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Minimization of Casting Defects in Aluminum Alloys Wheels through Manufacturing Processes, Quality Control, and Design

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Abstract: ***In vehicle sector diverse kinds of alloys are used for manufacturing the components so that it can progress the enactment as well as dependability of component. But now a days these alloys are being switched to aluminum alloys to produce the vehicle components so that it can maintain good quality associated to other alloys which is being used. During manufacturing of this automobile component the industry should also distillate on quality of the component. The quality of the component can be increased by monitoring the defects and evaluating it. The aim of this project is to drop the casting defects with the help of quality tools and it also shows how design plays major role in manufacturing. The casting defect analysis is carried out by data analysis and Ishikawa diagram techniques. Defects such as shrinkage, crack, porosity, and air inclusion are acknowledged and studied methodically and these defects are shown with the help of cause and effect diagram. Designing of alloy wheels is very important before manufacturing because it helps to know various stresses and strains acting on the wheel and it also benefits to know where the tension is being ensued on the wheel part.***
Keywords: cause and effect diagram, defect of alloy wheel, design of alloy wheel.

I. INTRODUCTION

Over the past two period the use of aluminum casting in automobile production increased. The main purpose of using aluminum in automobile industry is to progress the performance of the vehicle predominantly fuel efficiency. Throughout the production of aluminum alloy wheels the typically used raw material is Al-Si casting alloys. As of their good casting properties and due to these alloys will provide good corrosion
resistance and strength so that vehicle can acclimatize to road and weather condition. While production of aluminum alloy wheels there is an accumulation of Al-Si castings alloys and it also decides to which type of Al-Si alloy to be carefully chosen as a right application for an appropriate product. Some of the main Al-Si alloy casting element are silicon, magnesium, iron, beryllium, zinc, strontium, and titanium. Each of these element has some special feature of casting alloy and alloys are formed with desired properties. The production of aluminum alloy wheels are generally produced by lower pressure die casting for applying this as casting method the Al-Si casting alloy should be elect as high adaptation of permanent mold metal and it is Possible to achieve effective and efficient aluminum alloy wheel production. For each defect. This enables the running to get information on production status and the role of parameters through production.

A. Steps of Alloy Wheel Production Process

It comprise of following steps

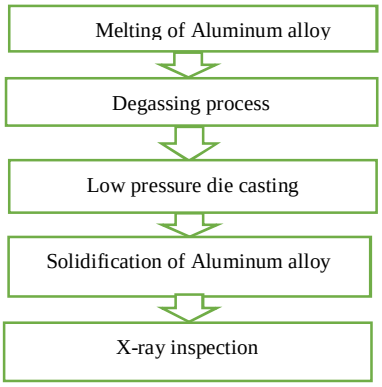

Figure1: Steps of Alloy Wheel Production Process

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II. PROBLEM DEFINITION

The product is considered is alloy wheels. During the manufacturing of alloy wheels various casting defects is formed due to improper method of casting and design analysis is done on the model to check whether the load applied to model is safe..

A. Objectives of Paper

The main objective of this project is to reduce the defects which occurs in alloy wheel while casting and by using quality control tool the quality of the product is improved and defects are minimized and it also shows the role of design helps which plays an important role before manufacturing the wheels.

III. METHODOLOGY

During production of aluminum alloy wheels examine the defect being caused during the casting process of alloy wheels mostly analyze of defect is done by using techniques like historical data, fishbone diagram, and root cause analysis and by design of experiments. But in these Fish bone diagram and Pareto diagram is used to identify the defects. There are steps followed to identify the defects of casting process.

The defect should be recognized correctly during the time of casting process.

Once the defect is identified from the casting process then select among the best quality tool should be applied to control the defects so that in order to improve the quality of the product.

If there is wrong implementation of quality tool on the identification of defect then the defect will be increased and it would be very difficult to control it.

A. Fishbone Diagram

Now in these diagram th**e** defects are recognized during the production process of wheel so in such situation these tool is used and due to these diagram and all the defects are exhibited and all the data are collected and on this collected data numerous analysis are being done.

IV. ANALYSIS

To determine the rejections in castings, data for existence of defects is used Al alloy casting industry. By means of this data analysis it helps to identify existence defects in aluminum alloy castings. The details are shown in Table 1. Rejection in castings

Defects	Rejection in casting	Cumulative number	Cumulative %
shrinkage	4080	4080	38.63
porosity	2614	6694	63.32
crack	1413	8107	76.69
inclusion	989	9096	86.05
unfilling	414	9510	89.96
profile damage	196	9706	91.82
distortion	187	9893	93.59
metal sticking	157	10050	95.07
gas hole	124	10174	96.24
mismatch	89	10263	97.09
grinding shade	71	10334	97.76
half cycle	53	10387	98.26
below range	48	10435	98.71
ejection pin	44	10479	99.13
dents	39	10518	99.50
above range	27	10545	99.75
mesh	19	10564	99.93
without mesh	7	10571	100

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V. ROLE OF DESIGN IN MANUFACTURING

The ANSSYS software is used to construct the static load finite element model of steel wheels meant for simulating. There is two form of material used whose remain structural steel and Aluminum. The equivalent stress fullness is calculated established on the nominal stress method by in view of the effects of mean capacity, size, weakness notch, surface texture and scatter causes. The fatigue life of aluminum wheels as well as structural steel are anticipated by using the equivalent stress amplitude. The analysis revealed that the baseline wheel unsuccessful the test and its crack initiation remained around the hub bolt whole area that approved with the simulation. Circumstances von-misses stresses are less than ultimate strength. Deflections in aluminum are more when compared to steel. In modern years, FEA has been used nearly universally to solve structural engineering problems. One and only discipline that has depend on severely on this technology is the Automotive and Aerospace industry. Automotive and Aircraft companies need to confirm that none of their components fail, that is to stop providing the FEA has been used regularly in high volume assembly and manufacturing Industries for many years. As to get a product design wrong would be harmful. Diverse types of materials used at current work basically concentrated on two types of materials i.e. Aluminum and Stainless Steel alloy.

VI. ANALYSIS PROCEDURE

A. Procedure followed in designing the wheel

1) Note down the specification of the wheel

Table 2: Specification of wheel

Rim diameter	400mm
Rim width	360mm
Offset	132mm
Pitch circle diameter	90mm
Hub diameter	110mm

2) Drawing the model according to specification in CAD model.

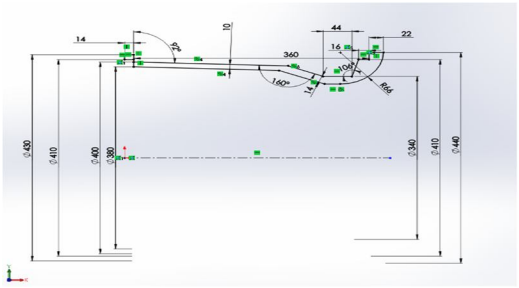

Figure 3: CAD model of wheel

3) CAD model drawn

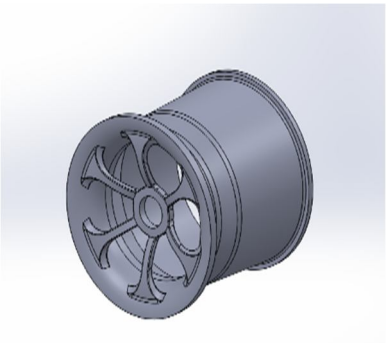

Figure 4: Model of wheel

4) After CAD model is drawn then it is run in ANSYS software for various analysis.
5) Consider the material properties of alloy wheel.

Table3: Material properties

Materials properties	Units
Tensile stress	230 Mpa
Modulus of elasticity	71 Gpa
Tensile yield stress	185 Mpa
Compressive yield stress	185 a

VII. STATIC LOAD ANALYSIS

Considering the weight of a passenger vehicle at 1200kg, the load is divided to four wheels (i.e. 300kg) to identify safe working load for the wheels by analyzing stress, strain and total deformation etc. which is useful in understanding the role of design in manufacturing.

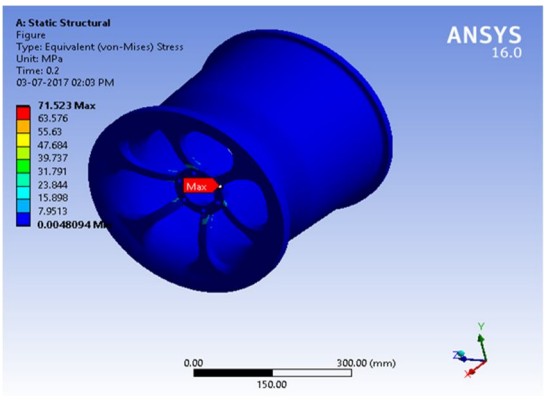

Figure 5: Stress levels in alloy wheel

Table 4: Analysis of wheel

	Stress
Maximum	71.52
Minimum	0

VIII. DYNAMIC LOAD ANALYSIS

This analysis is done by multiplying the load three times for considering the dynamic load case (i.e. 3×300= 900kg). Similar to the static analysis the load is applied to the wheel.

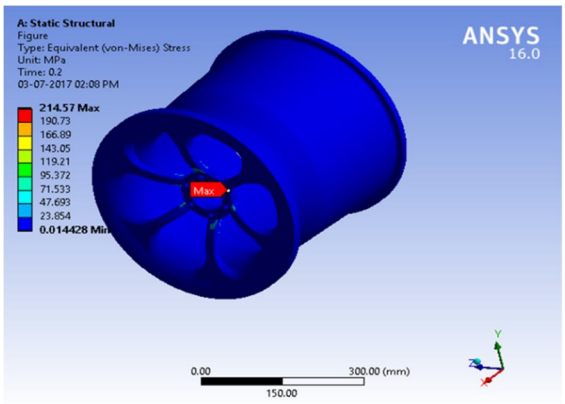

Figure 6: Stress levels in alloy wheel

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Table 5: Analysis of wheel

	stress
Maximum	214.57
Minimum	0

The above results show that the alloy wheel is safe for static analysis but has failed for dynamic analysis because the maximum stress is beyond the yield limit. This wheel is to be modified by increasing the thickness or changing the geometry for actual use in the vehicle.

IX. CONCLUSION

In this study, cast Al wheel production of a big casting plant was studied. Objective was to improve the quality of production by means of the collected data starting the process and Fishbone diagrams were applied

Quality of the production is improved by applying different quality tools and defects are identified by use of simulation software like PRO cast and MAGMA and analysis is done with the help of ANSYS software which helps in knowing the defects of each part of the product and it also helps to know stress strain of the product and also safety life of the product according to the weights applied to the product.

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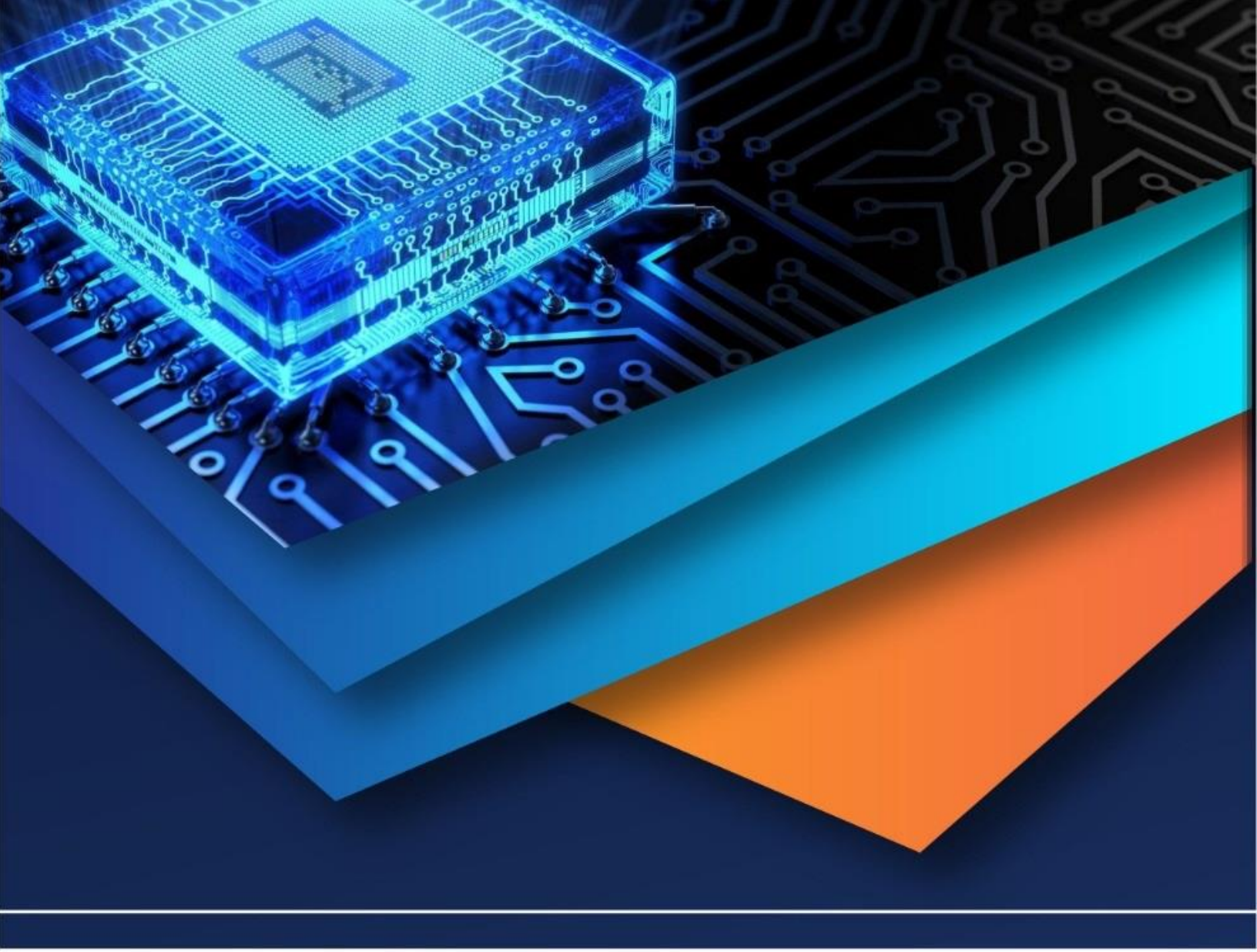

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