ANALYSIS OF SPROCKET STRENGTH FINITE ELEMENT ANALYSIS METHOD

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Abstract

The sprocket is a very essential part in the transmission of power and motion in most motorcycles. Generally sprockets are made of mild steel. In this Project report, existing sprocket motorcycle is compared with the sprocket of carbon fiber material. The drawing and drafting is done using CAD software. Further FEA software is used for analysis of sprocket chain. With different properties of mild steel and carbon fiber, stress and deformation of sprocket is compared. This work will be useful for further development of sprockets.

INTRODUCTION

Sprocket

The name 'sprocket' applies generally to any wheel upon which are radial projections that engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth. Sprockets can be supplied in various materials and styles, depending upon the application and severity of service requirements.

The selection of material used for the manufacturing of sprocket depends upon the strength and service conditions like wear and noise etc. also involves the cost as well as the material performance required. The sprockets maybe manufactured from metallic non-metallic materials. The steel is widely used for the manufacturing of sprocket due to its go wearing properties, excellent mach inability and case of producing complicated shapes by machining.

Sprockets can also be supplied in various cast materials as Standard Carbon Steel (with or without hardened teeth), Stainless Steel, Special materials such as alloy steel, bronze etc The nonmetallic materials like wood, compressed paper and plastics like Nylon, Acrylic and Polycarbonate etc. are used for gears, especially for reducing weight and noise.



Procedure For Production Of Sprocket

Materials For Sprocket

The selection of material used for manufacturing of sprocket depends upon the strength and service conditions like wear and noise etc. also involves the cost as well as the material performance required. The sprockets may be manufactured from metallic or non-metallic materials. The steel is widely used for the manufacturing of sprocket due to its good wearing properties, excellent mach inability and easy of producing complicated shapes by machining. Sprockets can also be supplied in various cast materials as Standard Carbon Steel (with or without hardened teeth), Stainless Steel, Special materials such as alloy steel, bronze etc. The non-metallic materials like wood, compressed paper and plastics like Nylon, Acrylic and Polycarbonate etc. are used for gears, especially for reducing weight and noise A) Mild Steel (IS 2062) At present sprocket chain is made of mild steel material .So, first analysis is done using MS as material. Steel is easy to get. Steel is easy - and it's also cheap. This is the main reason that 99% of the sprocket chain are made from steel. Steel is stiff but dense (heavy). Steel rates well in terms of both yield strength and ultimate strength, particularly if it's carefully alloyed and processed. Steel also resists fatigue failure well which is extremely useful - even if the sprocket chain flexes under load, such flexing need not lead to a critical failure.

Chemical Composition of Mild Steel: C- 0.23%, Mn-1.5%, S-0.05%, P-0.05%, Si-0.4%

The properties of mild steel are listed below.

Structural Properties:

Young's Modulus, (E) 2.1x105 MPa Poisson's Ratio (v) - 0.3 Density (ρ) - 7850 kg/m3 Yield Stress (σ) - 250 MPa Ultimate Tensile Stress (σ) - 390 MPa

Design And Analysis Of Sprocket

Model of Sprocket



In research section, there are consist of three element input that can be used to conduct the project research. Here method to conduct for each one of element is different. Research through the website is the best alternative in which much information can be found and collected. In addition, information regarding the competition date and venue last well-known also can be tell. There are a number of books where related with research objectives and can be used as a guide for completing the report and the fabrication process. Also for validity, the journals are related can also be downloaded and taken as a reference report. There are many websites that excess supply further information in respect of project problems and how to overcome some of the problems can be found.



Carbon Fiber sprocketMeshed model of sprocket in Hypermesh

Claims

- 1. A process for an improved carbon fiber, comprising the steps of winding a carbon fiber onto a bobbin which is thermally and mechanically stable at temperatures greater than 2000°C and which is chemically compatible with the carbon fiber, and thereafter, subjecting the carbon fiber to a heat treatment at a temperature greater than 2000°C.
- 2. The process of Claim 1, wherein the heat treatment is carried out by raising the temperature at a rate from about 200°C to 500°C per hour.
- 3. The process of Claim 1, wherein the heat treatment is carried out by raising the temperature at a rate from about 50°C to 100°C per hour. The process of Claim 1, wherein the heat treatment is carried out by raising the temperature to more than 2700°C.
- 4. The process of Claim 1, wherein the heat treatment is carried out so that the carbon fiber has a Young's modulus greater than about 100'Mspi.
- 5. The process of Claim 1, wherein the heat treatment is carried out so that the carbon fiber has a Young's modulus greater than about 90 Mpsi.

6. The process of Claim 1, wherein the heat treatment is carried out so that the carbon fiber has a Young's modulus greater than about 75 Mpsi.

tensile tests on the carbon Fiber

•	Tensile Strength (Kpsi)	Young's Modulus (Mpsi)	Fiber Density (Mg/m ³)
Spool A	317	123	2.14
Spool B	306	111	2.13
Spool C	295	117	2.13
Spool D	338	128	2.17

Implementation

The implementation of a sprocket will vary widely, depending on what the sprocket is intended to do. This section provides an overview of the steps involved in the implementation process. With the exception of the first step and final steps, many of these steps do not need to take place serially. For example, the page development and the Java class development can occur concurrently, though clearly they must be coordinated with each other.

What is FEM?

The finite element method (FEM) is a numerical method for solving problems of engineering and mathematical physics. It is also referred to as finite element analysis (FEA). Typical problem areas of interest include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential.

Analysis:

Analysis is done by selecting appropriate solver and carrying out the processes in various stages to get solution. Particularly analysis is carried out in three stages by performing various operations in software.

□ Pre-processing:

1) Meshing

In this stage IGS file is imported to the meshing software like Hypermesh 12.0. The CAD data of the Sprocket chain is imported and the surfaces were created and meshed. Since all the dimensions of the sprocket are measurable, the best element for meshing is the tetra-hedral element. Here, static analysis is used for analysis.

Fig shows the meshed model of sprocket in Hypermesh. For this following parameters are used. No. of Nodes: 16552 No. of Elements: 62272 Element size: 2mm

2) Boundary Conditions

After meshing is finished we apply boundary conditions. These boundary conditions are the reference points for calculating the results of analysis. Forces acting on sprocket:

- 1) Force acting on sprocket due to tension in tight side of chain (Torque at rear sprocket)
- 2) Gravitational force acting at the centre of sprocket (in this case neglected)

Calculation for Torque at rear sprocket (Pulsar 180):

Gear ratio = 26.93:1 Engine torque = 14.22 Nm @ 6500 rpm Torque at rear sprocket = Te X G = 14.22 X 26.93 = 383 Nm Below fig. 4.2 shows loads and constrain

Below fig. 4.2 shows loads and constraints applied in hypermesh. Sprocket has been constraint at the circumference and torque of 383 Nm is applied at the center.



Boundary conditions applied on sprocket in HypermeshSolution and Post-processing :

Meshed and boundary condition applied model is imported to the solver. Analysis process starts after applying run in the solver software. Software first calculates the deflection with respect to the boundary conditions applied. Then on the basis of deflection it computes strain. Once the strain is calculated we know modulus of elasticity then we can compute the stress values. Results are viewed and accordingly modifications are suggested. Changes are suggested according to high stress regions obtained. If the stresses are beyond the permissible limits then changes such as change in material, change in thickness of component or addition of ribs etc. are made according to suitability. The calculation of stress depends upon the failure theory suitable for the analysis. 1) Following are the results displayed for stress and deformation (MS).



Displacement result sprocket(MS)

Figures shows the analysis results obtained in ANSYS for sprocket with mild steel. Stress value for sprocket chain is 41.83 N/mm2 which is well below the critical value. Hence, design is safe. Deformation for sprocket chain is 0.0049 mm.

2) Following are the results displayed for stress and deformation(Carbon Fiber).



Von-Misses stress for sprocket (Carbon Fiber) Figure shows the analysis results obtained in ANSYS for sprocket with carbon fiber. Stress value for sprocket is 371.13 N/mm2 which is well below the critical value. Hence, design is safe. Deformation for sprocket is 0.091 mm. The analysis of sprocket has been done for all two materials viz. steel, carbon fiber. The comparison of properties and analysis results is shown in table A and B respectively.

Material	Mild Steel	Carbon Fiber
Young's	210 GPa	E1-190 Gpa,E2-
Modulus (E)		7.7 Gpa
Poisson's Ratio	0.3	0.35
(υ)		
Density (p)	7850 kg/m3	1600 kg/m3
Yield Stress	290 MPa	-
Ultimate		
Tensile		
Stress	390 MPa	2000 MPa
Mass (m)	0.847 Kg	Kg 0.173 Kg

Comparison of material properties

Comparison of analysis results

		Max.	Max.
S.No.	Material	Stress	Displacement
		41.83	
1	Steel	MPa	0.0049 mm
	Carbon	371.13	
2	Fiber	MPa	0.091 mm

Method Of Fabrication:

Preparation of carbon fibre prototype by hand lay-up method:

Hand lay-up is a simple method for composite production. A mould must be used for hand lay-up parts. Reinforcement fibers can be cut and laid in the mould. Resin must then be catalyzed and added to the fibers. A brush, roller or squeegee can be used to impregnate the fibers with the resin.

Process for preparation of Carbon Fiber Process for preparation of Carbon Fiber



Material Used:

1) Epoxy resin:

Epoxy laminating resin boasts higher adhesive properties and resistance to water Chemical name - Diglycidyl ether of biphenyl

- CatalystHardener:Organic peroxide or similar compound which, together with the accelerator, initiates the polymerization process of polyester and other resins. Chemical name-Triethylenetetramine.
- 3) Accelerator:

One of the two compounds (the other is catalyst) required to initiate the polymerization process.

Experimentation

Furthermost part So we want to validate the FEA analysis with the Experimental analysis. So both steel and carbon fiber sprocket tested were on UTM for experimental results.

Result:

The Comparison between Experimental Deformation and Finite element analysis Deformation are follows.

	Deformation (in mm)
FEA Results	0.0049
Experimental	
Results	0.0045

Table 5 Comparison between Experimental and FEA results

There is 8.1 % variation in FEA and experimental results of steel.

CONCLUSION

From results of finite element analysis it is observed that stresses are maximum at joint locations. It is also observed that both the materials have stress values less than their respective permissible yield stress values. Hence the design is safe. From analysis results and comparison of properties of all the materials, it is found that carbon fiber is the material which is having the least density; also it is easily available and cheap as compared to other alternate materials. Also machining cost for carbon fiber is less. Hence it is the best suited alternate material for sprocket and is expected to perform better with satisfying amount of weight reduction.

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