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Fibre-reinforced plastic composites — Determination of compressive properties in the in-plane direction

Composites plastiques renforcés de fibres — Détermination des caractéristiques en compression dans le plan

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 14126:1999), which has been technically revised.

The main changes are as follows:

— a new normative Annex A, alignment of specimen and loading train, has been added and subsequent annexes have been renumbered;

— Annex B, specimen preparation, is now normative to emphasise the importance of producing good quality specimens;

— two new informative Annexes F and G have been added.

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.

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Introduction

This document, originally published in 1999, was based on ISO 8515[1] with the scope extended from glass-fibre reinforcement to include all fibre-reinforced plastic composites, such as composites based on carbon and aramid fibres. Other source documents consulted included ASTM D 3410[2], SACMA SRM1[3], prEN 2850[4], CRAG 400[5], DIN 65380[6] and JIS K7076[7]. Several different types of anti-buckling fixtures/loading jigs, different materials and different specimen sizes are covered by these source documents, although all are parallel-sided coupons. New or modified geometry support jigs are still being developed, for example in JIS K7018[8].

This document harmonizes and rationalizes the current situation by:

a) concentrating on the quality of the test by limiting the maximum bending strain allowable (i.e. 10 % between 10 % and 90 % of the maximum load, as recommended by ASTM), so that an axial-load case can be assumed;

b) standardizing on two related specimen designs, one principally for aerospace type unidirectional pre-impregnated materials (i.e. Type A) and one for other materials/formats (i.e. Types B1/B2). The chosen specimen design can be used with different loading fixtures;

c) defining acceptable failure criteria (e.g. avoiding within grip failures);

d) including an equation for determining the specimen minimum thickness to avoid Euler buckling proposed by ASTM for harmonization purposes (taken from ASTM D 3410[2] in a modified form);

e) allowing any design of support/loading fixture to be used that meets the above bending requirements, using different principles of loading (i.e. essentially shear and combined loading);

f) ensuring that the test specimen and loading/support fixture are well aligned (see Annex A);

g) concentrating on the quality of specimen preparation (see Annex B);

h) including guidance on the use of digital image correlation (DIC) for strain and bending measurements (see Annex G);

NOTE 1 Compression properties measured in the through-thickness direction (direction 3 in Figure 1) are covered by ISO 20975-1[9].

NOTE 2 Compression properties of rigid plastics having only unaligned short (<7,5 mm) fibres or no fibre content [rather than long (>7,5 mm) discontinuous or continuous fibres] is covered by ISO 604[10].

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Fibre-reinforced plastic composites — Determination of compressive properties in the in-plane direction

1 Scope

1.1 This document specifies methods for determining the compressive properties, in directions parallel to the plane of lamination, of fibre-reinforced plastic composites, based on thermosetting or thermoplastic matrices. The compressive properties are of interest for specifications and quality-control purposes. The test specimens are machined from a flat test plate, or from suitable finished or semi-finished products.

1.2 Two loading methods and two types of specimen are described.

The loading methods are:

— Method 1: provides shear loading of the specimen (gauge length unsupported)

— Method 2: provides combined loading of the specimen (gauge length unsupported)

NOTE For tabbed specimens loaded using method 2, load is transferred through a combination of end-loading and shear-loading through the tabs.

The specimen designs are:

— Type A specimen: rectangular cross-section, fixed thickness, end-tabbed (mainly for aerospace style preimpregnates (~ 0,125 mm ply thickness)

— Type B specimen: rectangular cross-section, range of thicknesses, untabbed or end-tabbed, two specimen sizes are available (B1 and B2).

The Type A specimen is used for unidirectionally or biaxially reinforced materials tested in the fibre direction, where the fibres are normally either aligned continuous or aligned long (>7,5 mm) discontinuous. The Type B1 and B2 specimens are used for multi-directional aligned; mat, fabric and other multi-directionally reinforced materials where the fibre structure is more complex and/or coarser.

1.3 This document gives criteria for checking that the combination of test method and specimen design result in valid failures. It is noted that alternative test method/specimen combinations will not necessarily give the same result.

1.4 The methods specify required dimensions for the specimen. Tests carried out on specimens of other dimensions, or on specimens that are prepared under different conditions, can produce results that are not comparable. Other factors, such as the speed of testing, the support fixture used and the conditioning of the specimens, can influence the results.

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 1268 (all parts), *Fibre-reinforced plastics — Methods of producing test plate*

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ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

ISO 23788, *Metallic materials — Verification of the alignment of fatigue testing machines*

ASTM E 1012, *Standard practice for verification of testing frame and specimen alignment under tensile and compressive axial force application*

3 Terms and definitions

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

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

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

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

3.1
compressive stress
σ_c
compressive force experienced by the test specimen, at a particular time, divided by the initial cross-sectional area of the parallel-sided portion of the specimen

Note 1 to entry: It is expressed in megapascals.

3.2
compressive strength
compressive failure stress
σ_{cM}
maximum *compressive stress* (3.1) sustained by the specimen

Note 1 to entry: It is expressed in megapascals.

3.3
compressive strain
ε_c
decrease in length per unit length of the original gauge length

Note 1 to entry: It is expressed as a dimensionless ratio or in percent.

3.4
compressive failure strain
ε_{cM}
longitudinal compressive strain at the compressive failure stress

Note 1 to entry: It is expressed as a dimensionless ratio or in percent.

3.5
modulus of elasticity in compression
chord modulus
E_c
stress difference (σ" minus σ') divided by the corresponding strain difference (Ɛ" (= 0,002 5) minus Ɛ' (= 0,000 5))

Note 1 to entry: It is expressed in megapascals.

Note 2 to entry: See 10.2.

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