Abstract—This paper proposes the characteristics of design of spur gear tooth profile using parabolic curve as its line of action a mathematical equation of the line of curve path contact line of action, the equation of the tooth profile, and the equation of the conjugate tooth profile The influences of the two design parameters, that present the size (or shape) of the parabolic curve relative to the gear size, on the shape of tooth profiles and on the teeth contact ratio are also studied through the design The strength, including the Hertz teeth contact analysis (TCA) and fatigue life of the gear drive designed by using the proposed method is analyzed by an Finite element analysis (FEA) simulation. A comparison of the above characteristics of the gear drive designed with the involute gear drive is also carried out in this work. The results confirm that the proposed design method is more flexible to control the shape of the tooth profile by changing the parameters of the parabola carver.

Keywords:— Spur Gear, Heatz Stress Calculation, Contact Stress, & fatigue life Finite Element Analysis.

1. INTRODUCTION

1.1 SPUR GEAR

Gear are used to transmit torque, motion and angular velocity from one shaft to another in a wide variety of applications there is also a wide variety of gear types to choose from. This chapter will deal with the simplest types of gear, the spur gear, designed to operate on parallel. Gear are available many other tooth configuration for particular applications. This chapter will present brief introduction to designing with spur gear the complexity of the design problems increased significantly when these more complicated gear tooth shapes are used. The American Gear manufacturers association (AGMA) present detailed data and algorithm for their calculation. We will base this presentation on the AGMA recommendation. But cannot give a complete treatment of this complex subject. [20]. The gear tooth profile can be distinguished as involute and cycloid fillet curves. First of all, it is necessary to embody the gear tooth that has the involute gear tooth profile. If the basic specifications such as the pressure angle, module, number of teeth and shift coefficient are given, the involute gear tooth profile can be embodied using the gear specification and involute function [23].

In this paper first the solid model of the spur gear is made with relations and equations modeling option in CATIA-5. After the modelling of spur gear the assembly is created of two spur gears with different fillet radius profile in curve path of contact. The contact is defined at the pitch circle radius with the appropriate centre distance between the two gears. Then the whole assembly is imported in
ANSYS-14.0 Workbench for teeth contact analysis (TCA) and fatigue life. The results of ANSYS 14.0 are then compared with the AGMA standards for the specified gear set in contact. The purpose of this thesis is to develop a general model to study teeth contact stress analysis and fatigue life of any spur gears in curve path of contact.

2. LITERATURE REVIEW

There has been great deal of research on spur gear analysis, and a large body of literature on gear modelling has been published. The teeth contact analysis, bending stress and fatigue life of spur gear with different fillet radius, constant load and pressure angle. Various researches are An approximate equation for the relation between pinion and gear addendum modification factors for gears to have a pre-established value of the contact ratio, is given method to estimate those factors when the additional condition of balanced specific sliding is imposed, is also presented. Both nor tabular values, so that they are efficient for computer applications [13]. A method of designing high-contact-ratio spur gears using quadratic parametric tooth profiles for the shorter addendums and no undercut. A design procedure is developed and a simplified derivation of the mathematical model of parametric tooth profiles is presented the tooth root stresses and the static transmission errors are shown to be lower than those of high-contact-ratio spur gears with involute profiles, but the contact stresses and the wear height indices are traded off [15]. A modified geometry of an asymmetric spur gear drive designed as a combination of an involute gear and a double crowned pinion that enables to localize and stabilize the bearing contact and obtain a favorable shape of transmission errors of reduced Magnitude. Computerized design of spur gears of proposed geometry and simulation of their meshing and contact have been developed, that confirm reduction of contact and bending stresses for an asymmetric spur gear drive [7]. The line of action usually comprises only simple curves. It will be easier to manipulate the line of action when multisegment tooth profile curves are used. The proposed mathematical model will enhance the freedom of tooth profile design by combining the simple curves to the line of action. it is easier to study the kinematical characteristics of mating gears with nonstandard tooth profiles by applying the proposed mathematical model [30]. A new geometry of new type of as asymmetric face-gear drive with modified differs from the existing by application of asymmetric profile and double crowned pinion of the drive. The paper cover computerized design, simulation of meshing and contact and analysis by FEM [8]. A new methodology which greatly increases the contact ratio between the teeth of non-circular gears, using a pressure angle constant for any given tooth and a method to generate a cad representation proposed [9]. Comparative analysis of tooth-root strength evaluation methods used within is and standards and verifying them with developed models and simulations using the finite element method (Fem). The presented analysis is conducted for (1) wide range of spur and helical gears manufactured using racks or gear tools; and for (2) various combinations of key geometrical (gear design), the results will allow for a better understanding of existing limitations in the current and applied in engineering practice as well as provide a basis for future improvements and/or unifications of gear standards [1]. A methodology to synthesize the mating tooth surfaces of a face-milling spiral bevel gear set transmitting rotations with a predetermined fourth-order motion curve and contact path. A modified radial motion (MRM) correction in the machine plane of a computer numerical control (CNC) hypoid generator is introduced to modify the pinion tooth surface [18]. A new approach to design pinion machine tool-settings for spiral bevel gears by Shailesh Rajak, Dr. Veerendra Kumar, JEC, Jabalpur | Finite Element Analysis of Spur Gear: A Review
controlling contact path and transmission errors. It is based on the satisfaction of contact condition of three given control points on the tooth surface. The three meshing points are controlled to be on a predesigned straight contact path that meets the pre-designed parabolic function of transmission errors the proposed approach together with its ideas has been proven by a numerical example and the manufacturing practice of a pair of spiral bevel gears [3]. Spiral bevel gear sets which can be manufactured by cup-shape grinder or milling cutter on a general purpose four-axis milling machine is proposed a new approach of manufacturing the spiral bevel gear is developed. The major merit of this spiral bevel gear is only single axis motion has to be controlled during the cutting process [29]. In a given size of symmetric involute gear designed through conventional approach, as the load carrying capacity is restricted at the higher pressure angle due to tipping formation, the use of the asymmetric toothed gear to improve the fillet capacity in bending is examined in this study. Non-standard asymmetric rack cutters with required pressure angles and module are developed to generate the required pinion and gear of a drive with asymmetric involute surfaces and thyroidal cycloidal fillet profiles [27]. The pinion of the drive utilizes a cosine curve as the tooth profile. It takes the zero line of the cosine curve as the pitch circle, a period of the curve as a tooth space, and the amplitude of the curve as the tooth addendum a comparison study of these characteristics with the involute gear drive was also carried out in this work. The results confirm that the cosine gear drive has lower sliding coefficients and the contact and bending stresses of the cosine gear are reduced in comparison with the involute gear [24]. To use dynamic analysis to compare conventional spur gears with symmetric teeth and spur gears with a symmetric teeth the secondary objective is to optimize the asymmetric tooth design in order to minimize dynamic loads. This study offers preliminary results to designer’s founder standing dynamic behavior of spur gears with asymmetric teeth [6]. Investigates effect of addendum on tooth contact strength, bending strength and basic performance parameters of spur gears. Face-contact model of teeth, mathematical programming method (MPM) and three-dimensional (3D), finite element method (FEM) are used together to conduct loaded tooth contact analyses (LTCA), deformation and stress calculations of spur gears with different addendums and contact ratios so, scoring strength calculations of the tooth tip and root becomes more important when to use high contact ratio gears (HCRG) with long addendum [25]. The bending stress is indirectly related to shape changes made to the cutting tool. This work shows that the bending stress can be reduced significantly by using asymmetric gear teeth and by shape optimizing the gear through changes made to the tool geometry. This observation suggests the use of two new standard cutting tools [16]. A design procedure is developed and a simplified derivation of the mathematical model of tooth profiles is presented. The characteristics of the gear drive designed by the proposed method are analysed. A comparison study on the sliding coefficient with the involute gear drive is also carried out in this work [11]. A model of non-uniform load distribution along the line of contact, obtained from the minimum elastic potential energy criterion, is presented. This model combined with the equations of navies and hertz yields more realistic values of the bending and contact stresses [12]. Element constructions and dynamic analyses for involute spur/helical gears, including cylindrical and conical categories. High quality elements for gear dynamics can be generated automatically and parametrically. Many design parameters are incorporated such as pressure angle and correction factor dynamic sponges of spur and helical gear pairs are calculated by LS-DYNA. The
dynamic fillet stress of the spur gear pair is compared with an experimental result. It is expected that the proposed approach by the general purpose finite element software can be applied in gear dynamics, incorporating wide design and manufacturing considerations [14]. Proposed approach provides a complete and effective solution of the contact problem but satisfaction for application of the hertz or is its main drawback. On the other hand, a finite element model has been developed and validated in terms of the contact area, maximum contact pressure, pressure distribution, maximum tresca stress, and tresca stress distribution underneath the contacting surfaces [10]. A new conjugated tooth profile is generated by applying double-enveloping gear theory in cycloid drives. Based on coordinate transformation and gear geometry theory investigated by theoretical analysis and numerical new conjugated tooth profile is represented by comparison of induced normal curvature with conventional cycloid drives [2]. Presents a contact stress analysis for a pair of mating gears during rotation. Contact stress analyses for spur and helical gears are performed between two gear teeth at different contact positions during rotation. The rotation is compared with the contact stress at the (LPSTC) and the AGMA, the contact stress in a pair of mating gears is more severe than that of the AGMA standard [23]. A method for analyzing one of the gear dynamics excitations and contact condition of a generated hypoid gear that considers the measured tooth flank form is proposed. The contact pattern and transmission error are measured experimentally and are compared with the analysis results. It is confirmed that the result from the proposed analysis method agrees with the experimental result [21]. A generalized approach for defining the phenomenon undercutting of involute teeth is proposed, where besides the traditional boundary case, the maximum value of the radius of the rack-cutter fillet, at which there is no undercutting, is specified. Two types of quantitative indices for the estimation of the extent of undercutting of the teeth in a radial and tangential direction are defined [17]. The basic principle characterized by the advantages of involute and circular-arc gears is put forward. Based on the theory of conjugates curves, generation and mathematical model of this new transmission are presented. Finally, the three-dimensional solid model of a gear pair is developed to demonstrate the properties of this new transmission [4]. The surface and subsurface stresses of gear teeth are investigated using hertz an theory and the finite element method. The number of loading cycles required for fatigue crack initiation is predicted using the smith Watson topper method based on the multi axial fatigue mechanism. The life of the teeth is introduced to decrease the stresses on these points and improve their initiation fatigue life [28]. Calculated in terms of non-dimensional stress. The influence of gear drive parameters such as drive and coast side pressure angles, top-land thickness coefficients, contact ratio, coefficient of asymmetry, gear ratio and teeth number on load carrying capacity has been studied extensively on non-dimensional fillet stress and maximum contact stress and compared with that of the conventionally designed gears [19]. The meshing characteristics of tooth surfaces are evaluated according to the analyses of motion simulation, mechanics property and sliding coefficient. The transmission efficiency experiment is based on the developed gear prototype, and a comparison with an involute gear drive is presented. The further study on dynamics analysis and key manufacturing technology will be conducted, and this new type of gear drive is expected to have excellent transmission performance [5].

3. CONCLUSION

In this study, a literature review was conducted to identify recent finite element models of spur gear. On ground of
geometrical model, numerical model of spur gear is performed using finite element. Spur gear tooth profile using parabolic curve as its line of action the results confirm that the proposed design method is more flexible to control the shape of the tooth profile by changing the parameters of the parabola line of action or root fillet radius of gear profile. The strength including the contact stresses and life cycle, of the gear drive designed by using the proposed method is analyzed by an FEA simulation. The latest research results an reduce contact stress up to 15% without undercutting and interference any reduction of torque.

REFERENCES


[19] P. M a r i m u t h u , G . Muthuveerappan, Design of asymmetric normal contact ratio spur gear drive through direct design to enhance the load carrying capacity, Journal of Mechanism and Machine Theory, 95 (2016) 22–34, Elsevier Ltd.


[24] Shanmingluo, Yuewub, Jianwang,


[30] Zhang-Hua Fong, Ta-Wei Chiang A n d C h i e h - W e n T s a y , Mathematical Model for Parametric Tooth Profile of Spur Gear Using Line of Action Journal of Mathematical and Computer Modelling 36 (2002) 603-614,