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WHEELS AUTO MODELING USING FINITE ELEMENT METHOD

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Abstract: The question always arises buying rims "steel or alloy wheels?". In addition to the rims look more appealing than those of alloy steel, there are technical reasons why it tends to use them: reduced weight, starting and braking, rigidity, rapid cooling. Although it can produce sheet steel or cast alloy wheels profile is adopted depending on the specifics of the construction vehicles and the stress faced by their wheels. In this paper we studied the tensions that arise when a wheel is subjected to aerodynamic loading conditions, trying to play the best areas in which attention must be enhanced in order to prevent premature destruction. Using CATIA V5, we designed a concept of light and have undergone a finite element method using different forces and accelerations restrictions in areas where problems occur during use. Calculating the diagrams thus playing rim is observed when the material behavior is tensed and so we can correct the areas that present a danger of destruction. At the end of the method could draw the conclusion which shows the success of the concept, but also design new technologies for observation and verification of parts or assemblies.
Keywords: wheels auto, finite element method, aluminum alloys, stress

❖ Introduction

Although the design is changing rims, some classical models are still within the top preferences. Versions with 4 or 5 spokes or those with cross-spoke wheels are derived from racing cars. The conclusion is that it hides behind the form and function. The shape is derived from this calculation is to provide durability, low weight and hardness. On the other hand there and "trendy wheels" that change from one "season" to another. If these wheels to decide the importance of technical characteristics is the designer and engineer, [4]. Because these types of wheels have a relatively short life focuses on the methods of production as cheap and as fast. Unfortunately, to meet the above conditions, is unable to use the latest technology in the field. On the other hand, car manufacturers tend to include standard equipment alloy wheels. Since their invention in the '50s, alloy wheels have been used to improve machine performance.

In terms of material they are made, the wheels are magnesium alloy (the original version was produced) or aluminum alloy. The magnesium alloys are too fragile to be used on the streets. I'm pretty hard to maintain and limited in terms of resistance to harmful environmental factors. For example, the tendencies to oxidize magnesium have often varnished. Currently this type of wheels used on racing cars participating in such as Formula 1 races held in Indianapolis, etc.. which are continuously monitored by staff members. For normal use of the machines were designed aluminum alloy wheels having a greater resistance to common shocks from a road. They are made in different models, all weighing less than the steel version, [2].

Fig.1. Appearance of some wheels

❖ Methodology

When you think about when choosing a winter set of wheels to choose between alloy and steel wheels. Below we have listed some advantages and disadvantages to light:
- Alloy wheels - is a plus in terms of aesthetics - have a very good precision manufacturing - are lighter than steel rims - have a greater strength and durability - helps to brake
- Requires special care (especially in winter) to avoid damaging action skid materials, dust and mud;
Wheels of steel - Satisfy the requirements of drivers who want a winter set of wheels at the highest price - can be found in two types of finishes (black or metallic);
- Changing the layout is easy and relatively cheap by replacing the protective caps - are cheaper than alloy rims due to lower costs for materials and labor;
The question always arises buying rims "steel or alloy wheels?". In addition to the rims look more appealing than those of alloy steel, there are technical reasons why it tends to use them, fig. 1.

1. *Lightweight compared to steel wheels*. It is the most important asset of alloy rims. Items such as tires and brake system components in the vicinity of the wheel are the most affected by shocks (not protected by any damping system). The weight of these elements is much less requires less energy to be controlled.
2. *Starting and braking*. By reducing the total mass of the vehicle to facilitate both starting and braking.
3. *Rigidity*. A car equipped with alloy wheels will be much easier to control in a curve than on steel rims fitted. It is known that an alloy rim is more rigid than steel, which will influence how it behaves tire mounted on it. This will, in turn, less malleable by the opposing forces of resistance acting on her great curves, which leads to a good response.
4. *Rapid cooling*. Due to high thermal conductivity property of the material they are made of alloy wheels to ensure rapid cooling of the wheel and brake components in their proximity.

❖ CONSTRUCTION

In general running wheel disc pressed steel sheet, but in some cases logs are used and spoke cast or dragged in obtaining an adequate rigidity to the smallest weight. Merge wheel rim is made by welding, sheet metal disc by mechanical fasteners for spokes drawn, and if cast alloy wheels with lightweight wheels, disc and rim forming common body. Drive-wheel assembly is mounted on the hub with screws or bolts.

Configuration and rim profile is adopted depending on the specifics of the construction vehicles and the stress faced by their wheels. Depending on constructive solutions adopted there are two types of wheels:

❖ wheels joints (fig.2.a) - used in the wheels of cars, light commercial vehicles, 4x2 wheeled steering wheels and engines of small power tractors;

❖ removable wheels with cylindrical or slightly conical profile (fig.2.b) - used wheels trucks, buses, vans and heavy wheels of large and medium power tractors.

Fig.2. Constructive Solutions wheels

Joints with deep profile wheels have ears shoulder high profiled rim, providing a strong tire lateral stability. These buildings used tire edges are elastic and flexible, being allowed profiled rim mounting them directly.

If removable wheels, figure 2.b, less tapered profile, 5-15A taper creates the possibility of a better tire crosses. Installation is as simple as pushing the tire on the rim a border of fixed and removable border 2 fixation with flexible sealing ring 3 which is inserted into channel 4.

Fig.3. Elements of the rim

This construction allows easy mounting and dismounting tires and ensure takeover axial forces. For vehicles that are used for rear-wheel dual (double), disc wheel profile is designed to allow both wheels to the hub assembly, symmetrical about the plan to raise and support. If the rims for tubeless tires to be given to sealing surfaces must not show local irregularities or bulging, [1].

Symbolization. Ex. of symbolization: 5 ½ J x 49 ET 14H2 = 5 ½ inch rim width (inches), J = border rim shape feature point, x = rim in one piece, 14 = nominal rim diameter in inches (inches) H2 = rim profile; ET49 = depth Compression: 49m;

Oversize rim and tire, was conceived to enhance performance and appearance of your vehicle. It is accomplished by fitting larger diameter wheels and tires compared to the lower height. It is envisaged that following these changes to keep the overall diameter of the wheel to a maximum difference of 3% compared to the initial diameter. This is important because variations larger diameters would lead to traction problems, and finally to a modified fuel consumption. Also, the cars equipped with computer-assisted breaking some confusion could arise, leading to accelerated brake failure. The rule for dimensioning:

* Plus 1: Increase section width by 10 mm, reduces the appearance of 10 points. Increases rim diameter by 1 inch.
* Plus 2: Increase section 20 mm, decreases aspect with 20 points. Increases rim diameter by 2 inches

❖ AIDED DESIGN IN CATIA V5

CATIA (Computer Aided Three Dimensional Interactive Applications) product of Dassault Systemes is currently one of the most widely used integrated CAD / CAM / CAE in the world, with applications in various fields, including: mechanical engineering, aerospace, shipbuilding, automotive, robotics,
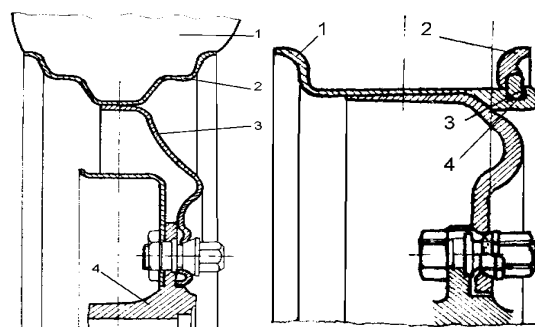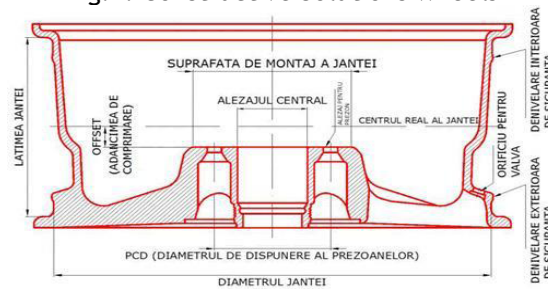
agricultural machinery, chemical, food and more. To version 5 is available since 1999, every new update is introduced new modules and functionality, while improving existing ones.

CATIA V5 is the top information technology design technologies such as machine building and construction industry in different parts. CATIA V5 is the cornerstone in the integration of people, tools, methods and resources in an enterprise. Its unique model Product/Process/Resources results in a truly collaborative work environment that enhances creativity and flow of information, the definition of 3D products and processes.

Using an intuitive interface and flexible CATIA Part Design module makes it possible to design three-dimensional sound of different pieces most often encountered in the design of mechanical products, as, with CATIA Sketcher, the other modules of the program. The module offers a highly productive working environment, each piece designed with a number of parameters, both in its use and in how CATIA Knowledge Advisor for parameterization and automatic creation of families of parts, a set of dependencies between parts, etc.

Fig.3. Masses Order

❖ ANALYSES

FINITE ELEMENTS ANALYSIS METHOD WITH WHEELS FEM incorporating CAD programs contain special procedures that allow optimization optimization through automatic calculation of optimal values for some design parameters so as to satisfy a set of conditions imposed on an objective function, defined by the user. Also, the designer can always return to the geometric shape of the structure, the material of which it will be made and, of course, the loads that will be covered in this stage of development where the structure is only a virtual model. The first step in addressing a new analysis is its choice of the [Insert], but, implicitly, the execution module, the type of static analysis (Static-house) is the default. As an immediate result, shaft specifications are added element 'Static Case ". The expansion element "Static Case" (press the mouse icon with the symbol "to his left"), its elements are displayed: Restrictions (Restraints), loads (Loads) solutions (Static Case Solution) and sensors (Sensors). They have very important roles in finite element analysis. Of course, the early analysis, sub-items do not contain values, the user must set restrictions and tests for the program to calculate solutions CATIA and activate the sensors. For example may be given three tests, Deformed Meshes, Von Mises stress and the estimated local error. They can be active and/or off simultaneously, the result of the analysis being presented on the screen, [3].

In general, instruments masses Masses are based on distribution theory, used to model the characteristics of purely inertial system, representing scalar fields table, a certain intensity, applied the model to be analyzed in a single point on an edge or a surface it. (Fig. 3).

Restrictions should be defined to represent a structural interface between the model and analyzed subassembly or assembly to which it belongs. If the model is not properly constrained, will result in many numerical problems (singularity) and finite element analysis could not be done. Clamp restriction model requires a one-piece module created a solid modeling program (Fig. 4).

Loads various instruments added load models will be analyzed by finite element method, essential step analysis process. These virtual loads simulating actual loads to which the model will be subjected during operation.

Fig.4. Order restraints

Fig.5. Pressure Control

Fig.6. Distributed control force

Fig.7. Acceleration command

Pressure - this charge, expressed in N / m creates a uniform pressure applied on the given area so that the forces exerted directions are always perpendicular (Fig. 5).

Distributed Force - distributed forces are in fact equivalent static system with a resultant force of a real force, applied at a certain point of a model or virtual components (Fig. 6).

Acceleration - is concentrated loads type acceleration field (N/kg or m/s) with uniform intensity, applied in virtual models or parts examined (Fig. 7).

❖ CONCLUSIONS

Compute a tool meets the most important roles in the finite element analysis of a model: triggers this process, but only for the completely bound and showing loads. Thus, throughout the process, the user defines a set of parameters (material characteristics, limitations, strengths etc.), Following the steps described above. Then, during calculation, the program transforms the conditions applied to interpret the model parameters, allowing users access to visual and numerical data.
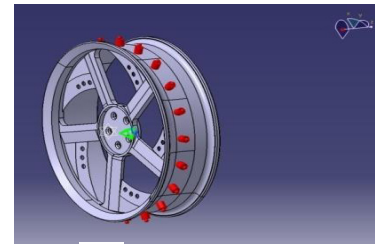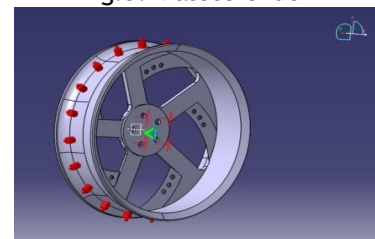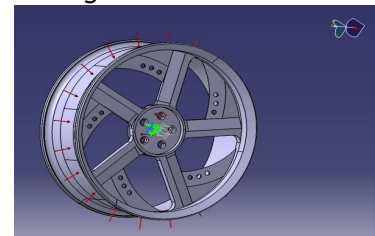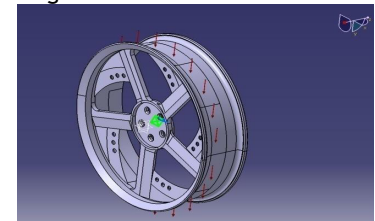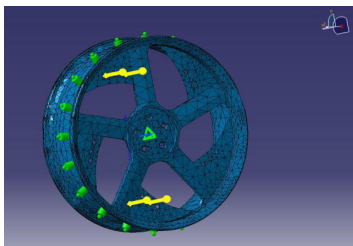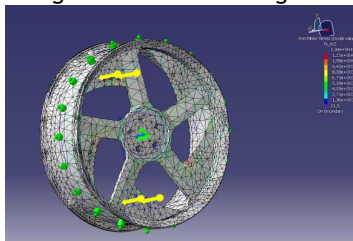
Fig.8. Deformation diagram

Fig.9. Von Mises Stress Diagram

Deformation - images provided by this tool are used to visualize the model analyzed in the distorted representation as a result of all the conditions imposed (material restriction loads) (Fig. 8). Von Misses Stress - images produced from the use of this tool shows Von Misses field model, representing in fact, a scalar field values derived from the volume density: strain energy and used to measure the tension created in the model (Fig. 9).

Displacement - tool is used to view the field trips (in mm) of network nodes as a result of the imposition of load restrictions and conditions on a model (Fig. 10).

Following analysis, the program discretized surface nodes and 14 253 4807 rim type TE4 elements that were used to play Deformed Mesh diagram. Consider having a rim made of aluminum 2710kg/m3 density and temperature variation of 2.36 K.
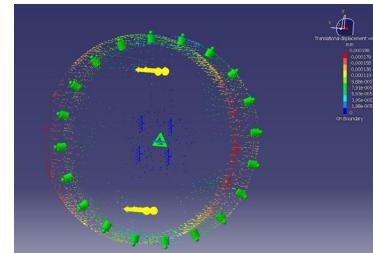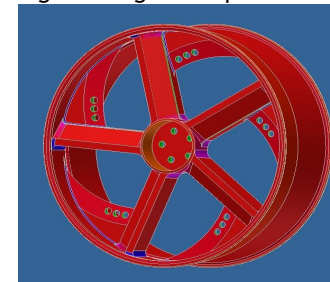

Fig.10. Diagram displacement

Getting the number of nodes and elements to apply a single restriction supportive axis forces Fx-182 N, N-0 Fy and Fz-413N, 2591 ± 001kg loads on a total of 14,421 lines that compose the song, they an X-axis inertial de6 mm, 9 mm Z axis and Y axis 7mm. Applying finite element program calculates a rigidity of 2.82 N on the curve track construction, restrictions imposed on a single area, the constraints are on one surface which is divided into a number of 258 points.

Applying energy of 1925 J-006's with the song being in balance, the program plays the Von Misses stress diagram (loading values in network nodes) after the Table 1.

Fig. 11. Air dispersion diagram

Following tests carried out we sought the advice of corporations specializing in design and manufacturing of car wheels, which are PIAA Corporation (USA) and Enke Corpoation (Japan), who helped design the tests based on which we performed. Their responses were:

Table 1. Finite element analysis result

Components	Force applied	Restrictions	Arrears	Size relative error
Fx (N)	5.1822e+001	-5.1822e+001	3.3040e-012	2.6954e-013
Fy (N)	2.0000e+000	-2.0000e+000	1.6995e-012	1.3864e-013
Fz (N)	-1.4131e-003	1.4131e-003	-1.0375e-011	8.4638e-013
Mx (N/m)	-1.6294e-001	1.6294e-001	-2.1683e-012	4.3130e-013
My (N/m)	3.7634e+000	-3.7634e+000	3.4395e-012	6.8415e-013
Mz (N/m)	-4.7306e-004	4.7306e-004	-4.0315e-013	8.0192e-014

PIAA Corporation - is a unique design with small defects in the layout STAS. Our tests show that a light produced by the initial appearance and size model for 17", 20", 21" inch would require producers of aluminum alloy. A problem would be hiding cover stud be bent in the wind very well so will lose the whole concept. Otherwise we want to congratulate you for design and design and wish you success in the future.

Enke Corporation - We are glad that you asked us to think and hope we can help. First we conducted a test I noticed that you made and I have attached chart to see the success of the rim. To explain the diagram as soon as possible: one is where the air has a very good aerodynamic curve, which means that the aerodynamic design point of view is correct, Area 2 is where the air is blocked so there will lose speed but that area is too small can be ignored. Instead hide stud should be done with great precision our advice a little curve max. 2-3 mm from the plane to remove the green rim.

This approach is useful for any product development needs of Class A-surfacing. CATIA V5 users can implement and practice the same technique, without adding any costly hardware. As a personal opinion I add, as a matter of fact, over time, the need to design a new model of the rim in a short period of time can be achieved only with computers, specialized software specifically with these dedicated engineers today.

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