ABSTRACT

Gear design is considered to be one of the most important and complicated fields of mechanical engineering design, because of its wide usage and applications, in mechanical and electrical systems.

Due to the high working speed requirements in industry of rotating components, gear design development becomes quite noticeable and rapid in the vicinity of parameters, and effects of dynamic load and dynamic stresses on its performance.

Consequently this work concentrates on the variation of static geometric parameters on gear tooth design as also, the dynamic loading. In this present work the spur gear of straight tooth is chosen under the theory of involute gears. The theories and formulations of spur gear tooth profile are investigated by its two parts; Involute and Trochoid and a geometric method for involute gearing is introduced. This method discriminates the involute gear tooth into segments to determine the conjugate profile, instead of following a point to point analytical approach to determine the path of contact, the geometry of the generating rack and mating wheel, while the actual tooth thickness is considered with infinitesimal local involutes.

A computer Qbasic programme is developed to simulate and plot spur gear tooth profile, including involute and trochoid curves based on the formulation of rack cutter. The resulting graphs show flexibility of this
approach and versatility of the programme to draw many different cases of spur gear teeth of any module, pressure angle, profile shift factor, number of teeth and rack cutter tip radius, and the ability to perform under standard and non-standard conditions.

This study has shown the effects of the related geometric parameters (pressure angle, profile shift factor, number of teeth and rack cutter tip radius) on spur gear tooth profile and then on the whole design of the spur gear. Also, a difficult case relating with base circle, root circle which is generated by these geometric parameters has also been discussed.

The influence of these parameters on the bending stress in root portion of the tooth has been studied; two Qbasic programs have been developed based on two theoretical methods to calculate the maximum bending and maximum compressive stresses. Finite element models have been built and stress analysis has been done. The finite element results have been compared to and discussed with the theoretical calculations.

Bending stresses in thin rim spur gear tooth fillets and root areas differ from the stresses in solid gears due to rim deformations. Rim thickness is a significant design parameter for these gears. The finite element analysis has taken two paths to study this parameter; the first as a segment of a thin rim gear, and the second with full rim ring. The finite element analysis was conducted on these two paths, the rim thickness was varied and the location and magnitude of the maximum von Mises stresses reported, design limits discussed and the results of the two paths of analysis compared.
Pitting is a surface fatigue failure the outcome of many repetitions of high contact stresses. Other surface failures are scoring, which is a lubrication failure, and abrasion, which is wear due to the presence of foreign material. The surface fatigue mechanism is not definitively understood. The contact-affected zone, in the absence of surface shearing tractions, entertains compressive principal stresses. Rotary fatigue has its cracks grown at or near the surfaces in the presence of tensile stresses, which are associated with crack propagation, to catastrophic failure. Because engineers had to design durable machinery before the surface fatigue phenomenon was understood in detail, they had taken the posture of conducting tests, observing pits on the surface, and declaring failure at an arbitrary projected area of hole, and they related this to the Hertzian contact pressure.

A problem of contact stress has been chosen contain two teeth in different contact positions, representing a mating pair of gears during the rotating operation, a programme by Qbasic language has been developed to plot a pair of teeth in contact, this programme has been run each 3° of pinion rotation from the first location of the contact to the last location of the contact to produce 10 cases. Each case represents a sequence position of contact between these two teeth. The program gave graphic and numerical results for the profiles of these teeth in each different position and locations of contact during the rotating operation.

Finite element models have been built for these cases and stress analysis has been done. The stress results have been obtained by contours and numerical values, a curve of these results presented. Finite element analysis
results have been compared with the theoretical calculations and a good matching is found between the two.

Natural frequencies and dynamic response of two spur gear sectors are investigated using a two dimensional finite element models that offers significant advantages for dynamic gear analyses. The gears are analyzed for different values of operating speed.

A primary feature of the modeling is that dynamic mesh forces are calculated using a detailed contact analysis at each time step as the gears roll through the mesh. Transient mode super position method has been used to find horizontal and vertical components of displacement and dynamic stresses, dynamic shear stress and dynamic von Mises stress. The finite element analysis software ANSYS has been used on the proposed models to find the natural frequencies by Block Lanczos technique and displacements and dynamic stresses by transient mode super position method. A comparison of theoretical (natural frequency and static stress) results with the finite element analysis results has been done. The effect of rotational speed of the gear on the dynamic response of gear tooth has been studied and design limits are discussed. All the stress finite element analyses which have been done in this work were under two-dimension plane stress condition.