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Increase the Life of Bend Pulley Lagging of HL-3 Conveyor using TQM

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Abstract - *This study focuses on increasing the life of bend pulley lagging in Hearth Layer (HL)-3 conveyors, a crucial component that provides traction and grip to the conveyor belt. Wear and tear of bend pulley lagging can lead to reduced conveyor belt life, increased maintenance costs, and production downtime. The study proposes a novel approach to increase the life of bend pulley lagging using a combination of high-performance materials and optimized design. The investigation involves testing various materials and design configurations for the bend pulley lagging, including rubber, ceramic, materials and different thicknesses and patterns. In this study, the principles of quality circle & total quality management(TQM) is used for better results.*

Key Words: **(Bend pulley lagging, conveyor belt, increased life, quality circle, total quality management)**

1. INTRODUCTION

JSW Steel is an Indian steel company that belongs to the JSW Group. The company was founded in 1982 and has its headquarters in Mumbai, India. It is one of the leading integrated steel manufacturers in India with a capacity of 18 million tons per annum. JSW Steel operates several manufacturing plants in India, including its flagship plant in Vijayanagar, Karnataka. The Vijayanagar plant is one of the largest single location steel plants in the world with a capacity of 12 MTPA. It is a fully integrated plant that includes iron ore beneficiation, coke ovens, blast furnaces, steel making, and downstream facilities. JSW Steel also operates a plant in Salem, Tamil Nadu, with a capacity of 1 MTPA, which produces cold rolled steel and galvanized steel products. The company's Dolvi plant in Maharashtra has a capacity of 5 MTPA and produces hot rolled and cold rolled steel products.

JSW Steel has a strong focus on innovation and sustainability. The company has invested in state-of-the-art technology to reduce its carbon footprint and improve energy efficiency. In addition, it has implemented several initiatives to promote environmental sustainability, including water conservation and waste management programs.

2. PROBLEM STATEMENT

The introduction of a cleat belt into the material handling process of a conveyor system has resulted in a wear and tear issue with the pulley lagging. This is due to the cleat pattern on the belt causing damage to the pulley lagging, which is crucial for the conveyor system's proper functioning. To avoid potential complications, it is important to investigate potential solutions to mitigate the problem and ensure the conveyor system runs smoothly.

❖ Problem Statement:- Low life of bend pulley lagging of HL-3 conveyor.

❖ Impact:- Cost

❖ Objective:- To enhance the life of Bend Pulley lagging by finding the root cause & also optimizing the cost.

❖ Goal:- To increase the life of pulley lagging from 2 months to 12 months .

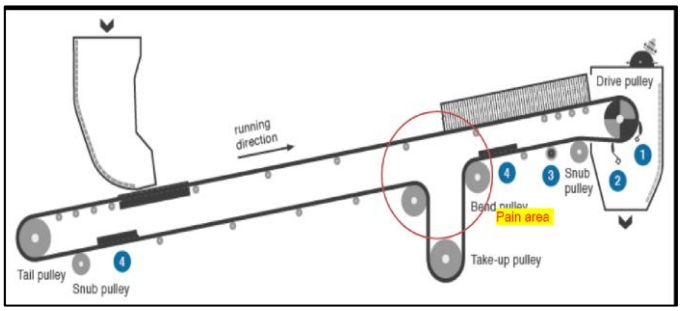

Fig.1: General arrangement of HL-3 Conveyor

Specifications of the HL Conveyor -

Materials Handled - Iron Pellets

Capacity - 600 TPH

Belt Length - 541 meters

Belt Width - 800 mm

Inclination - 11 degrees

Type of Take-Up unit - VGTU

No. of Pulleys - 08

Table -1: HL-3 Conveyor Vertical Take Up Gravity Unit

Sr.No	Belt Type Installed
1.	HR GRADE,800 MM WIDTH,6/3 800/4 NORMAL BELT
2.	HR GRADE,800 MM WIDTH,6/3 800/4. CLEAT TYPE

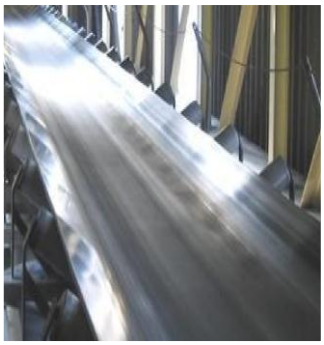

Fig. 2: Normal Type

Fig. 3: Cleat Type

Fig -4: Wear & Tear of Bend Pulley Lagging

3. ANALYSIS OF THE PROBLEM

3.1 Diagram

Fig.5: Diamond Grooved Rubber Lagging

3.2 Low Life of Bend Pulley

The idler pulley comes into contact with the cleat on the belt, causing it to wear out frequently. Specifically, the idler pulley needs to be replaced 12 times per year on average due to this contact.

3.3 Total Costing

Total annual cost of pulley lagging is-

Cost of diamond groove lagging

(20 mm thk)/sq. mtr = ₹ 8,500/-

Cost of pulley lagging

(dia. in mtr * face width in mtr * 3.14 * rate) (I) = (8,500*0.4*0.95*3.14) ₹ 5,071/-

Lagging damaged/year = 12

Manpower cost (II) = 700*6*0.6 = ₹ 2,520/-

Total cost of repair/year = (5,071+2,520)*12

(I+II)*12 = ₹ 91,092/-

4. IDENTIFICATION OF THE CAUSES

4.1 List of causes

Table -2 : List of causes

Sr.No	CAUSES
1.	Lagging process for cleat belt type not followed
2.	Pulley RPM is high causing wear
3.	Lagging sheet thickness not as suitable for cleat type of belt
4.	Poor Maintenance practices
5.	Poor Job supervision
6.	Poor lagging sheet Quality
7.	Faulty pulley design
8.	Design fault of take-up unit

4.2 Fishbone Diagram

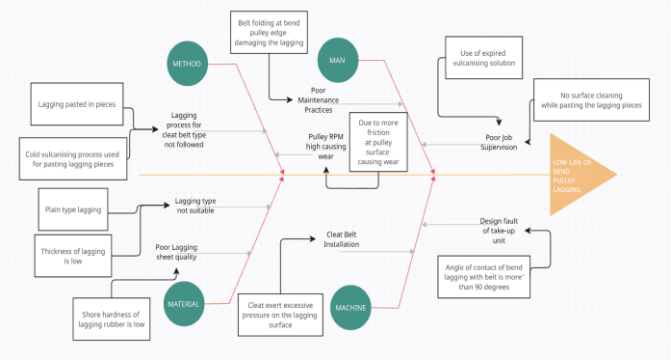

Fig.6: Fish Bone/ Ishikawa Diagram

4.3 Root Causes Analysis

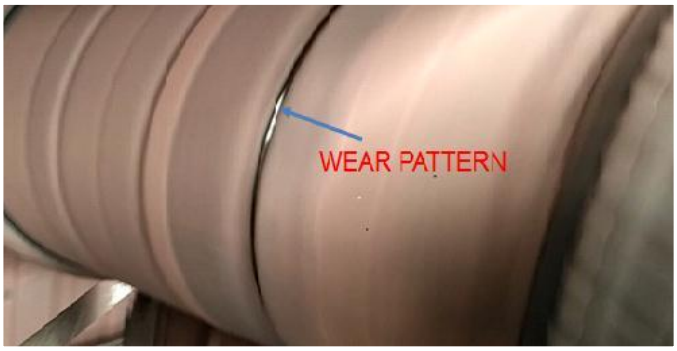

Fig.7: Wear pattern of lagging

From the FishBone diagram we found some finite causes & their root causes and from them we found one valid root cause by using the method of GEMBA visit : The pressure exerted by cleats on the lagging surface causes the lagging on the bend pulley to have a shorter lifespan.

5. DATA ANALYSIS

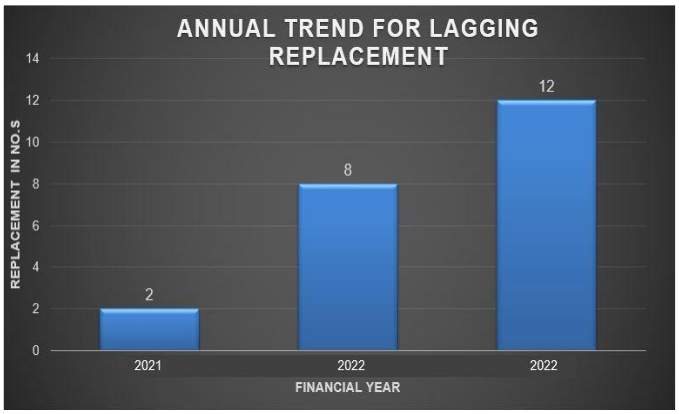

Fig.8: Annual trend report for lagging replacement

Table 3: Pressure calculation

Type of belting	Ar. of contact (Sq. mt)	Resultant force on pulley surface (KN)	Pressure on pulley surface (KN/ Sq. mt)
For normal belt type	0.80*0.2 = 0.16	X	X/0.16
For cleat belt type	0.11*0.2 = 0.022	X	X/0.022

From the above table it is clear that pressure on pulley surface due to cleat is approx. 7 times greater than in case of normal belt.

6. DEVELOPMENT OF THE SOLUTION

6.1 Replacing the current pulley by Diamond grooved type pulley

Table 4:

CRITERIA FOR SELECTION OF SOLUTION		
1.	Title of Solution 1	Replacing the current pulley by Diamond groove type pulley
2.	Estimated cost for implementation	₹ 12,4000/-
3.	Feasibility	Yes
4.	Implementation period	6-7 hrs.
5.	Advantages	The cleat surface doesn't touch the pulley shell, so there's no damage to the lagging or shell.
6.	Dis-advantages	The cost of implementation is relatively expensive, and there's a 4-5 month lead time for the procurement and delivery of the necessary materials to the site
7.	User friendly	Yes

Remarks : This solution was REJECTED.

Fig.9: Diamond Groove Pulley

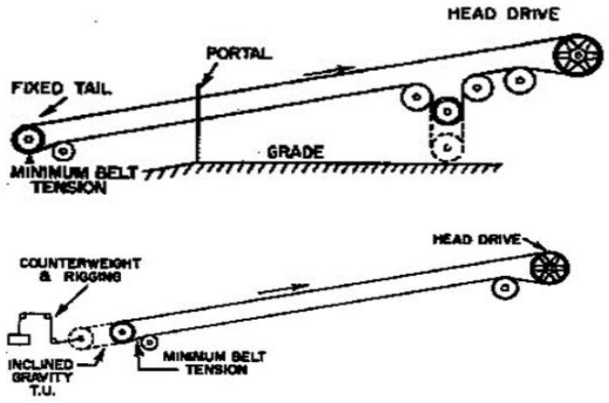

Fig.10: Conversion of VGTU to HGTU

6.2 Convert the vertical take up unit (VGTU) to a horizontal take up unit (HGTU)

Table 5:

CRITERIA FOR SELECTION OF SOLUTION		
1.	Title of Solution 2	Convert the vertical take up unit (VGTU) to a horizontal take up unit (HGTU)
2.	Estimated cost for implementation	₹ 32,0000/-
3.	Feasibility	Yes
4.	Implementation period	16 hrs. when HGTU is ready
5.	Advantages	From the conveyor system the bend pulley will get eliminated
6.	Dis-advantages	Due to increased load on the tail pulley, there may be a need to replace it based on the size of the shaft and drum. However, the cost of implementation is significant
7.	User friendly	Yes

Remarks : This solution was also REJECTED.

6.3 Replacement of Diamond grooved rubber lagging with Ceramic lagging

Table 6:

CRITERIA FOR SELECTION OF SOLUTION		
1.	Title of Solution 3	Replacement of diamond grooved rubber lagging with ceramic lagging
2.	Estimated cost for implementation	₹ 40,000/-
3.	Feasibility	Yes
4.	Implementation period	5-6 hrs.
5.	Advantages	Cleat surface does not come in contact with pulley shell and hence no damage of lagging/shell
6.	Dis-advantages	NIL
7.	User friendly	Yes

Remarks : This solution was also REJECTED.

Fig. 11 : Replacing by ceramic lagging

6.4 Additional lagging pieces of 200 mm width of 20 mm thk at edges over lagged pulley (20 mm thk + 10 mm thk)

Table 7:

CRITERIA FOR SELECTION OF SOLUTION		
1.	Title of Solution 4	Additional lagging pieces of 200 mm width of 20 mm thk at edges over lagged pulley(20 mm thk + 10 mm thk)
2.	Estimated cost for implementation	Rs. 9,500/-
3.	Feasibility	Yes
4.	Implementation period	5-6 hrs.
5.	Advantages	Cleat surface does not come in contact with pulley shell and hence no damage of lagging/shell
6.	Dis-advantages	NIL
7.	User friendly	Yes

Remarks : This solution was ACCEPTED.

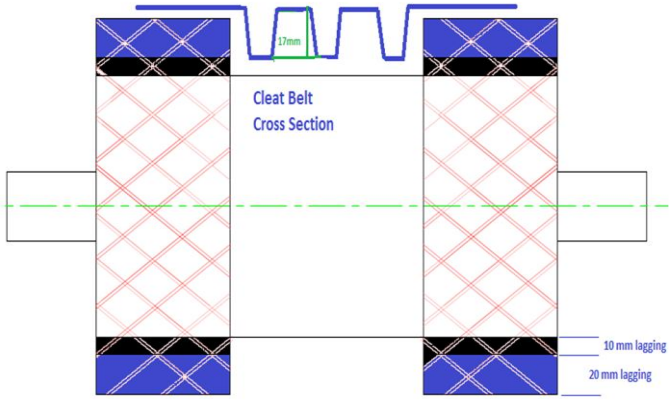

Fig.12: Addition of extra layer of lagging

3. CONCLUSIONS

This study was carried out using Total Quality Management and Quality Circle methodologies to identify and address the root cause of the problem - excessive pressure on the lagging of the bend pulley. The fishbone diagram was used to determine the root cause, which was then confirmed through root cause analysis. After careful consideration of four criteria, a solution was proposed that involved adding additional lagging pieces of 200 mm width at edge of pulley of 10 mm thick + 20 mm thick above 10 mm thick plain lagging on shell surface, which was selected for its cost-effectiveness. This solution, implemented with the principles of total quality management and the support of a quality circle, resulted in a significant increase in the life of the bend pulley lagging from 2 months to 12 months, while also preventing the cleat surface from coming into contact with the pulley shell and reducing the risk of lagging damage. As a result, the maintenance replacement cost of the pulley decreased, the life of pulley lagging was increased & the plant's productivity increased.

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