2024

INTERNSHIP REPORT

ATLAS ENGINEERING

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About Company

Atlas Engineering is a renowned industrial leader specializing in advanced manufacturing processes to create automotive parts. With decades of expertise, the company has earned a reputation for producing high-quality automotive parts and components using state-of-the-art techniques in the private sector. Key area of focus for Atlas Engineering includes many sectors, including gravity die casting at Aluminum Foundry, where innovative gravity die casting methods are employed to manufacture precise bridge fork tops and pistons for motorcycles that meet global standards. The company also specializes in high pressure die casting, polymer casting, mold manufacturing and machining processes.

The Company's manufacturing facilities are located at Karachi and Sheikhupura. The Company is producing motorcycle parts under strict quality assurance as per Japanese Standards (JIS/HES) for Atlas Honda Limited and its after sales market. In line with its vision and mission, Atlas Engineering is employing cutting edge technology to produce high quality auto parts and components at competitive prices.

Objective

The primary objective of this report is to address defects occurring in the riser region of component called BRIDGE FORK TOP during the gravity die casting process. These defects are due to factors such as improper mold design, suboptimal material properties, or inadequate process control. By identifying and mitigating the core issues, Atlas Engineering aims to enhance product quality, reduce waste, and optimize production efficiency. This report pertains to operations at the aluminum foundry within Atlas Engineering Pvt Ltd. Landhi Town, where Gravity Die Casting is utilized to produce complex Pistons and BFTs.

Supervised by: This report was completed under the supervision of **Senior Manager Aluminium Products Mr. Syed Ahmed Jawad.**

Gravity Die Casting

Gravity die casting is a manufacturing process you can specify to produce high-quality metal parts with complex shapes and a relatively good surface finish. It's a type of die casting method because it uses a die, but it differs greatly in complexity from the pressurized and squeeze-cast methods. One of its major advantages is the simplicity of the equipment and the potential to use it in traditional and very low-tech foundry conditions. It is widely viewed as an effective mass-production tool for producing metal components with moderate dimensional accuracy, consistent quality, and relatively short cycle times. This assertion is supported by the extensive use of the process across many moderate and high-volume sectors of manufacturing. The process is well-suited for demand ranging from 250 to 50,000 units per annum. Using cast iron or steel Molds provides greater repeatability, lower Labor, and improved cost-effectiveness in comparison to other casting methods, such as sand casting.

Gravity Die Casting Step by Step

Gravity casting works by allowing molten metal to flow gently into a permanent Mold under the influence of gravity alone. Listed below, you'll find a detailed breakdown of the steps involved in gravity die casting:

• Preheat the Die and Coat the Mold Cavity

Before starting the gravity die casting process, the die (also known as the mold) is preheated to a certain temperature to suit the charge metal. This prevents cold spots and ensures uniform solidification of the fill. This step helps to reduce thermal shock, improving the longevity of the die. Additionally, a release agent or coating is commonly applied to the inner surfaces of the die cavity. This coating helps facilitate the removal of the solidified part once the casting process is complete, by reducing sticking. Dies erode due to molten metal contact, especially in turbulent flow areas, because some casting metals can be quite abrasive. Die coating reduces this erosion, maintaining surface integrity for more cycles, whereas otherwise, the roughness would increase casting stick and defects.

• Pour Molten Metal into the Cavity

Once the die is preheated and coated, it is securely clamped together. Molten metal, typically aluminium or other non-ferrous alloys, is then poured into a pouring basin or runner system that leads to the die cavity. The molten metal enters the Mold cavity under the force of gravity alone, hence the name "gravity die casting." The carefully controlled pouring process helps minimize turbulence and air entrapment, resulting in better-quality castings. Filling from below allows the smooth upward rise of the charge meniscus and assists in driving out air and maintaining low turbulence.

Allow the Metal to Solidify

As the molten metal is introduced into the Mold cavity, it cools rapidly. Solidification starts first when the charge contacts the relatively cooler surfaces of the Mold and progresses inward toward the center of the casting cross-section. The metal fill cools rapidly in the Mold cavity, solidifying first at the cooler Mold surfaces and thinner sections, progressing inward. Preheated Molds ensure consistent solidification rates, preventing premature solidification in thin sections that could block metal flow. Solidification time varies with metal type and part design. Mold preheating benefits include avoiding thermal shock, maintaining molten metal temperature for proper flow, and reducing thermal stress in solidifying casting. The time required for solidification depends heavily on the type of metal being cast, the mass of the tool and charge, and the design of the part.

Open the Die and Remove the Part

After the charge has fully solidified within the die cavity, the clamps holding the die closed can be released. The opened die reveals the solidified casting that will precisely mirror the cavity it fills, with good dimensional accuracy and great repeatability between casts. The application of the release agent during the initial steps should allow the easy removal of the casting from the die.

Machine the Part if Needed

Once the casting is removed from the die, it may undergo further processing, such as machining, to achieve the desired final shape and surface finish, remove vent, fill and flash attachments, and improve local precision in areas of higher tolerance than the casting method can achieve. The decision to machine the part depends on its intended use and the required level of precision, as well as the quality of the die machining/fit.

The production speed of the gravity die casting process varies widely because of various factors, including the material being cast, the complexity of the part's design, and the size of the casting. The entire gravity die casting process typically takes anywhere from a few minutes for simpler castings to several hours for larger or more intricate parts that have longer cooling times. Cycle times can be reduced somewhat, although not without the potential for quality risks. Careful design of the casting process parameters, die design, and material selection allow for the balance of production and casting quality.

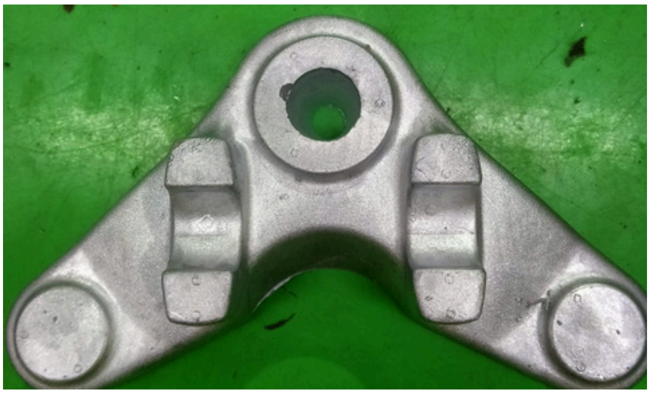
GRAVITY DIE CASTING FOR BRIDGE FORK TOP

- **What is Bridge fork Top?**

BFT, also called top triple clamp or upper yoke is a crucial part of the motorcycle's steering system, positioned near the handlebars. In Atlas Engineering Pvt Ltd, it is typically made of aluminum alloy due to its strength, lightweight nature, and resistance to corrosion. The company involves making BFT’s for 125CC and 100CC bike models locally which are:

1. **HONDA DELUXE**
2. **CG 125**

- **GRAVITY DIE CASTED BFT PART**



BFT Specifications:

- **Part Description:**

The part produced by Gravity Die casting is a structural component specifically designed for motorcycle handlebars. It serves as a critical connector, ensuring stability and precision in the assembly of the handlebar system. The design prioritizes strength, lightweight properties, and resistance to wear, making it ideal for high-performance applications.

- **Usage:**

This part is used in motorcycle handlebar systems, providing essential support and alignment to enhance rider control and safety.

- **Cycle Time:**

2 minutes.

- **Production Volume:**

Atlas Engineering manufactures and dispatches approximately 50000 units of this part per month, ensuring consistent supply to meet client demands.

- **Coating:**

To ensure the durability and quality of the casted components, the following coatings are applied:

- **HMC 26**
- **HMC 34**

- **Temperature:**

The casting process is conducted at a controlled mold temperature of 300°C-350°C and stabilizes from 270°C-300°C, ensuring optimal material flow and solidification.

• Material Used:

The primary material used for this part is Aluminum Metal Alloy, **HD1.1 and AC8A** .The 2 manufacturers and vendors for this material are**(sun metal)** and **(BR Casting)**, known for their excellent mechanical properties, corrosion resistance, and durability.

Aluminium alloys offer an ideal balance of strength and weight for enhanced control in various applications. Essential for manufacturing, it comes in different types:

1.V**irgin Ingots:**

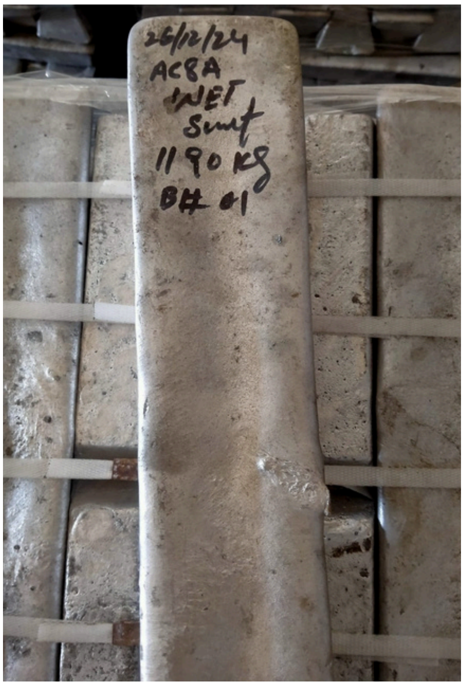
High-purity aluminum made directly from bauxite, ideal for high-performance applications.

2..**Swarf Ingots:**

Recycled aluminium chips, cost-effective and eco-friendly, used in non-critical applications.

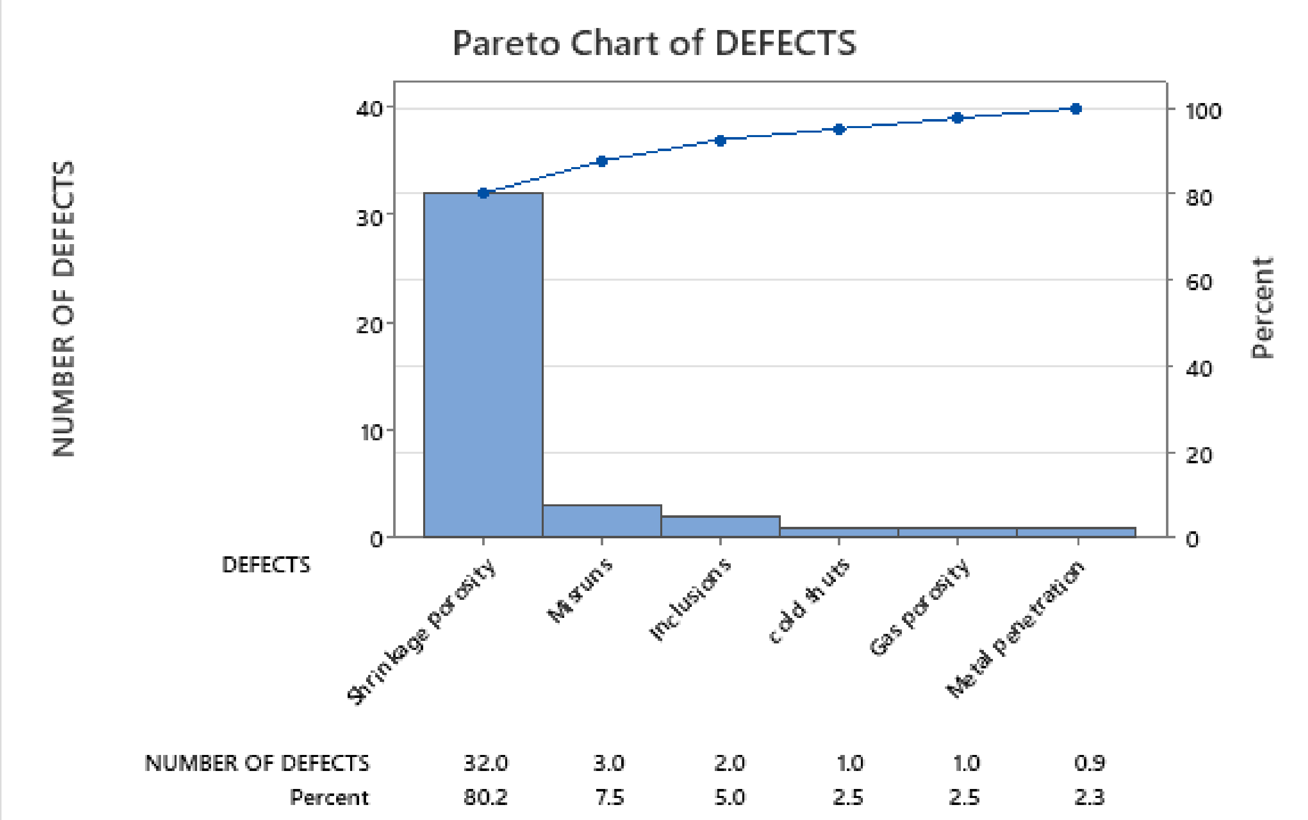
3. **Runner & Riser Ingots:**

Recycled casting remnants, re-melted for efficient reuse.



CASE STUDY

PARETO CHART ANALYSIS



	C1-T	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	DEFECTS	NUMBER OF DEFECTS										
1	Shrinkage porosity	10000										
2	Gas porosity	1100										
3	Inclusions	850										
4	Metal penetration	550										
5	cold shuts	0										
6	Misruns	0										

Worksheet 1

INTERPRETATION:

The Pareto chart shows the types of defects found during production. It clearly highlights that shrinkage porosity is the main defect observed, with a total of 10000 cases, making up 80% of all defects. No other defects, like gas porosity, inclusions, or cold shuts, were found to be vital few.

This means that shrinkage porosity is the biggest problem affecting the quality, and fixing this issue should be the top priority to improve the production process.

DEFECTS DESCRIPTION

- **Porosity:**

A casting defect caused by trapped gases or improper metal feeding during the pouring process. This results in small cavities or voids within the metal, reducing its structural integrity. To prevent porosity, proper venting, degassing, and careful control of the molten metal are essential.

- **Cold Shut:**

A defect that occurs when two streams of molten metal fail to fuse properly due to low pouring temperatures or turbulent flow. This creates visible lines or weak spots in the casting. It can be avoided by maintaining an optimal pouring temperature and ensuring a smooth, controlled flow of molten metal.

- **Misrun:**

This defect arises when the molten metal solidifies before completely filling the mold cavity, often due to low metal temperature, inadequate mold preheating, or a poorly designed gating system. Addressing these issues improves metal flow and prevents incomplete castings.

- **Hot Tears:**

Hot tears occur when the casting develops cracks or fractures during cooling due to uneven shrinkage or thermal stresses. This is often a result of poor mold design or inadequate cooling control. Ensuring uniform cooling and incorporating flexible mold designs can mitigate this issue.

- **Inclusions:**

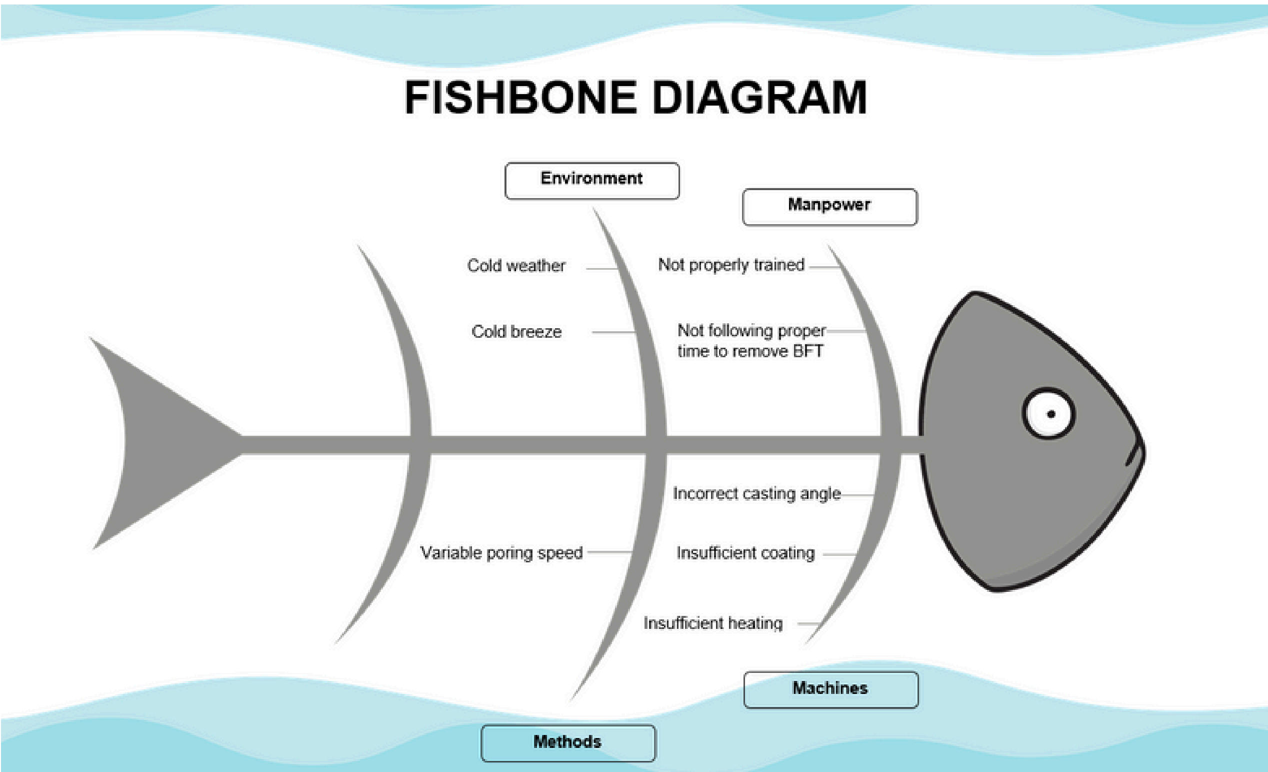
Foreign impurities, such as oxides or slag, become trapped in the casting during the melting or pouring process. These reduce the quality and mechanical properties of the final product. Clean melting practices, proper mold maintenance, and filtration of molten metal are effective preventive measures.

- **Metal Penetration:**

A defect where molten metal penetrates the mold surface, creating a rough or uneven casting surface. This typically occurs due to excessive pouring temperatures or improper mold materials. Using high-quality mold coatings and controlling the pouring temperature can resolve this issue.

GRAPHICAL INTERPRETATION OF DEFECTS ACCORDING TO QC TOOLS

- **CAUSE AND EFFECT (Shrinkage porosity)**



Interpretation:

1.Environment:

Cold Weather: Materials' ability to cool and solidify may be impacted by ambient temperatures.

Cold Breeze: Dimensional instability may result from abrupt or uneven cooling brought on by air drafts.

2. Manpower:

Undertrained:

Inadequate training or skills among employees may lead to mistakes during production.

Proper Time to Remove BFT Part:

Stress or deformation may result from removing the part too soon or too late.

3. Methods:

Variable Pouring Speed:

Defects or an uneven distribution of material may result from inconsistent pouring speeds during casting.

4. Machines:

Incorrect Casting Angle: Misalignment during casting could result in improper flow or uneven cooling.

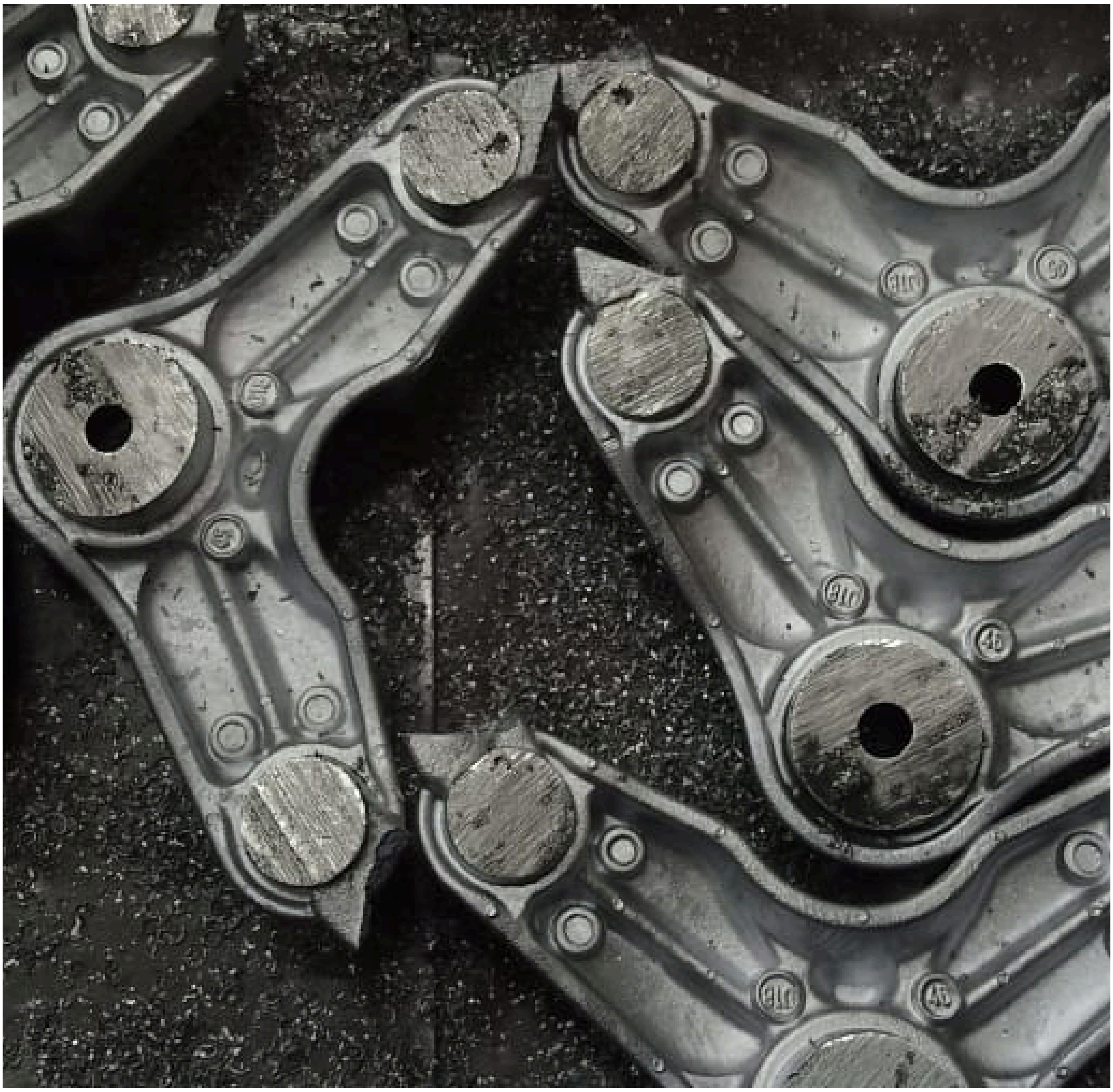
Understanding the Causes of Shrinkage Porosity

Shrinkage naturally occurs during the solidification of a casting. Any imperfections during casting can lead to uneven solidification, triggering internal pores. The formation of holes/pores inside the casting due to shrinkage is called shrinkage porosity. These defects can weaken the structural integrity of the material, and if they appear on the surface, they can negatively affect the component's appearance and corrosion resistance. Identifying the size, shape, and surface characteristics of these cavities is crucial for determining the cause of the defect. It is also important to distinguish shrinkage porosity from air entrapment. Shrinkage porosity cavities typically have angular surfaces, indicating insufficient material filling during solidification, whereas air entrapment defects are characterized by rounded shapes, caused by trapped air bubbles in the molten metal. Understanding these differences is essential for addressing the root cause of the defect and improving the casting process.

DEFECTS IN OUR CASE STUDY

To address the shrinkage defects identified in the BFT casting process, we are preparing to implement a series of experimental approaches to determine the most effective solution. First, we plan to adjust the cycle time to evaluate its impact on the solidification process. If necessary, we will modify the die temperature to achieve better fluidity and uniform cooling. Further experiments will involve altering the mold angle to enhance metal flow and reduce material starvation. Additionally, we aim to test the use of a Bunsen burner for uniform mold preheating as a potential short-term solution. Based on the results of these trials, we will adopt the approach that effectively minimizes defects and ensures the highest quality for the BFT components. This structured methodology will enable us to systematically identify and address the root causes of shrinkage defects.

Casting Defects in Bridge Fork Tops for a Closer Look



Atlas Engineering

Experimental Approaches:

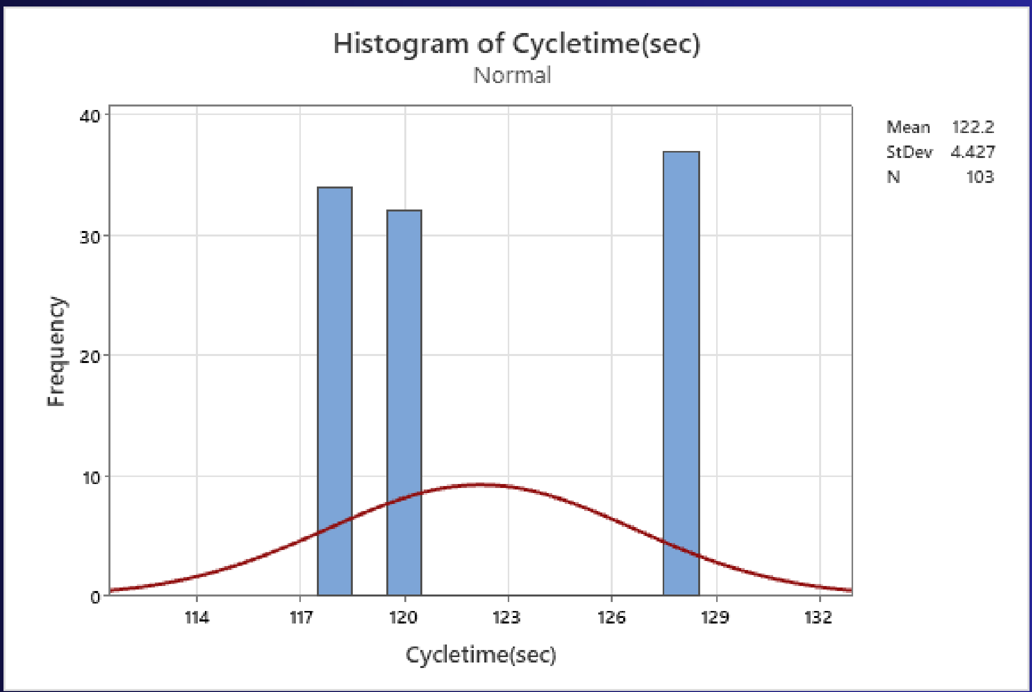
Based on the analysis of three data sets, we observed the relationship between pouring temperature, Mold angle, and defect rates in the gravity die-casting process:

APPROACH 1: (CYCLETIME)

In a controlled experiment conducted on Machines 1, 2, and 3, a dataset of 50 samples was produced under specific process parameters with adjusted cycle times. After completing the process, a thorough inspection revealed that 34 out of the 50 parts were defective.

DATE	SHIFT	TOTAL DEFECTIVES COUNT	CYCLE TIME(min)
16/12/2024	Morning	37	2:08
17/12/2024	Morning	34	1:58
18/12/2024	Morning	32	2:00

HISTOGRAM:



INTERPRETATION:

The histogram shows a roughly normal distribution of cycle times, with a mean of 122.2 seconds and a standard deviation of 4.427 seconds. Most cycle times are concentrated between 117 and 129 seconds, with peaks near 120 and 126 seconds. The narrow spread indicates low variability, suggesting a consistent process, although adjustments may be needed for specific cycle time targets.

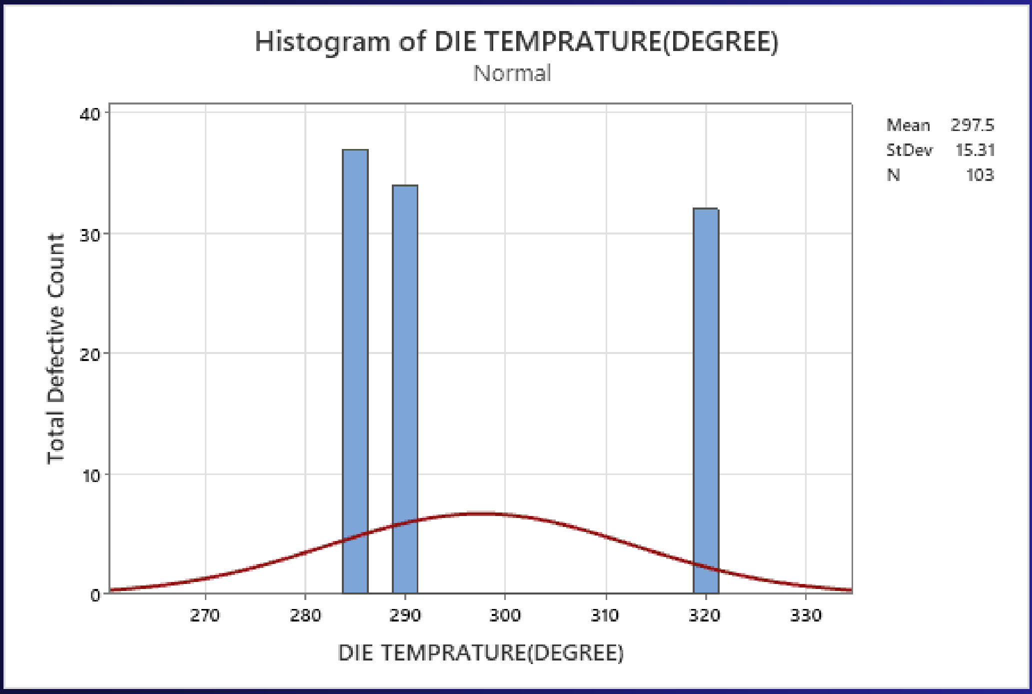
FAIL

APPROACH 2: (DIE TEMPERATURE)

The same number of 50 samples was produced. This time we have changed the pouring temperature to 285°C, 290°C & 320°C. Following inspection, it was observed that the defect rate increased to 37 defective parts out of the 50 samples. This data suggests that a lower pouring temperature combined with a steeper mold angle may contribute to a higher defect rate, indicating the need for careful parameter adjustment to enhance casting quality.

DATE	SHIFT	TOTAL DEFECTIVES COUNT	DIE TEMPRATURE(DEGREE)
16/12/2024	Morning	37	285
17/12/2024	Morning	34	290
18/12/2024	Morning	32	320

HISTOGRAM:



INTERPRETATION:

The histogram illustrates the relationship between die temperature and the total number of defective parts. It shows that at a lower temperature of 285°C, the defect count is at its highest. However, as the die temperature increases to 290°C and then 320°C, the number of defects decreases significantly. This indicates that lower die temperatures are linked to higher defect rates, emphasizing the need for maintaining an optimal die temperature to minimize defects and improve process efficiency

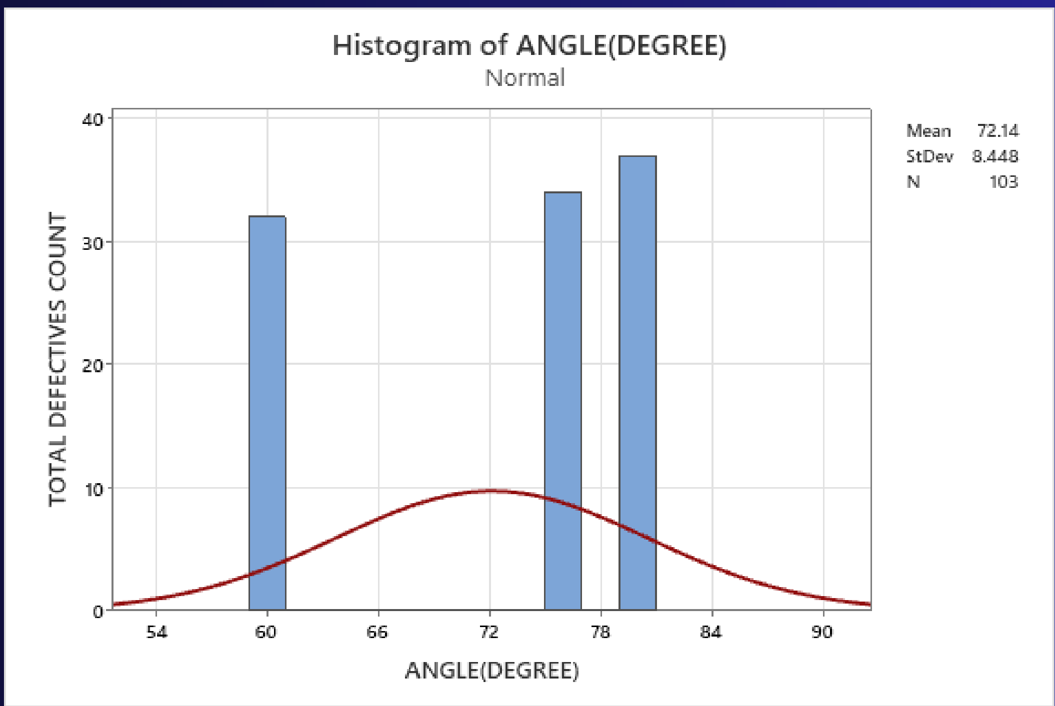
FAIL

APPROACH 3: (ANGLE)

The same number of 50 samples was produced. This time we have changed the angle to 60°, 75° & 80°.This data suggests that a lower pouring temperature combined with a steeper mold angle may contribute to a higher defect rate, indicating the need for careful parameter adjustment to enhance casting quality.

DATE	SHIFT	TOTAL DEFECTIVES COUNT	ANGLE(DEGREE)
16/12/2024	Morning	37	80
17/12/2024	Morning	34	75
18/12/2024	Morning	32	60

HISTOGRAM:



INTERPRETATION:

The histogram shows defect counts at various angles, with peaks around 60–62° and 78–80°. The mean angle is 72.14° with a standard deviation of 8.448. Defects are concentrated in specific angle ranges, deviating from a normal distribution, indicating critical angles that may require adjustment to reduce defects.

FAIL

APPROACH 4: (INCREASED TEMPERATURE USING BUNSEN BURNER)

In a controlled experimented conducted by Mr Safdar (Assistant Manager Aluminium Foundry) on machine 1 using current (43,44) mold , 6000 samples were produced with a high temperature of 450 C and was maintained by using a Bunsen burner at 75 degree angle. Inspection after machining revealed a whopping decrease in defect rate,with only 66 defectives out 0f 6000 samples, showing 1.1% defect rate.

Date	Shift	Total Defectives Count	Cycle Time	Die Temperature (c)	Angle(deg)
20/12/2024	Morning	66	2:00	450	60

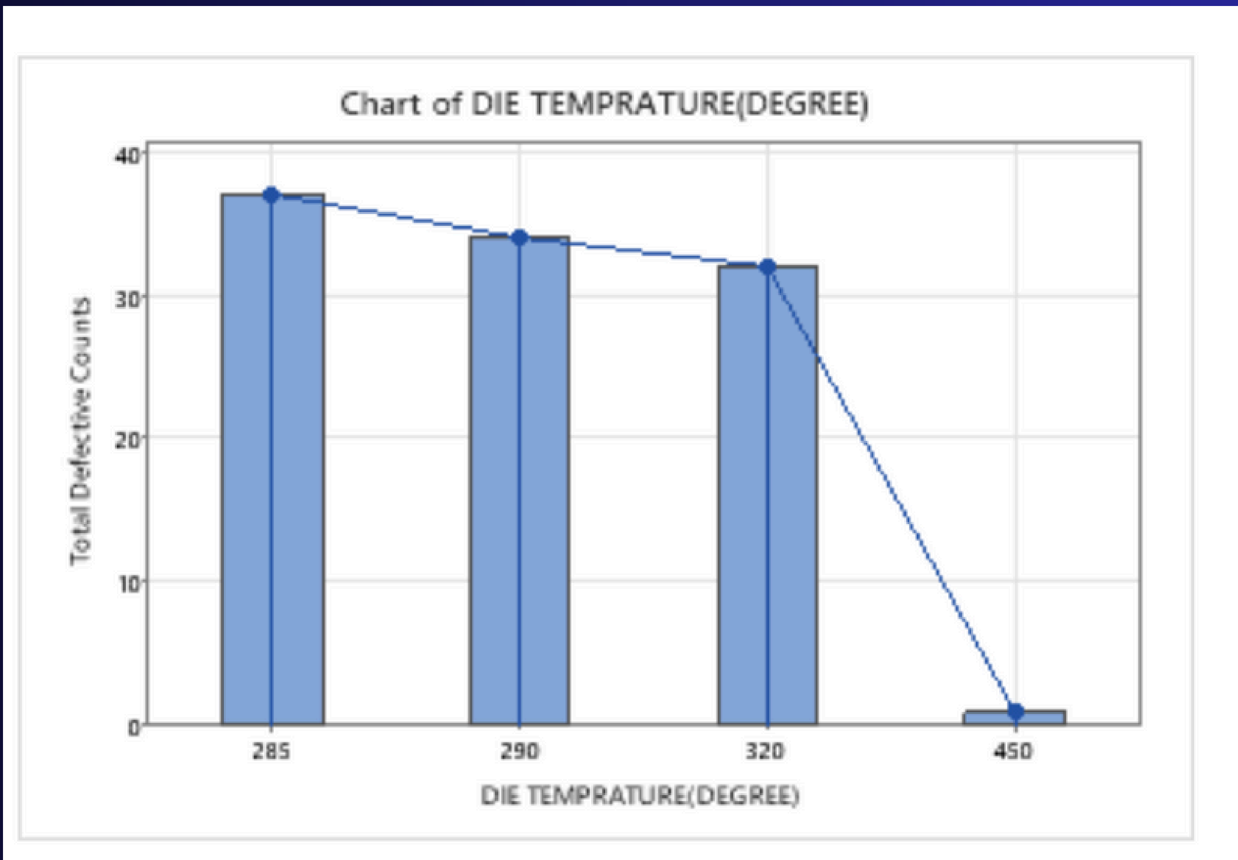
EXAMINING 4TH APPROACH:

The new data becomes:

No of samples	Total Defective Count	Cycle time(sec)	Die Temperature(deg)	Angle(deg)	Mold name
50	1.1	120	450	75	43,44

BARCHART:

DIE TEMPERATURE VS DEFECTS:

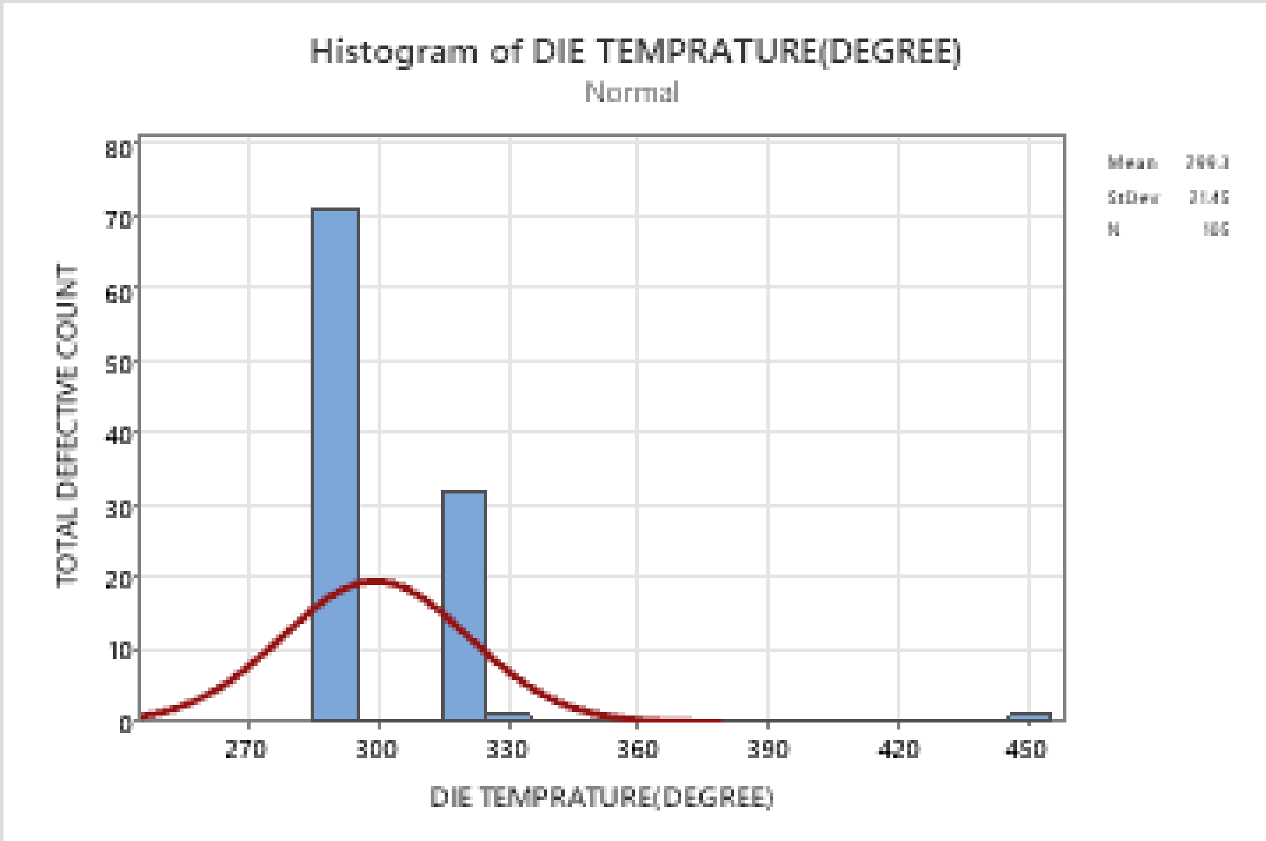


INTERPRETATION:

The chart shows the relationship between die temperature (°C) and total defective counts. At lower temperatures (285°C to 320°C), defective counts remain high, ranging from 38 to 35. However, at 450°C, the defective count drops sharply to nearly zero. This indicates that increasing die temperature significantly reduces defect rates, suggesting optimal quality is achieved at higher temperatures like 450°C.

HISTOGRAM:

DIE TEMPERATURE VS DEFECTS:



INTERPRETATION:

The histogram shows the distribution of die temperatures (270–450 degrees) for defective items, with defects peaking around 300 degrees at a count of 70. Defect counts drop significantly beyond 330 degrees. The process has a mean temperature of 290.3 degrees, a standard deviation of 21.65 degrees, and is based on 186 samples. The normal curve indicates a stable process, though the concentration of defects near 300 degrees suggests opportunities for improvement.

successful

APPROACH 5: (NEW MOLD)

In a controlled experiment conducted by (Assistant Manager Aluminium Foundry) on machine 3 using new ATMDC mold (51,52), 950 samples were produced with a temperature of 320 degree Celsius at 75 degree angle.The results of 100 samples machined was revealed to the group. Inspection after machining revealed a whopping decrease in defect rate, with only 1 defective out of 100 samples, showing only 1% defect rate!.

NOTE:

For approach 5 sample size is 100 and defect rate is 1%. Since, the majority sample size is 50

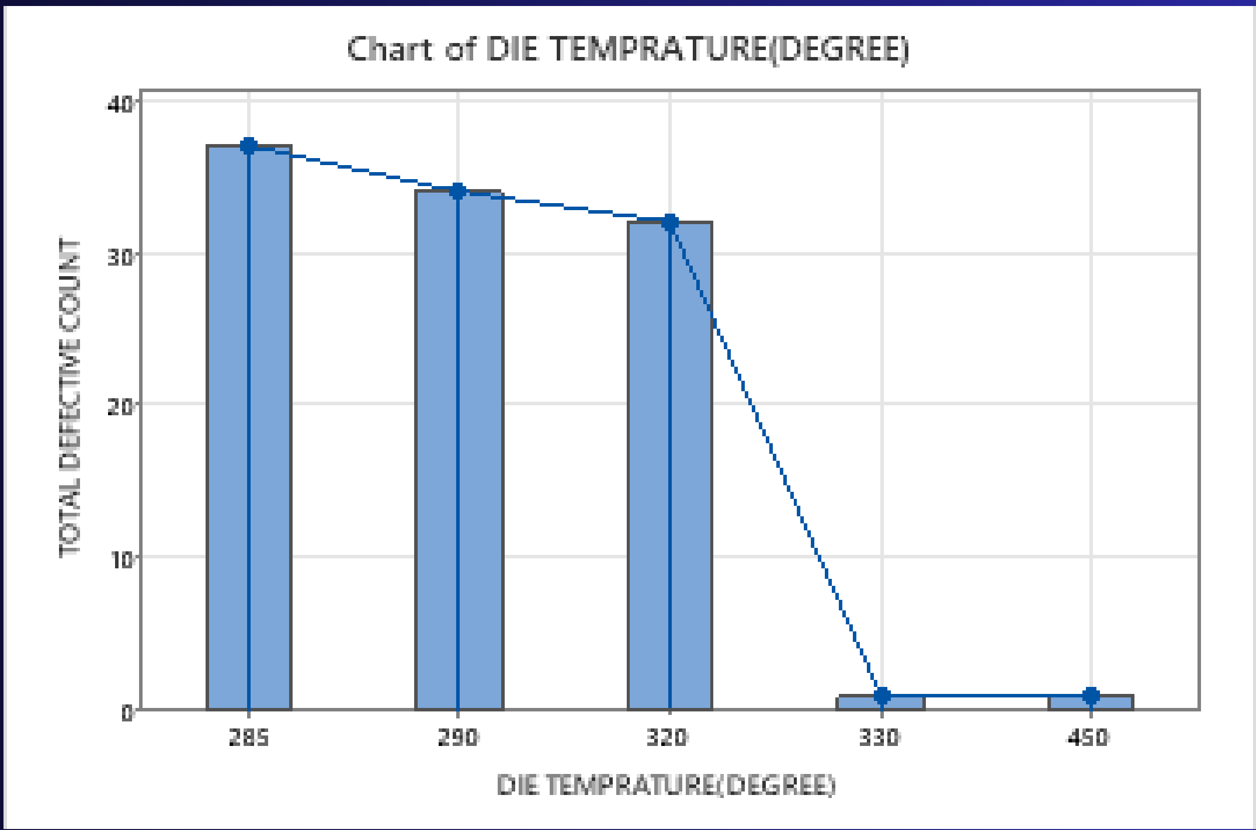
therefore, we assume the approaches 5 sample sizes as 50.

Date	Shift	Total Defectives Count	Cycle Time	Die Temperature(C)	Angle(deg)
20/12/2024	Morning	1	2:00	320	60

EXAMINING 5TH APPROACH:

BAR CHART:

DIE TEMPERATURE VS DEFECTS:

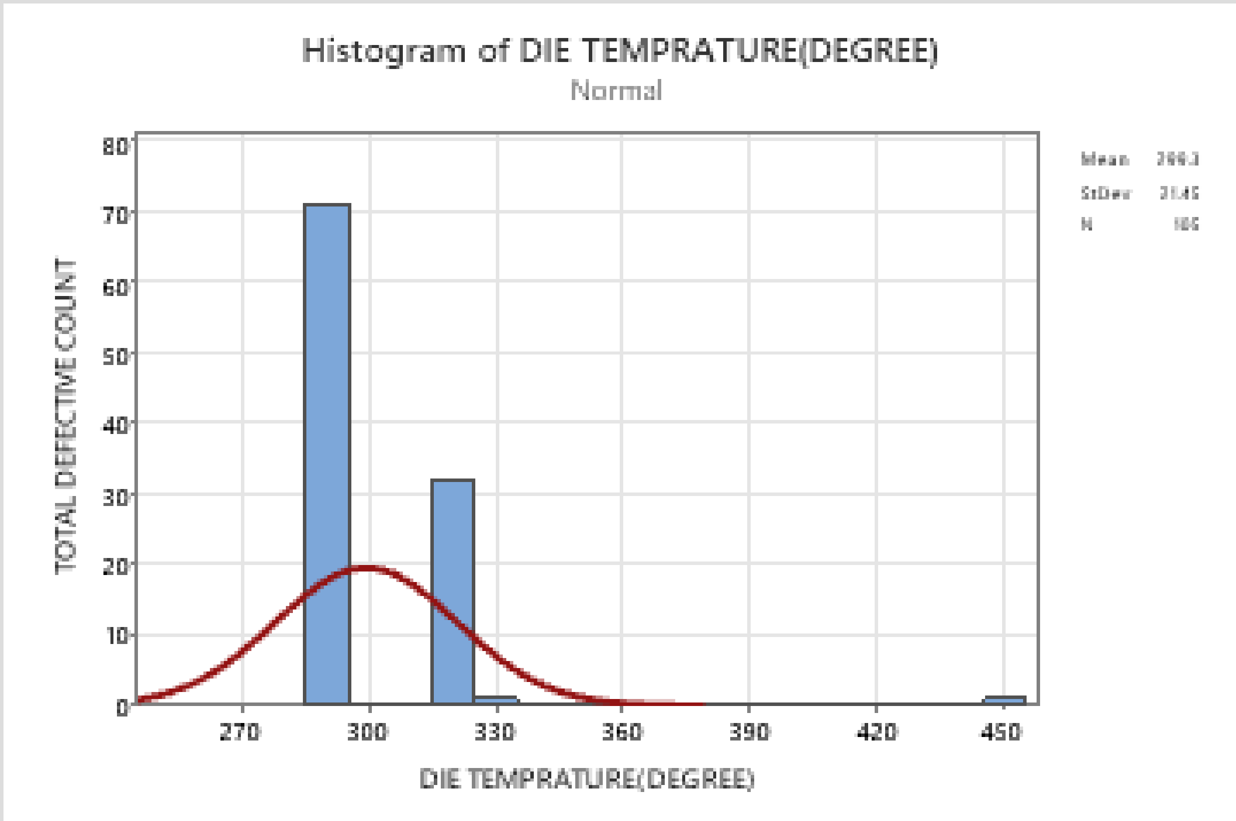


INTERPRETATION:

The chart shows the relationship between die temperature and defective count. Defects are high at 285°C (around 40), slightly decrease at 290°C and 320°C, and drop to nearly zero at 330°C and above. This suggests higher die temperatures significantly reduce defects, highlighting the importance of optimizing temperature for quality improvement.

HISTOGRAM:

DIE TEMPERATURE VS DEFECTS:



INTERPRETATION:

The histogram illustrates the relationship between die temperature and defective count, following a normal distribution. Most defects occur between 270°C and 330°C, peaking around 300°C with a count of approximately 70. Defects decrease significantly beyond 330°C, nearing zero at 450°C. With a mean temperature of 304.3°C and a standard deviation of 31.65°C, the data suggests that maintaining higher die temperatures reduces defects.

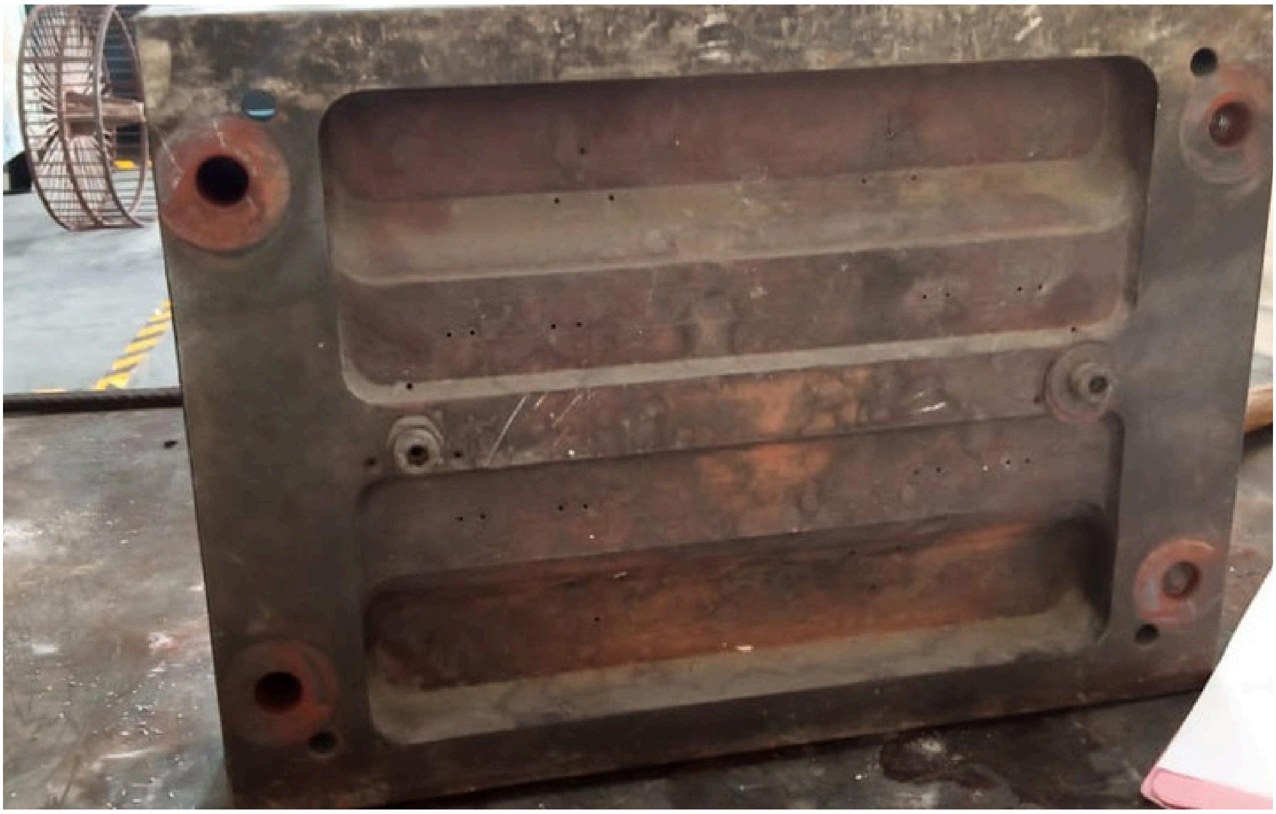
successful

MOLD/DIE SPECIFICATIONS:

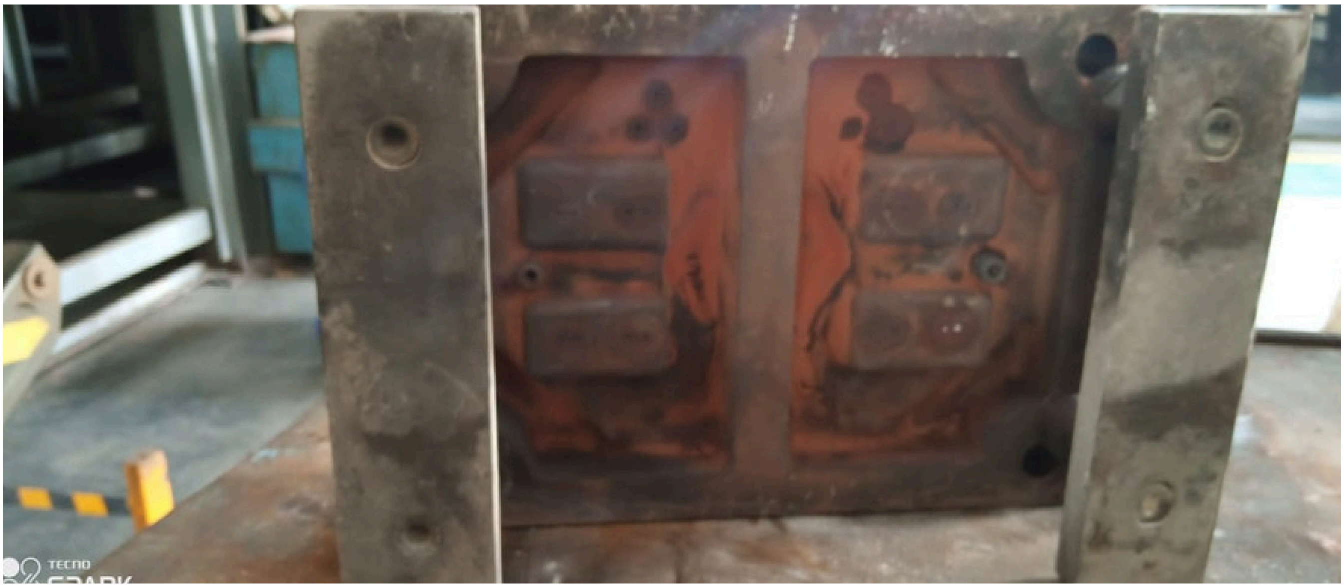
The die is used is made up of material called DIE STEEL. It is typically heated up to the temperature of 300-350 degrees Celsius. The components include upper portion of the die called COPE, the lower portion called DRAG and RUNNER/RISER, a path through which the aluminum alloy flows into the die and compensates for shrinkage.

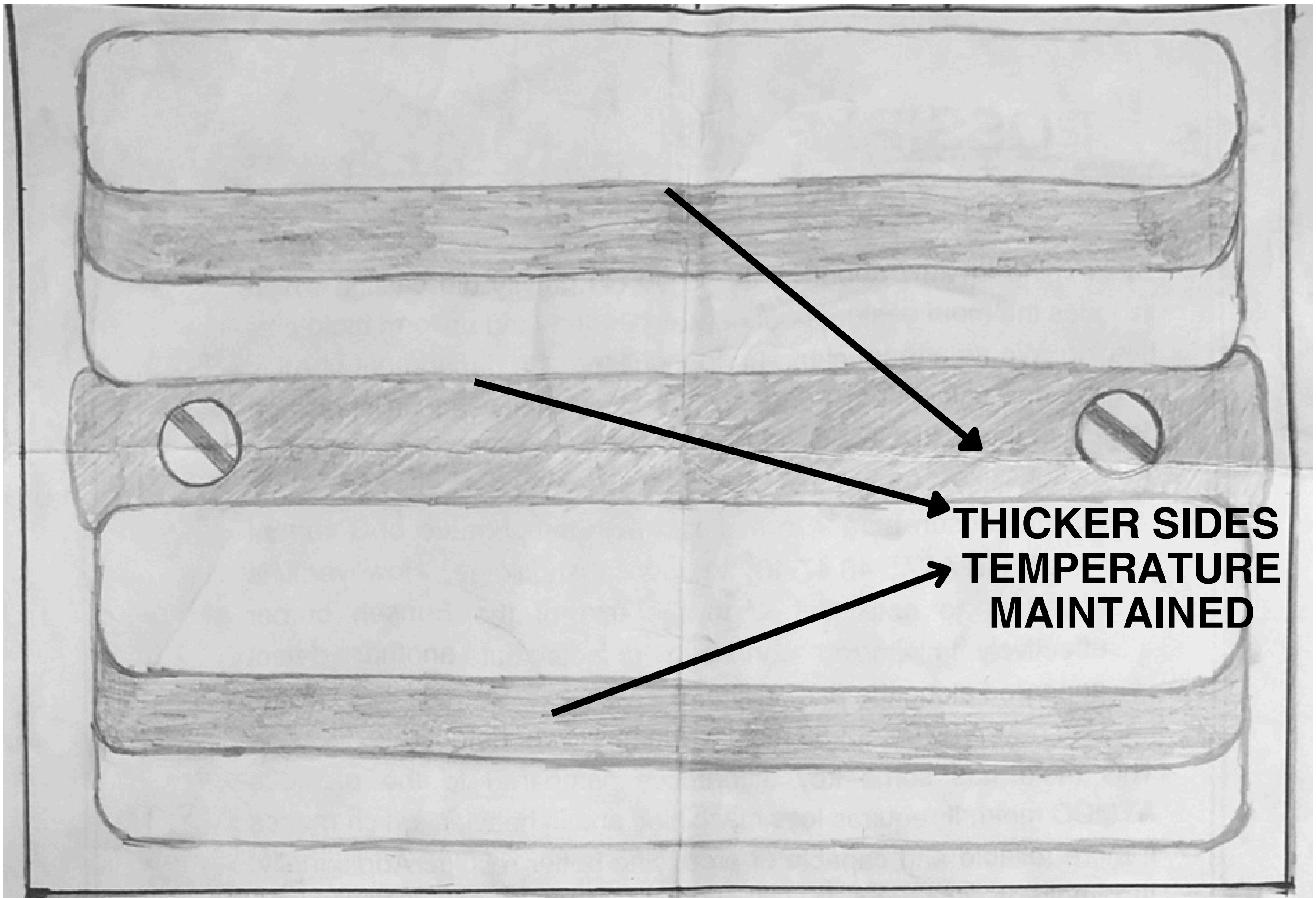
Mold (Current) **43,44/45,46 /47,48**	**Dimension**	**Mold 23,24(Taiwan)**	**Dimension**	**Mold NEW** **51,52**	**Dimension**
Length	350.52mm	Length	347.98mm	Length	347.9mm
Width	248.92mm	Width	248.92mm	Width	248.92mm
Thickness	60.96mm	Thickness	63.2mm	Thickness	63.5mm
Riser length	200.6mm	Riser length	175.26mm	Riser length	200.66mm
Locator pin	4	Locator pin	4	Locator pin	4
Weight	33kg	Weight	49.35kg	Weight	33.5kg

ATDMC NEW DIE

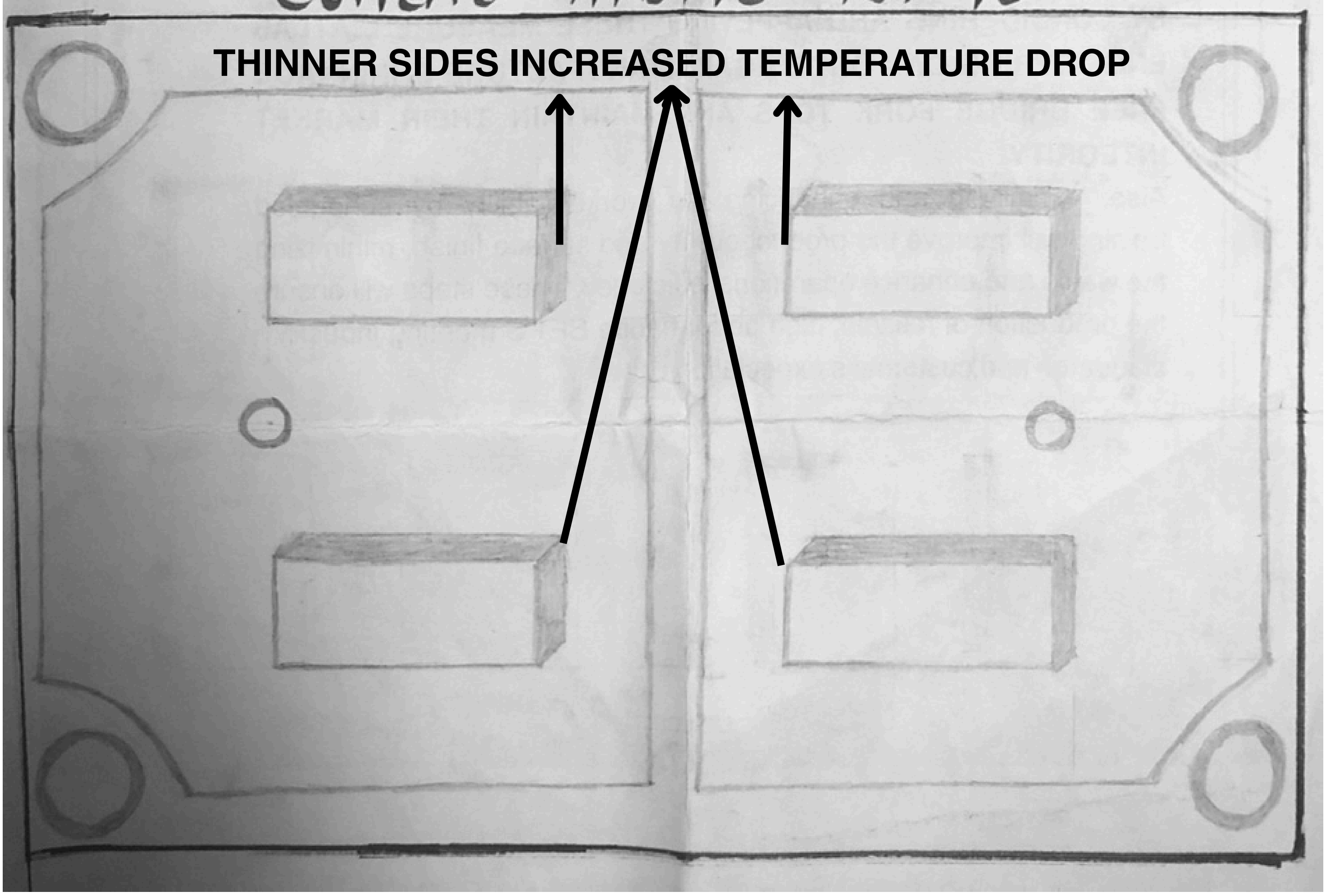


ATDMC CURRENT DIE





Current ATDMC 45, 46

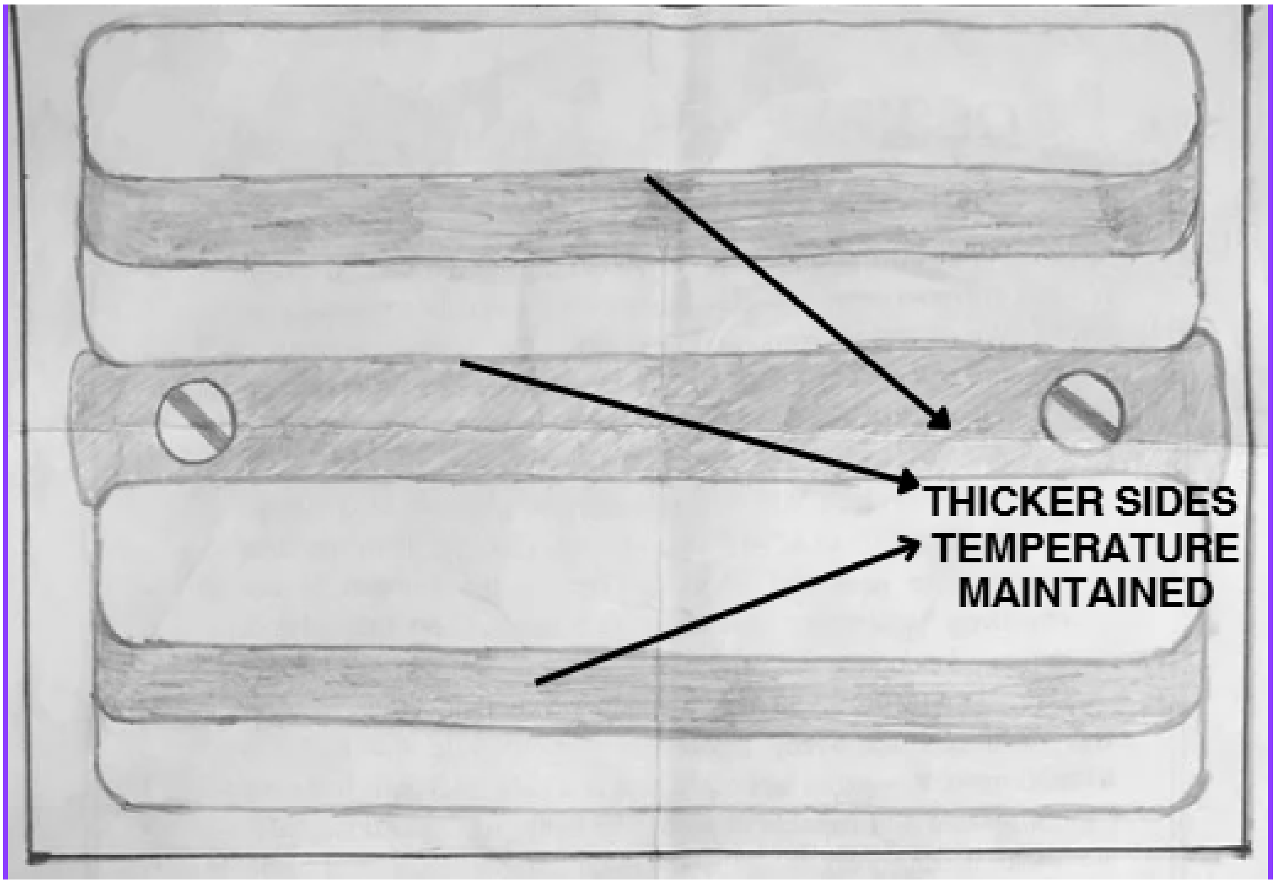


COMPARISION OF NEW ATDMC MOLD 51,52 & CURRENT ATDMC 43,44/45,46/47,48:

The new mold features uniformly thicker sides along the riser section, which help maintain the temperature of the molten metal and prevent rapid cooling. This new ATDMC mold is similar to previously used Taiwan 23,24 mold. This design ensures consistent thermal management, reducing the chances of shrinkage defects and resulting in better casting quality. In contrast, the current ATDMC mold has thinner sides along the riser section that allow the molten metal to cool more quickly in these areas, creating significant temperature drops. This uneven cooling leads to localized shrinkage porosity defects, compromising the overall casting integrity. The comparison highlights that the New mold's thicker design provides superior thermal stability, while the thinner sections in the current mold introduce thermal imbalances that negatively affect the casting process.

MOLD THICKNESS AFFECTING FACTOR

The thickness of the mold is influenced by the design of the riser section. Thicker sides around the riser prevent rapid cooling, allowing the molten metal to solidify more uniformly. In contrast, thinner sides result in faster cooling, which can lead to defects like porosity shrinkage. The new mold lower part weighs 33.5 kg, whereas the current ATDMC mold is comparatively lighter at 33 kg. ATDMC utilizes reverse engineering techniques to optimize and refine their molds, ensuring improved efficiency and reduced material usage without compromising quality.



POSSIBLE SOLUTIONS & CONCLUSION

By keeping in view about all the issues in gravity die castng,we as a team came up to result that the department of Atlas Engineering (Aluminium Foundry) can significantly reduce shrinkage defects in the BRIDGE FORK TOP production by implementing some new actions like:

- **Use a Bunsen burner to maintain high temperature of 3 current molds (43-44,45-46,47-48) to reduce shrinkage. However, it is important to note that while the use of the Bunsen burner effectively minimized shrinkage defects, another defect appeared along the parting line.**
- **Use new ATMDC 52-53 mold which has lower defect rate.**

This mold has some key differences compared to the previous ATDMC mold. The bottom part of mold (DRAG) is different in this design, which makes it prone to porosity shrinkage. It requires less machining, is heavier, and thicker at riser sections, which makes it more reliable and capable of producing better results. Additionally, the mold is designed to withstand high temperatures and work effectively in any weather conditions, which is crucial for consistent performance.

BY CONSIDERING AND APPLYING THESE MEASURES, ATLAS ENGINEERING CAN ONCE AGAIN MANUFACTURE SHRINKAGE FREE BRIDGE FORK TOPS AND MAINTAIN THEIR MARKET INTEGRITY.

Also, optimizing and enhancing the worker ability by scheduled training will improve the product quality and surface finish, minimizing the waste and enhance operational efficiency. These steps will ensure the production of reliable, high performance BFT'S meeting industry's standards and customer's expectations.

In conclusion, the two approaches that have proven successful are:

1. The use of a Bunsen burner to increase mold temperature temporarily.
2. The change of mold change will permanently resolve defects but, for now, increasing the mold temperature using the Bunsen burner offers a temporary solution.

Challenges Identified During the Defect Research Process

- **Opportunities for Improvement in Data Collection**

The Aluminum Foundry currently faces challenges in recording and collecting data efficiently. Improving this process can lead to smoother operations and more accurate analysis. Keeping office spaces and workstations clean and organized will also create a better work environment. Adding sitting areas for workers can improve comfort, reduce tiredness, and make the workplace more organized and productive.

- **Need for Enhanced Research and Development Capabilities**

Setting up a dedicated Research and Development Center would help the foundry focus on innovation and process improvement. This step would support the development of new ideas and technologies, contributing to the foundry's growth and eliminate future defects in the casting process.

"Expression of Gratitude to Atlas Engineering"

Atlas Engineering has provided an exceptional platform for practical learning, allowing us to gain invaluable insights into the aluminum foundry processes. The supportive and encouraging environment has greatly enhanced our learning experience. We are deeply grateful for the opportunities and resources provided, which have made this journey both memorable and enriching. Thank you, Atlas Engineering, for this incredible experience.

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