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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
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 10300 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10300-3 was prepared by Technical Committee ISO/TC 60, *Gears*, Subcommittee SC 2, *Gear capacity calculation*.

ISO 10300 consists of the following parts, under the general title *Calculation of load capacity of bevel gears*:

— *Part 1: Introduction and general influence factors*

— *Part 2: Calculation of surface durability (pitting)*

— *Part 3: Calculation of tooth root strength*

Annex A forms an integral part of this part of ISO 10300. Annex B is for information only.

In this corrected version of ISO 10300-3, Equation (57) has been corrected.

Introduction

Parts 1, 2 and 3 of ISO 10300, taken together with ISO 6336-5, are intended to establish general principles and procedures for the calculation of the load capacity of bevel gears. Moreover, ISO 10300 has been designed to facilitate the application of future knowledge and developments, as well as the exchange of information gained from experience. This part of ISO 10300 gives formulae for bending-strength rating in calculations for the avoidance of tooth breakage.

Failure of gear teeth by breakage can be brought about in many ways — severe instantaneous overloads, excessive pitting, case crushing and bending fatigue are some. The strength ratings determined by the formulae in this part of ISO 10300 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 can be used for determining a load rating that will prevent tooth root fillet fracture during the design life of the gear teeth. 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 part of ISO 10300. Moreover, special applications could require additional blank material to support the load.

Occasionally, surface distress (pitting or wear) may limit the strength rating, due either to stress concentration around large sharp-cornered pits, or to wear steps on the tooth surface. Neither of these effects are considered in this part of ISO 10300.

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 the criterion for the assessment of the bending tooth root strength, as when the allowable stress number is exceeded the teeth can experience breakage. When calculating the tooth root stresses of straight bevel gears, this part of ISO 10300 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 with the aid of the contact-ratio factor Y_ε (see clause 8). The procedure thus corresponds to method C for the tooth root stress of cylindrical gears (see ISO 6336-3).

For spiral bevel gears with a high overlap ratio ($\varepsilon_{v\beta} > 1$), the mid point in the contact zone is regarded as the critical point of load application. There is an interpolation for medium overlap ratio ($0 < \varepsilon_{v\beta} < 1$).

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. An S_F, the safety factor against tooth breakage, higher than the safety factor against damage due to pitting, is therefore generally to be preferred (see ISO 10300-1).

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