Structural bearings —

Part 1: General design rules

The European Standard EN 1337-1:2000 has the status of a British Standard

ICS 91.010.30

National foreword

This British Standard is the official English language version of EN 1337-1:2000.

The UK participation in its preparation was entrusted to Technical Committee B/522, Structural bearings, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 31 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This British Standard, having been prepared under the direction of the Sector Committee for Building and Civil Engineering, was published under the authority of the Standards Committee and comes into effect on 15 October 2000

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 36540 9

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1337-1

June 2000

ICS 91.010.30

English version

Structural bearings - Part 1: General design rules

Appareils d'appui structuraux - Partie 1: Indications générales

Lager im Bauwesen - Teil 1: Allgemeine Regelungen

This European Standard was approved by CEN on 30 April 2000.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1337-1:2000 E

Contents

Foreword

This European Standard 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 2000, and conflicting national standards shall be withdrawn at the latest by December 2000.

prEN 1337 "Structural bearings" 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 – Guided bearings and restrained bearings

Part 9 – Protection

Part 10 – Inspection and maintenance

Part 11 – Transport, storage and installation

This Part 1 "General design" includes Annexes A, B and C (informative).

Further to CEN/TC 167’s decision Part 1 and Part 2 form a package of standards and they come into force together, while the other parts come into force separately after the publication of Part 1 and Part 2.

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, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard is applicable to structural bearings, whether used in bridges or in other structures.

This European Standard does not cover:

a) bearings that transmit moments as a primary function;

b) bearings that resist uplift;

c) bearings for moving bridges;

d) concrete hinges;

e) seismic devices.

Although it is not intended to regulate temporary bearings this standard may be used as a guide in this case (temporary bearings are bearings used during construction or repair and maintenance of structures).

> NOTE 1: Although the specifications given in this European Standard are necessary, they are not sufficient in themselves for the overall design of the structures and for the consideration of geotechnical aspects.

See prEN 1337-2 to prEN 1337-8 for information relating to bearings for which specifications are laid down for certain ranges of temperature only.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

prEN 1337-2	Structural bearings – Part 2: Sliding elements
prEN 1337-3	Structural bearings – Part 3: Elastomeric bearings
prEN 1337-4	Structural bearings – Part 4: Roller bearings
prEN 1337-5	Structural bearings – Part 5: Pot bearings
prEN 1337-6	Structural bearings – Part 6: Rocker bearings
prEN 1337-7	Structural bearings – Part 7: Spherical and cylindrical PTFE bearings
prEN 1337-8	Structural bearings – Part 8: Guided bearings and restrained bearings
EN 1337-9 : 1997	Structural bearings – Part 9: Protection
prEN 1337-10	Structural bearings – Part 10: Inspection and maintenance
EN 1337-11: 1997	Structural bearings – Part 11: Transport, storage and installation
ENV 1991-1 : 1994	Eurocode 1: Basis of design and actions on structures – Part 1: Basis of design
ENV 1992-2 : 1996	Eurocode 2: Design of concrete structures – Part 2: Concrete bridges
ENV 1993-2 : 1997	Eurocode 3: Design of steel structures – Part 2: Steel bridges
ENV 1994-2 : 1997	Eurocode 4: Design of composite steel and concrete structures – Part 2: Composite bridges

3 Definitions and symbols

3.1 Definitions

For the purposes of this standard, the following definitions apply:

Ultimate limit state (ULS) and serviceability limit state (SLS) are defined in ENV 1991-1. They apply here in the same way.

3.1.1 bearings: Bearings are elements allowing rotation between two members of a structure and transmitting the loads defined in the relevant requirements as well as preventing displacements (fixed bearings), allowing displacements in only one direction (guided bearings) or in all directions of a plane (free bearings) as required.

The most common types of bearings are listed in table 1 and examples of these are are illustrated in figure 1 with the corresponding axes of coordinates.

A distinction is made between the following categories:

Category 1: All-round rotating bearings

Category 2: Bearings with uniaxial rotation

Category 3: Spherical and cylindrical bearings when the horizontal load is supported by the curved sliding surface

Category 4: All other bearings

The bearings of Nos 1.1 to 3.1, 3.3, 3.5 to 4.3, 8.1 and 8.2 belong to category 1.

The bearings of Nos 5.1 to 6.2, 7.3 and 7.4 belong to category 2.

The bearings of Nos 3.2, 3.4, 7.1 and 7.2 belong to category 3.

Table 1: Most common types of bearings

1							2	3	4	5	6	7	8	9	10	11	12	13			14
Relevant parts of the standard							No.	Symbol in the plan view	Symbol in direction		Kind of bearing	Relative movements						Reactions			
									x	y		displacements			rotation			forces			moment
2	3	4	5	6	7	8						v_x in x-direction	v_y in y-direction	v_z in z-direction	α_x about x-axis	α_y about y-axis	α_z about z-axis				
	X						1.1				Elastomeric bearing (EB)	deforming	deforming	small[2])	deforming	deforming		V_x	V_y	N	
	X					X	1.2				Elastomeric bearing with restraints (RS) for one axis[4])		none				[1])	V_x	V_y	N	
X	X					X	1.3				EB with unidirectional movable sliding part and RS for the other axis	sliding and deforming	none				[1])		V_y	N	
X	X						1.4				Elastomeric bearing with multidirectional movable sliding part		sliding and deforming				deforming			N	
X	X						1.5				Elastomeric bearing with unidirectional movable sliding part		deforming						V_y	N	
	X					X	1.6				Elastomeric bearing with securing device for two axes	none	none				[1])	V_x	V_y	N	
X	X					X	1.7				Elastomeric bearing with unidirectional movable sliding part and RS for two axes	sliding							V_y	N	
X	X					X	1.8				Elastomeric bearing with multidirectional movable sliding part and RS for two axes		sliding							N	

(continued)

Table 1 (continued)

1							2	3	4	5	6	7	8	9	10	11	12	13			14
Relevant parts of the standard							No.	Symbol in the plan view	Symbol in direction		Kind of bearing	Relative movements						Reactions			
												displacements			rotation						
									x	y		v_x in x-direction	v_y in y-direction	v_z in z-direction	α_x about x-axis	α_y about y-axis	α_z about z-axis	forces			mo-ment
2	3	4	5	6	7	8															
			X				2.1		△	△	Pot bearing	none	none	very small	deform-ing	deform-ing		V_x	V_y	N	
X			X				2.2		△		Pot bearing with unidirectional movable sliding part	sliding					1)		V_y	N	
X			X				2.3			△	Pot bearing with multidirectional movable sliding part		sliding				sliding and de-forming			N	
					X		3.1		△	△	Spherical bearing with RS beyond the rotating part	none	none	almost none	sliding	sliding	sliding	V_x	V_y	N	
					X		3.2				Spherical bearing with rotating part likewise as RS							V_x	V_y	N	
X					X		3.3		△		Spherical bearing with unidirectional movable sliding part (ext. guidance)	sliding					1)		V_y	N	
X					X		3.4				Spherical bearing with unidirectional movable sliding part (int. guidance)								V_y	N	
X					X		3.5			△	Spherical bearing with multidirectional movable sliding part		sliding							N	

(continued)

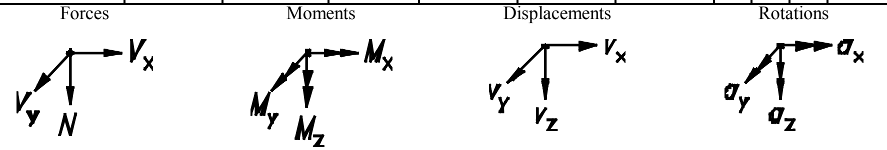
Table 1 (continued)

1							2	3	4	5	6	7	8	9	10	11	12	13			14
Relevant parts of the standard							No.	Symbol in the plan view	Symbol in direction		Kind of bearing	Relative movements						Reactions			
												displacements			rotation						
2	3	4	5	6	7	8			*x*	*y*		v_x in x-direction	v_y in y-direction	v_z in z-direction	α_x about x-axis	α_y about y-axis	α_z about z-axis	forces			mo-ment
				X			4.1				Steel point rocker bearing	none	none	almost none	rocking	rocking	sliding[1])	V_x	V_y	N	
X				X			4.2				Steel point rocker bearing with unidirectional movable sliding part	sliding							V_y	N	
X				X			4.3				Steel point rocker bearing with multidirectional movable sliding part	sliding	sliding							N	
				X			5.1				Steel linear rocker bearing	none	none		none[3])		none	V_x	V_y	N	M_x
X				X			5.2				Steel linear rocker bearing with unidirectional movable sliding part	sliding							V_y	N	M_x
X				X			5.3				Steel linear rocker bearing with multidirectional movable sliding part		sliding				sliding			N	M_x
		X					6.1				Single roller bearing	rolling	none				none[1])		V_y	N	M_x
X		X					6.2				Single roller bearing with sliding part movable in the other direction		sliding							N	M_x

(continued)

Table 1 (concluded)

1							2	3	4	5	6	7	8	9	10	11	12	13			14
Relevant parts of the standard							No.	Symbol in the plan view	Symbol in direction		Kind of bearing	Relative movements						Reactions			
									x	y		displacements			rotation			forces			moment
2	3	4	5	6	7	8						v_x in x-direction	v_y in y-direction	v_z in z-direction	α_x about x-axis	α_y about y-axis	α_z about z-axis				
X					X		7.1				Fixed cylindrical bearing	none	none	almost none	none[3]	sliding	none	V_x	V_y	N	M_x
X					X		7.2				Guided cylindrical bearing movable in y direction		sliding					V_x		N	M_x
X					X		7.3				Guided cylindrical bearing movable in x direction	sliding	none						V_y	N	M_x
X					X		7.4				Free cylindrical bearing movable in x and y direction		sliding				sliding			N	M_x
						X	8.1				Guide bearing with restraints for two axes = thrust bearing	none	none	sliding	sliding or deform-ing	sliding or deform-ing	sliding or de-forming	V_x	V_y		
						X	8.2				Guide bearing with restraints for one axis	sliding					none		V_y		



1) For individual types of bearings α_z may have strict tolerances, special design will be necessary if so required. For normal design purposes "none" means no movement other than that due to manufacturing tolerances and deformation.

2) Whether or not v_z is of importance to be checked in individual cases.

3) Combination with a sliding bearing results in unfavourable stresses in the PTFE.

4) Device to transfer the forces V_x or V_y.

NOTE: In practice *x* is the main direction of movement for bridges (see ENV 1992-2 and ENV 1993-2) and *z* the direction of the forces due to vertical loads.

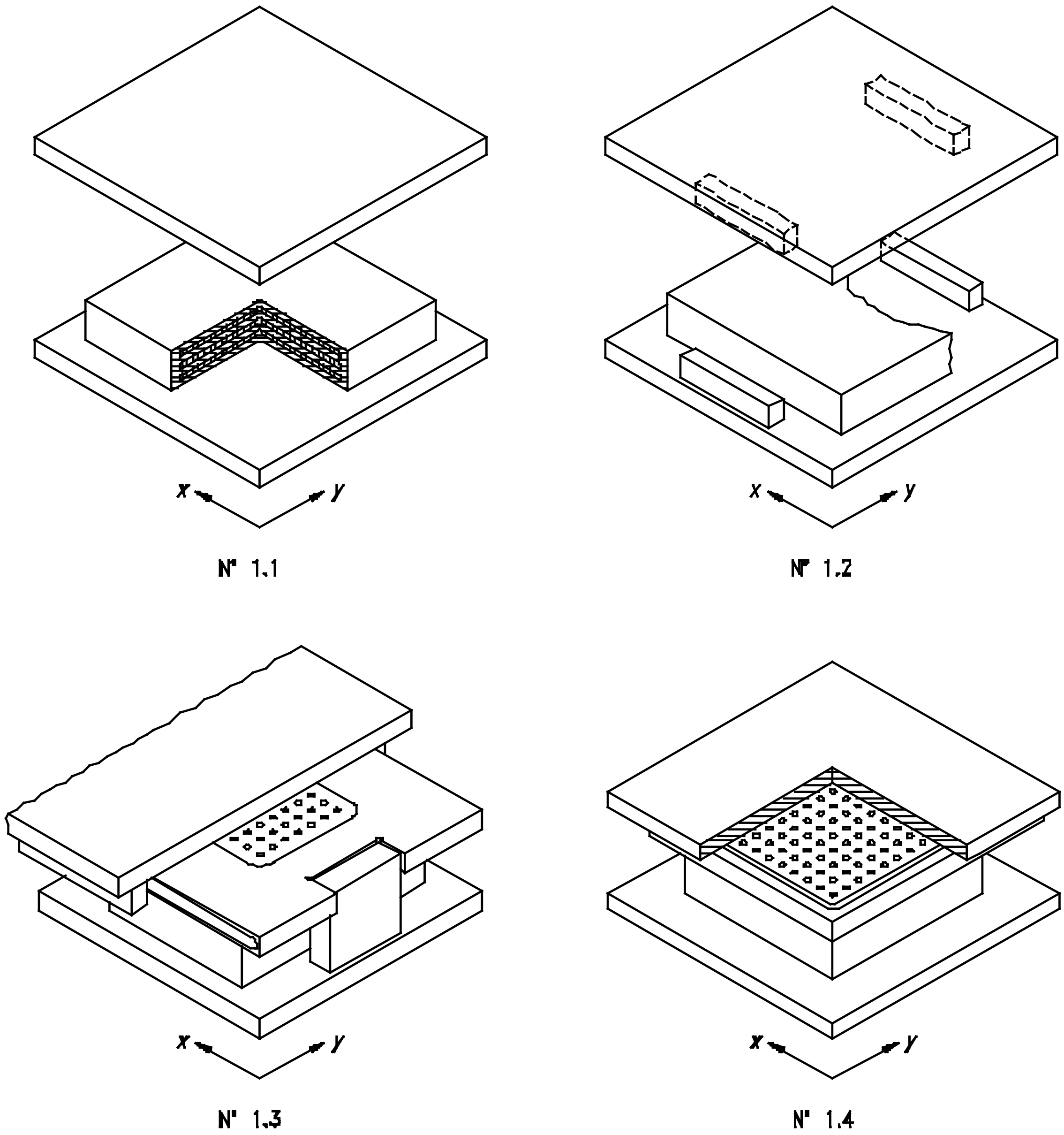
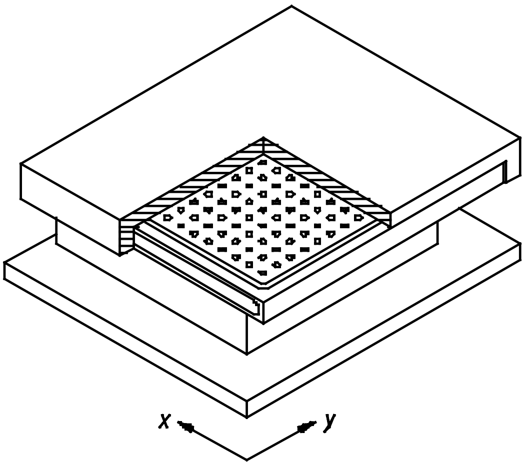
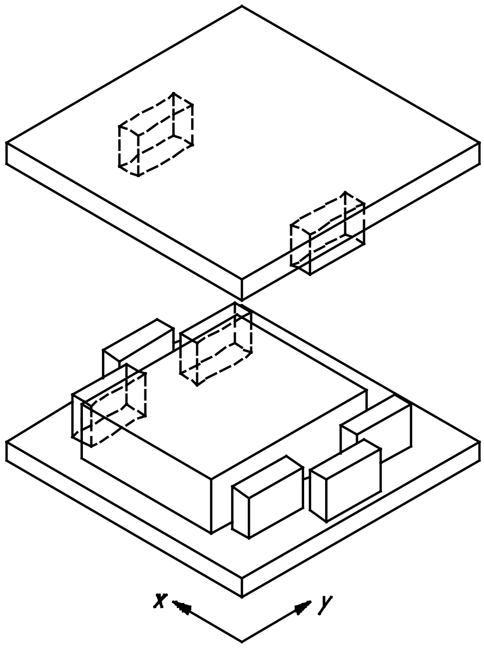


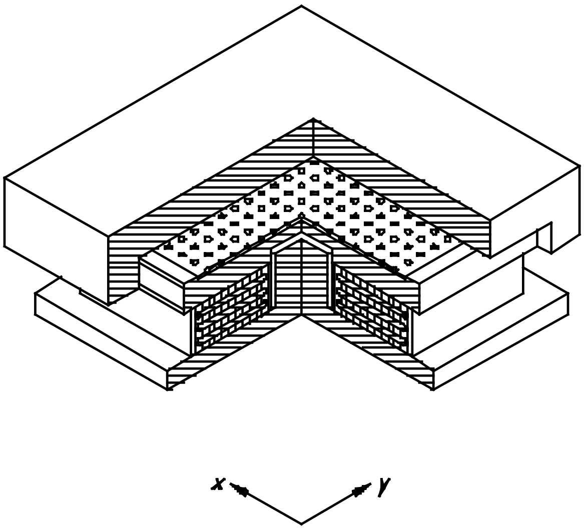
Figure 1: Examples of the most common types of bearings listed in table 1



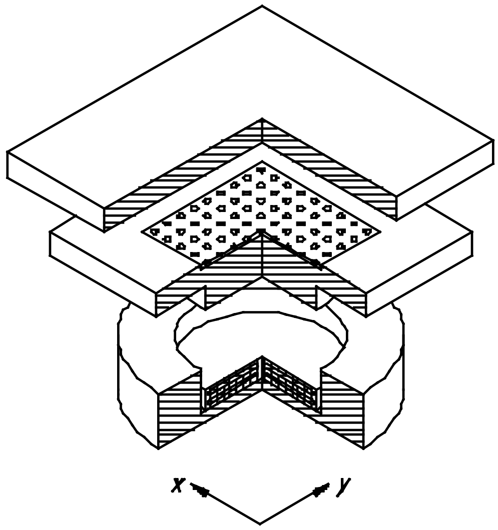
N° 1.5



N° 1.6



N° 1.7



N° 1.8

Figure 1 (continued): Examples of the most common types of bearings listed in table 1

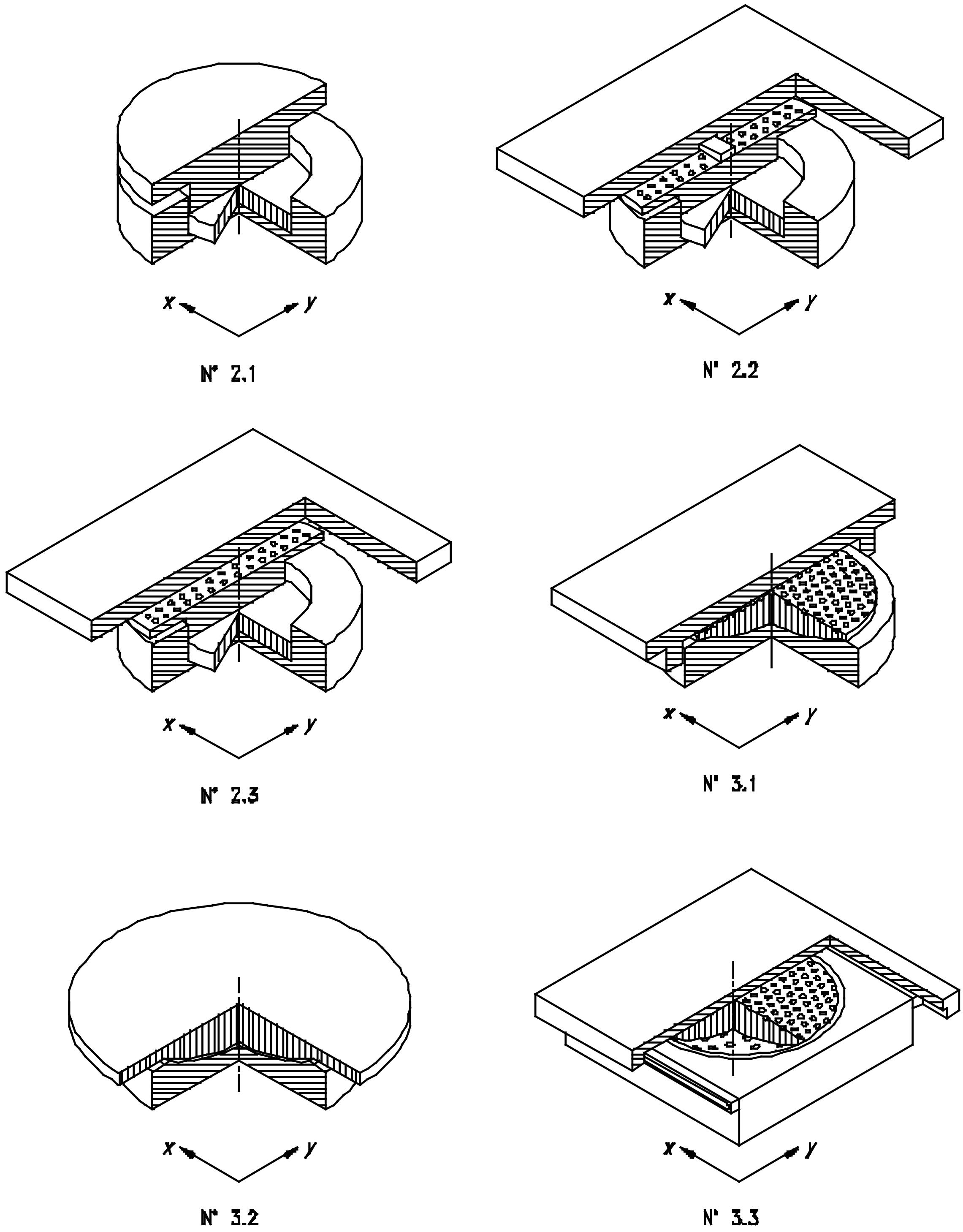
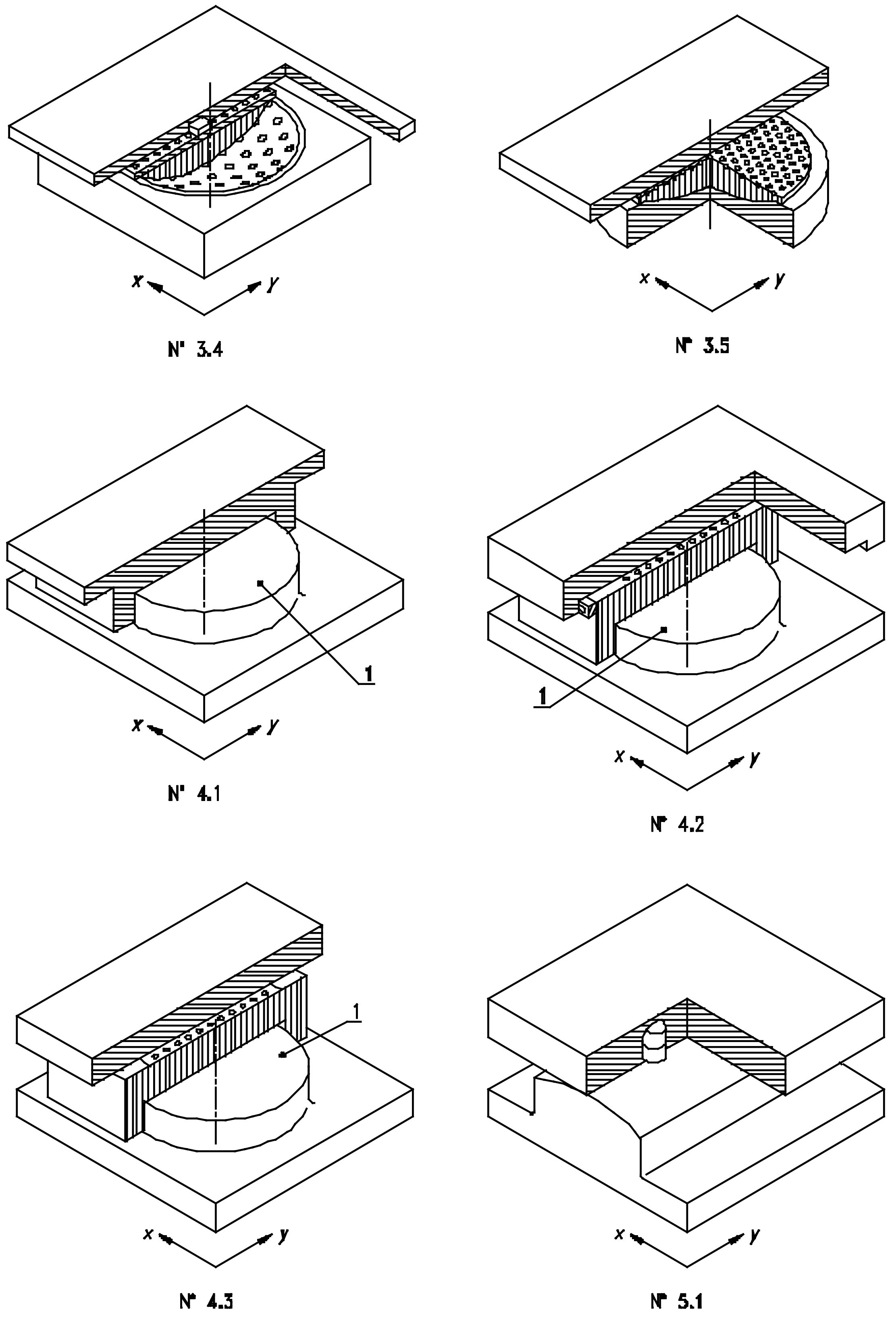
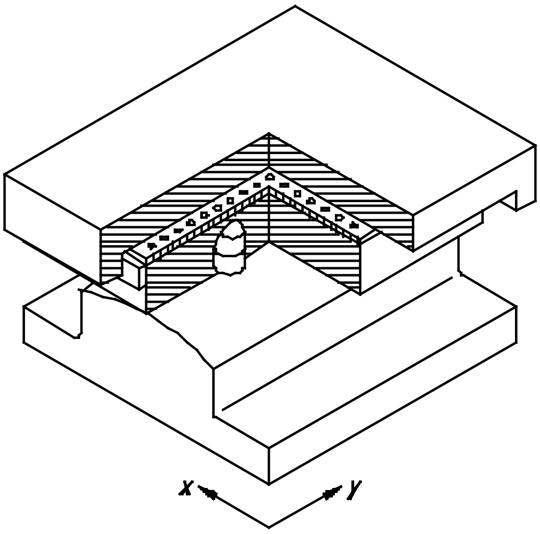


Figure 1 (continued): Examples of the most common types of bearings listed in table 1

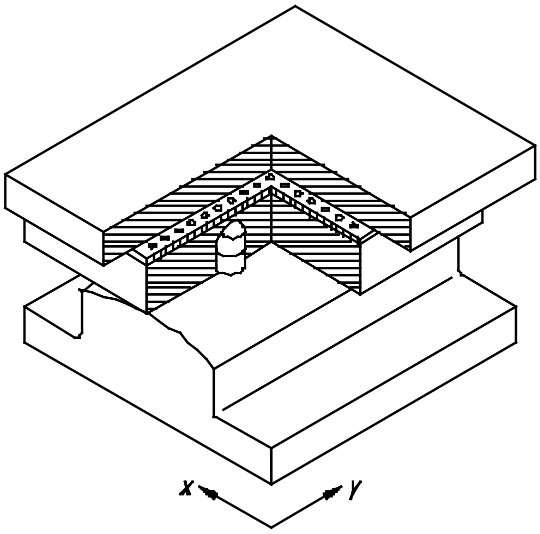


Legend
1 curved surfaces

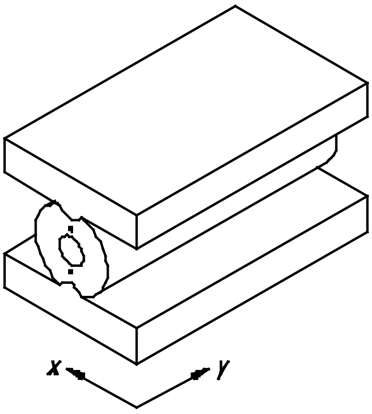
Figure 1 (continued): Examples of the most common types of bearings listed in table 1



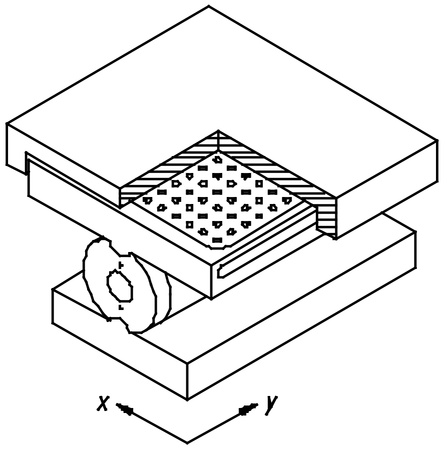
N° 5.2



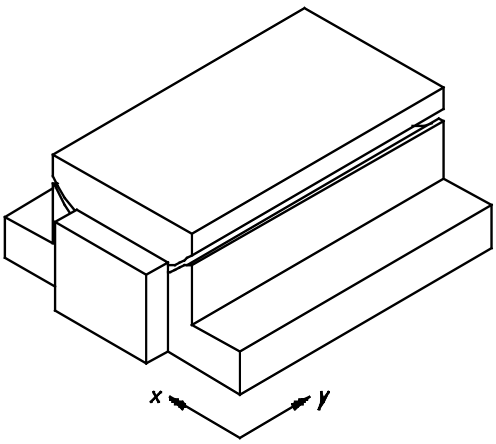
N° 5.3



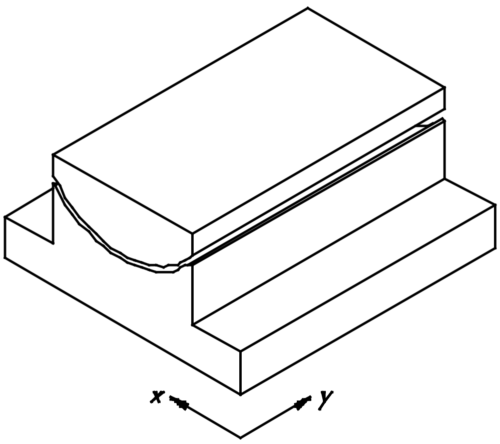
N° 6.1



N° 6.2

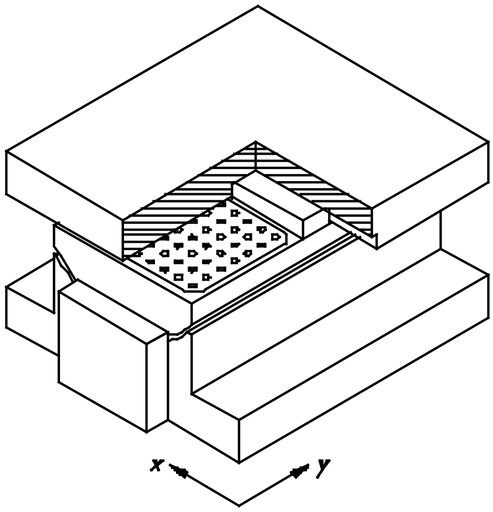


N° 7.1

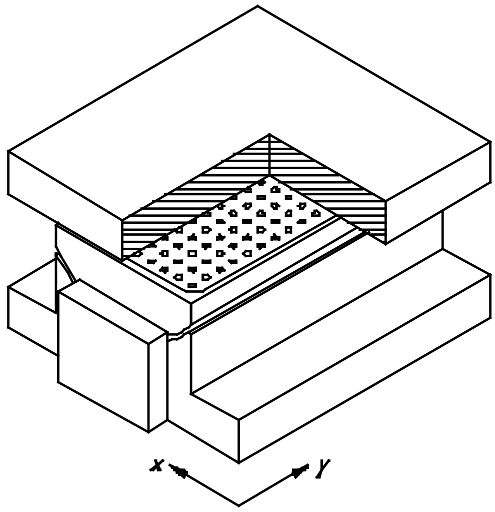


N° 7.2

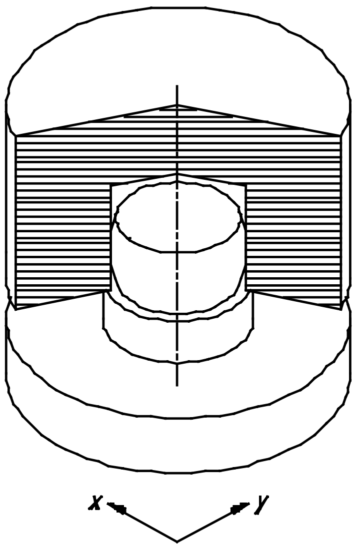
Figure 1 (continued): Examples of the most common types of bearings listed in table 1



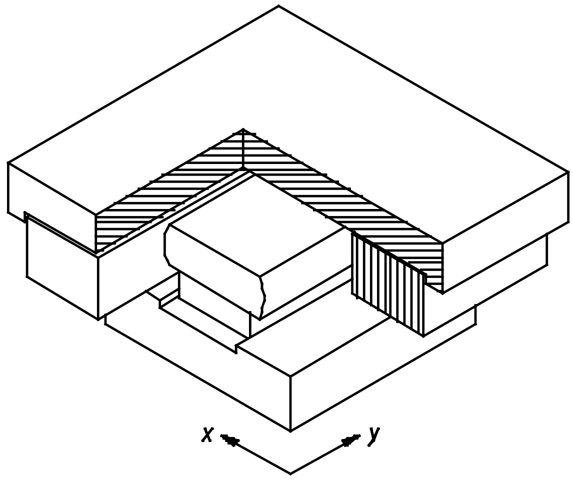
N° 7.3



N° 7.4



N° 8.1



N° 8.2

Figure 1 (concluded): Examples of the most common types of bearings listed in table 1

3.1.2 support:The support comprises all construction measures including the bearing which serve as a structural member to transmit forces and allow movements as intended.

3.1.3 bearing system: The bearing system for a structure is the combination of bearings which together provide for the movements and transmission of forces (see Figure 2).

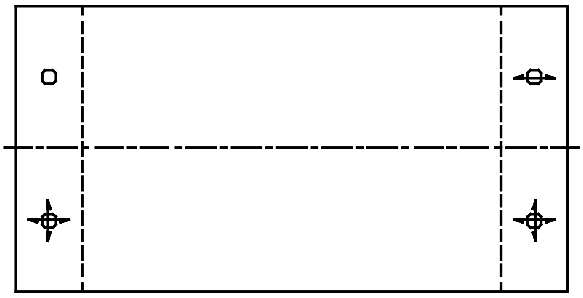


Figure 2: Example of a bearing system

3.2 Symbols used in Part 1

3.2.1 Latin upper case letters

K	Kelvins
M	Moment; Bending moment
N	Axial force
V	Shear force

3.2.2 Latin lower case letters

n	Number of bearings
r	Radius
t	Temperature
v	Displacement
x	Longitudinal axis
y	Transverse axis
z	Axis normal to the principle bearing surface

3.2.3 Greek letters

α	Coefficient of thermal expansion; factor; rotation
γ	Partial safety factor
Δ	Difference; increment
μ	Coefficient of friction

3.2.4 Subscripts

a	Adverse
c	Concrete
d	Design
k	Characteristic
l	Limit value
max	Maximum
min	Minimum
p	Anchorage, fixing device
r	Relieving; Reversible
x, y, z	Coordinates
R	Resistance, loadbearing resistance
S	Internal forces and moments, Stresses

4 General principles

Bearings and supports shall be designed so that bearings or parts of bearings can be inspected, maintained and replaced if necessary, in order to enable them to fulfil their function throughout the intended life of the structure.

Bearings shall be designed to permit the specified movement with the minimum possible reacting force.

Presetting shall be avoided as far as possible. If necessary the required presetting shall be carried out at the factory. If readjustment on site cannot be avoided it shall be carried out only by the manufacturer of the bearing or under his supervision.

5 Design principles

5.1 General

The design of the various bearings shall be based on serviceability and/or ultimate limit state depending on the safety classification of the limit state in consideration.

Where characteristic values and partial safety factors for loads and movements are not covered, either by this European Standard or an Eurocode, the designer shall determine his own values in accordance with the principles set out in ENV 1991-1 and in ENV 1992-2, ENV 1993-2 or ENV 1994-2.

NOTE: A special informative Annex B in ENV 1993-2 deals with bearings.

5.2 Safety against sliding in joints

Where the position of a bearing or part of a bearing is maintained completely or partially by friction its safety against sliding shall be checked at the ultimate limit state in accordance with the following:

$$V_{Sd} \leq V_{Rd}$$

where

V_{Sd} is the design shear force resulting from the actions

$V_{Rd} = \dfrac{\mu_k}{\gamma_\mu} \cdot N_{Sd} + V_{pd}$ is the design value of shear resistance

with

N_{Sd} minimum design force acting normal to the joint in conjunction with V_{Sd};

V_{pd} design strength of any fixing device in accordance with European standards or European technical approvals;

μ_k characteristic value of the friction coefficient
$\mu_k = 0{,}4$ for steel on steel
$\mu_k = 0{,}6$ for steel on concrete

γ_μ partial safety factor for friction
$\gamma_\mu = 2{,}0$ for steel on steel
$\gamma_\mu = 1{,}2$ for steel on concrete

The above-mentioned values of μ_k and γ_μ shall be used provided that prior to installation or assembly the surfaces of steel components are un-coated and free from grease or metal-sprayed or coated with fully hardened zinc silicate provided that any coating has completely hardened prior to installation or assembly of the components.

In other cases the values for μ_k and γ_μ shall be established from the results of tests.
In the case of dynamically stressed structures where extreme load fluctuations can occur, e. g. railway bridges and earthquakes, the horizontal forces shall not be resisted by friction. In these cases μ_k shall be taken as zero.

Safety against sliding in joints formed by elastomeric bearings without positive means of location shall be checked in accordance with prEN 1337- 3.

5.3 Conditions of installation

See EN 1337- 11.
Any particular conditions of installation shall be agreed between the purchaser and the manufacturer and shall be confirmed in writing when the bearings are delivered.

5.4 Increased movements

Unless other parts of this European Standard or relevant Eurocodes have more stringent requirements, in order to ensure with sufficient reliability that bearings do not become unstable, or cease to act as intended, their design movements shall be increased by the following:

a) rotation
±0,005 radians or ±10/r radians, whichever is the greater, (r measured in millimetres);

b) translation
±20 mm in both directions of movement with a minimum total movement of ±50 mm in the direction of maximum movement and ±20 mm transversely unless the bearing is mechanically restrained.

These requirements only apply for the design of movements capacities. They shall not be used where stresses are being calculated. They shall not be applied to elastomeric bearings.

5.5 Minimum movements to be assumed for the strength analysis

For the strength analysis of the bearing the resultant rotational movement shall be taken as not less than ±0,003 radians and the resultant translational movement as not less than ±20 mm or ±10 mm for elastomeric bearings.

If a bearing cannot rotate about one axis a minimum eccentricity of l /10 perpendicular to that axis shall be assumed. Where l is the total length of the bearing perpendicular to that axis.

6 Bearing resistances

6.1 General specifications

The values to be used for calculating the resistance to movement of the various types of bearings are given in the relevant parts of this European Standard. In addition to material variations these values also allow for manufacturing tolerances and inaccuracies in installation, given in the other Parts of this European Standard. They only hold good if the bearings are not subjected to any of the following:

a) temperatures above or below the maximum and minimum specified;

b) exceeding of the specified tolerances;

c) greater velocities of translation or rotation than those derived from the live loads according to ENV 1991-1;

d) presence of substances which are harmful to any of the materials in the bearing;

e) insufficient maintenance.

In all cases the value to be taken for any particular coefficient shall be the least favourable for the design feature under consideration.

6.2 Reaction to rolling and sliding of a set of bearings

Where a number of bearings are so arranged that the adverse forces, resulting from reaction to movement by some, are partly relieved by the forces resulting from the reaction to movement by others, the respective coefficients of friction μ_a and μ_r shall be estimated in the following manner, unless a more precise investigation has been made:

$$\mu_a = 0,5\mu_{max}(1+\alpha)$$

$$\mu_r = 0,5\mu_{max}(1-\alpha)$$

where:

μ_a is the adverse coefficient of friction;

μ_r is the relieving coefficient of friction;

μ_{max} is the maximum coefficient of friction for the bearing as given in other Parts of this European Standard;

α is a factor dependent on the type of bearing and the number of bearings which are exerting either an adverse or relieving force as appropriate; if a value for "α" is not given it shall be calculated in accordance with the following table:

Table 2: Factor α_n

n	α_n
≤ 4	1
$4 < n < 10$	$\frac{16-n}{12}$
≥ 10	0,5

7 Basic design features

7.1 Bearing clearance

7.1.1 Where bearings are designed to resist horizontal forces some movement will take place before clearances are taken up. Such movement shall be kept to a minimum. To this end the total clearance between extremes of movement shall not be more than 2 mm unless otherwise specified.

7.1.2 If the above value is exceeded particular care shall be taken to ensure that this does not compromise the function of the structure.

7.1.3 Clearances shall not be taken into account in allowing for horizontal movement unless it can be shown that they will be permanently available in the correct direction.

7.1.4 If more than one bearing is required to resist horizontal forces, the bearings and their supports shall be designed to ensure that an adverse distribution of clearances will not prevent this happening.

7.2 Safeguarding against loss of bearing components

Adequate measures shall be taken to ensure that no gradual slackening of a bearing assembly occurs as a result of dynamic loading.

7.3 Marking of bearings

7.3.1 All bearings shall be marked with the name of the manufacturer and place of manufacture, year of manufacture and serial number which shall be an individual number for each single bearing and unique to each type of bearing.

7.3.2 In addition all bearings other than elastomeric bearings shall be marked with the following:

– the type of bearing;

– the manufacturer's order number;

– the maximum design values of loadbearing capacity for normal and shear forces;

– the maximum design values of displacement capacity;

– the position in the structure;

– the direction of installation.

With the exception of the last two items, these markings shall be in such a form that they will be visible at all times and will remain legible and comprehensible throughout the life of the bearing.

7.4 Provisions for transport

7.4.1 All bearings which are made up of several components, which are not rigidly fixed together, shall be temporarily clamped together at the place of manufacture. Such clamps shall be sufficiently strong to hold the various bearing components in their correct positions during handling, transportation and installation. They shall be marked, e.g. painted a different colour from the bearing. They shall be easily removable after installation or designed to break once the bearing starts to function, without damaging the bearing.

7.4.2 All bearings that are too heavy to be easily handled manually shall have provision for the fitting of attachments for lifting devices.

7.5 Provisions for inspection

Where specified by the purchaser, bearings shall be provided with reference points to enable horizontal movement and rotation to be measured.

Movement indicators shall have the permissible extremes of movement marked.

NOTE: Where possible the movement indicators should be positioned so that they can be read from a readily accessible position.

7.6 Provision for resetting and replacement

Provisions shall be made to allow an easy replacement of bearings or parts of bearings by jacking the structure. It must be assumed in the design of the bearing that the structure will not be lifted by more than 10 mm if no other information is available. The replacement parts shall in every way be at least equal to the original quality of the parts replaced.

8 Drawing of the support plan

A drawing of the support plan shall be provided, if required by the purchaser.

In accordance with EN 1337-11 the same plan is called "drawing of the bearing system".

Annex A (informative)

Notes for guidance

A.1 Addition to clause 1 "Scope"

The arrangement of bearings for a structure shall be considered in conjunction with the design of the structure as a whole. The bearing forces and movements resulting from such consideration shall then be given to the bearing manufacturer to ensure that the bearings provided meet the requirements as closely as possible.

– with reference to a):
Bearings should not generally be expected to resist moments due to rotational movement about any axis parallel to the x-y plane. Where such rotational movement occurs provision should be made to accommodate it by means of the bearing or within the structure. In cases where the bearing is required to resist such rotational movement a careful analysis should be made to ensure that the bearing will not suffer adversely.

– with reference to b):
Bearing arrangements which, under certain conditions of loading, require bearings to resist uplift are liable to result in excessive wear in the bearings concerned. Where they are unavoidable a possible means of overcoming the problem is to prestress the joint to provide the necessary additional vertical force. Such applications are not covered in this European Standard.

A.2 Addition to clause 5 "Design principles"

A.2.1 Addition to 5.1 "General"

In the design of linear rocker and single roller bearings the full implications of uneven pressure along the length of the roller or rocker should be taken into account in the design of the structure and the bearing. The following are typical examples of cases where particular care is required:

a) structures curved in plan;

b) structures with slender piers;

c) structures without transverse beams.

A.2.2 Addition to 5.2 "Safety against sliding in joints"

Where holding down bolts or other similar devices are relied upon to provide some of the resistance to horizontal movement it should be demonstrated that this resistance is provided before any movement can take place. If bolts are provided in holes with normal tolerances movement will inevitably take place before the full resistance to movement is achieved. This is unacceptable.

A.2.3 Addition to 5.3 "Conditions of installation"

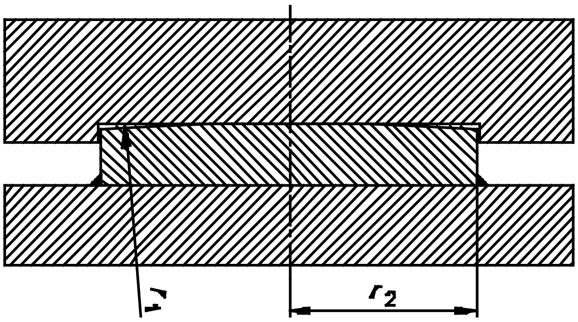
It is normally difficult to predict the conditions on site at the time of installation and hence to estimate precisely the movement to be considered. It is better, therefore, to base the design on the most unfavourable possible assumptions.

Should the owner of the structure wish to make allowance for the conditions existing at the time of installation, this should be agreed with the bearing manufacturer. Precise conditions for installation should be defined and care taken to ensure that these are followed.

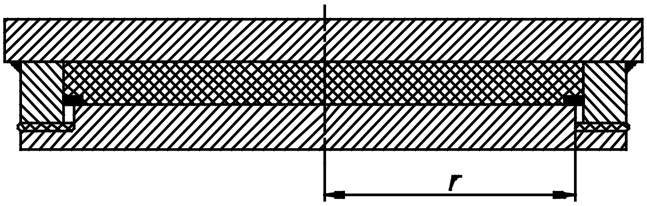
A.2.4 Addition to 5.4 "Increased movements"

A number of examples of the limiting radius "*r*" are given below:

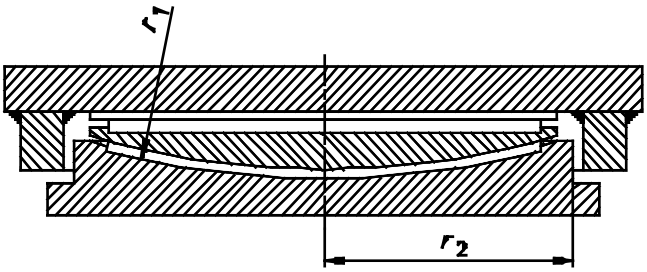
EXAMPLE 1:
There are two different dimensions to consider for point rocker bearings: For dimensioning the rocker of rocker bearings, the significant dimension is the radius of curvature, r_1; for dimensioning the limit stop of the outer bearing plate of rocker bearings, the significant dimension is the radius of recess, r_2.



EXAMPLE 2:
For pot bearings, the significant dimension is the radius of pot or lid, r.



EXAMPLE 3:
There are two different dimensions to consider for spherical bearings: For dimensioning the sliding surface of spherical bearings, the significant dimension is the radius of curvature of the sphere, r_1, while for dimensioning the limit stop, the significant dimension is one half of the inside diameter of the guide edges, r_2.



Where movements are small their calculation tends to be inexact. This applies to most rotational movements and to small translational movements. The purpose of 5.4 is to ensure that in such cases there is an adequate margin in the bearing design to ensure that a small error in calculation or setting does not lead to a serious malfunction of the bearing.

A.2.5 Addition to 5.5 "Minimum movement to be assumed for the strength analysis"

Particular care should be taken when calculating bearing movements if the result is obtained from two large movements of opposite direction (difference between large numbers). The most adverse combination of factors should be assumed to give the maximum possible movement.

A.3 Addition to clause 6 "Bearing reactions"

A.3.1 Addition to 6.1 a)

This restriction is necessary as some of the materials used in the manufacture of bearings possess the required properties in certain narrow temperature ranges only. In the case of PTFE, wear is more pronounced at high temperatures whereas, at low temperatures, the coefficient of friction in the sliding surfaces increases. Elastomers may become brittle at very low temperatures. The temperature limits at which the specified values are met, as shown in tests, are given in the other parts of this European Standard.

A.3.2 Addition to 6.2 "Reaction to rolling and sliding of a set of bearings"

Where values are assessed for the reaction of bearings to movement, full details of the conditions under which they were established should be given. An indication of the probable percentage falling outside the given values and the period of use for which the results will remain valid should also be given (see other parts of this European Standard).

Values for calculating reaction to movement and deformation are given in the other parts of this European Standard. They allow for the most adverse combination of the permitted variations in material properties, environmental conditions and manufacturing and fixing tolerances.

It should be particularly noted that the actual reaction to movement is likely to be considerably less than the calculated maximum. It should not therefore be included in calculations if this would be favourable to the design.

The least favourable value of the coefficients of friction (μ_a, μ_r) should always be used when designing other structural components that are affected by the secondary action effects.

Where environmental conditions exist which are unfavourable to a particular type of bearing consideration should be given to choosing a different type.

Alternatively special protection should be added to the bearing and provision made for both the prompt recognition of any deterioration and for suitable remedial action.

A.4 Addition to 7.1 "Bearing clearance"

With reference to 7.1.1: Some of the bearing clearances to be considered are:

a) for roller bearings, the clearance in the guides;

b) for point rocker bearings, the clearance between rocker and the recess in the upper outer plate;

c) for pot bearings, the clearance between the lid and the pot;

d) for spherical bearings, the clearance between the upper and lower plate of fixed spherical bearings;

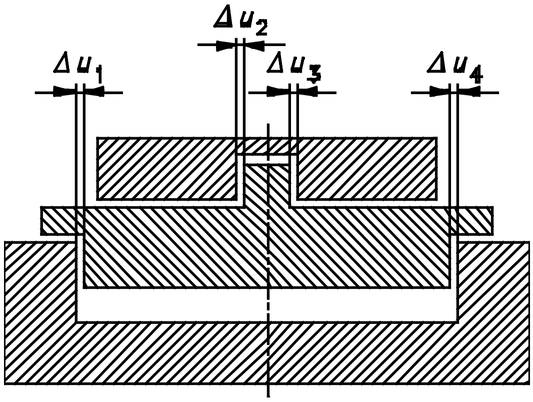
e) the clearance in fixing devices, meaning the clearance during installation;

f) the clearance in the guide surfaces of sliding bearings and of guided bearings;

g) the clearance in guided bearings and restraint bearings.

EXAMPLE 4:
The maximum clearance between two extreme positions would be equal to:

$$\Delta_u = \Delta_{u1} + \Delta_{u2} + \Delta_{u3} + \Delta_{u4}$$



A.5Addition to clause 8 "Drawing of the support plan"

A drawing of the support plan will generally be required for all but the most simple bridges and structures and should generally include the following, using the symbols and nomenclature listed in table 1:

a) a simplified general arrangement of the bridge showing the bearings in plan;

b) details at the bearing locations (e. g. reinforcement and recess);

c) a clear indication of the type of bearing at each location;

d) a table giving the detailed requirements for each bearing;

e) bedding and fixing details.

This may be provided by either the purchaser or bearing manufacturer or both, as appropriate.

Annex B (informative)

Typical bearing schedule

B.1 General

The purpose of a bridge bearing schedule is to list the information normally required for the design of the bearings for a particular structure. This information should ensure that bearings are designed and constructed so that under the influence of all possible actions unfavourable effects of the bearing on the structure are avoided. A drawing should accompany the schedule showing the layout of the bearings with identification marks, including a typical cross section of the bridge and particulars of any special locating requirements. Bearing functions should be indicated on the drawing by the symbols given in table 1. When a particular type of bearing is envisaged it should be described in accordance with table 1. When several types may satisfy the requirements set out in the schedule the items should be left open or possible alternative types listed.

Since it has not been possible to reach an agreement on the form of the bearing schedule should take, two alternatives are offered. The first is given in B.2 and conforms to British practice, while the second given in B.3 conforms to German practice. The specifier should use whichever form best suits his requirements, or devise his own schedule.

Every item in the typical schedule should be considered, but some may not be applicable to a particular bearing. Only relevant information should be given and when an item in the schedule is not applicable this should be stated. Additional information should be added when special conditions exist.

B.2 Schedule, Alternative 1

The following gives guidance for providing the information required in table B.1. The numbers correspond to the numbers in the table.

1) Structure name or reference
A name or reference number, unique to the structure, should be given.

2) Bearing identification mark and number in accordance with table 1
Bearings with different functions or loadcarrying requirements should be distinguished by a specific reference mark.

3) Number off
The quantity required of each particular mark of bearing should be stated.

4) Seating material
The materials on which each outer bearing plate bears should be stated as it may affect the design and finish of these plates.

5) Average design contact pressure
The average design contact pressure is the pressure on the effective contact area, according to the stress block theory, taking into account the distribution through the steel plates (for example see Part 2, Annex A), where applicable.

6) Design values of forces
The worst individual values of the design action effects should be given in the schedule. The most adverse combination of these values is usually sufficient for a satisfactory design of bearing. Only in special cases would greater economy be achieved by considering the actual coexistent values of action effects, in which case these should be given in detail.

7) Displacement
Displacement movements of the superstructure at a bearing should be determined and factored. Allowance should be made for any movement of the supporting structures.

Transverse and longitudinal movements are normally in a direction perpendicular and parallel to the longitudinal axis of a bridge span respectively. Where there is any likelihood of ambiguity (e. g. in the case of skew spans) directions of movement should be clearly indicated on the accompanying drawing.

8) Rotation
The irreversible and reversible rotational movements at the serviceability limit state that the bearing is required to accomodate should be given in radians. In the case of elastomeric bearings, the maximum rate, i. e. the ratio

$$100 \times \frac{\text{design rotation (radians)}}{\text{coexistent design vertical load (kN)}}$$

should also be given.

9) Maximum bearing dimensions
The maximum size of bearing that can be accomodated should be stated, as this will give optimum flexibility in the design of the bearing.

10) Tolerable movement of bearing under transient loads
The movement that can be tolerated at the bearing under transient loads, in directions in which the bearing is meant to provide restraint, should be given.

11) Reaction to displacement under serviceability limit state
In the design of the structure, reaction to displacement movements may be of significance and in that case the acceptable horizontal force generated by the bearing should be given for the serviceability limit state. For elastomeric bearings, the values to be given are those for slowly applied movements at normal temperatures (any necessary extra allowance for low temperatures and rapidly applied movements should be made by the designer of the structure).

12) Reaction to rotation under serviceability limit state
In the design of the structure, reaction to rotation may be of significance and in that case the acceptable moment of reaction generated by the bearing when subjected to the critical design load effects should be given for the serviceability design state. Elastomeric bearings should be treated as in item 11.

13) Type of fixing required
Various means of fixing the bearings to the superstructure and substructure are available, appropriate to different types of bearing. Particular requirements, such as friction, bolts, dowels, keys or other devices, should be stated.

If a proportion of the translational force is to be carried by friction, that proportion and the necessary surface condition should be stated.

14) Special requirements
Details of any special conditions, e. g. extreme exposure, high ozone concentration, limited access, non-horizontal seating, bearings not square to beams, temporary restraints, should be given. The highest and lowest temperatures and details of any special biological conditions to which the bearing may be exposed in service should be stated if they are different from those normally experienced.

Table B.1: Typical bearing schedule

1	Structure name or reference								
2	Bearing identification mark								
	Type of bearing (number in accordance with table 1)								
3	Number off								
4	Seating material 1)	Upper surface							
		Lower surface							
5	Average design contact pressure (N/mm^2) (capacity of structure)	Upper face		Serviceability limit state					
				Ultimate limit state					
		Lower face		Serviceability limit state					
				Ultimate limit state					
6	Design load (kN)	Serviceability limit state		Vertical N	max.				
					permanent				
					min.				
				Transverse $V_{y,sd}$					
				Longitudinal $V_{x,sd}$					
		Ultimate limit state		Vertical N					
				Transverse $V_{y,ud}$					
				Longitudinal $V_{x,ud}$					
7	Displacement (mm)	Serviceability limit state	Irreversible	Transverse $v_{y,sdi}$					
				Longitudinal $v_{x,sdi}$					
			Reversible	Transverse $v_{y,sdr}$					
				Longitudinal $v_{x,sdr}$					

(continued)

Table B.1 (concluded)

7	Displacement (mm)	Ultimate limit state	Irrever-sible	Transverse $v_{y,udi}$				
				Longitudinal $v_{x,udi}$				
			Rever-sible	Transverse $v_{y,udr}$				
				Longitudinal $v_{x,udr}$				
8	Rotation (radians)	Servi-ceability limit state	Irrever-sible	Transverse $\alpha_{y,sdi}$				
				Longitudinal $\alpha_{x,sdi}$				
			Rever-sible	Transverse $\alpha_{y,sdr}$				
				Longitudinal $\alpha_{x,sdr}$				
		Maximum rate (100×radians/kN)		Transverse $\alpha_{y,sdm}$				
				Longitudinal $\alpha_{x,sdm}$				
9	Maximum bearing di-mensions (mm)	Upper surface		Transverse				
				Longitudinal				
		Lower surface		Transverse				
				Longitudinal				
		Overall height						
10	Tolerable movement of bearing under transient loads (mm)			Vertical				
				Transverse				
				Longitudinal				
11	Maximum acceptable reaction to displacement under serviceability limit state (kN)			Transverse $W_{y,sd}$				
				Longitudinal $W_{x,sd}$				
12	Maximum acceptable reaction to rotation under serviceability limit state (kN×m)			Transverse $M_{y,sd}$				
				Longitudinal $M_{x,sd}$				
13	Type of fixing required			Upper face				
				Lower face				
14	Special requirements			State any other requirements on separate sheet.				

1) For example cement mortar, epoxy mortar, in situ concrete, precast concrete, steel, timber.

B.3 Schedule, Alternative 2

Table B.2: Typical bearing schedule

1	Name of building		
2	Installation location (axis)		
	Kind of bearing		
	Bearing type (number according to table 1)		
	Number of bearings		
3	Limit dimensions of bearings		Length (mm)
			Height (mm)
			Width (mm)
4	Presetting		v_{vx} (mm)
5	Combination of design values: Forces, displacements, rotations		
	N_{sd}	max. (kN)	
		permanent (kN)	
		min. (kN)	
	max. $V_{x,Sd}$ (kN)		
	max. $V_{yS,d}$ (kN)		
	$v_{x,d}$	max. (mm)	
		min. (mm)	
	$v_{y,d}$	max. (mm)	
		min. (mm)	
	$\alpha_{y,d}$	max. (‰)	
		min. (‰)	
	$\alpha_{\xi,d}$	max. (‰)	
		min. (‰)	

The table should be accompanied by the support plan and plans of adjacent components.

Annex C (informative)

Temperature, shrinkage and creep

Where national rules exist to cover the guidance given in this annex, these national rules shall take precedence over those given in this annex.

C.1Temperature

For the estimation of temperature during installation see Annex A of EN 1337- 11:1997.
For structural bearings the action of climatic temperature is a basic action for all combinations. The characteristic values of these variable actions can be assessed based on their mean frequency of occurrence, for example, daily and annual periods for frequent combinations and a period of 30 years for rare combinations, recorded by the nearest meteorological station.

The temperature fluctuations $t_{max} - t_{min}$ within the structure are dependent on the highest and lowest local ambient temperatures and on other climatic factors, such as the difference between continental and maritime climates. The effect of these factors is beyond the scope of this European Standard.

The temperatures t_{min} and t_{max} are mean values for the structure. The cross section and material of the structure, the local climatic conditions and existing national rules shall all be considered in their estimation.
The temperature fluctuation within the structure is:

$$\Delta t = |t_{\max} - t_{\min}| \tag{C.1}$$

If the exact temperature of the structure is known during installation:

$$\Delta t_l = 1{,}35 \times \Delta t$$

where:

Δt_l is the "realistic" variation in temperature.

Unless more accurate data are available the values should be increased more or less equally on both the warm and cold side, so that:

$$|t_{l,\min}| - |t_{\min}| \geq |t_{l,\max}| - |t_{\max}|$$

$t_{l,\min}, t_{l,\max}$ are "realistic" limit temperatures.

If the temperature of the structure during installation is estimated in advance an additional Δt^* in accordance with Table C.1 shall be included in accordance with Table C.1:

$$t^*_{l,\min} = t_{l,\min} - \Delta t^*$$
$$t^*_{l,\max} = t_{l,\max} + \Delta t^*$$

with

$t^*_{l,\min}, t^*_{l,\max}$ are "hypothetical" limit temperatures.

Table C.1: Limit temperatures

1	2	3
Temperature fluctuations within the structure	"realistic" limit temperatures when the exact temperature of the structure during installation is known and taken into consideration	"hypothetical" limit temperatures when the exact temperature of the structure during installation is estimated in advance
t_{min} t_{max}	$t_{l,min}$ $t_{l,max}$ ($\frac{\Delta t_l}{\Delta t} = 1,35$, unless otherwise stated)	$t^*_{l,min}$ $t^*_{l,max}$ ($t_l - t^*_l = \Delta t^*$ $\Delta t^* =$ 10 K for concrete, $\Delta t^* =$ 15 K for steel and steel on concrete)

C.2 Creep and shrinkage

Deformation due to creep and shrinkage shall be dealt with in the same way as additional thermal actions (generally speaking, cooling down).

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001. Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL