## 17. Technical data

### 17.1 Radial internal clearances vs. axial internal clearances

#### 17.1.1 Deep groove ball bearings

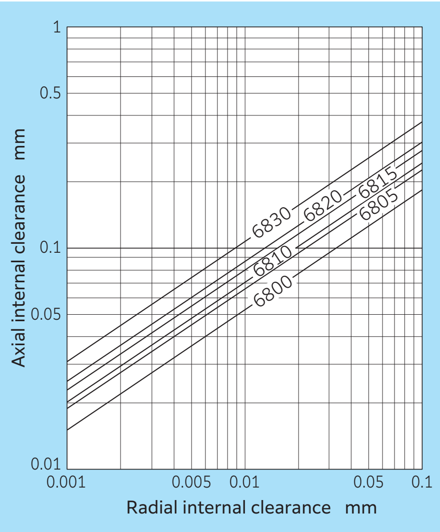



Fig. 17.1.1 Series 68 radial internal/axial internal clearances

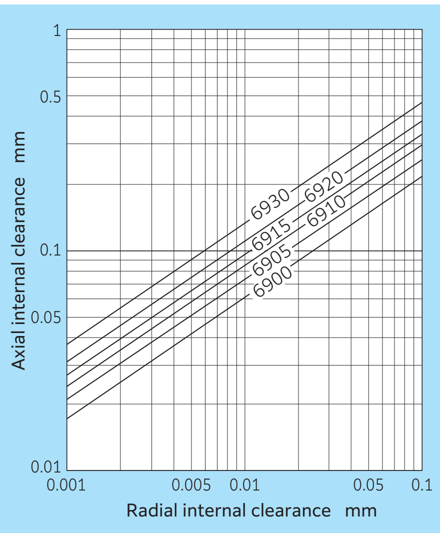



Fig. 17.1.2 Series 69 radial internal/axial internal clearances

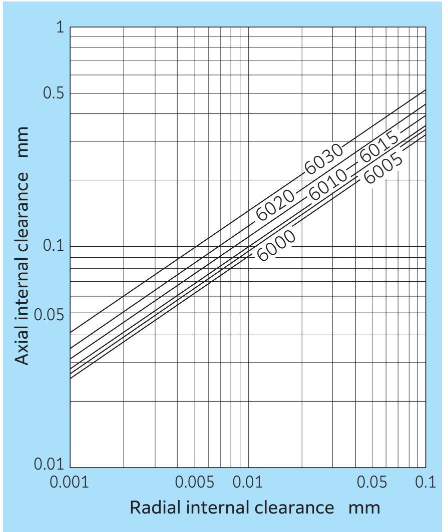



Fig. 17.1.3 Series 60 radial internal/axial internal clearances

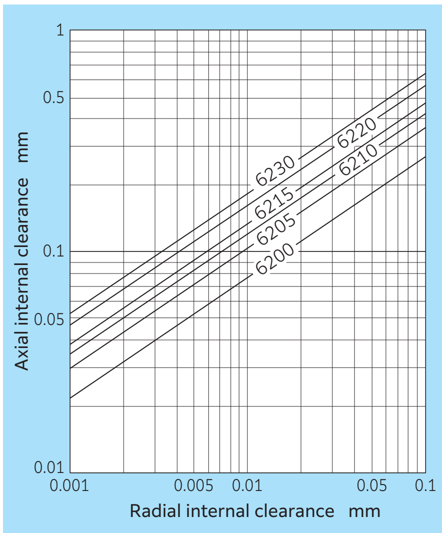



Fig. 17.1.4 Series 62 radial internal/axial internal clearances

Note: Please consult **NTN** Engineering for other types and sizes.





*This technical data shows calculated values based on representative values,
**NTN** does not guarantee these values.

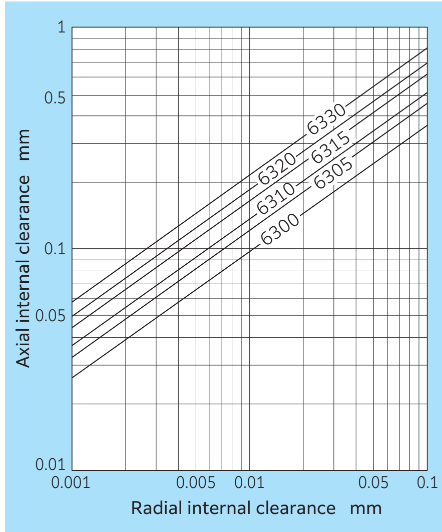



Fig. 17.1.5 Series 63 radial internal/axial internal clearances

Note: Please consult **NTN** Engineering for other types and sizes.

# Technical Data



＊This technical data shows calculated values based on representative values, **NTN** does not guarantee these values.

### 17.1.2 Double-row angular contact ball bearings

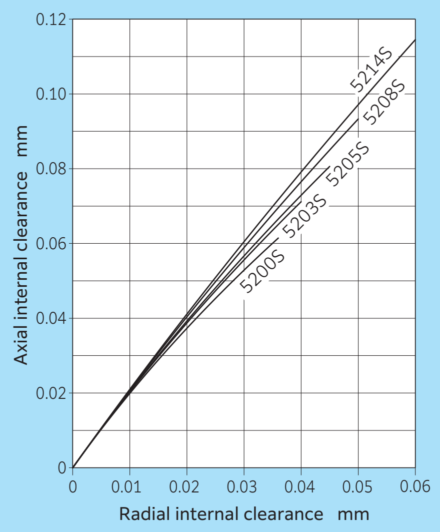



**Fig. 17.1.6 Series 52S radial internal/axial internal clearances**

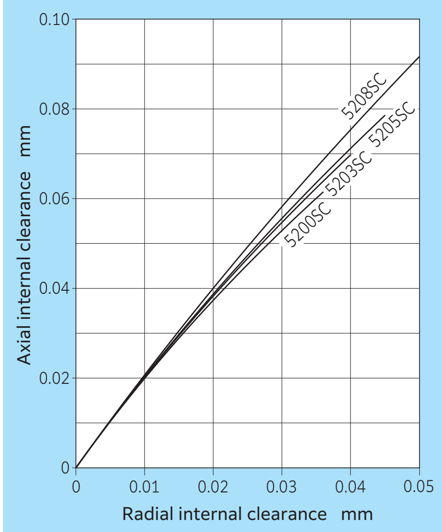



**Fig. 17.1.8 Series 52SC radial internal/axial internal clearances**

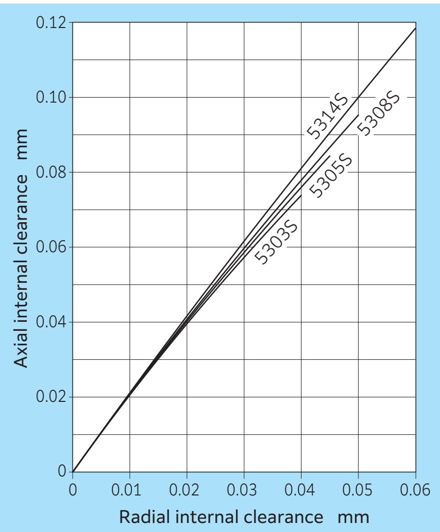



**Fig. 17.1.7 Series 53S radial internal/axial internal clearances**

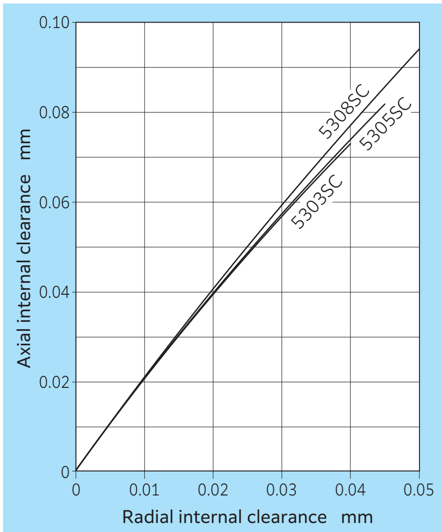



**Fig. 17.1.9 Series 53SC radial internal/axial internal clearances**

Note: Please consult **NTN** Engineering for other types and sizes.






# Technical Data

NTN

＊This technical data shows calculated values based on representative values, **NTN** does not guarantee these values.


### 17.1.3 Spherical roller bearings

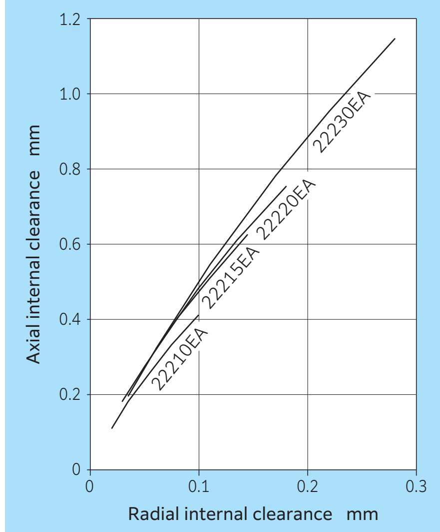



**Fig. 17.1.10 Series 222 radial internal/axial internal clearances**

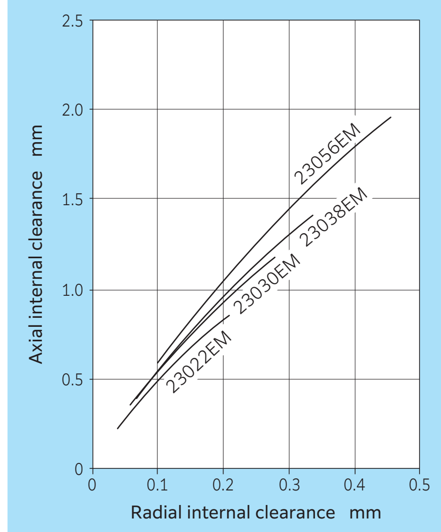



**Fig. 17.1.12 Series 230 radial internal/axial internal clearances**

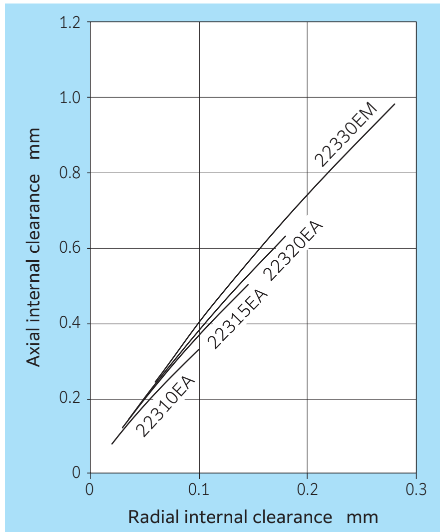



**Fig. 17.1.11 Series 223 radial internal/axial internal clearances**

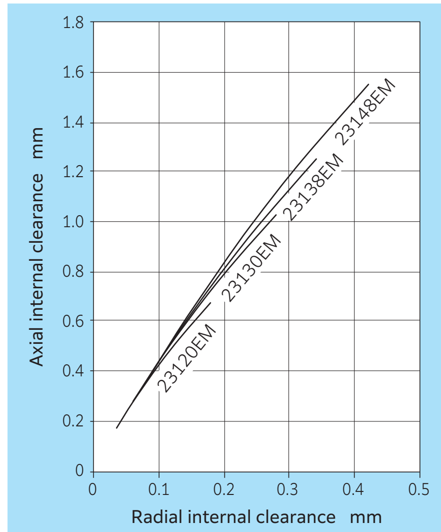



**Fig. 17.1.13 Series 231 radial internal/axial internal clearances**

Note: Please consult **NTN** Engineering for other types and sizes.

# Technical Data



∗This technical data shows calculated values based on representative values,
**NTN** does not guarantee these values.

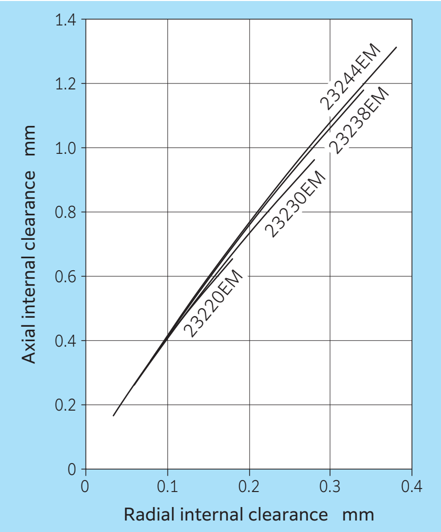



**Fig. 17.1.14 Series 232 radial internal/axial internal clearances**

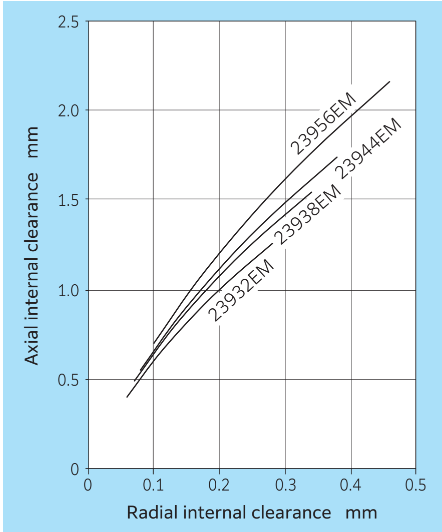



**Fig. 17.1.15 Series 239 radial internal/axial internal clearances**

Note: Please consult **NTN** Engineering for other types and sizes.





# Technical Data



∗This technical data shows calculated values based on representative values,
**NTN** does not guarantee these values.

## 17.2 Axial load vs. axial displacement

### 17.2.1 Angular contact ball bearings

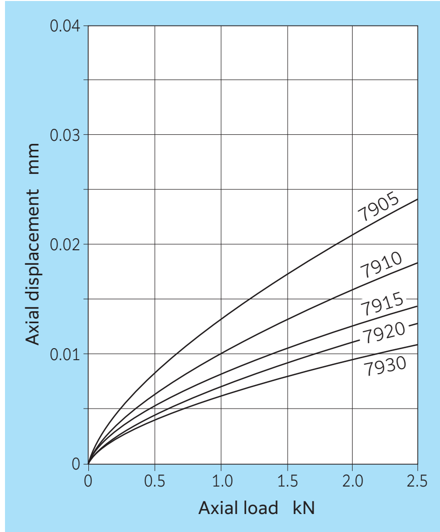



**Fig. 17.2.1 Series 79 axial load vs. axial displacement**

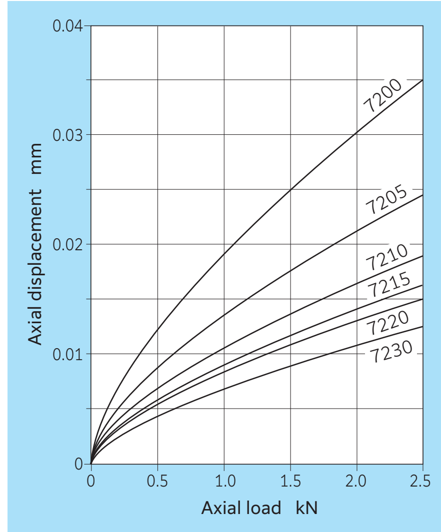



**Fig. 17.2.3 Series 72 axial load vs. axial displacement**

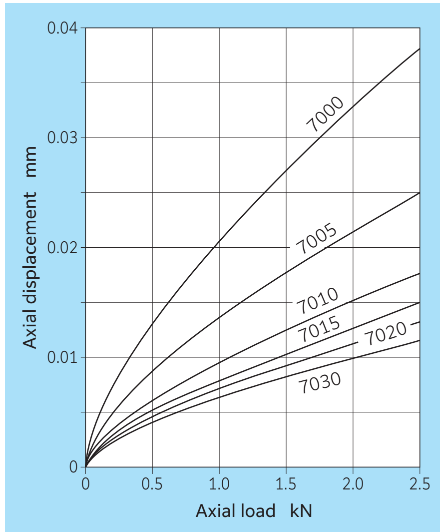



**Fig. 17.2.2 Series 70 axial load vs. axial displacement**

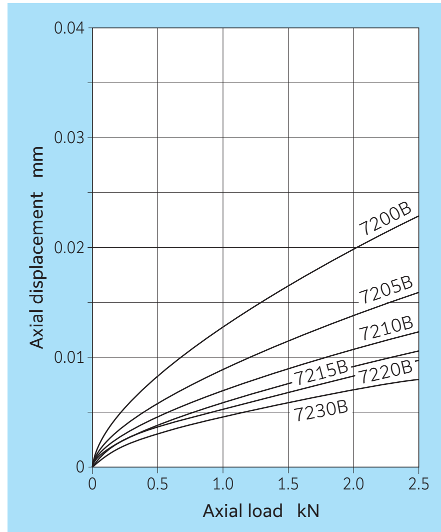



**Fig. 17.2.4 Series 72 B axial load vs. axial displacement**

Note: 1. Axial displacement may increase depending on the shape of the shaft/housing and fitting conditions.
2. Please consult **NTN** Engineering for other types and sizes.

# Technical Data



∗This technical data shows calculated values based on representative values, **NTN** does not guarantee these values.

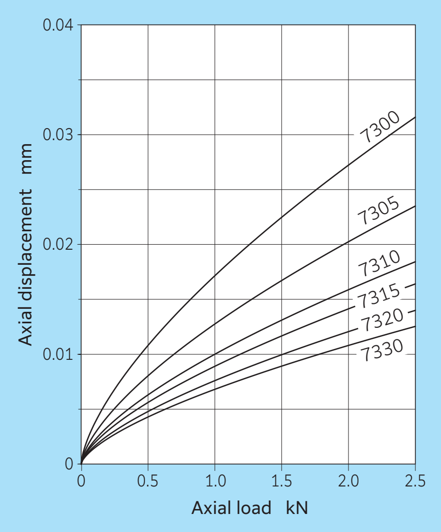



Fig. 17.2.5 Series 73 axial load vs. axial displacement

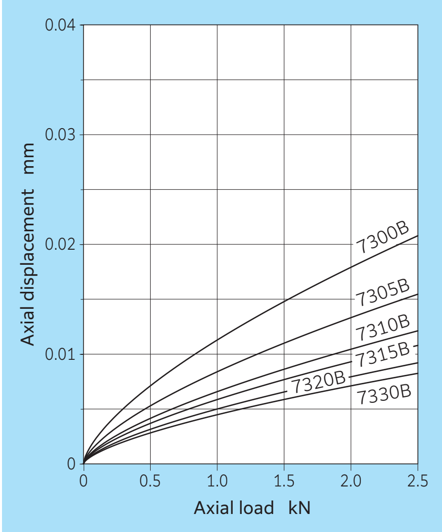



Fig. 17.2.6 Series 73B axial load vs. axial displacement

Note: 1. Axial displacement may increase depending on the shape of the shaft/housing and fitting conditions.
2. Please consult **NTN** Engineering for other types and sizes.





# Technical Data



∗This technical data shows calculated values based on representative values, **NTN** does not guarantee these values.

### 17.2.2 Tapered roller bearings

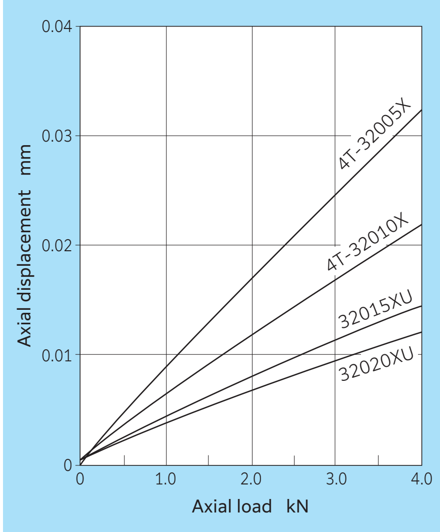



Fig. 17.2.7 Series 320 axial load vs. axial displacement

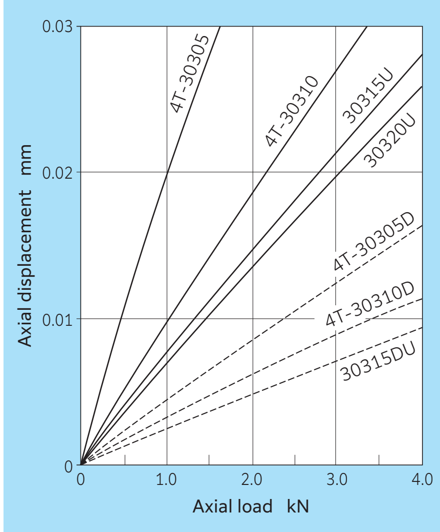



Fig. 17.2.9 Series 303/303 D axial load vs. axial displacement

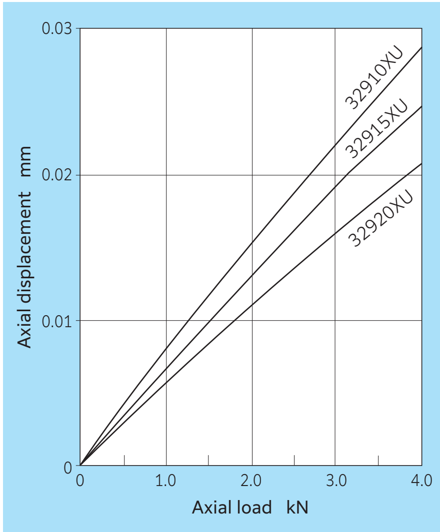



Fig. 17.2.8 Series 329 axial load vs. axial displacement

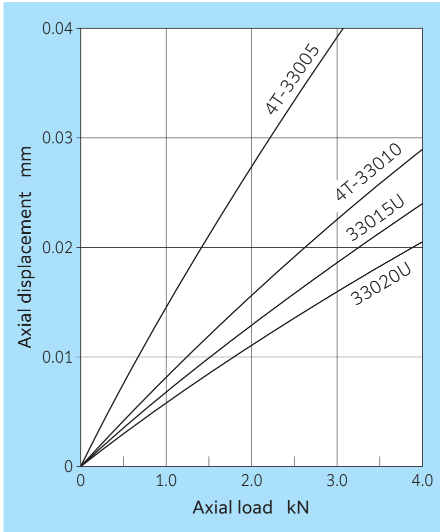



Fig. 17.2.10 Series 330 axial load vs. axial displacement

Note: 1. Values when the shaft and the housing are rigid bodies.
2. Axial displacement may increase depending on the shape of the shaft/housing and fitting conditions.
3. Please consult **NTN** Engineering for other types and sizes.

＊This technical data shows calculated values based on representative values, **NTN** does not guarantee these values.

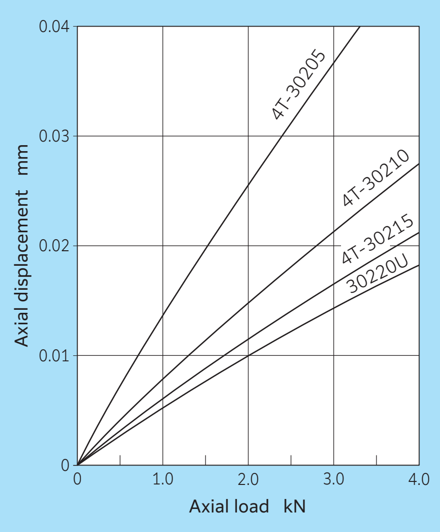



**Fig. 17.2.11 Series 302 axial load vs. axial displacement**

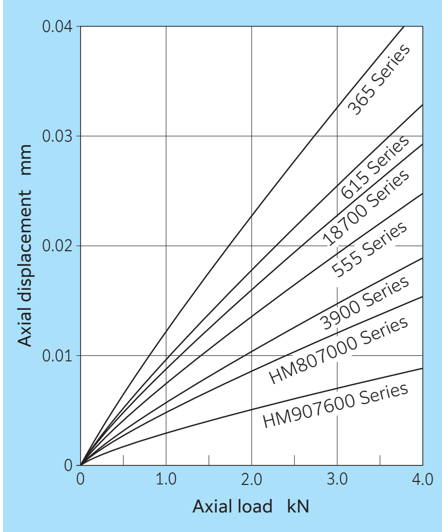



**Fig. 17.2.12 Inch series axial load vs. axial displacement**

Note: 1. Values when the shaft and the housing are rigid bodies.
2. Axial displacement may increase depending on the shape of the shaft/housing and fitting conditions.
3. Please consult **NTN** Engineering for other types and sizes.





＊This technical data shows calculated values based on representative values, **NTN** does not guarantee these values.

## 17.3 Allowable axial load

### 17.3.1 Deep groove ball bearings

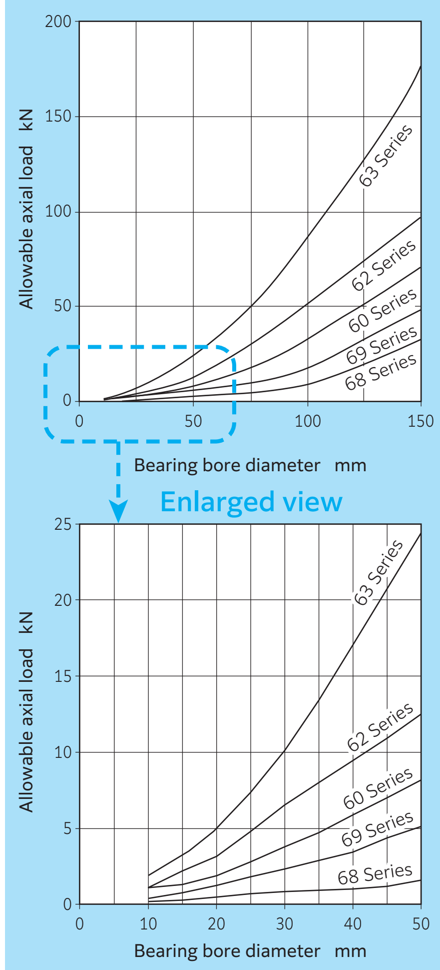



**Fig. 17.3.1 Allowable axial load for deep groove ball bearings**

Note: 1. Calculation of the allowable axial load uses the median of the radial clearance CN.
2. When an axial load is applied, the allowable axial load is the load whereby the contact ellipse exceeds the shoulder of the raceway.
3. Please consult **NTN** Engineering for other types and sizes.

### 17.3.2 Angular contact ball bearings

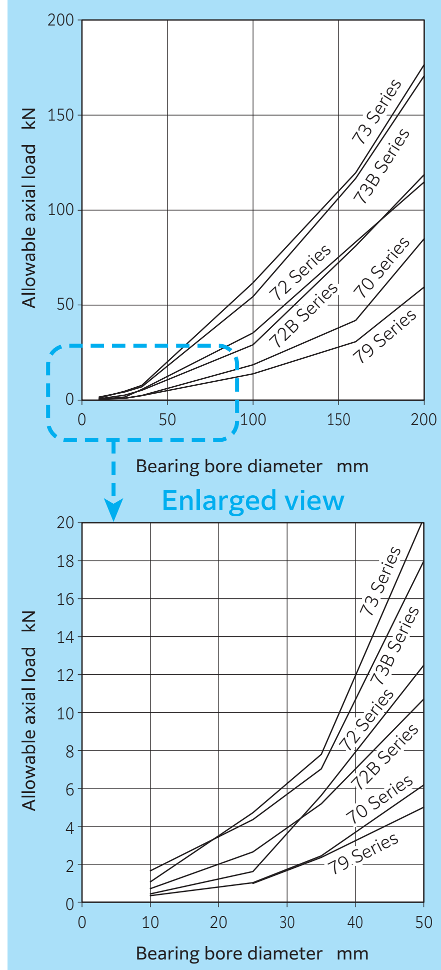



**Fig. 17.3.2 Allowable axial load for angular contact ball bearings**

Note: 1. When an axial load is applied, the allowable axial load is the load whereby the contact ellipse exceeds the shoulder of the raceway.
2. Please consult **NTN** Engineering for other types and sizes.

### 17.4 Fitting surface pressure

**Table 17.4.1** lists formulas for calculating the pressure and maximum stress between fitting surfaces.

**Table 17.4.2** can be used to determine the approximate average raceway diameter for bearing inner and outer rings.

The effective interference, in other words the actual interference $\Delta_{deff}$ after fitting, is smaller than the apparent interference $\Delta d$ derived from the measured values for the bearing bore diameter and shaft. This difference is due to the roughness or variations of the finished surfaces to be fitted. Due to this, it is necessary to assume the following reductions in effective interference:

For ground shafts: 1.0 to 2.5 $\mu$m
For lathed shafts: 5.0 to 7.0 $\mu$m

**Fig. 17.4.1** and **Fig. 17.4.2** show the root approximate values of the fitting surface pressure and the maximum stress when the solid steel shaft and the inner ring of Class 0 bearings ($d/D_i$ = 0.8) are fit.

**Table 17.4.1 Fitting surface pressure and maximum stress**

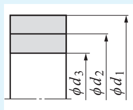
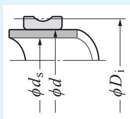
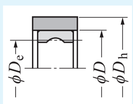
| Fit condition | | Calculation formula | Symbol (Unit: MPa, mm) |
|---|---|---|---|
| Fitting surface pressure | Two cylinders General type | $P=\dfrac{E_1\ E_2}{E_2\left\{\dfrac{(d_1^2+d_2^2)}{(d_1^2-d_2^2)}+\nu_1\right\}+E_1\left\{\dfrac{(d_2^2+d_3^2)}{(d_2^2-d_3^2)}-\nu_2\right\}}\cdot\dfrac{\Delta d_e}{d_2}$ | $P$ : Fitting surface pressure<br>$E_1, E_2$: Longitudinal elasticity factor of outer and inner cylinders<br>$\nu_1, \nu_2$ : Poisson's ratio of outer and inner cylinders<br>$\Delta d_e$ : Effective interference of two cylinders<br><br> |
| | Solid steel shaft/ inner ring fit | $P=\dfrac{E}{2}\ \dfrac{\Delta_{deff}}{d}\left[1-\left(\dfrac{d}{D_i}\right)^2\right]$ | $d$ : Shaft diameter, inner ring bore diameter<br>$d_s$ : Hollow shaft bore diameter<br>$D_i$ : Inner ring average raceway diameter<br>$\Delta_{deff}$ : Effective interference<br>$E$ : Longitudinal elasticity factor = 208 000 MPa<br><br> |
| | Hollow steel shaft/ inner ring fit | $P=\dfrac{E}{2}\ \dfrac{\Delta_{deff}}{d}\ \dfrac{[1-(d/D_i)^2]\,[1-(d_s/d)^2]}{[1-(d_s/D_i)^2]}$ | |
| | Steel housing/ outer ring fit | $P=\dfrac{E}{2}\ \dfrac{\Delta_{Deff}}{D}\ \dfrac{[1-(D_e/D)^2]\,[1-(D/D_h)^2]}{[1-(D_e/D_h)^2]}$ | $D$ : Housing bore diameter, outer ring outside diameter<br>$D_e$ : Outer ring average raceway diameter<br>$D_h$ : Housing outside diameter<br>$\Delta_{Deff}$: Effective interference<br><br> |
| Maximum stress | Shaft/ inner ring fit | $\sigma_{t\ max}=P\ \dfrac{1+(d/D_i)^2}{1-(d/D_i)^2}$ | $\sigma_{t\ max}$: Maximum stress<br>Inner ring bore diameter maximum circumferential stress. |
| | Housing/ outer ring fit | $\sigma_{t\ max}=P\ \dfrac{2}{1-(D_e/D)^2}$ | Outer ring outside diameter maximum circumferential stress. |





**Table 17.4.2 Average raceway diameter (approximate expression)**

| Bearing type | | Average raceway diameter (mm) | |
|---|---|---|---|
| | | Inner ring ($D_i$) | Outer ring ($D_e$) |
| Ball bearings | All types | $1.05\ \dfrac{4d+D}{5}$ | $0.95\ \dfrac{d+4D}{5}$ |
| Self-aligning ball bearings | 12 | $1.03\ \dfrac{3d+D}{4}$ | $0.97\ \dfrac{d+2D}{3}$ |
| | 13, 22 | $1.03\ \dfrac{3d+D}{4}$ | $0.97\ \dfrac{d+3D}{4}$ |
| | 23 | $1.03\ \dfrac{4d+D}{5}$ | $0.97\ \dfrac{d+4D}{5}$ |
| Cylindrical roller bearings [1)] | All types | $1.05\ \dfrac{3d+D}{4}$ | $0.98\ \dfrac{d+3D}{4}$ |
| Spherical roller bearings | Type B, type C, type 213 | $\dfrac{2d+D}{3}$ | $0.97\ \dfrac{d+4D}{5}$ |
| | ULTAGE™ series | $\dfrac{3d+D}{4}$ | $0.98\ \dfrac{d+5D}{6}$ |
| Tapered roller bearings | All types | $\dfrac{3d+D}{4}$ | $\dfrac{d+3D}{4}$ |

1) Average raceway diameter values when both side ribs are incorporated.
Note: $d$: inner ring bore diameter (mm) $D$: outer ring outside diameter (mm)

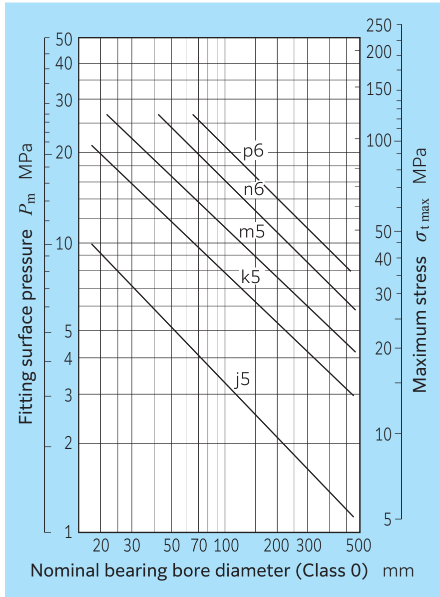



**Fig. 17.4.1** Average fit interference as it relates to surface pressure $P_m$ and maximum stress $\sigma_{t\ max}$

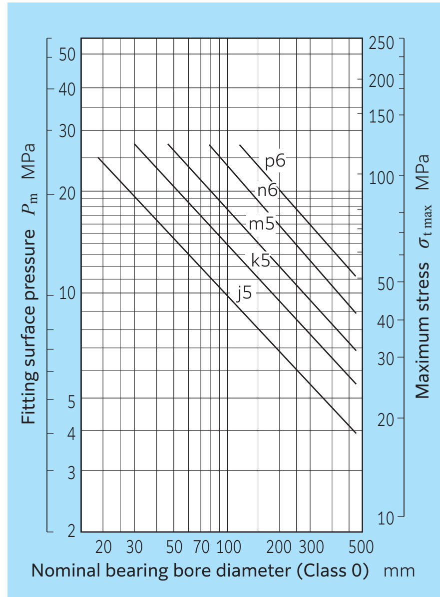



**Fig. 17.4.2** Maximum fit interference as it relates to surface pressure $P_m$ and maximum stress $\sigma_{t\ max}$

Note: For the recommended fitting, see the section of "7.3.2 Recommended fits".

### 17.5 Necessary press fit and pullout force

Formula (17.1) and formula (17.2) below can be used to calculate the necessary pullout force for press fits/pullout on inner rings and shafts or outer rings and housings. The force obtained by the formulas only serves as an approximation, and a larger load may be required for the actual installation and removal.

For shaft and inner rings:

$$K_d = \mu \cdot P \cdot \pi \cdot d \cdot B \quad \cdots\cdots (17.1)$$

For housing and outer rings:

$$K_D = \mu \cdot P \cdot \pi \cdot D \cdot B \quad \cdots\cdots (17.2)$$

Where:

$K_d$ : Inner ring press fit or pullout force, N
$K_D$ : Outer ring press fit or pullout force, N
$P$ : Fitting surface pressure, MPa (see **Table 17.4.1**)
$d$ : Shaft diameter, inner ring bore diameter, mm
$D$ : Housing bore diameter, outer ring outside diameter, mm
$B$ : Inner or outer ring width, mm
$\mu$ : Sliding friction coefficient (see **Table 17.5**)

**Table 17.5 Press fit and pullout sliding friction coefficient**

| Concern | $\mu$ |
|---|---|
| Inner (outer) ring press fit onto cylindrical shaft (bore) | 0.12 |
| Inner (outer) ring pullout from cylindrical shaft (bore) | 0.18 |
| Inner ring press fit onto tapered shaft or sleeve | 0.17 |
| Inner ring pullout from tapered shaft | 0.14 |
| Sleeve press fit onto shaft/bearing | 0.30 |
| Sleeve pullout from shaft/bearing | 0.33 |

### 17.6 Bearing technique calculation tool

The following calculations can be performed by using the bearing technique calculation tool on the **NTN** website (https://www.ntnglobal.com).

- Basic rating life calculation of single bearing
- Basic rating life calculation of gear load and bearing
- Basic rating life calculation of bearing load and bearing
- Calculation of operating clearance
- Calculation of bearing vibration frequency