MANUFACTURING OF CARBON FIBER SPROCKET

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ABSTRACT:

A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs or even sprockets that mesh with a Chain. The name 'sprocket' applies generally to any wheel upon which radial projections 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.

Generally sprockets are made of mild steel. They exist in various dimensions, teeth number and are made of different materials. Sometimes faulty chains quickly wear the sprocket. Possible causes of these problems are significant overload, breakage, high impact pressure, excessive chain wear far beyond replacement level, combination of worn chain with new sprockets etc. To ensure efficient power transmission chain sprocket should be properly designed and manufactured. There is a possibility of weight reduction in chain drive sprocket. During this work, a study of designing optimization of sprocket using different processes and techniques will be studied. During this work the designing of chain sprocket, analysis will be done by using FEA.

Index Terms - Sprocket, mild steel, carbon fiber, CAD, FEA, stress and deformation.

I. INTRODUCTION

The sprocket chain when used for long term faces problems such as pins or bushes wear out, broken plates and pins, wearing of sprocket etc. also chain sprockets works in very dirty environment which lowers its life. Normally sprocket chain is made up of alloy steel.

So the objectives of this study are,

- To increase strength of a sprocket so that it can be used for long time.
- To reduce the weight of sprocket.
- To select an alternative material for the sprocket.
- To analyses the sprocket with existing as well as alternating material.
- To validate the results for better output.

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For this research, many international and national papers were helpful. Worldwide researchers have applied the efforts of design sprocket chain as, Ebhota Williams S, et al., (2014), studied the fundamentals of sprocket design and manufacturing of a rear sprocket of Yamaha CY80 motorcycle through reverse engineering approach. The eight steps that are to be followed sequentially in the reverse engineering approach are discussed. They manufactured the sprocket by universal milling machine from the blanked mild carbon steel (AISI 1045) with chemical composition of C=0.45%, Mn=0.75%, P=0.03% max, S=0.04%. Then induction heat treatment was applied to move the material hardness from 13 HRC to 45 HRC. Swapnil Ghodake et al.., (2013), Sprocket weight optimization is done with reducing material to get optimized design which can perform well under torque condition keeping same constraints. For this purpose, an FEM tool is used for analyzing existing and optimized sprocket with different types of FEA techniques. Strain Gauging is done or correlation with FEA virtual strain to confirm the loadings.

Conceptual Test rig is proposed to validate the optimized sprocket. Chandraraj Singh Baghel, et al.., (2013), studied of the stress of chain; sprocket of motorcycle is compared with the sprocket of plastic material made by PEEK (polyether ether ketone). Chaitanya G Rothe et al.., (2015), deals with the replacement of conventional steel drive shaft with high strength carbon/epoxy composite drive shaft. The design parameters were optimized with the help of genetic algorithm (GA) with the objective of minimizing the weight of composite drive shaft. The result of GA are used for modelling of carbon/epoxy composite drive shaft and steel drive shaft using CAD software to perform static, buckling and modal analysis of both drive shaft using ANSYS. No researcher has applied effort for designing of sprocket with carbon fiber. Therefore, there is stern need to work on sprocket with composite material. In this work, we introduced the carbon fiber as replacement for conventional mild steel. Also we done the CAD through reverse engineering and analysis is carried out using Hypermesh and ANSYS.

II. CARBON FIBER LAMINATE MANUFACTURING

A prototype is fabricated using epoxy composite material for testing purpose.

HAND LAY-UP METHOD:

Hand lay-up is a simple method for composite production. A mould must be used for hand lay-up parts unless the composite is to be joined directly to another structure. The mould can be as simple as a flat sheet or have infinite curves and edges. For some shapes, moulds must be joined in sections so they can be taken apart for part removal after curing. Before lay-up, the mould is prepared with a

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release agent to insure that the part will not adhere to the mould. Reinforcement fibers can be cut and laid in the mould. It is up to the designer to organize the type, amount and direction of the fibers being used. Resin must then be catalysed and added to the fibers. A brush, roller or squeegee can be used to impregnate the fibers with the resin. The lay-up technician is responsible for controlling the amount of resin and the quality of saturation.

Fig. 5.1:Carbon fiber sheets

BONDING MATERIAL:

Epoxy Resin: Epoxy laminating resin boasts higher adhesive properties and resistance to water, ideal for use in applications such as boat building. Also used extensively in aircraft component manufacture. Epoxies are widely used as a primary construction material for high-performance boats or as a secondary application to sheath a hull or replace water-degraded polyester resins and gel coats.

Chemical name - Diglycidyl ether of biphenyl

Chemical name - Araldite- LY556.

Catalyst: Hardener: An organic peroxide or similar compound which, together with the accelerator, initiates the polymerization process of polyester and other resins. It should NEVER be mixed directly with an accelerator-this can cause an explosion. Catalyst is available as a liquid or paste.

Catalyst is organic peroxide (a powerful corrosive) and should not come contact with eyes, mouth or skin. Should it do so, wash from the skin immediately under a running tap. If it is splashed in the eyes, flush them with running water for at least fifteen, minutes, and call a doctor

Chemical name – Trietha Tetra mine.

Company name – Aradur-HY951

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Accelerator: One of the two compounds (the other is catalyst) required to initiate the polymerisation process. See Reaccelerated. Mixed directly with catalyst, the accelerator reacts explosively it is therefore usually added to the resin in manufacture so only catalyst need be added later.

Fig. 5.2:Preparing bonding liquid

LAMINATE MANUFACTURING:

For matrix material, epoxy LY556 and hardener HY951 were mixed in the mass ratio of 100:80 as shown in fig. 5.2. The resin and hardener mix was applied to the fibers. Fibers were coated with this mix as shown in fig. 5.3.

Fig. 5.3: Appling liquid to carbon fiber sheets

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Subsequent plies were placed one upon another as required orientations as shown in fig. 5.4. A hand roller was used to compact plies and remove entrapped air that could later lead to voids or layer separations.

Fig. 5.4: Placing carbon fiber sheets for plies

The mould and lay-up were covered with a release fabric as shown in fig. 5.5.

Fig. 5.5: Covering of plies

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Once the matrix and fibers are combined, it is necessary to apply the proper temperature and pressure for specific periods of time to produce the fiber reinforced structure as shown in fig. 5.6. For this purpose, resin-impregnated fibers were placed in the mould for curing. The press generates the temperature and pressure required for curing. In all cases, the mould was closed to stops giving nominal thickness.

Fig. 5.6: Appling pressure for settling

After the second period, the laminates were cooled to room temperature, removed from press and trimmed to size as shown in fig 5.7.

Fig. 5.7: Carbon fiber laminate

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III. FABRICATION OF CARBON FIBER SPROCKET

WATER JET CUTTING OF SPROCKET:

A water jet utilizes a high pressure stream of water to erode a narrow line in the stock material. To cut a wider range of materials from tool steel to titanium to foam, a granular (typically garnet) abrasive is added to the water jet, increasing the cutting power. Because the abrasive is added at the nozzle, it is simple to switch between water only and abrasive water jet cutting. This flexibility greatly enhances the versatility of a water jet machine, as it can easily switch from cutting ½" (1.27cm) foam gaskets to 4" (10.16cm) titanium brackets. A water jet cutting machine is shown in fig. 5.8.

WATER JET CUTTING MACHINE:

Fig. 5.8: Water jet cutting machine

- High Pressure Pump: The pump generates a flow of pressurized water for the cutting process.
- Catcher Tank: The water-filled catcher tank dissipates the energy of the abrasive jet after it has cut through the material being machined.
- Abrasive Hopper: The abrasive hopper and associated abrasive flow control system provide a metered flow of granular abrasive to the nozzle.
- X-Y Traverse System: A precision X-Y motion system is used to accurately move the nozzle to create the desired cutting path.

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- PC-based Controller: Advanced motion controllers for abrasive waterjet systems are PC-based and permit production of accurate parts with minimal operator experience as shown in fig 5.9.

Fig. 5.9: PC-based Controller

- Articulated Cutting Head: As an add-on option to OMAX water jets, this computer-controlled multi-axis cutting head permits angled cuts and can be used to automatically minimize taper for precise vertical cuts.
- Abrasive Water jet Nozzle: Inside the nozzle the pressurized water passes through a small-diameter orifice and forms a coherent jet of water. The jet then passes through a venture section where a metered amount of granular abrasive is drawn into the water stream. The mixture of water and abrasive particles passes through a special ceramic mixing tube and the resulting abrasive/water slurry exits the nozzle as a coherent cutting stream of abrasive particles travelling at very high speed.

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Fig. 5.10:Profile cutting of sprocket

STANDARD PROCEDURE FOR PROFILING OF SPROCKET:

All water jets follow the same principle of using high pressure water focused into a beam by a nozzle. Most machines accomplish this by first running the water through a high pressure pump. There are two types of pumps used to create this high pressure; an intensifier pump and a direct drive or crankshaft pump. A direct drive pump works much like a car engine, forcing water through high pressure tubing using plungers attached to a crankshaft. An intensifier pump creates pressure by using hydraulic oil to move a piston forcing the water through a tiny hole. The water then travels along the high pressure tubing to the nozzle of the waterjet. In the nozzle, the water is focused into a thin beam by a jewel orifice. This beam of water is ejected from the nozzle, cutting through the material by spraying it with the jet of high-speed water. The process is the same for abrasive water jets until the water reaches the nozzle. Here abrasives such as garnet and aluminum oxide, are fed into the nozzle via an abrasive inlet. The abrasive then mixes with the water in a mixing tube and is forced out the end at high pressure.

Fig. 5.11: Final prototype of carbon fiber sprocket

IV. CONCLUSION

From the manufacturing of carbon fiber sprocket we found that the properties of carbon fiber with compared toproperties of all the materials 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.

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