Repair/Remanufacture of Large Bearings and Slewing Bearings Saves Cost and Downtime

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Abstract

Roller Bearing Corp (RBC) recently upgraded its large bearing manufacturing and repair facility in Houston, TX. Significant investments were made in facility (new plant), equipment, gauging, NDT equipment, manufacturing systems and engineering design capabilities. These investments enhanced the facility's capabilities in both the manufacture of new bearings, and the repair/remanufacture of used bearings

Repairing/remanufacturing of large bearings presents an option worthy of evaluation due to its cost, and lead-time benefits over new bearings. Depending upon the level of repair/remanufacture the cost and lead time benefits can be significant. At 40% to 70% of the cost of a new bearing and 25 to 50% of the lead time, the repair option can save an end user thousands of dollars and months of downtime.

This article will focus on the plant's capabilities and methods of evaluating and repairing/ remanufacturing of large bearings and slewing bearings, which have been removed from applications due to their inability to function as required.

We will discuss how a bearing removed from service is qualified as repairable, and outline the processes used to enact the repair and the results that can be expected.

Background

Large bearings are typically expensive to buy and have long lead times. As a result, users of such bearings either have a spare bearing or face extensive downtime in case of a bearing failure. One good strategy towards minimizing the impact of bearing failure is removing it from its application prior to its serious degradation and replacing it with a spare bearing.

A bearing removed before it experienced significant degradation failure may well be a candidate for repair/refurbishment.

Repair/refurbishment are phrases which capture a variety processes aiming at bringing the bearing to usable condition which may be equivalent to a new bearing.

Upon receipt, RBC shall first evaluate the condition of a bearing and issue a detailed intake inspection report. Based on the evaluation and report, one of four levels of repair/ refurbishment may be proposed to the customer:

Level 1:
Bearings are thoroughly inspected for damage which may have occurred in storage and cleaned if necessary. Clearances are verified; the bearing is lubricated, and repackaged.

Level 2:
Bearings that have been used in the intended application are cleaned, examined and fully inspected. If required, raceways are polished. Components are re-assembled, clearances verified; bearing is lubricated and repackaged.

Level 3:
Worn or damaged bearings are cleaned, examined and fully inspected. Depending on the level of wear and damage, the bearing will undergo several processes that may include regrinding raceways, replacing rolling elements and cages. Components are re-assembled, clearances verified; bearing is lubricated and repackaged.

Level 4:
The bearings are cleaned, fully inspected and measured. This level of repair involves the replacement of a major component such as an inner or outer race in addition to the rolling elements.

RBC's Method of Bearing Evaluation

Many times bearings are received in fairly poor condition as shown in Figure 1 below.

Figure 1 - Bearing races, rollers and separators received for repair.

Bearing components are cleaned and inspected for critical dimensional and clearance characteristics.

We pay particular attention to determining the integrity of the raceway, namely the hardened case depth, surface hardness and any evidence of cracking. An advanced ultrasonic backscattering instrument is used to determine the hardened case depth. Figure 2 below shows the use of this instrument and the data it generates for the inspection report.

During refurbishment the case depth of the hardened layer is of critical importance. In repair operations requiring regrinding of the raceway, care must be taken to make sure that enough hardened case remains to support anticipated ball/roller loads in service. If it is know precisely what load levels are being carried by the bearing, then it is possible to calculate the minimum required effective case depth needed to sufficiently support those loads (effective case depth is the distance form surface where the hardness is HRC 50).

In most instances the applied loading and duty cycle information of a bearing being repaired is not known. In these cases, a design rule is applied (11% of the rolling element diameter) to approximate the required minimum effective case depth required. This design rule is based on extensive analytical data gathered from numerous bearing design studies that indicates that a sub-surface hardness pattern based on that magnitude of effective case depth, is sufficient to contain the vonMises stresses developed beneath the raceway surface, in the majority of large bearing applications.

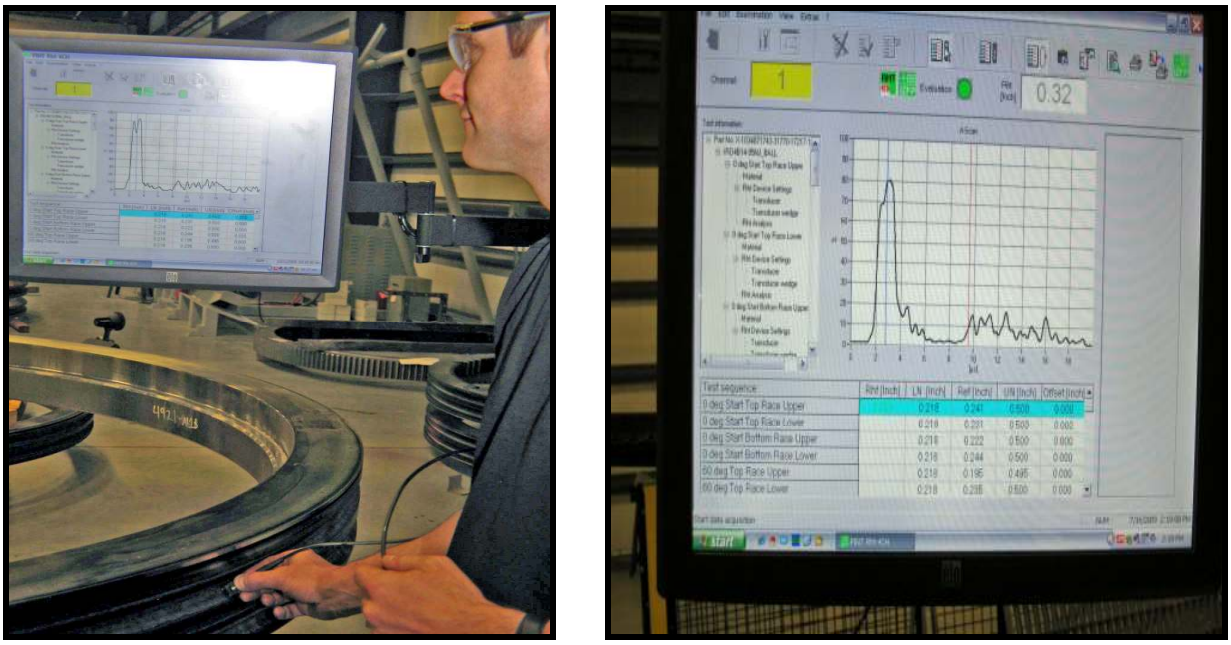

Figure 2 - Case depth measurement by ultrasonic backscattering

The hardness of the raceways is measured by a portable hardness tester which operates on the rebound energy principle (Figure 3).

Figure 3 - Measuring the hardness of the raceway.

It is important to determine if the raceways are compromised by fatigue cracks. Magnetic particle or die penetrant test methods are utilized to inspect the raceway surfaces for the existence or absence of cracks, see Figure 4 below.

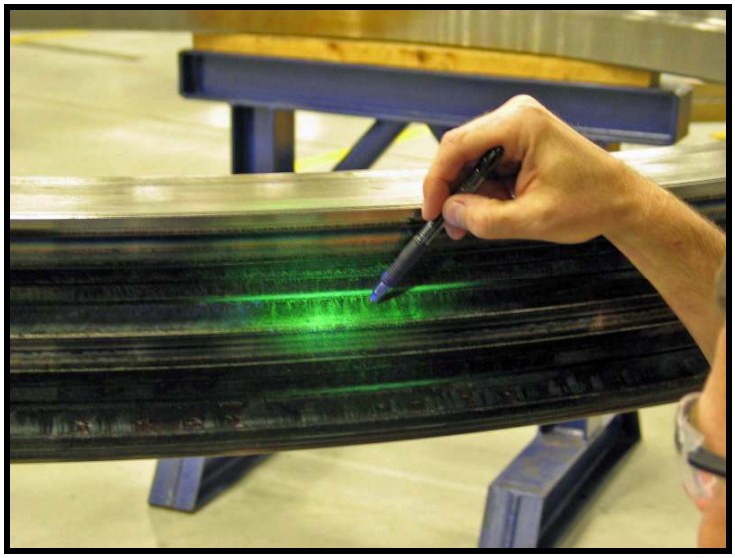

Figure 4 - Magnetic particle inspection of raceways.

The evaluation process, as well as, the repair/remanufacturing process is supported by up-to-date gauging equipment. Ball track diameters are measured by calibrated gauging bars (Figures 5 and 6).

Figure 5 - Setting diameter dimension gauge

Figure 6 - Measuring ball track diameter.

In the case of Level 3 and Level 4 repairs, it may be necessary to examine the overall design of the bearing for the application in question. This may be needed if it is suspected that the reason for the declining performance of the bearing was due to an inadequate design. The RBC engineering team is well qualified to make appropriate recommendations regarding key characteristics, such as bearing radial or axial play, or pre-load, or breakaway torque levels. These decisions are supported by analytical tools, such as, solid modeling, FEA analysis, and internal computational programs to calculate stresses and bearing lives as a function of the application parameters (an example of a solid model can be seen in Figure 7 below).

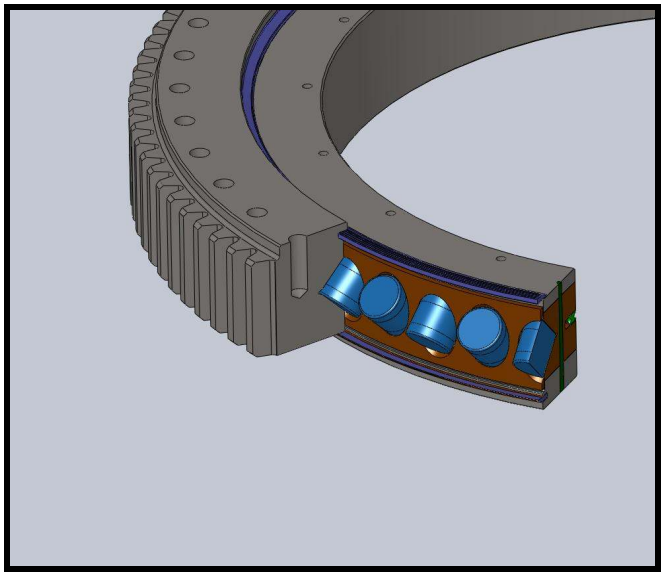

Figure 7 - Solid model of a cross roller slewing ring bearing.

If replacing components is required, in-house turning, gear cutting, induction hardening, and grinding capabilities are utilized as needed.

Figure 8 - Induction hardening of a ball path.

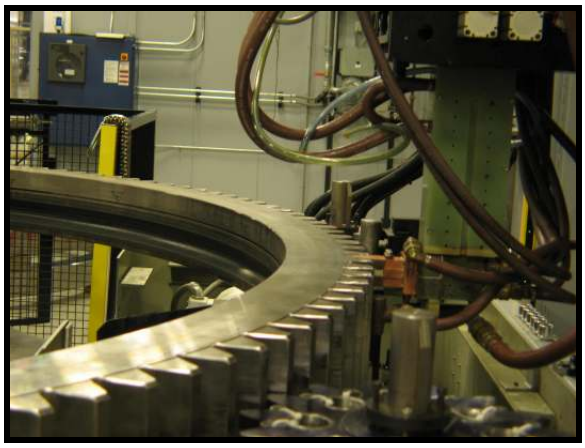

Figure 9 - Induction hardening of an external gear

Results expected from repaired/remanufactured bearings.

A Level 1 or 2 repair should result in a bearing with a useful life equivalent to that of a new bearing. It is basically a clean-up operation in which the hardened case depth is not affected; the integrity of all components is verified along with the proper internal clearances.

A Level 3 repair should result in a bearing with a useful life very close to that of the life of the original bearing. Grinding of the raceway will impact the effective case depth, but based on the proper evaluation the minimum required hardened case depth, the overall impact to service life is minimized.

A Level 4 repair should result in a bearing with a useful service life closely equivalent to a new bearing.

Summary

This article has briefly demonstrated how, with the right processes, technical capabilities and equipment, it is possible to repair/remanufacture large bearings and return them to useful service for a fraction of the time and money to replace. This presents a significant cost saving option to maintenance supervisors who have the responsibility of keeping large equipment up and running.

The RBC Houston facility has the technical know-how, the experience, the equipment, and the capacity to provide excellent repair/remanufacturing services of large diameter bearings. This includes ball, cylindrical roller, and tapered roller bearings from 36 inches to 169 inches in diameter.