INTERNATIONAL STANDARD

ISO 11343

First edition
1993-08-15

Adhesives — Determination of dynamic resistance to cleavage of high strength adhesive bonds under impact conditions — Wedge impact method

Adhésifs — Détermination de la résistance dynamique à un clivage de joints collés à haute résistance soumis aux conditions d'impact — Méthode d'impact au coin

Reference number
ISO 11343:1993(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11343 was prepared by Technical Committee ISO/TC 61, *Plastics*, Sub-Committee SC 11, *Products*.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland
Printed in Switzerland

Adhesives — Determination of dynamic resistance to cleavage of high strength adhesive bonds under impact conditions — Wedge impact method

1 Scope

This International Standard specifies a dynamic impact wedge method for the determination of the cleavage resistance under impact loading of high-strength adhesive bonds between two metallic adherends, when tested under specified conditions of preparation and testing.

The method allows a choice of sheet metal substrate corresponding to those materials frequently used in industry, e.g. for automotive applications.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 291:1977, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 4588:1989, *Adhesives — Preparation of metal surfaces for adhesive bonding.*

ISO 10365:1992, *Adhesives — Designation of main failure patterns.*

3 Definition

For the purposes of this International Standard, the following definition applies.

3.1 dynamic resistance to cleavage: Force per unit width, necessary to bring an adhesive joint to the point of failure by means of a stress applied by a wedge moving between the two substrates of the joint, and thus separating the adherends in a peeling mode.

It is expressed in kilonewtons per metre.

4 Principle

The method consists of the determination of the average cleavage resistance, expressed as force or energy, of the adhesive bond between two metallic adherends. The cleavage corresponds to the separation of the adherends by a wedge, moving at high speed, whose displacement is initiated by an impact.

5 Apparatus

5.1 Instrumented impact testing machine, capable of applying an impact energy of at least 50 J and preferably up to 300 J and an impact speed of at least 3m/s and preferably up to 5,5 m/s. It shall be provided with a suitable grip to hold the specimen. The jaws of this grip shall firmly engage the outer part of the ends of the metallic adherends and shall have provision for positive location of these adherends by means of a hardened steel bolt passing through the grips and through an 8 mm hole predrilled in the specimens, to clamp the assembly together.

The machine shall be equipped with an instrument capable of registering and storing the force data during the impact event, as a function of time or displacement of the wedge. The response time must be at least an order of magnitude shorter than the impact event. The machine shall be equipped with a microprocessor/computer in order to perform the necessary calculations for expression of results. Figure 1 represents a pendulum-type impact machine, using a piezoelectric transducer fixed to the specimen clamp.

NOTES

1 Falling weight and servohydraulic impact machines may be used for this test in addition to pendulum machines. Suitable machines are commercially available.[1)]

2 Data collection is controlled by the machine type. A servohydraulic machine provides both force-time and force-displacement data, while a pendulum-type or a falling weight machine provides force-time and, by calculation, force-displacement data. Therefore, both types of data are allowed.

3 The machine should be equipped with an environmental chamber to allow conditioning and testing at different temperatures if required.

5.2 Test wedge, made of hardened steel, for cleaving the specimen (see figures 2 and 3, symmetric and asymmetric wedges).

The wedge, attached to its support frame which has a vertical degree of freedom, is pulled through the adhesive joint by the force of the impact on the frame. Because of the degree of freedom, the wedge aligns itself with the adhesive joint during the test. The included angle of the wedge, its leading edge radius and its maximum depth will determine the progression of opening of the bonded joint ahead of the wedge tip. The wedge surface condition and state of cleanliness shall be maintained and inspected before each determination, since friction unduly increases the energy consumed.

Dimensions in millimetres

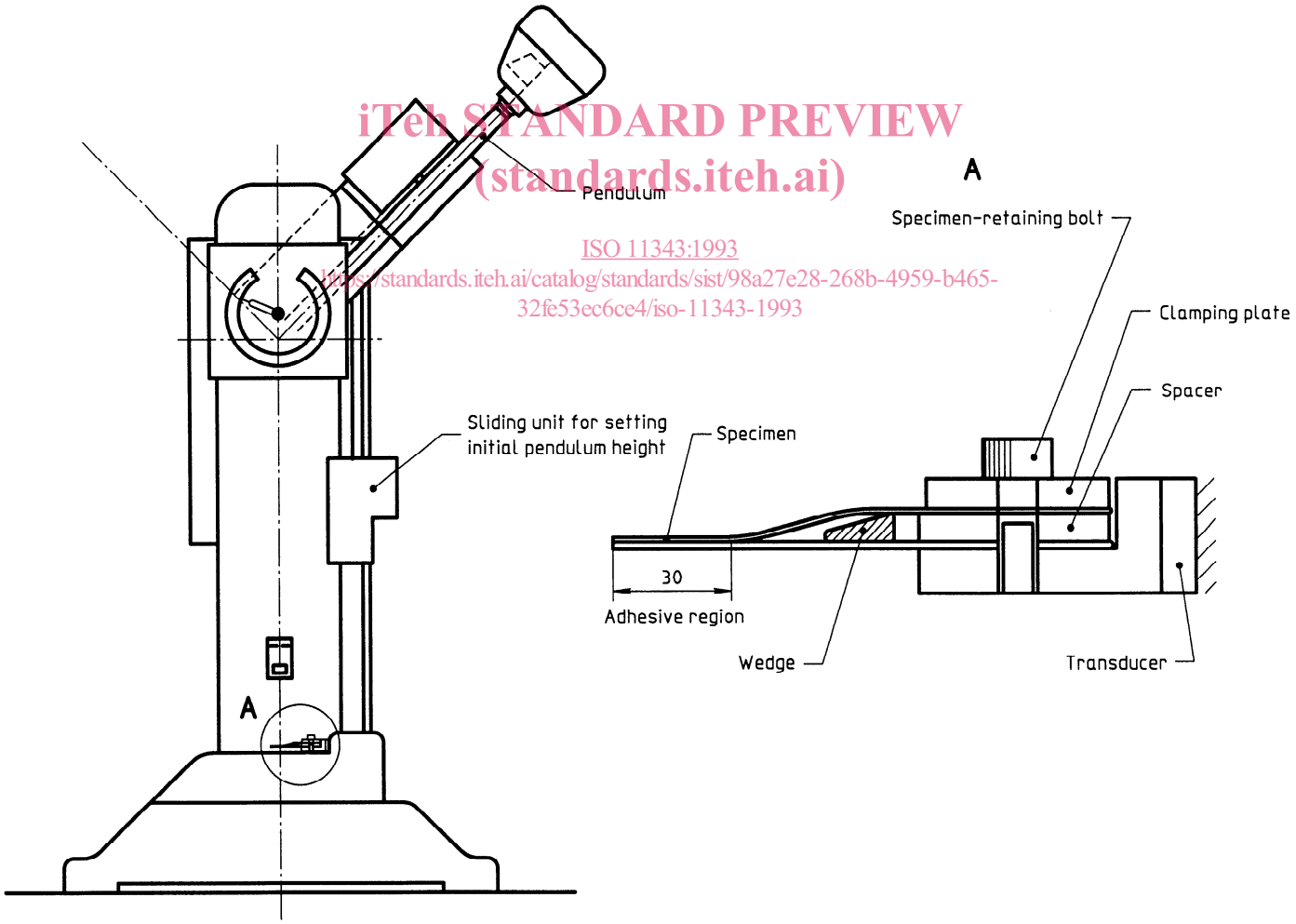


Figure 1 — Pendulum-type impact machine

1) Suppliers of such machines are: Rosand Precision Ltd., Balds Lane, Lye, Stourbridge, West Midlands, DY9 8SH, UK, and Zwick GmbH & Co., P.O. Box 4350, D-7900, Ulm-Einsingen, Germany. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the products supplied. Equivalent products may be used if they can be shown to lead to the same results.

Dimensions in millimetres

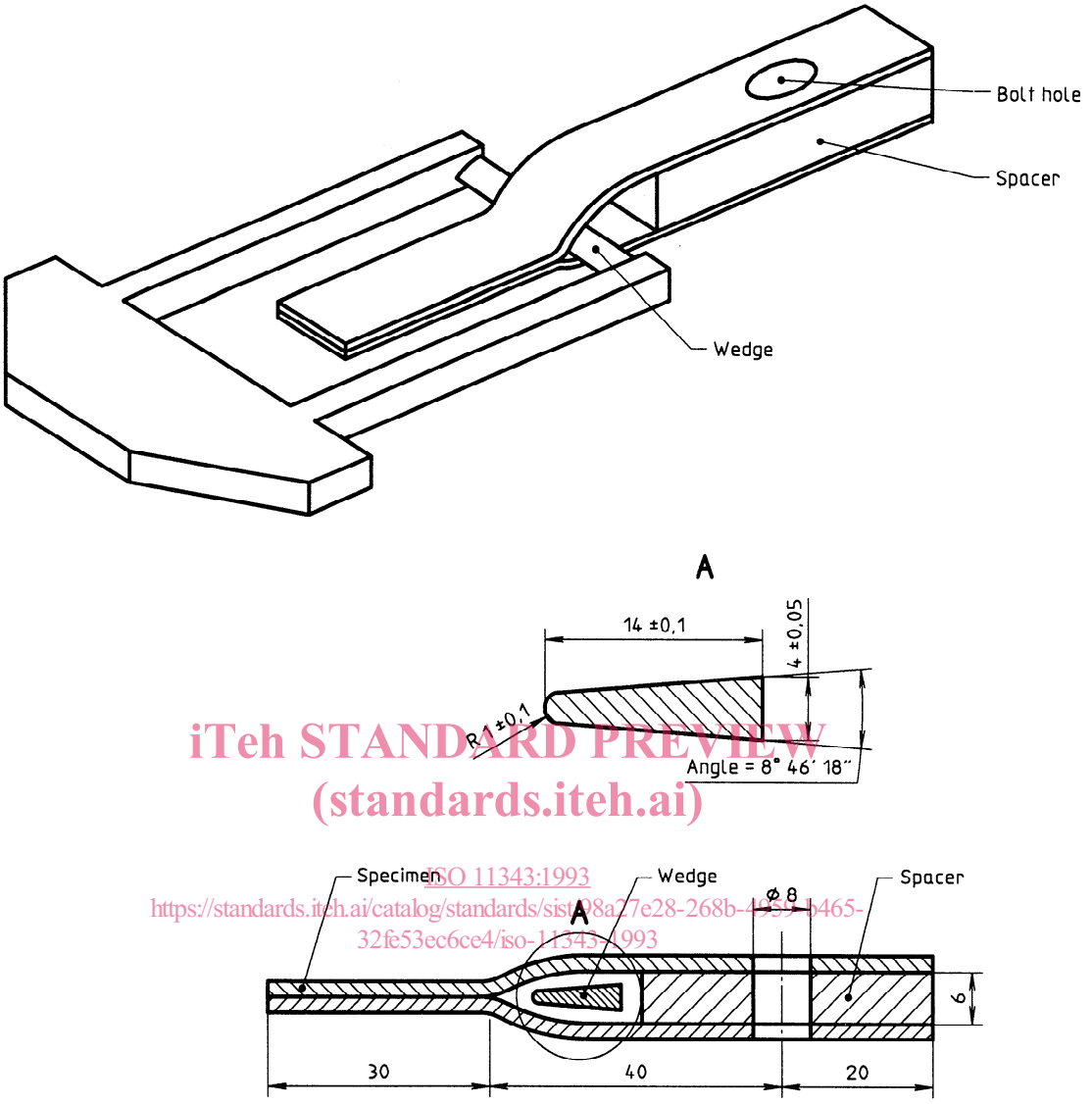


Figure 2 — Symmetric wedge

The three-dimensional diagram in figure 4 shows the interrelation of the path of the impact head and the positions of the wedge and the test specimen.

5.3 Device for measuring thickness, with an accuracy of ± 0,01 mm.

5.4 Wedge support frame, consisting of two parallel steel bars with the wedge fixed between them (at one of their ends) and a steel crosshead, for receiving the impact, positioned parallel to the wedge and connected perpendicular to the two bars at their other ends. The bar cross-section shall be 6,0 mm to 6,5 mm wide × 4,5 mm to 5,0 mm high. Total mass of the assembly shall be 820 g ± 5 g.

6 Specimens

6.1 Specimens of the dimensions as shown in figures 2 and 3 shall be prepared individually, and shall consist of two adherends properly prepared and bonded together.

6.2 Surface treatment shall be such as to obtain consistent results in the bonded assembly. Thus any surface contaminant required for the purpose of the test, e.g. oil, shall be applied to all specimens in a manner which ensures uniformity between specimens. The preparation of the surface shall be in accordance with either the adhesive manufacturer's instructions or ISO 4588.

Dimensions in millimetres

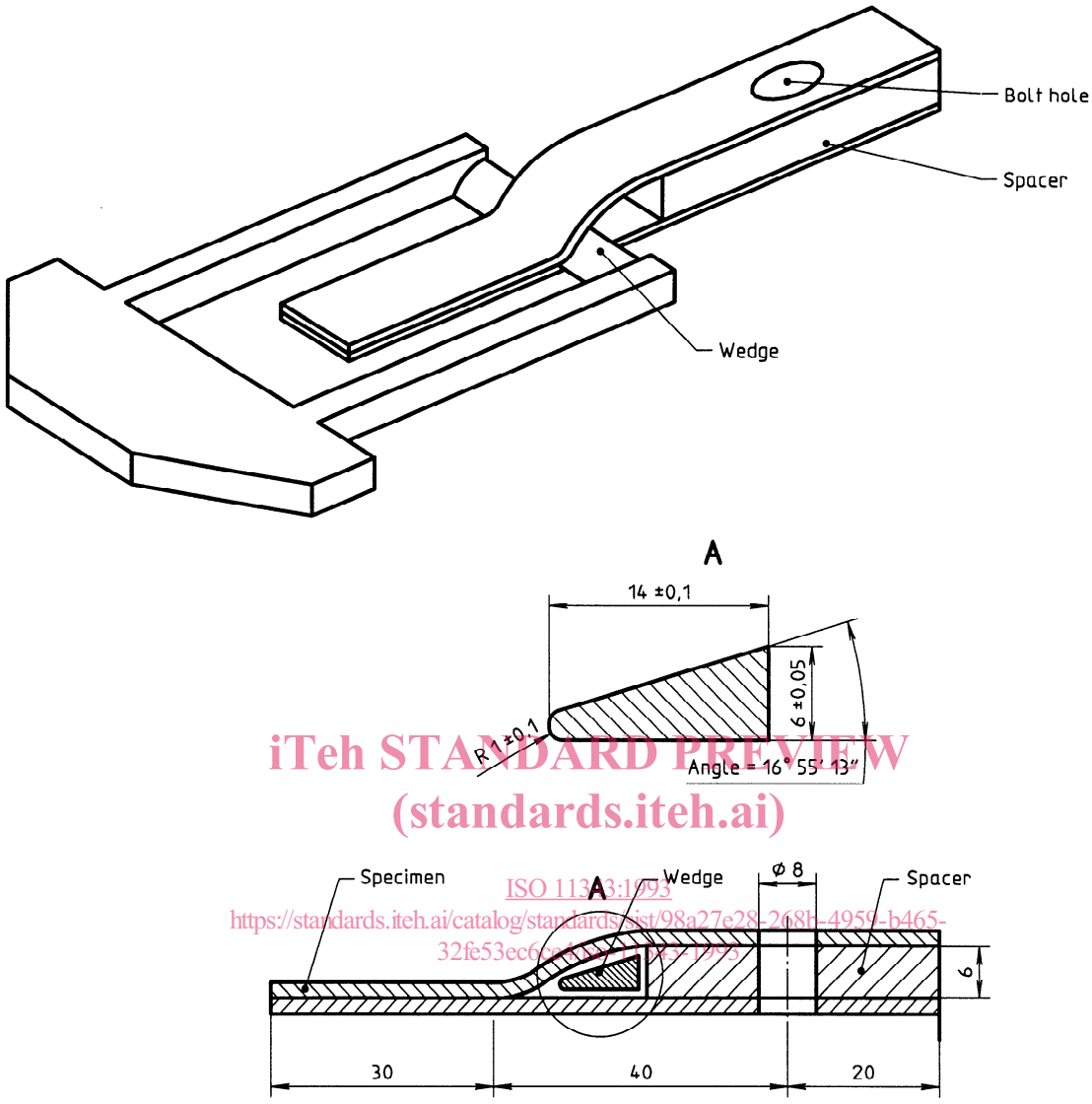


Figure 3 — Asymmetric wedge

The adhesive shall be applied in accordance with the manufacturer's instructions to obtain an optimum bond with minimum variation.

NOTE 4 Direct comparison of different adhesives can be made only when specimen construction, adherend materials and dimensions, and test conditions are identical.

6.3 The thickness of the adherends shall be chosen from sheet materials representative of industrial manufacturing and shall fall into the range 0,6 mm to 1,7 mm.

Where two adherends of different thicknesses are to be tested or where the adherends are of different modulus, the asymmetric wedge shall be employed with the higher-modulus or thicker adherend aligned with the bottom, flat side of the wedge. Where the adherends are identical, the symmetric wedge shall be employed.

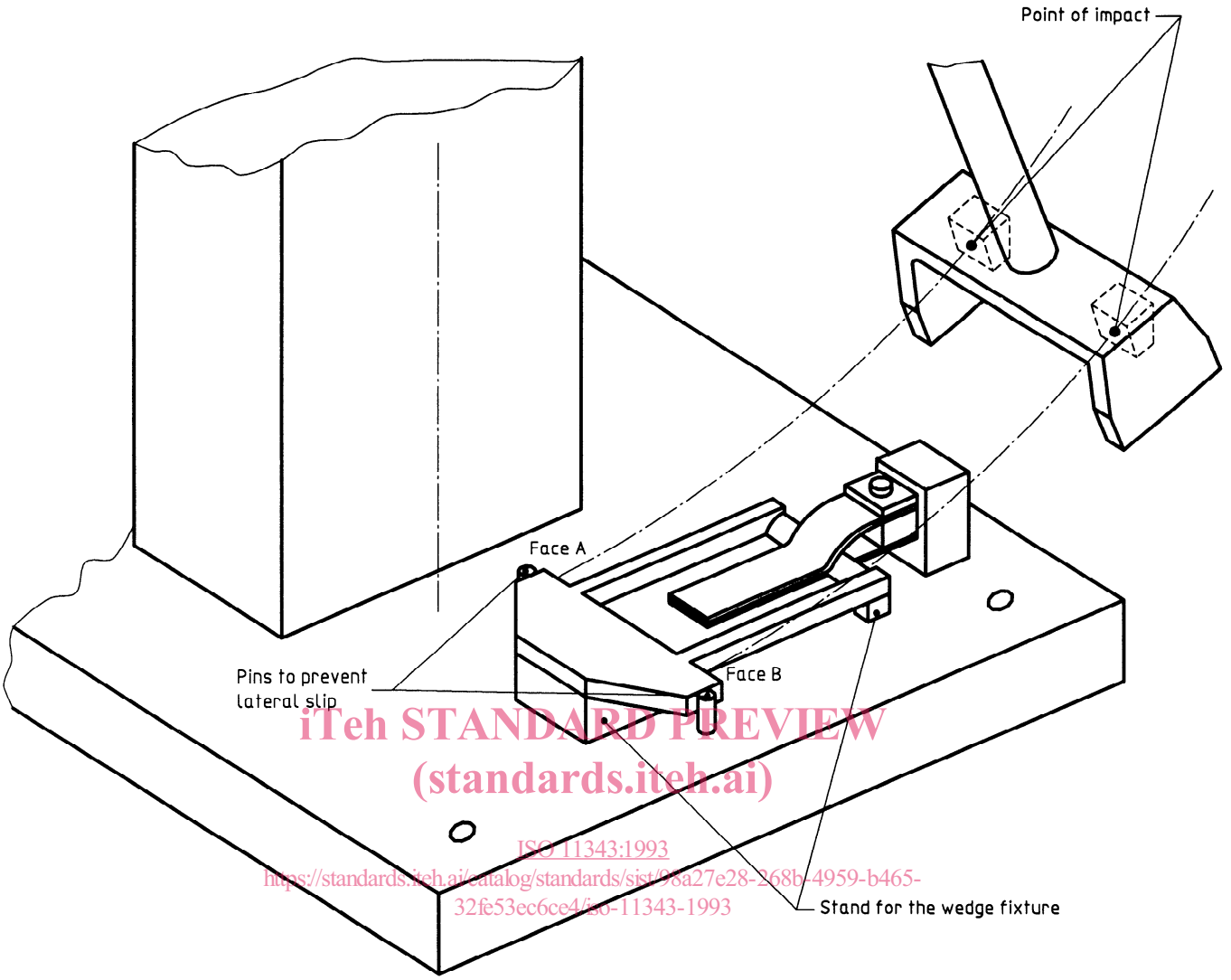
6.4 Specimens shall be prepared individually.

The width shall be either

a) 20 mm (preferred);

or

b) any other convenient width, provided that the test equipment is suitably adapted and the width is given in the test report.



Faces A and B of the crosshead are aligned parallel with the axis of the pendulum support

Figure 4 — Three-dimensional diagram of the pendulum impact wedge test

6.5 The unbonded ends of the adherends shall be bent to allow clamping in the grip of the testing machine. Adherends preformed to the shape of the wedge may also be used. When using the asymmetric wedge, only the top, thinner or lower-modulus adherend shall be bent.

6.6 The number of specimens to be tested shall be five or more.

6.7 The thickness of the adhesive layer after formation of the bond shall be determined on at least five specimens, to an accuracy of $\pm$ 0,01 mm (see 5.3). The maximum bond thickness shall be 2 mm.

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

NOTE 5 Bond thickness may be adjusted to a desired value by means of spacers, either removable or fixed to an adherend, provided that the same means are used for comparing results.

7 Test procedure

7.1 Insert the specimen into the wedge test fixture (5.2) as shown in figures 2 and 3, with the unbonded ends protruding enough to interleave the spacer. Assemble the test fixture, tighten the specimen-retaining bolt by hand, and tighten the bolt an additional quarter turn using an appropriate tool.

Select the impact velocity specified (3 m/s unless otherwise specified for aluminium alloy adherends; 2 m/s unless otherwise specified for steel adherends).

Select the temperature specified and allow the specimen to stabilize at that temperature for a specified period before applying the impact.

7.2 During the impact event, the transducer signal will be automatically and unselectively detected by the microprocessor and recorded; the force-time (or force-displacement) data can subsequently be manipulated separately.

7.3 Discard the result if the clamping bolt hole in the adherend becomes elongated or if the adherend fails on either side of the bolt hole. This indicates that the clamping pressure employed is insufficient and an adjustment is necessary.

8 Expression of results

Calculate an average cleavage force from the record of force-time (or force-displacement) data of the impact event, disregarding the first 25 % and the last 10 % of the curve. The average cleavage force shall be divided by the specimen width to provide a value for dynamic resistance to cleavage, expressed in kilonewtons per metre of specimen width.

NOTE 6 If the material being tested provides force curves which are highly irregular, then the test result should be discarded.

Using the computer, calculate the energy, expressed in joules per metre of specimen width, by integration of the force-time (or force-displacement) data between the first 25 % and the last 10 % of the curve.

9 Precision

The precision of this test method is not known because interlaboratory data are not available. When interlaboratory data are obtained, a precision statement will be added at the time of revision.

10 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) identification of adherends, including material thickness, width and surface preparation, and whether preformed or flat adherends were used;

c) identification of the adhesive tested, including type, source, manufacturer's code number, batch number, etc.;

d) description of the bonding process, including method of application of adhesive, drying and precuring conditions (where applicable), curing time, temperature and pressure;

e) average thickness of the adhesive layer after formation of the bond;

f) complete description of the specimen, including dimensions and construction, and number of specimens tested;

g) conditioning procedure prior to testing and the test conditions;

h) impact velocity selected;

i) calculated average cleavage force and the recorded curves of the force-time or the force-displacement event;

j) calculated dynamic resistance to cleavage;

k) calculated energy;

l) pattern of adhesive failure according to ISO 10365.

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