BS EN 6037:2015

BSI Standards Publication

Aerospace series — Fibre reinforced plastics — Test method — Determination of bearing strength

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National foreword

This British Standard is the UK implementation of EN 6037:2015.

BSI, a member of CEN, is obliged to publish EN 6037 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval as a European Standard.

This standard is based on the same technical content and wording as the original EN draft issued in 1995. The draft was never developed into a formal EN standard. The UK committee are of the opinion that further clarification may be needed in some sections.

The biggest technical update is the addition of a modification to the type 1 test as specified in the standard. The modification allows torque to be applied to the bolt under test. The current two test types in the standard are known as pin bearing with a clearance between specimen and grip and bolt bearing with an applied torque.

Furthermore, if a torque is applied, the UK committee recommends the use of in-built bushes (washers) which are twice the size of the bolt and that the bolt should be torqued 'finger-tight', e.g. 1.3 Nm.

The UK committee wish to point out that any deviations to this standard need to be agreed between the test house and the customer and that this should be detailed as agreed between parties.

The UK participation in its preparation was entrusted to Technical Committee ACE/65, Non-metallic materials for aerospace purposes.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 6037

November 2015

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English Version

Aerospace series - Fibre reinforced plastics - Test method - Determination of bearing strength

Série aérospatiale - Matières plastiques renforcées de fibres - Méthode d'essai - Détermination de la résistance au matage

Luft- und Raumfahrt - Faserverstarkte Kunststoffe - Prufverfahren - Bestimmung der Lochleibungsfestigkeit

This European Standard was approved by CEN on 28 June 2014.

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 6037:2015) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2016, and conflicting national standards shall be withdrawn at the latest by May 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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1 Scope

This European Standard defines the procedure to be used to determine the bearing strength of fibre composites with multidirectional reinforcement. This standard is applicable to composite laminates manufactured from unidirectional tape or woven fabric reinforcement.

This standard does not give any directions necessary to meet health and safety requirements. It is the responsibility of the user of this standard to consult and establish appropriate health and safety precautions.

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.

EN 2374, *Aerospace series — Glass fibre reinforced mouldings and sandwich composites — Production of test panels*

EN 2565, *Aerospace series — Preparation of carbon fibre reinforced resin panels for test purposes* [1)]

EN 2743, *Aerospace series — Fibre reinforced plastics — Standard procedures for conditioning prior to testing unaged materials*

EN 2823, *Aerospace series — Fibre reinforced plastics — Test method for the determination of the effect of exposure to humid atmosphere on physical and mechanical characteristics* [1)]

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
bearing stress at a given moment during the test
load experienced by the test specimen at a particular moment divided by the nominal bolt-diameter and the specimen thickness

3.2
yield bearing strength
bearing stress which results in a 0,02 times the diameter permanent set of the joint

3.3
ultimate bearing strength
bearing stress at the maximum load during the test (see Figure 1)

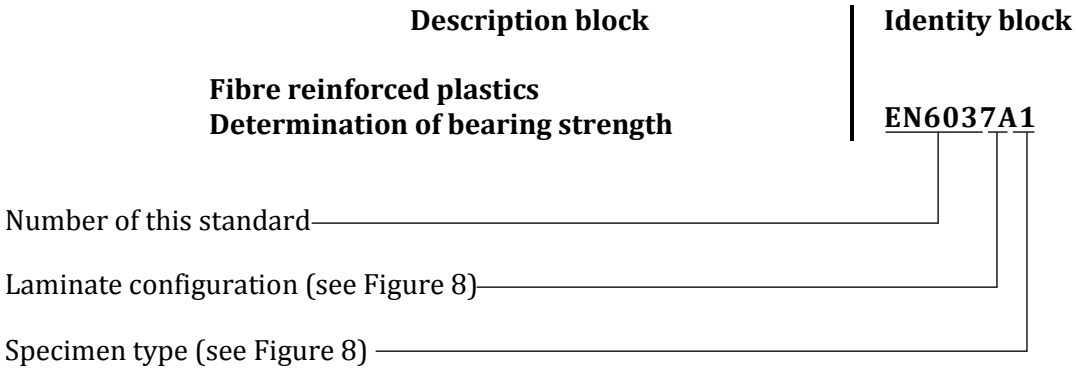
1) Published as ASD-STAN Prestandard at the date of publication of this standard. http://www.asd-stan.org/

4 Principle of the method

A tensile test is carried out on a flat laminate containing a hole; the load is applied by a bolt passing through the hole. A large specimen width is chosen, so that bearing failure occurs. The yield and ultimate bearing strengths are determined.

5 Designation of the method

The designation of the used method shall be drawn up according to the following example:



NOTE If necessary, the code I9005 shall be placed between the description block and the identity block.

6 Apparatus

6.1 Tensile testing machine, calibrated to maintain a load and displacement accuracy in tension within 1 %. There shall be the capability to record load-elongation diagrams.

6.2 A chamber adapted to the machine to carry out tests at a specified temperature. The chamber temperature shall be controlled to within ± 3 °C.

6.3 A timer.

6.4 A thermocouple with recorder if tests at temperatures other than ambient are required.

6.5 A flat-anvil micrometer with 6 mm diameter faces, accurate to within 0,01 mm.

6.6 An extensometer (gauge length of 50 mm recommended) or other equivalent strain measuring device to record elongations in terms of the applied load, accurate to within 1 % in the load range used.

7 Test specimen

7.1 Test specimen preparation

Prepare the required laminates according to EN 2565 method B for carbon and according to EN 2374 method B for glass, and the specimens according to Figure 8.

7.2 Tabs

Specimens type B without tabs. Specimens type A are with or without tabs. However, if tabs are used they shall be strain compatible with the composite being tested. They shall have the dimensions of the gripping area given in Figure 8. They shall be bonded on both specimen faces with an adhesive system that will meet the temperature and ageing requirements. Care should be taken that the adhesive bonding temperature does not add any undesired post cure effect to the laminate.

7.3 Number of test specimen

Six specimens shall be tested per test condition, except when otherwise specified by the Technical Specification.

If tests are carried out after ageing or at a temperature other than room temperature, care should be taken that room temperature/as received reference specimens according to EN 2743 taken from the same laminated plate are also tested.

7.4 Ageing of specimen

In case of tests after exposure to humid atmosphere, the conditioning shall be according to EN 2823.

8 Procedure

8.1 Conditioning

If not otherwise defined by the specification invoking the test, specimens to be tested dry on in the as cured state, should first be conditioned at (23 ± 2) °C, (50 ± 5) % RH in accordance with EN 2743, same requirements to be applied to perform room temperature testing.

Aged specimens shall be tested directly after ageing procedure (a maximum storage of 8 h at (23 ± 2) °C is allowed before testing).

8.2 Determination of specimen dimensions

After machining, measure on each test specimen: width, hole diameter and thickness using the micrometer of 6.5.

Thickness shall be the mean value obtained from three measurement points.

The thickness measurement points shall be selected to be as representative as possible for the neighbourhood of the hole.

8.3 Testing

Make any adjustments required for correct operation of the machine (calibration, etc.) (see 6.1).

Place the specimen in the jaws, ensuring that it is perfectly aligned and centered on the machine axis. Take extreme care with this operation since it affects the results and the scatter.

NOTE 1 The self-clamping jaws (for type 1 specimen Figure 9) or the clamping strips (for type 2 specimen Figure 10) shall fully cover the tabs or strips and protude by at least 7 mm.

NOTE 2 Pay attention to the 0,2 mm total clearance between specimen and clamping plates, i.e. about 0,1 mm both sides.

Select the appropriate load cell such that failure will occur between 20 % and 80 % of full scale.

Select the cross head speed at 1 mm/min.

Load the specimen to the estimated yield load (to be determined from the material specification) and then unload it to a value of about 10 % to 20 % of this estimated yield load. Then the specimen has to be reloaded until failure occurs. This test sequence is shown schematically in Figure 1.

Record the load elongation diagram (see 6.6).

Record the failure load.

8.4 Elevated and sub-zero temperature test

Make all adjustments required to ensure correct operation of the machine (see 6.1).

Set the chamber (see 6.2) to a temperature which does not differ from the test temperature by more than 10 °C. Wait at least 20 min for the chamber temperature to stabilize.

Place test piece in the jaws, ensuring that it is perfectly aligned as indicated in 8.2.

Next set the chamber (see 6.2) to the required temperature (determined during preliminary tests) and wait for the test piece to stabilize at the required temperature ± 3 °C for 5 min. A thermocouple (see 6.4) shall be mounted on the test piece and the temperature recorded.

The above time for aged specimen is 1 min (see 6.3).

Follow the same procedure as for the test at ambient temperature (see 8.2).

9 Presentation of the results

9.1 Bearing strengths

The yield bearing strength (p_y) and the ultimate bearing strength (p_u) are determined as follows:

For unnotched specimens

$$p_y = \frac{P_y}{d \times t}$$

$$p_u = \frac{P_u}{d \times t}$$

where

p_y is the yield bearing strength, in N/mm^2

p_u is the ultimate bearing strength, in N/mm^2

P_y is the load at 2 % permanent hole deformation, in N

P_u is the failure load, in N

d is the nominal pin diameter: 6,35 mm

t is the measured laminate thickness (see 8.1), in mm

NOTE 1 The above formula can be used only in case of bearing failure (see 9.2).

NOTE 2 Some examples are shown in Figure 2 (taken from Mll-HDBK5) how to derive a secondary modulus for the *Py*-determination as well as some examples of load displacement curves which are unacceptable for analysis.

9.2 Types of failure

To determine types of failure refer to Figures 3 to 7.

10 Test report

The test report shall refer to this standard and shall include the following.

10.1 Complete identification of the material tested, including at least type, source, manufacturer's code number, form, fibre areal mass, filament count, processing details, stacking sequence, test orientation.

10.2 All details about specimen preparation (including when applicable: tab material, tab adhesive and curing condition of this adhesive).

10.3 The measured specimen dimensions.

10.4 Ageing and/or exposure conditions prior to the test.

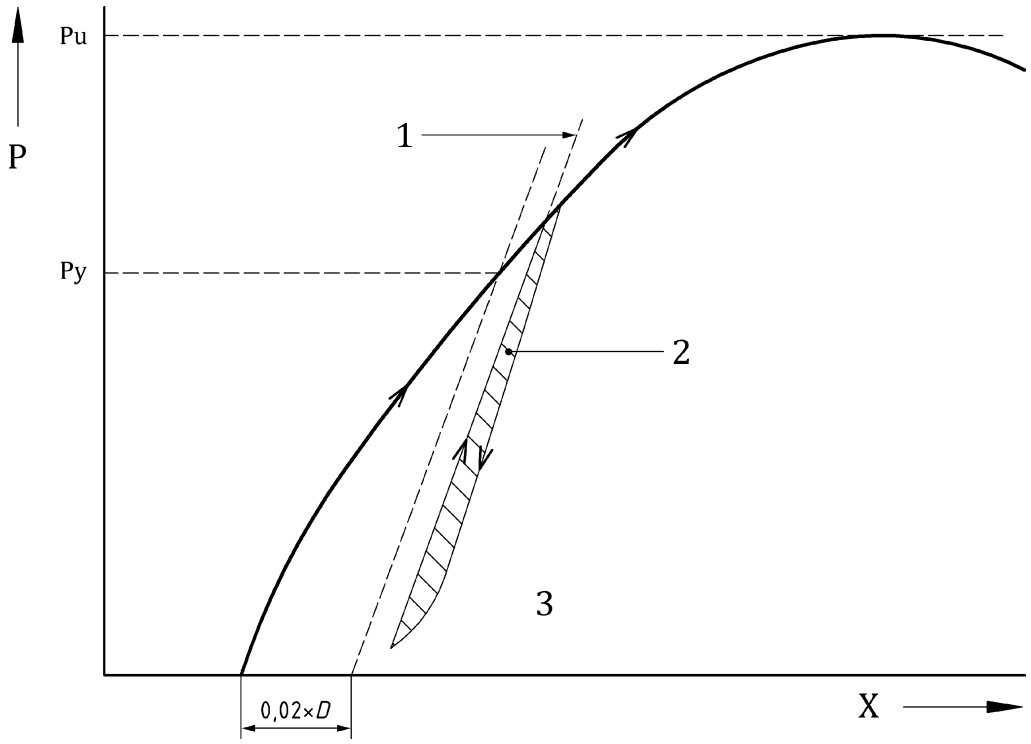
10.5 Date of test, facility and identification of individuals performing the tests.

10.6 Equipment, method and test parameters used.

10.7 Individual values, arithmetic mean and standard deviations per group of specimens of yield and ultimate bearing strengths, including relevant load-elongation curves.

10.8 Failure type per specimen (see Figures 3 to 7).

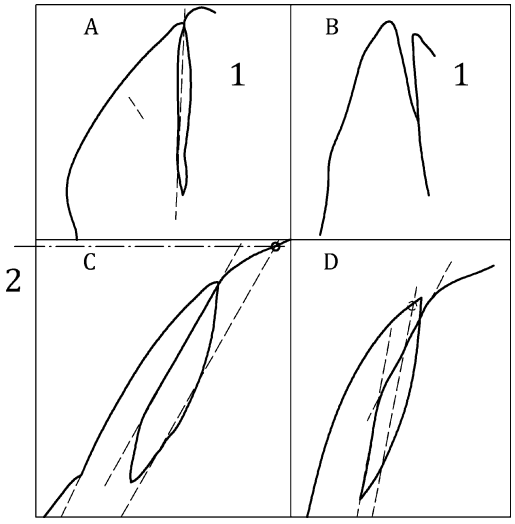
10.9 Any incident which may have affected the results and any deviation from this standard.



Key

1 Secondary modulus
2 Off loading-reloading loop
3 D = hole diameter
X Elongation

Figure 1 — Schematic presentation of the loading sequence



Key

1 Unacceptable for analysis
2 Load

Figure 2 — Examples of unacceptable curves A, B, C and D

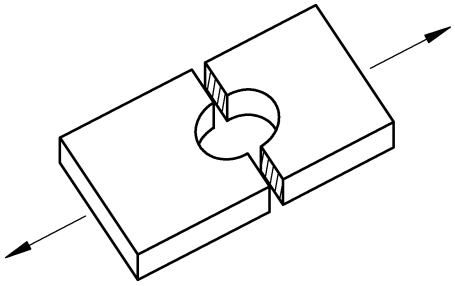


Figure 3 — Tensile failure unacceptable

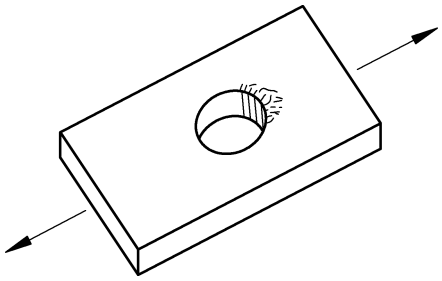


Figure 4 — Bearing failure

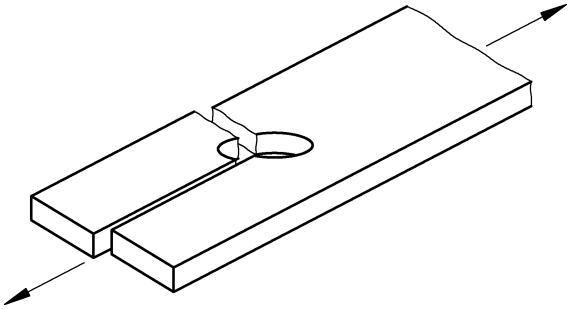


Figure 5 — Cleavage failure

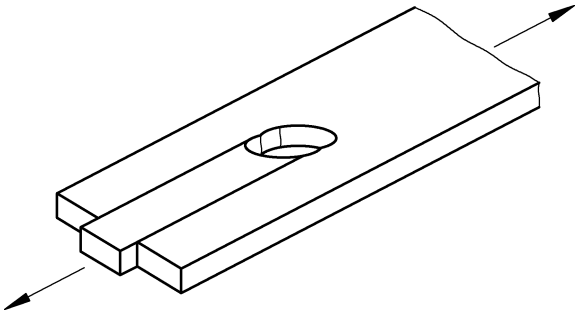


Figure 6 — Shear-out failure

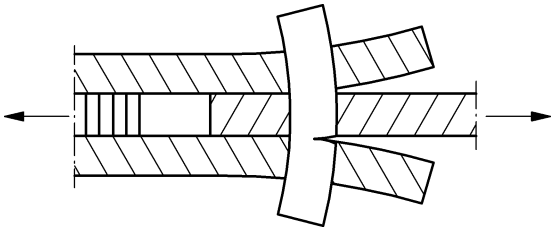
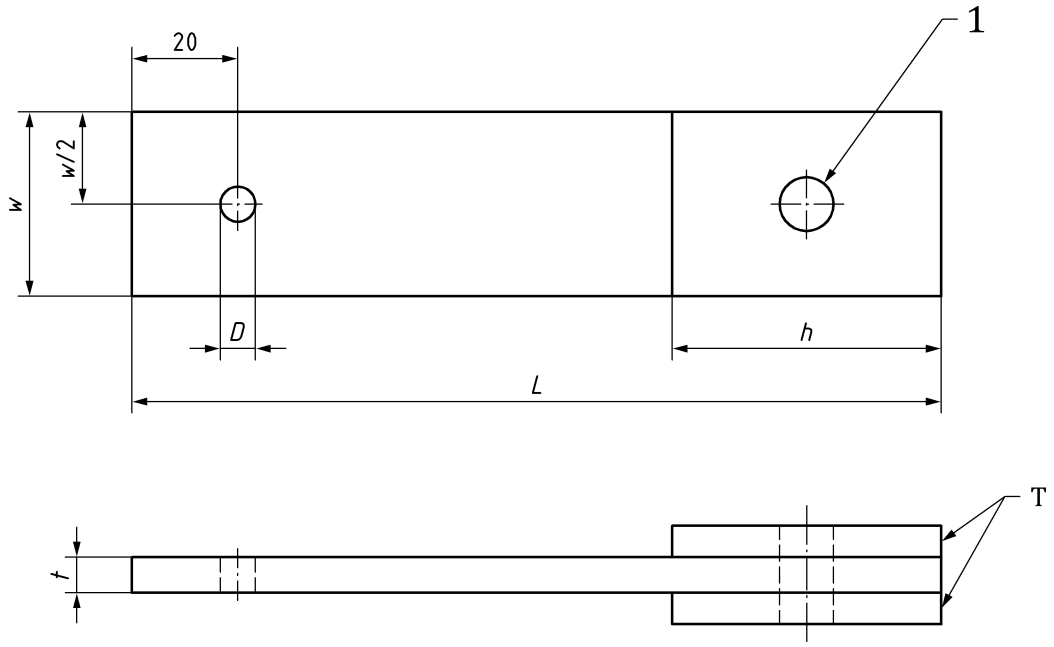


Figure 7 — Failure caused by bending of the bolt



Key

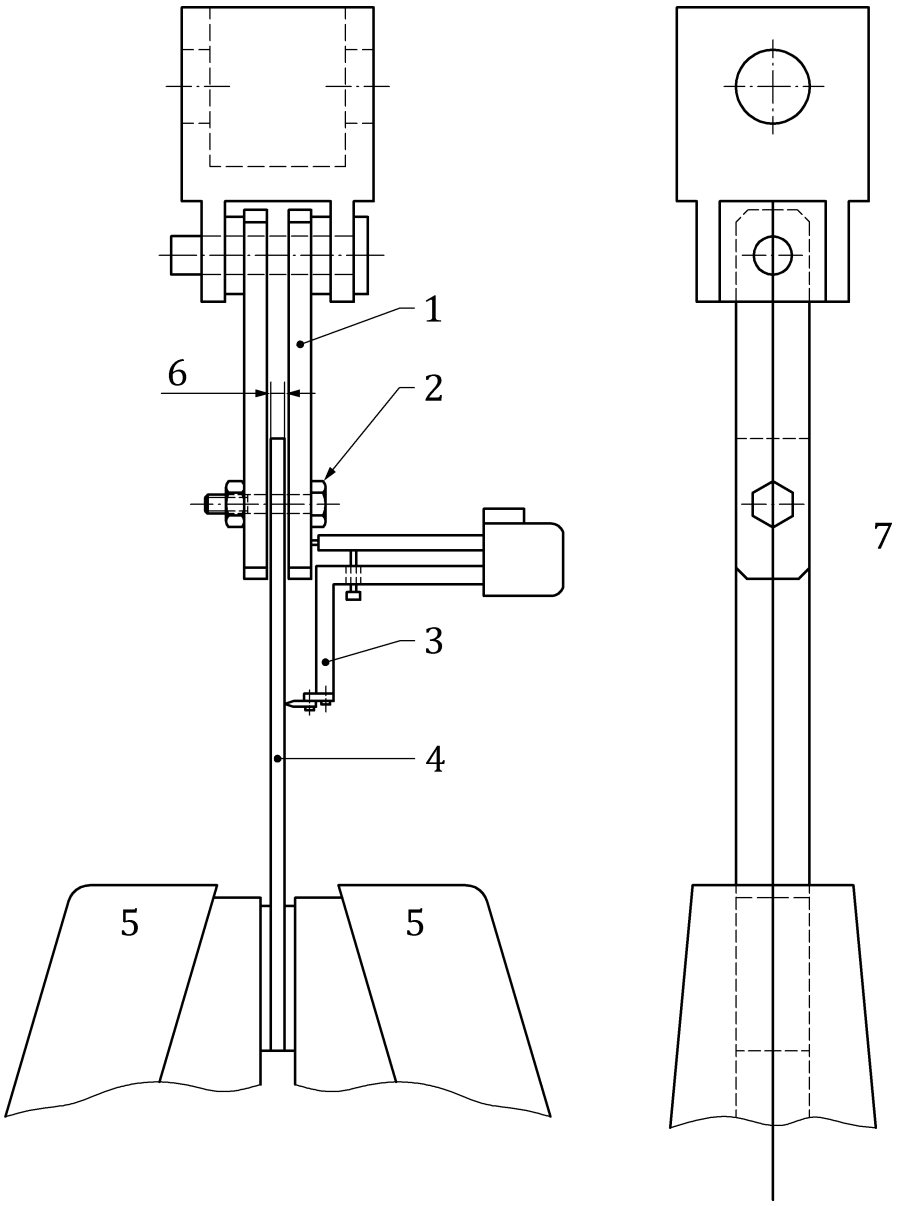
1 Specimen type 1: without hole, with tabs (see Figure 9)
Specimen type 2: with hole (1/2 "), no tabs (see Figure 10)

w = (35,0 ± 0,1) mm
L = (150 ± 1) mm
h = (50 ± 1) mm
t = (number of plies) × (cured ply thickness) of the used material (≈ 4 mm)
T = two layers of glass fibre laminate at ± 45°
D = 6,35 H11 (6,350 0 – 6,438 9) mm
¼ in H11 (0,250 0 – 0,253 5) in

Laminate lay ups

	Fibre areal weight g/m²	**Directed configuration B**	**Quasi–isotropic configuration A**
Tape	134	$(0, +45, -45, 0, 90)_{3sym}$	$(+45, 0, -45, 90)_{4sym}$
	145		
	190	$(0, +45, -45, 0, 90)_{2sym}$	$(+45, 0, -45, 90)_{3sym}$
	268		$(+45, 0, -45, 90)_{2sym}$
Fabric	all	no tests	$(+45, 0, -45, 90)_{nsym}$ n to be determined to achieve $t \approx 4$ mm

Figure 8 — Specimen

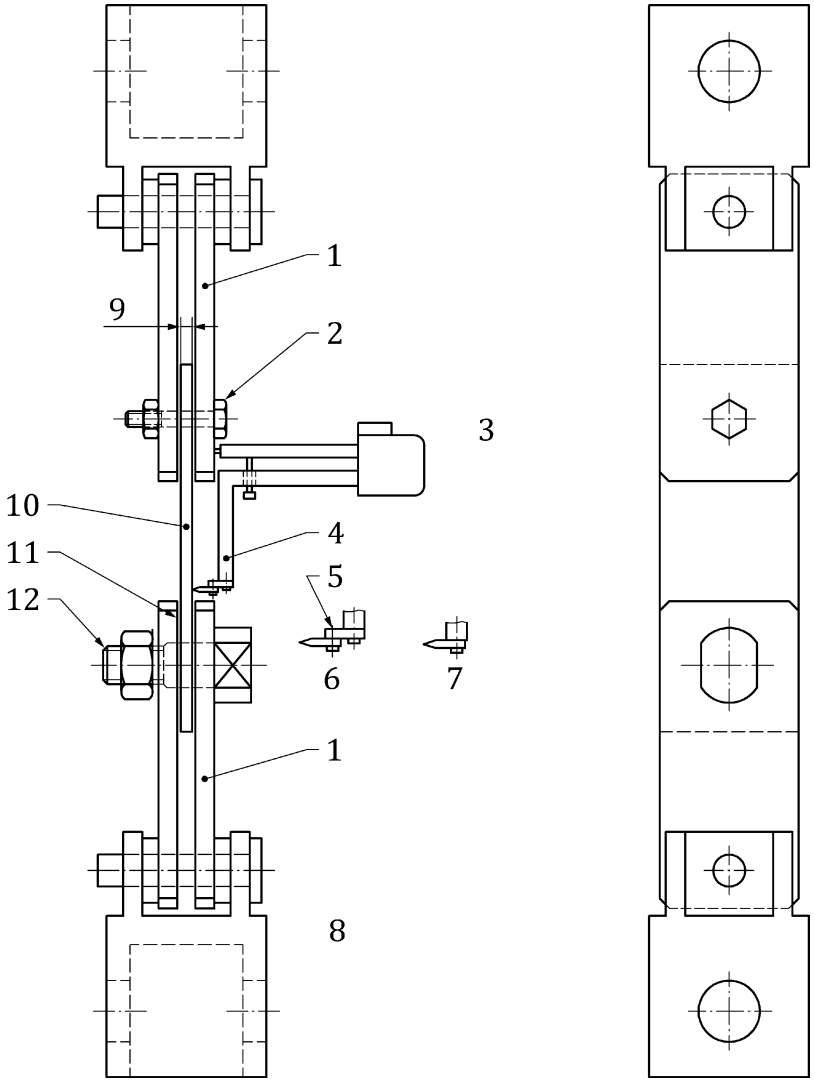


Key

1 Clamping strip (Cr-Mo-V steel hardened)
2 Bolt (1 100 N/mm²) Ø 6,35 mm (6,311 9 - 6,337 3) mm
Ø ¼ inch (0,248 5 - 0,249 5) inch
3 Extensometer
4 Specimen
5 Grip
6 Total clearance 0,2 mm (0,1 mm each side)
7 See Note

NOTE Extensometer not shown in front view

Figure 9 — Test set-up type 1 specimen without hole



Key

1 Clamping strip (Cr-Mo-V steel hardened)
2 Bolt (1 100 N/mm²) Ø 6,35 mm (6,311 9 - 6,337 3) mm
Ø ¼ inch (0,248 5 - 0,249 5) inch
3 See Note 1.
4 Extensometer
5 Al strip
6 Ex-meter for bearing strength
7 Standard ex-meter
8 See Note 2.
9 Total clearance 0,2 mm (0,1 mm each side)
10 Specimen
11 Tabs optional
12 ½" bolt – bolt has to be torqued

NOTE 1 Extensometer not shown in front view.

NOTE 2 Bearing strength extensometer to be calibre with unequal legs.
Al strip length depends on clamping strip thickness.

Figure 10 — Test set type 2 specimen with hole

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