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Composites and reinforcements fibres — Carbon fibre reinforced plastics (CFRPs) and metal assemblies — Characterization of durability of adhesive interfaces by wedge rupture test

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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 ~~documents~~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 ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.

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~~www.iso.org/members.html.

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Introduction

This document specifies a method for evaluating the durability of adhesive interfaces in the bonded assemblies of carbon fibre reinforced plastics (CFRPs) and metals by a wedge test with a double cantilever beam (DCB) specimen under specified environmental conditions. The wedge rupture test force the crack to propagate along the CFRP/adhesive or metal/adhesive interfaces, or within the adhesive layer. This test method provides a quantitative value for evaluating the effect of a harsh environmental condition on the durability of adhesive interfaces as an interfacial fracture energy. This method is intended for testing only those bonded plates used in bonding carbon fibre reinforced plastics (CFRPs) to metal assemblies.

The potential benefits to the users of CFRP-metal assemblies of implementing the durability of adhesive interfaces in the bonded plates of carbon fibre reinforced plastics (CFRPs) to metal assemblies based on this document are:

a) ~~a)~~ expanding CFRP applications to the fields of the combinations with metallic components;

b) ~~b)~~ the detection or the prevention of physical properties loss - such as ion migration and time-related degradation in sealant film, injected calking layer and glass fibre reinforced plastics (GFRPs) layer;

c) ~~c)~~ demonstrating the conformity to specified conditions for type certification requirements in the engineering such as aircraft developments;

d) ~~d)~~ evaluating the procedures for maintenance, repair and overhaul (MRO) in the engineering operations such of CFRP aircrafts.

It is not the intent of this document to imply the need for:

— ~~a)~~ omitting relevant field tests for CFRP related engineering;

— ~~b)~~ generally specifying the dimensions of test specimen to represent CFRPs related bonded or fastened structures;

— ~~c)~~ superimposing test results for specific applications of the parameters that exceed the range of this document~~;~~.

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Composites and reinforcements fibres ~~–~~ — Carbon fibre reinforced plastics (CFRPs) and metal assemblies ~~–~~ — Characterization of durability of adhesive interfaces by wedge rupture test

SAFETY STATEMENT — Persons using this document should be familiar with normal laboratory practice, if applicable. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and determine any applicable regulatory conditions~~.~~ prior to use. It is recognized that some of the materials permitted in this document might have a negative environmental impact. As technological advances lead to more acceptable alternatives for such materials, they will be eliminated to the greatest extent possible. At the end of the test, care should be taken to dispose of all waste in an appropriate manner.

1 Scope

This document specifies a method for determining the durability of the adhesive joints of carbon fibre reinforced plastics (CFRPs) and metal assemblies by a wedge rupture test using a double cantilever beam (DCB) specimen under specified environmental conditions. This method is intended for evaluating the safety and reliability of adhesives, primers, and surface treatments of the adherends.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes the 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 178, Plastics — Determination of flexural properties

ISO 10365, Adhesives — Designation of main failure patterns

ISO 9142, Adhesives — Guide to the selection of standard laboratory ~~*aging*~~*ageing* conditions for testing bonded joints

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10365 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~~https://www.iso.org/obp

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

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3.2 Symbols

a crack length from the wedge/adherend contact point to the crack tip (mm) (see ~~Figure 4)~~Figure 4)

a_0 initial crack length after insertion of a wedge (mm)

E_1 flexural modulus of the CFRP adherend (GPa); if the substrate is a fibre composite

E_2 flexural modulus of the metal adherend (GPa)

h_1 thickness of the carbon fibre reinforces plastic (CFRP) beam (mm) in a DCB specimen

h_2 thickness of the metal beam (mm) in a DCB specimen

~~E_1 flexural modulus of the CFRP adherend (GPa) ; if the substrate is a fibre composite~~

~~E_2 flexural modulus of the metal adherend (GPa)~~

~~Δ wedge thickness (mm)~~

G_C critical strain energy release rate, or adhesive fracture energy, for the applied opening load produced by the insertion of a wedge into the precrack (J/m^2)

Δ wedge thickness (mm)

4 Principle

The durability of the dissimilar adhesive joint interfaces between CFRP and metal is evaluated under harsh environments, such as high humidity, high temperature, high-and-low thermal cycles, salt mist environment, and so on, by the wedge test (see ISO 10354) using a DCB specimen. A wedge is driven into precrack preliminary made in the DCB specimen with an appropriate geometry, and the crack is propagated along the interfaces subjected to tensile opening load. The initial crack made by inserting the wedge is stabilized, but it will be propagated when the specimen is subject to a specified environmental condition. This experiment allows to evaluate the durability of the crack at the interface under a stressed condition quantitatively.

5 Apparatus

5.1 Wedge, with 25 mm width and 30 mm length and with a thickness of Δ, ranging from 1 mm to 3 mm, as shown in ~~Figure 1.~~Figure 1. The composition of the wedge will not interact chemically with the adherents of the tested specimens. Materials used for the wedge shall be stiff enough not to be deformed during the test. Stainless steel is recommended. The radius of the wedge tip shall be lower than 30° to initiate the insertion into the precrack and the surface of the wedge shall be smooth to make a smooth insertion into the precrack.

Dimensions in millimetres, except indicated otherwise

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