

## DESIGN AND ANALYSIS OF A COMPOSITE ALLOY WHEEL

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### ABSTRACT

In this project, an alloy wheel which is of casted form is considered. Then by using Computer Aided Design (CAD) the wheel is redesigned. The redesign is the modification of existing design patterns that are already in use. Further it is applied with Finite Elements (FE) with materials such as Magnesium and Aluminium. The purpose of project is to show the alloy wheel made of composite material. Hence, the composite considered here is Carbon Fiber. The Wheel is casted out of metal sheet by offsetting the outer surface to get the wheel structure. Carbon fiber is chosen for its less weight and more strength properties. Later, the analysis is done on the alloy wheel with materials Magnesium, Aluminium and Composite (carbon fibre). The results are compared in a structured manner; this will provide the detailed analysis of the properties of each material when used to create the alloy wheel.

### INTRODUCTION

The alloy wheel is the external round design of the metal on which within edge of the tire is mounted on vehicles, for example, autos. For instance, in a four-wheeler the rim is a loop appended to the external finishes of the spokes-arm of the wheel that holds the tire and tube.

Standard car steel alloy wheel is produced using a rectangular sheet metal. The metal plate is twisted to deliver a barrel shaped sleeve with the two free edges of the sleeve welded together. No less than one tube shaped stream turning operation is carried out to acquire a given thickness profile of the sleeve — specifically involving in the zone planned to constitute the external seat a point of slant with respect to the hub heading. The sleeve is then formed to get the rims on each favour a radially internal round and hollow divider in the zone of the external seat and with a radially external frusta-funnel shaped divider slanted at a point comparing to the standard slant of the rim seats. The rim is then aligned.

To help the barrel shaped rim structure, a circle is made by stamping a metal plate. It needs to have suitable gaps for the middle centre point and

fasteners. The spiral external surface of the wheel plate has a round and hollow geometry to fit inside the rim. The rim and wheel plate are amassed by fitting together under the external seat of the rim and the gathering welded together. Alloy wheel is the piece of car where it intensely experiences both static loads and additionally exhaustion stacks as alloy wheel voyages distinctive street profile

### Nomenclature of Wheel Rim

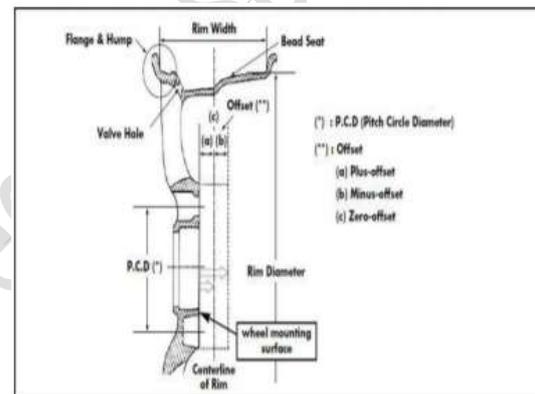


Fig 1: Rim Nomenclature

1. Wheel: Wheel is for the most part made out of rim and disc.
2. Rim: This is a section where the tire is introduced.
3. disc: This is a piece of the rim where it is settled to the hub centre
4. Offset: This is a space between wheel mounting surface where it is rushed to centre and focus line of rim..
5. Flange: The rib is a piece of rim which holds the two beds of the tire.
6. Bead Seat: Bead situate approaches in contact with the dot face and it is a piece of rim which holds the tire an outspread way.

7. Hump: It is a knock what was put on the bed situate for the globule to keep the tire from sliding off the rim while the vehicle is moving.

8. Well: This is a piece of rim with profundity and width to encourage tire mounting and expulsion from the rim.

Steel and light compound are the chief materials utilized as a part of an amalgam wheel however some composite materials together with glass-fiber are being utilized for unique wheels

#### TYPES OF ALLOY WHEELS

##### Wire Spoke Wheel

Wire talked wheel is a central where the outside edge some bit of the wheel (edge) and the turn mounting part are associated by various wires called spokes. The present autos with their high quality have made this kind of wheel make old. This sort of wheel is so far used on incredible vehicles. Light composite wheels have making starting late, an outline to offer emphasis to this spoke effect to fulfill customers frame requirements.

##### Steel Disc Wheel

This is a rim which hones the steel-made rim and the wheel into one by joining (welding), and it is utilized for the most part for traveller vehicles particularly unique gear tires.

##### Light Alloy Wheel

These wheels depend on the utilization of light metals, for example, aluminum and magnesium has come to be prevalent in the market. This wheel quickly wind up noticeably standard for the first gear vehicle in Europe in 1960's and for the substitution tire in United States in 1970's. The benefits of each light combination wheel are clarified as beneath.

##### Aluminium Alloy Wheel

Aluminium is a metal with components of phenomenal daintiness, warm conductivity, rust encounter, physical characteristics of throwing, low warmth, machine handling and reutilizing, and so on. This metals fundamental preferred standpoint is decreased weight, high exactness and design decisions of the wheel. This metal is valuable for

vitality safeguarding in light of the fact that it is possible to re-cycle aluminium effort Lesley.

##### Magnesium alloy wheel

Magnesium is around 30% lighter than aluminium and furthermore honourable with respect to measure steadiness and effect resistance. However, its utilize is for the most part confined to hustling, which needs the elements of weightlessness and high quality to the detriment of weathering resistance and design decision, and so on contrasted and aluminium. As of late, the innovation for throwing and fashioning is enhanced, and the erosion resistance of magnesium is likewise making strides. This material is getting uncommon consideration because of the recharged enthusiasm for vitality preservation.

##### Titanium alloy wheel

Titanium is an excellent metal for erosion resistance and quality (around 2.5 times) contrasted and aluminium, however it is sub-par because of machine handling, designing and more cost. It is still in the improvement arrange despite the fact that there is some use in the field of hustling.

##### Composite material wheel

The composite material wheel is not the same as the light amalgam wheel, and it is produced for the most part for low weight. However, this wheel has deficient consistency against warm and for best quality. Advancement is proceeding.

#### Literature review

Anusha et al. [1] focused on suggesting a new composite material magnesium AZ91E2% Al<sub>2</sub>O<sub>3</sub> to the alloy wheels. The ANSYS software is used to carry out the static and impact analysis. And the results proved that a new proposed composite material is a liable replacement for alloy wheels. The results were produced only for the proposed alloy but there was no comparison done with respect to other materials. Santhosh Kumar et al. [19] did analysis and design optimization of Automotive Wheel Rim. Three materials magnesium alloy, steel alloy and aluminium alloy were used in his study. The author conducts a study on 5 spoke wheel and concludes that Aluminium is the best among the all three materials used. The results are concluded with the help of finite element analysis. The comparison

between the magnesium and aluminium alloy was analysed but no comparison of result is done for the existing and the new wheel geometry. Daniel Antony et al. [2] used a new composition material in their study. The Aluminium alloy PEEK (Polyether ether ketone) with 30% glass fiber and a comparative study for PEEK-90 HMF 40 was carried out, the analysis was carried out to determine displacements and safe stresses using NX NASTRAN software, and results were obtained. The study was limited only to a particular material and a particular design.

**METHODOLOGY**

The process for the creation of finite elements on a CAD geometry of a wheel is described below. Further, application of boundary conditions and a finite element analysis of the wheel are explained. Post-processing tools are used in HyperView to determine deformation and stress characteristics of the loaded wheel.

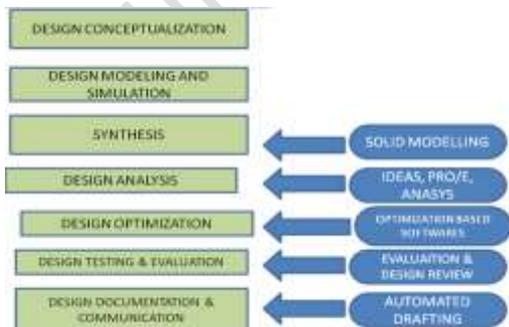
The four objectives to be completed are:

Setting up the problem in Hyper Mesh

Applying Loads and Boundary Conditions

**COMPUTER AIDED DESIGN**

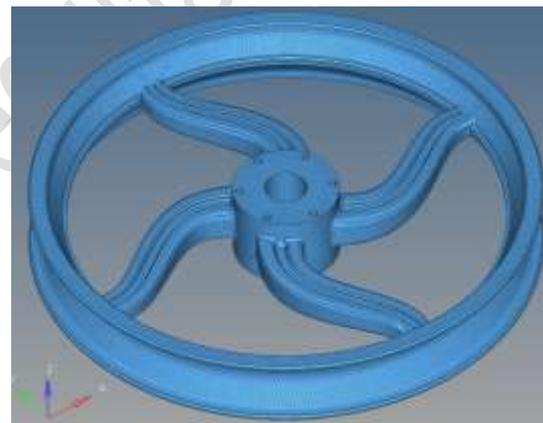
Computer-aided design (CAD) is the use of computer technology for the design of objects, real or virtual. CAD often involves more than just shape. As in the manual drafting of technical and engineering drawings, the output of CAD often must convey also symbolic information such as materials, processes, dimensions, and tolerances, according to application-specific conventions.



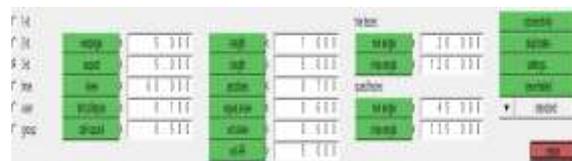
**INTRODUCTION TO CATIA**

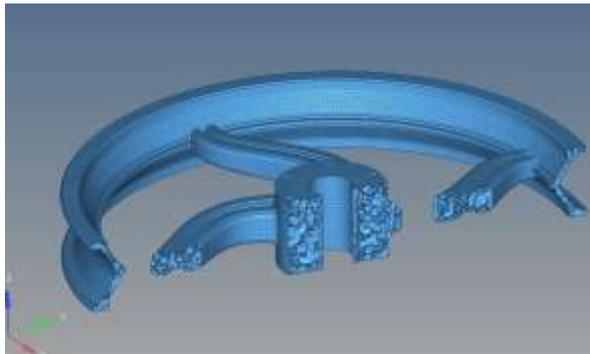
CATIA is an absolutely mechanization programming which relates with the mechanical field. It is graphical UI which is certainly not hard to learn in addition the thing is highlight based and parametric strong showing. We can draw 2D and 3D models of a range and in like way the get-together of the parts should be possible in it. The shape or geometry of the model or assembling is poor upon the qualities which are suggested as objectives. Modules, for instance, sketcher module used to design 2D illustrations, part layout module is used to diagram the 3D models of geometry, and Assembly work arrangement is used to accumulate the different parts which are pulled in the part plot module. Kinematics is used to give the entertainment or development to the part bodies which are arranged and amassed to some degree and get together layout modules.

**BACKGROUND**

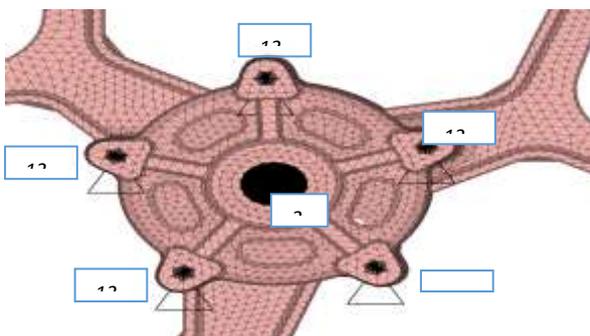
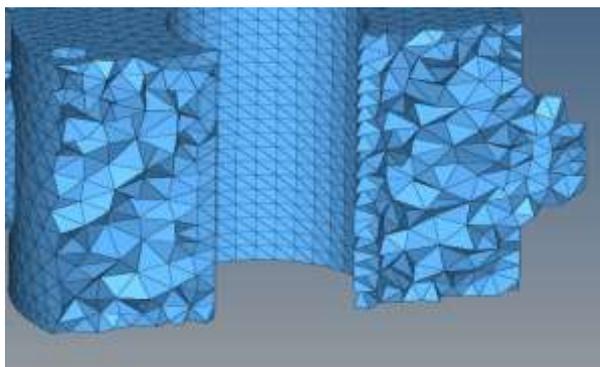


Mesh parameters:-  
Durability considaration  
Element size – 4mm  
Tet collaps - .1





Section View



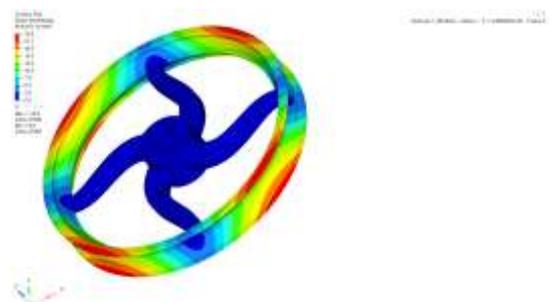
**Step 11: Create pressure load**

The weight of the car on the tire was considered to be 1,000 pounds, which is the maximum load for which the tire is rated. Given that the average car is about 2,000 pounds, which is distributed over 4 tires (500 pounds per tire), the 1,000 pound maximum is about twice what a tire would actually have to support. This weight was applied as a pressure load onto the bottom section of the wheel. Specifically, this load is carried by the part of the wheel called the bead seat, which is the flat area just inside the outer rim.

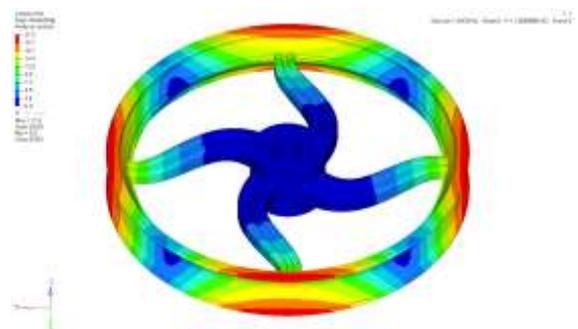
<p>Force: 1000 lb = 4448.22 N          Area: 2900 mm<sup>2</sup>          Pressure = 1.53386 MPa</p>
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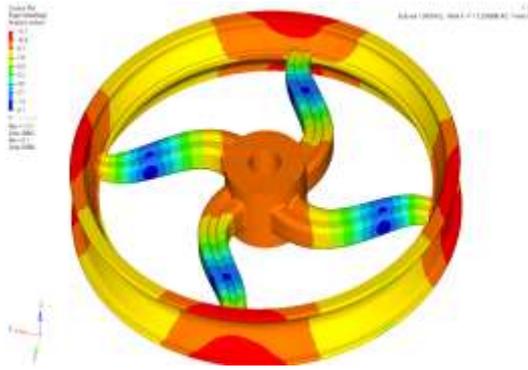
7<sup>TH</sup> MODE – bending



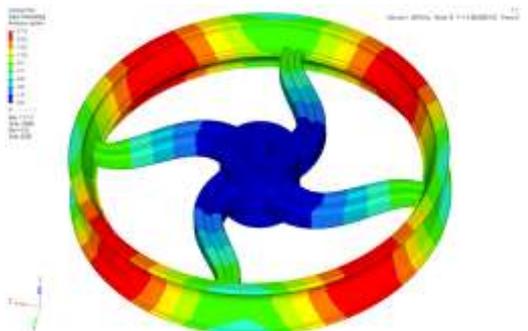
8<sup>TH</sup> MODE – bending



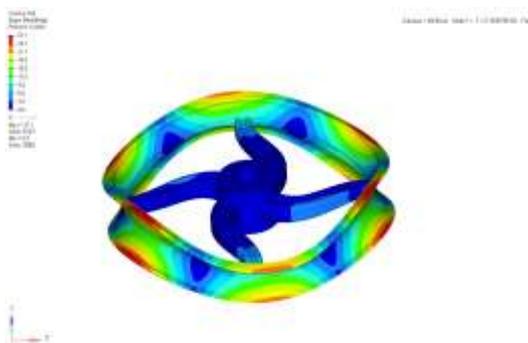
9<sup>TH</sup> MODE – BENDING



10<sup>TH</sup> MODE - bending



11<sup>TH</sup> MODE – Twist



### CONCLUSION AND RECOMMENDATIONS

The process for the creation of finite elements on CAD geometry of a wheel is described below. Application of boundary conditions and a finite element analysis of the wheel are explained.

Hare the casted wheel for the bike is considered for the test case based on that considerations we have done wheel design i.e. casted one and done 3d modal in Catia software checked in analysis over strength point of view and performance point of view and finally observed the wheel is overweight and strength point of view also less performance later the design modification is done in 3d modal this time I have considered the sheets for main case and the

materials also used in instead of aluminum sleeted carbon fiber and tested in FE with the case load cases and done the modal analysis for that so structural frequency is improved and strength point of we observed the better strength then the old one

So coming to the conclusion of this project we have achieved the very good improvement in design point of view as well as the analysis point of view when compare to metallic wheel the carbon fiber has proved the good properties in the final competition. So we can choose the composite bodies for the wheels.

### REFERENCES

- [1] Barbero, E. J. (2008). Finite Element Analysis of Composite Materials. Boca Raton: CRC Press.
- [2] Barbero, E. J. (2011). Introduction to Composite Materials Design. Boca Raton: CRC Press. [3] Mallick, P. (2008). Fiber-Reinforced Composites Materials Manufacturing and Design. Boca Raton: CRC Press.
- [4] Milliken, W. F., & Milliken, D. L. (1995). Race Car Vehicle Dynamics. Warrendale: Society of Automotive Engineers
- [5] The Tire and Rim Association. (2006). 2006 Year Book - Rim Sections. The Tire and Rim Association