

3.2 Focus on selecting bearing types

When selecting bearing types, it is essential to completely understand the working conditions of bearings. The following Table 3.1 lists the major analytical items and makes more specific explanations for the selecting sequences of bearings.

Table 3.1

Item to be considered		Selection method
1) Bearing installation space	Bearing type which can be mounted in target equipment	<ul style="list-style-type: none"> When design shafting, the rigidity and intensity of shaft are considered, so the shaft diameter shall be determined in advance, i.e. bearing inner diameter. However rolling bearings have many dimension series and types, and the optimal bearing type shall be chosen from them.
2) Load	Magnitude, direction and property of bearing load (Bearing's load capacity is expressed by basic load rating, and its values are shown in the bearing table.)	<ul style="list-style-type: none"> Bearing load are changeable, such as load magnitude, whether only radial load or axial load, single direction or two-direction, vibration or impact degree, etc. After considering these factors, then select the optimal bearing type.
3) Rotation speed	Bearing type which can response to the mechanical speed (The value of rotation speed limit is expressed by limit speed, which is shown in the bearing specification table)	<ul style="list-style-type: none"> The limit rotation speeds of bearings do not only depend on bearing types, but are also limited by bearing dimensions, cage types, accuracy classes, load-up conditions and lubrication etc. These factors must be considered when choosing bearings. The following bearings are mostly applied to high speed rotation: deep groove ball bearing, angular contact ball bearing and cylindrical roller bearing.
4) Running accuracy	Bearing types with required running accuracy (Dimensional accuracy and running accuracy have already been standardized)	<ul style="list-style-type: none"> Machine tool spindles, gas turbines and controlling machines require high running accuracy, high rotary speed and low friction, where bearings above Grade 5 shall be used. Deep groove ball bearing, angular contact ball bearing and cylindrical roller bearing are often used.
5) Rigidity	Bearing types which can meet with mechanical bearing rigidity (When bearing load, the contacting surface of the rolling element and raceway of the bearing may generate elastic deformation. "High rigidity" means that the deformation of this kind of elastic deformation is small.)	<ul style="list-style-type: none"> At the positions of machine tool spindles and automobile and final reduction gear etc., the rigidity of the bearing as well as shaft must be improved. Roller bearing generates smaller deformation than ball bearing when bearing load. Rigidity can be improved by applying preload (negative clearance) to the bearing. This method is applicable to angular contact bearing and taper roller bearing.

Table 3.1(continue)

Item to be considered		Selection method
6) Misalignment of inner ring and outer ring	Analy the factors which cause the misalignment tilt of bearing inner ring and outer ring (such as load caused deflection shaft and housing inaccuracy or mounting error), and select the bearing which can suit this working condition.	<ul style="list-style-type: none"> If the misalignment of inner ring and outer ring is too large, bearing will generate internal load and cause damage. Therefore, the bearing type which can take this kind of misalignment shall be chosen. In general, allowable misalignment angle (or self-aligning angular) increases according to the following order: Cylindrical roller bearing < tapered roller bearing < deep groove ball bearing (angular contact ball bearing) < self-aligning roller (ball) bearing
7) Mounting and dismounting	Consider the mounting/dismounting method and frequency	<ul style="list-style-type: none"> When mounting is frequent, cylindrical roller bearing, needle roller bearing and tapered roller bearing with separable inner ring and outer ring are used. Tapered bore self-aligning ball bearing and tapered bore spherical roller bearing are easy to mounting by using adapter sleeve or withdrawal sleeve.

Meanwhile the requirements for the function and performance of bearings must be compared with the characteristics of various bearings. Table 3.2 list the characteristics of main bearing types for reference.

Table 3.2 Structures and characteristics of rolling bearings

Bearing type performance and characteristic	Deep groove ball bearing	Angular contact ball bearing			Four-point contact ball bearing	Self-aligning ball bearing	Cylindrical roller bearing				Needle roller bearing (solid type)	Tapered roller bearing		Spherical roller bearing	Thrust ball bearing		Cylindrical roller thrust bearing	Needle roller thrust bearing	Tapered roller thrust bearing	Spherical-thrust roller bearing		
		Single row	Matched	Double row			NU, N	NJ, NF	NUP, NH	NNU, NN		Single row	Double row, four-row		Flat back faces	Aligning seat washer						
load capacity	Radial load	○	○	⊙	⊙	○	○	⊙	⊙	⊙	⊙		⊙	⊙	⊙	⊙	×	×	×	×	×	△
	axial load	○ ↔	⊙ ←	⊙ ↔	⊙ ↔	⊙ ↔	△ ↔	×	△ ←	△ ↔	×		×	⊙ ←	⊙ ↔	△ ↔	○ ←	○ ←	⊙ ←	⊙ ←	⊙ ←	⊙ ←
	combined load	○	○	⊙	⊙	○	△	×	△	△	×		×	⊙	⊙	△	×	×	×	×	×	△
	impact resistance	△	△	△	△	△	△	⊙	⊙	⊙	⊙		○	⊙	⊙	⊙	△	△	○	○	⊙	⊙
high rotation	⊙	⊙	⊙	○	⊙	△	⊙	⊙	⊙	⊙		○	○	○	○	△	△	△	△	△	△	△
high accuracy	⊙	⊙	⊙		⊙		⊙			⊙			○			○						
low noise low torque	⊙						○															
rigidity			○		○		○	○	○	⊙		○	○	⊙				⊙	⊙	⊙		
misalignment	○	△	×	×	×	⊙	△	△	△	△		△	△	△	⊙	×	⊙	×	×	×	×	⊙
separable	×	×	×	×	■	×	■	■	■	■		■	■	■	×	■	■	■	■	■	■	■
arrangement	fixed end	■ ↔	■ ←	■ ↔	■ ↔	■ ↔	■ ↔	×	■ ←	■ ↔	×	×	■ ←	■ ↔	■ ↔							
	free end	□		□	□	□	□	■	□	□	■	■		□	□							

Remarks:
 ⊙: excellent ○: good △: fair ×: unacceptable →: one direction only ↔: both direction □: acceptable ■: acceptable, but shaft shrinkage must be compensated for