

Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media —

Part 5: Linings on concrete components

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National foreword

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

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Foreword

This document (EN 14879-5:2007) has been prepared by Working Group CEN/BT/Task Force 130 "Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media", 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of an identical text or by endorsement, at the latest by February 2008, and conflicting national standards shall be withdrawn at the latest by February 2008.

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 United Kingdom.

1 Scope

This document describes the requirements for and methods of testing of organic linings which are applied to concrete process engineering equipment that will come in contact with aggressive 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).

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

- to protect the component from damaging effects of aggressive substances;
- to protect waters (e.g. ground water) from harmful substances;
- to protect the charge from becoming contaminated by components released from the substrate material;
- to achieve a particular surface quality.

The different lining systems are:

- a) bonded linings;
- b) mechanically fixed linings;
- c) loose linings of sheeting material;
- d) loose linings of pre-formed pieces or lining units.

Handling of aggressive or water pollutant materials is understood to include

- e) storage;
- f) filling;
- g) loading and unloading;
- h) manufacture;
- i) treatment;
- j) use.

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 228, *Automotive fuels — Unleaded petrol — Requirements and test methods*

EN 590, *Automotive fuels — Diesel — Requirements and test methods*

EN 1766, *Products and systems for the protection and repair of concrete structures — Test methods — Reference concretes for testing*

EN 10204, *Metallic products — Types of inspection documents*

EN 13067, *Plastics welding personnel — Qualification testing of welders — Thermoplastic welded assemblies*

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

EN 13813, *Screed material and floor screeds — Screed material — Properties and requirements*

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 14879-4, *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 ISO 75-1, *Plastics — Determination of temperature of deflection under load — Part 1: General test method (ISO 75-1:2004)*

EN ISO 175, *Plastics — Methods of test for the determination of the effects of immersion in liquid chemicals (ISO 175:1999)*

EN ISO 178, *Plastics — Determination of flexural properties (ISO 178:2001)*

EN ISO 179 (all parts), *Plastics — Determination of Charpy impact properties*

EN ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets (ISO 527-3:1995)*

EN ISO 846:1997, *Plastics — Evaluation of the action of microorganisms (ISO 846:1997)*

EN ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868:2003)*

EN ISO 1133, *Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics (ISO 1133:2005)*

EN ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method (ISO 1183- 1:2004)*

EN ISO 2286 (all parts), *Rubber- or plastics-coated fabrics — Determination of roll characteristics*

EN ISO 6721-2, *Plastics — Determination of dynamic mechanical properties — Part 2: Torsion-pendulum method (ISO 6721-2:1994, including Technical Corrigendum 1:1995)*

EN ISO 14632, *Extruded sheets of polyethylene (PE-HD) — Requirements and test methods (ISO 14632:1998)*

EN ISO 15013, *Extruded sheets of polypropylene (PP) — Requirements and test methods (ISO 15013:1998)*

EN ISO 22088-4, *Plastics — Determination of resistance to environmental stress cracking (ESC) - Part 4: Ball or pin impression method (ISO 22088-4:2006)*

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*

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

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 813, *Rubber, vulcanized or thermoplastic — Determination of adhesion to a rigid substrate — 90 degree peel method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14879-1:2005 and the following apply.

NOTE The terms used to designate structural elements requiring surface protection are usually based on the function of the elements in the process plant. For the sake of consistency, the most common of these elements are referred to here on the basis of their function within the structure.

3.1

floor (bottom)

flat or inclined surface, such as the floor of a production or storage area, and the bottom of a vessel

3.2

wall

vertical or almost vertical limiting surface, such as the wall of a production and storage area, and the wall of a vessel

3.3

ceiling (top)

upper limiting surface, such as the ceiling of a production and storage area, and the top of a vessel

3.4

gutter

open indentation, moulded in the floor, through which fluids may drain away

3.5

trench

open or covered element in the floor of any shape or size, whose invert is considerably lower than the floor, and through which fluids may drain away

3.6

pipe

hollow cylinder of any shape or size, through which fluids, gases and vapours may pass

3.7

sump

depression in the floor, designed as the lowest point from which collected substances can be drained off

3.8
collecting basin
tight basin or area designed to collect any water pollutants leaking in an emergency

3.9
tank
open or closed facility of any shape or size designed to contain permanently fluids, solids, gases and vapours

NOTE Typical designations for containers are basin, cistern, vessel and tank

4 Concepts and selection criteria

4.1 Surface protection types and systems

4.1.1 General

Surface protection is usually applied as a lining as in 4.1.2 and Clause 5, as a coating as in EN 14879-3 or as a composite coating or lining system as in prEN 14879-6. The last of these combines a chemically resistant sealing coat with a wearing layer.

4.1.2 Protective linings

Linings based on organic binders, such as

a) Bonded linings

Bonded linings comprise pre-fabricated sheets that are fixed to the substrate by means of an adhesive applied over the entire surface area. The sheets are then jointed using an adhesive or by welding.

b) Mechanically fixed linings

Linings made of thermoplastic units (e.g. sheets, slabs or pre-formed pieces) that are fixed to the concrete substrate by means of fasteners systematically arranged on the units' underside. The lining units are then jointed by welding.

These linings may be applied either during the construction of the concrete member or after construction has been completed, in which case the lining is attached to a layer of facing concrete.

c) Loose linings of sheeting material

Pre-fabricated linings that are laid loosely on the substrate, jointed and then fixed to the walls by means of metal beads, for example.

The sheets are usually surfaced with gravel or screed, or protected against exposure to sunlight, warping and mechanical damage by means of a masonry facing.

d) Loose linings of pre-formed pieces or linings units

Linings made of pre-formed pieces laid in the concrete member and then fixed or welded at the top edge, if necessary.

4.2 Selection criteria

4.2.1 General

The stress to be encountered by a protective lining shall be known before the requirements for it can be specified. For the scope of this standard, the stress types detailed in 4.2.2 to 4.2.8 are the most relevant. Where necessary, grades have been used to describe different levels of stress.

4.2.2 Aggressive substances

Aggressive substances or water pollutants may occur as solids or fluids. Their aggressive action on concrete usually occurs when they are in a liquid state (e.g. aqueous solutions or condensates). The substances may occur in their pure state or as mixtures and may attack the concrete at varying intervals.

These substances shall be designated using the Geneva nomenclature, IUPAC¹⁾ nomenclature or CAS²⁾ number. They may also be designated by trivial names which have become established in the literature. Concentrations and any changes to these shall be given as a percentage by mass or volume, or as g/l, g/kg, mol/l etc. The pH value shall also be given for aqueous solutions.

All constituents, including traces and impurities, shall be named, even if they do not attack concrete. Successive exposure shall be represented accordingly.

Table 1 lists chemicals which are commonly used, having the properties mentioned above.

1) International Union of Pure and Applied Chemistry.

2) Chemical Abstract Service.

Table 1 — Classification of frequently (commonly) used chemicals

Type of chemical	Examples	
I. Inorganic chemicals		
Inorganic, non-oxidizing acids	HCl H ₂ SO ₄ H ₃ PO ₄	Hydrochloric acid Sulphuric acid, up to 70 % Phosphoric acid
Inorganic, oxidizing acids	HNO ₃ H ₂ SO ₄ CrO ₃ , H ₂ CrO ₄ HClO ₃	Nitric acid Sulphuric acid, over 70 % Chromic acid Chloric acid
Inorganic acids, dissolving SiO ₂	HF H ₂ SiF ₆ HBF ₄	Hydrofluoric acid Hexafluorosilicic acid (containing HF) Tetrafluoroboric acid (containing HF)
Salts	NaCl FeSO ₄ Na ₂ CO ₃	Sodium chloride Iron (II) sulphate Sodium carbonate
Bases	NaOH KOH CaO, Ca(OH) ₂ NH ₄ OH	Sodium hydroxide Potassium hydroxide Calcium oxide Calcium hydroxide Ammonia solution (Ammonium hydroxide solution)
Oxidizing bases	NaOCl	Sodium hypochlorite
II. Organic chemicals		
Organic acids	HCOOH CH ₃ COOH CH ₂ ClCOOH (COOH) ₂ CH ₃ CHOHCOOH	Formic acid Acetic acid Chloroacetic acid Oxalic acid Lactic acid
Aliphatic hydrocarbons	C ₆ H ₁₄ C ₈ H ₁₈	Hexane Octane
Aromatic hydrocarbons	C ₆ H ₆ C ₆ H ₅ CH ₃ C ₆ H ₄ (CH ₃) ₂	Benzene Toluene Xylene
Alcohols	CH ₃ OH C ₂ H ₅ OH C ₄ H ₉ OH CH ₂ OHCH ₂ OH	Methanol Ethanol Butanol Ethenediol
Aldehydes, Ketones, esters	CH ₂ O CH ₃ COCH ₃ C ₂ H ₅ COCH ₃ CH ₃ COOC ₂ H ₅	Formaldehyde Acetone Methyl ethyl ketone (2.butanone) Ethyl acetate
Aliphatic halogenated hydrocarbons	CH ₂ Cl ₂ C ₂ HCl ₃ C ₂ Cl ₃ F ₃	Dichloromethane Trichloroethylene Trichlorotrifluoroethane
Aromatic Halogenated hydrocarbons	C ₆ H ₅ Cl ClC ₆ H ₄ CF ₃	Chlorobenzene Chlorobenzotrifluoride
Aliphatic amines	CH ₃ NH ₂ (C ₂ H ₅) ₃ N NH ₂ C ₂ H ₄ NH ₂	Methylamine Triethylamine Ethylene diamine
Aromatic amines	C ₆ H ₅ NH ₂ C ₆ H ₅ N	Aniline Pyridine
Phenols	C ₆ H ₅ OH CH ₃ C ₆ H ₄ OH	Phenol Cresol
Fats, oils		Vegetable and animal fats and oils
NOTE The grades 0 to 2 and 4 are normally not applicable for linings according to this standard.		

4.2.3 Type and frequency of fluid loading

The requirements for the protective or sealing function of a surface protection system are linked to the type and frequency of the fluid loads to which it will be exposed. Exposure shall be graded as follows.

- Grade 0: no exposure to fluids.
- Grade 1: sporadic exposure to droplets of fluid (e.g. laboratory floors, floors in small units, walls).
- Grade 2: frequent, short-term exposure to splashes of fluid, where the surfaces are regularly flushed (e.g. floors of closed production plants).
- Grade 3: exceptional and limited exposure to fluids during operations (e.g. due to plant failure) in, for example, collecting basins.
- Grade 4: constant or frequent exposure to a film of fluid, due to wetness, condensation, puddles, trickles and the like (e.g. floors in production plants, electroplating plants or pumping stations).
- Grade 5: operational exposure to a constant flow of fluid involving no significant hydrostatic pressure (e.g. open gutters, trenches and their pump sumps, closed trenches and pipes).
- Grade 6: constant exposure of containers to fluid contents for unlimited periods (e.g. vessels, pits).

4.2.4 Thermal loading

Temperature influences the effectiveness of a surface protection system in the following ways.

a) Aggressiveness of medium

Elevated temperatures increase the aggressiveness of the medium by raising the levels of its chemical reactions and diffusion, and also through the accumulation of volatile substances in the headspace.

b) Thermal stress

Temperatures which deviate from the installation temperature cause thermal stress between the substrate and the surface protection system and may cause peeling, cracks, etc. This may result from the direct action of hot or cold media, or from radiant heat and extreme ambient temperature.

The maximum thermal load shall be stated in °C.

4.2.5 Changes in temperature

Changes in temperature include

- a) temperature changes at the protective surface during exposure to fluid loads of grades 3 to 5 as in 4.2.3 involving changed medium temperatures;
- b) temperature changes as otherwise constantly heated or cooled surfaces, resulting from operational contingencies, such as start-up and shutdown;
- c) temperature changes, possibly involving thermal shock, which occur during cleaning operations;
- d) process-related changes in the temperature of the medium under loading conditions corresponding to grade 6 (as in 4.2.3).

Temperature changes due to climatic influences are dealt with in 4.2.7.

The source, degree, speed and frequency of temperature changes shall be taken into consideration when assessing their effect.

The following grades serve in assessing the effects of temperature changes, whereby details of the frequency and the duration of temperature changes are to be given for grades 1 to 4.

- Grade 0: no temperature changes;
- Grade 1: infrequent temperature changes of not more than 50 K;
- Grade 2: infrequent temperature changes of more than 50 K;
- Grade 3: frequent temperature changes of not more than 50 K;
- Grade 4: frequent temperature changes of more than 50 K;
- Grade 5: temperature changes involving thermal shock (assessment not possible with this standard).

4.2.6 Mechanical loading

The effectiveness of a surface protection system may be impaired through exposure to mechanical loads or hydrostatic pressure during operation or assembly. The following grades shall be used to assess such loads.

- Grade 0: no loads, or hydrostatic pressure up to 0,05 bar;
- Grade 1: loads up to 0,2 N/mm² (e.g. pedestrian traffic, light transport, static loading);
- Grade 2: loads up to 1 N/mm² (e.g. vehicles with pneumatic tires, static loading);
- Grade 3: loads over 1 N/mm², for example
 - a) loads of 1 N/mm² to 7 N/mm² (e.g. vehicles with Vulkollan wheels, static loading) and
 - b) loads over 7 N/mm² (e.g. vehicles with polyamide wheels, static loading);
- Grade 4: impact loads, such as those resulting from setting down sharp-edged objects (e.g. barrels), and from scraping (e.g. shovel loaders);
- Grade 5: hydrostatic pressure from 0,05 bar to 0,5 bar;
- Grade 6: hydrostatic pressure greater than 0,5 bar.

NOTE The grades 2 to 4 are normally not applicable for linings without additional protection according to this standard.

4.2.7 Climate Influences

Climatic influences may affect the durability of a surface protection system, and shall be graded as follows.

- Grade 0: no climatic influences: the component is located inside a building and is not exposed to climatic influences.
- Grade 1: limited climatic influences: a roof protects the component, which is exposed to limited climatic influences.
- Grade 2: full climatic influences: the component is located outside, and is fully exposed to climatic influences.

4.2.8 Additional requirements

Additional requirements may derive from special applications, and are not fully covered by this standard. They may refer to water protection, explosion protection, fire behaviour, decontamination, health and safety (particularly in the case of foodstuffs and drinking water), non-slip surfaces and smoothness.

4.3 Load profile

The loads described in 4.2.2 to 4.2.8 shall be recorded, together with the grades selected, using the form reproduced in Annex A.

Tables B.1 to B.5 list frequently occurring load profiles and suitable surface protection systems.

5 Concepts

5.1 Lining materials

Lining materials, including materials used for attaching the lining to the substrate and for jointing, shall be capable of withstanding the chemical, mechanical and thermal loads included in the 'load profile' drawn up as specified in 4.2.3 to 4.2.8 and in Annex B.

Specific properties (e.g. compatibility between chemicals and the lining, resistance to mould and bacterial growth, resistance to ultraviolet or radioactive radiation, or electrostatic dissipation) may be required for special applications.

5.2 Lining materials manufacturer

Manufacturers of lining materials shall have suitable, functional manufacturing equipment and qualified personnel.

Lining materials shall be accompanied upon delivery by an inspection certificate 3.1 according to EN 10204.

5.3 Applicator

The applicator shall have suitable equipment and qualified personnel; this will ensure that the lining is properly applied in accordance with this standard.

6 Materials

6.1 Materials for bonded linings

6.1.1 Soft rubber

Soft rubber linings shall consist of single- or double-ply sheets of self-vulcanising, or partially or completely vulcanised soft rubber. Lining systems of soft rubber may be applied in multiple layers.

Table 2 lists commonly used rubbers and the maximum temperatures for which they are suitable.

Table 2 — Recommended maximum operating temperatures for soft rubbers

Symbol	Rubber type	Maximum temperature in °C
NR	Isoprene rubber (Natural rubber)	+ 80
CR	Chloroprene rubber	+ 80
IIR	Isobutene-isoprene rubber (Butyl rubber)	+ 100
BIIR	Bromo-isobutene-isoprene rubber (Bromobutyl rubber)	+ 100
CIIR	Chloro-isobutene-isoprene rubber (Chlorobutyl rubber)	+ 100
CSM	Chlorosulfonylpolyethylene	+ 80
NBR	Acrylonitrile-butadiene rubber (nitrile rubber)	+ 80

The operating temperatures for which the rubbers are suitable will depend on the type and duration of loading.

Table 3 specifies requirements for soft rubber sheeting.

Table 3 — Requirements for soft rubber sheeting

Sheeting type	Rubber type	Nominal thickness, in mm (testing as in EN ISO 2286)	Density in g/cm ³ (testing as in EN ISO 1183-1)	Shore A hardness (testing as in EN ISO 868)	Tear strength in N/mm ² (testing as in ISO 37)	Elongation at break, as a percentage
Vulcanised single-ply sheets	IIR, BIIR, CIIR CSM	2 to 5 2 to 5	1,10 to 1,30 1,20 to 1,70	50 to 65 55 to 70	≥ 4 ≥ 3	≥ 300 ≥ 300
Vulcanised double-ply sheets	IIR, BIIR, CIIR, CSM NBR	2 to 5 2 to 5	1,10 to 1,30 1,20 to 1,40	50 to 65 60 to 80	≥ 3 ≥ 4	≥ 300 ≥ 300
Partially vulcanised single-ply sheets ^a	CIIR and BIIR	2 to 5	1,10 to 1,30	50 to 65	≥ 3	≥ 300
Self-vulcanising single-ply sheets ^a	CIIR, BIIR NR CSM CR	2 to 5 2 to 5 2 to 5 2 to 5	1,10 to 1,30 1,10 to 1,40 1,20 to 1,50 1,40 to 1,70	50 to 65 50 to 65 55 to 70 55 to 70	≥ 4 ≥ 4 ≥ 4 ≥ 5	≥ 300 ≥ 400 ≥ 300 ≥ 300

^a Values refer to the rubber in its completely vulcanised state.

6.1.2 Thermoplastics

Thermoplastics sheets shall be of polyisobutylene (PIB) or plasticised poly(vinyl chloride) (PVC-P).

The operating temperatures for which these thermoplastics are suitable are given in Table 4.

The operating temperatures for which the thermoplastics are suitable will depend on the type and duration of loading.

Table 4 — Recommended maximum operating temperatures for thermoplastics

Symbol	Type of thermoplastic	Maximum temperature, in °C
PIB	Polyisobutylene	+ 80
PVC-P	Plasticised poly(vinyl chloride)	+ 65

Table 5 contains general requirements for thermoplastic sheeting.

Table 5 — Requirements for thermoplastics sheeting used in process plant

Type of thermoplastic	Nominal thickness, in mm (testing as in EN ISO 2286)	Tear strength, in N/mm ² (testing as in EN ISO 6721-2)	Elongation at break, as a percentage
PIB	1,5 to 3	> 3	> 350
PVC-P-BV (compatible with bitumen)	1,5 to 3	> 15	> 200
PVC-P-NB (incompatible with bitumen)	1,5 to 3	> 15	> 200

6.2 Materials for mechanically fixed linings

Table 6 lists thermoplastics commonly used for mechanically fixed linings and the temperature ranges for which they are suitable.

Table 6 — Recommended operating temperature ranges for thermoplastics used in mechanically fixed linings

Symbol	Type of thermoplastic	Temperature range, in °C
PVC-U	Non-plasticised poly(vinyl chloride)	– 5 to + 60
PE-HD	High density polyethylene	– 30 to + 80
PP	Polypropylene	– 5 to + 100
PVDF	Poly(vinylidene fluoride)	– 30 to + 140

The operating temperature ranges for which the thermoplastics are suitable will depend on the type and duration of loading.

Table 7 specifies requirements for materials used in mechanically fixed linings.

Table 7 — Requirements for thermoplastics used in mechanically fixed linings

Property	Unit	Testing as in	Requirements for			
			PVC-U	PE-HD (see EN ISO 14632)	PP (see EN ISO 15013)	PVDF
Nominal thickness	mm	EN ISO 2286	≥ 3	3 to 10	3 to 10	≥ 3
Density	g/cm ³	EN ISO 1183-1	Formulation- dependent	As specified for sheet groups 1 and 2 in EN ISO 14632	0,90 to 0,91	1,76 to 1,80
Melt-flow rate	g/(10 min)	EN ISO 1133	—	190/5: 0,3 to 1,5	190/5: 0,4 to 0,8	230/5: 1,6 to 6,2
Tensile strength at break (for PVC-U, tear strength)	N/mm ²	EN ISO 6721-2	≥ 55	As in EN ISO 14632	As in EN ISO 15013	≥ 50
Modulus of elasticity (tensile test)	N/mm ²	EN ISO 178	≥ 3 000			≥ 2 400
Notched bar impact strength	kJ/m ²	EN ISO 179	≥ 2			20
Deflection temperature	°C	EN ISO 75-1				142
Dimensional change after exposure to heat	%	-	Less than 5			Less than 2 (testing for 1 h at 150 °C)

As regards the fixing of the lining, the following requirements shall be met:

- The attachment of the fastener to the lining shall be sufficiently strong and free of residual stresses.
- The arrangement of attachments to the concrete substrate shall ensure that the lining is securely fixed without stress.

6.3 Materials for loose linings

6.3.1 Sheets

The materials described in 6.1 to 6.2 may be used for loose linings, depending on the load profile and application. Polyethylene copolymers and multi-layered sheeting may also be used.

Requirements shall be taken from Table 3, 5, 7 or 8, depending on the material selected.

Table 8 — Requirements for polyethylene sheeting used as loose lining

Type of material	Relevant standard	Nominal thickness, in mm (testing as in EN ISO 2286)	Tear strength, in N/mm ² (testing as in EN ISO 6721-2)	Elongation at break, as a percentage
PE-LD	EN ISO 14632 (by analogy)	≥ 2	> 10	> 600
PE copolymer		≥ 2	> 20	> 725

6.3.2 Pre-formed pieces

Pre-formed pieces shall be of the materials specified in 6.2 and shall meet the requirements of Table 7.

7 Application

7.1 Bonded linings

7.1.1 Rubber linings

7.1.1.1 Substrate preparation

The concrete surface shall be prepared in accordance with EN 14879-1. Pores, cavities and any uneven patches shall be filled or smoothed over using a polymer modified cement or a solvent-free epoxy resin mortar.

If spark testing will be carried out to check the lining's continuity, the concrete surface shall be fully covered with a conductive resin. Where a non-conductive material is used to level the surface, an electrically conductive primer shall be applied so that the spark testing can be performed.

7.1.1.2 Ambient conditions

The substrate temperature shall be at least + 5 °C and at least 3 °C above the dew point. Throughout the lining process, suitable measures shall be taken to ensure that the substrate temperature never falls below these values.

7.1.1.3 Lining process

Normally, a primer is to be applied to the substrate to improve adhesion. The primer shall be fully dried before the adhesive is applied.

To ensure adhesion over the entire surface, the adhesive should be applied to the substrate and the underside of the rubber sheet simultaneously.

After the required drying time (which will vary depending on the adhesive used), apply the rubber sheet to the substrate using a special roller or other appropriate tool, ensuring that adhesion occurs over the entire area.

7.1.1.4 Jointing

Jointing shall be carried out according to the manufacturer's instructions, taking the requirements of EN 14879-4 into account.

7.1.2 Lining with thermoplastics

7.1.2.1 Substrate preparation

The concrete surface shall be prepared in accordance with EN 14879-1. Pores, cavities and any uneven patches shall be filled or smoothed over using a polymer modified cement or a solvent-free epoxy resin mortar.

Once the substrate is fully covered with filler, it is normally made electrically conductive so that, later, the lining can be spark tested for continuity. Where a non-conductive material is used to level the surface, an electrically conductive primer shall be applied so that the spark testing can be performed.

7.1.2.2 Ambient conditions

See 7.1.1.2.

7.1.2.3 Lining process

Normally, a suitable primer is to be applied to the substrate to improve adhesion. The primer shall be fully dried before the adhesive is applied.

To ensure adhesion over the entire surface, a solvent-based contact adhesive shall be applied to the substrate and the underside of the thermoplastics sheet simultaneously. The adhesive selected shall be suitable for the thermoplastic material used.

After the required drying time (which will vary depending on the adhesive used), apply the thermoplastic sheet to the substrate using a special roller or other appropriate tool, ensuring that adhesion occurs over the entire area.

A hot-melt bitumen adhesive may be used where thermoplastics that are compatible with bitumen are laid on floor surfaces.

Under certain circumstances, some types of thermoplastic sheeting may be laid on a special emulsion adhesive.

7.1.2.4 Jointing

Depending on the type of sheeting used for the lining, the following welding methods may be used for jointing (the manufacturer's instructions shall be observed):

- Hot gas welding (as in DVS 2225-1);
- Heated wedge welding (as in DVS 2225-1);
- Diffusion bonding (a solvent welding procedure; as in DVS 2225-1).

The first two methods listed shall be performed by persons qualified in accordance with EN 13067 and carried out according to national guidelines, e. g. DVS 2225-1.

7.2 Mechanically fixed linings

7.2.1 Substrate preparation

It may be necessary to bridge cracks in the substrate that are wider than those described in EN 14879-1. In this case, any permanent deformation shall be no more than 3 % of the spacing of the anchor elements to prevent stress cracking of the lining. If, within the area concerned, there are any weld seams, the maximal permissible deformation reduces to 2 % of the spacing of the anchors from which the width of the weld seam has to be deducted.

For mechanically fixed linings moisture affecting from the rear side is admissible. However, if the lining is subjected to hydrostatic pressure on its rear side, e.g. in the event of ground water diffusing through the concrete, evidence of long-term anchoring strength and resistance to bulging between the anchors is to be recorded by performing a test according to 10.2.6.2.2, taking the operating conditions into account.