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Application of Tribology for Enhancing the Life of Sugar Mill Roll Bearing and Journal

Speaker

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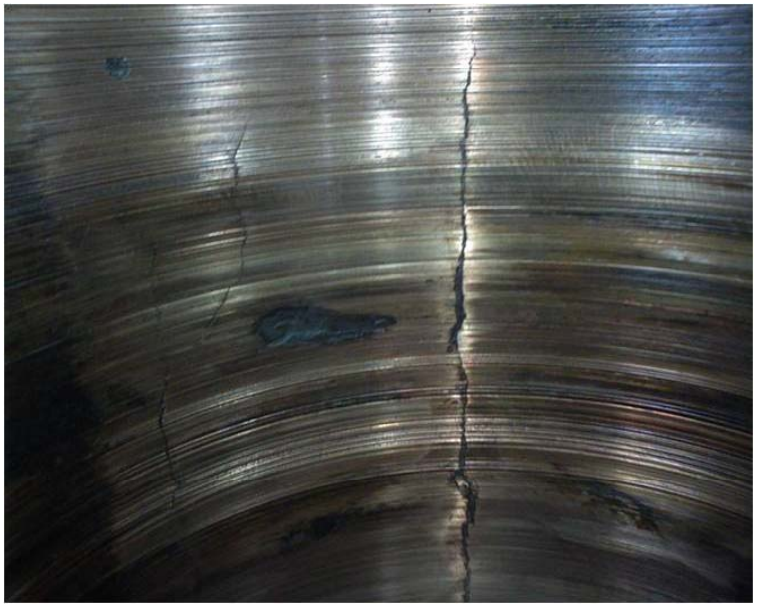
Mill Roll Bearings: Background

- Subjected to very high radial load at low speed.
- Non-uniform lifting of top roll
- Bearing liners in two halves
- Ingress of contaminants



Results

- Rapid wear and scoring
- High lubricant consumption
- Occasional failure of mill roll shaft or bearing

Objective of the Study

Enhancing the life and reliability of mill roll bearings and journals

through

the application of Tribological principles

without

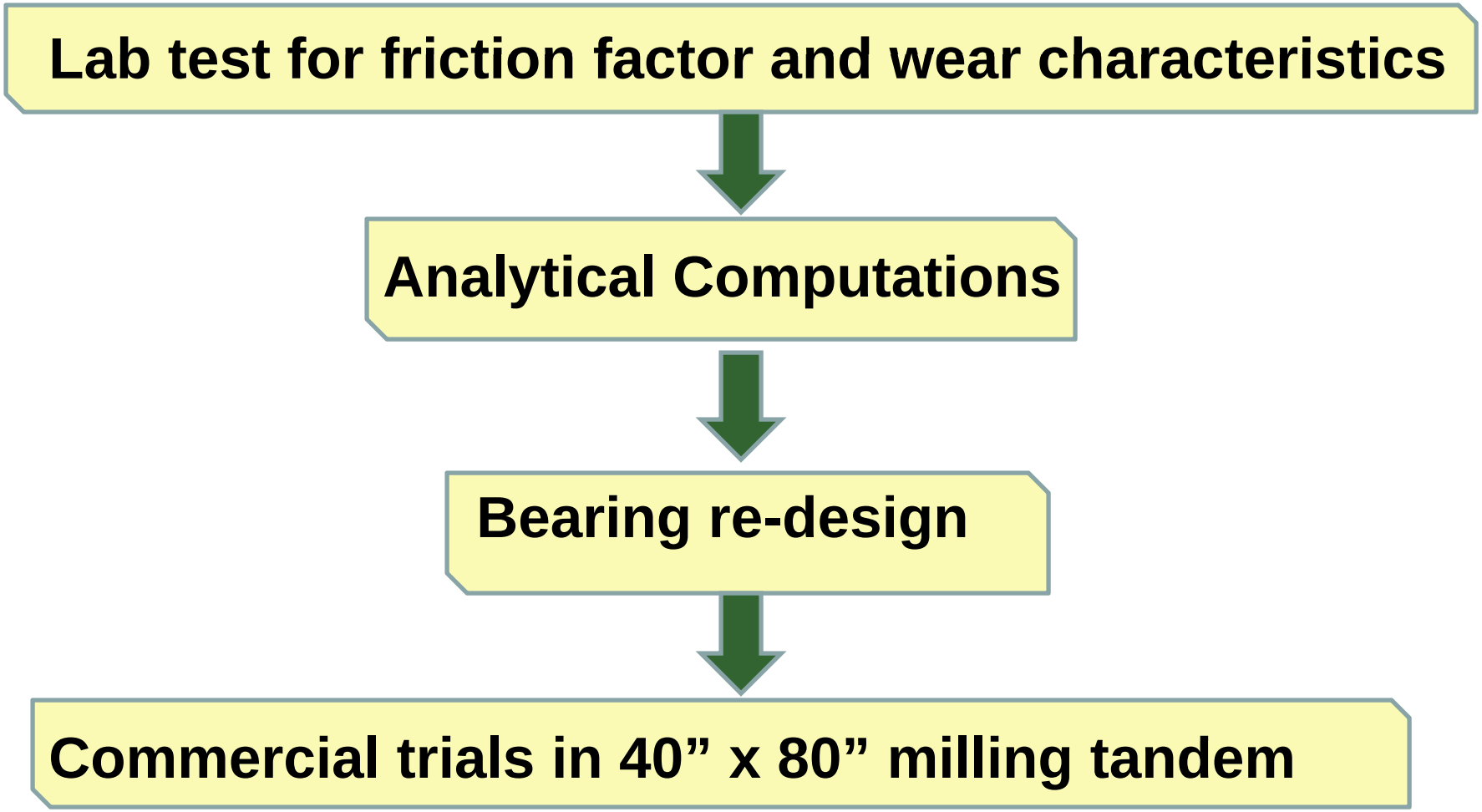
changing materials and the basic design

Tribology

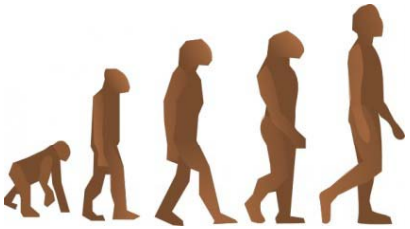
- It is the science of interacting surfaces in relative motion

- It applies principles of friction, wear and lubrication for design of bearings to:
  - ✓ Enhance life and reliability
  - ✓ Reduce lubricant consumption

Study Methodology

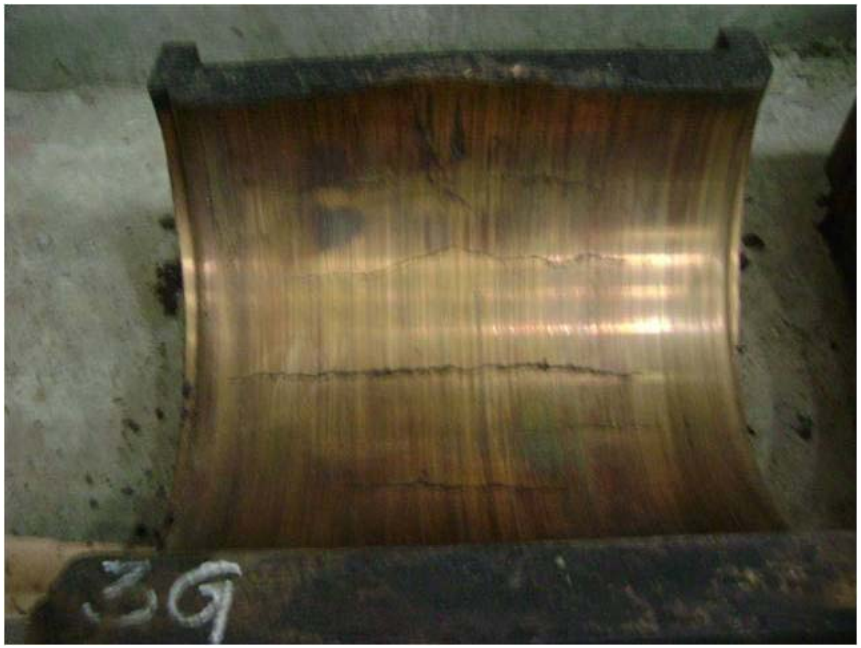


Outcome of Study



Transformation of Mill Bearing

from



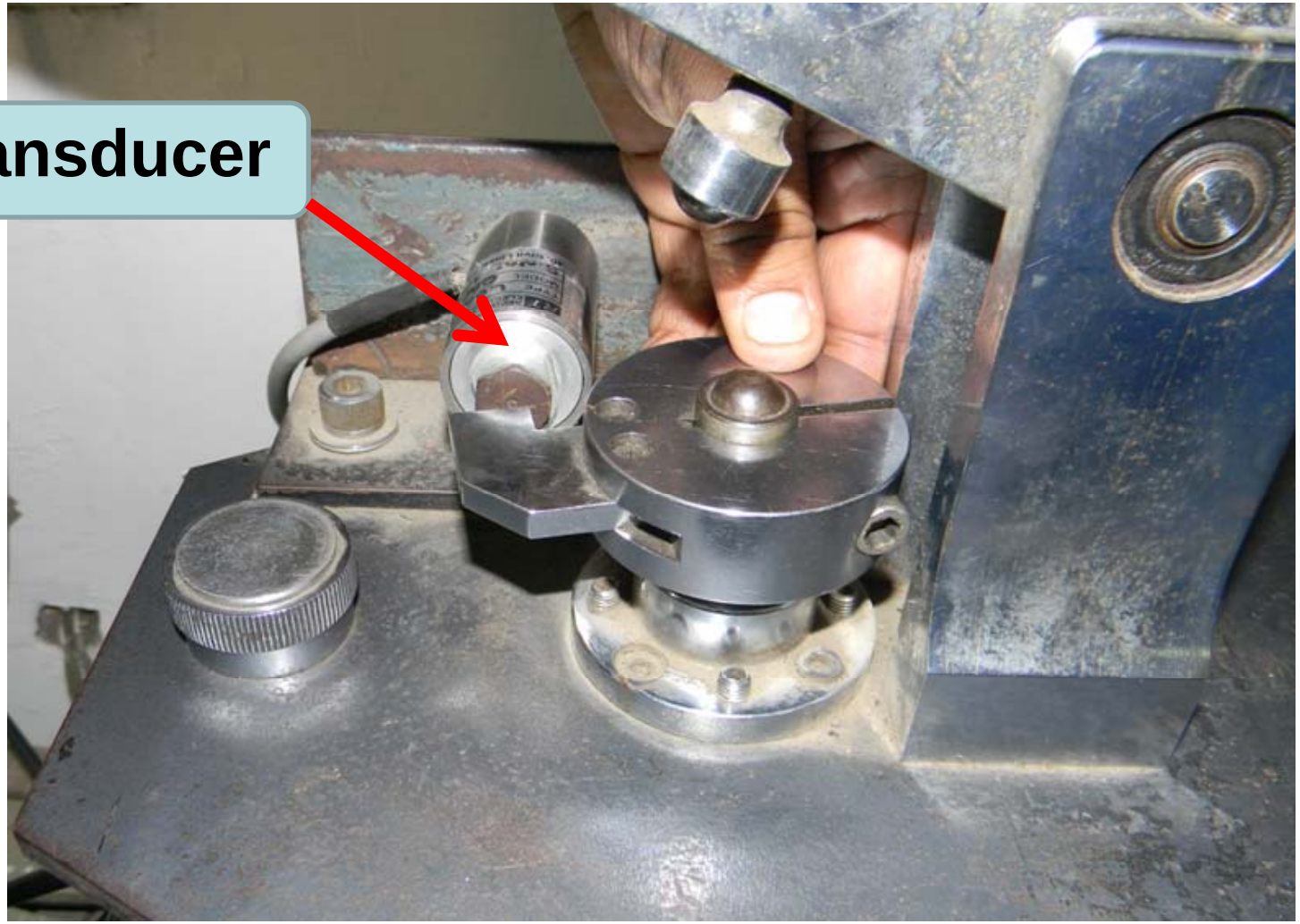
to

Lab Tests : Pin and Disc Machine

Pin holder, upside down

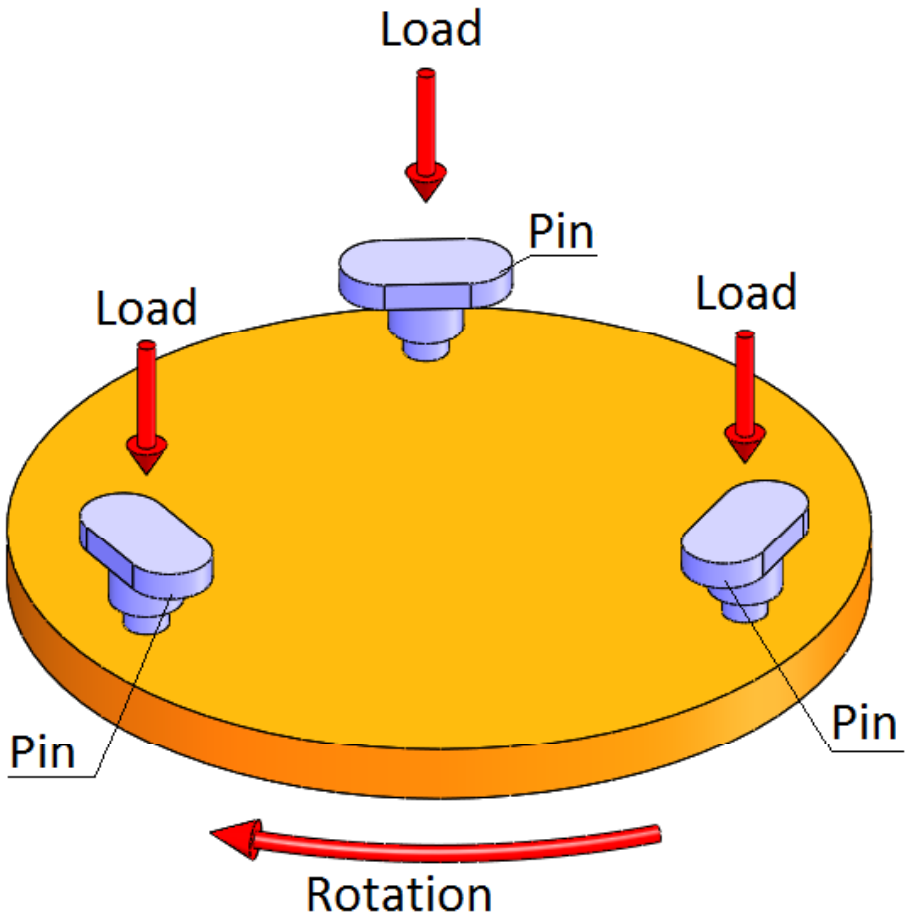
Pin holder, in position

Lab Tests : Pin and Disc Machine…



Machine ready for Tests

Schematic of Pin and Disc Machine



Pin : Represents Liner

Disc : Represents shaft

Lab Test: Procedure

❖ Tribo-pair tested

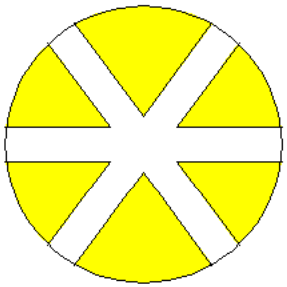
- ❑ **Bearing** : Leaded bronze, CC495K (EN 1982)
- ❑ **Roll Shaft** : Carbon Steel, SAE 1045, 230 BHN
- ❑ **Lubricant** : Alpha SMR Heavy (Make: Castrol)

❖ Test Parametres

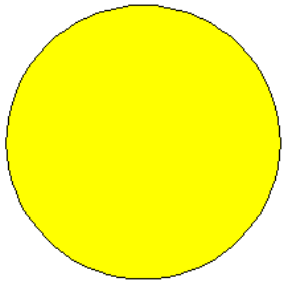
- ❑ **Contact Pressure** : 2 Mpa
- ❑ **Disc Speed** : 250 rpm
- ❑ **Test Duration** : 30 Minutes

Lab Test: Procedure….

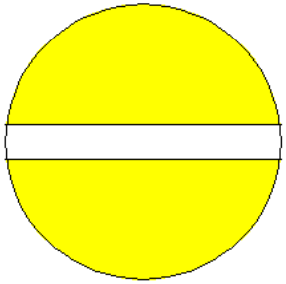
- Groove Patterns tested



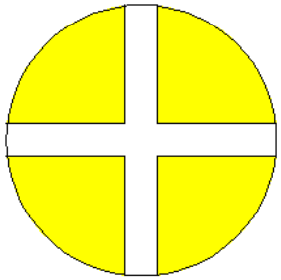
(A): Multiple Grooves



(B): No groove

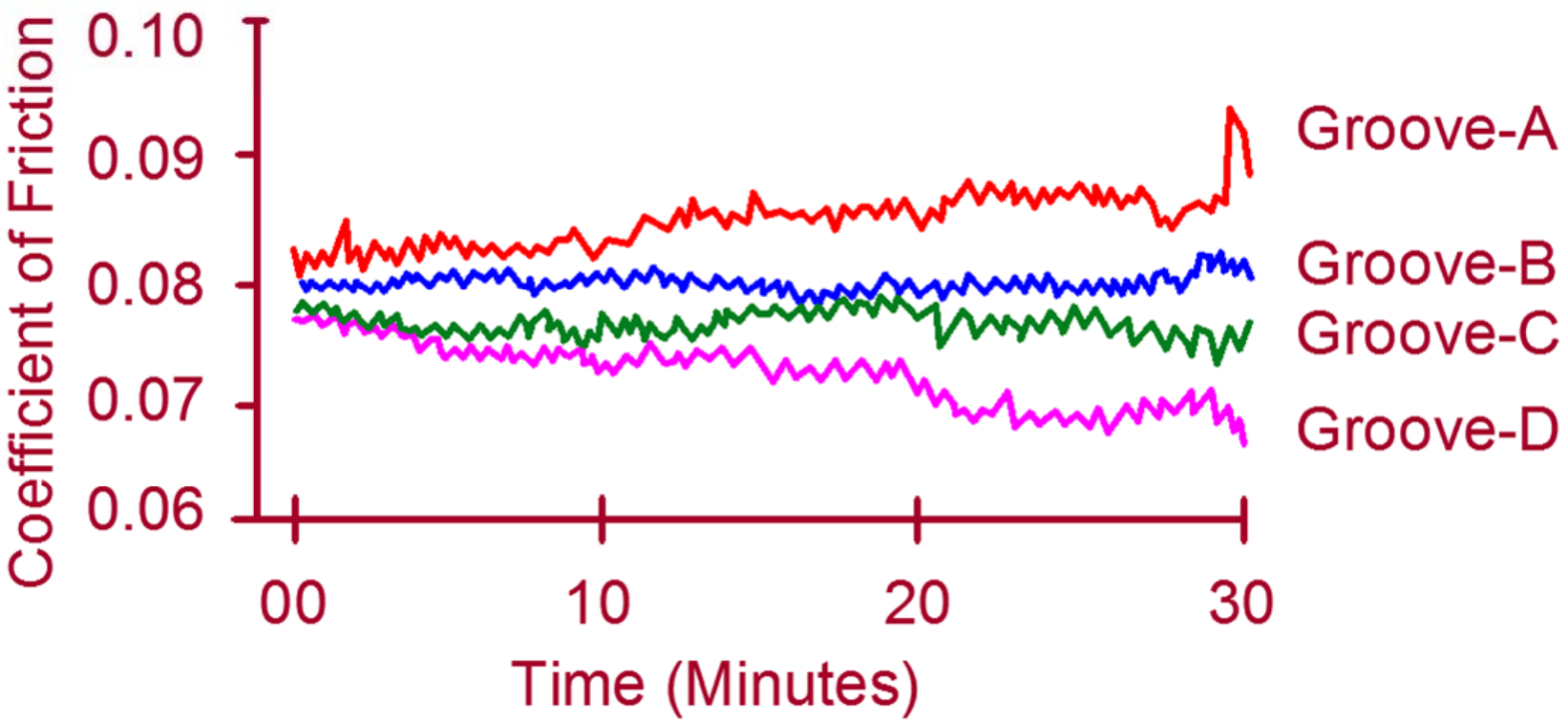


(C): Single Groove



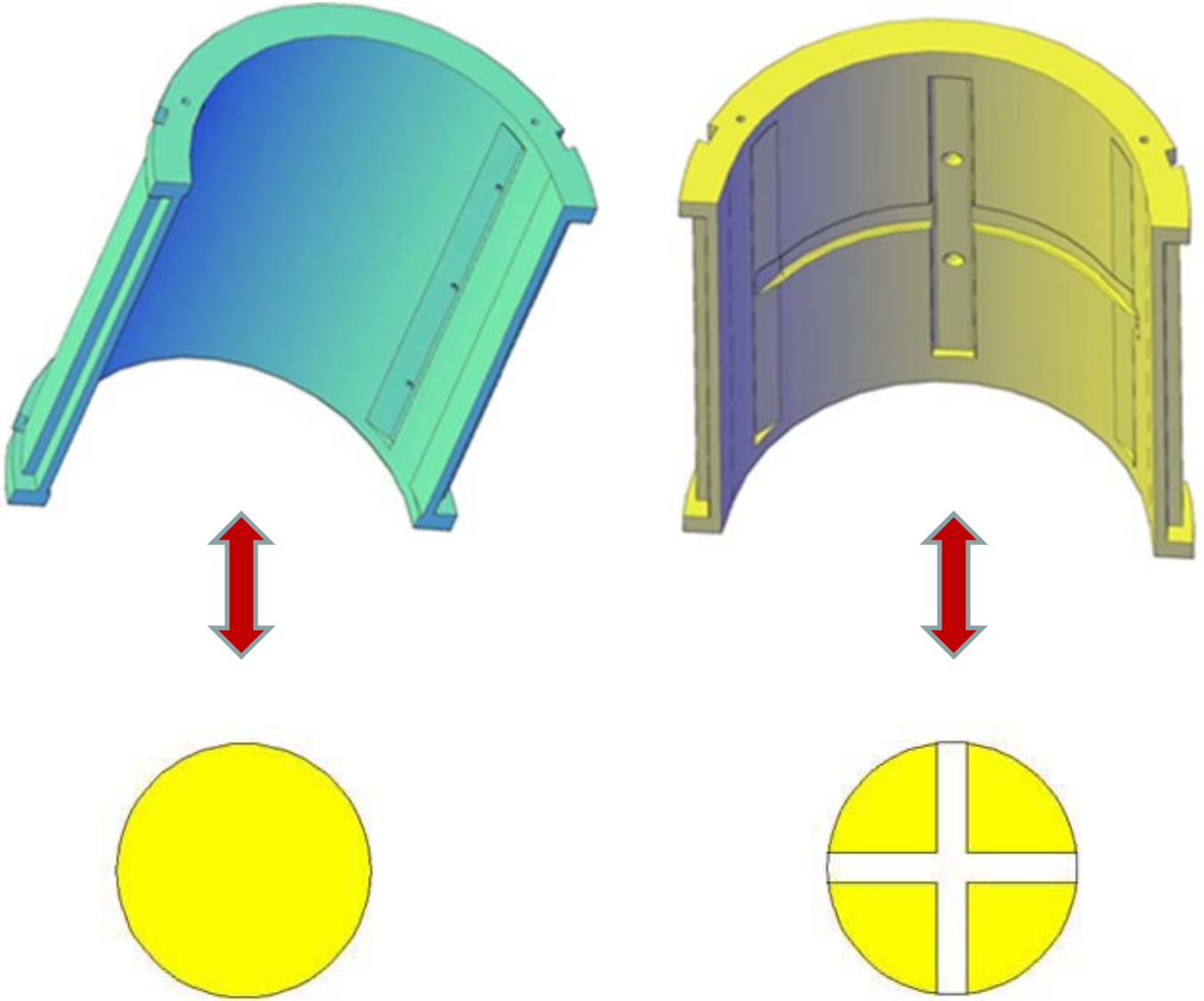
(D): Cross Grooves

Lab Test: Results



Groove Pattern (D) has the lowest coefficient of friction

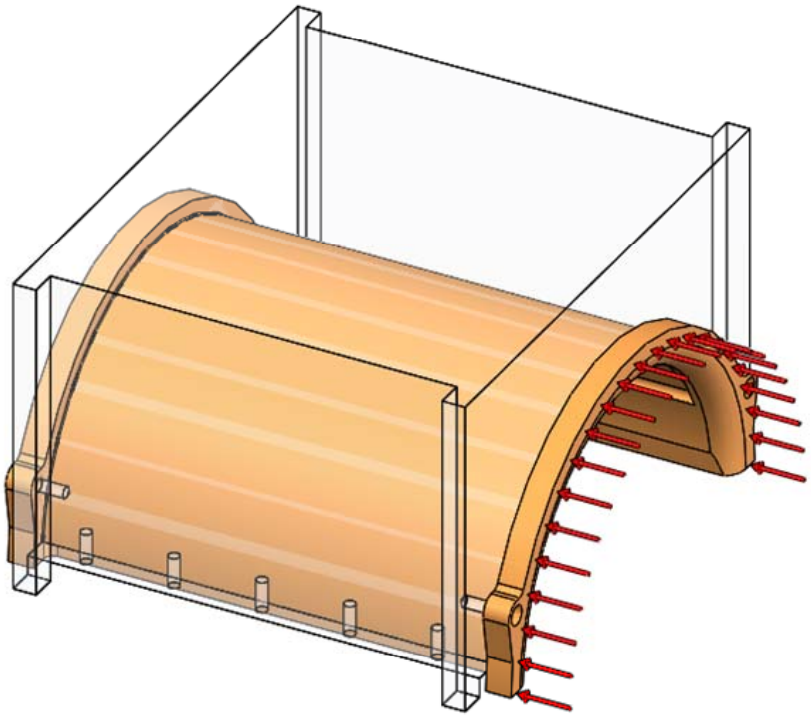
Conventional Vs Adopted Groove

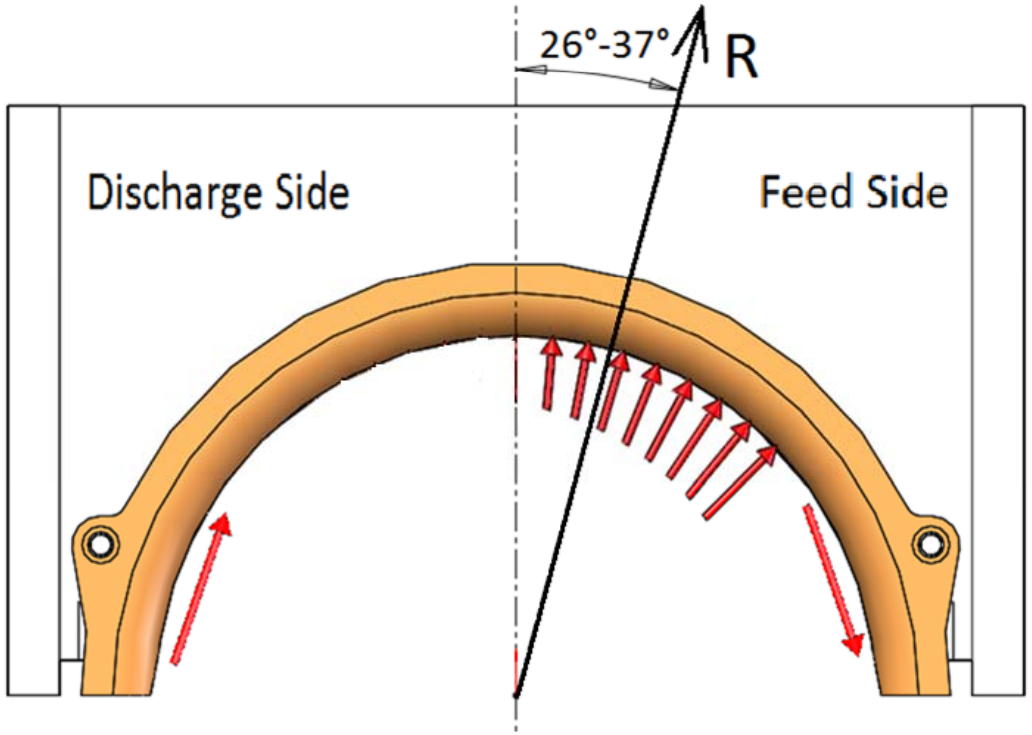


Computations: 40” x 80” Mill

- Verification of Structural Strength of top roll bearing liner of mill with conventional drive
- Thermal computations at interface of roll journal and bearing liner:
  - ✓ Heat Generation and temperature rise
  - ✓ Expansions

Computations: Loads on top bearing



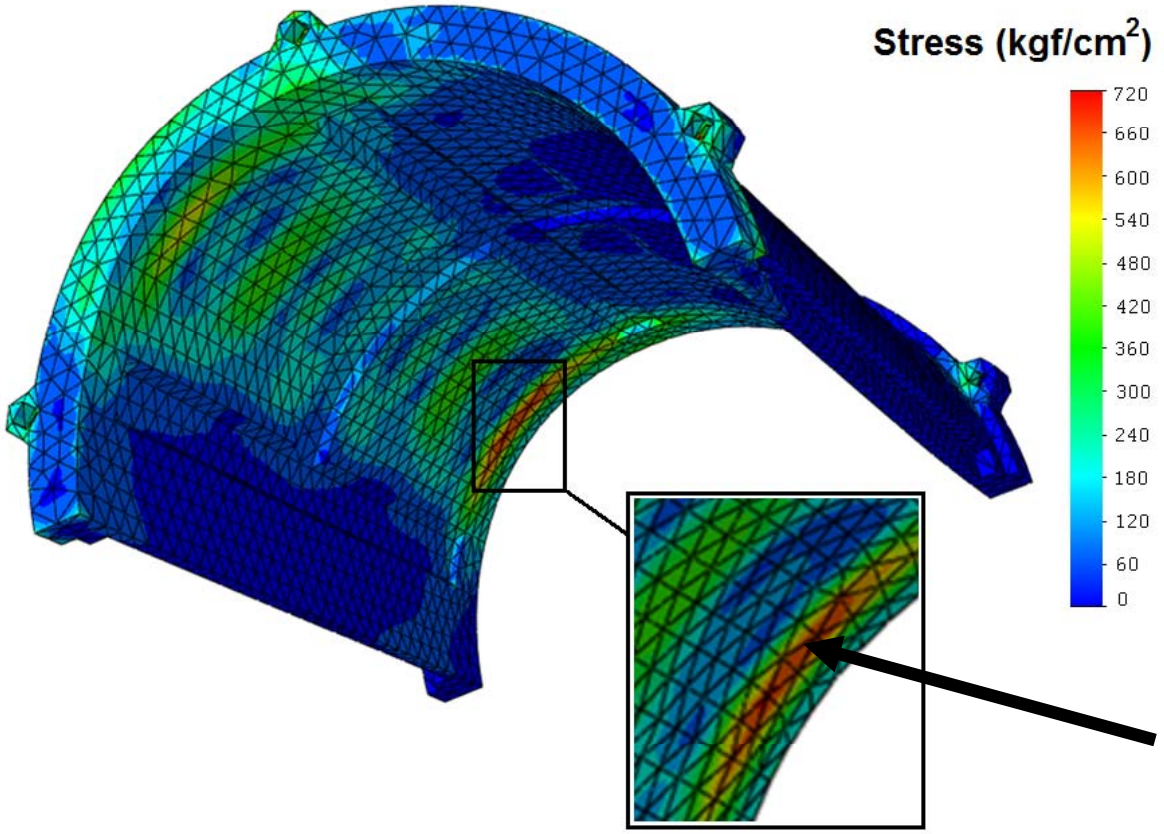


Axial Thrust = 29 tons

Resultant Load, R = 292 tons

Frictional Load = 44 tons

Computations: Stress on top bearing



Max Stress
720 kgf/cm^2

Peak stress levels are away from the grooves

Computations: Thermal Loads

- **Heat generation is directly proportional to:**
  - **Resultant operating radial load on the bearing**
  - **Sliding velocity at shaft and bearing interface**
  - **Coefficient of friction**

Computations: Thermal Loads….

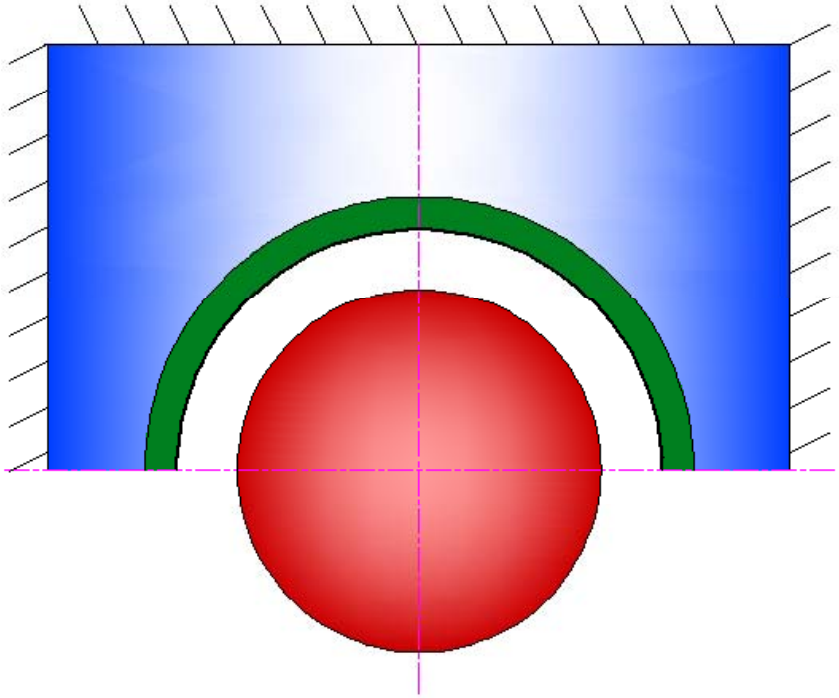
- Computed maximum heat generation based on following worst case scenario:
  - Maximum radial load of 292 tons
  - Maximum sliding velocity of 0.13 m/sec
  - Maximum friction coefficient of 0.15

Bearing Location	Max. Heat Generation kW
Top Roll	47.2
Feed Roll	9.1
Discharge Roll	21.0

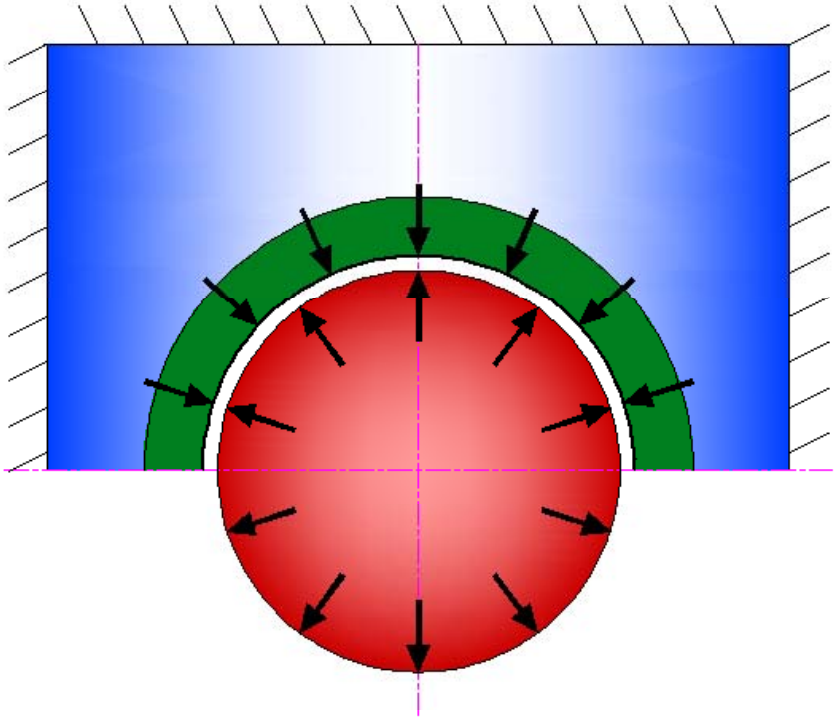
Computations: Thermal Expansions

- **Thermal expansion is function of:**
  - **Thermal conductivities of shaft and liner**
  - **Partition of heat between the shaft and liner**
  - **Coeff of thermal expansion of shaft and liner**
  - **Temp of water for bearing housing cooling**

Computations: Thermal Expansion…



Clearance At
Stand Still Position



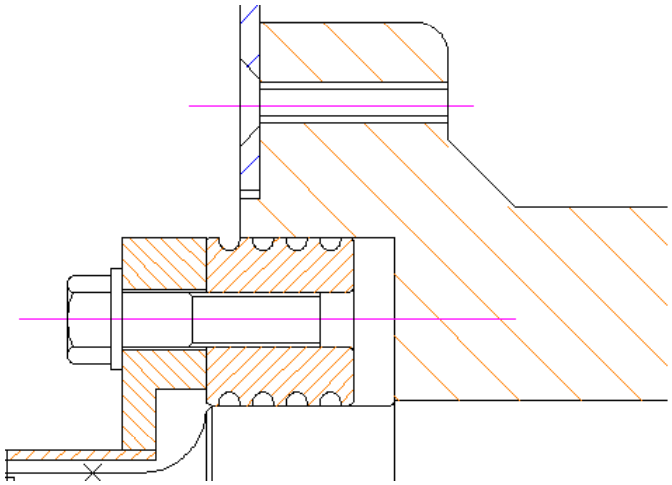
Clearance At
Working Position

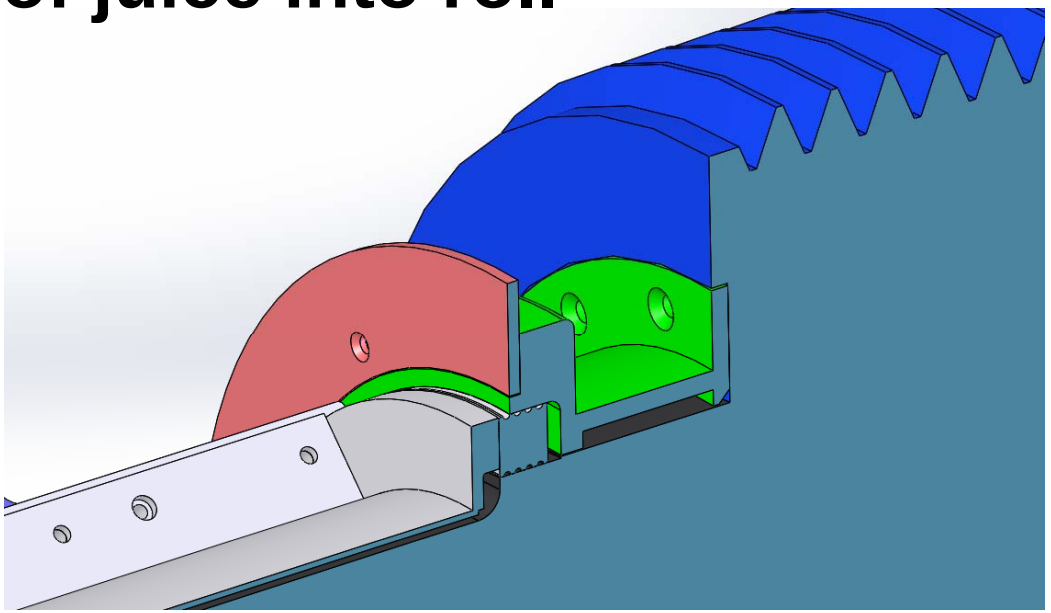
Total thermal expansion at interface (max): 1.1 mm

Innovative Sealing Arrangements

➢ Labyrinth Sealing arrangement for Bottom Rolls

- ✓ **Prevent ingress of juice into roll**

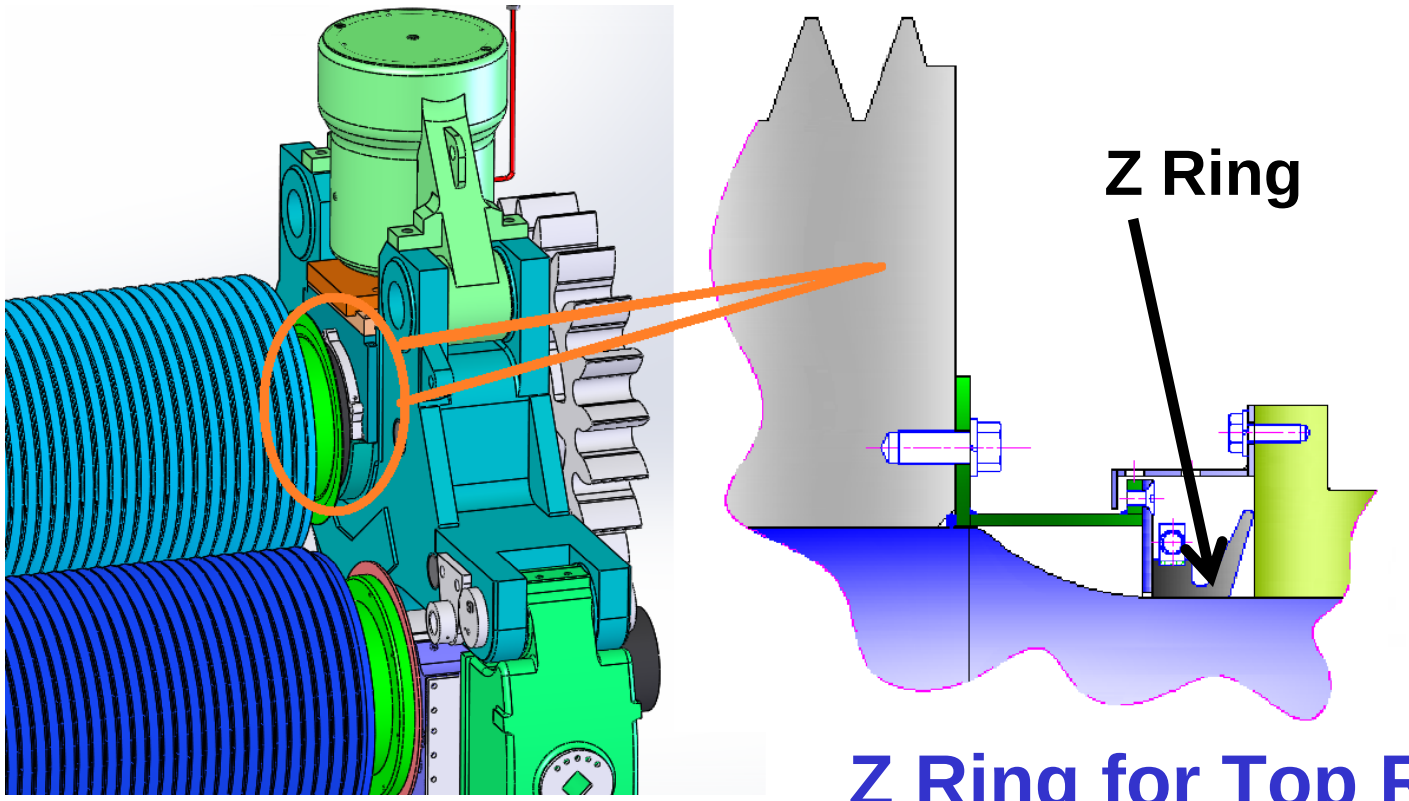




➢ Limitations

- ❑ **Applicable for bottom rolls only**

Innovative Sealing Arrangements.....



Z Ring for Top Roll

- **Limitations**
  - Rubbing action due to top roll float tears off the seal edges : requires frequent replacement

Final Recipe of Modified Bearing

- Cross pattern adopted for lubricating grooves
- Diametrical clearance increased to 1.1 mm
- Journal hardness increased to 230 BHN
- Innovative sealing solutions incorporated

Field results of modified bearings

Substantial reduction in wear rate of bearing liner.

Modified Bearing after two crops

Field results of modified bearings…

Modified Bearing after three crops

Thank You
Gracias
Obrigado

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