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AMERICAN GEAR MANUFACTURERS ASSOCIATION

Load Distribution Factors - Analytical Methods for Cylindrical Gears

AGMA 927-A01

AGMA INFORMATION SHEET

(This Information Sheet is NOT an AGMA Standard)

American Gear Manufacturers Association

Load Distribution Factors - Analytical Methods for Cylindrical Gears
AGMA 927–A01

Approved October 22, 2000

ABSTRACT

This information sheet describes an analytical procedure for the calculation of the face load distribution. The iterative solution that is described is compatible with the definitions of the term face load distribution (K_{H}) of AGMA standards and longitudinal load distribution ($K_{H\beta}$ and $K_{F\beta}$) of the ISO standards. The procedure is easily programmable and flow charts of the calculation scheme as well as examples from typical software are presented.

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Foreword

[The foreword, footnotes and annexes, if any, in this document are provided for informational purposes only and are not to be construed as a part of AGMA Information Sheet 927–A01, *Load Distribution Factors – Analytical Methods for Cylindrical Gears.*]

This information sheet provides an analytical method to calculate a numeric value for the face load distribution factor for cylindrical gearing.

This is a new document, which provides a description of the analytical procedures that are used in several software programs that have been developed by various gear manufacturing companies. The method provides a significant improvement from the procedures used to define numeric values of face load distribution factor in current AGMA standards. Current AGMA standards utilize either an empirical procedure or a simplified closed form analytical calculation. The empirical procedure which is used in ANSI/AGMA 2101–C95 only allows for a nominal assessment of the influence of many parameters which effect the numeric value of the face load distribution factor. The closed form analytic formulations which have been found in AGMA standards suffer from the limitation that the shape of the load distribution across the face width is limited to a linear form.

The limitations of the previous AGMA procedures are overcome by the method defined in this information sheet. This method allows for including a sufficiently accurate representation of many of the parameters that influence the distribution of load along the face width of cylindrical gears. These parameters include the elastic effects due to deformations under load, and the inelastic effects of geometric errors as well as the tooth modifications which are typically utilized to offset the deleterious effects of the deformations and errors.

The analytical method described in this information sheet is based on a ”thin slice” model of a gear mesh. This model treats the distribution of load across the face width of the gear mesh as being independent of the any transverse effects. The method also represents all of the elastic effects of a set of meshing teeth (tooth bending, tooth shear, tooth rotation, Hertzian deflections, etc.) by one constant, i.e., mesh stiffness ($C_{\gamma m}$). Despite these simplifying assumptions, this method provides numeric values of the face load distribution factor that are sufficiently accurate for industrial applications of gearing which fall within the limitations specified.

The first draft of this information sheet was made in February, 1996. This version was approved by the AGMA membership on October 22, 2000.

Special mention must be made of the devotion of Louis Lloyd of Lufkin for his untiring efforts from the submittal of the original software code through the prodding for progress during the long process of writing this information sheet. Without his foresight and contributions this information sheet may not have been possible.

Suggestions for improvement of this document will be welcome. They should be sent to the American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, Virginia 22314.

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Load Distribution Factors - Analytical Methods for Cylindrical Gears

1 Scope

This information sheet covers a method for the evaluation of load distribution across the teeth of parallel axis gears. A general discussion of the design and manufacturing factors which influence load distribution is included.

The load distribution factors for use in AGMA parallel axis gear rating standards are defined, to improve communication between users of those standards.

Historically, analytical methods for evaluating load distribution in both AGMA and ISO standards have been limited by the assumption that load is linearly distributed across the face width of the meshing gear set. The result of this assumption is often overly conservative (high) values of load distribution factors. The method given here is considered more correct.

1.1 Method

A simplified iterative method for calculation of the face load distribution factor, based on combined twisting and bending displacements of a mating gear and pinion, is presented. The transverse load distribution (in the plane of rotation) is not evaluated in this information sheet. This method assumes that the mesh stiffness is a constant through the entire contact roll and across the face. General guidance for design modifications to improve load distribution is also included.

1.2 Limitations of method

This method is intended to be used for general gear design and rating purposes. It is intended to provide a value of load distribution factor and a means by which different gear designs can be analytically compared. It is not intended for rigorous detailed analysis to calculate the actual distribution of load across the face width of gear sets.

The knowledge and judgment required to evaluate the results of this method come from experience in designing, manufacturing and operating gear units. This method is intended for use by the experienced gear designer, capable of understanding its limitations and purposes. It is not intended for use by the engineering public at large.

2 References

The following documents were used in the development of this information sheet. At the time of publication, the editions were valid. All publications are subject to revision, and the users of this manual are encouraged to investigate the possibility of applying the most recent editions of the publications listed:

AGMA Technical Paper P109.16, *Profile and Longitudinal Corrections on Involute Gears*, 1965

ANSI/AGMA 1012-F90, *Gear Nomenclature, Definitions Of Terms With Symbols*

ANSI/AGMA 2101-C95, *Fundamental Rating Factors And Calculation Methods For Involute Spur And Helical Gear Teeth*

ANSI/AGMA ISO 1328-1, *Cylindrical Gears - ISO System of Accuracy - Part 1: Definitions and Allowable Values of Deviations Relevant to Corresponding Flanks of Gear Teeth*

ISO 6336-1:1996, *Calculation of load capacity of spur and helical gears - Part 1: Basic principles, introduction and general influence factors*

Dudley, D.W., *Handbook of Practical Gear Design*, McGraw-Hill, New York, 1984

Timken Engineering Design Manual, Volume 1