HYATT®

Heavy Duty Truck and Trailer
Bearing Failure Analysis

THE GENERAL®

An ISO / TS 16949 Certified Company

Company Overview

General Bearing Corporation (GBC) occupies a unique position in the bearing industry. Renowned for its ability to combine quality with competitive cost structures, GBC's winning combination has been used to establish a first class reputation at Original Equipment Manufacturers as well as the Aftermarket. With engineering, sales, and logistics located in New York, and state-of-the-art manufacturing facilities in China, General Bearing is an ISO/TS 16949 certified manufacturer of ball and roller bearings. Under our brands HYATT and THE GENERAL, OEMs and distributors around the world rely on General Bearing Corporation for consistent, high quality products and service.

General Bearing Corporation Headquarters
West Nyack, NY

Industries currently using General Bearing products include:

- Heavy Trucks
- Truck Trailers
- Automotive
- Electric Motors
- Industrial Equipment
- Lawn & Garden
- Material Handling
- Office Equipment
- Power Tools
- Railroad
- Recreational Vehicles

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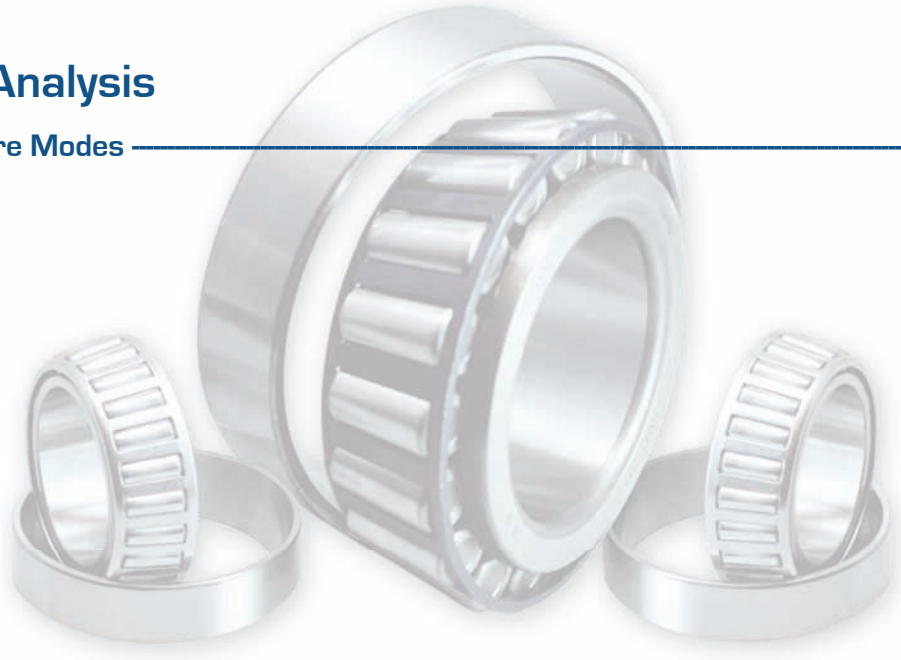


Introduction

The size of a bearing has no affect on its resistance to improper operating conditions, poor handling, or environmental influences. Bearings are precision components. Their manufacturing tolerances are often not found in other components that are part of the same assembly. Modern machining techniques and processes have managed to keep the cost of bearings low, masking their value as highly precise machine elements.

It is a known statistical fact that greater than 90% of all bearing failures are due to external influences. These include lubrication conditions, assembly installation techniques, contamination of the operating environment, and improper bearing size selection for the application.

Under proper operating conditions, a bearing should only fail from fatigue which is predictable based on the bearing size and it's application parameters.

Many other types of bearing damage can be prevented with the knowledge of how external influences affect the life of a rolling bearing.

For that reason, we present this guide as a reference towards understanding the causes and effects of bearing damage.

Prior to Installation

- Bearings should be stored in a clean and dry location without exposure to vibration.
- Keep bearings in their original packaging until they are installed.
- Hands should be clean and dry. Gloves are recommended.
- The work area should be clean with minimal exposure to contaminant generating equipment.
- Handle bearings with care. A drop from even a low height or a low shock load can cause rolling surface brinelling, a starting point for surface damage.
- Avoid cleaning or degreasing a new bearing as it will remove the preventative rust coating.
- Never spin a bearing with compressed air.

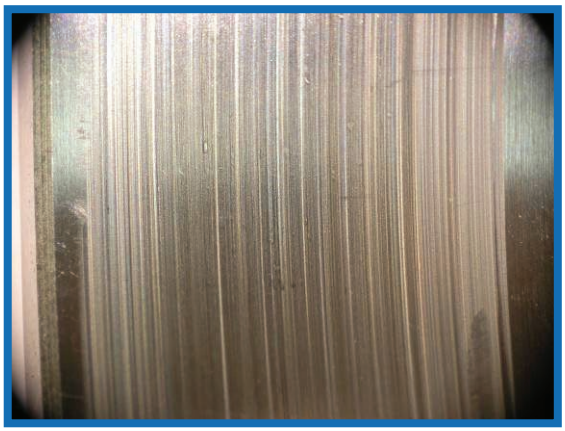
Correct Bearing Installation Techniques

- Use the appropriate sized tools for the bearing. Check for tool wear often.
- Assure that both the shaft and housing seating areas are clean and free from contaminants. The dimensions of the shaft and housing as well as any radii contacting the bearing should be confirmed as correct for the bearing size chosen.
- Do not apply shock loads to the bearing during assembly either through mishandling or direct use of a hammer.
- Use only the lubricant chosen for the application during installation. Do not mix lubricants.
- Avoid touching bearing surfaces with bare hands as this can lead to surface oxidation.
- Prior to press fitting, assure the bearing is aligned. Only apply force to the bearing race being pressed. For example: Do not cross load the bearing by pressing on the inner race when the outer race is being fitted.

Failure Modes

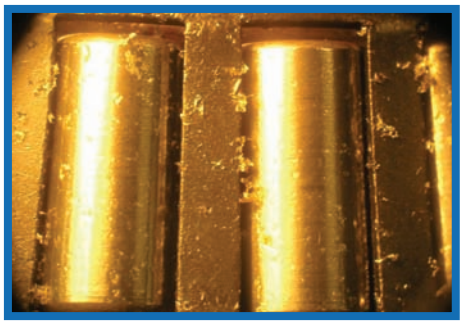
Grooving

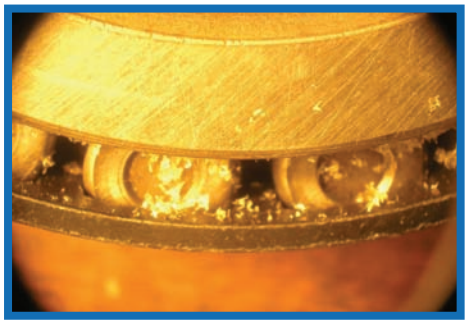
- Grooving occurs when hard contaminants enter the bearing and get wedged in the cage and cut grooves in the rollers.
- Particles can also get caught between rollers and cut grooves in the bearing races.
- The damage is permanent and will lead to early bearing failure.



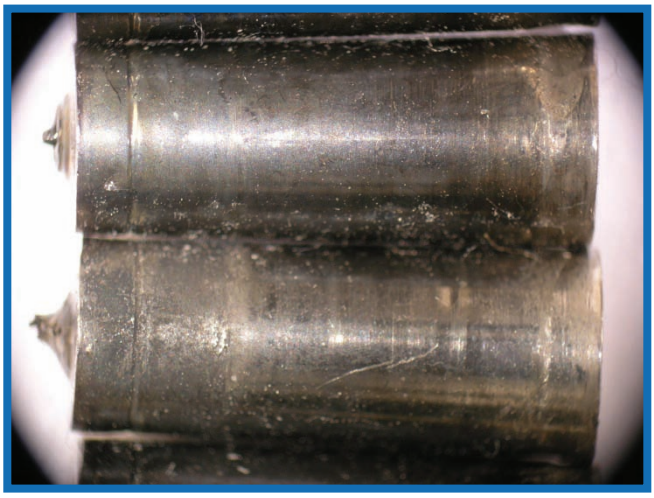
Pitting and Contaminants

- Pitting is damage that is also caused by foreign material such as dirt or metal particles entering the bearing.
- The most likely source of these particles are improperly cleaned housings.
- Even light pitting may lead to eventual bearing failure. Caution should be taken to evaluate whether lightly damaged parts should be returned to service.
- Excessive contaminants and resulting raceway pitting.





Excessive Abrasive Wear from Contaminants

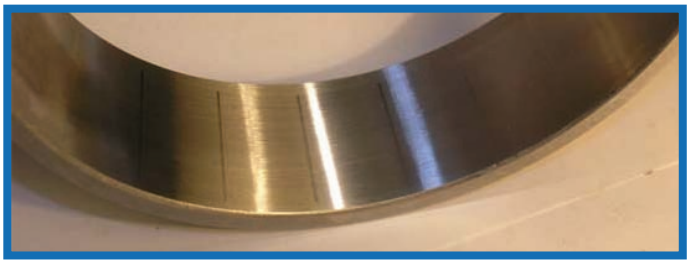


- Extremely contaminated environments will cause excessive wear to the point of wearing down roller ends as shown here. Bearing life is severely reduced in this situation.
- Abrasive wear occurs when a hard rough surface slides across a softer surface.
- Damage caused by lubricant-borne particles in rolling/sliding contacts can severely reduce the operational life of ball and roller bearings.
- Lubricant supplies frequently contain such contaminating particles, either generated from within the machinery itself or incorporated into the fluid from the surroundings.

Etching from Moisture Contamination

- When water is allowed to enter the bearing assembly and mix with the system lubricants, a chemical reaction can cause surface etching as shown above.

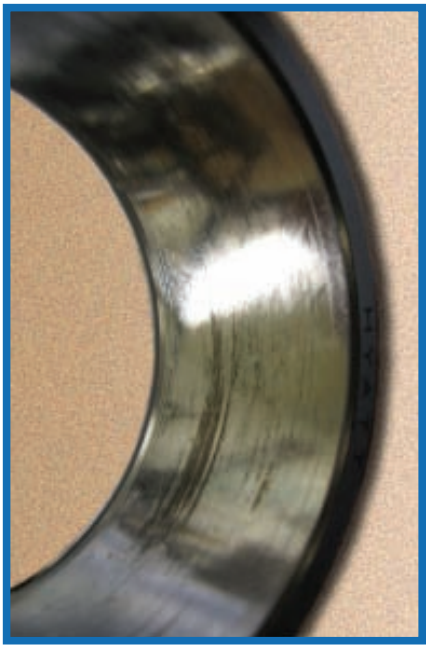
Frictional Corrosion

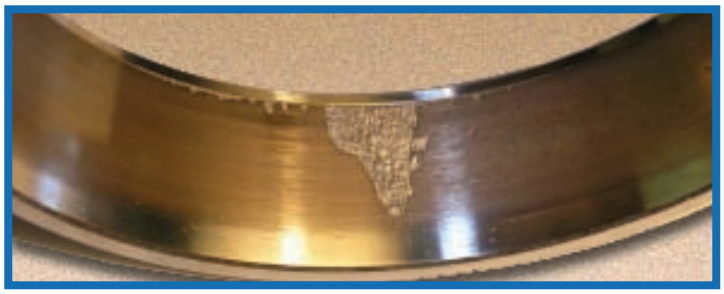


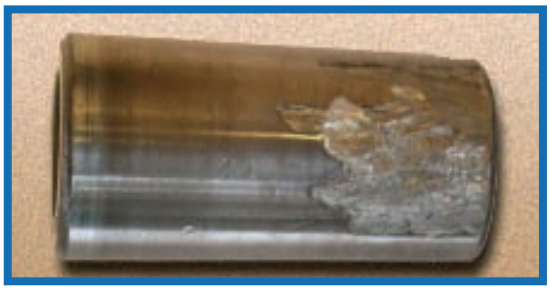
- Small vibrations will cause the bearing rolling pathway surfaces to rub together when the bearing is not rotating, such as when an assembly with installed bearings are shipped.
- The rubbing eventually leads to surface oxidation and a failure initiation point.
- Properly installed bearings with correct clearance and lubrication can alleviate this.

Misalignment

- Misalignment caused by installtation forces the centerline of the inner bearing race (cone) to operate at a slight angle to the centerline of the outer race (cup).
- This causes the load to be unevenly distributed creating greater than expected stress at one end of the rolling surfaces.
- Eventually, this will lead to surface spalling and premature failure as shown.
- The unexpected forces caused by misalignment can extend outside of the bearing, influencing the bearing mating components and causing other unexpected and uneven wear. In the photos shown here, a misalignment condition has caused wear between the cone bore and shaft outer diameter and caused the bore to have a polished appearance.

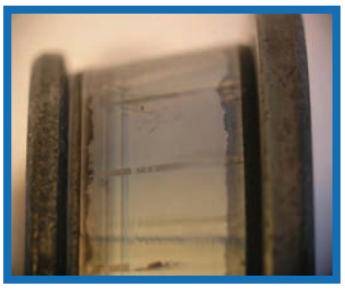






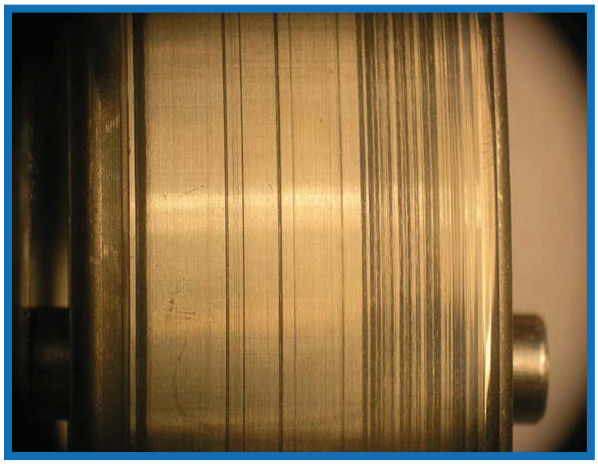
Static Overload

- Static overload of a stationary bearing from either load or shock will produce true brinelling or permanent plastic deformation at the rolling element and raceway contact points.
- Excessive preload, improper installation, or improper handling can all cause this condition.
- This will lead to premature failure.



Outer Diameter Damage

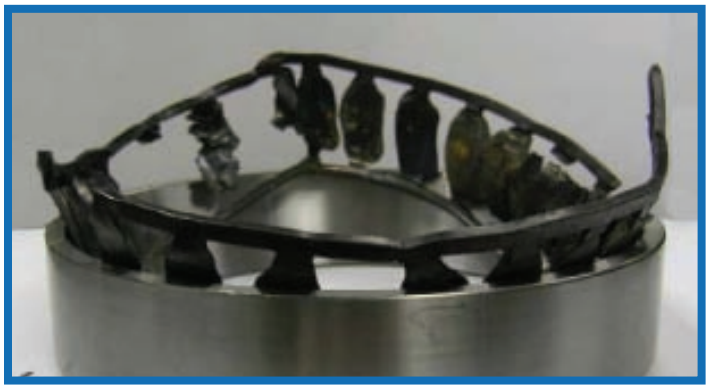
- In these photos, grooves and heavy wear on the outer diameter of the cup indicate that the cup was spinning inside the housing/hub. This condition is most often caused by improper fits or misalignment.

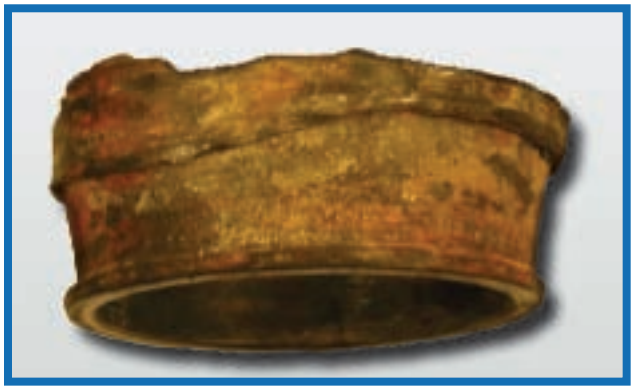


Effects of Lubrication Starvation

- Lack of lubrication in fully loaded bearings will cause prompt and severe failure. Improper maintenance, installation, and poor sealing are several root causes.

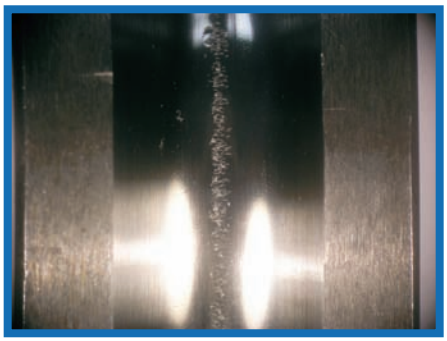
- In addition to the destruction of the roller separator pictured above, overheating due to high friction will affect all bearing components.

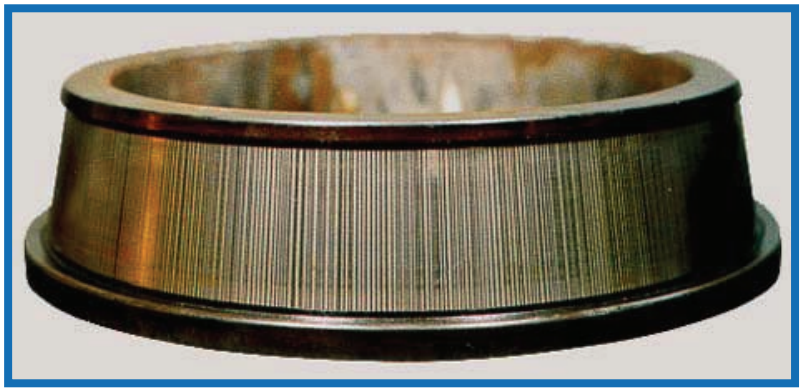


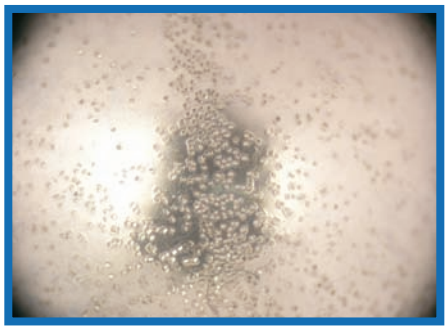


Effects of Electrical Current

- Due to small internal clearances in the bearing, electrical current can arc between component surfaces causing rolling surface pitting. This will eventually lead to failure.
- Proper grounding techniques should be employed to avoid current passing through bearings.







Fracture

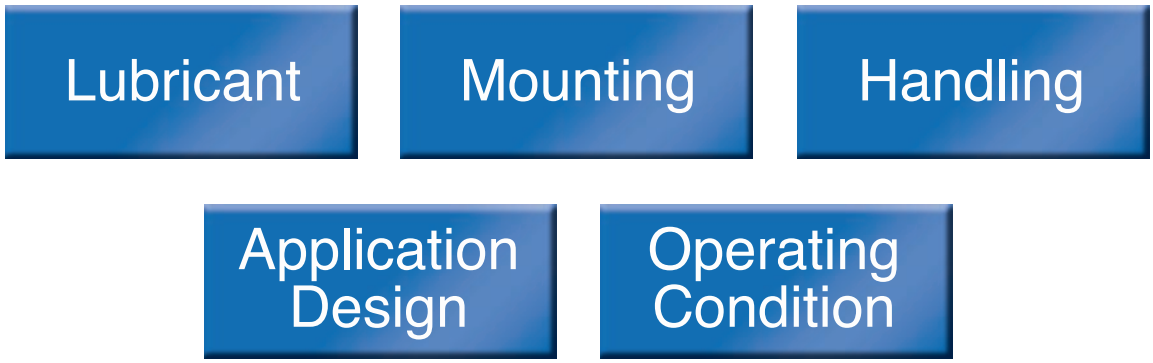
- Excessive preload, high shock loads, poor handling and extreme thermal conditions can lead to component fracture.

Failure Modes

- ISO 15242:2004(E) is a comprehensive document on Bearing Failure Analysis. Almost all bearing failure modes can be classified into one of these six categories:

Failure Causes

- Almost all bearing failure causes can be classified into one of these five categories:



Lubricant Based Failure Causes

- All bearings need proper lubrication to function properly. Lubrication must be correctly selected, be applied to the correct quantity level, be clean, monitored, and maintained correctly.

	Insufficient Lubricant	Excessive Lubricant	Incorrect Viscosity	Inadequate Quality	Contamination
Increased Wear	✓		✓	✓	✓
Tracks					✓
Scores					✓
Material Smearing	✓		✓	✓	
Scratches	✓		✓	✓	
Hot Running	✓	✓	✓	✓	
Pitting	✓		✓	✓	✓
Spalling	✓		✓	✓	✓
Rust				✓	✓
Cage Fracture	✓		✓		
Indentations					✓
Thermal Cracks	✓		✓	✓	

Operating Condition Based Failure Causes

- Operating conditions must be carefully considered when choosing the proper bearing and determining the bearing's expected life.

	Excessive Speed	Excessive Load	Frequently Fluctuating Loads	Vibration	Passage of Electrical Current
Increased Wear	✓	✓	✓	✓	
Scores			✓		
Material Smearing	✓	✓	✓	✓	
Fluting					✓
Chatter Marks				✓	
Hot Running	✓	✓			
Pitting	✓	✓	✓	✓	✓
Spalling	✓	✓	✓	✓	✓
Fretting (Rust)				✓	
Fracture Cracks		✓		✓	
Cage Fracture	✓		✓	✓	
Indentations		✓			
Thermal Cracks		✓			

Bearing Mounting Based Failure Causes

- Incorrect mounting practices can severely shorten bearing life.

	Faulty Electrical Insulation	Incorrect Mounting	Incorrect Heating	Misalignment
Increased Wear			✓	✓
Scratches		✓		✓
Fluting	✓			
Hot Running	✓			
Pitting	✓	✓		✓
Spalling	✓	✓		✓
Electrical Craters	✓			
Fracture Cracks		✓		
Cage Fracture		✓		
Deformation		✓	✓	✓
Indentations		✓		
Thermal Cracks			✓	

	Undesirable preload	Impact	Inadequate fixing	Uneven seating Surface	Incorrect Seating fit
Increased Wear	✓	✓	✓	✓	✓
Tracks	✓	✓	✓	✓	✓
Smearing			✓		
Hot Running	✓				✓
Pitting	✓		✓	✓	✓
Spalling	✓		✓	✓	✓
Fretting (rust)				✓	✓
Fracture Cracks	✓		✓	✓	
Cage Fracture	✓	✓			
Deformation	✓	✓	✓	✓	✓
Thermal Cracks	✓		✓		✓

Application Design Based Failure Causes

- Proper bearing selection, along with the components they are mounted to, will enhance bearing life.

	Incorrect Bearing Selection	Unsuitable Adjacent Components
Smearing	✓	✓
Scratches	✓	✓
Hot Running	✓	✓
Fretting (rust)	✓	✓
Fracture Crack	✓	✓
Cage Fracture	✓	✓
Spalling	✓	✓

Bearing Handling Based Failure Causes

- Bearing handling, storage, and transportation should follow proper guidelines to avoid rolling surface damage.

	Incorrect Bearing Storage	Vibration During Transportation
Scratches		✓
Corrosion (rust)	✓	
Fretting (rust)		✓
Indentations		✓

General Bearing Corporation

Established in 1958, General Bearing Corporation is the market leader of tapered roller bearings for wheel end applications in the North American truck and trailer industries. Since 2000, we have sold more than 40 million tapered roller bearing cups and cones to truck and trailer manufacturers.

At General Bearing, we understand that providing a high quality product and award winning customer service is not enough to maintain our position as the market leader. That's why we support the product with an engineering team dedicated solely to the truck and trailer industries.

We work with you to be sure the bearings you get match the needs of your specific application. Using innovative application simulation software, we're able to assess bearing performance in non-standard running conditions. Given your application specifics, we can also provide you with bearing life calculations so you'll know the product you're using will exceed your expectations.

Should you have any wheel end issues, our failure analysis lab is staffed with world class engineers who specialize in determining the root cause of failure. With state-of-the-art equiptment, our engineers can provide a clear picture of what occurred, so that future failures can be avoided.

If you require General Bearing Engineering support, please contact your local Sales Representative, or find us on the web at www.generalbearing.com

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