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Connector Crack Analysis Elimination Of Crack In Connector Manufacturing Process

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ABSTRACT:LGB is a one of the leading automotive machined components and sub assemblies manufacturer in South India. They manufactures Fuel injection pump components for major OEM & Tier1 Industries, The engineers do the design and maintain the tooling utilized in the manufacturing lines.

In this company Raw material Bar are cut with cutting machine and machining in the CNC turn mill centre with three stages. After that, parts are Heat treated and vibro cleaned and black coated and cleaned with ultrasonic machine and send to customer.

They have some problems in production in their connector production line some of the parts having surface crack in connector neck surface area, due to this they doing 100% of crack detection (MPI) both in process and final inspection, due to this their productivity affected and not able to meet the customer target quantities .To solve this issues we analysis the each process and which process and what parameters create the crack in connector neck area

OBJECTIVIES:

The main objective is to study the connector manufacturing process and identify the factors and parameters to create the crack in the connector neck area and solve the issues in systematic problem solving approach and produce the crack free parts..

I. INTRODUCTION

The Automotive industry is one of the key sectors of the Indian economy. In an attempt to promote market growth, the Ministry of Finance had announced a cut in the corporate tax rate in 2019. This revision in corporate taxes is anticipated to attract FDI in the country's manufacturing sector, which is expected to help the automotive industry marginally. Furthermore, Government initiatives like Make in India and Automotive Mission Plan 2026 have boosted the Indian automotive sector. The Automotive Mission Plan 2026 is a collective vision of India's automotive industry and the government that aims to make the Indian automotive industry the driving factor of the Make in India initiative. So we need to produce defect free product to our customer, Also if its any dimensional defects can be easily identified by customer incoming line and assembly line , But surface and internal part cracks not able to identify with normal instruments . so we need to take the precaution to avoid this kind of issues in the parts with effective process design and manufacturing methods.

II.LITERATURE REVIEW

- Edward Igelegbai (2015) et al., investigated mechanical properties and microstructure of brass alloys. He stated that, increases of zinc in brass leads to improve hardness, yield strength, tensile strength and ductility of brass alloy.
- Prabhakar Purushothaman (2014) et al., discussed hertz contact theory validation. He concluded that, the stress value changes with contact area. If higher the contact area the stress generated will be reduced.

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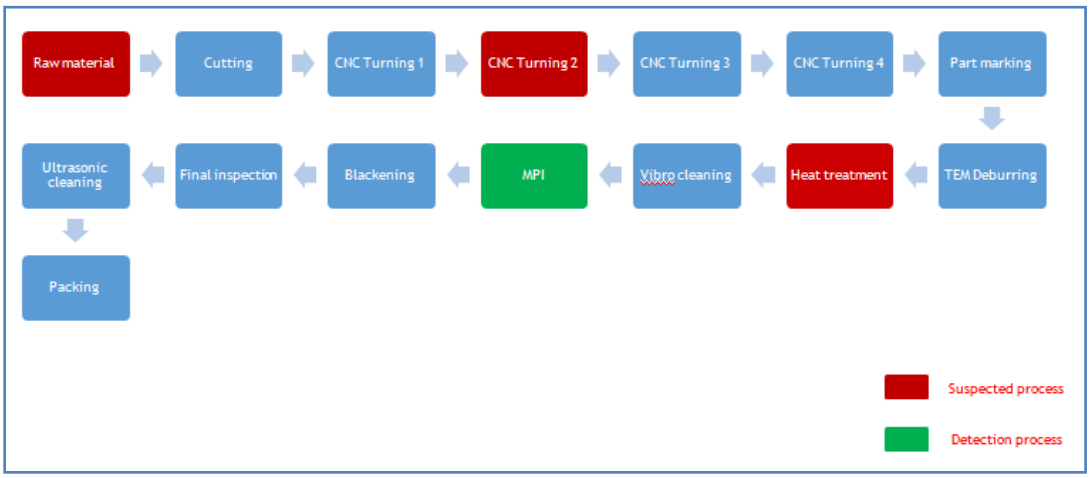
III.CONNECTOR PROCESS FLOW:



IV.EXPLANATION FOR POTENTIAL CAUSE OF CRACK

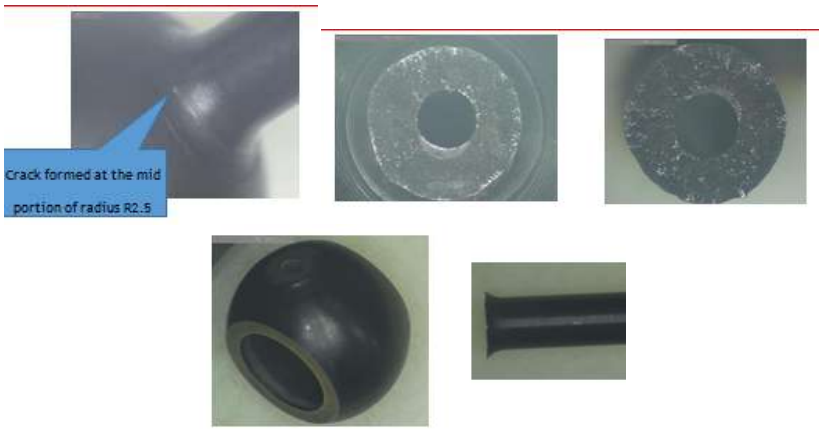
1. Raw Material :
- Presence of pin holes, porous and fold / lap
- Uncontrolled non-metallic inclusions

2. CNC Machining :
- Stress induced in weak area when turning operation

3. Heat Treatment :
- High Austenising temperature
- Selection of quenching medium
- Delay in tempering
- Improper quenching

V.DEFECT PART ANALYSIS

Defect part analysed both dimensionally and visually found below observations,



VISUAL INSPECTION OBSERVATIONS:

- Crack formed at the mid portion of radius R2.
- No other damages observed
- Blackening happened the cracked area, hence crack was generated before blackening operation

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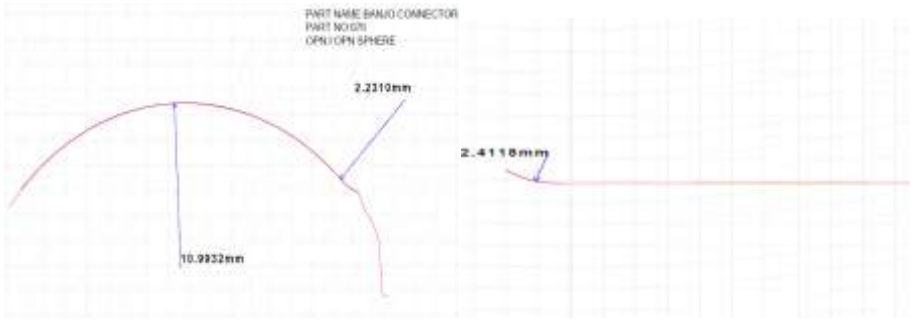
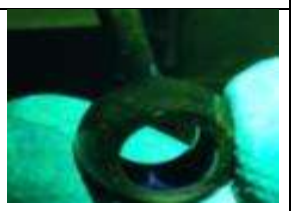
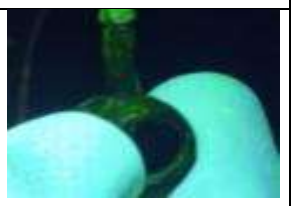
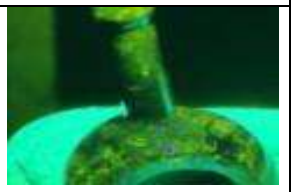
VI.DIMENSIONAL INSPECTION OBSERVATIONS



- No dimensional deviation found
- Profile formation and roughness are found normal

VII.CNC MACHINING SIMULATION TRAILS OBSERVATIONS

Trial #	Current method	Simulation method	No. of sample used	Result	Visualisation
T1	Part is clamped in soft jaws, the effective Jaws clamping length 15mm in CNC 2nd operation	Lesser Clamping area in Jaws (Jaws length 9.5mm)	10 nos	No Crack found in MPI test (in soft stage and HT stage)	
T2	Turning with coolant in CNC 2nd operation	Dry Cut (Without Coolant)	10 nos	No Crack found in MPI test (in soft stage and HT stage)	
T3	Merging of ø22 spear and R2.5 at 3.25mm height from the part center in CNC 2nd operation	Merging of ø22 spear and R2.5 at 4.15 mm height from the part center in CNC 2nd operation	10 nos	No Crack found in MPI test (in soft stage and HT stage)	
T4	Feed rate for OD Roughing 0.25mm/rev in CNC 2nd operation	Increased 20% Additional Feed (Feed rate – 0.3) manually with use of feed rate knob	10 nos	No Crack found in MPI test (in soft stage and HT stage)	

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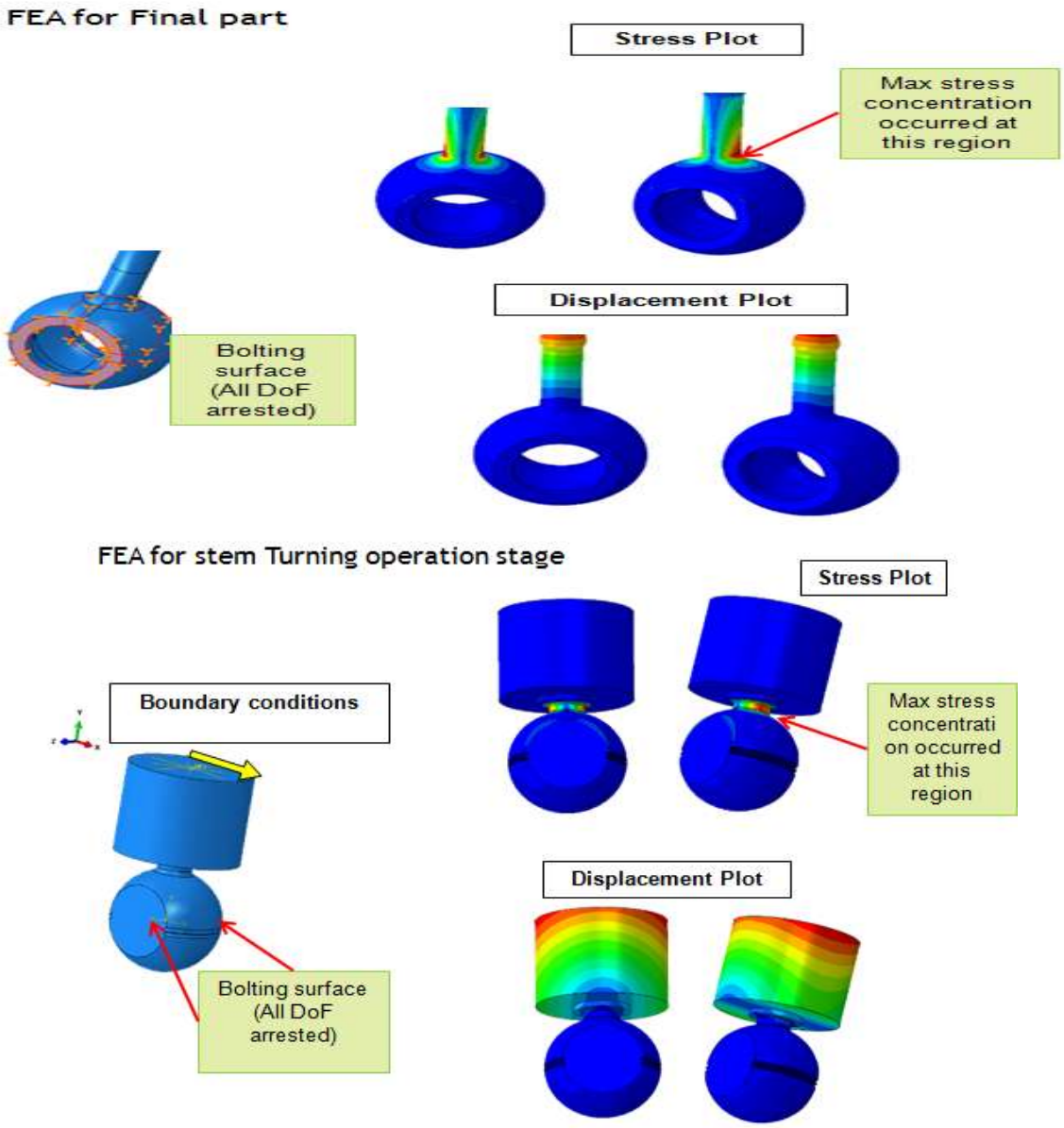
VIII.FINITE ELEMENT ANALYSIS

FEA (Finite Element Analysis) done for both Final stage part and CNC Turning stage parts,



IX.FEA OBSERVATIONS:

The R2.5 is the potential area tends to prone for crack since the cross-section area is very less in CNC 2nd operation.

So during CNC operation due to the high stress in radius 2.5 area crack generation will be happen.

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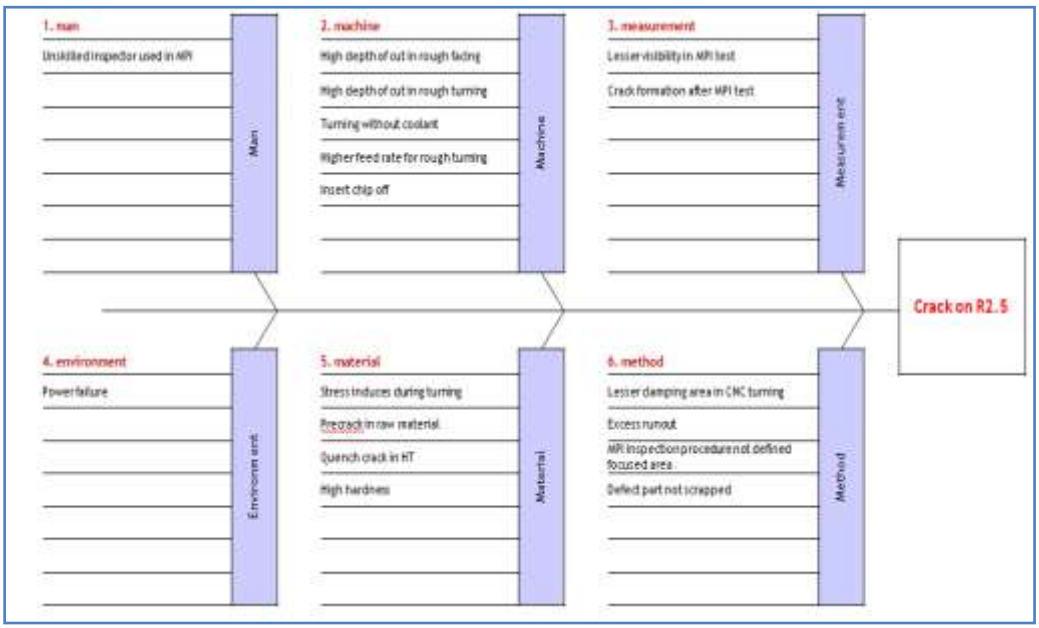
X.ROOT CAUSE ANALYSIS



No.	Ishikawa Category	Ishikawa Cause Item (Possible Cause)	Description	Relevancy for consideration (relevant for further root cause analysis, or to be excluded from analysis)	Reason for excluding
1	Man	Excluded Cause	Unskilled inspector used in MPI	excluded	Level 2 certified inspectors used for MPI.
2	Machine	Excluded Cause	High depth of cut in rough facing	excluded	In simulation trials, no crack formed, but insert got
		Excluded Cause	High depth of cut in rough turning	excluded	In simulation trials, no crack formed
		Excluded Cause	Turning without coolant	excluded	In simulation trials, no crack formed
		Excluded Cause	Higher feed rate for rough turning	excluded	In simulation trials, no crack formed
		Excluded Cause	Insert chip off	excluded	In simulation trials, no crack formed
3	Measurement	Possible cause	Lesser visibility in MPI test	Relevant	Visibility is more for MPI after blackening process than bef
		Excluded Cause	Crack formation after MPI test	excluded	Blackening happened inside crack
4	Environment	Excluded Cause	Power failure	excluded	Machines are connected with UPS
5	Material	Possible cause	Stress induces during turning leads crack	Relevant	FEA shows stress induced at lesser C/S at R2.5 in CNC 2
		Excluded Cause	Precrack in raw material	excluded	No abnormality found in microstructure analy
		Excluded Cause	Quench crack in HT	excluded	No abnormality found in microstructure analy
		Excluded Cause	High hardness	excluded	Hardness found with in specification
6	Method	Excluded Cause	Lesser damping area in CNC turning	excluded	In simulation trials, no crack formed
		Excluded Cause	Excess runout	excluded	In simulation trials, no crack formed
		Excluded Cause	MPI procedure not defined focused area	excluded	Verified procedure found OK

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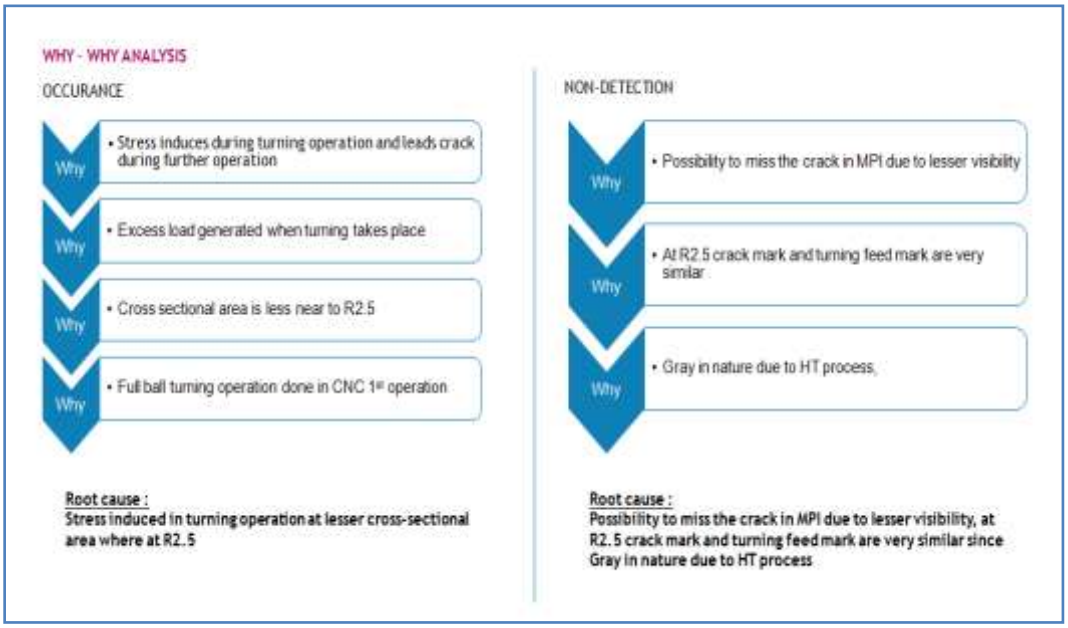
XI.WHY - WHY ANALYSIS

Analysis done for occurrence and Non detection of Defective parts due to stress induced in lesser cross sectional area the crack initiation and after HT process the part colour change to gray and crack marks and turning feed line very similar so missing possibility in MPI (Magnetic particle inspection)

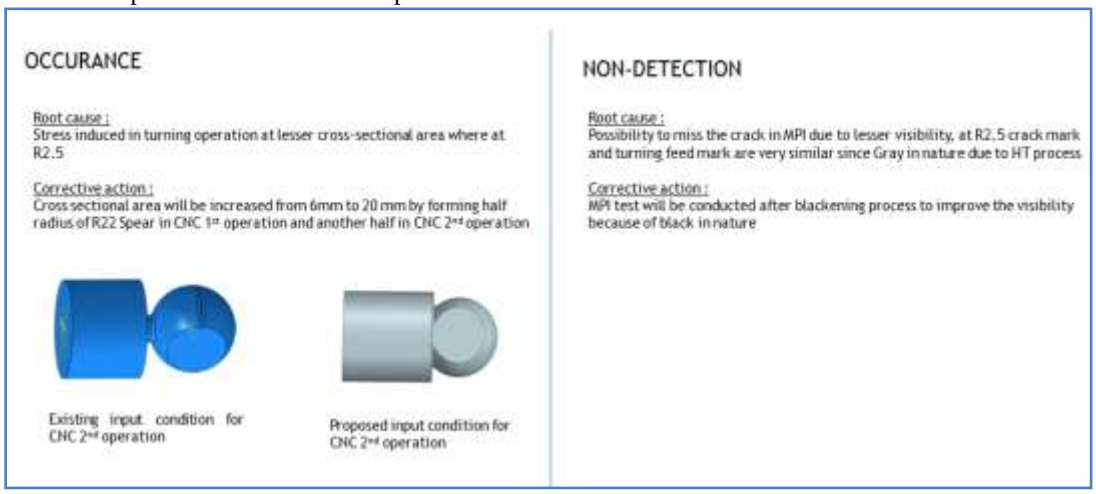


XII.SIMULATION RESULTS & CONCULUSION:

- No deviation observed in raw material and HT process metallurgic ally
- Based on various simulation trials we could not be able to re-generate the defect.
- Hence the defective was not formed in the regular manufacturing process, unless otherwise an external force applied as shown in slide # 15
- Based on Finite Element Analysis (FEA) the R2.5 is the potential area tends to prone for crack since the cross-section area is very less in CNC 2nd operation.

XIII.CORRECTIVE ACTION:

- Cross sectional area will be increased from 6mm to 20 mm by forming half radius of R22 Spear in CNC 1st operation and another half in CNC 2nd Operation
- MPI Test will be conducted after blackening process to improve the visibility because of black in nature



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