



BEARING FAILURE ANALYSIS

Example Type B Report

Tapered Roller Automotive Wheel Bearing Failure

1. INTRODUCTION

A wheel bearing was supplied to us for inspection and report, a double row tapered roller hub unit. See Fig 1.



Fig 1

We understand that the bearing had been fitted to a van with a mileage of 123,095 recorded. We understand that the kit was fitted then failed two days later whilst on a motorway.

2. INSPECTION

As can be seen in Fig 1 the return consisted of a stub axle, a wheel hub and flange that also contained the bearing outer ring. Two inner rings, assorted crushed rollers and parts of seals and cages along with a circlip were also included in the delivery.

2.1 Stub Axle

Fig 2 shows the abutment shoulder of the stub axle against which the inner ring side face is located.

As can be seen there is an area of new grinding (3 o'clock to 6 o'clock in the photograph). The shiny and clean nature of this mark suggests that the grinding was carried out as part of the disassembly process.

On close examination of other sections of this shoulder (9 o'clock to 6 o'clock) heavy burrs and deep circumferential markings could be seen. These marks were discoloured through heat tempering to a deep blue. This discoloration over the wear marks clearly suggested that the markings and damage had been present for some time prior to this failure occurring.

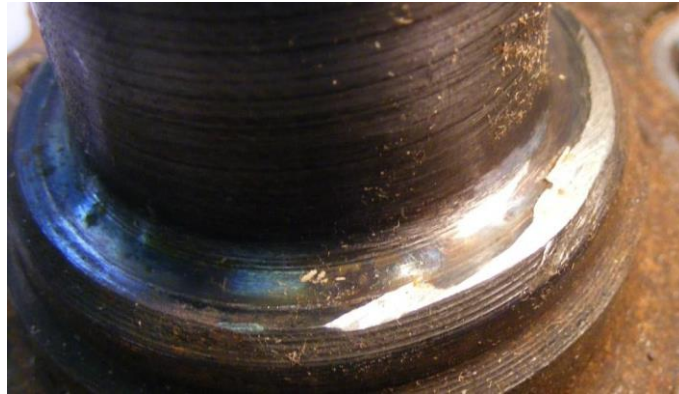
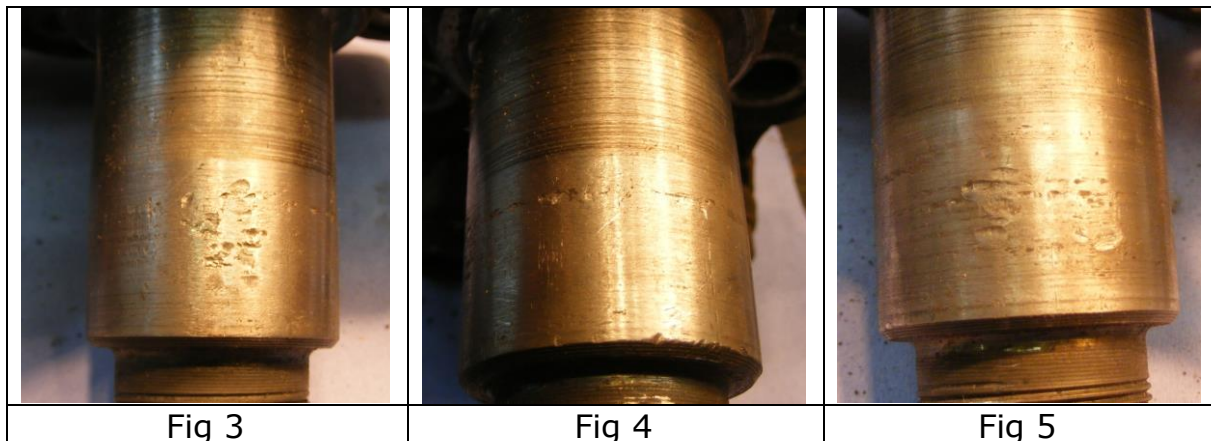


Fig 2

Figs 3, 4 and 5 all show the stub shaft journal. There are two distinct areas of marking; there is clear evidence of rotation on the shaft close to the abutment shoulder and deep pitting close to the threaded end of the shaft.

The marks are consistent around the full circumference.



The edges of the pitting marks and indentations in the surface of the shaft showed evidence of smoothing and edge distortions, most clearly demonstrated in Fig 5. This is classical evidence of the shaft having been damaged as a result of an earlier bearing failure and a further set of bearings fitted over the areas of damage.

2.2 Bearing Inner Raceways

The two inner rings are shown in Fig 6. As can be seen both have heavily distorted and smeared raceways. The roller retaining ribs at the rear side of each ring are distorted, as is the nose region of the rings.

Damage of this type often occurs as a result of the rolling elements having run in loose and unguided or in an unrestrained condition.

The ring to the right of the figure has slightly more distortion and is discoloured more through overheating. This suggests that the inner ring was subject to more loading in service than the other raceway from the pair.



Fig 6

Fig 7 and 8 show the back surface of the ring along with areas of the bore from the inner ring on the right hand side of Fig 6.

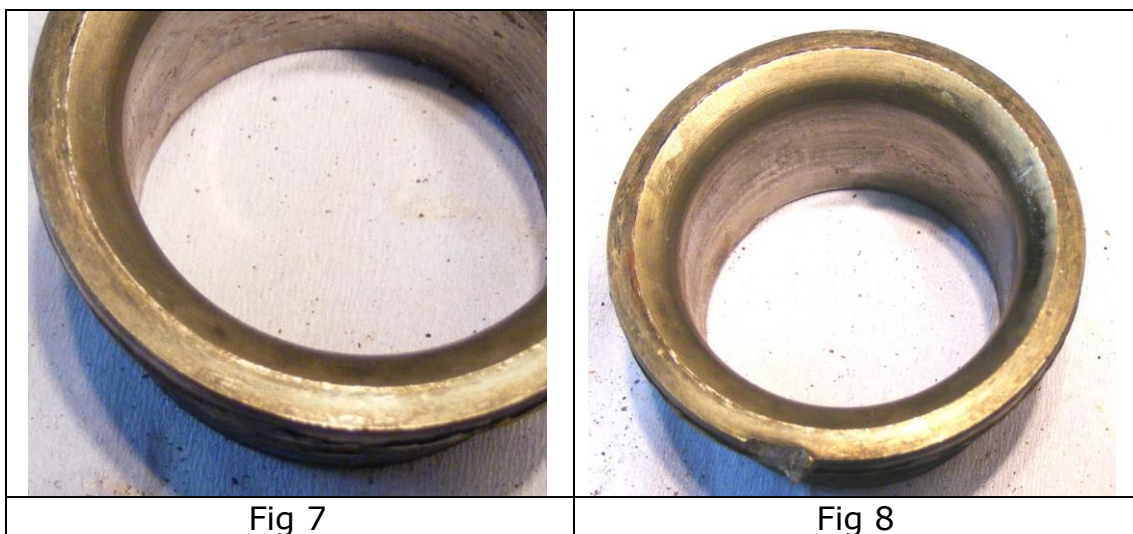


Fig 7

Fig 8

The bore has evidence of some rotation along with markings suggesting some deformation had been present on the shaft to which the bearing was fitted.

As can be seen there was no grinding marks on the outer side face. This suggests that the bearing was not fitted against the inner abutment face (previously noted as having been marked with a grinder). This suggests that this ring was fitted to the threaded end of the stub shaft.

Fig 9 shows the nose of the same inner ring. As can be seen there is much evidence of impact damage and heat tarnishing. The impact damage appears to have been caused during bearing removal from the shaft. Areas without indenting show heat tarnishing, burrs and evidence of inconsistent contact. These marks suggest that the nose of the ring has not been in firm contact with the other ring in the pair.



Fig 9

Fig 10 shows the bore and nose of the second inner raceway ring. The image shows heavy rotation marks and pick up within the bore. The nose is marked similarly to the first ring inspected, with heavy indentation marks.



Fig 10

Fig 11 shows a close up of the nose side surface, as can be seen there are heavy burrs and obvious signs of rotational scuffing.

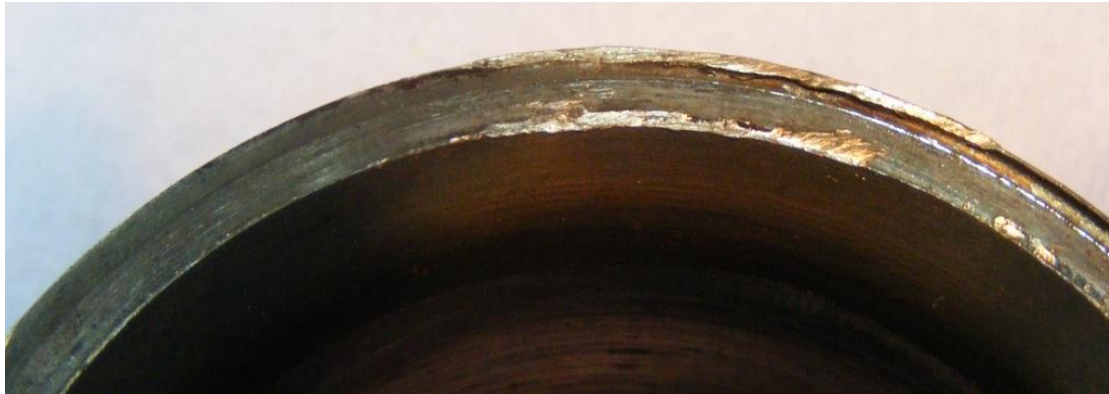


Fig 11

Fig 12 and 13 show the larger, outer side face of the second inner ring. The image reveals the ring has an inconsistent witness mark on this face. Such inconsistency generally occurs when the bearing is not squarely and firmly located up against a true and square abutment shoulder.

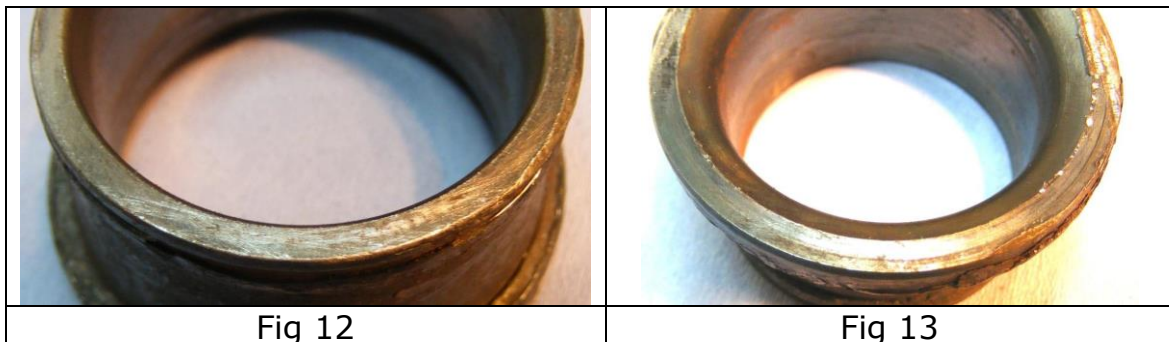


Fig 14 shows the rollers from the return. The image reveals all rollers are deformed, smeared and crushed. Some rollers appear to have a small pip extruded from them. This again is classical of rolling elements coming off the raceway and back rib during service and riding on non-load bearing points of the ring.



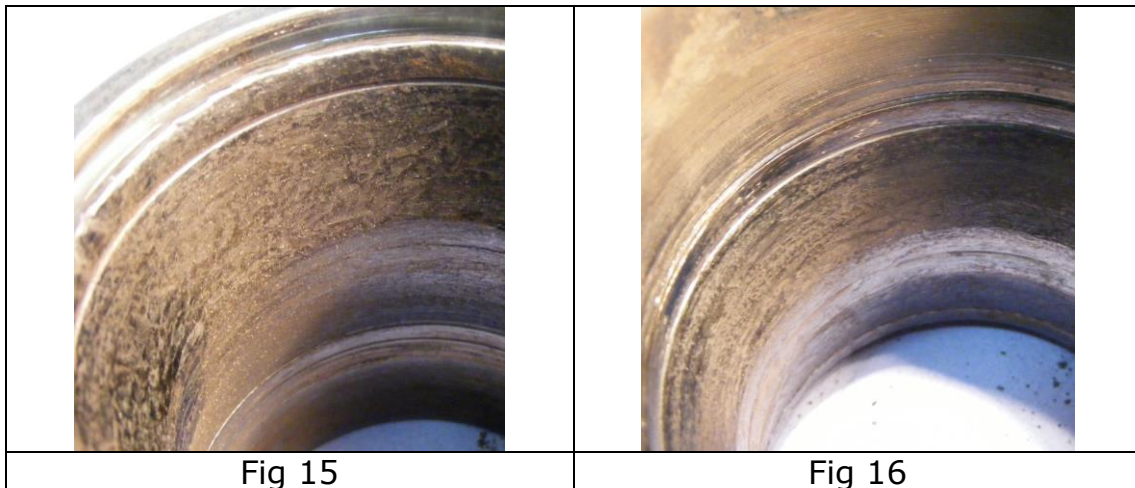
Fig 14

2.3 Bearing Outer Raceways.

The two outer raceways are both produced in a single piece outer ring. Fig 15 and 16 show the raceways as examined within the hub.

The outer ring appears to be securely adhered to the vehicle hub forging. This suggests that the ring had rotated within the hub and become friction welded to the housing bore and locating shoulder.

The raceways are both pitted and scarred suggesting that overloading and overheating has occurred prior to removal.



3 DISCUSSIONS AND CONCLUSIONS

From the gathered evidence it is clear that there has been damage and wear on the stub shaft and its abutment shoulder prior to the installation of this bearing assembly.

Double row tapered roller bearings are precision designed to be fitted to a vehicle so that the micron level internal clearances are at a pre-determined value when all components are tightened and secured. This value ensures an optimum service life during operation.

This adjustment also ensures that the load from the application is carried equally on both the raceways of the bearing. It is clear from Fig 6 that the threaded end raceway has been subjected to a higher loading than the other "inboard" raceway.

The fact that the nose side face of both inner rings show evidence of movement clearly suggests that the inner rings were not securely locked against each other during service. Such a condition often happens when bearings are fitted to a shaft with prior damage and pick up. We often see metal from the shaft being broached off by the ring during pressing into place. This broaching gives a false feeling of secure location as the raceway prematurely snags on a shaft damage high point.

From the gathered evidence it is clear that the bearings have been fitted to components that were previously damaged. This damage has resulted in the bearing inner rings not locating correctly and subsequently moving during service, this movement has resulted in excessive internal end float occurring and the rolling elements moving in unintended planes, skewing and snagging. Such movement will result in the generation of excess heat and raceway damage as seen.

We therefore conclude that this failure has occurred for reasons outside the control of the bearing manufacturer, namely that the bearing was fitted to unserviceable and damaged mating components.