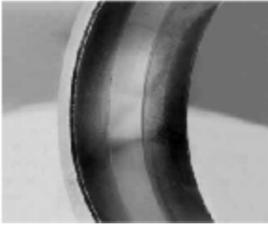
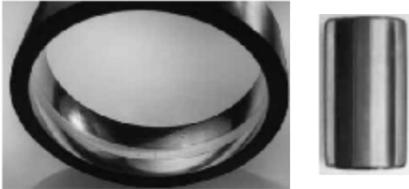
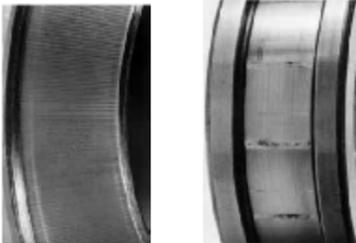
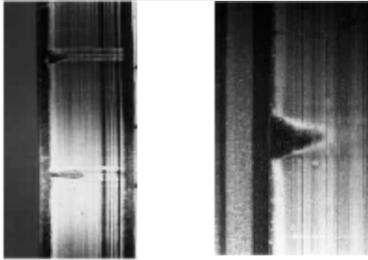
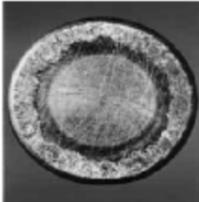
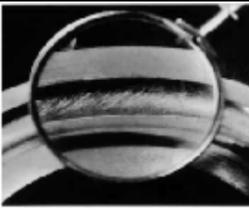
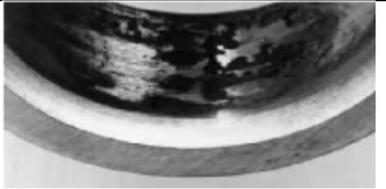


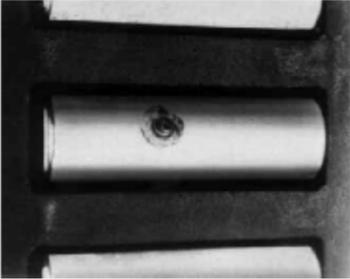
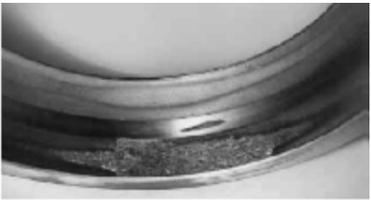
## BEARING FAILURE ANALYSIS

| TYPE OF DAMGE/FAILURE                    |                                                                                     | PICTORIAL VIEW                                                                                                                                                               | How to Identify ?                                                                                         | Why it happens ?                                                                                                                                                                                       | How to Prevent ?                                                                                    |
|------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| WEAR                                     | Wear Caused by abrasive particles.                                                  |                                                                                             | Small indentations around the raceways & rolling elements. Dull, worn surfaces.                           | Lack of cleanliness before & during mounting operation.                                                                                                                                                | Do not unpack bearing until just before it is to be mounted. Keep workshop clean & use clean tools. |
|                                          |                                                                                     |                                                                                                                                                                              | Grease discoloured green                                                                                  | Ineffective seals.                                                                                                                                                                                     | Check & possibly improve the sealing.                                                               |
|                                          |                                                                                     |                                                                                                                                                                              |                                                                                                           | Lubricant contaminated by worn particles from brass cage.                                                                                                                                              | Always use fresh, clean lubricant. Wipe the grease nipples. Filter the oil.                         |
|                                          | Wear Caused by Inadequate Lubrication.                                              |                                                                                             | Worn, frequently mirror-like, surfaces: at a large stage blue to brown discoloration.                     | Lubricant has gradually been used up or has lost its lubricating properties.                                                                                                                           | Check that the lubricant reaches the bearing                                                        |
|                                          |                                                                                     |                                                                                                                                                                              |                                                                                                           |                                                                                                                                                                                                        | More frequent relubrication.                                                                        |
| Wear Caused by Vibration.                |   | Depressions in raceways. These depressions are rectangular in roller bearings & circular in ball bearings. The bottom of these depressions may be bright or dull & oxidised. | The bearing has been exposed to vibration while stationary.                                               | Secure the bearing during transport by radial preloading. Provide a vibration-damping base. Where possible, use ball bearings instead of roller bearings. Employ oil bath lubrication, where possible. |                                                                                                     |
| INDENTATION                              | Indentation caused by faulty mounting or overloading.                               |                                                                                           | Indentaion in the raceways of both rings with spacing equal to the distance between the rolling elements. | Mounting pressure applied to the wrong ring.                                                                                                                                                           | Apply the mounting pressure to the ring with the interference fit.                                  |
|                                          |                                                                                     |                                                                                                                                                                              |                                                                                                           | Excessively hard drive-up on tapered seating.                                                                                                                                                          | Follow instruction in case of tapered seating given by bearing manufacturer.                        |
|                                          |                                                                                     |                                                                                                                                                                              |                                                                                                           | Overloading while not running.                                                                                                                                                                         | Avoild overloading or use bearings with higher basic static load ratings.                           |
|                                          | Indentation caused by foreign particles.                                            |                                                                                           | Small indentations around the raceways & rolling elements. Dull, worn surfaces.                           | Ingress of foreign particles into the bearing.                                                                                                                                                         | Cleanliness to be observed during the mounting operation.                                           |
|                                          |                                                                                     |                                                                                                                                                                              |                                                                                                           | Uncontaminated lubricant.                                                                                                                                                                              |                                                                                                     |
|                                          |                                                                                     |                                                                                                                                                                              |                                                                                                           | Improved seals.                                                                                                                                                                                        |                                                                                                     |
| Smearing of roller ends & guide flanges. |  | Scored & discoloured roller ends & flange faces.                                                                                                                             | Sliding under heavy axial loading & with inadequate lubrication.                                          | More suitable Lubricant.                                                                                                                                                                               |                                                                                                     |

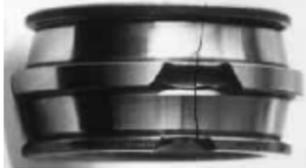
## BEARING FAILURE ANALYSIS

| TYPE OF DAMGE/FAILURE |                                  | PICTORIAL VIEW                                                                     | How to Identify ?                                                                   | Why it happens ?                                                                                                                                       | How to Prevent ?                                                                                                                                                       |                                                                                                                                                                             |
|-----------------------|----------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PRIMARY DAMAGE        | SMEARING                         | Smearing rollers & raceways                                                        |    | Scored & discoloured areas at the start of the load zone in raceways & on the surface of the rollers.                                                  | Roller acceleration on entry into the loaded zone.                                                                                                                     | More suitable Lubricant. Reduce bearing internal clearances.                                                                                                                |
|                       |                                  | Raceway smearing at intervals corresponding to the roller spacing.                 |    | Transverse smear streaks- spaced at intervals equal to the distance between the rollers- in the raceways of cylindrical roller bearings.               | During the mounting operaton, the ring with the roller & cage assembly has been entered askew on the other ring.                                                       | Rotate the inner & outer ring during entry. Lubricant the surfaces well. Use a mounting ring when fitting a series of bearings.                                             |
|                       |                                  |                                                                                    |                                                                                     | Transverse smear streaks- spaced at intervals equal to the distance between the rollers- in the raceways of Spherical & Taper roller bearings.         | Blows applied to the wrong ring or heavy preloading without rotating the bearing.                                                                                      | Rotate the bearing when it is being adjusted. Apply the mounting force against the ring with the tightest fit; never allow the forces to pass through the rolling elements. |
|                       |                                  | Smearing of External surfaces                                                      |    | Score & discoloured riing bore or outside surface or faces.                                                                                            | Ring rotation relative to shaft or housing.                                                                                                                            | Select heavier interfearance fit.                                                                                                                                           |
|                       | Smearing in thrust ball bearing. |  | Diagonal smear streaks in the raceways.                                             | Loading too light in relation to speed of rotation.                                                                                                    | Preload the bearing by using springs.                                                                                                                                  |                                                                                                                                                                             |
|                       | SURFACE DISTRESS                 | Surface Distress                                                                   |  | Initially the damage is not visible to the naked eye. A more advanced stage is marked by small, shallow craters with crystalline fracture surfaces.    | Inadequate or improper lubrication.                                                                                                                                    | Improve lubrication.                                                                                                                                                        |
|                       |                                  | CORROSION                                                                          | Deep seated rust                                                                    |                                                                     | Greyish black streaks across the raceways, mostly coinciding with the rolloing element spacing. At a later stage, pitting of raceways & other surfaces of the bearing. | Presence of water, moisture or corrosive substance in the bearing over a long period of time.                                                                               |
|                       | Fretting corosion                |                                                                                    |  | Areas of rust on the outside surface of the outer ring or in the bore of the inner ring. Raceway path pattern heavily marked at corosponding position. | Fit too loose. Shaft or housing seating with error of form.                                                                                                            | Adust Seating.                                                                                                                                                              |

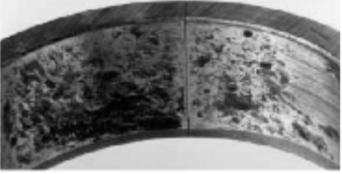
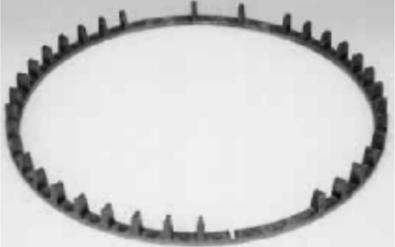
## BEARING FAILURE ANALYSIS

| TYPE OF DAMGE/FAILURE          |                                                                                     | PICTORIAL VIEW                                                                                                                                                            | How to Identify ?                                                                                                                                                         | Why it happens ?                                                                                                                      | How to Prevent ?                                                                                                                                                                                                                                                                                   |
|--------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ELECTRIC CURRENT DAMAGE        | Damage caused by the passage of electric current.                                   |                                                                                          | Dark brown or greyish black fluting (Corrugation) or creases in raceways & rollers. Balls have dark discoloration only. Sometimes ZigZag burns in ball bearings raceways. | Passage of electric current through rotating bearing.                                                                                 | Re-route the current to by-pass the bearing.                                                                                                                                                                                                                                                       |
|                                |                                                                                     |                                                                                                                                                                           | Localised burns in raceways & on rolling elements.                                                                                                                        | Passage of electric current through non-rotating bearing.                                                                             | Use Insulated bearings.                                                                                                                                                                                                                                                                            |
| NG OR SPALLING                 | Flaking caused by Preloading                                                        |                                                                                          | Heavily marked path patterns in raceways of both rings.                                                                                                                   | Preloading on account of fits being too tight.                                                                                        | After the fits or select bearing with larger internal clearance.                                                                                                                                                                                                                                   |
|                                |                                                                                     |                                                                                                                                                                           | Flaking usually in the most heavily loaded zone.                                                                                                                          | Excessive drive-up on tapered seating.                                                                                                | Do not drive the bearing so far up its tapered seating.                                                                                                                                                                                                                                            |
|                                |                                                                                     |                                                                                                                                                                           |                                                                                                                                                                           | Single row angular contact ball bearing or taper roller bearings adjusted to give excessive preload.                                  | Re-adjust the bearings to obtain lighter preload.                                                                                                                                                                                                                                                  |
|                                | Flaking caused by oval compression                                                  |                                                                                         | Heavily marked path patterns at two diametrically opposed sections of either bearing ring. Flaking in these sections.                                                     | Oval shaft or oval housing seating. The latter is a common defect in split housing & machine frames.                                  | Usually it is necessary to manufacture a new shaft or new housing to remedy this defect. On expedient is to spray metal on the components & then regrind. If it is a matter of an oval shaft with the bearing mounted on sleeve, it is possible to adjust the shaft by grinding, in certain cases. |
|                                |                                                                                     |                                                                                                                                                                           |                                                                                                                                                                           | The bore of plummer blocks mounted on an uneven base becomes oval when bolts are tightened.                                           | Adjust the base.                                                                                                                                                                                                                                                                                   |
|                                | Flaking caused by Axial compression                                                 |                                                                                        | Heavily marked path patterns at two diametrically opposed sections of either bearing ring. Flaking in these sections.                                                     | Incorrect mounting which result it axial loading, e.g. excessive preloading of angular contact ball bearings & taper roller bearings. | Check adjustment when mounting the bearings.                                                                                                                                                                                                                                                       |
|                                |                                                                                     |                                                                                                                                                                           |                                                                                                                                                                           | The non-locating bearing has jammed.                                                                                                  | Check the fit & lubricant the surfaces.                                                                                                                                                                                                                                                            |
| Flaking Caused by misalignment |  | Deep groove ball bearings: diagonal path pattern, severely marked at two diametrically opposed sections. Cylindrical roller bearings: flaking at the edge of the raceway. | Bearing seating out of alignment. Bearing mounted on the skew.                                                                                                            | Rectify the seatings. Use mounting sleeve with parallel faces.                                                                        |                                                                                                                                                                                                                                                                                                    |
|                                |                                                                                     |                                                                                                                                                                           | Axial freedom of movement has not been sufficient to accommodate the thermal expansion.                                                                                   | If temperature differential between shaft & housing cannot be reduced, provide greater freedom of movement.                           |                                                                                                                                                                                                                                                                                                    |
| Flaking caused by indentations |  | Flaking in conjunction with indentations coinciding with the rolling element spacing.                                                                                     | Indentations resulting from faulty mounitng practice or overloading of the no-rotating bearing.                                                                           | Apply the mounting pressure to the ring with the interference fit.                                                                    |                                                                                                                                                                                                                                                                                                    |
|                                |                                                                                     |                                                                                                                                                                           |                                                                                                                                                                           | Follow instruction in case of tapered seating given by bearing manufacturer.                                                          |                                                                                                                                                                                                                                                                                                    |
|                                |                                                                                     |                                                                                                                                                                           |                                                                                                                                                                           | Avoidl overloading or use bearings with higher basic static load ratings.                                                             |                                                                                                                                                                                                                                                                                                    |
|                                |                                                                                     |                                                                                                                                                                           |                                                                                                                                                                           | Cleanliness to be observed during the mounting operation.                                                                             |                                                                                                                                                                                                                                                                                                    |

## BEARING FAILURE ANALYSIS

| TYPE OF DAMGE/FAILURE |                                                                              | PICTORIAL VIEW                                                                      | How to Identify ?                                                                   | Why it happens ?                                                                                                                                                       | How to Prevent ?                                                                                                                                                                                                                                                                                                                                                                             |                                                                                          |
|-----------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| SECONDARY DAMAGE      | FLAKI                                                                        |    | Flaking in conjunction with small indentations.                                     | Indentaion made by foreign particles.                                                                                                                                  | Uncontaminated lubricant.<br>Improved seals.                                                                                                                                                                                                                                                                                                                                                 |                                                                                          |
|                       |                                                                              |    | Flaking caused by smearing                                                          | Flaking at the start of load zone in raceways of roller bearings.                                                                                                      | Skid smearing.                                                                                                                                                                                                                                                                                                                                                                               | More suitable Lubricant.<br>More suitable Lubricant. Reduce bearing internal clearances. |
|                       | Flaking, coinciding with the roller spacing, in raceways of roller bearings. |                                                                                     |                                                                                     | Trnsverse smearing resulting from faulty mounting practice.                                                                                                            | Rotate the inner & outer ring during entry. Lubricant the surfaces well. Use a mounting ring when fitting a series of bearings.<br>Rotate the bearing when it is being adjusted. Apply the mounting force against the ring with the tightest fit; never allow the forces to pass through the rolling elements.<br>Select heavier interfearence fit.<br>Preload the bearing by using springs. |                                                                                          |
|                       | Flaking caused by Deep seated rust                                           |                                                                                     |   | Greyish black streaks across the raceways, mostly coinciding with the rolloing element spacing. At a later stage, pitting of raceways & other surfaces of the bearing. | Presence of water, moisture or corrosive substance in the bearing over a long period of time.                                                                                                                                                                                                                                                                                                | Improve sealing. Use lubricant with better rust inhibiting properties.                   |
|                       | Flaking caused by Fretting corosion                                          |                                                                                     |  | Areas of rust on the outside surface of the outer ring or in the bore of the inner ring. Raceway path pattern heavily marked at corosponding position.                 | Fit too loose. Shaft or housing seating with error of form.                                                                                                                                                                                                                                                                                                                                  | Adust Seating.                                                                           |
|                       | Flaking caused by fluting or craters                                         |  | Flaking in conjunction with bright or corroded fluting or craters.                  | Wear resulting from vibrations while the bearing was not running.                                                                                                      | Re-route the current to by-pass the bearing.                                                                                                                                                                                                                                                                                                                                                 |                                                                                          |
|                       |                                                                              |                                                                                     | Flaking in conjunction with drak coloured or burnt fluting or craters.              | Electric current damage                                                                                                                                                | Use Insulated bearings.                                                                                                                                                                                                                                                                                                                                                                      |                                                                                          |
|                       | CRACKS                                                                       | Cracks caused by rough treatment                                                    |  | Crack                                                                                                                                                                  | Blows , with hammer or hardened chisel, have neen directed against the ring when the bearing was bearing mounted.                                                                                                                                                                                                                                                                            | Always use a soft drift or mounting sleeve. Never subject the bearing to direct hits.    |
|                       |                                                                              | Cracks caused by excessive drive-up                                                 |  | The bearing has cracked right through & has lost its frop on the shaft.                                                                                                | Excessive drive-up on tapered seating or sleeve.                                                                                                                                                                                                                                                                                                                                             | Follow bearing manufacturers instruction concening on tapered seating.                   |
|                       | Interference fit on cylindrical searing too heavy.                           |                                                                                     |                                                                                     |                                                                                                                                                                        | Alter the fit.                                                                                                                                                                                                                                                                                                                                                                               |                                                                                          |

## BEARING FAILURE ANALYSIS

| TYPE OF DAMGE/FAILURE |                                                                                     | PICTORIAL VIEW                                                                    | How to Identify ?                                                                                                  | Why it happens ?                                                                    | How to Prevent ?                             |
|-----------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------|
|                       | Cracks caused by fretting corrosion                                                 |  | Cracks, transverse in inner rings & generally longitudinal in outer rings, in conjunction with fretting corrosion. | Fretting corrosion                                                                  | Adust Seating.                               |
| RETAINER              | RETAINER DAMAGE                                                                     |  | Cage crack                                                                                                         | High forces of inertia                                                              | -                                            |
|                       |                                                                                     |                                                                                   |                                                                                                                    | Excessive speed                                                                     | Select bearings with cages of special design |
|                       |                                                                                     |                                                                                   |                                                                                                                    | Inadequate lubrication                                                              | -                                            |
|                       |                                                                                     |                                                                                   |                                                                                                                    | Abbrasive particles                                                                 | -                                            |
|                       |                                                                                     |                                                                                   |                                                                                                                    | When cage in center of the rolling elements, resultant force may cause cage damage. | -                                            |
| Blockage              | Fragments of flaked material (Hard Particles) between the cages & rolling elements. | -                                                                                 |                                                                                                                    |                                                                                     |                                              |