammer to prevent deformation, and install it to the housing (**Fig. 14.12**).

To remove the pressed steel cover, put a screwdriver into the groove on the periphery of the cover, and slightly pry it.



**Fig. 14.12 Installing steel plate cover**

- (4B) When installing the cast iron cover, fit the cover to the cover groove of the housing, and fix it with the bolt. For the tightening torque of the cast iron cover mounting bolt, see the **Supplementary table 2** at the end of this catalogue.
- (5) Install another cover to the housing in a similar manner.
- (6) Check for abnormality of the installed cover.
- (7) At last, turn the shaft with your hands, and check for abnormality in the rotating status of the bearing.

#### 14.2 Test run inspection

After installation of the insert bearing unit is complete, execute the test run inspection to ensure that it is done appropriately.

The test run inspection should be executed by following the procedures below. Check for abnormality in the bearing unit.

- (1) Turn the shaft with your hands, and make sure that the bearing is rotated smoothly. If any jam, vibration, great rotation torque (heavy), or uneven rotation is found, the bearing is judged to be faulty.
- (2) Execute power run with no load and at a low speed, and check for abnormal noise and vibration.
- (3) Carry out power run under the specified conditions, and check for abnormal noise, vibration, and temperature increase.

**Table 14.2** shows the main faults that may occur during the test run inspection of the insert bearing unit and causes.

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Table 14.2 Main faults occurred during test run inspection and their causes

Faults	Causes
Exces-sively great torque, uneven rotating torque	(1) Faulty installation, leading to preload onto bearing in axial direction (2) Inappropriate handling or installation, leading to interference of oil seal with flinger (slinger) (3) Excessive tightening of locknut (adapter), leading to too small internal clearance of bearing
Abnormal noise, abnormal vibration	(1) Insufficient tightening of set screw of bearing inner ring or mounting bolt of housing (2) Excessively large internal clearance of bearing (3) Bend on shaft, deviation of shaft center of shouldered shaft (4) Faulty accuracy of shaft (5) Insufficient rigidity or faulty flatness of base
Abnormal tempera-ture increase	(1) Excessively small internal clearance of bearing (2) Inappropriate installation, leading to preload onto bearing in axial direction (3) Great load applied (4) Allowable rotational speed is exceeded (5) Faulty flatness of base (6) Inappropriate handling or installation, leading to interference of oil seal with flinger (slinger)

14.3 Periodic inspection

Koyo Insert Bearing Units do not need to be inspected, as well as standard sealed bearings. However, for especially important purposes, periodic inspection must be executed with appropriate intervals for safe operation of the bearing unit.

Since a insert bearing unit cannot be disassembled for inspection of internal status, check the appearance and operating status as shown below, and ensure that the bearing unit is free from fault or not.

- (1) Appearance
- (2) Looseness of set screw of bearing inner ring or mounting bolt of housing
- (3) Vibration, noise
- (4) Temperature
- (5) Grease supply interval, check of supplied amount

Table 14.3 shows the main faults found during the periodic inspection of insert bearing unit and their causes.

If any fault is found in the insert bearing unit during the periodic inspection, immediately provide countermeasures against them, and carry out them. If the unit is judged to be difficult to be used, replace the bearing unit. It is important to replace the bearing unit to prevent expanding damage to other parts.

Table 14.3 Main faults found during periodic inspection and their causes

Faults	Causes
Exces-sively great torque (heavy)	(1) Degraded grease (2) Interference of oil seal with flinger (slinger) due to excessive supply of grease (3) Deformation of flinger (slinger), leading to interference with oil seal (4) Abnormal load due to expansion of shaft
Abnormal noise, abnormal vibration	(1) Insufficient tightening of set screw of bearing inner ring or mounting bolt of housing (2) Wear on fitting surface of shaft and bearing inner ring due to creep or fretting (3) Ingress of foreign matters into bearing (4) Damage to raceway surface or rolling contact surface of rolling element by rolling fatigue (5) Dent on raceway surface or rolling contact surface of rolling element by excessive load (6) Excessive warp or bend of shaft
Abnormal tempera-ture increase	(1) Degraded grease (2) Interference of oil seal with flinger (slinger) due to excessive supply of grease (3) Deformation of flinger (slinger), leading to interference with oil seal (4) Looseness of set screw or locknut (adapter) of bearing inner ring (5) Abnormal load due to expansion of shaft (6) Damage to raceway surface or rolling contact surface of rolling element by rolling fatigue

14.4 Supply of grease

In Koyo Insert Bearing Unit, grease of good quality is packed with high quality oil seal. Therefore, grease life is long under standard operating conditions, and use without lubrication is enabled.

If the operating temperature is high or the unit is used in the environment exposed to dusts or high humidity, grease may be degraded faster, leading to faulty lubrication in a short period.

Since Koyo Insert Bearing Units are lubricated type bearings, fresh grease must be periodically supplied to the bearings, if they are used for such purposes that premature degradation of grease is expected.

The insert bearing units can maintain normal lubricated status and longer service life by supplying fresh grease.

14.4.1 Grease life and supply intervals

Grease life of a packed grease insert bearing, like a insert bearing unit, can be found by **Equation (5.10)** in page 37. It is recommended to supply grease with the intervals of 1/4 to 1/3 of grease life found by the calculation shown above to insert bearing units, taking peculiarity of lubricating method and safety of bearing unit into consideration.

If the bearing unit is used under severe environmental conditions, including much dust and high humidity, the greasing intervals must be further shortened, taking these influences into consideration.

If operating conditions of the insert bearing unit are not clear or the unit is operated under standard conditions, consider the greasing intervals shown in **Table 14.4** as the guideline.

14.4.2 Greasing amount

Initial greasing amount of Koyo Insert Bearing Unit is approximately 30 to 35% of the internal space capacity of the bearing. If amount of grease supplied in the bearing is excessive, agitating resistance of grease increases, leading to abnormal heat or grease leak. DO NOT exceed the initial greasing amount.

**Table 14.5** shows the recommended values of greasing amount of Koyo Insert Bearing Unit.

If the unit is used at a low speed, supply grease of double amount of that shown in **Table 14.5** is recommended to increase dust preventive performance.

- [Remarks] 1. For greasing amount of the UK type bearing, use this table, too.
2. For greasing amount of the triple-lip seal type, 1.5 times of the values shown in this table are recommended.
3. Values shown in this table are applicable to standard grease (specific gravity : 0.9 g/ml). If you use greases of other specific gravity, adopt values converted with the same volume.

Table 14.5 Greasing amount of insert bearing unit (recommended)

Bore dia. code	Greasing amount, g		
	Diameter Series <sup>1)</sup>		
	UC200	UCX00	UC300
01	0.7		
02	0.7		
03	0.7		
04	0.7		
05	0.8	1.3	1.8
06	1.3	1.8	2.5
07	1.8	2.3	3.4
08	2.3	2.8	4.6
09	2.8	3.2	6.3
10	3.2	4.3	8.1
11	4.3	5.5	11
12	5.5	6.8	14
13	6.8	7.7	17
14	7.7	9	21
15	9	11	25
16	11	14	29
17	14	17	34
18	17	21	40
19	—	—	47
20	—	29	61
21	—	—	69
22	—	—	84
24	—	—	98
26	—	—	126
28	—	—	151

Table 14.4 Greasing intervals of insert bearing unit (recommended)

Operating temperature, °C		Grease Intervals			Bearing used	Grease supplied
over	up to	Substantially clean	Much dust	Much dust and muddy water		
	50	(3 months) not necessary	(2 months) 1 year	(1 month) 4 months	(Low temperature D2K2) <sup>1)</sup>	(Lithium) Lithium
50	70	1 year	4 months	1 month	Standard bearing	
70	100	6 months	2 months	2 weeks		
100	120	2 months	2 weeks	5 days	High temperature D1K2	Lithium
120	150	2 weeks	5 days	2 days		
150	180	1 week	2 days	1 day		

Note 1) Greasing intervals in parentheses are applicable to the cold resistant type (D2K2).

[Remark] Greasing intervals shown in this table are applicable to the unit to be operated for 8 to 10 hours a day. If operating hour is out of this range, find the greasing interval proportionally by this table.

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14.4.3 Types of grease supplied

Though various types of greases used for insert bearing units are available, if dissimilar grease, especially grease of which soap base is different, is mixed, lubricating performance may be significantly degraded.

Therefore, the same grease to be supplied as the initially packed grease must be used, and avoid use of dissimilar grease.

It is recommended to supply the same grease to Koyo Insert Bearing Unit as the initially packed grease (see **Table 3.3**). If you have no choice but to use other greases, you have to use grease of the same type (thickener) as the initially packed grease, if not the worst.

14.4.4 Supplying grease

When supplying grease to a insert bearing unit, use the grease nipple and grease gun installed to the housing (**Fig. 14.13**).

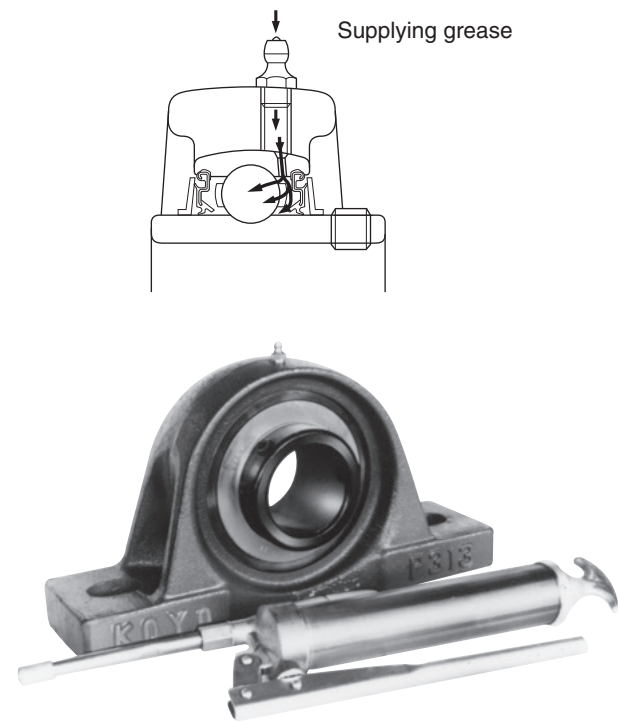


Fig. 14.13 Supplying grease to insert bearing unit

- (1) Clean the grease nipple and area around it to prevent ingress of foreign matters.
- (2) Clean the grease gun, and pack clean grease.
- (3) Supply grease.

When supplying grease to the insert bearing unit, turning of the shaft with your hands or turning of the bearing unit at a low speed is recommended.

It allows appropriate discharge of old grease and even supply of fresh grease into the bearing.

If the grease supply with the grease nipple of the standard type (type A) is difficult because of the structure of the machine, grease nipples of the type B or type C are also available. Contact JTEKT.

**Fig. 14.14** shows the types of grease nipples.

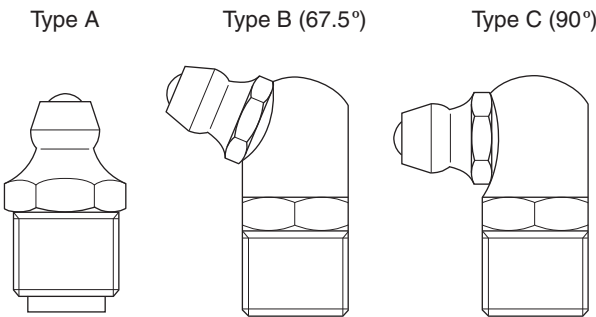


Fig. 14.14 Types of grease nipple for insert bearing unit

When supplying many insert bearing units with the centralized lubricating device, use soft grease with consistency from about 300 to 380, and provide piping appropriately so that grease of the specified amount is supplied.

Piping to the insert bearing unit should be provided with the tapped hole of the grease nipple of the housing. However, if size of the tapped hole on the housing differs from that of thread of the piping, use the reducing socket.

**Fig. 14.15** shows the structure of the reducing socket for centralized lubricating.

When executing centralized lubricating, it is effective for the lubricating surface of the bearing to supply grease of the amount shown in **Table 14.5** by dividing into several times.

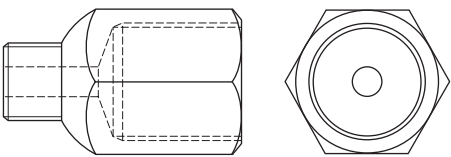


Fig. 14.15 Reducing socket for centralized lubricating

For details of grease nipples and reducing sockets, see “**16 Parts and accessories**”.

## 14.5 Replacing bearing

Since the bearings and the housings of Koyo Insert Bearing Units are compatible, if a bearing is faulty, it can be replaced and used continuously.

Replacing procedures of the bearing of the insert bearing unit are shown below.

- (1) Remove the bearing unit from the shaft and the base.
- (2) Screw in the set screw so that the head of the set screw does not project out from the outside diameter surface of the inner ring of the bearing.  
Head of the set screw may be hooked on the housing when the bearing is tilted.
- (3) Turn the bearing by 90° with a handle of a hammer until the bearing is horizontal.
- (4) Take out the bearing from the bearing groove of the housing.

To fit a new bearing to the housing, reverse the removing procedures.