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ISO 76

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Rolling bearings — Static load ratings

Roulements — Charges statiques de base

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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 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:

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

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.

5.2 Static equivalent radial load

5.2.1 Static equivalent radial load for single bearings

The static equivalent radial load for radial ball bearings is the greater of the two values given by the equations:

$$P_{0r} = X_0 F_r + Y_0 F_a \quad (2)$$

$$P_{0r} = F_r \quad (3)$$

where the values of factors X_0 and Y_0 are as given in Table 2. These factors apply to bearings with cross-sectional groove radii according to 5.1.1. For other groove radii, calculation of X_0 and Y_0 may be carried out by means of ISO/TR 10657:1991.

Values of Y_0 for intermediate contact angles, not given in Table 2, are obtained by linear interpolation.

Table 2 — Values of factors X_0 and Y_0 for radial ball bearings

Bearing type		Single-row bearings		Double-row bearings	
		X_0	Y_0	X_0	Y_0
Radial contact ball bearings [a]		0,6	0,5	0,6	0,5
Angular contact ball bearings, $\alpha =$	5°	0,5	0,52	1	1,04
	10°	0,5	0,5	1	1
	15°	0,5	0,46	1	0,92
	20°	0,5	0,42	1	0,84
	25°	0,5	0,38	1	0,76
	30°	0,5	0,33	1	0,66
	35°	0,5	0,29	1	0,58
	40°	0,5	0,26	1	0,52
	45°	0,5	0,22	1	0,44
Self-aligning ball bearings, $\alpha \neq 0°$		0,5	0,22 cotα	1	0,44 cotα

[a] The permissible maximum value of F_a/C_{0r} depends on bearing design (internal clearance and raceway groove depth).

5.2.2 Static equivalent radial load for bearing combinations

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

When calculating the static equivalent radial load for two similar 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 a face-to-face arrangement, the X_0 and Y_0 values for a double-row bearing and the F_r and F_a values for the total loads on the arrangement shall be used.

5.2.2.2 Tandem arrangement

When calculating the static equivalent radial load 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, the X_0 and Y_0 values for a single-row bearing and the F_r and F_a values for the total loads on the arrangement shall be used.

6 Thrust ball bearings

6.1 Basic static axial load rating

The basic static axial load rating for single-direction and double-direction thrust ball bearings is given by the equation:

$$C_{0a} = f_0 Z D_w^2 \sin\alpha \qquad (4)$$

where the values of f_0 are as given in Table 1 and Z is the number of balls carrying load in one direction.

The equation applies to bearings with cross-sectional raceway groove radii not larger than $0{,}54D_w$.

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 larger groove radius. 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 (3-30) given in ISO/TR 10657:1991.

6.2 Static equivalent axial load

The static equivalent axial load for thrust ball bearings with $\alpha \neq 90°$ is given by the equation:

$$P_{0a} = 2{,}3\, F_r \tan\alpha + F_a \qquad (5)$$

This equation is valid for all ratios of radial load to axial load in the case of double-direction bearings. For single-direction bearings, it is valid where $F_r/F_a \leqslant 0{,}44 \cot\alpha$ and gives satisfactory but less conservative values of P_{0a} for F_r/F_a up to $0{,}67 \cot\alpha$.

Thrust ball bearings with $\alpha = 90°$ can support axial loads only. The static equivalent axial load for this type of bearing is given by the equation:

$$P_{0a} = F_a \qquad (6)$$

7 Radial roller bearings

7.1 Basic static radial load rating

7.1.1 Basic static radial load rating for single bearings

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

$$C_{0r} = 44\left(1 - \frac{D_{we}\cos\alpha}{D_{pw}}\right) i Z L_{we} D_{we} \cos\alpha \qquad (7)$$

NOTE Equation (7) is based on the same modulus of elasticity, Poisson's ratio and rolling element load distributions as given by the note to Table 1.

7.1.2 Basic static radial load rating for bearing combinations

7.1.2.1 Back-to-back and face-to-face arrangements

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

7.1.2.2 Tandem arrangement

The basic static radial load rating for two or more similar single-row radial roller 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.

7.2 Static equivalent radial load

7.2.1 Static equivalent radial load for single bearings

The static equivalent radial load for radial roller bearings with $\alpha \neq 0°$ is the greater of the two values given by the equations:

$$P_{0\mathrm{r}} = X_0 F_\mathrm{r} + Y_0 F_\mathrm{a} \quad (8)$$

$$P_{0\mathrm{r}} = F_\mathrm{r} \quad (9)$$

where the values of factors X_0 and Y_0 are as given in Table 3.

Table 3 — Values of factors X_0 and Y_0 for radial roller bearings with $\alpha \neq 0°$

Bearing type	X_0	Y_0
Single-row	0,5	0,22 cotα
Double-row	1	0,44 cotα

The static equivalent radial load for radial roller bearings with $\alpha = 0°$, and subjected to radial load only, is given by the equation:

$$P_{0\mathrm{r}} = F_\mathrm{r} \quad (10)$$

The ability of radial roller bearings with $\alpha = 0°$ to support axial loads varies considerably with the design and execution of the bearing. The bearing user should therefore consult the bearing manufacturer for recommendations regarding the evaluation of equivalent load in cases where bearings with $\alpha = 0°$ are subjected to axial load.

7.2.2 Static equivalent radial load for bearing combinations

7.2.2.1 Back-to-back and face-to-face arrangements of single-row angular contact roller bearings

When calculating the static equivalent radial load for two similar single-row angular contact roller bearings mounted side by side on the same shaft, such that they operate as a unit (paired mounting) in a back-to-back or a face-to-face arrangement, the X_0 and Y_0 values for a double-row bearing and the F_r and F_a values for the total loads on the arrangement shall be used.

7.2.2.2 Tandem arrangement

When calculating the static equivalent radial load for two or more similar single-row angular contact roller bearings mounted side by side on the same shaft, such that they operate as a unit (paired or stack mounting) in a tandem arrangement, the X_0 and Y_0 values for a single-row bearing and the F_r and F_a values for the total loads on the arrangement shall be used.

8 Thrust roller bearings

8.1 Basic static axial load rating

8.1.1 Basic static axial load rating for single-direction and double-direction bearings

The basic static axial load rating for single-direction and double-direction thrust roller bearings is given by the equation:

$$C_{0a} = 220 \left(1 - \frac{D_{we} \cos\alpha}{D_{pw}} \right) Z L_{we} D_{we} \sin\alpha \quad (11)$$

where Z is the number of rollers carrying load in one direction.

In cases where rollers have different lengths, ZL_{we} is taken as the sum of the lengths, as defined in 3.8, of all the rollers carrying load in one direction.

NOTE Equation (11) is based on the same modulus of elasticity, Poisson's ratio and rolling element load distributions as given in the note to Table 1.

8.1.2 Basic static axial load rating for bearings mounted in a tandem arrangement

The basic static axial load rating for two or more similar single-direction thrust roller 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 axial load rating of one single-direction bearing. The bearings need to be properly manufactured and mounted for equal distribution of the load between them.

8.2 Static equivalent axial load

8.2.1 Static equivalent axial load for single-direction and double-direction bearings

The static equivalent axial load for thrust roller bearings with $\alpha \neq 90°$ is given by the equation:

$$P_{0a} = 2{,}3\, F_r \tan\alpha + F_a \quad (12)$$

This equation is valid for all ratios of radial load to axial load in the case of double-direction bearings. For single-direction bearings, it is valid where $F_r / F_a \leqslant 0{,}44 \cot\alpha$ and gives satisfactory but less conservative values of P_{0a} for F_r / F_a up to $0{,}67 \cot\alpha$.

Thrust roller bearings with $\alpha = 90°$ can support axial loads only. The static equivalent axial load for this type of bearing is given by the equation:

$$P_{0a} = F_a \quad (13)$$

8.2.2 Static equivalent axial load for bearings mounted in a tandem arrangement

When calculating the static equivalent axial load for two or more similar thrust roller bearings mounted side by side on the same shaft, such that they operate as a unit (paired or stack mounting) in a tandem arrangement, the F_r and F_a values for the total loads on the arrangement shall be used in Equation (12).

9 Static safety factor

9.1 General

The suitability of a bearing selected for heavily loaded applications should be checked to ensure that its basic static load rating is adequate. This can be determined with the aid of the static safety factor S_0, which is given by the equations:

$$S_0 = \frac{C_{0r}}{P_{0r}} \qquad (14)$$

$$S_0 = \frac{C_{0a}}{P_{0a}} \qquad (15)$$

Equation (14) applies to radial bearings and Equation (15) to thrust bearings.

Where the bearing is dynamically loaded and the selection has been made on the basis of life, it is also advisable to check that the basic static load rating is adequate for attaining the performance requirements of the application.

The guideline values of S_0 given in 9.2 and 9.3 for various types of operation and application requirements regarding smooth and vibration-free running are applicable to rotating bearings and are based on experience.

For other specific operating conditions, the bearing manufacturer should be consulted for guidance on the applicable S_0 values.

9.2 Ball bearings

Guideline values of the static safety factor S_0 for ball bearings are presented in Table 4.

Table 4 — Guideline values of static safety factor S_0 for ball bearings

Type of operation	S_0 min.
Quiet-running applications: smooth-running, vibration-free, high rotational accuracy	2
Normal-running applications: smooth-running, vibration-free, normal rotational accuracy	1
Applications subjected to shock loads: pronounced shock loads [a]	1,5

[a] Where the magnitude of the load is not known, values of S_0 which are at least 1,5 should be used. If the magnitude of the shock loads is known exactly, smaller values of S_0 can be applied.

9.3 Roller bearings

Guideline values of the static safety factor S_0 for roller bearings are presented in Table 5.

Table 5 — Guideline values of static safety factor S_0 for roller bearings

Type of operation	S_0 min.
Quiet-running applications: smooth-running, vibration-free, high rotational accuracy	3
Normal-running applications: smooth-running, vibration-free, normal rotational accuracy	1,5
Applications subjected to shock loads: pronounced shock loads [a]	3
For thrust spherical roller bearings, a minimum S_0 of 4 is recommended for all types of operation. For case-hardened, drawn cup needle roller bearings a minimum S_0 of 3 is recommended for all types of operation.	

[a] Where the magnitude of the load is not known, values of S_0 which are at least 3 should be used. If the magnitude of the shock loads is known exactly, smaller values of S_0 can be applied.

Annex A
(informative)

Discontinuities in the calculation of basic static load ratings

A.1 General

The factors used for the calculation of basic static load ratings C_{0r} and C_{0a} according to this International Standard are slightly different for radial and thrust angular contact ball bearings.

Therefore, there is a discontinuity in the calculated static axial load rating (C_{0a}) when a bearing with the contact angle α = 45° is first regarded as a radial bearing ($C_{0a} = C_{0r} / Y_0$) and then as a thrust bearing.

This annex explains why the load rating factors are different, and shows how the load ratings can be re-calculated in order to bring about correct comparisons under the same conditions.

A.2 Symbols

The same symbols are used as presented in Clause 4, but some additional symbols also apply:

C_{0aa} is the adjusted basic static axial load rating for a thrust bearing ($\alpha > 45°$), in newtons;

C_{0ar} is the adjusted basic static axial load rating for a radial bearing ($\alpha \leqslant 45°$), in newtons;

r_e is the cross-sectional raceway groove radius of outer ring, in millimetres;

r_i is the cross-sectional raceway groove radius of inner ring, in millimetres.

A.3 Different factors for calculating basic static load rating for radial and thrust angular contact ball bearings

A.3.1 Angular contact radial ball bearings

In the calculation of C_{0r}, the conformities between the balls and the raceways are according to 5.1.1.

$r_i/D_w \leqslant 0{,}52$ and $r_e/D_w \leqslant 0{,}53$

A.3.2 Angular contact thrust ball bearings

In the calculation of C_{0a}, the conformities between the balls and the raceways are according to 6.1.

$r_i/D_w \leqslant 0{,}54$ and $r_e/D_w \leqslant 0{,}54$

A.4 Comparison of adjusted basic static axial load ratings C_{0ar} and C_{0aa} for radial and thrust angular contact ball bearings

A.4.1 General

For certain applications, angular contact ball bearings with contact angles $\alpha \leqslant 45°$ and $\alpha > 45°$ are manufactured with the same conformities between the balls and the raceways, and sometimes there is a need to calculate and also to compare their true axial load ratings.

The basic static load ratings C_{0r} and C_{0a} can be calculated using this International Standard or taken from a bearing catalogue if available from that source.

However, as described in A.3, C_{0r} and C_{0a} are calculated with different conformities for radial and thrust bearings. If a correct calculation and comparison is to be made, C_{0r} and C_{0a} have to be recalculated to adjusted basic static axial load ratings C_{0ar} and C_{0aa}, based upon the same conformities.

The recalculation can be performed using Equations (A.1) to (A.4) for the two different conformities — radial bearing conformities and thrust bearing conformities given in A.3.1 and A.3.2, respectively.

Comparison of load ratings is mainly of interest for bearings intended to operate in applications where axial loads are predominant, and therefore comparison of basic static axial load ratings is dealt with in this annex.

The contact angle α is assumed to be constant, independent of the axial load, which means that the accuracy is reduced for bearings with small contact angles, subjected to heavy loads.

A.4.2 Angular contact ball bearings with radial bearing conformities

($r_i/D_w \leqslant 0{,}52$ and $r_e/D_w \leqslant 0{,}53$)

$$C_{0ar} = C_{0r}/Y_0 \quad \text{(A.1)}$$

$$C_{0aa} = 1{,}43C_{0a} \quad \text{(A.2)}$$

A.4.3 Angular contact ball bearings with thrust bearing conformities

($r_i/D_w \leqslant 0{,}54$ and $r_e/D_w \leqslant 0{,}54$)

$$C_{0ar} = 0{,}7C_{0r}/Y_0 \quad \text{(A.3)}$$

$$C_{0aa} = C_{0a} \quad \text{(A.4)}$$

A.5 Examples

A.5.1 Angular contact ball bearing with $\alpha = 45°$

Compare the adjusted basic static axial load ratings of a single-row angular contact ball bearing with $\alpha = 45°$, when it is regarded as a radial bearing and as a thrust bearing. For the selected bearing $(D_w \cos\alpha)/D_{pw} = 0{,}16$ and $i = 1$. The bearing has radial bearing conformities.

As a radial bearing

C_{0r} is calculated according to Equation (1), i.e. $C_{0r} = f_0\, i\, Z\, D_w^2 \cos\alpha$. According to Table 1, $f_0 = 14{,}9$ and according to Table 2, $Y_0 = 0{,}22$.

$$C_{0r} = 14{,}9 \times Z \times D_w^2 \times \cos 45° = 10{,}54\, Z\, D_w^2$$

By inserting C_{0r} and Y_0 in Equation (A.1):

$$C_{0ar} = 10,54 \times Z \times D_w^2/0,22 = 47,9\ Z\ D_w^2$$

As a thrust bearing

C_{0a} is calculated according to Equation (4), i.e. $C_{0a} = f_0\ Z\ D_w^2 \sin\alpha$, and inserted in Equation (A.2). According to Table 1, $f_0 = 48,8$.

$$C_{0aa} = 1,43 \times 48,8 \times Z \times D_w^2 \times \sin 45° = 49,3\ Z\ D_w^2$$

These calculations show that the basic static load ratings $C_{0ar} \approx C_{0aa}$, which confirms that there is no discontinuity.

A.5.2 Angular contact ball bearing with $\alpha = 40°$

Calculate the adjusted basic static axial load rating C_{0ar} of a single-row angular contact ball bearing with the contact angle $\alpha = 40°$. The bearing has thrust bearing conformities. $D_w/D_{pw} = 0,091$, ball diameter $D_w = 7,5$ mm, number of rows of balls = 1 and the number of balls $Z = 27$.

According to Table 1, for $(D_w \cos 40°)/D_{pw} = 0,091 \times \cos 40° = 0,07$, and then $f_0 = 16,1$. From Table 2, $Y_0 = 0,26$.

Equation (1) gives

$$C_{0r} = f_0 Z\ D_w^2 \cos\alpha = 16,1 \times 27 \times 7,5^2 \times \cos 40° = 18\ 731$$

NOTE This load rating is based on radial bearing conformities.

According to Equation (A.3):

$$C_{0ar} = 0,7 \times 18\ 731/0,26 = 50\ 430$$

$$C_{0ar} = 50\ 400 \text{ N}$$

A.5.3 Angular contact ball bearing with $\alpha = 60°$

Calculate the adjusted basic static axial load rating C_{0aa} of a single-row angular contact ball bearing with the contact angle $\alpha = 60°$. The bearing has thrust bearing conformities. $D_w/D_{pw} = 0,091$, ball diameter $D_w = 7,5$ mm and the number of balls $Z = 27$.

According to Table 1, for $(D_w \cos 60°)/D_{pw} = 0,091 \times \cos 60° = 0,046$, and then $f_0 = 57,82$.

Equation (4) gives

$$C_{0a} = f_0\ Z\ D_w^2 \sin\alpha = 57,82 \times 27 \times 7,5^2 \times \sin 60° = 76\ 049$$

NOTE This load rating is based on thrust bearing conformities.

According to Equation (A.4):

$$C_{0aa} = C_{0a} = 76\ 049$$

$$C_{0aa} = 76\ 000 \text{ N}$$

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