



# **FAILURE ANALYSIS OF SLEWING GEAR BOX AND BELT DRIVE DRUM ASSEMBLY OF SPREADER 116 AT NLCIL**



*Submitted by*

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# ABSTRACT

- Neyveli Lignite Corporation India Limited (NLCIL) is a leading public sector undertaking owned by a government of India.
- In NLCIL mines, open cast mining technology is adopted in which numbers of specialized mining equipment's (SME) are used. Spreader plays a vital role in mining.
- Upon analysis a major problem has been raised from Spreader's slewing gear box, then the common failure is produced by the belt drive drum assembly's shaft due to shearing.
- Here all failures occurring in slewing gear box and belt drive drum assembly is studied and analyzed based on FMEA & FEA analysis.

# INTRODUCTION

- NLC India Ltd (NLCIL) formerly, Neyveli Lignite Corporation Limited, a Navaratna enterprise of Government of India (GOI).
- It is a public-sector enterprise engaged in mining of lignite and generation of power through lignite based thermal power plants.
- The Neyveli Mine IA lignite mine is an opencast mine, operated by Neyveli Lignite Corporation (NLC) India Limited, with a capacity of 3 million tons per year, and located near the town of Neyveli in Cuddalore district in Tamil Nadu, India.
- The mine IA has proposed expansion to 4 million tons per annum.
- The mine supplies the 600-megawatt (MW) Neyveli Thermal Power Station and the 420MW Thermal Power Station I Expansion.

# SME - SPREADER

- Spreaders (specialized mining equipment) used in surface mining and mechanical engineering/civil engineering.
- The primary function of a spreader is to act as a continuous spreading machine in large-scale open pit mining operations.
- Bucket-wheel excavators, BWEs, are used for continuous overburden removal in surface mining applications.
- The overburden is then delivered to the discharge boom, which transfers the cut earth to another machine for transfer it to the central collection area where the material will be sorted. Then the remains of the overburden will be transported to the spreader which then scatters the overburden at the dumping ground.

# VIEW OF SPREDER

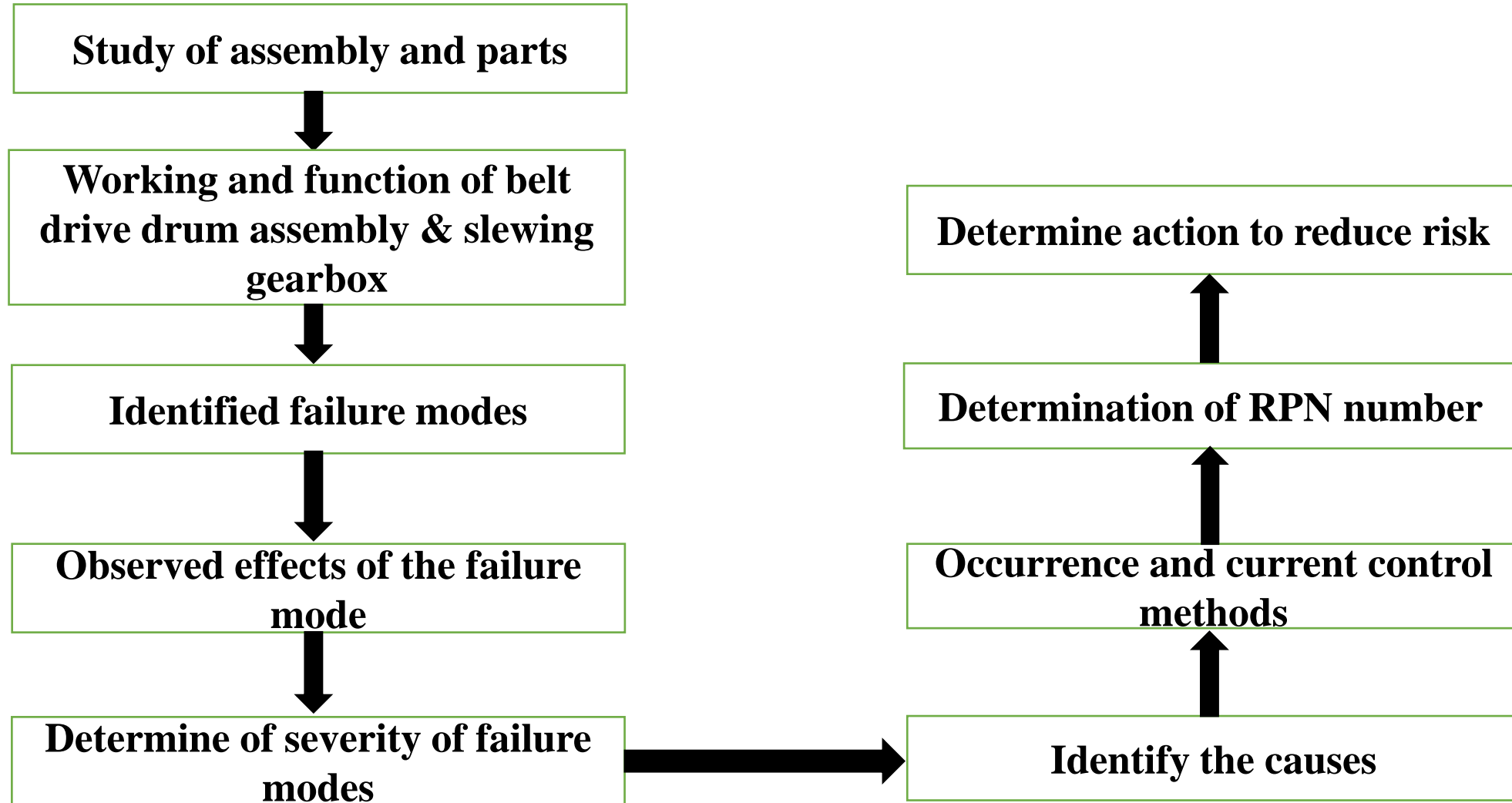


# OBJECTIVES

Our project mainly entangles two objectives.

- To perform a failure analysis in a particular shaft. This shaft is the main component, used for rotating the drum of conveyor belt in the spreader. It has been recorded that the shaft is failing for every 1-2 month. Varying impact load on belt is bringing failure to shaft.
- To prevent the failure of slewing gearbox due to loosening of bolts which results in oil leakage.

# WORKING METHODOLOGY





# PARTS ANALYSED

**SLEWING GEAR BOX**



**BELT DRIVE DRUM ASSEMBLY**





# WORKING OF BELT DRIVE DRUM ASSEMBLY

- The belt drum assembly is used to move the conveyor belt in the spreader.
- There are two types of drum in spreader.
  - A) Driver
  - B) Driven
- From the belt drive gearbox the power is transmitted to the drum by shaft. The rotating drum results in the linear motion of the conveyor belt which help the sand to fill the area.

# WORKING OF SLEWING GEAR BOX

- Slewing gearbox is used to slew the discharge boom of the spreader.
- It rotates up to 180 degrees.
- The slew gearbox having sun pinion and planetary gears arrangement to reduce the initial input speed.
- The slew gearbox is powered by using electrical motor.

# FAILURE DATA

SI. NO	DATE	UNIT NO	FAILRE DATA OF BELT DRIVE DRUM ASSEMBLY
1.	13-11-2017	A/232	Shaft got cut near coupling.
2.	24-11-2017	A/552	Shaft got cut in-between shaft taper Step bearing assembly.
3.	02-12-2017	A/552	Shaft got cut at bearing seating.
4.	14-08-2018	A/552	Shaft got cut near coupling.
5.	15-09-2018	A/552	Shaft got cut near coupling.
6.	19-03-2019	A/200	Shaft got cut in-between shaft taper Step bearing assembly.
7.	07-11-2019	A/650	Shaft got cut in-between shaft taper Step bearing assembly.
8.	16-11-2019	A/650	Shaft got cut near coupling.
9.	27-01-2020	A/271	Shaft got cut in-between shaft taper Step bearing assembly.
10.	11-04-2020	A/271	Shaft got cut near coupling.

SI. NO	DATE	UNIT NO	FAILURE DATA OF SLEWING GEAR BOX
1.	11-05-2020	U/485	Bolts got loosen results in oil leak
2.	21-10-2019	U/485	Bolts got loosen results in oil leak
3.	12-10-2019	A/200	Bolts got loosen results in oil leak
4.	08-10-2019	A/200	Bolts got loosen results in oil leak
5.	28-05-2019	A/135	Bolts got loosen results in oil leak
6.	19-03-2019	A/200	Bolts got loosen results in oil leak
7.	25-02-2019	A/200	Bolts got loosen results in oil leak
8.	24-02-2019	A/200	Bolts got loosen results in oil leak
9.	24-02-2019	A/140	Bolts got loosen results in oil leak
10.	14-02-2019	A/140	Bolts got loosen results in oil leak

# **PROBLEM IDENTIFICATION**

## **MAJOR CAUSES FOR FAILURE IN BELT DRIVE DRUM ASSEMBLY:**

- Shaft got cut near coupling.
- Shaft got cut in-between shaft taper step bearing assembly.
- Shaft got cut at bearing seating.

## **MAJOR CAUSES FOR FAILURE IN SLEWING GEAR BOX:**

- The torque is transmitted to the bolts which causes shear.
- The shear results in loosening of bolts, which causes opening of bolts resulting in oil leak.

# RISK PRIORITY NUMBER

## RPN FOR SHAFT:

The Risk Priority Number, or RPN, is a numeric assessment of risk assigned to a process, or steps in a process, as part of Failure Modes and Effects Analysis (FMEA)

$$\begin{aligned}\text{RPN number of the shaft} &= S \times O \times D \\ &= 7 \times 7 \times 7 \\ &= 343\end{aligned}$$

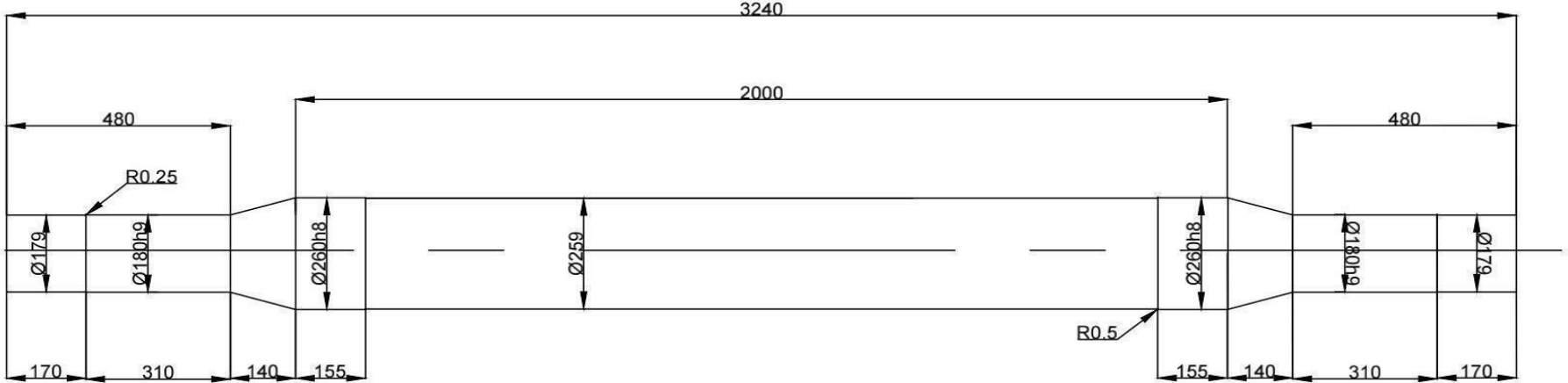
## RPN FOR SLEWING GEAR BOX HOUSING:

$$\begin{aligned}\text{RPN number of the oil leakage due to bolts} &= S \times O \times D \\ &= 6 \times 7 \times 7 \\ &= 294\end{aligned}$$

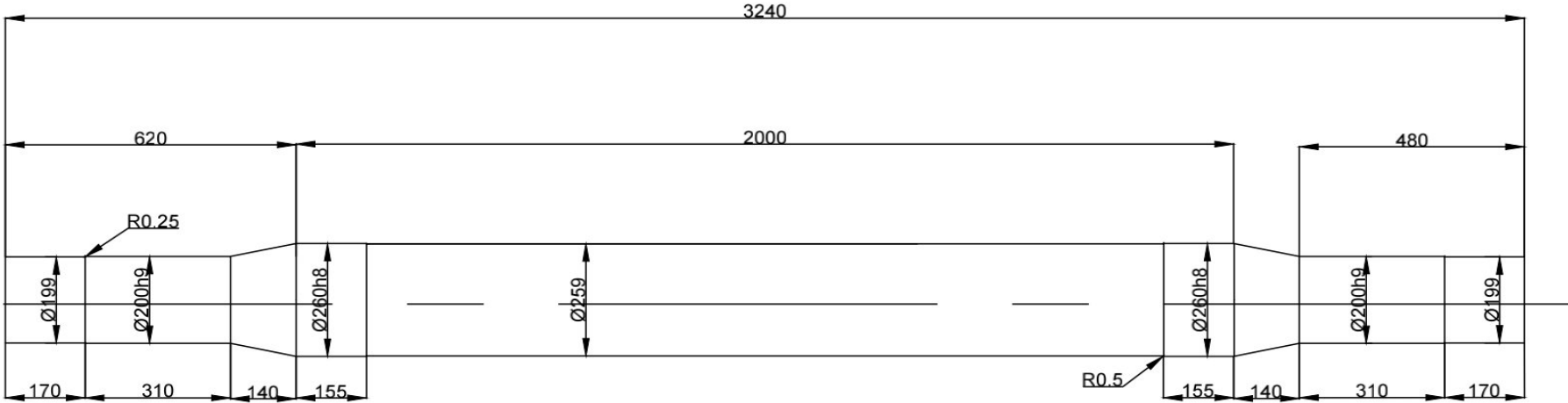
# **SUGGESTIONS FOR BELT DRIVE DRUM ASSEMBLY**

- The bearing withstands the load and no bearing failure reported and the dynamic load of bearing found matching.
- Shaft re modification work with the given load was undertaken.
- Shaft size for existing mode is found to be 180 mm.
- Taking into consideration the shaft failure increase in the factor of safety was suggested.
- When the factor of safety increased the shaft size got increased to 200 mm.
- Without changing the 260 diameter step increase the diameter of 180mm diameter to 200 mm diameter.

EXISTING SHAFT



MODIFIED SHAFT





# SELECTION OF BEARING

- The bearing used in the belt drive drum assembly of spreader is spherical roller bearing.
- For shaft of existing model the bearing used is 23140 CCK/W33 and bearing sleeve is found to be H3140.
- As per the SKF/FAG bearing catalogue the bearing number found to be 23144 CCK/W33 of shaft 200 mm.
- Bearing sleeve found to be H3148.

# **SOFTWARES USED**

## **FOR MODELING:**

- ✓ SOLIDWORKS 2020
- ✓ CATIA V5 2018

## **FOR ANALYSIS:**

- ✓ ANSYS 2018 R1

# **ANALYSIS PERFORMED**

- Stress analysis
- Deformation analysis
- Modal analysis

# STRESS IN EXISTING MODEL OF SHAFT

**B: Static Structural**

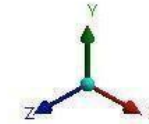
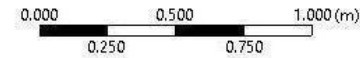
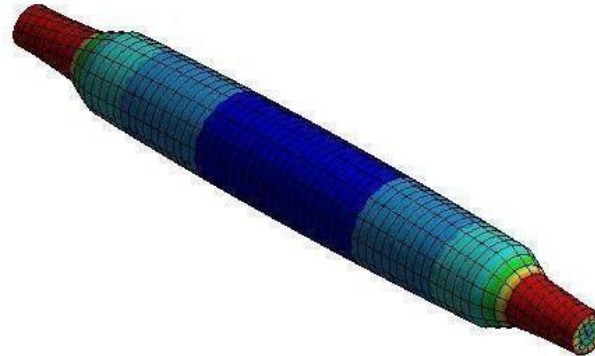
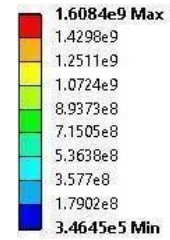
Equivalent Stress

Type: Equivalent (von-Mises) Stress

Unit: Pa

Time: 1

08-Apr-22 2:50 PM



# STRESS IN MODIFIED MODEL OF SHAFT

**A: 200 shaft**

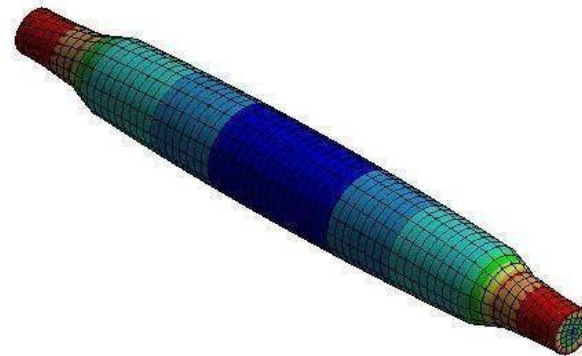
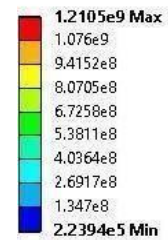
Equivalent Stress

Type: Equivalent (von-Mises) Stress

Unit: Pa

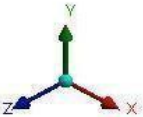
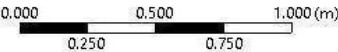
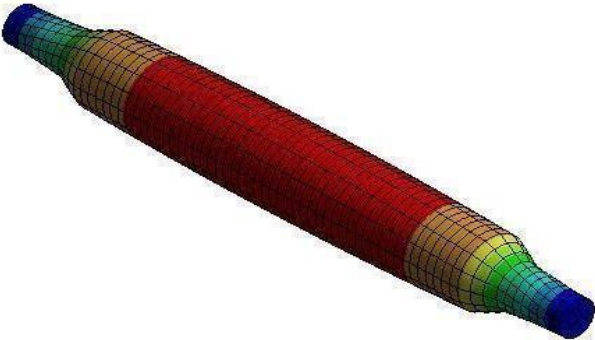
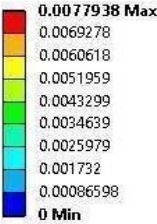
Time: 1

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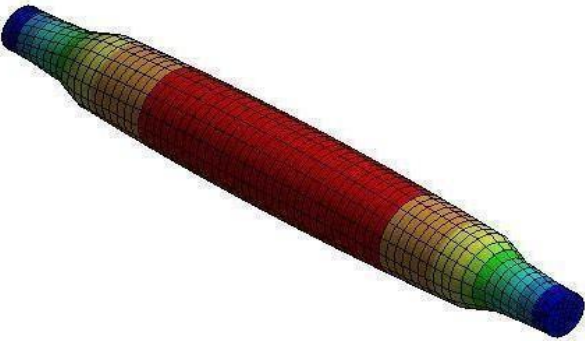
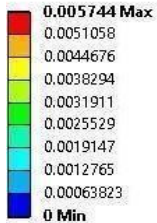
# DEFORMATION IN EXISTING MODEL

B: Static Structural  
Total Deformation  
Type: Total Deformation  
Unit: m  
Time: 1  
08-Apr-22 2:50 PM



# DEFORMATION IN MODIFIED MODEL

A: Static Structural  
Total Deformation  
Type: Total Deformation  
Unit: m  
Time: 1  
08-Apr-22 2:51 PM



# SUGGESTIONS FOR SLEWING GEAR BOX

- Torque arresting/transmitting ring plates (2 nos) with key be introduced to the in between mounting mother plate and the gearbox fixing joint.
- The joint between ring plates (900 mm diameter) and its preceding joint to be drilled for additional fixing holes and dowel holes.

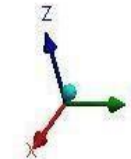
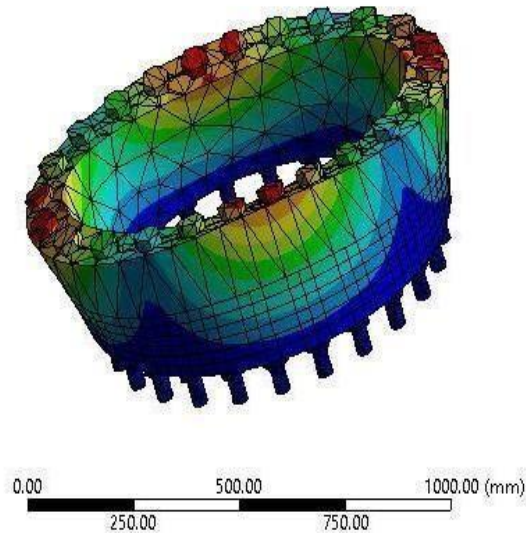
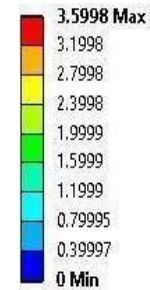
Additional fixing holes 6 nos × M20 size

Additional dowel holes 6 nos - Ø20 & dowel pins

# MODAL ANALYSIS OF EXISTING MODEL

## A: Modal

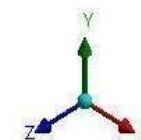
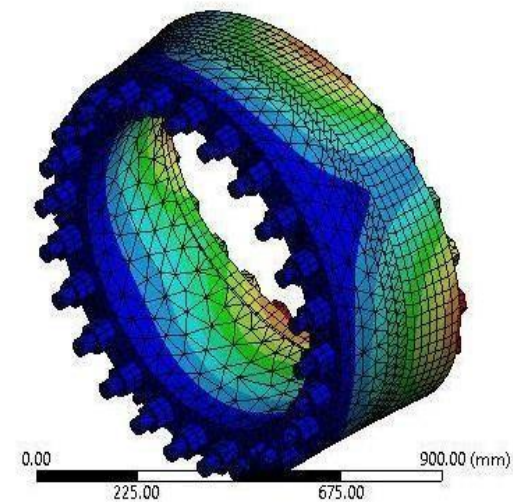
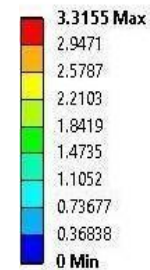
Total Deformation  
Type: Total Deformation  
Frequency: 1520.4 Hz  
Unit: mm  
06-May-22 3:29 PM



# MODAL ANALYSIS OF MODIFIED MODEL

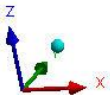
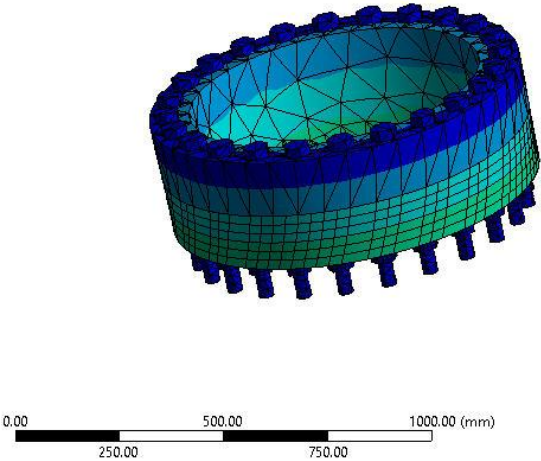
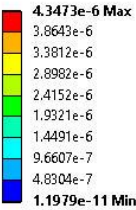
## A: Modal

Total Deformation  
Type: Total Deformation  
Frequency: 1296.9 Hz  
Unit: mm  
06-May-22 1:17 PM



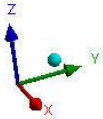
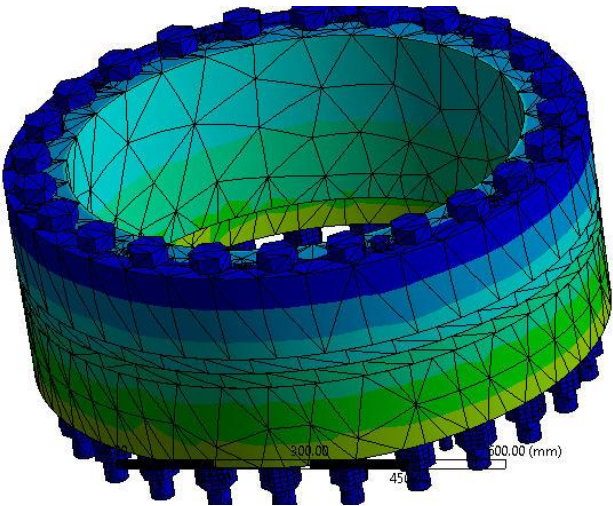
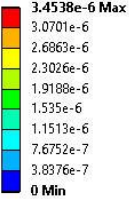
# STRESS IN EXISTING MODEL

A: Static Structural  
Equivalent Stress  
Type: Equivalent (von-Mises) Stress  
Unit: MPa  
Time: 1  
12-May-22 4:11 PM



# STRESS IN MODIFIED MODEL

A: Static Structural  
Equivalent Stress  
Type: Equivalent (von-Mises) Stress  
Unit: MPa  
Time: 1  
12-May-22 12:19 PM





# FEA RESULTS

## FEA RESULTS FOR SHAFT:

DESCRIPTION	EXISTING MODEL	MODIFIED MODEL	PERCENTAGE DECREASE
Stress(N/m <sup>2</sup> )	1.43e <sup>9</sup>	1.08e <sup>9</sup>	24.5%
Deformation(m)	0.0077	0.0057	25.97%

## FEA RESULTS FOR SLEWING GEAR BOX HOUSING:

DESCRIPTION	EXISTING MODEL	MODIFIED MODEL	PERCENTAGE DECREASE
Stress(MPa)	4.34e <sup>-6</sup>	3.45e <sup>-6</sup>	20.5%
Strain	2.19e <sup>-8</sup>	1.52e <sup>-8</sup>	30.5%

The operating frequency is found to be 16 Hz which is very much smaller than the modified frequency which has a frequency of 1296 Hz

# COST ANALYSIS

Existing shaft and modified shaft manufacturing cost expected to be remains same or with marginal difference is obtained from NLCIL executives.

THE BEARING COST FOR 23140 CCK/W33 = 38940 Rs

THE BEARING COST FOR 23144 CCK/W33 = 52815.17 Rs

The new Plummer block cost is same as the previous Plummer block (data given by department).

Output coupling manufacturing cost may remain the same/or with marginal increase by considering the increase in bearing and Plummer block purchase value the cost involved is RS 13875.17/-

# CONCLUSION

- The shaft cut was a major cause for the failure of belt drum assembly. The diameter of the shaft at both ends has been increased from 180mm to 200mm.
- From the FEA analysis, it is found that the internal stress in the suggested model is 25% less than in the existing model.
- The failure of the slewing gearbox was oil leakage due to shearing of the bolts. To overcome this problem, the torque arresting/transmitting ring plates (2 no's) with keys are introduced.
- The joint between ring plates for the diameter of 900mm and its preceding joint had to be drilled for additional fixing bolts M20 and Additional dowelpins diameter 20mm.
- From that, the loosening of bolts due to shear will get arrested. Hence, there is no leakage of oil into the slewing gearbox of the spreader.

# REFERENCES

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**THANK YOU.**