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SPHERICAL AND CYLINDRICAL BEARING WITH SPECIAL SLIDING MATERIAL MADE OF FLUOROPOLYMER

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1 SCOPE OF THE EAD

1.1 Description of the construction product

The construction product is a spherical or cylindrical bearing with special sliding material made of fluoropolymer which permits rotation and displacement movements by a plane and a curved sliding surface between bearing plates of steel (see Figure 1 and Figure 2). The subject of the EAD is the complete bearing, including, if relevant, the necessary guides or restraints. As an alternative to Figure 1, the bearing may also be used upside down, i.e. with flat sliding surfaces lying below (meaningful, for example in the case of steel bridges).

The spherical and cylindrical bearings with special sliding material made of fluoropolymer are designed according to EN 1337-7 and may be combined with sliding elements according to EN 1337-2 as shown in EN 1337-1. Instead of PTFE according to EN 1337-2, a low friction fluoropolymer made of a specified PTFE (polytetrafluoroethylene) with melting temperature of at least 50°C higher than the maximum operating temperature described below, is used for the sliding surfaces of the bearing. This low friction fluoropolymer is suitable for low and high temperatures with improved wear resistance and load-bearing capacity and it is not covered by the scope of EN 1337-2. The geometrical conditions of the special sliding material sheets are given in Annex B.

Sliding surfaces with a diameter of the circumscribing circle of sliding material sheets less than 75 mm or greater than 2500 mm, or with effective bearing temperatures less than - 50 °C or greater than + 48 °C, or up to + 90 °C if required by the manufacturer, are outside the scope of this EAD. Effective bearing temperatures above + 48 °C are limited to short periods as due to climate temperature changes. If composite material in accordance with EN 1337-2 is used in guides, the maximum effective bearing temperature is limited to + 48 °C. Spherical and cylindrical bearings with special sliding material made of fluoropolymer with an included angle $2\theta > 60^\circ$ and $2\theta > 75^\circ$ respectively are beyond the scope of this EAD (see Clause 1 and Figure 6 of EN 1337-7).

For the types of the bearings covered by this EAD, the drawings given in EN 1337-7, clause 3.1.2 and clause 3.1.9 apply. The components are indicated as given in the next Figures 1 and 2.

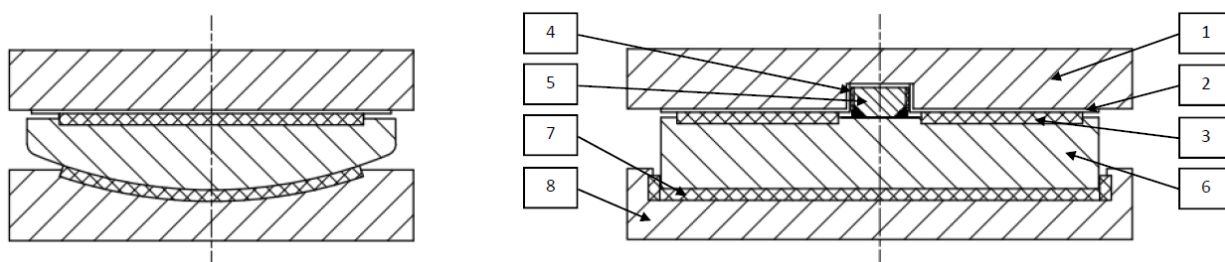


Figure 1: Cylindrical bearing

Legend for Figure 1:	
1 sliding plate	5 guide
2 austenitic steel sliding sheet	6 rotational element
3 fluoropolymer sheet	7 fluoropolymer sheet
4 fluoropolymer sheet or composite material strip	8 backing plate

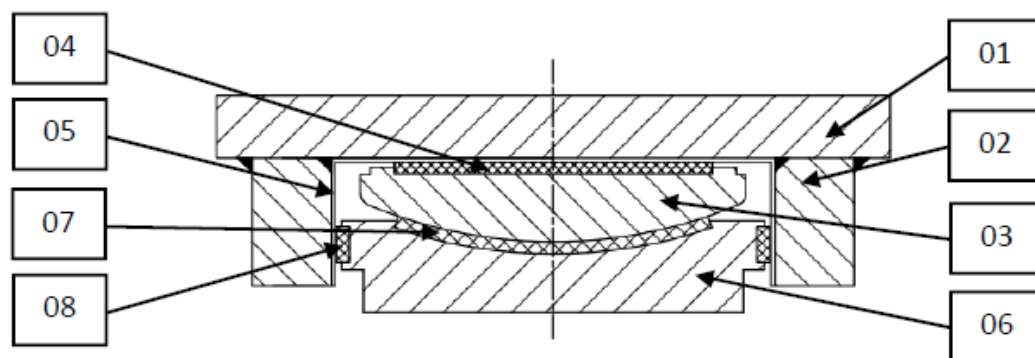


Figure 2: Spherical bearing

Legend for Figure 2:	
1 sliding plate	5 austenitic steel sliding sheet
2 guide	6 backing plate
3 rotational element	7 fluoropolymer sheet
4 fluoropolymer sheet	8 fluoropolymer sheet

This EAD is valid for products with geometrical properties according to Annex B of this EAD.

The sliding materials in the bearing are combined as shown in Table 1. Only one combination is used in a sliding surface. The sliding surface is lubricated in accordance with EN 1337-2, clause 7.4.

Table 1 - Combination of materials for permanent applications as sliding surfaces for spherical and cylindrical bearings with special sliding material made of fluoropolymer

Plane surface ¹⁾		Curved surface		Guides	
dimpled fluoropolymer	austenitic steel	dimpled fluoropolymer	austenitic steel	undimpled fluoropolymer ²⁾	austenitic steel
			hard chromium	CM1	
				CM2	
¹⁾ The sliding surface may be subdivided in two restrained parts above and below the rotation element permitting in total the design movement ²⁾ Instead of the undimpled fluoropolymer sheets, only where self-alignment between the mating parts of the bearing is possible, composite materials in accordance with either clause 5.3.1 or 5.3.2 of EN 1337-2 can be used.					

The mating surfaces are made of either austenitic steel in accordance with clause 5.4 of EN 1337-2, or hard chromium plating in accordance with clause 5.5 of EN 1337-2.

The ferrous materials used for backing plates of the sliding surfaces are in accordance with EN 1337-2, clause 5.6.

Attachment of sliding materials in accordance with clause 7.2 of EN 1337-2.

The product is not fully covered by the following harmonised technical specification:

EN1337-7:2004-03 (“Structural bearings – Part 7: Spherical and cylindrical PTFE bearings”)

Instead of PTFE according to EN 1337-2, referred to in EN 1337-7, a low friction fluoropolymer made of a specified PTFE (polytetrafluoroethylene) is used as sliding material.

Furthermore the effective bearing temperatures, covered by this EAD are from - 50 °C up to + 90 °C.

The sliding surfaces covered by this EAD comprise a diameter of the circumscribing circle of sliding material sheets not less than 75 mm and not greater than 2500 mm.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product, as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The spherical and cylindrical bearings with special sliding material made of fluoropolymer are intended to be used for the support of bridges or building works in accordance with the scope of EN 1337-1 where the requirements on the individual bearings are critical.

Spherical and cylindrical bearings with special sliding material made of fluoropolymer are suitable for all types of structures. They are especially suitable for non-rigid structures with relatively large and frequent displacements caused by working loads, next for superstructures that induce fast sliding displacements in bearings, e.g. in bridges for the high speed railways, as well as for regions with continuously low and high temperatures. Effective bearing temperatures above 48 °C are limited to short periods as due to climate temperature changes.

The spherical and cylindrical bearings with special sliding material made of fluoropolymer are mainly used in concrete, steel and composite structures.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the spherical and cylindrical bearings with special sliding material made of fluoropolymer for the intended use as to be expressed in the European Technical Assessment in terms of years depending on the accumulated total sliding path assessed according to clause 2.2.6 and Annex E of this EAD. These provisions are based upon the current state of the art and the available knowledge and experience.

The working life of the bearing is reduced to 10 years if in bearing's guides the composite materials according to EN 1337-2 are used instead of the special sliding material made of the specified fluoropolymer.

When assessing the product the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works¹.

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

¹ The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

1.3 Specific terms used in this EAD

(if necessary in addition to the definitions in CPR, Art 2):

For the purposes of this EAD, the specific terms and definitions given in EN 1337-2 and 1337-7 apply.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

2.1.1 Essential characteristics of the spherical and cylindrical bearings with special sliding material made of fluoropolymer

The essential characteristics of the spherical and cylindrical bearings with special sliding material made of fluoropolymer and assessment methods, which are relevant for the assessment and verification of constancy of performance of the spherical and cylindrical bearings with special sliding material made of fluoropolymer, are given in Table 2.

Table 2 shows how the performance of spherical and cylindrical bearings with special sliding material made of fluoropolymer is assessed in relation to the essential characteristics.

Table 2 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Load bearing capacity	2.2.1	level
2	Rotation capability	2.2.2	level
3	Displacement capacity	2.2.3	level
4	Durability aspects	2.2.4	description
5	Load bearing capacity (of the sliding element)	2.2.5	level
6	Coefficient of friction (of the sliding element)	2.2.6	level
7	Durability aspects (of the sliding element)	2.2.7	description

2.1.2 Essential characteristics of the components of the spherical and cylindrical bearings with special sliding material made of fluoropolymer

2.1.2.1 Special sliding material made of fluoropolymer

Table 3 shows how the performance of the special sliding material made of fluoropolymer is assessed in relation to the essential characteristics.

Table 3 Essential characteristics of the special sliding material made of fluoropolymer and methods and criteria for assessing the performance of the special sliding material made of fluoropolymer in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Material properties of special sliding material made of fluoropolymer	2.2.8	level ^{*)}
2	Compressive strength of special sliding material made of fluoropolymer	2.2.9	level
3	Load – deformation behaviour of special sliding material made of fluoropolymer	2.2.10	level
4	High temperature resistance of special sliding material made of fluoropolymer	2.2.11	description
5	Resistance of special sliding material made of fluoropolymer against chemical and environmental influences	2.2.12	description
*) Properties of the material to be laid down in the technical documentation deposited by the manufacturer with the Technical Assessment Body			

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

Characterisation of the spherical and cylindrical bearings with special sliding material made of fluoropolymer to be assessed shall be done in accordance with the geometrical conditions of special sliding material made of fluoropolymer given in Annex B of this EAD.

2.2.1 Load bearing capacity

The curved sheet of special sliding material made of fluoropolymer shall be assessed according to clauses 6.2.1 to 6.2.3 of EN 1337-7, with adaptations accounting for the essential characteristics of the special sliding material made of fluoropolymer used in the sliding surfaces:

- when calculating the total eccentricity e_t of the axial force N_s , the frictional resistance of the sliding surfaces shall be stated using the coefficients of friction of the special sliding material made of fluoropolymer assessed in accordance with clause 2.2.6 of this EAD;
- the compressive strength shall be assessed using the relevant values of the temperature-dependent characteristic compressive strength of the special sliding material made of fluoropolymer assessed in accordance with clause 2.2.9 of this EAD.

The backing plates with concave surfaces shall be assessed in accordance with clause 2.2.5 in this EAD taking into account dimensional limitations shown in Figure 7 of EN 1337-7.

In case free spherical bearings (see Figure 4 a) of EN 1337-7) are fixed by a steel restraining ring as shown in Figure 4 d) of EN 1337-7, for the assessment of the steel restraining ring, the design rules for pot and piston of pot bearings given in clause 6 of EN 1337-5 apply.

The load bearing capacity, stated in the European Technical Assessment, is referring to the maximum diameter of the sheet of special sliding material made of fluoropolymer covered by the EAD and stated in the ETA and to each of the temperatures assessed in accordance with clause 2.2.9 in this EAD.

2.2.2 Rotation capability

The rotation capability shall be assessed by check of the geometrical conditions.

The possible material combinations of curved sliding surfaces are given in Table 1 in this EAD.

The sliding surfaces shall be assessed equivalent to clause 6.2.4 of EN 1337-7 and according to clause 2.2.6 of this EAD.

Where, according to clause 6.4 of EN 1337-2 under predicted rotation about a transverse axis the differential deformation of the sheet made of special sliding material in guides across its smallest dimension for the un-factorised characteristic actions would exceed 0,2 mm, a rotation element shall be included in the backing plate. The material combination of this rotation element shall be designed in accordance with the requirements of the mating surfaces of guides given in this EAD or pot to piston contact surfaces given in EN 1337-5.

The rotation capability is stated in the European Technical Assessment by means of minimum and maximum rotation angle.

2.2.3 Displacement capacity

The displacement capacity under consideration of EN 1337-1 shall be assessed by check of the geometrical conditions and the product characteristics of the used sliding elements.

For the single, maximum displacement, the assessment in equivalence to clause 6.5.1 of EN 1337-2 applies.

The total displacement capacity is stated in the European Technical Assessment by means of the accumulated sliding path assessed in accordance with Annex D in this EAD.

2.2.4 Durability aspects

The measures for the protection of the spherical and cylindrical bearing with special sliding material made of fluoropolymer from the effects of the environment and other external influences, which would reduce the working life, shall be assessed in accordance with clause 4 of EN 1337-9.

2.2.5 Load bearing capacity (of the sliding element)

2.2.5.1 Sliding surfaces

The sliding element shall be assessed in accordance with sub clauses 6.8.1 to 6.8.3 of EN 1337-2, with adaptations accounting for the essential characteristics of the special sliding material made of fluoropolymer:

- possible material combinations are given in Table 1 in this EAD;
- the compressive strength shall be assessed using the relevant values of the temperature-dependent characteristic compressive strength of the special sliding material made of fluoropolymer assessed in accordance with clause 2.2.9 in this EAD.

For curved sliding surfaces clause 2.2.1 in this EAD also applies.

2.2.5.2 Backing plates

The backing plates of the sliding surfaces shall be assessed in accordance with clause 6.9 of EN 1337-2, with adaptations accounting for the essential characteristics of the special sliding material made of fluoropolymer:

- for the assessment of the maximum deformation $\Delta w_{adm} \geq \Delta w_1 + \Delta w_2$ (see EN 1337-2, Figure 9) of the backing plate, the formula (1) given below may be used for the values of the relevant material characteristics fulfilling the boundary conditions given in Table 4.

$$\Delta w_{adm} = h_0 \left(0,45 - 1,708k \sqrt{\frac{h_0}{L}} \right) \text{ with } h_r [mm] = h_0 - \Delta w_1 - \Delta w_2 - \Delta h \geq 1,0 + \frac{L[mm]}{2000} \quad (1)$$

In the above formula L is the diameter of the circumscribing circle of sliding material sheet, whereas h_0 is the height of protrusion of the sheet of sliding material in unloaded condition, Δh is the variation of the protrusion height, and h_r is the protrusion after loading, means when having applied the maximum load but before removing. Stiffness coefficient k assessed according to clause 2.2.10, Table 7 in this EAD.

If not, an individual formula for the assessment of the maximum deformation Δw_{adm} is to be developed in a revised version of this EAD.

Note 1: This approach should ensure that unacceptable assumptions for the use of a sliding material with different material characteristics than those meeting the boundary conditions in Table 4 are avoided.

Table 4: Boundary conditions for relevant material characteristics

Property	Boundary condition
Protrusion after loading [mm]	$1 \text{ mm} \leq h_r \leq 0,66 h_0^{(a)}$
Settlement of sliding material [mm]	$\Delta w_{adm} \leq 4 \times k'_{50\%(p=0,5 f_k)} \sqrt{\frac{h_{(L=155 \text{ mm})}^3}{155 [\text{mm}]}} \quad (b)$
Stiffness coefficient, modulus of elasticity	Numeric value $k, E_{ip} \quad (c)$
Ratio tensile strength/yield strength	< 3.0
Ratio elongation at break/yield deformation	> 13
<p>^(a) h_0 is the height of the protrusion in the initial (unloaded) condition; h_r is the height of protrusion after 48 hours of constant load according to clause C.1 in this EAD</p> <p>^(b) $k'_{50\%(p=0,5 f_k)}$ is the mean value of the stiffness coefficient assessed at pressure level $p = 0,5 f_k (T_0)$ according to clause C.2 in this EAD</p> <p>^(c) see Table 7, clause 2.2.10 in this EAD</p>	

Note 2: The boundary conditions given in Table 4 are not to be considered as threshold values for the product covered by the EAD. They are boundary conditions for the possible application of the relevant formula stated above. The relevant material characteristics are given by means of levels. If they meet the conditions given in Table 4, the formula given above can be used.

2.2.6 Coefficient of friction (of the sliding element)

The friction coefficients reflecting the sliding behaviour of the special sliding material made of fluoropolymer are assessed according to the tests given in Annex D of this EAD.

A) Assessment of the friction coefficients for sliding elements combined with dimpled and lubricated special sliding material-sheets

After the assessment of the maximum accumulated sliding path, $\mu_{s,T}$ shall be assessed at - 10 °C, - 25 °C and + 21 °C at the pressure levels $1/3 f_k$, $1/6 f_k$ and $1/12 f_k$, where f_k is the characteristic compressive strength of the special sliding material made of fluoropolymer at temperature $T \leq 35$ °C assessed in accordance with clause 2.2.9 in this EAD, following the test procedure A₁ of Table D.3.

The assessment at - 10 °C is related to assessment of the friction coefficients for sliding elements combined with dimpled and lubricated special sliding material sheets at low temperatures, whereas the minimum effective bearing temperature does not fall below - 35 °C.

The assessment at - 25 °C is related to assessment of the friction coefficients for sliding elements combined with dimpled and lubricated special sliding material sheets at very low temperatures, whereas the minimum effective bearing temperature does fall below - 35 °C (down to - 50 °C).

The assessment at + 21 °C is related to assessment of the friction coefficients for sliding elements combined with dimpled and lubricated special sliding material sheets at moderate low temperatures, whereas the minimum effective bearing temperature does not fall below - 5 °C.

B) Assessment of the friction coefficients for guides

After the assessment of the maximum accumulated sliding path of guides, equivalent to 20 % of the sliding path of the dimpled and lubricated special sliding material sheets according to clause A) above, $\mu_{s,T}$ shall be assessed at - 10 °C, - 25 °C and + 21 °C at the pressure level of $1/3 f_k$ following the test procedure A₁ of Table D.3.

The assessment at - 10 °C is related to assessment of the friction coefficients for guides at low temperatures, whereas the minimum effective bearing temperature does not fall below - 35 °C.

The assessment at - 25 °C is related to assessment of the friction coefficients for guides at very low temperatures, whereas the minimum effective bearing temperature does fall below - 35 °C (down to - 50 °C).

The assessment at + 21 °C is related to assessment of the friction coefficients for guides at moderate low temperatures, whereas the minimum effective bearing temperature does not fall below - 5 °C.

2.2.6.1 Sliding elements incorporating dimpled and lubricated sheets made of special sliding material made of fluoropolymer

Based on the results of testing, the maximum friction coefficient μ_{max} for each temperature range stated above, assessed as a function of the average contact pressure on the sliding material sheet σ_p (MPa), including the minimum and maximum levels of contact pressure $1/12 f_k$ and $1/3 f_k$, shall be stated in the ETA.

If the coefficients of friction in each phase of the long-term friction test does exceed the values at the end of the long-term friction test, the exceeding expressed by related percentage shall be considered for the assessment of the values of the friction coefficient μ_{max} for the different temperature ranges.

If the range of operating temperature shall be extended to T_{max} , with $+ 48$ °C $\leq T_{max} \leq + 90$ °C, the friction coefficients assessed in both phases A₁ of the high temperature programme test in accordance with Table D.4 shall be expressed by means of levels and stated separately in the ETA for the extended operating temperature range, if they exceed the values measured in any type A₁ phase of the long-term friction test.

The friction coefficients assessed in short term friction tests (phase A₁) with lubricant previously exposed to $T_{max} + 10$ °C for 60 days shall be expressed by means of levels and stated separately in the ETA for the

extended operating temperature range, if they exceed the values measured in the phase A₁ of the long-term friction test.

2.2.6.2 Sliding elements for guides incorporating undimpled and initially lubricated sheets made of special sliding material made of fluoropolymer

Based on the test results as addressed in sub clause B), the maximum friction coefficient μ_{\max} assessed for each temperature range stated above, shall be stated in the ETA.

The extension of the range of operating temperature up to not more than + 90 °C is justified by the additional test given in clause 2.2.9 of this EAD and Annex D of this EAD.

2.2.7 Durability aspects (of the sliding element)

Clause 7.3 of EN 1337-2 applies.

2.2.8 Material properties of special sliding material made of fluoropolymer

Material properties of the special sliding material made of fluoropolymer shall be assessed in accordance with the methods specified in the following sub clauses and expressed by means of levels in accordance with Table 5.

The test specimens shall be prepared from fully finished sheet but without impressed dimples.

The test specimens shall be tested at + 23 °C ± 2 °C, except for the assessment of melting temperature.

Table 5: Material properties of special sliding material made of fluoropolymer

Property	Testing Standard	Result
Young modulus	EN ISO 527-1 and -3	Level *)
Yield strength		Level *)
Tensile strength		Level *)
Elongation at break		Level *)
Ball hardness	EN ISO 2039-1	Level *)
Mass density ^(a)	EN ISO 1183	Level *)
Melting temperature ^(a)	EN ISO 11357-3	Level *)
^(a) To be assessed on un-aged specimen only *) Properties of the material to be laid down in the technical documentation deposited by the manufacturer with the Technical Assessment Body (see Table 3)		

2.2.8.1 Tensile properties

The test for young modulus, yield strength, tensile strength and elongation at break shall be conducted on five specimens Type 5 (in accordance with Figure 2 of EN ISO 527-3). The thickness of the specimens shall be 2 mm ± 0,2 mm and the speed of testing shall be 50 mm/min for tensile strength and elongation at break, and 1 mm/min for young modulus and yield strength.

For assessment of ageing effects of the special sliding material made of fluoropolymer, four specimens of the material shall be subjected to accelerated ageing by exposure to T_{\max}^2 for a duration of 168 hours. After that, the material properties given in Table 5 shall be assessed.

² T_{\max} is the maximum operating temperature required by the manufacturer, with + 48°C ≤ T_{\max} ≤ + 90°C

The mechanical properties of the aged specimens shall not deviate essentially in comparison with the results of un-aged specimens.

2.2.8.2 Ball hardness

A total of 10 ball hardness tests shall be conducted using at least three specimens with a minimum of three tests per specimen; the nominal thickness of the specimens shall be at least 7 mm.

2.2.8.3 Mass density

The test shall be conducted on three specimens in accordance with EN ISO 1183 (all parts).

2.2.8.4 Melting temperature

The test specimens shall be prepared from fully finished sheet.

The test shall be conducted on three specimens in accordance with EN ISO 11357-3.

2.2.9 Compressive strength of special sliding material made of fluoropolymer

The temperature dependent characteristic compressive strength f_k of the special sliding material made of fluoropolymer shall be assessed according to the test described in Annex C, clause C.1 for the following temperatures:

$$T = T_0: \quad f_k (T_0) \text{ with } T_0 \leq +35 \text{ }^\circ\text{C}$$

$$T = 48 \text{ }^\circ\text{C}: \quad f_k (T_{48})$$

If the range of operating temperature shall be extended up to T_{\max} , with $+48 \text{ }^\circ\text{C} \leq T_{\max} \leq +90 \text{ }^\circ\text{C}$:

$$T = 60 \text{ }^\circ\text{C}: \quad f_k (T_{60})$$

$$T = 70 \text{ }^\circ\text{C}: \quad f_k (T_{70})$$

$$T = 80 \text{ }^\circ\text{C}: \quad f_k (T_{80})$$

$$T = 90 \text{ }^\circ\text{C}: \quad f_k (T_{90})$$

with $T \leq T_{\max}$

The characteristic compressive strength shall be expressed by means of levels in accordance with Table 6 and stated in the ETA.

Table 6 - Characteristic compressive strength of special sliding material made of fluoropolymer

Characteristic compressive strength [MPa]	Main sliding Surface Permanent and Variable Loads	$f_k (T)$
	Guides Variable Loads	
	Guides Permanent Loads Effects of temperature, shrinkage and creep	$f_k (T)/3$

Note: For bearings exposed to a maximum effective bearing temperature in excess of $+35 \text{ }^\circ\text{C}$ and up to $+48 \text{ }^\circ\text{C}$, the characteristic compressive strength shall be estimated by linear interpolation of the values $f_k (T_0)$ and $f_k (T_{48})$.

For bearings exposed to a maximum effective bearing temperature in excess of $+48 \text{ }^\circ\text{C}$ and up to $+90 \text{ }^\circ\text{C}$, the characteristic compressive strength may be estimated by linear interpolation of the values above $f_k (T_{48})$.

2.2.10 Load-deformation behaviour of special sliding material made of fluoropolymer

The load-deformation behaviour of the special sliding material made of fluoropolymer, assessed in tests in accordance with clause 2.2.8.1 and Annex C of this EAD shall be expressed by means of levels in accordance with Table 7 below.

Table 7 Load - deformation behaviour of special sliding material made of fluoropolymer

Property	Test method	Result
Protrusion after loading [mm] ^(a)	cl. 2.2.9 and Annex C	Level*)
Stiffness coefficient, modulus of elasticity ^(b)	Annex C	Level
Ratio tensile strength/yield strength	cl. 2.2.8.1	Level*)
Ratio elongation at break/yield deformation	cl. 2.2.8.1	Level*)
<p>^(a) "Protrusion after loading" is the height of protrusion after 48 hours of constant loading, meaning when having applied the maximum load but before removing.</p> <p>^(b) The 95 % characteristic value of the stiffness coefficient k and the 50 % characteristic value of the notional design modulus of elasticity E_p determined by tests acc. Annex C, clause C.2</p> <p>*) Properties of the material to be laid down in the manufacturer's technical documentation deposited with the Technical Assessment Body (see Table 3)</p>		

2.2.11 High temperature resistance of special sliding material made of fluoropolymer

The high temperature resistance of the fluoropolymer shall be expressed by means of the minimum melting temperature assessed in accordance with clause 2.2.8.4 in this EAD.

The fluoropolymer is considered as resistant to high temperature in case of a minimum melting temperature of at least 50 °C above the maximum operating temperature T_{max} requested by the manufacturer.

Note: The pass/fail criteria indicated are not considered as pass/fail criteria for the product covered by the EAD. They are only referring to the assessment of the components parameters.

2.2.12 Resistance of special sliding material made of fluoropolymer against chemical and environmental influences

The relevant resistance against chemical and environmental influences of the special sliding material made of fluoropolymer shall be assessed following EN ISO 175 by separate exposure of test specimens described below for 60 days at ambient temperature to silicon grease acc. to EN 1337-2, distilled water and saturated aqueous solutions of:

- sodium chloride
- chromium chloride
- ferric chloride
- zinc chloride

Additionally, the long-term resistance against loss of material properties due to exposure to silicon grease according to EN 1337-2 shall be assessed by exposure of test specimens described below for 14 days at + 70°C.

After the exposure, the change of volume, loss of weight and the elongation at break acc. to clause 2.2.8.1 of this EAD shall be measured on five specimens each.

Test specimen: 50 mm x 25 mm x 1 mm for weight and volume measurements
 Type 5 in accordance with Figure 2 of EN ISO 527-3 for elongation at break

If the range of operating temperature shall be extended to T_{max} , with $+ 48\text{ °C} \leq T_{max} \leq + 90\text{ °C}$, specimens as described above shall be exposed to silicon grease acc. to EN 1337-2 for 90 days at T_{max} and for 21 days at $T_{max} + 10\text{ °C}$. After the exposure, the change of volume and the elongation at break acc. to clause 2.2.8.1 of this EAD shall be measured on five specimens each.

The sliding material is regarded as resistant in case of a maximum volume swelling of 3 %, a maximum loss of weight of 0,5 % and a not essential alteration of the elongation at break according to clause 2.2.8.1 of this EAD after the above mentioned exposure of virgin sheets to each of the mentioned media and temperature.

The special sliding material made of fluoropolymer is regarded as resistant to operating temperatures up to T_{max} in case of a maximum volume swelling of 3 %, a maximum loss of weight of 0,5 % and a not essential alteration of the elongation at break acc. to clause 2.2.8.1 of this EAD after the above mentioned exposure of virgin sheets to silicon grease and temperatures of up to $T_{max} + 10\text{ °C}$.

Note: The pass/fail criteria indicated are not considered as pass/fail criteria for the product covered by the EAD. They are only referring to the assessment of the components parameters.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is: Decision 1995/467/EC, as amended by Decision 2001/596/EC and Decision 2002/592/EC

The system is: 1

Note: Provisions for structural bearings in buildings and civil engineering works where requirements on individual bearings are critical. Critical in the sense that those requirements may, in case of failure of the bearing, put the works or parts thereof in states beyond those regarded as serviceability and ultimate limit states (cf. EN 1337-7, Table ZA.2).

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are given for the product and for the raw materials and constituents in EN 1337-7, whereas details for the special sliding material made of fluoropolymer are laid down in Table 8.

Table 8 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC)					
Special sliding material made of fluoropolymer					
1	Material properties of special sliding material	3.4.1	3.4.1	5 for tensile properties 3 for ball hardness	once each batch ≤ 500 kg (Note: If supported by relevant data and in agreement with the body laying down the conditions in the control plan, the test batch size may be increased to the actual size of the production batch)
2	Mass density of special sliding material	3.4.2	3.4.2	3	
3	Melting temperature of special sliding material	3.4.3	3.4.3	1	
4	Sliding behaviour of special sliding material	3.4.4	3.4.4	1	
5	Geometrical properties of special sliding material sheet	3.4.5	3.4.5	testing not required	each sheet
6	Raw material of special sliding polymer	3.4.6	3.4.6	testing not required	each batch

3.3 Tasks of the notified body

The corner stones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance of the spherical and cylindrical bearing with special sliding material made of fluoropolymer are laid down in Table 9.

The extent and frequency of factory production control as well as of initial inspection of the manufacturing plant and of factory production control are given for the product and for the raw materials and constituents in EN 1337-7. The details for the special sliding material made of fluoropolymer are laid down in the control plan for the manufacturer.

Table 9 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	According to EN 1337-7 Special sliding material made of fluoropolymer: According to Table 8 in this EAD				when starting the production process or when starting a new production line
Continuous surveillance, assessment and evaluation of factory production control					
2	According to EN 1337-7 Special sliding material made of fluoropolymer: According to Table 8 in this EAD For bearings with a diameter L of the special sliding material made of fluoropolymer in the main sliding surface larger than 1500 mm: Single acceptance or at least 5 % per lot of production				Twice a year

3.4 Special methods of control and testing used for the verification of constancy of performance

3.4.1 Material properties of the special sliding material made of fluoropolymer

The Young modulus, yield strength, tensile strength, elongation at break and ball hardness of the special sliding material made of fluoropolymer shall be measured in accordance with the methods given in sub clauses 2.2.8.1 and 2.2.8.2 of this EAD by means of a level.

The results of the testing shall comply with the levels laid down by the manufacturer in the control plan based on the initial assessment for issuing the ETA with consideration of the following tolerances:

- Young modulus: $\pm 20\%$
- Yield strength: $\pm 10\%$
- Tensile strength: Minimum value
- Elongation at break: Minimum value
- Ball hardness: $\pm 20\%$

All specimens shall pass all the tests conducted on them.

3.4.2 Mass density of the special sliding material made of fluoropolymer

The mass density of the special sliding material made of fluoropolymer shall be measured in accordance with the method given in sub clause 2.2.8.3 of this EAD by means of a level.

The result of the testing shall comply with the level laid down by the manufacturer in the control plan based on the initial assessment for issuing the ETA with consideration of the following tolerances:

- Mass density: $\pm 2 \%$

All specimens shall pass all the tests conducted on them.

3.4.3 Melting temperature of the special sliding material made of fluoropolymer

The melting temperature of the special sliding material made of fluoropolymer shall be measured in accordance with the method given in sub clause 2.2.8.4 of this EAD by means of a level.

The result of the testing shall comply with the level laid down by the manufacturer in the control plan based on the initial assessment for issuing the ETA with consideration of the following tolerances:

- Melting temperature: Minimum value

3.4.4 Sliding behaviour of the special sliding material made of fluoropolymer

The sliding behaviour of the special sliding material made of fluoropolymer shall be measured in a short-term friction test in accordance with the method given in Annex A of this EAD by means of a level.

The coefficients of friction in each phase of short-term friction test shall not exceed the values given in Table A.1 of this EAD based on the initial assessment for issuing the ETA.

3.4.5 Geometrical properties of the special sliding material sheet

The control of geometrical properties (thickness t_p and dimensions, shape and pattern of dimples) of special sliding material sheet shall be carried out in accordance with Annex B, clause B.1 of this EAD.

The admissible tolerance on thickness t_p of single sheets or associated multiple sheets of special sliding material made of fluoropolymer is $\begin{matrix} +0,3 \\ -0,0 \end{matrix}$ mm for sheets with a diameter L less than 1200 mm and $\begin{matrix} +0,4 \\ -0,0 \end{matrix}$ mm for larger sheets.

Compliance with the requirements shall be verified by means of inspection certificates type 2.2 in accordance with EN 10204 from the supplier of moulded sheets.

3.4.6 Raw material of the special sliding material made of fluoropolymer

The special sliding material made of fluoropolymer shall consist of a specified polytetrafluoroethylene (PTFE) processed from a granular resin that has never been preformed or moulded. The material does not include mixtures of PTFE resin with additives such as colorants, fillers or plasticizers; nor does it include reprocessed or reground resin or any fabricated articles. Each delivery shall include a certificate of the supplier regarding the composition of the base material.

The bulk density, particle size, standard specific gravity, tensile strength and elongation at break of the base material shall be taken from the documentation accompanying each batch from the supplier of ground resin.

The values shall comply with the relevant specifications laid down by the manufacturer in the control plan and based on the initial assessment for issuing the ETA.

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment is of relevance.

EN 1337-1	Structural bearings - Part 1: General design rules
EN 1337-2	Structural bearings - Part 2: Sliding elements
EN 1337-5	Structural bearings - Part 5: Pot bearings
EN 1337-7	Structural bearings - Part 7: Spherical and cylindrical PTFE bearings
EN 1337-9	Structural bearings – Part 9: Protection
EN ISO 175	Plastics - Methods of tests for the determination of the effects of immersion in liquid chemicals
EN ISO 527-1	Plastics - Determination of tensile properties - Part 1: General principles
EN ISO 527-3	Plastics - Determination of tensile properties - Part 3: Test conditions for films and sheets
EN ISO 1183-1	Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pycnometer and titration method
EN ISO 1183-2	Plastics - Methods for determining the density of non-cellular plastics - Part 2: Density gradient column method
EN ISO 1183-3	Plastics - Methods for determining the density of non-cellular plastics - Part 3: Gas pycnometer method
EN ISO 2039-1	Plastics- Determination of hardness - Part 1: Ball indentation method
EN 10204	Metallic products – Types of inspection documents
EN ISO 11357-3	Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization
EN 1990	Eurocode - Basis of structural design

ANNEX A TEST METHOD OF FRICTION COEFFICIENT OF THE SPECIAL SLIDING MATERIAL MADE OF FLUOROPOLYMER

This Annex describes the test method used within the factory production control as defined in Table 8, Item 4, in this EAD and referred to the assessment given in Annex D in this EAD.

A.1 Method of assessment

To check the sliding behaviour of the special sliding material made of fluoropolymer as element of the factory production control it suffices to perform a short term friction test with 1 phase of 22 m sliding distance of type A₁ according to Annex D, Table D.3 of this EAD on a specimen with dimpled and lubricated special sliding material made of fluoropolymer combined with austenitic steel.

A.2 Criteria

The coefficients of friction in each phase of short-term friction testing of phase A₁ shall not exceed the levels according to Table A.1 below.

Table A.1 The maximum coefficients of friction in short term tests of dimpled and lubricated sheets of special sliding material made of fluoropolymer in combination with austenitic steel (pressure level: $f_r/3$)

Temperature	Total slide path			
	0 to 22 m			
	$\mu_{s,1}$	$\mu_{dyn,1}$	$\mu_{s,T}$	$\mu_{dyn,T}$
-50 °C	-	-	level	level
-35 °C	-	-	level	level
0 °C	level	level	-	-

NOTE $\mu_{s,1}$ and $\mu_{dyn,1}$ are the static and dynamic coefficients of friction at the first cycle, $\mu_{s,T}$ and $\mu_{dyn,T}$ the corresponding coefficients for the relevant temperatures at subsequent cycles

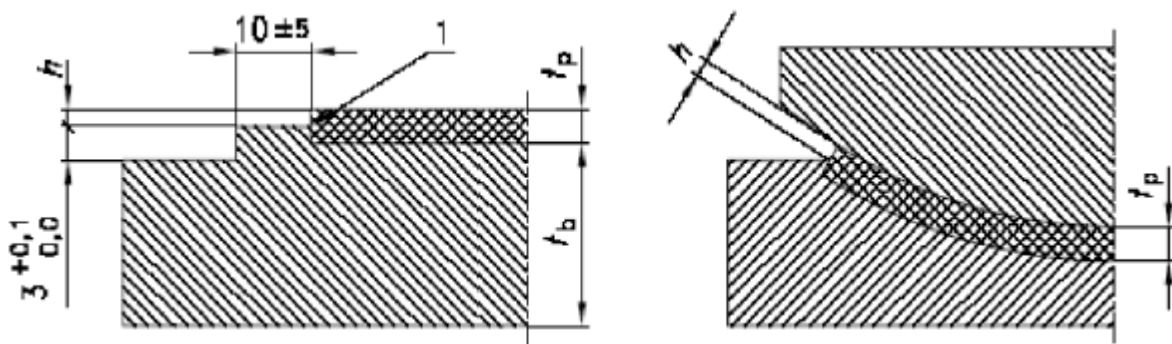
Levels to be stated in the control plan, based on results from long-term friction test for issuing the ETA according to Annex D, first phase A₁.

ANNEX B GEOMETRICAL CONDITIONS OF THE SPECIAL SLIDING MATERIAL MADE OF FLUOROPOLYMER

The figures given in clause B.1 and Table B.1 of this Annex establish the geometrical conditions for sheets of the special sliding material made of fluoropolymer for which this EAD applies (see also clause 1.1 in this EAD).

B.1 Recessed special sliding material sheets

The special sliding material sheets are recessed into a backing plate as shown in Figure B.1 below. The shoulders of the recess are sharp and square to restrict the flow of the sliding material. The radius at the root of the recess does not exceed 1 mm. Intermittent gap between the edge of the sheet of sliding material and the recess does not exceed the values given in Table 12 of EN 1337-2 at room temperature. For diameters L between 1500 and 2500 mm, the gaps are limited to L [mm] / 1250.



(See Figure 2 of EN 1337-2)

Figure B.1 -Details of special sliding material recess and relief

Table B.1- Geometrical conditions thickness t_p and protrusion h of the special sliding material sheet

	Flat and curved sliding surfaces	Guides ^(a)
Thickness t_p in mm	$2,75 \times h \leq t_p \leq 10,0$; with h in mm	$7,0 \leq t_p \leq 10,0$
Protrusion h in mm	$h = 2,25 + L/2000$ but not less than 2,5 mm	$h = 2,5 \pm 0,2$
L - diameter or diagonal of the projected area of the special sliding material sheet in mm ^(a) the width of the guide strips is not less than 15 mm, and the modified shape factor calculated as per EN 1337-2, cl. 6.2.1.3, is greater than 4.		

The tolerance on the protrusion h is $\pm 0,2$ mm for L less than or equal to 1200 mm and $\pm 0,3$ mm for L greater than 1200 mm. The protrusion h is assessed at marked measuring points, where the corrosion protection coating does not exceed 300 μm . There are at least two measuring points, suitably located.

Special sliding material sheets used in the main flat or curved sliding surface are provided with a uniform pattern of dimples to retain the lubricant. The dimensions, shape and arrangement of the dimples in the unloaded and unused condition, and the alignment respect to the main direction of sliding, comply with the provisions in Figure 1 of EN 1337-2.

B.2 Flat special sliding material sheets

Provisions for flat PTFE sheets given in sub clause 6.2.1.1 of EN 1337-2 apply.

B.3 Curved special sliding material sheets

Provisions for curved PTFE sheets for cylindrical and spherical sliding surfaces given in sub clause 6.2.1.2 of EN 1337-2 apply, with the following adaptations:

- if circular special sliding material sheets for spherical sliding surfaces are subdivided in a disc and an annulus, the disc is not less than $\frac{2}{3} L$ for sheets with a diameter larger than 1500 mm;
- the absence of two symmetrical circular segments for not subdivided sheets is permissible, if the limitation for the included angle given in the scope and the proof of not separation of the sliding surface given in clause 6.8.2 of EN 1337-2 is fulfilled for both the main axes.

The curved special sliding material sheet may be attached to either the convex or the concave backing plate of the curved sliding surface.

B.4 Additional provisions

As an alternative to the geometrical rules given above and/or in clause 6.2.1 of EN 1337-2, flat and curved surfaces of spherical bearings made of special sliding material made of fluoropolymer may consist of one centric circular sheet with diameter "a" and one or more concentric annuli with a constant width "b". The dimensions "a" and "b" are not smaller than 50 mm. The radial distance between the individual sheets is not less than 10 mm and not greater than twice the thickness of the backing plate, of the special sliding material made of fluoropolymer or the mating material, whichever is least.

ANNEX C ASSESSMENT OF COMPRESSIVE STRENGTH AND LOAD-DEFORMATION BEHAVIOUR

C.1 Compressive strength

The load bearing capacity of the special sliding material made of fluoropolymer is assessed by a long-term compression test. Under the application of an uniform pressure on the specimen of sliding material equal to the characteristic compressive strength $f_k(T)$, defined in 2.2.9 in this EAD, the decrease of the protrusion shall end before 48 hours of constant loading.

At pressures lower than f_k no cracks shall occur in the sliding material.

The test specimens shall be prepared from fully finished sheet.

Test parameters:

Specimen: - dimpled special sliding material-sheet:

$L = 155$ mm

$t_p =$ maximum value [mm] according to the range given in Table B.1 in this EAD

$t_p - h =$ maximum value [mm] according to the range given in Table B.1 in this EAD

- special sliding material-sheet for guides (undimpled):

$L \times a = 200 \times 15$ mm,

$t_p = 7$ mm,

$t_p - h = 4,5$ mm

- Lubricant and dimples acc. EN 1337-2

- Austenitic steel acc. EN 1337-2

- Rigid backing plates acc. EN 1337-2

Temperature: $T_0 \leq + 35$ °C and $T = + 48$ °C ± 2 °C

If the range of operating temperature shall be extended to T_{max} ,

with $+ 48$ °C $\leq T_{max} \leq + 90$ °C:

additionally $T = + 60$ °C, $T = + 70$ °C, $T = + 80$ °C and $T = + 90$ °C ± 2 °C, with $T \leq T_{max}$

Number of tests: minimum 3 per each temperature level

Loading time: > 48 hours

Pressure $p = f_k(T)$ applied: to be expressed by means of a level and stated in the ETA

The size of the protrusion h shall be continuously recorded.

The decrease of protrusion shall be defined as ended, if the change in height per hour in relation to the initial value of protrusion is less than 0,5 ‰.

C.2 Load deformation behaviour

The load deformation behaviour of the special sliding material made of fluoropolymer at SLS condition is assessed by a long-term compression test. Under a compressive stress $p = 0,25 f_k$ and $p = 0,5 f_k$ the decrease Δh of the protrusion after 48 hours of constant loading shall be assessed.

The test specimens shall be prepared from fully finished sheet with impressed dimples.

Test parameters:

- Specimen: - dimpled special sliding material-sheet:
 $L = 155$ mm
 $t_p =$ value [mm] as assessed according to clause C.1 in this EAD
 $t_p - h =$ value [mm] as assessed according to clause C.1 in this EAD
- Lubricant and dimples acc. EN 1337-2
 - Austenitic steel acc. EN 1337-2
 - Rigid backing plates acc. EN 1337-2

Temperature: $+ 23 \text{ °C} \pm 2 \text{ °C}$

Number of tests: Minimum 3 for each pressure level

Loading time: > 48 hours

Pressure: $p = 0,25 f_k (T_0)$ and $p = 0,5 f_k (T_0)$

The size of the protrusion h shall be continuously recorded.

The measured characteristic value Δh determined as the difference between the initial value h_0 in unloaded condition and the final value h after 48 hours under load shall be statistically evaluated in accordance with EN 1990, Annex D "Design assisted by testing" and the following characteristics assessed:

- stiffness coefficient $k = \frac{\Delta h}{h_o} \sqrt{S} = \frac{\Delta h}{h_o} \sqrt{\frac{L}{4h_0}}$ as 95 % and 50% characteristic values
- notational elastic modulus $E_{tp} = p \frac{t_p}{\Delta h}$ as 50 % characteristic value.

ANNEX D ASSESSMENT OF SLIDING BEHAVIOUR

The principles of assessing the sliding behaviour of the sliding surfaces, the terms and definitions as well as the test equipment and specimens are shown in Annex D of EN 1337-2. To assess the sliding behaviour of special sliding material made of fluoropolymer in guides an additional long-term test for initially lubricated strips without dimples shall be carried out.

The test procedure shall be carried out under the following conditions:

- Specimen: - Mating surfaces, backing plates and lubricant acc. EN 1337-2
- for dimpled special sliding material sheets
 - $L = 75$ mm
 - $t_p =$ value [mm] as assessed according to clause C.1 of this EAD
 - $t_p - h =$ value [mm] as assessed according to clause C.1 of this EAD
 - for guides (undimpled special sliding material sheets):
 - $L \times a = 200 \times 15$ mm,
 - $t_p = 7$ mm,
 - $t_p - h = 4,5$ mm

Test parameters and test conditions for sliding elements combined with special sliding material made of fluoropolymer are given in Table D.3 of this Annex.

The test specimen with dimpled and lubricated special sliding material made of fluoropolymer shall be subjected to a long-term friction test, whereas the principles of the test phases are given in Table D.1 of this Annex for an example of 50.000 m total slide path.

The test specimen used in curved sliding surfaces only shall be subjected to a long-term friction test of 1/5 in relation to the accumulated sliding path of the main sliding surfaces; the principles of the test phases are given in Table D.2 of this Annex for an example of 10.000 m total slide path.

Table D.1 – Long-term friction test programme for dimpled and lubricated flat surfaces

	Example for 50.000 m total slide path						
Phase Number	1	2	3	.....	19	20	21
Type	A ₁	B	A ₁	.....	A ₁	B	A ₁
Distance	22 m	≥ 1.000 m and ≤ 11.000 m	22 m	.....	22 m	≥ 1.000 m and ≤ 11.000 m	22 m

If the range of operating temperature shall be extended up to a maximum temperature of T_{max} , with $+48\text{ °C} \leq T_{max} \leq +90\text{ °C}$, a test specimen as given above with dimpled and lubricated special sliding material made of fluoropolymer shall be subjected to a high temperature programme test consisting of 3 phases in accordance with Table D.4 of this Annex.

The fitting for the test specimen for guides with undimpled and initially lubricated special sliding material sheets made of fluoropolymer shall correspond in principle to those of composite materials as shown in Figure D.3 of EN 1337-2.

The test specimen shall be subjected to a long-term friction test, whereas the principles of the test phases are given in Table D.2 of this Annex for an example of 10.000 m total slide path.

Table D.2 – Long-term friction test programme for initially lubricated guides and for the main curved sliding surfaces

	Example for 10.000 m total slide path				
Phase Number	1	2	3	4	5
Type	A ₁	B	A ₁	B	A ₁
Distance	22 m	≥ 1.000 m and ≤ 6.000 m	22 m	≥ 1.000 m and ≤ 6.000 m	22 m

Table D.3 - Friction test conditions for special sliding material made of fluoropolymer in accordance with Figure D.1

Type A₁ (phase 1,3,5 ... Temperature-Programme-Test) according to Figure D.1			
Contact pressure of lubricated special sliding material made of fluoropolymer	σ_p	$0,33 f_{k0}^{+3}$	MPa
Temperature	T	0/-10/-20/-35/-50/+35/+21 (± 1)	°C
Temperature gradient		$0,5 \pm 1,0$	°C/min
Preload time	t_{pl}	1	H
Sliding distance	s	$10_0^{+0,5}$	mm
Dwell time at the end of the strokes	t_0	12 \pm 1	S
Number of cycles (two strokes)	N	1100	
Sliding speed (constant)	v	$0,4_0^{+0,1}$	mm/s
Dwell between phases	t_0	1	h
Type B (phase 2, 4, 6 ...) according to Figure D.1			
Contact pressure of lubricated special sliding material made of fluoropolymer	σ_p	$0,33 f_{k0}^{+3}$	MPa
Temperature	T	21 \pm 1	°C
Temperature gradient		$0,5 \pm 1,0$	°C/min
Sliding distance ¹⁾	s	8 ^{+0,5}	mm
Number of cycles (two strokes)	N	62.500 (1 km) $\leq n \leq$ 3.125.000 (50 km)	
Sliding speed (constant)	v	15 ($\pm 0,1$)	mm/s
Type F (High- Temperature - Programme - Test)			
Contact pressure of lubricated special sliding material made of fluoropolymer	σ_p	$0,33 f_{k,max}^{+3} \text{ }_0^{2)}$	MPa
Temperature	T	+ 21/ + $T_{max}^{2)}$ /+ 21 (± 1)	°C
Temperature gradient		$0,5 \pm 1,0$	°C/min
Preload time	t_{pl}	1	h
Sliding distance	s	$10_0^{+0,5}$	mm
Dwell time at the end of the strokes	t_0	12 \pm 1	s
Number of cycles (two strokes)	N	300/5500 ³⁾ /300	
Sliding speed (constant)	v	$0,4_0^{+0,1}$	mm/s
Dwell between phases	t_0	1	h
¹⁾ Depending on the characteristics of the testing equipment, the sliding distance s may be increased up to $s = 40$ mm, and the total number of cycles N arranged accordingly, in order to maintain the same total accumulated sliding path of the phase ²⁾ Depending on the maximum operating temperature requested by the manufacturer; ³⁾ Including heating and cooling phase			

Table D.4 - High temperature friction test programme for dimpled and lubricated surfaces

	166 m total slide path				
Phase Number	1	2			3
Type	A ₁	F			A ₁
T [°C]	0/-10/-20/-35/-50/+35/+21	+21	+ T _{max} ^{1) 2)}	+21	0/-10/-20/-35/-50/+35/+21
Distance	22 m	6 m	110 m ¹⁾	6 m	22 m
¹⁾ Including heating and cooling phase; ²⁾ Depending on the maximum operating temperature required by the manufacturer					

Note: The high temperature programme test shall show the influence of high temperature during sliding movements on the change of friction behaviour.

Evaluation of 166 m according to Table D.4: 50 % of 11 phases (for the long-term friction test according to Table D.1 for 50 km) of 22 m equal to rounded 122 m plus the initial and end phase of both 22 m gives 166 m.

The contact pressure in phase F of the friction test is $0,33 f_k$ at T_{max} [°C] due to the respectively reduced compressive strength of the special sliding material made of fluoropolymer at high temperature.

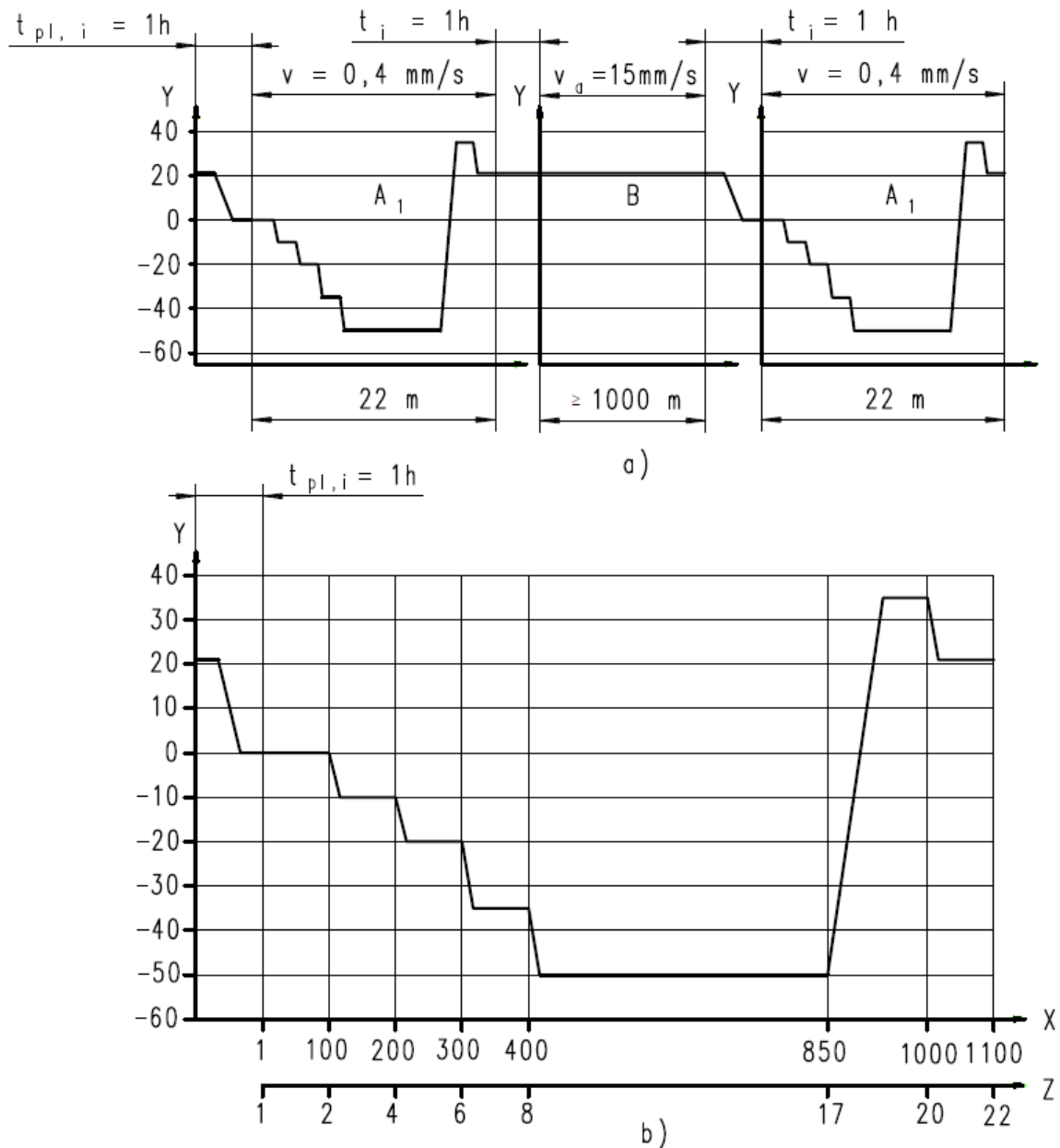


Figure D.1- Temperature profile of the long term friction test (only first three phases shown)

- Key:
- x Number of cycles n
 - y Temperature T (°C)
 - a) Temperature -Programme-Test
 - b) Total slide path

ANNEX E WORKING LIFE OF THE CONSTRUCTION PRODUCT

The working life of structural bearings with sliding elements depends in particular on wear in the sliding surface by imposed movements combined with external loads. The durability of the sliding material is additionally affected by the sliding speed and the operating temperature.

Therefore, the singular case of intended use affects the expected working life.

Structural bearings with sliding elements made of PTFE acc. to EN 1337-2 are to be assumed suitable at least for the minimum working life of 10 years as per Table 2.1 of EN 1990 (design working life category 2).

Based on these assumptions the working life of spherical and cylindrical bearings with special sliding material made of fluoropolymer as per clause 1.2.2 in this EAD shall be calculated as follows without consideration of the more severe test conditions:

$$WL = WL_{PTFE} \cdot \frac{S_{T,D1}}{S_{T,PTFE}}$$

Where

$S_{T,PTFE}$ accumulated slide path in accordance with Table D.2 of EN 1337-2 ($S_{T,PTFE} = 10.000$ m)

$S_{T,D1}$ Accumulated slide path in accordance with Table D.1 of Annex D

As example, for $S_{T,D1} = 50.000$ m

$$WL = WL_{PTFE} \cdot \frac{S_{T,D1}}{S_{T,PTFE}} = 10 \cdot \frac{50.000}{10.000} = 50 \text{ Years}$$