Technical Specification

ISO/TS 16774-6

Second edition
2024-08

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

Part 6: Test method for response to the substrate movement

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

Partie 6: Méthode d'essai de la réponse aux mouvements du substrat

Reference number
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Foreword

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 7, *Maintenance and repair of concrete structures.*

This second edition cancels and replaces the first edition (ISO/TS 16774-6:2017), which has been technically revised.

The main changes are as follows:

— in 6.1 a), a recommendation regarding the specification of the fine aggregate, as well as the necessary reference to the relevant standard, has been added;

— in 6.1 d), the text has been revised to provide clearer context.

A list of all parts in the ISO/TS 16774 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.

Introduction

This document is linked to ISO/TR 16475. ISO/TR 16475 outlines six basic properties and the required performance levels of water-leakage repair materials; The ISO/TS 16774 series proposes sample testing methods for evaluating the respective properties of the repair materials.

The test methods in this document are intended to serve as reference for nations that have not yet developed a test method for the six required performance properties of water-leakage repair materials. Many of the dependent variables outlined in the reference test methods of this document are subject to change in accordance with the environmental conditions (temperature and humidity, chemical solution and concentration, width of movement activity, water pressure or water flow velocity, etc.) outlined in the standards used in respective countries.

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

The repair material injected into a test specimen with an artificial crack undergoes simulated movements normally caused by thermal expansion, settlement and vibrations in leakage cracks found in concrete structures outlined in different national testing parameters that reflect different environmental conditions. 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 under the same environmental conditions.

NOTE 1 The test method in this document 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.

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

Part 6:
Test method for response to the substrate movement

1 Scope

This document specifies a laboratory test method for evaluating the substrate (crack) movement response of water-leakage crack repair materials through permeability testing.

This document outlines general principles and procedures for the test method. Specific variables that control the quantifiable parameters of the testing are filled in using relevant national standards or testing parameters, or both.

2 Normative reference

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, *General practices 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 terminology databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://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.

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

4 Principle

Response to loss, deterioration and other physical changes by the behavioral movement of leakage crack (such as crack movements caused by thermal shrinkage and expansions, differential settlement, and/or vibrations) is one of the fundamental properties that water leakage repair materials should possess. To evaluate the repair material's responsiveness to substrate movement, this test method uses two separate procedures:

a) a substrate movement test method;

a) a permeability test method.

The test specimen with an artificial crack is injected with repair material, and the specimen goes through an induced tensile/compressive stress test for a specified number of cycles using a substrate movement simulating apparatus, such as a universal testing machine (UTM). To evaluate whether the repair material loses its waterproofing property due to tensile/compressive stress (substrate/crack movement), the specimen goes through a water permeability test for the last stage of the test method.

5 Apparatus

5.1 Substrate movement apparatus, which must be able to exert a cycle of predetermined width of compressive and tensile force per one minute. A universal testing machine (UTM) should be used for this test method.

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

5.3 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 Conditions outlined in 5.2 and 5.3 are subject to change in accordance to different national testing parameters and requirements.

6 Preparation

6.1 Test specimen and artificial crack conditions

a) 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 should be made using concrete or mortar.

The mix proportion is (water : cement : fine aggregate = 1 : 2 : 6, mass ratio). The fine aggregate used should be specified. A different standard specification can apply.

NOTE 1 The curing period for the mortar or concrete substrate parts is approximately 72 hours, but can also be subject to change according to different national testing parameters and requirements.

b) The bottom substrate is drilled with evenly spaced holes (Ø 2,5 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 2 The purpose of these pinholes is to check for signs of leakage during repair material injection and during permeability testing.

c) 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, 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.

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

d) The specimen surface should be cleaned before injecting the repair material to remove any debris. After placing the test specimen under water for a specified amount of time to ensure that the substrate surface is sufficiently wet for repair material injection, inject the repair material into the specimen.

The injection method varies according to different national testing parameters and requirements. The manufacturer's instructions should be followed if available. Debris and other substances, if present, should be cleared prior to material injection.

NOTE 3 For detailed and clearer explanation, refer to Annex A

6.2 Ambient conditions

Keep the test room at a temperature (22 ± 2) °C and a humidity at (55 ± 5) % (standard drying conditions of a drying shrinkage state conditions outlined in ISO 1920-8) during the experiment unless specifically required otherwise.

NOTE Temperature values are subject to change according to different national standards. For example, warmer countries have ranges that can reach up to (27 ± 2) °C and can have a range at (16 ± 3) °C. The same applies to humidity conditions.

7 Procedure

7.1 Substrate behaviour stress test

a) Place the test specimen on the substrate movement apparatus.

NOTE 1 Once the test specimens have been injected with the repair materials and taken out of the water after the specified duration, attach the fixing bolt to the upper substrate that will connect to the jig on the substrate movement apparatus (universal testing machine).

b) Run the substrate movement test.

NOTE 2 The substrate movement simulation test will consist of applying tensile and compressive stress on the test specimen through repeated cycles of induced motion. The apparatus jig will pull on the upper part of the specimen for a specifed width and press down the same length. This procedure will repeat until sufficient amount of tensile/compressive stress has been applied on to the specimen. Duration, width and cycle number are subject to change according to different national test parameters and requirements.

c) Remove the test specimen from the substrate movement apparatus and record its conditions. Proceed to the permeability test.

NOTE 3 For a detailed explanation, refer to Annex A.

7.2 Permeability test

a) Place the specimen in the permeability test chamber.

NOTE 1 The procedure outlined follows the steps required for the output method of this permeability test. Other methods, if applicable, can be used for this step.

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

c) Run the permeability test.

NOTE 2 Water/air pressure values are subject to change according to different national test parameter requirements.

d) Observe and record if there is leakage or not with the test specimen.

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

NOTE3 For a detailed explanation, refer to Annex A.

8 Presentation of results

The continually induced physical stress of the test cycles can affect the repair material's performance level. This test method evaluates the physical properties of the repair materials under the prescribed conditions of permeability testing through a qualitative evaluation of whether the repair material can maintain adequate waterproofing properties. These results can be used in the future as a database which can provide guidance

for selecting appropriate repair materials with the required responsive properties against substrate/crack movement 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 repair material of the test target:

a) producer (name, address and phone number);

b) production date, time and place of the repair material;

c) type, storage method and authentication of the repair material;

d) manufacturer's product instructions and relevant repair material guidelines;

e) data on 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:

a) project of the test target;

b) application areas of the test specimen;

c) 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 shall record the following information on the test:

a) reference to this document (including its year of publication)

b) test manager;

c) name and purpose of the test;

d) ambient condition of the lab (temperature, relative humidity, safety conditions etc.);

e) production time and place of the specimens;

f) shape and size of the specimens, and the number of replicates of the specimens for repeat test;

g) identification of the specimens (lot no. etc.);

h) curing and storage conditions;

i) information on the test repair material (name, producer, validity etc.);

j) test data (production, measurement, test period etc.);

k) type of facilities, equipment, tools;

l) status of test equipment, tools;

m) test results prepared in accordance with Clause 8;

n) details on other test programmes and procedures.

o) any deviations from the procedure;

p) any unusual features observed;

q) the date of the test.

Annex A
(informative)

Example test method

A.1 Principle

This example test method evaluates a repair material's resistance to tensilve/compressive stress caused by substrate movement using artificial cracked test specimens. The repair material is injected into these specimens and is placed on a universal testing machine (UTM) where the specimen undergoes detailed and specific substrate movement cycles. Afterwards, a permeability test can be conducted to see if leakages occur to determine whether the substrate movement stress changed the repair material's waterproofing properties

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

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

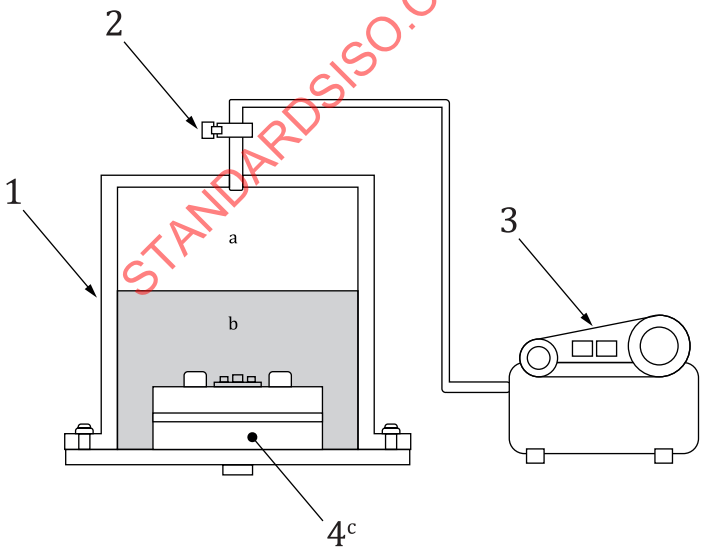
A.2 Apparatus

A.2.1 Universal testing machine (UTM), which can exert a minimum cycle of 0 mm to approximately 2,5 mm width of compressive and tensile force per minute.

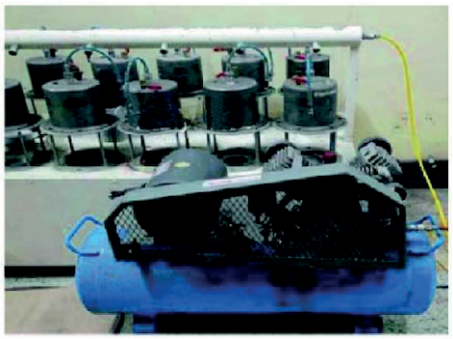
A.2.2 Air compressor, which should be able to handle minimum air pressure value of 0,1 N/mm^2 to 0,3 N/mm^2.

A.2.3 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.2.4 Test specimen.

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

A.2.4.1 Fixing jig for connecting test specimen to universal testing machine (UTM) (⌀ 6 mm).

A.2.4.2 Upper substrate part (acrylic, ⌀ 100 mm × 30 mm).

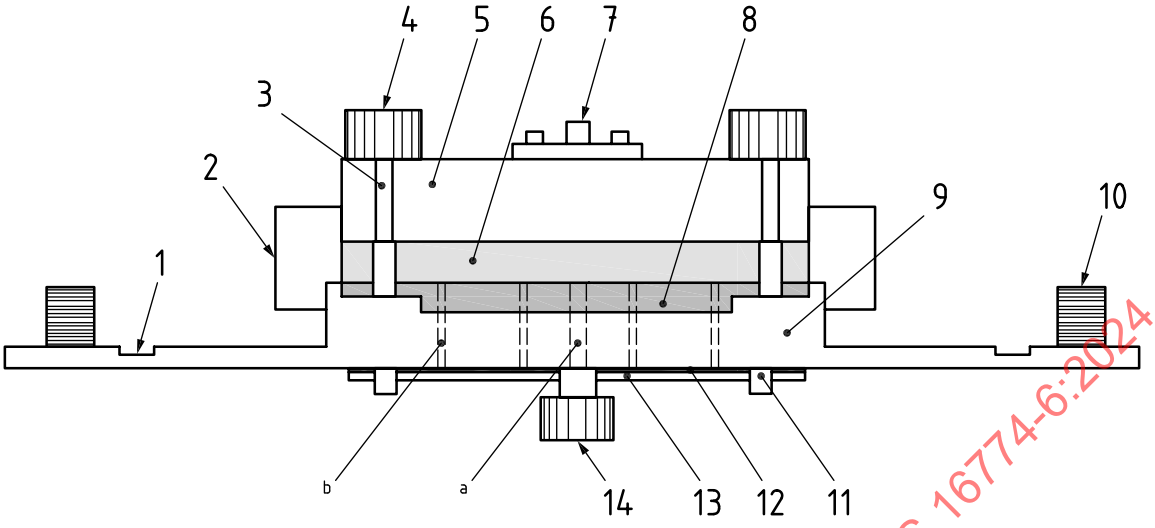
A.2.4.3 Repair material, see 3.1.

A.2.4.4 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.2.4.5 Steel plate for setting the concrete or mortar substrate in place (STS 304, ⌀ 220 mm × 5 mm).

A.2.4.6 Non-woven fabric for filtering repair material particulates when testing cementitious grout material (synthetic fibre, ⌀ 100 mm, 180 g/m^2).

A.2.4.7 Acrylic plate for setting the non-woven fabric in place (acrylic, ⌀ 100 mm × 5 mm).

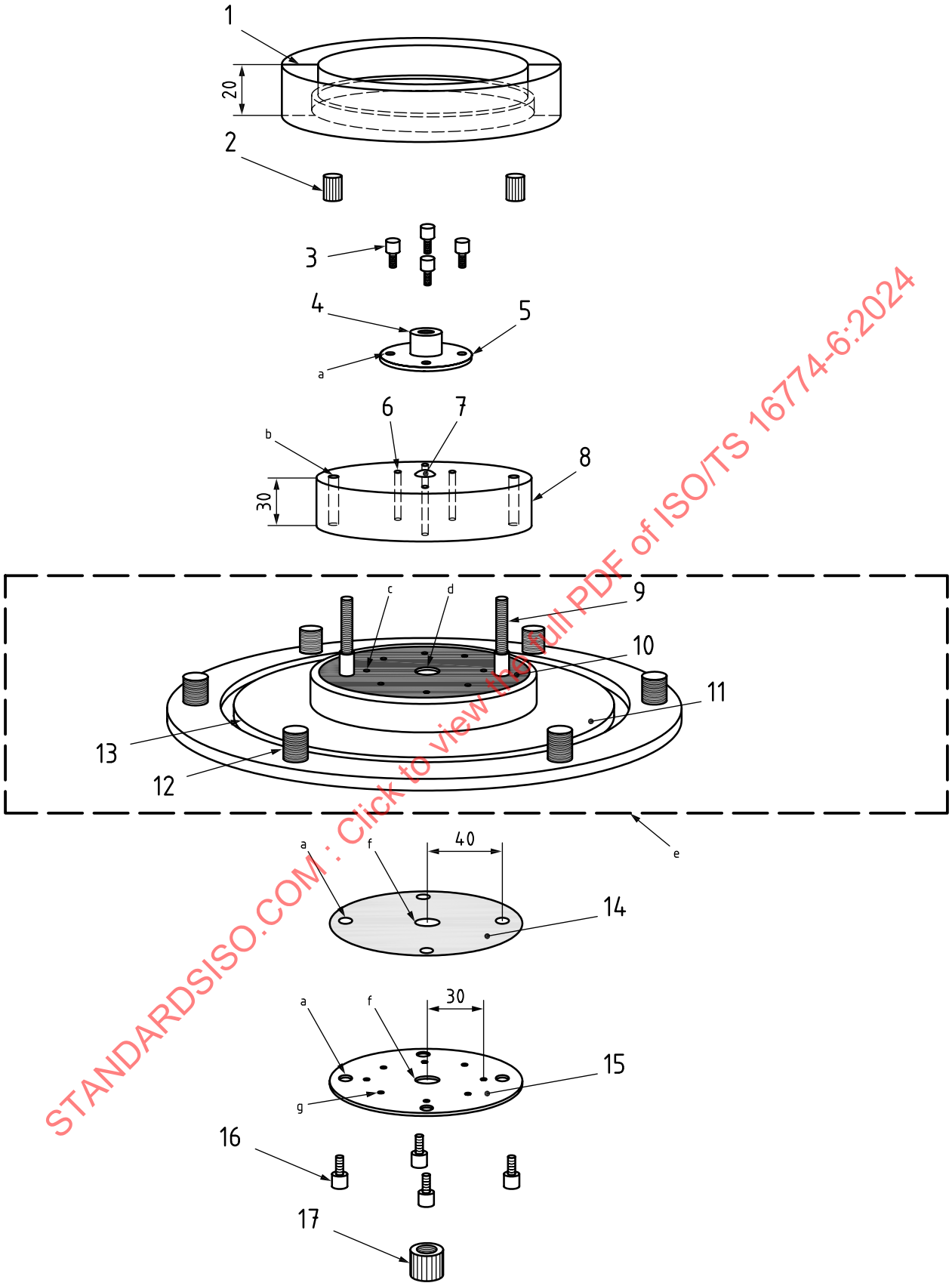


Key

1	O-ring (width 5 mm)	9	steel plate for fixing mortar substrate (Ø 220 mm × 5 mm)
2	acrylic band for seal	10	bolt for fixing with chamber (Ø 6 mm)
3	bolt for connecting upper substrate	11	bolt for fixing acrylic plate (Ø 6 mm)
4	fixing nut for connecting mortar substrate (Ø 6 mm)	12	non-woven fabric for filtering repair material
5	upper substrate (acrylic, Ø 100 mm × 30 mm)	13	acrylic plate for fixing non-woven fabric
6	repair material	14	inlet cover for injecting (Ø 12 mm)
7	fixing jig	a	Injection hole (Ø 10 mm).
8	mortar substrate	b	Leakage hole (Ø 2,5 mm).

Figure A.2 — Diagram of the test specimen

Dimensions in milimetres



Key

1 acrylic band for seal

2 fixing nut for fixing mortar substrate (Ø 6 mm)

13 O-ring (width: 5 mm)

14 non-woven fabric for filtering repair material

3 bolts for fixing connecting jig (Ø 6 mm)
4 nut for connection (Ø 12 mm)
5 connecting jig
6 nut for fixing (Ø 6 mm)
7 level instrument
8 upper substrate (acrylic)
9 bolt for connecting upper substrate
10 mortar substrate
11 steel plate for fixing mortar substrate
12 bolt for fixing with chamber (Ø 10 mm)
15 acrylic plate for fixing non-woven fabric
16 bolt for fixing acrylic plate (Ø 6 mm)
17 inlet bar for injection (Ø 12 mm)
[a] Hole for fixing (Ø 7 mm).
[b] Hole for connecting bolt (Ø 8 mm).
[c] Leakage hole (Ø 2,5 mm).
[d] Injection hole (Ø 10 mm).
[e] See Figure A.4.
[f] Injection hole (Ø 20 mm).
[g] Leakage hole (Ø 2,5 mm).

Figure A.3 — Basic parts planar of test specimen

A.2.5 Other apparatus.

A.2.5.1 Injector suitable for the application of the tested repair material into the concrete specimen.

A.2.5.2 Water container.

A.2.5.3 Masking tape, silicone sealant and/or additional sealing materials.

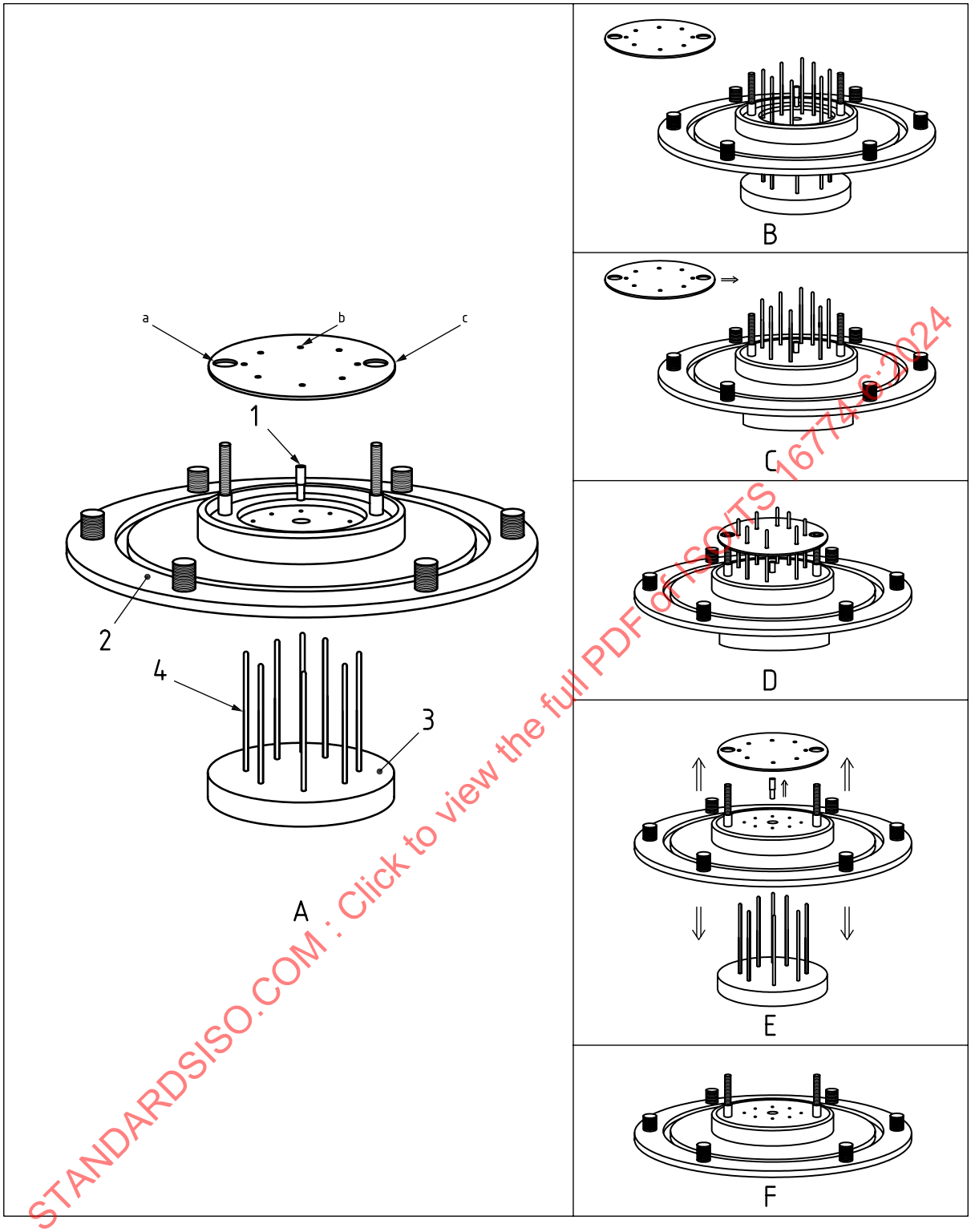
A.3 Preparation

A.3.1 Test specimen assembly part 1

a) 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).

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

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



Key

1 inlet bar
2 steel plate
3 pin plate
4 pins for leakage hole (Ø 2,4 mm × 100 mm)
A diagram of mortar substrate
B step 1
C step 2

a Hole for connecting bolt (Ø 10 mm).
b Hole for fixing pins (Ø 2,5 mm).
c Hole plate.

D step 3
E step 4
F step 5

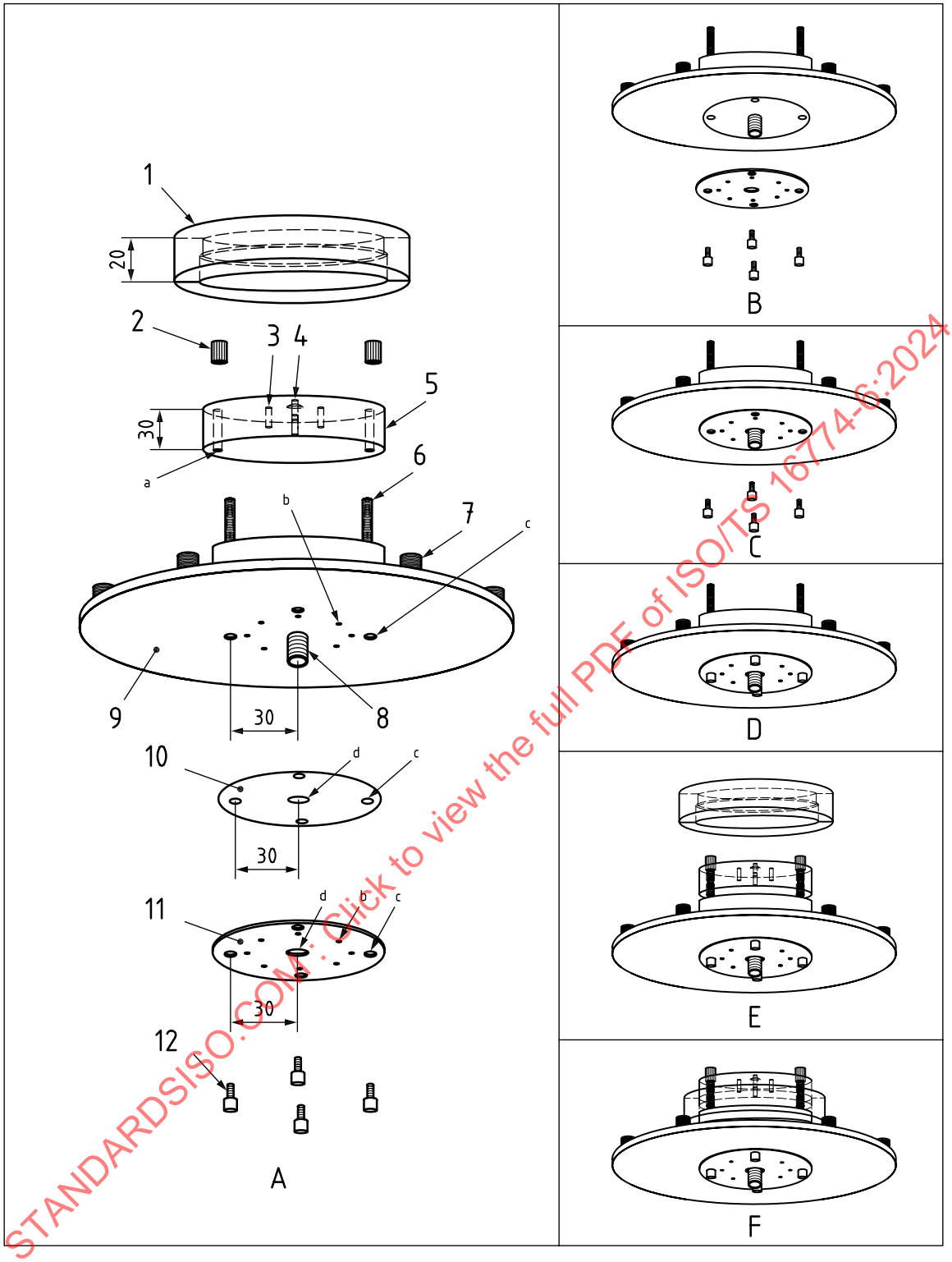
Figure A.4 — Test specimen assembly part 1

A.4 Test specimen assembly Part 2

a) 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).

b) 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).

c) 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 5 in Figure A.5).



Key

1	acrylic band for seal	A	diagram of back side of the steel plate
2	fixing nut for fixing mortar substrate (Ø 6 mm)	B	step 1
3	nut for fixing (Ø 6 mm)	C	step 2
4	level instrument	D	step 3
5	upper substrate (acrylic)	E	step 4
6	bolt for connecting upper substrate specimen	F	step 5
7	bolt for fixing with chamber (Ø 10 mm)	a	Hole for connecting bolt (Ø 8 mm).
8	bolt type inlet bar injection (Ø 20 mm)	b	Leakage hole (Ø 2,5 mm).