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Third edition
2017-09

Dentistry — Water-based cements —

Part 2: Resin-modified cements

Médecine bucco-dentaire — Ciments à base d'eau —
Partie 2: Ciments modifiés par addition de résine

Reference number
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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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 106, *Dentistry*, Subcommittee SC 1, *Filling and restorative materials*.

This third edition cancels and replaces the second edition (ISO 9917-2:2010), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the adoption of ISO 13116 as the measuring procedure of the test method for radio-opacity;

— the inclusion of tooth core build-up as a restoration in the scope;

— the adoption of other minor technical revisions in the test methods.

A list of all parts of the ISO 9917 series can be found on the ISO website.

Introduction

This document has been prepared in order to present the requirements and test methods for cements in which setting is achieved by a combination of an acid-base reaction and polymerization. The polymerization component of the reaction may be activated by mixing different components or through application of energy from an external source. As far as possible, test methods employed within this document have been harmonized with those used in ISO 4049 and ISO 9917-1.

No specific qualitative and quantitative requirements for ensuring the absence of biological hazard are included in this document, but it is recommended that reference be made to ISO 10993-1 and ISO 7405 when assessing possible biological or toxicological hazards.

Dentistry — Water-based cements —

Part 2:
Resin-modified cements

1 Scope

This document specifies requirements and test methods for water-based dental cements in which setting is achieved by a combination of an acid-base reaction and polymerization. The materials are intended for luting, base or lining, restoration and tooth core build up purposes.

EXAMPLE Conventional glass polyalkenoate cements are normally formed by reacting an ion-leachable aluminosilicate glass with a polyalkenoic acid in an aqueous environment. Materials that fall within the scope of this document will normally be able to effect setting by such an aqueous acid-base type reaction but in addition will be able to undergo setting by polymerization.

NOTE The attention of manufacturers and test laboratories is drawn to the closely-related International Standards ISO 4049 and ISO 9917-1 so that they can consider which is the most appropriate for evaluating any individual product.

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 1942, *Dentistry — Vocabulary*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 6344-1, *Coated abrasives — Grain size analysis — Part 1: Grain size distribution test*

ISO 7491, *Dental materials — Determination of colour stability*

ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO 13116:2014, *Dentistry — Test method for determining radio-opacity of materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1942 and the following apply.

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

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

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

3.1
mixing time
portion of the working time required in order to obtain a satisfactory mix of the components

Note 1 to entry: Materials that fall within the scope of this document include materials that require mixing and single component materials that do not require mixing.

[SOURCE: ISO 9917-1:2007, 3.1, modified — "that part of" has been replaced with "portion of" in the definition, and note 1 to entry has been added.]

3.2
working time
period of time, measured from the start of mixing (if required), during which it is possible to manipulate the material without an adverse effect on its properties

[SOURCE: ISO 9917-1:2007, 3.2 modified]

3.3
setting time
period of time, from the start of mixing, until the completion of setting, as defined by the ability of the material to support an indenter under a known load, when the material needs to be mixed to set

3.4
outer pack
packaging used for single dose container(s)/capsule(s)

3.5
outermost packaging
packaging used to combine material and additional items, including instructions for use and any proportioning or mixing devices that are supplied with the material

4 Classification and applications

4.1 Classification

For the purposes of this document, materials consist of water-based components which set by acid-base reaction and polymer-based component(s) are classified on the basis of their setting characteristics of polymer-based component(s) as follows:

— Class 1: materials setting of polymer-based components is activated following mixing of the components of the material;

— Class 2: materials setting of polymer-based component(s) is activated by irradiation of light to the mixed material;

— Class 3: materials setting of polymer-based components is activated following mixing of the components and which can also be activated by irradiation of light to the mixed material.

4.2 Applications

For the purposes of this document, the clinical application of these materials is signified as follows:

a) luting;

b) base or lining;

c) restoration, including for tooth core build-up.

5 Requirements

5.1 Materials

During the course of testing, there shall be no visible signs of extraneous matter in any component. Separately supplied liquid shall be free of any gelation.

NOTE Gelation is the transition of a material from a fluid consistency to a state in which the material has developed viscous or elastic properties. See ISO 14356:2003, 3.9.

5.2 Working time

When tested in accordance with Annex A, the working time shall comply with the requirements given in Table 1 and shall be at least as long as the value given by the manufacturer (see Table 2, item 22).

5.3 Setting time — Class 1 and Class 3 materials only

When tested in accordance with Annex A, the setting time of Class 1 and Class 3 materials shall comply with the requirements given in Table 1 and shall be no longer than the value given by the manufacturer (see Table 2, item 23).

5.4 Film thickness — Luting materials only (see 4.2)

The film thickness of luting materials when determined in accordance with Annex B, shall be no more than 5 µm above any value claimed by the manufacturer (i.e. the first requirement) and in any event shall comply with the requirements given in Table 1 (i.e. the second requirement).

5.5 Flexural strength

When tested in accordance with Annex C, the flexural strength shall comply with the requirements given in Table 1.

5.6 Radio-opacity

If the manufacturer claims that the material is radio-opaque (see Table 2, item 14), the radio-opacity, determined in accordance with Annex D and ISO 13116:2014, 7.3 or 7.4, shall be equal to or greater than that of the same thickness of aluminium. If greater radio-opacity is stated by the manufacturer, it shall not be less than the value stated by the manufacturer (see Table 2, item 15).

5.7 Shade and colour stability — Restorative materials only

When tested in accordance with Annex E, the set material shall closely match that of the shade guide specified by the manufacturer. When tested in accordance with Annex E and ISO 7491, there shall be no more than a slight change in colour after 7 d.

6 Sampling

A sample drawn from one batch shall provide sufficient material to complete all the prescribed tests plus an allowance for any repeat tests, should they become necessary. The test sample shall consist of packages prepared for retail sale.

Table 1 — Requirements for dental cements

Application	Film thickness[a] µm Max.	Working time[b] min Min.	Setting time[c] min Max.	Flexural strength MPa Min.
Luting	25	1,5	8	10
Base or lining	—	1,5	6	10
Restoration	—	1,5	6	25

[a] The determined value shall be no more than 5 µm above any value claimed by the manufacturer.

[b] Class 2 and Class 3 materials tested without activation by light.

[c] Class 1 and Class 3 materials only. Class 3 materials tested without activation by light.

7 Test conditions and preparation of test specimens

7.1 Test conditions

Prepare and test all specimens at an ambient temperature of (23 ± 2) °C. Control the relative humidity to ensure that it remains at (50 ± 20) % at all times. If the material was refrigerated for storage, allow it to reach (23 ± 2) °C before testing. Test equipment shall be maintained at the condition specified in individual tests.

For Class 2 and Class 3 materials, activating radiation shall be excluded during the determination of working time.

Water used in all tests specified in this document shall be prepared in accordance with ISO 3696, grade 2.

For Class 2 and Class 3 materials, refer to the manufacturer's instructions (see Table 2, item 24), which state the external energy source to be used. Ensure that the source is in a satisfactory working condition.

7.2 Method of mixing

The cement shall be prepared according to the manufacturer's instructions. Sufficient cement shall be mixed to ensure that the preparation of each specimen is completed from one mix. A fresh mix shall be prepared for each specimen.

NOTE For encapsulated materials, more than one capsule, simultaneously mixed, might be required for certain specimens. Likewise, for materials supplied in single dose containers, several containers might be required for each test specimen.

7.3 Inspection

Visual inspection shall be used in determining compliance with 5.1 and Clause 8.

8 Packaging, marking and information to be supplied by the manufacturer

8.1 Packaging

The components of the material shall be supplied in properly sealed containers which adequately protect their contents and have no adverse effect on the quality of the product.

An outer pack may be used to present the individual containers as a single unit or for marking of a single dose capsule, syringe or bottle.

NOTE Single paste and powder-liquid encapsulated products can be sold as a pack containing many unit doses of material.

8.2 Marking and instructions for use

Information shall be clearly marked on the outermost packaging or containers (for multi-dose packs or capsules), as appropriate, and as indicated in Table 2.

Instructions shall accompany each package of the material and shall include the information appropriate to the material (see Clause 4), as indicated in Table 2, where "M" means mandatory, "OPT" means optional, and "NA" not applicable.

Information additional to that specified in Table 2 may be supplied at the discretion of the manufacturer. Regulations might also require additional information to be supplied.

NOTE Table 2 contains several optional references and serves as a guide to the manufacturer as to the sort of information which might be useful to dentists.

Table 2 — Requirements for marking and instructions for use

	Items of marking and instructions for use	Outermost packaging see 3.5	Outer pack of capsule(s) see 3.4	Capsules, syringes or bottles (of single-dose)	Manufacturer's instruction leaflet
1	The name of the product	M	M	NA	M
2	The identification or name of the manufacturer	M	M	OPT	M
3	The address of the manufacturer or the agent responsible for sale	M	OPT	NA	M
4	URL	OPT	OPT	NA	OPT
5	The recommended conditions of storage	M	OPT	NA	M
6	The manufacturer's batch number	M	M	OPT	NA
7	The expiry date, expressed in accordance with ISO 8601, for the cement when stored under the manufacturer's recommended conditions	M	M	OPT	NA
8	The classification of the cement (see 4.1)	M	OPT	OPT	M
9	The clinical application (see 4.2)	OPT	OPT	NA	M
10	The number of containers/capsules, for capsule or cartridge cements	M	M	NA	NA
11	The net mass in each container/capsule	OPT	M	OPT	OPT
12	Shade and/or colour of the cement according to the manufacturer's nominated shade guide (for multi-shade materials only)	OPT	M	OPT	OPT
13	If the material is designated opaque, a clear statement to this effect[a]	M	OPT	OPT	M
14	If the cement is designated radio-opaque (see 5.6), a clear statement to this effect	OPT	OPT	OPT	M

"M" mandatory

"OPT" optional

"NA" not applicable

[a] Opaque designation can be included in the shade.

Table 2 *(continued)*

	Items of marking and instructions for use	Outermost packaging see 3.5	Outer pack of capsule(s) see 3.4	Capsules, syringes or bottles (of single-dose)	Manufacturer's instruction leaflet
15	If a specific statement on the extent of radio-opacity is made, the equivalent thickness of aluminium for 1 mm thickness of the cement (see 5.6) and an explanation of the radio-opacity value shall be included in the information for the users. EXAMPLE "Aluminium has a radio-opacity equivalent to that of dentine. Thus, 1 mm of material having a radio-opacity equivalent to 1 mm of aluminium has a radio-opacity equivalent to that of dentine."	OPT	OPT	NA	M
16	The recommended ratio of components (e.g. powder/liquid) and instructions for use of any proportioning aids (e.g. scoops, etc.) and the proportions on a mass/mass basis to a precision of 0,1 g (for hand mixed materials only)	OPT	OPT	NA	M
17	The rate of incorporation of the powder into the liquid (for hand-mixed materials only)	OPT	OPT	NA	M
18	The mixing time (see 3.1), if mixing is required	OPT	OPT	NA	M
19	The mixing condition (if appropriate, the condition and type of the mixing slab and spatula) for hand-mixed materials only	OPT	OPT	NA	M
20	For encapsulated cements, the method of bringing about physical contact between the components, if required	OPT	OPT	NA	M
21	The method, timing and type of mechanical mixing, if required	OPT	OPT	NA	M
22	The working time (see 3.2)	OPT	OPT	NA	M
23	The setting time (for Class 1 and Class 3 materials only, see 3.3)	OPT	OPT	NA	M
24	The external energy source(s) with the exposure time, or the radiation excitance with the exposure time, all of which recommended by the manufacturer and any special instructions for use of the equipment (for Class 2 and Class 3 materials only)	OPT	OPT	NA	M
25	The maximum thickness of layer for polymerization [for Class 2 and Class 3 materials for Application c) only, see 4.2]	OPT	OPT	NA	M
26	The minimum time at which finishing and polishing may be commenced (for restoration only, see 4.2)	OPT	OPT	NA	M
27	The recommended method of finishing (for restoration only, see 4.2)	OPT	OPT	NA	OPT

"M" mandatory

"OPT" optional

"NA" not applicable

[a] Opaque designation can be included in the shade.

Table 2 *(continued)*

Items of marking and instructions for use		Outermost packaging see 3.5	Outer pack of capsule(s) see 3.4	Capsules, syringes or bottles (of single-dose)	Manufacturer's instruction leaflet
28	The necessity of applying varnish to the finished surface of the material	OPT	OPT	NA	OPT
29	The precautions necessary to prevent premature activation of setting (Class 2 and Class 3 materials only)	OPT	OPT	NA	M
30	Special indications or warnings, when necessary, in respect to such properties as toxicity, hazard, flammability or tissue irritancy, for both patient and operator	OPT	OPT	OPT	M
"M" mandatory "OPT" optional "NA" not applicable [a] Opaque designation can be included in the shade.					

Annex A
(normative)

Determination of working time and setting time

A.1 Apparatus

A.1.1 Test environment, capable of being maintained at a temperature of (37 ± 1) °C and a relative humidity of at least 50 %.

A.1.2 Indenter.

A.1.2.1 General

The indenter shall have a given mass and a flat end with a given diameter. The tip shall be cylindrical for approximately 5 mm. The indenter end shall be plane and perpendicular to its long axis.

A.1.2.2 Indenter for working time, of mass: (28,00 ± 0,25) g and diameter: (2,0 ± 0,1) mm.

A.1.2.3 Indenter for setting time, of mass: (400 ± 5) g and diameter: (1,0 ± 0,1) mm.

A.1.3 Metal mould, with a thickness (5 ± 2) mm having a circular or square hole of (10 ± 2) mm diameter/length cut in a sheet of metal at least 16 cm^2.

NOTE Internal corners of a square hole can be rounded.

A.1.4 Metal block, with a thickness of at least 8 mm and a volume of at least 60 cm^3.

A.1.5 Aluminium foil.

A.1.6 Timer, capable of reading to 1 s.

A.1.7 Magnifier, capable of ×2 magnification.

A.2 Determination of working time

A.2.1 Procedure

Class 2 and Class 3 materials should be handled in the absence of light with wavelengths from 400 nm to 500 nm using, for example, a dark room and/or filtered light.

The test shall be performed under the conditions described in 7.1.

Place the mould (A.1.3), conditioned to (23 ± 1) °C, on the block (A.1.4) covered with the aluminium foil (A.1.5), also conditioned to (23 ± 1) °C, and fill to a level surface with mixed cement.

Ten seconds before the end of the working time given by the manufacturer (see Table 2, item 22) or the minimum value given in Table 1 (whichever is the longer), carefully lower the indenter (A.1.2.1) vertically on to the surface of the cement and allow it to remain there for 5 s. Note whether the indenter makes a complete circular indentation in the surface of the cement.

Repeat the test with two separate mixes of the material.

A.2.2 Treatment of results

In order to satisfy the requirements, the indenter shall make a complete circular indentation in the surface of the cement specimen. All three values of indentation shall comply 10 s before the working time stated by the manufacturer (see Table 2, item 22) and with the minimum value of working time in Table 1.

A.3 Determination of setting time — Class 1 and Class 3 materials only

A.3.1 General

NOTE The purpose of this test is to confirm that Class 1 and Class 3 materials will set in the absence of light activation.

A.3.2 Procedure

Place the mould (A.1.3), conditioned to (23 ± 1) °C, on the aluminium foil (A.1.5), mix or dispense the cement, start the timer (A.1.6) and fill the mould to a level surface with mixed cement.

Sixty seconds after the end of mixing, place the assembly, comprising mould, foil and cement specimen, on the block (A.1.4), in the test environment (A.1.1). Ensure good contact between the mould, foil and block.

Class 3 materials shall be tested without the use of activating light.

Ten seconds after the setting time stated by the manufacturer (see Table 2, item 23) or the limit value stated in Table 1 (whichever is the shorter) carefully lower the indenter (A.1.2.2) vertically on to the surface of the cement and allow it to remain there for 5 s. Remove the indenter from the surface and note whether the indenter fails to make a complete circular indentation in the cement, when viewed using a magnifier (A.1.7) of ×2 magnifications.

Repeat the test twice.

A.3.3 Treatment of results

In order to satisfy the requirements, the indenter shall fail to make a complete circular indentation in the cement for all three tests.

Annex B
(normative)

Determination of film thickness — Luting materials only

B.1 Apparatus

B.1.1 Two glass plates, optically flat, square or circular, transparent, having a contact surface area of (200 ± 25) mm^2. Each plate shall be of a uniform thickness of not less than 5 mm.

B.1.2 Loading device, of the type illustrated in Figure B.1, or an equivalent means, whereby a force of (150 ± 2) N shall be generated vertically on the specimen via the upper glass plate.

The anvil that is attached to the bottom of the rod carrying the load shall be horizontal and parallel to the base. The load shall be applied smoothly and in such a manner that no rotation occurs.

B.1.3 Screw micrometer or **equivalent measuring instrument**, having graduations of 1 µm or smaller.

B.1.4 Timer, capable of reading to 1 s.

B.2 Procedure

Measure and record to an accuracy of 1 µm the combined thickness of the two optically flat glass plates (B.1.1) stacked in contact and designate this measurement reading A. Remove the upper plate and place (0,10 ± 0,05) ml or the equivalent mass of the mixed cement in the centre of the lower plate and place this centrally below the loading device (B.1.2). Place the second glass plate centrally on the cement in the same orientation as in the original measurement.

Ten seconds before the end of the manufacturer's stated working time (see Table 2, item 22), apply the load to generate a force of (150 ± 2) N vertically and centrally to the specimen via the top plate. Ensure that the cement has completely filled the space between the glass plates. When at least 10 min have elapsed after the application of the load, remove the plates from the loading device and measure the combined thickness of the two glass plates and the cement film in the same location. Designate this measurement reading B.

Record the difference in thickness of the plates with and without the cement film (i.e. the difference between reading B and reading A) as the thickness of the film. Repeat the test four times.

B.3 Treatment of results

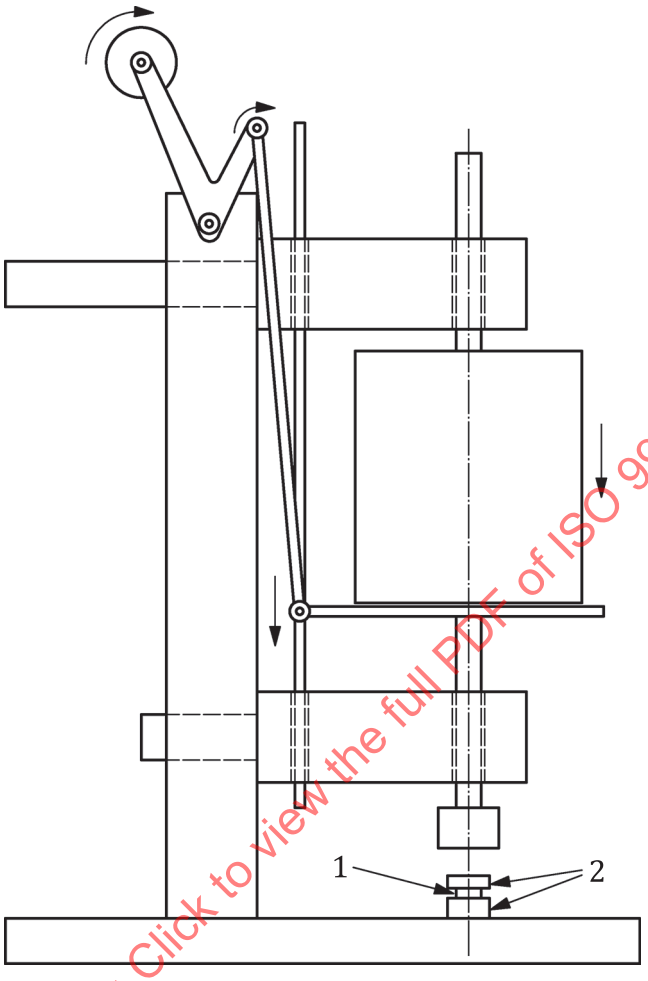
Record the film thickness of the five specimens and report as follows.

a) If at least four of the values are equal to or less than 25 µm, the material is deemed to have complied with the requirement of Table 1.

b) If three or more values are greater than 25 µm, the material is deemed to have failed.

c) If only three of the values are equal to or less than 25 µm, repeat the whole test. If one or more of the values is greater than 25 µm on the second occasion, the material is deemed to have failed the whole test.

d) If the manufacturer claims a specific value for film thickness, at least four of the five values shall be no more than 5 µm greater than the claimed value in order to comply with the first requirement of 5.4.



Key

1 specimen
2 glass discs

Figure B.1 — Loading device for use in film thickness test

Annex C
(normative)

Determination of flexural strength

C.1 Apparatus

C.1.1 Mould for the construction of specimens

C.1.1.1 General

The exact nature of the mould is not specified but shall enable specimens to be prepared according to the manufacturer's instructions. Two examples of suitable moulds are given in C.1.1.2 and C.1.1.3.

C.1.1.2 Mould, for the preparation of a test specimen (25 ± 2) mm × (2,0 ± 0,1) mm × (2,0 ± 0,1) mm. A suitable mould is illustrated in Figure C.1. The mould may be constructed from stainless steel, a cast sheet of PMMA [poly (methyl methacrylate)] or another suitable non-reactive mould material. A release agent may be required to aid removal of specimens. If a release agent is used, it shall have no effect on the setting of the cement.

NOTE An example of a suitable release agent is a 3 % solution of paraffin wax in hexane.

Dimensions in millimetres

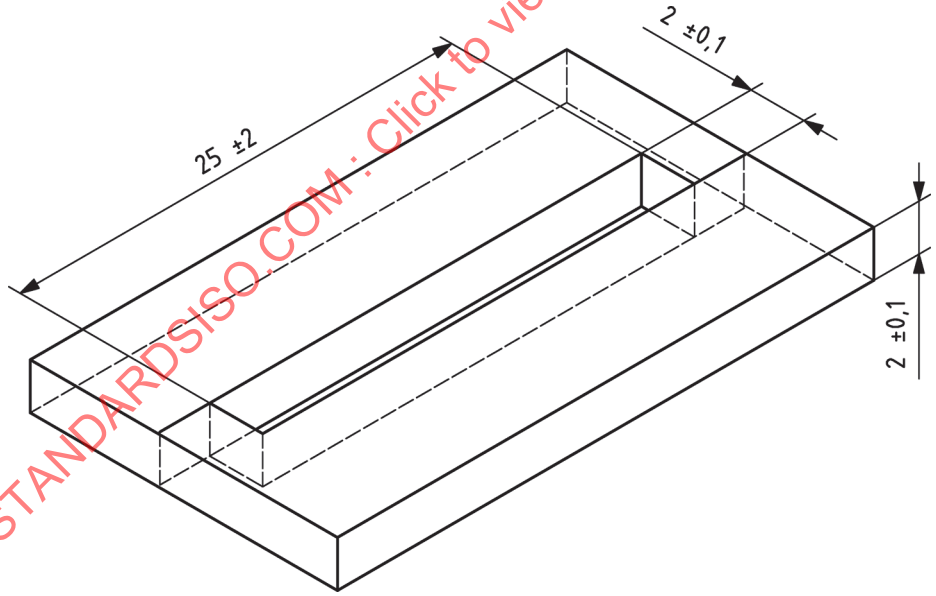


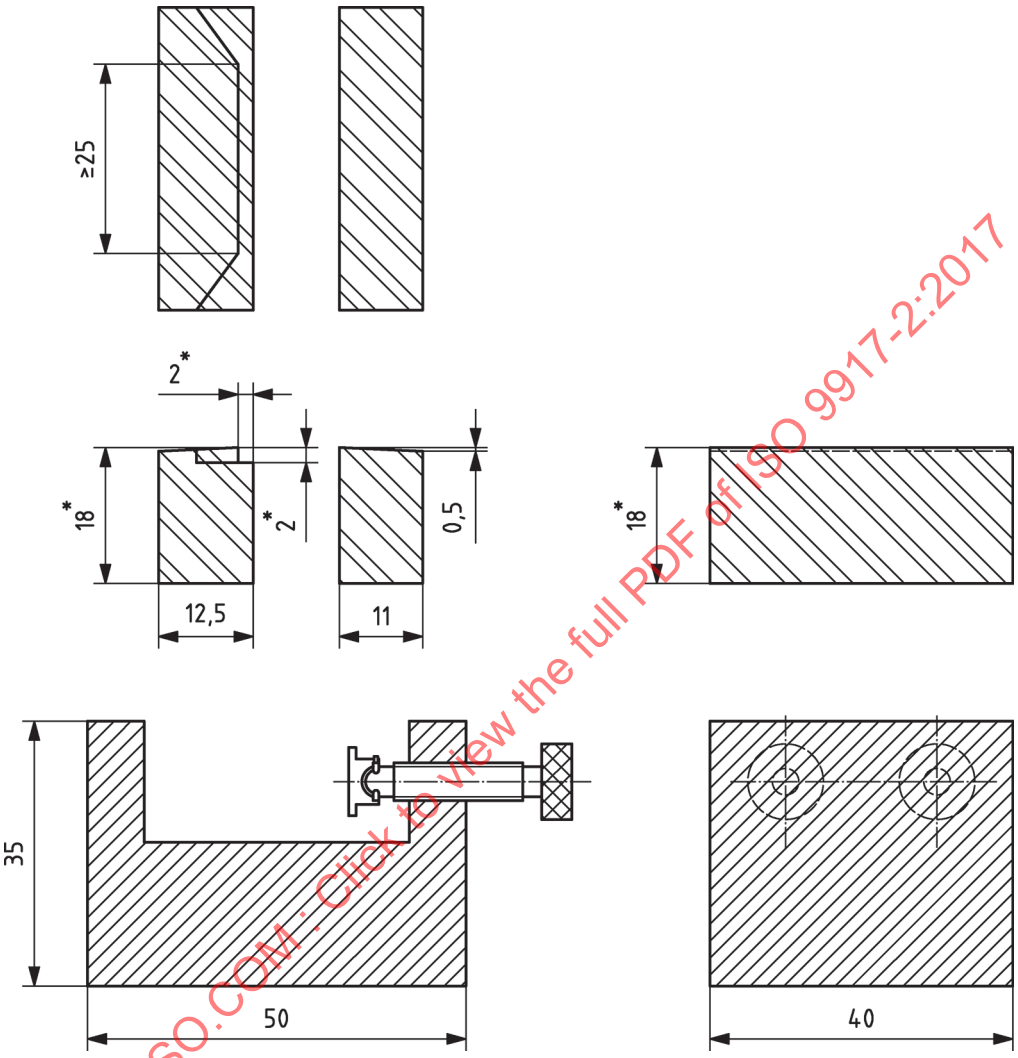
Figure C.1 — Mould for flexural strength specimen

C.1.1.3 Alternative mould, for specimen preparation, as shown in Figure C.2. The mould blocks shall be constructed from sheet made of PMMA to avoid sticking. The moulds shall be regularly inspected and replaced when damaged or worn. A release agent may be required to aid removal of specimens. If a release agent is used, it shall have no effect on the setting of the cement.

NOTE An example of a suitable release agent is a 3 % solution of paraffin wax in hexane.

The mould is used in conjunction with a levelling press which may be constructed from any rigid material (e.g. aluminium in Figure C.2) and which compresses the material within the mould while maintaining the upper and lower specimen surfaces in a plano-parallel arrangement.

Dimensions in millimetres



Materials:

PMMA

aluminium

NOTE Except for mould cross-section including the height of the defining blocks (marked *), no dimension is critical.

Figure C.2 — Alternative mould design and arrangement for flexural strength specimens

C.1.2 Flexural properties test equipment and test jig

C.1.2.1 Test equipment, calibrated to provide a constant crosshead speed of (0,75 ± 0,25) mm/min or a rate of loading of (50 ± 16) N/min.

C.1.2.2 Test jig, consisting essentially of two rods (2 mm in diameter), mounted parallel with 20 mm between the centres of each and a third rod (2 mm in diameter) centred between, and parallel to, the other two, so that the three rods in combination can be used to give three-point loading to the specimen.

C.1.2.3 Rigid plates, each of sufficient area to cover the mould. (C.1.1.1 or C.1.1.2).

C.1.2.4 Polyester film, e.g. dental matrix strip.

C.1.2.5 Water bath, capable of being maintained at (37 ± 2) °C.

C.1.2.6 Micrometer or equivalent device, having graduations of 0,01 mm or smaller.

C.1.2.7 Clamp, suitable for holding the specimen mould assembly during conditioning in the water bath (C.1.2.5).

C.1.2.8 External energy source(s), as recommended by the manufacturer for use with the test material (see Table 2, item 24).

C.1.2.9 Abrasive paper, P150 or P320 according to ISO 6344-1.

C.1.2.10 Timer, capable of reading to 1 s.

C.2 Specimen preparation

C.2.1 Specimen preparation — Class 1 materials

Ensure mould surfaces are clean and, if appropriate, coated with a suitable release agent. Mix the test cement according to the manufacturer's instructions and load at the centre of the mould cavity without delay, such that flow is outwards, leaving the mould overfilled and making no attempt to level. This should be done within the working time of the material (see Table 2, item 22).

Immediately apply polyester film(s) (C.1.2.4) and rigid plate(s) (C.1.2.3) onto the exposed surface(s) of the material and place the assembly in a levelling press. Apply a load to the plate(s) to extrude excess material. Place the assembly in the water bath (C.1.2.5) and leave to set for 1 h.

After setting, remove the specimen from the mould and remove any flash by abrading it with P150 or P320 abrasive paper, taking care not to damage the specimen, and store in distilled water at (37 ± 2) °C for (24 ± 1) h.

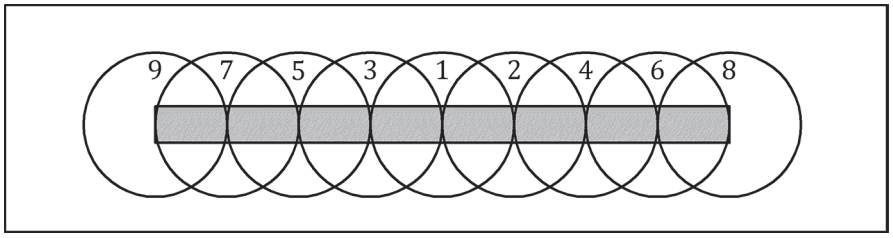
Prepare five such specimens.

C.2.2 Specimen preparation — Class 2 and Class 3 materials

Fill the mould with the material within the working time of the cement (see Table 2, item 22) and cover both sides with a polyester film (C.1.2.4) and rigid plate(s) (C.1.2.3). Place the assembly in a levelling press such that the assembly can be compressed to extrude excess material at a time within the working time of the material (see Table 2, item 22). Remove the rigid plate(s).

Place the exit window of the external energy source (C.1.2.8) at the centre of the specimen and against the film. Irradiate that section of the specimen with the external energy source for the exposure time, or with the radiant exitance (using for example the unit of mW/cm^2, for the exposure time, both of which are recommended by the manufacturer. Move the exit window to the section next to the centre overlapping the previous section and irradiate for the recommended exposure time described above.

NOTE The degree of overlap can incorporate not more than half of the previous area of irradiation covered by the irradiation window of the external energy source. See Figure C.3.



NOTE In the example, the diameter of the irradiation window of the external energy source is 7 mm.

Figure C.3 — Schematic diagram of overlapping irradiation zones for the preparation of the flexural strength specimens

Irradiate the section on the other side of the centre in the same way. Continue this procedure until the entire length of the specimen has been irradiated for the recommended exposure time. Repeat the irradiation procedure on the other side of the specimen.

Clamp (C.1.2.7) the assembly and place it in the water bath (C.1.2.5) maintained at (37 ± 2) °C, for 15 min. Then, remove the specimen from the mould, mark the specimen at one end to indicate the face which was cured first and remove any flash by abrading it with P150 or P320 abrasive paper, avoiding the top and bottom surfaces and store in distilled water at (37 ± 2) °C for (24 ± 1) h.

Prepare five such specimens.

C.3 Procedure

Carefully remove each specimen from the water bath and measure the dimensions of the specimen to an accuracy of 0,01 mm using the micrometer (C.1.2.6) at the centre of the specimen. Visually inspect each specimen without magnification and reject any specimens having surface defects or air inclusions, and prepare supplemental specimen(s) if necessary, according to C.2.

Store each of the specimen that passed the inspection in the water bath at (37 ± 2) °C until commencement of testing.

Transfer the specimen to the flexural properties testing equipment (C.1.2.1), ensuring that the first cured surface of the specimen (as constructed in the mould) remains the lower surface during testing (i.e. the side in tension). The specimen shall be positioned in the centre of the test jig (C.1.2.2), perpendicular to the three rods. Within 10 s of removing the specimen from the water bath, load the specimen at a crosshead speed of (0,75 ± 0,25) mm/min or at a rate of loading of (50 ± 16) N/min, applied until the specimen fractures.

Record the maximum force exerted on the specimen.

Repeat the test on the four other specimens.

C.4 Calculation and expression of results

Calculate the flexural strength, σ, in megapascals, using Formula (C.1):

$$\sigma = \frac{3FL}{2bh^2} \tag{C.1}$$

where

F is the maximum force, in newtons, exerted on the specimen;

L is the distance, in millimetres, between the supports, accurate to 0,01 mm;

b is the width, in millimetres, at the centre of the specimen measured prior to testing;

h is the height, in millimetres, at the centre of the specimen measured prior to testing.

C.5 Treatment of results

Compare the values of flexural strength with the limit value specified in Table 1. If four or five results are not less than the minimum value, the material passes the test. If two or fewer results satisfy the limit value, the material fails the test. If three specimens satisfy the limit value, prepare and test five further specimens. All five results in the second series shall comply with the limit value specified in Table 1.