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A Review of Optimization of Alloy Wheel Rim

Abhinandan Choubey[1], N. V. Saxena[2]
[1]Research Scholar, [2]Head and Professor
[1,2]Department of Mechanical Engineering, MIT, Bhopal, India

Abstract: The purpose of a car wheel rim is to provide a firm base to hold the tire. The rim design is an important industrial activity that influences the quality of the product. While designing such critical automotive components taking care of protection and costs are very important concerns in order to use it safely. The major technical considerations while modeling any new alloy wheel rim are styling, aesthetic, mass, manufacturability, and capability. The present work deals with a newly designed wheel rim to the analysis of equivalent maximum stresses in medium weight vehicles which have a wide range of scope for research for its improved performance and application. In particular, decisions related to the sizing of the wheel rim, to the number and type of spokes and to the spokes structural layout are addressed. The process relies on the combination of a simplified finite element model of the tire/wheel assembly and artificial neural networks used for global approximation, within a multi-objective optimization framework.

Keywords: Road Safety Elements, Safe Approach System, Plastics, Economic, Long Lasting, Sustainable.

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I. INTRODUCTION

Alloy wheels are made of an alloy of light metals, namely aluminum, nickel, magnesium, or a mixture of these metals. They offer performance benefits over steel wheels, as they are often several pounds lighter weight per wheel - much less weight way quicker acceleration and quicker stopping. less weight also method much less strain on suspension components in extreme driving conditions, alloy wheels are better able to dissipate heat away from brake components than their steel counterparts. this comparative study offers with the searching of new cheaper alloy material that can use as an alternative for high-cost Mg alloy wheel and can overcome different obstacles of pitting, deterioration, cracking and different troubles that place in Mg based alloy.

Selection of a suitable material for wheel rim is a work of utmost importance due to the fact design of rim plays an important role in the overall performance of the vehicle. the magnesium primarily based wheels are similar the other Die-cast wheels. Wheel is a main transfer component between the tyre and vehicle and it is made up of aluminum and magnesium has come to be popular in the market. The wheel must have the following main requirements:

- It must be balanced both statically as well as dynamically.
- It must be lightest possible so that the un-sprung weight is least.
- It must be possible to remove or mount easily.
- It must be adequate to perform the above functions.

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- The wheel material should not deteriorate with weather conditions and period of time. The suitable protective treatment has to be given when the material is alleged to corrosion.

II. IMPORTANTS OF ALLOY WHEELS

Alloy wheels started in racing, but increasingly more humans are putting them on their ordinary vehicles. The general public buy a set of alloy wheels because they decorate the appearance of their motors, but there are simply many different benefits to having them on a vehicle. They weigh drastically much less than their metal-plated competition, at the same time as being notably long lasting. Adding a set of alloy wheels to any car increases the general price of the auto. Depending on the make and model of the car, some alloy wheels can be fitted to offer the automobile more brake clearance. A few specialists claim alloy wheels also boom the fuel mileage and handling with and performance of the vehicle.

- Aesthetic Appeal

- Light weight: Aluminium is the important material that makes alloy wheels so mild. wheels are classified as unsprung weight, which means weight that isn't supported by using the automobile's suspension. unsprung weight makes the vehicle vulnerable to surprise transmission. alloy wheels decrease the unsprung weight, and due to this decrease weight, there is an growth inside the vehicle's managing, specifically within the steerage precision. a lighter wheel additionally makes it easier for the car to boost up, and this will provide drivers a small boom in fuel mileage.

- Durability

- Unique mechanical, thermal and recycling properties.

- Electrical and thermal conductivity

- Corrosion resistance

- Suitability for surface treatments

- The diversity of the alloys and intermediates

- Ease of use

- Recycling

- Face-Cantered Cubic unit cell promotes ductility & machinability.

- Ductility promotes bending failure rather than fractures

Fig 1: wheel rim

III. LITERATURE REVIEW

Pravin Vasant Patil et al. (2024) In modeling the time spent in producing the 3-D models and the risk involved in design and manufacturing process can be easily minimized. For better design results this CATIA model is imported to ANSYS for analysis work. ANSYS software is the latest used for simulating the different forces acting on the component and also for calculating and viewing the results. A solver mode in ANSYS software calculates the stresses, deflections and their relations without manual interventions, reduces the time compared with the method of mathematical calculations by a human. Also, in the weight of component is display by density and size of material.

Sunil N. Yadav (2023) examines the impact of the camber angle on the stress distribution and fatigue life of a car's rim under radial load conditions due to the relief and bumps. The finite element analysis (FEA) is completed by simulating the test conditions to analyze the stress distribution and durability of the car's steel rim.

HTAY HTAY WIN et al. (2021) This paper presents the modal analysis of car's wheel rim of Aluminium Alloy under the value of speed 100km/h. The model of wheel rim is drawn by using SolidWorks 2014 and analysed by ANSYS 14.5. The wheel rim is

P205/75R*15. There are many forces acting on the wheel rim. Inflation pressure acts on the rim at 241kPa. Principal stress theory, von- Mises stress theory, deformation and natural frequency equations are applied by theoretically and numerically.

RishabhIshar et al. (2020) The purpose of this paper is to find the displacement and stress profiles for a truck wheel rim by subjecting it to a number of loading conditions. The paper uses two materials: Al 6061 T6 and Forged steel and two trucks: Eicher 10.59 XP and Tata SFC 909 EX for the analysis. The paper concludes that Al 6061 T6 is a better material for manufacturing of wheel rim from the perspective of mass optimization while forged steel is a better material when only maximum displacement is considered.

KalpeshR.Salunkhe et al. (2019) Wheel is a main mechanical term of the vehicular suspension system that supports the static and dynamic loads encountered during vehicle action. Since cars carry heavy loads of occupants as well as self-weight, the alloy wheel rim should be strong enough to withstand this load. Thus, their design should be done very cautiously. At last the results of total deformation and equivalent stresses are obtained for different wheel rim materials and compared with each other. Thus, the best material can be selected for manufacturing of the wheel rim

S.Ganesh (2017) Alloy wheels would be car wheels made from an aluminum or magnesium alloy, or sometimes a mixture of the two. The light alloy wheels are distinguished from the normal metal wheels by their low weight, which improves the steering and the speed of the vehicle. Alloy wheels reduce the unexposed weight of a car compared to conventional steel wheels. In this project, a parametric model for a light alloy rim used in a four-wheel vehicle is designed to collect data from the reverse engineering method of the current project. The design is evaluated by analyzing the model and converting the rim styles so that they are stable and balanced. The material must not deteriorate due to atmospheric agents and corrosion.

Hongyu Wang (2013) A study was conducted to achieve the streamlined construction of bicycles, the Insight optimization software, integrated into Solid Works and Abaqus. The three-dimensional parametric version of the circle section is mainly based on solid parts. The finite element method is used to analyze stress and displacement distributions in a difficulty level of the rim with a variable section on the joint influence of radial load and inflation pressure.

Liangmo Wang (2011) The fatigue life of the aluminium wheels has been replaced by that foreseen on the basis of the amplitude of the equivalent deformation and the S-N curve of the aluminium alloy rim. The results of the aluminium wheel fatigue test bench show that the reference wheel failed the test and that its crack opening passed into the cavity of the hub bolt corresponding to the simulation. Using the method proposed in this article, the wheel life cycle has increased to over 1.0 × 105 and has met the design requirements. The result showed that the proposed approach to integrate finite element analysis and the nominal stress method is a good effective method for predicting the fatigue life of aluminium wheels.

Haruyukikonishi(2009) implemented a method for impact strength estimation of the automotive wheel has been developed based totally on static FEM analysis and simplified dynamic analysis the use of a mass-spring system. aluminium disk wheels were analyzed, and the critical drop height for failure was estimated. the consequences of two factors, (1) the moment of inertia of the spokes and (2) the thickness of the rim flange, on the impact strength of the wheel were investigated. the analytical results show good agreement with result of the impact test of the forged aluminium disk wheel. in addition, effect tests of cast aluminium disk wheel have been performed. in this case, the failure at the compressive side of the spoke was observed. the mechanism of this kind of failure was discussed based on the results strain measurement

IV. OUTCOMES

In the stress analysis, the stress is much greater in the rim as compared to the disk portion of the wheel and reduction in weight results in cost-saving. The failure of rim wheel is due to crack initiated near the hole and spoke which further gets propagated throughout the rim which leads to fatigue failure. Radial and cornering loads determine the performance characteristics of an alloy wheel for structural integrity. Rim spoke should not break while rough driving condition which can analyze through impact analysis. To improve the fatigue life and reduce the weight in the aluminum wheel rim, critical stresses are determined in the spoke area FEA software.

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