INTERNATIONAL STANDARD

ISO 4823

Fourth edition
2015-08-01

Dentistry — Elastomeric impression materials

Médecine bucco-dentaire — Matériaux à empreintes, à base d'élastomères

Reference number
ISO 4823:2015(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 106, *Dentistry*, Subcommittee SC 2, *Prosthodontic materials*.

This fourth edition cancels and replaces the third edition (ISO 4823:2000), which has been technically revised with the following changes:

— modification of the sequence of requirements having the requirements for packaging and labelling listed before the requirements for characteristics and properties;

— the restriction that the working time shall be at least 30 s longer than the mixing time was eliminated; this was considered necessary in view of the fact that several products have shorter working time;

— working time test procedure using the dead weight method (Sink-in method) for Type 0 materials which had been exempt from this requirement in the third edition was introduced (see 7.3.2);

— the current displacement Rheometer procedure stated in ISO 4823:2000 will continue to be used for testing Type 1, 2, and 3 materials without modifications;

— concerning the order in which some clauses are presented, whereas in later years, most dental product standards have been structured to have the requirements and test methods clauses appear before the requirements for labelling and instructions for use clauses, this International Standard gives first ordering to the labelling and instructions for use requirements. This change was thought to be necessary because experience informs us that test operators will be better equipped to obtain success in testing if they first take into account the information available in the labelling and in the instructions for use;

— Clause 6 has been added for reasons explained in its first paragraph;

— concerning the Annexes

  — Annex A was created due to the ISO Central Secretariat suggestion that all figures, grouped together instead of being presented individually on related pages of the text, are to be presented in a normative Annex and numbered according to existing rules. This is to make it easier for the figures to be located by users of the document;

— Annex B provides for standardized hand mixing methods to be used by test operators so that specimen preparation mixing of the test specimens will be uniform and consistently fairer to the various products;

— Annex C identifies sources for the working-time test apparatus and the linear variable displacement transducer (LVTD).

Dentistry — Elastomeric impression materials

1 Scope

This International Standard specifies the requirements and tests that the state-of-the art body of knowledge suggests for helping determine whether the elastomeric impression materials, as prepared for retail marketing, are of the quality needed for their intended purposes.

NOTE This International Standard does not address possible biological hazards associated with the materials. Therefore, interested parties are encouraged to explore ISO 7405 and ISO 10993 for assessment of such hazards.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 6873, *Dentistry — Gypsum products*

3 Terms and definitions

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

3.1
consistency
degree of firmness with which particles of a material, prepared for use, cohere so as to allow the material to flow, or resist flow, as required to achieve the purpose for which it is intended

3.2
elastic recovery test
DEPRECATED: compression set
DEPRECATED: permanent deformation
DEPRECATED: recovery from deformation
⟨elastic impression materials⟩ method of determining whether the materials possess the elastic properties required to recover adequately after deformation occurring when the materials used for forming impressions are removed from the mouth

3.3
extrusion mixing
method by which two or more material components are extruded simultaneously from their separate primary containers through a special mixing tip from which the material components emerge as a homogeneous mixture

3.4
hand mixing
method of mixing the components of a material by means of manual kneading or spatulation

3.5
primary packaging
container designed to come into direct contact with the product

[SOURCE: ISO 21067:2007, 2.2.2, modified — “packaging” replaced by “container” in the definition.]

3.6
mixing time
time, measured from first contact between different components of a material being mixed, required to achieve a homogeneous mixture when the components are mixed according to the manufacturer's instructions

Note 1 to entry: The time of first contact between extrusion-mixed material components is defined as the time when the material components can be seen entering into the mixing nozzle.

3.7
outer package
wrapping or carton, which may be required by law or a standard to bear specified labelling, used to cover one or more primary containers in preparation for retail marketing

3.8
strain-in-compression test
⟨elastic impression materials⟩ method of measuring the flexibility/stiffness property ranges of materials so as to determine whether the set materials, when formed as impressions, can be removed from the mouth without injury to impressed oral tissues and will have adequate stiffness in the more flexible portions of impressions to resist deformation when model-forming products are poured against them

3.9
working time
period of time beginning with the commencement of mixing and ending before the material being mixed has begun to exhibit elastic properties that will prevent the material from being manipulated as required to form an impression or a mould having the desired surface detail and dimensional characteristics

4 Classification

Materials covered by this International Standard are classified according to the following consistencies determined immediately after completion of mixing according to the manufacturer's instructions (see 5.3):

— Type 0: putty consistency;

— Type 1: heavy-bodied consistency;

— Type 2: medium-bodied consistency;

— Type 3: light-bodied consistency.

5 Requirements for packaging, labelling, and information in manufacturer's instructions

5.1 Packaging requirements

No packaging requirements are specified in this International Standard, but it is important for manufacturers to take into account that the packaging should be such that it will not contaminate or permit contamination of ingredients of the material components during recommended storage conditions. Structure of the primary packaging should also be such that no leakage or inadvertent extrusion of the contents can occur during storage and such that the containers will not rupture during use of the extrusion methods recommended by the manufacturer.

5.2 Labelling requirements

5.2.1 Outer packages (containing one or more primary containers)

Labelling of the outer packaging prepared for retail marketing containing one or more primary containers shall bear the following information:

a) recommended storage conditions for the unopened package;

b) brand name;

c) name and address of the manufacturer or the name of another company authorized by the manufacturer to market the material under a different brand name;

d) identification of the consistency of the material as putty, heavy-bodied, medium-bodied, or light-bodied (see Clause 4) (the type number may also be included);

e) manufacturer's batch reference(s);

f) USE BEFORE DATE, identified as such, beyond which the material may not exhibit its best properties. The date shall be expressed as a six-digit number, for example, 2014-09, where the first four digits indicate the year (2014) and the last two digits indicate the month (September);

g) minimum volume that would result from mixing the entire component contents included in the outer package.

5.2.2 Primary containers within outer packaging

Labels for primary containers shall bear the following information:

a) brand name;

b) name of the manufacturer or name of another company authorized to market the material under a different brand name;

c) component identification (not required when the components for extrusion mixing are supplied in separate but joined primary containers);

d) manufacturer's batch references.

5.3 Requirements for information in manufacturer's instructions

5.3.1 General

Each package in which the components of an impression material are prepared for retail marketing shall be accompanied by the instructions and other information needed to ensure optimum performance of the material in clinical practice

5.3.2 Identifying information

The following identifying information is required:

a) trade-name or brand-name of the product;

b) chemical nature of the elastomeric system: for example, polyether, polysulfide, silicone (condensation type), or silicone (vinyl polysiloxane, addition type).

5.3.3 Specific instructions for use

Where applicable, the specific instructions for use shall include the following:

a) recommended storage conditions after the initial opening of the primary containers;

b) statements indicating that working time and other characteristics of the material can be affected significantly by the following factors, as may be applicable:

   — room temperature variations;

   — variations in the speed and friction involved in mixing;

   — hand/fingertip temperatures when kneading putty mixes;

   — moisture contamination or relative humidity;

   — contamination, either due to direct contact with latex dam or gloves used in clinical practice or due to the presence of such contaminants on teeth at the time they are impressed;

c) proportions for hand-spatulated mixes (mass to mass and volume to volume);

d) recommended mixing apparatus and procedures to include the generic identification of any hand coverings (gloves or polymer sheeting) that should be used to avoid contamination of the materials during hand manipulation;

e) mixing time required to obtain a homogeneous mixture of an amount of the material having a volume of 15 ml (see 5.3 and Annex B);

f) working time;

g) minimum time the impression should remain in the mouth before removal;

h) minimum or maximum time lapse, or both, permitted between removal of the impression from the mouth and pouring the gypsum product into the impression;

i) identification of at least two gypsum products, complying with requirements of ISO 6873, which the impression material manufacturer has found to be compatible with the impression material being tested: one Type 3 product (dental stone, model) and either one Type 4 product or one Type 5 product (dental stone, high strength);

j) when the manufacturer's instructions state that an impression made of a material may be disinfected, the disinfecting procedure shall be described in detail and a reference indicating that the disinfection procedure will not alter the potential of the impression for optimum performance shall also be identified;

k) when a manufacturer claims that a material in itself is antimicrobial and will remain so without further treatment after the impression is removed from the mouth, the manufacturer shall identify the reference on which the claim is based.

5.4 Requirements for characteristics and properties

5.4.1 Component colours

Different components intended for use in the same mixture shall be supplied in contrasting colours to provide a means of determining when the components have been thoroughly mixed.

5.4.2 Mixing time (hand-spatulated or hand-kneaded mixes)

When the impression material components are combined according to the manufacturer's instructions and the results of the mixing are evaluated according to 7.1, the average time required to achieve a homogeneous mixture (essentially streak-free) shall not exceed the time stated by the manufacturer.

5.4.3 Consistency

When tested according to 7.2, the test disc diameter shall be in the range given in Table 1 for the consistency assigned to the material by the manufacturer.

5.4.4 Working time

When tested according to 7.3, the working time shall not be less than that stated in the manufacturer's instructions.

5.4.5 Detail reproduction

When tested according to 7.4, the line width reproduced shall not exceed the appropriate value given in Table 1.

5.4.6 Linear dimensional change

When tested according to 7.5, the linear dimensional change shall not exceed the appropriate value given in Table 1.

5.4.7 Compatibility with gypsum

The impression material shall impart a smooth surface to and separate cleanly from the gypsum model material poured against it. When tested according to 7.6, the line width reproduced shall not exceed the appropriate value given in Table 1.

5.4.8 Elastic recovery

When tested according to 7.7, the elastic recovery shall be greater than or equal to the value given in Table 1.

5.4.9 Strain-in-compression

When tested according to 7.8, the strain-in-compression shall be in the appropriate range given in Table 1.

Table 1 — Characteristic and physical property requirements

Type	Test subclause no. and description							
	7.2		7.4	7.5	7.6	7.7	7.8	
	Consistency (Test disc diameter) mm		Detail reproduction (Line width reproduced)[a] µm	Linear dimensional change % max.	Compatibility with gypsum (Line width reproduced)[a] µm	Elastic recovery % min.	Strain-in-compression %	
	min	max					min	max
0	—	35	75	1,5	75	96,5	0,8	20
1	—	35	50	1,5	50	96,5	0,8	20
2	31	41	20	1,5	50	96,5	2,0	20
3	36	—	20	1,5	50	96,5	2,0	20

[a] The line reproduction shall be considered satisfactory if the required line a, b, or c is continuous between the lines d_1 and d_2. See test block in Figure A.12.

6 Pre-test planning approaches

The information in this Clause is provided to help test operators avoid losses of time due to trial and error efforts occurring when such information is not taken into account before test procedures, such as those described in Clause 7, are begun.

6.1 Sampling

Observe the following guidelines when procuring samples of materials for testing.

a) Procure only samples that have been packaged for retail or franchise marketing and that have labelling **Use by** dates that have not expired.

b) Wherever possible, select only those samples that have the same lot (batch) number [see 5.2.1 e)].

c) Sample size required

— as much as 900 ml might be needed for conducting all of the required tests and for the considerable practice, that might be necessary for the test operator to become proficient in specimen preparation and testing, and

— for the gypsum materials needed for the impression material compatibility with gypsum test, at least 1 000 g.

6.2 Pre-test product examinations

These examinations are helpful in determining whether the sample procured (6.1) is fit for objective testing.

6.2.1 Examinations for compliance with labelling requirements

Examine the consumer packaging components for compliance with the labelling requirements before any attempt to open a packaging component has defaced or obliterated any labelling entry information needed for storage or use of the product (for example, **Use by** date).

NOTE At this point, it is recommended that the following information about the product be recorded for future reference in a test record format, if possible:

— brand name, type, and class of the product, if applicable, along with an added numeric or alpha numeric symbol for the sample;

— **Use by** date for the product;

— lot number for each component.

6.2.2 Examinations for effectiveness of the packaging

Before opening any primary packaging container, examine it for possibilities that the quality of the content might have been compromised since its manufacture. For example, evidence such as the following:

— loose tube caps or canister lids or leakage;

— container rupture or punctures;

— shrinkage of the content of a container such as can be detected by sight, sound, or touch.

Caution — Do not use any compromised materials for preparing specimens.

6.2.3 Examinations for compliance with requirements for instructions for use

a) Before discarding any secondary packaging

   — examine the labels to determine whether they include any of the instructions for use information specified in 5.3, and

   — locate and retain any instruction sheet that might have been provided outside the primary container.

b) Examine the instructions for use for compliance with requirements stated in 5.3.3.

6.3 Essential pre-test preparatory practices

6.3.1 Laboratory conditions

Unless otherwise specified in this International Standard, conduct all specimen preparation and testing under the ambient laboratory conditions of (23 ± 2) °C and (50 ± 10) % relative humidity. And, unless otherwise specified, bring all equipment and materials to be used in the tests to the ambient temperature before beginning specimen preparation.

6.3.2 Apparatus function verification steps

a) Examine all accessories, instruments, and equipment for functional effectiveness before they are used in a test.

b) Clear all instrumentation or equipment surfaces that will come in contact with the specimen material of any contaminants that might influence the test result.

c) Perform whatever calibration steps necessary to ensure that the items comply with specifications stated for them in this International Standards or in the normative supporting reference ISO 6873.

6.3.3 Volume of materials to be mixed for each specimen

Unless otherwise specified in this International Standard, the volume mixed for each specimen shall be (15 ± 0,5) ml.

6.3.4 Order for conducting examinations and tests

a) Irrespective of the number of tests required, always conduct the examinations first and then conduct the mixing time test, the component colour evaluation, and the working time test, in that order.

b) When there is a need to conduct all of the other tests, conduct all of the tests in the order they are described in Clause 7, unless there is some compelling reason not to do so.

6.3.5 Standardized approaches to proportioning, mixing, and handling of hand mixed materials to be tested

See Annex B.

6.3.6 Timing for the specimen preparation and test procedures

A timing device such as a stop watch accurate to 1 s over a 30 s period shall be used for timing each requiring specimen preparation and test step.

6.3.7 Simulated oral time/temperature treatment of specimens formed in completely closed mould assemblies

(For the detail reproduction, linear dimensional change, elastic recovery, and strain-in-compression test specimens)

Immediately after the specimen forming material has been completely enclosed in the specimen forming assembly, the entire assembly shall be conditioned at (35 ± 1) °C for the time period recommended by the manufacturer for leaving the material in the mouth.

6.4 Pass/fail determinations

Except for the consistency and working time tests, the minimum number of specimens to be tested for pass/fail determinations shall either be three or five, as indicated in the first **Specimen preparation** subclause for each related test procedure.

a) **For a three-specimen minimum**, make a series of three specimens initially. If at least two of the three specimens comply with the related requirement, the material passes. If none comply, the material fails. If only one specimen complies, make three additional specimens. If two of the additional specimens comply, the material passes. Otherwise, the material fails.

b) **For a five-specimen minimum**, make and test a series of five specimens initially. If at least four of the five specimens comply with the related requirement, the material passes. If only one or two specimens comply, the material fails. If only three specimens comply, make a series of five additional specimens. If four of the second series of specimens comply, the material passes. Otherwise, the material fails.

6.5 Expression of test results

Record the number of specimens tested and whether the material passes or fails.

7 Test methods — Specific

7.1 Mixing-time

7.1.1 Apparatus

7.1.1.1 Recommended mixing apparatus [5.3.3 d)].

7.1.1.2 Timing device (6.3.6).

7.1.2 Specimen preparation and test procedure (five specimens)

Proportion and mix the required volume of material (6.3.3) for each specimen. Record the time required to obtain a homogeneous mixture for each specimen. Calculate the mean of the results for the five specimens.

NOTE Mixes made for this test can be used to provide increments of material needed for the consistency test (7.2).

7.1.3 Pass/fail determination and expression of results

Determine whether the mean result obtained in accordance with 7.1.2 complies with 5.4.2 and report the results.

7.2 Consistency

7.2.1 Apparatus and materials

7.2.1.1 Two glass plates, a loading plate of approximately 60 mm by 60 mm and at least 3 mm thick and a base plate of dimensions equal to or greater than those of the loading plate.

7.2.1.2 Material delivery system, for delivering a volume of (0,5 ± 0,02) ml of the material onto the base plate (see Figure A.1).

7.2.1.3 Polyethylene sheets, wrinkle-free, approximately 60 mm by 60 mm and 0,035 mm thick (one per specimen).

7.2.1.4 Polyethylene sheet discs, approximately 10 mm in diameter and 0,035 mm thick (two per specimen).

7.2.1.5 Elastomeric plug, for forming the floor of the test increment-containing cavity.

7.2.1.6 Test apparatus, for applying a force of (14,71 ± 0,01) N (see Figure A.2). The mass of the glass loading plate shall be included as part of the test load.

NOTE The dial indicator illustrated as a part of the test instrument in Figure A.2 plays no part in the consistency test.

7.2.1.7 Linear measuring instrument, accurate to 0,5 mm, for measuring diameters of the test specimen disc (7.2.3).

7.2.1.8 Timing device (6.3.6).

7.2.2 Advance preparation steps

Accomplish the following steps before beginning any of the test procedures:

— adjust the test apparatus (7.2.1.6) so that the contact surface of the loading shaft foot can descend within 5 mm of the top surface of the apparatus base;

— cover the top surface of the base plate (7.2.1.1) with a polyethylene sheet (7.2.1.3);

NOTE A thin film of silicon grease applied to the bottom of the loading plate will secure the polyethylene sheet covering in place, as required for the test.

— use the depth-gauge end of the plunger (see Figure A.1) to push the elastomeric plug (7.2.1.5) into the tapered end of the dispensing tube to the depth allowed by the stop;

— use the depth-gauge end of the plunger to seat two of the polyethylene sheet discs (7.2.1.4) to cover the cavity floor formed by the plug.

7.2.3 Specimen preparation and test procedure (3 specimens)

Accomplish the following steps within 25 s after the completion of mixing:

— slightly overfill the cavity in the dispensing tube (see Figure A.1) with the mixed material and strike off the excess to form the test increment;

— push the increment-extruding end of the plunger against the elastomeric plug to expel the test increment, along with one or both of the polyethylene discs, onto the centre of the base plate. Do not attempt to separate the discs from the test increment;

— centre the increment on the base of the test apparatus (7.2.1.6) directly under the elevated loading-shaft foot;

— place and hold the glass loading plate centred and in contact with the shaft foot;

— allow the (14,71 ± 0,01) N load to descend slowly onto the increment.

NOTE To obtain a more uniformly circular specimen disc, keep the glass plates as parallel as possible during loading and keep rotation of the plates to a minimum.

Allow the total load to rest on the specimen-forming assembly for 5 s. Lift the foot of the loading shaft from contact with the loading plate and allow the assembly to remain at room temperature for at least 15 min. Separate the loading plate from the assembly so as to leave the specimen on the base plate. Use the measuring instrument (7.2.1.7) to make two diametral measurements of the specimen, one across the major diameter of the disc and one across the minor diameter. Report the average of the two measurements as the diameter to be considered when determining whether the specimen complies with the diameter requirement specified in Table 1.

7.2.4 Pass/fail determination and expression of results

See 6.4 and 6.5.

7.3 Working-time

NOTE There are two working time test apparatus required depending on the type of material being evaluated. Type 0 materials are tested using a weight loading device and types 1, 2, and 3 are evaluated using the displacement rheometer described under 7.3.3.

7.3.1 Apparatus and materials applicable to the Type 0 materials

7.3.1.1 Specimen forming ring mould, (40,0 ± 0,2) mm I.D. 48 mm O.D and (9,0 ± 0,1) mm in height.

7.3.1.2 Flat glass or polymeric specimen forming base plate, approximately 50 mm by 50 mm and about 6 mm thick.

7.3.1.3 Mould release agent, such as silicone grease that will not react with the material being tested.

7.3.1.4 Clay or soft wax, capable of being moulded so as to fix the ring mould (7.3.1.1) to the base plate (7.3.1.2).

7.3.1.5 Timing device, such as a stop watch.

7.3.1.6 Working time test apparatus (see Figure A.2), which allows for a load application of 12,75 N and has a loading shaft which can be fixed with its foot resting at a point 10 mm above the floor of the specimen forming mould assembly, the height from which the loading shaft foot shall travel on its way to penetration of the specimen material. The apparatus has been adapted to provide for a pre-test fiducial measurement to be made with loading shaft foot in contact with the top surface of the ring mould in the specimen forming assembly and to provide for a test measurement, to be made 3 s after contact of the test specimen material with the foot of the loading shaft, for the purpose of determining whether the loading shaft foot has descended into the specimen material in the mould to a depth of at least 4 mm (5 mm above the floor of specimen forming mould cavity). The test apparatus shall be equipped with the required weights, a dial indicator having divisions of 0,01 mm, and a loading shaft having a foot 16 mm in diameter.

7.3.1.7 Modified table fork, for initial incorporation of base and accelerator components.

7.3.1.8 Nitrile protective gloves.

7.3.2 Working time test for the Type 0 materials

7.3.2.1 Test procedure (five specimens)

— Clear the ring mould (7.3.1.1), the base plate (7.3.1.2), and the loading shaft foot of the apparatus (7.3.1.6) of contaminants and coat them with a thin film of the mould release agent (7.3.1.3).

— Centre the ring mould on the base plate and use clay or wax (7.3.1.4) to fix the two components in this relationship so as to form the specimen forming mould cavity assembly.

— Load the required weights (12,75 N total) on the weight support or collar of the loading shaft.

— Proportion the hand mixed materials preparatory to mixing.

— Position the specimen forming assembly beneath the foot of the loading shaft such that the following steps can be completed preparatory to testing:

  — position the shaft foot such that it comes to rest on the top surface of the ring mould;

  — let the dial indicator spindle descend into contact with the top surface of the loading shaft;

  — record the dial gauge reading resulting from the dial indicator spindle contact as Reading **a**;

  — lift the loading shaft and lock it in place so that the foot is exactly 1 mm or more above the top of the ring mould in the specimen forming assembly.

7.3.2.2 Specimen formation and positioning steps

Complete the following steps in quick succession:

— cover the hands with the protective gloves (7.3.1.8);

— use the modified fork (7.3.1.7) for initial mixing of the putty components;

— use the gloved hands to knead the putty mixture until it is streak-free;

— slightly overfill the specimen forming mould cavity with the mixed material and strike off the excess level with the top of the specimen forming ring mould;

— centre the filled assembly beneath the centre of the loading shaft foot;

— unlock the loading shaft and carefully let it descend until the foot is barely in contact with the test material and lock the shaft in this position.

7.3.2.3 Test procedure steps

At 1 s before the working time stated in the instructions, unlock the loading shaft and allow the foot to descend into the material in the ring mould cavity over a period of 3 s.

Lock the shaft in the lowest position the foot has reached and record the dial indicator reading as Reading **b**.

Calculation of results

Subtract dial indicator Reading **a** from Reading **b** to determine the depth to which the loading shaft foot has descended into the test material

7.3.2.4 Pass/fail determination and expression of results

If the load shaft foot has descended to at least 4 mm into the test material, the specimen complies with the requirement stated in specific instructions for use, see 5.3.3 f). Otherwise, it fails. Additionally, see 6.4 and 6.5.

7.3.3 Apparatus and materials applicable to the Types 1, 2, and 3

7.3.3.1 Rheometer working time test apparatus, including the parts illustrated in Figure A.3 to Figure A.10, as well as the three electronic components listed immediately below.

7.3.3.2 A passive (i.e. not spring loaded) DC-Linear variable displacement transducer, with suitable power supply (DC-LVDT) or a LVDT requiring an external modulator/demodulator having a working range of >12,5 mm.

7.3.3.3 Suitable regulated DC power supply, for the LVDT.

7.3.3.4 Chart recorder, compatible with the DC-LVDT and associated elements or similar electronic equipment such as that using an analog to digital data module and appropriate software on a computer.

7.3.3.5 Mixing apparatus [5.3.3 d)].

7.3.3.6 Timing device (6.3.6).

7.3.4 Pretest apparatus function verification and assembly

7.3.4.1 Check for friction

Before using the test apparatus (7.3.3.1), use the following procedure to determine whether the friction between the bearing areas of glide track (see Figure A.5) and the sliding polymer blocks (see Figure A.7) is within acceptable limits (see also Figure A.3):

— do not use lubricants in attempts to reduce friction;

— detach the LVDT core carrier rod (see Figure A.3) from the polymer block 4_L;

— clean and dry the bearing surfaces of the sliding blocks and glide track and examine them for defects that can be detected by touch (burrs, nicks, etc.) and eliminate any such defects;

— seat the sliding blocks in the glide track and use the perforated test plate (see Figure A.8) and the plate aligning and locking pins, Parts 5_L and 5_R (Figure A.3 and Figure A.9) to relate the parts as for testing;

— elevate one end of the apparatus so that the base is at an approximate 20° angle to horizontal;

— move by hand the sliding block/perforated test plate assembly in the glide track to the upper extreme position and release it immediately.

If the assembly moves freely to the lower extreme position under the pull of gravity, the friction is within acceptable limits.

Repeat the steps described above, with the opposite end of the apparatus elevated, to determine whether freedom of movement in the opposite direction is also acceptable.

If the friction cannot be reduced to acceptable limits by removal of burrs, contaminates, etc, it might be necessary to resurface the bearing areas to eliminate binding interferences that might be contributing to the friction.

Upon achieving acceptable limits for friction, remove the test plate, reattach the core carrier rod to the sliding block 4_L in Figure A.3, and proceed with assembly of the apparatus·

7.3.4.2 Apparatus assembly

Connect the LVDT (7.3.3.2) to the recorder (7.3.3.4) and to the power supply (7.3.3.3). Adjust the LVDT body position as required to establish a body/core relationship whereby a full-scale deflection of the recorder pen indicates a rheometer displacement of 3,5 mm. Confirm that the recorder pen reflects a linear function of the rheometer displacement.

7.3.4.3 Test procedure (five specimens)

When combining hand-mixed materials, start the timing device (7.3.3.6) at the commencement of mixing. For the extrusion mixed materials, delay starting the timing device until the material components can be seen entering into the mixing nozzle. After completion of mixing, accomplish the following steps within 55 s:

— deposit an increment of about 2 ml of the material centred on the slotted surface of the test specimen pedestal (see Figure A.3 and Figure A.6);

— force the perforated test plate into the centre of the impression material increment until the undersides of both ends of the plate come into contact with the upper surfaces of the sliding polymer blocks, 4_L and 4_R, and so that the mixed material extrudes through at least 28 of the perforations;

— align the locking pin holes in the perforated plate with the pin holes in the sliding blocks and insert the locking pins, 5_L and 5_R (see Figure A.3), to secure the parts in the relationship for testing;

— zero the chart recorder pen before activating the recorder chart drive as required to begin the test schedule described below.

For materials having a stated working time of 3 min or less [6.3 f)], begin testing at 60 s to 90 s after commencement of mixing. For materials having a greater stated working time, begin testing 2 min before the end of the stated working time. Apply finger pressure or another controlled force against the sliding block, 4_R, so as to displace the sliding block/perforated plate assembly 0,25 mm, as reflected by the chart recorder tracing. Remove the force immediately after completing this displacement and observe behaviour of the recorder pen.

Repeat the displacement procedure at 15 s intervals until the chart recorder pen tracing (see Figure A.11) first indicates that the specimen has begun to exhibit elastic properties that can adversely affect impression quality.

Subtract 15 s from the time the first indication was recorded that the specimen has begun to exhibit elastic properties and report the result as the working time.

7.3.5 Pass/fail determination and expression of results

See 6.4 and 6.5.

7.4 Detail reproduction

7.4.1 Apparatus and materials

7.4.1.1 Test block (see Figure A.12) **and ring mould accessory** (see Figure A.13). Clean the test block ultrasonically before each use.

7.4.1.2 Oven, set at (35 ± 1) °C, for dry heat conditioning of the test block prior to use.

7.4.1.3 Flat glass or metal plate, approximately 50 mm by 50 mm and at least 3 mm thick.

7.4.1.4 Polyethylene sheets, approximately 50 mm by 50 mm and 0,035 mm thick (one per specimen).

7.4.1.5 Water bath, for maintaining a temperature of (35 ± 1) °C in simulation of a mouth temperature environment.

7.4.1.6 Microscope, equipped for ×4 to ×12 magnification and low angle illumination.

7.4.1.7 Timing device (6.3.6).

7.4.2 Specimen preparation (three specimens)

Before mixing the material for each of the three specimens, place the test block and ring mould (7.4.1.1) in the oven (7.4.1.2) for conditioning, for at least 15 min.

Cover the underside of the glass or metal plate (7.4.1.3) with a polyethylene sheet (7.4.1.4).

NOTE A thin film of silicone grease spread over the plate will help secure the polyethylene sheet to the plate during specimen formation.

Accomplish the following steps within 60 s after completion of mixing:

— remove the test block and ring mould from the oven;

— seat the ring mould on the test block to form the specimen forming cavity;

— introduce an increment of the mixed material (enough to slightly overfill the cavity) along one side of the cavity such that it can be directed to first enter the scribed lines a, b, and c on one side of the test block, and be gradually forced through application of pressure applied by the glass or metal plate to flow into the lines to their opposite ends;

— press the polyethylene-covered plate down against the top of the ring mould so as to expel the excess material;

— 60 s after completion of the mix, place this specimen-forming assembly in the water bath (7.4.1.5) for the minimum time recommended by the manufacturer's instructions for leaving the impression in the mouth [see 5.3.3 g)].

After completion of the water bath treatment, separate the impression material specimen in the ring mould from the specimen forming assembly and flush the specimen surface with distilled or deionized water. Use a gentle stream of clean air to blow away moisture. The lines on the specimens will be positive copies (raised lines) of the lines scribed in the test block surface.

For elastomeric impression materials which might adhere to the test block, the lined surface may be treated with an anti-adherent substance, provided the anti-adherent does not react with the test specimen or test block to cause an undesirable test result.

7.4.3 Test procedure

Immediately after blowing moisture from the specimen, use the microscope (7.4.1.6) to examine the specimen for compliance with the related requirement shown in Table 1.

NOTE Differences in colours of the materials might make it necessary to use different light intensities or different colour filters, or both, when viewing specimens to determine whether the required lines have been reproduced in surfaces of the impression material specimens and in gypsum specimens made for the compatibility with gypsum test.

Specimens found to be in compliance with the related requirements for this test can be used for the linear dimensional change test (7.5).

7.4.4 Pass/fail determination and expression of results

See 6.4 and 6.5.

7.5 Linear dimensional change

7.5.1 Apparatus and materials

7.5.1.1 Detail reproduction test specimens, made according to 7.4.2, examined according to 7.4.3, and found to be in compliance with the related requirement specified in Table 1.

7.5.1.2 Glass plate, approximately 50 mm by 50 mm and at least 3 mm thick (one for each specimen).

7.5.1.3 Talcum powder.

7.5.1.4 Measuring microscope, accurate to 0,01 mm, equipped for ×4 to ×12 magnification, low angle illumination, and a measuring travel of at least 27 mm.

7.5.2 Test block line-length measurement procedure

7.5.2.1 Test block preparation and positioning

Prepare and position the test block as follows:

— clean the test block ultrasonically before beginning the procedure;

— position the test block on the microscope stage (7.5.1.4) with line d_1 to the right and with line c appearing as the lower line as shown in Figure A.14 a);

— relate the *X* axis of the microscope cross hair parallel to, and approximately 0,03 mm below line c as shown in Figure A.14 c). This will place the *Y* axis of the cross hair parallel to lines d_1 and d_2;

— move the microscope slide or stage to bring the *Y* axis of the cross hair at least 0,1 mm outside and to the right of line d_1 on the test block.

7.5.2.2 Test block line-length measurement steps

Proceed with the following steps taking into account that after positioning the test block according to the last step in 7.5.2.1, the direction of travel of the microscope slide or stage should not be reversed at any point during subsequent travels until after the final measurements between lines d_1 and d_2 have been recorded:

— move the left edge of the *Y* axis of the cross hair into alignment with the inner edge of line d_1, stop the travel motion, and record the reading for this position as the initial measurement [see Figure A.14 c)];

— move the left edge of the *Y* axis of the cross hair into alignment with the inner edge of line d_2, stop the travel motion, and record the reading for this position as the final measurement;

— calculate and record the difference between the initial and final readings. Make two additional measurements for the distance between lines d_1 and d_2. Average the three values and record the result as L_1.

7.5.3 Specimen preparation (three specimens)

Dust the underside of each detail reproduction test specimen (7.5.1.1) and the top surface of the glass plate (7.5.1.2) with talcum powder (7.5.1.3). Then seat the dusted specimen to rest on the dusted plate and store this assembly in the laboratory environment until the time specified for its measurement in accordance with 7.5.4.1.

7.5.4 Test specimen measurement

7.5.4.1 Time for specimen measurement

The time at which the specimens are to be measured shall be related as follows to the permissible time lapse, recommended in the manufacturer's instructions [5.3.3 h)], between removal of the impression from the mouth and pouring of the gypsum product:

— when a manufacturer's instructions state that pouring of the impressions can be delayed for 24 h or more, the specimens shall be measured at 24 h after separation from the forming assembly;

— when the manufacturer states a maximum permissible time delay of less than 24 h before pouring the impressions, the specimens shall be measured at the end of the maximum permissible time delay stated.

7.5.4.2 Specimen measuring procedures

Follow the procedure described in 7.5.2.2 for measuring the distance between lines d_1 and d_2, along line c, on the specimen, with the following exception: place the specimen on the microscope stage with line d_2 positioned to the right for the initial measurement, as illustrated in Figure A.14 b), thus ensuring that line c will appear as the lower line. Record this measurement as L_2.

7.5.4.3 Calculation of results

Calculate the percentage of dimensional change, ΔL, for each specimen to the nearest 0,05 %, using Formula (1):

$$\Delta L = 100 \cdot \left(\frac{L_1 - L_2}{L_1} \right) \quad (1)$$

where

L_1 is the distance measured between lines d_1 and d_2 on the test block (7.5.2.2);

L_2 is the distance measured between lines d_2 and d_1 on the impression material specimen (7.5.4.2).

Report whether the percentage of change for each specimen complies with the pertinent requirement specified in Table 1.

7.5.4.4 Pass/fail determination and expression of results

See 6.4 and 6.5.

7.6 Compatibility with gypsum

7.6.1 Apparatus and materials

7.6.1.1 Detail reproduction test specimens, made according to 7.4.2, examined according to 7.4.3, and which have been found to be in compliance with the related detail reproduction requirement shown in Table 1.

7.6.1.2 Ring mould (7.4.1.1).

7.6.1.3 Riser, see Figure A.13.

7.6.1.4 Slit mould (see Figure A.13), with a mechanism such as a worm gear clamp for closing the slit.

Use of the slit mould requires that the mould be clamped such that the slit will be closed during formation of the gypsum specimen. Later, the clamping force is released to allow the slit to open for easy removal of the specimen. The brass alloy used for this mould should have a strain-at-elastic-limit sufficiently high to permit the mould to be closed and opened repeatedly without significant permanent reduction in width of the slit.

7.6.1.5 Flat glass or metal plate, approximately 50 mm by 50 mm and at least 3 mm thick.

7.6.1.6 Two dental gypsum products [see 5.3.3 i) and ISO 6873]

— one Type 3, dental stone, model

— either one Type 4 or one Type 5, dental stone, high strength

Well before their anticipated use in the test, the gypsum products shall be evaluated for compliance with the setting time (initial setting time) requirement specified in ISO 6873. Products which do not comply with the requirement shall not be used for this test. After the initial opening of their containers and between openings thereafter, the gypsum products shall be stored in sealed containers so as to protect them from moisture contamination.

7.6.1.7 Mould release agent, such as silicone grease, which will be non-reactive with the slit mould (7.6.1.4) and the gypsum products.

7.6.1.8 Microscope (7.4.1.6).

7.6.1.9 Timing device (6.3.6).

7.6.2 Specimen preparation

Prepare three specimens for each of the two dental gypsum products required for use in the test.

7.6.2.1 Advance preparation

Accomplish the following steps before carrying out the test for compatibility with gypsum:

— treat the inner surface of the slit mould (7.6.1.4), including the slit surfaces, with a thin film of the mould release agent (7.6.1.7) and use the clamping mechanism to close the slit;

— position the specimen (7.6.1.1) in the ring mould (7.6.1.2) and press the riser (7.6.1.3) against the underside of the specimen so as to push the lined surface of the specimen to a position level with the top flat surface of the ring mould. Seat this assembly, with the riser in place, and the lined surface down, into the recess of the slit mould. Cover this part of the assembly with the plate (7.6.1.5) and invert the entire assembly.

7.6.2.2 Specimen formation

At the earliest time specified for pouring impressions after their removal from the mouth [5.3.3 h)], introduce the first increments of a gypsum mixture, through mechanical vibration, so that they flow down along an internal surface of the mould cavity to first cover the ends of the raised lines, a, b, and c, on one side of the specimen surface and to be directed to flow gradually over the lines to their opposite ends. Add enough of the gypsum mixture to slightly underfill the mould cavity.

Unless otherwise specified in manufacturer's instructions for the gypsum or impression material, store the gypsum/impression material assembly in the laboratory environment until 45 min after the initial setting time previously determined for the gypsum product, in accordance with 7.6.1.6. Separate the gypsum specimen from the assembly.

7.6.3 Test procedure

Use the microscope (7.6.1.8) to examine the lined surfaces of the gypsum specimen for compliance with the requirements specified in Table 1 (see also Note in 7.4.3).

7.6.4 Pass/fail determination and expression of results

See 6.4 and 6.5.

7.7 Elastic recovery

7.7.1 Apparatus and materials

7.7.1.1 Fixation ring with split mould, see Figure A.15.

7.7.1.2 Mould release agent, such as silicone grease.

7.7.1.3 Two flat glass or metal plates, approximately 50 mm by 50 mm and at least 3 mm thick.

7.7.1.4 Polyethylene sheets (wrinkle free), approximately 50 mm by 50 mm and 0,035 mm thick.

7.7.1.5 C-clamp, having a minimum screw opening of 40 mm and a minimum throat depth of 30 mm.

7.7.1.6 Water bath, see 7.4.1.5.

7.7.1.7 Timing device, see 6.3.6.

7.7.1.8 Small glass or metal test plate, approximately 15 mm by 15 mm and 2 mm thick.

7.7.1.9 Test apparatus, such as the one shown in Figure A.16. The dial indicator shall be accurate to 0,01 mm and shall have a capacity for contributing, along with the weight of the test plate (7.7.1.8), to the application of a total force of (0,6 ± 0,01) N. Set the stop on the test apparatus to limit compression of the test specimen to (6,0 ± 0,01) mm.

7.7.2 Specimen preparation

7.7.2.1 Advance preparation

Five specimens shall be prepared. Before preparing the specimens, carry out the following steps:

— apply a very thin film of the mould release agent (7.7.1.2) to the internal surface of the fixation ring and to all surfaces of the split mould (7.7.1.1);

— cover one surface of each of the plates (7.7.1.3) with a polyethylene sheet (7.7.1.4);

— seat the fixation ring on one of the polyethylene-covered plates.

7.7.2.2 Specimen formation

Carry out the following steps within 60 s after completing the mixing:

— fill the fixation ring slightly more than half full;

— press the split mould halves down through the impression material in the fixation ring until their bottom surfaces are in near contact with the polyethylene-covered base plate so as to force the impression material above the top of the split mould halves;

— press the second polyethylene-covered plate onto the material so as to expel almost all the excess and use the C-clamp (7.7.1.5) to force the plates into contact with the top and bottom surfaces of the split mould;

NOTE If glass plates (7.7.1.3) are used instead of metal plates, metal back-up plates can be used between the glass plates and the C-clamp parts to minimize scratching and breakage of the glass plates.

At 60 s after completion of mixing, place this specimen-forming assembly in the water bath (7.7.1.6) for the time specified in the manufacturer's instructions for leaving impressions in the mouth [5.3.3 g)];

Within 40 s after completion of the water bath storage, separate the specimen from the split mould, place the glass or metal test plate (7.7.1.8) to rest on the top surface of the specimen, and seat this assembly on the test apparatus base (7.7.1.9) centred in axial alignment with the dial indicator spindle.

7.7.3 Test procedure

Conduct the test in accordance with the following time schedule, where t is the time the specimen is removed from the water bath:

— t + 45 s: gently lower the dial indicator spindle contact point to rest on the test plate on top of the specimen;

— t + 55 s: read the dial indicator and record the reading as h_1;

— t + 60 s: deform the specimen (6,0 ± 0,1) mm, as limited by the stop on the test apparatus, within 1 s, release the deforming force slowly over a period of 5 s and then lift and hold the contact point from contact with the test plate remaining at rest on the specimen;

— t + 170 s: gently return the contact point to rest on the test plate;

— t + 180 s: record this dial indicator reading as h_2.

NOTE Possibilities for lateral displacement of the specimen during application of the deforming force can be reduced by cementing an abrasive paper covering, about 600 grit (FEPA 1200), over the surfaces of the apparatus base and the test plate that will be in contact with the top and bottom surfaces of the specimen during the test.

7.7.4 Calculation of results

Calculate the percentage of elastic recovery, K, for each specimen, using Formula (2):

$$K = 100 - \left[100 \left(\frac{h_1 - h_2}{h_0} \right) \right] \quad (2)$$

where

h_0 is the height of the split mould;

h_1 is the dial indicator reading at t + 55 s (immediately before the specimen is deformed);

h_2 is the dial indicator reading at t + 180 s (115 s after the deforming force has been removed from the specimen).

Discard values for defective specimens. Defective specimens can be identified by sectioning each specimen axially into eight approximately equal-sized segments and examining each segment for defects such as air inclusions.

7.7.5 Pass/fail determination and expression of results

See 6.4 and 6.5.

7.8 Strain-in-compression

7.8.1 Apparatus

Items listed in 7.7.1.1 to 7.7.1.7 are required for preparing the specimen together with a test apparatus, such as the one shown in Figure A.2, incorporating a dial indicator accurate to 0,01 mm.

7.8.2 Specimen preparation

Prepare five specimens according to the procedure described in 7.7.2, with the exception that the test plate (7.7.1.8) is not placed on the specimen.

7.8.3 Test procedure

Immediately after separation of the specimen from the forming assembly, position it on the base of the test apparatus (7.8.1) centred below the foot of the loading shaft. Conduct the test in accordance with the following time schedule, where t is the time the specimen is removed from the water bath:

— t + 60 s: lower the foot of the loading shaft into direct contact with the top of the specimen, thus applying an initial load of (1,22 ± 0,01) N exerted by the loading shaft/weight support assembly only;

— t + 90 s: lock the loading shaft in place, lower the dial indicator contact point to rest on the top of the loading shaft, and record the dial indicator reading as h_1;

— t + 95 s: remove the dial indicator contact point from contact with the loading shaft, unlock the loading shaft, and increase the load to a total force of (12,26 ± 0,01) N gradually over a period of 10 s;

— t + 135 s: lock the loading shaft in place, return the dial indicator contact point to rest on the loading shaft, and record the dial indicator reading as h_2.

7.8.4 Calculation of results

Calculate the percentage of strain-in-compression, E, for each specimen, using Formula (3):

$$E = 100 \cdot \left(\frac{h_1 - h_2}{h_0} \right) \tag{3}$$

where

h_0 is the height of the split mould;

h_1 is the dial indicator reading, 30 s after application of the initial load;

h_2 is the dial indicator reading, 30 s after complete application of the increased load. Examine any failing specimens according to the procedure described in 7.7.4.

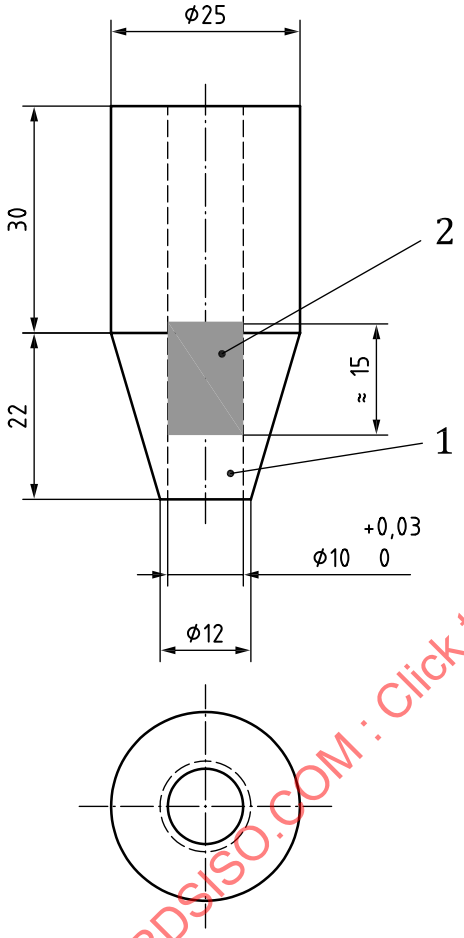
7.8.5 Pass/fail determination and expression of results

See 6.4 and 6.5.

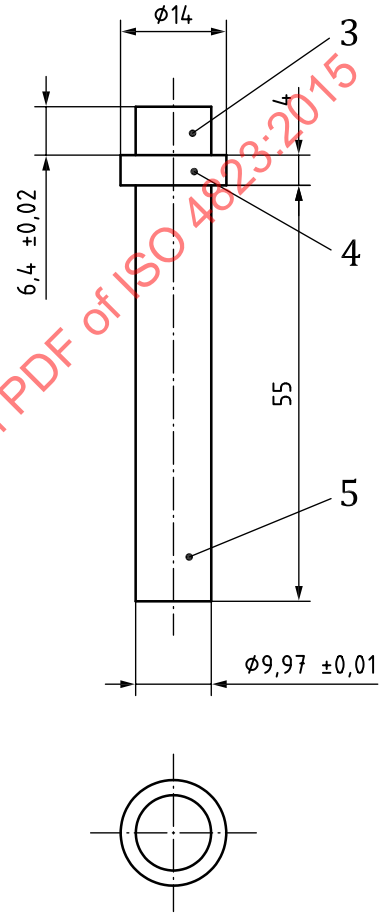
Annex A
(normative)

Figures cited in this International Standard

Dimensions in millimetres



a) Dispensing tube[a]



b) Depth gauge/specimen increment-extruding plunger[b]

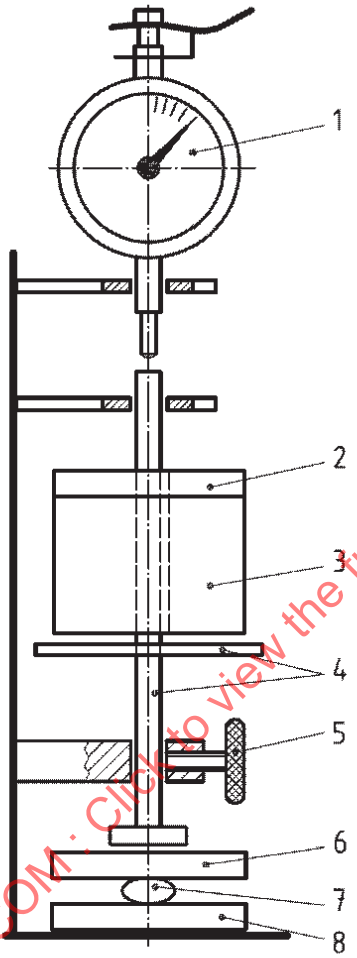
Key

1 cavity equal in volume to that of the increment of material [(0,50 ± 0,02) ml] needed for the test
2 elastomeric plug for forming the floor of the cavity
3 depth gauge for positioning the plug
4 depth gauge stop
5 increment-extruding end of plunger
a Dispensing tube is made of PFTE or acetal.
b Plunger is made of rigid metal or polymeric material.

NOTE 1 Other dimensions may be used when making these parts provided that the dispensing tube bore and the depth gauge are mated such that the cavity produced has a volume of (0,5 ± 0,02) ml and provided that lengths of the plug and the extruding end of the plunger ensure the complete extrusion of the specimen from the cavity.

NOTE 2 The elastomeric plug can be made by forming approximately 1 ml of heavy-bodied elastomeric impression material in the bore of the dispensing tube.

Figure A.1 — Delivery system for consistency test specimen material



Key

1 dial indicator

2 weight having a mass which, along with the masses of items 3, 4, and 6, will provide for the total force of (14,71 ± 0,01) N needed for the consistency test and a total force of (12,75 ± 0,01) N needed for the working time test of Type 0 materials

3 weight having a mass which, along with the mass of item 4, will provide for the total force of (12,26 ± 0,01) N needed to complete the strain-in compression test

4 loading shaft, complete with weight support, having a mass that will provide for the initial force of (1,22 ± 0,01) N needed for the strain-in compression test

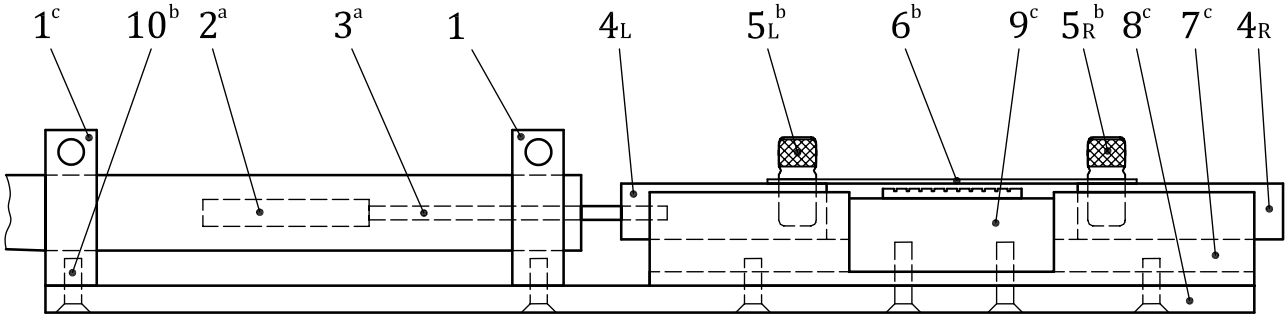
5 locking screw

6 loading plate

7 specimen increment

8 base plate

Figure A.2 — Apparatus for consistency and strain-in-compression tests and for working time of Type 0 materials



Key

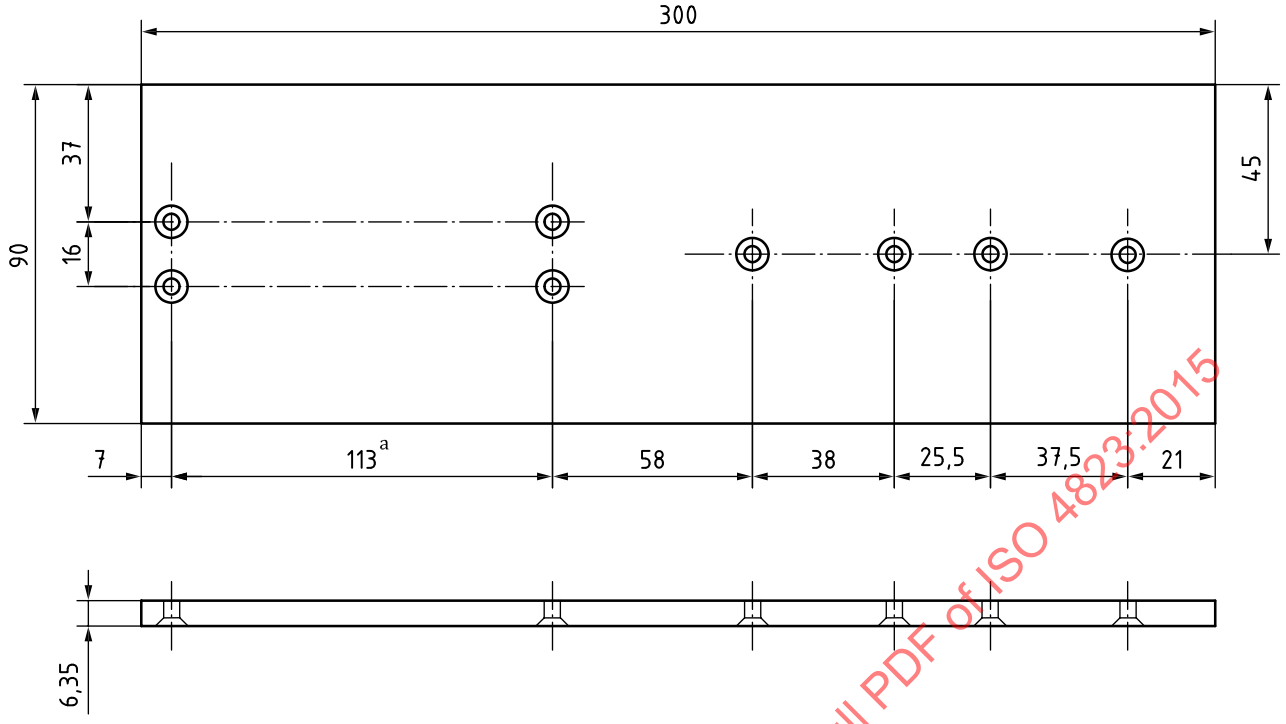
1 LVDT support
2 LVDT core
3 core carrier rod
4 4_L and 4_R: sliding polymer blocks
5 5_L and 5_R: plate aligning and locking pins
6 perforated test plate
7 glide track
8 instrument base
9 slotted specimen pedestal
10 flat-head assembly screws M3,5

a Components supplied by the LVDT manufacturer.
b Components made of stainless steel.
c Components made of anodized aluminium.

NOTE Location of the LVDT to the left of the other components favours right-handed use of instrument. Reversal of this relation so that the core carrier rod is attached to the sliding block 4_R favours left-handed use.

Figure A.3 — Working-time test instrument assembled

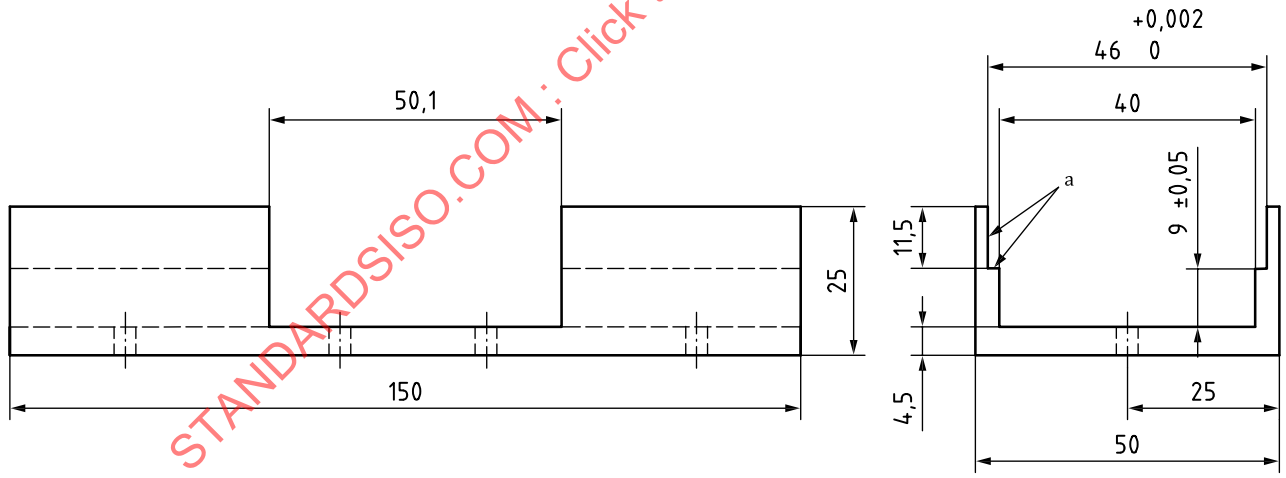
Dimensions in millimetres



a Distance between centres of the two LVDT supports. This dimension may vary depending upon the length of the LVDT used.

Figure A.4 — Instrument base — Working-time test instrument

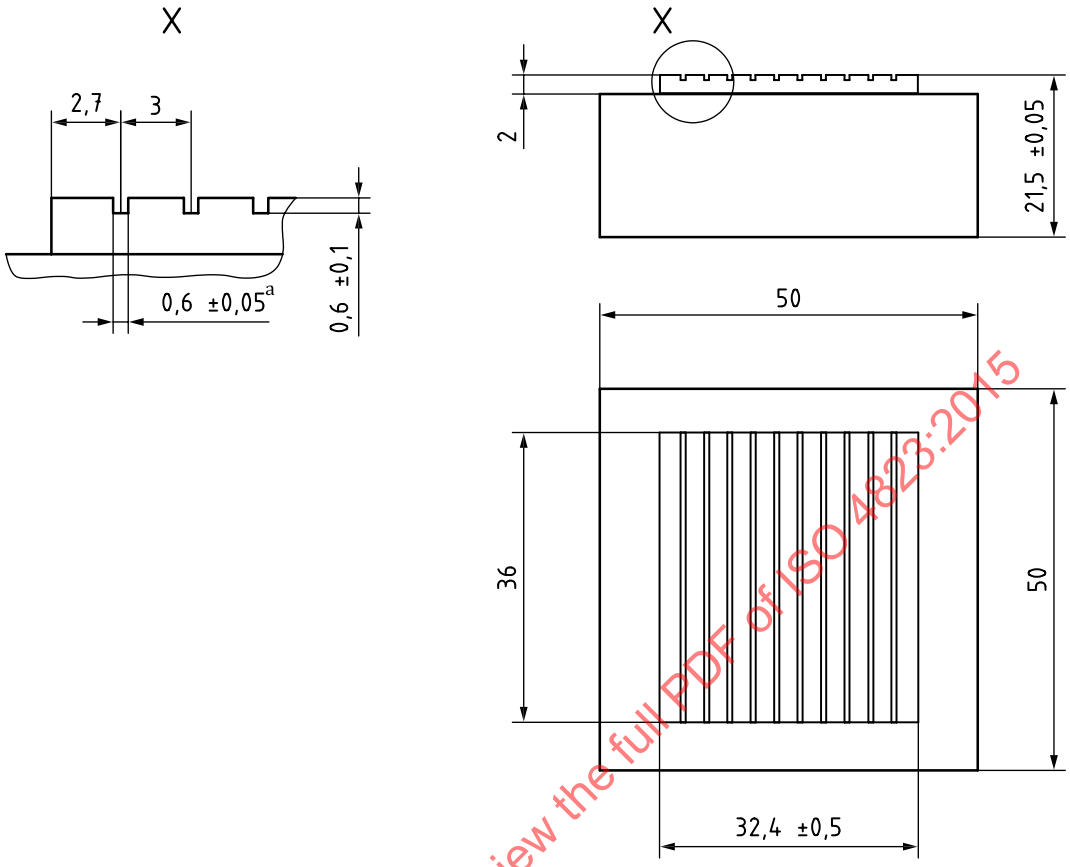
Dimensions in millimetres



a Indicates bearing surfaces of the glide track.

Figure A.5 — Glide track — Working-time test instrument

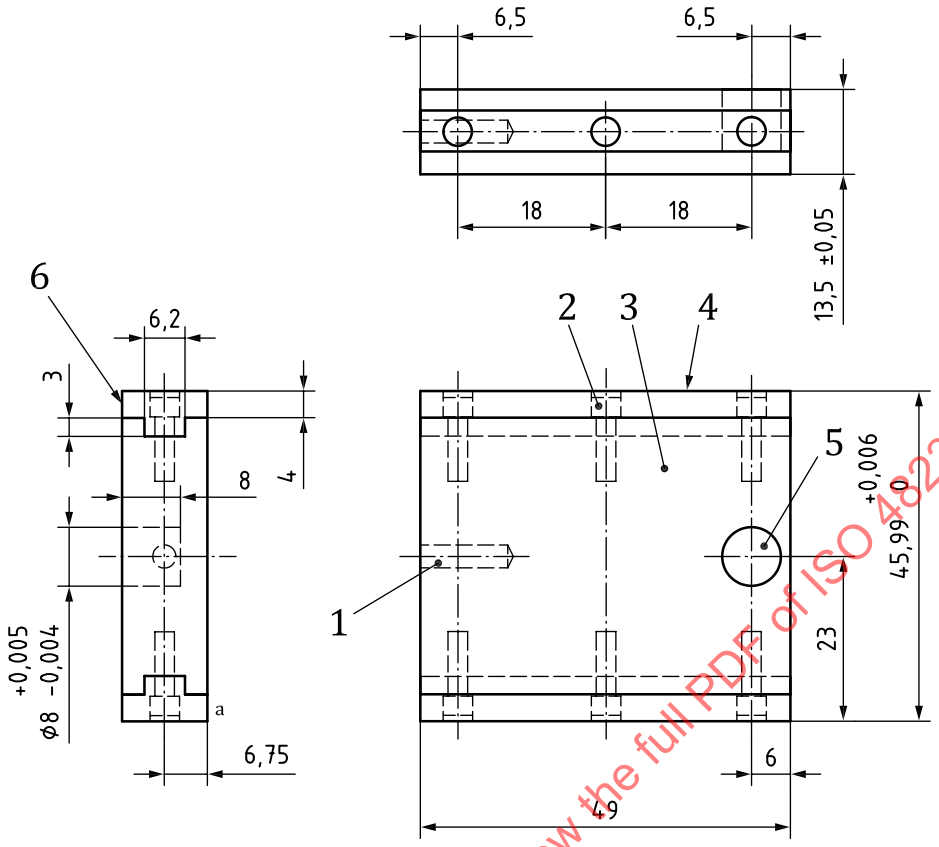
Dimensions in millimetres



a Ten slots with centres 3 mm apart.

Figure A.6 — Slotted specimen test pedestal — Working-time test instrument

Dimensions in millimetres

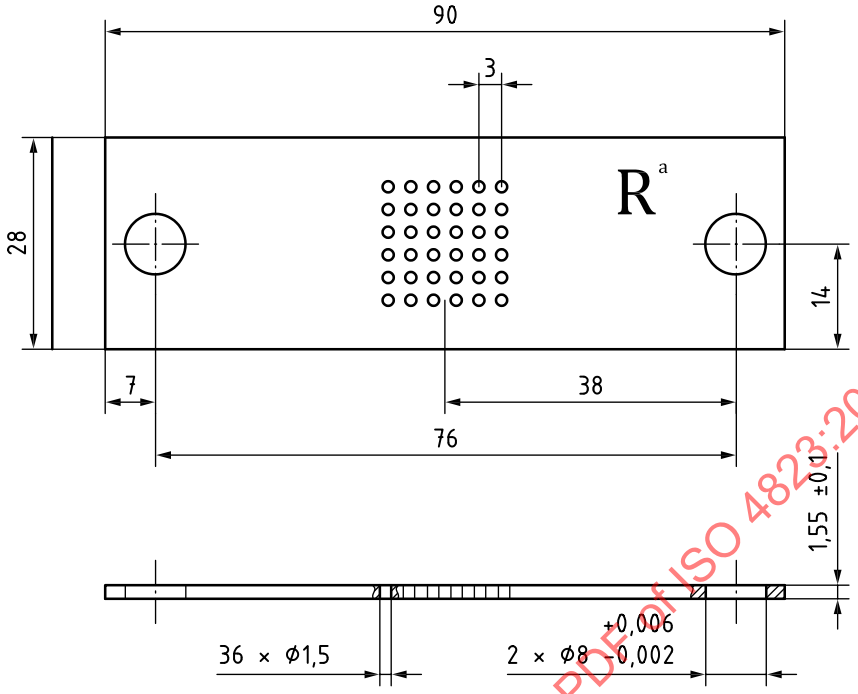


Key

1 hole sized and threaded in one of the blocks to accommodate the thread of the core carrier rod
2 cheese-head screws, M2,5 stainless steel (six places)
3 main body of block made of polyacetal
4 lateral bearing surface made of PFTE
5 hole to accommodate test plate aligning and locking pin
6 underside of bearing surface

Figure A.7 — Sliding polymer block — Working-time test instrument

Dimensions in millimetres



a Letter R marked in the top surface for use in positioning the test plate.

Figure A.8 — Perforated test plate — Working-time test instrument

Dimensions in millimetres

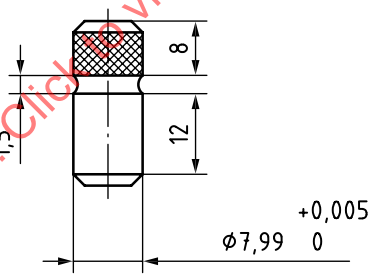
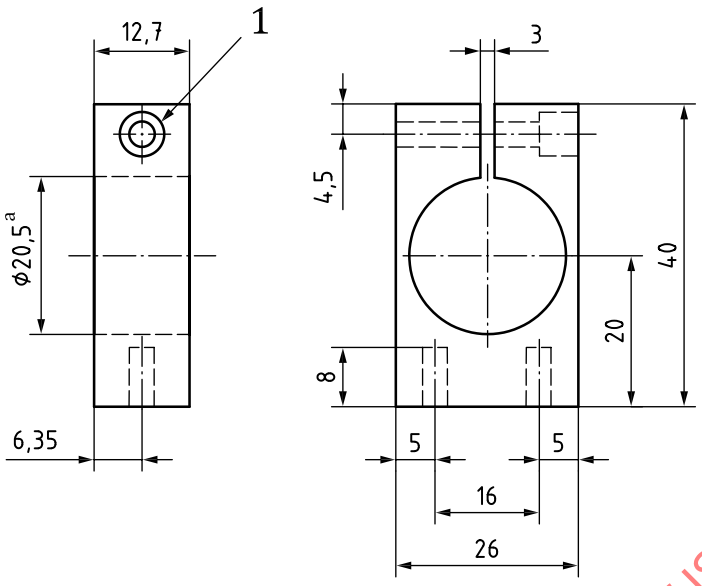


Figure A.9 — Test plate aligning and locking pin — Working-time test instrument

Dimensions in millimetres

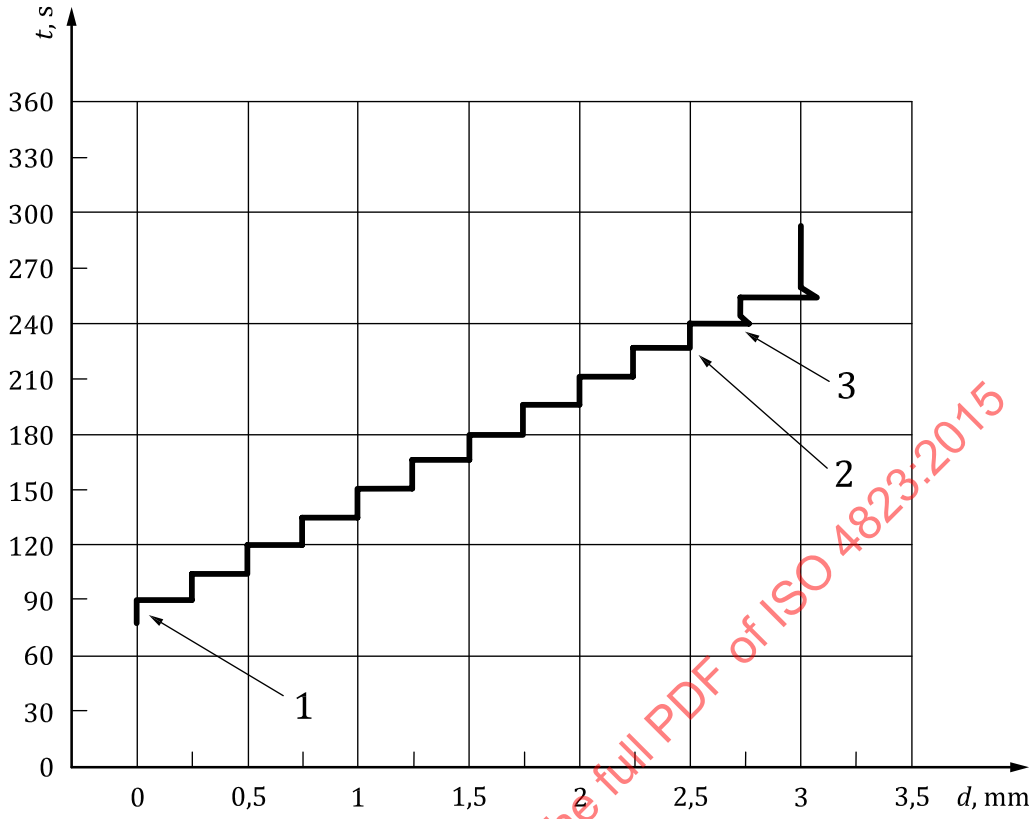


Key

1 cap-head screws, M4,5 stainless steel

a Dimension accommodating an LVDT with an outside diameter of about 20,5 mm. The dimension varies according to the outside diameter of the LVDT.

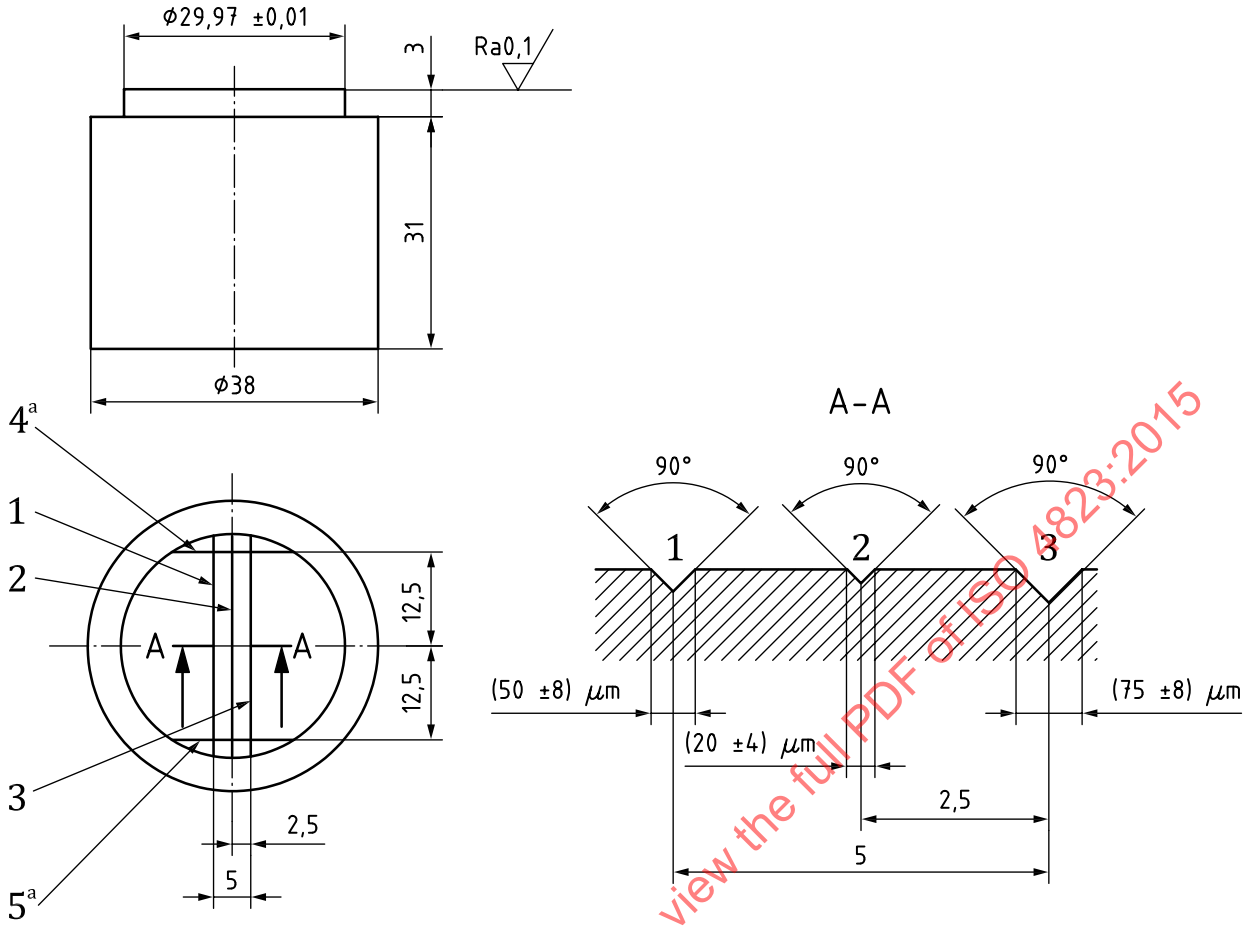
Figure A.10 — LVDT support — Working-time test instrument



Key

1 start chart recorder drive
2 working time
3 first indication of development of elastic property
d LVDT core displacement
t time

Figure A.11 — Example of a working-time test chart tracing



Key

1 line a
2 line b
3 line c
4 line d_1
5 line d_2
a Has the same width as line c.

NOTE 1 Unless otherwise specified, dimensions are in millimetres.

NOTE 2 Unless otherwise specified, tolerances are ±0,1 mm; surface roughness is 3,2 µm max. and material is cast or wrought austenitic stainless steel.

Figure A.12 — Test block for detail reproduction and tests for compatibility with gypsum