
**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*



This document is a preview generated by ELS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword.....	v
Introduction.....	vii
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	2
4 Symbols and general subscripts.....	2
5 Application.....	6
5.1 Calculation methods.....	6
5.1.1 General.....	6
5.1.2 Method A.....	6
5.1.3 Method B.....	6
5.1.4 Method C.....	6
5.2 Safety factors.....	7
5.3 Rating factors.....	7
5.3.1 Testing.....	7
5.3.2 Manufacturing tolerances.....	7
5.3.3 Implied accuracy.....	8
5.4 Further factors to be considered.....	8
5.4.1 General.....	8
5.4.2 Lubrication.....	8
5.4.3 Misalignment.....	8
5.4.4 Deflection.....	8
5.4.5 Materials and metallurgy.....	8
5.4.6 Residual stress.....	8
5.4.7 System dynamics.....	9
5.4.8 Contact pattern.....	9
5.4.9 Corrosion.....	9
5.5 Further influence factors in the basic formulae.....	9
6 External force and application factor, K_A.....	10
6.1 Nominal tangential force, torque, power.....	10
6.2 Variable load conditions.....	10
6.3 Application factor, K_A	10
6.3.1 Application factor — General.....	10
6.3.2 Influences affecting external dynamic loads.....	11
6.3.3 Establishment of application factors.....	11
7 Dynamic factor, K_v.....	11
7.1 General.....	11
7.2 Design.....	11
7.3 Manufacturing.....	12
7.4 Transmission error.....	12
7.5 Dynamic response.....	12
7.6 Resonance.....	13
7.6.1 General.....	13
7.6.2 Gear blank resonance.....	13
7.7 Calculation methods for K_v	13
7.7.1 General comments.....	13
7.7.2 Method A, K_{v-A}	14
7.7.3 Method B, K_{v-B}	14
7.7.4 Method C, K_{v-C}	18
8 Face load factors, $K_{H\beta}$, $K_{F\beta}$.....	20
8.1 General comments.....	20

8.2	Method A	20
8.3	Method B	21
8.4	Method C	21
8.4.1	Face load factor, $K_{H\beta-C}$	21
8.4.2	Local face load factor, $K_{H\beta,Y}$	21
8.4.3	Face load factor, $K_{F\beta-C}$	22
8.4.4	Lengthwise curvature factor for bending strength, K_{F0}	22
9	Transverse load factors, $K_{H\alpha}$, $K_{F\alpha}$	23
9.1	General comments	23
9.2	Method A	24
9.3	Method B	24
9.3.1	Bevel gears having virtual cylindrical gears with contact ratio $\epsilon_{vY} \leq 2$	24
9.3.2	Bevel gears having virtual cylindrical gears with contact ratio $\epsilon_{vY} > 2$	24
9.4	Method C	25
9.4.1	General comments	25
9.4.2	Assumptions	25
9.4.3	Determination of the factors	25
9.5	Running-in allowance, y_{α}	25
Annex A (normative) Calculation of virtual cylindrical gears — Method B1		27
Annex B (normative) Calculation of virtual cylindrical gears — Method B2		43
Annex C (informative) Values for application factor, K_A		49
Annex D (informative) Contact patterns		50
Bibliography		54

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 $c_\gamma = 20 \text{ N}/(\text{mm} \cdot \mu\text{m})$ (for bevel gears without offset only) has been removed;
- Figure 4 — dynamic factor, K_{v-C} , has been removed;
- Figure 5 — transverse load factors, $K_{H\alpha-B}$ and $K_{F\alpha-B}$ has been removed;
- Figure 6 — running-in allowance, y_α , of gear pairs with a tangential speed of $v_{mt2} > 10 \text{ m/s}$ has been removed;
- Figure 7 — running-in allowance, y_α , of gear pairs with a tangential speed of $v_{mt2} \leq 10 \text{ m/s}$ has been removed;
- [Figure A.6](#) — transverse path of contact has been newly inserted;

- [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.

This document is a preview generated by EVS

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).

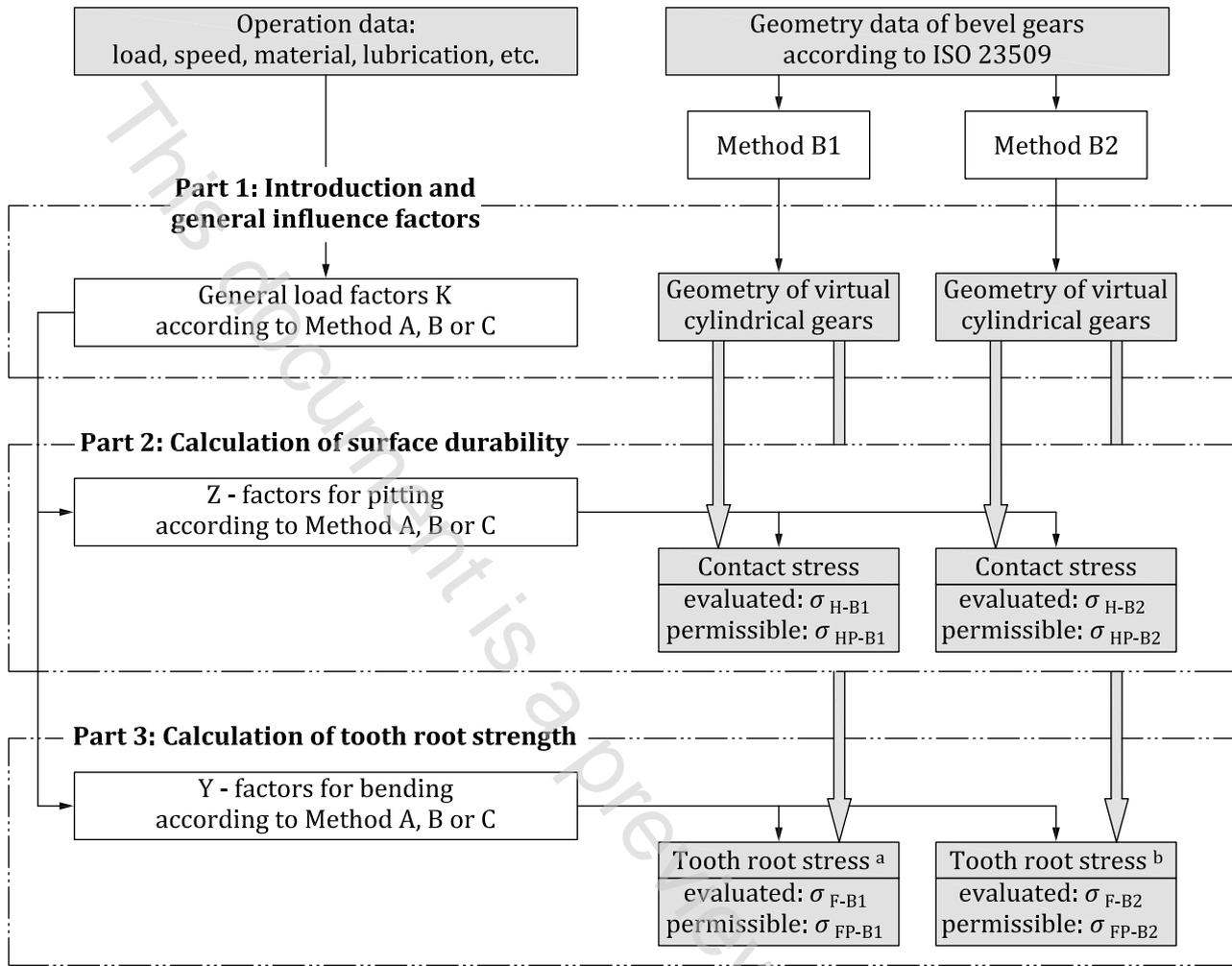
In view of the decision for ISO 10300 (all parts) to cover hypoid gears also, [Annex B](#) has been included in this document. Additionally, ISO 10300-2 is supplemented by a separate clause: “Gear flank rating formulae — Method B2”; as for ISO 10300-3, the former method B2, which uses the Lewis parabola 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.



- ^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)

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 $(\beta_{m1} + \beta_{m2})/2 > 45^\circ$, for effective pressure angles $\alpha_e > 30^\circ$ 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*

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-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· μ m)
$c_{\gamma 0}$	Mesh stiffness for average conditions	N/(mm· μ m)
c'	Single stiffness	N/(mm· μ m)
c_0'	Single stiffness for average conditions	N/(mm· μ m)
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