INTERNATIONAL STANDARD

ISO 6336-1

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# Calculation of load capacity of spur and helical gears —

## Part 1:
## Basic principles, introduction and general influence factors



*Calcul de la capacité de charge des engrenages cylindriques à dentures droite et hélicoïdale —*

*Partie 1: Principes de base, introduction et facteurs généraux d'influence*

Reference number
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# Contents







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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.



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.



International standard ISO 6336-1 was prepared by Technical Committee ISO/TC 60, *Gears*, Subcommittee SC 2, *Gear capacity calculation*.

ISO 6336 consists of the following parts, under the general title *Calculation of load capacity of spur and helical gears*:

- *Part 1: Basic principles, introduction and general influence factors*
- *Part 2: Calculation of surface durability (pitting)*
- *Part 3: Calculation of tooth bending strength*
- *Part 5: Strength and quality of materials*

Annexes A to D of this part of ISO 6336 are for information only.

## Introduction

This part of ISO 6336 and parts 2, 3 and 5 provide the principles for a coherent system of procedures for the calculation of the load capacity of cylindrical involute gears with external or internal teeth. ISO 6336 is designed to facilitate the application of future knowledge and developments, also the exchange of information gained from experience.

Design considerations to prevent fractures emanating from stress raisers in the tooth flank, tip chipping and failures of the gear blank through the web or hub should be analyzed by general machine design methods.



Several methods for the calculation of load capacity, also for the calculation of various factors are permitted (see 4.1.8). The directions in ISO 6336 are thus complex, but also flexible. As appropriate, the more detailed or simplified versions should be chosen for inclusion in application standards derived from this basic standard. Such application standards cover the following fields:

- industrial gears (detailed and simplified method);
- high-speed gears and gears of similar requirements;
- marine gears;
- vehicle gears.

These application standards feature clear, and to some extent simplified, rules for the calculations.

Included in the formulae are the major factors which are presently known to affect gear tooth pitting and fractures at the root fillet. The formulae are in a form that will permit the addition of new factors to reflect knowledge gained in the future.

# Calculation of load capacity of spur and helical gears

## Part 1: Basic principles, introduction and general influence factors

## 1 Scope

### 1.1 Intended use

This part of ISO 6336, together with parts 2, 3 and 5, provides a method by which different gear designs can be compared. It is not intended to assure the performance of assembled drive gear systems. It is not intended for use by the general engineering public. Instead, it is intended for use by the experienced gear designer who is capable of selecting reasonable values for the factors in these formulae based on knowledge of similar designs and awareness of the effects of the items discussed.



The formulae in ISO 6336 are intended to establish a uniformly acceptable method for calculating the pitting resistance and bending strength capacity of cylindrical gears with straight or helical teeth.



ISO 6336 includes procedures based on testing and theoretical studies such as those of Hirt [1], Strasser [2], and Brossman [3]. The results of rating calculations made by following this method are in good agreement with previously accepted gear calculations methods (see references [4] through [8]), for normal working pressure angles up to 25° and reference helix angles up to 30°.

For larger pressure angles and larger helix angles the trends of products $Y_F\ Y_S\ Y_\beta$ and respectively $Z_H\ Z_\varepsilon\ Z_\beta$ are not the same as those of some earlier methods. The user of ISO 6336 is cautioned that when the methods in ISO 6336 are used for other helix angles and pressure angles, the calculated results should be confirmed by experience.

### 1.2 Exceptions

The formulae in ISO 6336 are not applicable when any of the following conditions exist:

- spur gears with transverse contact ratios less than 1,0;
- spur or helical gears with transverse contact ratios greater than 2,5;
- where interference exists between tooth tips and root fillets;
- when teeth are pointed;
- when backlash is zero.

The rating formulae in ISO 6336 are not applicable to other types of gear tooth deterioration such as plastic yielding, scuffing, case crushing, welding and wear, and are not applicable under vibratory conditions where there may be an unpredictable profile breakdown. The bending strength formulae are applicable to fractures at the tooth fillet, but are not applicable to fractures on the tooth working surfaces, failure of the gear rim, or failures of the gear blank through web and hub. ISO 6336 does not apply to teeth finished by forging or sintering. It is not applicable to gears which have a poor contact pattern.

The procedures in ISO 6336 provide for the calculation of load capacity, based on pitting and tooth-root breakage. At pitch line velocities below 1 m/s the gear load capacity is often limited by abrasive wear (see other literature for information on the calculation for this).

### 1.2.1 Scuffing

Formulae for scuffing resistance on cylindrical gear teeth are not included in ISO 6336. At the present time, there is insufficient agreement concerning the method for designing cylindrical gears to resist scuffing failure.

### 1.2.2 Wear

Very little attention and concern have been devoted to the study of gear tooth wear. This subject primarily concerns gear teeth with low surface hardness or gears with improper lubrication. No attempt has been made to cover the subject in ISO 6336.

### 1.2.3 Micropitting

ISO 6336 does not cover micropitting, which is an additional type of surface distress that may occur on gear teeth.

### 1.2.4 Plastic yielding

ISO 6336 does not extend to stress levels greater than those permissible at $10^3$ cycles or less, since stresses in this range may exceed the elastic limit of the gear tooth in bending or in surface compressive stress. Depending on the material and the load imposed, a single stress cycle greater than the limit level at $< 10^3$ cycles could result in plastic yielding of the gear tooth.



## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 6336. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 6336 are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.



ISO 53: 1974, *Cylindrical gears for general and heavy engineering - Basic rack.*

ISO 468: 1982, *Surface roughness - Parameters, their values and general rules for specifying requirements.*

ISO 701: 1976, *International gear notation - Symbols for geometrical data.*

ISO 1122-1: 1983, *Glossary of gear terms - Part 1: Geometrical definitions.*

ISO 1328-1: 1995, *Cylindrical gears - ISO system of accuracy - Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth.*

ISO 6336-2: 1996, *Calculation of load capacity of spur and helical gears - Part 2: Calculation of surface durability (pitting).*

ISO 6336-3: 1996, *Calculation of load capacity of spur and helical gears - Part 3: Calculation of tooth bending strength.*

ISO 6336-5: 1996, *Calculation of load capacity of spur and helical gears - Part 5: Strength and quality of material.*

ISO/TR 10495: 1996, *Calculation of cylindrical gears – Calculation of service life under variable load.*

## 3 Definitions, symbols and units

For the purposes of ISO 6336, the definitions given in ISO 1122-1 apply.

Symbols are based on and are extensions of the symbols given in ISO 701 and ISO 1328-1. Only symbols for quantities used for the calculation of the particular factors treated in ISO 6336 are given, together with preferred units. Table 1 list the symbols used in the calculations for all parts of ISO 6336.

**Table 1 - Symbols and abbreviations used within ISO 6336-1, 2, 3 and 5**

| Symbol | Description | Unit |
|---|---|---|
| **Principal symbols and abbreviations** | | |
| $a$ | center distance[1)] | mm |
| $b$ | facewidth | mm |
| $c$ | constant | - |
| $d$ | diameter (without subscript, reference diameter) | mm |
| $e$ | auxiliary quantity | - |
| $f$ | deviation, tooth deformation | µm |
| $g$ | path of contact | mm |
| $h$ | tooth depth (without subscript, root circle to tip circle) | mm |
| $i$ | transmission ratio | - |
| $k$ | addendum truncation factor | - |
| $l$ | bearing span | mm |
| $m$ | module,<br>mass | mm<br>kg |
| $n$ | rotational speed | $s^{-1}$ or $min^{-1}$ |
| $p$ | pitch,<br>number of planet gears | mm<br>- |
| $q$ | auxiliary factor,<br>flexibility of pair of meshing teeth, see clause 9<br>material allowance for finish machining, see clause 5 of ISO 6336-3 | -<br>(mm·µm)/N<br>mm |
| $r$ | radius (without subscript, reference radius) | mm |
| $s$ | tooth thickness, distance between mid-plane of pinion and the middle of the bearing span | mm |
| $u$ | gear ratio $(z_2 / z_1) \geq 1$ [1)] | - |
| $v$ | tangential velocity (without subscript, at the reference circle ≈ tangential velocity at pitch circle) | m/s |
| $w$ | specific load (per unit facewidth, $F_t / b$) | N/mm |
| $x$ | profile shift coefficient | - |
| $y$ | running-in allowance (only with subscript $\alpha$ or $\beta$) | µm |
| $z$ | number of teeth[1)] | - |
| A, B, C, D, E | points on path of contact (pinion root to pinion tip, regardless of whether pinion or wheel drives, only for geometrical considerations) | - |
| $B$ | total facewidth of double helical gear including gap width | mm |



1) For external gearing $a$, $z_1$, and $z_2$ are positive; for internal gearing $a$ and $z_2$ have a negative sign, $z_1$ has a positive.

| Symbol | Description | Unit |
|---|---|---|
| *C* | constant, coefficient,<br>relief of tooth flank | -<br>µm |
| *D* | diameter (design) | mm |
| *E* | modulus of elasticity | $N/mm^2$ |
| Eh | material designation for case-hardening steel, case hardened | - |
| Eht | case depth, see ISO 6336-5 | mm |
| *F* | composite and cumulative deviations,<br>force or load | µm<br>N |
| *G* | shear modulus | $N/mm^2$ |
| GG | material designation for grey cast iron | - |
| GGG | material designation for cast iron (perlitic, bainitic, ferritic structure) | - |
| GTS | material designation for black malleable cast iron (perlitic structure) | - |
| HB | Brinell hardness | - |
| HRC | Rockwell hardness (C scale) | - |
| HR 30N | Rockwell hardness (30 N scale), see ISO 6336-5 | - |
| HV | Vickers hardness | - |
| HV 1 | Vickers hardness at load $F$ = 9,81 N, see ISO 6336-5 | - |
| HV 10 | Vickers hardness at load $F$ = 98,10 N, see ISO 6336-5 | - |
| IF | material designation for steel and GGG, flame or induction hardened | - |
| *J* | Jominy hardenability, see ISO 6336-5 | - |
| *K* | constant, factors concerning tooth load | - |
| *L* | lengths (design) | mm |
| *M* | moment of a force | Nm |
| MX<br>ME<br>MQ<br>ML | symbols identifying material and heat-treatment requirements, see ISO 6336-5 | - |
| *N* | number, exponent, number of load cycles, resonance ratio | - |
| NT | material designation for nitriding steel, nitrided | - |
| NV | material designation for through-hardening and case-hardening steel, nitrided (nitr.), nitrocarburized (nitrocar.) | - |
| *P* | transmitted power | kW |
| *S* | safety factor | - |
| St | material designation for steel ($\sigma_B$ < 800 $N/mm^2$) | - |
| *T* | torque,<br>tolerance | Nm<br>µm |
| V | material designation for through-hardening steel, through-hardened ($\sigma_B \geq$ 800 $N/mm^2$) | - |
| *W* | weighing factor | - |
| *Y* | factor related to tooth-root stress | - |
| *Z* | factor related to contact stress | - |

| Symbol | Description | Unit |
|---|---|---|
| $\alpha$ | pressure angle (without subscript, at reference cylinder) | ° |
| $\beta$ | helix angle (without subscript, at reference cylinder) | ° |
| $\gamma$ | auxiliary angle,<br>shear strain,<br>pinion offset factor, see equations in clause 7 | °<br>-<br>µm |
| $\delta$ | deflection | µm |
| $\varepsilon$ | contact ratio, overlap ratio, relative eccentricity (see clause 7) | - |
| $\eta$ | effective dynamic viscosity of the oil wedge at the mean temperature of wedge | mPa s |
| $\vartheta$ | temperature | °C |
| $\mu$ | coefficient of friction | - |
| $\nu$ | Poisson's ratio,<br>kinematic viscosity of the oil | -<br>$mm^2/s$ |
| $\rho$ | radius of curvature,<br>density (for steel, $\rho = 7{,}83 \times 10^{-6}$) | mm<br>$kg/mm^3$ |
| $\sigma$ | normal stress | $N/mm^2$ |
| $\tau$ | shear stress | $N/mm^2$ |
| $\chi$ | running-in factor | - |
| $\psi$ | auxiliary angle,<br>relative bearing clearance (see clause 7) | °<br>- |
| $\omega$ | angular velocity | rad/s |
| $\Gamma$ | parameter on the line of action | - |
| $\Psi$ | reduction of area on fracture | % |
| **Subscripts to symbols** | | |
| - | reference values (without subscript) | |
| a | addendum,<br>tooth tip | |
| ann | annulus gear | |
| b | base circle,<br>facewidth | |
| be | bearing | |
| ca | case | |
| cal | calculated | |
| co | contact pattern | |
| dyn | dynamic | |
| e | outer limit of single pair tooth contact | |
| eff | effective value, real stress | |
| f | tooth-root, dedendum | |
| i | internal | |
| k | tooth truncation,<br>values related to the notched test piece | |
| lim | value of reference strength | |

| Symbol | Description | Unit |
|---|---|---|
| m | mean or average value (mean section) | |
| ma | manufacturing | |
| max | maximum value | |
| min | minimum value | |
| n | normal plane,<br>virtual spur gear of a helical gear,<br>number of revolutions | |
| oil | oil | |
| p | pitch,<br>values related to the smooth polished test piece | |
| par | parallel | |
| pla | planet gear | |
| r | radial | |
| red | reduced | |
| rel | relative | |
| s | tooth thickness,<br>notch effect | |
| sh | shaft | |
| stat | static (load) | |
| sun | sun pinion, sun gear | |
| t | transverse plane | |
| th | theoretical | |
| v | velocity,<br>losses | |
| w | working (this subscript may replace the apostrophe) | |
| y | running-in,<br>any point on the tooth flank | |
| A | application,<br>external shock loads | |
| C | pitch point,<br>profile and helix modification | |
| D | speed transformation,<br>reducing or increasing | |
| E | elasticity of material,<br>resonance | |
| F | tooth-root stress | |
| G | geometry | |
| H | Hertzian stress (contact stress) | |
| L | lubrication | |
| M | material | |
| N | number (a specific number may be inserted after the subscript N in the life factor) | |

| Symbol | Description | Unit |
|---|---|---|
| P | permissible value,<br>rack profile | |
| R | roughness,<br>rows | |
| T | test gear,<br>values related to the standard reference test gear | |
| W | pairing of materials | |
| X | dimension (absolute) | |
| z | sun | |
| $\alpha$ | transverse contact,<br>profile | |
| $\beta$ | helix,<br>facewidth,<br>crowning | |
| $\gamma$ | total (total value) | |
| $\Delta$ | rough specimen | |
| $\varepsilon$ | contact ratio | |
| 0 | basic value,<br>tool | |
| 1 | pinion | |
| 2 | wheel | |
| 1..9 | general numbering | |
| I(II) | end relief,<br>reference (nonreference) face | |
| ′ | single-flank (subscript w possible) single-pair tooth contact | |
| ″ | double-flank contact (simultaneous contact between working and non-working flanks) | |
| **Combined symbols** | | |
| $b_{be}$ | length of journal bearing | mm |
| $b_{cal}$ | calculated facewidth (figure 9) | mm |
| $b_{c0}$ | length of tooth bearing pattern at no load (contact marking) | mm |
| $b_{red}$ | reduced facewidth (facewidth minus end reliefs) | mm |
| $b_s$ | web thickness | mm |
| $b_B$ | facewidth of one helix on a double helical gear | mm |
| $b_{I(II)}$ | length of end relief | mm |
| $c_P$ | bottom clearance between basic rack profile and mating profile | mm |
| $c_\gamma$ | mean value of mesh stiffness per unit facewidth | N/(mm·µm) |
| $c'$ | maximum tooth stiffness per unit facewidth (single stiffness) of a tooth pair | N/(mm·µm) |
| $c'_{th}$ | theoretical single stiffness | N/(mm·µm) |
| $d_a$ | tip diameter | mm |
| $d_b$ | base diameter | mm |
| $d_e$ | diameter of circle through outer point of single pair tooth contact | mm |

| Symbol | Description | Unit |
|---|---|---|
| $d_f$ | root diameter | mm |
| $d_{f2}$ | root diameter of internal gear | mm |
| $d_{sh}$ | external diameter of shaft, nominal for bending deflection | mm |
| $d_{shi}$ | internal diameter of a hollow shaft | mm |
| $d_w$ | pitch diameter | mm |
| $d_B$ | ball diameter (ball bearing) | mm |
| $d_{1,2}$ | reference diameter of pinion (or wheel) | mm |
| $f_{be}$ | component of equivalent misalignment[2)] due to bearing deformation | µm |
| $f_{ca}$ | component of equivalent misalignment[2)] due to case deformation | µm |
| $f_{f\alpha}$ | profile form deviation (the value for the total profile deviation $F_\alpha$ may be used alternatively for this, if tolerances complying with ISO 1328-1 are used) | µm |
| $f_{ma}$ | mesh misalignment[2)] due to manufacturing deviations | µm |
| $f_p$ | transverse single pitch deviation | µm |
| $f_{par}$ | non-parallelism of pinion and wheel axes (manufacturing deviation) [2)] | µm |
| $f_{pb}$ | transverse base pitch deviation (the values of $f_{pt}$ may be used for calculations in accordance with ISO 6336, using tolerances complying with ISO 1328-1) | µm |
| $f_{sh}$ | component of equivalent misalignment[2)] due to deformations of pinion and wheel shafts | µm |
| $f_{shT}$ | component of misalignment due to shaft and pinion deformation measured at a partial load | µm |
| $f_{sh0}$ | shaft deformation under specific load[2)] | µm·mm/N |
| $f_{H\beta}$ | helix slope deviation (the value for the total helix deviation $F_\beta$ may be used alternatively for this, if tolerances complying with ISO 1328-1 are used) | µm |
| $f_{H\beta 6}$ | tolerance on helix slope deviation for ISO accuracy grade 6 | µm |
| $g_\alpha$ | length of path of contact | mm |
| $h_{aP}$ | addendum of basic rack of cylindrical gears | mm |
| $h_{a0}$ | tool addendum | mm |
| $h_{fP}$ | dedendum of basic rack of cylindrical gears | mm |
| $h_{f0}$ | tool dedendum | mm |
| $h_{f2}$ | dedendum of tooth of an internal gear | mm |
| $h_{min}$ | minimum lubricant film thickness | mm |
| $h_F$ | bending moment arm for tooth-root stress | mm |
| $h_{Fa}$ | bending moment arm relevant to load application at the tooth tip (defined by the contact point of the 30° tangents) | mm |
| $h_{Fe}$ | bending moment relevant to load application at the outer point of single pair tooth contact | mm |
| $l_a$ | effective length of roller (roller bearings) | mm |
| $m^*$ | relative individual gear mass per unit facewidth referenced to line of action | kg/mm |
| $m_n$ | normal module | mm |



2) The components in the plane of action are determinant.

| Symbol | Description | Unit |
|---|---|---|
| $m_{red}$ | reduced gear pair mass per unit facewidth referenced to the line of action | kg/mm |
| $m_t$ | transverse module | mm |
| $n_{1,2}$ | rotation speed of pinion (or wheel) | $min^{-1}$ or $s^{-1}$ |
| $n_E$ | resonance speed | $min^{-1}$ |
| $p_{bn}$ | normal base pitch | mm |
| $p_{bt}$ | transverse base pitch | mm |
| $q'$ | minimum value for the flexibility of a pair of meshing teeth | (mm·µm)/N |
| $q_{pr}$ | protuberance of the tool, see figure 2 of ISO 6336-3 | mm |
| $q_s$ | notch parameter, $q_s = s_{Fn} / 2\rho_F$ | - |
| $q_{sk}$ | notch parameter of the notched test piece | - |
| $q_{sT}$ | notch parameter of the standard reference test gear, $q_{sT}$ = 2,5 | - |
| $q_\alpha$ | auxiliary factor | - |
| $s_c$ | film thickness of marking compound used in contact pattern determination | µm |
| $s_{pr}$ | residual fillet undercut, $s_{pr} = q_{pr} - q$ | mm |
| $s_{Fn}$ | tooth-root chord at the critical section | mm |
| $s_R$ | rim thickness | mm |
| $t_g$ | maximum depth of grinding notch | mm |
| $w_m$ | mean specific load (per unit facewidth) | N/mm |
| $w_t$ | tangential force per unit tooth width, including overload factors | N/mm |
| $x_E$ | rack shift coefficient for adjustment of tooth thickness | - |
| $x_{1,2}$ | addendum modification coefficient of pinion (or wheel) | - |
| $y_\alpha$ | running-in allowance for a gear pair | µm |
| $y_\beta$ | running-in allowance (equivalent misalignment) | µm |
| $z_n$ | virtual number of teeth of a helical gear | - |
| $z_{1,2}$ | number of teeth of pinion (or wheel)[1)], see page 3 | - |
| $B^*$ | constant, see equations in clause 7 | - |
| $C_a$ | tip relief | µm |
| $C_B$ | basic rack factor (same rack for pinion and wheel) | - |
| $C_{B1}$ | basic rack factor (pinion), see 9.3.1.4 | - |
| $C_{B2}$ | basic rack factor (wheel), see 9.3.1.4 | - |
| $C_M$ | correction factor, see clause 9 | - |
| $C_R$ | gear blank factor, see clause 9 | - |
| $C_{ZL, ZR, Zv}$ | factors for determining lubricant film factors, see 11.2 of Part 2 | - |
| $C_\beta$ | crowning height | µm |
| $C_{I(II)}$ | end relief | µm |
| $D_{be}$ | bearing bore diameter (plain bearings) | mm |
| $D_{sh}$ | journal diameter (plain bearings) | mm |
| $F_{be\ r}$ | radial force on bearing | N |

| Symbol | Description | Unit |
|---|---|---|
| $F_{bn}$ | (nominal) load, normal to the line of contact | N |
| $F_{bt}$ | nominal transverse load in plane of action (base tangent plane) | N |
| $F_m$ | mean transverse tangential load at the reference circle relevant to mesh calculations, $F_m = (F_t K_A K_v)$ | N |
| $F_{m\,T}$ | mean transverse tangential part load at reference circle | N |
| $F_{max}$ | maximum tangential tooth load for the mesh calculated | N |
| $F_t$ | (nominal) transverse tangential force at reference cylinder | N |
| $F_{tH}$ | determinant tangential load in a transverse plane for $K_{H\alpha}$ and $K_{F\alpha}$, $F_{tH} = F_t K_A K_v K_{H\beta}$ | N |
| $F_\alpha$ | total profile deviation | µm |
| $F_\beta$ | total helix deviation | µm |
| $F_{\beta 6}$ | tolerance on total helix deviation for ISO accuracy grade 6 | µm |
| $F_{\beta x}$ | initial equivalent misalignment (before running-in) | µm |
| $F_{\beta x\,cv}$ | initial equivalent misalignment for the determination of the crowning height (estimate) | µm |
| $F_{\beta x\,T}$ | equivalent misalignment measured under a partial load | µm |
| $F_{\beta y}$ | effective equivalent misalignment (after running-in) | µm |
| $K'$ | constant for the pinion position in relation to the torqued end | - |
| $K_v$ | dynamic factor | - |
| $K_A$ | application factor | - |
| $K_{F\alpha}$ | transverse load factor (root stress) | - |
| $K_{F\beta}$ | face load factor (root stress) | - |
| $K_{H\alpha}$ | transverse load factor (contact stress) | - |
| $K_{H\beta}$ | face load factor (contact stress) | - |
| $K_\gamma$ | mesh load factor (takes into account the uneven distribution of the load between meshes for multiple transmission paths) | - |
| $J^*$ | moment of inertia per unit facewidth | kg·mm²/mm |
| $N_B$ | number of balls (or rollers) per row | - |
| $N_F$ | exponent | - |
| $N_L$ | number of load cycles | - |
| $N_M$ | number of mesh contacts per revolution (normally 1, for idler 2) | - |
| $N_R$ | number of rows per bearing | - |
| $N_S$ | resonance ratio in the main resonance range | - |
| $N_w$ | number of webs | - |
| $R_a$ | arithmetic mean roughness value, $R_a = 1/6\ R_z$ | µm |
| $R_z$ | mean peak-to-valley roughness (as specified in ISO 468) | µm |
| $R_{zk}$ | mean peak-to-valley roughness of the notched, rough test piece | µm |
| $R_{zT}$ | mean peak-to-valley roughness of the standard reference test gear, $R_{zT} = 10$ | µm |
| $S_F$ | factor of safety from tooth breakage | - |

| Symbol | Description | Unit |
|---|---|---|
| $S_H$ | factor of safety from pitting | - |
| $So$ | Sommerfeld number | - |
| $T_{1,2}$ | nominal torque at the pinion (or wheel) | N·m |
| $Y_F$ | tooth form factor, for the influence on nominal tooth-root stress with load applied at the outer point of single pair tooth contact | - |
| $Y_{Fa}$ | form factor, for the influence on nominal tooth-root stress with load applied at the tooth tip | - |
| $Y_{FS}$ | tip factor, equal ($Y_{Fa}$ $Y_{Sa}$), accounts for influences covered by $Y_{Fa}$ and $Y_{Sa}$ | - |
| $Y_{Nk}$ | life factor for tooth-root stress, relevant to the notched test piece | - |
| $Y_{Np}$ | life factor for tooth-root stress, relevant to the plain polished test piece | - |
| $Y_{NT}$ | life factor for tooth-root stress for reference test conditions | - |
| $Y_R$ | tooth-root surface factor (relevant to the plain polished test piece) | - |
| $Y_{R\ rel\ k}$ | relative roughness factor, the quotient of the gear tooth-root surface factor of interest divided by the notch test piece factor, $Y_{R\ rel\ k} = Y_R / Y_{Rk}$ | - |
| $Y_{R\ rel\ T}$ | relative surface factor, the quotient of the gear tooth-root surface factor of interest divided by the tooth-root surface factor of the reference test gear, $Y_{R\ rel\ T} = Y_R / Y_{RT}$ | - |
| $Y_S$ | stress correction factor, for the conversion of the nominal bending stress, determined for application of load at the outer point of single pair tooth contact, to the local tooth-root stress | - |
| $Y_{Sa}$ | stress correction factor, for the conversion of the nominal bending stress determined for load application at the tooth tip, to the local tooth-root stress | - |
| $Y_{Sag}$, $Y_{Sg}$ | stress correction factors for teeth with grinding notches | - |
| $Y_{Sk}$ | stress correction factor, relevant to the notched test piece | - |
| $Y_{ST}$ | stress correction factor, relevant to the dimensions of the reference test gears | - |
| $Y_X$ | size factor (tooth-root) | - |
| $Y_\beta$ | helix angle factor (tooth-root) | - |
| $Y_\delta$ | notch sensitivity factor of the actual gear (relative to a polished test piece) | - |
| $Y_{\delta k}$ | sensitivity factor of a notched test piece, relative to a smooth polished test piece | - |
| $Y_{\delta T}$ | sensitivity factor of the standard reference test gear, relative to the smooth polished test piece | - |
| $Y_{\delta\ rel\ k}$ | test relative notch sensitivity factor, the quotient of the gear notch sensitivity factor of interest divided by the notched test piece factor, $Y_{\delta\ rel\ k} = Y_\delta / Y_{\delta k}$ | |
| $Y_{\delta\ rel\ T}$ | relative notch sensitivity factor, the quotient of the gear notch sensitivity factor of interest divided by the standard test gear factor, $Y_{\delta\ rel\ T} = Y_\delta / Y_{\delta T}$ | - |
| $Y_\varepsilon$ | contact ratio factor (tooth-root) | - |
| $Z_v$ | velocity factor | - |
| $Z_B$, $Z_D$ | single pair tooth contact factors for the pinion, for the wheel | - |
| $Z_E$ | elasticity factor | $\sqrt{N/mm^2}$ |
| $Z_H$ | zone factor | - |
| $Z_L$ | lubricant factor | - |
| $Z_N$ | life factor for contact stress | - |