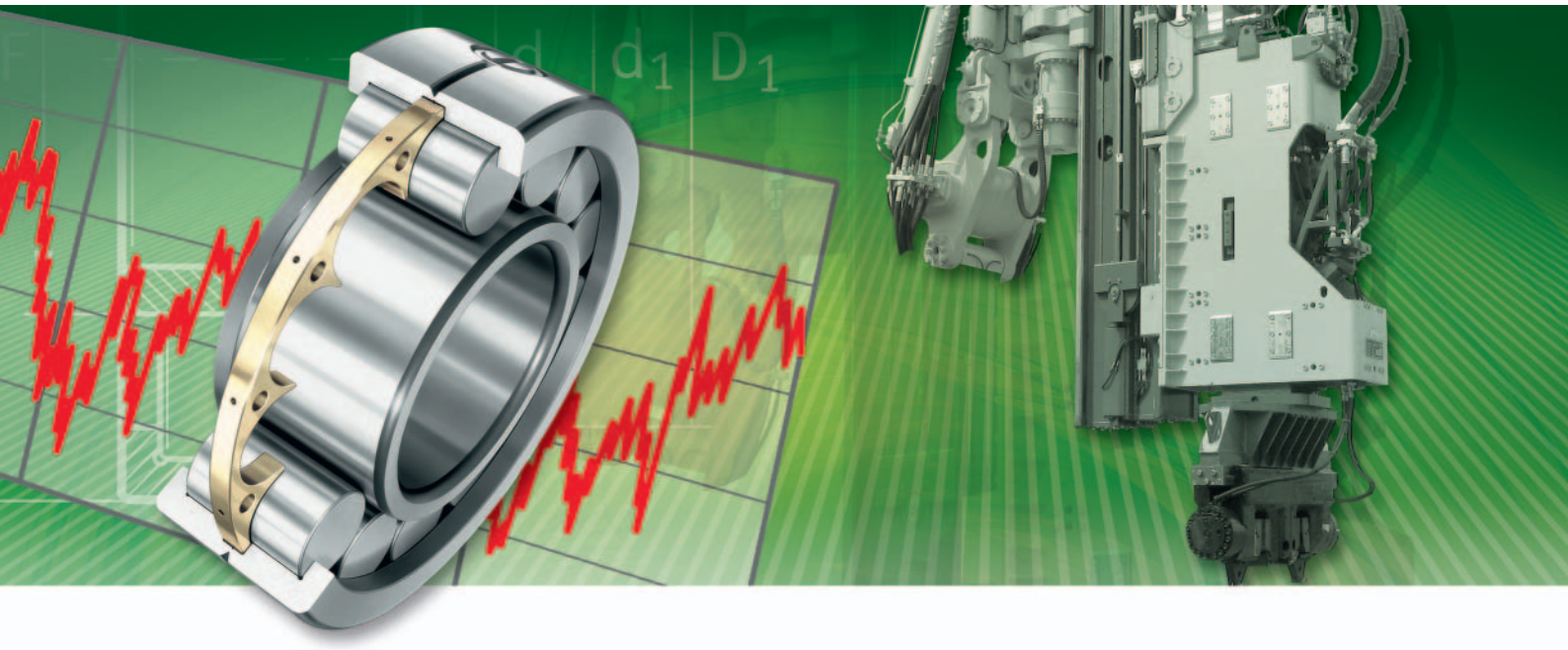


Cylindrical and Needle Roller Bearings for Vibratory Machinery

Reliable solutions for extreme requirements

SCHAEFFLER

Reliable solutions for extreme requirements

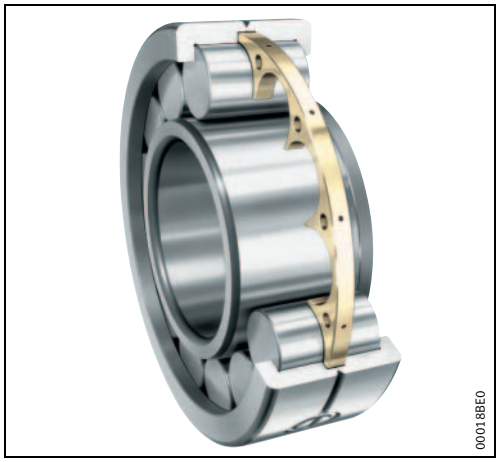


Figure 1: Cylindrical roller bearing LSL1923 with disc cage

In order to achieve reliable bearing arrangements for imbalance shafts in vibratory machinery, Schaeffler has developed cylindrical roller bearings of X-life quality as part of its product range that not only give high performance but are also cost-effective and energy-efficient. These bearings facilitate reliable, low-friction, smooth running even under the challenging conditions that are present, for example, in construction machinery.

The category of vibratory machinery includes equipment such as vibratory motors, rolling mill drives, tandem and combination rollers, top vibrators and deep vibrators. Top vibrators are used to insert sheet piles or pipes while deep vibrators are used to create so-called pile foundations through the compaction of loose earth. The common feature of these machines is that they place particularly high demands on the bearing arrangements fitted. Due to the shock type loads, high speeds, accelerations and centrifugal forces as well as vibrations and oscillations, the bearings used must have very high performance characteristics.

The centrifugal accelerations may be up to 550 m/s^2 and the bearing speeds may be up to 4 000 min^{-1}.

The environmental conditions present, such as large temperature differences and poorly aligned shafts, are normally unfavourable and place an additional burden on the machinery and the rolling bearing arrangements.

Cylindrical roller bearings with disc cage

Cylindrical roller bearings have been used for decade as non-locating, semi-locating and locating bearings. They comprise bearing rings, rolling elements and, depending on the design variant, a cage. Due to their construction, they have extremely high radial load carrying capacity and high rigidity. They are particularly suitable for compact designs. In addition to high radial forces, cylindrical roller bearings can also support axial forces if they are used as semi-locating or locating bearings. While the radial loads are transmitted through the raceways, the axial load is transmitted via the ribs and the end faces of the rolling elements.

Cylindrical roller bearings LSL are characterised in particular by their machined brass disc cage. The special geometry of this flat disc cage not only reduces the mass of the bearing and cage but also generates less friction, since the rolling elements undergo less braking once they are outside the load zone, *Figure 2*. In addition, the bearing can accommodate a large number of rolling elements. This has a positive influence on the basic dynamic load rating and the calculated rating life.

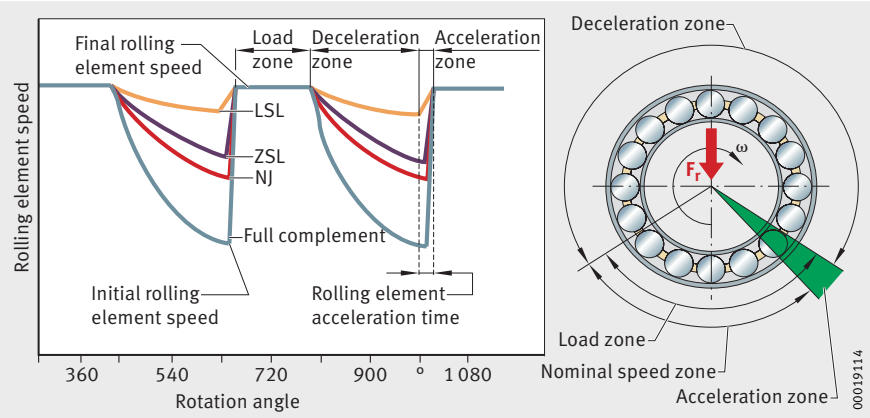


Figure 2: Rolling element speed as a function of rotation angle

Friction is decreased by up to 50% in comparison with full complement cylindrical roller bearings, which reduces the operating temperature, drive power required and makes a significant contribution to achieving a longer operating life. Tilting of the shaft is securely supported by specially profiled inner ring raceways.

For example, the imbalance shafts in top vibrators from RTG Rammtechnik, a subsidiary of Bauer AG, Schrobenhausen, are supported by eight low-friction cylindrical roller bearings LSL192324-TB-XL with disc cages. The bearing can securely transmit the extreme centrifugal accelerations of up to 550 m/s^2.

Needle roller bearings RNA for imbalance adjustment

The unit for imbalance adjustment constitutes a particularly important bearing position in the top vibrators under consideration. Until now, plain bushes had always been used in this case which, however, are characterised by high friction values as well as heavy wear and also lead to long adjustment times in the positioning of the imbalance masses. For this application, Schaeffler has developed a special bearing arrangement using needle roller bearings RNA that has lower friction and adjustment times reduced by between 30% and 40%. The new design incorporates both the shaft and housing. As a result, smaller drive units for the swivel motion can be used in the imbalance adjustment unit.
The change from plain bearings to rolling bearings thus gives significant advantages in terms of the (energy) efficiency of the machine.

The use of needle roller bearings RNA makes it possible to reduce the bearing friction in imbalance adjustment in top vibrators. As a result, there is of course a beneficial effect on bearing life. This was demonstrated in a field test. In a Mäkler MR type top vibrator from Bauer, the rolling bearings subjected to heavy loads were carefully examined after 300 hours of operation. The result was a very uniform load pattern without wear on the shaft, *Figure 4* and *Figure 5*.

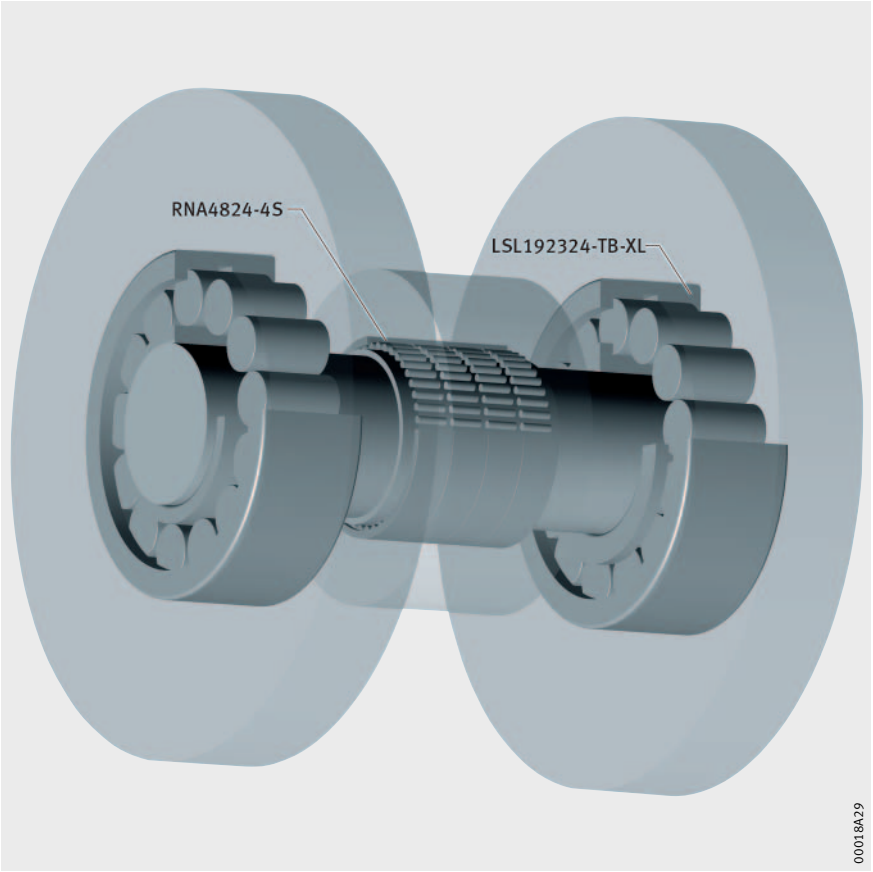


Figure 3: Imbalance shaft in top vibrator

This solution has now proved successful in volume use. The top vibrator exceeds its nominal service life without any troublesome wear problems.

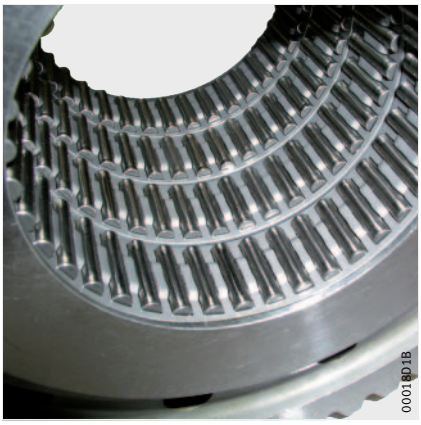


Figure 4: Needle roller bearing RNA4824-4S

Figure 5: Imbalance adjustment unit

Improved rib contact

For its cylindrical roller bearings of the X-life premium grade, Schaeffler has used new calculation methodsand manufacturing processes to achieve a further improvement in rib contact, *Figure 6*. In bearings of the design TB (toroidal crowned), the end faces of the rollers have a special curvature design giving an optimised contact geometry between the rib and the end face of the roller, thus minimising the maximum contact pressure. This special construction facilitates the formation of a lubricant film capable of supporting loads. The risk of mixed friction is considerably reduced, while wear of the ribs and roller end faces is prevented completely. A further factor comes into play here: Depending on the magnitude of the axial load, the frictional torque is reduced by up to 50%. As a result, there is a significant reduction in the bearing temperature during operation.

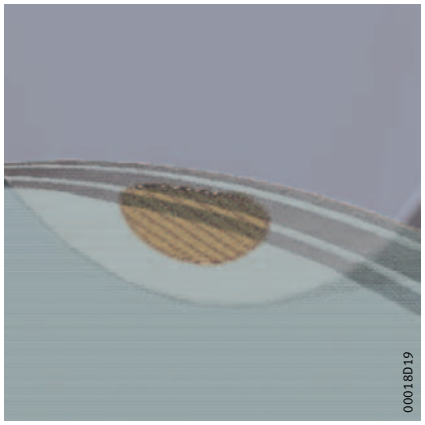


Figure 6: Improved rib contact between roller end face and inner ring rib face

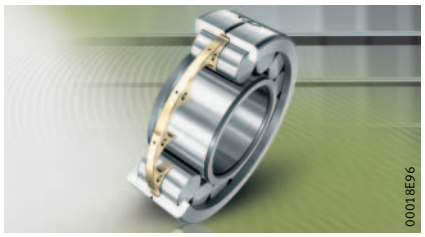
Lubricant film with higher load carrying capacity

The lubricants normally used tend to decrease in viscosity with increasing temperature. Oils become increasingly thin as the temperature rises.
Since the new bearings generate significantly less heat, the lubricants remain cooler and the reduction in the local viscosity is reduced slightly. The lubricant film formed is significantly more capable of supporting loads.
As a result, optimum separation is achieved between the roller end face and the inner ring rib face.

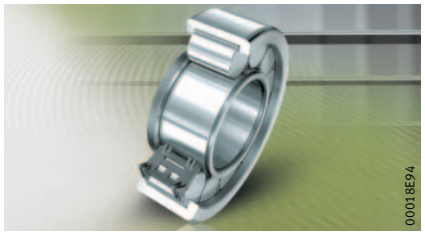
Extended maintenance intervals

In the case of the cylindrical roller bearings LSL with optimised rib contact, the permissible axial load is 60% of the radial load, which was not possible with earlier designs. It is important in this case to consider all the boundary conditions of the specific application in their entirety. Overall, the improvement gives a significant increase in the operating life of the bearings. Furthermore, new design possibilities such as downsizing can be considered. For construction machinery, this can also have the effect of extending the necessary maintenance intervals.

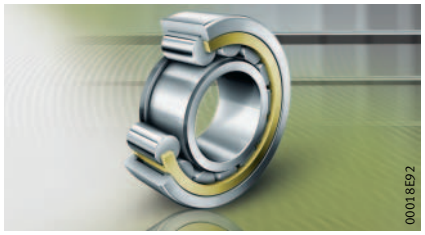
Cylindrical and needle roller bearings for vibratory machinery



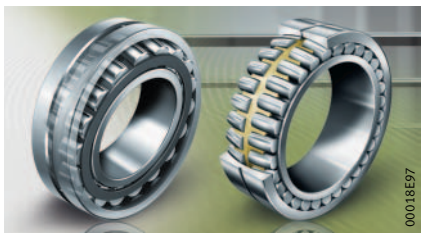
Low friction cylindrical roller bearings LSL with disc cage
Application: Imbalance bearing arrangement
Further information: HR 1, LVM



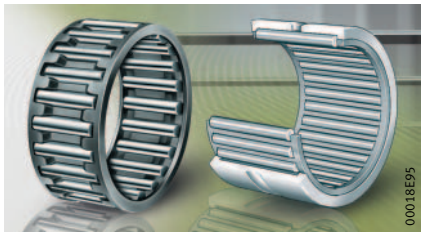
Low friction cylindrical roller bearings ZSL with plastic spacers
Application: Imbalance bearing arrangement
Further information: HR 1, LVM



Cylindrical roller bearings NJ..-MP1A with solid brass cage, externally guided
Application: Imbalance bearing arrangement, drive bearing arrangement
Further information: HR 1



Spherical roller bearings 223, special design
Application: Imbalance bearing arrangement
Further information: TPI 197



Needle roller and cage assemblies KZK, externally guided
Further information: TPI 94

Needle roller bearings RNA, without inner ring
Further information: HR 1

Advice on the selection of bearings and the design of bearing arrangements in vibratory machinery is available from Schaeffler application engineers and the Schaeffler engineering service worldwide.

MATNR 036929220-0000 / SSD 28 / GB-D / 2012031 / Printed in Germany by mandelkow

Schaeffler Technologies
AG & Co. KG

Industriestraße 1–3
91074 Herzogenaurach
Germany
Internet www.ina.com
E-Mail info@schaeffler.com

In Germany:
Phone 0180 5003872
Fax 0180 5003873

From other countries:
Phone +49 9132 82-0
Fax +49 9132 82-4950

Schaeffler Technologies
AG & Co. KG

Georg-Schäfer-Straße 30
97421 Schweinfurt
Germany
Internet www.fag.com
E-Mail FAGinfo@schaeffler.com

In Germany:
Phone 0180 5003872
Fax 0180 5003873

From other countries:
Phone +49 9721 91-0
Fax +49 9721 91-3435

Issued: 2012, March

SSD 28 GB-D