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Replacement of Pulley Lagging on the Bases of FMEA and Cost.

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Abstract - *Belt conveyor is today's very important mechanism used for raw material transportation in many industries. It consist three roller type belt conveyor system for heavy duty application. Belt conveyor used for iron processing industry whose design capacity is 600 TPH. The paper is to study about to examine the Failure Mode and Effect Analysis (FMEA) in the BEND PULLEY OF BELT CONEVYOR SYSTEM. The measurement used to obtain the objectives of this study include; analyzing and identifying the reasons, root causes of failure, critical cause and modification in design. In this study, the final results conclude after the four solutions, better result is selected on the basis of cost.*

***Key Words*: (FMEA, Bend Pulley, Root Causes, Cost)**

1. INTRODUCTION

JSW Dolvi Works is India's first to adopt a combination of Conarc Technology for both steel-making and compact strip production (CSP), aiding the production of hot rolled coils. From automotive and industrial to consumer durables, Dolvi manufactures products that meet the needs of companies across sectors. The 5 MTPA integrated steel plant at Dolvi is ad-vantageously located on the West coast of Maharashtra. It is connected to a jetty which can handle cargo of up to 15 MTPA. Conveyor belt used has been manufactured by METSO company. Metso provides world leading products and services built on technological excellence, experience and high safety standards. Company is supported by a global network of over 15000 professionals in more than 50 countries. Pulley used has been manufactured by UTTAM GALVA STEELS LTD company. Uttam Galva Steels Ltd is one of the largest manufacturers cold rolled steel (CR) and galvanized steel (GP) in Western India. The company procures hot rolled steel and processes it into CR and further into GP and colour-coated coils. Uttam Galva group also runs two more plants in India:-Uttam Galva Metallics Limited and Uttam Value Steels Limited (previously known as Lloyds Steel Industries Limited) both at Wardha, Maharashtra.

The purpose of the FMEA is to take actions to eliminate or reduce failures, starting with the highest-priority ones. Failure modes and effects analysis also documents current knowledge and actions about the risks of failures, for use in continuous improvement. FMEA is used during design to prevent failures.

2. PROBLEM DEFINITION

Conveyor system consists of flat belt used for material handling process. As per the requirement of the capacity of the material handling, flat belt is replaced by cleat belt. Due to installation of cleat belt, the issue related to bend pulley lagging has been raised. In this, there is wear out of pulley lagging due to cleat pattern on the belt.

- Problem Statement:- low life of bend pulley lagging of HL-3 conveyor.
- Impact:- Cost.
- Objective:- To enhance the life of bend pulley lagging.
- Goal:- To increase life of lagging of pulley.

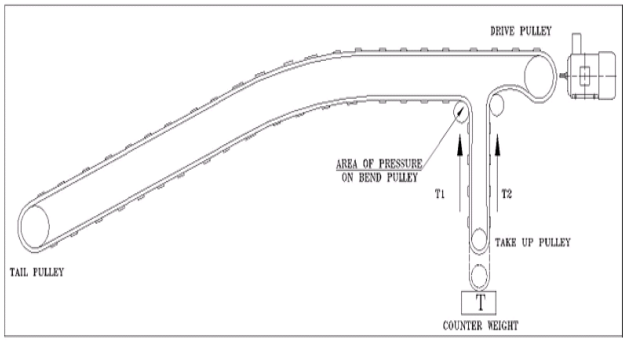

Fig. 1 : Line diagram of conveyor belt system

Type of Belting	Area of contact (Sq. mtr)	Resultant force on pulley surface in (KN	Pressure on pulley surface (KN/Sq. mtr)
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

Table -1:

From the above, Pressure on pulley surface due to cleat is approx. 7 times greater than in case of normal belt

Fig. 2: Wear out of bend pulley lagging

3. Analysis of problem:-

- **Diagram**

Fig. 3: Diamond grooved rubber lagging

- **Low Life of Bend Pulley**

Due to the presence of cleat on the belt, the idler pulley which comes in a contact with cleat, gets worn out. The frequency of worn out of the idler pulley is for 12 times per year.

- **Pie Chart**

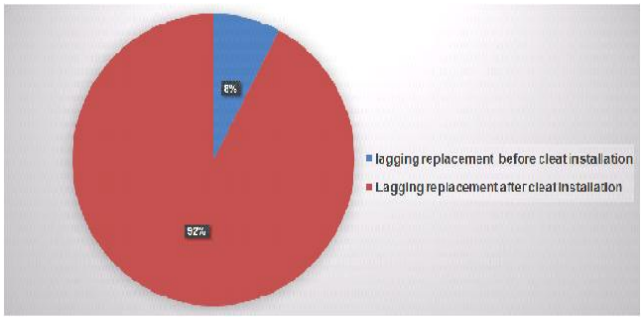

Fig. 4: Lagging wear out of pulley

- **Costing**

Costing of replacement of lagging:-

1. Cost of Pulley = Rs36500/-
   a) 1mm thick./Sq. metre= Rs121.88/-
   b) For 1.5m length and 1mm thick./Sq. metre = Rs425/-
   c) Area of pulley $= \pi DL$=3.14×0.74×1.5 = 3.487m^2
2. Cost of Diamond Groove rubber lagging = (3.487 × 425) = Rs8500/-
3. Cost of idler pulley with Diamond Groove Rubber lagging = Rs45000/-

4. Identification of causes

1. 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

Table -2:

2. Diagram

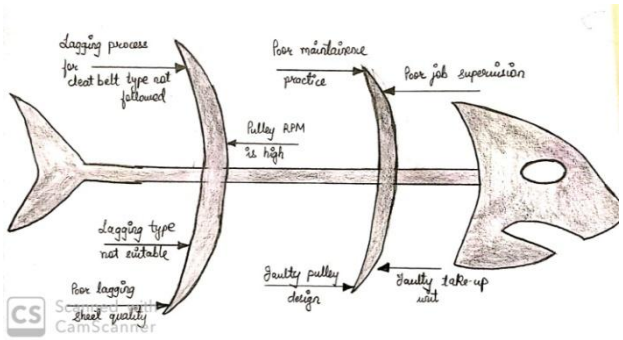

Fig. 5 : Fish bone diagram

3. Chart

Validation of critical causes using FMEA

Failurepart	Failure causes	Severity	Occurrence	Detection	RPN
PULLEYLAGGING	Cold vulcanising process is used for pasting lagging	9	5	5	255
	Thickness o flagging is low	9	5	6	270
	Plain type lagging	8	6	6	288
	Plain type lagging	9	6	5	270
	Cleat exerting excessive pressure on pulley lagging surface	8	5	4	160
	No surface cleaning while pasting lagging sheet on to pulley	9	6	4	216
	Angle of contact of bend pulley with belt is more than 90 degree causing more wear	8	6	5	240
	More friction at pulley surface causing wear	8	6	4	192
	Belt folding at bend pulley shell edge damaging the lagging	8	5	5	200

Table -3:

4. Critical causes

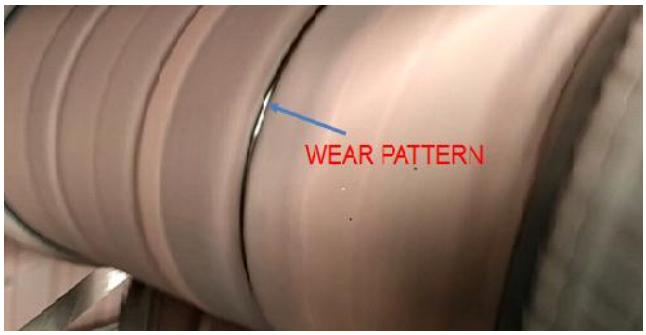

Fig. 6 - Cleats exert excessive pressure on the lagging surface which leads to the low life of lagging of bend pulley

5. Analysis of solution:-

- **Replacement by ceramic lagging instead of diamond groove rubber lagging.**

Fig. 7: TYPES OF LAGGING

Area of pulley = πDL= 3.14×0.74×1.5 = 3.487m^2

1mm /Sq. metre = Rs1147.11/-

10mm/Sq. metre = Rs11471.11/-

Total Cost of ceramic lagging = (Area × 10mm/Sq. metre) = Rs40000/-

Total Cost of Ceramic lagged Pulley = (cost of pulley + cost of ceramic pulley)

= 36500+40000

= Rs76500/-

Advantage:-

a) Ceramic coating used for resistance to excessive wear and tear and more grip.

Disadvantage:-

b) Effects belt life as ceramic acts as abrasive to belt at point of contact and will wear with faster rate.

Remarks:- REJECTED

- **Conversion of vertical take up pulley to horizontal take up pulley.**

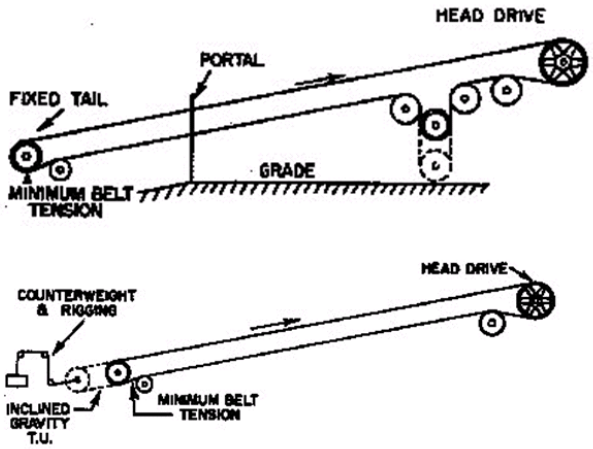

Fig. 8 : ELEMINATE TAKE UP BEND PULLEY

Cost of VGTU Pulley = Rs320000/- (Including Counter weight, rigging and 3-roller)

Advantage:-

a) Bend pulley will get eliminate from conveyor system.

Disadvantage:-

b) Load on tail pulley will increase and may need to be replaced with respect to shaft and drum size.

c) Cost of implementation is very high.

Remarks:-REJECTED

- **Groove type pulley.**

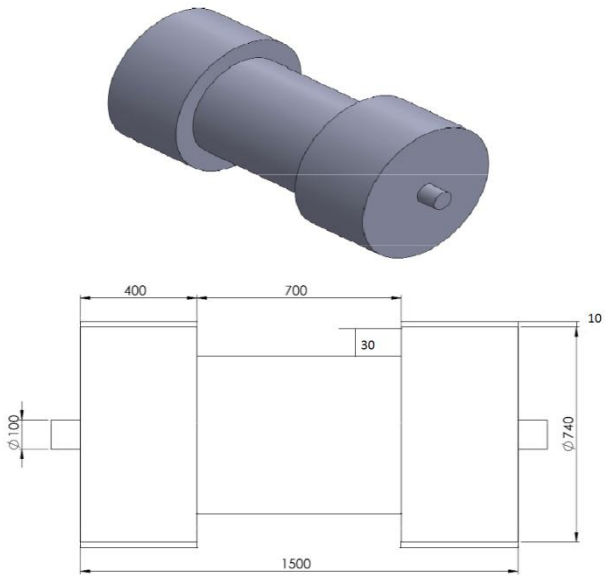

Fig. 9 : PULLEY WITH GROOVE

a) Cost of solid pulley = Rs36500/-

b) Cost of grooving :-

- Area of Groove part = πDL = 3.14×0.06×0.7 = 0.13m^2
- For 1m^2Area = Rs60000/-
- Therefore for 0.13m^2Area = Rs7800/-

c) Cost of Lagging =(Area of lagging ×Cost of 1mm/ Sq.metre lagging x10mm thickness)

=(1.8589×121.88x10)

=Rs2266/-

Total cost = (Cost of solid pulley + cost of grooving for 0.13m^2Area + Cost of Lagging)

= 36500+7800+2266) = Rs46566/-

Advantage:-

a) Cleat surface does not come in contact with pulley shell and hence no damage of lagging/shell.

Disadvantage:-

a) Cost of implementation is relatively high and time for procurement to delivery of material at site is more which is 15 to 20 days.

Remarks:-REJECTED

- **Additional lagging pieces of 400mm width of 20mm thick at edges over lagged pulley**

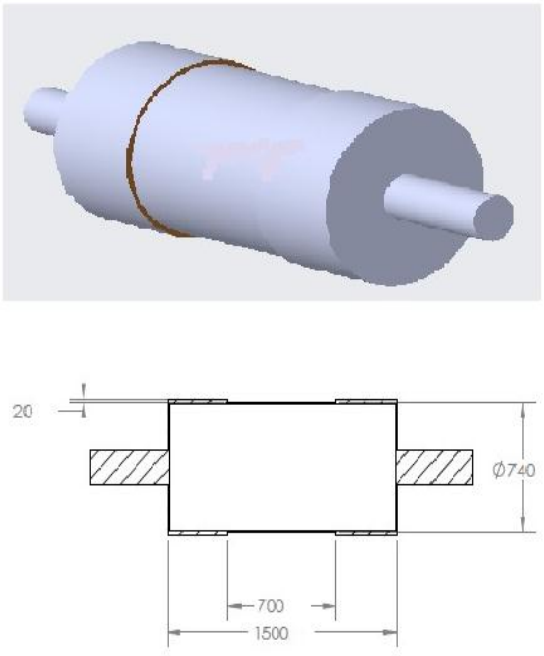

Fig. 10 : ADDITIONAL LAGGING OF 20mm

Area for 1 piece = πDL = 3.14×0.74×0.4 = 0.92944m^2

Area for 2 piece = 1.8589m^2

Cost of lagging:-

- 1mm/Sq. metre = Rs121.88/-
- 400mm Width and 1mm thick = (Area for 2 piece ×1mm/Sq. metre)

  = Rs226.56/-
- For 10mm thick = Rs2265.6/-
- For 20mm thick =Rs4531.2/-

Total Cost of Additional lagged pulley = (cost of the pulley +cost of additional)

= 36500+4531.2

=Rs41031.2/-

Advantage:-

a) Cleat surface does not come in contact with the pulley shell and hence no damaged of lagging/shell.

Remarks:-ACCEPTED

6. CONCLUSION:

The problem is defined on the basis of cost. Analysis of problem is carried out on the basis of previous data of the wear out of lagging of pulley. Fish bone diagram is used to determine the Root cause. The Root cause analysis is done which results into excessive pressure. Root cause analysis is carried out from which we select one confirmed root cause by calculating the RPN(RISK PRIORITY NUMBER). Then critical cause which is cleat exerted excessive pressure on the lagging of bend pulley is selected. In the development of solution part we came across the four criteria, one of the method which is Additional lagging pieces of 400mm width of 20mm thick at edges over lagged pulley is selected based on cost. From this method, we have observed that the life of bend pulley lagging has increased from 2 months to 12 months. The advantage of the solution is that the cleat surface does not come in contact with the pulley shell and hence there will be no damaged of lagging. Thus the life of bend pulley is increased and the maintenance replacement cost of pulley is decrease. Because of this, the productivity of the plant is increased.

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