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Structural bearings - Part 3: Elastomeric bearings

Appareils d'appui structuraux - Partie 3: Appareils d'appui en élastomère

Lager im Bauwesen - Teil 3: Elastomerlager

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

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

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Contents

Foreword

This document (EN 1337-3:2005) 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of an identical text or by endorsement, at the latest by September 2005, and conflicting national standards shall be withdrawn at the latest by December 2006.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.

This European Standard EN 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 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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This part of EN 1337 applies to elastomeric bearings with or without complementary bearing devices to extend their field of use such as flat sliding elements covered by EN 1337-2 or sliding surface described in 4.4.4, as used in bridge structures or any other structure with comparable support conditions.

This part of EN 1337 applies to elastomeric bearings with dimensions in plan up to (1200 x 1200) mm and does not cover elastomeric bearings made with other elastomers materials than those specified in 4.4.1. It applies to laminated bearings types A, B, C, laminated sliding bearings types E and D, plain pad and strip bearings type F.

This part deals with bearings for use in operating temperatures ranging from – 25 °C to + 50 °C and for short periods up to + 70 °C.

It is recognised that the air temperature in some regions of Northern Europe is lower than –25 °C.

In this case of very low operating temperature (down to – 40 °C), it is essential that bearing characteristics comply also with the shear modulus at very low temperature (see 4.3.1.3. and annex F)

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.*

prEN 1337-8, *Structural bearings - Part 8: Guide bearings and restrain bearings.*

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

EN 1337-10; *Structural Bearings - Part 10: Inspection and maintenance.*

EN 1337-11; *Structural bearings - Part 11: Transport, storage and installation.*

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*

ISO 34-1, *Rubber, vulcanized or thermoplastic - Determination of tear strength - Part 1: Trouser, angle and crescent test pieces.*

ISO 37, *Rubber, vulcanized or thermoplastic - Determination of tensile stress-strain properties*.

ISO 48, *Rubber, vulcanized or thermoplastic - Determination of hardness (hardness between 10 IRHD and 100 IRHD).*

ISO 188, *Rubber, vulcanized or thermoplastic - Accelerated ageing and heat resistance tests.*

ISO 815, *Rubber, vulcanized or thermoplastic - Determination of compression set at ambient, elevated or low temperatures.*

ISO 1431-1, *Rubber, vulcanized or thermoplastic - Resistance to ozone cracking - Part 1: Static strain testing.*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1337-1:2000 and the following apply.

3.1.1
batch
individual mix or blend of mixes of elastomer, when used for bearing production or a number of identical components produced at the same machine setting

3.1.2
elastomer
macromolecular material, which returns to approximately its initial dimensions and shape after substantial deformation by a weak stress and release of stress. In this part of the standard it defines the compound that will be used for the production of a rubber part or parts.

3.1.3
elastomeric bearing
bearing comprising a block of vulcanised elastomer that may be reinforced with one or more steel plates

3.1.4
laminated bearing
elastomeric bearing reinforced internally with one or more steel plates, chemically bonded during vulcanisation

3.1.5
plain pad bearing
elastomeric bearing consisting of a solid block of vulcanised elastomer without internal cavities

3.1.6
sliding elastomeric bearing
laminated bearing with a PTFE sheet, at top surface, which may be vulcanised directly onto the outer layer of elastomer or fixed to a steel plate, in contact with a sliding plate

3.1.7
sliding plate
component which bears on and is immediately adjacent to the top sliding surface of a bearing. It can be:

a) a single piece of austenitic steel,

b) a thin plate of austenitic steel fixed to a mild steel supporting plate,

c) a thin plate of austenitic steel bonded to an elastomeric interlayer which is vulcanised to a mild steel supporting plate.

3.1.8
strip bearing
plain pad bearing for which the length is at least ten times the width

3.1.9
top sliding surface
polytetrafluoroethylene surface vulcanised on to an elastomeric bearing, in contact with the sliding plate which allows relative translatory displacement

3.2 Symbols

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

3.2.1 Latin upper case letters

A Overall plan area of elastomeric bearing .... mm²

A'	Effective plan area of laminated bearing (area of the steel reinforcing plates)	mm²
A_r	Reduced effective plan area of elastomeric bearing	mm²
C_c	Compressive stiffness of a bearing	N/mm
D	Overall diameter of circular bearing	mm
D'	Effective diameter of circular laminated bearing	mm
E	Modulus of elasticity	MPa
E_b	Bulk modulus	MPa
E_{cs}	Intersecting compression modulus	MPa
E_d	Design load effects	
F_{xd}, V_{yd}	Horizontal design forces	N: kN
F_{xy}	Maximum resultant horizontal force obtained by vectorial addition of v_x and v_y	N: kN
F_{zd}	Vertical design force	N: kN
G	Nominal value of conventional shear modulus of elastomeric bearing	MPa
G_{dyn}	Conventional shear modulus of elastomeric bearing under dynamic actions	MPa
G_e	Shear modulus of elastomer	MPa
G_g	Conventional shear modulus of elastomeric bearing determined by testing	MPa
$\mathrm{K_{ce}}$	Factor for strain due to compressive load for elliptical bearing	
$\mathrm{K_{de}}$	Factor for vertical deflection for load for elliptical bearing	
$\mathrm{K_{se}}$	Factor for restoring moment for elliptical bearing	
$\mathrm{K_f}$	Friction factor	
$\mathrm{K_h}$	Factor for induced tensile stresses in reinforcing plate	
$\mathrm{K_L}$	Type loading factor	
$\mathrm{K_m}$	Moment factor	
$\mathrm{K_p}$	Stress correction factor for the steel reinforcing plates	
$\mathrm{K_r}$	Rotation factor	
$\mathrm{K_s}$	Factor for restoring moment	
M_e	Experimental value of restoring moment	N x mm: kN x m
M_d	Design value of restoring moment	N x mm: kN x m
R_d	Design value of resistance	

R_{xy} Resultant of the forces resisting to translatory movement

S Shape factor

S_1 Shape factor for the thickest layers

S_d Design value of an internal force or moment of a respective vector of several internal forces or moments

T_o Average total initial thickness of bearing ignoring top and bottom covers .... mm

T_b Total nominal thickness of bearing .... mm

T_{bo} Mean total initial thickness of bearing .... mm

T_e Total nominal thickness of elastomer .... mm

T_q The average total initial thickness of elastomer in shear, including the top and bottom covers when these are not restrained for shearing. .... mm

3.2.2 Latin lower case letters

a Overall width of bearing (shorter dimension of rectangular bearing)........................ mm

a_e Minor axis of elliptic bearing

a' Effective width of laminated bearing (width of the steel reinforcing plates).............. mm

b Overall length of a bearing (longer dimension of a rectangular bearing) .... mm

b_e Major axis of elliptical bearing

b' Effective length of a laminated bearing (length of the steel reinforcing plates)........ mm

c compression stiffness .... N/mm

f_y Yield stress of steel.. N/mm²

l_p Force free perimeter of elastomeric bearing

n Number of elastomer layers

t Thickness of plain pad or strip bearing .... mm

t_e Effective thickness of elastomer in compression... mm

t_i Thickness of an individual elastomer layer in a laminated bearing .... mm

t_p Thickness of PTFE sheet.. mm

t_s Thickness of steel reinforcing plate .... mm

t_{so} Thickness of outer steel reinforcing plate .... mm

v_{cd} Total vertical deflection .... mm

v_x Maximum horizontal relative displacement in direction of dimension a .... mm

v_y Maximum horizontal relative displacement in direction of dimension b .... mm

v_z Vertical movement/deflection.. mm

v_{xy} Maximum resultant horizontal relative displacement obtained by vectorial addition of v_x and v_y .... mm

3.2.3 Greek letters

α Angular rotation of a bearing .... rad

α_a	Angular rotation across width *a* of a rectangular bearing .... rad
α_b	Angular rotation across length *b* of a rectangular bearing .... rad
α_{ab}	Resultant angular rotation across width *a* and length *b* of a rectangular bearing .... rad
α_d	Angular rotation across the diameter *D* of a circular bearing .... rad
γ_m	Partial safety factor for the resistance
δ	Vertical deflection of individual elastomer layer .... mm
Σ	Sum of values
$\varepsilon_{\alpha,d}$	Design strain in elastomer slab due to angular rotation
$\varepsilon_{c,d}$	Design strain in elastomer slab due to compressive loads
$\varepsilon_{q,d}$	Design shear strain in elastomer slab due to translatory movements
$\varepsilon_{t,d}$	Total nominal design strain in elastomer slab
ε_z	Compressive strain of a bearing
μ_d	Design friction coefficient
μ_e	Friction coefficient for elastomer
σ_c	Compressive stress .... MPa
σ_m	Average of the compressive stress .... MPa
σ_s	Tensile stress in steel .... MPa
τ	Shear stress .... MPa

3.2.4 Subscripts

d	Design
dyn	Dynamic
k	Characteristic
max	Maximum
min	Minimum
t	Total
u	At ultimate limit state

3.3 Abbreviations

For the purposes of this document, the following abbreviations apply.

CR	Polychloroprene Rubber
NR	Natural Rubber
pphm	Parts per hundred million by volume
PTFE	Polytetrafluoroethylene
SLS	Serviceability Limit State
ULS	Ultimate Limit State

4 Requirements

4.1 General

The level of quality required for an Elastomeric Bearing is mainly defined in terms of product performance through the limiting values and quantifiable characteristics by reference to complete bearings.

The specifications for materials from which the product shall be manufactured complement the essential requirements.

To ensure appropriate levels of performance, it is also necessary to refer to the following parts of EN 1337:

- part 1 General design rules
- part 2 Sliding elements
- part 8 Guide bearings and restrain bearings
- part 9 Protection
- part 10 Inspection and maintenance
- part 11 Transport, storage, and installation

4.2 Functional requirements

Elastomeric bearings shall be designed and manufactured to accommodate translational movements in any direction and rotational movements about any axis by elastic deformation, in order to transmit in a correct manner, from one structural component to another, the design forces and accommodate the design movements derived from the structural analysis.

They can be combined with complementary bearing devices to extend their field of use, such as a sliding system, either temporary or permanent, or a constraining system in any direction.

Elastomeric bearings shall function correctly when they are subject to normal environmental conditions and maintenance, during an economically reasonable designed working life. Where exceptional environmental and application conditions are encountered additional precautions shall be taken (see EN 1337-9). The conditions shall then be precisely defined.

Although elastomeric bearings are designed to accommodate shear movements, they shall not be used to provide permanent resistance to a constantly applied external shear force.

4.3 Performance requirements for complete bearings

This section defines all quantifiable characteristics of complete bearings. It specifies also the type of test either type test or routine test, their frequency and the type of the samples (see clause 8).

NOTE The laboratory temperature range for testing has been enlarged from that normally specified, taking into account that the properties of elastomers suitable for bearings do not change significantly between 15 °C and 30 °C. In the event of a conflict between test results from two different laboratories the range 23 °C ± 2 °C should take precedence.

4.3.1 Shear modulus

The shear modulus (G_g) is the apparent "conventional shear modulus" of elastomeric bearings determined by testing at different temperatures or after ageing in accordance with the method specified in annex F (normative).

NOTE See informative annex D.

4.3.1.1 Shear modulus at nominal temperature

At a nominal temperature of 23 °C ± 2 °C the value G_g of the conventional shear modulus shall comply with one of the values given hereafter:

G_g * = 0,7 MPa G_g = 0,9 MPa G_g * = 1,15 MPa

*Only if specified by the structure designer.

The test shall be performed for type tests at a temperature of 23 °C ± 2 °C, and for routine test at a temperature of 23 °C ± 5 °C.

- Requirements: The value of shear modulus G_g obtained by test shall comply with the following tolerances:

G_g = 0,9 MPa ± 0,15 MPa

G_g^* = 0,7 MPa ± 0,10 MPa

G_g^* = 1,15 MPa ± 0,20 MPa

*Only if specified by the structure designer.

The sample surfaces shall be free from voids, cracks or faults for example arising from moulding or bonding defects.

- Testing conditions: The tests shall be performed not earlier than one day after vulcanisation.

4.3.1.2 Shear modulus at low temperature

At low temperature the conventional shear modulus shall comply with the following requirement:

G_g low temperature ≤ 3 G_g

The test shall be performed as a type test.

- Samples conditioning: The uncompressed bearing shall be air-cooled in a chamber at

-25 °C ± 2 °C for 7 days.

- It shall be supported in such a way as to allow free circulation of air around it.

- Testing conditions: - In a chamber at –25 °C ± 2 °C or

- At a maximum temperature of 25 °C provided that, during the test, the edge surface temperature shall not be higher than –18 °C.

- Mean pressure: 6 MPa.

4.3.1.3 Shear modulus at very low temperature

At very low temperature the conventional shear modulus shall comply with the following requirement:

G_g very low temperature ≤ 3 G_g

The test shall be performed as a type test.

- Samples conditioning: The uncompressed bearing shall be air-cooled in a chamber at –40 °C ± 3 °C for 7 days.

- It shall be supported in such a way as to allow free circulation of air around it.

- Testing conditions: - In a chamber at –40 °C ± 3 °C or

- At a maximum temperature of 25 °C provided that, during the test, the edge surface temperature shall not be higher than –18 °C.

- Mean pressure : 6 MPa.

4.3.1.4 Shear modulus after ageing (3 days at 70 °C)

This test determines the variation of conventional shear modulus after accelerated ageing and shall be performed as a type test.

$$G_g \text{ after ageing} \leq G_g \text{ before ageing} + 0{,}15 \text{ MPa}$$

- Conditioning of the samples : the uncompressed bearing shall be stored in a heated chamber at :

70 °C ± 2 °C for 3 days

- It shall be supported in such a way as to allow free circulation of air around it.

- Testing conditions: The test shall be performed at laboratory temperature (23 °C ± 5 °C), not earlier than 2 days after the end of the ageing procedure.

4.3.2 Shear bond strength

The shear bond strength of elastomeric bearings shall determined in accordance with the method specified in annex G.

4.3.2.1 Shear bond strength at ambient temperature

At a temperature of 23 °C ± 5 °C the shear bond test shall be performed as a type and a routine test.

- Requirements : The slope of the force-deflection curve shall not show a maximum or a minimum value up to the maximum shear strain of 2. At maximum strain the edge of the bearing shall be free from splitting within the rubber due to moulding or bonding defects.

- Testing conditions : Mean pressure : 12 MPa

4.3.2.2 Shear bond strength after ageing (3 days at 70 °C)

After ageing the shear bond test shall be performed as a type test.

- Requirements: as in 4.3.2.1.

- Conditioning of the samples and testing conditions: as in 4.3.1.4.

4.3.3 Compression stiffness

The compression stiffness of elastomeric bearings shall be determined in accordance with the method specified in annex H.

For the type test, level 1 of the compressive test method is applicable.

For the routine test, level 2 of the compressive test method is applicable.

For a particular project when specified by the structure designer, level 3 of the compressive test method is applicable.

4.3.3.1 Type test (level 1 of testing method)

- Requirements:
  - The slope of the force-deflection curve shall not show a maximum or a minimum value of up to the maximum design load (5·*G* A' S / 1,5)
  - At the maximum load the edge of the bearing shall be free from splits within the rubber for example due to moulding or bonding defects.
  - No misplaced reinforcing plates.
  - The conventional intersecting modulus (E_{cs}) shall be recorded.
- Testing conditions : At ambient temperature: Conventional intersecting modulus (E_{cs}) shall be determined at 23 °C ± 5 °C between 30 % and 100 % of the maximum load (5·*GA*'·S / 1,5).

4.3.3.2 Routine test : Quick compressive test (level 2 of the testing method)

This test is normally made on bearings by the manufacturer, to check for misplaced reinforcing plates, bond failures at the steel/elastomer interface, surface defects and out of tolerance stiffness under the maximum load for the application.

- Requirements: There shall be no visual evidence of bond failure, misaligned reinforcing plates, or splits in the surface of the elastomer. The corrugations due to the restraining effects of the plates shall be uniform.
- Testing conditions: The serviceability limit state load specified, at ambient temperature (23 °C ± 5 °C) is applied to the bearing and held constant during a visual examination for the above defects. Where defects are suspected they shall be proved by other appropriate tests.

  During this test, the deflection between 30 % and 100 % of the maximum load for the application shall be recorded and used to check the consistency of the stiffness values.

4.3.3.3 Inspection under compressive load (level 3 of the testing method)

When specified, this test is carried out on every bearing as part of the normal production process. Its main objective is to eliminate by visual inspection poorly made bearings in a quick and efficient way.

- Requirements: There shall be no visual evidence of bond failure, misaligned reinforcing plates, or defects developing during testing in the surface of the elastomer under the maximum load for the application. The corrugations due to the restraining effects of the plates shall be uniform.
- Testing conditions: The serviceability limit state load is applied. The temperature of the room in which the bearings are tested shall not vary more than 10 °C throughout the test.

4.3.4 Resistance to repeated loading in compression

The resistance to repeated loading in compression of elastomeric bearings shall be determined in accordance with the method specified in annex I.

- Requirements: The intersecting compression modulus after dynamic fatigue shall be less than or equal to the intersecting modulus prior to dynamic fatigue + 12 %.

  No faults accepted: bonding defects, cracks, etc.

- Testing conditions: At laboratory temperature 23 °C ± 2 °C. The temperature rise in the bearing during the test should not exceed: 42 °C and the frequency may be adjusted to achieve this requirement.

  Numbers of cycles: 2 000 000

  Frequency: < 3 Hz

  During the test, the variation of stress shall be between the two following values:

  Minimum mean pressure: 7,5 MPa

  Maximum mean pressure: 25 MPa

NOTE It is essential to carry out the test at higher stresses than those which occur in practice, because the number of cycles is much less than expected during the life of bearing.

4.3.5 Static rotation capability

4.3.5.1 General

The static rotation capability of elastomeric bearings shall be determined on the base of the eccentric loading test and/or restoring moment, in accordance with test methods indicated in the following clauses.

The purpose of these tests is to determine the performance of elastomeric bearings under static rotation conditions. For most purposes the static rotation behaviour calculated from the equation in 5.3.3.6 and 5.3.3.7 is adequate, but if rotational performance is critical and the main reason for using the bearing is to provide rotation for elastomeric bearing type E and D a type test shall be carried out. Two aspects of rotational performance may be assessed, the maximum angle of rotation and the restoring moment exerted by the bearing on the structure. These two aspects can be determined respectively by the eccentric loading test or restoring moment test.

NOTE For a given bearing construction the manufacturer can only change the value of the shear modulus of the rubber to influence the rotational performance so it may be necessary to waive the requirements of 4.3.1 to achieve the desired performance. The consequence of such a change is that the vertical deflection (5.3.3.7.) will be affected.

4.3.5.2 Eccentric loading test

This test shall be performed to verify the maximum angle of rotation by determination of the area and mean pressure at the contact surface under imposed eccentricity or by determination of the maximum eccentricity to produce a specified contact area.

It shall be determined in accordance with the method specified in annex J.

- Requirements: Neither the uplift contact area, nor the mean contact pressure, shall exceed the values specified.

  When no value has been specified the following requirement shall be satisfied:

No faults accepted (bonding defects, cracks, etc) under an angle of rotation of 0,025 rad and an eccentricity of 1/6th of the smaller plan dimension of the test piece.

- Testing conditions: At laboratory temperature (23 °C ± 2 °C), the test is carried out with an experimental arrangement with known and low friction which permits rotation of the top surface relative to the bottom surface and loading bearing to the design value with a determined eccentricity or at different degrees of eccentricity.

4.3.5.3 Restoring moment test

The purpose of this test is to determine the experimental value of the restoring moment of a bearing.

It shall be determined in accordance with the method specified in annex K.

- Requirements: The experimental values of the restoring moment (M_e) shall not exceed the value agreed between the purchaser and the supplier

- Testing conditions: At laboratory temperature (23 °C ± 5 °C), the test is carried out under a mean pressure of 7 MPa. A moment is applied repeatedly for 10 cycles at a frequency ≤ 0,03 Hz to produce the required rotation.

4.3.6 Ozone resistance

The ozone resistance of elastomeric bearings shall be determined in accordance with the method specified in annex L.

The purpose of this test is to determine the ozone resistance of a complete bearing under compression and shear deformation.

- Requirements: No cracks in rubber.

  No cracks or bonding failure on the edge surface of the bearing.

- Testing conditions:

Mean pressure:	1,3 $G \cdot S$
Shear deformation:	$v_x = 0{,}7 \cdot T_q$
Testing temperature:	40 °C ± 2 °C
Ozone concentration:	NR : 25 pphm
	CR : 50 pphm
Testing time:	72 h

4.3.7 PTFE / elastomer shear bond strength

The PTFE/elastomer shear bond strength of elastomeric bearings shall be determined in accordance with the method specified in annex M.

The purpose of this test is to verify the correct bonding of the PTFE sheet of the sliding surface onto the external elastomer layer.

- Requirements: The slope of the force-deflection curve shall not show a maximum or a minimum value up to the maximum shear strain of 2. At maximum strain the PTFE / elastomer interfaces shall be free from bonding defects.

- Testing conditions: This test shall be performed at a temperature of 23 °C ± 5 °C.

Mean pressure: 6 MPa

4.4 Material properties

4.4.1 General

The elastomer used in the manufacture of Elastomeric Bearings should be specified in the project documentation as either natural rubber (NR) or chloroprene rubber (CR) as the raw polymer. Blending with up to 5 % of another polymer, which may be added to aid processing, is permitted. No reclaimed or ground vulcanised rubber shall be used.

NOTE Natural rubber bearings can be protected by a cover of polychloroprene, both parts being vulcanised simultaneously.

4.4.2 Physical and mechanical properties of elastomer

The physical and mechanical properties of the elastomer shall comply with the requirements given in Table 1, depending upon the raw polymer used. In case of a natural rubber bearing having a polychloroprene cover, the natural rubber does not have to be tested for ozone resistance.

The polychloroprene compound for the cover shall meet the requirements for polychloroprene and the core shall meet the requirements for NR, except for ozone resistance.

The frequency of the tests is given in clause 8.

The specifications are given for moulded test pieces or samples taken from complete finished bearings. In this case they shall be taken from the top and bottom surfaces or first internal layer, and from the internal layer at the centre of the bearing.

Table 1 — Physical and mechanical properties of elastomer

Characteristics	Requirements			Test methods
G Modulus (MPa)	0,7	**0,9**[a]	1,15	
Tensile strength (MPa) Moulded Test Piece Test Piece from Bearing	 ≥ 16 ≥ 14	 **≥ 16** **≥ 14**	 ≥ 16 ≥ 14	ISO 37 type 2
Minimum Elongation at break (%) Moulded Test Piece Test Piece from Bearing	 450 400	 **425** **375**	 300 250	
Minimum Tear Resistance (kN/m) CR NR	 ≥ 7 ≥ 5	 **≥ 10** **≥ 8**	 ≥ 12 ≥ 10	ISO 34-1 Trouser (Method A)
Compression Set (%) 24 h ; 70 °C	CR ≤ 15 NR ≤ 30			ISO 815 ϕ 29 x 12,5 mm Spacer : 9,38 - 25 %
Accelerated Ageing (Maximum change from unaged value) - Hardness (IRHD) NR 7 d, 70 °C CR 3 d, 100 °C - Tensile strength (%) NR 7 d, 70 °C CR 3 d, 100 °C - Elongation at break (%) NR 7 d, 70 °C CR 3 d, 100 °C	 - 5 +10 ± 5 ± 15 ± 15 ± 25 ± 25			ISO 48 ISO 188
Ozone Resistance Elongation : 30 % - 96 h 40 °C ± 2 °C NR 25 pphm CR 100 pphm)	No cracks			ISO 1431-1

[a] See 4.3.1.1.

4.4.3 Steel reinforcing plates

4.4.3.1 Inner plates

The inner reinforcing plates shall be of steel grade S 235 according to EN 10025 or steel with a minimum equivalent elongation at break. Their minimum thickness shall be 2 mm.

The provisions of 5.3.3.5 shall apply.

4.4.3.2 Outer plates for type C (see Table 2)

The outer reinforcing plates shall be of steel grade S 235 according to EN 10025 or steel with a minimum equivalent elongation at break.

For elastomeric bearings type C with internal layers less than or equal to 8 mm thick, the minimum thickness of the outer plates shall be 15 mm.

For thicker layers, the minimum thickness of the outer plates shall be 18 mm.

4.4.4 Sliding surfaces

This section deals with sliding materials vulcanised onto the elastomer or recessed into a backing plate as shown in Table 2, Bearings type D and E respectively.

The sliding surface of bearings type D shall only be used to accommodate irreversible movements (creep, shrinkage, etc.).

For all considerations which are not stipulated hereafter for bearings type D and E, EN 1337-2 applies.

4.4.4.1 Bonding of austenitic steel for bearings type D and type E (see Table 2)

For sliding elastomeric bearings, austenitic steel sheets can be bonded to the backing plate by means of an elastomeric layer.

The following requirements shall be satisfied:

- Thickness of the backing plate: see 6.9 of EN 1337-2:2004.
- Thickness of the elastomer, if present between the backing plate and the austenitic steel sheet: 2,5 mm ± 0,5 mm
- Minimum thickness of the austenitic steel sheet : 2 mm

4.4.4.2 Top sliding surface of bearings type D (see Figure 1 and Table 2)

The following requirements shall be satisfied:

-	Minimum thickness of PTFE sheet:	$t_p >$ 1,5 mm
-	Maximum thickness of PTFE sheet:	$t_p <$ 2,5 mm
-	Thickness of elastomer under the PTFE:	Max: 3 mm
		Min: 0,5 mm (at any point)
-	Depth of the dimples if any:	Min: 1 mm
		Max: 2,5 mm

4.4.4.3 Lubrication dimples of bearing type D (see Figure 1 and Table 2)

Lubricant retention dimples in PTFE shall comply with the following requirements.

Where dimples are produced by hot pressing, the temperature of the vulcanising process shall not exceed 200 °C.

The plan area of the cavities shall be between 20 % and 30 % of the total PTFE bearing surface including the area of the dimples.

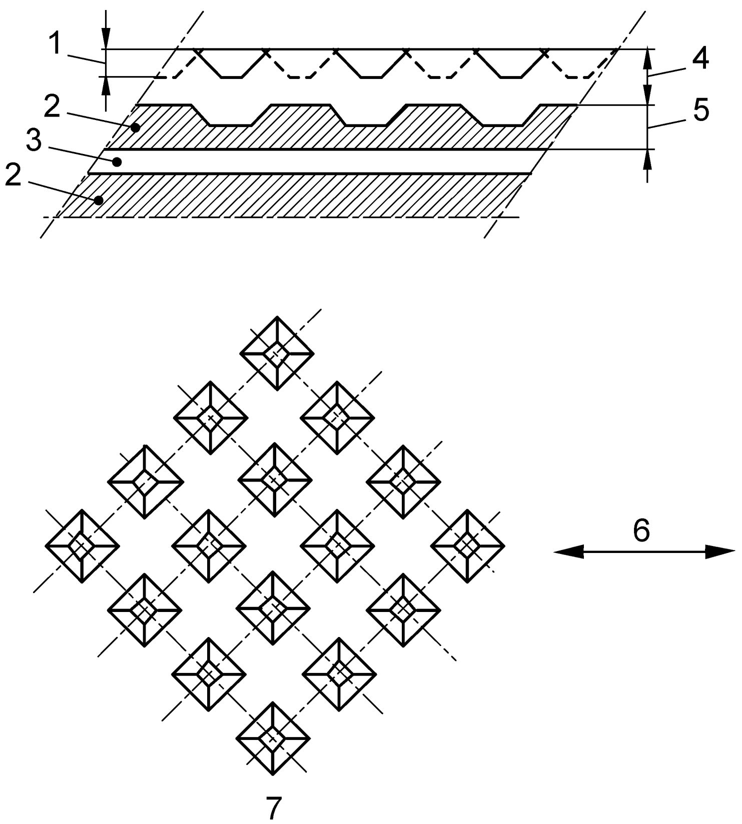
The volume of the cavities shall not be less than 10 % nor more than 20 % of the volume of PTFE, including the volume of cavities.

Undimpled PTFE sheets as sliding material for bearings of type D shall only be used if so specified by the structure designer.

4.4.4.4 Friction coefficient

For sliding elastomeric bearings the friction coefficient shall be determined in the same way and shall satisfy the same requirements as other sliding elements (see 6.9 of EN 1337-2:2004).

Partial cross section example of elastomeric bearing external layers type D



Key

1 1 mm < dimple depth < 2,5 mm

2 Elastomeric layers

3 Reinforcing steel plate

4 1,5 mm < t_p < 2,5 mm

5 0,5 mm < thickness of elastomer < 3 mm

6 Main direction of sliding

7 Plan view

Figure 1 — Lubrication dimples of bearing type D

5 Design rules

5.1 General

Elastomeric bearings shall be designed to meet the relevant provisions of this section at ultimate limit state.

At the ultimate limit state the strength and stability of bearings shall be adequate to withstand the ultimate design loads and movements of the structure.

Performance and durability of bearings designed according to this standard are based on the assumption that tolerances given in clause 6 are complied with.

5.2 Design values of actions

Elastomeric bearings shall be designed in such a way that design value of actions S_d (see form in Table E.1) does not exceed the design value of resistance R_d, taking into account all the principal and secondary action effects and the relative movements as defined in 5.5 of EN 1337-1:2000.

When installation inaccuracies exceed the specified tolerance limits given in 7.1, the consequences of this deviation on the structures shall be determined.

5.3 Laminated bearings

5.3.1 Types of laminated bearings

Bearing design shall be in accordance with one of the types or a combination of the types classified as in Table 2.

5.3.2 Sizes and shapes of laminated bearings

Bearing types are rectangular or circular but, for particular applications elliptical or octagonal (approximating to elliptical) shapes are acceptable. Specific design rules for elliptical bearings are given in annex A (normative). Octagonal bearings may be regarded as elliptical for all calculations, other than shape factor and pressure, with the major and minor axes equal to the length and width dimensions.

A particular bearing shall be designed with internal rubber layers of the same thickness between 5 mm and 25 mm each.

Recommended standard sizes for bearings type B are given in Table 3.

For laminated bearings it is permissible to reduce the loaded area, without changing the plan dimensions, by including holes of uniform section in the loaded area.

The symbols used in design rules are shown in Figure 2.

Dimensions in millimetres

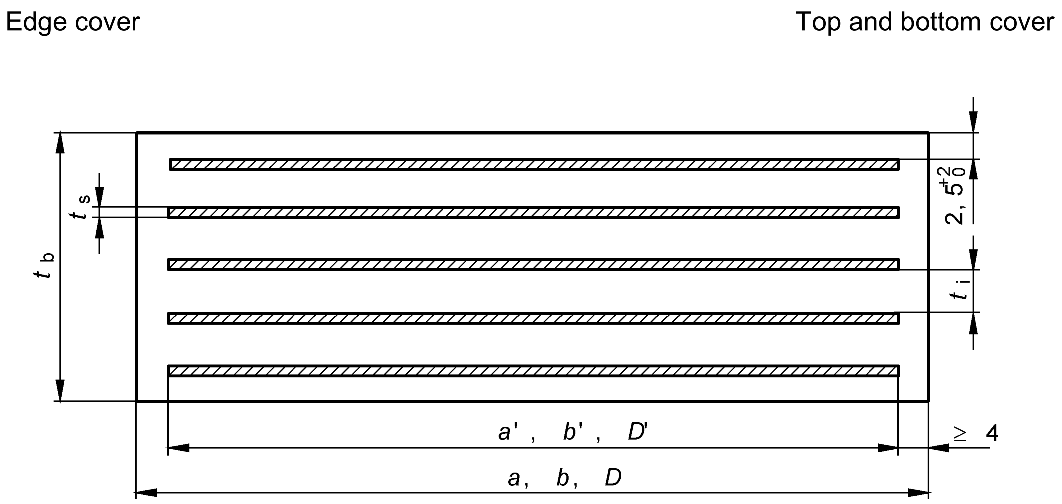
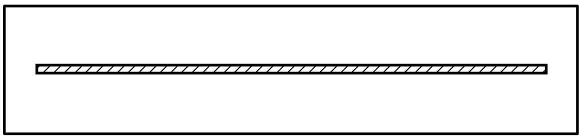
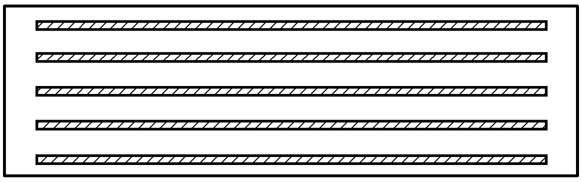
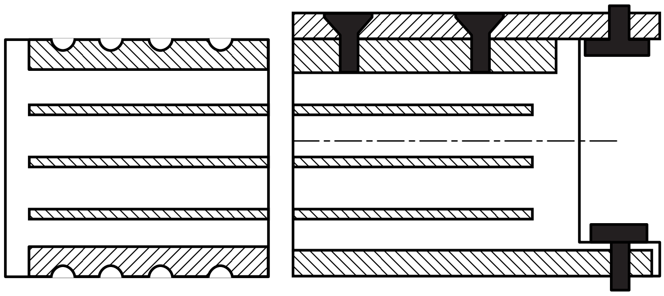
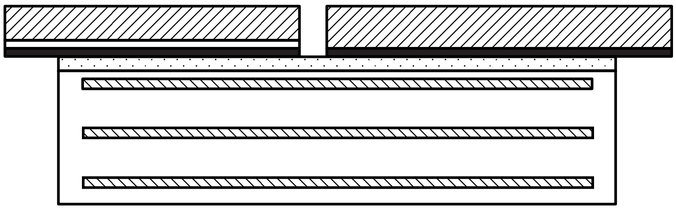
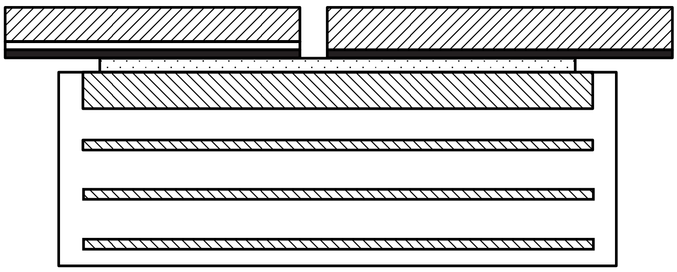


Figure 2 — Typical cross section of an elastomeric bearing type B

Table 2 — Different types of bearing cross sections

- Type A: Laminated bearing fully covered with elastomer comprising only one steel reinforcing plate.	
- Type B: Laminated bearing fully covered with elastomer comprising at least two steel reinforcing plates.	
- Type C: Laminated bearing with outer steel plates (profiled or allowing fixing). NOTE The sketch shows examples of a few fixing methods; other methods can be used by agreement.	
- Type D: Type B with PTFE sheet bonded to the elastomer.	
- Type E: Type C with one outer plate bonded to the elastomer and PTFE sheet recessed in the steel.	
- Type F: Plain pad bearings and strip bearings	

NOTE Features of the above types can be combined.

Table 3 — Standard sizes for bearings type B

Dimensions a x b (mm) or D	THICKNESS in mm						Number of layers n	
	Unloaded bearing		Elastomer (total [a])		Elastomer layers	Reinforcing plates	min.	max.
	min.	max.	min.	max.				
100 x 150	30	41	16	24	8	3	2	3
100 x 200	30	41	16	24	8	3	2	3
150 x 200	30	52	16	32	8	3	2	4
ϕ 200	30	52	16	32	8	3	2	4
150 x 250	30	52	16	32	8	3	2	4
150 x 300	30	52	16	32	8	3	2	4
ϕ 250	30	52	16	32	8	3	2	4
200 x 250	41	74	24	48	8	3	3	6
200 x 300	41	74	24	48	8	3	3	6
200 x 350	41	74	24	48	8	3	3	6
ϕ 300	41	74	24	48	8	3	3	6
200 x 400	41	74	24	48	8	3	3	6
250 x 300	41	85	24	56	8	3	3	7
ϕ 350	41	85	24	56	8	3	3	7
250 x 400	41	85	24	56	8	3	3	7
300 x 400	57	105	36	72	12	4	3	6
ϕ 400	57	105	36	72	12	4	3	6
300 x 500	57	105	36	72	12	4	3	6
ϕ 450	57	105	36	72	12	4	3	6
300 x 600	57	105	36	72	12	4	3	6
350 x 450	57	121	36	84	12	4	3	7
ϕ 500	57	121	36	84	12	4	3	7
400 x 500	73	137	48	96	12	4	4	8
ϕ 550	73	137	48	96	12	4	4	8
400 x 600	73	137	48	96	12	4	4	8
450 x 600	73	153	48	108	12	4	4	9
ϕ 600	73	153	48	108	12	4	4	9
500 x 600	73	169	48	120	12	4	4	10
ϕ 650	73	169	48	120	12	4	4	10
600 x 600	94	199	64	144	16	5	4	9
ϕ 700	94	199	64	144	16	5	4	9
600 x 700	94	199	64	144	16	5	4	9
ϕ 750	94	199	64	144	16	5	4	9
700 x 700	94	220	64	160	16	5	4	10
ϕ 800	94	220	64	160	16	5	4	10
700 x 800	94	220	64	160	16	5	4	10
ϕ 850	94	220	64	160	16	5	4	10
800 x 800	110	285	80	220	20	5	4	10
ϕ 900	110	285	80	220	20	5	4	10
900 x 900	110	285	80	220	20	5	4	11

[a] Total thickness without 2,5 mm top and bottom cover

5.3.3 Basis of design

The design rules are based on the assumption that the elastomer is an viscoelastic material, the deflection of which under a compressive load is influenced by its shape. Reinforcing plates in the bearing shall be chemically bonded to the elastomer to prevent any relative movement at the steel / elastomer interface.

Design calculation shall not be applied to the external top and bottom layer when their thickness is less or equal to 2,5 mm.

All designed bearings including standard sizes shown in Table 3 shall meet the requirements given hereafter:

a) Maximum design strain

At any point in the bearing the sum of the strains ($\varepsilon_{t,d}$) due to the design load effects (E_d) is given by the expression:

$$\varepsilon_{t,d} = K_L (\varepsilon_{c,d} + \varepsilon_{q,d} + \varepsilon_{\alpha,d}) \quad (1)$$

where:

$\varepsilon_{c,d}$ is the design strain due to compressive design loads as defined in 5.3.3.2.

$\varepsilon_{q,d}$ is the design shear strain due to design translatory movements as defined in 5.3.3.3.

$\varepsilon_{\alpha,d}$ is the design strain due to the design angular rotation as defined in 5.3.3.4.

K_L is a type-loading factor; see annex C (normative) to determine value.

$\varepsilon_{t,d}$ shall not exceed the maximum value $\varepsilon_{u,d}$ given by the expression:

$$\varepsilon_{u,d} = \frac{\varepsilon_{u,k}}{\gamma_m} \quad (2)$$

where:

$\varepsilon_{u,k}$ is the maximum permissible value of 7 for ULS (See note 1)

γ_m is a partial safety factor which value may be chosen in the National Annex.
The recommended value is $\gamma_m = 1.00$

b) Maximum tensile stresses in reinforcing plates

Reinforcing plates shall be designed for ULS as defined in 5.3.3.5.

c) Stability criteria (see 5.3.3.6)

Stability criteria shall be evaluated taking into account the following:

- Stability regarding rotation
- Stability regarding buckling
- Stability regarding sliding

d) Forces, moments, and deformations exerted on the structure (see 5.3.3.7)

Forces, moments and deformations shall be evaluated taking into account the following:

- The pressure at the contact surfaces between the bearing and the structure
- The force exerted on the structure by the bearing resisting translatory movement
- The restoring moment due to the bearing resisting rotational movement
- Vertical deflection due to the vertical load

NOTE The nominal shear modulus can be modified for dynamic load effects (railway structures, earthquake), depending on the exciting frequencies (generally frequencies > 6Hz) and movement amplitudes: the factor, which may vary for different compounds, can be obtained experimentally.

5.3.3.1 Shape factor

The shape factor S is a means of taking account of the shape of the elastomer in strength and deflection calculations. It is the ratio of the effective plan area of an elastomeric slab to its force-free surface area, including holes.

For laminated bearings the shape factor S for each individual elastomer layer is given by the expression:

$$S = \frac{A_1}{l_p \cdot t_e} \qquad (3)$$

For plain pad bearings the shape factor S is given by the expression:

$$S = \frac{A}{l_p \cdot t_e} \qquad (4)$$

For strip bearings the shape factor S is given by the expression:

$$S = \frac{a}{2t_e} \qquad (5)$$

where:

A_1 : is the effective plan area of the bearing, i.e. the plan area common to elastomer and steel plate, excluding the area of any holes if these are not later effectively plugged.

A : is the overall plan area of the elastomeric bearing.

a : is the overall width of the strip bearing.

l_p : is the force-free perimeter of the bearing including that of any holes if these are not later effectively plugged.

t_e : is the effective thickness of an individual elastomer layer in compression; in laminated bearings it is taken as the actual thickness, t_i, for inner layers, and 1,4 t_i for outer layers with a thickness ≥ 3 mm ; in plain pad and strip bearings it is taken as 1,8 t_i (t_i is the thickness of an individual elastomer layer).

NOTE For a rectangular bearing without holes:

$$A_1 = a' \cdot b' \text{ and} \qquad (6)$$

$$l_p = 2\,(a' + b') \qquad (7)$$

where

a' : is the effective width of the bearing (i.e. the width of reinforcing plates).

b' : is the effective length of the bearing (i.e. the length of reinforcing plates).

5.3.3.2 Design strain due to compressive load

For calculation purpose G shall be one of the values defined in Table 1.

$\varepsilon_{c,d}$ is the design strain due to compressive loads, and is given by the expression:

$$\varepsilon_{c,d} = \frac{1{,}5 \cdot F_{z,d}}{G \cdot A_r \cdot S} \tag{8}$$

A_r : is the reduced effective plan area due to the loading effects, where A_r is given by the expression:

$$A_r = A_1 \left(1 - \frac{v_{x,d}}{a'} - \frac{v_{y,d}}{b'} \right) \tag{9}$$

where

$v_{x,d}$: is the maximum horizontal relative displacement of parts of the bearing in the direction of dimension *a* of the bearing due to all design load effects ;

$v_{y,d}$: is the maximum horizontal relative displacement of parts of the bearing in the direction of dimension *b* of the bearing due to all design load effects.

5.3.3.3 Shear strain

The shear strain $\varepsilon_{q,d}$ of the elastomer due to translatory movement shall not exceed 1,00, and is given by the expression.

$$\varepsilon_{q,d} = \frac{v_{xy,d}}{T_q} \tag{10}$$

where

$v_{xy,d}$: is the maximum resultant horizontal relative displacement of parts of the bearing obtained by vectorial addition of $v_{x,d}$ and $v_{y,d}$;

($v_{x,d}$ and $v_{y,d}$ are defined in 5.3.3.2)

T_q : is the total thickness of the elastomer in shear including the top and bottom cover, unless relative movement between the outer plates of the bearing and the structure is restrained by dowelling or other means.

NOTE The maximum permissible value for $\varepsilon_{q,d}$ defined as 1,00 for ULS has been derived from $\varepsilon_{g,k}$ by multiplying with γ_f = 1,40

5.3.3.4 Design strain due to angular rotation

The nominal strain due to angular rotation is given by the expression:

$$\varepsilon_{\alpha,d} = \frac{\left(a'^2 \cdot \alpha_{a,d} + b'^2 \cdot \alpha_{b,d} \right) t_i}{2 \sum \left(t_i^3 \right)} \tag{11}$$

$\alpha_{a,d}$: is the angle of rotation across the width, *a*, of the bearing;

$\alpha_{b,d}$: the angle of rotation (if any) across the length, *b*, of the bearing;

t_i : is the thickness of an individual layer of elastomer.

5.3.3.5 Reinforcing plate thickness

To resist induced tensile stresses under load, the minimum thickness of the steel plates in a laminated bearing is given by the expression:

$$t_s = \frac{\mathrm{K_p} \cdot F_{\mathrm{z,d}} \cdot (t_1 + t_2) \cdot \mathrm{K_h} \cdot \gamma_{\mathrm{m}}}{A_{\mathrm{r}} \cdot f_{\mathrm{y}}} \quad \text{and} \quad t_{\mathrm{s}} \geq 2 \text{ mm} \tag{12}$$

where

$F_{z,d}$ and A_r are as defined in 3.2

t_1 and t_2 are the thickness of elastomer on either side of the plate;

f_y is the yield stress of the steel;

K_h is a factor for induced tensile stresses in reinforcing plate which value is given hereafter:

without holes : $K_h = 1$

with holes : $K_h = 2$

γ_m is the partial safety factor which value may be chosen in the National Annex.

The recommended value is given hereafter: $\gamma_m = 1,00$

K_p is a stress correction factor which value is given hereafter:

$K_p = 1,3$

5.3.3.6 Limiting conditions

- Rotational limitation condition

For laminated bearings, the rotational limitation shall be satisfied when the total vertical deflection $\Sigma v_{z,d}$ (see 5.3.3.7.) complies with:

For rectangular bearings $$\sum v_{\mathrm{z,d}} - \frac{\left(a' \cdot \alpha_{\mathrm{a,d}} + b' \cdot \alpha_{\mathrm{b,d}}\right)}{\mathrm{K_{r,d}}} \geq 0 \tag{13}$$

For circular bearings $$\sum v_{\mathrm{z,d}} - \frac{\left(D' \cdot \alpha_{\mathrm{d}}\right)}{\mathrm{K_{r,d}}} \geq 0 \tag{14}$$

where

D' is the effective diameter of the bearing

$K_{r,d}$ is a rotation factor, which is defined in annex B (normative)

$\Sigma v_{z,d}$ is the total vertical deflection producing α_a and α_b

- Buckling stability

For laminated bearings, the pressure, $\frac{F_{z,d}}{A_r}$ shall satisfy the following expression:

For rectangular bearings $\frac{F_{z,d}}{A_r} < \frac{2 \cdot a' \cdot G \cdot S_1}{3 \cdot T_e}$ (15)

For circular bearings a' shall be deemed to be the diameter.

- Non sliding condition For non anchored bearings the following formulae shall be satisfied:

$F_{xyd} \leq \mu_e \cdot F_{z,d\ min}$

and under permanent loads:

$$\sigma_{cd\ min} = \frac{F_{z,d\,min}}{A_r} \geq 3 \text{ (in N/mm}^2\text{)} \tag{16}$$

where

$F_{xy,d}$: is the resultant of all the horizontal forces

$F_{z,d\ min}$: is the minimum vertical design force coexisting with $F_{xy,d}$

μ_e : is the friction coefficient given by the expression hereafter:

$$\mu_e = 0{,}1 + \frac{1{,}5K_f}{\sigma_m}$$

where

K_f = 0,6 for concrete

= 0,2 for all other surfaces including bedding resin mortars.

σ_m is the average of the compressive stress in megapascals from $F_{z,d\ min}$

NOTE The design values of the friction coefficients for the sliding condition are relatively low to allow for long term effects. Nevertheless more onerous values of μ_e than those mentioned above can be specified for structures with high dynamic conditions, such as railway bridges, or with smooth plinth surfaces.

Where a bearing fails to satisfy the requirements for stability against sliding, positive means of location shall be provided to resist the whole of the horizontal forces.

5.3.3.7 Forces, moments, and deformations exerted on the structure

- Pressure on the contact surfaces

Elastomeric bearing exert a non-uniform pressure on the contact surface with the structure.

It is sufficient to ensure that mean pressure does not exceed the strength of the supporting material.

- Force exerted on the structure by the bearing resisting translatory movement

The force R_{xy} exerted on the structure by the bearing resisting translatory movement is given by:

$$R_{xy} = \frac{A \cdot G \cdot v_{xy}}{T_e} \tag{17}$$

where

R_{xy}:	is the resultant of the forces resisting to translatory movement
A	is the total plan area of the bearing
G	is the shear modulus of the bearing
T_e :	is the total thickness of elastomer in shear

The force R_{xy} shall not exceed the value specified.

- Resistance to rotation

The design value of the restoring moment due to rotation about an axis through the centre of the bearing, parallel to the length (b direction), is given by the following expressions:

for rectangular bearing : $$M = G \cdot \frac{\alpha \cdot a'^5 \cdot b'}{n \cdot t_i^3 \cdot K_s} \tag{18}$$

for circular bearing : $$M = G \cdot \frac{\alpha \cdot \pi \cdot D'^6}{512 \cdot n \cdot t_i^3} \tag{19}$$

To determine the factor K_s see Table 4 hereafter

Table 4 — Restoring moment factor

b*/*a	0,5	0,75	1	1,2	1,25	1,3	1,4	1,5
K_s	137	100	86,2	80,4	79,3	78,4	76,7	75,3
b*/*a	1,6	1,7	1,8	1,9	2	2,5	10	∞
K_s	74,1	73,1	72,2	71,5	70,8	68,3	61,9	60

NOTE 1 If $b < a$ the formula is still applicable for rotation about the axis parallel to b, but in this case b is the shorter dimension and a is the longer dimension, in contrast with the definitions given in 3.2.

NOTE 2 The calculated value of the restoring moment is sufficient for most purposes but if a precise knowledge of its value is necessary then the value should be determined experimentally.

Vertical deflection

The total vertical deflection v_c of a laminated bearing is the sum of the vertical deflection of the individual layers given by the expression:

$$v_c = \Sigma \frac{F_z \cdot t_i}{A'} \cdot \left(\frac{1}{5 \cdot G \cdot S_1^2} + \frac{1}{E_b} \right) \quad (20)$$

The vertical deflection of elastomeric bearings shall be estimated from the expressions given above for use in conjunction with 5.3.3.6. Where a precise value is required it shall be checked by testing sample bearings.

NOTE 1 The value of the bulk modulus E_b generally used is the following:

$$E_b = 2000 \text{ MPa}$$

NOTE 2 The actual deflection of a bearing includes an initial bedding down phase that can produce deflections of approximately 2 mm. Thereafter, the stiffness of the bearing increases with increasing load. Where the vertical deflection under load is critical to the design of the structure, the stiffness of the bearing should be ascertained by tests. However, a variation of as much as ± 20 % from the observed mean value may still occur. When a number of similar bearings are used at a support and the differential stiffness between the bearings is critical for the structure, a variation of compressive stiffness should be allowed in the design, equal to either ± 15 % of the value estimated from the above equation, or ± 15 % of the mean value observed in tests.

NOTE 3 The calculation for the deflection of plain bearings is likely to underestimate the deflection under permanent loads and overestimate the deflection under transient loads.

5.4 Plain pad bearings

This type of bearing, consisting of a solid block of elastomer without reinforcing plates, is not generally used for bridge structures. These bearings are only suitable for low pressure and predominantly static actions as indicated below.

5.4.1 Geometry

Plain pad bearings are generally of square, rectangular or circular plan area. The thickness shall not be less than 8 mm.

5.4.2 Loads

The mean design pressure, σ_{cd}, on a plain pad bearing is defined by the expression:

$$\sigma_{cd} = \frac{F_{z,d}}{A} \quad (21)$$

where :

$F_{z,d}$: is the vertical design load effect

A : is the overall plan area of the plain pad bearing

The mean design pressure, σ_{cd}, shall not exceed 1,4 G_dS or 7 G_d, whichever is the lesser, where

G_d is the design shear modulus of the elastomer and S is the shape factor of the elastomer slab

NOTE The maximum permissible value for σ_{cd} for ULS has been derived from GS or 5 G for SLS by multiplying with γ_f = 1,40.

5.4.3 Shear strain

The provisions of 5.3.3.3 shall apply.

5.4.4 Stability criteria

Rotation : The provisions of 5.3.3.6 shall apply.

Buckling : Thickness < 1/4 minimum lateral dimension.

Sliding : The provisions of 5.3.3.6 for all loads shall be applied and

$$\frac{F_{z,d}}{A_r} > 1 + \frac{a}{b} \text{ for permanent loads.} \tag{22}$$

5.4.5 Deformations and forces exerted on the structure

Vertical deflection: The deflection is given by the equation for a single layer in 5.3.3.7.

(Ignoring term involving the bulk modulus).

Mean Pressure :

$$\frac{F_{z,d}}{A} \tag{23}$$

Translatory: The force arising from the shear strain is given in 5.3.3.7.

5.5 Strip bearings

This type of bearing consisting of a solid strip of elastomer without reinforcing plates is not generally used for bridge structures.

5.5.1 Geometry

The thickness of strip bearings shall not be less than 8 mm.

5.5.2 Loads

The mean design pressure, σ_{cd}, on a strip bearing as defined by the expression :

$$\sigma_{cd} = \frac{F_{z,d}}{A} \tag{24}$$

Shall not exceed the maximum limit value σ_{cd} = 1,4 GS or 7 G, whichever is the lesser,

where :

$F_{z,d}$: is the vertical design load effect

A : is the overall plan area of the strip bearing

G : is the nominal shear modulus of the elastome;

S : is the shape factor of the elastomer slab

5.5.3 Shear strain

The calculation for determining ε_{qd} described in 5.3.3.3 shall apply. The shear strain shall be limited to the following value:

$$\varepsilon_{qd} \leq 0,3$$

5.5.4 Stability criteria

Rotation: $$\sum \delta > \frac{a\alpha_a}{3} \tag{25}$$

Buckling: Thickness < 0,25 · width

Sliding: The provisions in 5.3.3.6 for all loads shall be applied and

$$\frac{F_{z,d}}{A_1} > 1 + \frac{a}{b} \quad \text{for permanent loads.} \tag{26}$$

5.5.5 Deformations and maximum forces exerted on the structure

Vertical deflection: The deflection is given by the equation for a single layer in 5.3.3.7 (Ignoring term involving the bulk modulus).

Mean Pressure: $$\frac{F_{z,d}}{A} < G_d S \text{ or } 5G_d \text{ whichever is lower.} \tag{27}$$

Translatory The force arising from the shear strain is given in 5.3.3.7.

5.6 Sliding elastomeric bearings

Bearings of type D and E in Table 2 shall conform to the design rules and manufacturing tolerances for laminated bearings, see 5.3.3.

The maximum frictional force $F_{xy,d}$, when calculated in accordance with EN 1337-2 shall comply with:

$$F_{xy,d} \leq R_d$$

$$R_d = AG$$

6 Manufacturing tolerances

6.1 Plan size

The tolerances of the linear dimension shall be : -2 mm / +4 mm

6.2 Thickness of elastomer layers

The mean thickness is the arithmetical average of the thickness measured at five points on the major surface as indicated for the various shaped bearings.

Rectangular:	corners and centre,
Circular:	corners of inscribed square and centre,
Elliptical:	ends of major and minor axes and centre,
Octagonal:	midpoints of sides of circumscribed rectangle and centre.

6.2.1 Internal layer

5 mm $\leq t_i < 10$ mm	Mean thickness	= nominal thickness	± 15 % or ± 0,9 mm whichever is greater
	Individual thickness	= mean thickness	± 15 % or ± 0,9 mm whichever is greater
10 mm $\leq t_i < 15$ mm	Mean thickness	= nominal thickness	± 12 % or ± 1,5 mm whichever is greater
	Individual thickness	= mean thickness	± 12 % or ± 1,5 mm whichever is greater
15 mm $\leq t_i \leq 25$ mm	Mean thickness	= nominal thickness	± 10 %
	Individual thickness	= mean thickness	± 10 %

NOTE All the dimensions measured refer to the reinforcing plates. In order to measure the thickness of an individual layer it is essential to cut the sample bearing.

6.2.2 External layer on top and bottom surfaces for laminated bearings

The nominal distance between restraining material and external plane is : 2,5 mm (type "B" bearing system).

The tolerance regarding this thickness is: - 0 / + 2 mm.

For external layers thicker than 2,5 mm the tolerance specified in 6.2.1 shall apply, provided that the minimum thickness is not thereby reduced to less than 2,5 mm.

6.2.3 Tolerances of total thickness of bearing system

NOTE When combined with sliding elements, it is recommended to use close tolerances divided by 2.

6.2.3.1 Mean thickness tolerances

The mean thickness is the arithmetical average of thickness measured at each corner and at the centre. The tolerance of the total mean thickness (T_{bo}) according to the nominal thickness is:

	$T_{bo} \leq$	100	± 2 mm
100	$< T_{bo} \leq$	150	± 3 mm
150	$< T_{bo}$		± 4 mm

6.2.3.2 Parallelism of external faces

The accepted variations of thickness between two consecutive corners are:

- 0,2 % of the distance between those two points or 1 mm whichever is larger for bearing plan dimensions under 700 X 700 mm.

- 0,3 % of the distance between those two points or 1 mm whichever is larger for bearing plan dimensions larger than 700 X 700 mm.

6.2.3.3 Flatness

The flatness of a bearing is assessed by placing a straight-edged along a diagonal (or diameter) of the load bearing surface of the bearing. The gap between a straightedge and the surface of the bearing shall not exceed 0,3 % of the diagonal (or diameter) or the value defined hereafter whichever is greater.

T_{bo}	≤	50	± 1,0 mm
50	< T_{bo} ≤	100	± 1,5 mm
100	< T_{bo} ≤	150	± 2,0 mm
150	< T_{bo}		± 2,5 mm

In the case of convex surface, the point of contact of the straightedge may be adjusted if necessary to ensure that the gaps at each end are equal.

NOTE When combined with sliding elements, it recommended to use close tolerances divided by 2.

6.2.4 Edge cover thickness for laminated bearings

The minimum distance between steel reinforcing plate and edge shall be 4 mm.

6.3 Reinforcing steel plate for laminated bearings

Tolerance on the nominal values of the length and width:		+ 2 mm / - 1 mm
Tolerance on the nominal values of the thickness:	$t_s \leq 4$ mm	+ 0,8 mm / - 0,4 mm
	$t_s > 4$ mm	+ 1,1 mm / - 0,4 mm

The flatness of a steel reinforcing plates is assessed by placing a straightedge along a diagonal (or diameter) of the plate surface. The gap between a straightedge and the surface of the plate shall not exceed 1 % of the diagonal (or diameter) or 1,5 mm whichever is greater.

7 Special requirements

In order for the bearings to perform as intended, the following requirements shall be observed.

7.1 Plinth of the structure - Tolerances of the contact area with the structure

7.1.1 General

Bearings may be set in mortar or placed directly onto a suitable plinth. In the latter case the plinth surface shall meet the requirements given hereafter.

7.1.2 Surface conditions

The plinth surface shall be clean and dry. Free particles shall not be permitted.

Individual surface imperfections shall be less than 100 mm^2 in area, and not differ in height by more than 2,5 mm from the surrounding surface. The total area of the imperfections shall not be more than 2 % of the plan area of the bearing.

7.1.3 Surface flatness

A straight-edge placed along a diagonal of the proposed contact area shall not reveal hollows in excess of 2 mm or 0,3 % of the considered length whichever is greater.

7.1.4 Surface level

The plinth shall be level to within a maximum permissible error in rotation from specified position of:

0,3 % for bearings supporting a precast or steel structure.

1 % for bearings supporting a cast in place structure.

NOTE 1 Where prefabricated members are placed on bearings a layer of grout or similar setting material should normally be included to take up any discrepancy.

NOTE 2 These values do not apply to plain pad bearings and strip bearings. Under normal conditions of installation the tolerances of the contact area of the structure are generally covered by the minimum thickness allowed (see 5.4.1 and 5.5.1).

7.2 Positive means of location

Where a bearing requires positive means of location in accordance with 5.3.3.6, these shall restrict the movement between the structure and the bearing surfaces in contact with it to no more than 5 mm or less if so specified by the structure designer. They shall be designed to resist the residual horizontal force on allowing for the friction calculated according to 5.3.3.6. They shall be such that the bearing can be removed with the structure jacked up by not more than 10 mm unless otherwise agreed with the designer of the structure.

7.3 Marking and labelling

Each rubber bearing is uniquely and individually numbered on its external faces.

As a minimum, a label is vulcanised on the top or bottom of the bearing detailing:

- the manufacturer's name

- the manufacturing number

and the manufacturer's name or symbol on one of the edges.

Marking shall be resistant to water and normal wear and tear.

Covering the "C" type elastomer bearing systems, an indelible label carrying the same details as those mentioned on the self-vulcanising label (see above).

Bearings with enhanced very low temperature performance shall be distinctly marked "Very Low Temp".

NOTE For CE marking and labelling subclause ZA.3 applies.

8 Conformity evaluation

8.1 General

The tests and inspections in this clause shall be carried out to demonstrate the products conformity with this document.

The given procedure for evaluation of conformity is also valid for non-series production.

The tests and inspections required under a factory production control scheme shall be in accordance with annex N.

8.2 Control of the construction product and its manufacture

8.2.1 General

The extent and frequency of factory production control by the manufacturer shall be in accordance with Tables 7 and 8.

In addition, the bearing manufacturer shall check the inspection certificates of constituents comply with this document.

8.2.2 Initial type tests

The type tests shall be carried out prior to commencing the manufacture by an approved testing laboratory, or under their direction.

The requirements are specified in 4.3.

The type test frequency and the sample sizes are defined in Tables 6, 7 and 8.

NOTE 1 The tests may be carried out at the manufacturer's premises provided that the equipment is calibrated to a National and/or European Standard and that the tests are directed by a representative of the approved test laboratory.

NOTE 2 When required, an analysis may be made on a sample of the compound from a bearing. The analysis type should be defined by agreement between the purchaser and the supplier.

8.2.3 Routine testing

The routine testing shall be carried out continuously by the manufacturer.

For complete bearings the requirements are specified in 4.3.

The routine test frequency and the sample sizes are defined in Tables 5, 7 and 8.

The routine test frequency for complete bearings is defined in terms of volume for each thickness category as determined hereafter.

The complete bearing production is broken down into four categories of thickness as defined hereafter:

1 -		$T_b \leq$	50 mm
2 -	50 mm	$< T_b \leq$	100 mm
3 -	100 mm	$< T_b \leq$	150 mm
4 -	150 mm	$< T_b$	

The first manufactured production bearing of each category shall be tested. As soon as the manufacturer has produced the relevant volume given in Table 5 new tests shall be performed.

8.2.4 Control of raw materials

The bearing manufacturer shall carry out tests and inspections on the incoming raw and constituent materials and components as stipulated in Table 8.

Where incoming raw and constituent materials and components are released before testing for urgent production purposes, they shall be positively identified and recorded in order to permit immediate recall and replacement in the event of non-conformance to specified requirements.

8.2.5 Audit-testing

When a purchaser requires a third party control, the factory production control scheme shall be audited at regular intervals, not less than twice a year.

8.3 Sampling

For the Conformity Evaluation, the type tests shall be carried out on samples as defined hereafter in Table 6. The routine tests shall be carried out on samples chosen completely at random within the range being produced.

8.3.1 Samples for audit testing

The sample shall be as described in this part of this document. The third party sampler at his discretion shall take it, from the inspection lot at random, without regard to its quality. The samples shall be clearly marked so that there is no possibility of error. The sampler shall prepare a record of the sampling procedure.

8.4 Non-compliance with the technical specification

If the result of the test or inspection on a product is unsatisfactory, the manufacturer is obliged at once to take the steps necessary to rectify the shortcoming. Products, which do not comply with the requirements, are to be set aside and marked accordingly. When the shortcoming has been rectified, the test or inspection in question is to be repeated without delay, provided that this is technically possible and is necessary as evidence that the defects have been overcome.

Table 5 — Routine test frequency for complete bearings

Type of test	Total Thickness			
	$T_b \leq 50$	$50 < T_b \leq 100$	$100 < T_b \leq 150$	$T_b > 150$
Compression stiffness [a]	150 dm^3	250 dm^3	300 dm^3	350 dm^3
Shear Stiffness	1 500 dm^3	2 500 dm^3	3 000 dm^3	3 500 dm^3
Shear Bond	3 000 dm^3 on sample type I (see 8.2.3)			

NOTE 1: The volumes indicated above refer to the volume of rubber in the bearings.
NOTE 2: For compression stiffness and shear stiffness the test should be performed on the first manufactured production bearing of each category.
[a] Quick compressive test as described in 4.3.3.2.

Table 6 — Definition of bearing sample type sizes for tests

Bearing sample types	a	b	no. layers	(thickness of layers and steel reinforcing plates)
I	200	300	3	(8 + 3)
II	400	500	5	(12 + 4)
III	600	700	7	(16 + 5)

NOTE If a manufacturer does not produce these standard sizes, the bearings should be the nearest sizes in the manufacturer's range.

Table 7 — Test frequency and bearing sample type for tests on complete bearings

§ Ref	Designation	Type of test	Sample type (See Table 6)	Frequency
4.3.1	Shear Stiffness			
4.3.1.1	At ambient temperature	Initial type test Routine test	I-II-III see 8.2.3	1 see 8.2.3
4.3.1.2	At low temperature	Initial type test	I	1
4.3.1.4	After ageing	Initial type test	I-II-III	1
4.3.2	Shear bond			
4.3.2.1	At ambient temperature	Initial type test Routine test	I-II-III see 8.2.3	1 see 8.2.3
4.3.2.2	After ageing	Initial type test	I-II-III	1
4.3.3	Compression stiffness	Initial type test Routine test	I-II-III see 8.2.3	1 see 8.2.3
4.3.4	Repeated loading compression	Initial type test	I	1
4.3.5	Static rotation			
4.3.5.2	Eccentricity method	Initial type test	I-II-III	1 [a] and/or
4.3.5.3	Restoring moment	Initial type test [a]	I	1 [a]
4.3.6	Ozone resistance	Initial type test	I	1 [a]
4.3.7	PTFE/elastomer Shear bond (for type D only)	Initial type test	See annex M	1 [a]

[a] If specified by the structure designer

Table 8 — Test frequency and source of samples for tests of raw material properties

ISO Ref.	Designation	Type of test	Frequency Number of tests	Sample Source	Observation
ISO 37	Tensile strength	Initial type test Routine test	1 Every batch of compound	Moulded " "	Sample type II[a]
	Elongation at break	Initial type test	1	From bearing	
ISO 34-1	Tear resistance	Initial type test Routine test	1 4/year	Moulded " "	
ISO 815	Compression set	Initial type test Routine test	1 4/year	Moulded " "	
ISO 188	Accelerated ageing	Initial type test Routine test	1 4/year	Moulded " "	
ISO 1431-1	Ozone resistance	Initial type test Routine test	1 1/year	Moulded " "	

NOTE 1 A batch is an individual mix or a blend of mixes if these are used for bearing production.

NOTE 2 The routine and type tests are designed to ensure that bearings up to (900 x 900) mm in plan are manufactured satisfactorily. For larger sizes, the supplier and purchaser should agree on the size or sizes to be tested as well as on the test procedure.

[a] See Table 6

9 Criteria for in-service inspection

During inspection of items listed in EN 1337-10 the following criteria shall be checked:

- The top and bottom load bearing surfaces shall be in full contact with the plinth (bottom supporting surface) and the soffit (top supporting surface). If there is imperfect contact between the surfaces given above the angle between the soffit and the plinth shall be checked against the design specifications.

- The magnitude of the shear deflection of each bearing shall be checked to ensure that it is within the design specifications.

- A visual inspection shall be made of all the accessible edges. A note shall be made of the size and position of any cracks or splits, or uneven bulges.

- Examine the plinth and soffit for signs of displacement from bearing original position (Black marks may give an indication of movement).

If applicable:

- Examine the sliding surfaces for cleanliness and that the movements are within the design range and report results.

- Examine the protective coating and / or dust protection for signs of deterioration and report results.

Annex A
(normative)

Elliptical bearings

A.1 General

Elliptical bearings shall comply with the design rules (see clause 5). To determine the specific values for this particular geometry of bearing the following formulae apply.

- Nominal strain due to compressive load

$$\varepsilon_{ce} = \frac{(4 \cdot t_i \cdot F_d)}{(\pi \cdot K_{ce} \cdot b_e \cdot a_e^2 \cdot G)} \tag{A.1}$$

For factor K_{ce} see Table A.1

- Nominal strain due to angular rotation

$$\varepsilon_{\alpha e} = \frac{3\alpha}{8} \cdot \left(\frac{a_e}{t_i}\right)^2 \tag{A.2}$$

- Restoring Moment

$$M_t = G_d \frac{\alpha \cdot a_e^5 \cdot b_e}{n \cdot t_i^3 \cdot K_{se}} \tag{A.3}$$

For factor K_{se} see Table A.1

- Vertical deflection per layer

$$\Sigma v_{z,d} = \Sigma \frac{F_{z,d} \cdot t_i}{A'} \cdot \left(\frac{1}{3G \cdot \left(\frac{a_e}{t_i}\right)^2 \cdot K_{de}} + \frac{1}{E_b} \right) \tag{A.4}$$

For factor K_{de} see Table A.1

Table A.1 — Factors for Elliptical Bearings

b/a	1,0 [a]	1,5	2,0	3,0	4,0	6,0	8,0	10,0	∞
K_{ce}	0,25 [a]	0,252	0,258	0,262	0,266	0,269	0,270	0,277	0,300
K_{de}	0,125 [a]	0,174	0,204	0,233	0,249	0,265	0,272	0,277	0,300
K_{se}	150 [a]	115,6	100	84,4	75,7	68,7	64,1	62	60

[a] The values in the first column can be used only for interpolation not for circular case.

The area, A, and perimeter, P ,of the ellipse shall be calculated by the formulae:

$A = 0,25 \cdot \pi \cdot a_e \cdot b_e$ $\quad$ $P = 0,5 \cdot \pi \cdot (a_e + b_e)$

In all other equations in the design rules a_e and b_e may be substituted for a and b respectively.

Annex B
(normative)

Rotational limitation factor

B.1 General

The value of the rotational limitation factor used is the following: $K_{r,d}$= 3

Annex C
(normative)

Maximum design strain in laminated bearings

C.1 General

The value of the factor K_L is equal to 1,0.

If requested by the structure designer, K_L may be defined as follow:

1,5 for live load effects

1,0 for all other effects (including wind and temperature).

Annex D
(informative)

Shear modulus comments

D.1 Shear modulus tests

It is convenient for some purposes to calculate the apparent "conventional shear modulus" of the elastomer from the measured stiffness. It should be noted however that elastic bending of the steel reinforcing plates may occur and that, in this case, the calculated modulus (G) would be lower than that determined on a double or quadruple shear test laboratory specimen (G_e).

D.2 Shear modulus and hardness

The correlation between shear modulus and hardness is not precise and the following figures for hardness are given as a guide only.

G_g = 0,7 MPa ---> 50 ± 5 IRHD

G_g = 0,9 MPa ---> 60 ± 5 IRHD

G_g = 1,15 MPa ---> 70 ± 5 IRHD

D.3 Stiffening effects, which arise at low temperatures

All elastomers stiffen as the ambient temperature approaches the Glass transition temperature and this effect is independent of time, except for normal heat transfer effects. Both NR and CR also stiffen due to crystallisation but both the magnitude and rate is time dependent. A further complication is that the rate of crystallisation also depends on the elastomer used. With such complex behaviour it is impossible to devise a single test to cover all conditions. Experience shows that bearings which pass 4.3.1.2 should be satisfactory in most parts of Europe. In regions where the mean daily temperature is continuously below – 10 °C for more than six weeks, it would be prudent to carry out more extensive tests, or to seek expert advice.

Annex E
(informative)

Typical bearing schedule

E.1 General

The purpose of a bridge bearing schedule (see Table E.1) 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 EN 1337-1.

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.

An appropriately completed schedule should be suitable for inclusion in the tender documents.

E.2 Information for Table E.1

The following information gives guidance for completing each item in the typical bridge bearing schedule.

1) Bearing identification mark and number in accordance with Table E.1

   Bearing with different functions or load carrying requirements should be distinguished by a unique reference mark.

2) Number off

   The required quantity of each particular mark of bearing should be stated.

3) 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.

4) Average design contact pressure

   The average design contact pressure is the pressure on the effective contact area.

5) Design load affects

   The structure designer should give the worst individual values of the design load effects 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 load effects, in which case these should be given in detail.

6) Displacement

   Displacement 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.

7) Rotation

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

$$100 \times \frac{\text{design rotation (in radians)}}{\text{coexistent design vertical load(in kN)}}$$ should also be given

8) Maximum bearing dimensions

The maximum size of bearing that can be accommodated should be stated, as this will give optimum flexibility in the design of the bearing.

9) 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.

10) Reaction to displacement under serviceability limit state

In the design of the structure, reaction to displacement movements may be of significance, in which case the acceptable horizontal force generated by the bearing should be given for the serviceability limit state. 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).

11) Reaction to rotation under serviceability limit state

In the design of the structure, reaction to rotation may be of significance in which 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, as defined in paragraph 10.

12) 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.

13) 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 E.1 — Typical bridge bearing schedule

BRIDGE NAME OR REFERENCE

Bearing identification mark							
Number off							
Seating material[a]	Upper surface						
	Lower surface						
Allowable average contact pressure (N/mm²)	Upper face	Serviceability					
		Ultimate					
	Lower face	Serviceability					
		Ultimate					
Design load effects (kN)	Ultimate limit state	Vertical	max.				
			permanent				
			min.				
		Transverse					
		Longitudinal					
	Serviceability limit state	Vertical					
		Transverse					
		Longitudinal					
Translation (mm)	Ultimate limit state	Transverse					
		Longitudinal					
	Serviceability limit state	Transverse					
		Longitudinal					
Rotation (radians)	Ultimate limit state	Transverse					
		Longitudinal					
Maximum bearing dimensions (mm)		Transverse					
		Longitudinal					
		Overall height					
Tolerable movement of bearing under transient loads (mm) If relevant		Vertical					
		Transverse					
		Longitudinal					
Allowable resistance to translation under serviceability limit state (kN) If relevant		Transverse					
		Longitudinal					
Allowable resistance to rotation under serviceability limit state (kN.m) If relevant		Transverse					
		Longitudinal					
Type of fixing required		Upper face					
		Lower face					

NOTE State any other requirements on separate sheet.

[a] For example cement mortar, epoxy mortar, in situ concrete, precast concrete, steel, timber.

Annex F
(normative)

Shear modulus test method

F.1 General

This annex describes a method of determining the apparent shear modulus (G_g) of bearings.

F.2 Concept and scope

This annex describes a method of determining the apparent shear modulus of complete elastomeric bearings. If bearings are too large to be accommodated in the press, they may be reduced in plan size by cutting samples in half subject to the agreement of the purchaser. However the press shall be big enough to accommodate the sizes given in 4.3.7.

F.3 Definitions

F.3.1 Shear stress (τ): ratio of shear force to plan area of bearing.

F.3.2 Shear strain: ratio of shear deflection to total thickness of rubber including top and bottom covers unless these are restrained by positive location devices.

F.3.3 Shear modulus: ratio of difference in shear stress to relative difference in shear strain.

NOTE The shear modulus (G_g) is conventionally defined as the intersecting modulus for relative shear deformation corresponding to the following displacements:

$$v_{X1} = 0{,}27 \cdot T_q \text{, and } v_{X2} = 0{,}58 \cdot T_q \text{.}$$

where T_q is the average total initial thickness of rubber, including the top and bottom covers when these are not restrained for shearing.

F.4 Principle

The test consists of measuring the shear deflection of a pair of identical elastomeric bearings, when they are subjected to increasing shear loads. From these measurements the apparent shear modulus is calculated and the surfaces of the bearings, when under full load, are examined for defects.

F.5 Equipment

F.5.1 Testing equipment

The test machine, shown schematically in Figure F.1, shall be capable of providing a compressive load to a pair of bearings separated from each other by a movable plate, and also providing a shear deflection under controlled conditions. The equipment shall provide a method of measuring the compressive load and the shear force, together with the shear deflection. The measuring equipment shall have an accuracy of less than or equal to 2 % of the maximum values recorded. The platens shall be thick enough to prevent significant distortion (<1 % of measured bearing deflection) under the maximum loading, and their dimensions in plan greater than the plan area of the sample under test.

F.5.2 Non-sliding surfaces

In order to reduce the likelihood of the test pieces slipping during the shear deflection, it is necessary to fit high friction plates to the platens and to the moveable plate of the test machine.

Alternatively, the test piece may be positively located by metal strip whose thickness shall not exceed the thickness of the outer steel plate plus cover.

F.6 Test pieces

F.6.1 Dimensions

The test pieces shall be in accordance with the design recommendation of clause 5. If the pair of bearings is unstable in test arrangement under the loads applied additional pairs of bearings shall be used to make the assembly stable.

F.6.2 Measurement of the undeformed test piece

The average initial thickness of each test piece shall be measured using a minimum of two gauges placed equidistant from the centre of the bearing. An additional pair of gauges may be used if required in order to establish the variation in thickness across the bearing, and in this case the gauges shall be arranged symmetrically either at the corners or at the mid-points of the sides.

The plan dimensions shall be measured along the edges.

F.7 Operating procedure

F.7.1 Conditioning of test pieces

Conditioning of test pieces shall start after a minimum period of 24 h after vulcanisation.

After artificial ageing, testing shall not be performed until the test piece has stabilised at the testing temperature. In the absence of direct measurement it may be assumed that this is the case after a period of 24 h has elapsed.

After low or very low temperature conditioning, the test shall be performed before the edge surface temperature reaching the value specified in 4.3.1.2 and 4.3.1.3. A low stiffness foam may be used to insulate the edges for the purpose of this test.

F.7.2 Testing procedure

The test pieces shall be placed symmetrically on each side of the movable plate so that the shear direction is across the width of the bearing.

A mean pressure of 6 MPa shall be applied.

The bearings shall be subjected to shear at a constant and maximum speed of 150 mm / minute to the maximum test deflection v_{xm} ($0,7\ T_q \leq v_{xm} \leq 0,9\ T_q$) and then returned to zero deflection. The compressive stress shall be removed and the test pieces left undisturbed for five minutes and then shear again to v_{xm} .

The horizontal deflection and force shall be recorded continuously or at a minimum 10 equal intervals during the loading part of the cycle.

F.8 Results

F.8.1 Shear stress

Shear stress τ in MPa is given by:

$$\tau = \frac{F_x}{A} \qquad \text{(F.1)}$$

where F_x is the shear force in Newton and A is the area in mm² on which the compressive load acts (i.e. plan area of one bearing). When two bearings are tested back to back in the normal way the force applied is $2F_x$ and the area is “2 A”

F.8.2 Shear strain

Shear strain ε_q is given by the expression:

$$\varepsilon_q = \frac{v_x}{T_q} \qquad \text{(F.2)}$$

F.8.3 Shear modulus

The conventional shear modulus *G*, in MPa, is obtained from the measurements, using:

$$G_g = \frac{\tau_{s2} - \tau_{s1}}{\varepsilon_{qx2} - \varepsilon_{qx1}} \qquad \text{(F.3)}$$

where:

τ_{s2} is the shear stress and ε_{qx2} the shear strain at a deformation of v_{x2} = 0,58 T_q

τ_{s1} is the shear stress and ε_{qx1} the shear strain at a deformation of v_{x1} = 0,27 T_q

F.9 Test report

The test report shall contain the following information:

1 - Identification of the test pieces (name of manufacturer, origin and number of each bearing).

2 - Thickness and number of layers and plan dimensions of test pieces.

3 - The size of the cut test piece when appropriate.

4 - Condition of test pieces prior to and after testing.

5 - Date, duration and temperature of test.

6 - Value of compressive load.

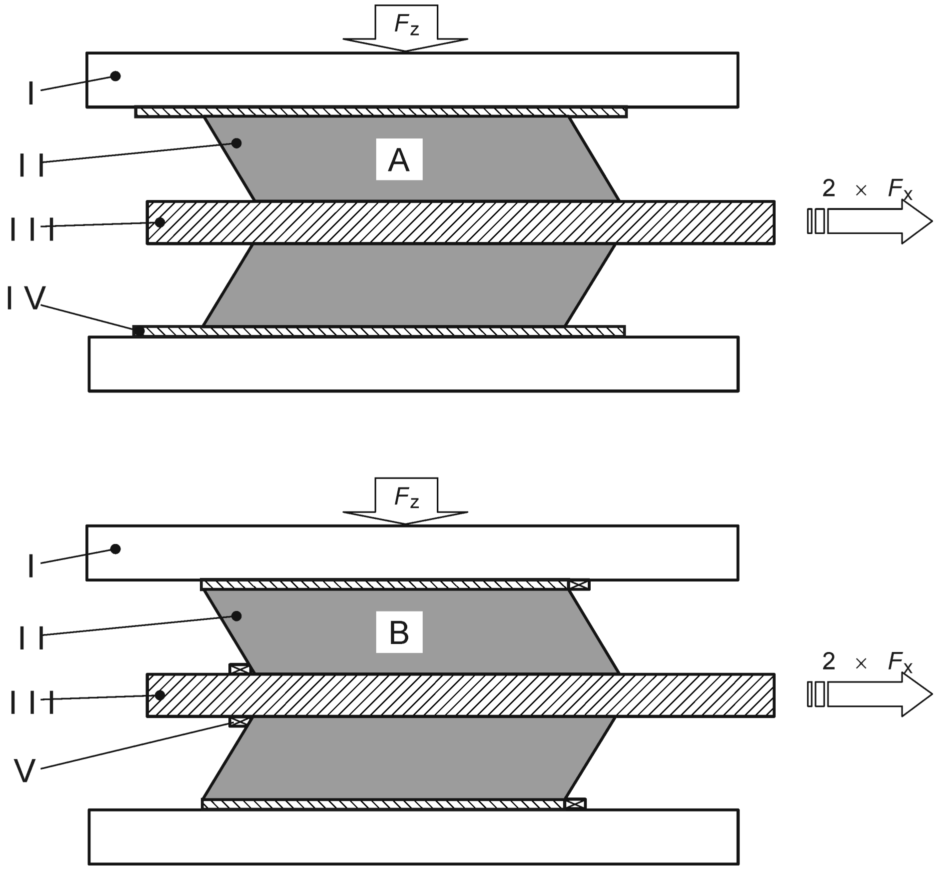
7 - Speed of shear strain.

8 - Values of measured shear forces and deflections (graph).

9 - Calculated G_g Modulus.

10 - Any deviations from the method outlined here.

11 - Statement that the test was performed in accordance with the standard, provided that there were no deviations.



Key

A = Type E

B = Type C

I Press platens

II Test piece

III Movable plate

IV Lining plates with grooves to prevent slippage (Type E)

V Metal strip to prevent slippage (Type C)

Figure F.1 — Schematic diagram of shear modulus test equipment

Annex G
(normative)

Shear bond test method

G.1 General

This annex describes a method for testing the adequacy of the bond strength of bearings subjected to shear. If bearings are too large to be accommodated in the testing rig and if the purchaser agrees the bearing may be cut into two equal parts or bond test on samples may be substituted.

G.2 Concept and scope

This annex describes a method for testing the adequacy of the shear bond strength between the rubber and steel plates in complete elastomeric bearings.

NOTE Cut bearings are likely to give lower bond strengths than complete bearings because of flaws introduced by the cutting operation. Unsatisfactory results obtained from cut bearings should therefore be treated with reserve.

G.3 Definitions

G.3.1 Shear stress (τ): ratio of shear force to plan area of bearing.

G.3.2 Shear strain: ratio of shear deflection to total thickness of rubber including top and bottom covers.

G.3.3 Shear bond strength: If failure occurs, the shear bond strength is the shear stress, calculated as in F.7.1, at the time of failure.

G.4 Principle

The test is the same as that for shear modulus except that the compressive stress is larger and the shear deflection is continued to give larger shear strains (up to a value of 2). The test may be carried out on the same test piece as that used for the shear modulus test and may be performed as an extension of this test.

G.5 Equipment

G.5.1 Testing equipment

The test machine, shown schematically in Figure G.1, shall be capable of providing a compressive load to a pair of bearings separated from each other by a movable plate, and also providing a shear deflection under controlled conditions. The equipment shall provide a method of measuring the compressive load and the shear force, together with the shear deflection, to an accuracy of less than or equal to 2 % of the maximum values recorded. The platens shall be thick enough to prevent significant distortion (<1 % of measured bearing deflection) under the maximum loading and their dimensions in plan greater than the plan area of the sample under test. However the press shall be big enough to accommodate the sizes of the test pieces in accordance with the recommendation of clauses 5 and 8.

G.5.2 Non-sliding surfaces

In order to reduce the likelihood of the test pieces slipping during the shear deflection, it is necessary to fit high friction plates to the platens and to the moveable plate of the test machine.

G.6 Test pieces

G.6.1 Dimensions

All test pieces shall meet the non-buckling requirement of 5.3.3.7. If the pair of bearings is unstable in the test arrangement under the loads applied, additional pairs of bearings shall be used to make the assembly stable.

G.6.2 Measurement of the undeformed test piece

The plan dimensions shall be measured along the edges.

G.7 Operating procedure

G.7.1 Conditioning of test pieces

The period between vulcanisation and test shall be a minimum of 24 h.

After artificial ageing, testing shall not be performed until the test piece has stabilised at the testing temperature. In the absence of direct measurement, it may be assumed that this is the case after a period of 24 h has elapsed.

G.7.2 Testing procedure

The test pieces shall be placed symmetrically on each side of the movable plate so that the shear direction is across the width of the bearing. A mean pressure of 12 MPa shall be applied.

NOTE If necessary the compressive load shall be increased to prevent slippage, but it should not exceed that permitted under the design rules given in clause 5.

The bearings shall be sheared at a constant and maximum speed of 100 mm / min.

The horizontal deflection and force shall be recorded continuously or at a minimum of 10 equal intervals during the loading part of the cycle. When the maximum deflection is reached (shear strain = 2) the deflection shall be maintained for 5 min in order to allow flaws to develop.

After removal of the shear force the bearing should be examined visually, whilst still under the compressive load, and any bulges which could indicate bond failure should be noted. It may be necessary to cut the edge cover to confirm the presence of flaws arising from bond failure.

G.8 Results

The results shall be in the form of a graph of shear force against shear defection to indicate observed failure points. In addition, the detection of any flaws during the visual inspection shall be recorded, together with their position in the bearings.

G.9 Test report

The test report shall contain the following information:

1 - Identification of the test pieces (name of manufacturer, origin and number of each bearing).

2 - Thickness and number of layers and plan dimensions of test pieces.

3 - The size of the cut test piece, when appropriate.

4 - Condition of test pieces prior to and after testing.

5 - Date, duration and temperature of test.

6 - Value of compressive load.

7 - Rate of the shear strain.

8 - Description of the bearing condition at a shear strain equal to 2.

9 - Graph of stress against displacement.

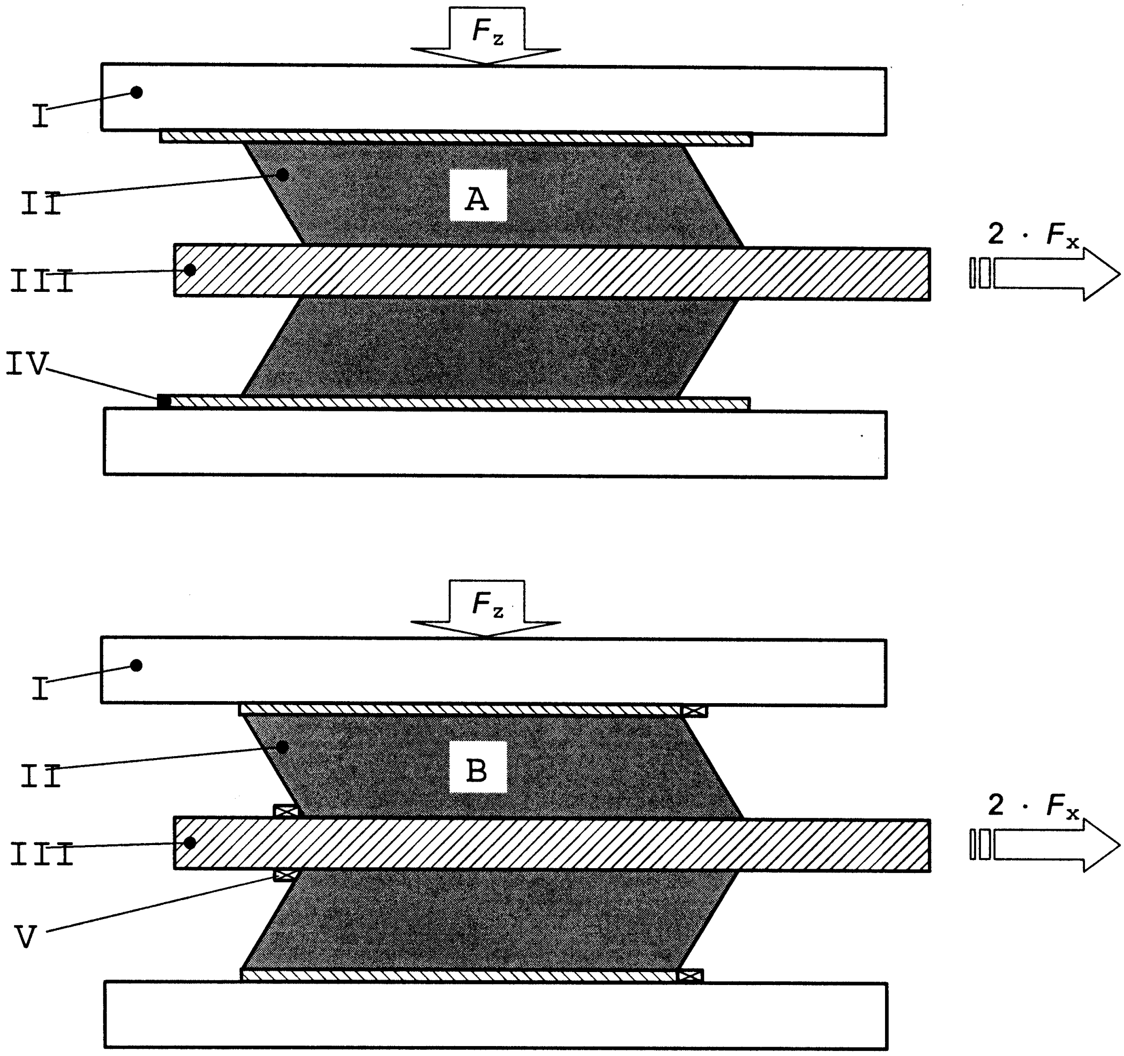
10 - the value of the shear bond strength, if failure has occurred.

11 - Bond failures should be classified as follows :

Elastomer -	failure within elastomer.
Elastomer/adhesive -	failure within elastomer-adhesive interface.
Adhesive/primer -	failure within adhesive-primer interface.
Primer/steel -	failure within primer-steel interface.

12 - Any deviations from the method outlined in this document.

13 - Statement that the test was performed in accordance with the standard, provided that there were no deviations.



Key

A = Type E

B = Type C

I Press platens

II Test piece

III Movable plate

IV Lining plates with grooves to prevent slippage (Type E)

V Metal strip to prevent slippage (Type C)

Figure G.1 — Schematic diagram of shear bond strength test equipment

Annex H
(normative)

Compression test method

H.1 Scope

This annex describes a method of determining the apparent compression modulus of complete elastomeric bearings and production tests of compression behaviour.

H.2 Definitions

H.2.1 Compressive stress (σ_C): ratio of compressive force to area of reinforcing plates A_1.

H.2.2 Intersecting compression modulus (E_{cs}) : ratio of stress difference to corresponding strain difference.

H.2.3 Compressive strain : ratio of change in total rubber thickness to undeformed rubber thickness, ignoring the top and bottom covers when their nominal thickness is less than or equal to 2,5 mm.

H.3 Principle

The test consists of measuring the compression of an elastomeric bearing when subjected to increasing compressive loads. From these measurements the intersecting compression modulus E_{cs} is calculated, and the surface of the bearing, when under full load, is examined for defects.

H.4 Equipment

The test machine shown schematically in Figure H.1 shall be capable of compressing the bearing under controlled conditions. It shall also provide a method of measuring the compressive load and the compressive deflection to an accuracy of less than or equal 2 % of the maximum values recorded. The platens shall be thick enough to prevent significant distortion (<1 % of measured bearing deflection) under the maximum loading and their dimensions in plan greater than the plan area of the sample under test.

H.5 Test pieces

H.5.1 Dimensions

The test piece shall meet the non-buckling requirement of 5.3.3.7.

H.5.2 Measurement of the undeformed test piece

The average initial thickness of the test piece shall be measured using a minimum of two gauges placed equidistant from the centre of the bearing and on a line passing through the centre of the bearing. An additional pair of gauges may be used in order to establish the variation in thickness across the bearing, and in this case the gauges shall be arranged symmetrically either at the corners or at the mid-points of the sides.

The plan dimensions shall be measured along the edges, but the effective area, A', of a laminated bearing is given by the area of the plates, not the superficial area of the bearing. The manufacturer of the bearing shall supply the dimensions of the reinforcing plates.

H.6 Operating procedure

H.6.1 Conditioning of test pieces

The period between vulcanisation and test shall be a minimum of 24 h at the ambient temperature of the laboratory.

H.6.2 Testing procedure

The test piece shall be placed at the centre of the testing platen, to an accuracy of better than 1/50th of the smaller plan dimension of the test piece.

H.6.2.1 Level 1

The maximum load, as specified in 4.3.3.1.shall be applied to the bearing, held for 1 min and then removed. This process shall be repeated so that two complete loading and unloading cycles are carried out.

After a further 10 min under zero load, the deflection gauges shall be re-zeroed at a load corresponding to 5 MPa and then the load shall be applied progressively with a minimum of six increments. At each measuring point, the load shall be maintained at a constant value for a minimum of 2 min to minimise viscoelastic effects. When the bearing is fully loaded a visual examination of the exposed surfaces shall be made.

NOTE 1 Initial deflections may be disproportionately large as a result of bedding down.

NOTE 2 Additional information may be obtained, if required, about the viscoelastic behaviour of the elastomer at maximum load, by maintaining the load and observing the resulting creep over a period of 30 min.

H.6.2.2 Level 2

The maximum compressive load shall be applied to the bearing and released before any measurements are taken.

After this first loading, the maximum compressive load, as specified in 4.3.3.2 shall be applied progressively with a minimum of five increments at a rate of 5 ± 0,5 MPa / min.

The deflection shall be recorded at 1/3 of the maximum load and at the maximum load. A visual examination of the exposed surfaces shall be made.

H.6.2.3 Level 3

The maximum compressive load, as specified in 4.3.3.3 shall be applied and a visual examination of the exposed surfaces of the bearing shall be made.

H.7 Results

H.7.1 Visual examination

Any surface defects or irregular surface corrugations which would indicate irregularly positioned plates or irregular bulges which would indicate bond failures near the surface, shall be recorded.

H.7.2 Compressive strain (Levels 1 and 2)

The compressive strain, ε_c, is given by

$$\varepsilon_c = \frac{v_z}{T_o} \qquad \text{(H.1)}$$

where, v_z, is the average recorded deflection and T_o is the average total initial thickness of rubber ignoring the top and bottom covers.

NOTE The value of the deflection between zero load and the first value recorded should be obtained by linear extrapolation.

H.7.3 Intersecting compression modulus (Level 1)

$$E_{cs} = \frac{\sigma_{c2} - \sigma_{c1}}{\varepsilon_{c2} - \varepsilon_{c1}} \qquad \text{(H.2)}$$

where σ_{c2} is the stress at maximum load, σ_{c1} is the stress at 1/3 maximum load, ε_{c2} is the strain at maximum load and ε_{c1} is the strain at 1/3 maximum load.

If the compressive load (F_z) is measured in Newtons, and the lengths in mm, then the compressive modulus will be given in MPa.

H.7.4 Compressive stiffness

The compressive stiffness of a bearing is given by:

$$c_c = \frac{F_{z2} - F_{z1}}{v_{z2} - v_{z1}} \qquad \text{(H.3)}$$

where:

- F_{z2} and F_{z1} are respectively the maximum load and 1/3 load of the maximum load

- v_{z2} - v_{z1} are the corresponding vertical deflection of the bearing at the same two loads

H.8 Test report

The test report shall contain the following information:

1 - Identification of the test pieces (name of manufacturer, origin and number of each bearing).

2 - Thickness and number of layers and plan dimensions of test pieces.

3 - Condition of test pieces prior to and after testing.

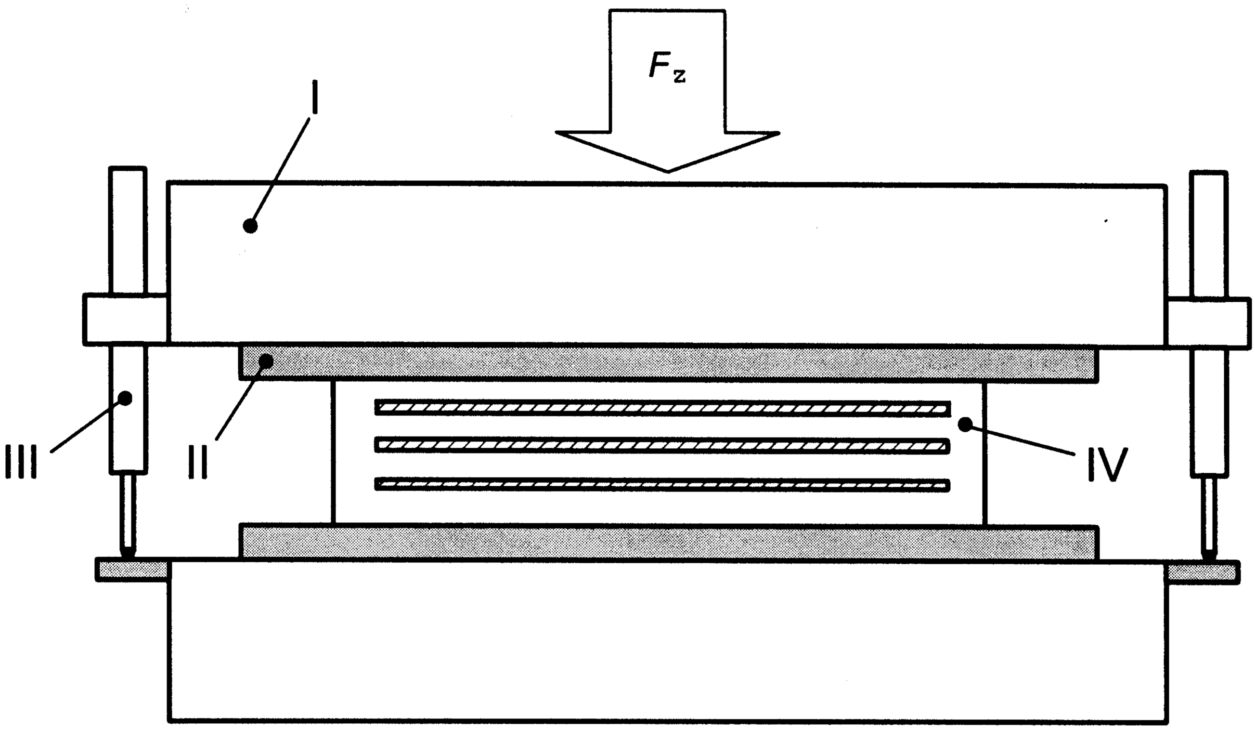
4 - Date, duration and temperature of test.

5 - Values of compressive loads and deflections together with a graph showing load against deflection

6 - Value of the intersecting compression modulus or compression stiffness, as appropriate.

7 - Any deviations from the method outlined here.

8 - Statement that the test was performed in accordance with the standard, provided that there were no deviations.



Key

I Press platens

II Lining plates with grooves to prevent slippage

III Deflection gauges

IV Test piece

Figure H.1 — Schematic diagram of compression test equipment

Annex I
(normative)

Repeated Loading Compression Test Method

I.1 Concept and scope

This annex describes a method of determining the performance of bearings subjected to repeated low frequency compression.

I.2 Definitions

I.2.1 Compressive stress (σ_c): ratio of compressive force to area of restraining plates A_1.

I.2.2 Intersecting compression modulus (E_{cs}) : ratio of stress difference to corresponding strain difference.

I.2.3 Compressive strain : ratio of change in total rubber thickness to undeformed rubber thickness, ignoring the top and bottom covers when their thickness is less or equal to 2,5 mm.

I.3 Principle

The test consists of subjecting the bearing to repeated compressive loading between the limits specified, in order to determine the change in the intersecting compression modulus, and to record the development of any surface defects.

I.4 Equipment

I.4.1 Testing equipment

The test machine shown schematically in Figure I.1, shall be capable of compressing the bearings under cyclic conditions up to a stress of 25 Mpa. It shall also provide a method of measuring the compressive load and the compressive deflection, to an accuracy of 1 % of the maximum values recorded. The platens shall be thick enough to prevent significant distortion (<1 % of measured bearing deflection) under the maximum loading. The rotation of the platens shall be less than 0,005 radians. The machine shall be capable of cycling at a frequency up to 3 Hz and shall be fitted with a counter to record the number of cycles.

I.4.2 Non-sliding surfaces

In order to reduce the likelihood of the bearing moving horizontally during testing it is necessary to fit high friction plates to the platens and to the moveable plate of the test machine.

Alternatively, the test piece may be positively located by metal strip whose thickness shall not exceed the thickness of the outer steel plate plus cover.

I.5 Test pieces

I.5.1 Dimensions

The test pieces shall preferably be in accordance with Table 6 - Type I

I.5.2 Measurement of the undeformed test piece

The average initial thickness of each test piece shall be measured, using a minimum of two gauges placed equidistantly from the centre of the bearing on a line passing through the centre of the bearing. An additional pair of gauges may be used, if required, in order to establish the variation in thickness across the bearing. In this case, the gauges shall be arranged symmetrically either at the corners or at the midpoints of the sides.

The plan dimensions shall be measured along the edges, but the effective area, *A*', of a laminated bearing is given by the area of the plates, not the superficial area of the bearing. The manufacturer of the bearing shall supply the dimensions of the reinforcing plates.

I.5.3 Temperature control

The temperature of the test piece shall be measured and if the value reaches 40 °C the frequency of the cycling shall be reduced in order to reduce the surface temperature to less than 40 °C.

NOTE When possible, instead of measuring the exposed surface temperature, a suitable means of measuring the temperature in the centre of the sample should be provided.

I.6 Operating procedure

I.6.1 Conditioning of test pieces

The period between vulcanisation and test shall be a minimum of 24 h.

I.6.2 Testing procedure

The test piece shall be placed at the centre of the testing platen to an accuracy of better than 1/50th of the smaller plan dimension of the test piece.

A static compression test shall be carried out in accordance with H.6.2.1. The cyclic loading test shall be carried out between the values 7,5 MPa and 25 MPa at a frequency less than 3 Hz. The frequency shall be reduced during the test, if necessary, to ensure that the surface temperature does not exceed 40 °C.

The cyclic part of the test shall cease, and the load shall be removed, when the number of cycles reaches 2 000 000. After a recovery period of 24 h, a static compression test shall be carried out as before.

I.7 Results

The values of the intersecting compression modulus, before and after the cyclic test, shall be calculated as described in the compression test method and reported. The value after cycling shall not be more than 2 % above the original value. The surfaces shall be examined and any flaws or defects shall be reported.

I.8 Test report

The test report shall contain the following information:

1 - Identification of the test pieces (name of manufacturer, origin and number of the bearing).

2 - Thickness and number of layers and plan dimensions of test pieces.

3- Condition of test pieces prior to and after testing including details of all defects, if any.

4 - Date, duration and temperature of test.

5 - Type of testing machine.

6 - Frequency.

7 - Number of cycles.

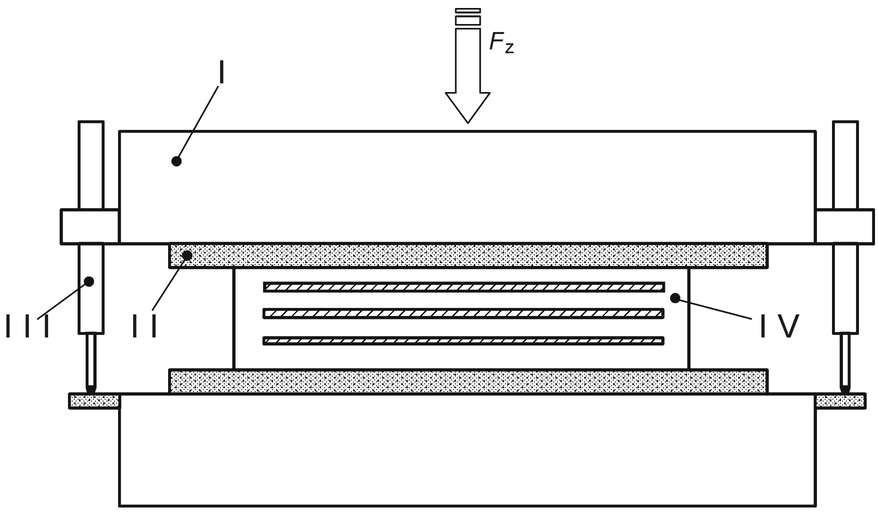
8 - The values of the minimum and maximum compressive stresses.

9 - The values of the intersecting compression modulus before and after the cyclic test.

10- Description of bearing condition after 2 000 000 cycles and any defects.

11 - Any deviations from the method outlined here.

12 - Statement that the test was performed in accordance with the standard, provided that there were no deviations.



Key

I Press platens

II Lining plates with grooves to prevent slippage

III Deflection gauges

IV Test piece

Figure I.1 — Schematic diagram of repeated loading compression test equipment

Annex J
(normative)

Eccentric loading test method

J.1 Concept and scope

This annex describes a method of determining the contact area between the bearing and the platen, under an eccentric loading or the maximum eccentricity to give a specified contact area.

J.2 Definitions

J.2.1 Angle of rotation: the angle between the top and bottom surfaces of the bearing.

J.2.2 Eccentricity: the distance between the line of action of the compressive force and the line normal to the plan surface of the bearing passing through the intersection of the diagonals of the plan surface.

J.2.3 Contact surface: the area of the bearing surface in contact with the surface through which the compressive force acts.

J.2.4 Uplift: the area of the bearing surface not in contact with the surface through which the compressive force acts.

J.3 Principle

The test consists of measuring in a press the rotation of a free intermediate movable plate installed between two bearings symmetrically placed from the theoretical axis of rotation (see Figure J.1).

From these measurements the contact area with a given eccentric loading or the degree of eccentricity with full contact can be determined.

J.4 Equipment

J.4.1 Testing equipment

The test machine, shown schematically in Figure J.1a, shall be capable of applying the required compressive eccentric load to the bearing. Similarly, the test machine shown in Figure J.1b, shall be capable of applying the required compressive load to a pair of bearings separated from each other by a movable plate. The equipment shall provide a method of measuring the compressive load and the rotation to an accuracy of less than or equal to 2 % of the maximum values recorded. The minimum number of deflection gauges is four, which shall be placed equidistantly from the axis of rotation of the movable plate. If information about possible asymmetrical deformation of the bearing is required along the axis of rotation, then four gauges shall be used at each corner of the bearing. The platens shall be thick enough to prevent significant distortion (<1 % of measured bearing deflection) under the maximum loading and their dimensions in plan greater than the plan area of the sample under test. The rotation of the fixed platens shall be less than 0,001 rad.

J.4.2 Non-sliding surfaces

In order to reduce the likelihood of the test pieces slipping during the shear deflection, it is necessary to fit high friction plates to the platens and to the movable plate of the test machine.

J.5 Test pieces

J.5.1 Dimensions

All test pieces shall meet the non-buckling requirement of 5.3.3.7.

J.5.2 Measurement of the undeformed test piece

The average initial thickness of each test piece shall be measured using a minimum of two gauges placed equidistantly from the centre of the bearing. An additional pair of gauges may be used, if required, in order to establish the variation in thickness across the bearing and in this case the gauges shall be arranged symmetrically, either at the corners, or at the midpoints of the sides.

The plan dimensions shall be measured along the edges.

J.6 Operating procedure

J.6.1 Conditioning of test pieces

The period between vulcanisation and test shall be a minimum of 24 h.

J.6.2 Testing procedure

J.6.2.1 Contact area with a given eccentric loading

The test pieces shall be placed in the press so that the load is applied eccentrically to the degree specified. The test pieces shall be placed to an accuracy of not less than 1/50th of the smaller plan dimension of the test piece. The specified load (with a maximum value of $3{,}5 \cdot G_d \cdot A' \cdot S$ / 1,5) shall be applied for 1 min and then removed. Then the bearing shall be left unloaded for 10 min. The specified load shall be reapplied and, after a period of 5 min, readings of the displacement gauges shall be recorded. The uplift area shall be determined by probing the gap between the bearing and the platen surfaces with a 0,1 mm feeler gauge.

J.6.2.2 Degree of eccentricity with full contact area

The test pieces shall be placed in the press so that the eccentricity is 1/6th of the specified bearing dimension. The specified load (with a maximum value of $3{,}5 \cdot G_d \cdot A' \cdot S$ / 1,5) shall be applied and the uplift investigated with a feeler gauge as described in J.6.2.1. This process shall be repeated at progressively increasing or decreasing eccentricities as appropriate, until no uplift is observed. Once the approximate value of the eccentricity has been determined, all loads shall be removed and the bearing shall be left for 10 min. Then the loads shall be applied again for 5 min and the contact area shall be measured. The bearing shall be unloaded and left for 60 min. The degree of eccentricity shall be increased by 10 % and the specified loads shall be re-applied. The contact area shall be measured as before and the value of the eccentricity shall be determined by extrapolation.

J.7 Results

- Contact area with a given eccentric loading

The contact surface area shall be given in percentage of the total contact surface of the bearing.

- Degree of eccentricity with full contact area

The degree of eccentricity shall be given in millimetres as the distance between the symmetry bearing axis corresponding to the rotation to the theoretical axis of loading.

J.8 Test report

1 - Identification of the test pieces (name of manufacturer, origin and number of each bearing).

2 - Thickness and number of layers and plan dimensions of test pieces.

3 - Condition of test pieces prior to and after testing.

4 - Date, duration and temperature of test.

5 - Type of testing machines.

6 - The mean applied compressive stress at the maximum eccentricity or that specified.

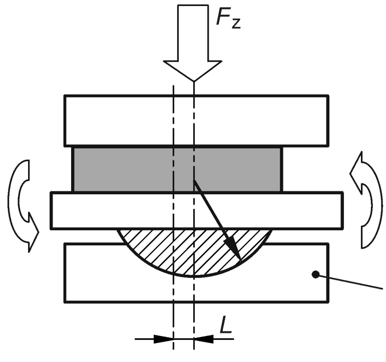
7 - Angle of rotation corresponding to each increment.

8 - Values and direction of eccentricity L at each increment.

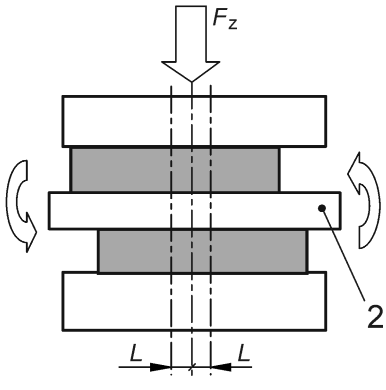
9 - Load - bearing surface area at each increment.

10 - Any deviations from the method outlined here.

11 - Statement that the test was performed in accordance with the standard, provided that there were no deviations.



Method with one test piece



Method with two test pieces

Key

1 Low friction swivel knuckle

2 Movable plate

Figure J.1 — Diagrammatic arrangement for determination of the rotation capacity

Annex K
(normative)

Restoring Moment Test Method

K.1 Concept and scope

This annex describes a method of determining the restoring moment of complete elastomeric bearings.

K.2 Definition

Restoring moment is defined as the moment required to rotate the bearing through an angle of ± 0,003 rad.

K.3 Principle

One method of achieving this with a single bearing is shown in Figure K.1a where a cylindrical bearing of known frictional characteristics is used. The moment is applied through a lever arm. An alternative method, using two bearings and a lever arm is shown in Figure K.1b.

K.4 Equipment

The equipment for this test shall consist of a press of adequate capacity to apply a mean pressure of 7 MPa to the test piece. It shall be able at the same time to apply a cyclic rotational motion at a frequency of ≤ 0,03 Hz.

K.5 Test pieces

The tests shall be carried out on bearings as indicated in 8.2.

If two bearings are tested, they shall be from the same production run and shall be of identical design.

K.6 Operating procedure

K.6.1 Conditioning of test pieces

The period between vulcanisation and test shall be a minimum of 24 h.

K.6.2 Testing procedure

The bearing shall be rotated at the specified frequency while subjected to the specified compressive load for 10 cycles. The force on the lever arm shall be recorded.

K.7 Results

For the single bearing test, the experimental value of the restoring moment M_e is given by the expression:

$$M_e = \left(\frac{(F_{z1} - F_{z2})}{2} \cdot L \right) - M_f \tag{K.1}$$

where F_{z1} is the positive value of the load and F_{z2} is the negative value of the load applied at the tenth cycle to the lever arm, at a distance L from the centre of the bearing, and M_f is the frictional moment of the low friction swivel knuckle.

For the two bearing tests the restoring moment is given by

$$M_e = \frac{(F_{z1} - F_{z2})}{4} \cdot L \tag{K.2}$$

K.8 Test report

The test report shall contain the following information :

1 - Identification of the test pieces (name of manufacturer, origin and number of each bearing).

2 - Thickness and number of layers and plan dimensions of test pieces.

3 - Condition of test pieces prior to and after testing.

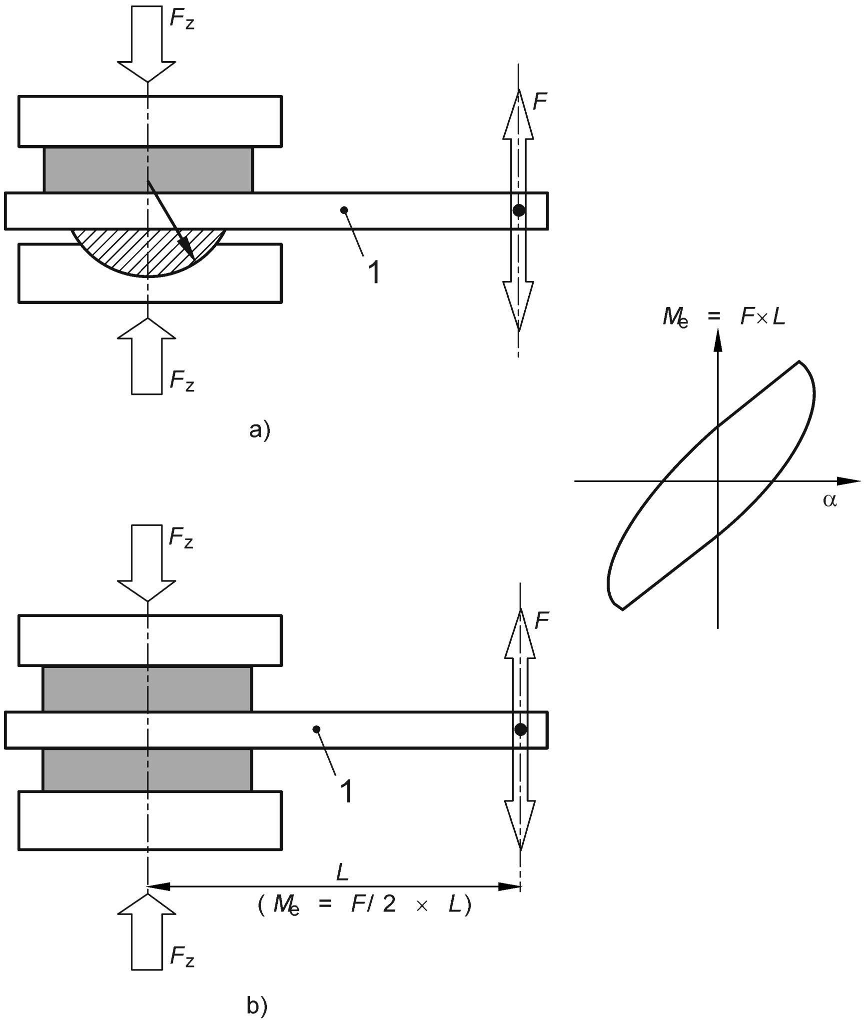
4 - Date, duration and temperature of test.

5 - Compressive stress σ_c, load F_z and distance L.

6 - Measured rotation and restoring moment.

7 - Any deviations from the method outlined here.

8 - Statement that the test was performed in accordance with the standard, provided that there were no deviations.



Key

1 Lever arms

a) With one bearing and a low friction joint bearing

b) With two bearings

Figure K.1 —Schematic diagram for restoring moment test equipment

Annex L
(normative)

Resistance to ozone test method

L.1 Concept and scope

This annex describes a method of determining the resistance of complete bearings to ozone.

L.2 Principle

Prior to exposure to ozone the bearings shall be deformed by the required amount and clamped in this position and then exposed to a specified level of ozone.

L.3 Equipment

The schematic diagram for ozone test equipment is shown in Figure L.1.

L.3.1 A test chamber

This is a thermostatically controlled chamber lined with material, which does not react to ozone (for example, stainless steel or aluminium), large enough to contain the test equipment. The chamber may include a window through which the bearing can be seen.

L.3.2 A source of ozonised air

One of the following may be used to ozonise the air.

- An ultraviolet ray lamp.

- A discharge tube.

The ozonised air may be diluted to reach the required ozone concentration. The air used for the formation of ozone or for dilution should first be cleaned of impurities by passing it over active carbon. It should be free from contamination, which could affect the ozone concentration, the measurement of the ozone concentration or cracking effects.

The ozonised air supplying the chamber passes through a temperature exchanger, which brings it up to the temperature required for the test.

L.3.3 Means of checking the ozone concentration, automatic or otherwise

When an ultraviolet light source is used, control can be exercised by modifying the potential applied to the lamp, or the air discharge, or even by masking part of the lamp. When a discharge tube is used, the quantity of ozone produced can be controlled by modifying the potential applied to the generator, the size of the electrodes, the discharges of oxygen or the amount of air used to dilute. Dilution of the ozonised air may also be done in two stages. Controls should ensure the maintenance of the concentration within the tolerance limits of ± 5 pphm.

In addition, each time the test chamber is opened to introduce samples, or to examine them, the ozone concentration should revert to the test concentration within 30 min. The ozone concentration in the chamber should never be greater than the upper limit of the nominal test concentration.

L.3.4 Static test equipment (see Figure L.2)

Complying with the following conditions.

L.3.4.1 Description

The equipment, shown schematically in Figure L.2, consists of two fixed plates with a movable plate, so that the two bearings can be compressed and sheared to the values specified in 4.3.6.

L.3.4.2 Anti-creep device

To prevent the samples sliding over the steel plates during the test, anti-creep devices shall be fitted. These are lining plates with grooves (indicate shape and frequency) perpendicular to the direction of sliding.

L.4 Samples

This test is carried out on two bearings of identical design from the same manufacturing batch.

L.4.1 Dimensions

The bearing shall be in accordance with 8.2.2.

L.5 Operating procedure

L.5.1 Conditioning of bearing

The period between vulcanisation and test shall be a minimum of 24 h.

L.5.2 Test procedure

The test conditions shall be as specified in 4.3.6.

L.5.3 Testing technique

The samples shall be placed symmetrically on either side of the movable plate so that the width is in the direction of shear. The compressive force shall be applied followed by the shear strain.

L.6 Expression of results

Any cracks in the surface should be noted, together with any bulges indicating bond failure whilst the bearings are still deflected.

L.7 Test report

The test report shall contain the following information:

1 - Identification of the bearing (name of manufacturer, origin and number of each bearing).

2 - Thickness and number of layers and plan dimensions of bearing.

3 - Condition of bearing prior to and after testing.

4 - Date, duration and temperature of test.

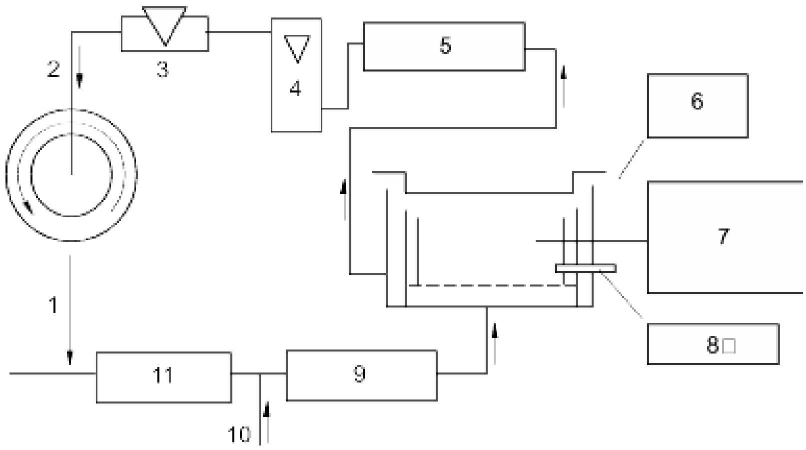
5 - Ozone concentration and method of evaluation.

6 - Compressive stress or compressive strain as appropriate.

7 - Any damage (cracks, loss of adhesion, etc.).

8 - Any deviations from the method outlined here.

9 - Statement that the test was performed in accordance with the standard, provided that there were no deviations.



Key

1 Recycling air

2 Incoming air

3 Regulator

4 Flowmeter

5 Purifier column

6 Sampling hatch

7 Ozone concentration

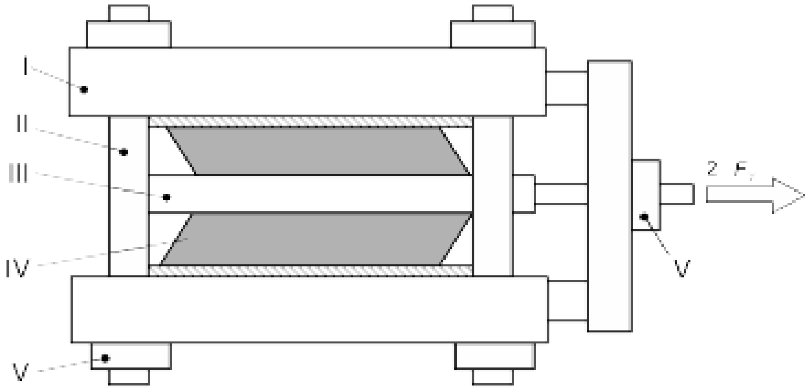
8 Thermometer

9 Heat exchanger

10 Air for dilution

11 Ozonizer

Figure L.1 — Schematic diagram of ozone test equipment



Key

I Fixed platens

II Lining plates with grooves to prevent slippage

III Movable plate

IV Test piece

V Locking nuts

Figure L.2 — Details of rig to keep the bearings in shear

Annex M
(normative)

Shear bond test method for PTFE/elastomer interface

M.1 General

This annex describes a method for testing the adequacy of the bond strength of PTFE/ elastomer interface for bearing type D.

M.2 Concept and scope

This annex describes a procedure for testing the adequacy of the method for bonding PTFE and also elastomer to steel for bearings type D. The test piece is specially made as shown in Figure M.2

M.3 Definitions

M.3.1 Shear stress (τ): ratio of shear force to plan area of bearing.

M.3.2 Shear strain: ratio of shear deflection to total thickness of rubber including top and bottom covers.

M.3.3 Shear bond strength: the shear stress in the bearing at the instant when failure of the bond occurs.

M.4 Principle

The test consists of checking the correct bonding of PTFE sheet interfaces with the elastomer layer of a bearing subjected to increasing shear loads up to a shear strain value of 0,95

M.5 Equipment

M.5.1 Testing equipment

The test machine, shown schematically in Figure M.1, shall be capable of providing a compressive load to a pair of bearings separated from each other by a movable plate, and also providing a shear deflection under controlled conditions. The equipment shall provide a method of measuring the compressive load and the shear force, together with the shear deflection, to an accuracy of less than or equal to 2 % of the maximum values recorded. The platens shall be thick enough to prevent significant distortion (<1 % of measured bearing deflection) under the maximum loading and their dimensions in plan greater than the plan area of the sample under test.

M.5.2 Non-sliding surfaces

In order to reduce the likelihood of the test pieces slipping during the shear deflection, it is necessary to fit high friction plates to the platens and to the moveable plate of the test machine.

M.6 Test pieces

M.6.1 Dimensions

The test pieces shall have the minimum plan dimensions of 200 mm X 300 mm and shall be made according to Figure M.2.

M.7 Operating procedure

M.7.1 Conditioning of test pieces

The period between vulcanisation and test shall be a minimum of 24 h.

Testing shall not be performed until the test piece has stabilised at the testing temperature. In the absence of direct measurement it may be assumed that this is the case after a period of 24 h has elapsed.

M.7.2 Testing procedure

The test pieces shall be placed symmetrically on each side of the movable plate so that the shear direction is across the width of the bearing. A compressive load of 6 MPa shall be applied.

The bearings shall be sheared at a constant and maximum speed of 100 mm/min.

The horizontal deflection and force shall be recorded at a minimum of 10 equal intervals during the loading part of the cycle.

When the maximum deflection is reached (shear strain = 0,95) the deflection shall be maintained for 5 min in order to allow flaws to develop.

At the maximum shear strain the bearing should be examined visually, for signs of bond failure.

M.8 Results

If any flaws are detected during the visual inspection they shall be recorded, together with their position in the bearing.

M.9 Test report

The test report shall contain the following information:

1 - Identification of the test pieces (name of manufacturer, origin and number of each bearing).

2 - Condition of test pieces prior to and after testing.

3 - Date, duration and temperature of test.

4 - Value of compressive load.

5 - Speed of the shear strain.

6 - Description of the test pieces condition at a shear strain equal to 0,95.

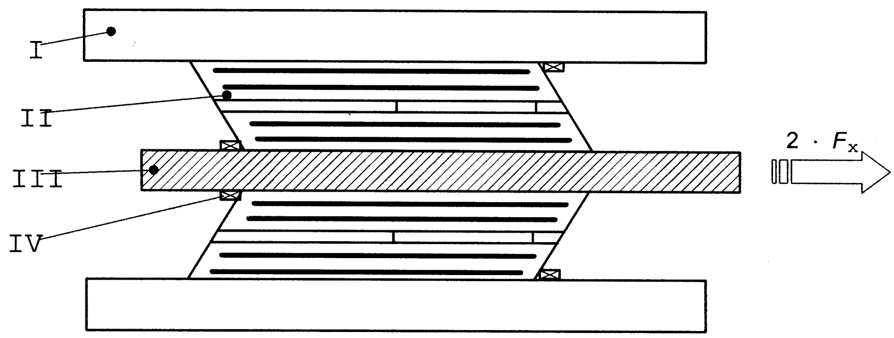
7 - The value of the shear bond strength, if failure has occurred.

8 - Bond failures should be classified as follows:

Elastomer	failure within elastomer.
Elastomer / adhesive -	failure within elastomer-adhesive interface.
Adhesive / primer -	failure within adhesive-primer interface.
Primer / PTFE -	failure within primer-PTFE interface.

9 - Any deviations from the method outlined in this document.

10 - Statement that the test was performed in accordance with the standard, provided that there were no deviations.



Key

I Press platens

II Test piece

III Movable plate

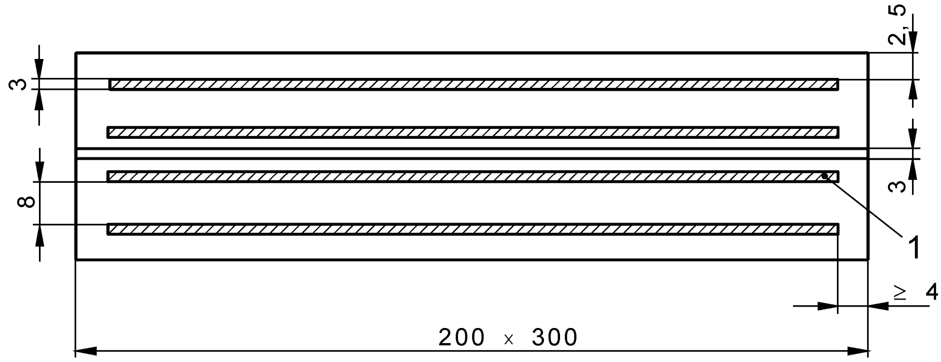
IV Non sliding strip devices

Figure M.1 — Schematic diagram of PTFE / elastomer bond test equipment

Dimensions in millimetres

PTFE sheet bonded on both sides

(thickness = 1,5)



Key

1 PTFE sheet

Figure M.2 — Cross-section of PTFE / elastomer bond test piece

Annex N
(normative)

Factory production control

N.1 General

N.1.1 Objects

The manufacturer shall exercise a permanent Factory Production Control (FPC).

NOTE A quality management system based on the relevant part of the EN ISO 9000 series or equivalent, including specific requirements from this document, can be considered as suitable.

The manufacturer is responsible for organising the effective implementation of the FPC system. Tasks and responsibilities in the production control organisation shall be documented and this documentation shall be kept up-to-date. In each factory the manufacturer may delegate the action to a person having the necessary authority to:

a) identify procedures to demonstrate conformity of the construction product at appropriate stages,

b) identify and record any instance of non–conformity,

c) identify procedures to correct instances of non-conformity.

N.1.2 Documentation

The manufacturer shall draw up and keep up-to-date documents defining the FPC, which he applies.

The manufacturer's documentation and procedures shall be appropriate to the construction product and manufacturing process. All FPC systems shall achieve an appropriate level of confidence in the conformity of the construction product. This involves:

a) the preparation of documented procedures and instructions relating to FPC operations, in accordance with the requirements of this European Standard (see N.1.3),

b) the effective implementation of these procedures and instructions,

c) the recording of these operations and their results,

d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of non-conformity.

N.1.3 Operations

FPC includes the following operations :

a) the specification and verification of raw materials and constituents,

b) the control and tests to be carried out during manufacture of the construction product according to a frequency laid down,

c) the verifications and tests to be carried out on finished construction products according to a frequency, which may be laid down in the technical specifications and adapted to the product and its conditions of manufacture.

NOTE 1 The operations under b) centre as much on the intermediate states of the construction product as on manufacturing machines and their adjustment and equipment etc. These controls and tests and their frequency are chosen based on type of construction product and composition, the manufacturing process and its complexity, the sensitivity of product features to variations in manufacturing parameters etc.

NOTE 2 With regard to operations under c), where there is no control of finished construction products at the time there are placed on the market, the manufacturer should ensure:

- packaging, and reasonable conditions of handing and storage, do not damage construction products,

- the construction product remains in conformity with the technical specifications.

NOTE 3 The appropriate calibrations should be carried out on defined measuring and test instruments.

N.2 Verifications and tests

N.2.1 General comments

The manufacturer shall have or have available the installations, equipment and personnel which enable him to carry out the necessary verifications and tests. He may, as may his agent, meet this requirement by concluding a sub-contracting agreement with one or more organisations or persons having the necessary skills and equipment.

The manufacturer shall calibrate or verify and maintain the control, measuring or test equipment in good operating condition, whether or not it belongs to him, with a view to demonstrating conformity of the construction product with its technical specification. The equipment shall be used in conformity with the specification or the test reference system to which the specification refers.

N.2.2 Monitoring of conformity

If necessary, monitoring is carried out on the conformity of intermediate states of the product and at the main stages of its dispatch.

This monitoring of conformity focuses where necessary on the construction product throughout the process of manufacture, so that only products having passed the scheduled intermediate controls and tests are dispatched.

N.2.3 Tests

Tests shall be in accordance with the test plan (Tables 6, 7 and 8) and can be carried out in accordance with the methods indicated in this document

NOTE The manufacturer himself can carry out initial type tests on the product but in that case they have to be validated by an approved body.

The manufacturer shall establish and maintain records, which provide evidence that the construction products have been tested. These records shall show clearly whether the construction product has satisfied the defined acceptance criteria. Where the construction product fails to satisfy the acceptance measures, the provisions for non-conforming products shall be applied.

N.2.4 Treatment of construction products which do not conform

If control or test results show that the construction product does not meet the requirements, then necessary corrective action shall immediately be taken. Construction products or batches not conforming shall be isolated and properly identified. Once the faults have been corrected, the test or verification in question shall be repeated.

If construction products have been delivered before the results are available, a procedure and record shall be maintained for notifying customers.

N.2.5 Recording or verifications and tests (manufacturer's register)

The results of factory production controls shall be properly recorded in the manufacturer's register. The construction product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the register under the signature of the person responsible for control who carried out the verification.

With regard to any control result not meeting the requirements of this document, the corrective measures taken to rectify the situation (e.g. further test carried out, modification of manufacturing process, throwing away or putting right or product) shall be indicated in the register.

In case of third party surveillance the records shall be made available to the third party for examination.

N.3 Traceability

It is the manufacturer's, or his agent's, responsibility to keep full records of individual construction, products or product batches, including their related manufacturing details and characteristics and to keep records of to whom these construction products and the related manufacturing details shall be completely identifiable and retraceable. In certain cases, for examples for bulk products, a rigorous traceability is not possible.

Annex ZA
(informative)
Clauses of this European Standard addressing the provisions of the EU Construction Products Directive

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under a mandate [1] given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European Standard, shown in this annex meet the requirements of the mandate given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of the elastomeric bearings covered by this annex for their intended uses indicated herein; reference shall be made to the information accompanying the CE marking.

WARNING: Other requirements and other EU Directives, not affecting the fitness for intended uses may be applicable to the elastomeric bearings falling within the scope of this standard.

NOTE 1 In addition to any specific clauses relating to dangerous substances contained in this standard, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements needs also to be complied with, when and where they apply.

NOTE 2 An informative database of European and national provisions on dangerous substances is available at the Construction web site on EUROPA (accessed through http://europa.eu.int/comm/enterprise/construction/internal/dangsub/dangmain.htm).

This annex establishes the conditions for the CE marking of elastomeric bearings intended for the uses indicated in Tables ZA.1.a to ZA.1.c and shows the relevant clauses applicable.

This annex has the same scope as clause 1 of this standard and is defined in Tables ZA.1.a to ZA.1.c.

1 M/104 "Structural bearings" as amended by M/132

Tables ZA.1 - Scope and relevant clauses

Table ZA.1.a

Construction Products: Type A, B, C and F elastomeric bearings without any sliding surfaces or elements as covered in the scope of this document

Intended uses: In buildings and civil engineering works

Requirements	Requirement clause(s) in this and other European Standard(s):	Mandated level(s) or class(es):	Notes:
Load bearing capacity	EN 1337-3 clauses - 4.3.1 (shear modulus) - 4.3.2 (shear bond) - 4.3.3 (compression stiffness) - 4.3.4 (resistance to repeated loading in compression) - 4.4.3 (steel reinforcing plates) - 5.1 (design rules – general) - 5.3.3 (basis of design) - 5.4 (plain pad bearings) - 5.5 (strip bearings)	None	Information on characteristics of materials and on geometry
Rotation capacity	EN 1337-3 clauses - 5.1 (design rules – general) - 5.3.3.4 (design strain due to angular rotation) - 5.3.3.6 (limiting conditions) - 5.3.3.7 (forces, moments and deformations exerted on the structure)	None	Information on characteristics of materials and on geometry
Durability aspects	EN 1337-3 clauses - 4.3.6 (ozone resistance) - 4.4.2 (physical and mechanical properties of elastomer) - 5.1 (design rules – general) EN 1337-9:1997, 4.1.1.1 (Performance)	None	Pass/fail criteria

Table ZA.1.b

Construction Products: Type D elastomeric bearings with sliding surfaces as covered in the scope of this document **Intended uses**: In buildings and civil engineering works			
Requirements	**Requirement clause(s) in this and other European Standard(s):**	**Mandated level(s) or class(es):**	**Notes:**
Load bearing capacity	EN 1337-3 clauses - 4.3.1 (shear modulus) - 4.3.2 (shear bond) - 4.3.3 (compression stiffness) - 4.3.4 (resistance to repeated loading in compression) - 4.4.3 (steel reinforcing plates) - 5.1 (design rules – general) - 5.3.3 (basis of design)	None	Design value, in kN
Rotation capacity	EN 1337-3 clauses - 5.1 (design rules – general) - 5.3.3.4 (design strain due to angular rotation) - 5.3.3.6 (limiting conditions) - 5.3.3.7 (forces, moments and deformations exerted on the structure)	None	Design value, in radians
Durability aspects	EN 1337-3 clauses - 4.3.6 (ozone resistance) - 4.3.7 (PTFE/elastomer shear bond strength) - 4.4.2 (physical and mechanical properties of elastomer) - 4.4.4 (sliding surfaces) - 5.1 (design rules – general) EN 1337-9:1997, 4.1.1.1 (Performance)	None	Pass/fail criteria

Table Z.A.1.c

Construction Products: Type E Elastomeric bearings with sliding elements as covered in the scope of this document **Intended uses**: In buildings and civil engineering works			
Requirements	**Requirement clause(s) in this and other European Standard(s):**	**Mandated level(s) or class(es):**	**Notes:**
Load bearing capacity	EN 1337-3 clauses - 4.3.1 (shear modulus) - 4.3.2 (shear bond) - 4.3.3 (compression stiffness) - 4.3.4 (resistance to repeated loading in compression) - 4.4.3 (steel reinforcing plates) - 5.1 (design rules – general) - 5.3.3 (basis of design)	None	Design value, in kN
Rotation capacity	EN 1337-3 clauses - 5.1 (design rules – general) - 5.3.3.4 (design strain due to angular rotation) - 5.3.3.6 (limiting conditions) - 5.3.3.7 (forces, moments and deformations exerted on the structure)	None	Design value, in radians
Durability aspects	EN 1337-3 clauses - 4.3.6 (ozone resistance) - 4.4.2 (physical and mechanical properties of elastomer) - 5.1 (design rules – general) EN 1337-9:1997, 4.1.1.1 (Performance)	None	Pass/fail criteria
Load bearing capacity (of sliding element)	EN 1337-2:2004, 5.3, 5.5, 6 and 8.3	None	Design value, in kN
Coefficient of friction (of sliding element)	EN 1337-2:2004, 4.1.1	None	Tabulated value (Table 1)
Durability aspects (of sliding element)	EN 1337-2:2004, 4.3.5.2, 4.7, 5.1 and 5.2 EN 1337-9:1997, clause 4	None	Pass/fail criteria

The requirement on a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, manufacturers placing their products on the market of these MSs are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option “No performance determined” (NPD) in the information accompanying the CE marking (see Clause ZA.3) may be used. The NPD option may not be used, however, where the characteristic is subject to a threshold level.

ZA.2 Procedures for attestation of conformity of elastomeric bearings

ZA.2.1 System(s) of attestation of conformity

The systems of attestation of conformity of the elastomeric bearings indicated in Tables ZA.1.a to ZA.1.c, in accordance with the Decision of the Commission 95/467/EC of 1995-10-24 as given in Annex III of the mandate "Structural bearings", is shown in Table ZA.2 for the indicated intended uses and relevant level(s) or class(es):

Table ZA.2 - System(s) of attestation of conformity

Product	Intended use(s)	Level(s) or class(es)	Attestation of conformity systems
Elastomeric bearings; sliding elastomeric bearings	In buildings and civil engineering works where requirements on individual bearings are critical (1)	None	1
	In buildings and civil engineering works where requirements on individual bearings are not critical (2)		3
System 1: See Directive 89/106/EEC (CPD) Annex III.2.(i), without audit testing of samples System 3: See Directive 89/106/EEC (CPD) Annex III.2.(ii), Second possibility			
(1) Critical in the sense that those requirements may, in case of failure of the bearing, put the whole works or part thereof beyond those limit states regarded as serviceability and ultimate. (2) Not critical in the sense that those requirements may not, in case of failure of the bearing, put the whole works or part thereof beyond those limit states regarded as serviceability and ultimate and there is no risk to life.			

The attestation of conformity of the elastomeric bearings in Tables ZA.1a to ZA.1.c shall be based on the evaluation of conformity procedures indicated in Tables ZA.3.a and ZA.3.b resulting from the application of the clauses of this or other European Standard indicated therein.

Table ZA.3.a - Assignment of evaluation of conformity tasks for elastomeric bearings without sliding elements under system 1

Tasks		Content of the task	Clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to all characteristics of the relevant Table ZA.1	EN 1337-3 clauses - 8.1 (conformity evaluation – general) - 8.4 (non-compliance with technical specification)
	Further testing of samples taken at factory	All characteristics of the relevant Table ZA.1	EN 1337-3 clauses - 8.1 (conformity evaluation – general) - 8.3 (sampling) - 8.2.3 (routine testing)
Tasks for the notified body	Initial type testing	All characteristics of the relevant Table ZA.1	EN 1337-3 clauses - 8.1 (conformity evaluation – general) - 8.3 (sampling) - 8.2.2 (initial type tests)
	Initial inspection of factory and of FPC	Parameters related to all characteristics of the relevant Table ZA.1	EN 1337-3 clauses - 8.1 (conformity evaluation – general) - 8.2.3 (routine testing)
	Continuous surveillance, assessment and approval of FPC.	Parameters related to all characteristics of the relevant Table ZA.1	EN 1337-3 clauses - 8.1 (conformity evaluation – general) - 8.2.3 (routine testing)

Table ZA.3.b - Assignment of evaluation of conformity tasks for elastomeric bearings without sliding elements under system 3

Tasks		Content of the task	Clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to all characteristics of the relevant Table ZA.1	EN 1337-3 clauses - 8.1 (conformity evaluation – general) - 8.4 (non-compliance with technical specification)
Tasks for the notified body	Initial type testing	All characteristics of the relevant Table ZA.1	EN 1337-3 clauses - 8.1 (conformity evaluation – general) - 8.3 (sampling) - 8.2.2 (initial type tests)

Table ZA.3.c – Assignment of evaluation of conformity tasks for elastomeric bearings with sliding elements under system 1

<table>
<tr><th colspan="2">Tasks</th><th>Content of the task</th><th>Clauses to apply</th></tr>
<tr><td rowspan="2">Tasks for the manufacturer</td><td>Factory production control (FPC)</td><td>Parameters related to all characteristics of the relevant Tables ZA.1.b and ZA.1.c</td><td>EN 1337-3 clauses
8.1 (conformity evaluation – general)
8.4 (non-compliance with technical specification)
EN 1337-2:2004 clauses
8.2.1 (general)
8.2.3 (FPC)
8.3 (raw materials and constituents)
8.4 (sampling)</td></tr>
<tr><td>Further testing of samples taken at factory</td><td>All characteristics of the relevant Tables ZA.1.b and ZA.1.c</td><td>EN 1337-3 clauses
8.1 (conformity evaluation – general)
8.3 (sampling)
8.2.3 (routine testing)
EN 1337-2:2004 clauses
8.2.1 (general)
8.2.3 (FPC)
8.3 (raw materials and constituents)
8.4 (sampling)</td></tr>
<tr><td rowspan="3">Tasks for the notified body</td><td>Initial type testing</td><td>All characteristics of the relevant Tables ZA.1.b and ZA.1.c</td><td>EN 1337-3 clauses
8.1 (conformity evaluation – general)
8.3 (sampling)
8.2.2 (initial type testing)
EN 1337-2:2004 clauses
8.2.1 (general)
8.2.3 (FPC)
8.3 (raw materials and constituents)
8.4 (sampling)</td></tr>
<tr><td>Initial inspection of factory and of FPC</td><td rowspan="2">Parameters related to all characteristics of the relevant Tables ZA.1.b and ZA.1.c</td><td rowspan="2">EN 1337-3 clauses
8.1 (conformity evaluation – general)
8.2.3 (routine testing)
EN 1337-2:2004 clauses
8.2.1 (general)
8.2.3 (FPC)
8.3 (raw materials and constituents)
8.4 (sampling)</td></tr>
<tr><td>Continuous surveillance, assessment and approval of FPC</td></tr>
</table>

Table ZA.3.d – Assignment of evaluation of conformity tasks for elastomeric bearings with sliding elements under system 3

Tasks		Content of the task	Clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to all characteristics of the relevant Tables ZA.1.b and ZA.1.c	EN 1337-3 clauses 8.1 (conformity evaluation – general) 8.4 (non-compliance with technical specification) EN 1337-2:2004 clauses 8.2.1 (general) 8.2.3 (FPC) 8.3 (raw materials and constituents) 8.4 (sampling)
Tasks for the notified body	Initial type testing	All characteristics of the relevant Tables ZA.1.b and ZA.1.c	EN 1337-3 clauses 8.1 (conformity evaluation – general) 8.3 (sampling) 8.2.2 (initial type testing) EN 1337-2:2004 clauses 8.2.1 (general) 8.2.3 (FPC) 8.3 (raw materials and constituents) 8.4 (sampling)

ZA.2.2 EC Certificate and declaration of conformity

When compliance with this annex is achieved:

a) For bearings under system 1, the certification body shall draw up a certificate of conformity (EC Certificate of conformity) with the information indicated below. This EC Certificate of conformity entitles the manufacturer to affix the CE marking, as described in ZA.3.

The EC Certificate of conformity shall include the following information:

– Name, address (or identification number) of certification body,

– Name and address of the manufacturer, or his authorised representative established in the EEA and place of production,

– Description of the product (type, identification, use, ...) and a copy of the information accompanying the CE marking,

– Provisions to which the product conforms (e.g. annex ZA),

– Particular conditions applicable to the use of the product (e.g. provisions for the use of a bearing under certain conditions, etc),

– The certificate's number,

– Conditions and period of validity of the certificate,

– Name of, and position held by, the person empowered to sign the certificate.

In addition, for each product covered by an EC Certificate of conformity, the manufacturer shall draw up a declaration of conformity (EC Declaration of conformity) including the following information:

- Name and address of the manufacturer, or his authorised representative established in the EEA,

- Number of the attached Certificate of factory production control,

- Name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or of his authorised representative.

Both documents shall be presented in the official language or languages of the Member State of the EU in which the product is to be used.

b) For bearings under system 3, the manufacturer shall draw up a declaration of conformity (EC Declaration of conformity) including the following information:

– Name and address of the manufacturer, or his authorised representative established in the EEA and place of production,

– Description of the product (type, identification, use, ...),

– Provisions to which the product conforms (e.g. annex ZA),

– Particular conditions applicable to the use of the product (e.g. provisions for the use of a bearing under certain conditions, etc),

– Name and address of the approved laboratory that carried out the initial type tests.

– Name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or of his authorised representative.

This EC Declaration of conformity entitles the manufacturer to affix the CE marking, as described in ZA.3.

This document shall be presented in the official language or languages of the Member State of the EEA in which the product is to be used.

ZA.3 CE marking

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the Elastomeric bearing (or when not possible it may be on the accompanying label, the packaging or on the accompanying commercial documents). The following information and characteristics shall accompany the CE marking symbol (where relevant):

- identification number of the notified body,

- name and address of the manufacturer,

- last two digits of the year of affixing the CE marking,

- number of the certificate of conformity (if relevant),

- the number of this standard (EN 1337-3,)

- the product name and type.

- Information on the mandated characteristics:

  - Values and, where relevant, level or class to declare for each mandated characteristic as indicated in "Notes" in Table ZA.1,

  - As an alternative, where possible, standard designation may be given. This designation should give information on all the characteristics, if all are not covered, then values for those not covered must be additionally given.

The NPD option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements.

Examples for elastomeric bearings combined with flat slidings under system 1 are given in Figure ZA.1 for information to be given on the product and Figure ZA.2 for information to be given with the accompanying documents. Figure ZA.2 reflects the characteristics given in Table ZA.1.b.

CE	*CE conformity marking, consisting of the «CE»-symbol given in Directive 93/68/EEC.*
0123-CPD-0001	*Identification number of the certification body (when relevant)*
10 Any Co Ltd	*Name or identifying mark of the manufacturer*

Figure ZA.1 - Example of CE marking information on the bearing

CE	*CE conformity marking, consisting of the «CE»-symbol given in Directive 93/68/EEC.*
0123-CPD-0001	*Identification number of the certification body*
Any Co Ltd, PO Box 21, B-1050	*Name or identifying mark and registered address of the manufacturer*
04	*The last two digits of the year in which the marking was affixed*
0123-CPD-0456	*Number of the EC certificate of conformity*
EN 1337-3: 2004	*No. of European Standard*
BEARING N° …………	*Identification of product and intended use*
Elastomeric bearing for minimum operating temperature of –25/-40 °C, for uses in buildings and civil engineering works where requirements on individual bearings are <u>critical</u>	*and*
BEARING G modulus of elastomer (MPa) Yield strength of steel (MPa) Geometry (as in attached drawings or description) SLIDING ELEMENT Geometry (as in attached drawings or description)	*Information on mandated characteristics* 1)

1) In the absence of Nationally Determined Parameters (NDP), e.g. partial safety factors, and in the case of prescribed bearings, the manufacturer should provide the G modulus of the elastomer and the tensile yield strength of the steel used for the reinforcing plates, as well as the geometrical characteristics of the bearing

Figure ZA.2 - Example of CE marking information on the accompanying documents

In addition to any specific information relating to dangerous substances shown above, the product should also be accompanied, when and where required and in the appropriate form, by documentation listing any other legislation on dangerous substances for which compliance is claimed, together with any information required by that legislation.

Note: European legislation without national derogation need not be mentioned

Bibliography

[1] EN ISO 9001, *Quality management systems - Requirements (ISO 9001:2000)*

[2] EN 1990 *Eurocode, Basis of structural design*

[3] EN 1991 *Eurocode 1, Actions on structures*