CAUSES AND FAILURE PATTERN OF BEARINGS IN RAILWAY BOGIES AND THEIR REMEDIES

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ABSTRACT

In this paper author describes the roll of spherical roller bearings in railway bogie wheels. Spherical roller bearings are critical components whose failure may have catastrophic consequences. The present study aims to analyses the mechanical stability of greases and temperature of bearings as indicators for condition-based bearing maintenance. The performed case study includes nine fully-formulated commercial greases examined in the wheel bearings of five ore cars operated in railway workshop. The studied about bogie travelled a distance of about 300000 km during a period of three years. Small samples of the bearings were taken on eight occasions to test their mechanical stability. Addition, the temperatures of the bearings was continuously recorded. Then after the testing, the wear, electrical damage, and corrosion of the bearings were examined and measured. One of the findings is that the shear stress of the grease at a certain shear velocity (the certain yield stress (CEY) value) is a good maintenance indicator and is highly dependent on the grease type. The wear, electrical damage and corrosion of spherical bearing also depend on the grease type. However, no oxidation of the greases was identified. The paper describes a systematic methodology to determine an overall maintenance indicator for railway roller bearings which is based on the field work. Dismount roller bearings at every alternative inspection in workshops for renewal of felt ring. If any defect on roller bearing or its components is suspected, bearing should be dismounted and sent for inspection.

KEYWORDS: Failure patterns; Spherical Roller Bearing, remedies.

1. INTRODUCTION TO BASIC BEARING CONSTRUCTION

Rolling stock employs a large variety of bearings. Spherical roller bearings for passenger coach applications are specially important and require extremely high levels of performance, durability and reliability.

In order to achieve these high levels, NBC(NEI-Bearing manufacturer for Indian railway ) performs strict inspection and quality control at every stage of design, and production, from selection of material to the processing technology used for manufacturing the bearings.

First spherical roller bearing was manufactured in year 1976 and since then NEI (National Engineering Industries Ltd) has made continuous efforts to improve the quality of products supplied to Indian Railways.

Spherical roller bearing consist of an outer ring having a continuous spherical raceway within which it operates, two rows of barrel shaped rollers, which in turn are guided by an inner ring with two raceways separated by center rib (Refer to Fig. 1)

They are usually of the double row design, both the rows of the rollers having common spherical raceways in the outer ring. Spherical roller bearings have a large capacity for radial loads, axial loads in either direction, and complex loads. They are suited for the applications such as railways rolling.

Stocks where vibration and shock loads are encountered ,spherical roller bearings for railways passengers coaches are manufactured and supplied for a controlled amount if radial clearance. Therefore, races and rollers are not interchangeable.

All spherical roller bearing are fitted with machined brass cages. Brass is the most preferred cage material for bearing used in railways all over the world. Spherical roller bearings for Meter Gauge and Broad gauge passenger coaches have symmetrical roller design

FIGURE 1 BEARING COMPONENTS
1.1 Outer ring
Outer ring for spherical roller bearings are manufactured from forged and rolled rings from bearing quality steel. It is through hardened and precision ground all over. The track or roller surface of bearing outer ring is spherical in shape for self-aligning.

1.2 Inner Ring
Inner ring for spherical roller bearing are also made from bearing quality steel which is forged and rolled. Inner rings are also precision machined heat-treated and precision ground. Inner ring have two rolling surface which are ground together with high accuracy.

1.3 Roller
Roller are either forged or machined from bearing quality steel bars & then through hardened and ground to high degree of accuracies. In bearing 22320 and 22326, symmetrical design rollers are used and for bearing 22328, asymmetrical design rollers are used.

1.4 Cage
Spherical roller bearings are fitted with machined brass cages. These cages are made from brass centrifugal castings and then precision machined. Brass cages have advantage of assuring positive lubrication and cooler running of the bearing therefore are best recommended for railway applications.

![FIGURE 2 DESCRIPTION ABOUT FAILURE OF BEARING](image)

In general, if rolling bearings are used correctly they will survive to their predicted fatigue life. However, they often fail prematurely due to avoidable mistakes. Failure of the rolling bearing can occur for a variety of reasons. Accurate determination of the cause of a bearing failure must to make suitable recommendations for eliminating the cause.

The major factors that singly or in combination may lead to premature failure during service include incorrect mounting, excessive loading, inadequate & insufficient lubrication, impact loading, vibrations, contamination, entry of harmful liquids.

It is difficult to determine the root cause of some of the premature failures. If all the conditions at the time of failure, and prior to the time of failure are known, including the application, operating conditions and environment, then by studying the nature of failure and its probable causes, the possibility of similar future failures can be reduced. Two or more failure pattern can occur simultaneously and can thus be in competition with one another to reduce the bearing life. Also a pattern of failure that is active for one period in the life of a bearing can lead to or can even be followed by another failure mechanism, which then cause premature failure. Thus in some instances, a single failure pattern will be visible and in other indications of several failure pattern will be evident, making exact determination of root cause difficult. So when more than one bearing failure pattern has been occurred, proper analysis depends on careful examination of failed components. In contrast to fatigue life, this premature failure could be caused by:

1. IN CORRECT FIT
2. IMPROPER MOUNTING
3. IMPROPER HANDLING
4. POOR LUBRICATION
5. CONTAMINATION
6. EXCESSIVE HEATING
7. EXCESSIVE LOAD

2. Types of failure pattern in bearing
2.1 Rust and corrosion
Causes: Surface becomes partially or fully rust sometimes rusted at spacing equal to distance between rolling element due to improper storage, packaging and insufficient rust preventative, invasion of moisture and handling with bare hands

Remedies: Take measure to prevent rusting while in storage, Improve sealing performance, Improve method of assembly and handling.
2.2 Fretting
Causes: Fretting surfaces wear producing red colored particles that form hollows due to insufficient interference and lubrication and vibration during transport or when not operating condition
Remedies: Improve fit, Check surface roughness of Journal and housing, Check consistency of grease, Do not use worn out or damaged housings

2.3 Flaking
Causes: Flakes form on the surface of the raceway and roller elements. When the flakes fall off, the surface becomes rough and uneven due to contamination and insufficient precision of journal or housing
Remedies: Find the cause of heavy load, Check internal clearance regularly, Improve precision of journal and housing, Improve operating conditions, Improve method of assembly and handling, Check grease and greasing method

2.4 Seizure
Causes: Bearing heats up, becomes discoloration and eventually seizes up due to bad quality of grease and insufficient grease and softening due to abnormal temperature rise
Remedies: Check grease type and quantity, Check internal clearance regularly, Improve method of assembly and handling

2.5 Cracking
Causes: Split and cracks in bearing rings and rollers due to rapid heating during mounting, excessive shock load, hammer and impact of large foreign particles, large flaking and overheating by creeping
Remedies: Avoid rapid heating of bearing during mounting, Reconsider operating condition, Improve method of assembly and handling, Prevention of creep, Do not use excessively worn-out or deformed housing, Excessive moment

2.6 Cage damage
Causes: Breaking or wear of cage due to excessive moment load, high speed rotation or excessive fluctuation of speed trapping of foreign objects and misalignment
Remedies: Investigate rigidity of system, Reconsider operating conditions, Improve method of assembly and handling

2.7 Rolling path Skewing
Causes: Roller contact path in raceway surface stray or skews due to deformation or tilt of bearing and insufficient rigidity if journal and housing
Remedies: Re-check internal clearance, Re-check precision of journal and housing, Investigate rigidity of system

2.8 Smearing and Scuffing
Causes: Surface becomes rough with small deposits. 'scuffing' generally refers to roughness of the ring ribs and rollers end faces due to excessive sliding of rolling elements and surface roughness
Remedies: Check the quality / quantity of grease, Improve sealing performance, Check operating conditions, Improve method of assembly and handling

2.9 Indentations
Causes: Hollows in raceway surface produced by solid foreign objects trapped or impacts (false) due to ingress of solid foreign and objects trapping of flaked particles
Remedies: Improve sealing performance, Improvement in handling and mounting practices, Check involved bearing for flaking if dents produced by metal practices, Always use clean grease

2.10 Electrolytic corrosion
Causes: Pits from on raceway and develop into ripples. Further development leads to corrugated surface due to electric current flowing through raceway and change of raceways/roller color
Remedies: Create a bypass for current, Insulate the bearing

2.11 Peeling
Causes: Peeling is a cluster of very small spalls. Peeling can also include very small cracks which develop into spalls due to ingress of foreign matter and improper lubrication
Remedies: Use good quality of grease, Replacement of grease after recommended interval
3. CONCLUSION
Poor lubrication and poor mounting of bearing on axle wheel can cause accidental damage while traveling of passenger coach so by using specialized lubricating grease which is standardize by bearing manufacturing company and design of bearing is used. Now a days with spherical roller instead of cylindrical roller bearing because they automatically compensate for large angular errors (shaft misalignments) and they are self-aligning bearings designed for heavy radial loading. This feature of this bearing has great practical importance in those cases where it is difficult to obtain exact parallelism between the shaft and housing both axes. So these bearings are suitable where misalignment can arise from mounting errors or from deflection of the shaft.

References
[1] Railway workshop, Bhavnagar
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