A Literature Review on Chain Drives

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Abstract- *Chain drive is a most conventional model used for transmitting the mechanical power from one place to another. Chain drive so called positive drive because of its less wear and tear. One of the major problems faced by chain drive is its less efficiency or mechanical advantage. This paper reviews patents and experimental work brought by researchers on drive mechanism of vehicle in order to optimize its operating performance and also to reduce impact of meshing noise. Hereby we have gone through various analysis such as kinematic, dynamic, approximate and theoretical analysis on chain drive system to optimize its performance.*

Keywords- Conventional model, positive drive, drive mechanism, meshing noise and experimental analysis

I. INTRODUCTION

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered. For example, when the bicycle pedals' gear rotate once, it causes the gear that drives the wheels to rotate more than one revolution.

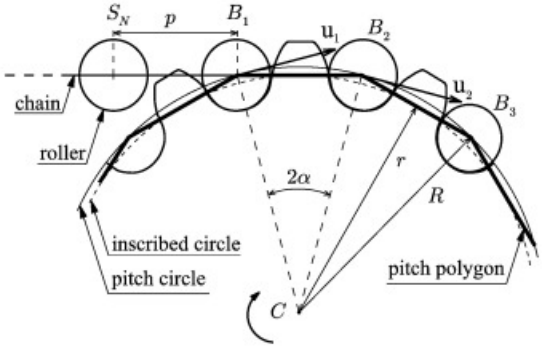

Fig.1. Roller chain geometry

II. LITERATURE SURVEY

Nikhil.D.pachkawade and Dr.Girish.D.Mehta [1] had done a work on dynamic analysis of roller chain link with the consideration of polygonal action, chordal action and periodic length. During varying load condition, the chain itself vibrates which provides impact loads in its sprockets and it enhances wear and tear. Author evidenced that linear speed of chain is not uniform and it varies from Vmax to Vmin. In order to reduce the variation in chain speed, the no of teeth of sprocket should be increased. For dynamic analysis, it has been chosen that the roller chain and it is done by rotating the sprocket in anticlockwise direction with angular displacement of 2 degree and for one articulation 17 degree and dynamics of a link of a chain drive during one articulation is always nonlinear.

Niels Fuglede and John Juel Thomsen [2] done an analysis of simplified modelling and dynamic effects of meshing. They examined the transverse vibrations of roller chain and effects of interaction with sprockets by modelling the chain as uniform string. Intensities between roller and sprockets and nonlinearity of sprockets also investigated. It has been assumed that chain as uniform heavy string, variation of chain density and cross sectional area are neglected, chain tension and length are considered as constant. The effect of chain and sprocket by making the string kinematically forced and also they analysed the effect of meshing by specifying the position of impact surface. And furthermore, they aim to examine the validity of physical approximations by comparing analytical results with detailed multibody dynamic simulation.

R.Gopinath [3] presented the design of silent chain drive mechanism which helps us to reduce noise, vibrations, wear and also increases the power transmitting capability. This work aims to manufacture silent chain drive which consist of two link plates that are interconnected with the help of the connecting pins and each link plate has teeth inside flank surface and outside flank surface where sprocket has tooth surface profile that is an envelope of trajectories of the inner flank surface of the link, with this arrangement the chordal action of the silent chain is suppressed at both sprocket, thereby decreasing the noise ,vibration and increasing the power transmission .The main disadvantage is that it cannot be used for reverse direction of the vehicle .The main point in designing the silent chain drive is using small pitch chains

with large number of teeth .It should wrap the small sprocket for at least 120° ,idler sprocket can be provided to the sprocket for maintaining the tension of the chain drive.

Smit patel and Meet patel [4] have carried research work to increase the output power on the chain drive by giving small amount of input power .This is done with the help of the speed increasing mechanism .The speed increasing mechanism consist of a small intermediate sprocket and a second chain is trained on the large intermediate sprocket and driven chain .The radius of intermediate sprocket is greater than that of the driven sprocket .The small and large intermediate sprocket are journaled to the same shaft .A mere experiment is done on the gear ratio for the front and small intermediate ,it is obtained as 0.33 by choosing choosing optimal number of teeth on each gears and on calculation with big intermediate sprocket and rear sprocket .We obtain gear ratio as an average of 0.6.Thus the speed is increased on comparing with input and output sprockets .This method can be used to power magnification of bicycle drive because it is cost effective and will be easily apply on the conventional bicycle.

Erickson et al [5] had patented work on drive sprocket in order to increase the performance of chain drive mechanism. Increasing the mechanical advantage, it is possible to increase the chain drive efficiency. Since Erickson changed the drive sprocket diameter to increase the mechanical advantage. A new drive sprocket assembly having a variety of drive sprocket gears which are radially displaced. These gears are mounted on shafts. The shafts are placed between the base plates and the end plates. Every shaft has unique degree of twist in accordance with effective diametric range. By moving the drive sprocket between the base plate and end plate, sprocket is forced to extend or contract radially along the shaft due to twist of respective shafts accordingly the drive sprocket diameter can be varied. This entire mechanism is achieved by either pulling or pushing of the knob.

Lawrence R. Gardner [6] had done patented work with the invention of automatic chain tensioning unit. A simple chain drive assembly usually consists of a drive chain which is wrapped or looped around the drive sprocket and the driven sprocket to transmit power to the driven shaft. This design while being of simple design, has its problems, some of which are elongation of the drive chain, leading to wear of the drive sprocket and driven sprocket as well as chain. This result in a loosening of the drive chain which then tends to skip over the drive sprocket or driven sprocket, when the unit is under operating load. This creates a need for a tensioner to eliminate this common problem. The tensioner design consists of a pair of idler assembly, each of which has one central idler sprocket and two indexing sprockets. These two pairs are aligned accurately by chain. This setup is installed near to the driven sprocket. When torque is introduced into the drive chain assembly, tight side of the drive chain will attempt to straighten itself out. Due to tensioning unit, the tight side of the drive chain cannot attain a straight line. As the taut side of the drive chain attempts to gain a straight line, it draws the automatic chain tensioner unit with it, which in turn moves the slack side of the drive chain to the working or tight side of the drive chain. So that it is able to prevent the elongation of chain.

Troedsson and L. Vedmar [7] proposed a method to determine the static load Distribution in a Chain Drive. In this model the complete geometry is used without any assumption. In order to obtain a model for determining the load distribution along the sprockets and the forces in the chain. This transmission is divided into four parts, these four parts are tension span, slack span, driven sprocket and drive sprocket. In this tension span most of the power is transmitted between the two sprockets. So, tension force dominates the gravitational force. since friction is neglected, the tension span was model as a series of massless spring, each of the spring has a same elasticity as a chain link and have all of the coordinates is straight line. But in the slack span where the gravitational force dominates the tension force. Slack side is quite different from the tension span, since the tension force is very small. The major part of the tension force comes from the gravitational force in the chain. This side can therefore not assumed as a straight line.

Yong Wang, Desheng Ji, Kai Zhan [8] had performed the experimental study on meshing impact and friction of chain. He developed a new type of sprocket tooth profile is theoretically developed in order to improve the operational performance of roller chains under high-speed situation. The tooth profile of the sprocket can ensure that the meshing between sprocket and chain roller is an approximate conjugate action. The center line of the roller chain is a tangent line of the sprocket pitch circle alternately due to the polygonal action. The periodical variation of the chain center line affects directly the chain velocity and instantaneous angular velocity of the driven sprocket. To reduce the velocity variations, it is necessary to ensure that the arc length of the pitch circle in one pitch angle is equal to the pitch of the chain, or, that the moving distance of the chain at any moment is equal to the arc length of the pitch circle to be turned. Impact force occurs when the roller chain engages with the sprocket especially at high speed. The transient peaks of the impact force are present during chain starts to mesh into the sprocket. The impact force is one of the main sources of vibration and noise existed in the timing chain drive mechanism. Hence he achieved reduction in meshing impact and friction in chain drive.

James B. Spicer and Christopher J.K Richardson [9] had done the journal on the effects of frictional loss on bicycle chain drive efficiency for energy loss mechanisms. An analytical study of frictional energy loss mechanisms for chain drives is given along with series of experimental measurements of chain drive efficiencies under a range of power, speed and lubrication conditions. They found that chain line offset and chain lubrication have a negligible effect on efficiency under laboratory conditions. It was found that larger sprockets provide more efficient transfer of power while smaller sprocket proved to be less efficient. From the journal, I understood that the efficiency of bicycle chain drive depends intimately on the chain operation as it engages and departs from the sprockets on the high tensions part of the drive. The result of the study indicate that chain tension and sprocket size primarily affect the efficiency and that non-thermal loss mechanisms dominate overall chain drive efficiency.

H. Zheng, Y. Wang et al [10] presents a practical approach for predicting the meshing noise due to the impact of chain rollers against the sprocket of chain drives. Undesirable noise and vibration have driven researchers to make their contributions on the dynamic behaviour and vibration analyses of chain drive systems. On the subject of vibration and noise analyses of chain drive systems, five major categories may be classified as noise source identification, load distribution analysis, kinematic analysis, dynamic and vibration analysis, and noise and vibration control. The most significant source is from the impact between the chain link and the sprocket tooth during the meshing process. This so called &meshing noise is closely related to the overall dynamic behaviour of the chain and various parameters. Finite element techniques and numerical software codes are employed to model and simulate the acceleration response of each chain roller which is necessary for noise level prediction of a chain drive under varying operation conditions and different sprocket configurations. The predicted acoustic pressure levels of meshing noise are compared with the available experimental measurements. It is shown that the predictions are in reasonable agreement with the experiments and the approach enables designers to obtain required information on the noise level of a selected chain drive in a time- and cost-efficient manner.

Junzhou huo and tao li [11] presented the static and dynamic characteristics of the chain drive system of a heavy duty apron feeder, an essential part of mobile crushing station, typically adopts chain drive system to offer transmission. According to this journal, I understood that the large materials generate as several times force as bulk materials and the impulsive loads from a shovel of materials almost double chain tension. In this study, they have calculated chain tension and the interaction force between rollers and sprockets in meshing area and this reveals that the initial pressure angle have effects on chain link forces and interaction forces. Theoretical analysis of this journal indicates that the teeth number and sprocket pitch have the most influential effect on the vibration in the conveying direction. They have verified the multi body dynamics using theoretical results and dynamics simulation.

John Juel Thomsen [12] have reported an analysis on kinematics of roller chain drive. They had done various analysis such as exact and approximate analysis on the roller chain, chain drive, four bar mechanism and multi body simulation. The kinematic model defines how the chain drive elements and their dimensions are simplified as the rigid components connected by perfect frictionless joints. A chain drive is modeled as the four bar mechanism and equation governing position, velocity and acceleration are presented and solved approximately. It treats the case where the span connects the sprockets such that they rotate in the same direction. As the result, it is demonstrated how the kinematic analysis can be used for interpreting simulation results.

III. CONCLUSION

Different kinds of experimental studies have been performed by researchers related to driving chain mechanism. Several researchers had determined dynamic analysis and meshing impact on chain as well as load distribution on chain in order to increase the stability of mechanism. While some researcher patented their works in order to increase the efficiency of the chain drive. Also some parameters like friction had analyzed to increase the efficiency.

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