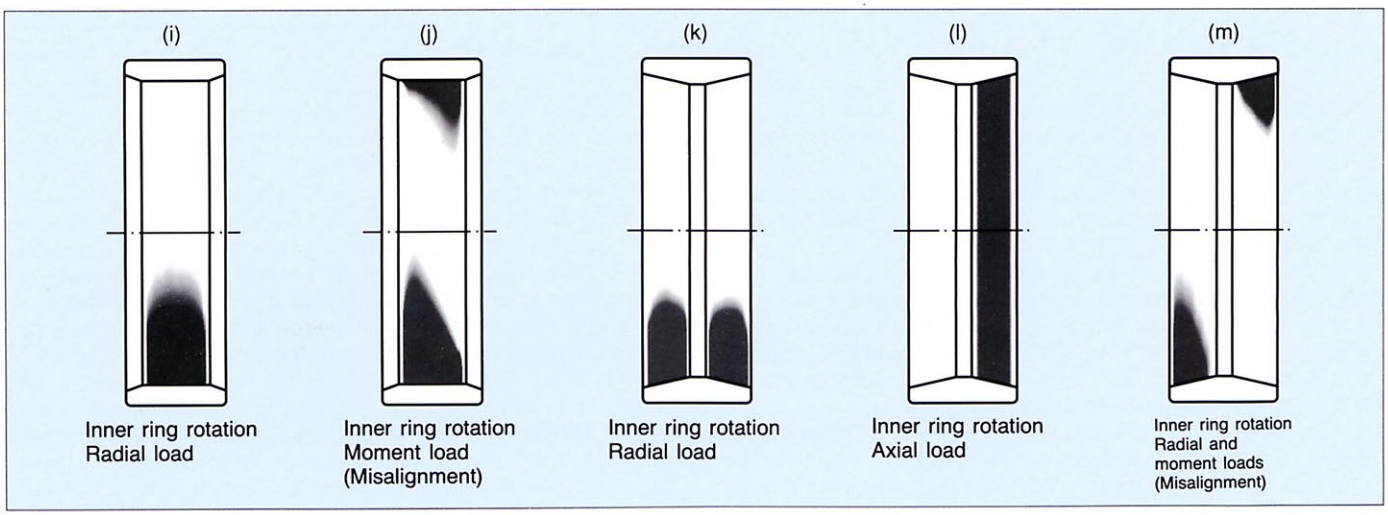

Fig. 6.2 Typical running traces on roller bearings

7. Bearing Damage and Countermeasures

In general, if rolling bearings are used correctly, they will survive to their predicted fatigue life. Bearings, however, often fail prematurely due to avoidable mistakes. In contrast to fatigue life, this premature failure is caused by improper mounting, mishandling, poor lubrication, entry of foreign matter or abnormal heat generation.

For example, one cause of premature failure is rib scoring which is due to insufficient lubrication, use of improper lubricant, faulty lubrication system, entry of foreign matter, bearing mounting error, excessive deflection of the shaft or some combination of these. If all conditions are known for the times both before and after the failure, including the application, the operating conditions, and environment, then a countermeasure can be determined by studying the nature of the failure and its probable causes. A successful countermeasure will reduce similar failures or prevent them from happening again.

Sections 7.1 through 7.18 give examples of bearing damage and countermeasures. Please consult these sections when trying to determine the cause of bearing damage. By the way, the bearing diagnostic chart in the Appendix may be useful as a quick reference guide.

7.1 Flaking

Damage Condition	Possible Cause	Countermeasure
Flaking occurs when small pieces of bearing material are split off from the smooth surface of the raceway or rolling elements due to rolling fatigue, thereby creating regions having rough and coarse texture.	Excessive load Poor mounting (misalignment) Moment load Entry of foreign debris, water penetration Poor lubrication, Improper lubricant Unsuitable bearing clearance Improper precision for shaft or housing, unevenness in housing rigidity, large shaft bending Progression from rust, corrosion pits, smearing, dents (Brinelling)	• Reconfirm the bearing application and check the load conditions • Improve the mounting method • Improve the sealing mechanism, prevent rusting during non-running • Use a lubricant with a proper viscosity, improve the lubrication method • Check the precision of shaft and housing • Check the bearing internal clearance

Photo 7-1-1
Part: Inner ring of an angular contact ball bearing
Symptom: Flaking occurs around half of the circumference of the raceway surface
Cause: Poor lubrication due to entry of cutting coolant into bearing

Photo 7-1-2
Part: Inner ring of an angular contact ball bearing
Symptom: Flaking occurs diagonally along raceway
Cause: Poor alignment between shaft and housing during mounting

Photo 7-1-3
Part: Inner ring of deep groove ball bearing
Symptom: Flaking of raceway at ball pitch
Cause: Dents due to shock load during mounting

Photo 7-1-4
Part: Inner ring of an angular contact ball bearing
Symptom: Flaking of raceway at ball pitch
Cause: Dents due to shock load while stationary

Photo 7-1-5
Part: Outer ring of Photo 7-1-4
Symptom: Flaking of raceway surface at ball pitch
Cause: Dents due to shock load while stationary

Photo 7-1-6
Part: Balls of Photo 7-1-4
Symptom: Flaking of ball surface
Cause: Dents due to shock load while stationary

Photo 7-1-7
Part: Inner ring of a spherical roller bearing
Symptom: Flaking of only one raceway over its entire circumference
Cause: Excessive axial load

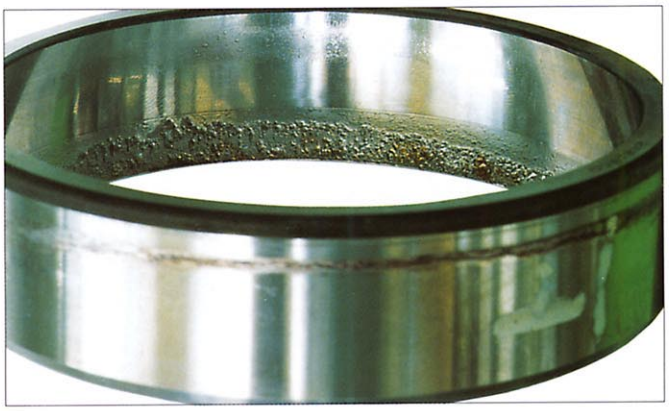

Photo 7-1-8
Part: Outer ring of Photo 7-1-7
Symptom: Flaking of only one raceway over its entire circumference
Cause: Excessive axial load

Photo 7-1-9
Part: Inner ring of a spherical roller bearing
Symptom: Flaking of only one row of raceway
Cause: Poor lubrication

Photo 7-1-10
Part: Rollers of a cylindrical roller bearing
Symptom: Premature flaking occurs axially on the rolling surfaces
Cause: Scratches caused during improper mounting

7.2 Peeling

Damage Condition	Possible Cause	Countermeasure
Dull or cloudy spots appear on surface along with light wear. From such dull spots, tiny cracks are generated downward to a depth of 5 ~ 10 μm. Small particles fall off and minor flaking occurs widely.	Unsuitable lubricant Entry of debris into lubricant Rough surface due to poor lubrication Surface roughness of mating rolling part	• Select a proper lubricant • Improve the sealing mechanism • Improve the surface finish of the rolling mating parts

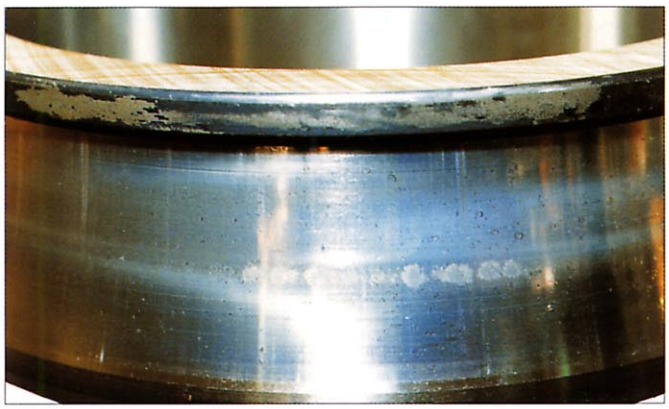

Photo 7-2-1
Part: Inner ring of a spherical roller bearing
Symptom: Round shaped peeling pattern occurs on the center of the raceway surface
Cause: Poor lubrication

Photo 7-2-2
Part: Enlargement of pattern in Photo 7-2-1

Photo 7-2-3
Part: Convex rollers of Photo 7-2-1
Symptom: Round shaped peeling pattern occurs on the center of the rolling surfaces
Cause: Poor lubrication

Photo 7-2-4
Part: Outer ring of a spherical roller bearing
Symptom: Peeling occurs near the shoulder of the raceway over the entire circumference
Cause: Poor lubrication

7.3 Scoring

Damage Condition	Possible Cause	Countermeasure
Scoring is surface damage due to accumulated small seizures caused by sliding under improper lubrication or under severe operating conditions. Linear damage appears circumferentially on the raceway surface and rolling surface. Cycloidal shaped damage on the roller end. Scoring on rib surface contacting roller end.	Excessive load, excessive preload Poor lubrication Particles are caught in the surface Inclination of inner and outer rings Shaft bending Poor precision of the shaft and housing	• Check the size of the load • Adjust the preload • Improve the lubricant and the lubrication method • Check the precision of the shaft and housing

Photo 7-3-1
Part: Inner ring of a spherical roller bearing
Symptom: Scoring on large rib face of inner ring
Cause: Roller slipping due to sudden acceleration and deceleration

Photo 7-3-2
Part: Convex rollers of Photo 7-3-1
Symptom: Scoring on roller end face
Cause: Roller slipping due to sudden acceleration and deceleration

Photo 7-3-3
Part: Inner ring of a tapered roller thrust bearing
Symptom: Scoring on the face of inner ring rib
Cause: Worn particles become mixed with lubricant, and breakdown of oil film occurs due to excessive load

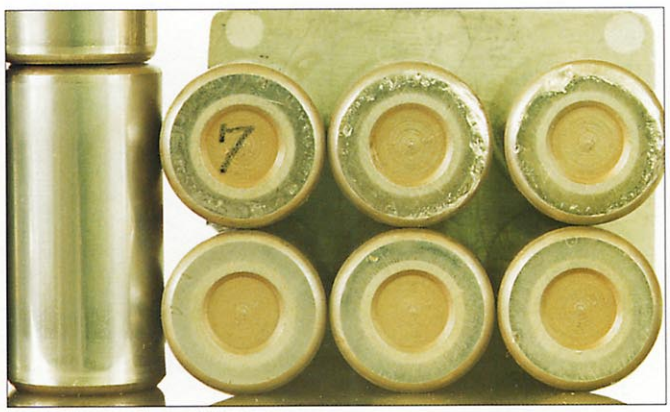

Photo 7-3-4
Part: Rollers of a double-row cylindrical roller bearing
Symptom: Scoring on the roller end face
Cause: Poor lubrication and excessive axial load

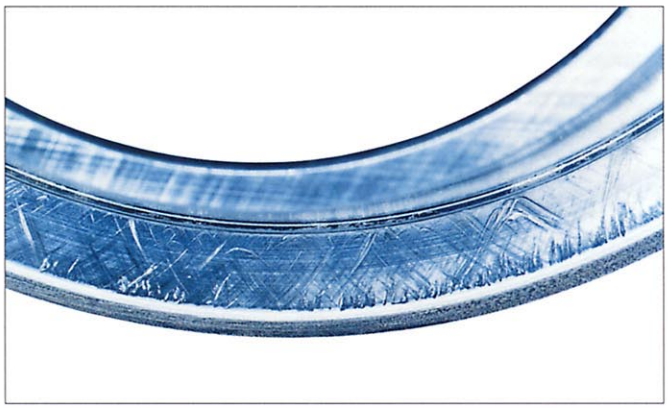

Photo 7-3-5
Part: Inner ring of a spherical thrust roller bearing
Symptom: Scoring on the rib face of inner ring
Cause: Debris, which is caught in surface, and excessive axial loading

Photo 7-3-6
Part: Convex rollers of Photo 7-3-5
Symptom: Scoring on the roller end face
Cause: Debris, which is caught in surface, and excessive axial loading

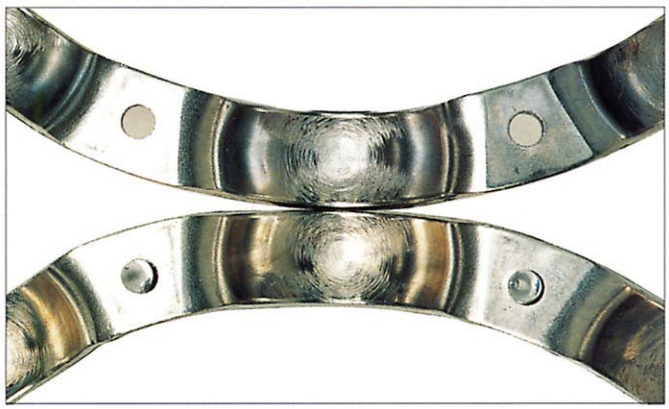

Photo 7-3-7
Part: Cage of a deep groove ball bearing
Symptom: Scoring on the pressed-steel cage pockets
Cause: Entry of debris

7.4 Smearing

Damage Condition	Possible Cause	Countermeasure
Smearing is surface damage which occurs from a collection of small seizures between bearing components caused by oil film rupture and/or sliding. Surface roughening occurs along with melting.	High speed and light load Sudden acceleration/deceleration Improper lubricant Entry of water	• Improve the preload • Improve the bearing clearance • Use a lubricant with good oil film formation ability • Improve the lubrication method • Improve the sealing mechanism

Photo 7-4-1
Part: Inner ring of a cylindrical roller bearing
Symptom: Smearing occurs circumferentially on raceway surface
Cause: Roller slipping due to excessive grease filling

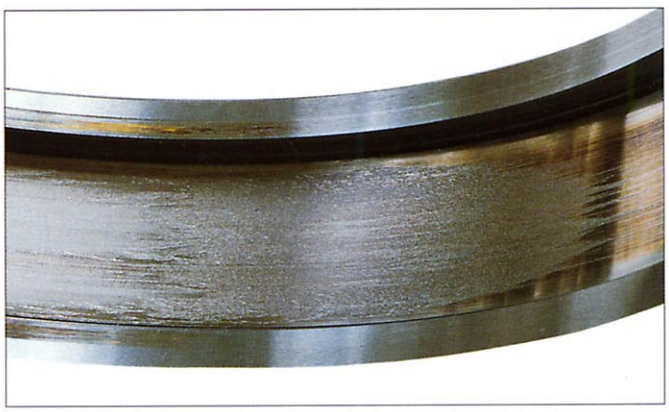

Photo 7-4-2
Part: Outer ring of Photo 7-4-1
Symptom: Smearing occurs circumferentially on raceway surface
Cause: Roller slipping due to excessive grease filling

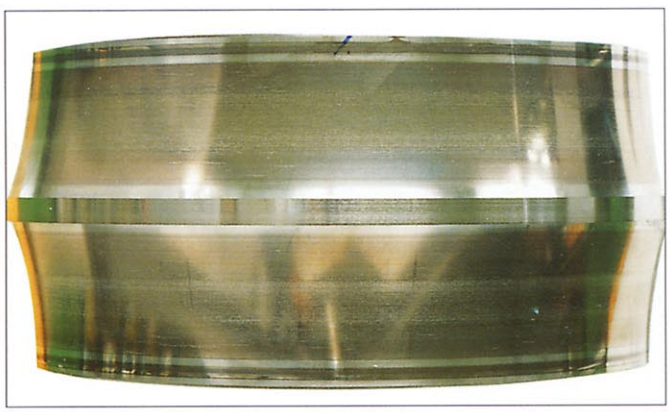

Photo 7-4-3
Part: Inner ring of a spherical roller bearing
Symptom: Smearing occurs circumferentially on raceway surface
Cause: Poor lubrication

Photo 7-4-4
Part: Outer ring of Photo 7-4-3
Symptom: Smearing occurs circumferentially on raceway surface
Cause: Poor lubrication

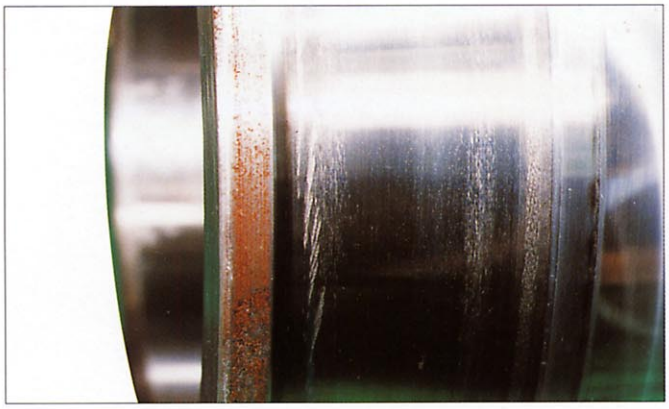

Photo 7-4-5
Part: Inner ring of a spherical roller bearing
Symptom: Partial smearing occurs circumferentially on raceway surface
Cause: Poor lubrication

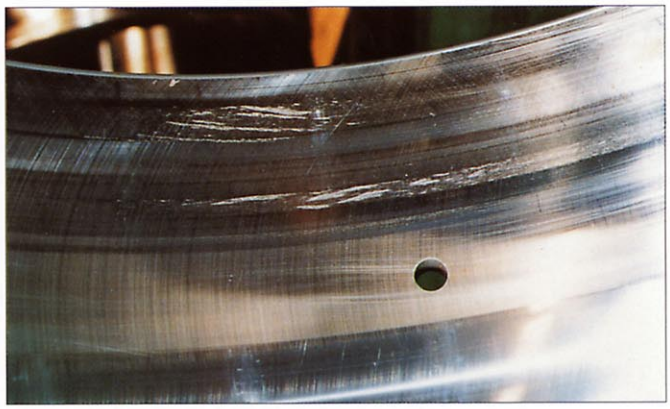

Photo 7-4-6
Part: Outer ring of Photo 7-4-5
Symptom: Partial smearing occurs circumferentially on raceway surface
Cause: Poor lubrication

Photo 7-4-7
Part: Convex rollers of Photo 7-4-5
Symptom: Smearing occurs at the center of the rolling surface
Cause: Poor lubrication

7.5 Fracture

Damage Condition	Possible Cause	Countermeasure
Fracture refers to small pieces which were broken off due to excessive load or shock load acting locally on a part of the roller corner or rib of a raceway ring.	Impact during mounting Excessive load Poor handling such as dropping	• Improve the mounting method (Shrink fit, use of proper tools) • Reconsider the loading conditions • Provide enough back-up and support for the bearing rib

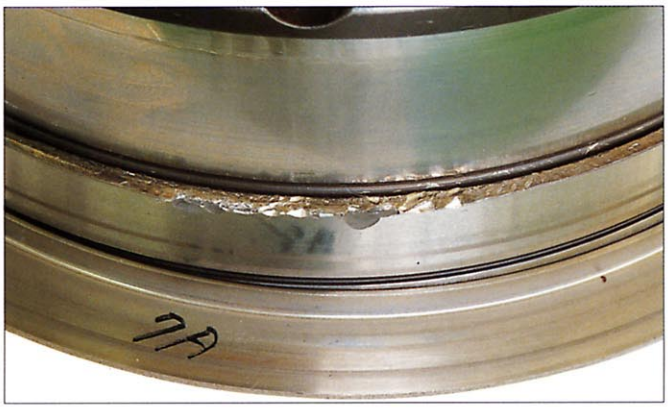

Photo 7-5-1
Part: Inner ring of a double-row cylindrical roller bearing
Symptom: Chipping occurs at the center rib
Cause: Excessive load during mounting

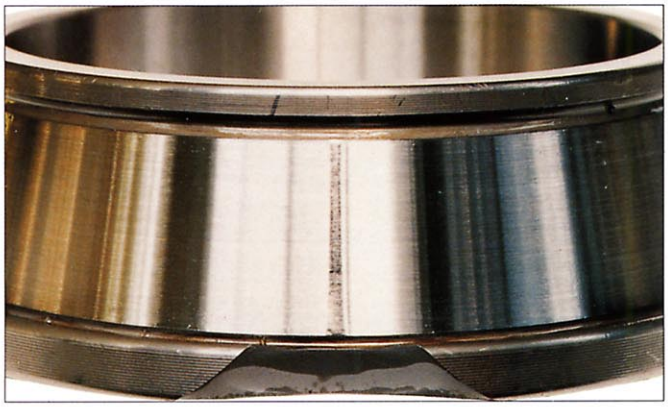

Photo 7-5-2
Part: Inner ring of a tapered roller bearing
Symptom: Fracture occurs at the cone back face rib
Cause: Large shock during mounting

Photo 7-5-3
Part: Inner ring of a spherical thrust roller bearing
Symptom: Fracture occurs at the large rib
Cause: Repeated load

Photo 7-5-4
Part: Outer ring of a solid type needle roller bearing
Symptom: Fracture occurs at the outer ring rib
Cause: Roller inclination due to excessive loading
(Needle rollers are long compared to their diameter. Under excessive or uneven loading, rollers become inclined and push against the ribs.)

7.6 Cracks

Damage Condition	Possible Cause	Countermeasure
Cracks in the raceway ring and rolling elements. Continued use under this condition leads to larger cracks or fractures.	Excessive interference Excessive load, shock load Progression of flaking Heat generation and fretting caused by contact between mounting parts and raceway ring Heat generation due to creep Poor taper angle of tapered shaft Poor cylindricality of shaft Interference with bearing chamfer due to a large shaft corner radius	• Correct the interference • Check the load conditions • Improve the mounting method • Use an appropriate shaft shape

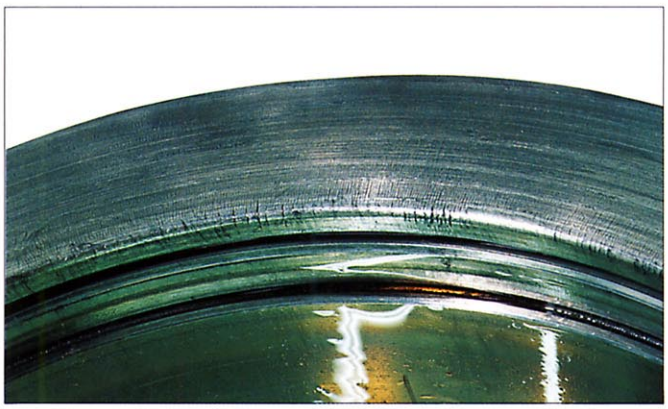

Photo 7-6-1
Part: Outer ring of a double-row cylindrical roller bearing
Symptom: Thermal cracks occur on the outer ring side face
Cause: Abnormal heat generation due to contact sliding between mating part and face of outer ring

Photo 7-6-2
Part: Roller of a tapered roller thrust bearing
Symptom: Thermal cracks occur at large end face of roller
Cause: Heat generation due to sliding with the inner ring rib under poor lubrication

Photo 7-6-3
Part: Outer ring of a double-row cylindrical roller bearing
Symptom: Cracks propagated outward in the axial and circumferential directions from the flaking origin on the raceway surface
Cause: Flaking from a flaw due to shock

Photo 7-6-4
Part: Outer ring of a double-row cylindrical roller bearing used for outer ring rolling (Outer ring rotation)
Symptom: Cracks occur on outside surface
Cause: Flat wear and heat generation due to non-rotation of the outer ring

Photo 7-6-5
Part: Raceway surface of outer ring in Photo 7-6-4
Symptom: Outside surface crack developing on the raceway

Photo 7-6-6
Part: Inner ring of a spherical roller bearing
Symptom: Axial cracks occur on raceway surface
Cause: Large fitting stress due to temperature difference between shaft and inner ring.

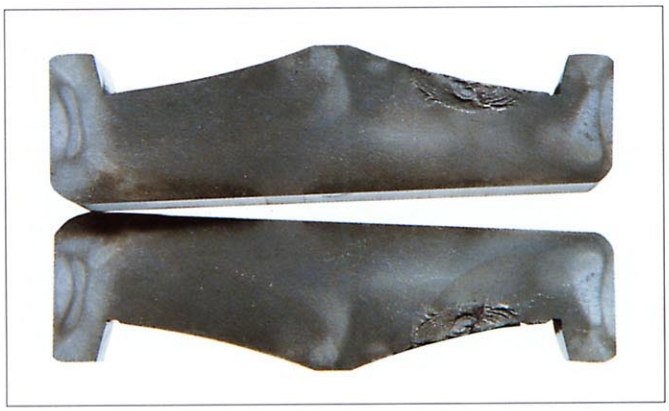

Photo 7-6-7
Part: Cross section of a fractured inner ring in Photo 7-6-6
Symptom: Origin is directly beneath the raceway surface

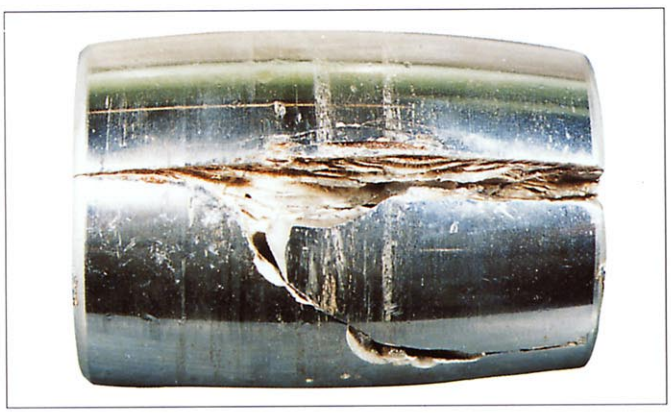

Photo 7-6-8
Part: Roller of a spherical roller bearing
Symptom: Axial cracks occur on rolling surface

7.7 Cage Damage

Damage Condition	Possible Cause	Countermeasure
Cage damage includes cage deformation, fracture, and wear Fracture of cage pillar Deformation of side face Wear of pocket surface Wear of guide surface	Poor mounting (Bearing misalignment) Poor handling Large moment load Shock and large vibration Excessive rotation speed, sudden acceleration and deceleration Poor lubrication Temperature rise	• Check the mounting method • Check the temperature, rotation, and load conditions • Reduce the vibration • Select a cage type • Select a lubrication method and lubricant

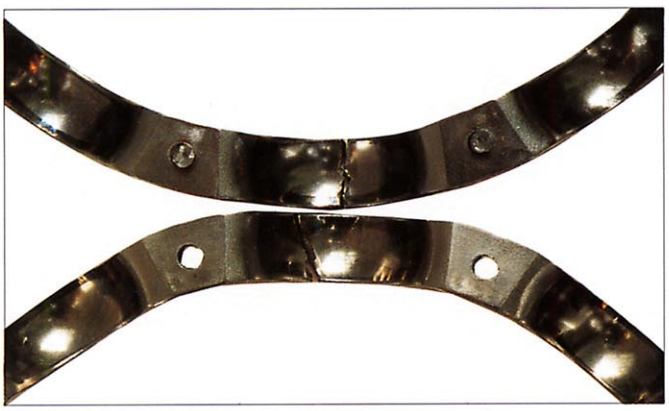

Photo 7-7-1
Part: Cage of a deep groove ball bearing
Symptom: Fracture of pressed-steel cage-pocket

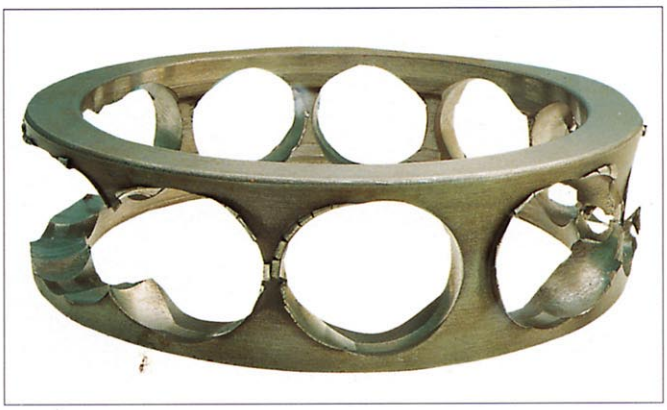

Photo 7-7-2
Part: Cage of an angular contact ball bearing
Symptom: Pocket pillar fractures from a cast iron machined cage
Cause: Abnormal load action on cage due to misaligned mounting between inner and outer rings

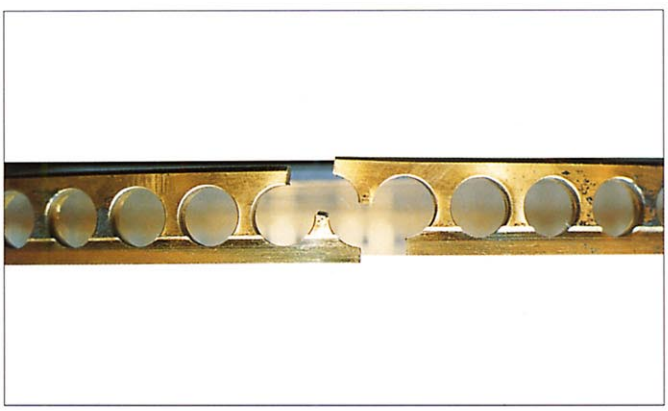

Photo 7-7-3
Part: Cage of an angular contact ball bearing
Symptom: Fracture of machined high-tension brass cage

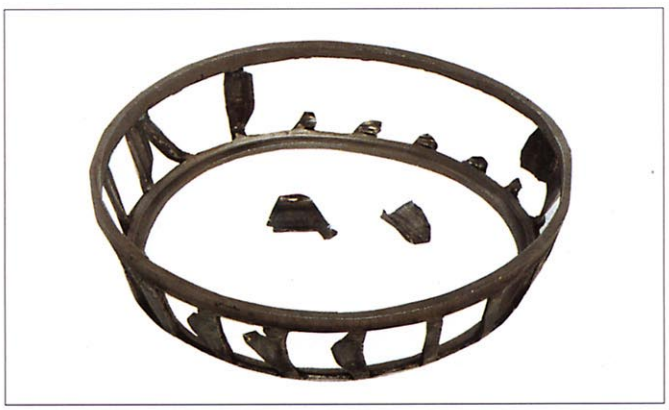

Photo 7-7-4
Part: Cage of a tapered roller bearing
Symptom: Pillar fractures of pressed-steel cage