

Design Modification and Analysis of Automobile Wheel Rim Using Finite Element Analysis

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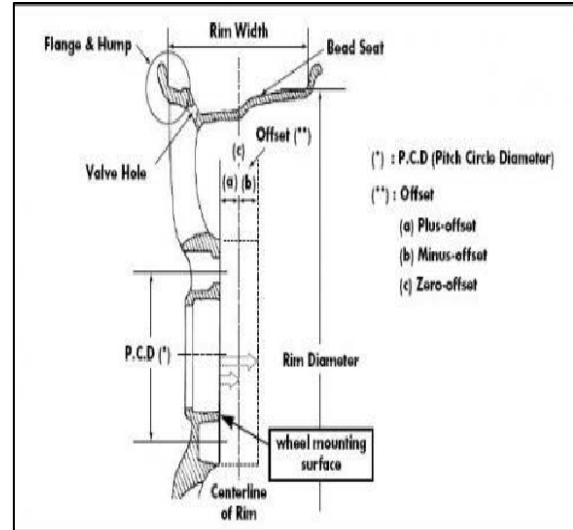
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Abstract— Importance of wheel in the automobile is obvious. The vehicle may be towed without the engine but at the same time even that is also not possible without the wheels, the wheels along the tire has to carry the vehicle load, provide cushioning effect and cope with the steering control. Generally wheel spokes are the supports consisting of a radial member of a wheel joining the hub to the rim. Spokes make vehicles look great but at the same time they require attention in maintenance. To perform their functions best, the spokes must be kept under the right amount of tension. If a spoke does break, the wheel generally becomes instantly unbalanced also the hub may break. The purpose of the car wheel rim provides a firm base on which to fit the tire. The motorcycle riders are subjected to extreme vibrations due to the vibrations of its engine, improper structural design of the motorcycle and the bad road conditions. So in this project the attempt has been made to reduce the vibrations of vehicle by providing springs instead of the spokes at the wheel. The springs will work as suspension members at wheels as well as they will provide proper strength that is adequate to proper operation of the wheel. The CAD model of a motor cycle will be made in solid works and later it is analyzed in ANSYS 14.5. The results of suspension of ordinary wheel rim and spring based rim will be compared.

Key words: Wheel rim, solid works, ANSYS, Stress Analysis

NOMENCLATURE OF WHEEL:

- Wheel: Wheel is generally constitute of rim and disc
- Rim: This is a part where the tire is installed
- Disc: This is a part of the rim where it is fixed to the axle hub
- Offset: This is a space between wheel mounting surface where it is bolted to hub and center of the line.
- Bead Seat: Bead seat approaches in contact with the bead face and it is a part of rim which holds the tire in a radial direction
- Hump: It is a bump what was put on the bed seat for the bead to prevent the tire from sliding off the rim while the vehicle is moving



I. INTRODUCTION

Several thousand years ago was the start of the history of wheel when the human race began to use the log to transport heavy objects. The original of the wheel were the round slices of a log and it was gradually reinforced and used in this form for centuries on both carts and wagons.

There are many different types of wheel rims and they can be divided into many types depending on the manufacturing processes material used etc. As shown in Fig.1 shows different kinds of wheels like steel disc, aluminum alloy and spoke wheel which all are used for different purposes today.



Steel Disc Aluminium alloy Spoke Wheel

Fig 1: Types of Wheel rim

The steel disk wheel and the light alloy wheel are the most typical installation. The method of manufacturing the light alloy wheel, which has become popular in recent years, is explained here. The manufacturing method for the light alloy wheel is classified into two. They are cast metal or the forged manufacturing methods.

Accordingly they also can be divided into one-piece, two piece and three-piece rims. Wheel rims can be made by different manufacturing methods like casting and forging.

The present scenario in automobile industry focuses on continually reducing weight of the automobile

and maintaining the efficiency constant or increasing it. Different material has been used on the same design for reducing weight of the automobile and still materials or design modifications scope are there to reduce weight as well as maintain efficiency. Another most important aspect is to reduce the vibrations at as least as possible to get a comfortable ride.

II. LITERATURE REVIEW

Saurabh M Paropate* et al.[1] a parametric model was designed for Alloy wheel used in two wheelers from existing model of pulsar 150 cc. For modal analysis, the model was built, loads were applied and solutions were obtained. A fatigue lifetime prediction method of alloy wheels was proposed to ensure their durability at the initial design stage. Aluminum, magnesium, carbon fiber and thermoplastic resin were analyzed for the present model. For all comparing the three materials of stress, displacement, total deformation, weight, and cost of material suggestion was that the thermoplastic resin is best material for wheel rim but due to their high manufacturing cost presently we are not using this material.

S Vikranth Deepak¹*, C Naresh and Syed Altaf Hussain[2] In this project a parametric model was designed for Alloy wheel used in four wheeler by collecting data from reverse engineering process from existing model. Car model is Ford Fiesta. Aluminum, zinc and Magnesium materials were compared for model and analysis showed that aluminum alloy was best for the model of wheel rim for load, factor fatigue life, stress, strain, total deformation etc.

Ravi Lidoriya, Sanjay Chaudhary and Anil Kumar Mohopatra [3] In this project work the entire wheel design of two wheeler was chosen and analyzed by applying different load and redesign the wheel again to minimize the deformation and material will be changed from aluminum to PEEK(polyether ether ketone). After analyzing all the materials it is clear that PEEK 90HMF20 is best material for the replace of Aluminum material.

Saran Theja M1, Shankar G, Vamsi Krishna M[4] A typical alloy wheel configuration of Suzuki GS150R commercial vehicle is chosen for study. Finite element analysis has been carried out to determine the safe stresses and pay loads. The present work attempts to analyse the safe load of the alloy wheel, which will indicate the safe drive is possible. The author derived that stresses induced in 4-Spokes Alloy wheel are less as compared with Al-Alloy of the 5 and 6 Spokes. The weights of the Mg alloy with 4-Spokes wheel is less as compared with Al-Alloy of the 6, 5 and 4 Spokes. Fatigue life cycle for the Mg-alloy is more as compared with all Al-alloys materials.

V. Karthi, N. Ramanan, J. Justin Maria Hillary[5] The project was to design the motor cycle alloy wheel using the PRO-E and Analyze with the ANSYS. The analysis is done with the maximum load can be applied on rim. The rear wheel and front wheel have their own maximum load that can be supported. The best one is titanium alloy to compare with aluminum and magnesium alloy 'But the cost of the titanium alloy is high. It should corrosion resistance and also the life is more.

N. Satyanarayana & Ch.Sambaiah [6] In this paper a detailed "Fatigue Analysis of Aluminum Alloy Wheel under Radial Load". During the part of project a static and

fatigue analysis of aluminum alloy wheel A356.2 was carried out using FEA package. They found out the total deformation, alternative stress and shear stress by using FEA software. And also found out the life, safety factor and damage of alloy wheel by using S-N curve. S-N curve is input for a A.356.2 material.

Mr. Sunil N. Yadav, Prof. N. S. Hanamapure [7] this work was aimed to investigate the effect of slip angle on stress distribution and fatigue life for radial fatigue testing SAE J328 standard was used. The stresses are much higher in the disc area than the rim area. The likely failures locations identified in the wheel rim by finite element analysis are stud holes, stiffening buldge and ventilation holes.

Jaimon Dennis Quadros, Suhas, Vaishak N.L [8], Shilpa.B4 An attempt has been made to analyze and obtain the idealized operating conditions of the human body. The analysis has shown that for the given vehicle and human body, the idealized operating speed for HERO HONDA SPLENDOR vehicle on the terrain of specified amplitude at given input is found to be 49.66 km/hr on the frequency of 8 HZ.

T. Siva Prasad,T. Krishnaiah, J. Md. Iiyas, M.Jayapal Reddy[9] static analysis work was carried out by considered two different materials namely aluminum and forged steel and their relative performances have been observed respectively. In addition to wheel rim is subjected to modal analysis, a part of dynamic analysis is carried out its performance is observed. In This paper by observing the results of both static and dynamic analysis obtained forged steel is suggested as best material.

BGN Satya prasad M Anil kumar[10] Here a mass reduction of 340gm per wheel is achieved which mounts to 1.7kg per car considering the spare wheel. This mass reduction results in two benefits. Decrease in total weight of the car and decrease in cost of production by doing topology optimization.

Rajarethinam P, Periasamy K[11] . Stresses induced in 5Spokes Alloy wheel are less as compared with Al-Alloy of the 6 Spokes. The Induced Stress due to braking torque in the 5 Al-Spoke wheel are lesser than the remaining wheels. Material reduction can be done by reducing number of Spokes.

P. Meghashyam, S. Girivardhan Naiduand N. Sayed Baba[12] In addition to this rim is subjected to vibration analysis (modal analysis), a part of dynamic analysis is carried out its performance is observed. In this paper by observing the results of both static and modal analysis obtained forged steel is suggested as best material. By comparing the aluminum and forged steel the conclusion was made that the behavior of forged steel was better than aluminum since in both the cases von-mises stresses is less than the ultimate strength, talking deflections into account.

Shivakumara BS[13] The literature review reveals that the vibrations are most hazardous to the health if it exceeds the limit. The experiments were conducted to measure the magnitude of the vibrations acting on the rider during motorcycle riding under various road conditions.

The vibrational effects are more hazardous on motorcyclist. As for as possible, measures is to be taken to avoid prolonged exposure to vibration.

III. CONCLUSION

From review of above literature we can conclude the following points:

- Wheel rim of different composite material can be made out like tungsten, aluminum alloy, zinc alloy wheel etc.
- Composite material reduces the overall weight of the automobile hence enhances more mileage of it.
- Fatigue life Analysis has to be done in accordance to stress analysis to know the exact lifecycle of wheel rim.
- Vibration is also the most important criteria nowadays so design changes should be done to reduce the vibration and have a comfortable ride.
- Wheel rim parameters like rim diameter, camber angle caster angle hub diameter and hub width are to be changed and rim's topology has to be optimized.

The objective for my PG dissertation is to modify the conventional design of wheel rim in order to have reduced weight and low vibration and to analyze it and also to compare the results with conventional wheel rim.

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