

A REVIEW ON MATERIALS USED FOR WHEEL RIMS

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ABSTRACT

Wheel rim is an inseparable part of an automobile. Its main functions are to help propulsion of a vehicle on the road as well as withstand against the vehicle weight and practical conditions such as turning and braking, environmental conditions. In automobile wheels rotates continuously during propulsion therefore total load on a vehicle induces alternating fatigue stress in a wheel rim. In order to sustain all loads and practical conditions wheel materials must be of good quality. This paper presents various materials used for wheel rims and their properties such as thermal conductivity, corrosion resistance, price, availability, maintenance, rim manufacturability from that material, availability, manufacturing processes as well as advantageous and disadvantageous of materials.

Keyword: - Rim materials, Properties, Cooling, Cost, manufacturability, Al 356, Steel C 1008, Forged steel.

1. INTRODUCTION

Wheel rim is an inseparable part of an automobile mounted on the axle hub of a vehicle. Its main functions are to rotate over the axle of a automobile so as to use power from engine to propel automobile, provide support for braking system over its body, dissipate heat generated in the body of wheel rim to surrounding environment, support whole body weight as well as withstand against impact load due to pot holes and road irregularities with constant load of rider body as well as constant tyre pressure.



Fig-1 Wheel rim of a scooter showing various parts

1.1 Introduction to wheel rim materials

Wide varieties of materials are available in the market can be used for wheel rims. In ancient period wheel rims are manufactured from single piece wooden material, after some millennium metals are evolved and a circular ring are mounted over wooden spoke wheel rim in order to avoid the wear of wheel due to road surface. At the end of

eighteenth century a wire spoke wheel rims was used in an automobile after evolution of first engine and car. Wire spoke wheels used up to 1920. After first world war rim design revolution takes place and wire spoke wheels replaced by a sheet metal and casted wheel rims. However rim manufacturing process changed its testing methods as well as basic design requirements are same yet. Now a day following materials are generally used for wheel rim: Al alloys, Mg alloys, Steel 1008, forged steel, Carbon fibers [3].

1.2 Manufacturing processes of wheel rims

Casting [4], forging, press working are the three main manufacturing processes are used for the production of any type of automobile wheel rim. In any wheel rim types of defect occurred such as manufacturing defect and service defects. The defects introduced during the manufacturing process are known as manufacturing defects while defects introduced during service life of wheel rim are known as service defects. In casting several types of casting processes are used such as low pressure and high pressure die casting, gravity die casting, squeeze and centrifugal. Generally casting introduces so many types of defects such as blow holes, subsurface defects cavities, porosity and uneven shrinkage [4]. Parameters of wheel rim design vary as manufacturing process changes. Forging is one of the excellent manufacturing methods for better quality rim, but this method is very costlier as compare to other methods. Rims of heavy vehicles such as truck, trolleys and tempos are manufactured from forging method. Press working method is used to manufacture the rims which are used for light duty vehicles, scooters, auto rickshaws etc. Generally press worked rims are two piece wheel rims.

2. LITERATURE REVIEW

The Aluminium Automotive Manual (2011) has studied the various types of wheel rim materials with its advantageous, disadvantages, rim manufacturing processes, mechanical properties of materials, aluminium sheet metal wheel rims as well as basic requirements of rim. But research is limited to only aluminium material and not explained the other types of materials. According to this manual basic requirements are strength, structural stiffness, fatigue behaviour and crash worthiness etc [1].

M. Sabari et.al (2015) has studied the comparative study of car wheel rim materials for its deformation with the help of FEA methods. In his study he considered two materials namely carbon steel and aluminium alloy. CAD model of both material has drafted using Solidworks software and then analysis performed by using CATIA software. In this research researcher changed the two parameters such as load applied and speed of wheel rim. By changing load and cruising speed rims has analyzed also graph of maximum displacement against speed plotted and it is found that as speed increases displacement of both material increases. Displacement in alloy wheel rim is more than the steel.

T. Siva Prasad et.al (2014) has studied the properties of various types of wheel rims with advantageous and disadvantages of various materials such as Al, Mg, carbon fiber, steel, etc. he studied comparatively aluminium and forged steel for static displacement, von Mises stress and dynamical displacement. Researcher found that stress induced as well as displacement of aluminium wheel rim is more than the forged steel. Researcher suggested forged steel is best material for a wheel rim [3].

N. Satyanarayana et.al (2012) has studied the over casted Aluminium alloy (Al.356.2) wheel rim for finding fatigue behaviour under constant loading. Researcher not considered the comparison of Al.356.2 with other types of materials.

Sourav Das (2014) has studied the design and weight optimization of sport utility car wheel rim by taking AlSi7Mg0.3 aluminium alloy wheel. According to researcher and wheel rim material manuals aluminium alloys, magnesium alloys are light in weight, very good heat conductor as well as excellent aesthetic appearance. Ductility of magnesium alloys is very low as compared to aluminium alloys. Also magnesium rims are not repairable after it's bending [5].

S. Ganesh et.al (2014) has studied the Al 356.2 aluminium alloy wheel for spiral wheel rim used for four wheel vehicles and given the properties of various rim materials with some drawbacks. Paper said that magnesium rims are strong enough but not suitable for off road vehicles yet they are used in a Mercedes-G car models. Only one big disadvantage of magnesium is bent rim cannot be repaired therefore such rims are directly fall in scrap [6].

3. CONCLUSIONS

Wide varieties of materials are available in the market which can be used for the wheel rim. Generally used wheel rim materials are Al alloy, Mg alloy, Steel C 1008, Forged Steel. Each material has some advantages over the other. If original equipment manufacturers require excellent aesthetic shape with very good heat dissipation without

compromise with its associated costs then light weight material such as Al and Mg alloys can be used for wheel rims. But such material can not suitable for off road vehicles, farm equipments (tractor, trolleys and harvesters). For heavy duty vehicles wheel rims Steel C 1008 and forged steel are best materials.

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REFERENCES

- [1]. "The Aluminium Automotive Manual", Version 2011 European aluminium association.
<http://www.european-aluminium.eu/wp-content/uploads/2011/11/AAM-Applications-Chassis-Suspension-3-Wheels.pdf>
- [2]. M. Sabri, M. Rezal, A. Mu'az, K. Shahril, J. Ihsan, "Deformation Behaviour analysis of Car Wheel Rim under Different Loading Using Finite Element Method", international Journal of Engineering and Technology, pp- 181-184, Volume 5, No.3, March, 2015
- [3]. T. Siva Prasad, T. Krishnaiah, J. Md. Iliyas, M. Jayapal Reddy "A Review on Modeling and Analysis of Car Wheel Rim using CATIA & ANSYS" at International Journal of Innovative Science and Modern Engineering (IJISME) ISSN: 2319-6386, Volume-2, Issue-6, May 2014
- [4]. "Fatigue Analysis of Aluminum Alloy Wheel Under Radial Load" by N. Satyanarayana & Ch. Sambaiah at International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Vol-2, Issue-1, 2012.
- [5]. "Design and Weight Optimization of Aluminum Alloy Wheel" by Sourav Das, (CAE Analyst) Altair Engineering India Pvt Ltd, Bangalore at International Journal of Scientific and Research Publications, Volume 4, Issue 6, June 2014 ISSN 2250-3153
- [6]. "Design and Analysis of Spiral Wheel Rim for Four Wheeler" by S.Ganesh and Dr. P. Periyasamy at the International Journal of Engineering and Science (IIES), Volume-3, Issue-4, Pages-29-37, 2014, ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805.
- [7]. "Fatigue life analysis of Aluminium wheels by Simulation of Rotary Fatigue Test" by Liangmo Wang, Strojiniski vestnik- Journal of Mechanical Engineering 57 (2011)1, 31-39.

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