Bearing designs

Cylindrical roller bearings and units

Extract from the Railway technical handbook, volume 1, chapter 4, page 88 to 95

Cylindrical roller bearings and units

Cylindrical roller bearings and units are used for all kinds of railway rolling stock. These bearings are typically applied as sets of two single row bearings. The rollers in a single row cylindrical roller bearing are guided between the integral "open" flanges of the outer rings. These "open" flanges, combined with the specially designed and surface treated roller ends, provide improved lubrication, reduced friction and consequently lower operating temperatures. The outer ring with the integral flanges, together with the cylindrical roller and cage assembly, can be separated from the inner ring. This enables easy mounting and dismounting (→ **page 184**).

The main cylindrical roller bearing designs and sizes are described here in detail. For further application requirements, special bearing designs and sizes can be supplied on request. SKF has already introduced to the railway industry the next generation of cylindrical roller bearings, which is a sealed and ready-to-mount cylindrical roller bearing unit – called CRU. This design offers further benefits to railway customers (→ **page 92**).

Cylindrical roller bearings

SKF cylindrical roller axlebox bearings are manufactured in several designs, the main difference being in the configuration of the flanges.

NJ / NJP design also called WJ / WJP

A typical axlebox assembly is equipped with a set of NJ / NJP (WJ / WJP) cylindrical roller bearings.

This design is offered for full bore axleboxes with a closed front cover. The most popular are the NJ and NJP designs, which comply with DIN 5412-11. In this German standard, the bearings are called WJ referring to the NJ design and WJP referring to the NJP design, to be able to differentiate the specific axlebox bearing design from standard bearings. The reason for this specific designation is that some boundary dimensions of these bearing designs deviate from standard catalogue bearings.

The main benefit is a rather small bearing width providing a shorter axle journal, which results in reduced axle bending. This reduces micro-movement of inner rings on the journal and lowers the risk of fretting corrosion. The NJ / NJP (WJ / WJP) cylindrical roller bearing design is very common in some European countries and with customers outside Europe who prefer these bearing and axlebox designs.

NJ (WJ) design

The outer ring has two integral flanges and the inner ring one integral flange. The bearing is therefore suitable for the axial location of a shaft in one direction. This bearing design is widely used for the wheel side position of the axlebox bearing set.

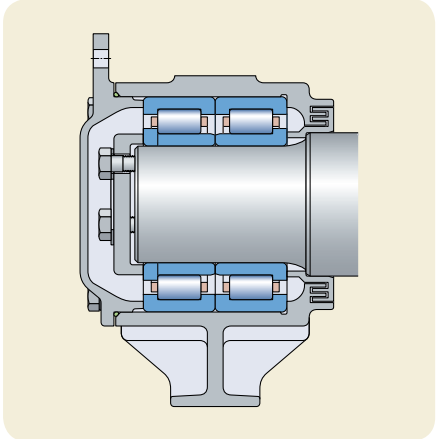
NJP (WJP) design

The outer ring has two integral flanges and the inner ring one non-integral flange in the form of a loose flange ring. This bearing design is widely used for the outer side position of the axlebox bearing set.

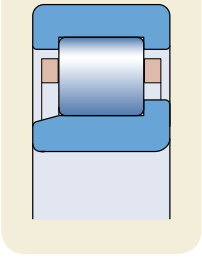
German standard

In DIN 5412-11, not only boundary dimensions are standardized, but also the internal design, including radial and axial clearance. For example, for the bearing size WJ / WJP 130 x 240 P, clearances are:

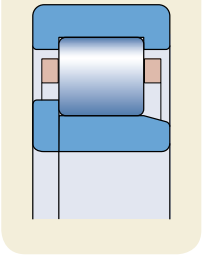
- Radial clearance: 0,130 to 0,180 mm
- Axial clearance: 0,400 to 0,900 mm for a bearing set



Typical axlebox assembly equipped with a set of NJ / NJP cylindrical roller bearings also called WJ / WJP cylindrical roller bearings



NJ (WJ) design



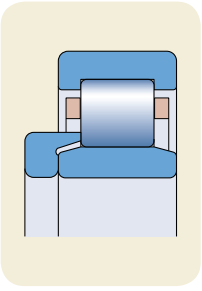
NJP (WJP) design

NJ / NU design with an HJ angle ring

This design is based on an NJ design bearing located at the wheel side position and previously described. On the opposite side, an NU design bearing is applied in combination with an HJ angle ring. This bearing arrangement requires a slightly longer axle because of the width of the additional angle ring. This design is an alternative to the previous one, but offers easier mounting because of the lead-in function (tapered transition between inner ring raceway and inner ring side faces).

NU design + HJ angle ring

The outer ring of NU design bearings has two integral flanges and the inner ring is without flanges. The NU design bearing, combined with an HJ angle ring, is used for the outer side position of the bearing set. The HJ angle ring for axlebox applications is usually specially designed to meet the requirements for axial clearance.



NU design + HJ angle ring

Polymer cage

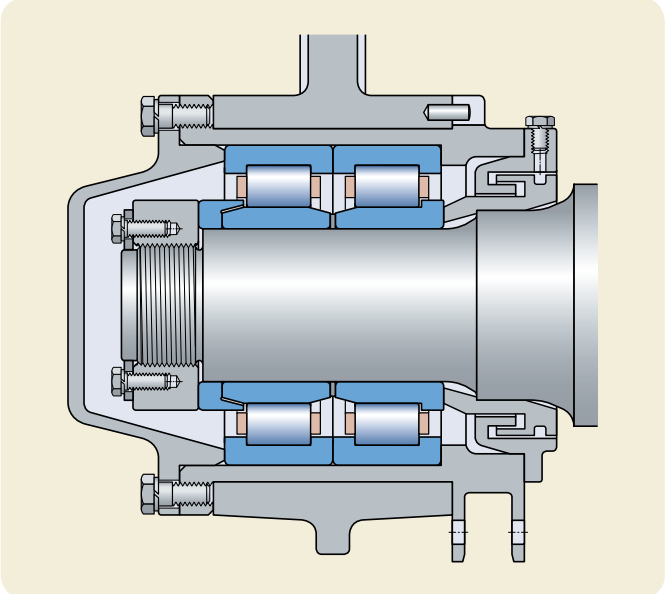
A key component in achieving reliability and safety of cylindrical roller bearing units is the cage. Cages in rolling bearings perform many functions:

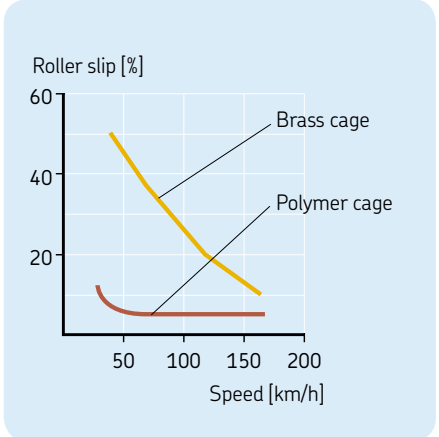
- During operation, the rolling elements pass from the loaded into the unloaded zone where the cage has to guide the rolling elements.
- Provide and distribute lubricant and dampen vibrations.
- Provide correct retention of the rolling elements during mounting and maintenance operations, thus enabling easier handling.

Historically, machined brass cages were used for cylindrical roller bearings. Today, mainly polymer cages are used. Pressed steel cages are only applied upon a customer's request. Polymer cages have been in service since 1990 with excellent results (→ **page 81**).

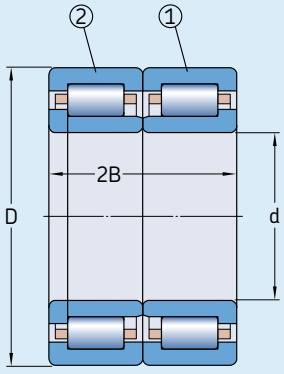
SKF polymer cage for cylindrical roller bearings

Typical application of an axlebox assembly fitted with a combination of a set of NJ / NU cylindrical roller bearings and an HJ angle ring

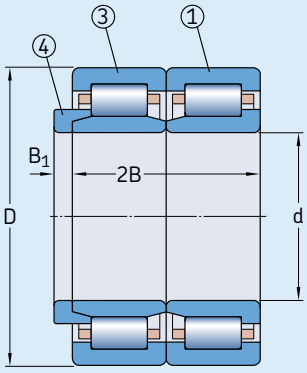




Roller slip of a cylindrical roller bearing equipped with a brass cage or a polymer cage



Type WJ + WJP or NJ + NJP



Type NJ + NU + HJ angle ring

① WJ and NJ design
② WJP and NJP design
③ NU design
④ HJ angle ring

Size	Principal dimensions				Basic designation
	d	D	2B	B_1	
–	mm				–
CRB 90 x 160	90	160	104,8	–	**WJ / WJP 90 x 160P**[1]
CRB 100 x 180	100	180	120,6	–	**WJ / WJP 100 x 180P**[1]
CRB 120 x 215	120	215	146	–	**WJ / WJP 120 x 215P**[1]
CRB 120 x 240	120	240	160	–	**WJ / WJP 120 x 240P**[1]
CRB 130 x 220	130	220	122	–	**WJ / WJP 130 x 220P**[1]
CRB 130 x 240	130	240	160	–	**WJ / WJP 130 x 240P**[1]
CRB 130 x 250	130	250	160	–	**WJ / WJP 130 x 250P**
CRB 150 x 270	150	270	146	12	**NJ 2230 EC / NU 2230 EC / HJ 2230 EC**
CRB 180 x 320	180	320	172	–	**NJ 2236 EC / NJP 2236 EC**

These figures are for information only. Contact SKF for detailed product specifications.

[1] In accordance with the German standard DIN 5412-11

Cylindrical roller bearing units

SKF has introduced to the railway market the CRU – a cylindrical roller bearing unit. This design is based on the long term experience of cylindrical roller bearings. The unit's design offers bogie and vehicle suppliers and railway operators the advantage of a sealed and factory pre-lubricated unit that is easy to mount. The critical greasing procedure is moved from the wheelset workshop environment to the location for bearing production where greasing can be done in a very clean environment using the right grease, grease quantity and distribution inside the bearing (→ **page 17**). The sealing is designed as a labyrinth seal which has no friction and wear during operation. This design is offered for full bore axleboxes with a closed front cover.

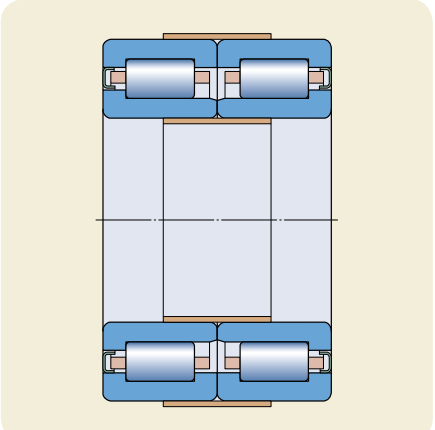
Short CRU design

The short CRU version has a rather small width like the NJ / NJP (WJ / WJP) design, which contributes to a more compact axlebox design and a shorter axle journal. This results in reduced axle bending and movement between the journal seat and bearing, which in turn results in less wear.

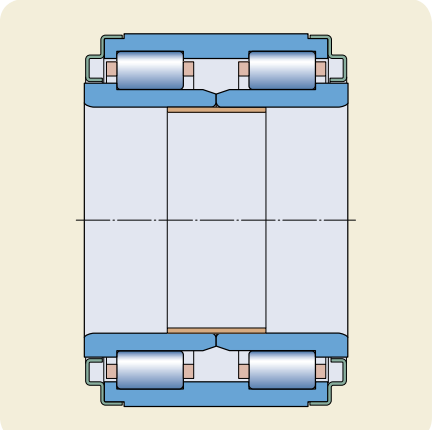
A mounting sleeve is inserted inside the bore of the inner rings to facilitate mounting. The sleeve is automatically removed by pressing the inner rings onto the journal of the wheelset. In addition, a sleeve on the outer ring enables easier pushing the unit into the axlebox bore.

Long CRU design

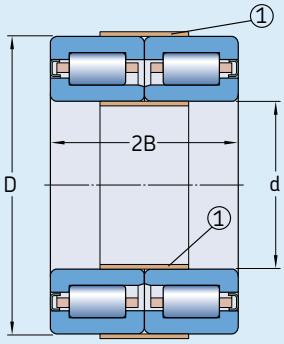
The long CRU version is used for specific applications, especially larger sizes where a larger grease quantity has to be applied to reach the required performance and to meet longer service interval requirements. A mounting sleeve is inserted inside the bore of the inner rings for easy mounting. The one-piece outer ring has two raceways for the roller sets.



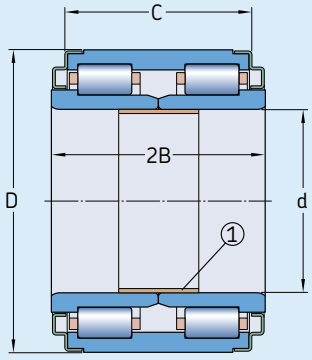
Short CRU design with a mounting sleeve on the inner rings and outer rings to facilitate mounting



Long CRU design with a mounting sleeve on the inner rings



Type 1



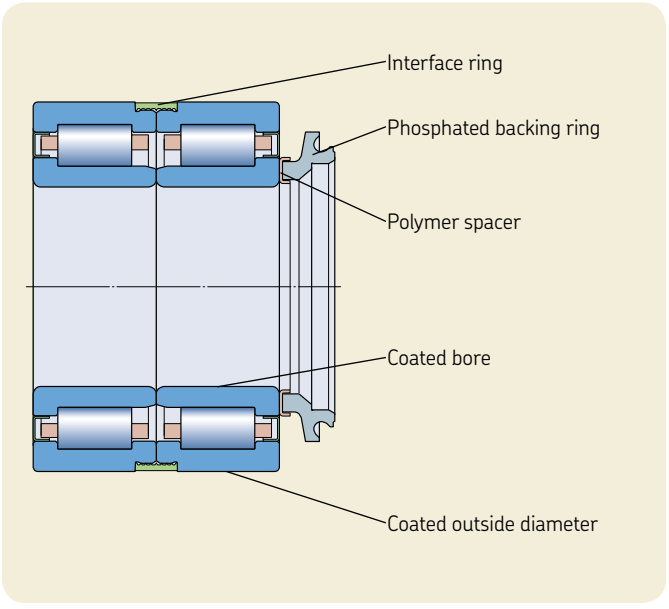
Type 2

① Mounting sleeves

Size	Principal dimensions				Type
	d	D	C	2B	
–	mm				–
CRU 100 x 180	100	180	–	120,6	1
CRU 120 x 200	120	200	–	112	1
CRU 120 x 215	120	215	–	146	1
CRU 130 x 220	130	220	–	160	1
CRU 130 x 240	130	240	–	160	1
CRU 130 x 240	130	240	164	160	2
CRU 150 x 250	150	250	160	180	2
CRU 160 x 270	160	270	150	170	2

These figures are for information only. Contact SKF for detailed product specifications.

Cylindrical roller bearing unit CRU plus design



CRU plus design equipped with a polymer spacer and a phospated backing ring

CRU plus design

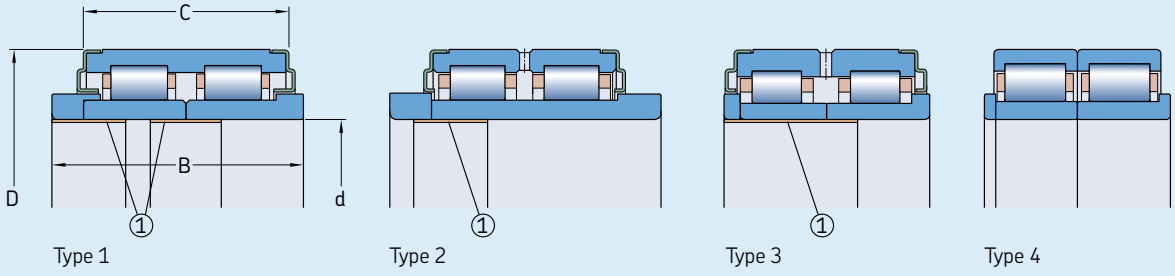
This advanced design offers some additional features to increase performance level by applying a more robust design with anti-fretting features for easier mounting and dismounting. These features include:

- coated bore and outside diameter for improved resistance against fretting corrosion and reduced mounting forces when pressing the bearing unit onto the axle journal
- polymer spacer at the backing ring for avoiding fretting corrosion between the contact areas of the backing ring and inner ring side face
- interface ring for retaining the outer rings as a set and locating them in the correct load zone position
- phosphated backing ring for improved resistance against resulting damage from micro movements

CRU plus design benefits

- improved resistance against fretting corrosion
- easier mounting and dismounting
- less force required when pressing the unit onto the axle journal

Cylindrical roller bearing units for axial displacement



Type 1 Type 2 Type 3 Type 4

① Mounting sleeves

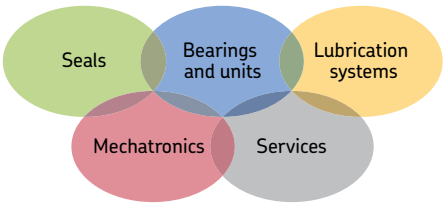
Size	Principal dimensions				Axial displacement	Type
	d	D	C	B		
–	mm					–
CRU 150 x 270	150,022	270	174	215	+/-10,0	1
CRU 160 x 270	160	270	150	176	+/-15,0	2
CRU 160 x 280	160	280	159	180	+/-10,0	3
CRB 180 x 320	180	320	172	192	+/-10,0	4

These figures are for information only. Contact SKF for detailed product specifications.

Cylindrical roller bearings and units for middle axle applications

The 3-axle bogie design could require an extended bearing axial displacement to enable the middle axle to move when running in curves (→ **page 38**). In principle, this requirement could be necessary for all vehicles without bogies that have more than two axles, like 3-axle shunting locomotives.

These bearings are designed according to customer specifications. In the table above, most current bearing sizes and designs are listed. For new designs, type 3 is preferable.



The Power of Knowledge Engineering

Drawing on five areas of competence and application-specific expertise amassed over more than 100 years, SKF brings innovative solutions to OEMs and production facilities in every major industry worldwide. These five competence areas include bearings and units, seals, lubrication systems, mechatronics (combining mechanics and electronics into intelligent systems), and a wide range of services, from 3-D computer modelling to advanced condition monitoring and reliability and asset management systems. A global presence provides SKF customers uniform quality standards and worldwide product availability.

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