ANSI/AGMA 2003-B97
(Revision of
ANSI/AGMA 2003-A86)

AMERICAN NATIONAL STANDARD

Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, Zerol Bevel and Spiral Bevel Gear Teeth

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ABSTRACT

This standard specifies a method for rating the pitting resistance and bending strength of generated straight bevel, zerol bevel and spiral bevel gear teeth. A detailed discussion of factors influencing gear survival and a calculation method are provided.

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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 ANSI/AGMA Standard 2003-B97, *Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, Zerol Bevel and Spiral Bevel Gear Teeth*.]

This standard presents general formulas for rating pitting resistance and bending strength of generated straight bevel, zerol bevel and spiral bevel gear teeth, and supersedes the following previous standards:

AGMA 212.02, *Standard for Surface Durability (Pitting) Formulas for Straight Bevel and Zerol Bevel Gear Teeth*

AGMA 216.01, *Standard for Surface Durability (Pitting) Formulas for Spiral Bevel Gear Teeth*

AGMA 222.02, *Standard for Rating The Strength of Straight Bevel and Zerol Bevel Gear Teeth*

AGMA 223.01, *Standard for Rating the Strength of Spiral Bevel Gear Teeth*

The purpose of standard 2003-A86 was to establish a common base for rating various types of bevel gears for differing applications and to encourage the maximum practical degree of uniformity and consistency between rating practices within the gear industry.

The formulas presented in this standard contain numerous terms whose individual values can vary significantly depending on application, system effects, accuracy and manufacturing method. Proper evaluation of these terms is essential for realistic rating. The knowledge and judgment required to properly evaluate the various rating factors come primarily from years of accumulated experience in designing, testing, manufacturing and operating similar gear units. The detailed treatment of the general rating formulas for specific product applications is best accomplished by those experienced in the field.

ANSI/AGMA 2003-A86 consolidated and updated previous standards to facilitate application by elimination of redundant material, and also to stress the importance of checking both pitting resistance and bending strength aspects to insure a reliable and well balanced design.

The first draft of ANSI/AGMA 2003-A86 was made in May 1980. It was approved by the AGMA membership in June, 1985. It was approved as an American National Standard on May 2, 1986, but was not published until early 1987. The edition contained editorial items which were discovered after publication and corrected by the members of the AGMA Gear Rating Committee in the spring of 1988.

This revision, AGMA 2003-B97, began as a proposal by the US Delegation to the International Standards Organization (ISO) in 1988 as an effort to reach a consensus. It contains revisions and updates which make it closer to ISO as follows:

- The calculations for dynamic factor and geometry factors appear in a draft of ISO 10300;
- The table for load distribution factor is the same as appears in a draft of ISO 10300;
- The material grade requirements are similar to those of ISO 6336-5;
- Each symbol used in AGMA 2003-B97 has the ISO equivalent symbol adjacent to it in parentheses.

Several significant changes were introduced in AGMA 2003-B97:

- The introduction of material grade requirements to provide guidance in the selection of stress numbers;

- The replacement of the external dynamic factor;
- Replacing the internal dynamic factor with a new dynamic factor;
- Equations for size factor for bending and pitting resistance were introduced;
- An adjustment of the load distribution factor;
- Revision of the allowable stress numbers;
- Elimination of the stress correction factor;
- The life factor curve for pitting resistance was adjusted to compensate for revisions to previously mentioned factors;
- The fundamental contact stress formula was adjusted to remove the term accommodating light load conditions.

The term zerol or Zerol is used to define a spiral bevel gear with a zero spiral angle. Zerol is a registered trademark of the Gleason Works.

Suggestions for improvement of this standard 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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American National Standard -

Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, Zerol Bevel and Spiral Bevel Gear Teeth

1 Scope

1.1 Rating formulas

This standard provides a method by which different gear designs can be compared.

The formulas in this standard are intended to establish a uniformly acceptable method for calculating the pitting resistance and bending strength capacity of generated straight bevel, zerol bevel and spiral bevel gear teeth; curved and skewed tooth. They apply equally to tapered depth and uniform depth teeth.

The knowledge and judgment required to evaluate the various rating factors come from years of accumulated experience in designing, manufacturing and operating gear units. Empirical factors given in this standard are general in nature. AGMA application standards may use other empirical factors that are more closely suited to the particular field of application. This standard is intended for use by the experienced gear designer, capable of selecting reasonable values for the factors. It is not intended for use by the engineering public at large.

1.2 Exceptions

The rating formulas in this standard are not applicable to other types of gear tooth deterioration such as scuffing, wear, plastic yielding, scoring, case crushing and welding and are not applicable when vibratory conditions exceed the limits specified for the normal operation of the gears (see ANSI/AGMA 6000-B96, *Specification for Measurement of Lateral Vibration on Gear Units*).

The formulas of this standard are not applicable when any of the following conditions exist:

- bevel gears with offset, such as hypoids;
- straight and zerol bevel gears with transverse contact ratios, m_p (ε_α) less than 1.0;
- bevel gears with modified contact ratios, m_o (ε_o) less than 1.0;
- bevel gears which have a poor contact pattern;
- interference exists between tips of teeth and root fillets;
- teeth are pointed;
- backlash is zero;
- bevel teeth finished by forging, casting or sintering.

Design considerations to prevent fractures emanating from stress risers on the tooth profile, tip chipping and failures of the gear blank through the web or hub should be analyzed by general machine design methods.

1.2.1 Scuffing

Formulas for scuffing resistance on bevel gear teeth are not included in this standard. At the present time, there is insufficient agreement concerning the method for designing bevel gears to resist scuffing failure.

1.2.2 Wear

Very little attention and concern have been devoted to the study of gear tooth wear. This subject primarily concerns gear teeth with low surface hardness or gears with improper lubrication. No attempt has been made to cover gear tooth wear in this standard.

1.2.3 Plastic yielding

This standard does not extend to stress levels above those permissible for 10^3 cycles, since stresses in this range may exceed the elastic limit of the gear