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European Technical Assessment

ETA 21/0726 of 19.10.2021

General part

Technical Assessment Body issuing the ETA: ITeC	
ITeC has been designated according to Article 29 of Regulation (EU) No 305/2011 and is member of EOTA (European Organisation for Technical Assessment)	
Trade name of the construction product	**VSLide spherical bearing**
Product family to which the construction product belongs	5 – Structural bearings, pins for structural joints
Manufacturer	**VSL INTERNATIONAL** Wankdorfallee 5 3014 Bern Switzerland
Manufacturing plant(s)	Ribera del Congost s/n 08520 Les Franqueses del Vallès (Barcelona) Spain
This European Technical Assessment contains	15 pages including 2 annexes which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with Regulation (EU) 305/2011, on the basis of	European Assessment Document 050009-00-0301 *Spherical and cylindrical bearing with special sliding material made of fluoropolymer.*

General comments

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

Communication of this European Technical Assessment, including transmission by electronic means, shall be in full (excepted the confidential Annex(es) referred to above). However, partial reproduction may be made, with the written consent of issuing Technical Assessment Body. Any partial reproduction has to be identified as such.

Specific parts of the European Technical Assessment

1 Technical description of the product

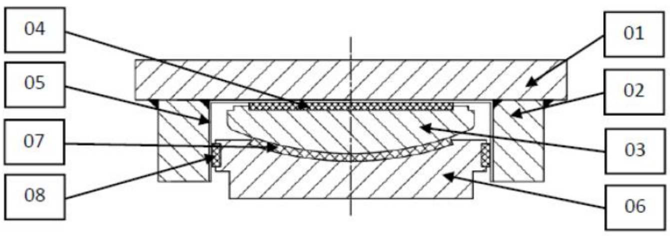
VSLide spherical bearing permits rotation and displacement movements by a plane and a curved sliding surface between bearing plates of steel. The subject of the ETA is the complete bearing, including, if relevant, the necessary guides or restraints. As an alternative to Figure 1.1, the bearing may also be used upside down, i.e. with flat sliding surfaces lying below (meaningful, for example in the case of steel bridges).

VSLide spherical bearings 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 (polytetrafluoroethylene) according to EN 1337-2, VSLide™-M is used for the sliding surfaces of the bearings. VSLide™-M is a low friction fluoropolymer made of a specified PTFE, suitable for low and high temperatures outside the scope of EN 1337-2 with improved load-bearing capacity.

This ETA covers sliding surfaces with a diameter of the circumscribing circle of VSLide™-M sheets greater than 75 mm or less than 1.500 mm and with effective bearing temperatures greater than - 50 °C or less than + 90 °C. When composite material of type CM1 in accordance with EN 1337-2 is used in guides, the maximum effective bearing temperature is limited to + 48 ºC.

VSLide spherical bearing with an included angle $2\theta > 60°$ are beyond the scope of this ETA (see Clause 1 and Figure 6 of EN 1337-7).

For the types of the bearings covered by this ETA, the drawings given in EN 1337-7, clause 3.1.2 and clause 3.1.9 apply. The components are indicated as given in Figure 1.1.



1. Sliding plate
2. Guide
3. Rotational element
4. VSLide™-M sheet
5. Austenitic steel sliding sheet
6. Backing plate
7. VSLide™-M sheet
8. VSLide™-M sheet or CM1 according to clause 5.3.1 of EN 1337-2

Figure 1.1: VSLide spherical bearing.

Combination of materials

The combinations of materials used in the sliding surfaces are given in Table 1.1. Only one combination is used in a sliding surface. The sliding surface is lubricated in accordance with clause 7.4 of EN 1337-2.

Plane surface (1)		Curved surface		Guides	
Dimpled VSLide™-M	Austenitic steel	Dimpled VSLide™-M	Austenitic steel	Undimpled VSLide™-M (2)	Austenitic steel
			Hard chromium	CM1	

Notes:

(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 VSLide™-M sheets, only where self-alignment between the mating parts of the bearing is possible, composite material of type CM1 in accordance with clause 5.3.1 of EN 1337-2 can be used.

Table 1.1: Combination of materials for permanent applications as sliding surfaces for spherical bearings with special sliding material made of VSLide™-M.

VSLide™-M sheets are confined according to Annex B of the EAD.

Austenitic steel sheets are attached by continuous fillet welding in accordance with clause 7.2.1 of EN 1337-2.

Composite material of type CM1 is attached in accordance with clause 7.2.3 of EN 1337-2.

VSLide™-M sheets

The composition of the material is confidential, whereas details are laid down in Table 3.4 of this ETA and relevant information is laid down in technical documentation to this European Technical Assessment, deposited with the ITeC -The Catalan Institute of Construction Technology-. The geometrical conditions of VSLide™-M sheets are in conformity with Annex B of the EAD.

The curved VSLide™-M sheet may be attached to either the convex or the concave backing plate of the curved sliding surface.

Composite material

As an alternative to VSLide™-M sheet, for strips in guides the composite material of type CM1 in accordance with clause 5.3.1 of EN 1337-2 may be used (see Table 1.1 in this ETA).

Austenitic steel

Austenitic steel is in accordance with EN 1337-2, clause 5.4.

Hard chromium plated surfaces

Hard chromium plated surfaces are in accordance with EN 1337-2, clause 5.5. The substrate is as specified in clause 5.5.2 of EN 1337-2.

Lubricant

Silicon grease according to EN 1337-2, clause 5.8, is used as lubricant for sliding surfaces.

Ferrous materials for backing plates

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

Examples of VSLide spherical bearings are given in Annex 1 of this ETA.

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.

2 Specification of the intended use(s) in accordance with the applicable European Assessment Document (hereinafter EAD)

VSLide spherical bearing is 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.

VSLide spherical bearing is suitable for all types of structures, as well as for regions with continuously low and high temperatures.

The range of effective bearing temperature of VSLide spherical bearing covered by this ETA when undimpled VSLide™-M sheet is used in guides is - 50 °C and up to + 90 °C. When composite material of type CM1 in accordance with EN 1337-2 is used in guides, the effective bearing temperature is limited down to - 35°C and up to + 48 °C.

Effective bearing temperatures above + 48 °C are limited to short periods as due to weather changes.

VSLide spherical bearing is also intended for the use in superstructures where working loads induce fast sliding displacements in bearings.

VSLide spherical bearing is mainly used in concrete, steel and composite structures.

The provisions made in this ETA are based on an assumed working life of at least 10 years for VSLide spherical bearing, depending on the accumulated total sliding path assessed according to Clause 3.1.3 of this ETA, and provided that VSLide spherical bearing is subject to appropriate use and maintenance. These provisions are based upon the current state of the art and the available knowledge and experience.

The assumed working life of the VSLide spherical bearing is of at least 10 years if composite material of type CM1 according to EN 1337-2 is used in guides, instead of VSLide™-M sheets.

The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and reference to the methods used for its assessment

Performance of the VSLide spherical bearing related to the basic requirements for construction works (hereinafter BWR) were determined according to EAD 050009-00-03.01 *Spherical and cylindrical bearing with special sliding material made of fluoropolymer.*

Essential characteristics of VSLide spherical bearing are given in Table 3.1.

3.1 Performance of the VSLide spherical bearing with special sliding material made of fluoropolymer

Basic Works Requirement	Essential characteristic	Performance
BWR 1 Mechanical resistance and stability	Load bearing capacity	See clause 3.1.1
	Rotation capability	See clause 3.1.2
	Displacement capacity	See clause 3.1.3
	Durability aspects	See clause 3.1.4
	Load bearing capacity (of the sliding element)	See clause 3.1.5
	Coefficient of friction (of the sliding element)	See clause 3.1.6
	Durability aspects (of the sliding element)	See clause 3.1.7

Table 3.1: Essential characteristics and performance of VSLide spherical bearing.

3.1.1 Load bearing capacity

The curved sliding surfaces are designed according to clauses 6.2.1 to 6.2.3 of EN 1337-7, with adaptations accounting for the essential characteristics of the VSLide™-M sliding material used in the sliding surfaces:

- The total eccentricity e_t of the axial force N_S is calculated considering the frictional resistance of the VSLide™-M sheets given in clause 3.1.6 of this ETA.
- The characteristic compressive strength of VSLide™-M is given in Table 3.4 in this ETA.

The backing plates with concave surfaces are designed in accordance with clause 6.9 of EN 1337-2 and considering dimensional limitations shown in Figure 7 of EN 1337-7.

For VSLide™-M combined with flat sliding elements, Clause 3.1.5 in this ETA further applies.

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, the design rules for pot and piston of pot bearings given in clause 6 of EN 1337-5 apply for the assessment of the steel restraining ring.

The horizontal load bearing capacity of VSLide spherical bearing fixed by a steel restraining ring is determined in accordance with the simplified formulas given in clause 6.2.2 of EN 1337-5.

The load bearing capacity is determined for the single VSLide spherical bearing under a fundamental combination of actions in relation to the compressive stress on the sliding surfaces in accordance with Equation (1) in this ETA, see Clause 3.1.5.1.3. Referring to the maximum dimension of VSLide™-M sheets covered by this ETA, the maximum load bearing capacity of VSLide spherical bearing at the relevant temperature is given in Table 3.2.

Maximum effective bearing temperature	Maximum load bearing capacity [kN]
T ≤ 32 °C	204 484
T = 48 °C	170 403
T = 60 °C	153 363
T = 70 °C	136 323
T = 80 °C	119 282
T = 90 °C	102 242

Table 3.2: Maximum load bearing capacity of VSLide spherical bearing under a fundamental combination of actions.

The load bearing capacity given in Table 3.2 includes a coefficient of reduction of λ = 0,9 to consider load eccentricity in Equation (2) in this ETA, and a partial safety factor for sliding materials γ_m = 1.4 (see Clause 3.1.5.1.3 in this ETA).

3.1.2 Rotation capability

Combinations of materials for curved sliding surfaces are given in Table 1.1 in this ETA.

Coefficients of friction of curved sliding surfaces are given in Clause 3.1.6 in this ETA.

For the single, maximum rotation angle, the capacity is given by the geometrical design of the curved sliding surfaces in accordance with EN 1337-7, clause 6.2.4.

Where, according to clause 6.4 of EN 1337-2 under predicted rotation about a transverse axis the differential deformation of the VSLide™-M sheet in guides across its smallest dimension for the un-factorized characteristic actions would exceed 0,2 mm, a rotation element is included in the backing plate. The material combination of this rotation element is in accordance with the requirements of the mating surfaces of guides given in Table 1.1 or pot to piston contact surfaces given in EN 1337-5.

The maximum rotation angle of VSLide spherical bearing is 0,05 radian about any horizontal axis. VSLide spherical bearing allows free rotation about their vertical axis.

3.1.3 Displacement capacity

Combinations of materials for plane surfaces and guides are given in Table 1.1 of the ETA.

Coefficients of friction of plane sliding surfaces and guides are given in Clause 3.1.6 in this ETA.

The maximum accumulated sliding path of plane sliding elements combined with dimpled and lubricated VSLide™-M sheets is 10 000 m.

The maximum accumulated sliding path of guides combined with undimpled VSLide™-M sheets is 2 000 m.

If composite material of type CM1 is used in guides, relevant clauses of EN 1337-2 apply.

For the single, maximum displacement, the capacity is given by the geometrical design of the sliding elements in accordance with clause 6.5.1 of EN 1337-2.

3.1.4 Durability aspects

The measures for the protection of VSLide spherical bearing from the effects of the environment and other external influences, which would reduce the working life, are in accordance with clause 4 of EN 1337-9.

Depending on the project requirements, VSLide spherical bearings are equipped with a protective paint system for atmospheric-corrosivity categories C4 or C5 and durability high or very high according to EN ISO 12944 Parts 1 and 2.

3.1.5 Load bearing capacity (of the sliding element)

3.1.5.1 Sliding surfaces

3.1.5.1.1 General

The sliding surfaces are designed in accordance with clause 6.8 of EN 1337-2, adapted to the performance of VSLide™-M sheets by means of the following:

- The material combinations are given in Table 1.1 in this ETA.
- The frictional resistance of the sliding surfaces is expressed by means of the coefficients of friction given in Clause 3.1.6 in this ETA.
- The characteristic compressive strength of VSLide-M is given in Table 3.4 in this ETA.

For composite material of type CM1 used in guides, relevant clauses of EN 1337-2 apply.

Deformation of sliding materials are not used to accommodate rotations except as permitted in clause 6.4 of EN 1337-2.

3.1.5.1.2 Non-separation of sliding surfaces

With the exception of guides, plane and curved sliding surfaces are designed so that under the characteristic combination of actions, the minimum pressure σ_p acting on the VSLide™-M sheet meets the condition $\sigma_p \geq 0$.

3.1.5.1.3 Compressive stress

Under a fundamental combination of actions, the following condition is met:

$$N_{Sd} \leq \frac{f_k(T)}{\gamma_m} \cdot A_r \qquad (1)$$

Where:

N_{Sd} is the design value of the axial force due to the design values of action,

$f_k(T)$ is the temperature dependent characteristic compressive strength of sliding material:

- for VSLide™-M sheets, $f_k(T)$ is given in Table 3.4 of this ETA,
- for composite material of type CM1 used in guides, Clause 6.6 in EN 1337-2 applies.

γ_m is a partial safety factor for materials in accordance with EN 1990. If not otherwise specified, the recommended value is γ_m = 1,4. The value shall be stated in the technical documentation accompanying the Declaration of Performance.

A_r is the reduced contact area of the sliding surface whose centroid is the point through which N_{Sd} acts with the total eccentricity e_t, which is caused by both mechanical and geometrical effects, and is calculated on the basis of the theory of plasticity assuming a rectangular stress block.

For guides, eccentricity can be neglected.

Note: Formulae for the evaluation of the eccentricities of curved surfaces in the most common cases are given in Annex A of EN 1337-7.

The reduced contact area A_r is given by the formula:

$$A_r = \lambda \cdot A \qquad (2)$$

Where:

λ is a coefficient given in Annex 2 of this ETA.

A is the contact area of the plane sliding surface or of the projected curved sliding surface.

For VSLide™-M sheets with minimum dimension “a” ≥ 100 mm (according to Figure 3 of EN 1337-2), the contact areas A and A_r are taken as the gross area without deduction for the area of the dimples. For sheets with “a” < 100 mm the area of the dimples is deducted from the gross area.

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3.1.5.2 Backing plates

The load bearing capacity of the backing plates of the sliding surfaces is assessed according to Clause 6.9 of EN 1337-2.

3.1.5.2.1 General

The design of the backing plates follows the provisions given in Clause 6.9.1 of EN 1337-2.

3.1.5.2.2 Deformation assessment

The total deformation $\Delta w_1 + \Delta w_2$ of the backing plates (see Figure 9 of EN 1337-2) is determined in compliance with Clause 6.9.2 of EN 1337-2.

The total deformation of the backing plates is assessed using the formula:

$$\Delta w_1 + \Delta w_2 \leq \Delta w_{adm} = h_0 \cdot \left(0{,}45 - 1{,}708 \cdot k \cdot \sqrt{h_0/L}\right) \qquad (3a)$$

With $$h_r\,[mm] = h_0 - \Delta w_1 - \Delta w_2 - \Delta h \geq 1{,}0 + \frac{L\,[mm]}{2.000} \qquad (3b)$$

Where:

k is the stiffness coefficient of dimpled VSLide™-M sheets defined in Clause 3.2 in this ETA.

h_0 is the height of protrusion of the VSLide™-M sheet in unloaded condition, according to Annex B of the EAD.

L is the diameter of the circumscribing circle of VSLide™-M sheet, with L ≤ 1.500 mm according to this ETA.

A suitable method for calculating the deformation Δw_1 for common materials is given in Annex C of EN 1337-2.

The thickness of the backing plates is in accordance with clause 6.9.3 of EN 1337-2 in order to fulfil the minimum stiffness for transport and installation.

3.1.6 Coefficient of friction (of sliding element)

The following coefficients of friction μ_{max} are used for the design of VSLide spherical bearing.

These values do not apply in the presence of high dynamic actions which may occur for instance in seismic zones.

The effects of friction are not to be used to relieve the effects of externally applied horizontal loads.

The following coefficients of friction are valid up to a maximum effective bearing temperature of + 90 °C.

3.1.6.1 Coefficient of friction at low temperatures

For sliding elements combined with dimpled and lubricated VSLide™-M sheets used in zones where the minimum effective bearing temperature does not fall below – 35 °C, the coefficient of friction μ_{max} is determined as a function of the average pressure on the sliding surface $\sigma_{VSLide^{TM}\text{-}M}$ [MPa] under the characteristic combination of actions, as follows:

$$0{,}019 \leq \frac{1{,}9}{40 + \sigma_{VSLide^{TM}\text{-}M}} \leq 0{,}035 \qquad (4)$$

For guides equipped with undimpled and initially lubricated VSLide™-M sheets, the coefficient of friction is μ_{max} = 0,060 regardless of the pressure.

3.1.6.2 Coefficient of friction at very low temperatures

For sliding elements equipped with dimpled and lubricated VSLide™-M sheets used in zones where the minimum effective bearing temperature falls below – 35 °C (down to – 50 °C), the coefficient of friction μ_{max} is determined as a function of the average pressure on the sliding surface $\sigma_{VSLide^{TM}\text{-}M}$ [MPa], as follows:

$$0{,}025 \leq \frac{3{,}4}{75 + \sigma_{VSLide^{TM}\text{-}M}} \leq 0{,}038 \qquad (5)$$

For guides equipped with undimpled and initially lubricated VSLide™-M sheets, the coefficient of friction is μ_{max} = 0,071 regardless of the pressure.

3.1.6.3 Coefficient of friction at moderate low temperatures

For sliding elements combined with dimpled and lubricated VSLide™-M sheets used in zones where the minimum effective bearing temperature does not fall below – 5 °C, the coefficient of friction μ_{max} is determined as a function of the average pressure on the sliding surface $\sigma_{VSLide^{TM}\text{-}M}$ [MPa], as follows:

$$0{,}016 \leq \frac{1{,}9}{60 + \sigma_{VSLide^{TM}\text{-}M}} \leq 0{,}024 \qquad (6)$$

For guides combined with undimpled and initially lubricated VSLide™-M sheets, the coefficient of friction is μ_{max} = 0,055 regardless of the pressure.

Note 1: The average pressure $\sigma_{VSLide^{TM}\text{-}M}$ on dimpled VSLide™-M sheets is estimated using the gross contact area, i.e. including the area of the dimples.

For guides equipped with composite material of type CM1, the coefficient of friction at the relevant temperature is given in clause 6.7 of EN 1337-2.

3.1.7 Durability aspects (of sliding element)

The sliding surfaces of VSLide spherical bearing are protected from corrosion and contamination in equivalence to Clause 7.3 of EN 1337-2.

Where the austenitic steel sheet is attached by continuous fillet weld, provided the area covered by the austenitic steel sheet is free from rust and rust inducing contaminants, no further treatment of the backing plate behind the austenitic steel sheet is required.

Areas of the backing plate behind the VSLide™-M sheet are protected by one coat of primer (dry film thickness 20 µm to 100 µm).

Suitable devices, like e.g. rubber skirts, are provided to protect sliding surfaces against contamination. Such protection devices are easily removable for the purpose of inspection.

For hard chromium surfaces special provisions are made to protect the surfaces in industrial environments as indicated in EN 1337-2, Clause 7.3.

3.2 Performance of the sliding material VSLide™-M

Basic Works Requirement	Essential characteristic	Performance
BWR 1 Mechanical resistance and stability	Material properties: • Young modulus • Yield strength • Tensile strength • Elongation at break • Ball hardness • Mass density • Melting temperature	Laid down in the technical documentation deposited with the ITeC
	Compressive strength of special sliding material VSLide™-M	See Table 3.4
	Load – deformation behaviour of special sliding material VSLide™-M:	

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Basic Works Requirement	Essential characteristic	Performance
	• Modulus of elasticity and stiffness coefficient	Modulus of elasticity: $E_{tp,50\%}$ ($\sigma_{VSLide™-M}$ = 90 MPa) = 850 MPa $E_{tp,50\%}$ ($\sigma_{VSLide™-M}$ = 45 MPa) = 1.150 MPa $E_{tp,50\%} = \frac{\sigma_{VSLide™-M}[MPa] - 45}{0,15} + 850$ Stiffness coefficient (1): $k_{95\%} = \frac{\sigma_{VSLide™-M}[MPa] - 45}{67,1} + 0,397$
	• Protrusion after loading [mm] • Ratio tensile strength / yield strength • Ratio elongation at break / yield deformation	Laid down in the technical documentation deposited with the ITeC
	High temperature resistance of the special sliding material	Resistant
	Resistance of the special sliding material against chemical and environmental influences	Resistant

Note:

(1) The stiffness coefficient k of VSLide™-M is expressed as a function of the average pressure $\sigma_{VSLide™-M}$ on the sliding material sheet under the characteristic combination of actions.

Table 3.3: Essential characteristics and performances of the special sliding material VSLide™-M.

Sliding surface	Type of load	Characteristic compressive strength $f_k(T)$ [MPa]					
		$f_k(T_0)$ $T_0 \leq 35$ °C	$f_k(T_{48})$ T = 48 °C	$f_k(T_{60})$ T = 60 °C	$f_k(T_{70})$ T = 70 °C	$f_k(T_{80})$ T = 80 °C	$f_k(T_{90})$ T = 90 °C
Main sliding surface	Permanent and variable loads	180	150	135	120	105	90
Guides	Variable loads						
Guides	Permanent loads, effects of temperature, shrinkage and creep	60	50	45	40	35	30

Table 3.4: Characteristic compressive strength of VSLide™-M.

4 Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

According to the decision 95/467/EC of the European Commission[1], amended by the Commission decision 2001/596/EC[2] and 2002/592/EC[3], the system of AVCP (see EC delegated regulation (EU) No 568/2014 amending Annex V to Regulation (EU) 305/2011) given in the following table applies.

Product	Intended use(s)	Level or class	System
VSLide Spherical Bearing	In buildings and civil engineering works where requirements on individual bearing are critical (1)	--	1

Note:

(1) '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.

Table 4.1: Applicable AVPC system.

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

All the necessary technical details for the implementation of the AVCP system are laid down in the *Control Plan* deposited with the ITeC[4], with which the factory production control shall be in accordance.

Products not manufactured by the kit manufacturer shall also be controlled according to the Control Plan.

Where materials/components are not manufactured and tested by the supplier in accordance with agreed methods, then they shall be subject to suitable checks/tests by the kit manufacturer before acceptance.

Any change in the manufacturing procedure which may affect the properties of the product shall be notified and the necessary type-testing revised according to the Control Plan.

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by the Catalonia Institute of Construction Technology.

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Institut de Tecnologia de la Construcció de Catalunya

Ferran Bermejo Nualart

Technical Director, ITeC

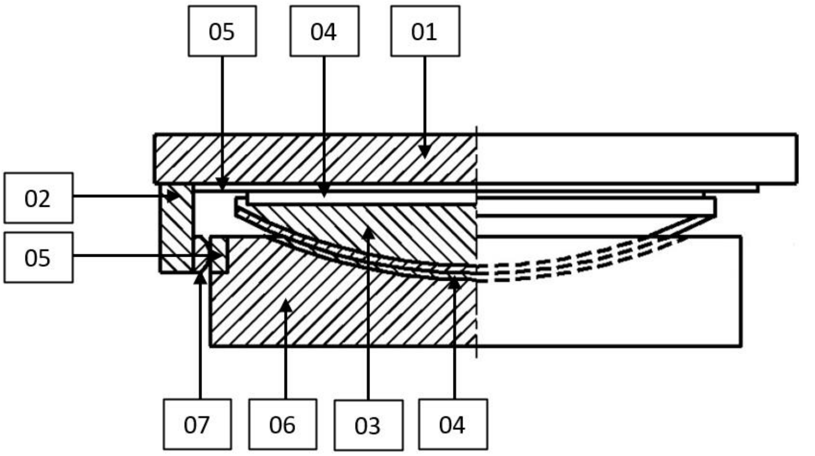
[1] Official Journal of the European Union (OJEU) L268/29 of 10/11/1995.

[2] Official Journal of the European Union (OJEU) L209/33 of 02/08/2001.

[3] Official Journal of the European Union (OJEU) L192/57 of 20/07/2002.

[4] The *Control Plan* is a confidential part of the ETA and is only handed over to the notified certification body involved in the assessment and verification of constancy of performance.

ANNEX 1: DESCRIPTION OF THE PRODUCT



1. Sliding plate
2. Guide
3. Rotational element (convex plate)
4. VSLide™-M sheet
5. Austenitic steel sliding sheet
6. Backing plate (concave plate)
7. Rocker strip

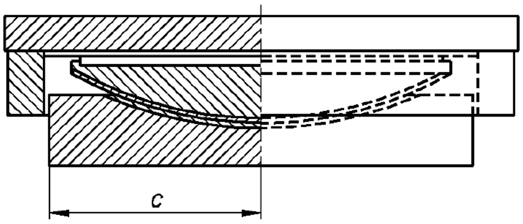
Guided spherical bearing (movable unidirectional) | Free spherical bearing (movable multidirectional)

Figure A.1.1: Assembly of a guided and free movable VSLide spherical bearing.

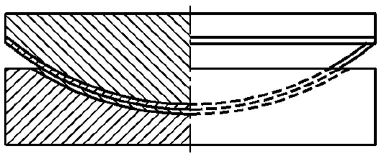
Thickness of dimpled sheets of VSLide™-M special sliding material to be used in flat or curved sliding surfaces: 8,0 mm.

Thickness of undimpled sheets of VSLide™-M special sliding material to be used in guides: 7,0 mm.

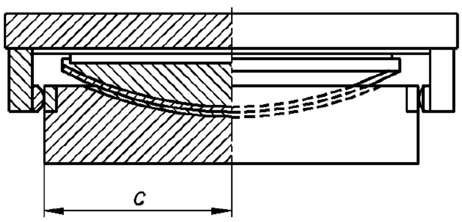
Examples of VSLide spherical bearing are shown in Figure A.1.2.



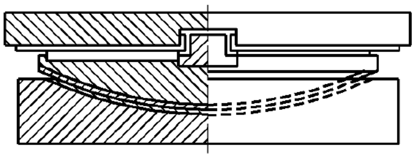
Fixed by a restraining ring (type 3.1)



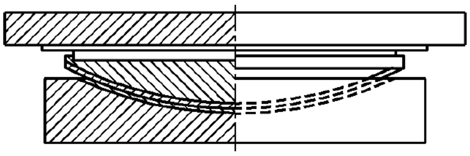
Fixed by the sliding surface (type 3.2)



Guided by external guides for displacement in one direction (type 3.3)



Guided by an internal guide for displacement in one direction (type 3.4)



Free for displacement in any direction (type 3.5)

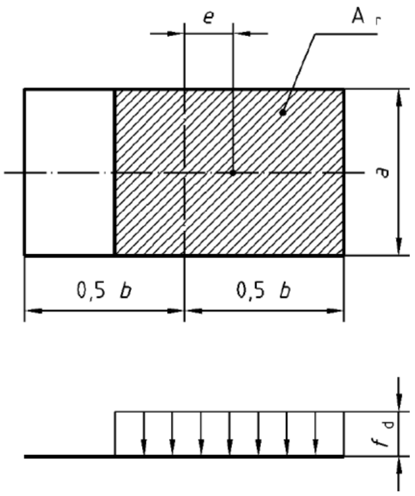
Note:

- Numbers in brackets refer to examples shown in Figure 1 of EN 1337-1, which are according to the bearing types in table 1 of EN 1337-1.

Figure A.1.2: VSLide spherical bearing.

ANNEX 2: REDUCED AREA FOR SLIDING ELEMENTS

This annex gives the values of the coefficient λ used in 3.1.5.1.3 of this ETA for the calculation of the reduced area A_r of curved sliding surfaces of the VSLide spherical bearings.



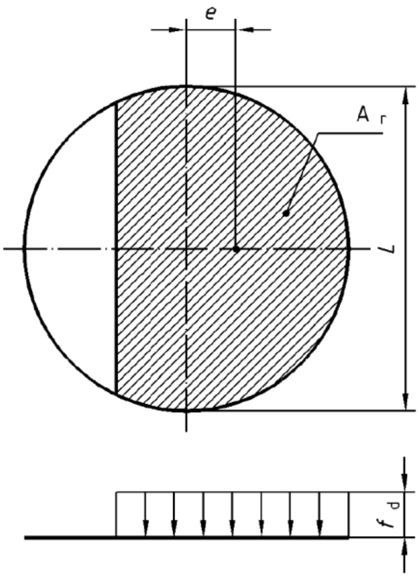
e: total eccentricity

θ: half included angle of the VSLide™-M curved surface

$A = a \cdot b$ (B.1)

$A_r = A - 2 \cdot e \cdot a = a \cdot (b - 2 \cdot e)$ (B.2)

Figure A.2.1: Reduced contact area A_r for rectangular sliding surfaces.



e: total eccentricity

θ: half included angle of the VSLide™-M curved surface

$A = \pi \cdot L^2/4$ (B.3)

$A_r = \lambda \cdot A$ (B.4)

Figure A.2..2: Reduced contact area A_r for circular sliding surfaces.

Parameter λ for curved and plane surfaces is given in Tables A.2.1 and A.2.2 below, respectively.

θ / e/L	30°	25°	20°	10°
0,00	1,000	1,000	1,000	1,000
0,01	0,982	0,981	0,980	0,979
0,02	0,962	0,961	0,960	0,958

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θ / e/L	30°	25°	20°	10°
0,03	0,942	0,940	0,938	0,936
0,04	0,922	0,919	0,916	0,913
0,05	0,901	0,898	0,894	0,890
0,06	0,880	0,876	0,872	0,867
0,07	0,858	0,853	0,849	0,844
0,08	0,836	0,831	0,826	0,820
0,09	0,814	0,808	0,803	0,796
0,10	0,792	0,786	0,780	0,773
0,11	0,770	0,763	0,757	0,749
0,12	0,747	0,740	0,733	0,724
0,13	0,725	0,717	0,710	0,700
0,14	0,702	0,693	0,686	0,676
0,15	0,680	0,670	0,663	0,653
0,16	0,657	0,647	0,639	0,628
0,17	0,635	0,624	0,616	0,604
0,18	0,612	0,601	0,592	0,581
0,19	0,590	0,578	0,569	0,557
0,20	0,567	0,556	0,546	0,533
0,21	0,545	0,533	0,523	0,510
0,22	0,523	0,511	0,500	--
0,23	0,501	--	--	--
0,24	--	--	--	--

Note: Intermediate values may be obtained by linear interpolation.

Table A.2.1: λ values for curved circular surfaces (according to EN 1337-7, Table B.1).

e/L	**0,005**	**0,010**	**0,020**	**0,030**	**0,040**	**0,050**	**0,060**
λ	0,990	0,979	0,957	0,934	0,912	0,888	0,865
e/L	**0,070**	**0,080**	**0,090**	**0,100**	**0,110**	**0,120**	**0,125**
λ	0,841	0,818	0,793	0,769	0,745	0,722	0,709
e/L	**0,130**	**0,140**	**0,150**	**0,160**	**0,170**	**0,180**	**0,190**
λ	0,697	0,673	0,649	0,625	0,601	0,577	0,552
e/L	**0,200**	**0,210**	**0,212**	**0,220**	**0,230**	**0,240**	**0,250**
λ	0,529	0,506	0,500	0,482	0,458	0,435	0,412

Table A.2.2: λ values for plane circular surfaces (according to EN 1337-2, Table A.1).

As an alternative to the exact values given in Table A.2.2, the following approximate formula can be used for flat circular surfaces:

$$\lambda = 1 - 0{,}75 \cdot \pi \cdot e/L \quad \text{(B.5)}$$