



SKF KEEPS WIND TURBINES SPINNING

By Colin Roberts

Wind turbine gearboxes outfitted with SKF's latest high-capacity bearings will provide greater reliability and longer life.

The signing of a contract for more than 5,000 sets of SKF's latest high capacity cylindrical roller bearings (HCCRB) for wind turbines will give added load carrying capacity, more reliability and longer life to the Nanjing Gear Company's range of gearboxes for wind applications. The following article—based on a recent site visit—explores the reasons for their choice, and the benefits they will enjoy as a result.

About 50 percent of these bearings are destined for gearboxes for European and U.S. customers, and the other half for Chinese and other Asian customers. With a range of gearboxes suitable for wind turbines from 200 kW to 2 MW the company will now increase the competitiveness of their already well-respected brand. NGC is the leading supplier in China for gearboxes for wind turbines. It is also the leading supplier in China for high-speed and heavy-load gearboxes for many industries, including steel and mining.

The HCCRB bearings will be of differing sizes in the bore diameter range 150 mm up to approx 300 mm, and occupy all of the classical cylindrical bearing positions in the wind turbine gearboxes where non-separate mounting is acceptable. This is mainly the case in planetary wheels.

When asked why SKF was chosen for this order, which is the biggest order between the two companies, H. Yueming—NGC general manager—says “In the wind power business we attach great importance on high quality and innovation. We chose SKF because we know that the most important component to ensure reliability of the gearbox is the bearing,” he explains. “We will have the best bearing supplier in the world to ensure the quality of the gearboxes we produce. We also believe that SKF will provide the best technical service in the bearing field, and we hope to develop a long-term cooperation to make technology exchanges to enhance our capabilities.”

Successful prototype tests, and technical information from SKF experts at their cylindrical roller bearing development center in Germany, were also influential in finalizing the decision to select the new high-capacity bearings.

HCCRB Features

The unique feature of the HCCRB is that load-carrying capacity has been increased substantially while maintaining the boundary and internal dimensions of standard cylindrical roller bearings. For engineers with a good knowledge of bearings that means a bearing was created that combines the load carrying capacity comparable with a full complement bearing, with

the benefits of a bearing with a cage. Along with the higher carrying capacity the new designs offer increased life. Calculations show that in one particular application the SKF Explorer version of the HCCRB will have an increase in bearing rating life of 35 percent compared with the standard full complement version, and 43 percent compared to a standard caged version.

According to ISO international standard 281 there are two ways to increase the

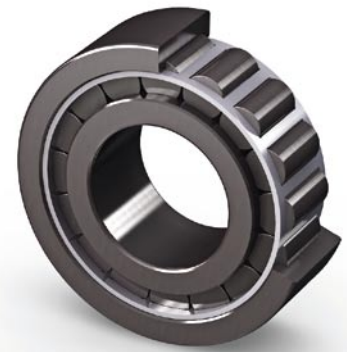


Fig. 1: Two types of HCCRB: outer ring shoulder guided (JA), at top; inner ring shoulder guided (JB) at bottom.

load carrying capacity while maintaining standardized boundary dimensions: increase the dimensions of the rollers and maintain the same number of rollers; and increase the number of rollers and maintain the roller dimensions.

For the first method there are other technical problems, because increasing roller dimensions reduces the inner and outer ring thicknesses and also the width of the side flanges. This results in reduced ring stiffness and flange strength, which in turn increases the risk of reduced bearing life due to increased wear, fretting corrosion, and ring creep or even ring fracture.


The second method offered theoretical improvements. All bearing companies have known this, and many have applied this as far as they could. The design that allows the maximum number of rollers is the full complement design. Here, the maximum number of rollers are placed between the rings leaving no space for a cage. This type of bearing is available from a number of bearing suppliers. Such bearings have limitations because the rollers are always in direct contact with each other, which cause sliding and increases friction and heat generation.


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Under certain circumstances, among them higher speeds, this leads to wear and premature bearing failure.

Bearings with cages—the vast majority of bearings produced worldwide—do not have this problem because the rollers sit in cage pockets preventing them from contacting each other. However, the addition of the cage takes up space, which reduces the maximum number of rollers possible.

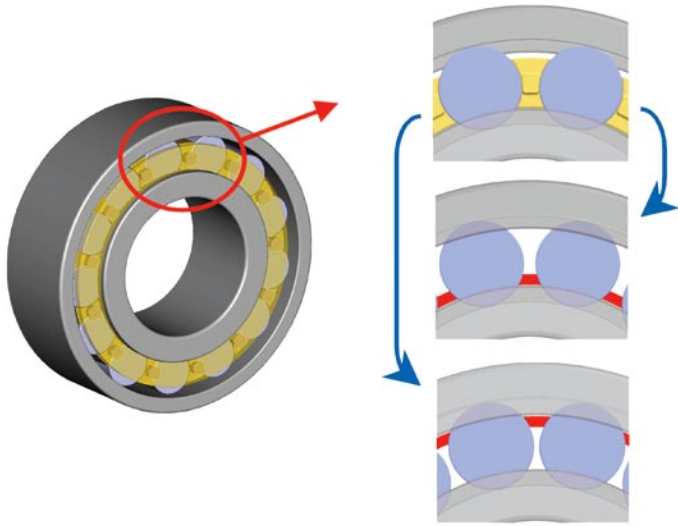


Fig. 2: Cage positions: standard (top); inner ring guided (middle); outer ring guided (bottom).

Unique Achievement

The unique feature of the HCCRB was achieved by a completely new window-type cage design that resulted in two versions; an outer ring shoulder guided cage (code JA); and an inner ring shoulder guided cage (code JB), as seen in fig. 1.

With these cages an extra one or two rollers per row can be added

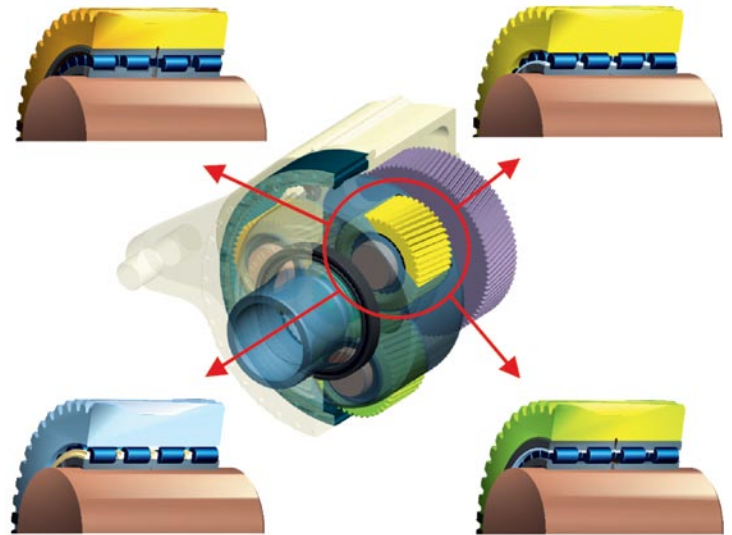


Fig. 3: Comparison of bearing types.

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Bearing execution	Standard	SKF Explorer*		
		High-capacity cylindrical roller bearing with an outer ring guided cage (JA)	High-capacity cylindrical roller bearing with an inner ring guided cage (JB)	Integrated standard cylindrical roller bearing with a machined brass cage
Customized bearing for wind gearbox application	Full complement cylindrical roller bearing			
Number of rollers per row	29	28	26	24
Relative calculated bearing life (ISO) (%)	100	135	109	92

*SKF Explorer bearings with increased load-carrying capacity.

Fig. 4: Table of bearing types.

to the bearing for the standard range, all of them separated by a cage. For customized bearings, even more rollers are possible. It is these rollers that deliver the additional carrying capacity, while the cage increases bearing life and overall performance compared to a full complement version.

The new cages differ from the standard cage in a number of ways that cannot be seen with the naked eye. But the most noticeable is that the standard cage is oriented around the connection circle of the mid-points of all rollers, while the new cages are moved toward the outer ring (JA type) or towards the inner ring (JB type), and that allows more space for more rollers (fig. 2).

The new cage designs were tested in prototype HCCRB bearings for more than one


year in many different tests to fully evaluate their capabilities and compare them with bearings fitted with standard cages and full complement bearings. All tests showed no limitations of the new bearing designs compared to standard designs. In fact, the new cage designs provide the following additional benefits:

- Improved oil flow by decreased cross section of the cage, which reduces heat generated;
- Lower weight that reduces inertia forces;
- Reduced slip in low load conditions which reduces the risk of smearing.

Figure 3 shows a gearbox application where the bearing under consideration is

supporting a planetary wheel. Calculations of four different bearing types show that the two new HCCRB bearings significantly outperform the standard caged version and the standard full complement version.

Conclusion

With the new HCCRB bearings the Nanjing Gear Company will be able to offer even higher load carrying capacity to their customers. This allows customers to consider greater gearbox reliability or a smaller gearbox, depending on the expected loads transmitted through the gearbox. And with wind turbine designs increasing in size and MW output all over the world, this puts Nanjing Gear Company in a position of even greater potential for these big turbines. 

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