To Improve Internal RFT by Eliminating Wrapper Fouling with Bumper Issue in MF 9500 Models

Rajesh S, Aravindhana S, Srinivasan V

Abstract: *Right First Time (RFT) is one of the internal business measure to ensure the quality of the product. This project deals with the elimination of wrapper fouling with bumper issue in MF 9500 Models. The wrapper is A class part which is assemble in front of tractors which when getting damage will lead to customer dissatisfaction. The wrapper damage at field results in customer / warranty claims thus increasing the external cost to the company. The wrapper damage issue is due to fouling issue in tractors and that issue is taken up for this study.. Initially PFMEA study conducted for wrapper assembly process. Further based on PFMEA results, a systematic analysis is done through cause and effect diagram to identify the other causes for wrapper damage issue. Since the cause and effect analysis not able to reveal the real root causes. Two models is proposed with modification and performance of the model is studied and compared. It is observed that proposed models are capable of reducing the wrapper damage considerably. It is also noted that modification in the proposed model reduces the operator inspection time and fatigue.*

Keywords : RFT, PFMEA, wrapper fouling, wrapper damage.

I. INTRODUCTION

In TAFE organization we follow Total Productive Maintenance (TPM) . Based on this practice we the team implement all the improvements in the plant. Total productive maintenance (TPM) is a method of maintaining and improving the integrity of production and quality systems through the machines, equipment, employees and the supporting processes. TPM can be of great value and its target is to improve core business processes .The main Objective of TPM is

- Zero Breakdown
- Zero Accident
- Zero Defects
- Zero Waste

A. TPM PILLARS

Total productive maintenance (TPM) consists of 8 pillars.

1. Autonomous Maintenance (JH)

2. Individual Improvement (KK)
3. Planned Maintenance (PM)
4. Development Maintenance (DM)
5. Quality Maintenance (QM)
6. Education and Training (E&T)
7. Safety , Health & Environment (SHE)
8. Office TPM (OTPM)

B. QM PILLAR

This issue deals with Quality Maintenance (QM) Pillar. In QM pillar one of the important methodologies is Figure of 8 approach which helps to solve the problem in 7 steps. Some of the analysis is:

- PM Analysis
- ABCD Approach
- QM matrix

B.1 PM Analysis

P-M analysis is an advanced articulation of TPM. This eight step process has been proven to reduce chronic losses to zero and has raised technological expertise in many manufacturing environments. P-M Analysis is eliminating chronic problems that have been neglected or unresolved in the past. P-M Analysis was specially developed to overcome the weaknesses of traditional methods.

P-M analysis is more than a methodology as it is a different way of thinking about the problem and the context in which ever they occur. P- M Analysis is a systematic Problem-Solving Philosophy for Chronic Losses. The term P-M Analysis comes from the following origin: P – Phenomena (non), Physical; M – Mechanism, Relationship (Machine, Man/Woman, Material, and Method). It is designed to help your TPM teams analyze and eliminate chronic problems that have been neglected or unresolved in the past.

Through P-M Analysis, teams really get in touch with their equipment. Its unique skill-building process improves technological know-how while delivering solutions to persistent problems. The first four steps of this rigorous 8-step program help teams isolate and understand the root causes of defects and failures within main equipment mechanisms and peripheral systems. The final four steps provide a systematic approach for effectively controlling those causes.

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A critical concept in P-M Analysis is physical analysis -- a way of thinking about how defects and failures are generated that forces us to look at the physical principles involved and to quantify the changes in the relationship between the equipment mechanisms and product parts involved. When a proper physical analysis is carried out, teams are far less likely to overlook important factors or to waste time pursuing unrelated ones. Although not a cure-all, P-M Analysis has reduced chronic losses to zero and raised technological expertise in many manufacturing environments.

II. PROBLEM DEFINITION

Right First Time (RFT) trend is attached below. Losses during manufacturing of tractor due to the quality defects is high and affects cost and delivery

$$RFT = \frac{\text{No of Tractors direct OK without defect}}{\text{No of Tractors produced}} \times 100$$

Fig. 1, 2 & 3. With help of Pareto analysis the Wrapper Fouling with Bumper issue is considered as top priority and selected the same.

III. METHODOLOGY

STEP 1 : IDENTIFY EXISTING SITUATION

Fig. 4. Wrapper to bumper gap spec 21 mm, actual 0 mm (After opening)

Fig. 5. Wrapper is Fouling with Bumper leading to damages after Hood swinging for multiple times.

TABLE-I: WRAPPER FRAME

Function unit	Check point	Requirement	Result
Wrapper frame angle	To be within the Spec	90°	90/91°
Bottom hood support bracket angle	To be within the Spec	90°	90°
FES mounting to wrapper mounting distance	To be within the Spec	140.8	140.4/140.6
Wrapper mounting bracket distance	To be within the Spec	37	36.88/37.05
Bottom hood support bracket bending distance	To be within the Spec	17	17.09/17.21
Inner width bottom hood support bracket	To be within the Spec	426	425.8/426.54

TABLE-II: WRAPPER

Function unit	Check point	Requirement	Result
Depth Frame mounting	To be within the Spec	74.6	74.4/74.8
Pitch distance Frame mounting	To be within the Spec	267	267/268
Pitch distance Frame mounting	To be within the Spec	236	236/237
Pitch distance Frame mounting	To be within the Spec	176	175/177
Pitch distance Frame mounting	To be within the Spec	29	29/30

TABLE-III: BUMPER

Function unit	Check point	Requirement	Result
Mounting plate face to front bumper face height	To be within the Spec	5	4.81/6.30
Inner width mounting plate	To be within the Spec	452+2	452/454
Inner width bumper cross stiffener	To be within the Spec	565	566/557
Mounting plate face to mounting hole distance	To be within the Spec	30	30.55/31.16

TABLE-IV: FRONT ENGINE SUPPORT

Function unit	Check point	Requirement	Result
Wrapper stopper angle	To be within the Spec	55°	54°45'/55°32'
Wrapper mounting to machining surface distance	To be within the Spec	25	24.9/25.7
Wrapper mounting to casting surface distance	To be within the Spec	34.2	33/33.6
Sump face to wrapper mounting hole distance	To be within the Spec	507	507.05/507.2

STEP 2 : RESTORE

If all the parts investigation is OK in above step , directly the step 2 is PASS.

STEP 3 : ANALYSE CAUSE

Fig. 6. Before swinging

Gap between wrapper and bumper is 21mm during first swing

Fig. 7. After Swinging- 5 Times

TABLE-V: GAP BETWEEN WRAPPER AND BUMPER IS ONLY 7 MM AND WRAPPER IS DAMAGED

Hood open and close swing	LH	RH	Remarks
1st time	20mm	21mm	OK
2nd time	16mm	15mm	OK
3rd time	12mm	13mm	OK
4th time	10mm	9mm	Wrapper is fouling with bumper
5th time	8mm	7mm	Wrapper is completely damage in fouling area

Fig. 8. Wrapper frame before fitment in tractor

Fig. 9. Wrapper frame after assembly (dismantled from the tractor)

Function unit	Check point	Before Fitment	After assembly- hood swinging
Wrapper frame angle	To be within the Spec 90 Deg	90°	94-97 Deg – Wrapper frame is deformed

Physical analysis using ABCD description - Hand Sketch

(A) Hood Assembly - Swinging

(B) Wrapper Frame

(C) Tensile Strength In Wrapper Frame – 240~400 Mpa

(D) Tensile Load – Acted During Swinging – 340~390 Mpa

TABLE-VI: INVESTIGATION RESULTS AND DEFICIENCIES IDENTIFIED

Contributing conditions	4M correlations (primary)	4M correlations(Secondary)
1. RM Strength , Welding Strength	1-1 .Wrapper Frame mechanical Properties	1.1.1 RM - Not matching to the specification
		1.1.2 Less Thickness of weld Channels
		1.1.3 Welding Size , thickness less
		1.1.4 Wrapper Design – Not withstanding Impact during swinging
2. Hood Swinging Angle/ Distance	2.1 More swinging angle / distance creates excess load	2.1.1 Wrapper stopper angle variation
		2.1.2 Excess Swinging angle- Design
		2.1.3 Less Clearance between Wrapper & Bumper after swinging - Design

Location check	Items to be checked	Measurement method	Tolerances	Measured value	Remarks
1-1 .Wrapper Frame mechanical Properties	1.1.1 RM - Not matching to the specification	RM Testing	Spec to IS1079- Grade D 240-400 MPA	295 MPA	OK
	1.1.2 Less Thickness of weld Channels	Vernier	3±0.2mm	3mm	OK
	1.1.3 Welding Size , thickness less	Metallurgy	3mm – Weld size Spec CPS303	3.5mm , as per spec CPS303	OK
	1.1.4 Wrapper Design – Not withstanding Impact during swinging	FEA	-	340-390 MPA	Not OK
2.1 More swinging angle / distance creates excess load	2.1.1 Wrapper stopper angle variation	Height Gauge	90 Deg	90 Deg	OK
	2.1.2 Excess Swinging angle- Design	Bevel Protractor	55Deg	55Deg	OK
	2.1.3 Less Clearance between Wrapper & Bumper after swinging - Design	Vernier	20 mm	20mm	OK

Contributing conditions	4M correlations (primary)	4M correlations(Secondary)
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Design Study – Impact Load

$$\text{Impact Load} = \frac{1}{2} M \cdot V^2 \text{ or } M \cdot G \cdot H$$

Fig. 10, 11. Impact Load Observed from 340- 390 MPA & Leads to Deformation upto 9.95mm

Channel Strength as per IS1079 – Grade D – 240-400 MPA. Peak Load observed in Side channel area leading to bending.

Fig. 12. Design Study – Swinging Study

Design gap between bumper and wrapper Hood opening angle 55° clearance between bumper and wrapper is 20 mm @ nominal

STEP : 4 ERADICATE CAUSES

Proposal -1

Fig. 13. Welding stiffener provision in Load acting area Impact Stress reduces but still deformation observed upto 5mm.

Trial Not Ok

Proposal -2 Swinging Angle – Modification

Present - Proposed

Fig. 14. Wrapper frame stopper plate angle 90° to 85°

Fig. 15. Fitment Taken and still wrapper frame bent observed after swinging 10 Times

Factory and Farm Equipment Ltd			Material Operations	
Fitment Test Report			Ref No: 2016-17/Case 8 / 87	
Change of description:	ASSY WRAPPER FRAME Bent test		Date : 21.06.17	
Purpose of change:	To address Blown and Blist defects in the ASSY WRAPPER FRAME			
Change initiated through:	1). BOM ☒ 2). Connected process at vendor end for Q.I ☐			
Detail of Addition Part:				
Serial No.	Part No.	Part Name	Vendor (if relevant)	BOM Ref. Type (if any)
1	1523A1910180	ASSY WRAPPER FRAME	MRP	
Fitment test details at assembly:				
S No	Parameter	Remarks	Status	
1	Visual	Visual inspection	OK	
2	Assembly	Assembly test	OK	
3	Wrapper Frame with	Before stroke above 80 mm gap	OK	
4	Wrapper Frame with	After 10 stroke 70 mm gap	OK	
5	Wrapper Frame with	After 20 stroke 60 mm gap	OK	
6	Wrapper Frame with	After 30 stroke 50 mm gap	OK	
7	Wrapper Frame with	After 40 stroke 40 mm gap	OK	
8	Wrapper Frame with	After 50 stroke 30 mm gap	OK	
Extra note added in Remarks				
Before stroke				
After stroke				

Fig. 16. Fitment Feedback found ok

Proposal -3

As a Proposal adding the tubular section as shown in image. Which will reduce the Wrapper twist. Also It will help to enhance the New hood lock Systems.

Tensile Strength- 450 MPA.

IS 4923 : 1997

Table 1 Dimensions and Properties of Square Hollow Sections
(Clause 8.1 and Note in Annex A)

Designation	Depth or Width D	Thickness	Weight	Area of Section	Moment of Inertia	Radius of Gyration	Elastic Modulus	Plastic Modulus
mm (1)	mm (2)	mm (3)	kg/m (4)	cm ² (5)	cm ⁴ (6)	cm (7)	cm ³ (8)	cm ³ (9)
25.0 x 25.0 x 2.6	25.0	2.6	1.69	2.16	1.72	0.89	1.38	1.76
30.0 x 30.0 x 2.6	30.0	2.6	2.10	2.68	3.23	1.10	2.15	2.68
30.0 x 30.0 x 3.2	30.0	3.2	2.49	3.17	3.62	1.07	2.41	3.08
30.0 x 30.0 x 4.0	30.0	4.0	2.94	3.75	3.97	1.03	2.64	3.50
32.0 x 32.0 x 2.6	32.0	2.6	2.26	2.88	4.02	1.18	2.51	3.11
32.0 x 32.0 x 3.2	32.0	3.2	2.69	3.42	4.54	1.15	2.84	3.59
32.0 x 32.0 x 4.0	32.0	4.0	3.10	4.07	5.05	1.11	3.14	4.11

STEP : 5 ESTABLISH CONDITIONS

TABLE-VII: REVISED QM MATRIX

Process	Parameter	Specification	Component dimension	Torque	Compliance
1-1. Wrapper Frame mechanical Properties	1.1.1 RM - Not matching to the specification	IS4923-Grade 25*25 450 MPA	⊕	⊗	⊕
	1.1.2 Less Thickness of weld Channels	3±0.2mm	⊕	⊗	⊕
	1.1.3 Welding Size, thickness less	3mm – Weld size Spec CPS303	⊕	⊗	⊕
	1.1.4 Wrapper Design – Not withstanding Impact during swinging	-	⊕	⊗	⊕
2.1 More swinging angle / distance creates excess load	2.1.1 Wrapper stopper angle variation	90 Deg	⊕	⊗	⊕
	2.1.2 Excess Swinging angle- Design	55Deg	⊕	⊗	⊕
	2.1.3 Less Clearance between Wrapper & Bumper after swinging - Design	20 mm	⊕	⊗	⊕

STEP : 6 IMPROVE CONDITIONS

Cost Impact- Calculation

Part No: 1523A93501

Part Name: Wrapper Frame

Cost Impact: 72 Rs/ Wrapper Frame

Wrapper Cost: 1642/ Piece

Avg Rejections: 16 nos month,

Rejection Cost: Rs 26272

Avg Prod Volume: 60nos /

Month (748 model)

Cost Increase due to Improvement: $72 \times 60 = 4320$

Cost Saving: (Direct) 21952/Month

STEP : 7 MAINTAIN CONDITIONS

Perform Checks (Horizontal Deployment)

S.No	What	When	Who	How	Remarks
1	Wrapper Frame – Tubular Design standardized across all models	Dec'18	R&D	Updating of dimension in drawing, through ECN drawing regularization process	Comp

IV. RESULT

STEP : 7 MAINTAIN CONDITIONS

Fig. 17. Maintain Conditions

V. CONCLUSION

Proposed Models are capable increasing the first pass yield from 83% to 89 %. It is also noted that warranty cost due to wrapper damage is significantly reduced and rework for the proposed model capable of reducing the cost by Rs 22000 per month. The proposed model is also capable of reducing the sick effect considerably. The maximum delivery time for the existing model is 3 and proposed model is capable of delivering the items within one day. Aesthetic model of the proposed reduces the inspector fatigue and avoids the wrapper damage.

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