SLOVENSKI STANDARD
SIST EN 13001-3-4:2019

01-april-2019

Žerjavi - Konstrukcija, splošno - 3-4. del: Mejna stanja in dokaz varnosti mehanizma - Ležaji

Cranes - General design - Part 3 4: Limit states and proof of competence of machinery - Bearings

Krane - Konstruktion allgemein - Teil 3 4: Grenzzustände und Sicherheitsnachweise für Maschinenbauteile - Lager

Appareils de levage à charge suspendue - Conception générale - Partie 3 4 : États limites et vérification d'aptitude des éléments de mécanismes - Paliers

Ta slovenski standard je istoveten z: **EN 13001-3-4:2018**

ICS:

21.100.01	Ležaji na splošno	Bearings in general
53.020.20	Dvigala	Cranes

SIST EN 13001-3-4:2019 **en,fr,de**

EUROPEAN STANDARD

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EN 13001-3-4

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English Version

Cranes - General design - Part 3-4: Limit states and proof of competence of machinery - Bearings

Appareils de levage à charge suspendue - Conception générale - Partie 3-4 : États limites et vérification d'aptitude des éléments de mécanismes - Paliers

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 13001-3-4:2018 E

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European foreword

This document (EN 13001-3-4:2018) has been prepared by Technical Committee CEN/TC 147 “Cranes - Safety”, the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annexes ZA, which are an integral part of this document.

This European Standard is one Part of the EN 13001 series. The other parts are as follows:

— Part 1: *General principles and requirements;*

— Part 2: *Load actions;*

— Part 3-1: *Limit states and proof of competence of steel structures;*

— Part 3-2: *Limit states and proof of competence of wire ropes in reeving systems;*

— Part 3-3: *Limit states and proof of competence of wheel/rail contacts;*

— Part 3-5: *Limit states and proof of competence of forged hooks;*

— Part 3-6: *Limit states and proof of competence of machinery — Hydraulic cylinders;*

— Part 3-7: *Limit states and proof of competence of machinery — Gears;*

— Part 3-8: *Limit states and proof of competence of machinery — Shafts.*

Annexes A, B, C and D are informative.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document is to be used together with EN 13001-1 and EN 13001-2 and as such they specify general conditions, requirements and methods to prevent mechanical hazards of cranes by design and theoretical verification.

NOTE 1 Specific requirements for particular types of crane are given in the appropriate European Standard for the particular crane type.

This document covers bearings in cranes. It is not intended for bearings being part of standard components, e.g. gearboxes, motors … however those bearings shall be designed using load actions from EN 13001-2 and classification parameters of EN 13001-1.

NOTE 2 EN 13001-3-7 is under preparation for gears and gearboxes and deals with load actions for bearings in gear boxes.

The following is a list of significant hazardous situations and hazardous events that could result in risks to persons during intended use and reasonably foreseeable misuse. Clauses 4 to 7 of this document are necessary to reduce or eliminate risks associated with the following hazards:

— exceeding the limits of strength (yield, ultimate, fatigue);

— exceeding temperature limits of material or components;

— elastic instability of the crane or its parts (buckling, bulging).

This document is not applicable to cranes which are manufactured before the date of its publication as an EN and serves as reference base for the European Standards for particular crane types (see Annex D).

NOTE EN 13001-3-4 deals only with limit state method in accordance with EN 13001-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 10083-1:2006, *Steels for quenching and tempering — Part 1: General technical delivery conditions*

EN 10247:2017, *Micrographic examination of the non-metallic inclusion content of steels using standard pictures*

EN 13001-1, *Cranes — General design — Part 1: General principles and requirements*

EN 13001-2, *Crane safety — General design — Part 2: Load actions*

EN 13001-3-1, *Cranes — General design — Part 3-1: limit states and proof of competence of steel structure*

EN ISO 148-1, *Metallic materials, Charpy pendulum impact test — Part 1: Test method (ISO 148-1)*

EN ISO 683-17, *Heat-treated steels, alloy steels and free-cutting steels — Part 17: Ball and roller bearing steels (ISO 683-17)*

EN ISO 4287:1998, *Geometrical product specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters (ISO 4287)*

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

ISO 76:2006, *Rolling bearings — Static load ratings*

ISO 281:2007, *Rolling bearings — Dynamic load ratings and rating life*

ISO 4306-1:2007, *Cranes — Vocabulary — Part 1: General*

3 Terms and definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010 and ISO 4306-1:2007, Clause 6 for the definitions of loads, and the following applies.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
plain bearing
bearing in which the type of relative movement is sliding but with the exclusion of those operating under conditions of hydrodynamic lubrication

3.1.2
rolling bearing
bearing operating with rolling motion between the parts supporting load and moving in relation to each other, which comprises raceway members and rolling elements with or without means for their spacing and/or guiding

Note 1 to entry: For the purposes of this document, it is designed to support radial, axial, or combined radial and axial load.

[SOURCE: ISO 5593, modified]

3.1.3
slewing ring
slewing ring bearing
large-size rolling-element bearing providing a connection between two adjacent structures and allowing rotation and transmission of loads between them (axial and radial loads and a tilting moment)

Note 1 to entry: Slewing ring is usually provided with holes for fixing bolts, with internal or external gear facilitating the rotation of one structure relative to the other and with lubrication and seals.

3.1.4
nominal contact angle
α
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 (see reference 04.02.10 in Figure 1 below)

[see SOURCE: ISO 5593:1997, definition 04.02.10 and Figures 93, 94]

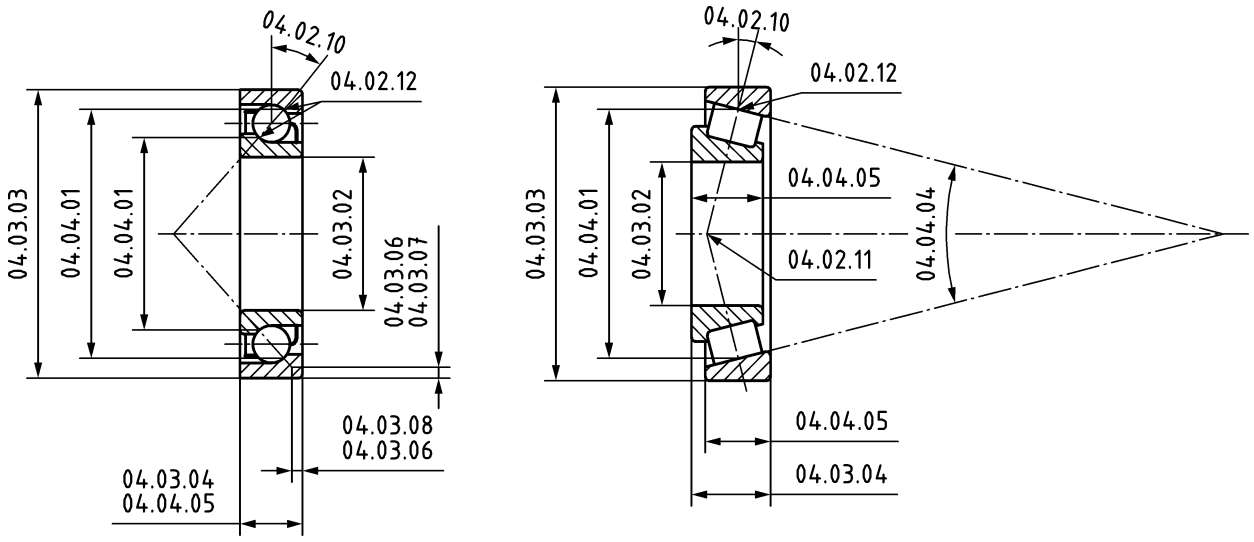

Figure 1 — Rolling bearings dimensions

3.2 Symbols and abbreviations

The symbols and abbreviations used in this document are given in Table 1.

Table 1 — Symbols and abbreviations

Symbols, abbreviations	Description
a_1	Life modification factor for reliability (ISO 281:2007)
A_{pF}	Apportionment factor for axial load F_a (slewing ring)
A_{pM}	Apportionment factor for tilting moment M_r (slewing ring)
A_s	Bolt stress area (fixing element)
b	Distance between two adjacent bolts (slewing ring)
C	Total number of working cycles (EN 13001-1)
C_a	Basic dynamic axial load rating (ISO 281:2007)
C_r	Basic dynamic radial load rating (ISO 281:2007)
$C_{a,Rd}$	Limit design dynamic axial load (slewing ring, rolling bearing)
$C_{r,Rd}$	Limit design dynamic radial load (slewing ring, rolling bearing)
C_{0a}	Basic static axial load rating (slewing ring, rolling bearing, spherical plain bearing)
C_{0r}	Basic static radial load rating (slewing ring, rolling bearing, spherical plain bearing)
$C_{0a,Rd}$	Limit design static axial load rating (slewing ring)
$C_{0r,Rd}$	Limit design static radial load rating (slewing ring)

Symbols, abbreviations	Description
C_1	Tightening torque
D_{in}	Internal diameter (thrust washer)
D_{ex}	External diameter (thrust washer, flanged bush)
D_m	Pitch Circle Diameter of rolling elements (denoted D_{pw} in ISO 76 and ISO 281)
D_{vi}	Pitch Circle Diameter of fixing elements
D_w	Ball diameter (rolling element)
D_{we}	Roller diameter (rolling element)
d	Nominal diameter of a screw/bolt (slewing ring); shaft diameter (plain bearing)
d_k	Sphere diameter of a spherical plain bearing
E	Modulus of elasticity
E_b	Modulus of elasticity of a bolt
E_p	Modulus of elasticity of a slewing ring supporting flange
e_m	Distance (lever arm) between external force F_e and the centre of the supporting width $2 \cdot u$ of the slewing ring
e_m^*	Lever arm of external load F_e to bolt axis (slewing ring)
e_n	Distance between bolt axis and the centre of the supporting width $2 \cdot u$ of the slewing ring
F_a	Axial load
$F_{a,i}$	Axial load, range i (fatigue)
F_b	Bolt load
$F_{b,f}$	Fatigue bolt load
$F_{b,2}$	Equivalent bolt load
F_c	Slewing ring contact load
F_d	Limit force
F_e	External load (slewing ring)
$F_{e,cr}$	Critical opening force for a slewing ring
$F_{e,max}$	Design maximum external load
$F_{e,f,max}$	Design maximum fatigue external load

Symbols, abbreviations	Description
$F_{p,min}$	Minimal preload in bolts
$F_{pb,Sd}$	Design plain bearing force
F_r	Radial load (slewing ring)
$F_{r,i}$	Radial load, range *i* (fatigue)
F_{Rd}	Limit design forces
$F_{Sd,f,i}$	Design dynamic load (plain bearing)
$F_{Sd,f,eq}$	Mean equivalent radial load (plain bearing)
F_y	Bolt yield force
f_c	Calculation factor (ISO 281:2007)
f_{f1}	Reliability factor (fatigue, slewing ring and rolling bearing)
f'_{f2}	Inclusion factor (fatigue slewing ring)
f_{f2}	Factor for additional influences (fatigue)
f'_{f3}	Surface hardness factor (fatigue)
f_{Rd}	Limit design stress
f_{ub}	Fixing element ultimate strength
f_y	Yield stress of material
f_{yb}	Fixing element yield stress
f_0	Factor for calculation of basic static load rating (ISO 76:2006)
f_1	Factor for shear in slewing ring sub-hardened layer (static)
f'_{f1}	Factor for shear in slewing ring sub-hardened layer (fatigue)
f_2	Deformation influence factor for slewing ring (static)
f'_2	Deformation influence factor for slewing ring (fatigue)
f_3	Surface hardness factor (static)
H_{ring}	Height of slewing ring
H_T	Height of tubular shell (slewing ring)
I_b	Moment of inertia of a bolt (slewing ring)
I_p	Moment of inertia of slewing ring supporting flange
K_{rep}; K'_{rep}	Excess load factor for raceway (slewing ring, static and fatigue)

Symbols, abbreviations	Description
$K_{rep,b}$	Excess load factor for bolts (slewing ring)
k_{pb}	Dynamic pressure spectrum factor (plain bearing)
k_{sr}	Dynamic load spectrum factor (slewing ring)
k_{rb}	Dynamic load spectrum factor (rolling bearing)
L_a	Axial loading offset (plain bearing)
L_b	Length of plain bearing
L_{ci}; L_{ce}	Internal and external chamfers of plain bearing
L_e	Length of equivalent elastic beam (slewing ring)
L_r	Radial loading offset (plain bearing)
L_{sr}	Length between supports of equivalent beam (slewing ring)
l_k	Effective clamping length
M_r	Tilting moment (slewing ring)
$M_{r,i}$	Tilting moment, range i (fatigue)
M_{fb}	Bolt prying moment (slewing ring)
m	Slope constant of the log p-log N curve (plain bearing)
N	Shaft rotational speed (plain bearing)
$N_{tot,pb}$	Total number of cycles (plain bearing)
n_s	Number of supports (slewing ring)
n	Number of cycles (plain bearing)
n_{sr}	Number of slewing rings during a crane design life
$P_{a,i}$	Design axial dynamic equivalent load, range i
$P_{a,Sd}$	Design axial dynamic load (slewing ring)
$P_{a,Sd,i}$	Design axial dynamic equivalent load, range i (rolling bearing)
$P_{r,i}$	Design dynamic radial equivalent load, range i
$P_{r,Sd}$	Design radial dynamic load (slewing ring)
$P_{r,Sd,i}$	Design radial dynamic equivalent load, range i (rolling bearing)
P_{0a}	Design axial equivalent static load (slewing ring)
$P_{0a,Sd}$	Static equivalent axial load (rolling bearing)
P_{0r}	Design radial equivalent static load (slewing ring)

Symbols, abbreviations	Description
$P_{0r,Sd}$	Static equivalent radial load (rolling bearing)
$P_{spb,Sd}$	Design equivalent load (spherical plain bearing)
p	Life exponent (slewing ring, rolling bearing)
p_{eq}	Equivalent design dynamic plain bearing pressure
p_L	Limit design dynamic plain bearing pressure
$p_{pb,i}$	Design dynamic plain bearing pressure, range i
$p_{pb,max}$	Maximum design dynamic plain bearing pressure
$p_{pb,Sd}$	Design cylindrical plain bearing pressure (static)
$p_{pb,Rd}$	Limit design cylindrical plain bearing pressure (static)
p_{spb}	Design surface pressure (spherical plain bearing)
$p_{spb,L}$	Limit design dynamic spherical plain bearing pressure
$(p \cdot v)_L$	Limit design effective transmitted power density (cylindrical plain bearing)
$(p \cdot v)_{spb,L}$	Limit design effective transmitted power density (spherical plain bearing)
Q_b	Highest contact load for a rolling element (slewing ring)
R_a	Average depth of surface profile in accordance with EN ISO 4287:1998
R_d	Design resistance
R_{ht}	Maximum possible hardened depth for an induction hardening
S_b	Bolt flexibility (slewing ring)
S_c	Flange flexibility (slewing ring)
S_d	Design stress or design force
S_{sr}	Connection flexibility (slewing ring)
$s_{a,cr}$	Critical lever arm of the contact force F_c (slewing ring)
s_a	Lever arm of the contact force F_c (slewing ring)
s_m	Bolt stress history parameter
s_{rb}	Rolling bearing load history parameter
s_{sr}	Slewing ring raceway load history parameter
S_0	Static safety factor (rolling bearing)
T_{max}	Limit operating temperature (plain bearing)
t	Thickness

Symbols, abbreviations	Description
t_{ch}	Projected thickness of plain bearing chamber
t_{af}	Thickness of plain bearing low friction layer
t_p	Supporting flange thickness (slewing ring)
u	Half-supporting with of slewing ring
U_D	Reference number of revolutions (slewing ring, rolling bearing)
U_i	Number of revolutions of range i
$U_{tot,sr}$	Total number of revolutions (slewing ring)
$U_{tot,rb}$	Total number of revolutions (rolling bearing)
v_{eff}	Shaft design effective sliding speed (plain bearing)
v_L	Limit design effective sliding speed (cylindrical plain bearing)
$v_{spb,eff}$	Spherical plain bearing effective sliding speed
$v_{spb,L}$	Limit design effective sliding speed (spherical plain bearing)
$\overline{X}_{ang}$	Average angular displacement (EN 13001-1)
X	Rolling bearing dynamic load factor (ISO 281:2007); plain bearing load factor
X_0	Rolling bearing static load factor (ISO 76:2006)
Y	Rolling bearing dynamic load factor (ISO 281:2007) ; plain bearing load factor
Y_0	Rolling bearing static load factor (ISO 76:2006)
Z_{aF}	Number of active rolling elements
Z_b	Number of slewing ring fixing elements
Z_d	Critical depth of the sub-hardened layer shear
α	Nominal contact angle (see 3.1.4) for slewing rings and rolling bearings; Angle of tilt for spherical plain bearings (ISO 12240)
α_c	Chamfer angle (plain bearing)
β_e	Calculation factor for the determination of the excess load factor K_{rep}
ΔF_b	Additional bolt force (slewing ring)
ΔM_{fb}	Additional prying moment (slewing ring)
$\Delta\sigma_c$	Characteristic fatigue strength
$\Delta\sigma_{Sd}$	Design stress range
$\Delta\sigma_{Rd}$	Limit design stress range