TECHNICAL SPECIFICATION

**ISO/TS 16774-5**

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# Test methods for repair materials for water-leakage cracks in underground concrete structures —

## Part 5: Test method for watertightness

*Méthodes d'essai pour matériaux de réparation pour fissures dues à l'eau dans les structures en béton —*

*Partie 5: Méthode d'essai de l'étanchéité à l'eau*



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# Foreword

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The committee responsible for this document is ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 7, *Maintenance and repair of concrete structures.*

A list of all parts in the ISO 16774 series can be found on the ISO website.



# Introduction

ISO/TR 16475 outlines six basic properties and the required performance levels of water-leakage repair materials, and ISO/TS 16774-1 through ISO/TS 16774-6 provide test methods designed to evaluate the respective properties of these repair materials.

These test methods are intended to serve as references for nations that have not yet developed a test method on the six proposed required performance properties of water leakage repair materials. If other forms of test methods that are simpler, more accurate or more organized are available, such methods are recommended for use instead.

Many of the dependent variables outlined in the ISO 16774 series of reference test methods are subject to change in accordance with the environmental conditions (temperature; chemical substance and concentration; relative humidity; width of movement activity; water pressure or water flow velocity, etc.) outlined in the standards and testing parameters used in respective countries.

In ISO/TS 16774-1, ISO/TS 16774-5 and ISO/TS 16774-6, for the purpose of objectively comparing the performance of injected repair materials, artificial cracks of same volume were used to control the usage of repair materials for each testing cycle and enable repetition of the same test methods under the same conditions.

# Test methods for repair materials for water-leakage cracks in underground concrete structures —

# Part 5:
# Test method for watertightness



## 1 Scope

This document specifies a laboratory test method for evaluating watertightness of water-leakage crack repair materials through permeability testing.

These permeability test procedures follow applied conditions outlined in different national testing parameters and requirements. As such, the results are only intended to provide a comparative performance evaluation of the waterproofing repair materials between different products of the same type of repair material.

This document outlines general guidelines and procedures for the test method. Specific variables that control the quantifiable parameters of the testing are filled in using relevant national standardizations and/or testing parameters.

NOTE 1 This test method classifies and categorizes materials that are tested into families of similar properties for the purpose of making relative comparisons with the data results.

NOTE 2 Each individual repair material can be further tested in an actual construction site application for a complete assessment.

## 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/TR 16475, *Guidelines for the repair of water-leakage cracks in concrete structures*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 16475 and the following apply.

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

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org.obp

**3.1**
**repair material**
<water-leakage cracks>material used for preventing the escape of water at cracks in concrete

EXAMPLE Injection type grouts, such as synthetic rubberized asphalt, mastic, urethane, poly-urea, etc.

Note 1 to entry: In this document, target ingredients are limited to injection materials outlined in ISO/TR 16475.

## 4 Principle

Impermeability to water pressure is one of the fundamental properties that water-leakage repair materials should possess. Property changes in the repair material due to the applied hydro-static pressure can influence the repair material's performance and lead to waterproofing failure. The test method in this document evaluates the watertightness properties of repair materials injected into a test specimen with an artificial crack through a permeability test (checking for leakage with a specified amount of water pressure), thereby assessing the material's performance in a qualitative method.

## 5 Apparatus

**5.1 Air compressor**, which should be able to handle minimum air pressure value of 0,1 $N/mm^2$ to 0,3 $N/mm^2$.

**5.2 Permeability test chamber**, which should be able to handle minimum water pressure value of 0,1 $N/mm^2$ to 0,3 $N/mm^2$ (output method).

NOTE Conditions outlined in 5.1 and 5.2 are subject to change in accordance with different national testing parameters and requirements.

## 6 Preparation of the test specimen and artificial crack conditions

1) Two separate concrete or mortar substrate parts should be cured to form a water-leakage crack test specimen. The parts consist of upper and bottom parts, and they should be flat and cylindrical in shape and made using concrete or mortar.

   NOTE The mix proportion is (water: cement: fine aggregate = 1: 2: 6, mass ratio). Curing period for the mortar or concrete substrate parts is approximately 72 h, but can also be subject to change in accordance with different national testing parameters and requirements.

2) The bottom substrate is drilled with evenly spaced holes (Ø2,5 mm) near the centre of the substrate. The pinholes shall be drilled all the way through from one surface of the substrate part to the other.

   NOTE The purpose of these pinholes is to check for signs of leakage during repair material injection and during permeability testing.

3) Spacers are placed on one surface of the bottom substrate part without covering the pinholes, and the upper substrate part is placed on top of the spacers. The substrate parts, now having formed the test specimen with the artificial crack, are held together with tape, silicone sealants or other applicable materials along the exterior side. The spacer height represents the width of the crack and can vary depending on the different national testing parameters and requirements.

   NOTE Any material can be used to hold the two substrate parts together with a crack space in between, but they should leave an inlet in one side for material injection.

4) The injection space should be flushed out with water before injecting the repair material to remove any debris as well as to verify that the interior mortar surface is sufficiently wet for repair material injection. After making sure the substrate parts are held together tightly, place the test specimen under water for a specified amount of time. After taking the specimen out of the water, inject the repair material into the specimen.

   The injection method varies according to different national testing parameters and requirements. If manufacturer's instructions are available, employment of this method is recommended. If debris and other substances are present they should be removed prior to material application.

NOTE For detailed and clearer explanation, refer to Annex A.

## 7 Procedure

1) Place the specimen in the permeability test chamber.

   NOTE The procedure outlined will follow the steps required for the output method of this permeability test. Other methods, if applicable, can be used for this step.

2) Fill the chamber with water. Connect the air compressor valves to the air compression chamber.

3) Run the permeability test.

   NOTE Water/air pressure values are subject to change in accordance with different national test parameter requirements.

4) Observe and record to see if there is leakage or not with the test specimen.

   Photos of the specimen and equipment conditions shall be taken at every stage possible during each and every test procedure for recording and information purposes.

NOTE For detailed and clearer explanation, refer to Annex A.

## 8 Presentation of results

The results of the repair material evaluation are based on a qualitative assessment of whether the tested material fails its waterproofing performance and leaks under a water pressure value outlined in the applied national test parameters and requirements. These results can be used in the future as a data base for a guideline on selecting appropriate repair materials with the required watertightness properties in leakage crack surfaces of underground concrete structures.

## 9 Test report

### 9.1 Information on the repair material of the test target

#### 9.1.1 General

The test report should record the following information on the repair material of the test target:

1) Producer (name, address, phone number).

2) Production date, time, place of the repair material.

3) Type, storage method and authentication of the repair material.

4) Manufacturer's product instructions and relevant repair material guidelines.

5) Data on the chemical composition of repair material as indicated in manufacturer's data sheet.

#### 9.1.2 Other information

The following information is recorded on demand, if required:

1) Project of the test target.

2) Application areas of the test specimen.

3) Result of some eco-toxicological performance tests to account for the release of hazardous substances and the subsequent effects on health and safety.

## 9.2 Information on the test

The test report should record the following information on the test:

1) Test manager.
2) Name, purpose of the test.
3) Ambient condition of the lab (temperature, relative humidity, safety conditions etc.).
4) Production time and place of the specimens.
5) Shape and size of the specimens, and the number of replicates of the specimens for repeat test.
6) Identification of the specimens (Lot No. etc.).
7) Curing and storage conditions.
8) Information on the test repair material (name, producer, validity etc.).
9) Test data (production, measurement, test period etc.).
10) Type of facilities, equipment, tools.
11) Status of test equipment, tools.
12) Test results.
13) Details on other test programmes and procedures.

# Annex A
(informative)

# Example test method

## A.1 Principle

This example test method evaluates the watertightness performance of a repair material injected into a test specimen with an artificial crack. The test specimen undergoes permeability testing where the repair material will be placed under a hydrostatic water pressure of approximately 0,1 N/mm$^2$ to 0,3 N/mm$^2$ for one hour to determine the permeability properties of the tested repair material.

This example test method employs test parameters and environmental conditions outlined in the test standards used in Korea.

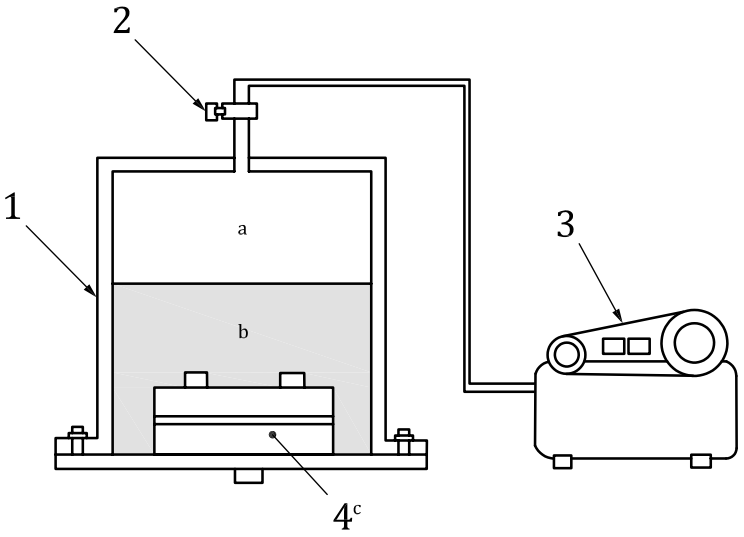
NOTE This test method requires the usage of fabricated and simulated artificial cracks as illustrated with the specimen used in this example.

## A.2 Apparatus

**A.2.1 Air compressor,** which should be able to handle minimum air pressure value of 0,1 N/mm$^2$ to 0,3 N/mm$^2$.

**A.2.2 Permeability test chamber**, which should be able to handle a minimum water pressure value of 0,1 N/mm$^2$ to 0,3 N/mm$^2$ (output method).

NOTE Refer to Figure A.1 a) and b)).




**a) Permeability test chamber (output)** **b) Compressor and water pressure chamber**

**Key**

| | | | |
|---|---|---|---|
| 1 | watertightness chamber | a | pressure: 0,3 N/mm$^2$ |
| 2 | pressure regulator | b | water: 1 L |
| 3 | air compressor | c | see Figure A.2 |
| 4 | test specimen | | |

**Figure A.1 — Apparatus for example test method**

### A.2.3 Test specimen.

NOTE Refer to Figures A.2 and A.3.

**A.2.3.1 Fixing bolt** for connecting test specimen to Universal Testing Machine (UTM)(⌀ 6 mm).

**A.2.3.2 Upper substrate part** (acrylic, ⌀ 100 mm × 30 mm).

**A.2.3.3 Repair material.**

**A.2.3.4 Concrete or mortar substrate part** (water: cement: fine aggregate = 1: 2: 6, mass ratio). Height of the concrete or mortar mould is 15 mm.

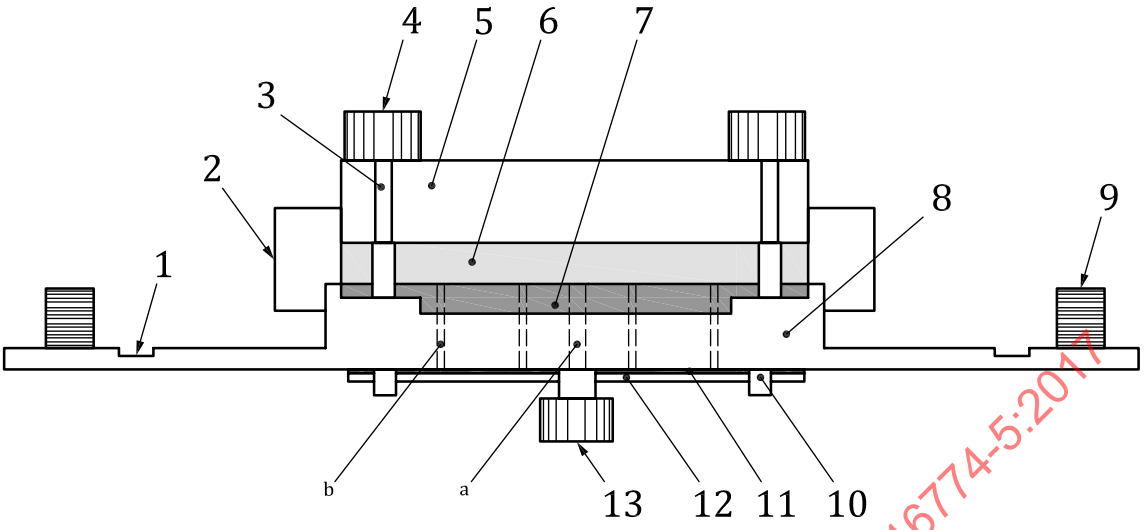
**A.2.3.5 Steel plate** for setting the concrete or mortar substrate in place (STS 304, ⌀ 220 mm × 5 mm).

**A.2.3.6 Non-woven fabric** for filtering repair material particulates when testing cementitious grout material (synthetic fibre, ⌀ 100, 180 g/m$^2$).

**A.2.3.7 Acrylic plate** for setting the non-woven fabric in place (acrylic, ⌀ 100 mm × 5 mm).



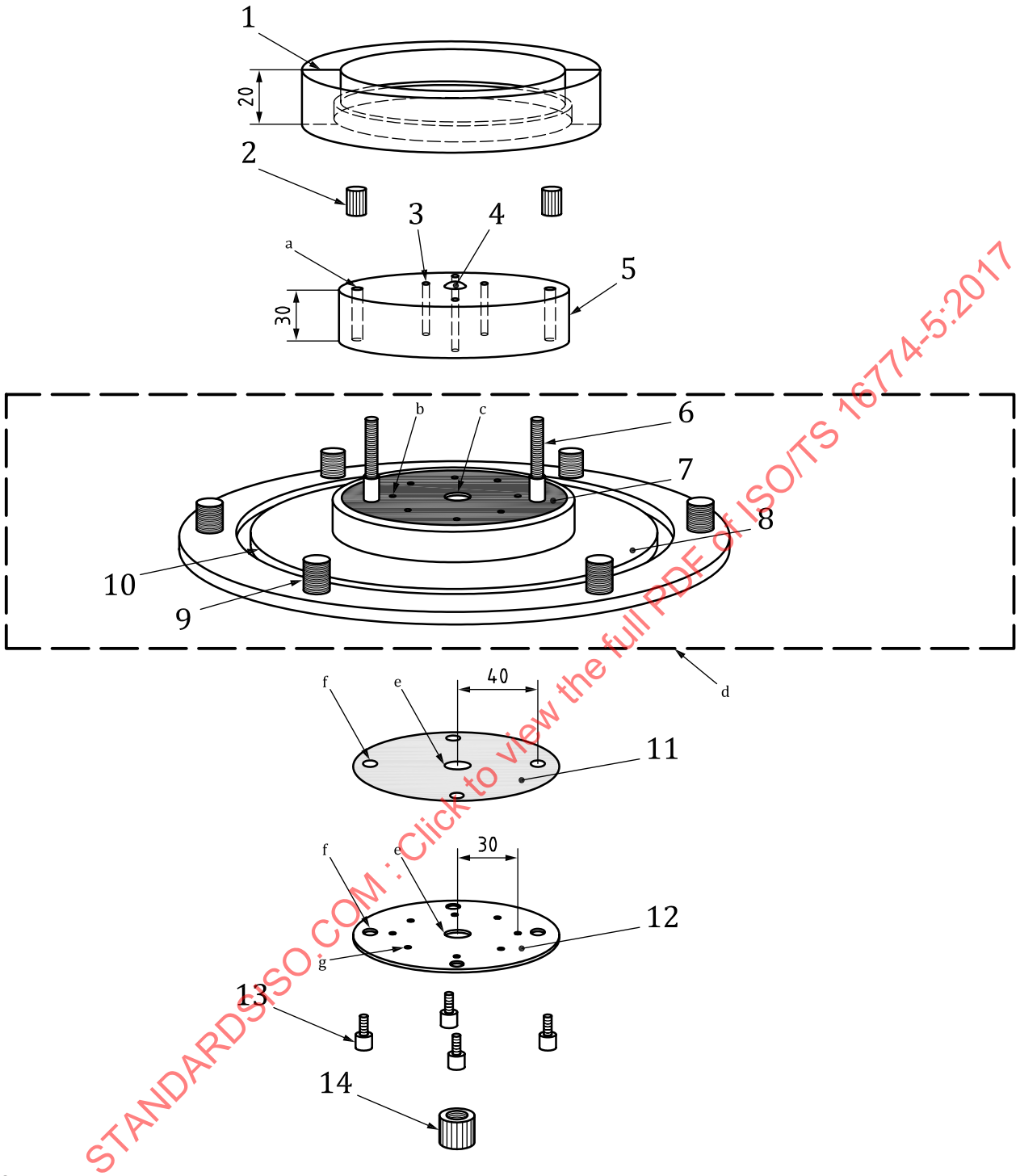



**Key**

| | | | |
|---|---|---|---|
| 1 | O-ring (width 5 mm) | 9 | bolt for fixing with chamber (Ø 10 mm) |
| 2 | acrylic band for seal | 10 | bolt for fixing acrylic plate (Ø 6 mm) |
| 3 | bolt for connecting upper substrate | 11 | non-woven fabric for filtering repair material |
| 4 | fixing nut for connecting mortar substrate (Ø 6 mm) | 12 | acrylic plate for fixing non-woven fabric |
| 5 | upper substrate (acrylic, Ø 100 × 30 mm) | 13 | inlet cover for injecting (Ø 12 mm) |
| 6 | repair material | a | injection hole (Ø 10 mm) |
| 7 | mortar substrate | b | leakage hole (Ø 2,5 mm) |
| 8 | steel plate for fixing mortar substrate (Ø 220 × 5 mm) | | |

**Figure A.2 — Diagram of the test specimen**

dimensions in millimetres






**Key**

| | | | |
|---|---|---|---|
| 1 | acrylic band for seal | 12 | acrylic plate for fixing non-woven fabric |
| 2 | fixing nut for fixing mortar substrate (Ø 6 mm) | 13 | bolts for fixing acrylic plate (Ø 6 mm) |
| 3 | injection hole (Ø 10 mm) | 14 | inlet bar for injection (Ø 12 mm) |
| 4 | level instrument | a | hole for connecting bolt (Ø 8 mm) |
| 5 | upper substrate (acrylic) | b | leakage hole (Ø 2,5 mm) |
| 6 | bolt for connecting upper substrate | c | injection hole (Ø 10 mm) |
| 7 | mortar substrate | d | see Figure A.4 |
| 8 | steel plate for fixing mortar substrate | e | injection hole (Ø 20 mm) |
| 9 | bolt for fixing with chamber (Ø 10 mm) | f | hole for fixing (Ø 7 mm) |

10 O-ring (width: 5 mm)
11 non-woven fabric for filtering repair material
g leakage hole (Ø 2,5 mm)

**Figure A.3 — Basic parts planar of test specimen**

### A.2.4 Others.

**A.2.4.1 Injector** suitable for the application of the tested repair material into the concrete specimen.

**A.2.4.2 Water container.**

**A.2.4.3 Masking tape, silicone sealant and/or additional sealing materials.**

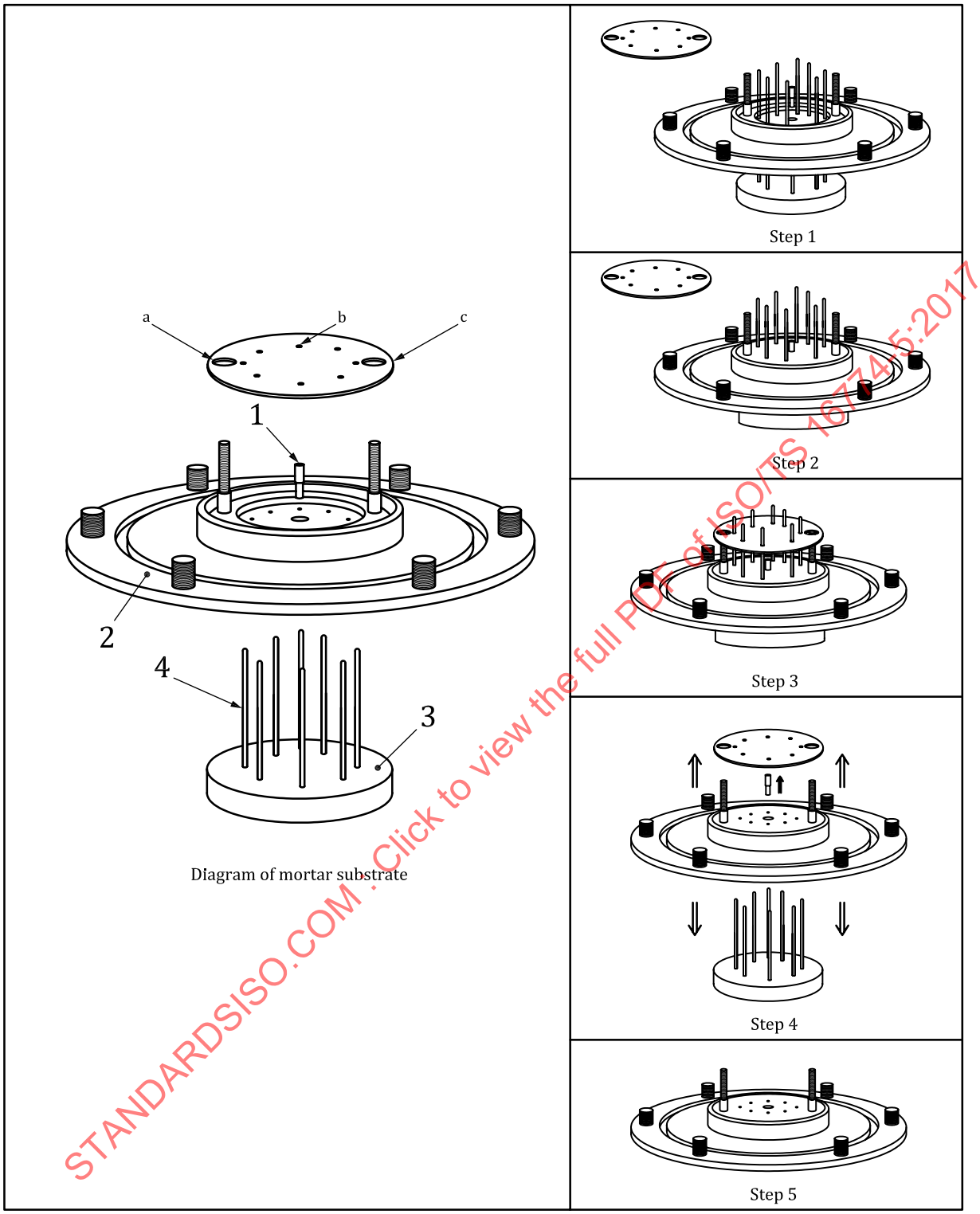
## A.3 Preparation

### A.3.1 Test specimen assembly part 1

1) Insert the inlet bar and the pin plate on the steel plate. Next, pour the mortar (the mortar substrate part) in the mould inside the steel plate (see steps 1, 2 and 3 in Figure A.4).

2) Cure the mortar substrate part for 72 hours at 20 ± 3 °C and >65 % RH, then remove the hole plate, pin plate and inlet bar (see step 4 in Figure A.4).

3) Place the entire specimen at rest for more than 168 hours at 20 ± 3 °C and >65 % RH (see step 4 in Figure A.4).






**Key**

| | | | |
|---|---|---|---|
| 1 | inlet bar | a | hole for connecting bolt (Ø 10 mm) |
| 2 | steel plate | b | hole for fixing pins (Ø 2,5 mm) |
| 3 | pin plate | c | hole plate |
| 4 | pins for leakage hole (Ø 2,4 mm × 100 mm) | | |

**Figure A.4 — Test specimen assembly part 1**

### A.3.2 Test specimen assembly part 2

1) Attach the non-woven fabric for filtering repair material particulates on the bottom of the steel plate, and fix it in place with the acrylic plate (see steps 1, 2 and 3 in Figure A.5).

2) Place the upper acrylic substrate part on the bolts so that it lies horizontally over the steel plate, parallel to the placement of the mortar substrate part (see step 4 in Figure A.5).

3) Place the acrylic band around the two substrate parts to cover the space openings on the side to prevent leakage during repair material injection. Apply silicone sealing if needed to close off the seams of the acrylic band for reinforced sealing (see step 4 in Figure A.5).