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Date: 23 December 2024

Origin: International

Latest date for receipt of comments: 15 February 2025

Project No. 2022/01036

Responsible committee: PRI/42 Fibre reinforced thermosetting plastics and prepregs

Interested committees:

Title: Draft BS EN ISO 8203-4 BS ISO 8203-4 Fibre-reinforced plastic composites. Non-destructive inspection. Part 4: Laser shearography.

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 8203-4

Fibre-reinforced plastic composites — Non-destructive inspection —

Part 4: Laser shearography

ICS: 83.120

ISO/TC 61/SC 13

Secretariat: JISC

Voting begins on:
2024-12-23

Voting terminates on:
2025-03-17

This document is circulated as received from the committee secretariat.

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Reference number
ISO/DIS 8203-4:2024(en)

Full document details: 24/30456273 DC

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Published in Switzerland

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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.

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 documents 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.

A list of all parts in the ISO 8203 series can be found on the ISO website.

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.

Fibre-reinforced plastic composites — Non-destructive inspection —

Part 4: Laser shearography

1 Scope

This document specifies the principal method for laser shearography non-destructive inspection (NDI) of fibre-reinforced polymer (FRP) composites. Out-of-plane surface displacement gradients are monitored, using coaxial illumination and observation perpendicular to the part surface. Defect detection relies on local influences on the global surface deformation from sub-surface anomalies under the selected loading regime.

This document is applicable to both monolithic and sandwich FRP laminate constructions, with or without curved surfaces, fibre-reinforced thermoset and thermoplastic matrix composites incorporating uni- or multi-directional reinforcements in either a continuous or discontinuous format; including but not limited to woven fabrics, stitched fabrics, short fibre, or particulate filled, honeycomb or foam cores, as well as combination or hybrid reinforcements.

The method can be used to detect and measure a wide range of manufacturing and in-service defects in these materials. The technique has the advantages of being fast, non-contact and suitable for inspecting large areas, with portable, real-time, and in-situ measurement capabilities. Laser shearography enables detection of imperfections/discontinuities which are detrimental to the performance or ultimate strength of the material.

This document is not applicable to variations on this basic configuration.

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.

IEC 60825-1, *Safety of Laser Products Part 1: Equipment classification and requirements*.

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 calibration target (non-spatial)

this constitutes a deformable membrane of known and adjustable out-of-plane displacement which provides a reproducible reference fringe pattern for assessing the shearography system operation, stability, limits, and sensitivity.

3.2

coherent light source

a monochromatic beam illumination having uniform phase over a length known as the coherence length.

3.3

decorrelation

the loss of phase data caused by test part deformation exceeding the optical measurement resolution or excessive relative motion of the part in either translation, expansion or tilt between images or phase steps.

3.4

defect

any structural imperfection or localised material inhomogeneity in a FRP composite material which affects the expected ultimate mechanical performance; examples include sandwich core crush, sandwich core separation, sandwich skin disbond, inclusion, delamination, porosity, impact damage, cracking, voids, moisture, or fibre waviness/wrinkling.

3.5

displacement derivatives/gradients

the spatial rate of change of displacement given by the relative deformation change between pairs of target surface points separated by a distance defined by the shear vector, directly related to strain

3.6

filtering

a mathematical process for reducing/smoothing image noise and removing uniform background fringes, used to enhance defect detection in laser shearography.

3.7

fringe contrast

a measure of interference quality; it is reduced by low illumination intensity, high signal to noise ratio, decorrelation and/or restriction of the CCD bit depth available to fringes due to excess brightness of ambient lighting; the aim should be to maximise fringe contrast whilst avoiding signal saturation.

3.8

fringe pattern

the light and dark speckle intensity bands resulting from constructive and destructive interference in the shearogram; each intensity band corresponds to paths of equal change in displacement gradient or phase shift.

3.9

image processing

the mathematical manipulation of shearograms to increase image contrast and improve defect visibility and characterisation.

3.10

indication

a notable feature in the uniform background phase map which suggests the presence of a defect; these may be localised concentrations, severe gradients, discontinuities, or other anomalies in the fringe/phase pattern which cannot otherwise be attributed to the expected underlying structure.

3.11

interferogram

the interference pattern which results from imaging the target surface speckle pattern with a shearing element to create an overlapping double image with an offset defined by the shear vector; the interferogram defines the surface interference map of the part for a given load/deformation condition.

3.12

interferometer

device for interfering coherent light, e.g. the Michelson interferometer which consists of two mirrors and a beam splitter combining light at the image plane; for purposes of laser shearography, one mirror tilts, acting as the shearing element.

3.13**laser shearography**

method of measuring changes in the out-of-plane surface displacement gradient of a component under a low applied stress compared to a reference condition using self-referencing, common path interferometry; the mathematical comparison between different stress states, and therefore different surface deformation states, enables defect identification.

3.14**monolithic composite laminates**

this is a laminate made of only one material system in a single process, as opposed to hybrid materials containing mixed fibre types or secondary bonded materials which contain adhesive bondlines.

3.15**natural defect artefact**

NDA

a FRP component containing naturally formed defects either in-service or by deliberate impact/overstressing of a test part; enables the inspection setup to be optimised for a given material/lay-up/geometry/surface finish combination with highly representative defects of unspecified dimensions; NDAs may be investigated by other NDI methods prior to shearography to enable comparisons of results.

3.16**optically rough surface**

roughness of the order of the illuminating light wavelength.

3.17**out-of-plane displacement**

deformation of the test part surface along an axis which is normal to the plane of the surface.

3.18**phase shift**

the change in the phase position of a wave, in radians.

3.19**projection (spatial calibration)**

calibration of the shearogram image dimensions from pixels to engineering units for accurate dimensioning of indications in the shearogram using software callipers; achieved by either manual definition of the measured versus pixel length of an object in the field of view or automatically using in-built laser pointers of fixed separation.

3.20**reference defect artefact**

RDA

FRP component containing artificially created defects designed to be representative of those occurring naturally in composites; the location and size of defects are well-controlled such that it may be used to evaluate the sensitivity and limits of detection for a given material/defect/surface finish combination, optimise the inspection setup or to investigate “fingerprint” indications for use in identifying the nature of unknown defects during inspection; once characterised, an RDA can then be used as a standard to test repeatability of the inspection system and thereby effective and consistent functioning of the inspection equipment.

3.21**sandwich construction**

this is comprised of relatively thin FRP laminate skins adhesively bonded either side of a thick but lightweight material core (usually foam or honeycomb) to form a very rigid structure.

3.22**shear calibration target**

this comprises an object with a high contrast geometrical pattern used to verify image offsets generated by the shearing element. Such targets incorporate visual markers with known geometrical offsets of both angle and size.