SLOVENSKI STANDARD
SIST EN 1337-5:2005

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Konstrukcijska ležišča – 5. del: Lončna ležišča

Structural bearings - Part 5: Pot bearings

Lager im Bauwesen - Teil 5: Topflager

Appareils d'appui structuraux - Partie 5: Appareils d'appui a pot

Ta slovenski standard je istoveten z: EN 1337-5:2005

ICS:

91.010.30	Tehnični vidiki	Technical aspects

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EUROPEAN STANDARD
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English version

Structural bearings - Part 5: Pot bearings

Appareils d'appui structuraux - Partie 5: Appareils d'appui à pot

Lager im Bauwesen - Teil 5: Topflager

This European Standard was approved by CEN on 4 June 2004.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This document (EN 1337-5:2005) has been prepared by Technical Committee CEN/TC 167 "Structural bearings", the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.

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 Annex ZA, which is an integral part of this document.

The European Standard EN 1337 consists of the following 11 parts:

Part 1 General design rules

Part 2 Sliding elements

Part 3 Elastomeric bearings

Part 4 Roller bearings

Part 5 Pot bearings

Part 6 Rocker bearings

Part 7 Spherical and cylindrical PTFE bearings

Part 8 Guide bearings and restrain bearings

Part 9 Protection

Part 10 Inspection and maintenance

Part 11 Transport, storage and installation

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This part of EN 1337 specifies the requirements for the design and manufacture of pot bearings which will be used for operating temperatures between – 40 °C and 50 °C.

This part of EN 1337 does not apply to pot bearings made with other materials than those specified in clause 5.

Bearings which are subjected to rotation α_d greater than 0,030 rad (see Figure 2) under the characteristic combination of actions or which incorporate elastomeric pads larger than 1500 mm in diameter are beyond the scope of this document.

Depending on the climatic region where the construction work is located the bearings can be designed to one of the following classes related to minimum operating temperatures (the minimum shade air temperatures): - 25 °C or – 40 °C.

When required to accommodate translational movements, pot bearings may be combined with sliding elements in accordance with EN 1337-2.

NOTE The minimum shade air temperature for a location should be obtained from meteorological data appropriate to a 120 year return period. Consideration should be given to adjustment of this temperature for height and local divergence such as frost pockets and sheltered low-lying areas if the data obtained applies to a general area rather than to a specific location.

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.

EN 1337-1:2000, *Structural bearings — Part 1: General design rules*.

EN 1337-2:2004, *Structural bearings — Part 2: Sliding elements*.

EN 1337-9:1997, *Structural bearings — Part 9: Protection*.

EN 1337-10, *Structural bearings — Part 10: Inspection and maintenance.*

EN 1990, *Eurocode - Basis of structural design*.

EN 10025-1, *Hot rolled products of structural steels - Part 1: General technical delivery conditions.*

EN 10025-2, *Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10083-3, *Quenched and tempered steels — Part 3: Technical delivery conditions for boron steels*.

EN 10088-2, *Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip for general purposes*.

EN 10113-1, *Hot-rolled products in weldable fine grain structural steels — Part 1: General delivery conditions*.

EN 10204, *Metallic products — Types of inspection documents*.

EN 12163, *Copper and copper alloys — Rod for general purposes*.

EN 12164, *Copper and copper alloys — Rod for free machining purposes*.

EN ISO 527-1, *Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1:1993 including Corr 1:1994).*

EN ISO 527-2, *Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:1993 including Corr 1:1994)*.

EN ISO 1133, *Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics (ISO 1133:1997)*.

EN ISO 2039-1, *Plastics - Determination of hardness - Part 1: Ball indentation method (ISO 2039-1:2001)*.

EN ISO 4288, *Geometrical product specifications (GPS) - Surface texture: Profile method - Rules and procedures for the assessment of surface texture (ISO 4288:1996)*.

EN ISO 7500-1, *Metallic materials - Verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Verification and calibration of the force-measuring system (ISO 7500-1:2004)*

ISO 1083, *Spheroidal graphite cast irons — Classification*.

ISO 1183, *Plastics — Methods for determining the density of non-cellular plastics*.

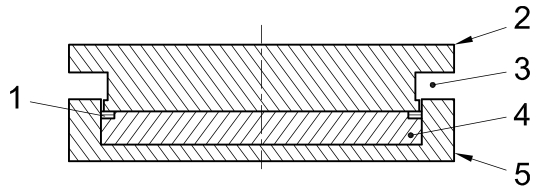
ISO 3755, *Cast carbon steels for general engineering purposes*.

ISO 6446, *Rubber products — Bridge bearings — Specification for rubber materials*.

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply (see Figure 1).



Key

1 Internal seal

2 Piston

3 Protection by external seal in this area

4 Elastomeric pad

5 Pot

NOTE Pot bearings can be used with the pot inverted.

Figure 1 — Details of a pot bearing

3.1.1
accumulated slide path
the sum of the relative movements between the internal seal and the pot wall resulting from variable rotations

3.1.2
elastomeric pad
component which provides the rotational capability

3.1.3
external seal
component or material which is used to exclude moisture and debris from the gap between the piston and the pot

3.1.4
internal seal
component which prevents escape of the elastomer material through the clearance between the recess walls and the piston when a compressive force is applied

3.1.5
lubricant
special grease used to reduce the friction between the pad and the metallic components for the purpose of reducing wear as well as the rotation stiffness

3.1.6
piston
component which closes the open end of the recess in the pot and bears on the elastomeric pad

3.1.7
pot
component with a machined recess which contains the elastomeric pad, piston and internal seal

3.1.8
pot bearing
structural bearing consisting of an elastomeric pad (rotational element) confined in a cylinder by means of a close fitting piston and an internal seal

3.1.9
sliding pot bearing
pot bearing combined with a sliding element to accommodate translational movement in one or any direction

3.2 Symbols

For the purposes of this document, the following symbols apply:

3.2.1 Latin upper case letters

A cross section area, in square millimetres

D internal diameter of pot, in millimetres

D_O outer diameter of pot ring, in millimetres

F_0 factor in restoring moment formula for zero rotation

F_1 factor in restoring moment formula for lubricated pad

F_2 factor in restoring moment formula for unlubricated pad

$F_{w,}$ resistance of weld in Newton per millimetre

$F_{xy,}$ applied horizontal load, in Newton

H depth of the cylindrical recess in millimetres

M resistance moment from pad and internal seal in test in Newton millimetre

M_e resistance moment from pad and internal seal in Newton millimetre

M_R additional moment from friction between piston and pot in Newton millimetre

M_T total resistance moment from rotation in Newton millimetre

N axial force in Newtons

R radius of contact surface in millimetres

T thickness of the pot base in millimetres

V total transverse or shear force in Newton

V' total transverse or shear force per unit length in Newton per millimetre

$V_{e,}$ shear force due to elastomer pressure in Newton

3.2.2 Latin lower case letters

b calculated piston/pot contact width, in millimetres

d diameter of elastomeric pad, in millimetres

d_{ct} effective contact diameter of upper surface, in millimetres

d_{cb} effective contact diameter of lower surface, in millimetres

f_U ultimate strength of material, in Newton per square millimetre

f_y yield strength of material, in Newton per square millimetre

$f_{e,d}$ design contact strength of the elastomer, in Newton per square millimetre

t nominal thickness of elastomeric pad in millimetres

w width of piston face in millimetres

3.2.3 Greek letters

γ_M partial safety factor

α rotation angle due to permanent and variable actions, in radians

α_1 resultant rotation angle due to permanent actions, in radians

α_2 resultant rotation angle due to traffic loads, in radians

θ rotation angle in restoring moment test, in radians

3.2.4 Subscripts

Rd design resistance

d design value

Sd design internal forces and moments from actions

u ultimate limit state

3.3 Abbreviations

PTFE polytetrafluoroethylene

POM polyoxymethylene (acetal)

4 Functional requirements

4.1 General

A pot bearing shall be capable of transferring applied vertical and horizontal loads between the superstructure and substructure and shall permit limited rotational movement (see 6.1.2). The internal seal system shall prevent extrusion of the elastomer from the pot.

These requirements shall be met with adequate reliability and durability, see EN 1990.

It is assumed that adequate reliability, durability, load bearing capacity and rotation capability result from adopting the design procedures given in clauses 5 and 6.

When using an internal seal system indicated in annex A, pot bearings designed and used in accordance with this part of EN 1337 are considered to meet the aforementioned requirements.

4.2 Tests for durability

When necessary (see 5.4) the long term functioning according to 4.1 shall be tested in accordance with annex E.

Acceptance criteria for these tests are:

— there shall be no extrusion of cohesive elastomeric material.

— the compression deformation under the test load shall have not increased for at least 24 h.

NOTE Wear of the seal and discoloration of the lubricant is acceptable in these tests.

5 Materials

5.1 General

Materials used for the manufacture of pot bearings shall be in accordance with the requirements given in the following sub-clauses.

5.2 Ferrous materials for pot and piston

The pot and piston shall be manufactured from ferrous materials in accordance with one of the following standards: EN 10025, EN 10083-3, EN 10113-1, EN 10088-2, ISO 3755, ISO 1083.

Specification and certification of material shall correspond to the requirements for resistance and durability, weldability, if applicable, and the operating temperature specified (see clause 1).

5.3 Elastomeric materials

The elastomer material used for the elastomeric pad shall be natural or polychloroprene rubber in accordance with ISO 6446.

5.4 Internal seal

Suitable internal seals are given in annex A.

The internal seals given in annex A shall be classified with regard to the standard accumulated slide path, given in annex E as follows:

- Seals according to A.1.1 accumulated slide path “b”, 1000 m
- Seals according to A.1.2 and A.1.3 accumulated slide path “c”, 2000 m
- Seals according to A.1.4 accumulated slide path “a”, 500 m

NOTE All seals given in annex A can be considered as suitable, according to the state of the art.

Internal seals made from materials not specified in annex A are beyond the scope of this standard and the test procedures described herein are not necessarily applicable, particularly with regard to long term effects.

For a seal system not specified in annex A, the ability of a pot bearing to satisfy these requirements shall be verified by testing in accordance with 4.2.

5.5 Lubricant

The lubricant shall not be harmful to the elastomer or other components and shall not cause excessive swelling of the elastomer.

Swelling of the elastomer is excessive when the relative change in weight is ≥ 8 % at 50 °C.

6 Design requirements

6.1 Design fundamentals

6.1.1 Principles of design calculation

For the design of bearings, the principles given in clause 5 of EN 1337-1:2000 apply.

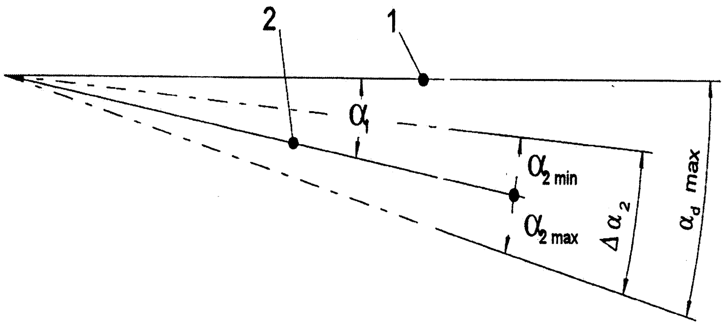
The design values of the effects (forces, deformations, movements) from the actions at the supports of the structure shall be calculated from the relevant combination of actions according to EN 1990.

NOTE The decisive design values are assumed to be available from a bearing schedule as shown in prEN 1993-2. Until prEN 1993-2 is available the guidance given in annex B of EN 1337-1:2000 may be used.

6.1.2 Rotation limitation

6.1.2.1 General

The relationship between the permanent and variable rotation angles is shown in Figure 2.



Key

1 Starting position (after installation)

2 Position due to rotation α_1 caused by permanent actions

α_{2min}, $\alpha_{2\,max}$ negative and positive rotation angles due to variable loads.

$\Delta\alpha_2$ range of rotation angles due to extreme positions of variable loads

$$\alpha_{max} = \alpha_1 + \alpha_{2max} \quad (1)$$

Figure 2 — Diagramatic representation of rotation angles

6.1.2.2 Rotation limitation

Under the characteristic combination of actions the maximum rotation α_{dmax} shall not exceed 0,03 rad.

Under the frequent combination of actions the difference in rotation $\Delta\alpha_{d2}$ shall not exceed 0,005 rad.

6.1.2.3 Variable rotation

Variable rotations result in an accumulated slide path, which affects the durability of the internal seal.

When required the actual accumulated slide path $S_{A,d}$ shall be calculated with data provided by the bridge designer using the following formula:

$$S_{A,d} = n_v \times \Delta\alpha_2 \times \frac{D}{2} \quad (2)$$

$$S_{A,d} \leq c \times s_T \quad (3)$$

in which:

$S_{A,d}$ = actual accumulated slide path due to characteristic traffic loads

n_v = number of vehicles (lorries) for the intended life of the bearing

c = factor to correct for the difference between the constant amplitude slide path used in the tests and the variable amplitude movements which actually occur due to traffic (equals :5)

s_T = accumulated slide path a,b or c in accordance with 5.4 or derived from testing in accordance with annex E

It is assumed that $\Delta\alpha_2$ has been determined using an appropriate single vehicle model. In the absence of such data, Fatigue Load Model 3 in accordance with ENV 1993-3 should be used.

NOTE The field of application of the internal seals corresponding to the technical classes listed in 5.4 is given in annex G, provided that no calculative verification is carried out.

6.1.3 Restraint moments due to rotation

6.1.3.1 Restraint due to rotation of elastomeric pad and internal seal

For the verification of the adjacent structural parts the maximum value of the restraint moment M_{emax} of the elastomeric pad shall be assumed to be:

$$M_{emax} = 32 \times d^3 \times (F_0 + (F_1 \times \alpha_1)+(F_2 \times \alpha_{2max})) \quad (4)$$

where:

F_0, F_1 & F_2 shall be determined from type tests conducted in accordance with annex D.

d is the diameter of elastomeric pad (mm)

M_{emax} is the restraint moment from the pad

α_1 is the resultant rotation angle due to permanent actions effects, in radians (rad), see Figure 2.

α_{2max} is the resultant rotation angle due to variable actions, in radians (rad) see Figure 2.

6.1.3.2 Resistance to rotation due to pot/piston contact

The additional moment $M_{\mu max}$ caused by friction at the pot/piston contact surface shall be considered. In determining this moment the maximum coefficient of friction between the pot wall and the piston shall be taken as 0,2.

6.1.3.3 Total restraint due to rotation

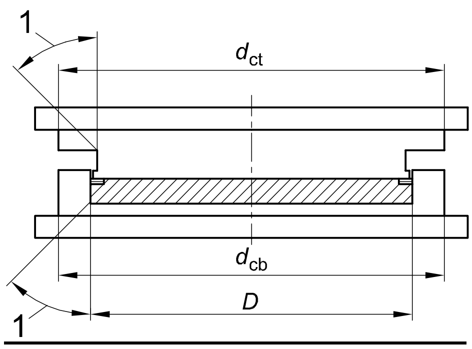
The total restraint due to rotation to be considered in the design of the adjacent structure and bearing components shall be taken as the vectorial sum of the moments determined in accordance with 6.1.3.1 and 6.1.3.2.

6.1.4 Vertical deformation

If the elastic compression stiffness of the bearing is of relevance to the design of the adjacent structure it shall be determined by means of testing (see annex B).

6.1.5 Load distribution through components

The load dispersion angle through a component, as shown in Figure 3, shall be taken as 45° unless a greater angle is justified by calculations which take into account the characteristics of the adjacent components, materials and structural members. In no case shall the load dispersion angle exceed 60°.



Key

1 Load dispersion angle

Figure 3 — Load distribution through components

6.1.6 Combination with sliding elements

When a pot bearing is combined with a sliding element in accordance with EN 1337-2, the interaction of the respective components particularly with regard to their relative stress and strain shall be considered. Additional mechanical and geometrical effects e.g. due to lateral forces in guides (friction, couple from action and reaction) causing eccentricities additional to those resulting from resistance to rotation as given in 6.1.3 shall be taken into account.

6.2 Design verification

6.2.1 Elastomeric pad

6.2.1.1 Contact stress

The design axial force N_{Sd} shall meet the following condition under the fundamental combination of actions:

$$N_{Sd} \leq N_{Rd}$$

Where:

$$N_{Rd} = \frac{N_{Rk}}{\gamma_M} \quad \text{is the design value of resistance of the elastomeric pad} \qquad (5)$$

N_{Rk} is the characteristic value of resistance of the elastomeric pad

The characteristic value of the resistance shall be determined from:

$$N_{Rk} = \frac{\pi}{4} \times d^2 \times f_{e,k} \quad \text{where:} \qquad (6)$$

d is the diameter of elastomeric pad (mm)

$f_{e,k}$ is the characteristic contact strength of the elastomer given by $f_{e,k}$ = 60 N/mm^2

NOTE 1 The compressive resistance $f_{e,k}$ of the elastomer in pot bearings, that leads to N_{Rk} is limited by the effectiveness of the seal preventing the elastomer from extruding between the piston and the pot wall.