TECHNICAL INSIGHT

A PUBLICATION OF NSK EUROPE

Fits
## The right fit prevents premature wear

It is important to choose the right fit to prevent slippage between the ring and the surrounding structure. If this kind of creep occurs, the fitting surfaces wear away and cause damage to the shaft. Metal grindings can also end up inside the bearing, causing damage and resulting in unwanted heat and vibrations. A number of factors have to be taken into account when choosing the right fit, such as the magnitude and type of the bearing load, temperature differences, and the tools used to assist with fitting and dismantling.

As a rule, creep can be prevented by securing the ring with sufficient interference. If the bearing is only subject to point loading, press fits are not normally needed for the rings. Sometimes, fits are made without inner and outer ring interference to cater for certain operating conditions or to make installation and removal easier. In such cases, damage to the fitting surfaces can be avoided by means of lubrication.

Load conditions and fits

The right fit can be selected by looking at the load and the operating conditions.
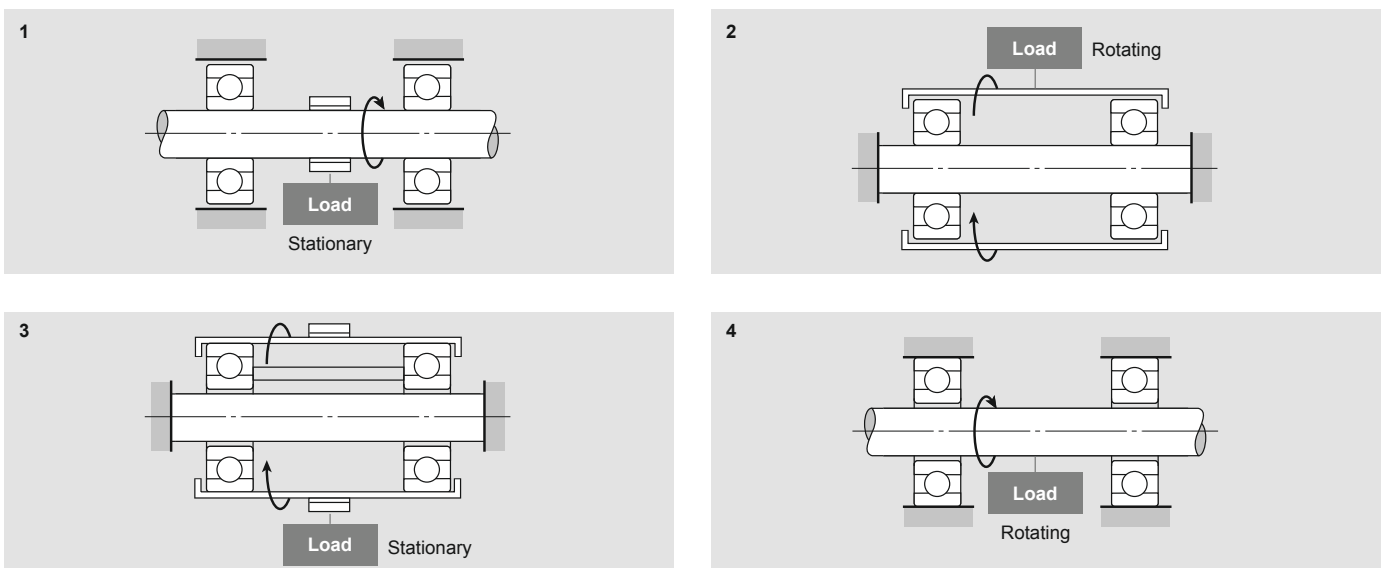
Loading point	Bearing operation		Load conditions	Fit	
	Inner ring	Outer ring		Inner ring	Outer ring
1. Stationary load	Rotating	Stationary	Rotating load on inner ring	Tight fit	Loose fit
2. Rotating load	Stationary	Rotating	Stationary load on outer ring		
3. Stationary load	Stationary	Rotating	Rotating load on outer ring	Loose fit	Tight fit
4. Rotating load	Rotating	Stationary	Stationary load on inner ring		
Indeterminate direction of load due to changes in direction or asymmetrical loading	Rotating or stationary	Rotating or stationary	Indeterminate direction of load	Tight fit	Tight fit

Magnitude of load and interference

The bearing load slightly reduces the inner ring interference. This reduction can be calculated using the following equation:

$$\Delta d_\text{F} = 0.08 \sqrt{\frac{d}{B} F_\text{r}} \cdot 10^{-3} \dots\dots (\text{N})$$

$$\Delta d_\text{F} = 0.25 \sqrt{\frac{d}{B} F_\text{r}} \cdot 10^{-3} \dots \{\text{kgf}\}$$

Δd_F : Decrease in the inner ring interference (mm)
d : Bearing bore diameter (mm)
B : Nominal inner ring width (mm)
F_r : Radial load on the bearing (N), {kgf}

The effective interference Δd should be larger than the interference resulting from the equation.

If the radial load exceeds 20% of the basic static load rating $C_{0\text{r}}$, the interference may be too small in these operating conditions. With this in mind, the interference should be calculated with the aid of this equation:

$$\Delta d \geqq 0.02 \frac{F_\text{r}}{B} \cdot 10^{-3} \dots\dots (\text{N})$$

$$\Delta d \geqq 0.2 \frac{F_\text{r}}{B} \cdot 10^{-3} \dots\dots \{\text{kgf}\}$$

Δd : Effective interference (mm)
F_r : Radial load on the bearing (N), {kgf}
B : Nominal inner ring width (mm)

Interference deviation due to temperature differences between the bearing and the shaft or housing

As the bearing temperature rises during operation, the effective interference is reduced. The reduction in inner ring interference resulting from this difference in temperature Δd_T can be calculated using the equation below:

$$\Delta d_T = (0.10 \sim 0.15) \cdot \Delta T \cdot \alpha \cdot d$$

$$\cong 0.0015 \, \Delta T \cdot d \times 10^{-3}$$

Δd_T : Decrease in dimensions caused by different inner ring temperature (mm)

ΔT : Temperature difference between the inside of the bearing and surrounding components (°C)

α : Coefficient of expansion of bearing steel = 12.5 x 10^{-6} (1/°C)

d : Nominal bearing bore diameter (mm)

The interference can also increase due to differences in temperature between the outer ring and the housing or differences in the coefficients of expansion.

Effective interference and surface finish of the shaft and housing

As the fit reduces the roughness of the fitting surfaces, the effective interference is lower than the apparent interference. The roughness of the surface determines the extent to which the interference is diminished. The latter can be calculated with the aid of the following equations:

For ground shafts $\quad \Delta d = \dfrac{d}{d+2} \Delta d_a$

For machined shafts $\quad \Delta d = \dfrac{d}{d+3} \Delta d_a$

Δd : Effective interference (mm)

Δd_a : Apparent interference (mm)

d : Nominal bearing bore diameter (mm)

According to these equations, the effective interference of bearings with a bore diameter of 30 to 150 mm is approximately 95% of the apparent interference.

Compressive stress, ring expansion and contraction

When bearings are installed on a shaft or in a housing with interference, the rings either expand or contract. Stress also occurs. Excessive interference can damage bearings, which is why the maximum interference should always be kept below approximately 7/10,000 of the shaft diameter.

Recommended fits

If the housing is thin or the bearing is installed on a hollow shaft, a tighter than normal fit must be used. Split housings often cause oval deformation within the bearing, so split housings should not be used if a tight fit is needed for the outer ring.

A tight fit should be used for both the inner and outer ring in applications where the shaft is exposed to strong vibrations.

Please refer to the main NSK bearing catalogue for recommended shaft and housing fits for radial bearings, thrust bearings and tapered roller bearings for common applications. Please contact NSK for advice on unusual operating conditions.