BRITISH STANDARD

BS 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

The European Standard EN 14879-3:2006 has the status of a British Standard

ICS 25.220.60

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National foreword

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14879-3

December 2006

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English Version

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

Systèmes de revêtements organiques de peinture et autres revêtements rapportés pour la protection des appareils et installations industriels contre la corrosion par des milieux agressifs - Partie 3: Revêtements sur béton

Beschichtungen und Auskleidungen aus organischen Werkstoffen zum Schutz von industriellen Anlagen gegen Korrosion durch aggressive Medien - Teil 3: Beschichtungen für Bauteile aus Beton

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Foreword

This document (EN 14879-3:2006) has been prepared by 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of an identical text or by endorsement, at the latest by June 2007, and conflicting national standards shall be withdrawn at the latest by June 2007.

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, 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.

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1 Scope

This European Standard specifies the requirements for and methods of testing of organic coatings 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 does not cover coatings as in EN ISO 12944-1, but it does apply to coatings 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 properties.

The different coating systems are:

a) impregnation, seals, thin coatings (applied by brushing, spraying or rolling);

b) high-build coatings (applied by brushing, spraying, rolling, trowelling or pouring (self-levelling));

c) laminate coatings;

d) resinous screed;

e) mastic asphalt screed with a waterproofing layer;

f) combinations of the above coatings.

Table 1 shows the coating methods to be employed for various types of concrete members.

Handling of aggressive or water pollutant materials is understood to include:

1) storage;

2) filling;

3) loading and unloading;

4) manufacture;

5) treatment;

6) use.

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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 59, *Glass reinforced plastics — Measurement of hardness by means of a Barcol impressor*

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 12350-1:1999, *Testing fresh concrete — Part 1: Sampling*

EN 12620, *Aggregates for concrete*

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

EN 13687-3, *Products and systems for the protection and repair of concrete structures — Test methods — Determination of thermal compatibility — Part 3: Thermal cycling without de-icing salt impact*

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*

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

EN ISO 291, *Plastics — Standard atmospheres for conditioning and testing (ISO 291:2005)*

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

EN ISO 2431, *Paints and varnishes — Determination of flow time by use of flow cups (ISO 2431:1993, including Technical Corrigendum 1:1994)*

EN ISO 2811-1, *Paints and varnishes — Determination of density — Part 1: Pyknometer method (ISO 2811-1:1997)*

EN ISO 2811-2, *Paints and varnishes — Determination of density — Part 2: Immersed body (plummet) method (ISO 2811-2:1997)*

EN ISO 2811-3, *Paints and varnishes — Determination of density — Part 3: Oscillation method (ISO 2811-3:1997)*

EN ISO 2815, *Paints and varnishes — Buchholz indentation test (ISO 2815:2003)*

EN ISO 3251, *Paint, varnishes and plastics — Determination of non-volatile-matter content (ISO 3251:2003)*

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EN ISO 4624, *Paints and varnishes — Pull-off test for adhesion (ISO 4624:2002)*

EN ISO 4625-1, *Binders for paints and varnishes — Determination of softening point — Part 1: Ring-and-ball method (ISO 4625-1:2004)*

EN ISO 6272-1, *Paints and varnishes — Rapid-deformation (impact resistance) tests — Part 1: Falling-weight test, large-area indenter (ISO 6272-1:2002)*

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

ISO 2559, *Textile glass — Mats (made from chopped or continuous strands) — Designation and basis for specifications*

ISO 8130 (all parts), *Coating powders*

IEC 60093:1993, *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 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 container

3.2
wall
vertical or almost vertical limiting surface, such as the wall of a production and storage area, and the wall of a container

3.3
ceiling (top)
upper limiting surface, such as the ceiling of a production and storage area, and the top of a container

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

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3.8
secondary containment
leaktight basin or area designed to collect any water pollutants leaking in an emergency

3.9
container
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, tank.

3.10
contract partners
coating material manufacturer, component manufacturer, person(s) responsible for applying the coating, and client ordering the coated component(s)

4 Surface protection systems and selection criteria

4.1 Surface protection types and system

Protective coatings for various types of concrete structures are listed in Table 1.

Table 1 — Protective coatings for various types of concrete structures

Protective coating	Coating thickness		Concrete structures according to EN 14879-1								
	Nominal value mm	Limit deviations %	Floors	Walls	Ceilings	Gutters	Channels	Pipes	Sumps	Secondary containment	Tanks
Brushed, sprayed, rolled on	≤ 1	± 50	x	x	x	—	—	x	—	x	—
Brushed, sprayed, rolled on	> 1	+ 30 – 20	x	x	x	—	—	x	—	x	—
Trowelled	2 up to 8	+ 50 – 30	x	x	x	x	x	x	x	x	x
Self levelled	2 up to 3	+ 30 – 20	x	—	—	x	—	—	—	—	—
Laminate coating	2 up to 6	+ 50 – 30	x	x	—	x	x	x	x	x	x
Resinous screed	≥ 5	+ 30 – 20	x	—	—	x	—	—	—	x[a]	—
Mastic asphalt screed	≥ 35	+ 20 – 10	x	—	—	x	—	—	—	x[a]	—
Combined coatings	≥ 3	+ 50 – 30	x	x	—	x	x	—	x	x	x
X Means commonly used											
[a] Not to be applied on vertical surfaces.											

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4.2 Selection criteria

4.2.1 General

The stress to be encountered by a protective coating shall be known before the requirements for it can be specified. For the scope or this European 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 Exposing media

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

These substances shall be designated using the Geneva nomenclature, IUPAC[1)] nomenclature or CAS[2)] 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 2 lists commonly used chemicals which may have the properties mentioned above.

1) International Union of Pure and Applied Chemistry.

2) Chemical Abstract Service.

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Table 2 — Classification of frequently (commonly) used chemicals

Type of chemical	Examples	
I. Inorganic chemicals		
Inorganic, non-oxidizing acids	HCl H_2SO_4 H_3PO_4	Hydrochloric acid Sulfuric acid, up to 70 % Phosphoric acid
Inorganic, oxidizing acids	HNO_3 H_2SO_4 CrO_3, H_2CrO_4 $HClO_3$	Nitric acid Sulfuric acid, over 70 % Chromic acid Chloric acid
Inorganic acids, dissolving SiO_2	HF H_2SiF_6 HBF_4	Hydrofluoric acid Hexafluorosilicic acid (containing HF) Tetrafluoroboric acid (containing HF)
Salts	$NaCl$ $FeSO_4$ Na_2CO_3	Sodium chloride Iron(II) sulfate Sodium carbonate
Bases	$NaOH$ KOH CaO, $Ca(OH)_2$ NH_4OH	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_3COOH $CH_2ClCOOH$ $(COOH)_2$ $CH_3CHOHCOOH$	Formic acid Acetic acid Chloroacetic acid Oxalic acid Lactic acid
Aliphatic hydrocarbons	C_6H_{14} C_8H_{18}	Hexane Octane
Aromatic hydrocarbons	C_6H_6 $C_6H_5CH_3$ $C_6H_4(CH_3)_2$	Benzene Toluene Xylene
Alcohols	CH_3OH C_2H_5OH C_4H_9OH CH_2OHCH_2OH	Methanol Ethanol Butanol Ethanediol
Aldehydes, ketones, esters	CH_2O CH_3COCH_3 $C_2H_5COCH_3$ $CH_3COOC_2H_5$	Formaldehyde Acetone Methyl ethyl ketone (2-butanone) Ethyl acetate
Aliphatic halogenated hydrocarbons	CH_2Cl_2 C_2HCl_3 $C_2Cl_3F_3$	Dichloromethane Trichloroethylene Trichlorotrifluoroethane
Aromatic halogenated hydrocarbons	C_6H_5Cl $ClC_6H_4CF_3$	Chlorobenzene Chlorobenzotrifluoride
Aliphatic amines and pyridine	CH_3NH_2 $(C_2H_5)_3N$ $NH_2C_2H_4NH_2$	Methylamine Triethylamine Ethylene diamine
Aromatic amines	$C_6H_5NH_2$ C_5H_5N	Aniline Pyridine
Phenols	C_6H_5OH $CH_3C_6H_4OH$	Phenol Cresol
Fats, oils		Vegetable and animal fats and oils

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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, secondary containment;

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

The thermal load caused by medium effect or other sources of heat affects the effectiveness of a surface protection system in the following way:

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 caused by increased/decreased medium temperatures;

b) temperature changes as otherwise constantly heated or cooled surfaces, resulting from operational circumstances, 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.

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The extent, direction, 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 up to 50 K;

Grade 2: infrequent temperature changes of more than 50 K;

Grade 3: frequent temperature changes up to 50 K;

Grade 4: frequent temperature changes of more than 50 K.

Grade 5: temperature changes involving thermal shock.

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/mm^2 (e.g. pedestrian traffic, light transport, static loading);

Grade 2: loads up to 1 N/mm^2 (e.g. vehicles with pneumatic tires, static loading);

Grade 3: loads over 1 N/mm^2, for example

a) loads of 1 N/mm^2 to 7 N/mm^2 (e.g. vehicles with Vulkollan wheels, static loading);

b) loads over 7 N/mm^2 (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.

4.2.7 Weather factors

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.

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4.2.8 Additional requirements

Additional requirements may derive from special applications, and are not fully covered by this European 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. The form reproduced in Annex A should be used.

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

5 Coatings

5.1 Concrete structure and surface appearance

The concrete surface to be coated shall comply with requirements in EN 14879-1 and be suitable for the coating material and the coating method employed.

Concrete parts that are to be coated should be designed without movement joints as the coating generally cannot bridge the joints permanently. If movement joints cannot be avoided, special constructions are required. Connections, penetrations, coating endings and transitions are special constructions, too.

5.2 Coating materials

Coating materials shall be selected which ensure that the coating will meet the requirements of this European Standard and they shall be resistant to the anticipated effects of chemical, mechanical and thermal stresses.

For the purposes of this European Standard, coating materials are cold-curing compounds that are brushed, trowelled, sprayed, rolled or floated on to the surface of concrete parts in one or more layers to form a covering film (coating). Coating materials may be solvent-containing as well as solvent free.

The manufacturer shall provide an adequate description of the material as regards its characteristics, processing and container marking, including, for instance, the items listed in Annex H.

5.3 Coating system

5.3.1 General

A coating system consists of one or more coats or layers. Possible types and build-ups are listed in Table 3. In order to achieve particular protective features, these coating systems may be combined.

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Table 3 — Coating system build-up

Brushed, sprayed or rolled coatings	Trowelled or Self-levelling coatings	Laminate coating	Resinous screed	Mastic asphalt screed
—	—	(Sealant)	—	—
—	(Sealant)	Top coat	—	Mastic asphalt layer
Top coat	Trowelled or self-levelling coatings	Laminate layer	(Sealant)	Waterproofing layer
(Intermediate layer)	(Intermediate layer)	(Intermediate layer)	Screed	(Intermediate layer)
(Primer)	(Primer)	(Primer)	(Primer)	(Primer)
Substrate				
Depending on the condition of the substrate and the type of coating system selected, the coatings indicated in brackets may be dispensed with. Because of the wide variety of possibilities, combinations of these coatings are not included in this table.				

5.3.2 Properties of coatings

The properties of coatings shall be subject to agreement and Annex A may serve as form.

Guideline values for the thickness of individual coats or layers are given in Table 4. The table gives approximate values. The thickness value of each coat shall be in accordance with the manufacturer's instructions.

Coats or layers shall be compatible with each other and adhere properly.

In order to improve the non-skid property of the coating, fine granules (sand or other fine-grained aggregates) may be spread on the fresh sealing coat, and a further sealing coat subsequently applied.

If dissipation capability of electrostatic charges is required, at least the upper coat shall be conductive.

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Table 4 — Coating thickness (approximate values, the thickness value of each coating shall be in accordance with the manufacturer's instructions)

Type of coat or layer	Coating method				
—	Brushed, sprayed or rolled	Trowelled or self-levelling	Laminate coating	Resinous screed	Mastic asphalt screed
—	Coating thickness, in mm				
Primer	≥ 0,05	≥ 0,05	≥ 0,05	≥ 0,05	≥ 0,05
Intermediate layer	≈ 1,0	≈ 1,0	≈ 1,0	—	≤ 5
Waterproofing layer	—	—	—	—	≥ 4
Trowelled coat	—	2,0 up to 8,0	—	—	—
Self-levelling coat	—	2,0 up to 3,0	—	—	—
Laminate layer	—	—	1,5 up to 4,0	—	—
Screed	—	—	—	≥ 5	≥ 30
Top coat	0,5 up to 2,0	—	0,5 up to 1,0	—	—
Sealant	—	≥ 0,1	≥ 0,1	≥ 0,1	—

5.3.3 Impregnating agents

Impregnating agents are low-viscosity, easily absorbed resins or resin solutions used to saturate the pores in screed or concrete substrates. They are designed to harden the floors of industrial buildings, increase their wear resistance and limit the effects of abrasion, such as dust build-up.

5.3.4 Primers

Primers are designed to seal the pores of the concrete substrate and provide a key for the coating. They consist of low-viscosity substances, which may be solvent-borne, and may be based on a different binder than that used in subsequent coats.

Care should be taken that solvents contained in the priming coat have fully evaporated before the subsequent coating is applied.

Depending on the coating system, the priming coat may be applied in one or more layers, quartz sand being spread over the fresh coating to form a key for the next coat or layer.

If an intermediate layer is applied to the entire surface, a priming coat can be omitted.

Bitumen first coats or heat resistant epoxy resins are used as primers for mastic asphalt screed.

5.3.5 Intermediate layers

Intermediate layers are used to fill and to even out inevitable surface irregularities (flash, cavities and pinholes).

In case of furane and/or phenol formaldehyde resin coatings, the fully cured intermediate layer shall inhibit the chemical reaction between the concrete substrate and the acid hardener. Intermediate layers may be based on a different resin than that used for subsequent coats.

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To facilitate continuity testing of subsequent coats, intermediate layers may be formulated conductive.

They may be substituted for by a solvent-free priming coat with filler or thixotropic additives or can be omitted.

5.3.6 Trowelled coatings

Trowelled and self-levelling coatings shall be continuous and show a smooth surface. Special care shall be taken to de-aerate the coating properly. Flaky or fibrous filler particles contained in the coating shall be embedded and orientated using special techniques. Trowelled coatings are applied in one or more layers.

Depending on the binder used, the consistence of trowelled coatings has different mechanical properties varying from hard and brittle to elastic.

Reinforcing materials such as textile glass mats may be inserted at critical points of concrete structures, such as junctions or edges.

5.3.7 Self-levelling coatings

In order to achieve a uniform thickness of trowelled and/or self-levelling coatings, particular attention shall be paid to the flatness of the substrate. The degree of viscosity of the coating material shall be selected to suit the slope of the substrate.

Self-levelling coatings are applied in one or more layers by pouring and levelling the coating material.

Depending on the binder used, self-levelling coatings have different mechanical properties varying from hard and brittle to elastic.

5.3.8 Laminate layer

A laminate layer is provided by applying one or more plies of reinforcing material that are thoroughly soaked with one of the binders listed in Table 5. The thickness of individual layers depends on the type of reinforcing material involved and the total thickness of the laminate layer is determined by the number and thickness of the individual coats.

Generally, the same type of binder is used for all the coats of a laminate layer.

Reinforcing materials shall be inserted over the entire surface in a previously applied resin layer or onto the wet primer or intermediate layer before curing using an appropriate roller.

Next, the laminate layer shall be soaked out with the binder and shall carefully be de-aerated.

Adjacent pieces of reinforcement (e.g. glass mats) shall overlap by at least 50 mm and layers shall be staggered.

Fillets and edges shall carefully be coated and overlapping shall be avoided in these areas.

5.3.9 Top coat

Top coats shall be used to even out and cover the rough surface of laminate layers as well as protruding fibres.

The top coat consists of one or more layers that are built up using the same type of binder employed for the laminate layer, or a higher quality binder of the same binder type.

The top coat of laminate coatings may include a fleece that is rolled into the freshly applied upper coat of the reinforcement layer or into an additional resin layer applied onto the hardened laminate layer and subsequently soaked with the resin.

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In cases where a thin top coat is directly applied to the primer, it is characterised as a sealant.

5.3.10 Waterproofing layer

In mastic asphalt screed with waterproofing layers, bitumen sheeting (minimum thickness 4 mm) can be used with metallic backing or polymeric torch-on membranes with an eccentric inner layer. They shall be welded holohedral on to the primed concrete surface. Lap joints of the metal-clad bitumen sheeting shall be covered with strips prior to the application of the mastic asphalt layer.

5.3.11 Screed

5.3.11.1 General

For the purposes of this European Standard, screed is a highly compact material that is applied in cases where the concrete members are to be exposed both to chemicals and mechanical loads.

Concerning physical characteristics of screed see EN 13813.

5.3.11.2 Resinous screed

Depending on the type of binder used, resinous screed may contain quartz mixtures or appropriate granular composites. The mixing of the components should take place in a compulsory mixer. The mixture shall be applied on the primed substrate, in case of EP mixtures preferable in to the still wet primer. Depending on its consistency, resinous screed shall be manually or mechanically compacted after having been laid. It generally has a rough surface.

Screed with high filler content, for which continuity may not be assumed, shall be sealed with one or more sealant coats.

5.3.11.3 Mastic asphalt screed

The hardness class, the grading of the aggregates and the thickness of mastic asphalt screed should be selected as a function of anticipated loads. Depending on the expected wear, mastic asphalt screed shall be applied in one or more layers.

The hot delivered mastic asphalt shall be applied on the waterproofing layer. After application mastic asphalt screeds do not need any compression. To improve the non-skid property of the surface, grit or chipping with (1 mm to 3 mm) or split (2 mm to 5 mm) shall be strewed on the still hot screed surface and slightly pressed into the asphalt.

5.3.12 Sealant

The sealant is designed to provide the coating a tight surface and usually contains the same type of binder as that used for the previous layer. Sealant coats shall provide special surface properties like dissipation of electrostatic charges, tightness, colouring or smoothness to the coating.

In order to improve the non-skid property of the sealing coat, fine granules (sand or other fine-grained aggregates) may be sprayed on the fresh top coat. A further sealant coat can be necessary.

5.4 Coating system components

5.4.1 General

Coating components are the individual parts of a coating system. These include binders, fillers, reinforcing materials and processing aids.

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5.4.2 Binders

Binders are the organic basis of the coating materials and they consist of reaction resins or asphalt.

The former being a combination of resin, a hardener and, where appropriate, an accelerator.

The binders listed in Table 5 or combinations thereof, are the ones most commonly used.

In compliance with 5.2, the manufacturer of the coating materials shall provide information describing the compatibility of the binders in the individual layers with various types of coats or layers.

Table 5 — Binders

Coating method	Binders [a]							
	EP	UP	VE	PUR	PMMA	PF	FU	Bitumen
Brushed, sprayed or rolled	x	—	x	x	x	—	—	—
Trowelled or self-levelled	x	x	x	x	x	x	x	—
Laminated coatings	x	x	x	x	—	x	x	—
Resinous screed	x	x	x	x	x	—	—	—
Mastic asphalt screed	—	—	—	—	—	—	—	x

[a] EP epoxy resin
UP unsaturated polyester resin
PUR polyurethane resin
PMMA methacrylic resin
PF phenol formaldehyde resin
FU furane resin
VE vinyl ester resin

5.4.3 Fillers and aggregates

Fillers and aggregates are used to influence the chemical and/or physical properties of the coating system.

Fillers shall be suited for the intended purpose and the type of binder and shall be inert to the range of application.

Fillers may consist of colloidal silicas (silicon dioxide), sand, grit, barite, carbon black, graphite, carbon fibres etc. The particle size or fibre length shall be selected in accordance with the coating method used.

The aggregates used in mastic asphalt screed may consist of gravel, grit, sand or rock flour.

5.4.4 Reinforcing materials

Reinforcing materials are used in laminate coatings and shall be inert to the intended uses and to the other coating materials. They shall have a low area weight combined with a high capacity to absorb the binder. Reinforcing materials shall be chemically inert in regard to the range of application. Size, finish and binder used in reinforcing materials shall be compatible with the type of binder used in the coating.

The manufacturer shall describe reinforcing materials in terms of their composition and mass per unit area.

The following materials may be used in reinforcement layers:

— textile glass mats as in ISO 2559;

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— woven glass fabric as in ISO 2559;

— E-CR or C type glass fibres according to ISO 2559;

— carbon fibres;

— synthetic fibres or synthetic fibre surfacing mats;

in top coats:

— fleece mats with C or E-CR type glass fibres according to ISO 2559;

— carbon fibres or synthetic fibre fleece mats;

— carbon fibres;

— synthetic fibres.

5.4.5 Processing aids

Processing aids are additives, such as pigments or thixotropic additives that may influence the rheological properties of resins.

Processing aids shall not impair the curing time or the chemical stability of the coating.

5.5 Reinforcing materials for laminate layers

Textile glass mats shall comply with the requirements specified in ISO 2559 and normally have a mass per unit area of 150 g/m^2 to 450 g/m^2. Woven glass fabric shall comply with the requirements specified in ISO 2559 and normally have a mass per unit area of 80 g/m^2 to 900 g/m^2.

5.6 Reinforcing materials for top coats

The fleece selected should contain a binder which is soluble in the binder of the coating. It should have a mass per unit area of 20 g/m^2 to 40 g/m^2 when made of carbon fibres or synthetic fibres, and of 20 g/m^2 to 50 g/m^2 when made of C or E-CR type glass fibres.

5.7 Coatings

The coatings according to this European Standard shall be tight and chemically resistant. The scope of testing and test conditions shall be according to Clause 8.

Prior to commissioning waiting times recommended by the manufacturer of the coating materials shall be observed. Guidance values are given in Table 6.

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Table 6 — Approximate curing times

Type of coating	Binder [a]							
	EP	UP	VE	PUR	PMMA	PF	FU	Bitumen
Brushed, sprayed or rolled	Approximate waiting times (in days) [b]							
thin coating	3	3	3	3	0,5	—	—	—
thick coating	7	5	5	5	0,5	—	—	—
Trowelled or self-levelling coating	7	5	5	5	0,5	7	7	—
Laminate coating	7	5	5	5	—	7	7	—
Resinous screed	7	5	5	5	0,5	—	—	—
Mastic asphalt screed	—	—	—	—	—	—	—	0,5

[a] For key to letter symbols, see Table 5.

[b] The waiting times apply to temperatures of about 20 °C.

5.8 Safety measures for storage, processing and waste disposal

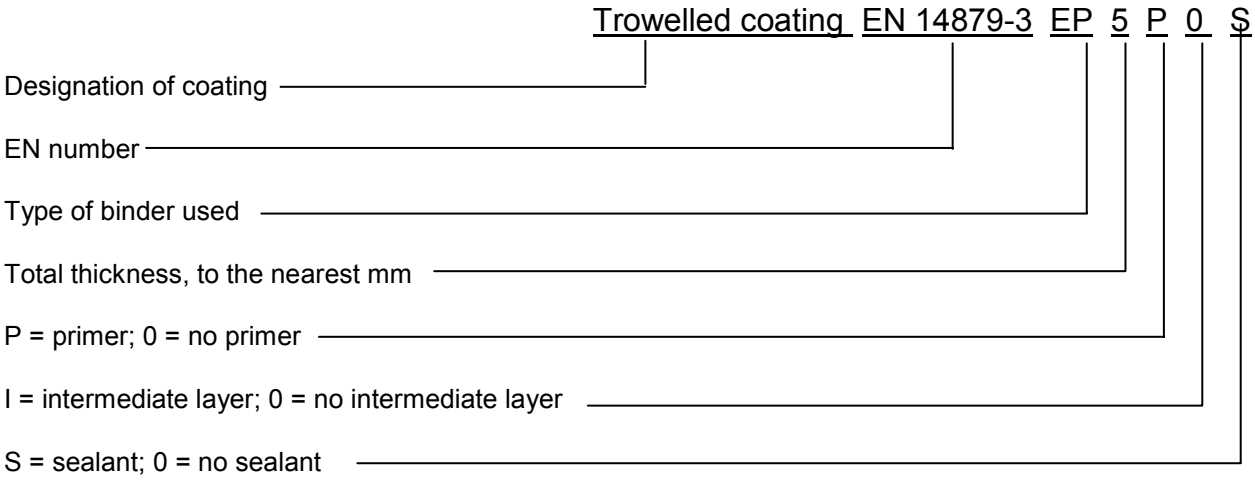
The manufacturer's instructions and the international and/or national regulations on dangerous substances and materials shall be observed with regard to the storage and processing of materials and their disposal.

6 Designations

Depending on the coating system selected, the primer (P), the intermediate layer (I), the top coat (T) or the sealant (S) may be omitted, in which case a zero shall be substituted for the symbol denoting the layer omitted.

EXAMPLES

a) The designation of a trowelled coating of a total thickness of 5 mm, based on an epoxy resin binder (EP), including a primer (P), no intermediate layer (I) and a sealant (S) reads:



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b) The designation of self-levelling coating based on polyurethane binder (PUR), with a total thickness of 2 mm, including a primer (P), without sealant reads:

Self-levelling coating EN 14879-3 PUR 2 P 0

c) The designation of a mastic asphalt screed of a total thickness of 35 mm, including a primer (P), an intermediate layer (I) and a waterproofing layer (W) reads:

Mastic asphalt screed EN 14879-3 35 P I W

d) The designation of an epoxy resin screed (EP) of a total thickness of 15 mm, including a primer (P), an intermediate layer (I) and a sealant (S) reads:

Screed EN 14879-3 EP 15 P I S

e) The designation of a coating applied by brushing, of a total thickness of 1,5 mm, based on a epoxy resin (EP), including a primer (P), an intermediate layer (I) and a top coat (T) reads:

Brushed coating EN 14879-3 EP 1,5 P I T

f) The designation of a laminate coating of a total thickness of 4 mm, based on a vinyl ester (VE) resin binder, including a primer (P), an intermediate layer (I), a reinforced layer (R) with 2 glass fibre mats, a top coat (T) and a sealant (S) reads:

Laminate coating EN 14879-3 VE 4 P I R 2 T S

g) The designations of combined coatings are based on those of the individual coatings incorporated.

EXAMPLE The designation of a self-levelling coating that is topped with a laminate coating reads:

Self-levelling coating EN 14879-3 PUR 2 P 0

with laminate coating EN 14879-3 FU 4 0 I R 2 T 0

7 Testing

7.1 General

The type and scope of testing and the test documentation required shall be determined on the basis of case-by-case agreements specifying for example:

a) requirements;

b) any deviations from requirements;

c) tests to be carried out;

d) the test equipment required;

e) the time of testing;

f) the ambient conditions.

7.2 Suitability testing

Suitability testing shall be carried out according to Clause 8.

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7.3 Receiving inspection of coating materials

7.3.1 General

Upon receiving the constituents of coating materials, the purchaser shall check them in compliance with 7.3.2. Random samples may be tested as specified in 7.3.3 to 7.3.5. In particular cases, 7.3.6 and 7.3.7, or further tests agreed upon, may apply.

7.3.2 Marking

The information given on the container or packaging shall be compared with the order and delivery documents.

7.3.3 Viscosity

Depending on the viscosity of coating components, the flow time shall be determined by using an EN ISO 2431 cup. Viscosity may also be determined using a rotational viscometer at defined velocity gradient in accordance with EN ISO 3219.

7.3.4 Density

The density of liquid constituents shall be determined in accordance with EN ISO 2811-1, EN ISO 2811-2 and EN ISO 2811-3, that of powder constituents in accordance with ISO 8130.

7.3.5 Colour

The colouring of the coating material shall be established by comparison with sample colours.

7.3.6 Non-volatile matter content

The non-volatile matter content shall be determined as described in EN ISO 3251, the time and temperature of testing being subject to agreement.

7.3.7 Binders

Infrared spectroscopy of fresh binder or of a dried binder film by using EN 1767 (or, if necessary, IR pyrolysis) may be helpful in identifying the type of binder of coating material supplied.

7.4 Tests during application of coating

7.4.1 General

The purpose of testing during the application is to control the compliance of the specification defined for the plant part and the application of the coating. These tests may include testing as described in 7.4.2 to 7.4.5. In addition to this, during application work samples may be prepared and tested. Subject to agreement, a test report covering the results shall be drawn up.

7.4.2 Suitability of concrete surface

The applicator of the coating shall control that the surface of concrete parts has been prepared in compliance with EN 14879-1.

7.4.3 Ambient conditions

It is necessary to control and to assure that the required ambient conditions are maintained from the start of the surface preparation until the completion of the waiting or reaction time.

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7.4.4 Coating process

The applicator of the coating shall check the compliance of the specified coating procedure including mixing procedure, application time and consumption figures in accordance to the manufacture's specification.

7.4.5 Individual layer thickness

The thickness of individual coats may be checked using the method described in EN ISO 2808, where applicable.

7.5 Acceptance testing

7.5.1 General

According to previously established criteria, the acceptance inspection shall be carried out together by both the applicator of the coating and the customer, or his representative (e.g. the inspection body), and an inspection report is to be drawn up.

If destructive testing has been agreed, these tests shall be performed on test panels prepared during the application process. Destructive testing is only to be carried out on the actual component in exceptional cases (subject to agreement).

The acceptance inspection of coatings may include testing as specified in 7.5.2 and 7.5.3.

7.5.2 Testing of coated component parts

7.5.2.1 Appearance

The surface appearance of the coating shall be checked by visual inspection. Blistering, cracks, inclusions, pinholes or other defects are not allowed.

7.5.2.2 Coating thickness

The coat/layer thickness is usually established on the basis of the amount of coating material used or by level measurement. For guideline values, see Table 4.

7.5.2.3 Continuity

The continuity of non-conductive coats with conductive primers and/or intermediate layers shall be tested in line with prEN 14879-4 using high voltage DC or pulsating DC equipment. The test voltage, voltage type and frequency as well as the sensitivity of the recording instrument shall be agreed upon. If the coating to be tested is conductive, continuity testing is not possible and possible alternative test methods shall be agreed upon.

Inclusions, impurities, pores, blisters, cracks or air inclusions which may influence the protection effect are not allowed.

7.5.2.4 Hardness

Hardness tests should preferably be carried out on test panels in accordance with 8.2.2.1.

7.5.2.5 Dissipation of electrostatic charges

The dissipation of electrostatic charges of coatings shall be determined in compliance with Annex G or EN 1081.

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7.5.3 Testing carried out on test panels

7.5.3.1 Adhesion

Adhesion testing shall be carried out as described in EN ISO 4624, the failure pattern being determined in compliance with EN ISO 4625-1. Subject to agreement, a cross-cut test as specified in EN ISO 2409 may be carried out on thin coatings.

7.5.3.2 Checking the coating system design

The coating system design may be checked by visual examination of a macro-examination specimen or if necessary by using a measuring magnifier.

7.6 Inspection report

An inspection report may be drawn up, for which the specimen form in Annex C may be used.

8 Suitability verification and tests

8.1 Requirements

8.1.1 General

Regarding coatings the subsequent requirements cover the whole scope of application outlined in Clause 4. In the concrete case of application, only certain requirements need to be met for the coating used depending on the loading of the component to be protected. An overview of the necessary certifications of suitability is given in the Annex D.

Requirements to which no verification is assigned for a certain surface protection system or a certain loading grade are omitted for this application.

Independently of this, the minimum requirements for the respective materials of the surface protection systems defined in this European Standard shall be met.

The usefulness of the stored or processed medium may not be impaired by the surface protection system. Special requirements for this are not part of this European Standard.

8.1.2 Fluid load, chemical resistance and tightness

The coating shall be tight and resistant to the expected fluid load under the respective loading grades according to Clause 4. The effect of the vapour phase and the effect of abrasive media (e.g. suspensions) and cleaning agents may have to be taken into account.

No verification is required for loading grade 1. For loading grade 2, verification is only required for very chemically aggressive media such as concentrated acids, organic solvents, oxidation agents.

The testing and evaluation of the test results shall be performed according to 8.2.2.2.

8.1.3 Thermal loads

The coating shall withstand the expected thermal load from influence of the media or other sources of heat (e.g. heat radiation).

The testing and evaluation of the test results shall take place according to 8.2.2.3.

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8.1.4 Temperature change loads

The coating shall be resistant to the expected weather-related load and temperature change load caused by exposure to the medium, operating conditions or cleaning processes.

The testing and evaluation of the test results shall be performed according to 8.2.2.4.

8.1.5 Mechanical loads

The coating shall be resistant to regularly expected mechanical loads according to the loading grades according to Clause 4.

Extraordinary loads such as dragging forks on forklift trucks, direct contact by vehicles with steel wheels (steel rollers) are not covered by the requirements specified here.

No particular tests are necessary for impregnation and sealant. Thin coatings are suitable for expected mechanical loads of loading grade 3a. The substrate shall be planned and designed for the respective mechanical load.

Resinous screeds, homogeneous thick coatings with a minimum hardness of 50 Shore D according to EN ISO 868 and laminate coatings without ductile intermediate layer are suitable for loading grade 3a without testing. A special proof of suitability has to be provided for all other coatings of this grade.

Practical experience shows that resinous screeds are suitable for load grade 3b without testing. A special proof of suitability is necessary for load grade 3b for thin coatings, thick coatings and laminate coatings.

Mastic asphalt screeds according to the classification in EN 13318 can be used for load grades 1, 2 and 3a and 3b without testing. See Table 7.

Table 7 — Mechanical loading of mastic asphalt screeds

<table>
<tr><th rowspan="3">Load grade according to Clause 4</th><th rowspan="3">Nominal thickness</th><th rowspan="3">Max. grain of additive</th><th colspan="3">Area of application according to EN 13813</th></tr>
<tr><th>Heated rooms</th><th>Unheated rooms and outdoors</th><th>Cooling rooms</th></tr>
<tr><th>mm</th><th>mm</th><th colspan="3">Hardness grade</th></tr>
<tr><td>3b</td><td>≥ 35
≥ 30</td><td>11
8</td><td rowspan="3">IC 10
or
IC 15</td><td rowspan="3">IC 15
or
IC 40</td><td rowspan="3">IC 40
or
IC 100</td></tr>
<tr><td>2 and 3a</td><td>≥ 30
≥ 25</td><td>8
5</td></tr>
<tr><td>1</td><td>≥ 30
≥ 25</td><td>8
5</td></tr>
</table>

8.1.6 Anti-slip properties

If industrial safety regulations demand anti-slip protection, this can be proven for example according to DIN 51130.

8.1.7 Crack bridging

To achieve the protection goals according to Clause 4, the coating shall be able to bridge cracks in the concrete substrate permanently under exposure to liquid of load grades 3, 5 and 6 after hardening; see EN 14879-1 for groups of crack widths.

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The test should be conducted according to 8.2.2.6.

In mastic asphalt screeds, the crack bridging capability up to 0,5 mm is considered given when a bitumen sheeting is used under the mastic asphalt screed.

8.1.8 Adhesion strength

The coating shall be firmly bonded with the substrate and in the case of multi-layered structures in itself.

Testing and evaluation of the test results should take place according to 8.2.2.7.

In the case of mastic asphalt screeds, the adhesion strength is considered given when a sheeting is used under the mastic asphalt screed.

The test is omitted for impregnation.

8.1.9 Ageing behaviour

The coating shall be resistant to ageing processes caused by heat and possibly by weather-related temperature change loads.

The testing and evaluation of the test results shall be performed according to 8.2.2.8.1 and possibly according to 8.2.2.8.2.

The resistance to ageing is proven with the test according to 8.2.2.2.4 for grade 6 of the liquid exposure.

Testing of the weathering behaviour according to 8.2.2.9 replaces the test according to 8.2.2.8.

8.1.10 Weathering behaviour

When using outdoors, the coating shall be resistant to weather influences.

With the test according to 8.2.2.8.2 satisfaction of the requirements of grade 1 according to 4.2.7 shall be proven.

With the test according to 8.2.2.9 satisfaction of the requirements of grade 2 according to 4.2.7 shall be proven.

The resistance to weathering of mastic asphalt screeds is considered given based on existing experience.

8.1.11 Concrete compatibility

The coating shall be able to withstand the expected alkaline load by the cemented substrate and shall not chemically attack it.

This requirement is covered by the adhesion strength tests according to 8.2.2.7 or the ageing behaviour according to 8.2.2.8 or the weathering behaviour according to 8.2.2.9.

8.1.12 Behaviour in cleaning and neutralisation processes

The coating shall be resistant to expected cleaning and neutralisation processes (pH change).

The selection of the cleaning procedure shall be agreed between the manufacturer and the user. As a rule, proof of experience is the basis for assessment. Tests may have to be made on the loaded component according to 8.2.2.10.

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8.1.13 Behaviour against micro-organisms

Coating used in industrial sewage plants shall be resistant to the effect of micro-organisms.

Coatings shall be resistant to the effects of micro-organisms when using in areas without special loading (only normal soiling, moisture).

Special tests shall be agreed for expected special loads by micro-organisms, e.g. in industrial sewage plants, bioreactors or composting plants.

8.1.14 Electrostatic dissipating capability

In plants handling flammable, highly flammable or extreme flammable liquids the coatings shall not lead to ignition hazards as a result of electrostatic charges.

The requirements are considered met when

— the dissipating resistance of the coating at every point does not exceed $1 \times 10^8\ \Omega$ or

— the volume resistance does not exceed $1 \times 10^8\ \Omega$ and the insulation resistance (surface resistance) does not exceed $1 \times 10^9\ \Omega$.

The test is conducted according to 8.2.2.11.

If resistance measurements cannot be made or the dissipation of electrical charges can be ensured by other comparable measures, the meeting of these requirements shall be proven.

Other requirements from other areas, e.g. explosion protection or ESD applications are not an object of this European Standard.

8.1.15 Behaviour in fire

The requirements for the behaviour in fire shall be defined plant-specifically according to industrial safety and building legislation requirements.

Coatings for secondary containments shall meet at least the requirements of building material grade E-d2 according to EN 13501-1.

8.2 Tests

8.2.1 General

The following tests apply exclusively to the suitability of the coating systems for the area of application according to Clause 4.

Verification of suitability can be given by

a) laboratory examinations by a testing laboratory or

b) proof of facts established by experience of the owner or manufacturer or

c) a combination of both a) and b).

For the verification of suitability according to a), the specimens with the respective material for the laboratory test shall be prepared in agreement with the testing laboratory. The identity of the materials shall be adequately proven to the testing laboratory by specification of physical-chemical parameters. Individual proof can also be given to the testing laboratory by certified reference objects.

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The following can be considered as proof of experience according to b):

— laboratory examinations with recorded and reproducible results;

— reference objects, which are proven executed with the coating system the suitability of which is to be verified and which have been conditioned sufficiently long under loads which are typical for the plant;

— resistance lists the basic conditions of which are known and can be proven by laboratory tests.

An overview of the necessary suitability verification is given in Annex D. Reference is made to Annex E with regard to the material/media combinations.

8.2.2 Coatings

8.2.2.1 Specimens

8.2.2.1.1 Concrete test panels

8.2.2.1.1.1 General

Concrete test panels without or with reinforcement should be used depending on the planned application. Test panels with reinforcement shall always be used when the respective test of the coating includes generating cracks according to 8.2.2.6.

8.2.2.1.1.2 Test panels without reinforcement

a) For tests on impregnation and sealant < 1 mm thick, test panels made of reference concrete type C (0.70) according to EN 1766 shall be used. For tests on coatings ≥ 1 mm thick, test panels made of reference concrete type MC (0.40) according to EN 1766 shall be used.

   Recommended panel size: 300 mm × 300 mm × 60 mm;

b) pre-cast concrete paving flags.

8.2.2.1.1.3 Test panels with reinforcement

Reinforced concrete panels according to Annex F shall be used as test panels.

8.2.2.1.1.4 Coating and storage of the test panels

The test panels shall be pre-treated and coated for practice-orientated 28 days after manufacture at the earliest according to manufacturer specifications.

In the case of verification of suitability according to a) under 8.2.1 the coating is applied in the presence of a person authorised by the manufacturer or a member of the testing laboratory.

Prior to coating, the test panels and the coating materials and all system components shall have been stored for at least 24 h in a normal climate 23/50-2 according to ISO 554.

Vertical and/or horizontal test panels shall be coated according to their area of application. The testing of the vertically coated panels includes the horizontally coated panels when the coating materials used only differ in the content of thixotropic agent necessary for processing on vertical or inclined surfaces.

For test panels with reinforcement, a 15 cm wide strip along the whole length of the test panels shall be coated. Two strips of about 2,5 cm in width shall be left free at the edges to observe cracks.

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Data such as room climate, material consumption, waiting times between the individual coating processes shall be documented in the coating process. The density of the raw materials shall be determined as a basis for the specifications of coating materials consumed.

After the hardening time specified by the manufacturer during which the coated test panels shall be stored in normal climate 23/50-2 according to ISO 554 they are tested according to the planned loading of the coating.

8.2.2.1.2 Steel test panels

Steel panels size 120 mm × 120 mm × 3 mm are to be coated with the conductive part of the coating structure. The layer thickness shall comply with manufacturer specifications.

8.2.2.1.3 Polyethylene test panels

Polyethylene test panels shall be coated with the conductive part of the coating structure whereby the grounding bands planned in the original structure shall be omitted. The layer thickness shall comply with manufacturer specifications.

8.2.2.1.4 Free film

For the test on the free film (top coat), the coating material shall be applied according to manufacturer specifications in at least application layer thickness on a level base which allows the coating film to be removed after the film has formed. A suitable base shall be selected according to the coating material; PTFE and PPH foil or photo paper are possible for example. Separating agents shall not be used.

8.2.2.2 Fluid load, resistance and tightness

8.2.2.2.1 General

The test shall be conducted according to the prescribed grade with the test method specified in Table 9. It takes place at + (23 ± 2) °C after at least 16 h pre-conditioning of the specimens in normal climate 23/50-2 according to ISO 554.

For load grades 5 and 6, the test shall be made at the temperatures of the operating medium.

The chemical resistance of the coating against the thermal load caused by the media according to 8.2.2.3 is proven with this test.

Testing of the fluid load of a higher load grade includes proof of resistance of the coating at a lower load grade, see Table 8.

Table 8 — Area of validity of the fluid load tests

Verification of load grade according to Clause 4	Includes verification of load grade according to Clause 4
6	1 to 5
5	1 to 4
4	1 and 2
3	1, 2 and 4
2	1

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8.2.2.2.2 Test fluids

The media test is to be conducted with the fluid against which the coating shall be tight and resistant.

If fluids can be classified in fluid groups with the specified concentration limits for proof of suitability for material/media combinations according to Annex E, the test with the test fluid specified there suffices. For internal coatings of containers loaded with media of groups 5, 6, 6a, 6b, 9, 9a, 10, 10a, 11 and 12, the tests shall be conducted with the respective storage medium.

8.2.2.2.3 Evaluation of the test results

The requirements are considered met when the coating shows no visible signs of change (with the exception of changes in colour and gloss) in the visual inspection after exposure to the liquid and no test fluid has penetrated the coating.

Changes in hardness shall be determined by measuring with a suitable method, e.g. Shore D according to EN ISO 868, Barcol according to EN 59, impression resistance according to Buchholz according to EN ISO 2815. The measurements are made 1 h after removing the test fluid as well as after 24 h conditioning in a normal climate 23/50-2 according to ISO 554. In the case of reversible changes, the measurement of the hardness can be made after 7 days conditioning with reassessment of the hardness.

The method for assessing the change in hardness of a coating (with the exception of mastic asphalt) shown in Figure 1 can be used to help choose the load grades 1 to 4.

In order to assess the chemical resistance of mastic asphalt screeds, a penetration test with a level die based on EN 13813 shall be made after exposure to the media. Specimens with an edge length of 10 cm to 15 cm should be sawn from the test panels exposed to the media. If the depth of penetration after exposure to the medium has increased by 50 % (related to the initial state), the mastic asphalt screed is to be considered not resistant.

The assessment of the free film after testing the fluid load according to test method B 6 is made by evaluating changes in mass, colour and hardness for example. The change in hardness of the coating shall be measured by a suitable method (e.g. Shore D, Barcol, Buchholz hardness).

8.2.2.2.4 Test method

8.2.2.2.4.1 B 1

The chemical resistance is tested in the form of a one-sided exposure to the test fluid. For this, several cylinders with an inside diameter of 10 cm which are filled to a level of at least 1 cm with different fluids and covered at the top may be placed simultaneously on the coating. The cylinders shall be made of material which is resistant to the test fluid. The duration of exposure to the fluid to be tested is specified dependent on the grade according to Clause 4 and specified in Table 9.

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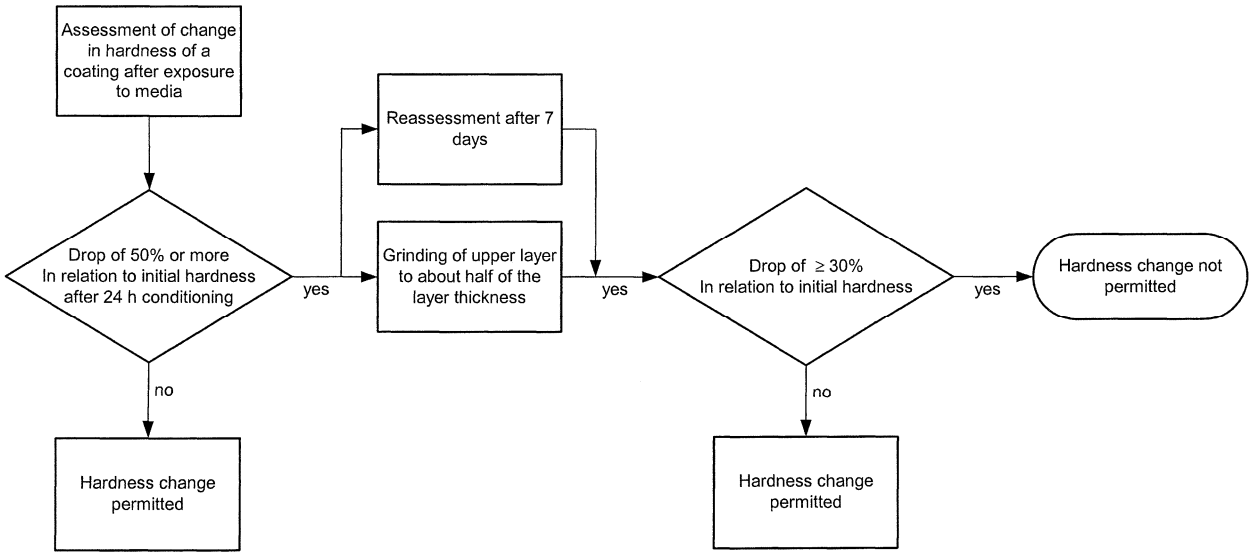


Figure 1 — Assessment of change in hardness of a coating after fluid load of load grades 1 to 4

8.2.2.2.4.2 B 2

The chemical resistance is tested in the form of a one-sided exposure to the test fluid. Several cylinders with an inside diameter of 10 cm each can be clamped to the test panel which are filled with a test fluid up to a level of at least 1 cm. An excess pressure of 1 bar shall be applied to the test fluid with compressed air, controlled by a pressure reducing valve. Under this pressure, the test fluid shall act on the coating for the test time specified in Table 9 for the appropriate load grade.

8.2.2.2.4.3 B 3

A cylinder with an inside diameter of 10 cm is clamped above the crack generated according to 8.2.2.6 and filled with test fluid up to a level of at least 1 cm. An excess pressure of 1 bar is applied to the test fluid with compressed air, controlled by a pressure reducing valve. Under this pressure, the test fluid shall act on the coating for the test time specified in Table 9 for the appropriate load grade.

During this test the width of the crack should be about 50 % of the crack width A, B or C according to EN 14879-1 to be tested.

If the effect of several fluids on a coating is to be tested, not all media tests have to be made above the generated crack. For some fluids which are to be seen by the testing institute as particularly critical, the test shall be made above the crack. Other fluids may be tested on the coated test panel next to the crack.

8.2.2.2.4.4 B 4

First the crack is generated according to 8.2.2.6, whereby the crack generated in the test panel is fixed so that the coating shall bridge the respective desired crack width A, B or C according to EN 14879-1 for the duration of exposure to the fluid.

A cylinder with an inside diameter of 10 cm shall be clamped over the open crack and filled with test fluid up to a level of at least 1 cm. An excess pressure of 1 bar shall be applied to the test fluid by compressed air controlled by a pressure reducing valve. Under this pressure, the test fluid shall act on the coating for 28 days.

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If the effect of several fluids on a coating is to be tested, not all media tests have to be made above the generated crack. For some fluids which are to be seen as particularly critical, the test shall be made above the crack. Other fluids may be tested on the coated test panel next to the crack.

8.2.2.2.4.5 B 5

A test device in accordance with EN 977 or a comparable test set-up in which test panels shall be installed in such a way that both the effect of the fluid phase and the vapour phase can be tested at the same time is suitable as a test set-up. The ratio of the volume of the test fluid in cm^3 to the surface of the coating exposed to the fluid in cm^2 shall be at least 8 : 1. The duration of exposure to the fluid is 90 days. It shall be performed at the planned operating temperatures with the tempered test fluid.

8.2.2.2.4.6 B 6

The test shall be made based on EN ISO 175. Immersion of the specimens in the test fluid at 23 °C or the planned operating temperature takes place up to weight constancy but at least 28 days. The changes in hardness and mass shall be recorded whereby the measurements shall be made after 7, 14, 21 and 28 days. Weight constancy is assumed when the change in mass between the last two measurements is < 0,5 %.

8.2.2.2.4.7 Necessary tests with existing experience

If there is already a suitability test for at least three media for the load grades 5 and/or 6, the test scope for testing the fluid load for other media (supplementary test) can be reduced. This applies for operating temperatures ≤ 50 °C in closed systems.

The flow chart of such a supplementary test is shown in Figure 2.

If there is already a suitability test for at least three media for load grade 3, procedure B 2 should be applied for further tests of the fluid load for other media. Exceptions to this are strongly diffusive media.

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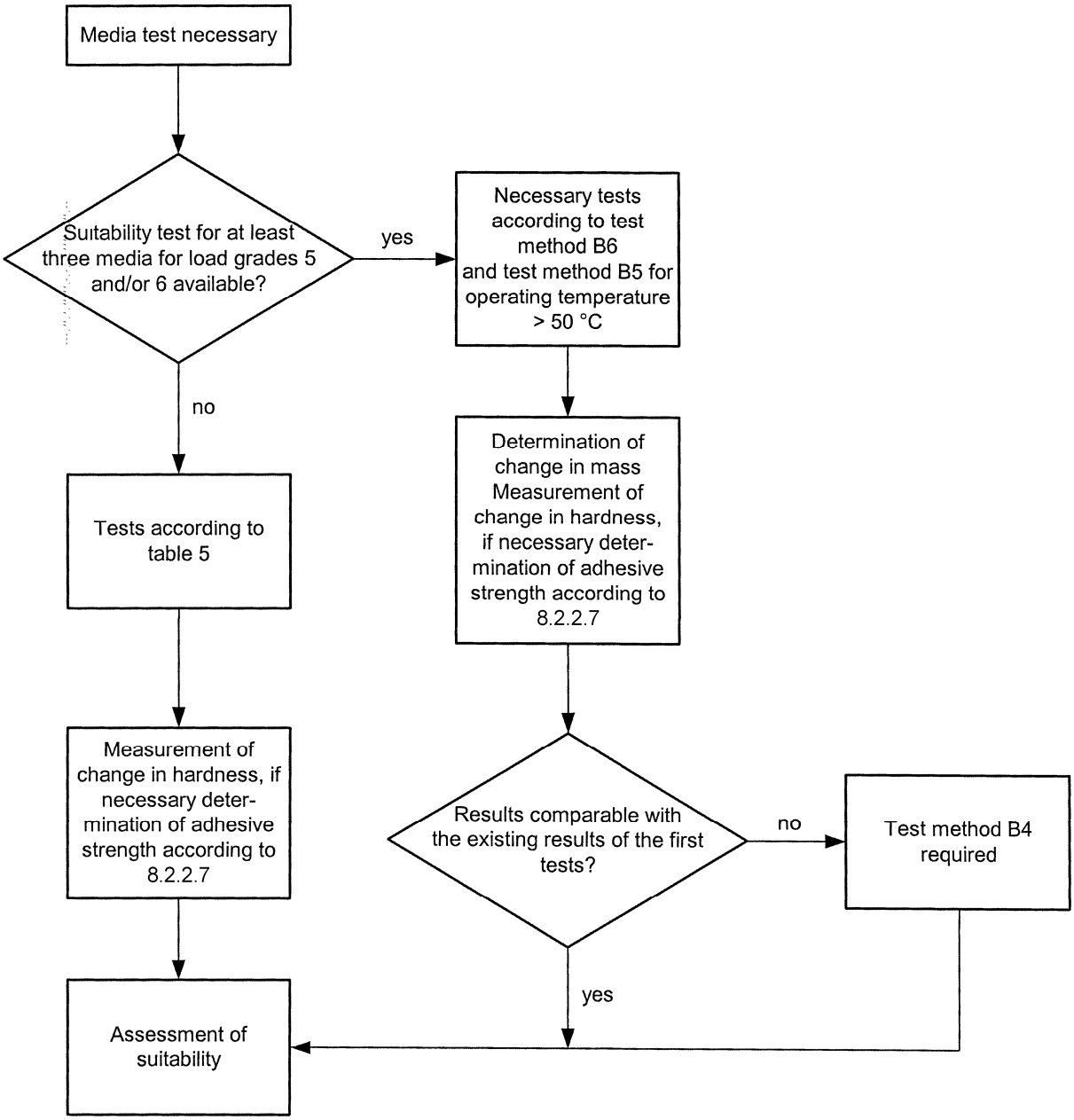


Figure 2 — Flow chart of the tests for load grades 5 and 6 of fluid load

8.2.2.3 Thermal loading

8.2.2.3.1 Thermal loading due to effect of the media

A special test is not necessary when the tests of the media effect for the respective application according to 8.2.2.2 are performed at the given temperatures.

8.2.2.3.2 Influence of other heat sources

The requirements are covered by the tests according to 8.2.2.8.1 Ageing by heat, 8.2.2.8.2 Ageing by temperature change load and possibly 8.2.2.9 Weather resistance.

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8.2.2.4 Temperature change loading

The resistance of coatings to temperature change load of load grades 1 to 2 according to Clause 4 is covered by fluid load tests according to 8.2.2.2 necessary for the respective application at the given temperatures.

The behaviour of a coating under exposure to often media-related temperature changes (grades 3 and 4 according to Clause 4) and weather-related temperature change load shall be proven with the test according to 8.2.2.8.2. This test also covers load grade 5 (temperature shock) at the same time.

8.2.2.5 Mechanical loading

8.2.2.5.1 General

NOTE Table 10 contains an overview of the behaviour of coatings under mechanical load.

8.2.2.5.2 Grade 1: Pedestrian

No special test of the resistance to mechanical load is necessary for grade 1.

8.2.2.5.3 Grade 4: Impact

The test shall be conducted based on EN ISO 6272. For this, practically coated test panels according to the application are used according to 8.2.2.1.1.2 after being subjected to heat ageing according to 8.2.2.8.1.

After at least 16 h conditioning in normal climate 23/50-2 according to ISO 554, five tests are made with the test apparatus described in EN ISO 6272 at different places on the coating with a (1 000 ± 1) g heavy weight. The weight is dropped from a height of 40 cm, corresponding to a fall energy of 4 Nm.

Loading shall be followed by visual inspection. The test is considered passed when no cracks or separations from the substrate are visible. In addition, no essential change in the initial layer thickness may take place. In cases of doubt, the cross section of the contact point shall be examined visually.

8.2.2.5.4 Load grades 5 and 6: Hydrostatic pressure

The requirements are covered by the test method B 3 according to 8.2.2.2.4.3 or B 4 according to 8.2.2.2.4.4.

8.2.2.6 Crack bridging

8.2.2.6.1 Type and number of sample bodies

At least 4 test panels according to 8.2.2.1.1.4 shall be used for the tests which have met the requirements according to 8.2.2.8.1 or 8.2.2.9 if necessary.

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Table 9 — Testing fluid load, resistance and tightness

<table>
<tr><td colspan="2">Type of coating
according to Clause 4</td><td colspan="8">Load grade according to Clause 4</td></tr>
<tr><td colspan="2"></td><td>1
sporadic droplets</td><td>2
frequent splashing</td><td>3
event of fault</td><td>4
constant wetness</td><td colspan="2">5
constant flow</td><td>6
constant filling</td></tr>
<tr><td>Coating</td><td>4.1.2</td><td>e.g. lab floors, floors in small plants, walls</td><td>e.g. floors in closed production plants</td><td>secondary containments</td><td>e.g. floors in production plants, galvanic plants, pump stations</td><td>open gutters, trenches and appropriate pump sumps</td><td>closed gutters, trenches, pipes and ditches</td><td>containers</td></tr>
<tr><td>Impregnations
Sealants</td><td>a)</td><td rowspan="6">suitable, no test required</td><td rowspan="6">suitable, for aggressive media
test method
B 1
24 h</td><td colspan="5" rowspan="2"></td></tr>
<tr><td>Thin coatings
< 1 mm</td><td>a)</td></tr>
<tr><td>Thick coatings
1 mm to 5 mm</td><td>b)</td><td>Test method
B 3
14 d

or
B 3
72 h [a]

or
B 2
14 d [b]</td><td>Test method
B 1
28 d

or
B 2
14 d</td><td>Test method
B 3
28 d

or
B 6 [b]</td><td>Test method
B 3 28 d
+
B 5 90 d
or
B 6 [b]</td><td>Test method
B 4 28 d
+
B 5 90 d
or
B 6 [b]</td></tr>
<tr><td>Laminate coatings</td><td>c)</td></tr>
<tr><td>Resinous screeds</td><td>d)</td><td rowspan="2">—</td></tr>
<tr><td>Mastic asphalt screeds</td><td>e)</td></tr>
<tr><td>Combinations of
4.1.2 a) to 4.1.2 e)</td><td>g)</td><td colspan="2">—</td><td colspan="6">The tests shall be conducted according to requirements of the exposed layer on the complete system.</td></tr>
</table>

[a] In plants in which infrastructural measures ensure that the maximum load duration does not exceed 72 h.

[b] For supplementary tests.

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Table 10 — Testing the resistance strength of coatings to mechanical load

Type of coating according to Clause 4		Load grade according to Clause 4						
		1	2	3		4	5	6
Coating	4.1.2	Load up to 0,2 N/mm^2; Pedestrian, transport with light cart or resting loads	Load up to 1 N/mm^2; e.g. air tyred vehicles or resting loads	3a Load from 1 to 7 N/mm^2 by vehicles with Vulkollan wheels or resting loads	3b Load > 7 N/mm^2 by vehicles with polyamide wheels or resting loads	Impact: setting down sharp-edged objects such as drums as well as dragging load and similar (shovel dozers)	Hydrostatic pressure: 0,05 bar to 0,5 bar	Hydrostatic pressure: > 0,5 bar
Impregnations Sealants	a)	suitable, no test required	suitable, no test required	suitable, no test required			—	
Thin coatings < 1 mm	a)			suitable,[a] no test required	proof necessary [b]	Test according to 8.2.2.5.3		
Thick coatings 1 mm to 5 mm	b)						Covered by 8.2.2.2.4.3 or 8.2.2.2.4.4	
Laminate coatings	c)							
Resinous screeds	d)			suitable, no test required	suitable, no test required		—	
Mastic asphalt screeds	e)			suitable, no test required [c]				
Combinations of 4.1.2 a) to 4.1.2 e)	g)	The test shall be made according to the requirements of the exposed layer on the complete system.						

[a] Restrictions see 8.1.2.4.

[b] See 8.1.2.4.

[c] See Table 7.

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8.2.2.6.2 Test run

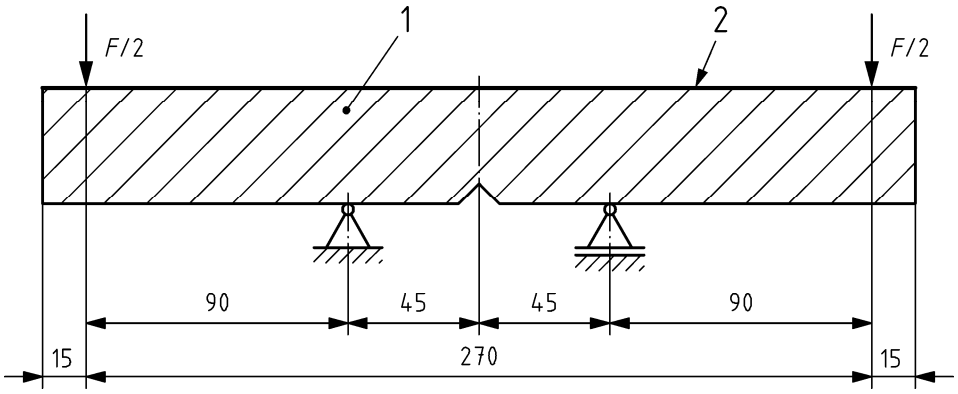
The crack bridging is tested in a distance or deformation controlled bending tension machine at a room temperature of (23 ± 2) °C according to the load arrangement shown in Figure 3. The test panels shall be pre-conditioned in normal climate 23/50-2 according to ISO 554 for at least 16 h prior to the test.

The crack opening speed after appearance of the crack in the concrete shall be 15 µm/min to 20 µm/min.

During the test the crack width in the uncoated edge area of the test panel surface shall be measured continuously. The crack to be generated shall be opened to the required crack width on both sides. In addition, the coating shall be observed during the test to determine any changes in the coating (e.g. occurrence of a bright zone, pore or crack formation). Then you should check whether the required crack width A, B or C according to EN 14879-1 is bridged by the coating. On reaching the required crack width, the crack opening shall be fixed in two cases, kept open for at least 16 hours and observed if possible. Every kind of change (incipient crack, crack or fracture) shall be specified in the test report.

If a pressure test is made on the test panel in the vicinity of the crack, the crack width shall correspond to the specifications according to 8.2.2.2.4.3 or 8.2.2.2.4.4 after fixing.

Dimensions in millimetres



Key
1 test panel
2 coated surface

Figure 3 — Load arrangement

In rigid coating systems the following changes in the load arrangement shown in Figure 3 (four-point bending test) are possible whilst retaining the distance apart of load application points of 270 mm:

— reduction in the application distance of the nominal breaking point (< 45 mm),

— with reduction to 0: loading of the test panel in a three-point bending test (test panel may be without nominal breaking point).

The used load arrangement shall be specified in the test report.

8.2.2.6.3 Evaluation of the test results

The requirements are considered satisfied when the coating bridges the cracks generated according to 8.2.2.6.2 on three of four test panels after testing according to 8.2.2.8.1 and/or 8.2.2.9.

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8.2.2.7 Adhesion strength

The test is conducted according to the pull-off method based on EN ISO 4624. Divergent from EN ISO 4624 a core drill can be used to drill to a depth of 10 mm into the substrate. The test die should be glued to the drilling core making sure that the drilling gap remains free of adhesive. Five tests each are made on two unloaded test panels, which have been coated according to the intended purpose according to 8.2.2.1.

The adhesion strength shall be greater than the surface tensile strength of the concrete according to EN 14879-1.

In addition to the test conditions (die geometry, test setup, adhesive, pull-off speed, position and identification of the test points), the adhesion strength (average value and individual values) shall be specified to 0,1 N/mm^2. The separation case shall be described according to EN ISO 4624.

8.2.2.8 Ageing behaviour

8.2.2.8.1 Ageing by heat

To test the ageing behaviour, coated test panels according to 8.2.2.1.1.2 and/or 8.2.2.1.1.3 shall be stored for 7 days at (70 ± 2) °C.

Then the test panels shall be assessed visually. It should be determined whether the coating or parts thereof have lifted or cracks are visible in the coating. If not, cracks are generated according to 8.2.2.6 with the crack width A, B or C according to EN 14879-1 to be tested after 14 days conditioning in normal climate 23/50-2 according to ISO 554 providing the coating needs to be crack bridging.

8.2.2.8.2 Ageing by temperature change load

At expected weather-related temperature fluctuation load of the coating, i.e. when using the coating outdoors and with frequently expected changes in temperature of load grades 3 and 4, according to 4.2.5, the temperature fluctuation load is to be carried out based on EN 13687-3.

Two not reinforced concrete panels according to 8.2.2.1.1.2 should be used as test panels. The test panels shall be visually assessed after 20 temperature change cycles. It should be determined whether the coating or parts thereof have lifted or cracks are visible in the coating.

The minimum adhesion strength shall also correspond with the minimum values according to 8.2.2.7 after temperature fluctuation loading.

8.2.2.9 Weathering behaviour

At least two test panels according to 8.2.2.1.1.2 or 8.2.2.1.1.3 shall be coated and (10 ± 1) mm high, firmly bonded and weather-resistant edging (e.g. of a polysulfide jointing sealant) applied to the narrow sides and one long side.

The test panels shall then be embedded outdoors in sand at a place exposed unobstructed to the elements in such a way that only the coated surface remains free. The test panels should be fixed so that they are inclined around their longitudinal axis in southerly direction.

The elevated edge of joint sealant on the south side, upper edge and upper edge of the parallel running (north) board long side are at the same height.

The test panels are exposed to the elements for two years. Cleaning and other intervention in the meantime is prohibited.

After two years storage outdoors and subsequent thorough cleaning it is determined whether the coating or parts thereof have lifted from the substrate. If this is not the case, cracks of the required crack width are

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generated according to 8.2.2.6.2 after 14 days conditioning in room air if the coating needs to be crack bridging. As a rule two critical media for the coating material shall be tested according to 8.2.2.2.

Additional tests can already be made after 6 months storage to assess the concrete compatibility and make a preliminary statement about the weather resistance.

8.2.2.10 Behaviour in cleaning and neutralisation processes

The chemical resistance of the coating to the specified cleaning agent shall be tested on the component according to 8.2.2.2.4.1 with test method B 1 over 24 h. Changes in the pH value shall be considered separately. The test with the cleaning agent can be omitted when a resistance to the media group 16 (Annex E) has been proven. In old systems, the test shall be repeated if necessary on the loaded component.

8.2.2.11 Electrostatic dissipation capability

8.2.2.11.1 General

The dissipation resistance is tested according to Annex G, the volume resistance according to IEC 60093 and the insulation resistance (surface resistance) according to IEC 60167 immediately after 24 h conditioning of the samples in normal climate 23/50-2 according to ISO 554 with a DC voltage of 100 V. This test should be repeated at the end of the ageing behaviour test according to 8.2.2.8.1. Treatment of the samples with organic solvents should be ruled out.

If the measured values at the end of ageing behaviour testing of hydraulically binding coatings are greater than the initial values, further tests regarding the durability of the dissipation capability are necessary.

EN 1081 can also be applied.

8.2.2.11.2 Measurement of the dissipation resistance

8.2.2.11.2.1 Homogeneously conductive coating structure

In a homogeneously conductive coating structure, the measurement of the dissipation resistance is made according to Annex G on a test panels according to 8.2.2.1.1.4.

8.2.2.11.2.2 Coating structure with insulating intermediate layers

In coating structures with insulating intermediate layers, the full coating structure including the grounding band described by the manufacturer should be applied to a test panels according to 8.2.2.1.1.4. The grounding band shall be integrated in the layer prescribed by the manufacturer on one of the narrow sides of the test panel. The dissipation resistance is measured by means of a circular electrode according to Annex G, but without a protective ring, whereby it is to be applied to the coating at the greatest possible distance from the integrated grounding band.

8.2.2.11.2.3 Sample areas

If there are any doubts as to the transferability of the measuring results determined on the specimens mentioned before, the measurement of the dissipation resistance may be made on a practice-orientated test with the coating system desired by the manufacturer.

8.2.2.11.2.4 Test run

The dissipation resistance is to be tested with a DC voltage of about 100 V as an electrical resistance between a circular electrode with a measuring area of 20 cm^2 without protective ring and grounding placed on the coating system.

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The coating system shall be rubbed down with a dry cloth at the place to be tested and a damp piece of blotting paper with a diameter of 50 mm placed on it (enough layers shall be used to level uneven floors) on which the measuring electrode is placed. A measurement shall be made at least one position per 1 m^2 of coating.

8.2.2.11.3 Measuring the volume resistance

Steel test panels according to 8.2.2.1.2 are coated for measuring the volume resistance. The measurement shall be made according to IEC 60093 with a DC voltage of 100 V.

8.2.2.11.4 Measuring the insulation resistance (surface resistance)

PE test panels are coated according to 8.2.2.1.3 to determine the insulation resistance. The measurement shall be made according to IEC 60167 with a DC voltage of 100 V.

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Annex A
(informative)

Specimen form

The copyright statement on page 1 prohibiting reproduction of any part of the standard does not apply to the following specimen form.

Specimen form

Load profile as in EN 14879-3 for nonmetallic protective coatings for concrete parts.

The form is to be completed separately for each part.

Plant _____

Structure to be protected

O Storeroom O Secondary containment O Production area O Container

Part to be protected

O Floor O Wall O Ceiling O Trench O Pipe O Sump

Application

O Storage O Filling O Loading/Unloading O Production O Treatment O Use

Load

1. Chemicals (use a separate sheet if necessary): _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

2. Grade of fluid load: _____

_____

_____

_____

3. Steam/Condensate: O yes O no

Gas O yes O no

4. Grade of thermal load: _____

_____

_____

5. Grade of temperature change: _____

_____

6. Grade of mechanical loading: _____

_____

7. Grade of exposure to climatic influences: _____

_____

_____

8. Additional requirements: _____

_____

_____

_____

_____

_____

_____

Signature: _____ **Date:**_____

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Annex B
(informative)

Selection criteria for surface protection systems

B.1 Load profiles and suitable surface protection systems for floors and walls

Table B.1 sets out load profiles for plant parts which are not exposed to or are only exposed to slight climatic influences. They are only exposed to fluid loads of grades 1 and 2, and their surface temperatures do not increase greatly nor are they subject to great temperature fluctuations. The surface protection used in these cases need only provide moderate protection.

Examples of these elements are:

— floors in storerooms for solid bulk materials or liquid chemicals in laboratory batches;

— floors in laboratories, control rooms and the like;

— floors in production areas with closed operation;

— walls in production and storage areas;

— ceilings in production and storage areas.

Table B.1 — Load profiles and suitable surface protection for floors and walls

Chemicals as in Table 2	Grade of fluid load (as in 4.2.3)	Temperature, in °C	Grade of temperature change (as in 4.2.5)	Grade of mechanical load (as in 4.2.6)	Grade of climatic influences (as in 4.2.7)	Type of surface protection		
						Coating	Lining	Composite
I and II	1	20	1	1	0 to 1	R	—	A
I and II	1	50	1	1	0 to 1	R	—	A
I and II	1	70	1 and 2	1	0 to 1	A	—	R
I and II	2	20	1	1	0 to 1	R	—	A
I and II	2	50	3	1	0 to 1	A	—	R
I and II	2	70	3	1	0 to 1	A	—	R
I and II	2	70	4	1	0 to 1	N	—	R
I and II	1	20	1	2	0 to 1	R	—	A
I and II	2	20	3	2	0 to 1	A	—	R
I and II	1	50	1	2	0 to 1	A	—	R
I and II	2	50	1 and 3	2	0 to 1	A	—	R
I and II	2	50	3	2	0 to 1	A	—	R
I and II	1	70	1 and 2	2	0 to 1	A	—	R
I and II	2	70	3 and 4	2	0 to 1	N	—	R
I and II	1	20 to 70	1 to 4	3	0 to 1	A	—	R
I and II	1	20 to 70	1 to 4	4	0 to 1	A	—	R
I and II	2	20 to 70	5	1 to 4	0 to 1	A	—	R

Key to symbols:
R: recommended surface protection
A: suitable alternative surface protection, depending on the durability of the system
N: not recommended as surface protection
—: not applicable

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B.2 Load profiles and suitable surface protection systems for secondary containments

Table B.2 gives load profiles for plant parts located inside or outside and which may, in the case of operational failure, be required to take up considerable amounts of fluids for a limited time.

Examples of such elements are:

— secondary containments and areas near storage tanks;

— storage areas for small drums and pallets;

— barrel stores.

Table B.2 — Load profiles and suitable surface protection for secondary containments

Chemicals as in Table 2	Grade of fluid load (as in 4.2.3)	Temperature, in °C	Grade of temperature change (as in 4.2.5)	Grade of mechanical load (as in 4.2.6)	Grade of climatic influences (as in 4.2.7)	Type of surface protection		
						Coating	Lining	Composite
I	3	20	1	0	0 to 2	R	A	A
I	3	20	1	0	0 to 2	A	A	R
I	3	50	1	0	0 to 2	R	A	A
II	3	50	1	0	0 to 2	A	A	R
I and II	3	70	1 and 2	0	0 to 2	A	A	R
I	3	20	1	1	0 to 2	R	A	A
II	3	20	1	1	0 to 2	A	N	R
I	3	50	1	1	0 to 2	R	A	A
II	3	50	1	1	0 to 2	A	N	R
I and II	3	70	1 and 2	1	0 to 2	A	A	R
I	3	20	1	2	0 to 2	A	N	R
II	3	20	1	2	0 to 2	A	N	R
I	3	50	1	2	0 to 2	A	N	R
II	3	50	1	2	0 to 2	A	N	R
I and II	3	70	1 and 2	2	0 to 2	A	N	R
I	3	20	1	3	0 to 2	A	N	R
II	3	20	1	3	0 to 2	A	N	R
I	3	50	1	3	0 to 2	A	N	R
II	3	50	1	3	0 to 2	A	N	R
I and II	3	70	1 and 2	3	0 to 2	A	N	R
I and II	3	20	1	4	0 to 2	N	N	R
I and II	3	50	1	4	0 to 2	N	N	R
I and II	3	70	1 and 2	4	0 to 2	N	N	R
I and II	3	20 to 70	5	0 to 1	0 to 2	A	A	R
I and II	3	20 to 70	5	2 to 4	0 to 2	N	N	R

Key to symbols:
R: recommended surface protection
A: suitable alternative surface protection, depending on the durability of the system
N: not recommended as surface protection

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B.3 Load profiles and suitable protection for production plant floors

Table B.3 gives load profiles for plant parts located inside or outside, and which are designed for exposure to fluids occurring as wetness, puddles, trickles, condensation etc. These parts require long-term protection and sealing. Examples of typical elements are:

— production area floors where open plant operation involves considerable leakage and dripping;

— floors in pumping areas;

— floors in filling areas.

Table B.3 — Load profiles and suitable surface protection for production plant floors

Chemicals as in Table 2	Grade of fluid load (as in 4.2.3)	Temperature, in °C	Grade of temperature change (as in 4.2.5)	Grade of mechanical load (as in 4.2.6)	Grade of climatic influences (as in 4.2.7)	Type of surface protection		
						Coating	Lining	Composite
I and II	4	20	1	1	0 to 2	A	N	R
I and II	4	50	1	1	0 to 2	A	N	R
I and II	4	50	3	1	0 to 2	A	N	R
I and II	4	70	1 and 2	1	0 to 2	A	N	R
I and II	4	70	3 and 4	1	0 to 2	N	N	R
I and II	4	20	1	2	0 to 2	A	N	R
I and II	4	50	1	2	0 to 2	A	N	R
I and II	4	50	3	2	0 to 2	A	N	R
I and II	4	70	1 and 2	2	0 to 2	A	N	R
I and II	4	70	3 and 4	2	0 to 2	N	N	R
I and II	4	20 to 70	1 to 4	3	0 to 2	N	N	R
I and II	4	20 to 70	1 to 4	4	0 to 2	N	N	R
I and II	4	20 to 70	5	1 to 4	0 to 2	N	N	R

Key to symbols:
R: recommended surface protection
A: suitable alternative surface protection, depending on the durability of the system
N: not recommended as surface protection

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B.4 Load profiles and suitable protection for gutters, trenches, pipes etc.

Table B.4 gives load profiles for plant parts located inside or outside, and which are designed for exposure to flowing fluids. In open plant parts, traffic may cause additional mechanical loading, and long-term surface protection is required for both open and covered parts. Such parts are typically exposed to media at a hydrostatic pressure of up to 0,05 bar.

Table B.4 — Load profiles and suitable surface protection for elements exposed to flowing fluids

Chemicals as in Table 2	Grade of fluid load (as in 4.2.3)	Temperature, in °C	Grade of temperature change (as in 4.2.5)	Grade of mechanical load (as in 4.2.6)	Grade of climatic influences (as in 4.2.7)	Type of surface protection		
						Coating	Lining	Composite
I and II	5	20	1	0	0 to 2	A	A	R
I and II	5	50	1	0	0 to 2	A	A	R
I and II	5	50	3	0	0 to 2	A	A	R
I and II	5	70	1 and 2	0	0 to 2	A	A	R
I and II	5	70	3 and 4	0	0 to 2	N	A	R
I and II	5	20	1	1	0 to 2	A	A	R
I and II	5	50	1	1	0 to 2	A	A	R
I and II	5	50	3	1	0 to 2	A	A	R
I and II	5	70	1 and 2	1	0 to 2	A	A	R
I and II	5	70	3 and 4	1	0 to 2	N	A	R
I and II	5	20	1	2	0 to 2	A	N	R
I and II	5	50	1	2	0 to 2	A	N	R
I and II	5	50	3	2	0 to 2	A	N	R
I and II	5	70	1 and 2	2	0 to 2	A	N	R
I and II	5	70	3 and 4	2	0 to 2	N	N	R
I and II	5	20 to 70	1 to 4	3	0 to 2	N	N	R
I and II	5	20 to 70	1 to 4	4	0 to 2	N	N	R
I and II	5	20 to 70	5	1 to 4	0 to 2	A	A	R

Key to symbols:
R: recommended surface protection
A: possible alternative surface protection, depending on the durability of the system
N: not recommended as surface protection

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B.5 Load profiles and suitable protection for containers

Table B.5 gives load profiles for containers with continual, long-term exposure to fluids, and also to hydrostatic pressure and mechanical loading caused by agitators. Examples of such containers are:

— sewage tanks;

— neutralization basins;

— sedimentation tanks;

— settling tanks.

Table B.5 — Load profiles and suitable surface protection for containers exposed to long-term hydrostatic pressure and mechanical loading

Chemicals as in Table 2	Grade of fluid load (as in 4.2.3)	Temperature, in °C	Grade of temperature change (as in 4.2.5)	Grade of mechanical load (as in 4.2.6)	Grade of climatic influences (as in 4.2.7)	Type of surface protection		
						Coating	Lining	Composite
I	6	20	1	0	0 to 2	R	R	A
I	6	50	1	0	0 to 2	A	R	A
I	6	50	3	0	0 to 2	A	R	A
II	6	50	1	0	0 to 2	A	A	A
II	6	50	3	0	0 to 2	A	A	R
II	6	70	1 to 4	0	0 to 2	A	A	R
I and II	6	20	1	5	0 to 2	R	R	A
I	6	50	1	5	0 to 2	A	R	A
I	6	50	3	5	0 to 2	A	R	A
II	6	50	1	5	0 to 2	A	A	R
II	6	50	3	5	0 to 2	A	A	R
II	6	70	1 to 4	5	0 to 2	A	A	R
I and II	6	20	1	6	0 to 2	A	R	R
I	6	50	1	6	0 to 2	A	R	R
I	6	50	3	6	0 to 2	A	R	R
II	6	50	1	6	0 to 2	A	A	R
II	6	50	3	6	0 to 2	A	A	R
I and II	6	70	1 to 4	6	0 to 2	A	A	R
I and II	6	20 to 70	5	0; 5; 6	0 to 2	A	A	R

Key to symbols:
R: recommended surface protection
A: possible alternative surface protection, depending on the durability of the system
N: not recommended as surface protection

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Annex C
(informative)

Acceptance inspection report

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Acceptance inspection report for coated concrete parts	
Client:	Order No.:
Project:	
Type of plant part:	
Type of coating:	
Tests	**Test results**
A. Checks prior to application	
1. Visual check of surface	
2. Concrete moisture	_____ %
3. Concrete strength	_____ N/mm^2
B. In-process checks	
1. Ambient temperatures and humidity	
2. Checking application steps	
C. Checks after completion of application	
1. Ambient conditions	Ambient temperature: _____ Temperature of member: _____ Relative humidity: _____
2. Visual check	
3. Coating thickness	
Nominal value: _____ mm	Actual value: _____ mm
4. Checking for defects	
Type of equipment used:	
Test voltage: _____ kV	
D. Testing carried out on test panels	
1. Shore/Barcol hardness:	
Type of equipment used: _____	
Nominal value: _____ Shore A/Shore D/Barcol	Actual value: _____ Shore A/Shore D/Barcol
2. Adhesion test:	
Equipment used: _____	
Nominal value: _____ N/mm^2	Actual value: _____ N/mm^2
Comments:	

Test site: Date					

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Annex D
(normative)

Overview of verification of suitability for coatings

Table D.1 — Necessity of proof for the requirements/section

Requirement		Load grade according to Clause 4						
		Grade						
		1 sporadic droplets	2 frequent splashing	3 event of fault	4 constant wetness	5 constant flow		6 constant filling
	Subclause	e.g. laboratory floors, floors in technical rooms, walls	e.g. floors in closed production plants	secondary containments	e.g. floors in production plants, galvanic plants, pump stations	open gutters, trenches and appropriate pump sumps	closed gutters, trenches, pipes and pits	containers
Fluid load, resistance and tightness	8.1.2	+	C	A	A	A	A	A
Thermal load	8.1.3	B	B	B	B	B	B	B
Temperature change load	8.1.4	B	B	B	B	B	B	B
Mechanical load	8.1.5	B	B	B	B	B	B	B
Slip protection	8.1.6	B	B	B	B	—	—	—
Crack bridging	8.1.7	—	—	A	B	A	A	A
Adhesion strength	8.1.8	A	A	A	A	A	A	A
Ageing behaviour	8.1.9	C	C	A	B	A	D	D
Weathering behaviour	8.1.10	B	B	B	B	B	B	B
Concrete compatibility	8.1.11	D	D	D	D	D	D	D
Behaviour in cleaning and neutralization processes	8.1.12	B	B	B	B	B	B	B
Behaviour against micro-organisms	8.1.13	C	C	C	C	C	C	C
Dissipation capability	8.1.14	B	B	B	B	B	B	B
Behaviour in fire	8.1.15	B	B	A	B	B	B	B

A Proof always necessary
B Proof only on demand
C Proof only for certain materials, media, versions or applications.
D Covered by other proof
\+ Suitable without proof
\- not applicable

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Annex E
(normative)

Test fluid groups for verification of suitability for material/media combinations

Table E.1 — Test fluid groups for verification of suitability for material/media combinations

No	Group	Test fluid
1 [a]	Petrol according to EN 228 with a maximum alcohol content of 5 %	47,5 vol.-% [h] toluene, 30,4 vol.-% [h] isooctane (2,2,4-trimethylpentane) 17,1 vol.-% [h] n-heptane 3,0 vol.-% [h] methanol 2,0 vol.-% [h] tert. butanol
1a [a]	Petrol according to EN 228 with a maximum alcohol content of 20 % (including 1)	42,3 vol.-% [h] toluene, 25,3 vol.-% [h] isooctane (2,2,4-trimethylpentane) 12,7 vol.-% [h] diisobutylene 4,2 vol.-% [h] ethanol 15,0 vol.-% [h] methanol 0,5 vol.-% [h] water
2 [b]	Aviation fuels	a) Aviation fuel 100 LL b) 50 vol.-% [h] toluene, 30 vol.-% [h] isooctane (2,2,4-trimethylpentane) 15 vol.-% [h] diisobutylene 5 vol.-% [h] ethanol c) Aviation turbine fuel Jet-A1 with additives (Nato-Code F-34)
3	Heating fuel oil EL unused combustion engine oils, unused vehicle gear oils, aliphatic and aromatic hydrocarbons with an aromatic content of ≤ 20 wt.-% [i] and a flash point of > 55 °C	80 vol.-% [h] Diesel fuel according to EN 590 20 vol.-% [h] 1-methylnaphthalene
3a [c]	Diesel fuel according to EN 590 with a maximum content of 5 % Biodiesel (including 3)	76 vol.-% [h] Diesel fuel according to EN 590 19 vol.-% [h] 1-methylnaphthalene 5 vol.-% [h] Rape-oil fatty acid methyl ester (RME)
3b [c]	Diesel fuel according to EN 590 with a maximum content of 20 % Biodiesel (including 3 and 3a)	64 vol.-% [h] Diesel fuel according to EN 590 16 vol.-% [h] 1-methylnaphthalene 20 vol.-% [h] Rape-oil fatty acid methyl ester (RME)
4	Raw oils	10,0 wt.-% [i] Iso-octane ASTM 10,0 wt.-% [i] toluene 20,0 wt.-% [i] heating fuel oil EL 10,0 wt.-% [i] 1-methyl naphthalene (min. 96 %) 47,7 wt.-% [i] heating fuel oil S 0,2 wt.-% [i] thiophene (99 %) 0,3 wt.-% [i] dibenzene sulfide 0,5 wt.-% [i] dibutyl disulfide (97 %) 1,0 wt.-% [i] naphthalic acid mixture (acid factor 230) 0,1 wt.-% [i] phenol 0,2 wt.-% [i] pyridine Mixed with 2,0 wt.-% [i] water

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Table E.1 (*continued*)

No	Group	Test fluid
5 [d]	All hydrocarbons including benzene and benzene mixtures	30 vol.-% [h] benzene, 30 vol.-% [h] toluene, 30 vol.-% [h] xylene, 10 vol.-% [h] methyl naphthalene
5a [e]	All hydrocarbons as well as used combustion engine oils and used vehicle gear oils with the exception of raw oils, benzene and benzene mixtures without fuels	60 vol.-% [h] toluene, 30 vol.-% [h] xylol, 10 vol.-% [h] methyl naphthalene
5b	— used combustion engine oils and — used vehicle gear oils with a flash point > 55 °C without fuels	80,0 wt.-% [i] motor oil based on mineral oil 10,0 wt.-% [i] toluene 9,9 wt.-% [i] water 0,1 wt.-% [i] anionic tenside sodium dodecylsulfate
6	all halogen hydrocarbons (including 6a and 6b)	dichloromethane (methylene chloride)
6a	aliphatic halogen hydrocarbons ≥ C_2 and aromatic halogen hydrocarbons	trichloroethylene
6b	aromatic halogen hydrocarbons	monochlorobenzene
7	all alcohols and glycol ethers (including 7a)	Methanol
7a	single and multiple value alcohols (up to max. 48 vol.-% [h] methanol), glycol ether (including 7b)	48 vol.-% [h] methanol, 48 vol.-% [h] isopropanol, 4 vol.-% [h] water
7b	alcohol ≥ C_2	48 vol.-% [h] ethanol 48 vol.-%[h] isopropanol 04 vol.-% [h] water
8 [f]	all organic esters and ketone (including 8a and 8b)	50 vol.-% [h] ethyl acetate 50 vol.-% [h] methylisobutylketone
8a	aromatic ester and ketone	50 vol.-% [h] methyl salicylate 50 vol.-% [h] acetophenon
8b	Biodiesel	Rape-oil fatty acid methyl ester (RME) (summer quality)
9	aliphatic aldehydes and their aqueous solutions (incl. 9a)	50 vol.-% [h] n-butyl aldehyde (Butanal) 50 vol.-% [h] n-heptaldehyde (Heptanal)
9a	aqueous solutions of aliphatic aldehydes up to 40 %	35 % to 40 % commercially available aqueous formaldehyde solution
10	cyclic and acyclic ether (including 10a)	tetrahydrofurane (THF)
10a	acyclic ether	diethylether
11	amines and their salts (in aqueous solution)	35 vol.-% [h] triethanolamine 30 vol.-% [h] n-butylamine 35 vol.-% [h] N, N-dimethylaniline
12 [g]	organic acids (carboxylic acids, except formic acids) and their salts (in aqueous solution)	50 vol.-% [h] acetic acid 50 vol.-% [h] propionic acid
12a [g]	aqueous solutions of organic acids (carboxylic acids) to 10 % as well as their salts (in aqueous solution)	10 wt.-% [i] aqueous acetic acid
13 [g]	mineral acids up to 20 % as well as acetic hydrolyzing inorganic salts in aqueous solution (pH < 6), except hydrofluoric acid and oxidizing acids and their salts	Sulfuric acid (20 %) Hydrochloric acid (20 %) should be used for testing inside coatings of containers
14 [g]	inorganic lies as well as alkaline hydrolyzing inorganic salts in aqueous solution (pH > 8), except ammonia solutions and oxidizing salt solutions (e.g. hypochlorite)	Sodium hydroxide (20 %) Sodium hydroxide (1 %) should be used additionally for testing inside coatings of containers
15 [g]	aqueous solutions of inorganic non-oxidizing salts with a pH value between 6 and 8	aqueous sodium chloride solution (20 %)
16	aqueous solutions of organic tensides	3 % solution of sodium laurylether sulfate $[C_{12}H_{25}\text{-}O\text{-}[(CH_2)_n\text{-}O]_m\text{-}SO_3]Na$ and sodium chloride in water 2 % of a fluid consisting of about 99 wt.-% [i] of a fat alcohol polyglycol ether $R\text{-}O(CH_2CH_2O)_nH$ (ethoxylation factor $n \approx 8$; as a mean value) in addition to small quantities of polymerized ethylene oxide (≤ 1 wt.-% [i]) 95 % water

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Table E.1 (*concluded*)

[a] Proof of suitability for group 1 is considered provided if tests with the test fluids of groups 5a or 5 and 7a or 7 have been passed.

[b] The tests shall be made with all test fluids. The suitability is only considered proven for this medium when testing only takes place with one test fluid.

[c] If the tests with groups 3 and 8 or 8b have been passed, the suitability for groups 3a and 3b applies additionally.

[d] Suitability for groups 2, 3, 3a, 4, 5a and 5b applies additionally providing the test with test fluid of group 5 has been passed.

[e] Suitability for groups 2, 3, 3a and 5b applies additionally providing the test with test fluid of group 5a has been passed.

[f] A test shall be made with the pure substance for acetone for load grade 6.

[g] Proceed as follows regarding practical testing if higher concentrations are to be permitted than specified in the groups:

a) If the tests with groups 12 and 12 a have been passed, the suitability for all concentrations or organic acids (carboxylic acids) in aqueous solution, except for formic acid > 10 % applies additionally.

b) For mineral acids of group 13 testing should take place within the scope of the suitability test on the one hand with the appropriate test fluid of the group and on the other hand with the maximum concentration desired by the applicant. As a result, this mineral acid is covered up to the tested maximum concentration but all other mineral acids belonging to the group only up to the concentration limit of the test fluid of the group.

c) Proof of suitability for group 15 is also considered provided if the tests with the test fluids of groups 13 and 14 have a positive outcome.

[h] vol.-%: volume fraction.

[i] wt.-%: mass fraction.

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Annex F
(normative)

Manufacture of test panels for coatings

Dimensions of the test panels: 200 mm × 300 mm × 40 mm.

A reinforcement of 6 longitudinal rods with a diameter of 4 mm with end hooks and 2 appropriate crossbars shall be installed towards the coating surface (Figure F.1). A steel wire with an elongation at break of about 25 % should be used. The concrete covering should be 1 cm. The reinforcement layer shall be fixed.

On the side facing away from the coating surface, the panels are given a continuous apparent join of triangular shape in the middle (Figure F.2).

The moulds are made of steel and have a PVC panel at the bottom. The walls shall be coated thinly with a mould separator.

The concrete mix shall be made in a dry state from round grain of particle size 0/8 according to EN 12620. The cement content of CEM I 32,5 R is z = 310 kg/m^3 and the content of coal ash f = 50 kg/m^3 concrete. A water cement value of 0.64 should be chosen. When allowing for the coal ash with k = 0,4 the following water bonding average value is given:

$w/(z + 0{,}4\,f)$ = 198 kg/m^3/(310 kg/m^3 + 0.4 × 50 kg/m^3) = 0,6

The consistency of the fresh concrete is in the range KS.

After pouring the mixture into the mould, the concrete is compressed on a vibrating table. The top of the panels is rubbed off with a wooden plank.

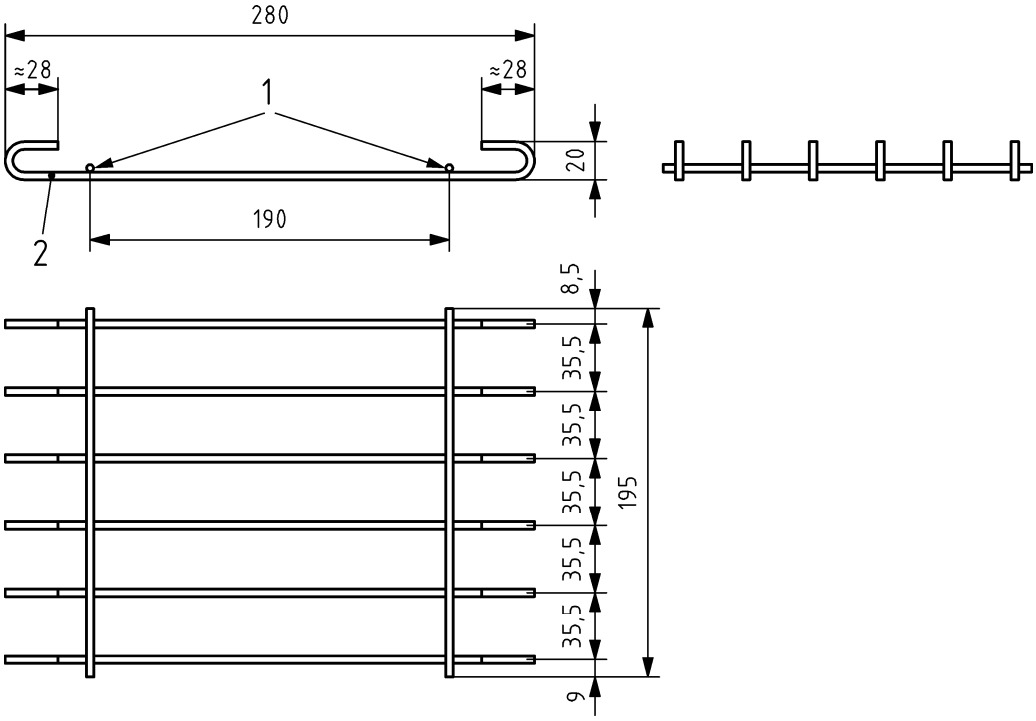
The test panels shall be stored according to 6.1 and 6.2 of EN 12350-1:1999 until their delivery. The separator is washed off after manufacture (before dispatch).

The concrete strength class shall be at least B 25.

Figure F.2 shows the test panel as it is manufactured for the coating on the area which lay on the mould. If the rubbed off area is to be coated, the reinforcement is at the top and the apparent join on the bottom.

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Dimensions in millimetres

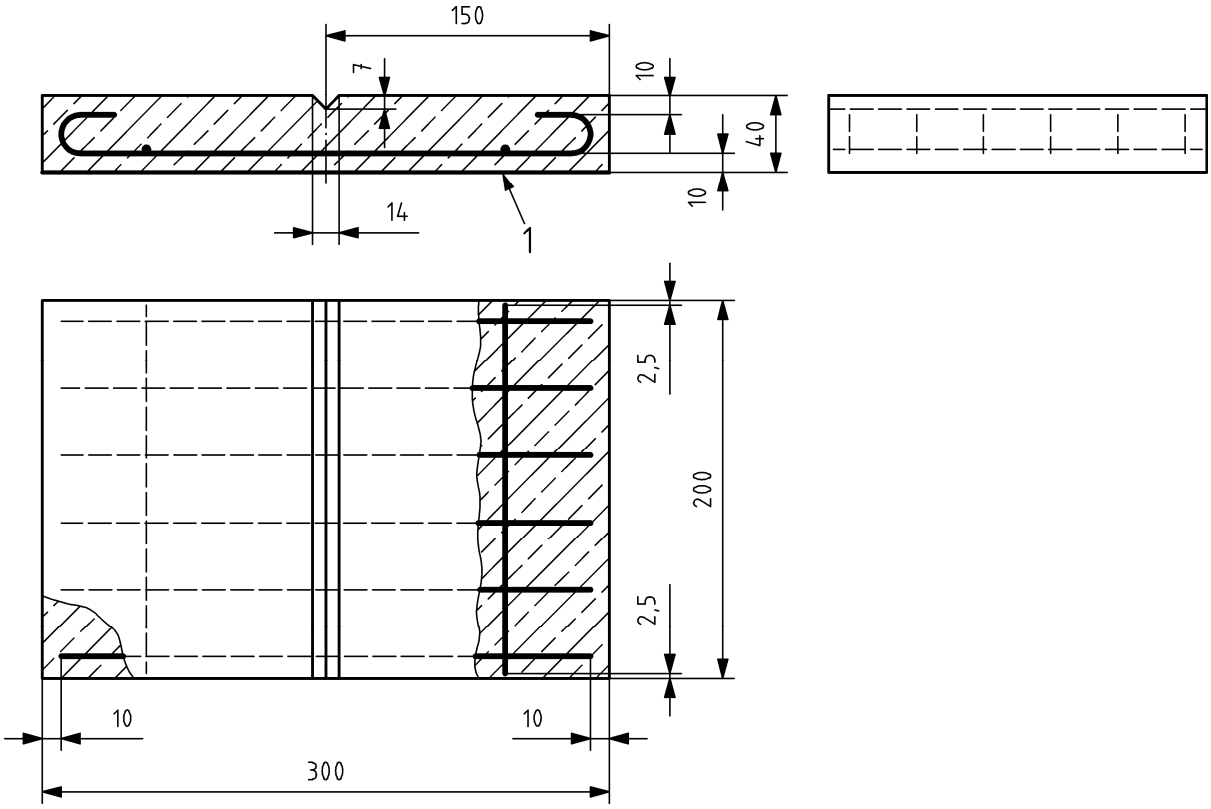


Key
1 spot welding
2 reinforcement steel ∅ 4 mm

Figure F.1 — Reinforcement of the sample panel

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Dimensions in millimetres



Key
1 side to be coated

Figure F.2 — Sample panel for testing coating materials and systems (coating on the surface which was on the mould)

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Annex G
(normative)

Testing the electrostatic dissipation capability

G.1 General

G.1.1 Dissipation resistance

The dissipation resistance shall be measured between a circular electrode of 50 mm diameter on the top of a sample and the grounding band integrated in the conductive layer.

G.1.2 Ground dissipating resistance

The ground dissipating resistance shall be measured between a circular electrode of 50 mm in diameter placed on the surface protection system and ground.

G.2 Testing the dissipation resistance of test samples

G.2.1 Instruments

— Resistance measuring instrument according to IEC 60093 with 100 V (DC);

— climate cabinet for conditioning the samples;

— circular measuring electrode of 50 mm diameter without protection ring;

— blotting paper or conductive rubber foil according to 7.7 of IEC 60093:1993 with 50 mm diameter.

G.2.2 Test procedure

The test samples shall be conditioned for 24 h in normal climate EN ISO 291, 23/50-2 according to ISO 554 prior to testing.

The measurement shall be made at 23 °C.

A blotting paper moistened with tap water or a foil of conductive rubber with a diameter of 50 mm should be placed on the surface of the sample body as a contact agent, the electrode placed flush and pressed down during the measurement with a force of about 10 N.

The resistance shall be measured between the electrode and the ground connection whereby the measuring positions shall be selected so that they are as far as possible away from the ground connection band.

G.2.3 Test report

The following shall be specified in the test report:

a) type of surface protection system;

b) material;

c) manufacturer;

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d) colour;

e) thickness of surface protection system;

f) dissipation resistance, single and average value;

g) conditioning conditions;

h) date of the test.

G.3 Measuring the ground dissipation resistance on the laid surface protection system

G.3.1 Instruments

See H.2.1 as well as a measuring instrument for temperature and relative humidity.

G.3.2 Preparation

The surface protection system shall be rubbed down with a dry cloth at the measuring point prior to testing.

G.3.3 Test procedure

The measurements can be carried out 4 weeks after applying the surface protection system at the earliest. The measurements can only be made on areas on which you can walk or drive (except container linings).

The blotting paper moistened with tap water or the rubber foil shall be placed on the prepared measuring point, the electrode placed flush and pressed down during the measurement with a force of about 10 N.

The ground dissipation resistance is measured between the electrode and the ground potential of the system.

The number of measurements shall be selected according to Table G.1.

Table G.1 — Number of measurements of the ground dissipation resistance

Area of the laid surface protection system m²	Number of measurements
below 10	1 measurement/1 m²
10 to 100	10 to 20 measurements
above 100	10 measurements/100 m²

— Ground dissipation resistance: at ambient temperature, the following maximum measured values are permitted:

— up to 50 % relative humidity: $1 \times 10^8\ \Omega$;

— above 50 % to 70 % relative humidity: $1 \times 10^7\ \Omega$;

— above 70 % relative humidity: $1 \times 10^6\ \Omega$.

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G.3.4 Test report

The following shall be specified in the test report:

a) type of surface protection system;

b) material;

c) manufacturer;

d) colour;

e) thickness of the surface protection system;

f) application date;

g) location and position of the surface protection system;

h) temperature and relative humidity;

i) number of measuring points;

j) ground dissipation resistance for every measuring point, in ohms;

k) scale drawing with the measuring points and the corresponding measuring results;

l) substrate data;

m) deviations from this standard;

n) date of the test.

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Annex H
(informative)

Information to be given by the coating material manufacturer

Table H.1 — Information to be given by the coating material manufacturer

Material characteristics	Binder used
	Solids content (expressed as percentage by volume or mass)
	Non-volatile matter content
	Viscosity or flow time
	Density
	Colour
	Mixing ratio
	Gel time
	Minimum shelf life and storage conditions
	Reference to hazards involved (e.g. marking in accordance with national regulations
Processing	Ambient conditions (e.g. ambient temperature, material temperature, dew point, relative humidity)
	Safety requirements for storage, processing and disposal
	Surface preparation of component material (e.g. ferritic steel, austenitic steel, non-ferrous metals)
	Mixing ratio and procedure
	Coating method (laminating, trowelling, spraying)
	Pot life and relevant temperature
	Thermal treatment
	Curing time and relevant temperature
	Processing time (for processes with several steps)
	Repairs
Container marking	Identification of manufacturer or supplier
	Product designation, trade name
	Classification
	Batch number
	Date of manufacture
	Minimum shelf life
	Colour
	Storage conditions
	Weight and volume

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A-Deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN/CENELEC member.

Comments on EN 14789-3 – National legislative/administrative deviations

In Germany construction products for stationary plants for the storage, filling and loading/unloading of water-hazardous substances require national technical verification with respect to section 1 No. 2 Model Water Construction Products Code.

A Verification of applicability (e.g. a allgemeine bauaufsichtliche Zulassung ('national technical approval')) is required for interior coatings for containers and pipes and for coatings which are used for other facilities in plants for the storage, filling and loading/unloading of water-hazardous substances.

Coatings for collecting rooms made of concrete used for heating oil, unused combustion engine oils, unused vehicle gear oils and mixtures of saturated and aromatic hydrocarbons with an aromatic content of ≤ 20 wt.% and a flash point > 55°C require a allgemeines bauaufsichtliches Prüfzeugnis ('national test certificate') according to Bauregelliste A Teil 2, lfd. Nr. 2.15 ('Construction Products List A part 2, No. 2.15').

Further regulations for the application of these products in Germany are given by water legislation (Verordnungen über Anlagen zum Umgang mit wassergefährdenden Stoffen ('Acts for plants for the handling of water-hazardous substances'), Technische Regeln wassergefährdender Stoffe (TRwS, 'technical rules water-hazardous substances')), especially in

TRwS 779 Allgemeine Technische Regelungen ('General Technical Rules') and

TRwS 786 Ausführung von Dichtflächen ('Execution of liquid-tight areas').

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