INTERNATIONAL STANDARD

ISO 17485

First edition
2006-06-15

Bevel gears — ISO system of accuracy

Engrenages coniques — Système ISO d'exactitude

Reference number
ISO 17485:2006(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17485 was prepared by Technical Committee ISO/TC 60, *Gears*.

Introduction

The measurement and tolerance specification of bevel gears are very complex subjects that were in need of international standardization. For these and other reasons, ISO/TC 60 approved the project based on a proposed document, ANSI/AGMA 2009-B01, *Bevel Gear Classification, Tolerances, and Measuring Methods*.

At an early stage it was decided to develop two documents: this International Standard, with accuracy grades and definitions, and a separate Technical Report, ISO/TR 10064-6, containing inspection practice and measuring methods. These practices and measuring methods include topics such as manufacturing considerations, CMM measurements, contact pattern checking, and advanced topics such as bevel gear flank form analysis.

Prior to the development of this International Standard, the accuracy grades described in ISO 1328, for cylindrical gears, were often used for bevel gears. However, this use was not always consistent with the specific requirements and general practices followed within the bevel gear industry. This International Standard contains items that are distinctly different from ISO 1328-1:1995:

— the definitions, tolerance diameter and measuring directions are specifically for bevel gears;

— accuracy grade tolerances are based on equations and not on tables;

— there is approximately one grade difference in tolerance level between bevel and cylindrical gears, similar to that used by the DIN system of tolerances.

The use of the definitions and accuracy grades within this International Standard should improve the consistent application of bevel gear geometrical tolerances for the general benefit of industry.

Bevel gears — ISO system of accuracy

1 Scope

This International Standard establishes a classification system that can be used to communicate geometrical accuracy specifications of unassembled bevel gears, hypoid gears, and gear pairs. It defines gear tooth accuracy terms and specifies the structure of the gear accuracy grade system and allowable values.

This International Standard provides the gear manufacturer and the gear buyer with a mutually advantageous reference for uniform tolerances. Ten accuracy grades are defined, numbered 2 to 11 in order of decreasing precision. Equations for tolerances and their ranges of validity are provided in 5.4 for the defined accuracy of gearing. In general, these tolerances cover the following ranges:

$1,0 \text{ mm} \leqslant m_{mn} \leqslant 50 \text{ mm}$

$5 \leqslant z \leqslant 400$

$5 \text{ mm} \leqslant d_T \leqslant 2\,500 \text{ mm}$

where

d_T is the tolerance diameter;

m_{mn} is the mean normal module;

z is the number of teeth.

See Clause 6 for required and optional measuring methods. As tolerances are calculated from the actual dimensions of a bevel gear, tolerance tables are not provided. In order to provide an overview, example values of tolerances and graphs are given in Annex A.

This International Standard does not apply to enclosed gear unit assemblies, including speed reducers or increasers, gear motors, shaft mounted reducers, high speed units, or other enclosed gear units manufactured for a given power, speed, ratio or application.

Gear design is beyond the scope of this International Standard. The use of the accuracy grades for the determination of gear performance requires extensive experience with specific applications. Therefore, the users of this International Standard are cautioned against the direct application of tolerance values to a projected performance of unassembled (loose) gears when they are assembled.

Tolerance values for gears outside the limits stated in this International Standard will need to be established by determining the specific application requirements. This could require the setting of a tolerance other than that calculated by the formulas in this International Standard.

2 Normative references

The following referenced documents are indispensable for the application 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 1122-1:1998, *Vocabulary of gear terms — Part 1: Definitions related to geometry*

ISO 23509[1)], *Bevel and hypoid gear geometry*

3 Terms, definitions and symbols

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

Some of the symbols and terminology contained in this document could differ from those used in other documents and standards. Users of this International Standard should assure themselves that they are using the symbols, terminology and definitions in the manner indicated herein.

3.1 Terms and definitions

3.1.1
index deviation
F_x
displacement of any tooth flank from its theoretical position, relative to a datum tooth flank

3.1.2
mean normal module
m_{mn}
ratio of the mean pitch diameter in millimetres to the number of teeth in a normal plane at the mean cone distance

$$m_{mn} = \frac{d_m}{z} \cos\beta_m = \frac{R_m}{R_e} m_{et} \cos\beta_m \quad (1)$$

where

d_m is the mean pitch diameter,

z is the number of teeth,

β_m is the mean spiral angle,

R_m is the mean cone distance,

R_e is the outer cone distance, and

m_{et} is the outer transverse module

3.1.3
reference gear
gear of known accuracy that is designed specifically to mesh with the gear to be inspected for composite deviation and contact marking tests

1) To be published.

3.1.4
total runout deviation

F_r

difference between the maximum and minimum distance perpendicular to the pitch cone, of a probe (ball or cone) placed successively in each tooth space, with the probe contacting both the right and left flanks at the tolerance circle approximately mid tooth-depth

NOTE Tolerances are provided in 5.4.4.

3.1.5
tooth mesh component single-flank composite deviation

f_{is}

value of the greatest single-flank composite deviation over any one pitch (360°/z), after removal of the long-term component (sinusoidal effect of eccentricity), during a single-flank composite test, when the wheel is moved through one revolution

NOTE This International Standard specifies the tolerance direction for tooth mesh component single-flank composite deviation to be along the arc of the tolerance diameter circle in a transverse section. Tolerances are provided in 5.4.5.

3.1.6
total single-flank composite deviation

F_{is}

total deviation, measured from minimum to maximum, during a single-flank composite test, when the wheel is moved through one revolution

NOTE This International Standard specifies the tolerance direction for total single-flank composite deviation to be along the arc of the tolerance diameter circle in a transverse section. See Annex B. Tolerances are provided in 5.4.6.

3.1.7
single pitch deviation

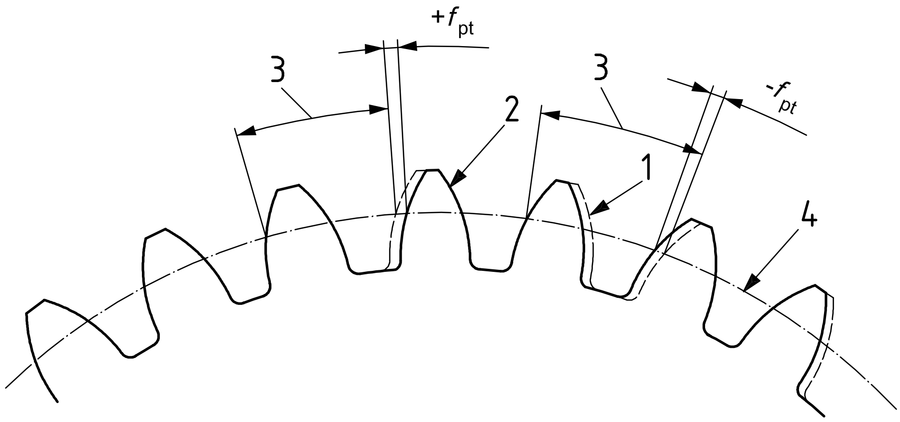
f_{pt}

displacement of any tooth flank from its theoretical position relative to the corresponding flank of an adjacent tooth, measured by a probe from a point on a flank, to a point on the adjacent flank, on the same measurement circle

See Figure 1.

NOTE 1 Distinction is made as to the algebraic sign of the measured value. Thus, a condition wherein the actual tooth flank position was nearer to the adjacent tooth flank than the theoretical position would be considered a minus (–) deviation. A condition wherein the actual tooth flank position was farther from the adjacent tooth flank than the theoretical position would be considered a plus (+) deviation.

NOTE 2 This International Standard specifies the tolerance direction of measurement for single pitch deviation to be along the arc of the tolerance diameter circle in the transverse section. Tolerances are provided in 5.4.2.



Key

1 theoretical tooth flank position
2 actual tooth flank position
3 theoretical circular pitch
4 measurement circle

Figure 1 — Pitch deviations

3.1.8
tolerance diameter
d_T
diameter where the mean cone distance, R_m, and the midpoint of the working depth intersect

See Figure 2.

NOTE The midpoint of the mean working depth is one half the depth of engagement of the two gears at the mean cone distance. The value of d_T can be determined by Equations (2) or (3).

$$d_{T1} = d_{m1} + 2\left(0{,}5\, h_{mw} - h_{am2}\right)\cos\delta_1 = d_{m1} + \left(h_{am1} - h_{am2}\right)\cos\delta_1 \quad (2)$$

$$d_{T2} = d_{m2} - 2\left(0{,}5\, h_{mw} - h_{am2}\right)\cos\delta_2 = d_{m2} + \left(h_{am2} - h_{am1}\right)\cos\delta_2 \quad (3)$$

where

$d_{m1, 2}$ is the mean pitch diameter (pinion, wheel);

h_{mw} is the mean working depth;

$h_{am1, 2}$ is the mean addendum;

$\delta_{1, 2}$ is the pitch angle (pinion, wheel).

These values can be obtained from manufacturing summary sheets or by calculations shown in ISO 10300 or in ISO 23509.

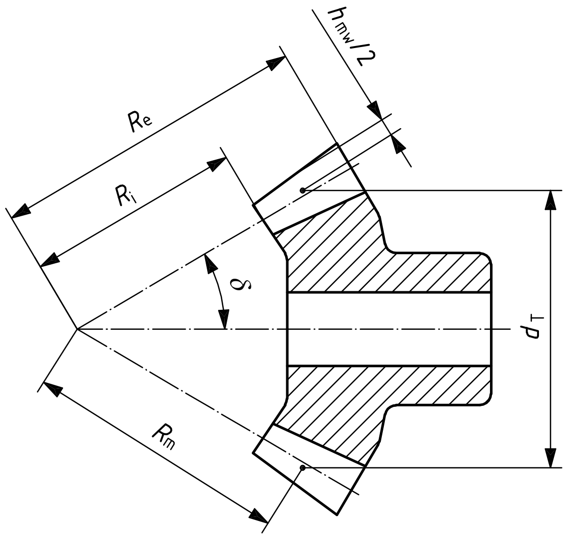
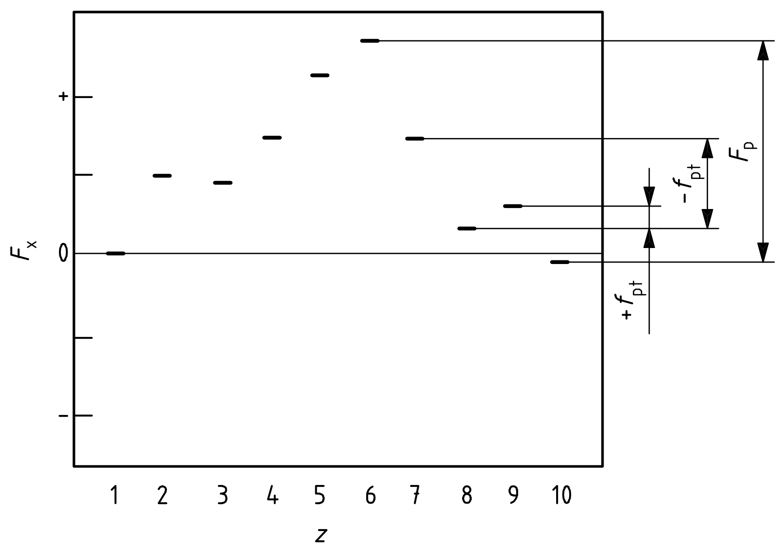


Figure 2 — Tolerance diameter

3.1.9
total cumulative pitch deviation
F_p
largest algebraic difference between any two index deviation values for a specified flank (left or right), without distinction as to the direction or algebraic sign of this reading

See Figure 3.

NOTE This International Standard specifies the tolerance direction of for total cumulative pitch deviation to be along the arc of the tolerance diameter circle in the transverse section. Tolerances are provided in 5.4.2.



F_x = index deviation
f_{pt} = single pitch deviation
F_p = total cumulative pitch deviation
z = tooth number

Figure 3 — Pitch data from single probe device

3.1.10
transmission error
θ_e
deviation of the position of the driven gear, for a given angular position of the driving gear, from the position that the driven gear would occupy if the gears were geometrically perfect

NOTE See Annex B for discussion of transmission error and single flank composite deviations.

3.2 Fundamental terms and symbols

The terminology and symbols used in this International Standard are listed alphabetically by symbol in Table 1, and alphabetically by term in Table 2. To convey the maximum amount of information, however, the names of a number terms have been rearranged in order to group principle characteristics.

Table 1 — Alphabetical table of symbols, by symbol

Symbol	Term	Where first used (clause/subclause/figure)
$d_{m1, 2}$	Mean pitch diameter (pinion or wheel)	3.1.8
d_T	Tolerance diameter	1
F_{is}	Single-flank composite deviation, total	3.1.6
F_{isT}	Single-flank composite tolerance, total	5.4.6
F_p	Cumulative pitch deviation, total	3.1.9
F_{pT}	Cumulative pitch tolerance, total	5.4.3
F_r	Runout deviation, total	3.1.4
F_{rT}	Runout tolerance	5.4.4
F_x	Index deviation	3.1.1
f_{is}	Single-flank composite deviation, tooth mesh component	3.1.6
$f_{is(design)}$	Single-flank composite deviation, design tooth mesh component	5.4.5
f_{isT}	Single-flank composite tolerance, tooth mesh component	5.4.5
f_{pt}	Single pitch deviation	3.1.7
f_{ptT}	Single pitch tolerance	5.4.2
h_{am}	Addendum, mean	3.1.8
h_{mw}	Working depth, mean	3.1.8
m_{et}	Module, outer transverse	3.1.2
m_{mn}	Module, mean normal	1
R_e	Distance, outer cone	3.1.2
R_i	Distance, inner cone	Figure 1
R_m	Distance, mean cone	3.1.2
$z_{1, 2}$	Number of teeth (pinion or wheel), tooth number	1
β_m	Mean spiral angle	3.1.2
$\delta_{1, 2}$	Pitch angle (pinion or wheel)	3.1.8
θ_e	Transmission error	3.1.10
Characteristic symbols as subscripts		
Symbol	**Term**	
m	Mean	
T	Tolerance	
1	Pinion	
2	Gear	

Table 2 — Alphabetical table of symbols, by term

Symbol	Term	Where first used (clause/subclause/figure)
h_{am}	Addendum, mean	3.1.8
R_m	Cone distance, mean	3.1.2
R_e	Cone distance, outer	1
R_i	Cone distance, inner	Figure 1
F_p	Cumulative pitch deviation, total	3.1.9
F_{pT}	Cumulative pitch tolerance, total	5.4.3
d_T	Diameter, tolerance	3.1.8
F_x	Index deviation	3.1.1
m_{mn}	module, mean normal	3.1.2
m_{et}	module, outer transverse	3.1.2
$z_{1,2}$	Number of teeth (pinion or wheel)	1
$\delta_{1,2}$	Pitch angle (pinion or wheel)	3.1.8
$d_{m1,2}$	pitch diameter, mean (pinion or wheel)	3.1.8
F_r	runout deviation, total	3.1.4
F_{rT}	Runout tolerance	5.4.4
f_{is}(design)	Single-flank composite deviation, design tooth mesh component	5.4.5
f_{is}	Single-flank composite deviation, tooth mesh component	3.1.6
f_{isT}	Single-flank composite tolerance, tooth mesh component	5.4.5
F_{is}	Single-flank composite deviation, total	3.1.6
F_{isT}	Single-flank composite tolerance, total	5.4.6
f_{pt}	Single pitch deviation	3.1.7
f_{ptT}	Single pitch tolerance	5.4.2
θ_e	Transmission error	3.1.10
β_m	Mean spiral angle	3.1.2
h_{mw}	Mean working depth	3.1.8

4 Application of classification system

4.1 General

The classification system is a numeric code identifying the accuracy grade tolerance for a specific gear.

4.2 Accuracy grade classification

4.2.1 General

This International Standard provides for ten accuracy grades, numbered 2 to 11.

Accuracy grade 2 has the smallest tolerances; accuracy grade 11 the largest. These accuracy grades are separated by a uniform geometric progression of tolerances (see 5.2).