Investigating Effects of Rim and Web Thickness on Root Stress of Thin-Rimmed Spur Gear With Symmetric Web Arrangement

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ABSTRACT – Caution on the allowable root stress values need to put in consideration for thin-rimmed gears due to the thickness of rim and web. This paper used the basic AGMA equation to predict gear tooth root stresses later to be compared with FE analysis. The aim of this paper is to investigate the effects on root stress of thin-rimmed spur gear with different rim and web thicknesses. Eight sets of thin-rimmed spur gear with different rim and web thickness have been simulated in Abaqus software as FE model for further analysis. Von Misses stress values were extracted at Hofer's critical section on tensile side of second tooth in contact. From the AGMA equation shows that tooth root stress constantly increases from 468.4 MPa for solid rim to 1222.5 MPa at 4mm rim thickness when 500 Nm of load applied. While FEM result shows Von Misses stress value to become uneven at the line of Hofer's critical section when different rim and web thickness involves.

1. Introduction

Nowadays, there are huge demands for lightweight and efficient gear in the industry especially in aerospace and transportation applications [1]. For thin-rimmed gears, bending stress can be different because of rim and web thickness factor [2].

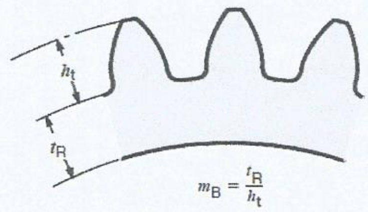
Therefore, recent researches were more focused on the use of Finite Element Method (FEM) to examine the root stress of gear tooth. Studies show that standard calculation method was not in good agreement with the experimental result due to changing on meshing stiffness the gear teeth pair along the line of action [3].

This paper used the basic Lewis Equation in AGMA 2001-D04 calculation to predict gear tooth strength and root stresses later to be compared with FE analysis.

2. Gear Design and Modelling

The gear design that has been used in this simulation was design based on basic involute profile [4]. Emphasis was given to the rim thickness factor K_B, for case of thin-rimmed gear. From the equation (1), knows

$$K_B = \begin{cases} 1.6 \ln \dfrac{2.242}{m_B} & m_B < 1.2 \\ 1 & m_B \geq 1.2 \end{cases} \qquad (1)$$



that value m_B under 1.2 should be put into consideration while other factor in the AGMA equation were remained constant.

Gear Pair Design

The design geometry and material properties for the gear pair were as in Table 2. Materials and gear geometry were determined properly based on existing literature. AISI3215 carbon steel was set as material for FEM material properties, with Young's Modulus value of 207 GPa, Density value 7700 Kg/m^3 and Poisson Ratio 0.29.

Symmetric web arrangement was used in this simulation with two different web thickness and four different rim thicknesses. Table 1 shows the web and rim thicknesses of the thin-rimmed spur gears with symmetric web arrangement.

Table 2: Design geometry and material properties

Parameter	Driven Gear (Thin-rimmed gear)	Driving Gear (Solid gear)
Number of teeth	18	24
Module (mm) m	4	
Pressure angle (degree) ϕ	20	
Face width (mm) F	30	
Pitch circle (mm)	72	96
Material	AISI3215	
Density (Kg/m^3) ρ	7700	
Young's Modulus (Gpa) E	207	
Poisson Ratio ν	0.29	

Table 1: Web and rim thickness of thin-rimmed spur gears with symmetric web arrangement

Gear Structure	Solid	Symmetric Web Arrangements							
Web Thickness (mm)	-	15				7.5			
Rim Thickness (mm)	-	10	8	6	4	10	8	6	4