Bogie subsystems
AMPEP

Extract from the Railway technical handbook,
volume 1, chapter 9, page 165 to 171

Bogie subsystems

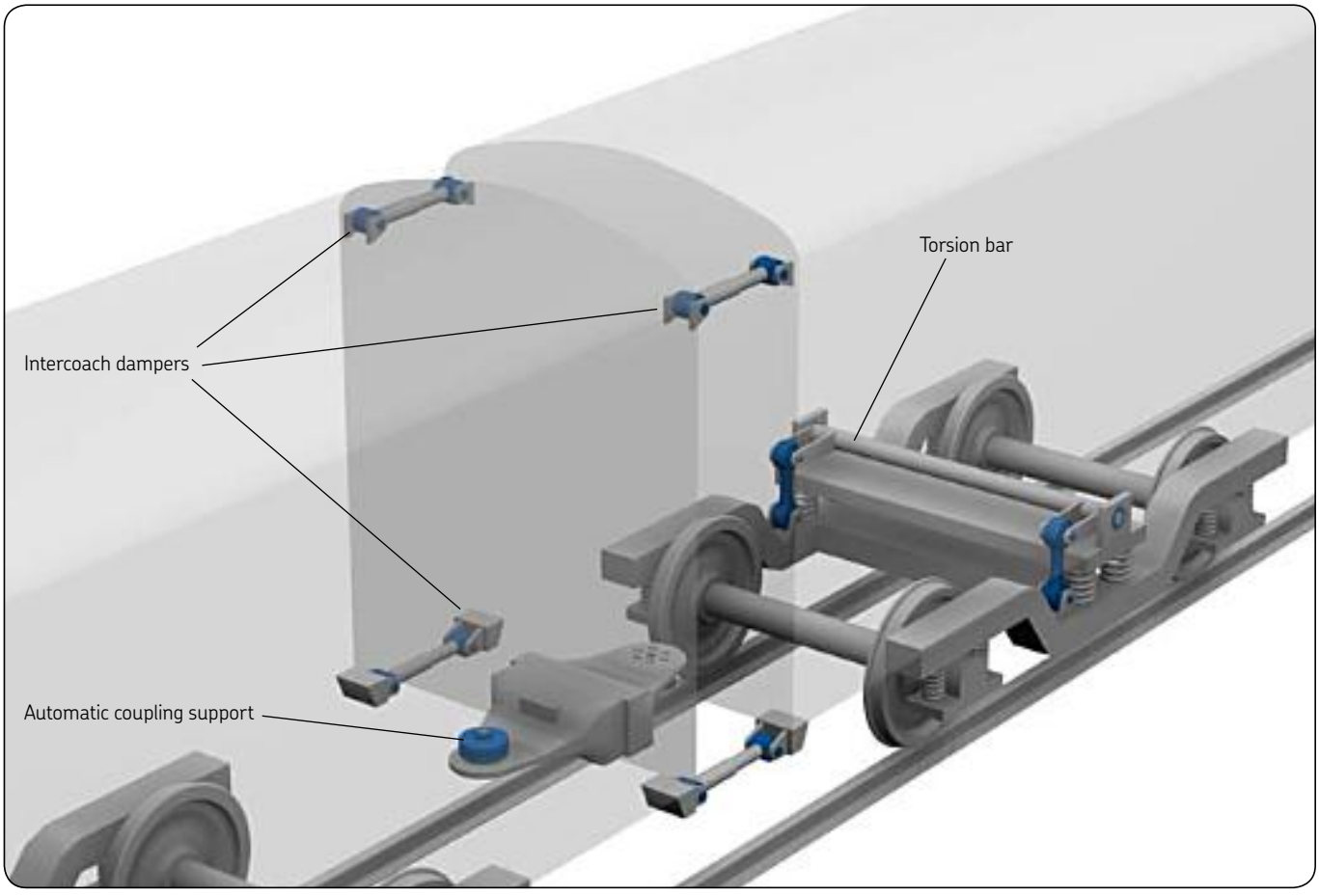
In addition to the comprehensive range of axlebox solution packages, SKF offers a complementary portfolio of additional subsystems for bogie applications. As with axlebox solutions, these subsystems contribute to increasing service life by reducing wear and maintenance requirements of railway bogies. Thus achieving a lower life cycle cost and increasing reliability.

AMPEP

The particular dynamic stresses in railway bogies demand special solutions such as high performance self-lubricating plain bearings.

These bearings are excellent solutions for applications where bearing pressures are high, movement slow and maintenance is difficult or even impossible. In rail bogies, self-lubricating plain bearings are used for torsion bars, damper attachment points, swing links, brake mechanisms, steering linkages, valve linkages, and automatic couplers as well as for tilt mechanisms of high-speed tilting trains.

AMPEP self-lubricating spherical plain bearings are high quality products that provide a low coefficient of friction combined with low wear rates. This is achieved by using woven polytetrafluoroethylene (PTFE) and glass fibres. Typically used in high-speed trains, AMPEP bearings are also used in locomotives, and passenger and mass transit vehicles like low-floor tramways [34].



Bearing capabilities

To meet the stringent requirements previously defined, the AMPEP solution is based on a low friction coefficient combined with sliding materials with low wear rates. The one-piece outer ring is formed around the spherical shape of the inner ring during the manufacturing process and contains no splits or loader slots. This provides excellent conformity of the mating surfaces.

AMPEP bearings are used for railway bogies as well as for aerospace applications where these bearings are approved by the Joint Aviation Authorities (JAA) and are designed in accordance with ISO 9002 and Aerospace Sector Certification Scheme TS 157.

AMPEP bearing benefits

- low friction and wear, minimal stick slip
- low life cycle cost
- excellent for oscillatory applications
- virtually maintenance-free, self-lubricating
- wide operating temperature range, from –50 up to +200 °C

Technical features

Main components of an AMPEP spherical plain bearing are:

- a one-piece outer ring
- a PTFE/glass fibre liner
- a ball or spherical inner ring

The surfaces are continuously lubricated by a film of PTFE during the entire life of the bearing.

Liner systems

AMPEP X1

The bearing liner AMPEP X1 is based on a woven polytetrafluoroethylene (PTFE) / glass fabric, laminated under heat and pressure with a phenolic resin-impregnated glass cloth. The oscillating movement of the bearing causes the spherical surface to be continuously lubricated with a film of PTFE during the life of the bearing, which provides a low coefficient of friction combined with low wear rates.

Various liner counterface combinations have different performance levels and can satisfy very stringent application criteria.

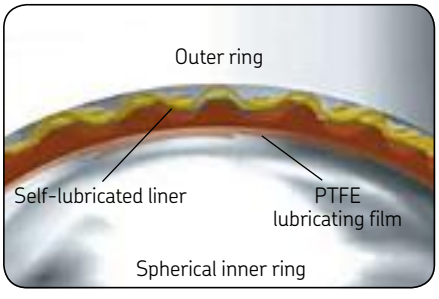
The AMPEP X1 liner system is qualified to American Aerospace Standard SAE AS81820 and is extensively used in aerospace and industrial applications.

AMPEP XLHP and XL

The AMPEP XL and latest generation XLHP bearings are the result of an extensive development programme to produce acceptable lifespan in arduous aerospace applications. They exceed international standards by a considerable margin, thus providing long life and reliability. The AMPEP XLHP and XL liner system employs super finished hard coatings on the counterface. Counterface variants include super finished through hardened steel, hard chrome and other coatings appropriate to the application and performance required. The bearings are manufactured from high-quality carbon or corrosion-resistant steel to meet the demand for high reliability and low life cycle cost.

AMPEP XLNT

To further extend the life of AMPEP bearings, the AMPEP XLNT ceramic system has been introduced, which provides a significant increase in the wear resistance of many bearing applications, further improving service life and reliability.



AMPEP spherical plain bearing, design principal features

Wear characteristics

Liner wear is primarily a function of bearing pressure, surface velocity and sliding distance at a given temperature. Other determining life factors are:

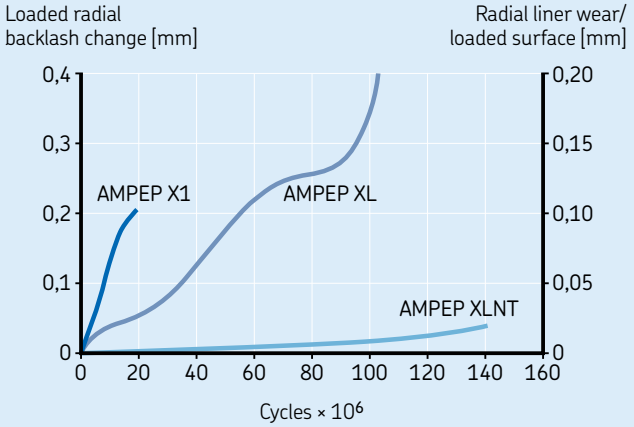
- **Surface finish of liner counterface**, life increases with improved surface finish.
- **Hardness of the liner counterface**, generally, the harder the surface the longer the life of the bearing. The surface should be hardened and corrosion resistant.
- **Good conformity** of the contact area between the liner and counterface is essential to maximize bearing life.
- **Absence of contaminants,** which otherwise increases wear. If water contamination is likely, the bearing should be sealed.

In a typical reversing load application, most rail applications require a wear limit of 0,125 mm per liner surface (0,25 mm of backlash). If the application is loaded primarily in one direction, the amount of acceptable backlash is restricted to the wear of one liner surface (0,125 mm). However, it is essential that an accurate analysis of the duty cycle of any particular application is performed if a service life is to be realistically predicted and obtained.

General operating guidance

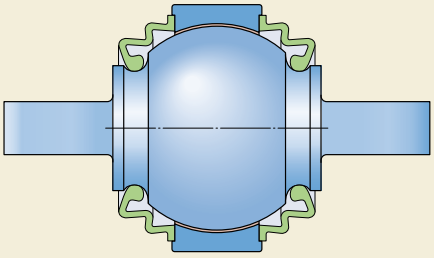
- **dynamic load** refers to steady loads with movement at the bearing surface
  - mean dynamic pressure from 3,5 up to 35 MPa
  - maximum dynamic operating pressure of 70 MPa
- **static load** implies a steady applied force with no movement of the sliding surfaces with respect to each other:
  - maximum static operating pressure of 140 MPa
  - maximum static bearing pressure of 280 MPa
- **surface velocity** up to 0,1 m/s
- **operating temperature** range from –50 up to +200 °C

Liner wear comparison

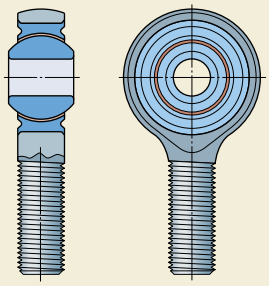


Frequency	6 Hz
Radial load	± 240 daN sinusoidal
Sliding velocity	0,046 m/sec
Radial projected stress	14,8 Mpa
Motion	± 11° oscillation
	± 5° misalignment

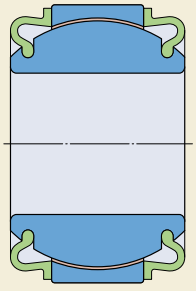
Bearing designs



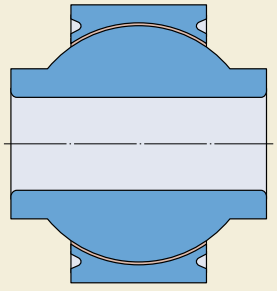
Sealed ball pin spherical plain bearing assembly used for intercoach dampers and torsion bars on high-speed trains



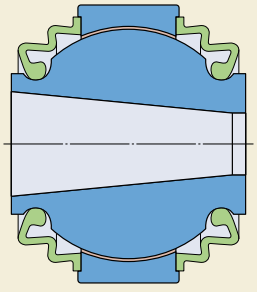
Rod end spherical plain bearing assembly used for double end links



Sealed spherical plain bearing assembly used for torsion bars and brake mechanisms

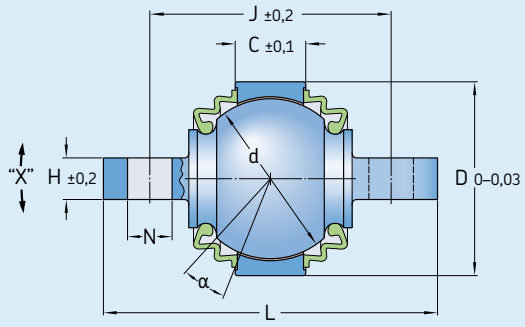


Spherical plain bearing assembly used for automatic couplers, steering pivot links and tail pin anchors



Sealed tapered spherical plain bearing assembly used for torsion bars on high-speed trains

Sealed ball pin spherical plain bearing assembly



Note:
Bearing must be clamped or bonded in position

Materials:
Outer ring and ball pin: medium carbon steel
Seal: rubber

Boundary dimensions								Maximum torque "X"[1]	Radial static limit load[2]	Mass	Liner system	Designation[3]
D	C	H	J	L	N	d	a					
mm							degrees	Nm	kN	kg	–	–
62	25	16	88	115	13	53	23	50	64	1,0	XL	**AMPEP 21-7075P**
	21	16	88	118	17,5	53	15	22,6	81	1,0	X1	**AMPEP 21-10031P**
	25	16	88	115	13	53	23	50	64	1,0	X1	**AMPEP 21-7955P**
75	28	16	94	128	17,5	62	18	50	79	1,6	XL	**AMPEP 21-7113P**
	29	19	127	171	17	62	18	7	100	2	XLHP	**AMPEP 21-12222P**
	28	16	98	128	17,5	62	18	50	71	1,6	X1	**AMPEP 21-7933P**
	28	26	130	174	19	62	18	50	149	2,2	X1	**AMPEP 21-8032P**
90	50	27	135	175	17	80	15	30	157	3,5	XLHP	**AMPEP 21-13080P**
105	40	30	125	171	25	92	12	50	316	4,5	XLHP	**AMPEP 21-12224P**

[1] Misaligning torque measured in plane "X"
[2] Radial static limit loads are based on bending failure of suitably clamped bearing assemblies using 2/3 ball pin yield stress (433 MPa)
[3] Other bearing configuration may be supplied on request

Application features

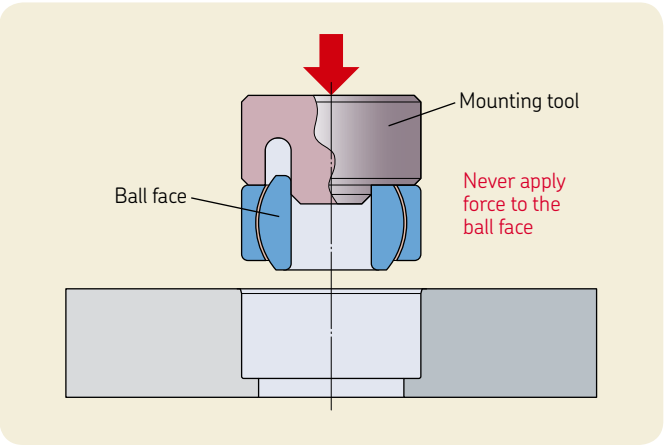
Wear in the bearing occurs as a result of movement between the mating surfaces under pressure. An accurate analysis of the duty cycle in any particular application is essential if an operating life is to be realistically predicted and obtained. In a typical rail bogie suspension system where extended lives are required, bearing pressures of 3,5 to 20 MPa are encountered, together with angles of oscillation of ± 1° at 30 Hz to ± 5° at 0,1 Hz. Under these demanding conditions, operating lives in excess of 2,2 million kilometres of travel are obtained.

For continuous running, it is recommended that surface velocities should not exceed 0,1 m/s. In applications where operation is intermittent, higher velocities may be tolerated. Temperature limits range from –50 up to 200 °C. However, wear rates are increased at the higher and lower temperatures.

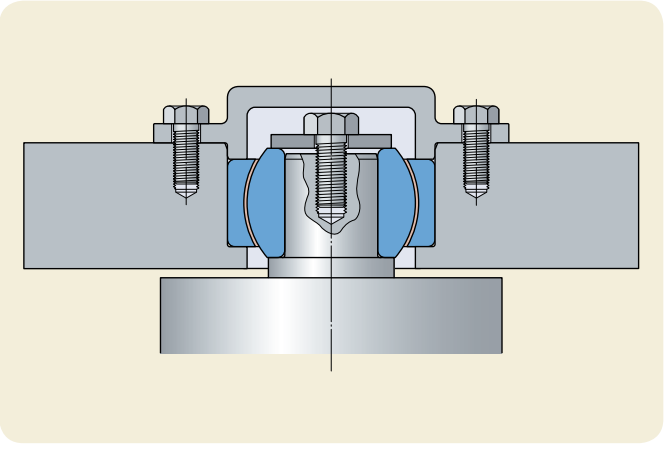
AMPEP bearings are manufactured with a preload and closely controlled conformity between the mating surfaces of the inner ring and outer ring. When fitting a spherical plain bearing in its housing, the bearing should be pressed onto its seating using a special tool.

To assist with correct alignment, a 1 × 15° leading chamfer should be machined at the edge of the housing bore and at the end of the shaft. Load must never be applied to the ball face as this can have an adverse affect on the bearing conformity.

The coefficient of friction for AMPEP bearings is approximately 0,05 – 0,1 at the bearing pressures encountered in rail applications. Thus, it is necessary to use an adhesive or to clamp the bearing to prevent the bearings from rotating in the housing or on the pin. When using an adhesive, it is important to seek guidance from the adhesive manufacturer, because cleanliness of mating surfaces is essential.



Bearing mounting procedure by using a mounting tool

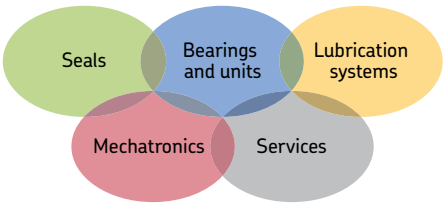


Typical installation of a spherical plain bearing assembly

Bearing tolerances and recommended tolerances for shaft and housing seats

Bearing outside diameter	h7
Housing inside diameter	J7
Shaft outside diameter	h7
Bearing inside diameter	K7

Cylindricity should be checked so it is within the bore tolerance. The resultant fits are transition fits and known to operate satisfactorily.



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.

References

[34] Kuře, G., Vicarage, A.: *High pressure and slow movement ideal for plain bearings.* SKF Evolution magazine (2001) 4, pp. 21–24.

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