INTERNATIONAL STANDARD

ISO 76

Third edition
2006-05-01

Rolling bearings — Static load ratings

Roulements — Charges statiques de base

Reference number
ISO 76:2006(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

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 76 was prepared by Technical Committee ISO/TC 4, *Rolling bearings*, Subcommittee SC 8, *Load ratings and life*.

This third edition cancels and replaces the second edition (ISO 76:1987), which has been technically revised. It incorporates ISO 76:1987/Amd 1:1999 in Annex A.

Introduction

Permanent deformations appear in rolling elements and raceways of rolling bearings under static loads of moderate magnitude and increase gradually with increasing load.

It is often impractical to establish whether the deformations appearing in a bearing in a specific application are permissible by testing the bearing in that application. Other methods are therefore required to establish the suitability of the bearing selected.

Experience shows that a total permanent deformation of 0,000 1 of the rolling element diameter, at the centre of the most heavily loaded rolling element/raceway contact, can be tolerated in most bearing applications without the subsequent bearing operation being impaired. The basic static load rating is, therefore, given a magnitude such that, approximately, this deformation occurs when the static equivalent load is equal to the load rating.

Tests in different countries indicate that a load of the magnitude in question can be considered to correspond to a calculated contact stress of

— 4 600 MPa[1)] for self-aligning ball bearings,

— 4 200 MPa for all other ball bearings, and

— 4 000 MPa for all roller bearings,

at the centre of the most heavily loaded rolling element/raceway contact. The equations and factors for the calculation of the basic static load ratings are based on these contact stresses.

The permissible static equivalent load could be smaller than, equal to or greater than the basic static load rating, depending on the requirements for smoothness of operation and friction, as well as on actual contact surface geometry. Bearing users without previous experience of these conditions will need to consult the bearing manufacturer.

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

Rolling bearings — Static load ratings

1 Scope

This International Standard specifies methods of calculating the basic static load rating and the static equivalent load for rolling bearings within the size ranges shown in the relevant ISO standards, manufactured from contemporary, commonly used, high quality, hardened bearing steel in accordance with good manufacturing practice and basically of conventional design as regards the shape of the rolling contact surfaces.

Calculations carried out in accordance with this International Standard do not yield satisfactory results for bearings in which, because of application conditions and/or internal design, there is a considerable truncation of the area of contact between the rolling elements and the ring raceways. The same limitation applies where application conditions cause deviations from a normal load distribution in the bearing, for example misalignment, preload or extra large clearance or where special surface treatment or coatings are used. Where there is reason to assume that such conditions prevail, the user should consult the bearing manufacturer for recommendations and the evaluation of the static equivalent load.

This International Standard is not applicable to designs where the rolling elements operate directly on a shaft or housing surface, unless that surface is equivalent in all respects to the bearing surface it replaces.

Double-row radial bearings and double-direction thrust bearings are, when referred to in this International Standard, presumed to be symmetrical.

In addition, guidelines are given for static safety factors to be applied in heavy loaded applications.

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 5593, *Rolling bearings — Vocabulary*

ISO 15241, *Rolling bearings — Symbols for quantities*

ISO/TR 10657:1991, *Explanatory notes on ISO 76*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5593 and the following apply.

3.1
static load
load acting on a bearing when the speed of rotation of its rings or washers in relation to each other is zero

3.2
basic static radial load rating
radial load which corresponds to a calculated contact stress at the centre of the most heavily loaded rolling element/raceway contact of

— 4 600 MPa for self-aligning ball bearings,

— 4 200 MPa for all other radial ball bearings types, and

— 4 000 MPa for all radial roller bearings

NOTE 1 In the case of a single-row angular contact bearing, the radial load rating refers to the radial component of that load which causes a purely radial displacement of the bearing rings in relation to each other.

NOTE 2 For these contact stresses, under static load, a total permanent deformation of rolling element and raceway occurs which is approximately 0,000 1 of the rolling element diameter.

3.3
basic static axial load rating
static centric axial load which corresponds to a calculated contact stress at the centre of the most heavily loaded rolling element/raceway contact of

— 4 200 MPa for thrust ball bearings, and

— 4 000 MPa for all thrust roller bearings

NOTE For these contact stresses, under static load, a total permanent deformation of rolling element and raceway occurs which is approximately 0,000 1 of the rolling element diameter.

3.4
static equivalent radial load
static radial load which would cause the same contact stress at the centre of the most heavily loaded rolling element/raceway contact as that which occurs under the actual load conditions

3.5
static equivalent axial load
static centric axial load which would cause the same contact stress at the centre of the most heavily loaded rolling element/raceway contact as that which occurs under the actual load conditions

3.6
static safety factor
ratio between the basic static load rating and the static equivalent load, giving a margin of safety against inadmissible permanent deformation on rolling elements and raceways

3.7
roller diameter
⟨calculation of load ratings⟩ theoretical diameter in a radial plane through the middle of the roller length for a symmetrical roller

NOTE 1 For a tapered roller, the applicable diameter is equal to the mean value of the diameters at the imaginary sharp corners at the large end and at the small end of the roller.

NOTE 2 For an asymmetrical convex roller, the applicable diameter is an approximation of the diameter at the point of contact between the roller and the ribless raceway at zero load.

3.8
effective roller length
⟨calculation of load ratings⟩ theoretical maximum length of contact between a roller and that raceway where the contact is shortest

NOTE This is normally taken to be either the distance between the theoretically sharp corners of the roller minus the roller chamfers, or the raceway width excluding the grinding undercuts, whichever is the smaller.

3.9
nominal contact angle
angle between a plane perpendicular to a bearing axis (a radial plane) and the nominal line of action of the resultant of the forces transmitted by a bearing ring or washer to a rolling element

NOTE For bearings with asymmetrical rollers, the nominal contact angle is determined by the contact with the ribless raceway.

3.10
pitch diameter of ball set
diameter of the circle containing the centres of the balls in one row in a bearing

3.11
pitch diameter of roller set
diameter of the circle intersecting the roller axes at the middle of the rollers in one row in a bearing

4 Symbols

For the purposes of this document, the symbols given in ISO 15241 and the following apply.

C_{0a} basic static axial load rating, in newtons

C_{0r} basic static radial load rating, in newtons

D_{pw} pitch diameter of ball or roller set, in millimetres

D_w nominal ball diameter, in millimetres

D_{we} roller diameter applicable in the calculation of load ratings, in millimetres

F_a bearing axial load (axial component of actual bearing load), in newtons

F_r bearing radial load (radial component of actual bearing load), in newtons

f_0 factor for calculation of basic static load rating

i number of rows of rolling elements

L_{we} effective roller length applicable in the calculation of load ratings, in millimetres

P_{0a} static equivalent axial load, in newtons

P_{0r} static equivalent radial load, in newtons

S_0 static safety factor

X_0 static radial load factor

Y_0 static axial load factor

Z number of rolling elements in a single-row bearing; number of rolling elements per row of a multi-row bearing with the same number of rolling elements per row

α nominal contact angle, in degrees

5 Radial ball bearings

5.1 Basic static radial load rating

5.1.1 Basic static radial load rating for single bearings

The basic static radial load rating for radial ball bearings is given by the equation:

$$C_{0r} = f_0\, i\, Z\, D_w^2 \cos\alpha \qquad (1)$$

where the values of f_0 are as given in Table 1.

The equation applies to bearings with a cross-sectional raceway groove radius not larger than 0,52D_w in radial and angular contact ball bearing inner rings, and 0,53D_w in radial and angular contact ball bearing outer rings and self-aligning ball bearing inner rings.

The load-carrying ability of a bearing is not necessarily increased by the use of a smaller groove radius, but is reduced by the use of a groove radius larger than those indicated in the previous paragraph. In the latter case, a correspondingly reduced value of f_0 shall be used. Calculation of this reduced value of f_0 may be carried out by means of Equation (3-18) given in ISO/TR 10657:1991.

5.1.2 Basic static radial load rating for bearing combinations

5.1.2.1 Two single-row radial contact ball bearings operation as a unit

The basic static radial load rating for two similar single-row radial contact ball bearings mounted side by side on the same shaft, such that they operate as a unit (paired mounting), is twice the basic static radial load rating of one single-row bearing.

5.1.2.2 Back-to-back and face-to-face arrangements of single-row angular contact ball bearings

The basic static radial load rating for two similar single-row angular contact ball bearings mounted side by side on the same shaft, such that they operate as a unit (paired mounting) in a back-to-back or face-to-face arrangement, is twice the basic static radial load rating of one single-row bearing.

5.1.2.3 Tandem arrangement

The basic static radial load rating for two or more similar single-row radial contact ball bearings or two or more similar single-row angular contact ball bearings mounted side by side on the same shaft, such that they operate as a unit (paired or stack mounting) in a tandem arrangement, is the number of bearings multiplied by the basic static radial load rating of one single-row bearing. The bearings need to be properly manufactured and mounted for equal distribution of the load between them.

Table 1 — Values of factor f_0 for ball bearings

$\frac{D_w \cos\alpha}{D_{pw}}$	Factor f_0		
	Radial ball bearings		Thrust ball bearings
	radial and angular contact	self-aligning	
0	14,7	1,9	61,6
0,01	14,9	2	60,8
0,02	15,1	2	59,9
0,03	15,3	2,1	59,1
0,04	15,5	2,1	58,3
0,05	15,7	2,1	57,5
0,06	15,9	2,2	56,7
0,07	16,1	2,2	55,9
0,08	16,3	2,3	55,1
0,09	16,5	2,3	54,3
0,1	16,4	2,4	53,5
0,11	16,1	2,4	52,7
0,12	15,9	2,4	51,9
0,13	15,6	2,5	51,2
0,14	15,4	2,5	50,4
0,15	15,2	2,6	49,6
0,16	14,9	2,6	48,8
0,17	14,7	2,7	48
0,18	14,4	2,7	47,3
0,19	14,2	2,8	46,5
0,2	14	2,8	45,7
0,21	13,7	2,8	45
0,22	13,5	2,9	44,2
0,23	13,2	2,9	43,5
0,24	13	3	42,7
0,25	12,8	3	41,9
0,26	12,5	3,1	41,2
0,27	12,3	3,1	40,5
0,28	12,1	3,2	39,7
0,29	11,8	3,2	39
0,3	11,6	3,3	38,2
0,31	11,4	3,3	37,5
0,32	11,2	3,4	36,8
0,33	10,9	3,4	36
0,34	10,7	3,5	35,3
0,35	10,5	3,5	34,6
0,36	10,3	3,6	—
0,37	10	3,6	—
0,38	9,8	3,7	—
0,39	9,6	3,8	—
0,4	9,4	3,8	—

NOTE This table is based on the Hertzian point contact equation with a modulus of elasticity of $2,07 \times 10^5$ MPa and a Poisson's ratio of 0,3. It is assumed that the load distribution results in a maximum ball load of $\frac{5 F_r}{Z \cos\alpha}$ for radial ball bearings and a maximum ball load of $\frac{F_a}{Z \sin\alpha}$ for thrust ball bearings. Values of f_0 for intermediate values of $\frac{D_w \cos\alpha}{D_{pw}}$ can be obtained by linear interpolation.