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Third edition
2023-08

Calculation of load capacity of bevel gears —

Part 1: Introduction and general influence factors

Calcul de la capacité de charge des engrenages coniques —
Partie 1: Introduction et facteurs généraux d'influence

Reference number
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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 10300-1:2014), which has been technically revised.

The main changes are as follows:

— Table 1 has been inserted in which only symbols and units used in this document are provided;

— Table 2 has been inserted;

— subclause 9.1 — boundary conditions for the calculation of the transverse load factors method B have been rearranged;

— Figure 3 — nomogram for the determination of the resonance speed, n_{E1}, for the mating solid steel pinion/solid wheel, with c_γ = 20 N/(mm · µm) (for bevel gears without offset only) has been removed;

— Figure 4 — dynamic factor, $K_{v\text{-}C}$, has been removed;

— Figure 5 — transverse load factors, $K_{H\alpha\text{-}B}$ and $K_{F\alpha\text{-}B}$ has been removed;

— Figure 6 — running-in allowance, y_α, of gear pairs with a tangential speed of v_{mt2} > 10 m/s has been removed;

— Figure 7 — running-in allowance, y_α, of gear pairs with a tangential speed of v_{mt2} ≤ 10 m/s has been removed;

— Figure A.6 — transverse path of contact has been newly inserted;

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— Figure A.7 — general definition of length of contact lines for local geometry data has been newly inserted.

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.

Several calculation methods, i.e. A, B and C, are specified, which stand for decreasing accuracy and reliability from A to C because of simplifications implemented in formulae and factors. The approximate methods in ISO 10300 (all parts) are used for preliminary estimates of gear capacity where the final details of the gear design are not yet known. More detailed methods are intended for the recalculation of the load capacity limits when all important gear data are given.

ISO 10300 (all parts) does not provide an upgraded calculation procedure as a method A, although it would be available, such as finite element or boundary element methods combined with sophisticated tooth contact analyses.

On the other hand, by means of such a computer program, a new calculation procedure for bevel and hypoid gears on the level of method B was developed and checked. It is part of the ISO 10300 series as submethod B1. Besides, if the hypoid offset, a, is zero, method B1 becomes identical to the set of proven formulae of the former version of ISO 10300:2001 (all parts).

In view of the decision for ISO 10300 (all parts) to cover hypoid gears also, Annex B has been included in this document. Additionally, ISO 10300-2 is supplemented by a separate clause: “Gear flank rating formulae — Method B2”; as for ISO 10300-3, the former method B2, which uses the Lewis parabola to determine the critical section in the root and not the 30° tangent at the tooth fillet as method B1 does, is now extended by the AGMA methods for rating the strength of bevel gears and hypoid gears. It was necessary to present a new, clearer structure of the three parts, which is illustrated in Figure 1.

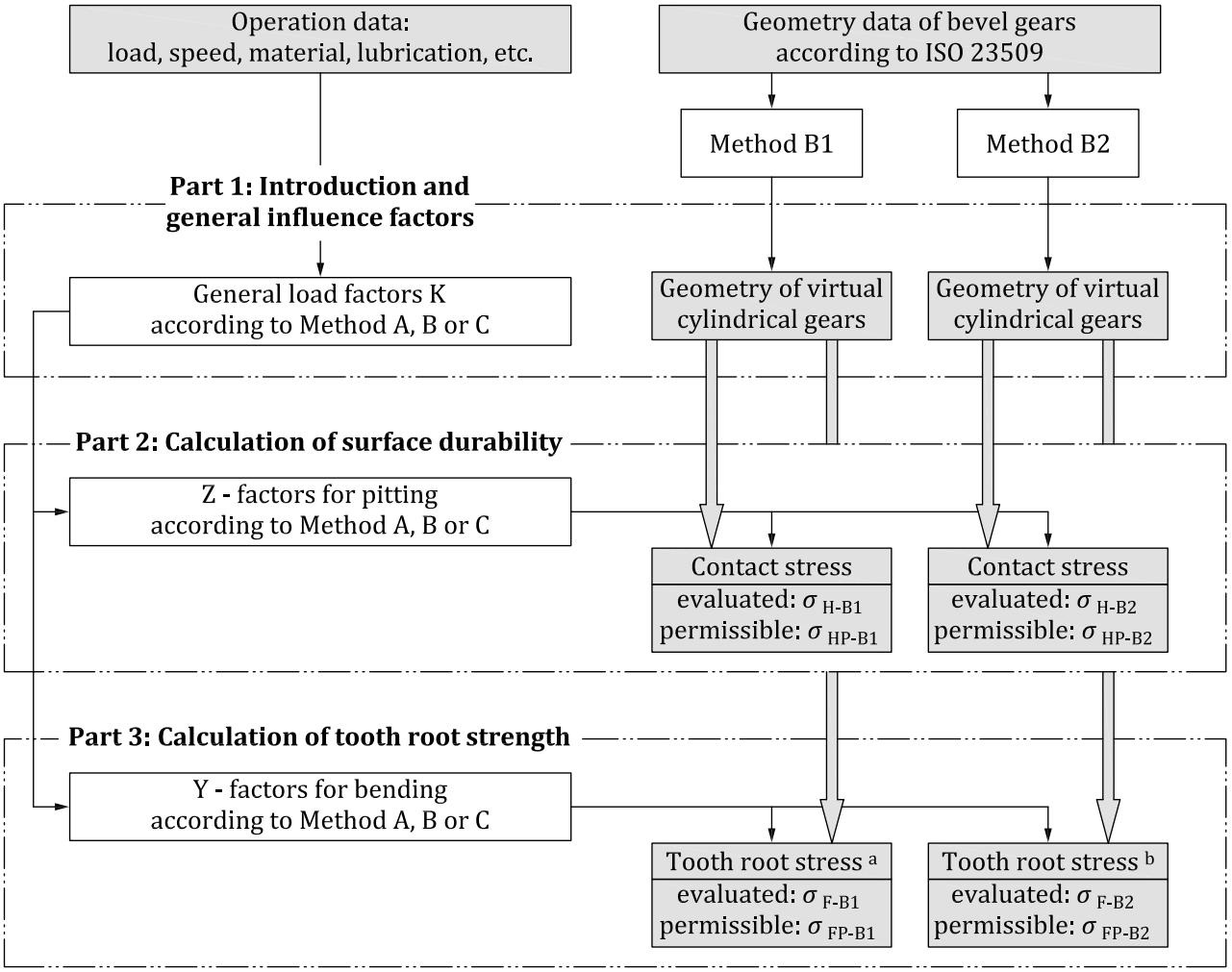
NOTE ISO 10300 (all parts) gives no preferences in terms of when to use method B1 and when to use method B2.

The procedures covered by ISO 10300 (all parts) are based on both testing and theoretical studies.

ISO 10300 (all parts) provides calculation procedures by which different gear designs can be compared. It is not meant to ensure the performance of assembled gear drive systems. It is intended for use by the experienced gear designer capable of selecting reasonable values for the factors in these formulae, based on knowledge of similar designs and on awareness of the effects of the items discussed.

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 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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[a] One set of formulae for both, bevel and hypoid gears.

[b] Separate sets of formulae for bevel and for hypoid gears.

Figure 1 — Structure of calculation methods in ISO 10300 (all parts)

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Calculation of load capacity of bevel gears —

Part 1:
Introduction and general influence factors

1 Scope

This document specifies the methods of calculation of the load capacity of bevel gears, the formulae and symbols used for calculation, and the general factors influencing load conditions.

The formulae in this document are intended to establish uniformly acceptable methods for calculating the load-carrying capacity of straight, helical (skew), spiral bevel, Zerol and hypoid gears. They are applicable equally to tapered depth and uniform depth teeth. Hereinafter, the term "bevel gear" refers to all of the gear types; if not, the specific forms are identified.

The formulae in this document take into account the known major factors influencing load-carrying capacity. The rating formulae are only applicable to types of gear tooth deterioration, that are specifically addressed in the individual parts of the ISO 10300 series. Rating systems for a particular type of bevel gears can be established by selecting proper values for the factors used in the general formulae.

NOTE This document is not applicable to bevel gears which have an inadequate contact pattern under load (see Annex D).

The rating system of this document is based on virtual cylindrical gears and restricted to bevel gears whose virtual cylindrical gears have transverse contact ratios of $\varepsilon_{v\alpha} < 2$. Additionally, for bevel gears the sum of profile shift coefficients of pinion and wheel is zero (see ISO 23509).

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 6336-6, *Calculation of load capacity of spur and helical gears — Part 6: Calculation of service life under variable load*

ISO 10300-2, *Calculation of load capacity of bevel gears — Part 2: Calculation of surface durability (macropitting)*

ISO 10300-3, *Calculation of load capacity of bevel gears — Part 3: Calculation of tooth root strength*

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

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ISO 23509:2016, *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 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/

4 Symbols and general subscripts

For the purposes of this document, the symbols given in ISO 701, ISO 17485, ISO 23509, and the following shall apply. See Tables 1 and 2.

Table 1 — Symbols

Symbol	Description or term	Unit
A	Auxiliary factor for calculating the dynamic factor $K_{v\text{-}C}$	—
A^*	Related area for calculating the load sharing factor Z_{LS}	mm
a	Hypoid offset	mm
a_{rel}	Relative hypoid offset	—
a_v	Centre distance of virtual cylindrical gear pair	mm
a_{vn}	Relative centre distance of virtual cylindrical gear pair in normal section	—
B	Accuracy grade according to ISO 17485	—
b	Facewidth	mm
b_{ce}	Calculated effective facewidth	mm
b_{eff}	Effective facewidth (e.g. measured length of contact pattern)	mm
b_v	Facewidth of virtual cylindrical gears	mm
$b_{v,eff}$	Effective facewidth of virtual cylindrical gears	mm
$b_{v,rel}$	Relative facewidth of virtual cylindrical gear	—
C_F	Correction factor of tooth stiffness for non-average conditions	—
C_{lb}	Correction factor for the length of contact lines	—
c_v	Empirical parameter to determine the dynamic factor	—
c_γ	Mean value of mesh stiffness per unit facewidth	N/(mm·µm)
$c_{\gamma 0}$	Mesh stiffness for average conditions	N/(mm·µm)
c'	Single stiffness	N/(mm·µm)
c_0'	Single stiffness for average conditions	N/(mm·µm)
d_e	Outer pitch diameter	mm
d_m	Mean pitch diameter	mm
d_T	Tolerance diameter according to ISO 17485	mm
d_v	Reference diameter of virtual cylindrical gear	mm
d_{va}	Tip diameter of virtual cylindrical gear	mm
d_{van}	Tip diameter of virtual cylindrical gear in normal section	mm
d_{vb}	Base diameter of virtual cylindrical gear	mm
d_{vbn}	Base diameter of virtual cylindrical gear in normal section	mm
d_{vf}	Root diameter of virtual cylindrical gear	mm
d_{vn}	Reference diameter of virtual cylindrical gear in normal section	mm

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