Spherical roller bearings

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Spherical roller bearings have two rows of rollers with a common sphered raceway in the outer ring and two inner ring raceways inclined at an angle to the bearing axis (➔ fig 1). This gives them an attractive combination of design features making them irreplaceable in many demanding applications. They are self-aligning and consequently insensitive to misalignment of the shaft relative to the housing and to shaft deflection or bending.

SKF spherical roller bearings are leading in design and can, in addition to high radial loads, accommodate high axial loads acting in both directions.

**Standard bearings**

The standard range of SKF spherical roller bearings comprises

- open bearings,
- sealed bearings and
- bearings for vibratory applications.

In addition to the standard range, SKF offers a wide range of special spherical roller bearings adapted for specific applications.

**Open bearings**

SKF spherical roller bearings are produced in several designs, depending on bearing series and size. The differences are

- the arrangement of the floating guide ring as well as
- the design of the inner ring and the cages,

as described in the following and shown in fig 2.

- **C(J), CC** Two window-type steel cages, flangeless inner ring and guide ring centred on the inner ring (a).
- **EC(J), ECC(J)** Two window-type steel cages, flangeless inner ring, guide ring centred on the inner ring and reinforced roller complement (a).
- **CA, CAC** One-piece machined brass cage of the double-pronged type, retaining flanges on the inner ring and guide ring centred on the inner ring (b).
- **CAF** As CA, but with a steel cage
- **ECA, ECAC** One-piece machined brass cage of the double-pronged type, retaining flanges on the inner ring, guide ring centred on the inner ring and reinforced roller complement (b).
- **ECAF** As ECA, but with a steel cage
- **E** When bearing bore diameter \( d \leq 65 \text{ mm} \):
  - Two window-type steel cages, flangeless inner ring and guide ring centred on the inner ring (c).
- **CAFA** One-piece machined steel cage of the double-pronged type centred on the outer ring raceway, retaining flanges on the inner ring and guide ring centred on the cages (d).
- **CAMA** As CAFA, but with a brass cage
Spherical roller bearings

Influence of operating temperature on bearing material
All SKF spherical roller bearings undergo a special heat treatment so that they can be operated at higher temperatures for longer periods, without the occurrence of inadmissible dimensional changes. For example, a temperature of +200 °C for 2 500 h, or for short periods at even higher temperatures is permitted.

Axial load carrying capacity
Because of their special internal design, SKF spherical roller bearings are able to accommodate heavy axial loads and even purely axial loads.

Axial load carrying capacity of bearings mounted on an adapter sleeve
If spherical roller bearings with adapter sleeves are mounted on smooth shafts with no fixed abutment, the magnitude of the axial load that can be supported is determined by the friction between the shaft and sleeve. Provided the bearings are correctly mounted, the permissible axial load can be calculated from

\[ F_{ap} = 0,003 B d \]

where
\[ F_{ap} = \text{maximum permissible axial load, kN} \]
\[ B = \text{bearing width, mm} \]
\[ d = \text{bearing bore diameter, mm} \]

Minimum load
In order to provide satisfactory operation, spherical roller bearings, like all ball and roller bearings, must always be subjected to a given minimum load, particularly if they are to operate at high speeds or are subjected to high accelerations or rapid changes in the direction of load. Under such conditions the inertia forces of the rollers and cage(s), and the friction in the lubricant, can have a detrimental influence on the rolling conditions in the bearing arrangement and may cause damaging sliding movements to occur between the rollers and raceways.

The requisite minimum load to be applied to spherical roller bearings can be estimated using

\[ P_{0m} = 0,01 C_0 \]

where
\[ P_{0m} = \text{minimum equivalent static load, kN} \]
\[ C_0 = \text{basic static load rating, kN} \]

In some applications it is not possible to reach or exceed the requisite minimum load. However, if the bearing is oil lubricated lower minimum loads are permissible. These loads can be calculated when \( n/n_r \leq 0,3 \) from

\[ P_{0m} = 0,003 C_0 \]

and when \( 0,3 < n/n_r \leq 2 \) from

\[ P_{0m} = 0,003 C_0 \left( 1 + 2 \sqrt{\frac{n}{n_r} - 0,3} \right) \]

where
\[ P_{0m} = \text{minimum equivalent static bearing load, kN} \]
\[ C_0 = \text{basic static load rating, kN} \]
\[ n = \text{rotational speed, r/min} \]
\[ n_r = \text{reference speed, r/min} \]

When starting up at low temperatures or when the lubricant is highly viscous, even greater minimum loads than \( P_{0m} = 0,01 C_0 \) may be required. The weight of the components supported by the bearing, together with external forces, generally exceeds the requisite minimum load. If this is not the case, the spherical roller bearing must be subjected to an additional radial load.

NoWear spherical roller bearings have proven to give reliable operation at very low loads. They can withstand longer periods of insufficient lubrication, sudden variations in load and rapid speed changes (➔ page 939).
**Equivalent dynamic bearing load**

For dynamically loaded spherical roller bearings

\[
P = F_r + Y_1 F_a \quad \text{when} \quad F_a/F_r \leq e \\
P = 0.67 F_r + Y_2 F_a \quad \text{when} \quad F_a/F_r > e
\]

The values of the calculation factors e, Y1, and Y2 will be found in the product tables.

**Equivalent static bearing load**

For statically loaded spherical roller bearings

\[
P_0 = F_r + Y_0 F_a
\]

The value of the calculation factor Y0 will be found in the product tables.

**Supplementary designations**

The designation suffixes used to identify certain features of SKF spherical roller bearings are explained in the following. The suffixes used to identify bearing (and cage) design, e.g. CC or E, are not included here as they are explained in the section “Standard bearings” on page 692.

- **C2**: Radial internal clearance smaller than Normal
- **C3**: Radial internal clearance greater than Normal
- **C4**: Radial internal clearance greater than C3
- **C5**: Radial internal clearance greater than C4
- **C08**: Heightened running accuracy to ISO tolerance class 5
- **C083**: C08 + C3
- **C084**: C08 + C4
- **2CS**: Sheet steel reinforced contact seal of acrylonitrile butadiene rubber (NBR) on both sides of the bearing. Annular groove and three lubrication holes in the outer ring covered with a polymer band. Lubricated with an extreme pressure bearing grease according to table on page 694

- **2CS2**: Sheet steel reinforced contact seal of fluoro rubber (FPM) on both sides of the bearing. Annular groove and three lubrication holes in the outer ring; covered with a polymer band. Lubricated with a polyurea high temperature grease
- **2CS5**: Sheet steel reinforced contact seal of hydrogenated acrylonitrile butadiene rubber (HNBR) on both sides of the bearing. Otherwise as 2CS2
- **HA3**: Inner ring of case-hardening steel
- **K**: Tapered bore, taper 1:12
- **K30**: Tapered bore, taper 1:30
- **P5**: Dimensional and running accuracy to ISO tolerance class 5
- **P6**: Dimensional and running accuracy to ISO tolerance class 6
- **P62**: P6 + C2
- **VA405**: Bearings for vibratory applications with surface hardened cages
- **VA406**: VA405 and PTFE-coated bore
- **VE552(E)**: Outer ring with three equally spaced threaded holes in one side face to accommodate hoisting tackle; the E indicates that appropriate eye bolts are supplied with the bearings
- **VE553(E)**: As VE552 but with threaded holes in both side faces
- **VG114**: Surface hardened pressed steel cage
- **VQ424**: Running accuracy better than C08
- **VT143**: Grease fill with an extreme pressure grease according to table on page 694
- **W**: Without annular groove and lubrication holes in outer ring
- **W20**: Three lubrication holes in the outer ring
- **W26**: Six lubrication holes in the inner ring
- **W33**: Annular groove and three lubrication holes in the outer ring
- **W64**: Solid Oil filling
- **W77**: Plugged W33 lubrication holes
- **W513**: W26 + W33
- **235220**: Inner ring of case-hardened steel with helical groove in bore
### Spherical roller bearings

**d 20 – 70 mm**

<table>
<thead>
<tr>
<th>Principal dimensions</th>
<th>Basic load ratings</th>
<th>Fatigue load limit</th>
<th>Speed ratings</th>
<th>Mass</th>
<th>Designations</th>
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<td>r/min</td>
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<td>tapered bore</td>
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<th>r1</th>
<th>r2</th>
<th>r3</th>
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* SKF Explorer bearing
### Dimensions

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<th>d</th>
<th>d₂</th>
<th>D₁</th>
<th>b</th>
<th>K</th>
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<th>dₐ</th>
<th>Dₐ</th>
<th>rₐ</th>
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<td>mm</td>
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|      |      |      |      |

**Table Data**

- **d** = 20 mm
  - d₂: 31.2 mm
  - D₁: 44.2 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1
  - dₐ min: 25.6 mm
  - Dₐ max: 46.4 mm
  - rₐ max: 1
  - e: 0.35
  - Y₁: 1.9
  - Y₂: 2.9
  - Y₀: 1.8

- **d** = 25 mm
  - d₂: 31.2 mm
  - D₁: 44.2 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 30.6 mm
  - Dₐ max: 46.4 mm
  - rₐ max: 1
  - e: 0.35
  - Y₁: 1.9
  - Y₂: 2.9
  - Y₀: 1.8

- **d** = 30 mm
  - d₂: 35.7 mm
  - D₁: 50.7 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1
  - dₐ min: 35.6 mm
  - Dₐ max: 56.4 mm
  - rₐ max: 1
  - e: 0.31
  - Y₁: 2.2
  - Y₂: 3.3
  - Y₀: 2.2

- **d** = 35 mm
  - d₂: 43.3 mm
  - D₁: 58.8 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 42.6 mm
  - Dₐ max: 56.4 mm
  - rₐ max: 1
  - e: 0.31
  - Y₁: 2.2
  - Y₂: 3.3
  - Y₀: 2.2

- **d** = 40 mm
  - d₂: 49.6 mm
  - D₁: 69.4 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 47.7 mm
  - Dₐ max: 65.6 mm
  - rₐ max: 1
  - e: 0.28
  - Y₁: 2.4
  - Y₂: 3.6
  - Y₀: 2.5

- **d** = 45 mm
  - d₂: 54.9 mm
  - D₁: 74.4 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 52.7 mm
  - Dₐ max: 78.1 mm
  - rₐ max: 1
  - e: 0.26
  - Y₁: 2.6
  - Y₂: 3.9
  - Y₀: 2.5

- **d** = 50 mm
  - d₂: 59.9 mm
  - D₁: 79.0 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 57.8 mm
  - Dₐ max: 83.1 mm
  - rₐ max: 1
  - e: 0.24
  - Y₁: 2.8
  - Y₂: 4.2
  - Y₀: 2.8

- **d** = 55 mm
  - d₂: 65.3 mm
  - D₁: 87.9 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 54.9 mm
  - Dₐ max: 91.5 mm
  - rₐ max: 1
  - e: 0.24
  - Y₁: 2.8
  - Y₂: 4.2
  - Y₀: 2.8

- **d** = 60 mm
  - d₂: 72.6 mm
  - D₁: 96.3 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 69.1 mm
  - Dₐ max: 101.5 mm
  - rₐ max: 1
  - e: 0.24
  - Y₁: 2.8
  - Y₂: 4.2
  - Y₀: 2.8

- **d** = 65 mm
  - d₂: 87.8 mm
  - D₁: 115.5 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 72.1 mm
  - Dₐ max: 128.2 mm
  - rₐ max: 2
  - e: 0.24
  - Y₁: 2.8
  - Y₂: 4.2
  - Y₀: 2.8

- **d** = 70 mm
  - d₂: 83.0 mm
  - D₁: 111.5 mm
  - b: 3.7 mm
  - K: 2
  - r₁,₂: 1,1
  - dₐ min: 79.1 mm
  - Dₐ max: 116.1 mm
  - rₐ max: 1
  - e: 0.24
  - Y₁: 2.8
  - Y₂: 4.2
  - Y₀: 2.8

**Diagram**

- Dimensions Abutment and Calculation factors
- Fillet dimensions
- d, d₂, D₁, b, K, r₁,₂, dₐ, Dₐ, rₐ, e, Y₁, Y₂, Y₀
### Spherical roller bearings

**d 75 – 110 mm**

![Diagram of cylindrical and tapered bore bearings](image)

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<tr>
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<th>Fatigue load limit</th>
<th>Speed ratings</th>
<th>Mass</th>
<th>Designations</th>
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