FATIGUE ANALYSIS OF STEERING RACK AND PINION SYSTEM

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Abstract

The steering rack and pinion systems are widely used in the automotive industry today due to their simplicity, compactness, and dependability. The primary goal of this paper is to investigate the fatigue of the steering rack and pinion system. In this paper, we analyzed two components in the steering system that are connected to each other. Firstly, this paper investigates the suitable material with proper boundary conditions for the model. Next, the contact of stresses between two mating gears of both the steering rack and pinion system must be determined. To pinpoint and observe the total deformation of the model design during simulation using ANSYS software. Lastly, in this paper, we must identify and discuss the life cycle and safety factor for the steering rack and pinion system model using a fatigue tool package. The ANSYS software results are presented and discussed to ensure that all objectives have been met successfully. The implementation via simulation results and mathematical calculations in research will improve the performance and efficiency of a design or model.

1   Introduction

The world has been soaring towards a higher level of modernization and globalization in innovation and technology that is mainly related to the critical and calculative thinking of every professional engineer in every sector. The most visible proof that we can observe is the evolution of the technology in the automotive sector that has changed from using an internal combustion engine to an electric vehicle. Furthermore, automotive components are also shown improvement over the years in design and quality [1] .

There are two main types of steering systems that are used on cars and light trucks, which are the rack-and-pinion system and the conventional, or parallelogram linkage steering system [2], [3]. However, the conventional type was only used on vehicles or automobiles until the 1970s, and today the rack-and-pinion system has almost completely replaced the steering system [4].

Rack-and-pinion steering is a straightforward system for converting steering wheel rotation into straight-line movement at the wheels [5]. The steering gear is made up of the rack, pinion, and associated housings and support bearings [6]. As the steering wheel is turned, the pinion rotates. Due to the pinion teeth mesh with the rack teeth, turning the pinion causes the rack to move to one side. Moving the rack causes the wheels to turn because it is linked to the steering knuckles [7]. Fig. 1 shows the pinion gear and the rack.

In the automotive industry, it is crucial to determine the design and fatigue life of the rack and pinion in the steering system [8]. Thus, in this study, a series of finite element models have been developed and analysed for rack and pinion systems to predict the fatigue life and safety factor of the steering system.

2.   Methodology

The methodology in this paper contains the fatigue analysis of the steering rack and pinion system by using the FEA package in ANSYS software. As we already have the design from the SOLIDWORKS software with the fixed parameter, the structural analysis of the design or model consists of the selection of the material, mesh, and fatigue tool analysis. The material of aluminium alloy 6061 was selected. It is critical to consider the materials and properties of the gear system when designing an efficient steering system [9]. Therefore, we focused mainly on a lightweight rack and pinion steering system for a car by replacing conventional materials with aluminium alloy 6061 due to its low cost and weight, taking contact stresses and bending stresses into account, and then verifying with Finite Element Analysis, FEA in ANSYS [10].
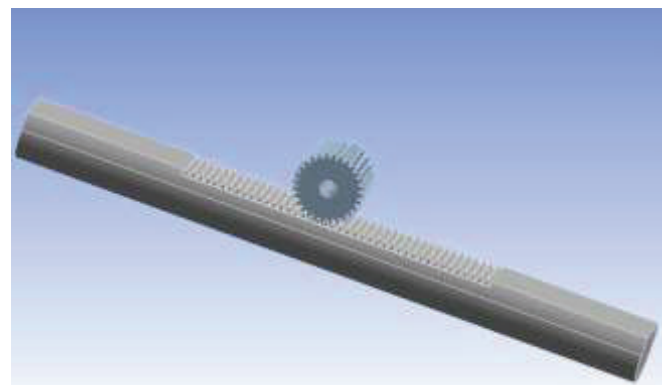

Fig. 1 Steering Rack and Pinion System Model

1