
**Ceramic tiles — Grouts and
adhesives —**

**Part 6:
Requirements, test methods,
evaluation of conformity, classification
and designation for waterproof
membranes used with the installation
of ceramic tiles**

Carreaux céramiques – Mortiers de joints et colles —

*Partie 6: Exigences, méthodes d'essai, évaluation de la conformité,
classification et désignation des membranes d'étanchéité utilisées
pour l'installation des carreaux céramiques*



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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 189, *Ceramic tile*.

A list of all parts in the ISO 13007 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ceramic tiles — Grouts and adhesives —

Part 6:

Requirements, test methods, evaluation of conformity, classification and designation for waterproof membranes used with the installation of ceramic tiles

1 Scope

This document applies to all bonded sheet waterproofing membranes that are used beneath ceramic tiling for internal and external tile installations on walls and floors.

This document provides the terminology concerning the products and specifies the test methods and the values of performance requirements for bonded sheet waterproofing products associated with tile adhesives.

Furthermore, this document specifies the evaluation of conformity and the classification and designation of all bonded sheet waterproofing products beneath ceramic tiling.

NOTE 1 Bonded sheet waterproofing products can also be used beneath other types of tiles (natural and agglomerated stones etc.), where they do not adversely affect these materials.

NOTE 2 This document does not address crack isolation, decoupling, sound control, thermal properties, or any aspect of membranes apart from waterproofing.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 13006, *Ceramic tiles — Definitions, classification, characteristics and marking*

ISO 13007-1, *Ceramic tiles — Grouts and adhesives — Part 1: Terms, definitions and specifications for adhesives*

ISO 13007-2, *Ceramic tiles — Grouts and adhesives — Part 2: Test methods for adhesives*

ISO 15605, *Adhesives — Sampling*

EN 197-1, *Cement — Part 1: Composition, specifications and conformity criteria for common cements*

EN 480-1:2014, *Admixture for concrete, mortar and grout — Test methods — Part 1: Reference concrete and mortar for testing*

EN 1008, *Mixing water for concrete — Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete*

EN 1067, *Adhesives — Examination and preparation of samples for testing*

EN 1931, *Flexible sheets for waterproofing — Bitumen, plastic and rubber sheets for roof waterproofing — Determination of water vapour transmission properties*

EN 12390-2, *Testing hardened concrete — Part 2: Making and curing specimens for strength tests*

EN 12620, *Aggregates for concrete*

ASTM E96, *Standard Test Methods for Water Vapor Transmission of Materials*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

bonded sheet waterproofing membrane

BM

single- or multi component waterproofing membrane applied as a preformed sheet in a uniform layer or layers, beneath ceramic tiling in such a manner as to be bonded to the substrate as well as the tile according to manufacturer's instructions

Note 1 to entry: The final waterproofing membrane may include a separately applied seam sealer.

Note 2 to entry: The bonded sheet waterproofing membrane can be flat or structured with a geometric configuration.

3.2

primer

liquid coating applied to the surface, prior to the application of a bonded sheet waterproofing product, to improve adhesion and durability of the bond between the substrate and the membrane

4 Requirements

The bonded sheet waterproofing membrane products shall comply with the characteristics specified in [Table 1](#).

[Table 2](#) gives the additional characteristics that might be required for special service conditions.

The tile adhesive used for evaluation should be the same for all testing performed in a series, a C2S1 adhesive being recommended. The amount of water and/or liquid admixture required for preparing the adhesives used to affix to the sheet membrane shall be the same for all tests.

Table 1 — Product requirements — Fundamental characteristics

Characteristic	Requirement	Test method
Initial tensile adhesion strength	$\geq 0,2 \text{ N/mm}^2$	A.6.2
Tensile adhesion strength after water contact	$\geq 0,2 \text{ N/mm}^2$	A.6.3 or A.6.4
Tensile adhesion strength after heat ageing	$\geq 0,2 \text{ N/mm}^2$	A.6.5
Tensile adhesion strength after freeze-thaw cycles	$\geq 0,2 \text{ N/mm}^2$	A.6.6
Tensile adhesion strength after contact with lime water	$\geq 0,2 \text{ N/mm}^2$	A.6.9
Water permeability	No visual penetration below membrane and $\leq 3,0 \text{ g}$ weight gain when tested at a seam	A.7
Fundamental characteristics are the characteristics that a bonded sheet waterproofing membrane product always needs to have.		

Table 2 — Product requirements — Optional characteristics

Characteristic	Requirement	Test method
Enhanced adhesion (BM2 rating) – All tensile strengths listed above	$\geq 0,5 \text{ N/mm}^2$	
Low water vapour permeance (W rating)	$< 1,0 \text{ Perm}$	A.8
Tensile adhesion strength after contact with chlorinated water (P rating)	$\geq 0,5 \text{ N/mm}^2$	A.6.7 or A.6.8
Optional characteristics are characteristics for specific service conditions where enhanced levels of performance are required, or which provide further information about its general performance.		

5 Classification and designation

The bonded sheet waterproofing membranes are classified according to the conformity with fundamental or optional characteristics from [Tables 1](#) and [2](#):

BM1 Bonded sheet waterproofing membrane;

OR

BM2 Enhanced adhesion bonded sheet waterproofing membrane.

NOTE Membranes not meeting the minimum tensile adhesion requirements of [Tables 1](#) and [2](#) are considered unbonded membranes.

It is possible to have different classes, related to the different optional characteristics given in [Table 2](#). These classes are designated by the following abbreviations:

P resistant to contact with chlorinated water (i.e. for use in swimming pools);

W resistant to water vapour permeation.

The product is designated by the symbol BM1 or BM2, followed by the abbreviation of the optional characteristics it has. [Table 3](#) describes the designation of the products types and classes which shall be used.

Table 3 — Classification and designation of bonded sheet waterproofing membranes

SYMBOL		DESCRIPTION
TYPE	CLASS	
BM1 or 2		Normal or enhanced adhesion bonded sheet waterproofing membrane
BM1 or 2	P	Normal or enhanced adhesion bonded sheet waterproofing membrane resistant to contact with chlorinated water
BM1 or 2	W	Normal or enhanced adhesion bonded sheet waterproofing membrane with low water vapour permeance
BM1 or 2	PW	Normal or enhanced adhesion bonded sheet waterproofing membrane with low water vapour permeance and resistance to contact with chlorinated water

6 Marking and labelling

Products conforming with the requirements of this document shall be clearly marked with the following information:

- a) name of the product;
- b) manufacturer's mark and place of origin;
- c) date or code of production, shelf life and conditions of storage;
- d) number of this document, i.e. ISO 13007-6, and date of issue;
- e) type of product according to [Clause 6](#) (using symbols given in [Clause 6](#));
- f) instructions for use:
 - substrate bonding materials required to adhere sheet membrane to substrate;
 - mode of application (including recommended primer and/or surface preparation);
 - minimum quantity or thickness of the adhesive product;
 - maturing time for initial membrane bonding to substrate (where applicable);
 - delay for installing ceramic tiles;
 - suitable tile adhesive(s) (type and class in accordance with ISO 13007-1);
 - field of application (internal, external, wall, floor etc.).

NOTE In the designation of a sheet waterproofing membrane, information about special properties can be included when the product is intended for use in specific applications.

This information shall be marked on the packaging and/or on the product's technical data sheet.

This does not remove the requirement that all manufacturers claiming conformity with this document should state declared values for the properties of their products, when required.

Annex A (normative)

Test methods

A.1 Sampling

A.1.1 Tile adhesive

Take a sample of at least 2 kg of the product to be tested in accordance with ISO 15605 and EN 1067.

A.1.2 Membrane

Cut a sample of at least 1 m² of the membrane to be tested. Avoid using membrane material from too close to the edge of the sheet.

A.1.3 Other: membrane adhesive (if required), primer (if required), seam sealer (if required)

Obtain a full unit of any of these materials if required.

A.2 Test conditions

Standard conditions shall be $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity (RH) and a circulation of air in the working area less than 0,2 m/s.

When the test specimens have to be conditioned according to the test method, the tolerances in the time of conditioning for all test specimens shall be as follows:

Conditioning	Tolerance
24 h	$\pm 0,5$ h
7 d	± 3 h
14 d	± 6 h
21 d	± 9 h
28 d	± 12 h

A.3 Test materials

A.3.1 General

Condition all test materials for at least 24 h under standard conditions. The materials to be tested shall be within their shelf life.

A.3.1.1 Sheet waterproofing membrane

The sheet waterproofing membrane is any self-bonded (peel and stick) or bonded sheet waterproofing membrane to be evaluated within this document.

A.3.1.2 Membrane adhesive

The membrane adhesive used is as recommended by the waterproofing membrane manufacturer.

A.3.1.3 Primer

The primer is used if applicable and requested by the manufacturer of the sheet waterproofing membrane.

A.3.1.4 Seam sealer

The seam sealer is used if applicable and requested by the manufacturer of the sheet waterproofing membrane.

A.3.1.5 Tile adhesive

The tile adhesive used for evaluation should be the same for all testing performed in a series, a C2S1 adhesive being recommended.

A.3.2 Ceramic tiles

The tiles shall be clean and dry.

The tiles used for this method shall be of:

- **type BI_a**: fully vitrified tile conforming to ISO 13006 with one side visually flat and no surface treatment, with a water absorption $\leq 0,5$ % by mass, unglazed and with a plain adhering surface, with facial dimensions of (50 ± 1) mm $\times$ (50 ± 1) mm for testing flat membranes.
- **type BI_a**: fully vitrified tile conforming to ISO 13006 with one side visually flat and no surface treatment, with a water absorption $\leq 0,5$ % by mass, unglazed and with a plain adhering surface, with facial dimension of (100 ± 1) mm $\times$ (100 ± 1) mm for testing geometrically configured membranes.

A.3.3 Test substrate

A.3.3.1 Concrete slab

The concrete slab shall comply with ISO 13007-2.

A.3.3.2 Other substrates (optional)

Other substrates may be used upon agreement if the substrate is recommended for the ceramic tile application by the membrane manufacturer. To demonstrate compatibility with other optional substrates, the product shall be applied to the selected substrate in accordance with the initial adhesion test method (A.6.2). When a result of more or equal to $\geq 0,2$ N/mm² is achieved or cohesive failure occurs in the substrate, the requirement is considered satisfied.

A.3.4 Ceramic tile adhesive

The ceramic tile adhesive shall comply with ISO 13007-1.

A.3.5 Sodium hypochlorite

Analytical or technical grade sodium hypochlorite is used.

A.4 Apparatus

A.4.1 Weight

A weight with a cross sectional area less than or equal to 100 mm $\times$ 100 mm, capable of exerting a force of $(20 \pm 0,05)$ N.

A.4.2 Pull head plates

Square metallic plates, with dimensions of less than or equal to 100 mm × 100 mm and a minimum thickness of 10 mm with a suitable fitting for connection to the test machine.

A.4.3 Machine for pull testing

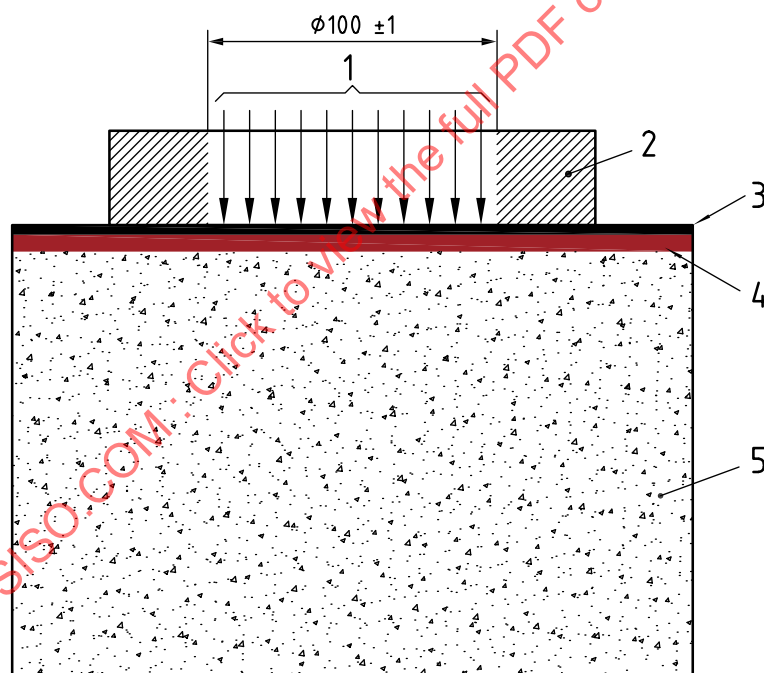
A test machine for direct pull tensile force test and with suitable capacity and sensitivity for the test. The machine shall be capable of applying the load to the pull-head plate at the rate of (250 ± 50) N/s through a suitable fitting that does not exert any bending force.

A.4.4 Air-circulating oven

An air-circulating oven capable of controlling the temperature to within ± 3 °C.

A.4.5 Equipment for water pressure permeability test

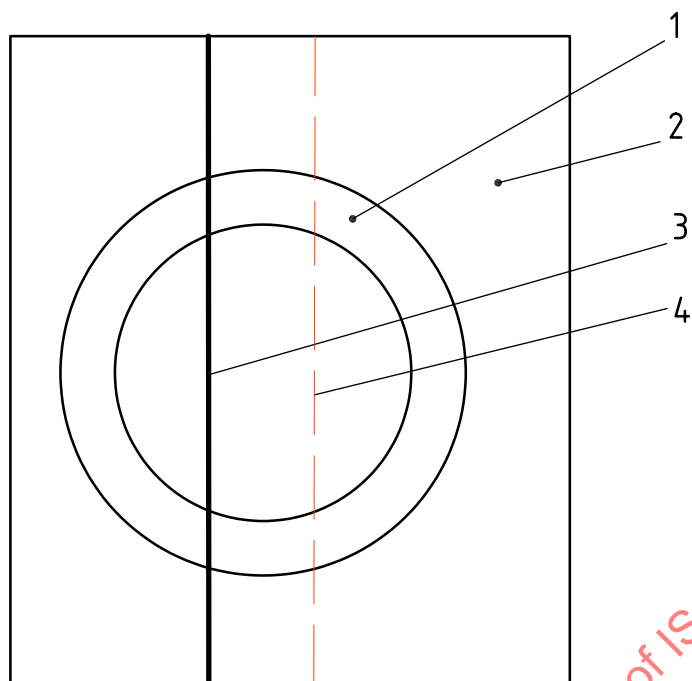
Any equipment which permits the specified specimen (A.7) to be placed in such a way that the water pressure acts from above the specimen. The machine shall permit the unexposed faces to be observed to detect any possible sign of water permeation (see Figure A.1). The internal diameter of the sealing ring shall be (100 ± 1) mm.



Key

- 1 water pressure
- 2 sealing ring
- 3 bonded sheet, waterproofing membrane
- 4 adhesive layer
- 5 concrete slab

Figure A.1 — Typical arrangement for determining water permeability



Key

- 1 pressure ring
- 2 bonded membrane
- 3 membrane seal edge
- 4 enclosed/hidden membrane edge

Figure A.2 — Top View of permeability test specimen showing membrane seam

A.4.6 Machine for tensile testing

A machine for tensile testing, for direct pull tensile force test and with suitable capacity and sensitivity for the test. The machine shall be capable of applying the load to the pull-head plate at the rate of (250 ± 50) N/s through a suitable fitting that does not exert any bending force.

A.5 Application of bonded sheet waterproofing membrane

To prepare the testing specimens as directed, follow all of the manufacturer's instructions for the bonding of the sheet membrane to the test block or permeability test substrate.

Allow all adhesives used to bond the sheet membrane to cure for the amount of time recommended by the manufacturer before the application of the tile adhesive.

A.6 Adhesion tests

A.6.1 Preparation of test pieces

Apply the bonded sheet waterproofing membrane to the surface of the substrate ([A.3.3](#)) in accordance with the manufacturer's instructions, including a primer if required.

Before applying the tile adhesive, allow the membrane covered concrete slabs to dry under standard conditions for at least 24 h, unless the manufacturer gives different instructions.

Apply a thin layer of the tile adhesive to the bonded sheet waterproofing membrane product with a straight edge trowel. Then apply a thicker layer and comb with a notched trowel having 6 mm × 6 mm notches at 12 mm centres.

For flat membranes, after 5 min place nine type BI_a tiles on the adhesive at a distance of 50 mm apart from each other and load each tile with $(20 \pm 0,05)$ N for 30 s.

For geometrically configured membranes, after 5 min place two to four type BI_a tiles on the adhesive at a distance of 50 mm apart from each other and load each tile with $(20 \pm 0,05)$ N for 30 s. The number of type BI_a tiles depends on the size of the substrate block; several specimen blocks might be necessary.

The trowel shall be held at an angle of approximately 60° to the substrate at a right angle to one edge of the slab and drawn across the slab parallel to that edge, in a straight line. The adhesive between the tiles must not be removed.

A.6.2 Initial adhesion

Prepare the test pieces in accordance with [A.6.1](#).

After 27 d, bond the pull head plates to the tiles with a suitable high strength adhesive (e.g. epoxide).

After a total of 28 d storage under standard conditions, determine the tensile adhesion strength by applying a force at a constant rate of (250 ± 50) N/s. Before the bond strength is determined, the sample surface shall be cut through to the surface of the concrete slab, around the perimeter of each tile.

Report the results in newtons (N) and express the tensile adhesion strengths following [A.6.10](#).

A.6.3 Adhesion strength after water contact

Prepare the test pieces in accordance with [A.6.1](#). Then, form an upstand, approximately 10 mm high, around the perimeter of the upper surface of the coated slab by applying, for example, a bead of silicone sealant. Condition the test pieces under standard conditions for 7 d.

Fill the reservoir formed by the sealant upstand to about 6 mm depth of water at the standard temperature. After 20 d, during which time the water level should be maintained at about 6 mm, pour away the water and wipe the surface of the test piece tiles dry with a cloth, before bonding the pull head plates to the tiles. After a further 7 h, fill the reservoir with a 6 mm depth of water at the standard temperature once again.

The following day pour away the water and immediately carry out the tensile adhesion test in accordance with [A.6.2](#).

Report the results in newtons (N) and express the tensile adhesion strengths following [A.6.10](#).

A.6.4 Alternative method for adhesion strength after water contact

Prepare the surface of the test pieces in accordance with [A.6.1](#).

All remaining faces of the slab, including the underside, shall then be sealed with an impervious, waterproof coating material, such as an epoxide or polyester based product, ensuring complete integrity of the coating on all the edges and at the junction with the bonded sheet waterproofing membrane on the upper face.

Condition the test pieces under standard conditions for 7 d and immerse them in water at the standard temperature.

After 20 d remove the test pieces from the water, wipe with a cloth and bond the pull head plates to the tiles. After a further 7 h immerse the test pieces in water at the standard temperature.

The following day remove the test pieces from water and immediately carry out the tensile adhesion test in accordance with [A.6.2](#).

Report the results in newtons (N) and express the tensile adhesion strengths following [A.6.10](#).

A.6.5 Adhesion strength after heat ageing

Prepare the test pieces in accordance with [A.6.1](#).

Condition the test pieces under standard conditions for 14 d and then place them in an air-circulating oven at $(70 \pm 3) ^\circ\text{C}$ for a further 14 d. Remove from the oven and bond the pull head plates to the tiles with a suitable high strength adhesive (e.g. epoxide).

Condition the test pieces for a further 24 h under standard conditions. Determine the tensile adhesion strength in accordance with [A.6.2](#).

Report the results in newtons (N) and express the tensile adhesion strengths following [A.6.10](#).

A.6.6 Adhesion after freeze-thaw

Prepare the surface of the test pieces in accordance with [A.6.1](#). In addition, a layer of the adhesive approximately 1 mm thick shall be applied with a straight edge trowel to the back face of the type BI_a tile before placing them on the substrate.

All remaining faces of the slab, including the underside, shall then be sealed with an impervious, waterproof coating material, such as an epoxide or polyester based product, ensuring complete integrity of the coating on all the edges and at the junction with the bonded sheet waterproofing membrane on the upper face.

Condition the test pieces for 7 d under standard conditions, followed by immersing in water for 21 d before carrying out 25 freeze-thaw cycles.

For each freeze-thaw cycle:

1. remove the test pieces from the water and lower the temperature to $(-15 \pm 3) ^\circ\text{C}$ within $2 \text{ h} \pm 20 \text{ min}$;
2. maintain the test pieces at $(-15 \pm 3) ^\circ\text{C}$ for $2 \text{ h} \pm 20 \text{ min}$;
3. immerse in water at $(20 \pm 3) ^\circ\text{C}$ and raise the temperature to $(15 \pm 3) ^\circ\text{C}$ and maintain this temperature for a minimum of 2 h before commencing the next freeze/thaw cycle.

Repeat the cycle 25 times. After the last cycle wipe the surface of the tiles with a cloth and bond the pull head plates to the tiles. Allow the test pieces to reach standard conditions for at least 7 h and then determine the tensile strength in accordance with [A.6.2](#).

Report the results in newtons (N) and express the tensile adhesion strengths following [A.6.10](#).

A.6.7 Adhesion after contact with chlorinated water

Prepare the test pieces in accordance with [A.6.1](#) and form the reservoir in accordance with [A.6.3](#).

Condition for 28 d before pouring an approximate 6 mm depth of chlorinated water into the reservoir. After 7 d pour away the chlorine water, rinse with clean tap water, wipe with a cloth and bond the pull head plates to the tiles. After a further 24 h under standard conditions, carry out the tensile adhesion test in accordance with [A.6.2](#).

Report the results in newtons (N) and express the tensile adhesion strengths following [A.6.10](#).

The testing solution, with a chloride and sulphate content of 200 mg/l each, shall be prepared with the addition of sodium chloride and sodium sulphate to fresh water.

The water shall be chlorinated by addition of pure sodium hypochlorite ([A.3.5](#)).

The chlorinated water concentration shall be kept constant within the range 0,3 mg/l to 0,6 mg/l checking the active chlorine content in water by titration (ISO 7393-3).

The pH value shall be determined daily and shall be kept in the range 6,5 to 7,8; any correction required should be carried out by increasing pH with the addition of sodium hydroxide, or by decreasing it with the addition of hydrochloric acid, daily.

The immersion time of the test pieces shall be extended for the time the active chlorine content was below the limit value of 0,3 mg/l (for example on Sundays and holidays).

A.6.8 Alternative method for adhesion after contact with chlorinated water

Prepare the surface of the test pieces in accordance with [A.6.1](#).

All remaining faces of the slab, including the underside, shall then be sealed with an impervious, waterproof coating material, such as an epoxide or polyester based product, ensuring complete integrity of the coating on all the edges and at the junction with the bonded sheet waterproofing membrane product on the upper face.

Condition the test pieces under standard conditions for 28 d and immerse them in chlorinated water at the standard temperature.

After 7 d remove the test pieces from the chlorinated water, wipe with a cloth and bond the pull head plates to the tiles.

After a further 24 h under standard conditions, carry out the tensile adhesion test in accordance with [A.6.2](#).

Report the results in newtons (N) and express the tensile adhesion strengths following [A.6.10](#).

The testing solution, with a chloride and sulphate content of 200 mg/l each, shall be prepared with the addition of sodium chloride and sodium sulphate to fresh water.

The water shall be chlorinated by addition of pure sodium hypochlorite ([A.3.5](#)).

The chlorinated water concentration shall be kept constant within the range 0,3 mg/l to 0,6 mg/l checking the active chlorine content in water by titration (ISO 7393-3).

The pH value shall be determined daily and shall be kept in the range 6,5 to 7,8; any correction required should be carried out by increasing pH with the addition of sodium hydroxide, or by decreasing it with the addition of hydrochloric acid, daily.

The immersion time of the test pieces shall be extended for the time the active chlorine content was below the limit value of 0,3 mg/l (for example on Sundays and holidays).

A.6.9 Adhesion after contact with lime water

Prepare the test pieces in accordance with [A.6.1](#). All remaining faces of the slab, including the underside, shall then be sealed with an impervious, waterproof coating material, such as an epoxide or polyester based product, ensuring complete integrity of the coating on all the edges and at the junction with the bonded sheet waterproofing membrane on the upper face.

Condition the test piece under standard conditions for 28 d and then immerse them in saturated lime water (pH $\geq$ 12) at 40 °C.

After 7 d remove the test pieces from the lime water, rinse with clean water, wipe with a cloth and bond the pull head plates to the tiles. After a further 24 h under standard conditions, carry out the tensile adhesion test in accordance with [A.6.2](#).

Report the results in newtons (N) and express the tensile adhesion strengths following [A.6.10](#).

A.6.10 Evaluation and expression of the results

The individual tensile adhesion strength is determined to an accuracy of $\pm 0,1 \text{ N/mm}^2$ using the following formula:

$$S = L / A$$

where

S is the individual tensile adhesion strength in N/mm^2 ;

L is the total load in N;

A is the bonding area in mm^2 (example, $100 \text{ mm} \times 100 \text{ mm} = 10\,000 \text{ mm}^2$).

The tensile adhesion strength for each set of conditions is determined as follows:

- determine the mean of the nine values;
- discard the values falling out of the range of $\pm 20 \%$ from the mean value;
- if five or more than five values remain, determine the new mean value;
- if less than five values remain, repeat the test;
- determine the mode of failure of the test pieces.

A.7 Water permeability

Test according to EN 14891.

The test sample is based on a permeable concrete substrate sealed in all lateral faces apart from the test area, covered across the surface with the bonded sheet waterproofing membrane, where a water pressure shall be applied. The applied membrane must include a seam prepared as specified by the manufacturer and placed as shown in [Figure A.2](#). The specimen is weighed after coating and before testing for water permeance and weighed again after testing.

The substrate is a slab with minimum dimension $150 \text{ mm} \times 150 \text{ mm} \times 100 \text{ mm}$ prepared using a water permeable concrete and with a plane surface ([Figure A.1](#)). In order to have a permeable concrete it is necessary to use a water/cement ratio ≥ 1 . The concrete shall be manufactured according to the following mix-design:

- | | |
|--|-----------------------|
| — CEM 32,5 R or 42,5 R type I, II, III and IV according to EN 197-1 | 250 kg/m^3 |
| — aggregate with particle size range 0 mm to 16 mm according to EN 12620 | 1 750 kg/m^3 |
| — mixing water according to EN 1008 | 250 kg/m^3 |

NOTE In case of bleeding, the addition of a water retaining admixture, according to EN 934-2, can be used. The particle size distribution of the aggregate is in compliance with the continuous grading curve in [Figure A.3](#).