Linear plain bearings

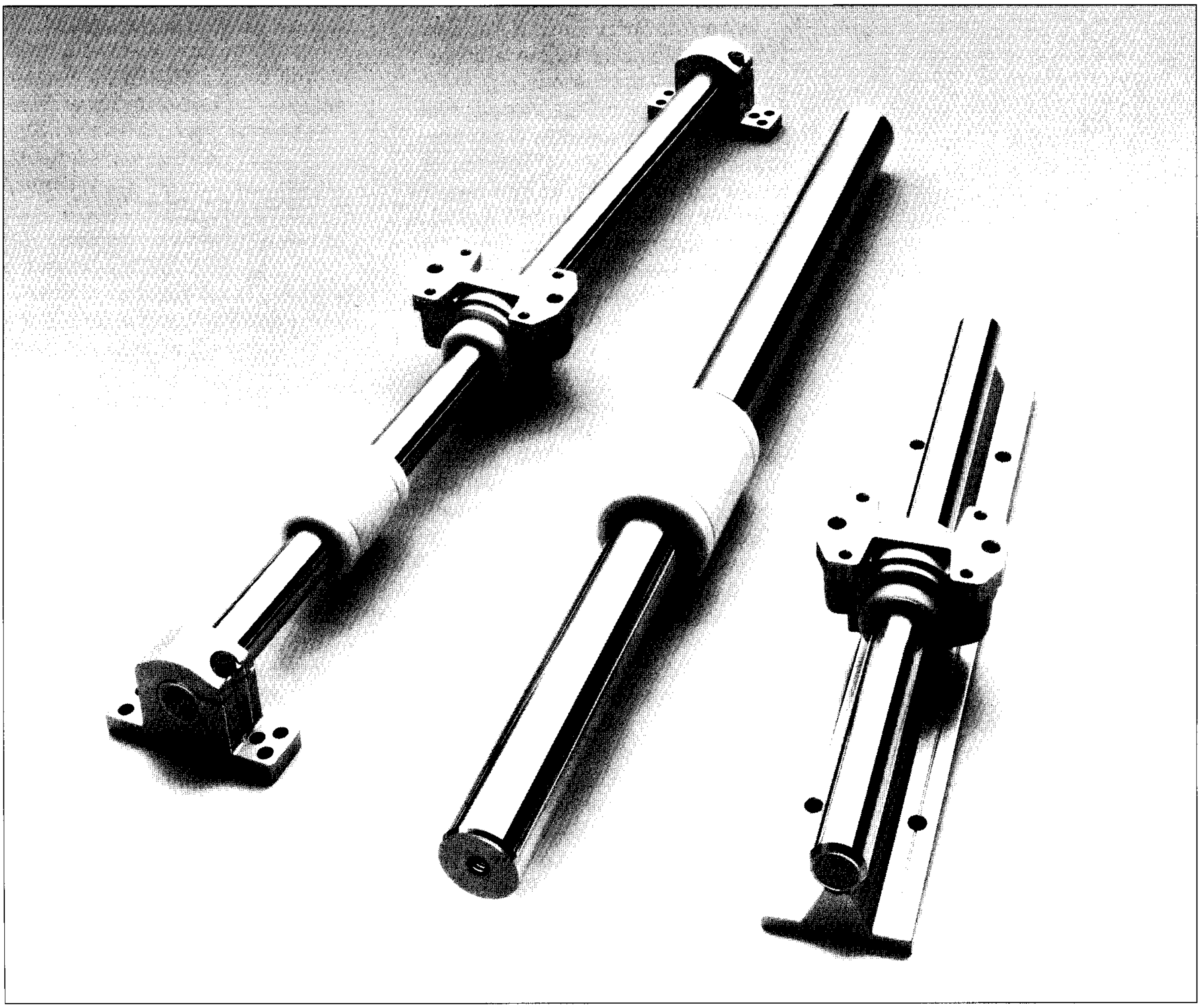
To complement the range of linear guidance systems with rolling elements, two series of linear plain bearings have been developed, having similar external dimensions to those of series 1 and series 3. These bearings can be used in certain applications where the use of rolling element bearings is inappropriate because of extreme operating conditions. This is especially relevant in cases of heavy impact, vibration or where high speeds and acceleration are required under light load conditions. For such applications dry sliding bearings are preferable to linear ball bearings although a greater degree of friction is to be expected.

Bearing types

LPBR linear plain bearings
The dimensions of these bearings correspond to those of ISO Series 1 and are interchangeable with linear ball bearings of the LBBS series.

LPAR and LPAT linear plain bearings
Bearings of the LPAR and LPAT series conform to the ISO Series 3 dimension specification and are interchangeable with linear ball bearings of the LBAR or LBCR and LBAT or LBCT series.

As in the case of linear ball bearings, in addition to the individual bearings, bearing units are also available.



Basic principles

The suitability of linear plain bearings for a given application depends largely on the frictional considerations, heat dissipation, the sliding properties of the mating surfaces and the efficiency of lubrication. In contrast to linear ball bearings, general statements regarding operational life and performance in specific applications cannot be accurately made.

Load carrying capacity
The dynamic load rating C is a factor denoting the properties of a linear plain bearing. This denotes the magnitude and direction of the constant load which, under conditions of continuous linear movement at a given speed and at room temperature, gives a certain nominal operational life expressed in running distance. Load rating figures are always dependent on the basic definition and therefore the dynamic load ratings stated by different manufacturers are not necessarily comparable.

The static load rating C_0 is used when the linear plain bearing is stationary (or subject to occasional slight movement). This factor should also be used where a dynamically loaded linear plain bearing is subjected to heavy impact. This gives an indication of the load which can be accepted by a linear plain bearing without exceeding a prescribed degree of distortion of the sliding surface. It is assumed that the components adjacent to the bearing are sufficiently rigid.

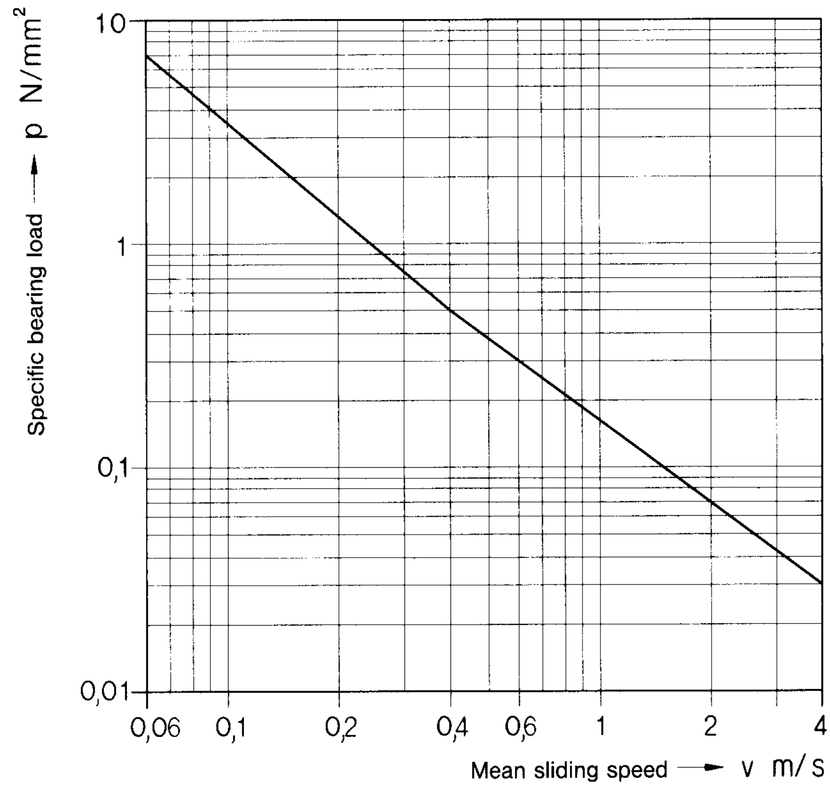
Operational life
The operational life of a linear plain bearing depends in practice upon the positive or negative effect, in the mixed or dry frictional area, of the increase in matching of the surfaces, also on the bearing clearance and/or the increase in bearing friction determined by the progressive wear of the sliding surfaces, plastic deformation and fatigue of the materials at the sliding surface.

Depending on the application and choice of sliding surfaces, a greater degree of wear or increase in friction is permissible. This also implies that under apparently equal operating conditions, the actual life achievable in practice can be vary.

All data relating to the dynamic load rating of SKF linear plain bearings refer to the nominal operational life by which it is understood that operational life which will be reached or exceeded by the majority of the linear dry sliding bearings. The method of calculation of the nominal operating life has been evolved empirically as a result of numerous laboratory tests. By the term effective (actual) life, on the other hand, we understand the life which, in individual cases, under the given operating conditions is actually achieved. This depends not only on the magnitude and nature of the load but also on many other influencing factors which are sometimes difficult or impossible to detect. These include dirt, corrosion, high frequency loads or movement cycles, blows, etc.

"pv" load/speed relationship
If the bearing size is dictated by virtue of the dimensions of the adjacent components, the shaft diameter is usually more or less predetermined.

Diagram 36
pv diagram for linear plain bearings



A check is then made to see whether the proposed bearing can in fact be used under the particular operating conditions (load, sliding speed). The required data (specific bearing load) and v (mean speed) can be calculated according to the formula

$$p = \frac{P}{F_w \cdot 2 \cdot C_4}$$

Where
p = specific bearing load N/mm^2
P = equivalent dynamic bearing load, N
F_w = bore of linear plain bearing, mm
C_4 = width of sliding surface, mm

The sliding speed is determined either by the drive relationships or it can be calculated where the stroke and frequency are known:

$$v = 2 \cdot s \cdot n / 60.000$$

where

v = mean operating speed, m/s

s = stroke, mm

n = stroke frequency, min^{-1} (number of movements from one end position to the other and back again)

If the initial check shows that the operating conditions are below the permissible limits indicated in diagram 36 "pv diagram for linear plain bearings", it can be assumed that the life of the bearing will be adequate. If however the maximum limits are exceeded a larger size of bearing should be selected in order to achieve the required pv value through reduction of the specific surface loading.

Range of applications

The sliding material employed consists of polyacetal incorporating a layer of polyethylene. This combination is particularly suitable for dry sliding bearing applications and is characterised by its excellent wear resistance. The maximum acceptable load rating is 14 N/mm^2. Recommended operating temperatures for continuous operation lie between −40 and +80°C and for short periods they may reach 120°C. It should however be noted that the mechanical stability of the synthetic material is temperature dependent and falls from a rating of 100% at room temperature to some 30% at 100°C.

Friction

The frictional qualities of linear plain bearings depend primarily on the loading of the bearing, the sliding speed and the lubrication conditions. In addition, the surface qualities of the mating surface and the operating temperature are of importance.

For linear plain bearings the coefficient of friction for dry running conditions lies between 0,17 and 0,21. The lowest figures for friction are generally obtained with high specific bearing loads and low sliding speeds. Under particularly unfavourable conditions and where the load is low, the indicated maximum values can be exceeded. The sliding material possesses the property of having a 'stiction' or static friction only slightly higher than the sliding friction coefficient and therefore stickslip is avoided. Sealed linear plain bearings, on account of the rubbing edges of the seals, show higher friction ratings. The corresponding values for the frictional and breakaway forces for the seals can be obtained from tables 26 or 27.

Tolerances

In order to assure full interchangeability with linear ball bearings, the external dimensions and tolerances of linear dry sliding bearings are identical to those of their equivalents. They differ only in the degree of radial clearance which, in accordance with the recommendations for dry sliding bearings, is significantly greater than for linear ball bearings.

The corresponding values can be obtained from the following table.

During the runningin period a greater degree of wear will be observed which will lead to additional increase in radial clearance.

Table 37

Radial clearance of LPAR and LPAT series bearings, using housing bore H7 and shaft diameter h7

Shaft diameter	Radial clearance LPAR max	min	LPAT max	min
mm	μm			
5	+110	+55		
8	+110	+55		
12	+160	+110	+205	+130
16	+160	+110	+205	+130
20	+165	+110	+210	+135
25	+165	+110	+210	+135
30	+165	+110	+210	+135
40	+165	+110	+215	+140
50	+165	+110	+215	+140
60	+220	+160	+275	+190
80	+220	+160	+275	+190

Table 38

Radial clearance of LPBR series bearings

Shaft diameter	Radial clearance max	min
mm	μm	
12	+175	+100
16	+205	+130
20	+210	+135
25	+210	+135
30	+260	+185
40	+330	+225
50	+380	+275

Lubrication

Linear plain bearings may be used with or without lubrication. For protection against corrosion and for improvement of sealing it is advisable in many applications to fill the bearing with lubricating grease. The most suitable greases are the corrosion resistant and water repellent lithium soap types of normal consistency, for instance the SKF LGMT 3 or LGHT 3 greases. On no account should greases containing molybdenum disulphide or other solid lubricants be used.

Bearing arrangements

In choosing the material and determining the quality of the mating surface for a linear plain bearing, the required performance of the bearing is of overriding importance. In most cases soft carbon steels with a ground surface are adequate. The roughness ratings R_a and R_z (in accordance with DIN 4768, part 1) should lie in region of 0,4 μm and 3 μm respectively.

Where the demands on the bearing are more stringent, hardened sliding surfaces with a surface hardness of at least 50 HRC or a surface treatment of the surface, for instance with hard chrome, can be advantageous. In such cases the value of R_a should be in the region of 0,3 μm and of R_z about 2 μm. A higher quality of the surface will also enhance the running qualities whereas a lower quality will result in greater wear.

Housing and shaft tolerances
Satisfactory support of a linear plain bearing can be obtained by machining the seating bore to the appropriate tolerance. For linear plain bearings of the LPBR series a tolerance of H7 is recommended.

On bearings of the LPAR and LPAT series, the outer diameter is machined slightly under size. When mounting these bearings, care should be taken to ensure that they are axially located through the use of the appropriate retaining rings. The use of retaining rings (figs 1 and 2) is particularly economical in terms of space requirements, enables rapid mounting and dismounting and simplifies the manufacture of adjacent components. Additional axial location can be provided by attaching a grease nipple in accordance with the tables shown on page 38 for LBCR and LBCT series bearings.

Mounting and dismounting
Skill and cleanliness are essential when mounting SKF linear plain bearings, to obtain optimum performance and to avoid premature bearing failure.

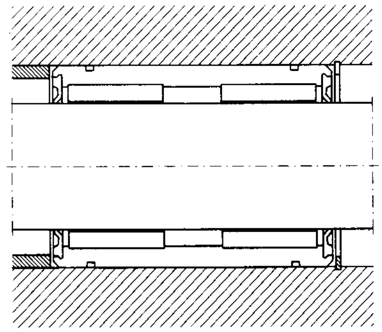
The bearings should not be removed from their original packaging until immediately before mounting, in order to avoid contamination through dirt. The condition of the shaft and adjacent surfaces should be checked closely in order to ensure that no scratching of the sliding surface of the bearing is caused through any sharp edges or burrs, or that an already damaged shaft is installed.

When mounting a linear plain bearing the use of a mandrel is recommended as in the case of linear ball bearings (see page 40). To facilitate mounting, the shaft ends should be chamfered to an angle of 10 to 20°. Light oiling or greasing of the bearing faces will then allow easy insertion.

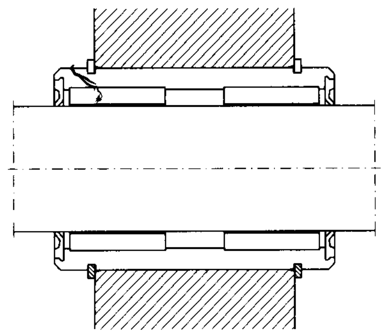
If a tight fit cannot be achieved, for instance on account of difficulties in mounting, or because of the available force for insertion, adequate securing in the housing can often be achieved through the use of adhesives. In such cases however an unacceptable degree of increased clearance should be compensated by a corresponding change in shaft tolerance.

Even in applications for which no constant lubrication is intended, it is advisable to apply some lubricant during the running in stage just after mounting. This will serve to lower the coefficient of friction during running in and to increase the life of the bearing.

If after dismounting the bearings are to be reused, they must be handled with the same degree of care as when mounting. The force used in extracting should always act concentrically on the bearing in order to avoid damage to the sliding surfaces.



1



2