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# Calculation of load capacity of bevel gears —

## Part 3: Calculation of tooth root strength

*Calcul de la capacité de charge des engrenages coniques —  
Partie 3: Calcul de la résistance du pied de dent*



Reference number  
ISO 10300-3:2023(E)

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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](http://www.iso.org/directives)).

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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 10300-3:2014), which has been technically revised.

The main changes are as follows:

- [Table 1](#) has been inserted;
- [Table 2](#) has been inserted;
- Figure 4 — surface condition factor,  $Y_{R,relT}$ , for permissible stress number relative to standard test gear dimensions has been removed;
- Figure 5 — relative notch sensitivity factor with respect to standard test gear dimensions has been removed;
- new [Figure 5](#) — life factor,  $Y_{NT}$  (standard reference test gears) has been added;
- Figure 7 — size factor,  $Y_X$ , for permissible tooth root stress has been removed.

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](http://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, it was agreed to include a separate clause: “Gear tooth rating formulae — Method B2” in this document, while the former methods B and B1 were combined into one method, i.e. method B1. So, 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.

Failure of gear teeth by tooth root breakage can be brought about in many ways; severe instantaneous overloads, excessive macropitting, case crushing and bending fatigue are a few. The strength ratings determined by the formulae in this document are based on cantilever projection theory modified to consider the following:

- compressive stress at the tooth roots caused by the radial component of the tooth load;
- non-uniform moment distribution of the load, resulting from the inclined contact lines on the teeth of spiral bevel gears;
- stress concentration at the tooth root fillet;
- load sharing between adjacent contacting teeth;
- lack of smoothness due to a low contact ratio.

The formulae are used to determine a load rating, which prevents tooth root fracture during the design life of the bevel gear. Nevertheless, if there is insufficient material under the teeth (in the rim), a fracture can occur from the root through the rim of the gear blank or to the bore (a type of failure not covered by this document). Moreover, it is possible that special applications require additional blank material to support the load.

Surface distress (pitting or wear) can limit the strength rating, either due to stress concentration around large sharp cornered pits, or due to wear steps on the tooth surface. Neither of these effects is considered in this document.

In most cases, the maximum tensile stress at the tooth root (arising from bending at the root when the load is applied to the tooth flank) can be used as a determinant criterion for the assessment of the tooth root strength. If the permissible stress number is exceeded, the teeth can break.

When calculating the tooth root stresses of straight bevel gears, this document starts from the assumption that the load is applied at the tooth tip of the virtual cylindrical gear. The load is subsequently converted to the outer point of single tooth contact. The procedure thus corresponds to method C for the tooth root stress of cylindrical gears (see ISO 6336-3<sup>[1]</sup>).

For spiral bevel and hypoid gears with a high face contact ratio of  $\varepsilon_{v\beta} > 1$  (method B1) or with a modified contact ratio of  $\varepsilon_{v\gamma} > 2$  (method B2), the midpoint in the zone of action is regarded as the critical point of load application.

The breakage of a tooth generally means the end of a gear's life. It is often the case that all gear teeth are destroyed as a consequence of the breakage of a single tooth. A safety factor,  $S_F$ , against tooth root breakage higher than the safety factor against damage due to macropitting is, therefore, generally to be preferred (see ISO 10300-1).