

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS B 1707 : 2018

(JGMA/JSA)

**Bevel gears—Definitions and
tolerance classification of tooth
flank form deviations**

ICS 21.200

Reference number : JIS B 1707 : 2018 (E)

PROTECTED BY COPYRIGHT

Date of Establishment: 2018-10-22

Date of Public Notice in Official Gazette: 2018-10-22

Investigated by: Japanese Industrial Standards Committee
Standards Board for ISO area

JIS B 1707:2018, First English edition published in 2019-04

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2019

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

PROTECTED BY COPYRIGHT

Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
3.1 General specifications	2
3.2 Profile deviation	4
3.3 Tooth trace deviation	7
3.4 Tooth surface deviation	10
4 Symbols and units	11
5 Measurement descriptions and number of teeth for gear	12
5.1 General	12
5.2 Measurement descriptions	12
5.3 Considerations for measurements on gears	13
5.4 Tolerance class	16
6 Tolerance values	17
6.1 General	17
6.2 Use of formulae	18
6.3 Tolerance formulae	18
Annex A (informative) Method to obtain reference surface of measurement	20
Annex B (informative) Evaluation of profile deviation and tooth trace deviation using second order analysis method	25
Bibliography	28

Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japan Gear Manufacturers Association (JGMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

Bevel gears—Definitions and tolerance classification of tooth flank form deviations

Introduction

The pitch deviation, total run-out and total single-flank composite deviation of the tooth flank of bevel gears are specified in **JIS B 1704:2010** that is prepared based on **ISO 17485:2006**. However, **JIS B 1704:2010** does not specify the accuracy on the tooth flank form deviations. Regarding the bevel gears, owing to the delay in the development of measurement technology of the tooth flank form deviations, “the tooth contact inspection” by the sensory evaluation has been practically used. Meanwhile, in 1978, the measurement technology of the tooth flank form deviations was developed in Japan. As the measuring machines of the tooth flank form of bevel gears have been developed in many countries, the measuring methods are becoming common in these 40 years. This Standard has been established to specify the definitions for the tooth flank form deviations of bevel gears.

1 Scope

This Standard specifies the definitions and tolerance classification of tooth flank form deviations of a single bevel gear and hypoid gear pair. The formulae on the tolerances are shown in **6.3**. The scope of this Standard shall be as follows.

$$0.3 \text{ mm} \leq m_{mn} \leq 50 \text{ mm}$$

$$1 \leq z \leq 400$$

$$5 \text{ mm} \leq d_T \leq 2500 \text{ mm}$$

where, d_T : tolerance diameter (mm)

m_{mn} : mean normal module (mm)

z : number of teeth

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0102-1 *Vocabulary of gear terms—Part 1: Definitions related to geometry*

JIS B 0121 *International gear notation—Symbols for geometrical data*

JIS B 0634 *Geometrical product specifications (GPS)—Filtration—Linear profile filters: Gaussian filters*

JIS B 0641-1 *Geometrical Product Specifications (GPS)—Inspection by measurement of workpieces and measuring equipment—Part 1: Decision rules for proving conformance or nonconformance with specifications*

JIS B 1704 *Bevel gear*

JIS Z 8401 *Guide to the rounding of numbers*

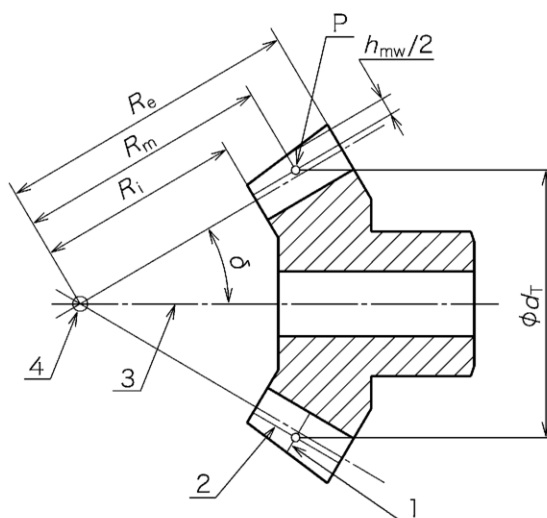
ISO 10300-1 *Calculation of load capacity of bevel gears—Part 1: Introduction and general influence factors*

ISO 23509 *Bevel and hypoid gear geometry*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS B 0102-1** and **JIS B 1704**, and the following apply.

Refer to Figure 1 for h_{mw} , R_e , R_m , R_i , δ and d_T .



1 Profile evaluation line 2 Tooth trace evaluation line 3 Datum axis of rotation 4 Pitch cone apex
P Flank mean point $h_{mw}/2$ Half of mean effective tooth depth d_T Tolerance diameter δ Pitch angle
 R_e Outer cone distance R_m Mean cone distance R_i Inner cone distance

Figure 1 Evaluation items of profile deviation and tooth trace deviation

3.1 General specifications

3.1.1

mean normal module m_{mn}

normal module at mean cone distance, which shall be obtained according to Formula (1)

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

3.1.2

flank mean point P

midpoint of effective tooth depth h_{mw} at mean cone distance R_m

3.1.3

tolerance diameter d_T

diameter of flank mean point (see Figure 1)

The tolerance diameter of pinion d_{T1} and the tolerance diameter of wheel d_{T2} shall be obtained according to Formula (2) and Formula (3).

$$d_{T1} = d_{m1} + 2 \left(\frac{h_{mw}}{2} - h_{am2} \right) \cos \delta_1 = d_{m1} + (h_{am1} - h_{am2}) \cos \delta_1 \dots\dots\dots (2)$$

$$d_{T2} = d_{m2} - 2 \left(\frac{h_{mw}}{2} - h_{am2} \right) \cos \delta_2 = d_{m2} + (h_{am2} - h_{am1}) \cos \delta_2 \dots\dots\dots (3)$$

Values of d_m , h_{mw} , h_{am} and δ shall be obtained from the specification sheets on manufacture, or according to the formulae specified in **ISO 10300-1** or **ISO 23509**.

3.1.4

reference surface of measurement

surface referred in the measurement of a gear to be measured

The tooth flank form deviation on this surface shall be zero.

NOTE Refer to Annex A for the method to obtain the reference surface of measurement.

3.1.5

profile evaluation line

line for the evaluation of the form deviation in the tooth profile direction of a gear to be measured on the reference surface of measurement

The direction of profile evaluation line shall be normally perpendicular to the pitch line passing through the flank mean point (see Figure 1).

3.1.6

tooth trace evaluation line

line for the evaluation of the form deviation in the tooth trace direction of a gear to be measured on the reference surface of measurement

The tooth trace evaluation line shall be normally a centreline of effective tooth depth passing through the flank mean point (see Figure 1).

3.1.7

evaluation grid points on tooth surface

intersection of the lines in a grid pattern for the evaluation of the tooth surface deviation of a gear to be measured on the reference surface of measurement (see Figure 2)

The number of evaluation grid points on tooth surface shall be as specified in **5.3.4**. The position of evaluation grid points on tooth surface shall be as specified in **5.3.5**.

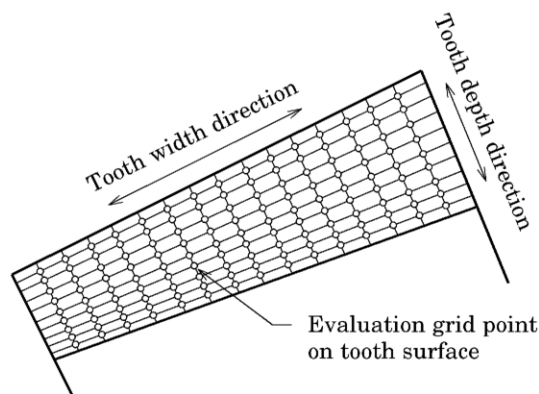


Figure 2 Example of evaluation grid points on tooth surface

3.1.8

cut-off wavelength of profile form filter λ_α

wavelength where 50 % of the amplitude of the profile deviation measurement data is transmitted as a result of the Gaussian low-pass filter

The cut-off value shall be as specified in **5.3.6**.

3.1.9

cut-off wavelength of trace filter λ_β

wavelength where 50 % of the amplitude of the tooth trace deviation measurement data is transmitted as a result of the Gaussian low-pass filter

The cut-off value shall be as specified in **5.3.6**.

3.2 Profile deviation

3.2.1 General

3.2.1.1

tip form point F_a

point at which a tooth flank starts at a tooth tip

If the tip surface is chamfered or the tooth tip is rounded, it is the end point of the usable flank. If the tip surface is not chamfered or the tooth tip is not rounded, it is the point at which a tooth flank intersects with a tip circle.

3.2.1.2

profile control point C_r

point nearest the dedendum of the design profile

When the profile control point near the dedendum is not specified, it shall be set to the position 90 % of the effective tooth depth from a tooth tip.

3.2.1.3

profile evaluation range L_α

section of measured profile for the analysis of profile deviation

Refer to **5.3.5** for the setting method.

3.2.1.4

measured profile

form of the tooth profile in which the tooth flank form deviation of reference surface of measurement on the profile evaluation line detected by a measuring machine is drawn along the position in the tooth depth direction

The tooth profile measuring range shall include the profile control point (3.2.1.2) and the tip form point (3.2.1.1).

3.2.1.5

profile deviation

amount in the normal direction, by which the measured profile (3.2.1.4) deviates from the design profile (3.2.2.1)

3.2.2 Analysis of profile deviation

3.2.2.1

design profile

tooth profile specified by the designer with the modification amount from the reference surface of measurement on the profile evaluation line to the position in the tooth depth direction (see Figure 3 to Figure 5)

When the design profile is not specified, the unmodified tooth profile form shall be used as the design profile. The design profile shall be determined as agreed between the parties concerned with delivery.

3.2.2.2

mean profile line

line (or curve) that represents the shape of the design profile (3.2.2.1), but aligned with the measured profile (3.2.1.4) over the profile evaluation range (3.2.1.3)

Refer to 5.3.8.2 for the creation method.

3.2.2.3

total profile deviation F_α

distance between two parallel facsimiles of the design profile (3.2.2.1) which enclose the measured profile (3.2.1.4) over the profile evaluation range (3.2.1.3) (see Figure 3 to Figure 5 and 5.3.8.2)

3.2.2.4

profile form deviation $f_{t\alpha}$

distance between two parallel facsimiles of the mean profile line (3.2.2.2) which enclose the measured profile (3.2.1.4) over the profile evaluation range (3.2.1.3) (see Figure 3 to Figure 5 and 5.3.8.2)

3.2.2.5

profile slope deviation $f_{H\alpha}$

distance between two facsimiles of the design profile which intersect the extrapolated mean profile line at the profile control point near dedendum C_f and the tip form point (see Figure 3 to Figure 5 and 5.3.8.2)

The profile slope deviation is deemed to be positive and the corresponding pressure angle deviation is deemed to be negative when the mean profile line shows an increase in material toward the tooth tip, relative to the design profile.

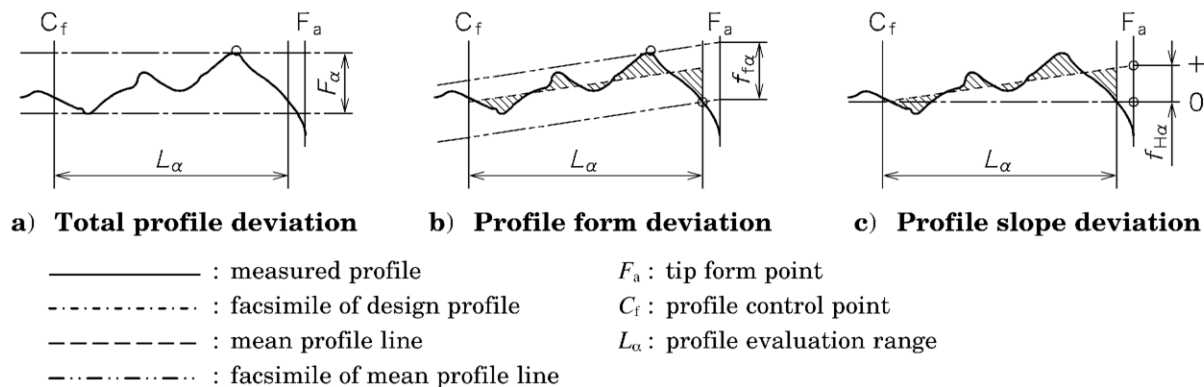


Figure 3 Example of profile deviation related to unmodified design profile

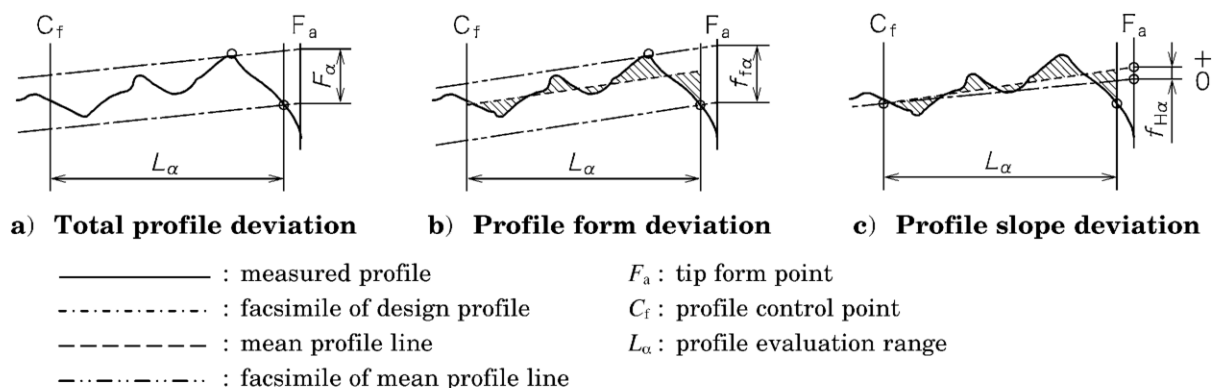


Figure 4 Example of profile deviation related to pressure angle modified design profile

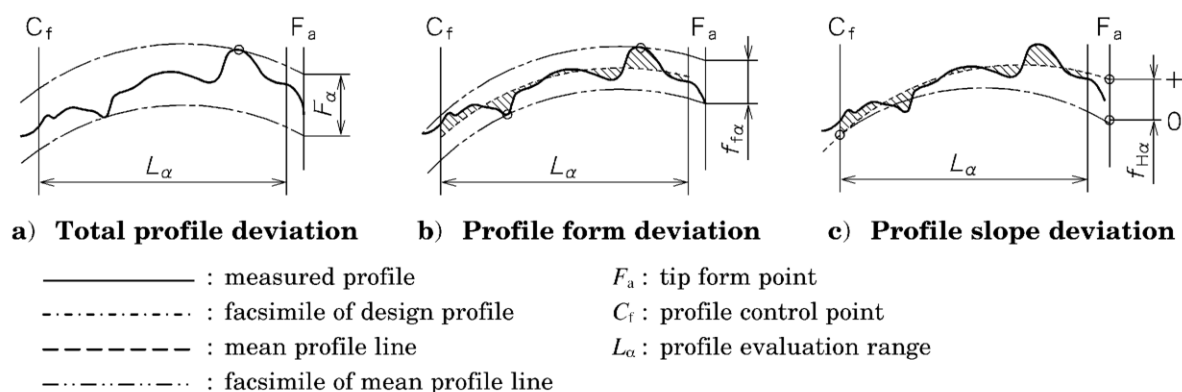


Figure 5 Example of profile deviation related to crowning-modified design profile