

A Review on Automobile Wheel Materials and Design

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Abstract – The history of road transportation or automobiles leads us back to the invention of wheels. Wheels are considered as the most significant invention of all time in human history, placing it as a vital component in automobile history. From that time onwards optimization and designing of several wheel models have been done. This paper discusses the materials and designs of automobile wheels that has been researched and proposed by different researchers. It primarily discusses best materials that can be used for wheel manufacturing, considering the strength and weight. Also discusses several optimized wheel designs and weight reduction done through shape optimization tools available in ansys and hyper mesh

Key Words: shape optimisation, wheel, strength, weight reduction, materials

1. INTRODUCTION

Wheel is basically a rotating component that rotates on a rigid axle. Wheels are intended for several purposes to move a load, performing labours in machine and majorly transportation. In an automobile wheel is considered as a vital component since development of automobile or transportation leads back to the invention of wheels. This paper majorly discusses about the automobile wheels. Today wheels are classified according to the material used and manufacturing methods. For example steel disk, aluminium alloy etc according to the materials, and cast wheels and forged wheels according to the manufacturing method.

1.1 WHEEL TERMINOLOGY

Before discussing about the materials and designs of the wheels let us look into some important terms and parts of an automobile wheel.

Offset: Distance from centre line to mounting surface that contacts the hub

Centre line: Line that passes through exact centre of rim width

Diameter: The actual height of tire measured through the centre

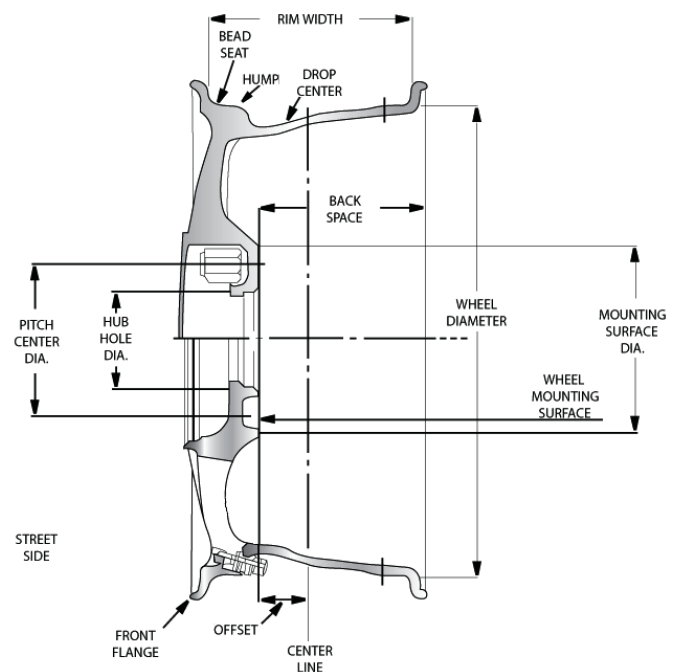


Figure.1.1.1: Terminology of wheel

Section height: The vertical distance between the edge of wheel rim and the top of the tire thread

Section width: The horizontal distance between the tire's side walls

2. LITERATURE REVIEW

2.1 MATERIALS USED IN AUTOMOBILE WHEELS

Yue Bao et al. [1] discussed usage of 'carbon epoxy fiber' (T300/5222) as wheel hub material and compared it with regular aluminium alloy wheels using hyperworks 14.0. The results show that at impact load condition composite material almost same deformation as aluminium alloy with considerable weight reduction upto 11.3%

Table -2.1.1. Comparison of finite element analysis at impact load condition

Material	Composite wheel	Aluminium alloy wheels
Maximum stress/Mpa	288.5	254.5
Maximum Strain	.01612	.03151
Maximum deformation/mm	6.348	5.858

Shewtabh Soman et al. [2] have done impact and modal analysis of several alloy metals that are commonly used for wheel manufacturing. Comparison is done on following alloys

- Conventionally used Al-12% alloy
- Aluminium alloy 5052
- Aluminium alloy 6061
- Ti-5 Al-2.5 Sn alloy
- Ti-13 V-11 Cr-3 Al alloy
- Mg-AZ31B alloy

From the analysis result they suggested that Mg-AZ31B is the best alloy with less deformation with less deformation.

Karthik A.S et al. [3] have done the analysis of aluminium, Titanium, magnesium with ansys workbench 16.5. Their analysis result are interpreted using the following table

Table - 2.1.2. Analysis result

Material	Von Mises Stress(Mpa)	Deformation(mm)
Aluminium	136.43	1.4085
Magnesium	135.64	2.2161
Titanium	135.23	1.037

From the results formulated they concluded that titanium is the best suited material for wheel.

Manivannan R et al.[4] done analysis of wheel rim made by different PEEK(Polyether ether ketone) composites and compared them with aluminium alloy wheel. The materials used for analysis are PEEK with 30% glass fiber, PEEK-90 HMF 20, PEEK-90 HMF 40. The analysis was done on ansys 17.0 software. After study they concluded that wheel using PEEK-90 HMF 20 has the deformation/mm similar to aluminium alloy with considerable weight reduction(15.61 to 8.04) making it as the suitable material

2.2 DESIGN OPTIMISATION OF AUTOMOBILE WHEELS

Mayur Khule et al. [5] have done stress analysis and weight optimization using shape optimization tool available in ansys work bench. The wheel used by them was similar to wheel of ford eco sport using shape optimizing tool they done weight reduction of 15.192 to 4.994 by compromising 6Mpa strength (90mpa to 84Mpa).

Saurav Das[6] done weight optimization on aluminium alloy wheels using FEA and shown that upto 50% weight reduction is possible from existing design. For this study he used Al-Si alloy containing 65-70% si and .3to 11% Mg. Weight optimization was done by him using hyper mesh optimization solver.

Ch. P. V. Ravi Kumar et al. [7] has determined rim thickness of standard cast aluminium alloy for plastic strain value less 4%. Since for standard aluminium alloys plastic strain greater than 4% causes cracking. They have done topology optimization by changing thickness of rim until plastic strain value is less than 4%. They used hypermesh V10.0 for finite element analysis. And impact analysis and plastic strain determination is done through LS- Dyna software.

3. CONCLUSION

Different materials and weight optimized designs have been discussed. On discussing about wheel materials we can understand the increasing potential of composite material replacing traditional alloy wheels. From the discussion of weight optimization using several software and materials we can conclude that proper adjusting of design space of wheel can give satisfying weight reduction without much compromise of strength

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