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Contact stress analysis of xylon coated spur gear using ANSYS workbench

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Abstract

One of the most crucial mechanical components of a mechanical power transmission system is the gear. To transfer torque, a spinning machine component with cut teeth meshes with another tooth component. Due to their great degree of versatility, gears are used in a broad variety of applications, from small wristwatches to massive heavy equipment like those used in the automotive and aerospace industries and marine engines. Contact stress and bending stress are therefore the two key factors that affect gear failures. In the current study, a static stress analysis is carriedout on the spur gear part to figure out the equivalent stress, total deformation, and stress intensity. Additionally, the component's possible fracture point is also located. Many materials, such as xylon, PTEF (polytetrafluoroethylene), and boron carbide, are used to increase the gear lifespan with the intention of reducing contact stress. Coated materials in gears are chosen because they are readily available and low-friction, and they are compared to conventional gear.

Introduction

An eco-friendly technology for coating fluoropolymer layers with controlled micron-thickness under insufficient lubrication or dry friction, a new surface have been developed over the spur gear. It works as the newly formed metal layer to decrease the dampen vibration [1], [2]. Due to the development of high-performance dispersions, fluoropolymer-coated materials are now widely used. These mixtures consist of composite particles suspended in an organic mixture [3]. As a result of the fluoropolymer family of materials (PTFE, PFA) and filler materials (molybdenum disulfide, silicone products) being present in the composite particles, a fluoropolymer film is produced that combines these properties with the good antifriction and antiadhesive qualities of the fluoropolymer materials lacks their good wear resistance due to the nature of the binder [4]. These days, active surfaces on old engine parts are covered (coated) with fluoropolymer compounds to increase friction coefficients, decrease wear, and quieten operation. A mechanical component called an agrarian distributes power from one shaft to another by way of the successful engagement of teeth in a successful contact [5]. In comparison to belt and chain drives, gear drives are more compact, run at faster speeds, and can be utilized in applications where accurate timing is required, belt or rope slipping is a frequent occurrence, or when transmitting motion or power between two shafts [6]. Slipping causes the system's velocity ratio to decrease. In precision machinery where a specific velocity ratio is crucial, the only positive drive is through gears or toothed wheels.

The simplest type of gear is a spur gear, which has teeth that are cut on the outer surface of a cylindrical blank in a direction parallel to the gear axis [7]. Typically, there are two types of spur gear drives: exterior gears and internal gears [8]. In the case of internal gears, teeth are only cut internally in the larger gear, and the pinion still has external teeth as is customary. External gears have teeth cut into the external peripherals of both the pinion and the gear. To transfer power between parallel shafts, spur gears are used [9]. The entire face-width of one gear will make contact with the complete face-width of its mate gear during engagement because the gear teeth are parallel to the axis. This causes noise, which gets louder as speed rises. As a result, spur gears are used for low-power transmission, although they are operated rather slowly. Spur gears may also be used in conjunction with pinion and rack gears to convert circular motion into linear motion [10]. Spur gears are often produced with an involute profile and a pressure angle of 14.5 or 20 degrees. The 20-degree pressure-angle gears are more commonly employed due to their great load-carrying capacity. They only place radial strains on their bearings because of the tooth structure, which is straight and parallel to the axis [11]. The majority of machine tools, including hobbing machines, milling machines, gear shapers, and broaching machines, can create spur gears because of their straightforward structural design. Spur gears can occasionally be stamped or cast [12].

When choosing the materials for toothed gears, it is important to make sure that the teeth have enough beam strength and that the surface layers are durable [13]. Different kinds of materials can be used to make gears, depending on what they are used for and where they are used [14]. It is important to consider the beam strength of the teeth and the durability of their surface layers when choosing the materials for toothed gears. Gears composed of many types of materials can be used, depending on the purpose and locations of applications. The materials that are most frequently used to make gears include ferrous metals, such as cast iron of various grades and alloy steels made of nickel, chromium, and vanadium, and non-ferrous metals, like titanium, bronze and brass. Non-metals such as plastic-oriented materials like phenolic resins, nylon, bakelite, mica and steel can be extensively employed in various engineering applications among all the materials described above with adequate heat treatment [15], [16], [17]. The pinion gear in a gear drive typically experiences more loading cycles than the wheel gear; as a result, the pinion should be constructed of stronger materials than the wheel [18]. Contact stress analysis plays the main role in spur gear design, based on the ANSYS analysis plan to create a new database that will help full gear manufacturers to find the coating thickness based on their applications.

Section snippets

Real time applications of spur gear

The gear transmission system is most widely used because of its high load-carrying capacity, high efficiency, and compact layout. From the smallest timepieces and instruments to the biggest and most powerful machinery like lifting cranes, gears are employed in many different fields and under a variety of different conditions [19]. Using gears with a diameter ranging from a few millimeters to many meters, they can be controlled to transmit power from negligibly small values to thousands of

Pro-E 5

By utilizing the software PRO-E 5, the specimens are modeled. With its distinctive features and adaptable user interface, the PRO-E 5 program makes modeling simple for users. Recent work has offered a number of methods for modeling the best gear design. It gives a computer design procedure for 20-degree pressure-angle gearing that disregards scoring for gear-tooth tips. This program changes the diametral pitch, face width, and gear ratio to get a good design for the gear mesh characteristics,

Methodology

The following are the processes by which the analysis is done.

- Importing to the ANSYS workbench
- Generating meshing
- Applying material properties
- Applying supports
- Applying loads
- Analyzing the deformation and stresses
- Plotting the graph

Existing gear (Gear-1) analysis results

Total deformation for uncoated gear is higher compared to coated gear which is shown in Fig. 2. The coated gear shows the various stress distributions in the particular gears. Uncoated gear no stress distributions show the more stress created in the uncoated spur gears. The color of the gear indicates the various stress levels in the coated gears.

Directional deformation occurs more in the coated gears as shown in Fig. 3. The colored gear shows the coated gears red color showing more in the

Conclusion

The profile is altered, examined, and contrasted with current equipment. When compared to the present gear, the stresses created in the designed gear are lower. Discretize and evaluate spur gear with the same gear parameters other than the tooth height. The result shows that the modified tooth has better control over displacement upto 2%. Therefore, an increase in tooth depth within a certain range assures that the vibration's magnitude can be effectively controlled. As a result, it is

CRediT authorship contribution statement

M. Karthick: Investigation, Writing – original draft. **Ch. Siva Ramakrishna:** Methodology, Writing – review & editing. **R. Pugazhenthi:** Conceptualization, Formal analysis. **Nitin Gudadhe:** Writing – review & editing. **S. Baskar:** Supervision, Writing – review & editing. **Renu:** Writing – review & editing. **Rajan Kumar:** Software.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: We wish to draw the attention of the Editor to the following facts which may be considered as potential conflicts of interest and to significant financial contributions to this work. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We

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References (24)

J. Kramberger *et al.*
Numerical calculation of bending fatigue life of thin-rim spur gears
Eng. Fract. Mech. (2004)

S. Glodež *et al.*
Evaluation of the service life of gears in regard to surface pitting
Eng. Fract. Mech. (2004)

E. Akata *et al.*

Three point load application in single tooth bending fatigue test for evaluation of gear blank manufacturing methods

Int. J. Fatigue. (2004)

D. Yogaraj *et al.*

Design and analysis of compact paddy harvester machine

Mater. Today Proc. (2022)

S. Chelliah *et al.*

Implementation of drive mechanism to control worktable motion in planer machine tool

Mater. Today Proc. (2022)

C.-K. Lee

Manufacturing process for a cylindrical crown gear drive with a controllable fourth order polynomial function of transmission error

J. Mater. Process. Technol. (2009)

I.H. Seol *et al.*

The kinematic and dynamic analysis of crowned spur gear drive

Comput. Methods Appl. Mech. Eng. (1998)

H. Wang *et al.*

Optimal engineering design of spur gear sets

Mech. Mach. Theory. (1994)

N. Sharma *et al.*

Development of quality microholes by electrical discharge drilling on Al/SiC composite using of Grey-desirability approach

Int. J. Light. Mater. Manuf. (2022)

A. Sharma *et al.*

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