



# A Review On Comparative Analysis Of Steel Wheel Rim And Alloy Wheel Rim Of Car With Various Materials

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**Abstract:** Design of any mechanical element is an initial/primary industrial process that influences the product's quality. In this study we consider an Alloy wheel rim belongs to a very high selling car in India. Both tyre and rim manufacturers beliefs that rim's dimensions, shape should be suitable to adequately accommodate the particular tire required for the car which may leads the easy interchangeability. In this review paper we also have studied the different types of material that we are going to use for analyzing alloy wheel rim. During the survey we planned to study the fatigue analysis of different materials like Aluminium alloy, Magnesium alloy, Titanium alloy and Carbon fiber on the basis of their deformation under load, maximum shear stress of materials, and equivalent stress of the materials. The wheel rim is designed by using modeling software Creo Parametric. The parameters for the rim are considered on basis of industrial standard. Later the Creo model is imported to ANSYS Workbench R19.2 with adequate engineering data with material properties where we simulate the different forces, pressure acting on the rim and calculate and view the results.

**Index Terms** - Alloy Wheel, Alloy Rim, Structural analysis, Aluminium alloy, Magnesium alloy, Titanium alloy

## I. INTRODUCTION

The evolution of automotive wheel since it was made up of wood till date it is forged to alloy which prove itself an important invention in the history of automotive sector. The wheel rim is an element which is wrapped around by the tyre of the vehicle. The rim hold the tire on the inside edge. It provides support to the suspension system during variable loading on vehicle.



Figure 1 Types: Alloy rim; Steel rim

Alloy wheel rim is made by mixture of metals and other materials to form a rigid alloy e.g. Al/Mg. Alloy rims are found lighter and stronger than traditional steel wheels, which improve a vehicle's performance, handling, and fuel efficiency. They also often have a more appealing aesthetic appearance, which can enhance the overall look of a vehicle. Wheel is an important structural member of the vehicular suspension system that supports the static and dynamic loads encountered during vehicle operation. A wheel is a circular device that is capable of rotating on its axis, facilitating movement or transportation while supporting a load. Alloy rims are made from Aluminium alloy and Magnesium alloy. Alloys are composition of a different metal and other element. An alloy provides greater strength as compare to pure metals, and also they have more ductile and much softer. Alloys of Aluminium and Magnesium have light weight as compare to pure metals. It has similar strength and better heat conduction, and alloy wheel provide better look of vehicle as compare steel wheels.

Aesthetic look, comparative weight, machinability and performance are the most important production issues related to the design of a new rim and its optimization correlates after manufacturing. Steel, Magnesium alloy, Aluminium alloys, Titanium Alloy etc. are being investigated for rim manufacturing.

### 1.1 Types of Rims

- Steel Rim
- Alloy Rim

## II. LITERATURE SURVEY

Table 2.1: Literature Survey

No.	Author / Title	Primary Motive	Investigation
1	Monica Namdev A Study of Design and Analysis of Automobile Wheel Rim Using Different Fillet Radius and Different Y Spoke Angle (IJRASET) May 2022	Structural Analysis of two rims with different materials	Three different materials taken into account. Alloy rim proven outperform in total deformation compared to steel rim, max value is 0.00155mm
2	G. Ashokkumar Design and Analysis of Wheel Rim by Using Catia & Ansys (IJRJET) Dec - 2016	Comparison of two types, forged steel and Aluminium in Ansys	Differential performances have been noted accordingly. Performance of the rim is evaluated after it has undergone vibration/modular analysis. Forged steel is optimum materials on the static and modal analytical results obtained. Aluminium wheel rims are exposed under more stress. Von-Miss stresses are lower in both circumstances than ultimate strength. Aluminum exhibits more lateral deformation than forged steel
	Ashish and Suresh Design and analysis of wheel rim using composite materials and carbon fibres June 2021	Automotive rims designing, manufacturing and analyzing with epoxy enforcement	Polymer Nano composites are lightweight and strong, which contributes to increased fuel efficiency. Carbon fibre is an excellent composite material for designing wheel rims. 2 types of carbon fibre considered and compared with Aluminium EC_UD 230GPa EC_UD 395GPa The findings are, carbon fibers are just a better choice for fabricating a rim, and its life can be extended by improving its surface finish.

3	S. Arunkumar Design and Material Optimization of an Automobile Wheel Rim by Finite Element Analysis Volume XII, Issue IV, 2020	lightweight and high strength material optimization for an automobile wheel rim with three materials	The wheel rim subjected to finite element technique. Material taken for investigation: Aluminum alloy 6061 S-Glass epoxy E-Glass epoxy The FEA results proved that the S-Glass epoxy resource automobile wheel rim deformed less and generated a greater values and moral principles stress distribution than other two
4	Mr. Chintapalli Shekhar International Journal of Advance Scientific Research And Engineering Trends Volume 5 Issue 7 July 2020	Designing a new alloy wheel rim considering following factors: styling, aesthetics, mass, manufacturability, and capabilities	Shear stress distribution in vehicle wheels subjected to increased pressure and radial load is examined while stress and displacement are examined. An alloy wheel rim was created using the Catia software. Static analysis was then performed on three materials under various loads considering the load and boundary conditions in ANSYS14.5: Carbon epoxy composite AL6061 Mg alloy findings of stress, total deformation, and shear stress were observed and compared between different wheel rim materials with hexagonal and elliptical spoke shapes.
5	Kalpesh R. Salunke International Advanced Research Journal in Science, Engineering and Technology Vol. 4, Issue 9, September 2017	Study of Parameter Estimation Techniques like Ansys workbench.	When examining the distribution of stress and displacement in vehicle wheels under increased Radial load and pressure. Utilizing ANSYS software, static structural study of the alloy wheel rim was performed using a range of objects, loads, and model parameters. Total deformation and equivalent stresses for various wheel rim materials are produced and evaluated.
6	Chaitany Sureddi Design, Material Optimization and Dynamic Analysis on Automobile Wheel Rim Volume 8, Issue 11, November 2018	Replacing the Rim materials with Composites	Composite materials are used to lighten the rim weight Finite element computations find the mass of the wheel rim from the current alloy wheels can be reduced. The stresses created by the rim will be less than the yield stress after optimization.
7	Aaron Ressa DEVELOPMENT OF A CARBON FIBER WHEEL RIM	Design a laminated carbon fibre composite rim	The elected design reduced the wheel's weight by nearly 50%. The composit is heated to 250°F with a 2°F per minute ramp and then temperature soaked for 2 hours. Because the composite lacks a

			cooling system, the pressure is let go after the heat soak and the part is permitted to cool naturally for approximately two hours until it reaches 150° F. The part is then taken away from the composite
8	Liangmo Wang Journal of Mechanical Engineering 57(2011)1, 31-39	Determination of rim's fatigue life	Aluminium wheels was created using the ABAQUS Simulate the rotary fatigue test. Based on the nominal stress approach, the equivalent stress amplitude was estimated by taking into account the effects of the mean load, size, fatigue notch, surface polish, and scatter variables. The equivalent stress amplitude and aluminium alloy wheel S-N curve were used to forecast the fatigue life of aluminium wheels. The findings of the aluminium wheel rotary fatigue bench test revealed that the baseline wheel failed the test and that the crack's initiation point coincided with the simulation in the hub bolt entire region. The wheel life cycle was increased to over 1.0105 using the technique
9	Yashwath Kandukuri Sai J. Inst. Eng. India Ser. C (August 2022) 103(4):939–94	The current work investigates lightweight composite wheel rims with improved stiffness to lower the weight of the formula car	Conventional wheel rims have been made of monolithic materials such as aluminium and magnesium alloys. The drawbacks of composite wheel rims include things like difficult fabrication, high cost, and complex design. After examining various alternative materials, the design and finite element analysis of carbon fibre wheel rims were done in the current work to replace the Aluminium wheel rims.

### III. PROBLEM FORMULATION

To design and analyze an optimized alloy wheel rim that minimizes weight while maintaining necessary structural integrity under various loading conditions, aiming to improve vehicle performance and fuel efficiency by exploring different material compositions and design parameters to reduce stress concentrations and potential failure points.

#### Key points:

**Focus on weight reduction:** Alloy wheels are often chosen for their lightweight properties, so optimizing the design to minimize material usage while maintaining strength is crucial.

**Structural integrity:** The design must withstand various forces acting on a wheel like impact loads, bending stress, and torsional stress during driving conditions.

**Material exploration:** Investigating different aluminum alloy compositions to find the best balance between strength, weight, and cost.

**Design parameters:** Exploring design features like spoke geometry, rim width, and hub dimensions to optimize load distribution and stress reduction.

#### IV. PROBLEM STATEMENT

To develop a novel alloy wheel rim design incorporating advanced manufacturing techniques to achieve superior strength-to-weight ratio and improved fatigue life compared to conventional alloy wheels.

To investigate the feasibility of using composite materials in conjunction with aluminum alloys to create a lighter and more resilient alloy wheel rim for high-performance vehicles.

To analyze the impact of different driving conditions (e.g., aggressive braking, rough roads) on the structural integrity of an alloy wheel rim and propose design modifications to mitigate potential failure points

#### V. METHODOLOGY

Design automotive wheel rims in CAD Modelling Software CREO Parametric.

Perform FEA analysis in ANSYS Workbench.

Compare materials for different alloy materials

Study the fatigue life of a rim.

Optimize thickness of rim and to reduce the material consumption.

Compare Result values.

#### VI. CONCLUSION

This survey of various research articles on different types of materials for alloy rim of a car optimized that every material that we studied with different opinions and result outputs of various researchers has its own strength, machinability. But out of all we would like to conclude that material for production of alloy wheel rim is Aluminium Alloy as it is easily available moreover, the cost of manufacturing of Aluminium alloy wheel rim is also cheaper in comparison to magnesium, titanium and CF. Aluminium alloy has more strength, machinability and non-corrosive characteristics compared to any other material like steel, magnesium and titanium alloys. We also found that in comparison with other material under fatigue analysis, Aluminium alloy is long lasting and less susceptible to break under sudden load.

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