SLOVENSKI STANDARD
SIST EN 4540:2012

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Aeronavtika - Kroglasti drsni zgibi iz korozijsko odpornega jekla s samomazalno oblogo in z zvišano obremenitvijo pod nizkimi nihanji - Tehnična specifikacija

Aerospace series - Bearings, spherical plain, in corrosion resisting steel with self-lubricating liner elevated load under low oscillations - Technical specification

Luft- und Raumfahrt - Gelenklager aus korrosionsbeständigem Stahl mit selbstschmierender Beschichtung, hohe Belastung bei geringer Drehbewegung - Technische Lieferbedingungen

Série Aérospatiale - Rotules, en acier résistant à la corrosion à garniture autolubrifiante à charge élevée sous faibles oscillations - Spécification technique

Ta slovenski standard je istoveten z: **EN 4540:2011**

ICS:

49.035	Sestavni deli za letalsko in vesoljsko gradnjo	Components for aerospace construction

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EUROPEAN STANDARD

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English Version

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

Foreword

This document (EN 4540:2011) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2012, and conflicting national standards shall be withdrawn at the latest by June 2012.

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1 Scope

This European Standard specifies the required characteristics, inspection and test methods, qualification and acceptance conditions for spherical plain bearings in corrosion resisting steel, self aligning with self-lubricating liner designed to withstand (under load) slight swivelling and slow rotations only.

This standard applies whenever referenced.

These bearings prEN 4538-1, prEN 4538-2, prEN 4539-1 and prEN 4539-2 are for actuator applications and for use in the temperature range – 54 °C to 163 °C and for EN 4538-003 and EN 4539-003 for use in the temperature range – 54 °C to 120 °C.

The liner may be of a fabric or composite material bonded to the inside diameter of the outer ring or in a composite material moulded into a pre-formed cavity between the inner and outer rings.

The duty cycle (Annex E, normative) has been established on the basis of a civil aircraft aileron surface application.

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.

prEN 4538-1, *Aerospace series — Bearings, spherical plain, in corrosion resisting steel with self-lubricating liner — Elevated load under low oscillations — Narrow series — Dimensions and loads — Metric series* [1)]

prEN 4538-2, *Aerospace series — Bearings, spherical plain, in corrosion resisting steel with self-lubricating liner — Elevated load under low oscillations — Narrow series — Dimensions and loads – Inch series* [1)]

EN 4538-003, *Aerospace series — Bearings, spherical plain, in corrosion resisting steel with self-lubricating liner elevated load under low oscillations — Narrow series — Dimensions and loads — Part 003: Inch series with low friction coefficient*

prEN 4539-1, *Aerospace series — Bearings, spherical plain, in corrosion resisting steel with self-lubricating liner — Elevated load under low oscillations — Wide series — Dimensions and loads — Metric series* [1)]

prEN 4539-2, *Aerospace series — Bearings, spherical plain, in corrosion resisting steel with self-lubricating liner — Elevated load under low oscillations — Wide series — Dimensions and loads — Inch series* [1)]

EN 4539-003, *Aerospace series - Bearings, spherical plain, in corrosion resisting steel with self-lubricating liner elevated load under low oscillations - Wide series - Dimensions and loads - Part 003: Inch series with low friction coefficient*

EN 9133, *Aerospace series — Quality management systems — Qualification procedure for aerospace standard parts*

ISO 11078, *Aircraft — De-icing/anti-icing fluids, ISO types II, III and IV*

TR 4475, *Aerospace series — Bearings and mechanical transmissions for airframe applications — Vocabulary* [2)]

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1) Published as ASD-STAN Prestandard at the date of publication of this standard by Aerospace and Defence Industries Association of Europe-Standardization (ASD-STAN), (www.asd-stan.org).

2) Published as ASD-STAN Technical report at the date of publication of this standard by Aerospace and Defence Industries Association of Europe-Standardization (ASD-STAN), (www.asd-stan.org).

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
self-lubricated spherical plain bearings, self-aligning in corrosion resistant steel with staking groove for actuator applications
these consist of two concentric rings, between which is interposed a self-lubricating liner which is bonded or moulded on the spherical surface of the outer ring.

The width of the inner ring is greater than the width of the outer ring, so that a tilting movement is possible in addition to the rotational movement.

The outer ring has no assembly slot.

This outer ring has grooves for mechanical swaging

3.2
surface discontinuities
see TR 4475

3.3
starting torque without load
see TR 4475

3.4
friction coefficient

the friction coefficient of the bearing under load is given by the following formula:

$$\mu = \frac{C}{FR}$$

where

μ friction coefficient;

C torque moment;

F load on the bearing;

R inner spherical ball radius.

3.5
permissible radial static loads radial (C_s)
this corresponds to a permissible unit pressure multiplied by the projected surface area, the inner ring being able to take any position within the limits of the tilting angle indicated in the product standards or design documentation.

The direction of the load shall remain in the center plane of the outer ring.

The radial projected surface area is given by the following formula:

$$A_r = K\,(C\ \text{min.} - 2\ T\ \text{max.})$$

Where the dimensions shown in Figure 1 are as given in the appropriate product standard

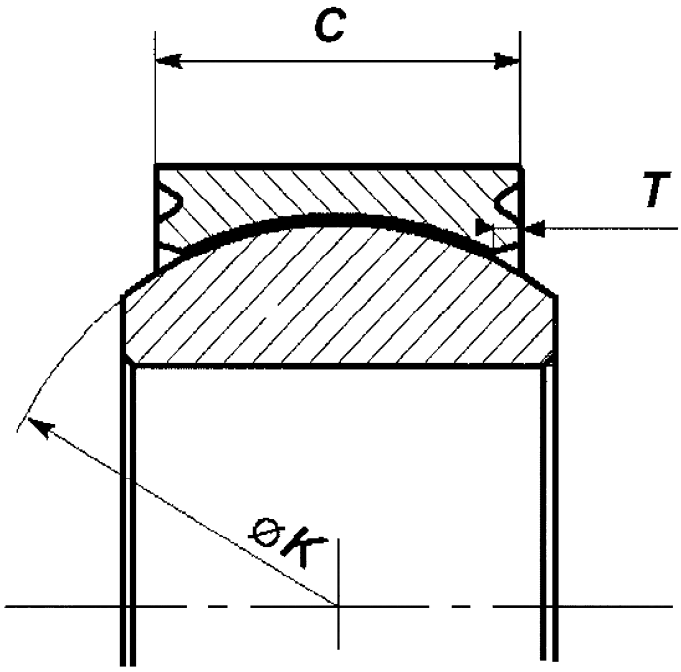

Figure 1

3.6
dynamic radial load (oscillatory duty cycles)
load which may be withstood by a bearing submitted to an oscillating movement following a given number and frequency of cycles, without the wear of the self-lubricating liner exceeding the values given in this standard

3.6.1
oscillating duty cycles
are defined in Annex E. The table defines unit pressure applied.

The dynamic radial load is defined for each bearing size by multiplying the unit pressure by the projected surface area, see dimensional standard

3.6.2
dynamic radial load C_{25}
one oscillating cycle includes an angular displacement of the inner ring in relation to the outer ring from 0° to 25°, then from 25° to – 25° and finally – 25° to 0°

3.6.3
dynamic radial load C_{250}
one oscillating cycle includes an angular displacement of the inner ring in relation to the outer ring from 0° to 25°, then from 25° to – 25° and finally – 25° to 0°

3.7
adhesion of the liner - Void
area where the adhesive bond is broken or non-existent and leaves a smooth and clean interface on the metallic surface

3.8
delivery batch
this consists of bearings with the same identity block, which may come from different production batches

3.9
ultimate static loads
is equivalent to 1,5 times the permissible static load

4 Required characteristics, inspection and test methods

See Table 1.

Table 1

Clause	Characteristics	Requirements	Inspection and test methods	Q [a]	A [b]
4.1	**Materials**	Shall conform with the product standards or design documentation.	Chemical analysis or certificate issued by semi-finished product manufacturer	X	X
4.2	**Dimensions and tolerances**	Shall conform with the product standards or design documentation. Dimensions not shown shall be at the manufacturer's option.	Suitable measuring instruments Measurement of bore and outer diameter: – rings with a width of ≤ 10 mm: in the center plane; – rings with a width of > 10 mm: in two planes parallel to the outer faces and at a distance from these faces of twice the maximum value of the ring chamfer. The minimum and maximum diameters shall be determined in each measuring plane. Measurement of ring width: – the width of each ring (distance between the two faces) shall be verified at a minimum of four points.	X	X
4.3	**Masses**	Shall conform with the product standards or design documentation.	Suitable methods	X	
4.4	**Marking**	Shall conform with the product standards or design documentation. It shall be legible and shall not adversely affect the material or the functioning of the bearing.	Visual examination	X	X
4.5	**Surface appearance**	– the bearings shall be free of surface discontinuities liable to have an adverse effect on their characteristics and endurance; – the liner shall not contain contaminant products and shall not show broken or voided areas; – lubrication shall not be permitted.		X	X
4.5.1	**Assembled bearings**		Visual inspection using suitable methods		
4.5.2	**Unassembled rings**		Magnetic or dye penetrant inspection		
4.6	**Hardness**	Shall conform with the product standards or design documentation.	Suitable processes and measuring instruments	X	X
4.7	**Surface roughness**	Shall conform with the product standards or design documentation.	Suitable measuring instruments or visual-tactile samples	X	X
4.8	**Surface treatment**	Shall conform with the product standards or design documentation.	– Visual inspection; – As per surface treatment standard.	X	X
4.9	**Behaviour in rotation and tilt**	Bearings shall be able to move freely within the angular limits specified in the product standards or design documentation.	Manual inspection	X	X

continued

Table 1 *(continued)*

Clause	Characteristics	Requirements	Inspection and test methods	Q [a]	A [b]
4.10	**Starting torque without load**	—	—	—	—
4.10.1	– **at ambient temperature.**	Shall conform with the product standards or design documentation.	Suitable processes and measuring instruments: – Measurement of the starting torque shall be preceded by some rotations and a few turning movements by hand; – Measure the torque, applied gradually to the inner ring, in both directions, with the outer ring held stationary. Read off the maximal value required to start up the inner ring.	X	X
4.10.2	– **at low temperature.**	Starting torque ≤ 2 times those listed in the product standards or design documentation.	– Subject the bearing, during 4 h at the minimum temperature ± 5 °C; – Immediately after, measure the torque following 4.10.1.	X	
4.10.3	– **after limit temperatures.**	Shall conform with Tables 2 (a) and 2 (b).	– Subject the bearing during 1 h at the minimum temperature ± 5 °C, then 1 h at the maximum temperature ± 2 °C; – Repeat successively × 10 this test; – 4 h after these tests, measure the torque, at ambient temperature, following 4.10.1.	X	
4.11	**Spherical surfaces conformity**	For bonded liners: Difference between the values measured normally to the spherical surfaces shall not exceed 0,08 mm.	Encapsulate the bearing in plastic material as used in metallurgical mounts. Section the bearing following a diameter plane and polish the surfaces (see Figure 2). By use of an optical comparator, for example, measure dimension "t" at a minimum of five uniformly spaced positions across the bearing (see Figure 2) on both opposite surfaces. The selected points shall include the middle position of the bearing at the C/10 positions.	X	
		For injected/moulded liners: the maximum thickness of the liner shall be located between the C/10 positions. The minimum thickness shall be 0,2 mm.	Encapsulate the bearing in plastic material as used in metallurgical mounts. Section the bearing following a diameter plane and polish the surfaces By use of an optical comparator, for example, measure dimension "t" at a minimum of five uniformly spaced positions across the bearing (see Figure 2) on both opposite surface. The selected points shall include the middle position of the bearing at the C/10 positions.	X	
4.12	**Permissible static loads:** – **radial:** C_s; – **axial:** C_a.	Shall conform with the product standards or design documentation. No maximum total deflection greater than those listed in Tables 3 (a) and 3 (b) under permissible static loads (C_s). After removing the loads, no permanent deformations greater than those listed in Tables 3 (a), 3 (b) and 3 (c).	See Annex A.	X	
4.13	**Ultimate static loads:** – **radial;** – **axial.**	After the removal of the loads, there shall be no cracks, no push out of the inner ring or deterioration of the bearing.	See Annex A.	X	

continued

Table 1 *(continued)*

Clause	Characteristics	Requirements	Inspection and test methods	Q [a]	A [b]
4.14 A	**Dynamic radial loads C_{25}:** **– at low temperature;** **– at high temperature.**	Shall conform with the product standards or design documentation. After the removal of the loads: – No metal-to-metal contact between inner and outer ring; – The liner wear shall not exceed the values listed in Table 4; – The peel-strength and the bond integrity shall be conform with 4.16 and 4.17. At the end of this test, the starting torque under radial load shall be measured and shall conform with values listed in Tables 5 (a), 5 (b) and 5 (c).	See Annex B. Suitable processes and measuring instruments	X	
4.14 B	**Dynamic radial loads C_{250}:** **for EN 4538-003 and EN 4539-003** **– at low temperature;** **– at high temperature.**	Shall conform with the product standards or design documentation. After the removal of the loads: – No metal-to-metal contact between inner and outer ring; – The liner wear shall not exceed the values listed in Table 4; – The peel-strength and the bond integrity shall be conform with 4.16 and 4.17. At the end of this test, the starting torque under radial load shall be measured and shall conform with values listed in Tables 5 (a), 5 (b) and 5 (c).	See Annex F. Suitable processes and measuring instruments		
4.14 bis	**Dynamic radial loads duty cycles:** **– at ambient temperature.** **Low friction coefficient for EN 4538-003 and or EN 4539-003**	Shall conform with the duty cycles. After the removal of the loads: – No metal-to-metal contact between inner and outer ring; – The liner wear shall not exceed the values listed in Table 4; – The peel-strength and the bond integrity shall be conform with 4.16 and 4.17. At the end of this test, the starting torque under radial load shall be measured and shall conform with values listed in Tables 5 (a), 5 (b) and 5 (c). Coefficient of friction to be measured before and completion of the duty cycles test at – 54 °C, – 30 °C, – 10 °C and ambient temperature. For each temperature three measurements must be taken at 10 MPa, 60 MPa and 120 MPa pressure. The maximum value of coefficient of friction is μ = 0,18.	See Annex E. See Annex G.	X	

continued

Table 1 *(concluded)*

Clause	Characteristics	Requirements	Inspection and test methods	Q [a]	A [b]
4.15	**Liner compatibility with the fluids**	At the end of this test: – No metal-to-metal contact between inner and outer ring; – The liner wear shall not exceed the values listed in Table 4; – The peel strength and the bond integrity shall be conform with 4.16 and 4.17; – The starting torque under radial load shall be measured and shall conform with values listed in Tables 5 (a), 5 (b) and 5 (c).	Check one bearing per fluid: – Put the inner ring perpendicularly to the outer ring; – The bearing shall be immersed for 24 h in the fluids listed in Annex C at the following temperatures: – (45 ± 3) °C for those defined in C.1 and C.2, – (70 ± 3) °C for those defined in C.3, – Ambient temperature for those defined in C.4; – Within 1/2 h after this test proceed to the test defined in B.2.4. Suitable processes and measuring instruments	X	
4.16	**Peel strength of the liner**	These requirements and this test apply only in the case where the manufacturer has established that the liner is peelable. The liner shall exhibit an average peel strength greater than 0,35 N for each millimetre of spherical width minus 2 mm to eliminate chamfers and edge effects. The mean peel strength value shall be determined with at least 75 % of the recorded value.	See Annex D. For acceptance, this test shall be carried out immediately after assembling and curing.	X	X
4.17	**Bond integrity**	For peelable liners, the liner: – shall not contain any contaminating substances; – shall adhere tightly to the outer ring over at least 90 % of the contact area. No void shall be allowed which cannot be described within a circle of diameter equal to: – 25 % of outer ring width; – 6 mm, whichever is smaller. For non-peelable liners, a sectioned bearing shall be examined for bond integrity. The liner: – shall adhere tightly to the outer ring over at least 90 % of the contact area. No void shall be allowed which cannot be circumscribed within a circle of diameter equal to: – 25 % of outer ring width; – 6 mm, whichever is smaller.	After the peel strength test, evaluate the location and size of any voids. Destructively examine the liner by chipping, scraping, abrasion, or other appropriate means to determine the bond integrity.	X	X

a Qualification test.

b Acceptance test.

Table 2 (a)

Nominal diameter mm	Metric series Starting torque at zero load N.m	
	EN 4538-1	EN 4539-1
12	0,072 to 0,80	0,072 to 0,80
15		
17		
20	—	
22	0,15 to 1,0	—
25		0,15 to 1,0
30	0,24 to 2,0	0,24 to 2,0
35		
40		0,36 to 3,50
45	0,36 to 3,50	
50		
55	—	

Table 2 (b)

Code	Nominal diameter mm	Inch series Starting torque at zero load N.m	
		EN 4538-2	EN 4539-2
03	4,83	0,036 to 0,34	0,036 to 0,34
04	6,35	0,066 to 0,56	0,036 to 0,34
05	7,94		
06	9,52		
07	11,11		
08	12,70		
09	14,29		
10	15,87		
12	19,05		
14	22,22	0,138 to 0,90	0,138 to 0,90
16	25,40		
20	31,75	0,24 to 1,50	0,138 to 1,80
24	38,10		
28	44,45		
32	50,80	—	