A Review of Design, Development and Analysis of Carbon Fiber Sprocket

[1]Mr. Swapnil S. Jadhav, [2]Prof. D. P. Patil, [3]Prof. S. S. Gunjate
[1]Student of M-Tech Design Engineering, [2]Associate Professor, [3]Assistant Professor
[1]Department of Mechanical Engineering,
[1]Padmabhooshan Vasantraodada Patil Institute of Technology, Budhgaon, Sangli, India

Abstract: Sprockets are most widely used in automobile sector and in machinery. These are used in two wheelers and four wheelers such as bikes, cycles, cars and other mechanism either to transmit revolving motion between two shafts wherever gears are incompatible or to communicate undeviating motion to a pathway etc. The sprocket is a very essential part in the transmission of power and motion in different applications.

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 this 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, modeling, meshing, post processing, manufacturing, testing and validation.**

I. INTRODUCTION

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.

Sprockets are used in bicycle, motorcycle, car tracked wheel, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc. Perhaps the most common form of sprocket may be found in the bicycle, in which the pedal shaft carries a large sprocket-wheel, which drives a chain, which, in turn, drives a small sprocket on the axle of the rear wheel. Early automobiles were also largely driven by sprocket and chain mechanism, a practice largely copied from bicycles.

Mostly work is done by using different grades of steel as their base material and re-designed the sprocket by using different CAD software. Some has given heat treatment and other types of chemical treatment to the sprocket to enhance its mechanical properties. From the review, now a day most of the motorbikes has conventional chain drive by which power is transmitted from engine to rear wheel. Chain drive consists of two main parts, one is chain and other is sprocket. Mostly chain and sprocket are made of mild steel material. As we know steel is corrosive and has less life and also has more weight. To overcome these and other problems there should be replacement for steel.

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II. LITERATURE REVIEW

Many researchers are working in the design and development of sprocket; some of their research is listed below;

[1] **Karim H. Shalaby et al. [01]** has studied involving the paper analyses and brings to light the importance of contact forces of the Inverted Tooth Chain (I.T.C.) plates on the sprocket wheel at different locations on the Analogue Huygens Pendulum, knowing that the contacts between plates and sprocket always cause vibrations and noise. The MSC ADAMS SOLVER/VIEW software, which is based on multi body dynamics, is used for simulating the contact forces. The simulation results lead to the conclusion that the contact between the plates of the inverted tooth chain (I.T.C.) and the sprocket produces elastic-plastic impacts.

[2] **Amol J. Kadam et al.[02]** has researched the basic aim of this review has been conducted on the most of the time conveyor chain is under tension which causes failure of chain assembly which is the major problem for industrial sector. Causes of this failure are improper design. It is important to study the influence of these parameters. All these parameters can be considered simultaneously and chain link design optimally. Optimization is the process of obtaining the best result under given circumstances in design of system. In optimization process we can find the conditions that give the maximum and minimum value of function. In this study a shape optimization process is used for the design of roller chain link for minimization of failure modes. This process various design variables, such as wall thickness of link,

breaking area of link and shape of the link. While deciding the shape optimization of roller chain link raw material plays important role, so it is necessary to decide raw material.

[3] **Chaitanya G. Rothe et al.** [03] has found this work 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.

[4] **R. V. Mulik et al.** [04] has researched the work includes developing a simulation model in suitable simulation software and its dynamic analysis. The results are expressed in terms of parameters such as contact forces and normal forces between different components and link tension forces etc. The results presented in this paper shows that the external forces and loads can be easily sustained by the timing chain components. The obtained values for the contact forces, tensions etc. were much below the maximum permissible values. The layout designed is compact, functionally and dynamically stable and safe and can be implemented in actual engine. The current layout can be modified further to a single chain layout for more compact and reliable design. The current methodology thus proves to be a fair solution to analyze timing chain drives, a vital component of an engine.

[5] **P.K. Harish Kumar et al.** [05] this study involves the fundamentals of sprocket design and manufacturing of a Yamaha CY80 motorcycle rear sprocket through reverse engineering approach. It discusses dimensioning, drafting, chemical composition, material selection, choice of manufacturing process, heat treatment, surface finish and packaging as the eight steps that need to be followed sequentially in this reverse engineering approach. In this work, universal milling machine was used to produce the sprocket from the blanked medium carbon steel (AISI 1045) with chemical composition of C=0.45%, Mn=0.75%, P=0.03% max, S=0.04%. Induction heat treatment was applied to move the material hardness from 13 HRC to 45 HRC as shown by hardness test.

[6] **Ebhota Williams S Peter et al.** [06] has studied involving the fundamentals of sprocket design and manufacturing of a Yamaha CY80 motorcycle rear sprocket through reverse engineering approach. It discusses dimensioning, drafting, chemical composition, material selection, choice of manufacturing process, heat treatment, surface finish and packaging as the eight steps that need to be followed sequentially in this reverse engineering approach. In this work, universal milling machine was used to produce the sprocket from the blanked medium carbon steel (AISI 1045) with chemical composition of C=0.45%, Mn=0.75%, P=0.03% max, S=0.04%. Induction heat treatment was applied to move the material hardness from 13 HRC to 45 HRC as shown by hardness test.

[7] **Chandraraj Singh Baghel et al.** [07] has researched the study of the stress of chain, sprocket of motorcycle is compared with the sprocket of plastic material made by PEEK. It has been achieved by using software ANSYS, by applying pressure in to the model of sprocket made in the said software. Sprocket of stainless steel is considered as an object and input variables have been taken by the physical measurement by vernier caliper, screw gauge, and different measuring instruments. As per requirement it has been designed as per the design procedure in Pro-E. With the insertion of that model into the software ANSYS and checking the finite element structure in that software; with different properties of stainless steel we found different values of equivalent stress, and total deformation. With same model of sprocket, analysis has been carried out in software ANSYS with the different properties of PEEK (polyether ether ketone).

[8] **Tushar D. Bhoite et al.** [08] has found the paper deals into various application aspects and manufacturing aspects to formulate an idea of the system. Finite Element Analysis (FEA) has been used to conduct shape optimization. Since lot of work has already been done in other components, in this paper the focus has been narrowed down to specific component of outer link. Within the outer link, most dimensions in the industry are parametrically defined, however one dimension, the radius that is in between the internal connecting holes is left to manufacturer convenience. In this paper we assess the impact of this radius on the stress in the system, and see if material saving and consequently efficiency increment is possible.

[9] **Candida Pereira et al.** [09] has researched a novel multibody methodology to address the kinematic and dynamic effects of roller chain drives is presented. The chain itself is modelled as a collection of rigid bodies, connected to each other by revolute clearance joints. Each clearance revolute joint, representing the connection between pair of links, is made up of the pin link/bushing link plus the bushing link/roller pairs, if the chain is a roller chain. The clearance joint approach is further extended to the roller/sprocket teeth surface contact pairs. The internal conformal contact and the external contact between these cylindrical geometries is described using a new analytical model that puts together the precision of the contact force evaluation with the numerical efficiency required. To start the dynamic simulation and to ensure the accuracy prediction outcomes of the dynamical behaviour of these nonlinear mechanical systems, a proper set of initial conditions on the positions and velocities of the chain drive components is required. Furthermore, the problem of contact initialization and its coordination with the numerical integration procedures is taken into account by controlling the time step size of the numerical integration algorithm in the vicinity of the impact. The methodologies adopted results in a computer program general enough to analyse very different chain drive systems, e.g. chain drives in industrial machines,

marine engines, car engines or motorbikes. This methodology is demonstrated through its application to the study of a bicycle roller-chain drive being the methodological assumptions discussed in the process.

[10] **Swapnil Ghodake et al.** [10] has found the in an excavator, a sprocket is a toothed wheel that engages with a chain or track to transmit rotary motion. Sprocket, track and idler form an assembly to cause the motion of excavator. Optimization is a methodology of making something (as a design, system, or decision) as fully perfect, functional, or effective as possible to maximize productivity or minimize waste. In this paper, 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 analysing existing and optimized sprocket with different types of FEA techniques. Strain Gauging is done for correlation with FEA virtual strain to confirm the loadings. Conceptual Test rig is proposed to validate the optimized sprocket.

III. METHODOLOGY

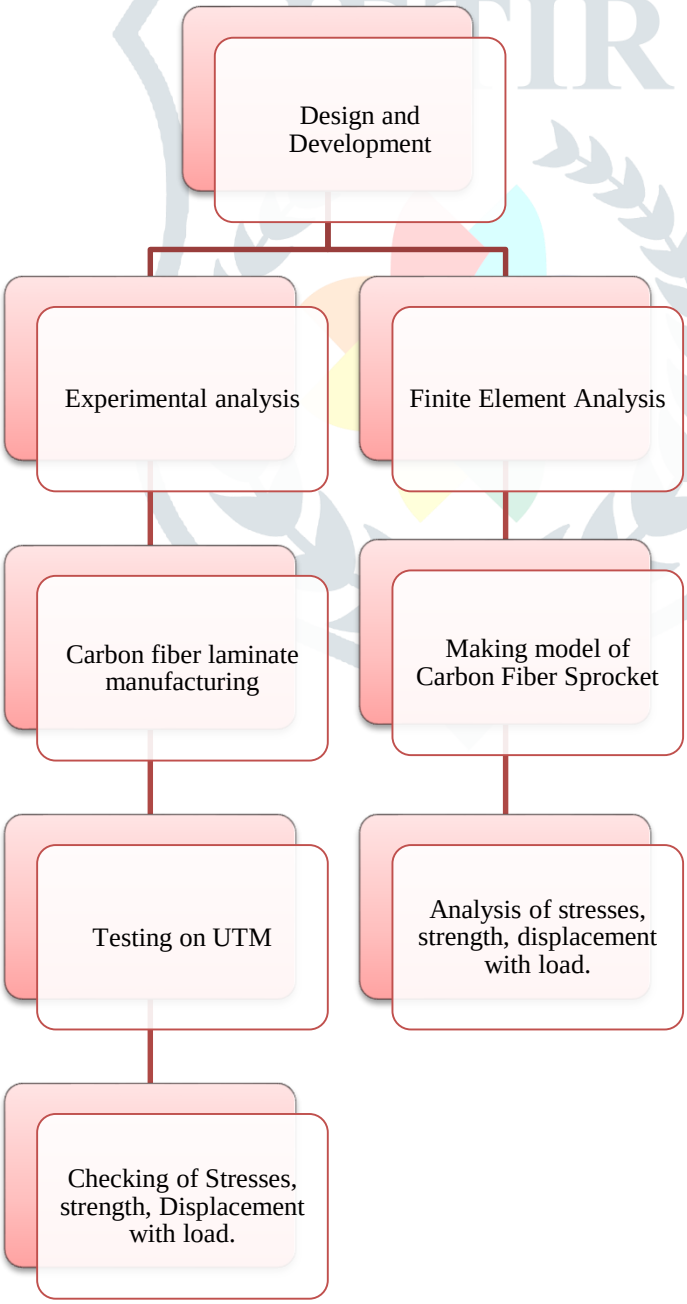
3.1 Theoretical work

- To review previous work regarding Chain Sprocket for automobile transmission system.
- Design of Carbon Fiber Sprocket.

3.2 Experimental work

- Design of Carbon Fiber Sprocket.
- To develop Carbon Fiber Sprocket as per design.
- To investigate performance of system by experimental and FEA.

3.3. Experimental flow chart



IV. CONCLUSION

From the literature review it is conclude that the limited research has been covered on the Design, Development and Analysis of Carbon Fiber Sprocket.

Chain sprocket has problems like braking of bushings and/or rollers, breaking of plates and pins, like wearing of sprockets at very fast rates, worn-out rollers, etc. 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.

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