TECHNICAL REPORT

ISO/TR 18845

First edition
2017-06

Dentistry — Test methods for machining accuracy of computer-aided milling machines

Médecine bucco-dentaire — Méthodes d'essai pour l'exactitude d'usinage des fraiseuses à commande numérique

Reference number
ISO/TR 18845:2017(E)

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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 106, *Dentistry*, Subcommittee SC 9, *Dental CAD/CAD systems*.

Introduction

Dental CAD/CAM systems have been successfully used for the fabrication of indirect dental restorations such as inlays, crowns and bridges. The accuracy of these restorations is one of the most important factors for their clinical success. This document provides standardized test methods to evaluate the machining accuracy of computer-aided milling machines which are used as a part of dental CAD/CAM systems and the information to be provided by the manufacturer. A flow chart of test method is shown in Annex A.

There is another method to evaluate accuracy of the target restoration(s) using coordinate measuring machine (CMM) and software. Test methods using CMM are shown in Annex B.

Dentistry — Test methods for machining accuracy of computer-aided milling machines

1 Scope

This document specifies the test methods to evaluate the machining accuracy of computer-aided milling machines as a part of dental CAD/CAM systems, which fabricate dental restorations, e.g. inlays, crowns and bridges.

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 18739, *Dentistry — Vocabulary of process chain for CAD/CAM systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1942, ISO 18739 and the following apply.

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

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

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

3.1
computer-aided milling machine
computer-aided machining device designed for subtractive manufacturing of dental prostheses using rotary instruments for cutting and grinding

4 Recommendations

The accuracy of target restoration(s) should be evaluated using the test methods described in Clause 5. The test method and its results should be provided in the instruction for use, the technical manual or other means. When the machining accuracy is affected by the material, appropriate material(s) should be tested. Testing should be performed on each material type that the manufacturer indicates for use by the device.

5 Test methods

5.1 Target restorations

Three types of restorations, a) Class II inlay, b) crown and c) four-unit bridge, are the targets of this document. Choose the type(s) following the applicable restoration(s) specified by the manufacturer. If any of the three restorations is not specified as applicable by the manufacturer, this restoration

is eliminated from the target. In other words, the fabrication of the restoration(s) and the accuracy evaluation are carried out only for the applicable restoration(s) specified by the manufacturer.

NOTE This test method is designed adopting the same principle as the examination method of clinical marginal adaptation. The clinical adaptation is examined checking the discrepancy between the restoration and the cavity margin or between it and the shoulder margin of abutment. The metal die for crown and four-unit bridge is used as same as ISO 12836.

5.2 Apparatus

Two types of metal dies given in Figure 1 (Class II inlay) and Figure 2 (crown and four-unit bridge dies) are used both for the preparation of three-dimensional data (manufacturing data set) and the evaluation of the accuracy of restorations. As shown in Figure 1 and Figure 2, these dies consist of a non-malleable metal die and one or more removable structure(s) used for the evaluation of accuracy. Each die should be measured using a measuring device with accuracy of ±2 µm to confirm the specified shape and dimensions. The measured data are used to prepare the three-dimensional data (see 5.3).

The diameter of the removable occlusal part should be not less than the diameter of abutment and the difference of diameter should be not more than 10 µm.

The surface roughness (Sa) of the die, excepting the surfaces which do not come in contact with the test specimens/machined restorations, should be less than 2 µm. Refer to ISO 25178-2 and other parts for test methods.

If a mark for reference point is necessary, a groove and/or a ridge may be placed on the part, but should be placed so as to not influence the evaluation of the results according to 5.5.

The shapes and sizes of test specimen of the crown and the bridge should conform to Figure 3 (crown) and Figure 4 (bridge). One proximal-side of crown and bridge should have a flat plane to orient their position.

NOTE 1 An example of the machining device to fabricate the dies is Vertical Center NEXUS 410B[1)].

NOTE 2 Coordinate measuring machine (CMM) can be useful to measure the size of die. An example of a CMM is America Strato-Apex 574[2)].

5.3 Preparation of three-dimensional data

To fabricate the target restorations, a design data set (STL data) for each of the restorations should be prepared. This design data set should then be processed by the CAM software to prepare the manufacturing data set. The design data set should not be modified by the CAM software.

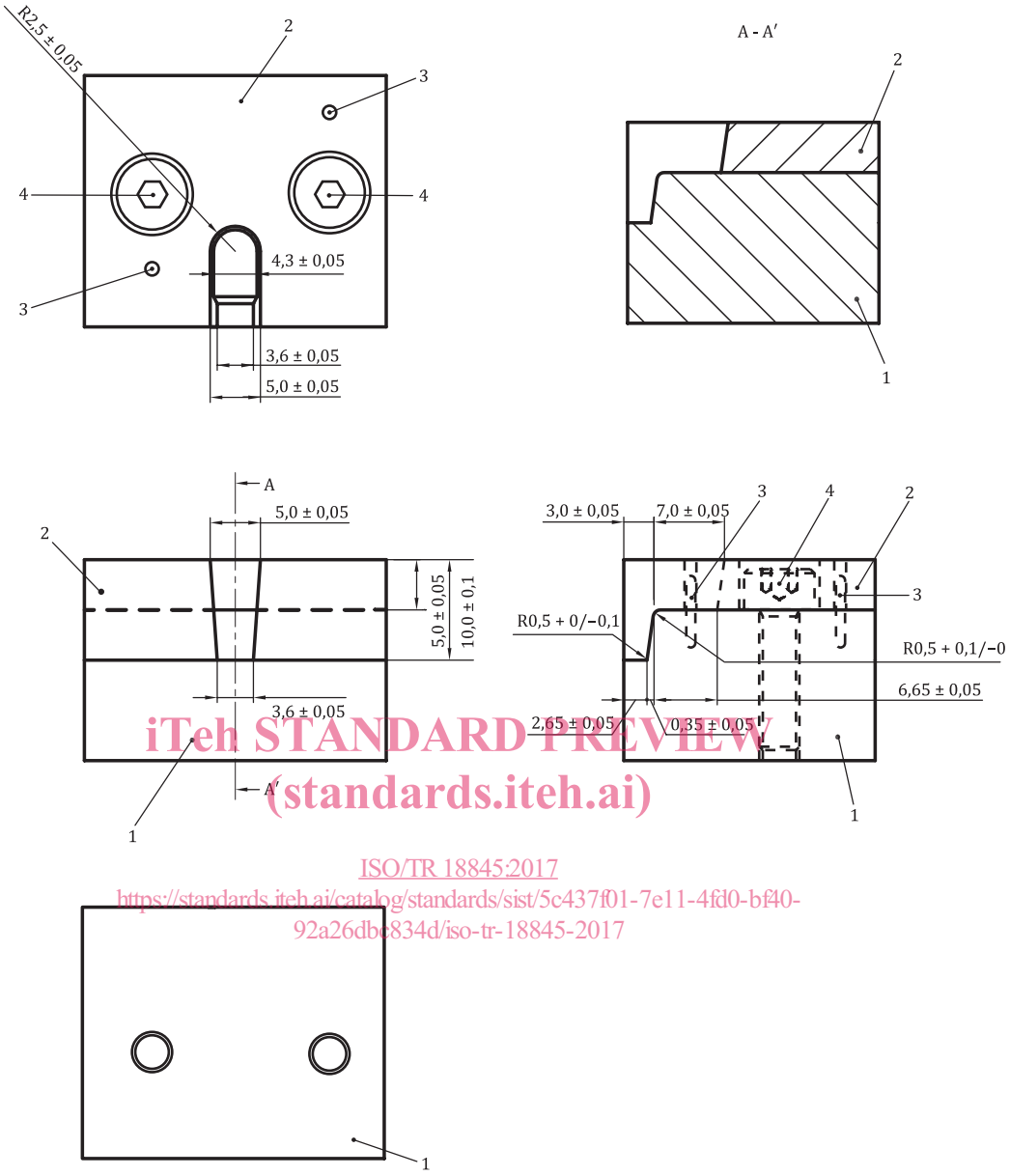
The dimensions of any surfaces in contact with the die surfaces are obtained from the measuring process in 5.2. Other dimensions are determined from Figure 3 and Figure 4.

The design data set should be prepared to ensure that the restoration comes in contact with the die without an allowance for cement space.

1) Vertical Center NEXUS 410B is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

2) America Strato-Apex 574 is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Dimensions in millimetres

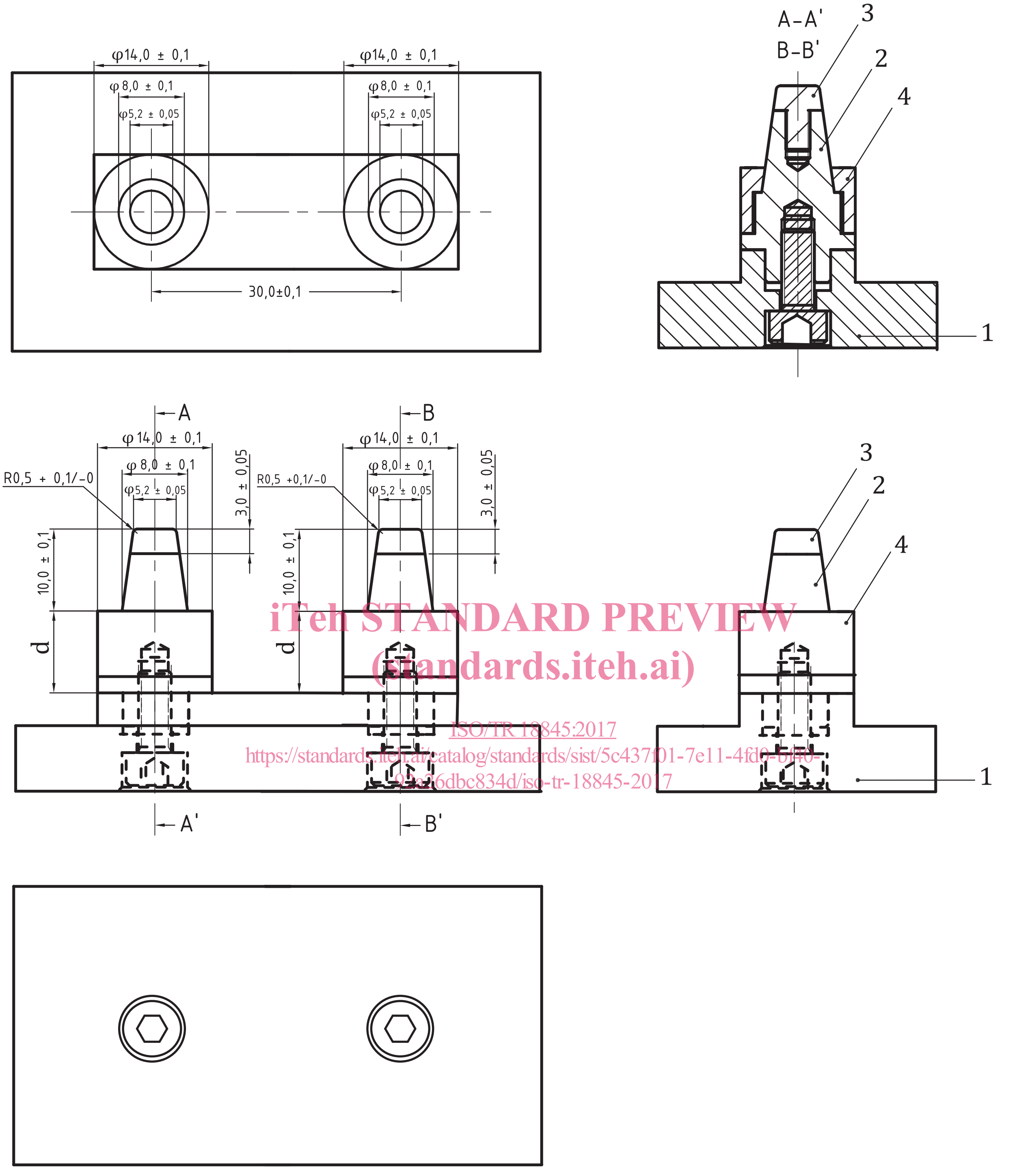


Key

1 metal die
2 removable part
3 positioning pin
4 fixing screw

Figure 1 — Die for class II inlay specimen

Dimensions in millimetres



Key

1 metal die

2 abutment

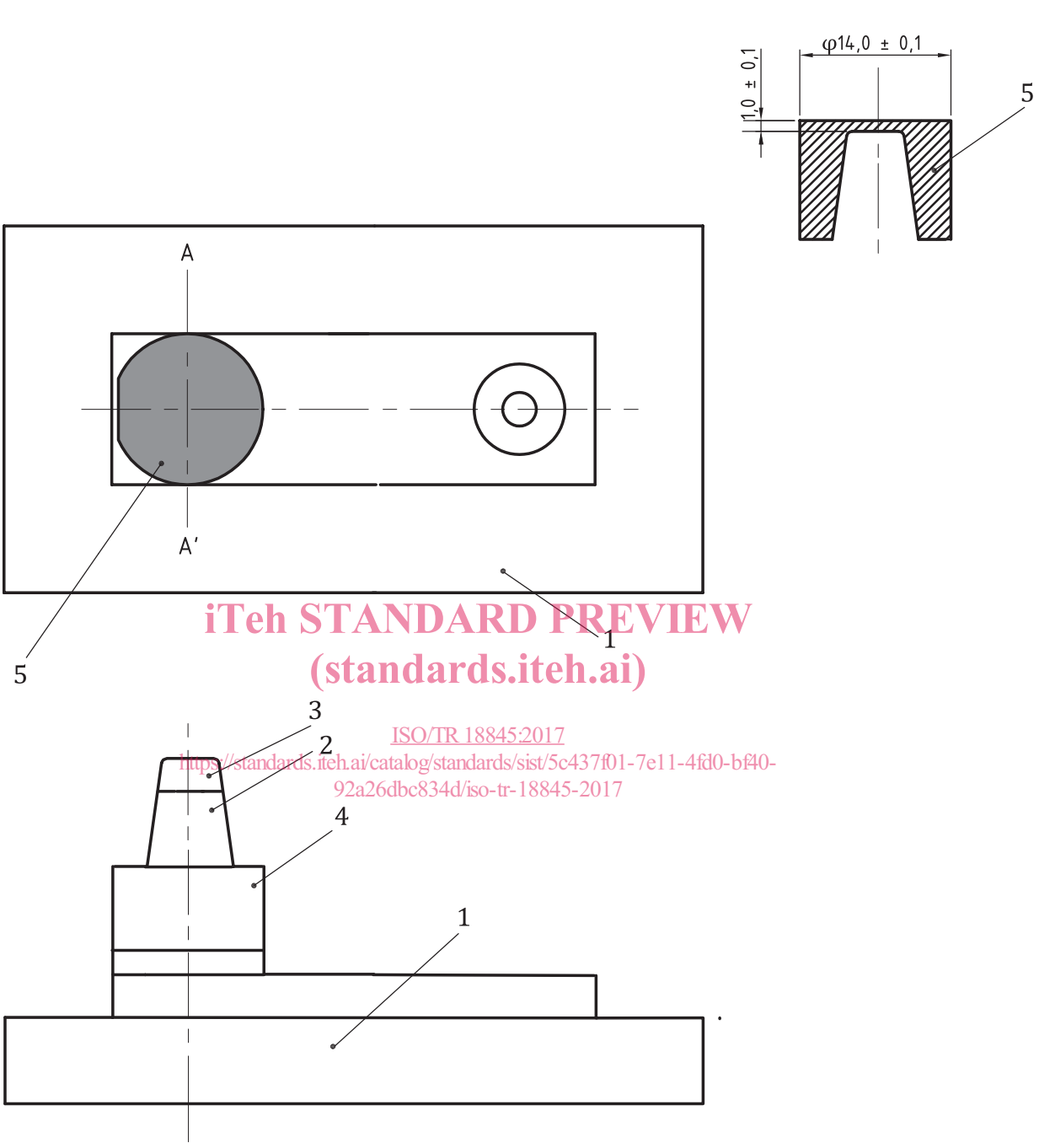
3 removable occlusal part

4 removable shoulder

d height of removable shoulder

Figure 2 — Die for crown and bridge specimen

Dimensions in millimetres



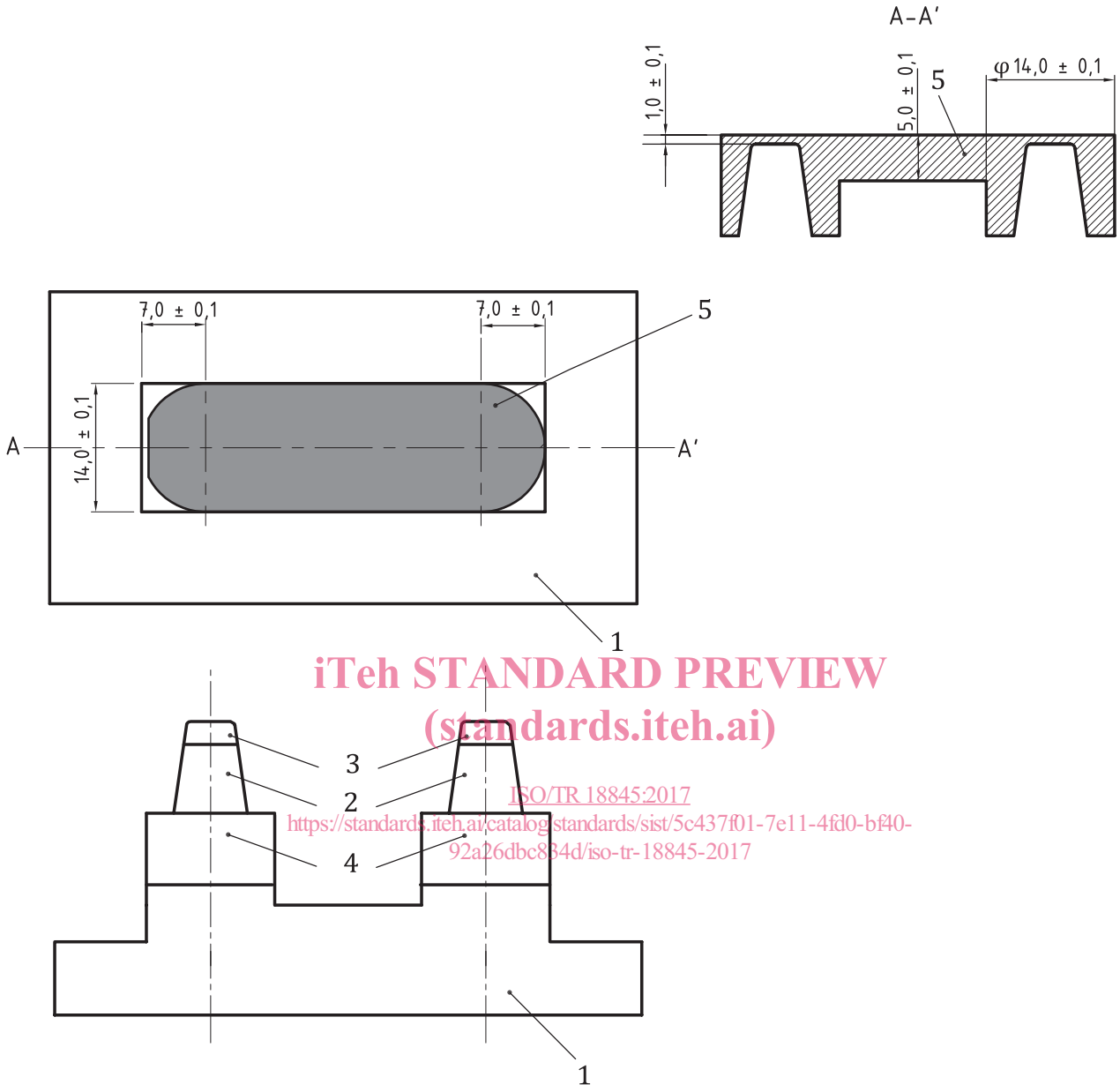
Key

1 metal die
2 abutment
3 removable occlusal part
4 removable shoulder
5 test specimen

NOTE The unspecified dimensions are determined using the measured data specified in the first paragraph of 5.2.

Figure 3 — Test specimen of crown

Dimensions in millimetres



Key

1 metal die
2 abutment
3 removable occlusal part
4 removable shoulder
5 test specimen

NOTE The unspecified dimensions are determined using the measured data specified in the first paragraph of 5.2.

Figure 4 — Test specimen of bridge

5.4 Machining of restorations

The prepared manufacturing data set should be input into the computer-aided milling machine following the manufacturer's instruction. The CAM software should use the same configuration and parameters