FINITE ELEMENT ANALYSIS OF CHERVOLET FRONT HUB WITH THE HELP OF INVENTER

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ABSTRACT

In this paper, we have done analysis and weight reduction of wheel hub with the help of finite element analysis .We show the result of present wheel hub material (cast iron)and compare with proposed model material(Nylon, molybdenum Disulphide) analysis. Finite element analysis as a method for reduction of cost in term of material and manufacturing. Commercial vehicle industry is focusing on bringing quality products at competitive costs. While product weight has got a direct impact on the cost of the component, it also has an impact in the operating profits in case of a commercial vehicle. This paper explains the use of the design and development of hub ,the result of this project is shown that proposed hub which based on Nylon, molybdenum Disulphide material is 64.2% less then the cast iron hub. Based on these optimization outputs, new practical designs were generated and FE analysis was carried out for the optimized design to verify the strength of the hub. This optimized material resulted in weight saving of the wheel hub without affecting the functional requirement.

Keywords-R**esearch and Development of wheel hub**

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I. INTRODUCTION

This Project is based on analysis of chervolet front hub for weight reduction and increase the strength of hub by the help of Altair. The weight and dimension of the hub must be as small as possible because of the un sprung weight which further reduce the rotational mass. Engineering component with optimum use of material and easy manufacturability is a direction where prior simulation through finite element method is found to be very useful. Wheel hub of car is one of the major and very important components and needs very good material and design in low cost and avoids failure. The three basic elements of a wheel are the hub, the spokes and the rim. Sometimes these components will be one piece, sometimes two or three. The hub is the centre portion of the wheel and is the part where the wheel is attached to the suspension through the wheel carrier (or knuckle). The spokes radiate out from the hub and attach to the rim. The rim is the outer part of the wheel that holds the tyre. A hub assembly contains the wheel bearing and hub to mount the wheel to vehicle .It is located between the brake rotor and axle

A.1 Design consideration

The bolt pattern is determined the by the number of bolt on the wheel hub. Selection of material strong enough to take the weight of the car. Wheel bearing in the hub depending on ID and OD of spindle coming out of hub. Type of lug nuts or bolts.

Wheel hub is highly streed safety component which must not fail under the applied loading condition. The main parameters for design of wheel hub assembly are loading condition, manufacturing process and material behaviour. The influence of these parameters are interactive so material fatigue behaviour will be change depending upon the wheel hub design and loading condition.

1) Selection of material: Any engineering component has one or more functions (to support a load, to contain a pressure, to transmit heat, etc.).The designer has an objective (to make it as cheap as possible, or as light as possible, or as safe as possible or some combination of these).The component must carry the given load without failure, it should function in a certain temperature range, etc. he objective must be achieved subject to constraints.

2)Material property: cost, density, modulus, strength, endurance limit, thermal conductivity, expansion coefficient ,Mechanical property- Hardness, Elastic constants, Yield strength, Ultimate strength, Fatigue, Fracture Toughness, Creep, Damping, Wear resistance, Spalling, Ballistic performance

3) Material selection methodology: Translate the design requirements into materials specifications. It should take into consideration the design objectives, constraints and free variables.

Screening out of materials that fail the design constraints. Ranking the materials by their ability to meet the objectives. Search for supporting information for the material candidates We select the Nylon, molybdenum Disulphide as compare to cast iron Nylon, molybdenum disulphides is -Low surface friction, Increased surface hardness, Increased heat resistance, Higher tensile properties Improved dimensional stability Enhanced sliding properties, Higher abrasion resistance, Low water absorption, Exceptional impact and notched impact strength, Good resistance to stress cracking, Excellent noise and vibration damping properties. Availble property of Nylon, molybdenum disulphides.

- Density, ASTM D792
- Water Absorption, ASTM D570, at 24 hours
- Water Absorption at Saturation, ASTM D570
- Hardness, Rockwell R, ASTM D785
- Tensile Strength, Yield, ASTM D638
- Elongation at Break, ASTM D638
- Tensile Modulus, ASTM D638
- Izod Impact, Notched, ASTM D256
- K (wear) Factor, ASTM D3702, 40 psi, 50 fpm
- Volume Resistivity, ASTM D257
- Dielectric Constant, ASTM D150
- Dielectric Strength, ASTM D149

- CTE, linear, ASTM D696
- Specific Heat Capacity
- Melting Point, ASTM D2133
- Maximum Service Temperature, Air, ASTM UL746B, Long Term
- Maximum Service Temperature, Air, Intermittent
- Deflection Temperature at 0.46 MPa (66 psi), ASTM D648
- Deflection Temperature at 1.8 MPa (264 psi), ASTM D648
- Flammability, UL94

Von Mises stress is widely used by designers, to check whether their design will withstand given load condition. In this lecture we will understand Von Mises stress in a logical way. Use of Von Mises stress

Von mises stress is considered to be a safe haven for design engineers. Using this information an engineer can say his design will fail, if maximum value of Von Mises stress induced in the material is more than strength of the material. It works well for most of the cases, especially when material is ductile in nature.

Distortion energy theory-Concept of Von mises stress arises from distortion energy failure theory. According to distortion energy theory failure occurs, when distortion energy in actual case is more than distortion energy in *simple tension case* at the time of failure.

Distortion energy-It is the energy required for shape deformation of a material. During pure distortion shape of the material changes, but volume does not change.

Distortion energy required per unit volume, ud for a general 3 dimensional case is given in terms of principal stress values as

$$u_d = \frac{1+\nu}{3E}\left[\frac{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2}{2}\right]$$

Distortion energy for *simple tension case* at the time of failure is given as

$$u_{d,sim} = \frac{1+\nu}{3E}\sigma_y^2$$

Expression for Von Mises stress

Above 2 quantities can be connected using distortion energy, so the condition of failure will be as follows.

$$\left[\frac{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2}{2}\right]^{1/2} \geq \sigma_y$$

Left hand side of above equation is denoted as Von Mises stress.

$$\left[\frac{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2}{2}\right]^{1/2} = \sigma_v$$

So as a failure criterion engineer can check, whether Von Mises stress induced in the material exceeds yield strength (for ductile) of the material. So the failure condition can be simplified as

$$\sigma_v \geq \sigma_y$$

Industrial Application of Von Mises Stress

Distortion energy theory is the most preferred failure theory used in industry. It is clear from above discussions that whenever an engineer resorts to distortion energy theory he can use Von Mises stress as failure criterion.

- Design factor and safety factor

The difference between the safety factor and design factor (design safety factor) is as follows: The safety factor is how much the designed part actually will be able to withstand (first "use" from above). The design factor is what the item is required to be able to withstand (second "use"). The design factor is defined for an application (generally provided in advance and often set by regulatory code or policy) and is not an actual calculation, the safety factor is a ratio of maximum strength to intended load for the actual item that was designed.

$$\text{Factor of Safety} = \frac{\text{Material Strength}}{\text{Design Load}}$$

- Design load being the maximum load the part should ever see in service.

By this definition, a structure with a FOS of exactly 1 will support only the design load and no more. Any additional load will cause the structure to fail. A structure with a FOS of 2 will fail at twice the design load.

Maximum Principal Strain Theory (St. Venant's Theory)

Strain is an actual physical quantity related to the change in dimensions, but stress is an abstract concept, that is, internal resistance per unit area. Even for the determination of stresses, strain gauges are used to measure the strains and the principal stresses are indirectly measured using the Young's modulus and Poisson's ratio of the material. In this theory, it is assumed that failure by yielding of a material takes place when the maximum principal strain in the material subjected to principal stresses is equal to the strain at the yield point in a simple tension or compression test.

COMPARATIVE ANALYSIS OF RELATED WORK

Lots of work has been done in the field of automobile performance analysis using finite element method rules and various alternatives and improvements have been proposed. We also have done compare analysis of two materials which one existing cast iron and second are nylonmolybdenum disulphide. The result is show volume and weight reduction analysis of these materials.

Problem description

Most of the mechanical systems are subjected to dynamic loading causing teeth crack, noise, teeth fatigue. The fundamental task is make small weight hub and strength is also increase. Using the Altair find out load is applied with different material we use nylon with composite and cast iron. Another key issue is how design hub when bearing load is applied including pin constraints and principle stress in all dimension also consider. During the design process, model parameters are often altered to evaluate alternative design choices, reduce weight.

Generic speciation of hub

1) Material used: - Nylon with composite (Nylon, molybdenum disulphide), second analysis with cast iron

2) Type – Chervolet hub

3) Application for case study – Automobile

Wheel hub assembly

In design stage, we estimated all the force acting on hub and disc.

The wheel hub was modeled in inventor with given parameter.

The forces were applied on model using finite element analysis in hypermesh.

The thickness of hub was varied in increment of 2mm till a factor of safety value of 2 was attained. Thus the final design of wheel hub is complete.

Methodology of wheel hub

1) Computational approach- Following software tools will be used- Inventor for modelling and analysis

2) Experimental set-up-using Chevrolet hub

Steps for the proposed work

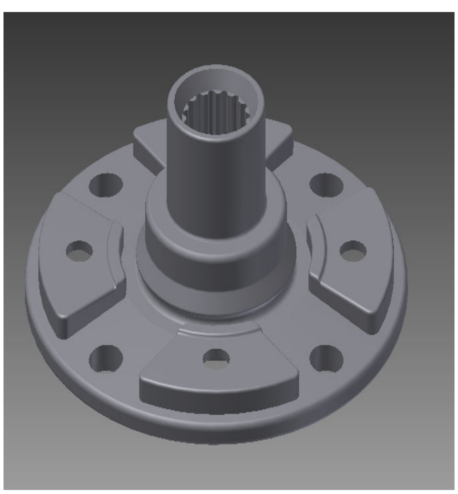
Creation of modelling of hub .

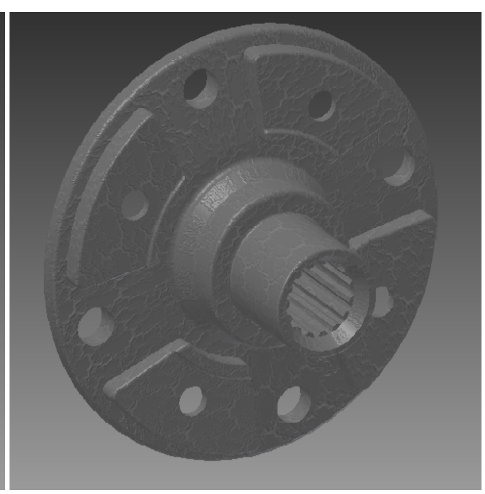
Importing the geometry for meshing.

Solving for the meshed model to identify mode shapes.

Viewing the results

Modifying the geometry/ mass Solving the meshed model again to identify mode shapes. Comparison / Interpretation of the results Recommendations.





Expected results

The modal analysis should help identifying weight reduction by use nylon with composite.

Stress Analysis Report (cast iron)

NAME	MINIMUM	MAXIMUM
Volume	145364 mm^3	
Mass	1.05389 kg	
Vonmises stress	0.0031221 Mpa	6.42715 Mpa
1st Principal stress	-1.45405 Mpa	3.7039 Mpa
3rd Principal stress	-6.57182 Mpa	0.594782 Mpa
Displacement	0 mm	0.000141226 mm
Safety factors	15 ul	15 ul

Stress Analysis Report (Nylon, molybdenum Disulphide)

NAME	MINIMUM	MAXIMUM
Volume	145364 mm3	
Mass	0.164261kg	
Vonmises stress	0.000241144Mpa	6.31064 Mpa
1st Principal stress	-2.03842Mpa	3.58666 Mpa
3rd Principal stress	-6.66909Mpa	0.87432 Mpa
Displacement	0mm	0.00570327 Mpa
Safety factors	13.1129 ul	15ul

The analysis report would help identifying the values to be omitted while making a recommendation at the `vehicle' level (complete assembly). , a weight savings of 64.2% coupled with an increase in yield

Strength of hub is realized in the optimized design of the wheel hub, so the cost of part is also reduced.

Besides, the reason of failure during operation might be the base of the hub as this has been found from the compilation of historical data during the study. Better results can be obtained while generating finer mesh at this region of interest.

Conclusion

The weight and dimension of the hub is such that it reduces the rotational mass and increase strength. The calculated parameter help us to design wheel hub The design part gives stability during rotation of the wheel .The design project enabled us to understand the various forces that act on a hub. Carry out physical experimentation to validate the model

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