

Spur Gear Bending Strength Geometry Factors: A Comparison of AGMA and ISO Methods

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ABSTRACT:

With the development of the ISO spur and helical gear rating standard (ISO/DIS 6336) it has become necessary to compare the ISO power rating standard to the corresponding AGMA standard. The purpose of the paper is to compare the behavior of the bending geometry factor (J factor) for spur gears. Computer software was used to compare J-factor values for 135 gear meshes. Results are compared from the matrix of gear sets which varies pressure angle, tool tip radius of curvature and tooth numbers. Of particular interest is the effect of profile-shift (also known as addendum modification).

The results clearly show that there is significant difference between the standards, in both the geometry factor values and the effects of profile shift. The strength increase when using profile shift in the ISO method is much less than is shown in the AGMA method. The ISO method's low sensitivity to profile shift might cause the designer to abandon strength optimization by profile shift because the benefits are only marginal. The question now remains, "Which method is more correct?" Further study is required to evaluate the causes of the discrepancies and possible remedies.

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Nomenclature

AGMA nomenclature:

C_ψ	- helical overlap factor
F	- net face width
J	- geometry factor for bending strength
K_f	- stress correction factor
K_a	- application factor for bending strength
K_v	- dynamic factor for bending strength
K_s	- size factor for bending strength
K_m	- load distribution factor for bending strength
K_B	- rim thickness factor
m	- transverse module
m_G	- gear ratio
m_N	- load sharing ratio
N_1	- number of teeth on pinion
N_2	- number of teeth on gear
s_t	- tensile stress
x_1	- pinion addendum modification coefficient
x_2	- gear addendum modification coefficient
Y	- tooth form factor
W_t	- tangential transverse load at operating pitch diameter

ISO nomenclature:

b	- face width
d_1	- pinion reference (standard) pitch diameter
d_{w1}	- pinion operating pitch diameter
F_t	- tangential transverse load at reference cylinder
F_{wt}	- tangential transverse load at operating pitch diameter
K_A	- application factor
K_V	- dynamic factor
$K_{F\beta}$	- face load distribution factor for root stress
$K_{F\alpha}$	- transverse load distribution factor for root stress
m_n	- normal module
m_t	- transverse module
x_1	- pinion addendum modification coefficient
x_2	- gear addendum modification coefficient
Y_F	- tooth form factor
Y_S	- stress correction factor
Y_β	- helix angle factor
β	- reference (standard) helix angle
σ_F	- tensile stress

Nomenclature defined in this paper:

J_1	- pinion geometry factor for bending strength
J_2	- gear geometry factor for bending strength
K_x	- profile-shift factor

Acronyms:

AGMA	- American Gear Manufacturers Association
ISO	- International Standards Organization
HPSTC	- highest point of single tooth contact

1. Introduction

The International Standards Organization (ISO) has neared completion of the strength rating standard for spur and helical gears. The final draft of the ISO spur and helical gear strength rating standard (ISO/DIS 6336) [1] is expected to be approved and published sometime in 1993. The equivalent AGMA standards are AGMA 2001-B88 [2] and AGMA 908-B89 [3]. Both ISO and AGMA show agreement that the rating procedure must consider both the pitting resistance and the tooth root bending strength, but the formulae often produce significantly different power ratings.

The ISO/DIS 6336 draft standard offers a variety of calculation methods for most steps in the rating procedure. The methods are named Method A, B, C, D, with each method having different formulae for each factor. Method A is defined as the experimental data method, to be used when the engineer has sufficient data and/or experience to evaluate the factors with greater certainty than the standard's empirical equations can provide. Method B is the most accurate and detailed approach available in the standard, based on analytical and empirical results. Methods C and D are usually a less-sophisticated version of Method B, where results are easier to compute but are also more conservative (to account for lower precision). This structure is much different from the AGMA procedure where generally there is only one method of computation (load distribution factor being an exception). For the purposes of this paper the "ISO method" refers to the Method B set of rules and equations.

The development of the ISO gear rating standard produces some important issues for engineers who currently use