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Development of a Computational Package for Kinematic Analysis and Design of Gear Pairs.

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Abstract

This project presents the development process of a computational package that performs the kinematic analysis and aids the design of gear pairs for application in mechanical transmissions based on a wide bibliographic revision on spur gears. This computational package aids not only on the selection of the gear pairs that better suits the design requirements but it also analyzes all the involved parameters, which might lead to the identification of optimization opportunities. Thus, this package configurates an important design tool that can be used on the R&D field for building downsized more reliable and efficient gear trains as well as for educational purposes.

Key words:

Gear Design, Computational Package, Gear Pair.

Introduction

Research and development of gear pairs is an effort of great interest once these components are widely employed on several mechanical transmission systems, being directly related to their dynamic behavior and efficiency. Gears are one of the oldest devices invented by man and their designs involve several parameters and many calculations [1]. For this reason, this project aims to develop a program that performs kinematic and dimensional analyses, providing the design parameters of the gear pair. In that way, the program minimizes engineering time and aids to understand the design steps as well as to make the iterative design choices.

Results and Discussion

An algorithm for calculating the design parameters has been developed from the AGMA standards [2,3]. The first step in the design process is to analyze the kinematic behavior of the gear pair, in order to determine the speed ratio, distance between centers, contact ratio, sliding velocity and also to verify the precision and interference. This analysis has been carried for two distinct and usual cases: in the first case the gears are predetermined; in the second one is necessary to obtain the gear pair that better satisfies the distance between centers and speed ratio established in the design.

Table 1. Kinematic analysis from the Case Study

Inputs	
Number of teeth of the driving gear	22
Number of teeth of the meshed gear	55
Diametral pitch	8
Pressure angle	20°
Rotational speed of driving gear	3750 rpm
Outputs	
Speed ratio	0.400
Distance between centers	4.8125 in
Contact ratio	1.6757
Initial sliding velocity	179.62 in/s
Final sliding velocity	160.34 in/s

Taking as inputs the data from the kinematic analysis, the operation load and conditions and the gear's material properties and geometric characteristics, the computational routine performs the dimensioning of the gear pair and provides the resulting bending and contact safety factors. Tables 1-2 show the inputs and outputs from the kinematic and dimensional analyses for a Case Study, respectively.

Table 2. Dimensional analysis from the Case Study

Inputs	
Power input	13.9230 hp
Ratio between face width and diametral pitch	12
Quality index	10
Brinell Hardness	250 HB
Young's modulus	30e6 psi
Poisson's ratio	0.28
AGMA Grade	1
Lubricant temperature	200 °F
Number of load cycles (pinion)	4.7e9
Commercial application	Yes
Reliability	99%
Solid disc	Yes
HPSTC	Yes
Idler	No
Outputs	
Bending safety factor for pinion	2.8688
Bending safety factor for gear	3.3879
Surface safety factor for pinion	1.0795
Surface safety factor for gear	1.1260

Conclusions

The computational package developed in this project presents appropriate results in accordance with literature results. Therefore, it can be used as an important tool for design the several gear pairs, reducing engineering time and aiding accurately in the design steps.

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[1]Dudley, D. W. The Evolution of the Gear Art. Washington, American Gear Manufacturers Association, 1969

[2]Norton, Robert L. Projeto de máquinas: uma abordagem integrada, 4 ed. Bookman, 2013.

[3]Shigley, Joseph E.; Mischke, Charles R; Budynas, Richard G. Projeto de engenharia mecânica, 7 ed. Bookman, 2005.

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