BEARING FAILURE ANALYSIS

Example Type B Report

Wind Turbine Blade Pitch Bearing Analysis

1. INTRODUCTION

Three wind turbine Rotor Pitch Blade bearings that had been in service for approximately 10 ½ years were supplied to us for inspection and report. The rotor pitch bearings are the right hand side of figure 1.

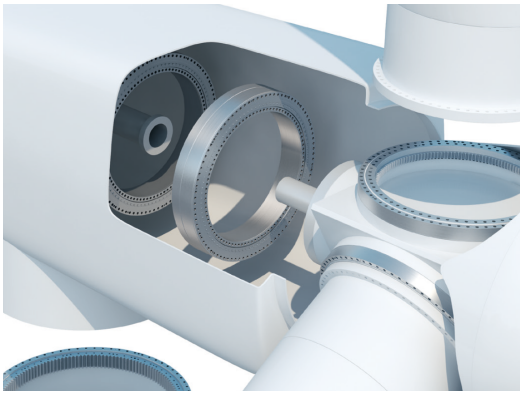

Figure 1

Rotor pitch blades are adjustable in order that the wind generator turbines can produce maximum output. The bearings that support the blades have to withstand continuous load changes resulting from these pulsating loads.

2. INSPECTION

The ball bearing weighing approximately 500 kg each arrived stacked on a pallet (see figure 2).

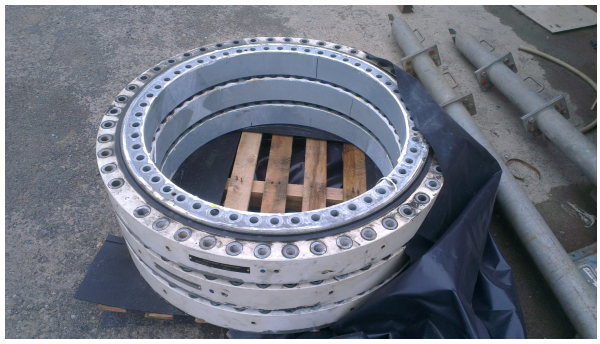

Figure 2

In order that a full and thorough examination of the rolling elements, lubricating grease and four-point contact raceways could be made it was necessary to cut the outer rings at two points. See figure 3.

Figure 3

2.1 Lubricating Grease

Samples of grease were removed from all three bearings and sent away for laboratory analysis. This analysis was to include a review of Ferrous Density i.e. the amount of ferrous material that is greater than 10µm in size along, Wear metal particles of less than 10 µm and other appropriate contaminant particles. Ample grease was found to remain within all the bearings.

2.2 Rolling Elements and Raceways

The components of all three bearings were carefully separated in order that cleaning and detailed inspections could be carried out. See figure 3

Figure 3

In all three bearings very light damage was identified around the location in the outer ring of the filling hole see figure 4.

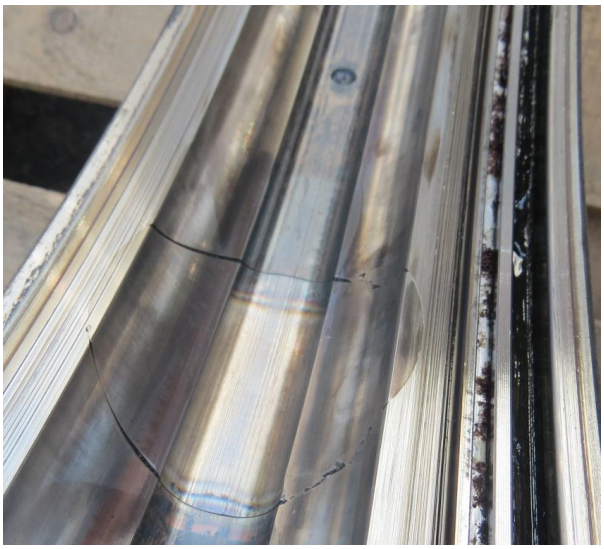

Figure 4

Results from in service grease analysis results, taken by the turbine operator, suggested that the limited amounts of small sized metallic debris was present. In two of the bearings, the remainder of the inner and outer raceways along with the steel balls all appeared in a serviceable condition and that no imminent failure was likely.

A typical raceway is shown in figure 5 and a typical set of the steel balls is shown in figure 6.

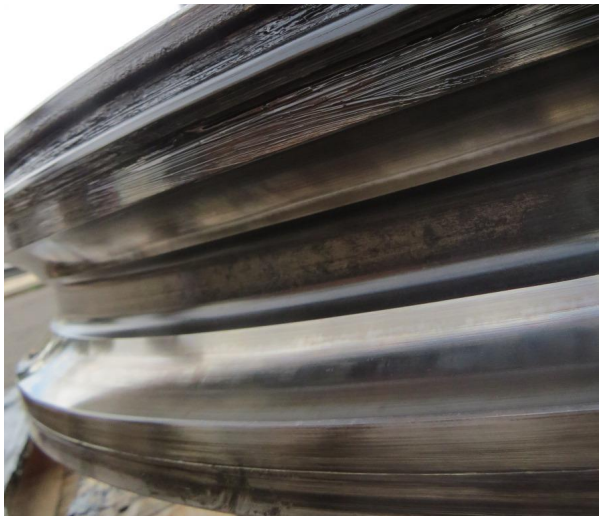	
Figure 5	Figure 6

The final bearing in the set of three was seen to have larger amounts of dry and dirty grit and lubricant around the seals. See figure 7.

The in service grease analysis for this bearing suggested that there would be less fatiguing damage found on the raceways as the wear metal results were dramatically less than that for the previous two bearings.

Fig 7

After cleaning both the outer and inner ring were seen to have large contact areas that had been affected by a phenomenon known as pear skinning. This is where large pieces of metallic debris become crushed onto the load-bearing surfaces by the rotating action of the bearing. See figure 8.

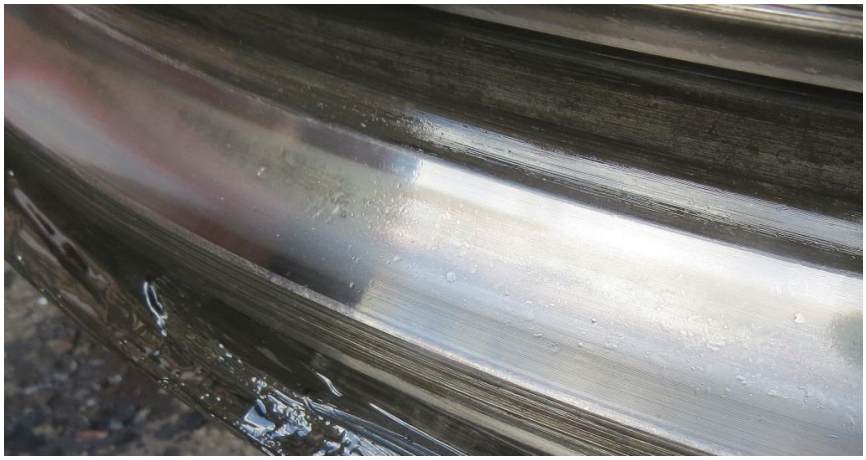

Figure 8

The steel balls from this bearing were also deeply discoloured and pear skinned. See figure 9.

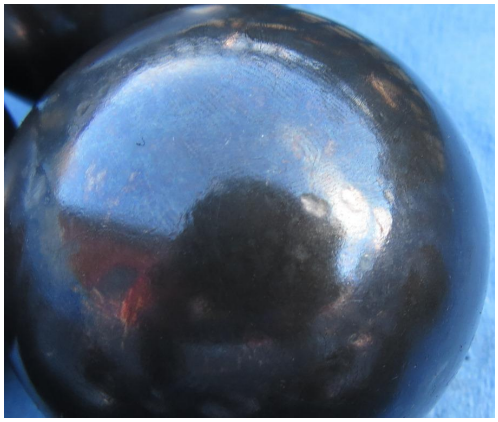

Figure 9

A full review of the inner ring identified a large area of fatiguing, see figure 10.

Fig 4

This large area of fatigue damage was clearly the source of the metallic debris that had caused the pear skinning. The fact that in service grease analysis has not detected the extent of the damage was investigated further.

The additional commissioned grease analysis, this time with a request to monitor metallic debris greater than 10 µm, was reviewed. As was expected a very high value was obtained. In addition to metal large amounts of silicon were also detected in this sample.

3. DISCUSSIONS AND CONCLUSIONS

Investigation identified that fatiguing and flaking existed within all bearings from this turbine, the most damaged of three, as well as having both large and small particles of metal within the grease had critical amounts of silicon also.

The investigation was able to demonstrate to the turbine operator that revised grease sampling techniques were required to identify critically damaged bearings. The investigation also suggested that a review of the bearing sealing should be undertaken to prevent or at least reduce the ingress of other external harmful particles such as sand or salt.

The fact that the bearings were dramatically larger than any we normally investigate did not prevent a full and thorough inspection being carried out and a report produced that provided the end user with useful information to help prevent future bearing failures.