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BSI Standards Publication

Aerospace series — Fibre reinforced plastics — Test method — Determination of the compression strength after impact

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

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Aerospace series - Fibre reinforced plastics - Test method - Determination of the compression strength after impact

Série aérospatiale - Matières plastiques renforcées de fibres - Méthode d'essai - Détermination de la résistance en compression après impact

Luft- und Raumfahrt - Faserverstärkte Kunststoffe - Prüfverfahren - Bestimmung der Restdruckfestigkeit nach Schlagbeanspruchung

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European foreword

This document (EN 6038:2015) 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.

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1 Scope

This European Standard defines a method to be used to measure the low speed impact resistance characteristics of fibre reinforced plastics.

It is applicable to composite laminates with unidirectional plies or woven fabric reinforcement.

This standard does not give any direction 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 2760, *Aerospace series — Steel FE-PL78 — 1 760 ≤ R_m ≤ 2 000 MPa — Bar — D_e ≤ 75 mm* 1)

3 Terms and definitions

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

3.1
compression strength after impact
maximum compression load experienced by the impacted specimen divided by the initial gross cross sectional area

4 Principle of the method

Subject the laminate specimen to impacts of varying energy, then measure the indentation depth and the compression strength after impact.

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

5 Designation of the method

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

Description block	Identity block
Fibre reinforced plastics **Determination of compression strength after impact**	**EN6038**

Number of this standard

6 Apparatus

6.1 Impact machine: drop weight impact tester, capable of capturing the drop weight after the first impact so that a restrike shall not occur (see Figure 3).

6.2 Impactor with the following characteristics (see Figure 1).

6.3 Flat-faced micrometer with 6 mm diameter anvils, calibrated to within 0,01 mm.

6.4 Depth gauge with hemispheric adapter, diameter 3 mm and calibrated to within 0,01 mm accuracy.

6.5 Test machine accurate to within 1 % in the relevant load range.

6.6 Compression tools (drawings in Figure 4 for information).

6.7 Vernier slide callipers calibrated to within 0,1 mm.

7 Test specimen

7.1 Specimen description

For the description, dimensions, tolerances see Figure 5.

7.2 Specimen preparation

The specimens are cut out from laminates. The coefficient of variation in the thickness measurements shall be smaller than 2 % per laminate. The laminates shall be produced according to EN 2565 for carbon, or according to EN 2374 for glass.

The laminate should be inspected for example by C-Scan to establish that the laminate is worth testing. If the NDT reveals unacceptable defects, limits defined by the specification invoking the test, the laminate should not be tested.

The process parameters shall be in line with the specification invoking the test.

7.3 Number of specimens

Eight specimens shall be tested, one for each energy specified as defined in 8.3.

Three specimens shall be tested at the BVID as defined in 8.5.

8 Procedure

8.1 Conditioning

The storage and testing of the dry specimens shall be carried out at (23 ± 2) °C, (50 ± 5) % relative humidity in accordance with EN 2743.

8.2 Determination of dimensions

Measure and record the thickness and width at three points of the specimen. Use the micrometer for the thickness and the vernier slide callipers for the width.

8.3 Impact tests

As shown in Figure 3, secure the specimen to a flat mounting plate using four snap fasteners. This leaves a clear window of [75 (± 0,1) × 125 (± 0,2)] mm.

Set the drop height according to the selected impact energy (see formula in 9.1).

Subject the specimens to impact with energy: 9, 12, 16, 20 and 25 joules (impactor 1 kg to 3 kg), 30 and 40 joules (impactor 4 kg to 6 kg).

The specimens must only receive one impact. Therefore bouncing must be prevented using a suitable device.

8.4 Indentation inspection

Inspect each specimen and assess, on the impact face and the opposite face:

— the visibility of the indentation,

— any breaks in the fibres.

Just prior to perform the compression test, set the specimen between two appropriate tabs. Using a depth gauge, measure the indentation depth on the impacted face to within 0,05 mm with the following procedure:

— measure the depth gauge value in the deapest part of the indented area,

— then measure the depth gauge value on 4 points as shown in Figure 2 and substract from the value in the indented area,

— the indented depth is the average of these 4 values.

8.5 Study of the barely visible impact damage (BVID)

Draw up the curve of the evolution of the indentation depth as a function of the impact energy.

By linear interpolation, determine the energy E_{BVID} (energy for the barely visible impact damage) corresponding to an indentation of 0,3 mm.

Subject three specimens to impact with energy E_{BVID}.

After having been impacted inspect on those three specimens the depth of the indentation (same as defined 8.4) and perform the compression test (same as defined in 8.6).

8.6 Compression tests on impacted specimens

Compression strength after impact has to be determined for all the specimens subjected to impact testing.

If required in the relevant specification, two strain gauges should be on the front face of the lowest impact energy specimen.

Carefully align the impacted specimen in the test rig (if any, the strain gauges should be at the top of the specimen during testing).

Select the range of loads so that break failure occurs between 20 % and 80 % of the scale.

Select a cross head speed of 0,5 mm/min.

Note the load *Pr* of the break failure.

Record the curve load versus time.

9 Presentation of the results

9.1 Impact energy

Energy E is expressed (depending on the test machine used) in joules using the formula:

$$E = m \times g \times h \quad \text{or} \quad E = 1/2\ m \times v^2$$

where

E impact energy, in J;

m is the impactor mass, in kg;

g = 9,81 in m/s^2;

h is the drop height, in m;

v is the speed at which the impactor impacts the specimen, in m/s.

9.2 Compression strength after impact at a specific impact energy level E

$$\sigma_{r(E)} = \frac{Pr}{w \times t}$$

where

$\sigma_{r(E)}$ is the compression strength after impact, in MPa;

Pr is the break failure load, in N;

w is the specimen width, in mm;

t is the thickness of the specimen, in mm.

9.3 Nominal compression strength after impact

$$\sigma_{rn(E)} = \frac{Pr}{w \times t_n}$$

where

$\sigma_{rn(E)}$ is the nominal compression strength after impact, in MPa;

Pr is the break failure load, in N;

w is the specimen width, in mm;

t_n is the nominal thickness of the specimen, in mm.

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, fibre areal weight, filament count, processing details.

10.2 All details regarding specimen preparation.

10.3 The measured test specimen.

10.4 Date of test, facility and identification of individuals performing the test.

10.5 Equipment, method and test parameters used.

10.6 For each impacted specimen record of:

— impact energy,

— visibility and depth of indentation,

— any breaks in the fibres (on both faces of the specimen),

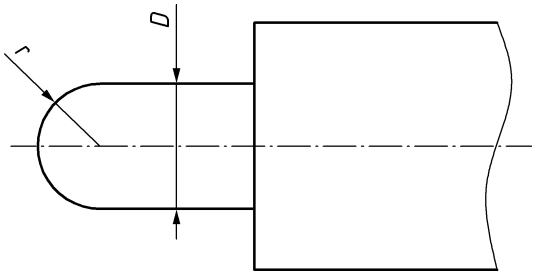
— compression strength after impact.

10.7 Curve of compression strength after impact versus energy.

10.8 Curve of indentation depth versus energy.

10.9 The Barely Visible Impact Damage and corresponding value of strength.

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



Mass : in the ranges 1 kg to 3 kg or 4 kg to 6 kg to within ± 10 g

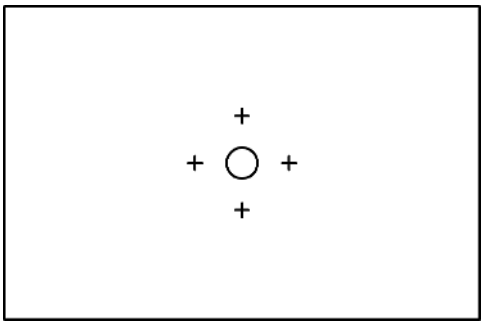
Diameter : $D = (16 \pm 0{,}5)$ mm

Sphere radius : $r = (8 \pm 0{,}25)$ mm

Material : steel $R_m = 2\,000$ MPa according to EN 2760 or equivalent

Roughness : $R_a < 0{,}8$ mm

Figure 1 — Impactor

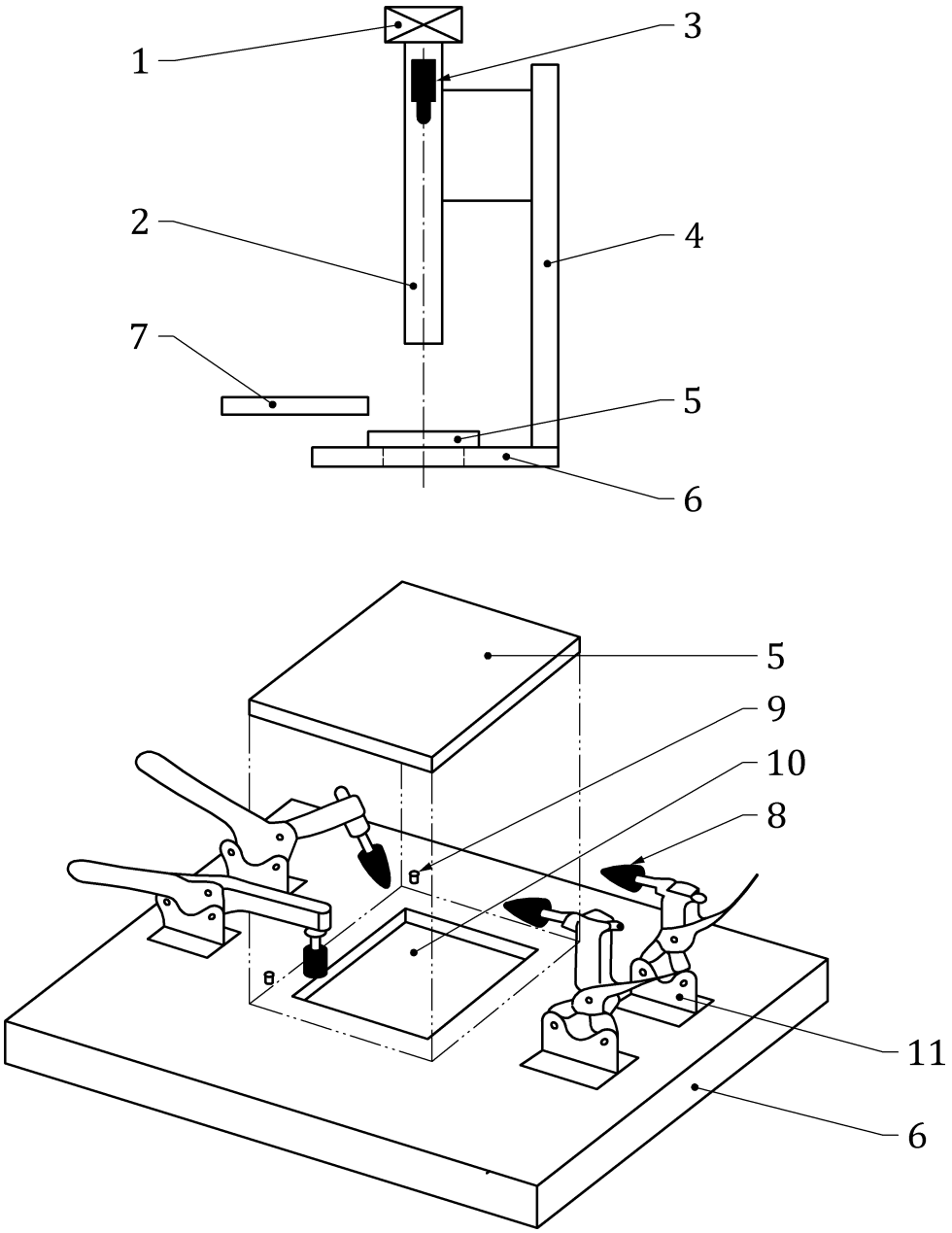


Key

◯ Indentation.

\+ Points to measure the indentation depth (at 20 mm from the indentation).

Figure 2 — Measurement of indentation depth



Key

1 Release system
2 Guide tube
3 Impactor (see Figure 1)
4 Support beam
5 Specimen (see Figure 5)
6 Steel base, thickness: 20 mm
7 Anti-bounce device
8 Rubbers
9 Guide pins
10 Window: (75 × 125) mm
11 Clamping system

Figure 3 — Impact test equipment (principle)

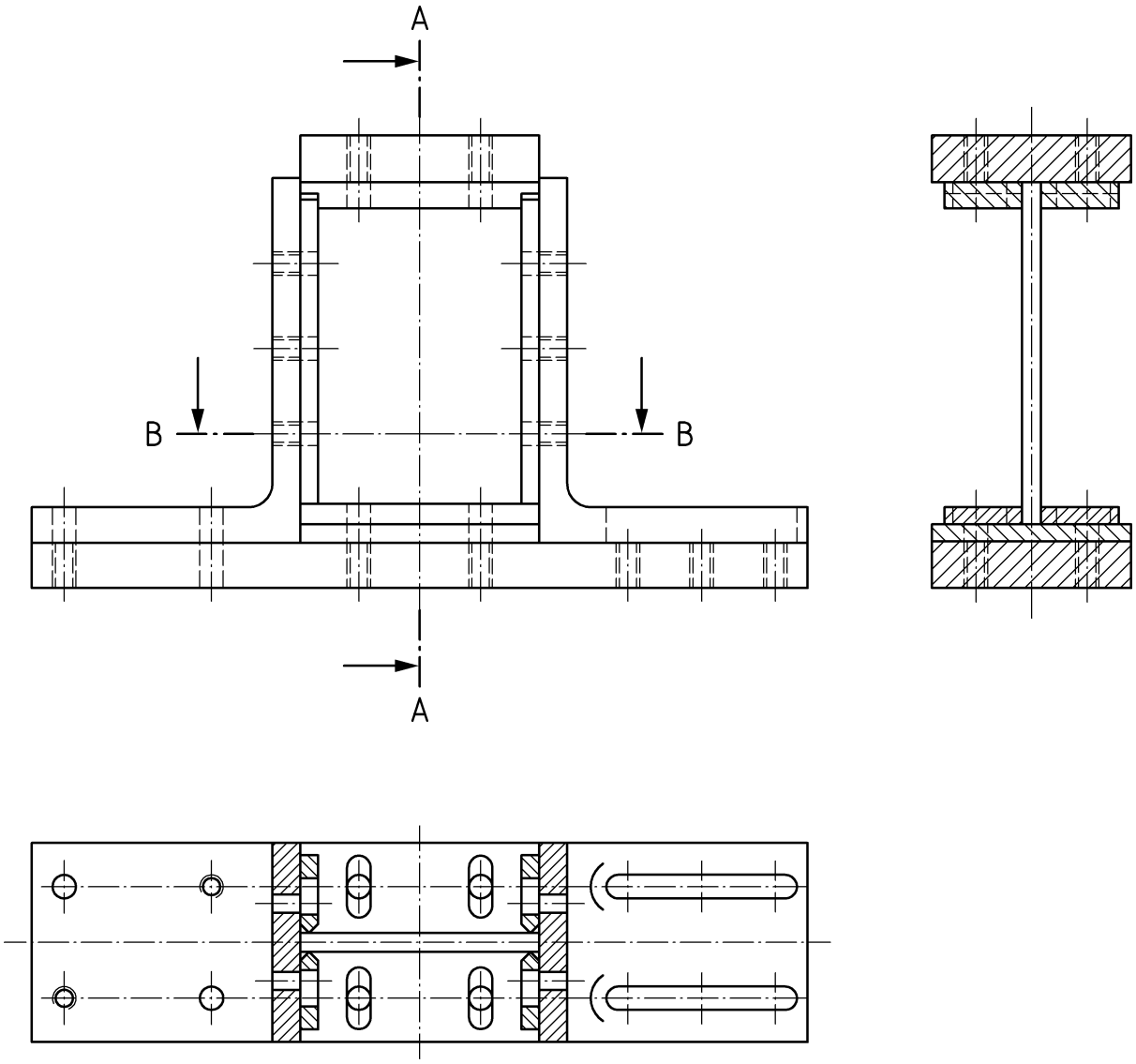
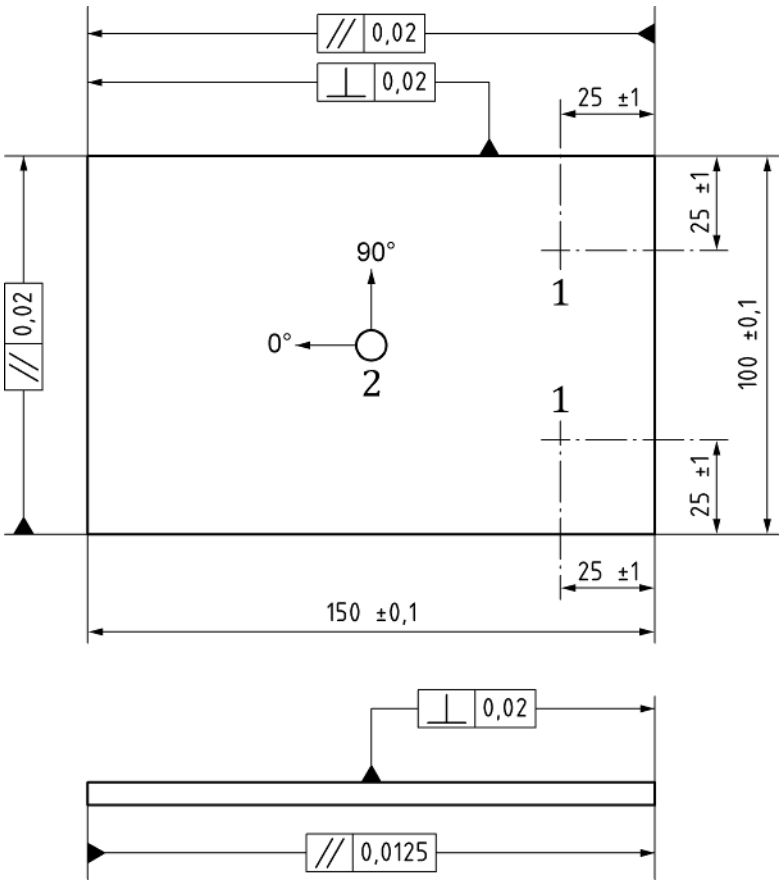


Figure 4 — Compression test equipment (principle)



Key

1 Strain gauge
2 impact location

Lay-up:

Tape lay-up : (45 / 0 / – 45 / 90) *n* sym

Fabric lay-up : [(± 45), (0,90)] *m* sym

NOTE *n* and *m* are to be determined to obtain a thickness of the laminate as close as possible to 4 mm. 0° is equivalent to "warp" direction and 90° is equivalent to welt direction.

Figure 5 — Impact specimen

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