Optimization of Bending Stress of Spur Gear Using Response Surface Optimization Technique

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ABSTRACT

This work deals with the reduction of bending stresses of the involute spur gear and pinion by introducing stress relieving feature of shapes i.e. elliptical hole. In this work the stress analysis of mating gears of the spur gear with five different modules is done to determine the bending stresses generated in the gear teeth. In the previous paper the results obtained from Finite Element Analysis (FEA) using Ansys are compared with the values obtained from response optimization tool. The materials of spur gear used for analysis are grade 1 steel. In this work, the stresses which were calculated has been reduced by introducing stress relieving feature of elliptical shapes in most stressed area. It was found that Stress relieving feature having the shape of elliptical yielded better results when compared to normal or without hole. In this Analysis the multi objective genetic algorithm has been taken and optimum shape parameter are proposed, which useful to give minimum bending stress and maximum life cycle of fatigue life as compare to existing work.

Keywords: *Optimization, Gears, Bending Stress, Response surface optimization, ANSYS.*

I. INTRODUCTION

Imagine two disks are placed side by side, tangent to each other (both touching), if one disk was rotated, due to friction (caused by surface roughness) the other disk would also rotate (in the opposite direction) however, slippage would be introduced due to variation in the surface roughness. Now if we were to increase that surface roughness by cutting the disks and forming teeth on the circumference (circular outer part) then slippage would be eliminated. As a result, we would have one of the most important fundamental mechanical devices, which can manipulate speed, torque and rotational axis. Almost all machines that involve rotation have gears. Gears are found in everything from cars to clocks.

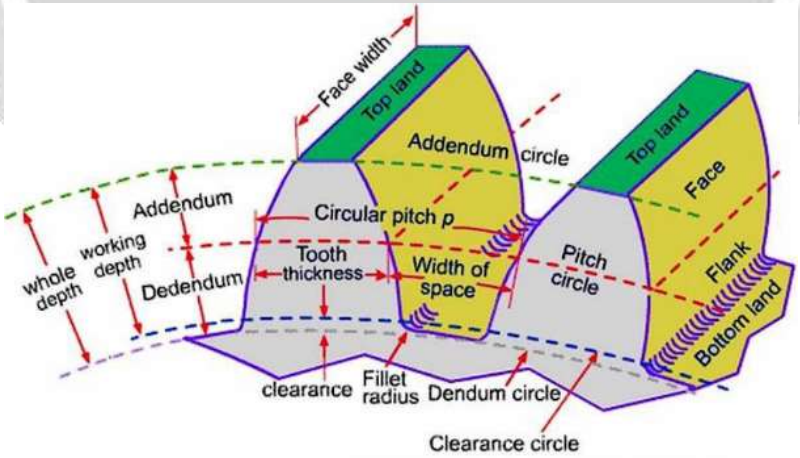

Fig 1. Different parameters of a gear

II. PROBLEM IDENTIFICATION

Gear Failures a combine of gears tooth in action usually subjected to cyclic stress failure that has tooth-bending fatigue, tooth-bending impact, and tooth wear [3]. Gear tooth failures occur in two distinct regions, the tooth flank and therefore the root fillet. Gear will fail in many modes.

III. METHODOLOGY

3.1 Design of Spur Gear

The spur gear is simplest types of gear manufactured and is mostly used for transmission of rotation between parallel shafts. The spur gear is that the first-choice possibility for gears except once high speeds, loads, and ratios direct towards different choices. Different gear types may be most popular to produce additional silent low-vibration operation. The spur gear is mostly elected to possess a quantitative relation vary of between 1:1 and 1:6 with a pitch line rate up to 25 m/s. The spur gear has an in-operation potency of 98-99%. The pinion is formed from a tougher material than the wheel. A gear try ought to be elect to possess the very best variety of teeth in line with an acceptable margin of error in strength and wear. The minimum variety of teeth on a gear with a traditional pressure angle of 20.

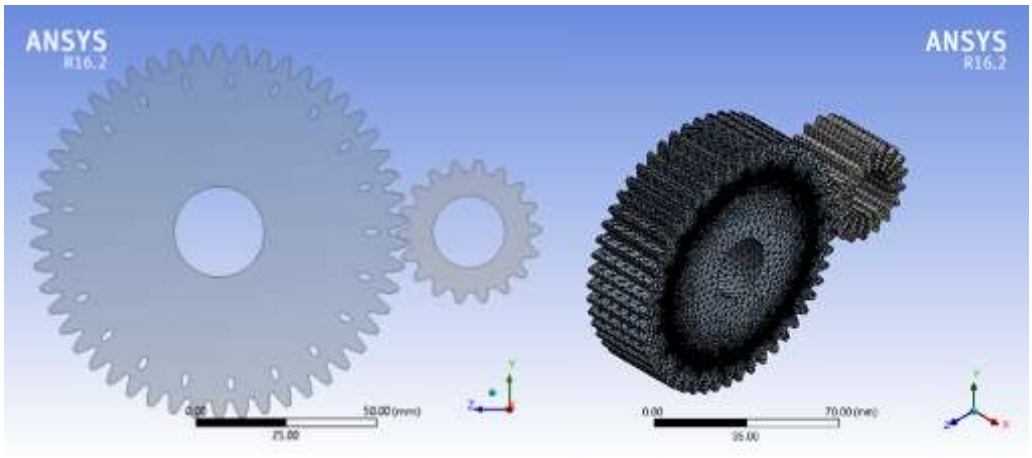

Fig 2. 3D Model (left) and meshed view (right) of involute gear arrangement

IV. RESULT AND DISCUSSION

In this section the value of stress obtained after optimization and compared with literature Vivek et. al. [3] with after optimization or proposed results.

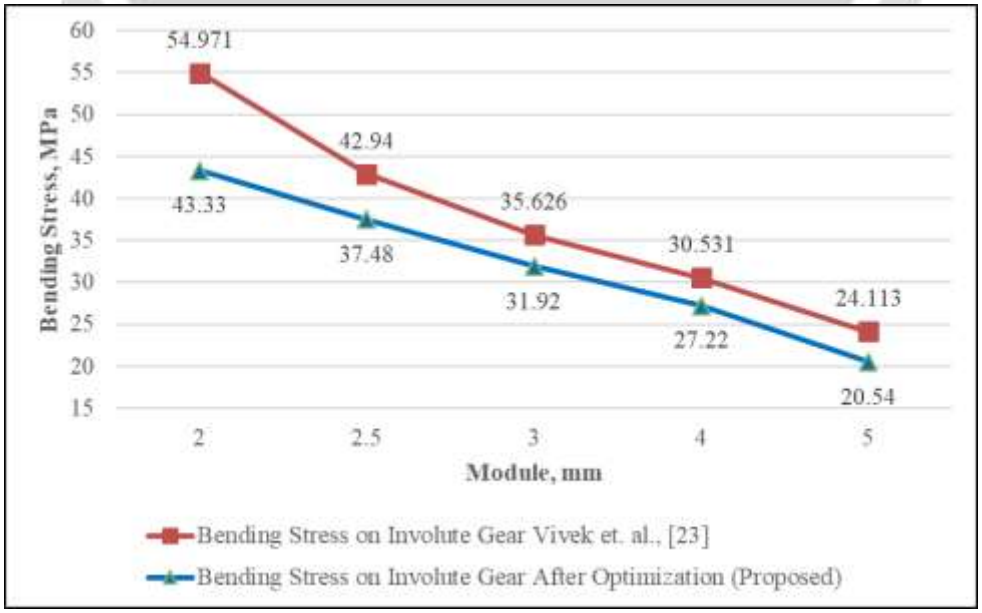

Fig 3. Graph plotted between of bending stress and different modules in involute gear before and after optimization

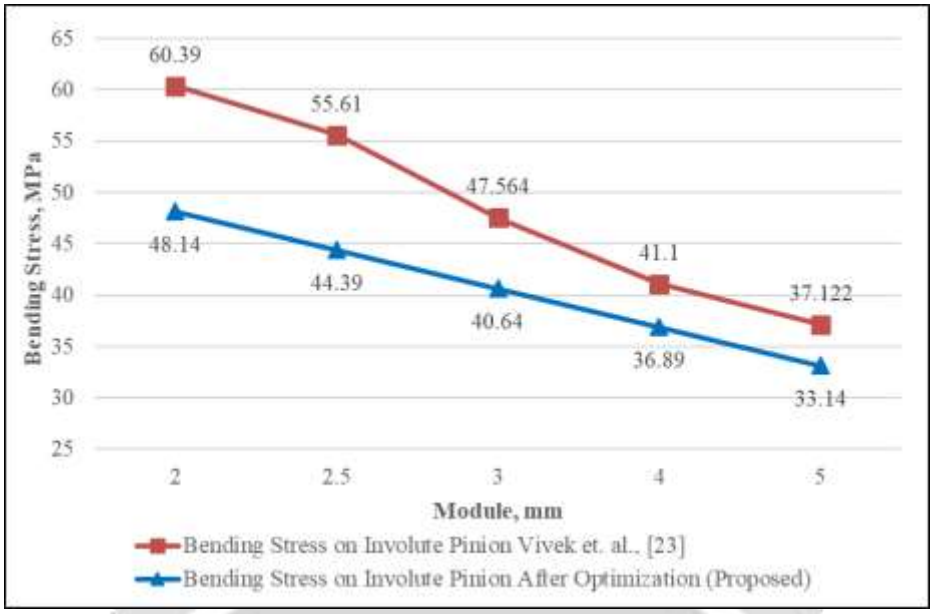

Fig 4. Graph plotted between of bending stress and different modules in involute pinion before and after optimization

Figure 3 and Figure 4, clearly shows that the output value of the bending stress on involute gear and pinion teeth was lower than the proposed results. If the value of modules was varying from 2 to 5, the bending stress was decreased both existing and proposed work, the proposed work gives minimum bending stress and increased the life of gear, it is suitable for safe.

V. CONCLUSION

- The main objective of the work is to relieve stress from the maximum value to as minimum as possible. So, the highest point of contact of teeth is selected as pressure application point which causes highest stress.
- The stress relieving features having a shape used in to regulate the stress flow.
- There is a good agreement to find the optimal value of bending stress distribution of spur gear for grade 1 steel materials with different module.
- Based on this work, the analysis of involute spur gear design is analyzed and choice the suitable gear arrangement.
- In this work the Multi objective Genetic Algorithm (MOGA) method has been taken because of there is multi objectives are here.
- After optimization with different modules the bending stress are reduces approx. 10%-21% in gear and approx. 10%-22% in pinion respectively as compared to Vivek et. al. [3].

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