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Aerospace series — Definitions of imperfections and defects in organic matrix composite materials

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National foreword

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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 committee manager.

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Aerospace series - Definitions of imperfections and defects in organic matrix composite materials

Série aérospatiale - Définitions des imperfections et défauts dans les matériaux composites à matrice organique

Luft- und Raumfahrt - Definitionen von Unvollkommenheiten und Defekten in der organischen Matrix Kompositmaterialien

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European foreword

This document (EN 4866:2021) 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 document 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 document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2021, and conflicting national standards shall be withdrawn at the latest by December 2021.

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

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1 Scope

This document provides a list of terms with their definitions illustrated by typical photographs, in order to define a common vocabulary on the imperfections and damage that may occur during the manufacture of organic matrix composite materials (which will be called “resin” in this document). Some types of damage may also be encountered in use.

This document is restricted to their definitions and does not give any acceptance criteria. The word “imperfection” will be preferred to the word “defect”, although the word “defect” might be usually used. Defect acceptance criteria to be discussed between the user and customer and documented appropriately between the two parties.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological 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 General

3.1.1
damage

damage corresponds to degradation of the resin and/or the fibres caused by mechanical, thermal or environmental stresses

3.1.2
defect

imperfection or damage which exceeds the part acceptance criterion

3.1.3
imperfection

particularity encountered in composite materials that may result from the manufacturing process and/or the conditions of use

Note 1 to entry: Detection may be carried out visually or by using laboratory equipment.

3.1.4
indication

information given by non-destructive test means and which may correspond to an imperfection

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3.2 Bonding imperfections

See also EN ISO 10365.

3.2.1
absence of adhesive
absence of adhesive with respect to the part definition

Note 1 to entry: See Figure B.1.

3.2.2
absence of contact
presence of the required adhesive on one or both faces of the assembly, but with no contact

Note 1 to entry: Encountered in case of poor matching.

Note 2 to entry: See Figure B.2.

3.2.3
adhesive joint colour heterogeneity
possible imperfections when using two-component adhesives of different colours, and caused by incomplete mixing of the components (visible in particular in the adhesive bead)

3.2.4
adhesive rupture
total or partial separation of a bonding interface without rupture of neither the substrate nor the adhesive

Note 1 to entry: As opposed to cohesive rupture (characterized by a rupture within the substrate or the adhesive).

Note 2 to entry: See Figure B.3 and Figure B.4.

3.2.5
debonding
separation of two items as a result of adhesive or cohesive failure in the adhesive layer

3.2.6
excessive adhesive bead
localised adhesive surplus on the edge of a joint plane

3.2.7
insufficient adhesion
localised insufficient adhesion between two materials (substrate, adhesive, primer, etc.) characterised by insufficient mechanical strength of the interface

3.2.8
junction imperfection
incorrect positioning of one part with respect to the other during bonding

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3.2.9
lack of adhesive
local lack of adhesive (insufficient quantity or poor distribution) with respect to the part definition

Note 1 to entry: See Figure B.5.

3.3 Presence of foreign substance

3.3.1
foreign object
presence of any solid (non-metallic) particle, which is not part of raw material formulation

3.3.2
inclusion
metallic foreign object

Note 1 to entry: See Figure C.3 and Figure C.4.

3.3.3
pollution
presence of liquid or powder substance, which is not part of raw material formulation

Note 1 to entry: See Figure C.5 and Figure C.6.

3.4 Surface imperfections

3.4.1
fern
cluster of localised areas of insufficient resin on the surface, having the appearance of a fern leaf

Note 1 to entry: Fern is a special case of surface porosities.

Note 2 to entry: See Figure D.1 and Figure D.2.

3.4.2
flaking
local tearing-off of material (see 3.9.8) of millimetric dimensions from the surface layer of a composite (flake detached or not) often localised on the edge of a part or of a hole

Note 1 to entry: See Figure D.3, Figure D.4 and Figure D.5.

3.4.3
wrinkle
fold of the fibres out of plane affecting one or more layers

Note 1 to entry: See Figure D.6, Figure D.7 and Figure D.8.

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3.4.4
imprint
hollow mark on the surface of the part related to the production tooling (mould or environment products)

Note 1 to entry: See Figure D.9.

3.4.5
indentation (dent/punching)
bump of material due to an impact on the part

Note 1 to entry: See Figure D.10.

3.4.6
line flash
line shaped accumulation of resin caused by an undulation close to the surface of the part

Note 1 to entry: See Figure D.11.

3.4.7
marbling
heterogeneity of the part's colour or gloss

Note 1 to entry: See Figure D.12.

3.4.8
nick
cut opening onto the surface of the part, due to a mechanical action (tool), which could affect the fibres

Note 1 to entry: See Figure D.13 and Figure D.14.

3.4.9
pill
cluster of fibre residues

Note 1 to entry: See Figure D.15.

3.4.10
projection
mark in relief (or surface topology imperfection) on the surface of the part

Note 1 to entry: See Figure D.16.

3.4.11
resin flash
thin layer of pure resin extending over the part surface

Note 1 to entry: See Figure D.17.

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3.4.12
scratch
thin surface mark due to a mechanical action, affecting only the resin

Note 1 to entry: See Figure D.18.

3.4.13
surface porosities
localized points of insufficient resin on the surface

Note 1 to entry: The term “crater” can be used in case of an isolated cavity opening onto the surface, of dimension greater than a few tenths of a millimetre.

Note 2 to entry: See Figure D.19 and Figure D.20.

3.5 Cavities

3.5.1
insufficient impregnation/dry area
lack of impregnation of the fibres by the resin

Note 1 to entry: See Figure E.1 and Figure E.2.

3.5.2
porosities
randomly distributed spherical gas cavities

Note 1 to entry: See Figure E.3, Figure E.4, Figure E.5 and Figure E.6.

3.5.3
voids
cavity with a tubular shape or whatever shape, e.g. bridging, piping

Note 1 to entry: Bridging is a condition where plies span an internal feature thus creating a void.

3.6 Fibres arrangement imperfection

3.6.1
bird eyes
local separation of two adjacent tows

Note 1 to entry: See Figure F.1.

3.6.2
gap/overlap
ply not positioned edge to edge with respect to the adjacent ply, which generates an overlap or gap of material

Note 1 to entry: The gaps and overlaps may be in the part definition.

Note 2 to entry: See Figure F.2 and Figure F.3.

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3.6.3
off-centring
modification of the angle between the warp and the weft

Note 1 to entry: See Figure F.4.

3.6.4
ply misorientation
deviation of the fibres' direction in a ply (unidirectional or fabric) compared to the theoretical definition

3.6.5
resin accumulation
surplus of a resin volume without fibre which could locally affect the Fibre Volume Ratio (FVR) and geometry of the part

Note 1 to entry: See Figure F.5, Figure F.6 and Figure F.7.

3.6.6
undulation
waviness deformation of the fibres in or out of the plane

Note 1 to entry: See Figure F.8 and Figure F.9.

3.7 Imperfection specific to sandwiches

3.7.1
accidental filling of honeycomb cells
filling of one or more honeycomb cells by skin resin, adhesive or densification resin

Note 1 to entry: See Figure G.1.

3.7.2
core crushing (honeycomb or foam)
damage to the core resulting in a local reduction in its thickness or shape, possibly leading to buckling of the honeycomb or deformation of the foam

Note 1 to entry: See Figure G.2 and Figure G.3.

3.7.3
cut honeycomb
cut in the honeycomb during the implementation process, by a sharp object

Note 1 to entry: See Figure G.4.

3.7.4
deformed honeycomb cells
sideways movement of the cell walls to produce one or several line(s) of distorted cells

Note 1 to entry: See Figure G.5 and Figure G.6.

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3.7.5
edge filling imperfection
insufficient resin filling on the edge of a sandwich panel

Note 1 to entry: See Figure G.7.

3.7.6
insufficient meniscus on honeycomb
the adhesive or resin does not produce an effective fillet on the honeycomb (fillet not formed or badly formed)

Note 1 to entry: See Figure G.8 and Figure G.9.

3.7.7
lack of densification
partial or total absence of the densification filling

Note 1 to entry: See Figure G.10.

3.7.8
separation of the honeycomb nodal joints
separation of adjacent honeycomb cells, possibly due to insufficient adhesive or incorrect bonding of the sheets forming the honeycomb

Note 1 to entry: See Figure G.11.

3.7.9
slope deformation (chamfer)
difference in slope angle with respect to the definition, by crushing of the core or slipping of the honeycomb

Note 1 to entry: This imperfection occurs mainly during the polymerisation phase.

Note 2 to entry: See Figure G.12 and Figure G.13.

3.7.10
telegraphing
collapse of the composite skin into the honeycomb cells

Note 1 to entry: See Figure G.14, Figure G.15 and Figure G.16.

3.8 Stitching imperfections

3.8.1
incorrect stitching depth
stitching depth does not conform with the definition

3.8.2
loop
thread pulled out of the weaving plane

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3.8.3
missing stitch
absence of stitch throughout the part thickness compared to the definition pattern

Note 1 to entry: See Figure H.1.

3.8.4
non-conforming spacing
spacing between the stitches does not conform with the definition pattern

3.8.5
non-conforming stitching angle
stitching angle does not conform with the definition

3.9 Damage

3.9.1
burn
sign of local thermal decomposition causing a colour variation, perhaps blackening, and which could damage the material

Note 1 to entry: See Figure I.1.

3.9.2
crack
rupture in the part thickness, with broken fibres, not crossing through the entire part

Note 1 to entry: See Figure I.2.

3.9.3
cut ply
accidental cut of the reinforcement, caused by a mechanical action

Note 1 to entry: See Figure I.3.

3.9.4
decohesion
fibre/resin separation

Note 1 to entry: See Figure I.4 and Figure I.5.

3.9.5
delamination
rupture in the resin resulting in separation between two layers of a stack (unidirectional, 2D woven, winding fabric)

Note 1 to entry: See Figure I.6, Figure I.7, Figure I.8, Figure I.9 and Figure I.10.

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3.9.6
microcrack
rupture located only in the resin, about a tenth of a millimetre long

Note 1 to entry: See Figure I.11.

3.9.7
perforation
through-hole caused by a shock/impact

Note 1 to entry: See Figure I.12.

3.9.8
tearing-off of material
removal of material composed of fibres and resin of centimetric dimensions affecting at least one ply

Note 1 to entry: See Figure I.13.

3.9.9
whitening of the resin
localised whitened area, due to opacification of the resin, caused by the start of a resin damage

Note 1 to entry: See Figure I.14.

3.10 Other

3.10.1
excessive resin flow
excessive pumping or migration of the resin possibly causing insufficient part thickness

3.10.2
feather duster
ply end with fibres fanned out

Note 1 to entry: See Figure J.1.

3.10.3
geometry imperfection
dimensional and shape requirements not respected

Note 1 to entry: One possible cause is the release of manufacturing stresses when demoulding (spring back effect).

3.10.4
non-conforming number of plies
lack or addition of one or more plies compared to the definition

3.10.5
non-conforming stacking sequence
orientation of one or more plies does not conform with the definition

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3.10.6
non-conforming thickness
thickness outside the dimensional tolerances

Note 1 to entry: See Figure J.2.

3.10.7
pinching
crushing of outer plies closing the mould

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Annex A
(informative)

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