

2. Selection of Bearings

2. Selection of Bearings

2-1. Description

The main points to consider when selecting bearings are longevity, reliability, and price. Furthermore, customers' demands for more versatile and functional bearings are increasing more than ever before. Therefore, when selecting bearings, various aspects have to be considered to select the most appropriate ones for the specific purposes.

The followings are the general procedures that are taken in selecting the most appropriate bearings. First of all, all the operating and surrounding conditions need to be analyzed. These have to be taken into considerations in each of the

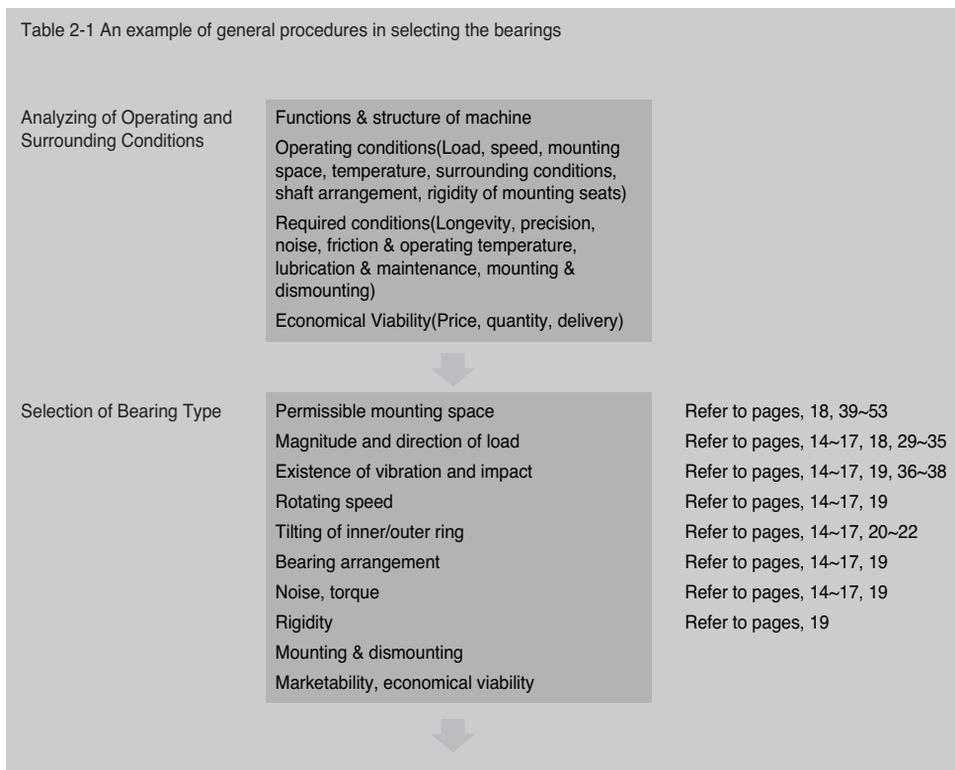
following stages of bearing selection procedures.

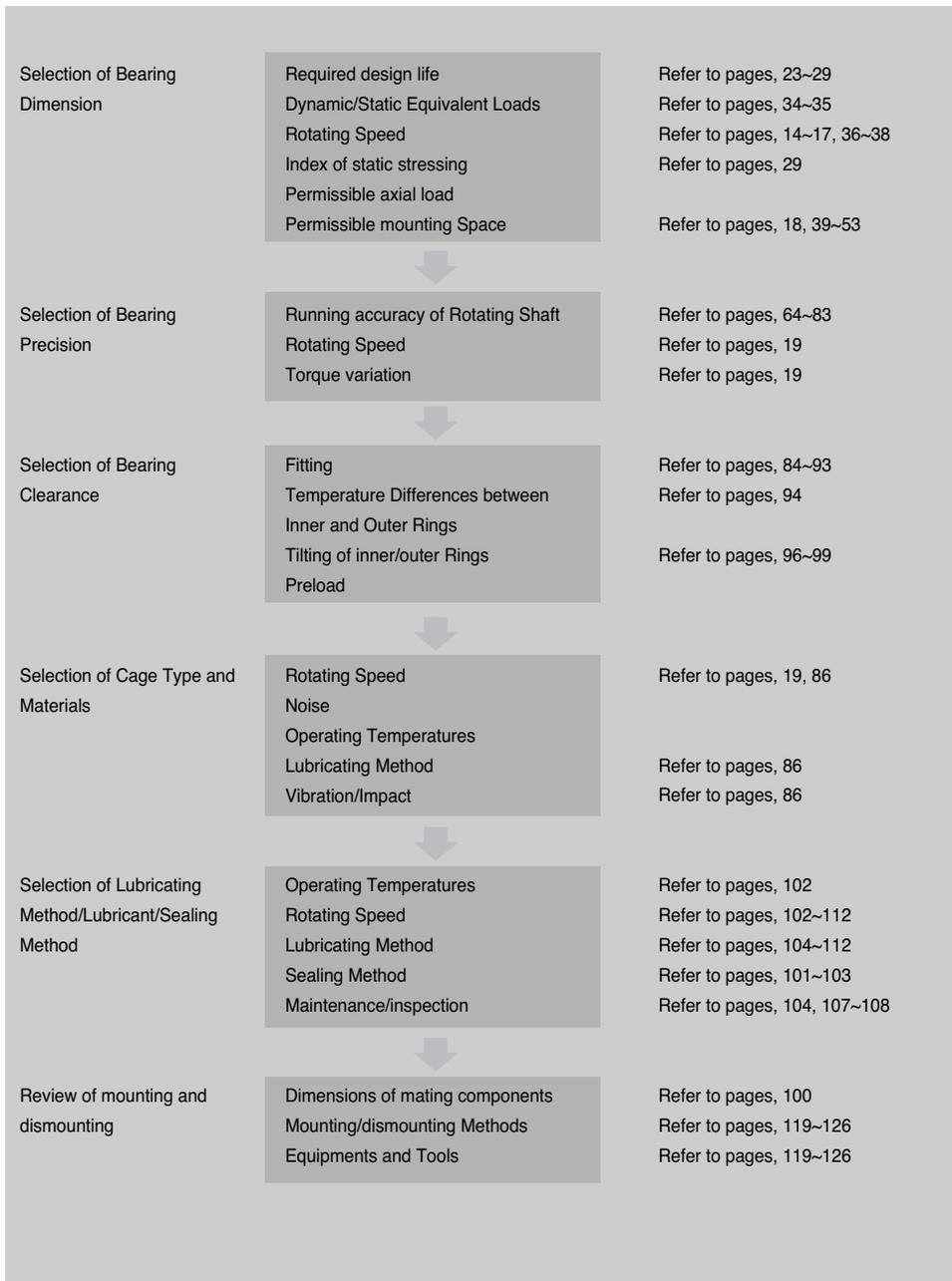
- Examination of bearing type
- Examination of bearing arrangement
- Examination of bearing dimension
- Examination of detailed specifications of bearing (precision, clearance & preload, cage type, lubricant, etc.)

When selecting the proper bearings for new machines or ones used under special settings and conditions, more complex calculations and designing(not shown in this catalogue) may be necessary. It is recommended to contact us when you are in these kinds of situations.

An example of general procedures in selecting the bearings is shown in Table 2-1 below.

Table 2-1 An example of general procedures in selecting the bearings



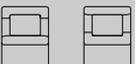
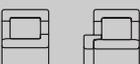
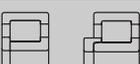
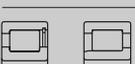


2. Selection of Bearings

2-2 Selection of Bearing Type

2-2-1 Comparisons of Different Bearings

Table 2-2 is the comparative table showing all main characteristics of bearings.

Table 2-2 Comparative Table of Bearings		Characteristics					
Compatibility							
	Excellent		Limited	Radial Load Carrying Capacity	Axial Load Carrying Capacity (both directions)	Length compensation within the bearing	Length compensation by loose fitting
	Good		Not compatible / Not allowed				
	Fair / Applicable						
Bearing Types							
Deep Groove Ball Bearing							
Angular Contact Ball Bearing					 ^a		
Double-Row Angular Contact Ball Bearing							
Self-Aligning Ball Bearing							
Cylindrical Roller Bearing NU, N							
NJ, NU + HJ							
NUP, NJ + HJ							
NN							
NCF, NJ23VH							
NNC, NNF							

← Single bearing or tandem arranged bearings

a) Assembled in couples

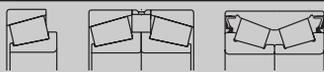
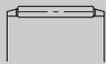
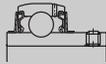
b) Small axial load

Separable Bearing	Compensation for Misalignment	Precision	High Speed Suitability	Low Noise Level	Tapered Bore	Sealing in One Side/Both Sides	Rigidity	Low Friction	Locating Bearing	Floating Bearing
✗	△	○	☆	☆	✗	☆	○	☆	◎	○
✗	✗	☆	☆ _c	◎	✗	✗	◎ _a	◎	☆ _a	○ _a
○	✗	○	○	△	✗	○	◎	○	◎	○
✗	☆	✗	◎	△	☆ _d	☆	△	◎	○	○
☆	△	◎	☆	○	○	✗	◎	◎	✗	☆
☆	△	○	◎ _b	△	✗	✗	◎	◎ _b	○	○
☆	△	○	◎ _b	△	✗	✗	◎	◎ _b	◎	△
☆	✗	☆	☆	○	☆	✗	☆	◎	✗	☆
○	△	✗	✗	✗	✗	✗	☆	✗	○	○
✗	✗	✗	✗	✗	✗	○	☆	✗	○	○

c) Applications limited when assembled in couples

d) Using adapter sleeve or withdrawal sleeve

2. Selection of Bearings

Compatibility		Characteristics				
 Excellent	 Limited	Radial Load Carrying Capacity	Axial Load Carrying Capacity (both directions)	Length compensation within the bearing	Length compensation by loose fitting	
 Good	 Not compatible / Not allowed					
 Fair / Applicable						
Bearing Types						
Tapered Roller Bearing						
Spherical Roller Bearing						
Needle Roller Bearing						
Unit Bearing						
Thrust Ball Bearing						
						
Thrust Angular Contact Ball Bearing						
						
Thrust Cylindrical Roller Bearing						
Thrust Spherical Roller Bearing						

 Single bearing or for tandem arranged bearings

a) Assembled in couples

c) Applications limited when assembled in couples
d) Using adapter sleeve or withdrawal sleeve

Separable Bearing	Compensation for Misalignment	Precision	High Speed Suitability	Low Noise Level	Tapered Bore	Sealing in One Side/Both Sides	Rigidity	Low Friction	Locating Bearing	Floating Bearing
☆ _f	△	◎	○ _c	△	×	×	☆ _a	○	☆ _a	△ _a
×	☆	×	○	△	☆ _d	○	◎	○	◎	○
☆	×	×	×	×	×	×	☆	×	×	☆
×	○ _e	×	△	×	×	☆	○	×	○	×
☆	○ _e	◎	○	△	×	×	○	○	○	×
☆	○ _e	×	△	×	×	×	○	△	○	×
×	△	☆	◎ _c	△	×	×	◎ _a	○	☆ _a	×
☆	×	☆	☆	△	×	×	☆	○	☆	×
☆	×	○	△	×	×	×	◎	×	◎	×
☆	☆	×	△	×	×	×	◎	△	◎	×

e) Thrust ball bearing with insert bearing and seating washer, installed on the spherical housing, can be corrected misalignment when assembling

f) Separation is limited in case of sealed types

g) Applicable in case of sealed types

2. Selection of Bearings

2-2-2 Permissible Mounting Space

Because the mounting space for bearing can be usually pre-determined, all of bore and outer diameters and widths of the bearing can be also easily decided at first. However, when designing a machine or an equipment, it is common to first decide the size of the shaft, and then the permissible space for the bearing in accordance with the diameter of the shaft, before selecting the appropriate bearing. Also, in most cases, the bore diameter of bearings is specifically designated, whereas the dimensions of outer diameter and width are usually proposed roughly. Therefore, bearings are usually chosen based on their inner diameters.

Bearings of various types and dimensions with same bore diameters are provided, therefore the most appropriate ones have to be carefully chosen after examining all the possibilities. Main dimensions

for each dimension group are shown in Chapter 6. Main Dimensions and Nominal Symbols on page 39.

2-2-3 Magnitude and Direction of Load

Loads applied to a bearing vary greatly depending on their magnitude, directions, or characteristics. The capacity for bearing to carry loads is called a load carrying capacity, and this load carrying capacity can be divided into radial load carrying capacity and axial load carrying capacity.

The radial and axial load carrying capacities for some radial and thrust bearings are shown in Fig. 2-1 and Fig. 2-2. When bearings of same dimension are compared, roller bearings have bigger load carrying capacity than ball bearings, and they can also withstand greater impact load than ball bearings.

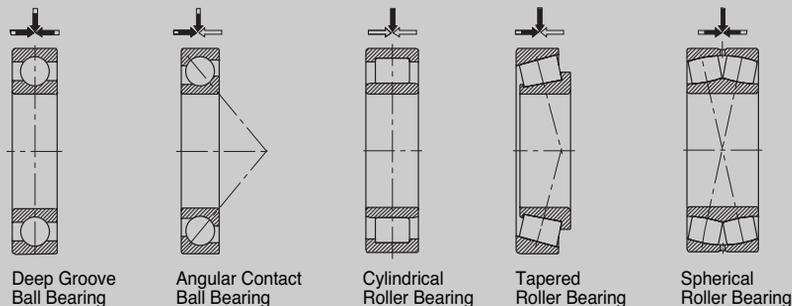


Fig. 2-1 Load Carrying Capacity of Radial Bearing

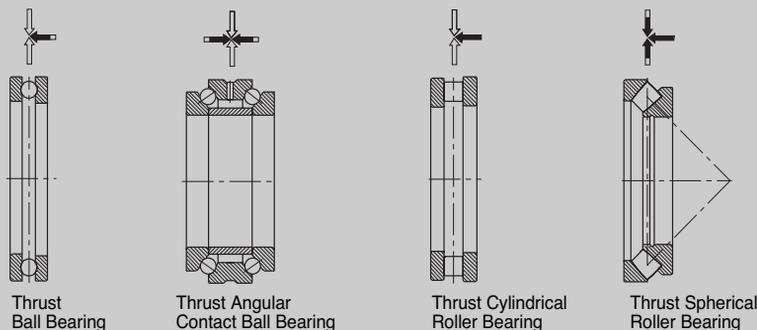


Fig. 2-2 Load Carrying Capacity of Thrust Bearing

2-2-4 Precision

Precision and running accuracy of KBC bearings comply with ISO 1132 and KS B 2014. In most cases, Tolerance Class "0" is more than enough to satisfy all the general requirements for the bearings. However, the bearings of higher Tolerance Classes have to be used when the specific performance requirements have to be met or when they are used under the special operating conditions, as shown below.

- When higher degree of precision for rotating component is required
(Eg.: Main shaft of machine tool, VTR drum spindle, etc.)
- When bearing is rotating at a very high speed
(Eg.: High frequency spindle, supercharger, etc.)
- When the friction variation of bearing is required to be very small
(Eg.: Precision measuring instrument, etc.)

2-2-5 Rotating Speed

The permissible speed for bearing varies depending on the types and sizes of bearings, and it depends also on the cage types and materials, bearing loads, and lubricating methods, etc.

The permissible speeds for KBC bearings in both cases of grease and oil lubrication are listed in the Dimension Table.

The permissible speed could be increased by improving the dimensional accuracy of bearing and its mating components enhancing the running accuracy of bearing, and adapting cooling lubrication and cages of special types and materials.

In general, thrust bearings have lower permissible speeds than radial bearings.

2-2-6 Misalignment of inner and outer rings

Inner and outer rings could become tilted due to various reasons, such as deflection of shaft caused by excessive load on long shaft or improper mounting procedures caused by fabrication defects in the mounted section.

Misalignment can also easily happen when independent housings, such as flanged or plummer block housings, are used.

The permissible misalignment for bearings varies

depending on their types and operating conditions. If the misalignment of inner and outer rings is large, the bearings with self-aligning capability, including self-aligning ball bearing, spherical roller bearing, or unit bearing, have to be used.

2-2-7 Noise and Torque

Both low noise level and torque are required for small electric equipments, office equipments, or home appliances. Deep groove ball bearings could be operated at a considerably low noise level, and they also produce low torque to make them quite suitable for above mentioned products. Various kinds of deep groove ball bearings of different noise levels are produced by KBC to meet different requirements for various usages.

2-2-8 Rigidity

When a load is applied to bearings, they deform elastically to certain degrees. If it deforms elastically very little, then its rigidity is said to be high, and if it deforms largely, then its rigidity is said to be low. If roller bearing is compared with ball bearing, then it is easy to guess that roller bearing has a higher rigidity, because its contact area between rolling elements and raceway is larger than ball bearing.

In many cases for angular contact ball bearings or tapered roller bearings, load is applied in advance to slightly deform them elastically, which, in return, increase their rigidity. This is called preload.

2-2-9 Mounting and Dismounting

Because all of cylindrical roller bearings, tapered roller bearings, and needle roller bearings are separable, it is easy to mount and dismount these bearings.

Also, the bearings with tapered bore can be easily mounted or dismounted by using adapter sleeve or withdrawal sleeve.

For the machines required to be assembled or disassembled frequently for periodic inspections or repairs, it is necessary for them to have the bearings that provide easy mounting and dismounting like the ones mentioned above.

2. Selection of Bearings

2-3 Bearing Arrangements

Rotating shaft needs to be supported by two or more bearings. At this time, following items have to be considered to determine the optimum bearing arrangements.

- Measures to be taken against elongation or contraction of shaft caused by temperature changes.
- Convenience and Easiness in mounting or dismounting the bearings.
- Rigidity of rotating components including bearings and preload method
- Misalignment of inner and outer rings caused by deflection of shaft or mismounting
- Appropriate distribution of axial and radial loads.

2-3-1 Locating Bearing and Floating Bearing

It is common to find the center of shaft not aligned properly with the center of housing, due to mismounting. Also the temperature elevation during the operation makes the shaft become longer. These changes in length are corrected by floating bearing.

Cylindrical roller bearings of N and NU types are the ideal floating bearings. These bearings are structured, so that the assembled components of roller and cage can move in axial direction on the lipless ring.

For deep groove ball bearings or spherical roller bearings, either inner or outer ring has to be loosely fitted for them to serve the same role as floating bearings. When it is applied with static load, either ring could be loosely fitted, but, in general, outer rings more than inner rings are chosen for loose fitting.

On the other hand, the locating bearings have to be carefully selected considering how big the axial load is, and how precisely the shaft has to be guided.

When the distance between bearings is too short, or the temperature changes in shaft is negligible enough not to cause any significant expansion of shaft, they can be used regardless of locating or floating sides. For example, there is a bearing arrangement which uses the combination of two angular contact ball bearings or tapered roller bearings that can receive axial load in one direction.

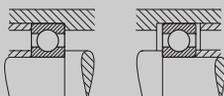
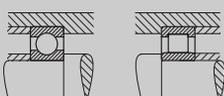
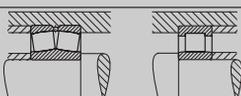
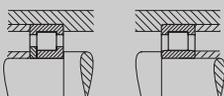
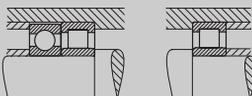
In this case, axial clearance after mounting can be adjusted by using the shim or the nuts.

2-3-2 Examples of Bearing Arrangement

Examples of bearing arrangements considering preload, rigidity, shaft expansion and mismounting,

etc. are shown on the Table 2-3, 2-4, and 2-5 as follows.

Table 2-3 Examples of locating / floating Bearing Arrangement

Bearing Arrangements Locating	Examples(Reference)
	<ul style="list-style-type: none"> - Most common arrangement - Not only radial load but also axial load to a certain degree could be applied. <p>Small pumps Automobile transmission</p>
	<ul style="list-style-type: none"> - High rotating speeds can be obtained, if the degree of mismounting is small and the deflection of the shaft is minimal. - Even if shaft is expanded and contracted repeatedly, it does not generate the abnormal axial load on the bearing. <p>Medium sized electric motor Air blower</p>
	<ul style="list-style-type: none"> - Most appropriate to be used when comparatively larger axial loads are applied in both direction - Double-row angular contact ball bearing could be used instead of combined angular contact ball bearing. <p>Worm gear reducer</p>
	<ul style="list-style-type: none"> - It is used when comparatively larger loads are applied. - Rigidity could be increased by the back-to-back arrangement of locating bearings with preload - It is necessary to reduce the mismounting by manufacturing both shaft and housing precisely. <p>Main shaft of large lathe machine Table roller for steel mills</p>
	<ul style="list-style-type: none"> - Radial load as well as an axial load to certain degree can be applied. - Both inner and outer rings could be tightly fitted. <p>Calender roll for paper making machine Axle box for diesel train</p>
	<ul style="list-style-type: none"> - It is commonly used when comparatively larger loads and impact loads are applied. - It is appropriate to use when mismounting or shaft deflection is expected. <p>Axle box of overhead crane driving wheel Large size reducer</p>
	<ul style="list-style-type: none"> - It is commonly used when comparatively larger loads and impact loads are applied, and also axial loads to a certain degree can be applied. - It is suitable when both inner and outer rings are tightly fitted. <p>Traction motor for automotive vehicles</p>
	<ul style="list-style-type: none"> - It is used when the shaft rotates at a high speed and when comparatively larger radial and axial loads are applied. - For deep-groove ball bearings, space between outer ring and housing should be provided to prevent radial load from being applied. <p>Transmission for diesel train</p>

2. Selection of Bearings

Table 2-4 Examples of Bearing Arrangements that do not distinguish locating or floating bearings

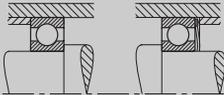
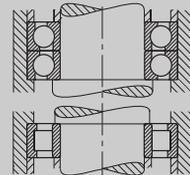
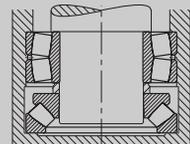
Bearing Arrangements	Contents	Examples(Reference)
	<ul style="list-style-type: none"> - Most common arrangement for small machines. - Preload could be applied by using the spring laterally to the side of outer ring of bearing. 	Small electric motor
	<ul style="list-style-type: none"> - Both radial and axial load can be applied, and it is suitable for high speeds. - It is suitable when rigidity of the shaft must be increased through preload - If a moment is applied, back-to-back arrangement is preferable than face-to-face arrangement. 	Main shaft of machine tools
	<ul style="list-style-type: none"> - It is commonly used when comparatively larger loads and impact loads are applied. - It is suitable when both inner and outer rings are tightly fitted. - Consideration has to be taken to prevent axial clearance from becoming too tight during operation. 	Final reduction gear for construction machine Sheave for mining machine
	<ul style="list-style-type: none"> - It is commonly used when comparatively larger loads and impact loads are applied. - When the distance between bearings is small, and when moment is applied, back-to-back arrangement is advantageous. On the other hand, when mismounting is considerably large enough, face-to-face arrangement is advantageous. - Face-to-face arrangement is easier when inner and outer rings are tightly fitted. - Care must be taken when applying the preload and when adjusting the clearance. 	Automobile wheels Worm gear reducer Pinion shaft
		

Table 2-5 Examples of Bearing Arrangements of vertical shaft

Bearing Arrangements	Contents	Examples(Reference)
	<ul style="list-style-type: none"> - Combined angular contact ball bearings are locating bearings, and cylindrical roller bearing is floating bearing. 	Small electric motor Small reducer
	<ul style="list-style-type: none"> - It is suitable when axial load is comparatively large. - The center of thrust spherical roller bearing needs to be aligned with that of spherical roller bearing. 	Central axle of crane