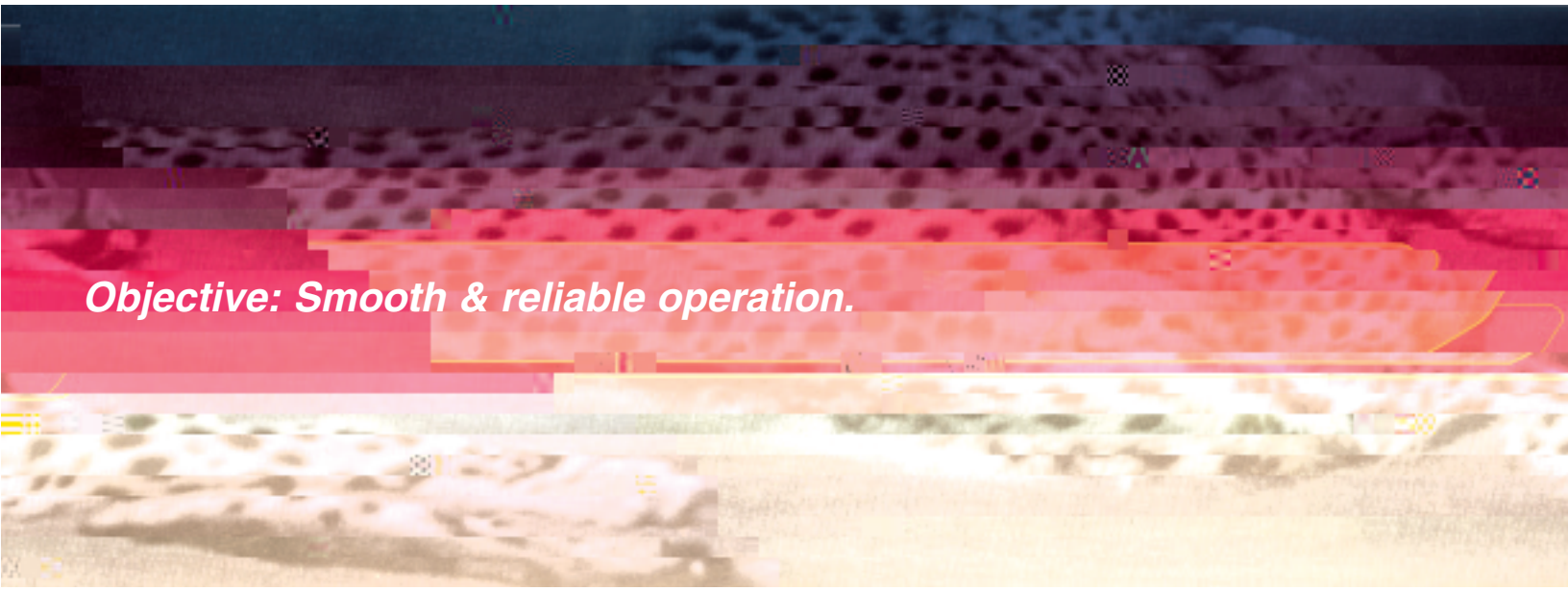
NSK Bearing Doctor

Diagnosis of Bearing Problems



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NSK Bearing Doctor - Index

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1. Introduction

When a rolling bearing i damaged during machine operation, the entire machine or equipment may eize or malfunction. ince bearing that fail prematurely or unexpectedly cau e trouble, it i important to be able to identify and predict failure beforehand, if po ible, o that preventative mea ure can be adopted.

Generally, bearing in pection or hou ing in pection can identify the cau e of the problem. Often the cau e i attributable to poor lubrication, improper handling, electing the wrong bearing, or not enough tudy of the haft and hou ing. U ually the cau e can be determined by con idering operation of the bearing before the failure, inve tigating the lubrication condition and the mounting condition, and carefully ob erving the damaged bearing it elf.

ometime bearing are damaged and fail both quickly and unexpectedly. uch premature failure i different from fatigue failure which i due to flaking. Bearing life can be eparated and categorized into two type : premature failure and normal rolling contact fatigue.

2. Bearing Handling

2.1 Precautions for Handling

ince rolling bearing are high preci ion machine part , they mu t be handled carefully. Even if high quality bearing are u ed, their expected life and performance cannot be attained if they are u ed improperly. The main precaution to be ob erved are a follow :

(1) Keep the Bearings and Surrounding Area Clean

Du t and dirt, even if invi ible to the naked eye, have harmful effect on bearing . It i nece ary to prevent the entry of du t and dirt by keeping the bearing and their environment a clean a po ible.

(2) Careful Handling

Heavy hock during handling may cratch or cau e other damage to the bearing po ibly re ulting in bearing failure. trong impact may cau e brinelling, breaking, or cracking.

(3) Use Proper Tools

Alway u e the proper tool when handling bearing and avoid general purpo e tool .

(4) Prevent Corrosion

ince per piration on the hand and variou other contaminant may cau e corro ion, keep your hand clean when handling bearing . Wear glove if po ible.

2.2 Mounting

It i advi able to tudy the bearing mounting thoroughly ince the quality of the bearing mounting influence the bearing' running accuracy, life, and performance. It i recommended that the mounting method include the following tep :

(1) Clean the bearing and urrounding part ;

(2) Check the dimen ion and fini h condition of related part ;

(3) Follow mounting procedure;

(4) Check if the bearing i mounted correctly;

(5) upply with correct kind and quantity of lubricant.

ince mo t bearing rotate with the haft, the bearing mounting method i generally an interference (tight) fit for the inner ring and haft while giving a clearance (loo e) fit for the outer ring and hou ing.

2.3 Check the Operation

After mounting the bearing, it i important to carry out an operating te t to confirm that the bearing i mounted properly. Table 2.1 indicate operating te t method . If irregularitie are detected, immediately u pend the te t and con ult Table 2.2 which li t appropriate countermea ure to pecific bearing problem .

Table 2.1 Method to check operation

Table 2.2 Cau e and countermea ure for operating irregularitie

4.1 Bearing Noise

During operation, ound detection in trument (tetho cope, N K Bearing Monitor, etc.) can be u ed to inve tigate the volume and characteri tic of the bearing rotation noi e. It i po ible to di tingui h bearing damage uch a mall flaking by mean of it unu ual yet characteri tic noi e.

4.2 Bearing Vibration

Bearing irregularitie can be analyzed by mea uring the vibration of an operating machine. A frequency pectrum analyzer i u ed to mea ure the magnitude of vibration and the di tribution of the frequencie . Te t re ult enable the determination of the likely cau e of the bearing irregularity. The mea ured data varie depending on the operating condition of the bearing and the location of the vibration pick-up. Therefore, the method require the determination of evaluation tandard for each mea ured machine.

It i u eful to be able to detect irregularitie from the bearing vibration pattern during operation. Plea e refer to the N K pamphlet Pr. No. 410 (Bearing Monitor) for more information about uch a device.

4.3 Bearing Temperature

Generally, the bearing temperature can be e timated from the temperature of the hou ing out ide urface, but a preferable way i to obtain direct mea urement from the bearing outer ring by a probe going through an oil hole.

U ually, the bearing temperature gradually increa e after the tart of operation until reaching a teady tate condition about 1 or 2 hour later. The bearing teady tate temperature depend on load, rotational peed and heat tran fer propertie of the machine. In ufficient lubrication or improper mounting might cau e the bearing temperature to ri e rapidly. In uch a ca e, u pend the machine operation and adopt an appropriate countermea ure.

4.4 Effects of Lubrication

The two main purpo e of lubrication are to minimize friction and reduce wear in ide bearing that might otherwi e fail prematurely. Lubrication provide the following advantage :

(1) Reduction of Friction and Wear

Direct metallic contact between the bearing ring , rolling element and cage, which are the ba ic component of a bearing, i prevented by an oil film which reduce the friction and wear in the contact area .

(2) Extension of Fatigue Life

The rolling fatigue life of bearing depend pi(ak1rde thTw(Thehc5ulic41.2T (ru tratea .)ETBT4F14 1 Tf14 0 0 147.500.0.2.83.0646 Tm1 0.5 0 0 k0.0333 T

(1) Grease lubrication

Grea e i a lubricant that i made from ba e oil, thickener, and additive . When electing a grea e, it i nece ary to elect a grea e that i uitable to the bearing application condition . There are large difference in performance even between different brand of the ame type of grea e. Therefore pecial attention mu t be given to grea e election. **Table 4.2** give example of application and grea e con i tency.

(2) Oil lubrication

There are everal different oil lubrication method : Oil bath, Drip feed, pla h, Circulating, Jet, Oil mi t, and Oil air. Oil lubrication method are more uitable for higher peed and higher temperature application than are grea e lubrication method . Oil lubrication i e pecially effective in the ca e where it i nece ary to di ipate heat to the exterior.

Be ure to elect a lubricating oil that ha uitable vi co ity at the bearing operating temperature. Generally, an oil with a low vi co ity i u ed for high peed application while an oil with high vi co ity i u ed for application with heavy load . For normal application condition , **Table 4.3** li t the uitable vi co ity range for the operating temperature.

For reference when making a election, **Fig. 4.1** how the relation hip between temperature and vi co ity for the lubricating oil. **Table 4.4** give example of how to elect the lubrication oil for different bearing application condition .

Table 4.3 Required vi co ity by bearing type

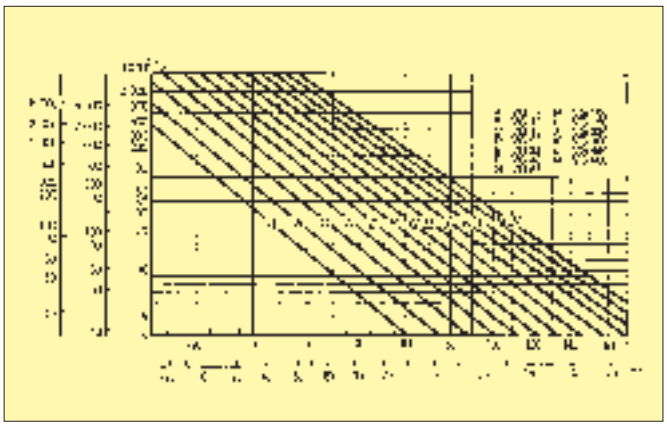


Fig. 4.1

Table 4.2 Example of application and grea e con i tency

	Central grea e upply Where fretting occur ea ily	Central grea e upply			

Table 4.4 election of lubricating oil for different bearing application

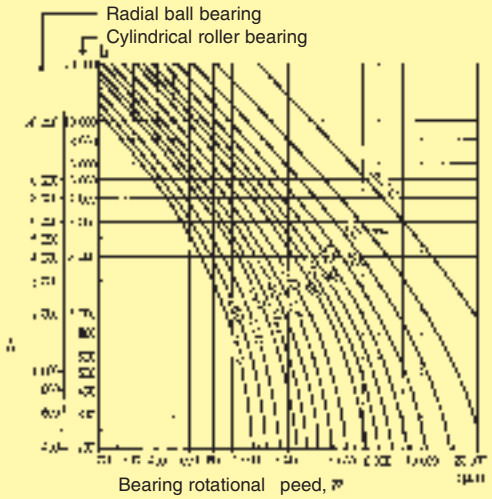
4.6 Replenishment and Replacement of Lubricant

(1) Grease replenishment intervals

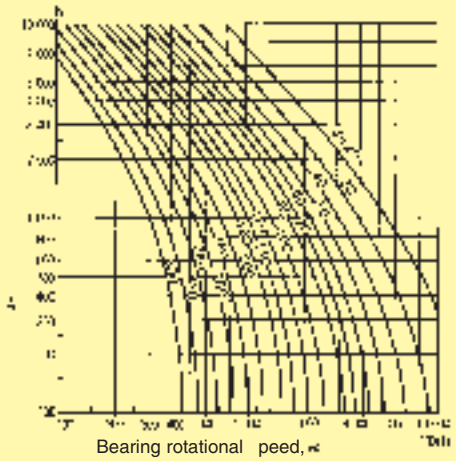
A time pa e , grea e deteriorate and the lubricating ability i degraded. Be ure to repleni h the grea e at the correct interval. The grea e repleni hment interval depend on factor like the bearing type, dimen ion , and rotation peed. Fig. 4.2 how approximate grea e repleni hment interval a a function of operating time and rotational peed. A a general rule, the grea e repleni hment interval hould be halved for each 15°C bearing temperature ri e above 70°C.

(2) Lubrication oil replacement interval

The oil replacement interval depend on the operating condition and the oil quantity. In general, for an operating temperature under 50°C, and in clean environment , the replacement interval i 1 year. If the oil temperature i above 100°C, then the oil hould be changed at lea t once every three month .



1 - Radial ball bearing and cylindrical roller bearing



2 - Tapered roller bearing and pherical roller bearing

Fig. 4.2 Grea e repleni hment interval

5. Bearing Inspection

When in pecting a bearing during periodic in pection of equipment, operating in pection , or replacement of adjacent part , determine the condition of the bearing and if it continued ervice i advi able.

A record hould be kept of the in pection and external appearance of di mounted bearing . After taking a grea e ample and mea uring the quantity of re idual grea e, the bearing hould be cleaned. Al o, determine whether abnormalitie and damage exi t in the cage, fitting urface , rolling element urface , and raceway urface . Refer to ection 6 regarding the ob ervation of running trace on the raceway urface.

When evaluating whether a bearing can be reu ed or not, the following point need to be con idered: degree of bearing damage, machine performance, critical nature of the application, operating condition , in pection interval. If the in pection reveal bearing damage or abnormalitie , then try to confirm the cau e and determine a countermea ure by referring to ection 7 and then carry out the countermea ure.

If your in pection di cover any of the following kind of damage, which would prevent the bearing from being reu ed, then the bearing mu t be replaced with a new one.

(1) Crack or chipping in the cage, rolling element , or raceway ring.
(2) Flaking in the rolling element or raceway ring.
(3) Notable coring on the rolling element , rib face (collar), or raceway urface.
(4) Notable wear on the cage or loo e rivet .
(5) Flaw or ru t on the rolling element or raceway urface.
(6) Notable dent on the rolling element or raceway urface.
(7) Notable creep of the outer ring out ide urface or inner ring bore.
(8) Di coloration due to heating.
(9) eriou damage on hield or eal of grea e packed bearing .

6. Running Traces and Applied Loads

A the bearing rotate , the raceway of the inner ring and outer ring make contact with the rolling element . Thi re ult in a wear path on both the rolling element and the raceway . Running trace are u eful, ince they indicate the loading condition , and hould be carefully ob erved when the bearing i di a embled.

If the running trace are clearly defined, it i po ible to determine whether the bearing i carrying a radial load, axial load or moment load. Al o, the roundne condition of the bearing can be determined. Check whether unexpected bearing load or large mounting error occurred. Al o, determine the probable cau e of the bearing damage.

Fig. 6.1 how the running trace generated in deep groove bearing under variou load condition . **Fig. 6.1 (a)** how the mo t common running trace generated when the inner ring rotate under a radial load only. **Figs. 6.1 (e)** through **(h)** how everal different running trace that re ult in a hortened life due to their adver e effect on the bearing .

imilarly, **Fig. 6.2** how different roller bearing running trace : **Fig. 6.2 (i)** how the outer ring running trace when a radial load i properly applied to a cylindrical roller bearing which ha a load on a rotating inner ring. **Fig. 6.2 (j)** how the running trace in the ca e of haft bending or relative inclination between the inner and outer ring . Thi mi alignment lead to the generation of lightly haded (dull) band in the width direction. Trace are diagonal at the beginning and end of the loading zone. For double-row tapered roller bearing where a ingle load i applied to the rotating inner ring, **Fig. 6.2 (k)** how the running trace on the outer ring under radial load while **Fig. 6.2 (l)** how the running trace on the outer ring under axial load. When mi alignment exi t between the inner and the outer ring , then the application of a radial load cau e running trace to appear on the outer ring a hown in **Fig. 6.2 (m)**.

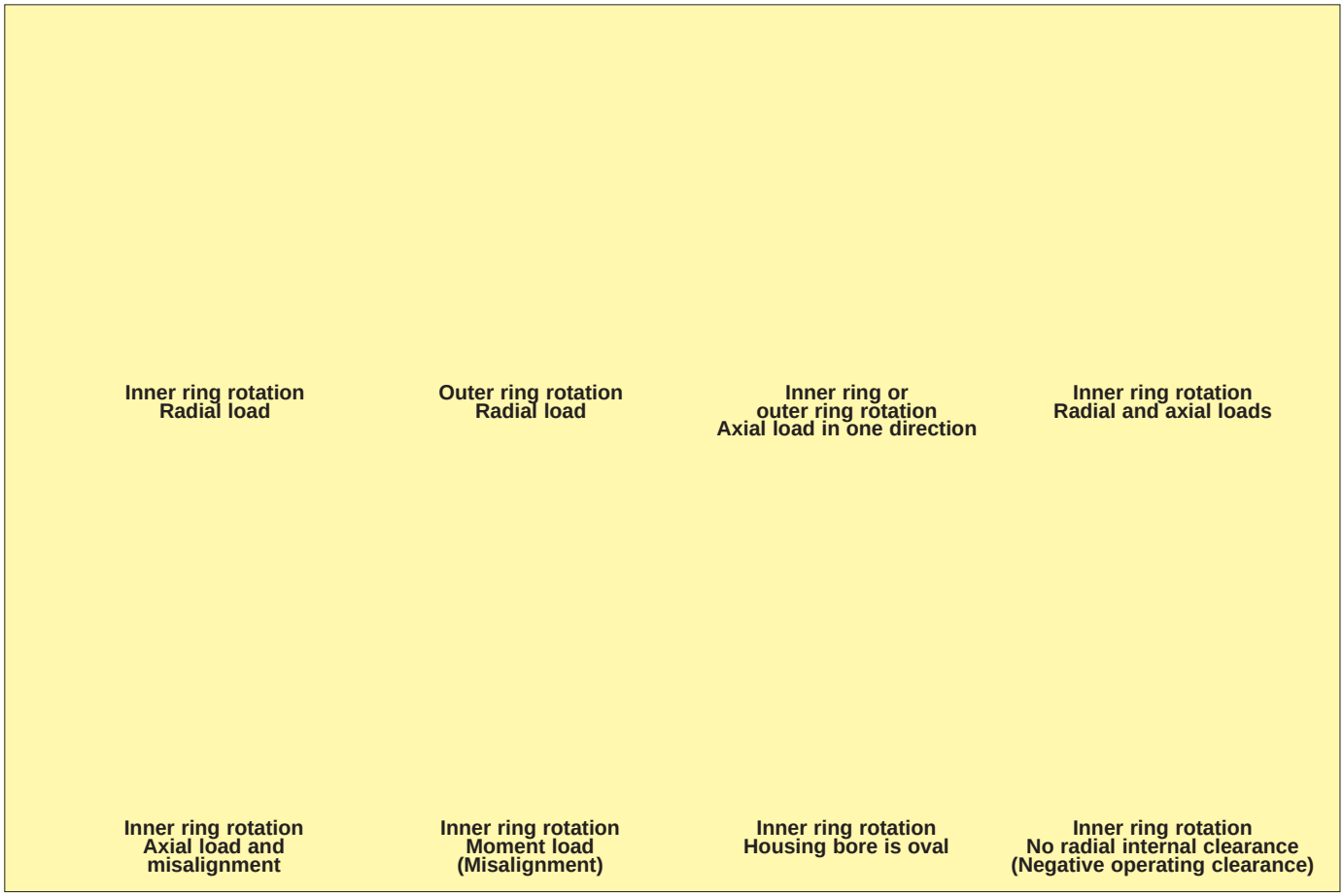
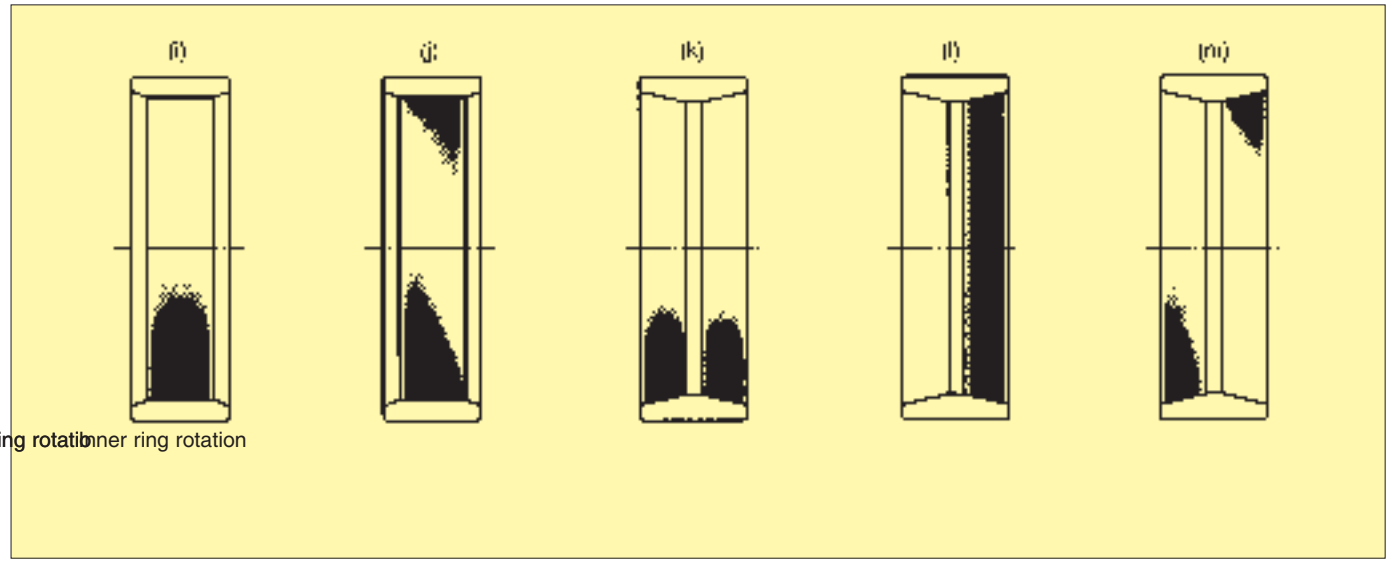


Fig. 6.1 Typical running trace of deep groove ball bearing

Fig. 6.2 Typical running trace on roller bearing



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 time 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 occur when mall piece of bearing material are plit off from the mooth urface of the raceway or rolling element due to rolling fatigue, thereby creating region having rough and coar e texture.	• Exce ive load • Poor mounting (mi alignment) • Moment load • Entry of foreign debri , water penetration • Poor lubrication, Improper lubricant • Un uitable bearing clearance • Improper preci ion for haft or hou ing, unevenne in hou ing rigidity, large haft bending • Progre ion from ru t, corro ion pit , mearing, dent (Brinelling)	• Reconfirm the bearing application and check the load condition • Improve the mounting method • Improve the ealing mechani m, prevent ru ting during non-running • U e a lubricant with a proper vi co ity, improve the lubrication method • Check the preci ion of haft and hou ing • Check the bearing internal clearance



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

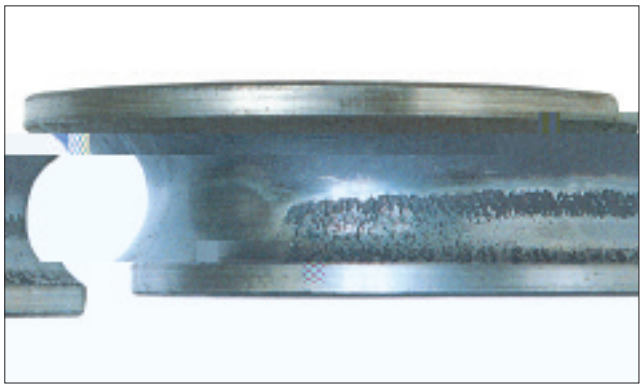


Photo 7-1-2
Part: Inner ring of an angular contact ball bearing
Symptom: Flaking occur diagonally along raceway
Cause: Poor alignment between haft and hou ing during mounting

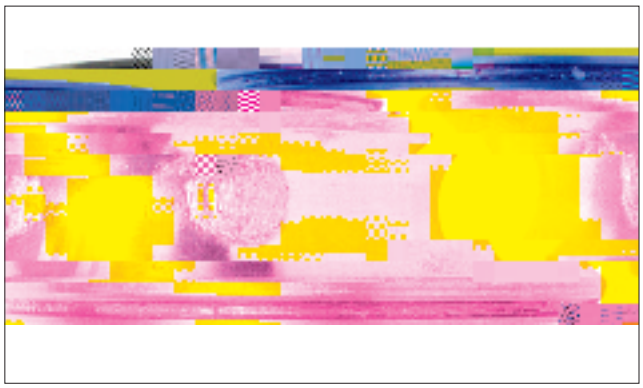


Photo 7-1-3
Part: Inner ring of deep groove ball bearing
Symptom: Flaking of raceway at ball pitch
Cause: Dent due to hock load during mounting



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

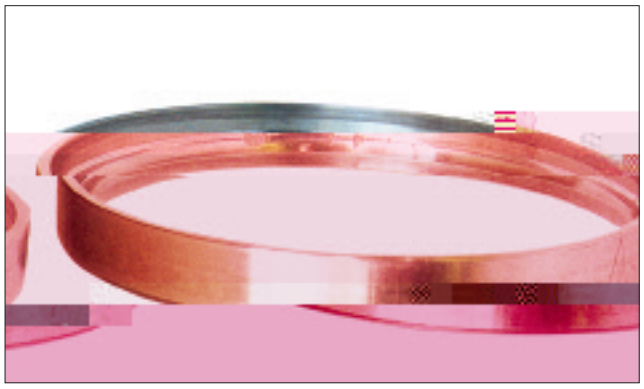


Photo 7-1-5
Part: Outer ring of **Photo 7-1-4**
Symptom: Flaking of raceway urface at ball pitch
Cause: Dent due to hock load while tationary



Photo 7-1-6
Part: Ball of **Photo 7-1-4**
Symptom: Flaking of ball urface
Cause: Dent due to hock load while tationary

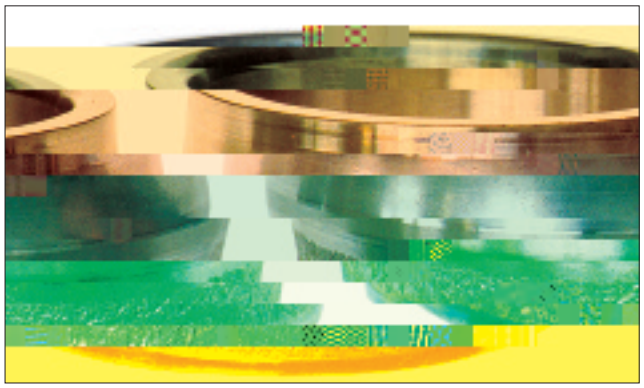


Photo 7-1-7
Part: Inner ring of a pherical roller bearing
Symptom: Flaking of only one raceway over it entire circumference
Cause: Exce ive axial load



Photo 7-1-8
Part: Outer ring of **Photo 7-1-7**
Symptom: Flaking of only one raceway over it entire circumference
Cause: Exce ive axial load



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



Photo 7-1-10
Part: Roller of a cylindrical roller bearing
Symptom: Premature flaking occur axially on the rolling urface
Cause: cratche cau ed during improper mounting

7.2 Peeling

Damage Condition	Possible Cause	Countermeasure
Dull or cloudy pot appear on urface along with light wear. From uch dull pot , tiny crack are generated downward to a depth of 5 ~ 10 um. mall particle fall off and minor flaking occur widely.	• Un uitable lubricant • Entry of debri into lubricant • Rough urface due to poor lubrication • urface roughne of mating rolling part	• elect a proper lubricant • Improve the ealing mechani m • Improve the urface fini h of the rolling mating part



Photo 7-2-1
Part: Inner ring of a pherical roller bearing
Symptom: Round haped peeling pattern occur on the center of the raceway urface
Cause: Poor lubrication



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



Photo 7-2-3
Part: Convex roller of **Photo 7-2-1**
Symptom: Round haped peeling pattern occur on the center of the rolling urface
Cause: Poor lubrication



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

Damage Condition	Possible Cause	Countermeasure
coring i urface damage due to accumulated mall eizure cau ed by liding under improper lubrication or under evere operating condition . Linear damage appear circumferentially on the raceway urface and rolling urface. Cycloidal haped damage on the roller end. coring on rib urface contacting roller end.	• Exce ive load, exce ive preload • Poor lubrication • Particle are caught in the urface • Inclination of inner and outer ring • haft bending • Poor preci ion of the haft and hou ing	• Check the ize of the load

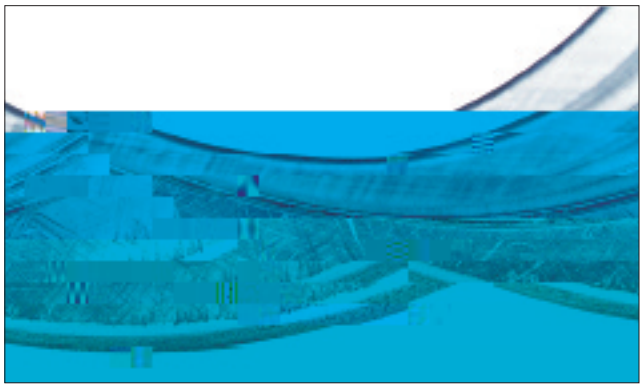


Photo 7-3-5
Part: Inner ring of a pherical thru t roller bearing
Symptom: coring on the rib face of inner ring
Cause: Debri , which i caught in urface, and exce ive axial loading



Photo 7-3-6
Part: Convex roller of **Photo 7-3-5**
Symptom: coring on the roller end face
Cause: Debri , which i caught in urface, and exce ive axial loading



Photo 7-3-7
Part: Cage of a deep groove ball bearing
Symptom: coring on the pre ed- teel cage pocket
Cause: Entry of debri

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Damage Condition
mearing i urface damage which occur from a collection of mall eizure between bearing component cau ed by oil film rupture and/or liding.



Photo 7-4-5
Part: Inner ring of a pherical roller bearing
Symptom: Partial mearing occur circumferentially on raceway urface
Cause: Poor lubrication



Photo 7-4-6
Part: Outer ring of **Photo 7-4-5**
Symptom: Partial mearing occur circumferentially on raceway urface
Cause: Poor lubrication



Photo 7-4-7
Part: Convex roller of **Photo 7-4-5**
Symptom: mearing occur at the center of the rolling urface
Cause: Poor lubrication

Photo 7-5-1

Part: Inner ring of a double-row cylindrical roller bearing

Symptom:

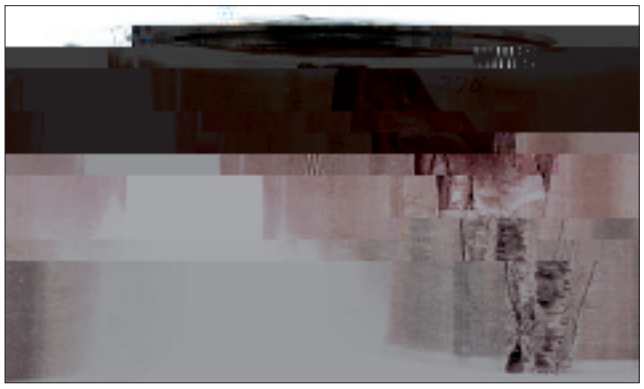


Photo 7-6-4
Part: Outer ring of a double-row cylindrical roller bearing u ed for outer ring rolling (Outer ring rotation)
Symptom: Crack occur on out ide urface
Cause: Flat wear and heat generation due to non-rotation of the outer ring

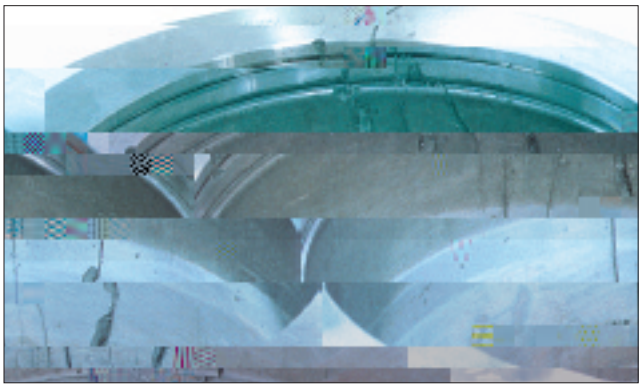


Photo 7-6-5
Part: Raceway urface of outer ring in **Photo 7-6-4**
Symptom: Out ide urface crack developing on the raceway

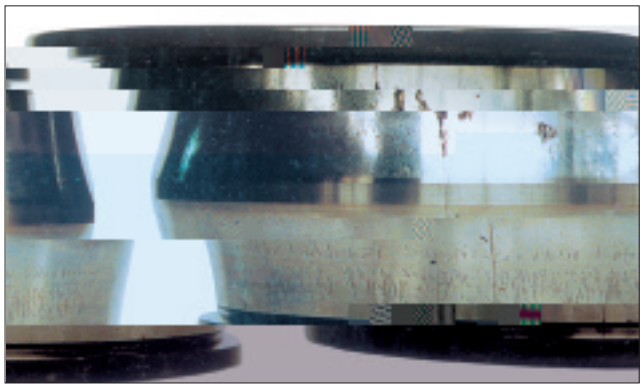


Photo 7-6-6
Part: Inner ring of a pherical roller bearing
Symptom: Axial crack occur on raceway urface
Cause: Large fitting tre due to temperature difference between haft and inner ring

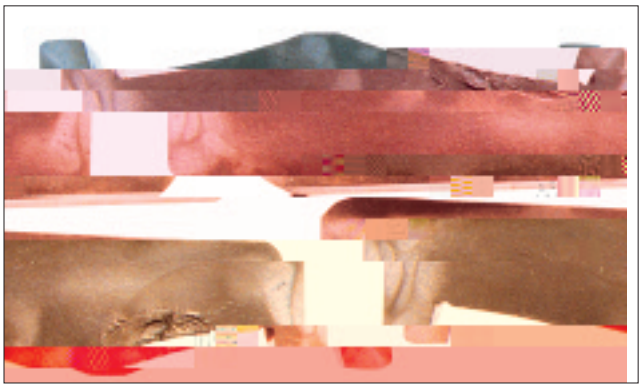


Photo 7-6-7
Part: Cro ection of a fractured inner ring in **Photo 7-6-6**
Symptom: Origin i directly beneath the raceway urface

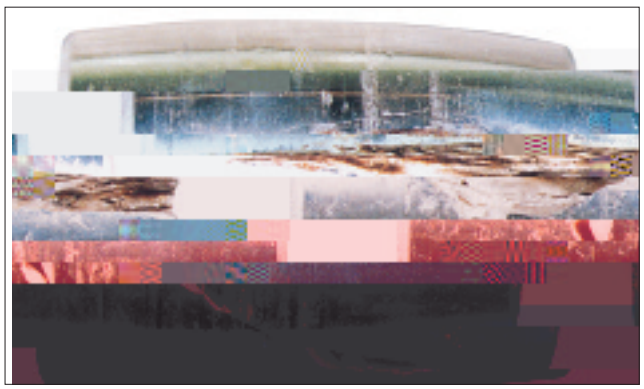


Photo 7-6-8
Part: Roller of a pherical roller bearing
Symptom: Axial crack occur on rolling urface

7.7 Cage Damage

Damage Condition	Possible Cause	Countermeasure
Cage damage include cage deformation, fracture, and wear. Fracture of cage pillar. Deformation of ide face. Wear of pocket urface. Wear of guide urface.	• Poor mounting (Bearing mi alignment) • Poor handling • Large moment load • hock and large vibration • Exce ive rotation peed, udden acceleration and deceleration • Poor lubrication • Temperature ri e	• Check the mounting method • Check the temperature, rotation, and load condition • Reduce the vibration • elect a cage type • elect a lubrication method and lubricant

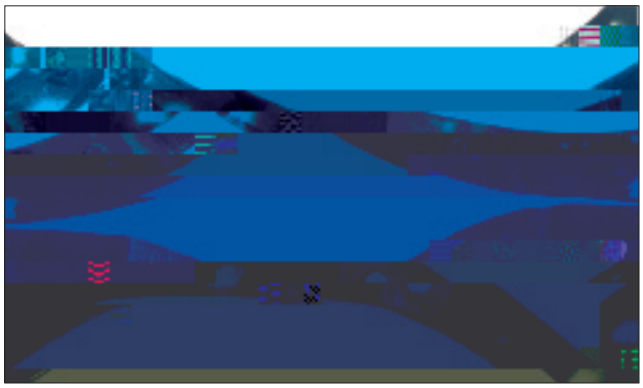


Photo 7-7-1
Part: Cage of a deep groove ball bearing
Symptom: Fracture of pre ed- teel cage-pocket



Photo 7-7-2
Part: Cage of an angular contact ball bearing
Symptom: Pocket pillar fracture from a ca t iron machined cage
Cause: Abnormal load action on cage due to mi aligned mounting between inner and outer ring

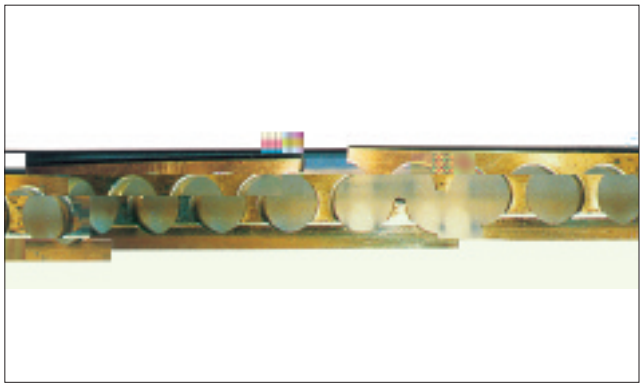


Photo 7-7-3
Part: Cage of an angular contact ball bearing
Symptom: Fracture of machined high-ten ion bra cage

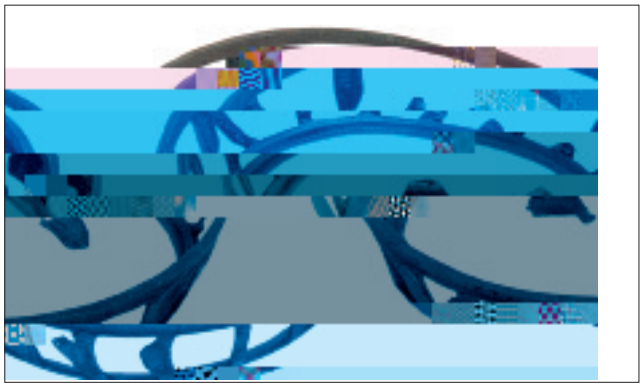


Photo 7-7-4
Part: Cage of a tapered roller bearing
Symptom: Pillar fracture of pre ed- teel cage

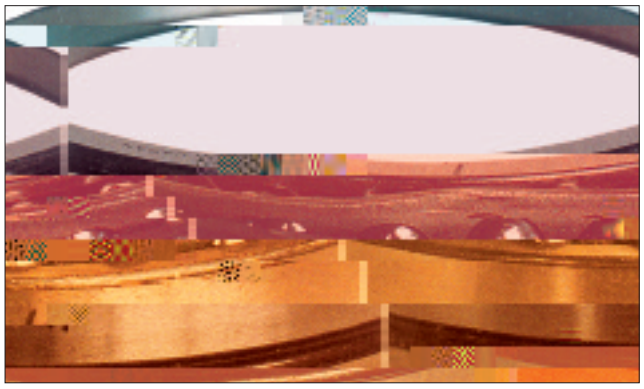


Photo 7-7-5
Part: Cage of an angular contact ball bearing
Symptom: Pre ed- teel cage deformation
Cause: hock load due to poor handling

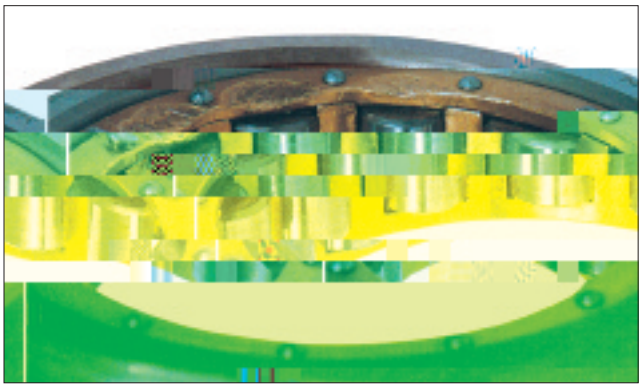


Photo 7-7-6
Part: Cage of a cylindrical roller bearing
Symptom: Deformation of the ide face of a machined high-ten ion bra cage
Cause: Large hock during mounting

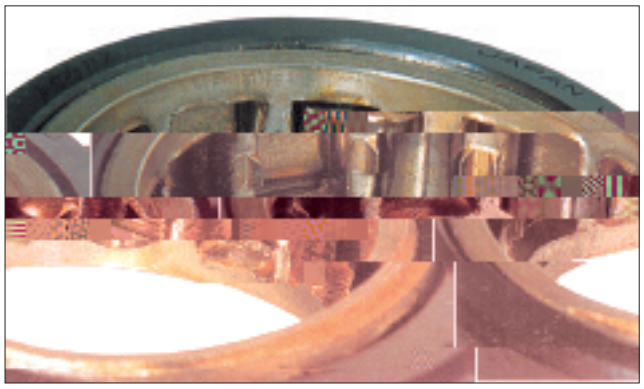


Photo 7-7-7
Part: Cage of a cylindrical roller bearing
Symptom: Deformation and wear of a machined high-ten ion bra cage

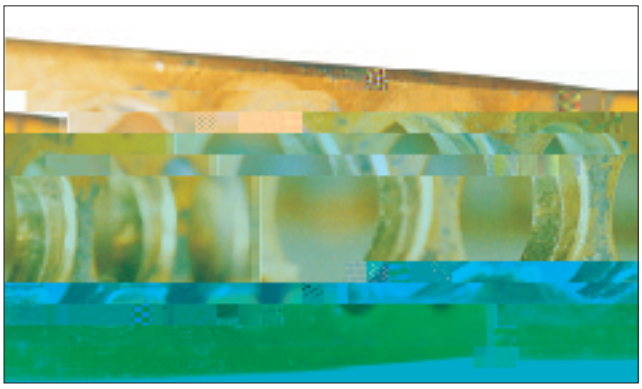


Photo 7-7-8
Part: Cage of an angular contact ball bearing
Symptom: tepped wear on the out ide urface and pocket urface of a machined high-ten ion bra cage

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7.8 Denting

Damage Condition	Possible Cause	Countermeasure
When debri uch a mall metallic particle are caught in the rolling contact zone, denting occur on the raceway urface or rolling element urface. Denting can occur at the rolling element pitch interval if there i a hock during the mounting (Brinell dent).	• Debri uch a metallic particle are caught in the urface • Exce ive load • hock during tran port or mounting	• Wa h the hou ing • Improve the ealing mechani m • Filter the lubrication oil • Improve the mounting and handling method

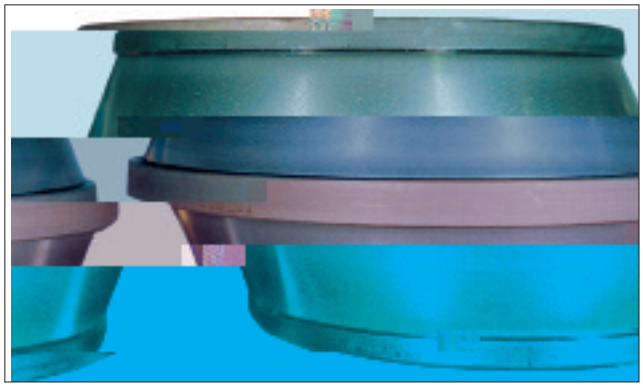


Photo 7-8-1
Part: Inner ring of a double-row tapered roller bearing
Symptom: Fro ted raceway urface
Cause: Debri caught in the urface

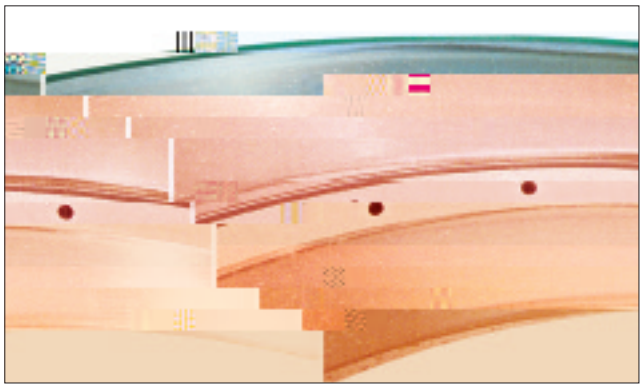


Photo 7-8-2
Part: Outer ring of a double-row tapered roller bearing
Symptom: Indentation on raceway urface
Cause: Debri caught in the urface

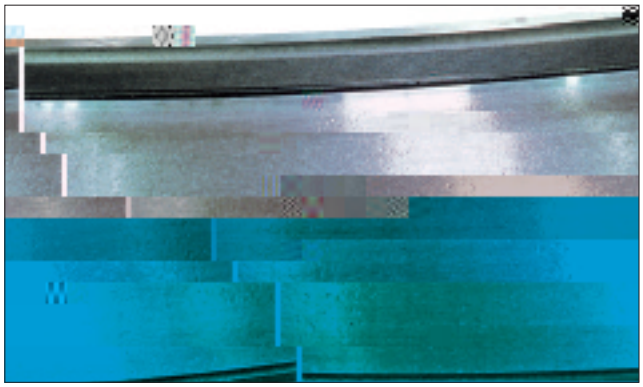


Photo 7-8-3
Part: Inner ring of a tapered roller bearing
Symptom: mall and large indentation occur over entire raceway urface
Cause: Debri caught in the urface



Photo 7-8-4:
Part: Tapered roller of **Photo 7-8-3**
Symptom: mall and large indentation occur over the rolling urface
Cause: Debri caught in the urface

7.9 Pitting

Damage Condition	Possible Cause	Countermeasure
The pitted urface ha a dull lu ter which appear on the rolling element urface or raceway urface.	• Debri become caught in the lubricant • Expo ure to moi ture in the atmo phere • Poor lubrication	• Improve the ealing mechani m • Filter the lubrication oil thoroughly • U e a proper lubricant



Photo 7-9-1
Part: Outer ring of a lewing bearing
Symptom: Pitting occur on the raceway urface
Cause: Ru t at bottom of indentation



Photo 7-9-2
Part: Ball of **Photo 7-9-1**
Symptom: Pitting occur on the rolling element urface

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7.10 Wear

Damage Condition	Possible Cause	Countermeasure
Wear i urface deterioration due to liding friction at the urface of the raceway, rolling element , roller end face , rib face, cage pocket , etc.	• Entry of debri • Progre ion from ru t and electrical corro ion • Poor lubrication • liding due to irregular motion of rolling element	• Improve the ealing mechani m • Clean the hou ing • Filter the lubrication oil thoroughly • Check the lubricant and lubrication method • Prevent mi alignment

Photo 7-10-1

Part: Inner ring of a cylindrical roller bearing
Symptom: Many pit occur due to electrical corro ion and wave- haped wear on raceway urface
Cause: Electrical corro ion

Photo 7-10-2

Part: Outer ring of a pherical roller bearing
Symptom: Wear having a wavy or concave-and-convex texture on loaded ide of raceway urface
Cause: Entry of debri under repeated vibration while tationary

Photo ETB 4

Photo 7-10-4 Progre ccur duexcProgImpe onation while
Part: Tapered roller of

Photo 7-1

Part: Inner ring of a deep groove ball bearing
Symptom: Fretting occur on the bore urface
Cause: Vibration

Photo 7-11-2

Part: Inner ring of an angular contact ball bearing
Symptom: Notable fretting occur over entire circumference of bore urface

Photo 7-12-1

Part: Inner ring of a deep groove ball bearing

Symptom: Fal e brinelling occur on the raceway

Cause: Vibration from an external ourc543.082 20.044 542.9228 21.9307 542.8651 22.515e0 0 196 22.5155 co93yCau e:

7.13 Creep

Damage Condition	Possible Cause	Countermeasure
Creep i the phenomenon in bearing where relative lipping occur at the fitting urface and thereby create a clearance at the fitting urface. Creep cau e a hiny appearance, occa ionally with coring or wear.	• In ufficient interference or loo e fit • In ufficient leeve tightening	• Check the interference, and prevent rotation • Correct the leeve tightening • tudy the haft and hou ing preci ion • Preload in the axial direction • Tighten the raceway ring ide face • Apply adhe ive to the fitting urface • Apply a film of lubricant to the fitting urface



Photo 7-13-1
Part: Inner ring of a pherical roller bearing
Symptom: Creep accompanied by coring of bore urface
Cause: In ufficient interference

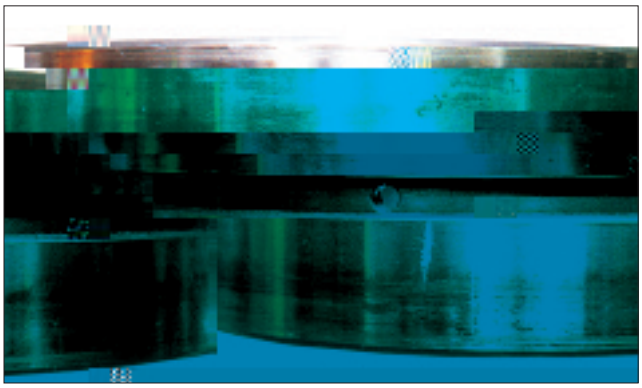


Photo 7-13-2
Part: Outer ring of a pherical roller bearing
Symptom: Creep occur over entire circumference of out ide urface
Cause: Loo e fit between outer ring and hou ing

Damage Condition	Possible Cause
When udden overheating occur during rotation, the bearing become di colored. Next, raceway ring , rolling element , and cage will often, melt and deform a damage accumulate .	• Poor lubrication • Exce ive load (Exce ive preload)

7.15 Electrical Corrosion

Damage Condition	Possible Cause	Countermeasure
When electric current pa e through a bearing, arcing and burning occur through the thin oil film at point of contact between the race and rolling element . The point of contact are melted locally to form “fluting” or groove-like corrugation which are een by the naked eye. The magnification of the e groove will reveal crater-like depre ion which indicate melting by arcing.	• Electrical potential difference between inner and outer ring	• De ign electric circuit which prevent current flow through the bearing • In ulation of the bearing

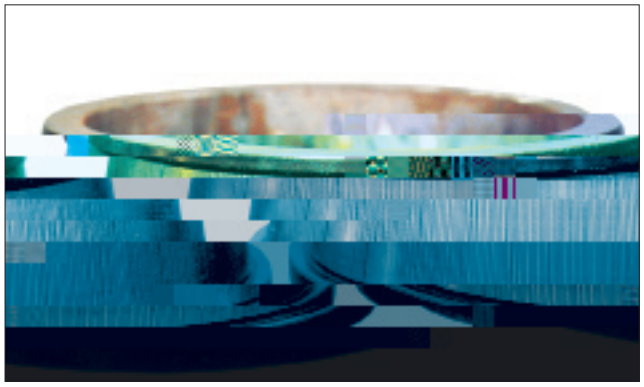


Photo 7-15-2

Part: Tapered roller in **Photo 7-15-1**

Symptom: triped pattern of corro ion occur on the rolling urface

Photo 7-15-4

Part: Ball of a deep groove ball bearing

Symptom: Electrical corro ion ha a dark color that cover the entire ball urface

7.16 Rust and Corrosion

Damage Condition	Possible Cause	Countermeasure
Bearing ru t and corro ion are pit on the urface of ring and rolling element and may occur at the rolling element pitch on the ring or over the entire bearing urface .	• Entry of corro ive ga or water • Improper lubricant • Formation of water droplet due to conden ation of moi ture • High temperature and high humidity while tationary • Poor ru t preventative treatment during tran porting • Improper torage condition • Improper handling	• Improve the ealing mechani m • tudy the lubrication method • Anti-ru t treatment for period of non-running • Improve the torage method • Improve the handling method

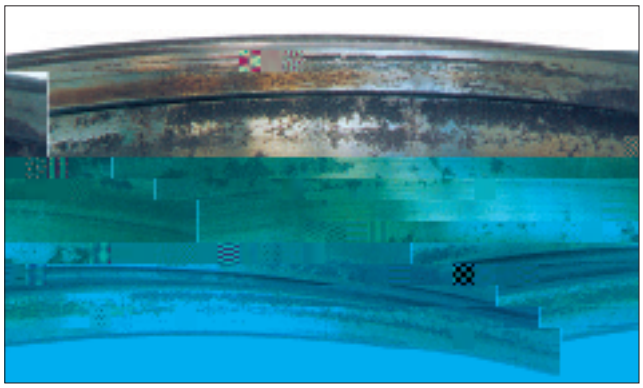


Photo 7-16-1
Part: Outer ring of a cylindrical roller bearing
Symptom: Ru t on the rib face and raceway urface
Cause: Poor lubrication due to water entry

Photo 7-16-2
Part: Outer ring of a lewing ring
Symptom: Ru t on raceway urface at ball pitch
Cause: Moi ture conden ation during tationary period

Photo 7-16-3
Part: Inner ring of a pherical roller bearing
Symptom: Ru t on raceway urface at roller pitch
Cause: Entry of water into lubricant

Photo 7-16-4
Part: Roller of a pherical roller bearing
Symptom: Pit- haped ru t on rolling contact urface. Corroded portion
Cause: Moi ture conden ation during torage

7.17 Mounting Flaws

Damage Condition	Possible Cause	Countermeasure
traight line cratche on urface of raceway or rolling element cau ed during mounting or di mounting of bearing.	• Inclination of inner and outer ring during mounting or di mounting • hock load during mounting or di mounting	• U e appropriate jig and tool • Avoid a hock load by u e of a pre machine • Center the relative mating part during mounting

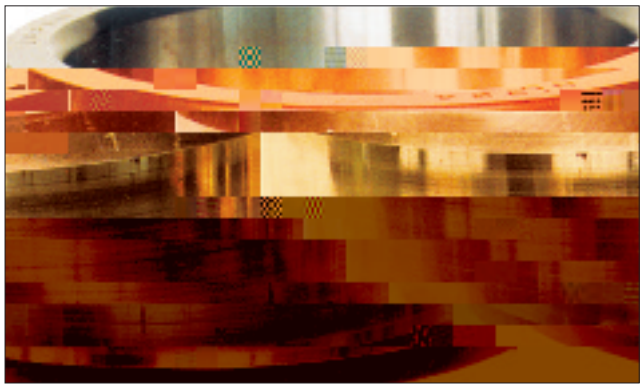


Photo 7-17-1
Part: Inner ring of a cylindrical roller bearing
Symptom: Axial cratche on raceway urface
Cause: Inclination of inner and outer ring during mounting

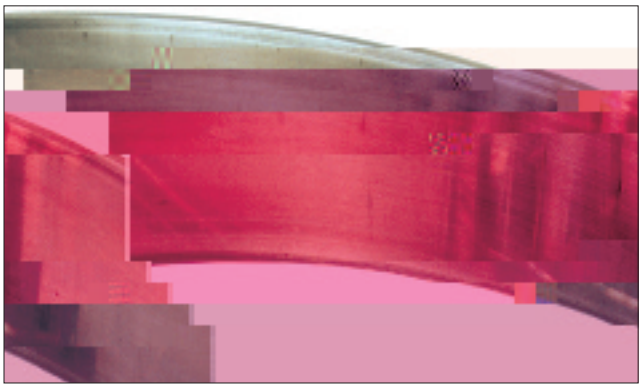


Photo 7-17-2
Part: Outer ring of a double-row cylindrical roller bearing
Symptom: Axial cratche at roller pitch interval on raceway urface
Cause: Inclination of inner and outer ring during mounting

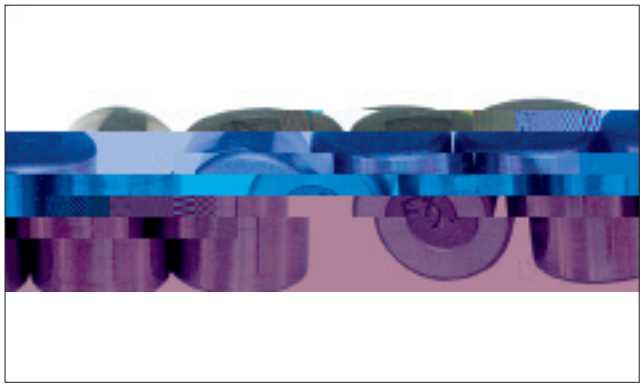


Photo 7-17-3
Part: Roller of a cylindrical roller bearing
Symptom: Axial cratche on rolling urface
Cause: Inclination of inner and outer ring during mounting

7.18 Discoloration

Damage Condition	Possible Cause	Countermeasure
Di coloration of cage, rolling element , and raceway ring occur due to a reaction with lubricant and high temperature.	• Poor lubrication • Oil tain due to a reaction with lubricant • High temperature	• Improve the lubrication method

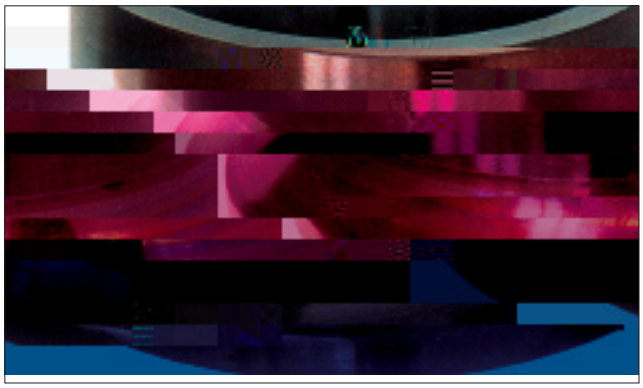


Photo 7-18-1
Part: Inner ring of an angular contact ball bearing
Symptom: Blui h or purpli h di coloration on raceway urface
Cause: Heat generation due to poor lubrication

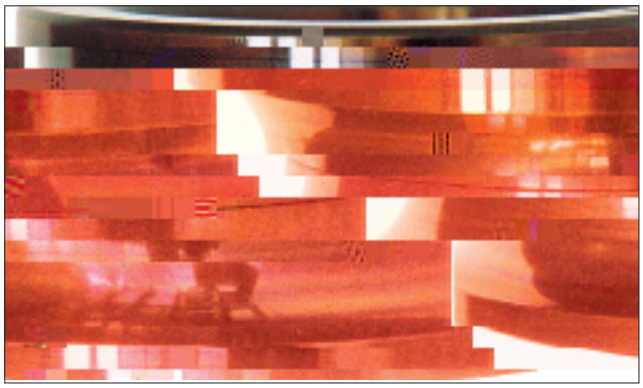


Photo 7-18-2
Part: Inner ring of a 4-point contact ball bearing
Symptom: Blui h or purpli h di coloration on raceway urface
Cause: Heat generation due to poor lubrication

Appendix - Bearing Diagnostic Chart

Damage name	Location (Phenomenon)	Stock - Shipping	Mounting	Shaft Housing	T	Moment	Ultra small load	High speed, High acceleration & deceleration	Shaking - Vibration Stationary	Bearing Selection

NSK LTD.-HEADQUARTERS, TOKYO, JAPAN www.nsk.com

Africa

South Africa:

NSK-RHP SOUTH AFRICA (PTY) LTD.

Asia and Oceania

Australia:

NSK-RHP AUSTRALIA PTY. LTD.

China:

NSK-RHP HONG KONG LTD.

KUNSHAN NSK CO., LTD.

GUIZHOU HS NSK BEARINGS CO., LTD.

NSK REPRESENTATIVE OFFICES

India:

RANE NASTECH LTD.

NSK REPRESENTATIVE OFFICE

Indonesia:

P.T. NSK BEARINGS MANUFACTURING INDONESIA

Korea:

NSK KOREA CO., LTD.

Malaysia:

NSK BEARINGS (MALAYSIA) SDN. BHD.

NSK MICRO PRECISION (M) SDN. BHD.

New Zealand: www.nsk-rhp.co.nz

NSK-RHP BEARINGS N.Z. LTD.

Philippines:

NSK REPRESENTATIVE OFFICE

ROL