

## 16. Bearing damage and corrective measures

### 16.1 Bearing damage, main causes of bearing damage, and remedies for correcting the problem

If handled correctly, bearings can generally be used for a long time before reaching their fatigue life. If damage occurs prematurely, the problem could stem from improper bearing selection, handling, or lubrication. If this occurs, take note of the application, operating conditions, and environment. By investigating several possible causes surmised from the type of damage and condition at the time the damage occurred, it is possible to prevent the same kind of damage from reoccurring.

Table 16.1 gives the main causes of bearing damage and remedies for correcting the problem.

For details, see the special catalog “Care and Maintenance of Bearings (CAT. No. 3017/E).”

Table 16.1 Bearing damage, main causes of bearing damage and remedies for correcting the problem

Phenomenon		
<p><b>Spalling (Flaking)</b></p> <p>The surface of the raceway and rolling elements peel away in flakes leaving a highly irregular and very poor surface.</p>   <ul style="list-style-type: none"> <li>● Inner ring of spherical roller bearing</li> <li>● Spalling on one row of the raceway surface in this case.</li> <li>● An excessive axial load is the cause.</li> </ul> <ul style="list-style-type: none"> <li>● Outer ring of angular contact ball bearing</li> <li>● Spalling on the raceway surface with spacing equal to the distance between balls.</li> <li>● Improper handling is the cause.</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Excessive load, normal fatigue life, improper handling</li> <li>● Improper installation</li> <li>● Insufficient accuracy of shaft or housing</li> <li>● Insufficient clearance</li> <li>● Contamination</li> <li>● Rust</li> <li>● Insufficient lubrication</li> <li>● Reduction in hardness due to abnormal temperature rise</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Select a different type or size of bearing.</li> <li>● Reevaluate the clearance.</li> <li>● Improve the precision of the shaft and housing.</li> <li>● Improve assembly method and handling.</li> <li>● Reevaluate the layout (design) of the area around the bearing.</li> <li>● Review lubricant type and lubrication methods.</li> </ul>	
<p><b>Seizure</b></p> <p>Extreme thermal conditions eventually resulting in seizure of the bearing.</p>   <ul style="list-style-type: none"> <li>● Inner ring of double-row tapered roller bearing</li> <li>● Seizure causes discoloration and softening, producing stepped abrasion on the raceway surface with spacing equal to the distance between the rollers.</li> <li>● Insufficient lubrication is the cause.</li> </ul> <ul style="list-style-type: none"> <li>● Inner ring of tapered roller bearing</li> <li>● Evidence of seizure on the large diameter side of raceway surface and large rib surface</li> <li>● Insufficient lubrication is one possible cause.</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Insufficient clearance (including clearances reduced by local deformation)</li> <li>● Insufficient lubrication or improper lubricant</li> <li>● Excessive loads (including excessive preload)</li> <li>● Roller skewing due to a misaligned bearing</li> <li>● Reduction in hardness due to abnormal temperature rise</li> <li>● High speed or large fluctuating load</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Review lubricant type and quantity.</li> <li>● Check for proper clearance. (Increase clearances.)</li> <li>● Take steps to prevent misalignment.</li> <li>● Improve assembly method and handling.</li> </ul>	
<p><b>Cracks/chips</b></p> <p>Localized spalling occurs. Little cracks or notches appear.</p>   <ul style="list-style-type: none"> <li>● Inner ring of tapered roller bearing</li> <li>● Chipped large rib.</li> <li>● Impact due to improper preloading is the cause.</li> </ul> <ul style="list-style-type: none"> <li>● Outer ring of four-row cylindrical roller bearing</li> <li>● Cracks in the circumferential direction of raceway surface</li> <li>● These cracks were initiated by spalling.</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Excessive shock loads</li> <li>● Improper handling (use of steel hammer, damage from large particle contamination)</li> <li>● Formation of decomposed surface layer due to improper lubrication</li> <li>● Excessive interference</li> <li>● Spalling</li> <li>● Friction cracking</li> <li>● Imprecise mating component (oversized fillet radius)</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Review lubricant (friction crack prevention).</li> <li>● Select proper interference and review materials.</li> <li>● Improve assembly method and handling.</li> </ul>	

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Table 16.1 (continued)

Phenomenon		
<p><b>Cage damage</b> Rivets break or become loose resulting in cage damage. Fracture of riveted steel cage at the corner radius.</p>   <ul style="list-style-type: none"> <li>● Cage of angular contact ball bearing</li> <li>● Breakage of high strength, machined brass cage</li> <li>● Insufficient lubrication is the cause.</li> </ul>   <ul style="list-style-type: none"> <li>● Cage of deep groove ball bearing</li> <li>● Breakage of riveted steel cage</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Excessive load or moment loading</li> <li>● High speed or excessive speed fluctuations</li> <li>● Insufficient lubrication</li> <li>● Impact with foreign objects</li> <li>● Excessive vibration</li> <li>● Improper mounting (mounted misaligned)</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Review lubricant type and lubrication methods.</li> <li>● Review cage type selection.</li> <li>● Investigate shaft and housing rigidity.</li> <li>● Improve assembly method and handling.</li> </ul>	
<p><b>Rolling path skewing</b> Abrasion or an irregular, rolling path skewing due to rolling elements along raceway surfaces.</p>   <ul style="list-style-type: none"> <li>● Spherical roller bearing</li> <li>● Uneven contact on inner ring, outer ring, and roller</li> <li>● Improper installation is the cause.</li> </ul> <ul style="list-style-type: none"> <li>● Roller of tapered roller bearing</li> <li>● Evidence of uneven contact on rolling element surface</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Insufficient accuracy of shaft or housing</li> <li>● Improper installation</li> <li>● Insufficient shaft or housing rigidity</li> <li>● Shaft whirling caused by excessive internal bearing clearances</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Reevaluate the clearance.</li> <li>● Improve the precision of the shaft and housing.</li> <li>● Review rigidity of shaft and housing.</li> </ul>	
<p><b>Smearing, Scuffing</b> The surface becomes rough and some small deposits form. Scuffing generally refers to roughness on the race rib face and the ends of the rollers.</p>   <ul style="list-style-type: none"> <li>● Inner ring of cylindrical roller bearing</li> <li>● Scuffing on the rib surface.</li> </ul> <ul style="list-style-type: none"> <li>● Inner ring of cylindrical roller bearing</li> <li>● Smearing on the raceway surface.</li> <li>● The cause is slippage of rollers due to contaminants.</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Insufficient lubrication</li> <li>● Contamination ingress</li> <li>● Roller skewing due to a misaligned bearing</li> <li>● Bare spots in the collar oil film due to large axial loading</li> <li>● Excessive slippage of the rolling elements</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Review lubricant type and lubrication methods.</li> <li>● Improve sealing performance.</li> <li>● Review preload.</li> <li>● Improve assembly method and handling.</li> </ul>	

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Table 16.1 (continued)

Phenomenon		
<p><b>Rust/corrosion</b> The surface becomes either partially or fully rusted, and occasionally rust occurs spaced at equal distances between rolling elements.</p>   <ul style="list-style-type: none"> <li>● Inner ring of tapered roller bearing</li> <li>● Rust at equal distances between rolling elements on raceway surface.</li> </ul> <ul style="list-style-type: none"> <li>● Outer ring of deep groove ball bearing</li> <li>● Rust on the outside diameter surface.</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Poor storage conditions</li> <li>● Poor packaging</li> <li>● Insufficient rust inhibitor</li> <li>● Penetration by water, acid, etc.</li> <li>● Handling with bare hands</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Take measures to prevent rusting while in storage.</li> <li>● Periodically inspect the lubricating oil.</li> <li>● Improve sealing performance.</li> <li>● Improve assembly method and handling.</li> </ul>	
<p><b>Fretting</b> There are two types of fretting. In one, a rusty wear powder forms on the mating surfaces. In the other, brinelling indentations form on the raceway corresponding to rolling element spacing.</p>   <ul style="list-style-type: none"> <li>● Inner ring of cylindrical roller bearing</li> <li>● Ripple-like fretting on the entire circumference of the raceway surface.</li> <li>● Vibration is the cause.</li> </ul> <ul style="list-style-type: none"> <li>● Inner ring of deep groove ball bearing</li> <li>● Fretting on the entire circumference of the raceway surface.</li> <li>● Vibration is the cause.</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Insufficient interference</li> <li>● Small bearing oscillation angle</li> <li>● Insufficient lubrication</li> <li>● Fluctuating loads</li> <li>● Vibration during transport, or while stopped</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Review lubricant type and lubrication methods.</li> <li>● Review the interference fit and apply a coat of lubricant to fitting surface.</li> <li>● Pack the inner and outer rings separately for transport.</li> </ul>	
<p><b>Wear</b> The surfaces wear and dimensional deformation results. Wear is often accompanied by roughness and scratches.</p>   <ul style="list-style-type: none"> <li>● Inner ring of cylindrical roller bearing</li> <li>● Stepped wear on the entire circumference of the raceway surface.</li> <li>● Insufficient lubrication is the cause.</li> </ul> <ul style="list-style-type: none"> <li>● Cage of cylindrical roller bearing</li> <li>● Wear of pocket part of high strength, machined brass cage</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Entrapment of foreign particles in the lubricant</li> <li>● Inadequate lubrication</li> <li>● Roller skewing due to a misaligned bearing</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Review lubricant type and lubrication methods.</li> <li>● Improve sealing performance.</li> <li>● Take steps to prevent misalignment.</li> <li>● Improve assembly method and handling.</li> </ul>	
<p><b>Electrolytic corrosion</b> Pits form on the raceway. The pits gradually grow into ripples.</p>   <ul style="list-style-type: none"> <li>● Inner ring of deep groove ball bearing</li> <li>● Ripple-like electrolytic corrosion on the raceway surface.</li> </ul> <ul style="list-style-type: none"> <li>● The cross section of the electrolytic corrosion on the roller rolling element surface is enlarged (x400).</li> <li>● The white layer shows up by nital etching of the cross section.</li> </ul>	<p><b>Causes</b></p> <ul style="list-style-type: none"> <li>● Electric current flowing through the rollers</li> </ul> <p><b>Correction</b></p> <ul style="list-style-type: none"> <li>● Create a bypass circuit for the current.</li> <li>● Insulate the bearing.</li> </ul>	



**16.2 Rolling paths and how load is applied**

When a bearing rotates in response to a load, the raceway surfaces of the inner and outer rings develop a hazy rolling path due to rolling contact with the rolling element. The rolling path on the raceway surface is normal. Evaluation of the rolling path of a used bearing can provide the engineer with useful information regarding the conditions the bearing had been exposed to.

Rolling path observation clarifies if a radial load was applied, an axial load was applied, or a moment load was applied. It can also show if the bearing experienced a large load or a mounting error. These observations provide extremely important references when determining the cause of bearing damage.

Fig. 16.1 shows rolling paths of point and linear contacts caused under various load conditions.

(1) is a general rolling path generated when a radial load is applied to a bearing with inner ring rotation. The width of the rolling path becomes small at the entrance of the load zone of the outer ring, which is the fixed side. On the other hand, (2) shows a rolling path pattern opposite to (1) when a radial load is applied during outer ring rotation. (3) is a rolling path generated when an axial load in one direction is applied to a bearing, and an example of linear contact on a spherical roller bearing. When a combined load is applied during inner ring rotation, a rolling path pattern such as (4) is caused. As shown in (5), when a radial load is applied to a bearing with significant misalignment due to a moment load, rolling paths are generated at two positions separated by 180 degrees in the load zone of the outer ring, which is the fixed side. (6) shows the case where the housing bore diameter is an ellipse. Rolling paths are left on the fixed side outer ring at two positions but are not misaligned. (5) and (6) indicate improper bearing use, and the bearing life may be shorter because of the adverse effect.

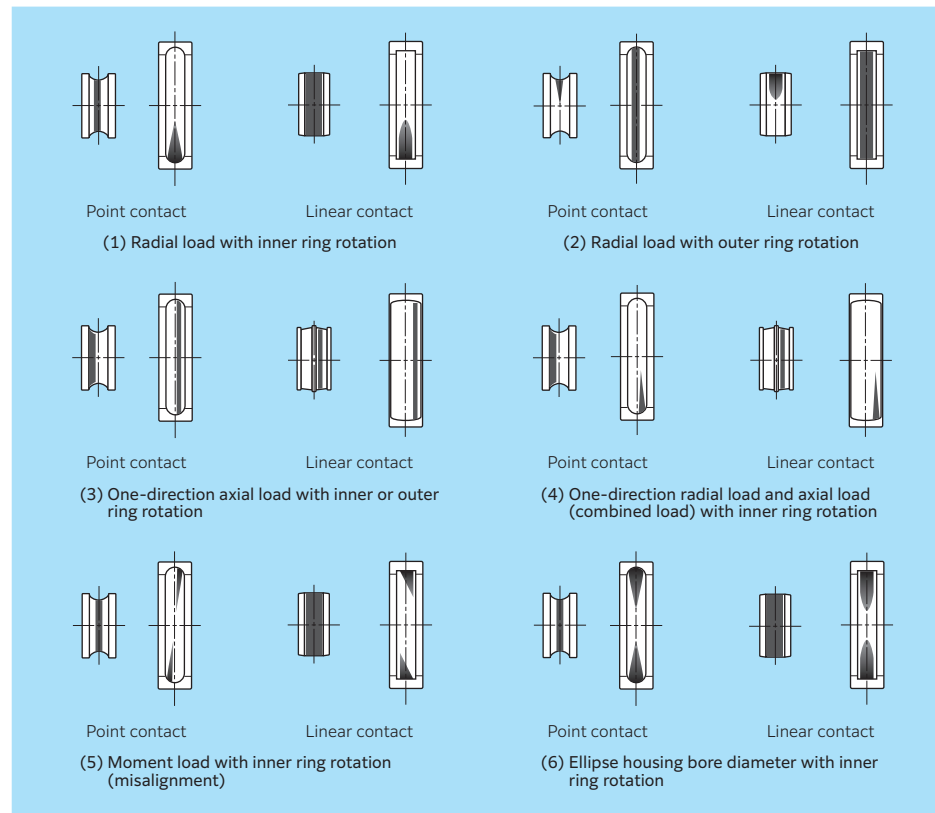


Fig. 16.1 Rolling paths and how load is applied