

Investigation Into Lap Crack Defects in Forged Components Using 8D Methodology Tools

Dr. Balaji Sontakke , Mr.Saujanya R. Yerunkar

Faculty of master in Technology in Manufacturing Engineering, Chhatrapati Shivaji Maharaj University, Shedung ,
Panvel , Maharashtra, India.

Student of master's in technology in Manufacturing Engineering, Chhatrapati Shivaji Maharaj
University, Shedung,panvel, Maharashtra, India.

Abstract

In the hot forging industry, surface defects such as lap cracks severely impact product quality, reliability, and production efficiency. This study investigates the occurrence of lap crack defects in forged components using the 8D (Eight Disciplines) Problem Solving Method—a structured and widely accepted tool within the IATF 16949 framework. By applying this method, root causes such as die misalignment, billet offsetting, and improper lubrication were identified. Corrective actions—including poka-yoke alignment systems, die reconditioning, and lubrication SOPs—were implemented, resulting in a significant reduction in lap crack defects. The First Piece Yield (FPY) improved from 85% to 92% and rejection rates dropped from c.4% to 1.2% over a span of four weeks. This study highlights the effectiveness of the 8D method in resolving critical quality issues in forging operations.

Keywords: Lap Crack, Forging Defect, 8D Problem Solving, Die Misalignment, Billet Offsetting, Root Cause Analysis

1. Introduction

Forging is a widely used manufacturing process in the metal forming industry to produce high-strength components with superior mechanical properties. It is particularly essential in sectors such as automotive, aerospace, and heavy machinery, where durability and reliability are critical. However, despite its advantages, forging is also susceptible to several surface and internal defects—one of the most common being lap cracks. Lap cracks are surface discontinuities that occur due to improper material flow during the forging process. These defects usually form when the metal folds over itself without properly bonding, often resulting from poor die design, misalignment, or inadequate process parameters. If not identified and corrected early, lap cracks can lead to part rejection, rework, customer dissatisfaction, and significant quality losses. This paper focuses on identifying and eliminating lap crack defects in forged components using structured problem-solving methods defined by IATF 16949. A detailed case study is conducted in a hot forging facility where repeated lap crack rejections were impacting productivity and First Piece Yield (FPY). By applying PFMEA to identify high-risk operations, and an 8D methodology to define root causes and implement corrective actions, the study aims to reduce rejection rates and improve overall process capability.

2. Problem Statement

In a XYZ forging plant producing SS flanges of “250DIN ASTM A182 F316L, Blind Flange, Pressure Nominal 16 bar”.

The Defect observed were:

- Lap Crack found on Face.

3. Objectives

The objective of this research is to:

- Analyze the process conditions contributing to lap crack formation.

- Apply IATF 16949 quality tools to identify, control, and eliminate root causes.

4. IATF 16G4G Quality Tools.

8D METHODOLOGY

The aim of the study is to consider quality improvement in industry to meet customer expectations. We assume that this study can be an example of the specifics of applying quality management tools to meet the stated goal. An important task was not only to identify errors but also to focus on the causes of errors. Another reason for choosing 8D was that it ensures, as mentioned, the effectiveness of failure mechanism controls, while consolidating their use in the future.

For analysis, a monitoring and improvement project was chosen for the most de- minded product of the forging process. As the most appropriate method, the 8D methodology has been applied. The project's issue has been a desire to improve the forging process by using the 8D methodology. The Global 8D problem-solving methodology was originated by the U.S. government following World War II as MIL-STD 1520, and was later adopted and improved upon by the Ford Motor Company. The 8D methodology was used to analyze the problem, which allowed for the identification of a critical cause of the defect and helped eliminate it. The 8D methodology includes an 8D report consisting of eight steps,

1D: Team Formation.

2D: Problem Definition and Description. 3D: Interim Containment Actions.

4D: Root Cause and Effect Analysis. 5D: Corrective Actions.

6D: Verification of Corrective Actions. 7D: Preventive Actions.

8D: Team and Individual Recognition.

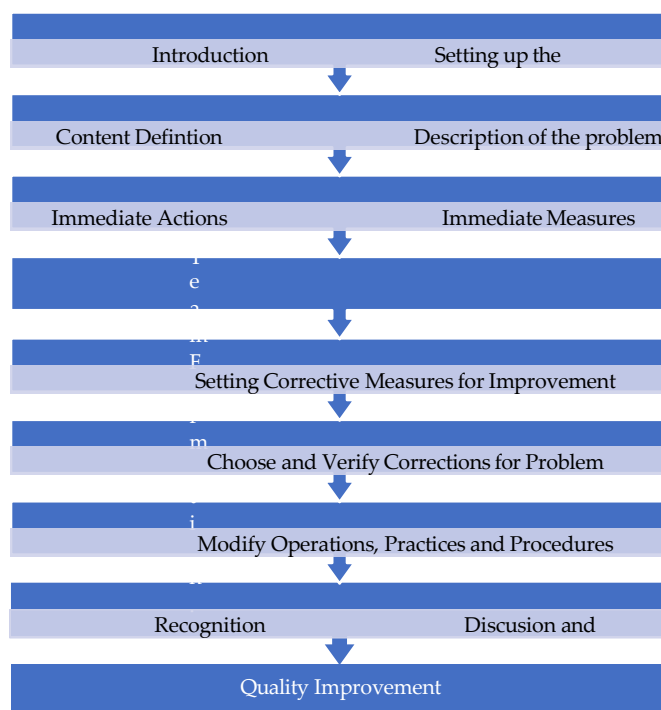


Figure 1. The 8 D methodology workflow.

D – 1 : Team Formation.

Establish a team of people with product/process knowledge about the Forging process.

D – 2: Problem Definition and Description

- What – Lap Crack found on Face.
- Where – Location Of Hammer/ Press.
- When – Mentioned the Date & Occurrence Time.
- How Many – No. of Affected pieces.
- Who Detected – Name of Supervisor.
- Impact – Production delay due to Rejection in Final Inspection.

D – 3: Immediate & Containment Action

- Stop Production Immediately.
- Switch the Production on another Machine.
- Isolated affected batch for further inspection.
- Inform to General Instruction team for 100 % inspection carried out for whole batch.
- Issue alert to Production & Tool Room team department for Die condition checked.

D – 4: Root Cause Analysis (RCA)

Method Used – Why – Why Analysis

1. Why the lap Crack found on face?

Because material layer folded over itself during forging.

2. Why the material folded over itself ? Because material offsetting was wrong.

3. Why the material offsetting was ?

Because operator using wrong offsetting method.

4. Why operator using wrong offsetting method ?

Because SOP's are available at at are only for RCS and Round bar not for CCB billets.

5. Why the SOP' s are not available in Stations ?

Because there is no formal linkage between Quality , Production , Cutting Shop and Tool Room department.

6. Why the formal Linkage no found between them ? Because of lack of Revision of procedure.

Conclusion Of Why- Why Analysis

1. Operator follow's wrong SOP's
2. Lack of Formal linkage between Departments.
3. No system validation of offset values after material orientation changed.

D – 5: Corrective Actions

Action	Responsibility	Deadline
Revise and Updated SOP's	Quality	Immediate
Implement Revision Control Process for Setup	QMS	Within 1 Week
Cross Check SOP's	Production & Quality	Before the Next Batch run
Train the Operator	Training Department	Weekly Session.

D – 6: Verification of Corrective Actions.

- Breaks the Sharp edges of Billet firstly and then offsetting the Billet
- Verify the Height / Diameter ratio of Offsetting Billet.
- Produce 100 Pieces without lap Crack.
- Visually and Metallurgical inspection Confirms No Lap on face.
- Verify operator follows the instructions.

D – 7: Preventive Actions.

- Introducing POKA – YOKA for billet alignment
- Add offset verification checkpoint in Control Plan.

D – 8: Team and Individual Recognition.

Recognize the collective efforts of the team. The team needs to be formally thanked by the organization.

5. Result

RCA confirm the Offsetting method was wrong , Because operator follows the wrong Sop's , Hence the resume the Production, replace the Operator and revise the SOP's.

6. Conclusion

This study successfully applied the 8D Problem Solving Method to investigate and eliminate lap crack defects in forged components. Lap cracks, caused primarily by billet offsetting were effectively addressed using structured tools such as the Why -Why analysis. These root causes, often missed in traditional inspection systems, were brought to light through cross-functional collaboration.

Permanent corrective actions—including the installation of poka-yoke fixtures, use of billet loading jigs, revised SOPs—resulted in measurable improvements. The First Piece Yield (FPY) increased from 85% to 92%, and lap crack rejection rates were reduced from 6.4% to 1.2% within four weeks. These improvements were sustained over time, indicating strong process stability.

7. References

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