BS ISO 15509:2019

BSI Standards Publication

Adhesives — Determination of the bond strength of engineering-plastic joints

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National foreword

This British Standard is the UK implementation of ISO 15509:2019. It supersedes BS ISO 15509:2001, which is withdrawn.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Adhesives — Determination of the bond strength of engineering-plastic joints

Adhésifs — Détermination de la résistance de joints collés des plastiques industriels

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This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 15509:2001), which has been technically revised. The main changes compared to the previous edition are as follows:

— the list of normative references in Clause 2 has been updated;

— the mandatory terms and definitions clause (Clause 3) has been inserted.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Methods of determining the strength of adhesive joints are well known. Several International Standards describe various methods including the lap-shear test or the butt torsion test. However, these methods are either not suitable for the determination of values which can be used for design purposes, or are restricted to metallic substrates. Because the existing International Standards for the measurement of the strength of bonded plastic materials are derived from test methods for metals and are less suitable for plastic materials due to the bending of substrates and varying modulus of elasticity, a new test method and a new test geometry have been developed and are described in this document.

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INTERNATIONAL STANDARD ISO 15509:2019

Adhesives — Determination of the bond strength of engineering-plastic joints

1 Scope

This document describes a test method for measuring the shear and/or tensile strength of an adhesively bonded plastic/plastic specimen of a specific design. This method allows the determination of a combined shear and tensile behaviour of the bond. These shear and tensile values are useful for design purposes.

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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 10365, *Adhesives — Designation of main failure patterns*

ISO 17212, *Structural adhesives — Guidelines for the surface preparation of metals and plastics prior to adhesive bonding*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Principle

A hollow cylindrical test specimen of specific design is used for the determination of the shear and tensile strengths of adhesively bonded plastic/plastic joints. These values can be used in calculation programmes. The rotationally symmetrical specimen allows testing under tensile, torsional or combined tensile/torsional loads if a suitable test machine is used.

NOTE 1 The shear stress is not uniformly distributed as the stress varies by approximately 15 % from the inner radius to the outer radius. Therefore, the calculated shear strength represents an “average” value.

NOTE 2 The origin of the stress distribution curve is the deformation of the bond line, as the deformation increases with increasing diameter. The superimposition of shear and tensile stresses is negligible in the bondline of rotationally symmetrical specimen compared to lap-shear specimen as described in ISO 4587,. There are practically no significant peaks in the stress distribution curve compared with the peaks observed in a lap-shear specimen, since the bond is continuous in the direction of the displacement.

5.1.3 Injection-moulding parameters

The parameters shall be agreed upon between the user and the plastic material supplier.

NOTE 1 The injection-moulding parameters will depend on the geometry of the mould and the nature of the plastic material.

Dimensions in millimetres

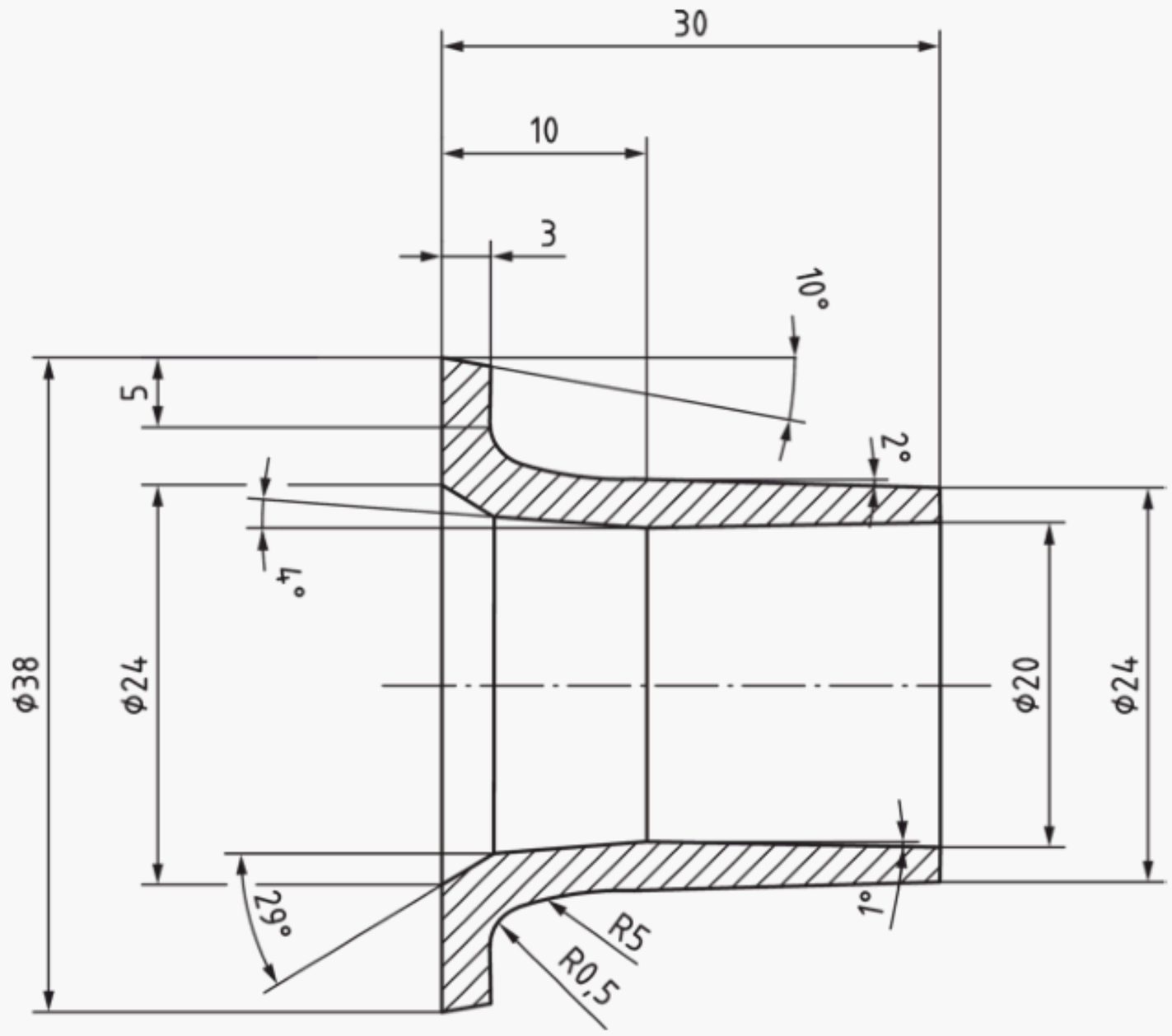


Figure 2 — Dimensions of adherend

The plastic material shall be pre-dried. The temperature and time shall be as agreed upon between the user and the plastic material supplier.

NOTE 2 Temperatures between 100 °C and 150 °C (depending on the type of plastic) over periods of 4 h to 6 h in a vacuum oven are the preferred conditions.

5.1.4 Removal of the sprue

Remove the central part, or sprue, from each of the adherends. A simple method consists of using a chisel while rotating the adherend in a lathe.

Avoid any contact with the bonding area during this operation.

5.1.5 Geometry

The specimen shall consist of two adherends bonded together.

The dimensions of each adherend shall be as given in Figure 2.

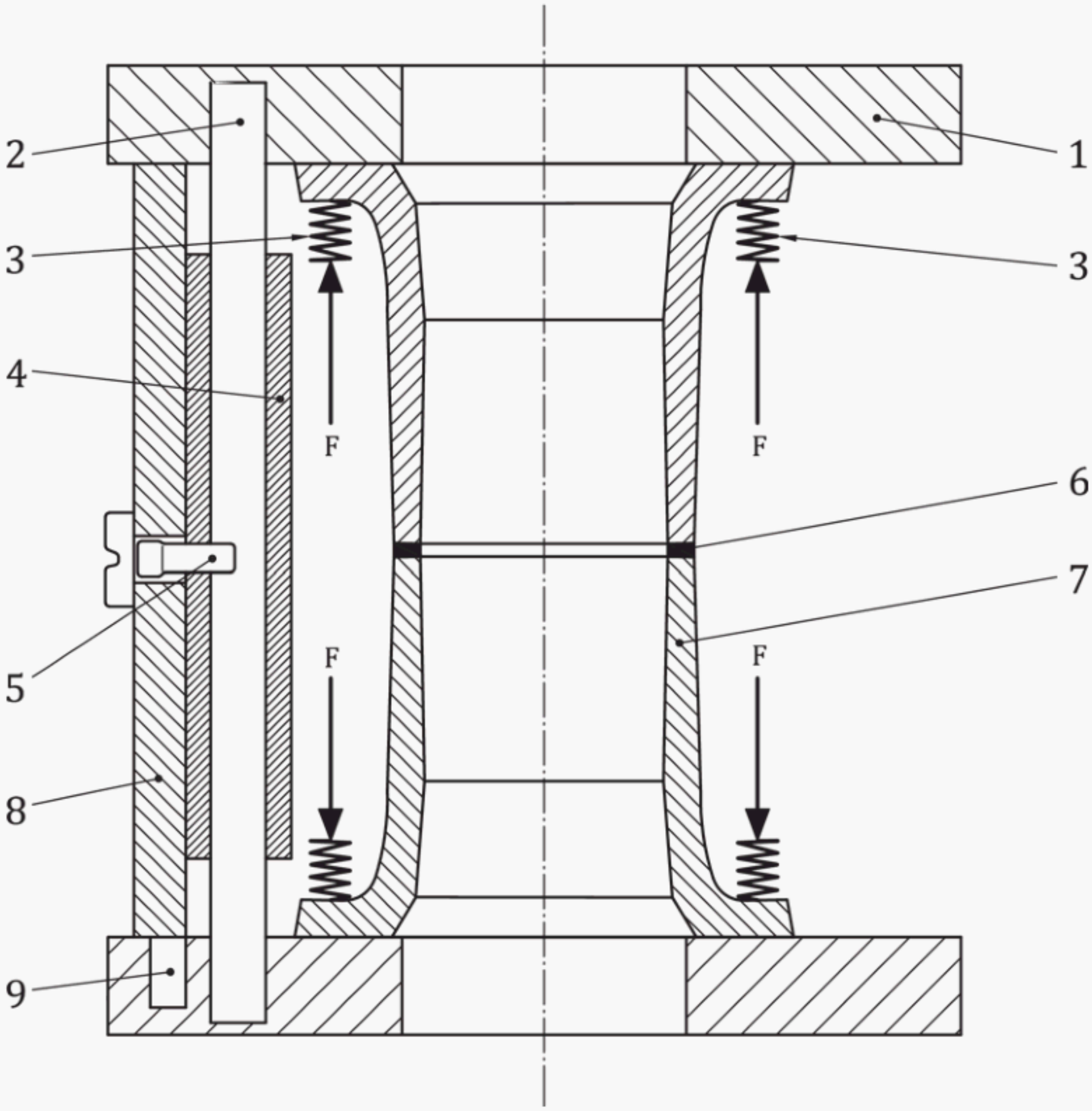
5.2 Surface preparation

Prepare the bonding surfaces of the adherends in accordance with ISO 17212.

Corona discharge at ambient pressure is the preferred method.

5.3 Assembly of the specimen in the mounting jig

Assemble the specimen using the mounting jig shown in Figure 3.



Key

1 baseplate

2 guide pin

3 fixation holding the adherend on the baseplate (three fixation points round the circumference, using springs exceeding a force higher than the weight of the adherend)

4 metal sleeve

5 screw for fixing spacers on the metal sleeve

6 gap for adhesive bond

7 adherend

8 spacer used to define the bond gap thickness (three pairs of spacers round the circumference, manufactured from the same material as the adherends)

9 adjustment screw (for adjusting bond gap)

Figure 3 — Schematic drawing of the specimen during the assembly process

NOTE 1 The mounting jig allows a small amount of movement of the adherends. This compensates for deformations which are caused by the shrinkage or thermal expansion of the adhesive and the adherends during curing.

The spacers shall be made of the same material as the adherends in order to eliminate differences in thermal expansion between the spacers and the adherends.

The spacers shall be linked to the metal sleeves which shall be freely movable along the guide pins.

The alignment of the adherends in the two halves of the mounting jig shall be ensured by a metal centering cone on each baseplate. Each cone shall be freely rotating and have a spring (strong enough to prevent the adherend sliding) which presses the adherend against the centering cone. When contact is established between the adherends and the centering cones, fix the adherends in place at the fixation points.

Assemble both baseplates (with the adherends but without adhesive) by introducing the guide pins into the sleeves and verify the gap between them (for the adhesive bond). The gap can be adjusted by means of the adjustment screws.

NOTE 2 The adjustment is usually made in order to achieve a bond thickness of 0,1 mm.

5.4 Application of the adhesive

Apply the adhesive using the application device as shown in Figure 4, as follows.

Place a baseplate carrying one of the adherends under the dispenser.

Adjust the dispenser so that the nozzle is located exactly above the application area. Apply the adhesive.

NOTE An automated rotating device coupled with the dispenser has been shown to give good results.

Assemble the two halves of the mounting jig and cure the adhesive in accordance with the manufacturer's instructions.

5.5 Conditioning and testing atmosphere

The specimens shall be conditioned and tested in one of the standard laboratory atmospheres specified in ISO 291.

6 Apparatus

5.1 Test machine, equipped with a temperature-controlled enclosure for tests carried out at temperatures other than ambient.

5.2 Clamping jig (see Figure 5), consisting of an adapter, and two jaws with hinge, screw and locknut.

NOTE This special clamping jig allows easy and quick fixing of the specimen in the test machine.

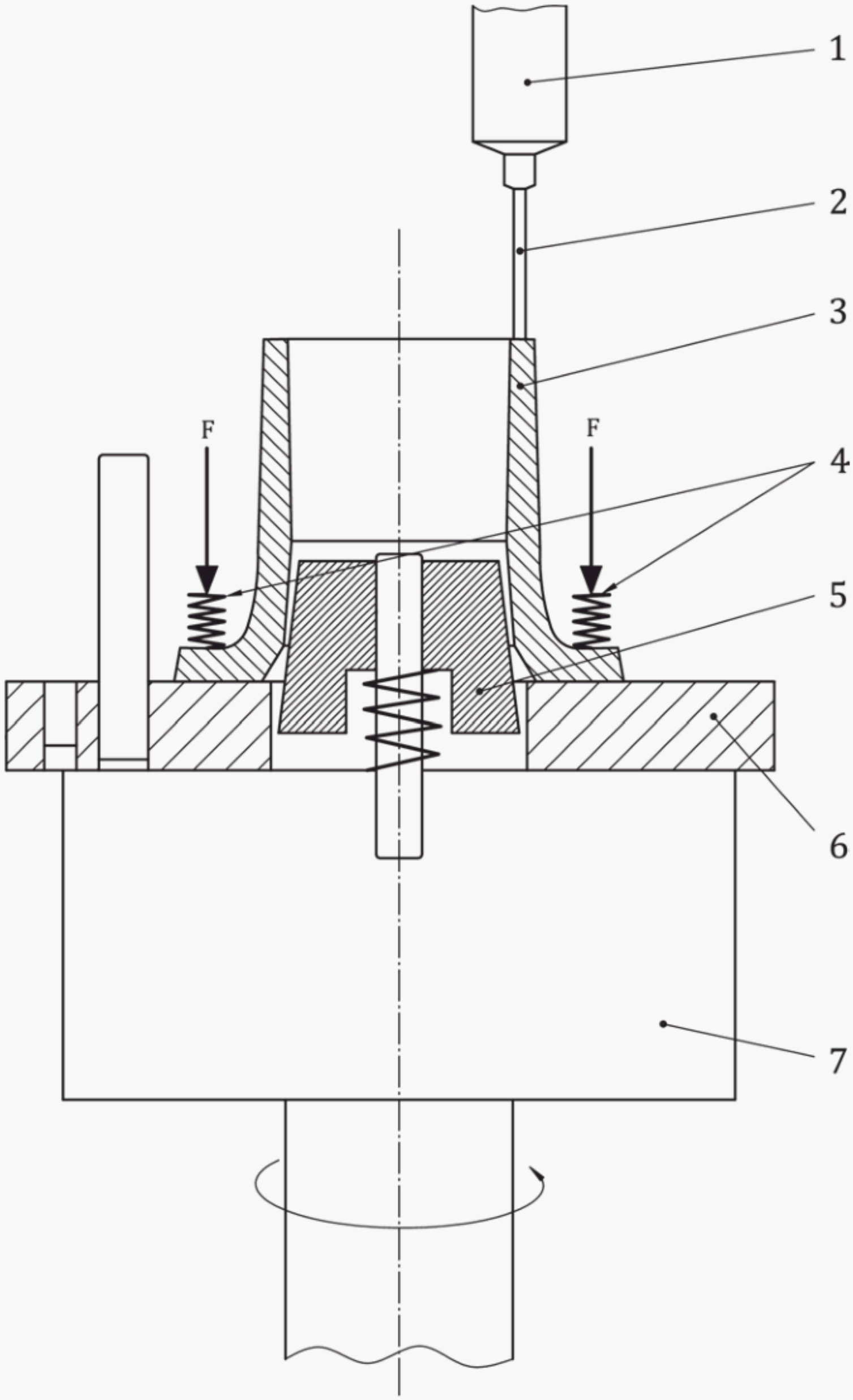
7 Procedure

Place the adapter and the specimen in the jaws. Secure them with the screws. Draw in the locknut to hold the specimen by its flange.

Insert the clamping jigs in the test machine, ensuring that no load is applied to the bonded joint.

Apply a tensile force at a crosshead speed of 1 mm/min and/or a torsional force at a speed of 5°/min until the joint fails. Record the ultimate force reached during the test.

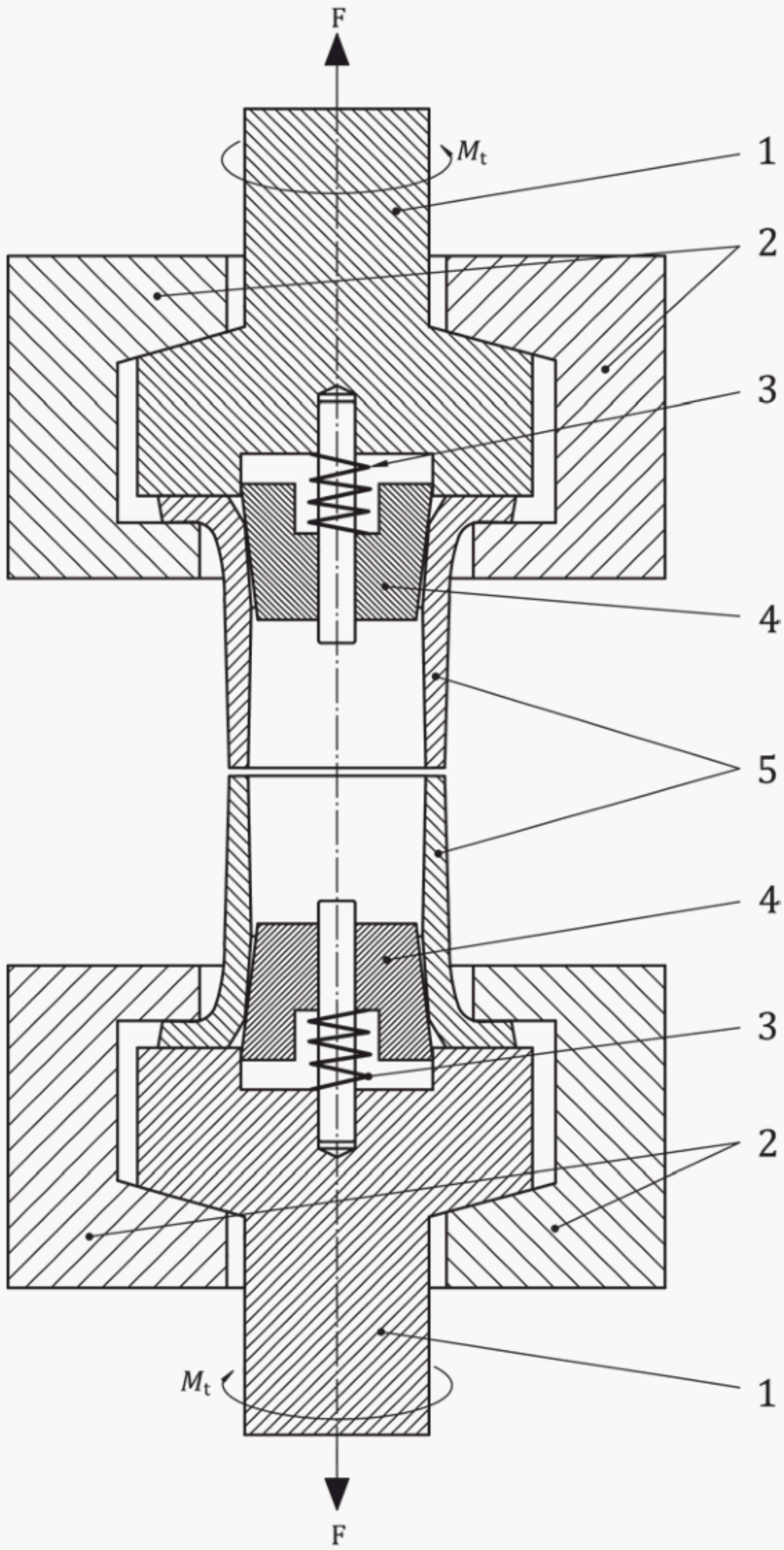
Examine the surface of the bonded parts after failure, and record the failure pattern in accordance with ISO 10365.



Key

1	dispenser
2	dispenser nozzle
3	adherend
4	fixation holding the adherend on the baseplate
5	centering cone
6	baseplate
7	rotating support

Figure 4 — Application of the adhesive



Key

1	adapter
2	jaws (hinge, screw and locknut not shown)
3	spring
4	metal centering cone
5	test specimen

Figure 5 — Schematic drawing of clamping jig

8 Expression of results

The bonded area corresponds to Formula (1)

$$\frac{\pi}{4}\left(d_1^2 - d_1^2\right) \tag{1}$$

where

d_1 is the outer diameter of the bonded area, expressed in millimetres (mm);

d_2 is the inner diameter of the bonded area, expressed in millimetres (mm).

Since d_1 = 24 mm and d_2 = 20 mm, the area is 138 m^2.

The tensile strength, in pascals is given by the force at failure in newtons, divided by the bonded area, in square millimetres.

The shear strength τ_{max} is given in megapascals by Formula (2)

$$\tau_{max} = \frac{M_t \times 16 \times d_1}{\pi\left(d_1^4 - d_2^4\right)} \tag{2}$$

where M_t is the moment at failure, expressed in megapascals (MPa).

9 Precision

The precision data of this test method are not available at the time of publication.

10 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 15509:2019;

b) all details necessary for complete identification of the adhesive tested, including type, source and manufacturer's code number, batch or lot number, etc.;

c) all details necessary for complete identification of the adherends used, including details of preparation and moulding, the method of preparation of the surface prior to bonding, the conditions used to cure the adhesive and the atmosphere used to condition the specimens;

d) the test conditions and test mode (tensile or torsional);

e) the number of specimens tested;

f) the shear and/or tensile strength of each specimen;

g) the failure pattern of each specimen, in accordance with ISO 10365;

h) the date of the testing.

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