BEARING FAILURE ANALYSIS

Example Type B Report

Pulley Bearing Failure

1. INTRODUCTION

Two 6219 ZZC3 shielded deep groove ball bearings and a central shaft from a damaged lift pulley were delivered to our workshop. See Fig 1 and Fig 2.

Fig 1

Fig 2

One of the bearings was in an assembled condition; however, the other had a cracked inner raceway and two loose metal shields. All bearings were very dirty and had a coating of unidentified gummy residue. The gummy residue had a strong rubbery smell.

The shaft journals (the location of the bearings) were worn and discoloured. These markings suggested that rotation between the shaft and the bearing bore had occurred.

The bore of the bearing with the cracked inner ring was discoloured and had evidence of fretting corrosion and rotation marks. This type of marking is often seen when a bearing is either loose on the shaft or when it is subject to vibration during service.

The outer surface of the outer ring showed that the bearing had also rotated within the housing during service.

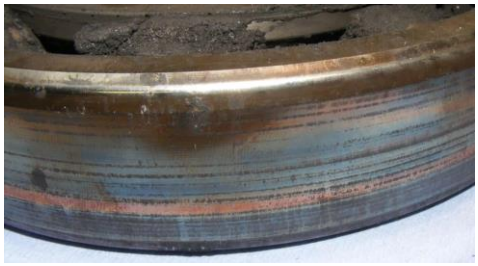

Fig 3

The bearing was held and an attempt made to rotate the rings by hand. The assembly was very notchy and would not turn more than a few degrees.

The cracked part of the ring was removed to reveal further cracks running fully through the ring, see Fig 7.

Fig 7

Around the area of the crack there was evidence of more gummy substance and small section of fatiguing.

In order that the investigation could be furthered, it was necessary to disassemble the bearing. This was accomplished by cutting the outer ring in two places, see Fig 8

Fig 8

The sections of outer ring were wiped to reveal areas where the gummy substance had dried and become bonded to the raceway surface. Areas

were washed in degreaser which still did not remove the entire residue. See Fig 9.

Fig 9

The inner ring is similarly shown in Fig 10. This is the area around the crack and as can be seen there are areas of surface fatigue. On close inspection of the bore, the area of fatigue corresponded to the area of most discolouration within the bore. This suggests that the bearing has been assembled in an outer ring rotation application and that this area is the point of maximum loading.

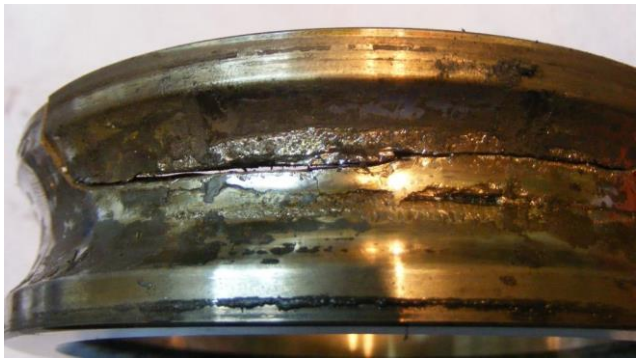

Fig 10

The balls held within the cage all fell out of the pockets very easily; this suggested that the cage was worn for some reason.

The pockets were inspected, see Fig 11, this clearly shows more gummy residue along with areas of wear and erosion.

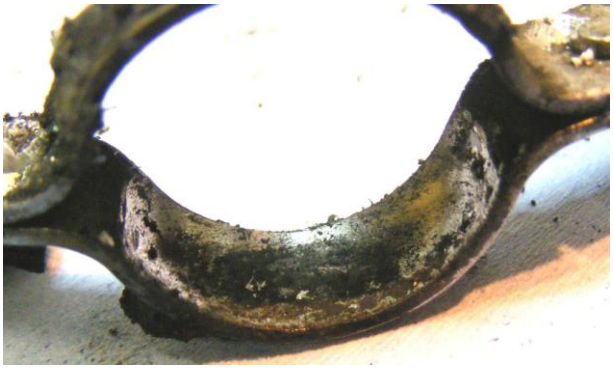

Fig 11

2.2 Ball Bearing Two

Fig 12 and 13 show both sides of bearing two.

Fig 12

Fig 13

Fig 12 shows some evidence of a dirty build up whilst Fig 13 shows a side that is relatively clean.

The bearing turned easily by hand but when visually inspected, the exterior surface of the outer ring showed some evidence of fretting. There was much less damage seen on this bearing than on bearing one. See Fig 14.

Fig 14

Fig 15 shows the bore of the bearing and as can be seen there is very little marking present.

Fig 15

The shields were removed, firstly from the dirty side of the bearing. As can be seen in Fig 16 there is a mass of clean grease with a trace of ingress dirt near the area of the inner ring. This clearly suggests that the bearing has been running in a dirty environment and that particles have

started to pass through the gap between the shield lip and the inner ring diameter.

Fig 16

Once again the bearing was cut to facilitate further internal inspections. See Fig 17.

Fig 17

The ball bearings remained firmly within the cage pockets suggesting that there was little to no wear on the balls or inside the cage itself.
The outer raceway wiped clean easily to reveal a generally normal surface. See Fig 18

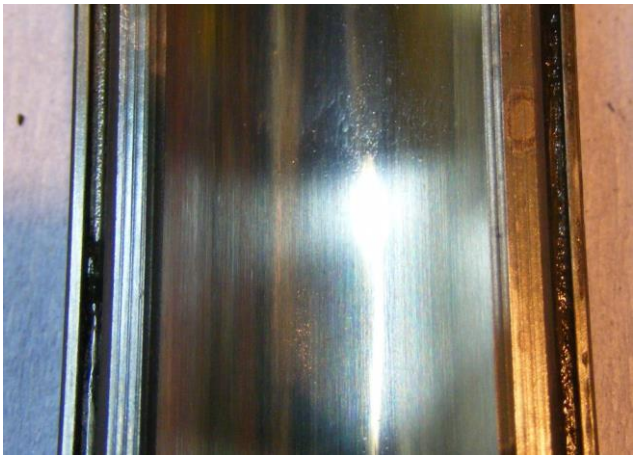

Fig 18

Fig 19 however shows that on the wiped inner ring there is the start of a build up of what appears to be more of the gummy residue. This residue has ingressed the bearing and then flowed towards the contact area of the raceway.

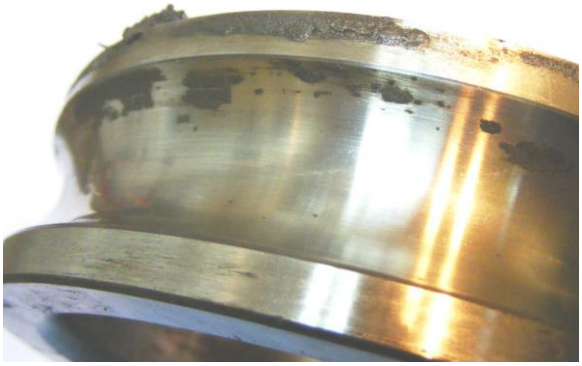

Fig 19

2. DISCUSSIONS AND CONCLUSIONS

Bearings of all types require a good clean lubricant charge to perform adequately. Dirt of any type will have an adverse effect on the life and performance of a bearing it comes in contact with.

It is clear that bearing one has been subjected to an abnormal amount of dirt of some kind and that this has entered the bearing void, mixing with the grease. As was stated earlier a ZZ type shielded bearing has a small sub millimetre gap between the edge of the shield and the inner ring. This type of bearing is generally used in clean applications where seal drag may cause some application problems or overheating.

Cage wear as seen in bearing number one is a classical sign of a bearing running in degraded lubricant. It seems clear that the dirt around the application has entered the bearing and mixed with the grease causing it to turn into a gummy, partially dry residue that did not protect the contact surfaces during service. Such a situation will rapidly induce stress in the surfaces of the raceway resulting in fatigue and quite often (as seen on this occasion) raceway fractures.

From the evidence gathered it is our opinion that the damage as seen is as a result of dirt entering the bearings during service and causing the lubricant to degrade rapidly.

The dirt seems to be very aggressive and as such even a 2RS sealed bearing may only have a minimal effect on increasing bearing life.

We would strongly recommend that the equipment user establishes where the dirt has originated from and then either prevent the build up or ensure that the area is cleaned regularly.

We can find no evidence to suggest that the bearings were defective in any way or had been supplied in a substandard condition.

These bearings are shielded to the side and have a greater than standard radial clearance between the balls and raceways. A shield is designed to retain lubricant within the bearings but as there is no contact or drag between the inner ring and the edge of the shield the bearing is not sealed from external moisture or fine dust.