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Design and development of carbon fibre Reinforced based alloy wheels with different material for motorcycle

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Abstract

The existing version of Alloy was available on the market with CAD using CATIA V5 software. Finite element Separation and analysis are performed using the CATIA V5 package. FEA has helped to identify areas with greater potential for objects and has also identified areas that can be changed and a well-designed model can be found. In this work, small defects occur in the composite phase of E-Glass Fiber Glass Fabric, also this small modulus is 0.04x109n / m^2. This work provides a comparative analysis of the various types of carbon-composite materials for alloy wheel construction.

Keywords: catia software, fem, fea, mesh analysis.

Introduction

Fuel-efficient vehicles are becoming increasingly popular, as they are being analyzed. Its efficiency is thousands of miles in just one liter of gasoline. The most important factor in these cars is aerodynamics and weight. The car body is well cleaned, causing slight obstruction in the passage to reduce aerodynamic resistance, and light components are used to reduce rolling resistance. The wheels of these cars should therefore be as light as possible. In addition to resisting rolling, the size of the rotating wheel plays a major role. The car only works for a few seconds, so it can accelerate faster, and then drive while the engine is off. Low rotational weight therefore causes the car to accelerate, which means the car is using less fuel. Areas of interest in wheel construction, indicated by:

- Aerodynamics
- Tires compatibility
- Weight
- Rigidity (obtaining low runouts and avoiding vibrations)
- Geometry (minimize the vehicle drag) Carbon fibre offers a low density, increased durability and rigidity, as stated by Chung [1].

In addition, it can easily reflect the geometry of the shape, enabling the construction of a complex wheel. There are two main types of high-strength carbon fiber or high-density modulus modules. The difference between them is based on the method of production. The increase in the modulus of impact elasticity causes a decrease in strength and leads to dense fibers. As the hem is exposed to fatigue and exhaustion, the strongest carbon is chosen. High-strength carbon fibers have high resistance and high strength, as found by Lew [1]. This study shows that without the rule of aluminum and nylon wheels, as shown, the introduction of carbon fiber wheel can reduce the weight of the car by about 15-20% compared to the aluminum disc with speakers, as found by Gomà Golanó [2]. This weight loss is very large compared to full aluminum wheels (about 55%) and much larger compared to nylon wheels or fields used on conventional motors (more than 60%), as described by Maserumule [3].

Backgrounds

It is responsible for transferring power from the moving parts of the car to the road, while also enabling the car to make directions. By designing the tire by adding equipment, it increases the size of the tire and rotating inertia, which negatively affects the performance and efficiency of the vehicle. This has led to significant developmental efforts to reduce tire weight and rotating inertia while maintaining or increasing material strength at the same time [1]. The tire should be designed for safety and light. Many studies have been published on the construction of steel [2, 3, 4] and aluminum [5, 6, 7, 8, 9] wheels. Steel and aluminum wheels are likely to reach the peak of weight loss with building materials that offer the following advantage.

Apart from the high strength of carbon fiber as a vehicle as a result of high power, low density and high fatigue areas, the increase in carbon fiber reinforced plastic (CFRP) wheels and related research studies is limited. Giger and Ermanni demonstrated the process of developing the CFRP motorcycle. However, this wheel was not tested at certified levels. Rondina et al investigated how to produce high-volume carbon fiber wheels. This research mimicked the production process; however, no certified tire appears to have been produced. In early 1979, research was conducted on the effectiveness of compounds that would be used as car tires.

Unlike isotropic substances, CFRP components are expensive to test and verify. Even small changes in geometry to prevent failure or reduce pressures can cause the production line to be refilled during the development process and existing equipment is released. This research paper demonstrates the development of a certified element (FE) model of investigating the suspension of attachment to improve CFRP wheel strength and 18% easier than the original aluminum wheel. Case study on real machine (OE) wheels designed and manufactured by Blackstone Tek (BST).

Effect of material selection

Lightweight is the current trend for the development of the automotive industry, simple quality means low fuel consumption and low emissions. The use of heavy equipment can help to reduce the weight of the car and improve the fuel economy. A report by the World Aluminum Association stated that the quality of the car itself was reduced by 10%, fuel consumption could be reduced by 6% to 8% and emissions by 4% [1]. Currently, an important method for Car lightweight is to use lightweight materials such as aluminum, magnesium, plastic, fiberglass or carbon fiber composites.

The wheel is used as a rotating part. Its heavy effect is equal to about 1.5 times the fixed parts. [2] Therefore, as an integral part of a car, wheels do not survive the practice of easy development.

Currently, domestic and international research on Composite hubs is rare. Xiandong Liu et al. [3] based on OptiStruct module software based on hub topology for thermoplastic efficiency, as well as RADIOSS solver for powerful simulation. The results show that an integrated wheel based on the main factor of major stress failure has a greater safety margin and decreases by 22.3% compared to an aluminum wheel; Bingpeng Li [4] use the manufacture of hot pressure cans made of composite harps to meet the static impact of a load of 600 kg on the 13˚ impact test; Yue Pan [5] Use a long fiber-reinforced glass with thermoplastic construction as a material, including Moldflow, Digimat, Abaqus and other software to mimic the strength of a composite hub under a scattering load. The results show that the anisotropy of the substance has a significant effect on stress and anxiety. Currently, it is not uncommon to report studying tire strength under three types of conditions. Therefore, the analysis of the integrated wheel under three conditions has a large reference value of the integrated wheel.

The overall performance of the Aluminum rim is satisfactory. But the two biggest drawbacks of this are the bad aesthetics and the negative weight on the hardness of the fitness. So to eliminate these two major issues, this year we will be making Carbon fiber rims. Now we will see some basics of carbon fiber and carbon fiber rims. Composite materials are made up of two or more different materials or stages, matrix and reinforcement. The matrix is the weakest part that contains reinforcement and transfers loads. Tightening is usually the strands that support the bulk of the load. The characteristics of a composite object depend on the combination of reinforcement and the matrix. A different combination of matrix and reinforcement is found in an object with high durability, or high strength, or resistance to additional temperatures, etc. What is even simpler is that it is usually lighter than conventional engineering materials (such as metals) while maintaining high mechanical properties. So when you work with composite materials, it's not just about designing a single product or piece, it's also about choosing the right matrix reinforcement - achieving the right things.

One of the most promising building materials is reinforced polymer composite fiber, which is widely used in the aerospace and aeronautic industry and is gaining momentum in the automotive industry. In particular carbon fiber reinforced polymer (CFRP) produces an excellent combination of low density, high modulus durability, high fatigue resistance and heat resistance. The project will therefore focus on carbon fiber-reinforced polymers (CFRP) because they are considered to be the best materials for the study program. Carbon fiber can be found in two main types, with a high-strength modulus (HM) or high-strength (HR). The structural differences are due to their different production lines. Carbon fiber is usually continuous, with a diameter of about 7 μm. The fiber itself provides a degree of anisotropy as the modulus of elasticity is completely different in the longitudinal direction of the fiber than that of the radial. It can be seen in Table 2, which lists their main machine properties. Note that this can vary for a number of reasons; this table provides general information to give an order of magnitude.

Method-finite element method (fem)

The finite element (FEM) method is a widely used method of quantitative problem solving from engineering and mathematical modeling. Common problem areas include traditional fields of structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic power.

FEM is a standard pricing method for resolving divided equations with two or three spatial variables (e.g., other boundary value problems). To solve the problem, FEM divides a large system into smaller, simpler components called finite elements. This is achieved by determining a certain space in the size of the space, which is used in the construction of the object: the solution base number, which has a few points. The formation of a moderate object of the boundary number problem ultimately results in an algebraic mathematical system. The method estimates anonymous activity over a domain. [1] Simple calculations that measure these endpoints are then compiled into a large measurement system that measures the whole problem. FEM then approaches the solution by reducing the associated error function with a calculus of variations.

Typical work out of the method involves:

1. Dividing the domain of the problem into a collection of subdomains, with each subdomain represented by a set of element equations to the original problem
2. Systematically recombining all sets of element equations into a global system of equations for the final calculation.

The global mathematical system has well-known solutions, and can be calculated from the initial values of the real problem to obtain the numerical answer. In the first step above, inventory arithmetic is a simple calculation that geographically calculates complex physical calculations to be studied, where the actual arithmetic is often differentiated (PDE). To explain the limitations of this process, the finite element method is often presented as a special case of the Galerkin method. The process, in mathematical language, is to create a combination of internal product residues and weight functions and set the aggregate to zero. In simple terms, it is a process that minimizes the error of guessing by inserting experimental functions into PDE. The remainder is an error caused by experimental activities, and the weighting tasks are polynomial measurement functions that process the rest. The process removes all local emissions from PDE, thus almost PDE is localized with

1. A set of algebraic equations for steady state problems,
2. A set of ordinary differential equations for transient problems.

These measurement sets are object numbers. Queues if the basic PDE is linear, and vice versa. Equation algebraic sets from solid state problems are solved using straight algebraic numerical methods, while standard equation sets arising from temporary problems are solved by combining numbers using standard methods such as Euler method or Runge-Kutta method.

In step (2) above, a global system of calculations is made from the measurement of objects by the conversion of links from local domains to domains. These spatial modifications include appropriate adjustment adjustments as they are used in relation to the index coordination system. The process is usually performed by FEM software using link data generated on subdomains.

FEM is better understood in its practical application, known as finite element analysis (FEA). FEA as used in engineering is a calculation tool for performing engineering analysis. It includes the use of spaced production techniques to break down a complex problem into smaller ones, as well as the use of encoded software with a FEM algorithm. In implementing FEA, a complex problem is usually a visual system with basic physics such as the Euler - Bernoulli beam equation, heat equation, or Navier-Stokes equations expressed in the PDE or equation equation, while minor subdivisions Problem complex represents various areas in the body system.

FEA is a good option for analyzing problems in complex environments (such as automobiles and oil pipelines), where the domain changes (such as in the duration of a moving border state), where the desired specifications vary across the domain, or where the Solution is not smooth. The simulation of FEA provides an important resource as it eliminates many of the conditions for the creation and testing of complex prototypes in a variety of high-fidelity situations. For example, in pre-accident simulation it is possible to increase the accuracy of prediction in "important" areas such as the front of the car and reduce the rear (thus reducing the cost of simulation). Another example would be the statistical weather forecast, where it is more important to have accurate forecasts for non-linear weather events (such as tropical cyclones, or eddies at sea) than in peaceful areas.

Types of fibers and their mechanical properties

The most common types of fibers used in industry are glass fibers, carbon fibers, and kevlar due to their ease of production and availability. Their mechanical features are very important to know, so a table of their mechanical properties is given below to compare them with the S97 steel. The angle of fiber orientation is very important due to the anisotropy of the fiber compounds (please see the section "Body Structures" for a detailed explanation). Components of composite materials can be tested using standard mechanical testing methods by placing samples at different angles (typical angles of 0°, 45°, and 90°) in relation to the shape of the fibers within the composite. Typically, a 0° axial alignment makes the joints resistant to longitudinal bending and axial tension / compression, a 90° hoop alignment is used to obtain resistance to internal / external pressure, and ± 45° is an ideal choice for obtaining resistance -torsion pure.

Table 1

Carbon reinforcement material name

Material name	Density/weight kg/m^3	Young's modulus of nm2	Poisson ratio
Standard Carbon Fiber Fabric	1600	$0.0143x10^9$	0.1
High Modulus Carbon Fiber Fabric	1600	$0.0118x10^9$	0.1
E-Glass Fibre Glass Fabric	1899.99	$0.04x10^9$	0.2
Kevlar Fabric	1399.99	$0.0333x10^9$	0.2
Standard Unidirectional Carbon Fiber Fabric	1600	$0.0074x10^9$	0.3

High Modulus Unidirectional Carbon Fiber Fabric	1600	$0.0057x10^9$	0.3
E-Glass Unidirectional Fiber Glass Fabric	1899.99	$0.025x10^9$	0.25
Kevlar Unidirectional Fabric	1399	$0.0133x10^9$	0.34
Steel	7860	$2x10^{11}$	0.266
AL	2710	$7x10^{10}$	0.346
Epoxy	1300	$3x10^9$	0.37

Results and simulation

This section presents the results of the simulations. For the purpose of FEA analysis, CATIA Workbench software Version V5 was used. The values for each material are given in the tables below; the stress distributions, depending on the material of the wheel, are illustrated in the figures. Analysis Hypothesis: This result is verified when applied a 10KN force in 20mm Mesh size with parabolic shape in mesh. This result is not fixed because result is case sensitive in System execution 8GB internal storage and Execution situations.

Figure 1. Alloy wheel Design CATIA v5 Software

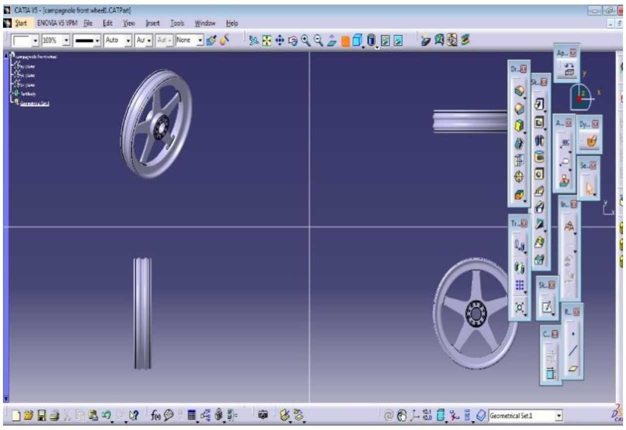

Figure 2. All view of design

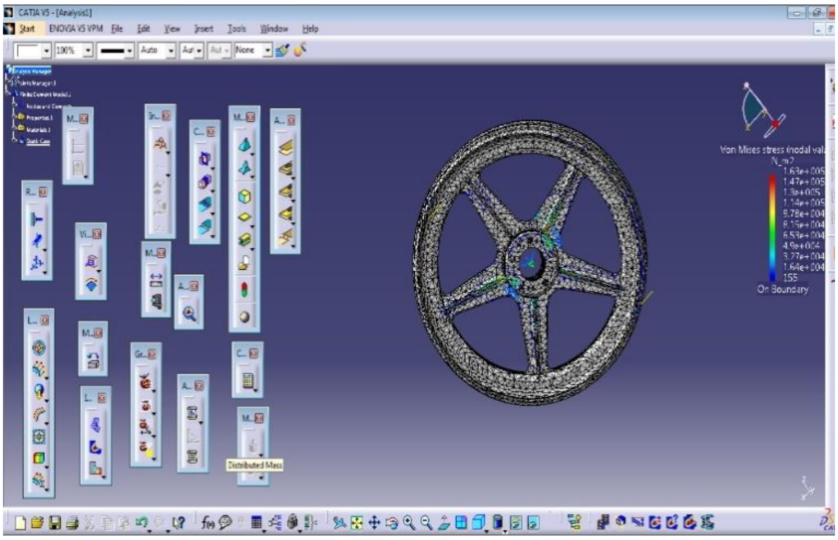

Figure 3. Meshing Elements

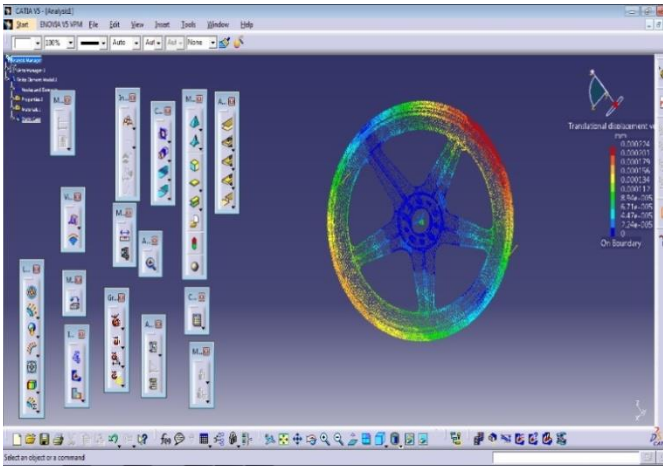

Figure 4. Stress Identification

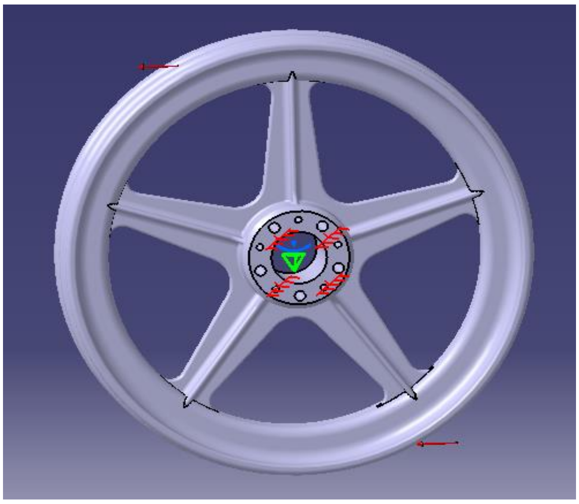

Figure 5. Clam and force direction

Table 2 presents the results obtained for a wheel made from materials. It is noticeable that this wheel has the highest mass, but also the lowest deformation and equivalent stress.

Table 2 *Analysis of material and weight and stress*

Material name	Density/weight kg/m3	Stress (10^4N/M2)
SCFF	1600	4.72
HMCFF	1600	14.4
EFGF	1899.99	14.2
KF	1399.99	15.9
SUCFF	1600	13.9
HMUCFF	1600	15.6
EUFGF	1899.99	15.2
KUF	1399	15.5
STEEL	7860	14.0
AL	2710	15.4
EPOXY	1300	72.4

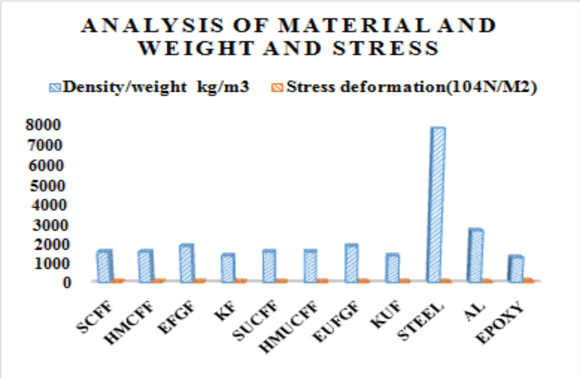

Figure 6. Stress and Material density analysis

Lastly, Table 2 presents the values for carbon-fibre reinforced polymer. In addition to the increased deformation and equivalent stress, a significant mass reduction can be observed.

Table 3

Comparison between previous and proposed result

Sl. No.	Previous result stress	Proposed result stress
1	108mpa	0.047mpa

Conclusions

Optional items are CFRP with very low weight and high disability. Significant deformities in the event of a simulation are based on a high safety coefficient simulation of dynamic conditions. In addition, a CFRP-shaped tire shows a high stress limit. As can be seen in Table 3, the deformities created in the test rig appeared to be low, compared to the applied force. This ensures durability and strength, combined with a magnesium harp producing the right wheel for an urban car light and efficiency.

The scope of the future

In addition, CFRP has a greater advantage than other things: it can be easily constructed into complex geometries. Aluminum mold served its purpose perfectly. Removable center pin is a great idea that helps customize a tire with different hub sizes. The process of supplying it is well suited for the purpose of tire production. Due to the large bend, the geometry of the wheels is complex and the proper flow of resin is an important problem. One of the most important benefits of a CFRP wheel is its impact on the environment, due to its low fuel consumption due to its low weight Acceptance.

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