SLOVENSKI STANDARD
SIST EN 14879-6:2010

01-marec-2010

Sistemi organskih premazov in prevlek za protikorozijsko zaġļ ito industrijskih naprav in obratov v kemijsko agresivnih pogojih - 6. del: Kombinirane prevleke s ploġļ icami in zidaki

Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 6: Combined linings with tile and brick layers

Beschichtungen und Auskleidungen aus organischen Werkstoffen zum Schutz von industriellen Anlagen gegen Korrosion durch aggressive Medien - Teil 6: Kombinierte Auskleidung mit Plattierungen (Plattenlagen) und Ausmauerungen

Systèmes des revêtements organiques pour la protection des appareils et installations industriels contre la corrosion par des fluides agressifs - Partie 6 : Revêtements rapportés associés à des couches de carreaux et de briques

Ta slovenski standard je istoveten z: EN 14879-6:2009

ICS:

25.220.60	Organske prevleke	Organic coatings

SIST EN 14879-6:2010 en,fr,de

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 14879-6

December 2009

ICS 25.220.60

English Version

Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 6: Combined linings with tile and brick layers

Systèmes des revêtements organiques pour la protection des appareils et installations industriels contre la corrosion par des fluides agressifs - Partie 6 : Revêtements rapportés associés à des couches de carreaux et de briques

Beschichtungen und Auskleidungen aus organischen Werkstoffen zum Schutz von industriellen Anlagen gegen Korrosion durch aggressive Medien - Teil 6: Kombinierte Auskleidung mit Plattierungen (Plattenlagen) und Aus-mauerungen

This European Standard was approved by CEN on 24 October 2009.

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

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

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 14879-6:2009: E

Contents

Page

Foreword

This document (EN 14879-6:2009) has been prepared by Technical Committee CEN/TC 360 “Project Committee - Coating systems for chemical apparatus and plants against corrosion”, the secretariat of which is held by DIN.

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 June 2010, and conflicting national standards shall be withdrawn at the latest by June 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

EN 14879, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media*, consists of the following parts:

— *Part 1: Terminology, design and preparation of substrate*

— *Part 2: Coatings on metallic components*

— *Part 3: Coatings on concrete components*

— *Part 4: Linings on metallic components*

— *Part 5: Linings on concrete components*

— *Part 6: Combined linings with tile and brick layers*

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

1 Scope

This European Standard describes the requirements for and methods of testing of combined systems with tile and brick layers which are applied to concrete or metallic process engineering equipment that will come in contact with chemical substances (liquids, solids and gases). The requirements specified here may be used for the purposes of quality control (e.g. as agreed between the contract partners or having been given by national regulations[1)]).

The standard applies to systems which serve one or more of the following purposes:

— to protect the component from adverse effects of aggressive substances;

— to protect waters (e.g. ground water) against hazardous substances;

— to protect the charge from becoming contaminated by components released from the substrate material;

— to achieve a particular surface quality.

The described combined systems can be used for concrete or metallic process engineering equipment that will come into contact with chemical substances.

The combined system is a combination of:

— a coating according to EN 14879-2 or EN 14879-3 with an additional layer of tiles or bricks embedded in cement mortar, resin based mortar and/or potassium silicate mortar as an adhesive bonding cement (referred to simply as cement in this standard); or

— a lining according to EN 14879-4 or EN 14879-5 with an additional layer of tiles or bricks embedded in cement mortar, resin based mortar and/or potassium silicate mortar as an adhesive bonding cement (referred to simply as cement in this standard).

For design and preparation of substrate, see EN 14879-1.

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 206-1, *Concrete – Part 1: Specification, performance, production and conformity*

EN 13501-1:2007, *Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests*

EN 14879-1:2005, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media – Part 1: Terminology, design and preparation of substrate*

EN 14879-2:2006, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media – Part 2: Coatings on metallic components*

EN 14879-3:2006, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media – Part 3: Coatings on concrete components*

1) For the purposes of this standard, the contract partners are the coating material, lining, mortar, tiles and bricks manufacturers, the component manufacturer, the person(s) responsible for applying the coating, lining, mortar, tiles and bricks, and the client ordering the finished component(s).

EN 14879-4:2007, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media – Part 4: Linings on metallic components*

EN 14879-5:2007, *Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media – Part 5: Linings on concrete components*

EN ISO 291, *Plastics – Standard atmospheres for conditioning and testing (ISO 291:2008)*

EN ISO 10545-12, *Ceramic tiles – Part 12: Determination of frost resistance (ISO 10545-12:1995, including Technical Corrigendum 1:1997)*

IEC 60093:1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*

IEC 60167, *Methods of test for the determination of the insulation resistance of solid insulating materials*

3 Terms and definitions

For the purposes of this document, the following terms and definitions in addition to those of EN 14879-1:2005, EN 14879-2:2006, EN 14879-3:2006, EN 14879-4:2007 and EN 14879-5:2007 apply.

3.1
combined lining system
combined lining system applied as a protection against chemical, mechanical and thermal loading

NOTE Such systems comprise a sealing layer and a service layer (see Figure 1). Taken together, the two layers provide a more effective protection than each layer would provide on its own.

3.2
sealing layer
bottom layer of the combined lining system that is applied to the concrete or metal surface

NOTE It serves both as a primer (promoting adhesion) and as a layer which is impervious to liquids.

3.3
service layer
top layer of the combined lining system, which is made of tiles or bricks bonded to the sealing layer by means of mortar or cement

NOTE It serves to protect the sealing layer from the direct contact with chemical, mechanical and thermal loads.

3.4
semi-finished product
tile, brick, also in other shapes

EXAMPLES Pipes, nozzles.

3.5
jointing mortar
mortar or cement used to fill the joints between the semi-finished products

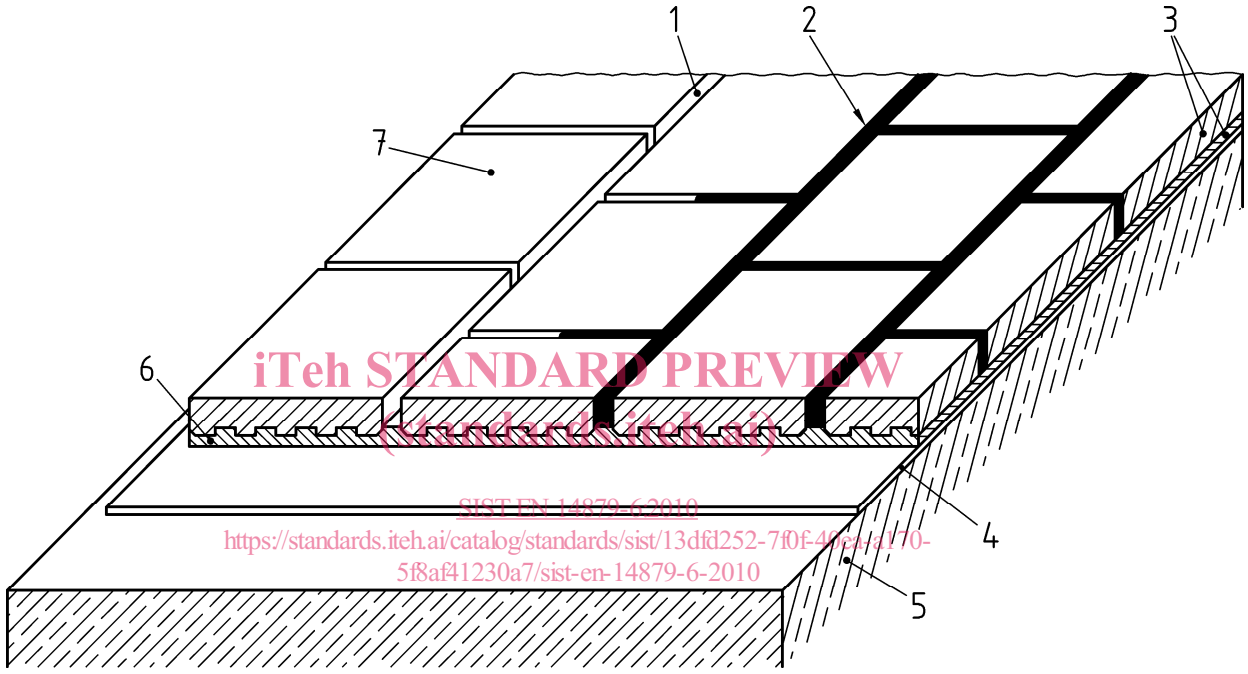
3.6
bedding mortar
mortar or cement used to form the bed between the sealing layer and the surfacing units

3.7
bed joint
layer of mortar between the sealing layer and the service layer

3.8
butt joint
joint between tiles and/or bricks

3.9
"closed-joint" technique
technique by which the bedding is laid and joints between tiles and/or bricks are filled at the same time

3.10
"open-joint" technique
technique by which the joints between tiles and/or bricks are left open and then filled at a later time



Key

1	Hollow joint, 6 to 8 mm wide	5	Steel or concrete substrate
2	Butt joints filled with jointing mortar/cement	6	Bed joint; bedding mortar/cement
3	Service layer (Combination of 6 and 7)	7	Acid-proof tiles, bricks
4	Sealing layer		

Figure 1 — Lay-up of a combined lining system

4 General

4.1 Steel vessels and apparatus

4.1.1 Calculating the dimensions of brick-lined steel vessels

The dimensions of brick-lined vessels shall be calculated so that deformations of the structure shall not at any point assume proportions liable to damage the brick lining.

Brick-lined vessels which are operated by heat and/or pressure shall be designed on the basis of principles that go beyond the requirements for pressure vessels, account being taken of the following:

a) The necessary contact between the vessel wall and the brick lining;

b) Protection against crack formation in the brick lining;

c) Swelling of the brick lining (mortar/cement) which is possible.

Harmful tensile stresses in brick linings shall be avoided. These stresses may be calculated primarily on the basis of the following variables:

d) Modulus of elasticity of the casing (E_e) and the brick lining (E_m);

e) Thickness of the vessel wall (S_e) and the brick lining (S_m);

f) Coefficient of linear expansion of the vessel wall (α_e) and the brick lining (α_m);

g) Thermal conductivity of the vessel wall (λ_e) and the brick lining (λ_m);

h) Thermal conductivity of the internal and/or external insulation (λ_i) and (λ_a), if fitted;

i) The internal (α_i) and external (α_a) heat transfer coefficients; allowance shall be made for the (occasionally unilateral) influence which the wind, solar radiation and rainfall may have on the temperature);

j) The swelling factors (q) of the materials used for the brick lining.

The properties of the materials shall be obtained from the manufacturer's information. Guideline values can be found in 4.5.

A stress determination for the brick lining shall be required if very high stresses of thermal origin and/or excess pressure are present. Stress determination may be omitted if experience is available on vessels of similar design operated under similar conditions.

The calculation of the thickness of the vessel wall and brick lining shall preferably be based on values established by experience, bearing in mind that swelling can cause the stresses in the casing and the brick lining to be greater when they are cold than when they are in operation. A subsequent calculation may be carried out to establish whether the stresses in the brick lining and the casing remain within the permissible limits in all cases. Otherwise, different building materials shall be selected, the dimensions shall be modified and/or the casing shall resist an initial tensile stress and the brick lining an initial compressive stress.

The thickness of the vessel walls may also be calculated from the requirement relating to compliance with the permissible tolerances in 4.1.2.

In calculations of the wall thickness of cylindrical or spherical vessels the influence of the brick lining may be taken into account in case of certain pressure and temperature conditions.

Careful account shall be taken of the deformation of the vessel casing by the imposed loads, especially in horizontal vessels. This can reach proportions that lead to damage to the brick lining without the permissible stresses in the casing being exceeded.

This type of deformation shall be kept to a low level by suitable design of the imposed loads and adequate reinforcement of the casing, according to national regulations, e.g. DIN 28080, DIN 28081-1, DIN 28081-2, DIN 28083-1, DIN 28084 (all parts), DIN 28082-1 and DIN 28082-2.

A deflection of $f \leq \frac{a}{1\,000}$ may be assumed as an indicative value when calculating the dimensions of flat vessel components, where *a* denotes the bearing width. Bearing widths that are common in practice are between 600 mm and 900 mm.

4.1.2 Dimensional tolerances (for steel and non-ferrous vessels)

For test methods for dimensional tolerances see Annex D.

After final installation the radii in the cylindrical part may not deviate from the mean value of the plane of measurement by more than ± 0,4 %; in vessels whose diameter exceeds 7 500 mm they may not deviate by more than ± 15 mm. The planes of measurement have a common centre axis. Generally speaking the circumference of the measurement circle U shall be divided into 16 equal segments U/16 in order to determine the measurement points. The adjustment of the deviation to the normal circle shall cover at least 1/16 of the length of the circumference, or at least 1 500 mm for diameters in excess of 7 500 mm. The maximum deviations of successive measurement points will therefore not exceed 0,4 % or 15 mm.

The distance between planes of measurement shall be 1 000 mm to 2 500 mm. These planes of measurement, which are perpendicular to the vessel axis, shall be 100 mm from the weld seams of the cylindrical courses with the exception of the first or last plane of measurement in the case of bases or covers according to DIN 28011, DIN 28013 and DIN 28014. With these torispherical or ellipsoidal heads the distance between the nearest plane of measurement and the weld seam between the base and the cylindrical part shall be 1 000 mm.

The roundness tolerances for bases and covers are given in national regulations, e.g. DIN 28011, DIN 28013 and DIN 28014, calculation according to EN 13445-3.

The straightness tolerance of flat walls shall be 10 mm for any profile lines in the vessel wall between 900 mm and 1 500 mm long. According to EN ISO 1101:2005 the straightness tolerance is defined as the distance between two parallel lines or planes, between which all points on the profile line in question shall lie.

The straightness tolerance of flat, rectangular or round bases shall be 10 mm for any profile lines in the vessel wall between 900 mm and 1 500 mm long.

Deviations from the ideal line (allowances) between one measurement point and another may not exceed half the tolerance and may only occur gradually.

4.1.3 Construction of steel vessels

Flat surfaces present problems with respect to brick linings. They shall therefore:

a) be kept as small as possible;

b) be strongly reinforced against bending;

c) be designed so as to have flexural strength at the corners;

d) have a retaining point for the brickwork on the free edge, if necessary (see Figure 2);

e) be designed with an inclination ≥ 2 % if necessary.

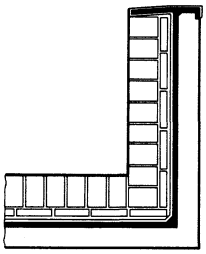


Figure 2 — Flat plate wall

Base and lateral supports shall only be fitted where absolutely necessary.

If vessel covers are to be brick-lined they shall be curved and have a support for the lining.

4.1.4 Installation of brick-lined vessels

The vessel shall be placed in its final position before being brick-lined. If this is not possible, any required transportation of brick-lined vessels shall be undertaken only if the brick lining is adequately stable. It is advantageous to install struts carefully for the transportation. The stability can be favourably affected by generation of a pre-stress. Rolling of brick-lined apparatus is not permissible.

Environmental and/or safety requirements are to be observed.

4.1.5 Leak tests

All vessels shall be leak-tested before being brick-lined.

4.1.6 Repairs and modifications

If brick-lined vessels require welding, the brick lining within a reasonable distance of the weld point shall be removed before welding takes place. The regulations that apply to brick-lined vessels shall also be observed.

4.2 Concrete vessels and apparatus

4.2.1 Calculating the dimensions of brick-lined concrete vessels

Dimensions of the vessels to be brick-lined are to be statically calculated so that the structural deformations are limited in such a way that no possibility of damages in the brick lining can occur. Here special attention should be paid to reduce cracks in the concrete, in relation to the sealing layer to be used. With consideration of thickness and elasticity of the sealing layer, the width of cracks in the concrete must be limited to 0,1 mm to 0,3 mm. The reinforcement is to be laid out in accordance with EN 206-1. When calculating and executing the concrete structure the operating temperature and pressure and the possible swelling of the brick lining should be considered. Damaging tensile strengths shall be avoided. The properties of the materials should be taken from the manufacturer's specifications. Typical values are given in 4.5. In case of higher temperatures and/or excess pressure a tensile appraisal will become necessary. Practical references can be applied.

4.2.2 Dimensional tolerances

At this time no regulated specifications exist. Admissible deviations shall be agreed with the manufacturer of the brick lining.

4.2.3 Requirements to the concrete construction

Requirements to the concrete construction and surface shall be in accordance to EN 14879-1.

4.3 Substrate preparation

For preparation of substrate see EN 14879-1.

4.4 Sealing layer

The sealing layer shall be either a coating according to EN 14879-2 and/or EN 14879-3 or a lining according to EN 14879-4 and/or EN 14879-5.

The sealing layer of a combined lining system serves as a sealing of the component and crack bridging of the concrete. Since in most cases the service layer also protects the sealing layer from direct exposure to chemical, mechanical or thermal loads, the suitability may only be determined by testing the system as a whole.

Taking into consideration the particular requirement and the expected life the combination of sealing layer and service layer that has the best all-around resistance shall be selected. As a rule, the system shall be designed either for the expected loads or (in special cases) for higher loads than expected.

a) Leak tightness

To prevent the leakage of fluids, the sealing layer shall be free of pinholes, inclusions and other defects, and shall be continuous in all areas, which need protection.

b) Vapour and/or liquid impermeability

The sealing layer shall be sufficiently impervious to vapour and/or liquids, that is, the substrate shall not be exposed to chemical attack, nor shall the layer disbond when loaded.

c) Chemical resistance

The sealing layer in combination with the service layer shall be adequately resistant to chemicals. A sealing layer — though not sufficiently resistant to long-term direct exposure — may fulfil its function, because the service layer above makes the attacking agent stagnant in that it hinders a direct contact with the agent and thus reduces the impact on the sealing layer.

d) Resistance to mechanical loading

The sealing layer has to be resistant enough to absorb the mechanical stress on the service layer and conduct it into the supporting substrate without any disadvantageous change of its structure or function. This applies to both resting loads and rolling loads which can also cause horizontal stress in addition to vertical compression. In this case the loading frequency is important. Deformation of the substrate due to shrinkage and creep, stresses caused by different rates of thermal expansion in the substrate and service layer, and the nature of cracking in the concrete substrate (see EN 14879-1 for a classification of cracks) shall also be taken into consideration when selecting sealing layer materials.

e) Thermal stability

Sealing layers shall be sufficiently resistant to heat. The thermal transmittance of the wear layer and the heat dissipation properties of the substrate shall be taken into consideration when designing the coating or lining system. In cases of doubt, the thermal behaviour of the entire system shall be calculated.

f) Resistance to ageing

The service layer protects the sealing layer from most external factors which could lead to premature ageing. However, the sealing layer's ageing behaviour can be adversely affected by long-term exposure to elevated temperatures. It shall be ensured that there is no loss of adhesion or an inability to bridge cracks caused by an increasing brittleness of the layer.

g) Maintenance

It shall be possible to repair the sealing layer.

4.5 Service layer

4.5.1 Bedding and jointing mortar/cement

4.5.1.1 General

In combined lining systems, the mortar is used for bonding the sealing layer to the service layer and for jointing the tiles and/or bricks of the service layer.

As a rule, the mortar is in direct contact with the process medium. After longer operating time even the mortar bed usually comes into contact with the medium.

The mortar used shall be selected on the basis of the expected loading, taking the load profile according to 4.7.1 to 4.7.5 and the following requirements into consideration.

a) Chemical resistance

The mortar that will come into contact with the medium shall be resistant to that medium. The duration of exposure to the medium, and concentration and temperature of the medium shall be taken into consideration.

b) Resistance to mechanical loading

The mortar shall be capable of transmitting any static or dynamic mechanical loads (including vibration) to the substrate via the sealing layer without becoming damaged, even under concurrent thermal loading.

The allowable, temperature depending surface pressure of materials with thermoplastic properties like bitumen, shall especially be considered.

c) Thermal stability

The mortar shall be resistant to any expected thermal loads. Especially to be considered are the maximum and minimum temperatures to which the mortar will be exposed, the duration of exposure, and the speed and frequency of any temperature changes.

d) Shrinkage

While hardening, mortar shrinks to an extent which depends on its specific material properties. In combined lining systems, this shrinkage and any changes in length are hindered, resulting in shrinkage stress. The mortar used shall form a solid bond with the sealing layer and tiles or bricks in the service layer. Additional measures such as sanding, keying or priming may be used to improve adhesion.

There shall be no cavities or cracks in the service layer. Shrinkages can be reduced by using for example thicker tiles or bricks.

e) Capability of dissipating electrostatic charges

If necessary, the resin based mortar's conductivity may be increased by adding suitable materials (e.g. carbon fillers).

The dissipation resistance is tested according to Annex C (normative) with a measuring voltage of 100 V.

The insulation resistance (surface resistance) is measured according to IEC 60167 with 100 V DC voltages. EN 1081 may still be used.

4.5.1.2 Materials

4.5.1.2.1 General

The following materials may be used for bedding and jointing:

a) cement mortar;

b) potassium silicate mortar;

c) bituminous compounds;

d) resin-based mortars (e.g. based on epoxy (EP), furan (FU), phenol formaldehyde (PF), unsaturated polyester (UP), or vinyl ester (VE)).

Table 1 presents the general characteristics of cement mortar, potassium silicate mortar and bituminous compounds. The general characteristics of the resin-based cement are presented in Table 2. Physical properties are given in Table 3.

Table 1 — General characteristics of cement mortar, potassium silicate mortar and/or bituminous compounds

	Cement mortar	Potassium silicate mortar	Bituminous compounds
Binder	Portland, blast furnace or high alumina cement	Potassium silicate, sodium silicate	Oxidized bitumen
Filler	Quartz, trass	Quartz	Quartz, kaolin, carbon, barites
Catalyst	Water	Neutralising agent	—
Processing aid	Non saponifiable resin emulsion	—	—
Hardening principle	Hydration	Coagulation	Solidification
Pot life	30 min to several hours	30 min to 2 h	—
Shrinkage, as a percentage by mass	0,6 to 0,9	1,5 to 2,5	[b]
May be subjected to loading after	several days	several days	after cooling
Adhesion to:			
— carbon	(not applicable)	(not applicable)	+
— ceramics	+	+	+
— steel	+	+	+
— concrete	+	+[a]	+
— rubber	–/+[a]	–	+
— thermoplastics	–/+[a]	–/+[a]	+
— resin coatings	–/+[a]	–/+[a]	
Use for:			
— floors and walls	++	○	+
— vessels and apparatus	+	++	+
— chemical loading	Suitable only at a pH > 4	Highly suitable at a pH < 5	+
— mechanical loading	+	+	○
— thermal loading	++	++	–

[a] With priming and sanding.

[b] The term "shrinkage" is not applicable to bituminous materials. The corresponding property in bitumen is the coefficient of cubic expansion, which is 0,000 61 within a temperature range of 15 °C to 200 °C.

Key to symbols:

++ very good/highly suitable

\+ good/suitable

○ good/suitable only under certain conditions

– poor/unsuitable