BS EN 6036:2015

BSI Standards Publication

Aerospace series — Fibre reinforced plastics — Test method — Determination of notched, unnotched and filled hole compression strength

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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 notched, unnotched and filled hole compression strength

Série aérospatiale - Matières plastiques renforcées de fibres - Méthode d'essai - Détermination de la résistance en compression trouée, lisse et trouée habitée

Luft- und Raumfahrt - Faserverstärkte Kunststoffe - Prüfverfahren - Bestimmung der Kerbdruckfestigkeit an gekerbten, ungekerbten und gebolzten Probekörpern

This European Standard was approved by CEN on 10 August 2013.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 6036:2015) 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of an identical text or by endorsement, at the latest by May 2016, and conflicting national standards shall be withdrawn at the latest by May 2016.

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1 Scope

This standard defines a method to be used to determine the compression strength of notched, unnotched and filled hole fibre reinforced plastics.

It is applicable to composite laminates with unidirectional layers 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 2489, *Aerospace series — Fibre reinforced plastics — Determination of the action of test fluids*

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
notched tensile strength
maximum compression load experienced by the notched test specimen divided by the initial cross sectional area within the gauge length

3.2
unnotched tensile strength
maximum compression load experienced by the unnotched test specimen divided by the initial cross sectional area within the gauge length

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

3.3
filled hole compression strength
maximum compression load experienced by the filled hole test specimen divided by the initial gross cross sectional area within the gauge length

3.4
K_{T1} **value**
unnotched compression strength divided by the filled hole compression strength

3.5
K_{T2} **value**
unnotched compression strength divided by the notched compression strength

4 Principle of the method

A compression test on unnotched specimen is carried out in order to determine the original material strength. The same test is performed either on notched or a filled hole specimen to determine the residual strength.

5 Designation of the method

The designation of the method used shall be in accordance with the following example:

Description block	**Identity block**
TEST METHOD	**EN6036 II A**

Number of this standard

Specimen type II (see Figures 1 to 3)

Laminate configuration A (see Table 1)

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

6 Apparatus

6.1 Compression test machine accurate to within 1 % equipped with facilities to record maximum load and fitted with suitable grips or used with compression jig featuring a grip and movement alignment system.

6.2 Chamber adapted to the machine to carry out tests at temperature. The temperature shall be maintained within ± 3 °C.

6.3 Timer.

6.4 Thermocouple with recorder to monitor temperature for tests at other than ambient.

6.5 Flat faced micrometre with 6 mm diameter faces, accurate to 0,01 mm.

6.6 Vernier calliper accurate to the nearest 0,1 mm.

7 Test specimen

7.1 Specimen description

For the description, dimensions and tolerances, see Figure 1 for notched type specimen, Figure 2 for unnotched type specimen and Figure 3 for filled hole type specimen. The laminate configuration for the fibre directions are defined in Table 1.

7.2 Test 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 and in accordance with EN 2374 for glass.

Special precautions have to be taken to ensure that no delamination occur during machining especially for the drilling of the notched and filled hole test specimens.

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 in 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 Tabs

The tests may be performed without the specimen being tabbed. However, if tabs are used they shall be strain compatible with the composite being tested either, by using precured tabs of 2 plies of fabric, lay-up (+45,–45) or by co-bonding using a suitable prepreg system. The precured tabs shall be bonded on both specimen faces with an adhesive system that will meet the temperature and ageing requirements. Care should be taken to avoid the bonding temperature to add any undesired post cure effect to the laminate.

7.4 Number of specimens

Five specimens shall be tested per test condition, except when otherwise specified in the technical specification. If tests are carried out after ageing or at a temperature different from room temperature, care should be taken to assure that room temperature/dry reference specimens, which had been machined from the same plate as the specimens under investigation are also tested.

7.5 Ageing

In case of tests after immersion, the conditions shall be according to EN 2489. For tests after exposure to humid atmosphere, the conditioning shall be in accordance with EN 2823.

8 Procedure

8.1 Conditioning

The storage and testing of as received specimens shall be carried out at (23 ± 2) °C, (50 ± 5) % relative humidity in accordance with EN 2743. Aged specimens shall be tested within a maximum of 8 h after removal from the exposure environment.

8.2 Determination of dimensions

Measure and record the thickness and width at three points in the gauge length of the specimen before ageing and again before mechanical testing. Use the micrometre (see 6.5) for the thickness and the vernier calliper (see 6.6) for the width. Average the three measurements.

8.3 Test at ambient temperature

Place the specimen in the jaws, ensuring that it is aligned within 1° and centred on the machine axis.

NOTE The jaws shall fully cover the tabs if used.

Select the load range such that failure occurs between 20 % and 80 % of full scale.

Compression load shall be applied at a constant cross head speed of 0,5 mm/min.

Record the maximum load *Pr*.

8.4 Test at temperature other than ambient

Apply a thermocouple (see 6.4) on the composite material as close as possible to the centre of the specimen and seal the thermocouple from the surrounding air by using vacuum bag sealant.

After a dry specimen has reached a temperature of 2 °C below the required elevated temperature or 2 °C above the required sub-zero temperature, the specimen shall be maintained at the required condition for five minutes prior to testing.

The above time for aged specimen is 1 min.

The heat up/soak cycle used shall be given in the test report.

For specimens that have been subjected to fluid immersion, apply EN 2489.

For specimens that have undergone humidity ageing, apply EN 2823.

Follow the same procedure as for the test at ambient temperature.

9 Presentation of the results

9.1 Tensile strength σ_c

For notched specimens

$$\sigma_{cn} = \frac{Pr}{t \times w}$$

For filled hole specimens

$$\sigma_{cf} = \frac{Pr}{t \times w}$$

For unnotched specimens

$$\sigma_{cu} = \frac{Pr}{t \times w}$$

where

$\sigma_{cn}, \sigma_{cf}, \sigma_{cu}$	are the tensile strengths for, notched, filled hole and unnotched specimens, in MPa;
Pr	is the maximum load, in N;
w	is the specimen width, in mm;
t	is the thickness of the specimen, in mm.

9.2 Nominal tensile strength σ^n_c

For notched specimens

$$\sigma^{n}_{cn} = \frac{Pr}{t_n \times w}$$

For filled hole specimens

$$\sigma^{n}_{cf} = \frac{Pr}{t_n \times w}$$

For unnotched specimens

$$\sigma^{n}_{cu} = \frac{Pr}{t_n \times w}$$

where

$\sigma^n_{cn}, \sigma^n_{cf}, \sigma^n_{cu}$	are the nominal tensile strength for, notched, filled hole and unnotched specimens, in MPa;
Pr	is the maximum load, in N;
w	is the specimen width, in mm;
t	is the nominal thickness of the specimen, in millimetres, as specified in the relevant material specification.

9.3 K_{T1} value (see 3.4)

$$K_{T1} = \frac{\sigma_{cu}}{\sigma_{cf}}$$

9.4 K_{T2} value (see 3.5)

$$K_{T2} = \frac{\sigma_{cu}}{\sigma_{cn}}$$

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 (including when applicable: tabs material, tabs adhesive and curing condition of this adhesive).

10.3 The measured specimen dimensions.

10.4 Ageing and/or exposure condition 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, mean value and standard deviation of tensile strength for notched, unnotched and filled specimen.

10.8 K_T values.

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

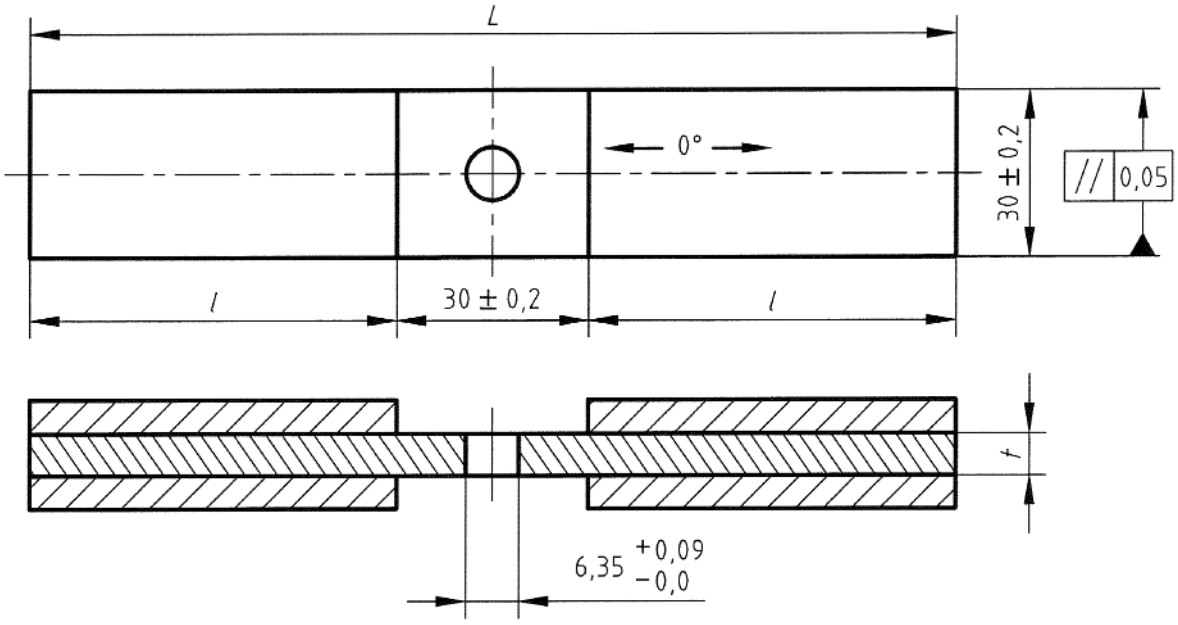
Table 1 — Laminate configurations

	Lay-ups for different fibre mass per unit area directed and quasi-isotopic laminates		
	Fibre mass per unit area (g/m^2)	Quasi-isotopic laminates Type A	Directed laminates Type B
Tapes	130-145	(45, 0, –45, 90) 4 sym.	(0, 45, –45, 0, 90) 3 sym.
	160-190	(45, 0, –45, 90) 3 sym.	(0, 45, –45, 0, 90) 2 sym.
	260-290	(45, 0, –45, 90) 2 sym.	(0, 45, –45, 0, 90) 2 sym.
Fabrics	—	(45, 0,[a] –45, 90 [a]) n [b] sym.	—

[a] 0° is equivalent to warp direction and 90° is equivalent to welt direction.

[b] n to be determined to have a laminate thickness as close as possible to 4 mm.

Dimensions in millimetres



Tabs

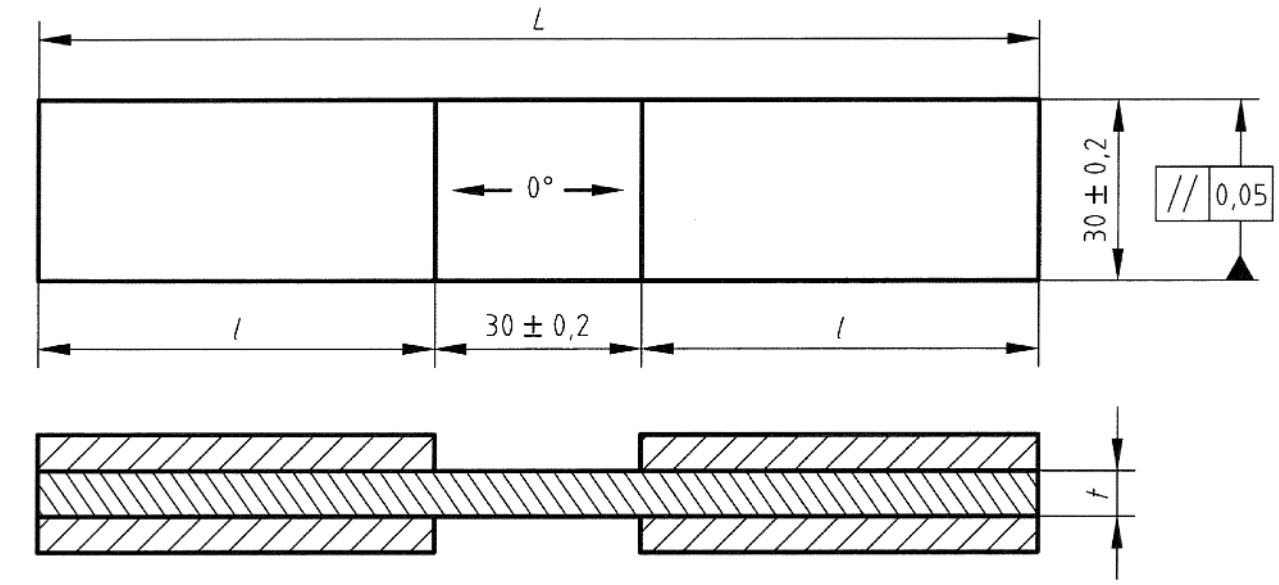
L = 2 l + 30 mm

l = table length: Function of the equipment (test machine, jaws, etc.) and/or the material to be tested (tabs must be able to transfer the shear loads).

t : according to lay-up (see Table 1).

Figure 1 — Notched compression specimen – Type I

Dimensions in millimetres



Tabs

L = $2\,l + 30$ mm

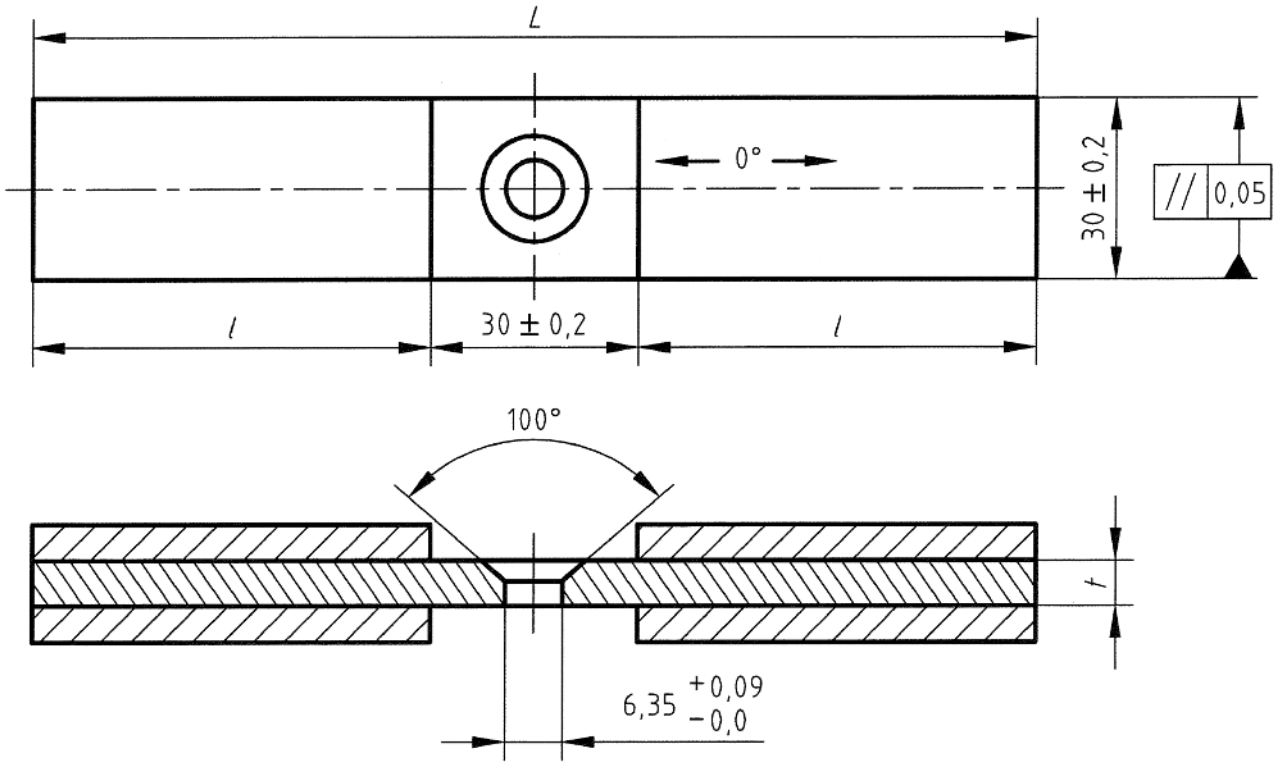
l = table length: Function of the equipment (test machine, jaws, etc.) and/or the material to be tested (tabs must be able to transfer the shear loads).

t : according to lay-up (see Table 1).

NOTE Parallelism of tab faces must be maintained to within 0,05 mm across width and length. Tabs faces must be parallel with specimen faces to within 0,05 mm.

Figure 2 — Unnotched compression specimen – Type II

Dimensions in millimetres



Tabs

L = 2 l + 30 mm

l = table length: Function of the equipment (test machine, jaws, etc.) and/or the material to be tested (tabs must be able to transfer the shear loads).

t : according to lay-up (see Table 1)

Bolt: NAS 1580V4T Torque: 7 Nm

Nut: MS21042-L4 Washer: Flat AN 960C416

Figure 3 — Filled hole compression specimen – Type III (Drawing: composite part only)

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