INTERNATIONAL STANDARD

ISO 10300-2

Third edition
2023-08

Calculation of load capacity of bevel gears —

Part 2: Calculation of surface durability (macropitting)

Calcul de la capacité de charge des engrenages coniques —

Partie 2: Calcul de la résistance à la pression superficielle (macro-écaillage)

Reference number
ISO 10300-2:2023(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 60, *Gears*, Subcommittee SC 2, *Gear capacity calculation*.

This third edition cancels and replaces the second edition (ISO 10300-2:2014), which has been technically revised.

The main changes are as follows:

— Table 1 has been inserted;

— Table 2 has been inserted;

— the term “pitting” has been replaced by “macropitting”;

— bevel gear factor, Z_K, for the calculation of the nominal value of the contact stress has been removed; instead, a new bevel gear factor, Z_{KP}, has been introduced for the calculation of the permissible contact stress;

— Formula (37) for the calculation of the length of action considering adjacent teeth has been modified;

— subclause 8.3 — work hardening factor, Z_W, has been updated and method A added;

— Figure 2 — load distribution in the contact area has been updated as the symbol for exponent e has been changed to e_{LS};

— Figure 6 — facewidth factor, Z_{FW} has been removed;

— Figure 7 — lubricant factor, Z_L, for mineral oils has been removed;

— Figure 8 — speed factor, Z_V has been removed;

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— Figure 9 — roughness factor, Z_R has been removed;

— Figure 10 — work hardening factor, Z_W has been removed;

— former Annex A has been replaced by new Annex A describing a local calculation method for surface durability (macropitting) – Method B1-localised.

A list of all parts in the ISO 10300 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

When ISO 10300:2001 (all parts) became due for its first revision, the opportunity was taken to include hypoid gears, since previously the series only allowed for calculating the load capacity of bevel gears without offset axes. The former structure is retained, i.e. three parts of the ISO 10300 series, together with ISO 6336-5, and it is intended to establish general principles and procedures for rating of bevel gears. Moreover, ISO 10300 (all parts) is designed to facilitate the application of future knowledge and developments, as well as the exchange of information gained from experience.

In view of the decision for ISO 10300 (all parts) to cover hypoid gears also, a separate clause: "Gear flank rating formulae — Method B2" has been included in this document, while the former method B was renamed method B1. It became necessary to present a new, clearer structure of the three parts, which is illustrated in ISO 10300-1:2023, Figure 1.

NOTE ISO 10300 (all parts) gives no preferences in terms of when to use method B1 and when to use method B2.

This document deals with the failure of gear teeth by macropitting, a fatigue phenomenon. Two varieties of macropitting are recognized, initial and destructive macropitting.

In applications employing low hardness steel or through hardened steel, initial macropitting frequently occurs during early use and is not deemed serious. Initial macropitting is characterized by small pits which do not extend over the entire facewidth or profile depth of the affected tooth. The degree of acceptability of initial macropitting varies widely, depending on the gear application. Initial macropitting occurs in localized overstressed areas and tends to redistribute the load by progressively removing high contact spots. Generally, when the load has been redistributed, the macropitting stops.

In applications employing high hardness steel and case carburized steel, the variety of macropitting that occurs is usually destructive. The formulae for macropitting resistance given in this document are intended to assist in the design of bevel gears which stay free from destructive macropitting during their design lives (for additional information, see ISO/TR 22849[5]).

The basic formulae, first developed by Hertz for the contact pressure between two curved surfaces, have been modified to consider the following four items: the load sharing between adjacent teeth, the position of the centre of pressure on the tooth, the shape of the instantaneous area of contact and the load concentration resulting from manufacturing uncertainties. The Hertzian contact pressure serves as the theory for the assessment of surface durability with respect to macropitting. Although all premises for a gear mesh are not satisfied by Hertzian relations, their use can be justified by the fact that, for a gear material, the limits of the Hertzian pressure are determined on the basis of running tests with gears, which include the additional influences in the analysis of the limit values. Therefore, if the reference is within the application range, Hertzian pressure can be used to convert test gear data to gears of various types and sizes.

NOTE Contrary to cylindrical gears, where the contact is usually linear, bevel gears are generally manufactured with profile and lengthwise crowning, i.e. the tooth flanks are curved on all sides and the contact develops an elliptical pressure surface. This is taken into consideration when determining the load factors by the fact that the rectangular zone of action (in the case of spur and helical gears) is replaced by an inscribed parallelogram for method B1 and an inscribed ellipse for method B2 (see ISO 10300-1:2023, Annex A for method B1 and Annex B for method B2). The conditions for bevel gears, different from cylindrical gears in their contact, are thus taken into consideration by the face and transverse load distribution factors.

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Calculation of load capacity of bevel gears —

Part 2:
Calculation of surface durability (macropitting)

1 Scope

This document specifies the basic formulae for use in the determination of the surface load capacity of straight and helical (skew), Zerol and spiral bevel gears including hypoid gears, and comprises all the influences on surface durability for which quantitative assessments can be made. This document is applicable to oil lubricated bevel gears, as long as sufficient lubricant is present in the mesh at all times.

The formulae in this document are based on virtual cylindrical gears and restricted to bevel gears whose virtual cylindrical gears have transverse contact ratios of $\varepsilon_{v\alpha} < 2$. The results are valid within the range of the applied factors as specified in ISO 10300-1.

The formulae in this document are not directly applicable to the assessment of other types of gear tooth surface damage, such as plastic yielding, scratching, scuffing or any other type not specified.

NOTE This document is not applicable to bevel gears which have an inadequate contact pattern under load.

The user is cautioned that when the formulae are used for large average mean spiral angles $(\beta_{m1} + \beta_{m2})/2 > 45°$, for effective pressure angles $\alpha_e > 30°$ and/or for large facewidths $b > 13\ m_{mn}$, the calculated results of this document should be confirmed by experience.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 701, *International gear notation — Symbols for geometrical data*

ISO 1122-1, *Vocabulary of gear terms — Part 1: Definitions related to geometry*

ISO 6336-5, *Calculation of load capacity of spur and helical gears — Part 5: Strength and quality of materials*

ISO 10300-1, *Calculation of load capacity of bevel gears — Part 1: Introduction and general influence factors*

ISO 17485, *Bevel gears — ISO system of accuracy*

ISO 23509, *Bevel and hypoid gear geometry*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1122-1 and ISO 23509 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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