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Aerospace series — Preparation of carbon fibre reinforced resin panels for test purposes

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National foreword

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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 - Preparation of carbon fibre reinforced resin panels for test purposes

Série aérospatiale - Préparation de panneaux à base de résine et fibres de carbone destinés à l'élaboration d'éprouvettes

Luft- and Raumfahrt - Herstellen von CFK-Prüfplatten

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Foreword

This document (EN 2565:2013) 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of an identical text or by endorsement, at the latest by February 2014, and conflicting national standards shall be withdrawn at the latest by February 2014.

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1 Scope

This European Standard describes the preparation of panels with any desired fibre orientation of unidirectional orientated carbon fibre or fabric with thermosetting resins.

The purpose of this standard is to describe recommended processes for the preparation of the panels from which test specimens subsequently are machined.

Standard specimens prepared in this manner may be used either for evaluating the components i.e. the carbon reinforcement, finishes, resins, catalysts, curing agents, etc. or for verifying the overall quality of the finished products.

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 2564, *Aerospace series — Carbon fibre laminates — Determination of the fibre-, resin- and void contents*

EN 2743, *Aerospace series — Fibre reinforced plastics — Standard procedures for conditioning prior to testing unaged materials*

3 Principle

Preparation of the laminates or panels by one of the following methods:

3.1 Method A (wet lay-up technique)

The carbon fibre reinforcement impregnated with liquid resin containing a suitable catalyst or curing agent is moulded under conditions of temperature and pressure appropriate for the resin and curing system.

3.2 Method B (prepreg)

The carbon fibre reinforcement impregnated with resin (prepreg) is moulded under conditions of temperature higher than room temperature and pressures appropriate for the resin system.

4 Equipment and materials recommended for the preparation of panels by methods A and B

4.1 Equipment

4.1.1 Press of any hydraulic or mechanical type, with the following requirements:

a) Temperature measuring and controlling devices to maintain the curing temperature between the specified limits.

b) Moulding force with an accuracy of 5 % over the period of time required for curing of the resin.

c) The pressing tool 1 (see Figure 1) consists of frame (1), ram (2) and base (3). The height of the frame shall be large enough to provide a moulding chamber where the reactive resin composition can be put in place in one operation.

By means of appropriately constructed guides, e.g. centering pins (4), a gap between the ram and the frame of 0,20 mm minimum shall be ensured.

d) The tool 2 (see Figure 2) consists of two flat plates, which shall be guided only at the four corners (open pressing tool).

By placing distance pieces between the guides, a specific thickness of the test panel can be obtained.

4.1.2 Autoclave of any dry heat type with the following requirements:

a) as 4.1.1 (a);

b) a heat up speed of at least 3 °C/min;

c) capable of maintaining the required pressure to an accuracy of 10 kPa over the period of time required for curing of the resin;

d) vacuum pumps capable of applying a vacuum equal to at least 80 kPa.

4.1.3 Ruler for measuring length and width to an accuracy of 0,5 mm

4.1.4 Micrometer screw type with an accuracy of 0,01 mm for measuring the thickness

4.1.5 Balance with an accuracy of 0,01 g

4.1.6 Cutting device such as a knife with a sharp blade

4.2 Materials

4.2.1 Metal lay-up plate of 500 mm × 500 mm × 7 mm or any other suitable dimensions agreed upon between the parties concerned.

4.2.2 When necessary, metal cover plate of 300 mm × 300 mm × 7 mm or any other suitable dimensions agreed upon between the parties concerned.

4.2.3 Where required, rubber pressure retaining rings resistant to a temperature at least 20 °C higher than the actual curing temperature.

4.2.4 Release film resistant to a temperature at least 20 °C higher than the actual curing temperature, such as polyvinylfluoride (PVF), polytetrafluoroethylene (PTFE) or PTFE coated fabric.

4.2.5 When necessary, perforated release film resistant to a temperature at least 20 °C higher than the actual curing temperature, such as PTFE or PTFE coated fabric.

4.2.6 Pressure blanket material with the capacity of formability, resistant to polymerisation products and resistant to a temperature at least 20 °C higher than the actual curing temperature, such as PVF, PTFE or PTFE coated fabric.

4.2.7 Breather material such as aluminium gauze and glass fabric.

4.2.8 Absorption material for absorption of excess resin. Examples are:

1) Woven glass fibre fabric having a surface mass of 100 g/m^2 capable of absorbing approximately 60 g/m^2 resin,

2) woven glass fibre fabric having a surface mass of 300 g/m^2 capable of absorbing approximately 115 g/m^2 resin,

3) polyamid fibre fabric having a surface mass of 60 g/m^2 capable of absorbing approximately 40 g/m^2 resin.

4.2.9 Metal edge surrounding material strips or other suitable material with a length of 300 mm and a width of 15 mm, or any other dimensions agreed upon between the parties concerned.

The thickness depends on thickness of plate or panel to be produced.

4.2.10 Sealing tape resistant to a temperature at least 20 °C higher than the actual curing temperature.

5 Working procedure

The materials to be used for preparing the test panels, including the material from which the test panels have to be made, shall be conditioned at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) % as specified in EN 2743 for at least 2 h.

5.1 Method A (wet lay-up technique)

5.1.1 The carbon fibre or carbon fibre fabric shall be conditioned during 6 h to the standard atmosphere as specified in EN 2743 and then impregnated with the required resin containing a suitable catalyst or curing agent.

5.1.2 The resin content of the impregnated carbon fibre assembly shall not be in excess of 45 % by weight.

5.1.3 From the prepared impregnated carbon fibre assembly the required number of layers to produce the final cured thickness of panel (see note in 5.1.5) are cut to the width and length required and placed on the lay-up plate (4.2.1) to produce a panel of the required dimensions.

5.1.4 Unless otherwise specified in the materials data sheet, not more than 50 % of the gel time of the resin at the temperature of the impregnation may elapse before the start of the cure cycle.

5.1.5 The assembly laminated on the metal lay-up plate (4.2.1) shall be made ready for curing as presented in Figure 1 or Figure 2 for pressing tools and Figure 3 or Figure 4 for bladder press method or autoclave method.

The total number of absorption layer material (4.2.8) for excess resin absorption depends on the actual resin content required for the cured laminate or panel (see Figure 5 as an example).

The laminate or panel thickness and resin content are also a function of pressure, temperature and other factors, depending upon the properties of the carbon fibre and of the resin system (see note).

NOTE It will be necessary, before marking the number of panels required for preparing the test specimens, to determine by experiment the number of layers from the prepared resin impregnated carbon fibre tape or sheet and number of absorption layers for excess resin combined with the pressure necessary to obtain panels of the required cured thickness and resin content.

5.1.6 The temperature, pressure and time of curing are stipulated by agreement or specified in the material data sheet, depending on the type of resin, catalyst or curing agent. The temperature stipulated shall be maintained during the curing cycle such that the temperature values indicated by the temperature measuring device will remain within the ranges required for the particular resin system (see Figure 6). The temperature of any point on the active surface of the plate or panel shall not differ by more than ± 2 °C from the value indicated by the temperature measuring device (4.1.1 (a) and 4.1 .2 (a)).

5.1.7 After completion of the curing process the test panel has to be taken from the press or autoclave and cooled if necessary in such a way that any deformation, damage, etc. is avoided.

5.1.8 The carbon fibre orientation(s) relative to the length direction of the panel shall be indicated on a pressure sensitive paper tag or other suitable means agreed upon and applied to the panel.

5.1.9 Where no other treatment is specified the panels may be used, in this condition, to produce test specimens.

If not specified in the relevant standard on testing the types, sizes and orientations of the specimens with respect to the orientation of the carbon fibre reinforcement within the panel shall be stipulated by separate agreement. The margins of the panels up to at least 10 mm from its edges shall be discarded.

5.2 Method B (prepreg)

5.2.1 If the material is stored at temperature lower than the standard specified temperature of EN 2743, it shall be retained in an airtight bag to prevent moisture pick-up.

The required material shall be conditioned at a temperature of (23 ± 2) °C and relative humidity of (50 ± 5) % as specified in EN 2743.

After conditioning the material required for the preparation of the test panels shall be cured within 6 h, unless otherwise specified.

5.2.2 The carbon fibre prepreg is cut to the width and length required to prepare a laminate of the required dimensions.

5.2.3 A lay-up to produce a cured test panel shall be prepared as described in clause 5.1.3 through clause 5.1.9.

5.3 Determination of the quality of the panels

5.3.1 Measure the length (4.1.3) of each of the four sides to an accuracy of 0,5 mm after having trimmed at least 10 mm from its edges (5.1.8). Calculate the arithmetic mean of the four measurements rounded off to the nearest mm.

5.3.2 Measure the thickness (4.1.4) at each of the four corners but not closer than 25 mm to the edges and in the centre to an accuracy of 0,05 mm.

Calculate the arithmetic mean of the five measurements rounded off to the nearest 0,1 mm.

5.3.3 If required, take a test specimen from two diagonally opposite corners with the dimensions of 20 mm × 10 mm at the thickness of the panel. From both test specimens the carbon fibre content by volume and weight shall be determined by resin digestion in accordance with EN 2564-A.

5.3.4 Determine the porosity and other defects by means of ultrasonic inspection method using the procedure agreed between the parties concerned.

6 Report of preparation of test panel

The report of preparation of the test panel shall include the following:

6.1 Place and date of production of test panel.

6.2 Details of number of plies, stacking sequence and ply orientation.

6.3 Description of materials including batch, roll numbers used for preparing the test panel (nature and type of resin, catalyst, curing agent or other additives including the amounts used, nature and type of carbon fibre, nature of finish, etc.).

6.4 Description of production equipment (type of press, autoclave, mould, method of checking temperatures and pressures, etc.).

6.5 Working procedure (designation of method as given in this standard, moulding pressure (or force), temperature, curing-time, post-curing, etc.).

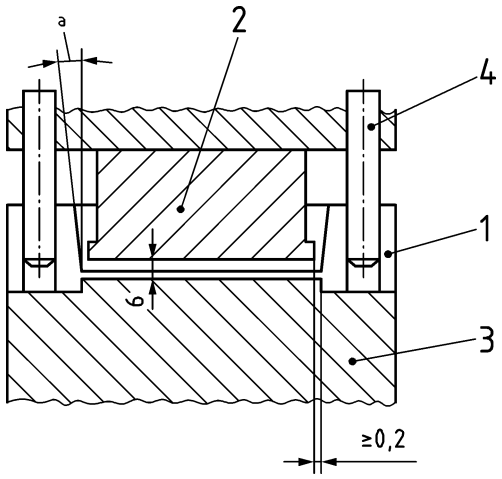
6.6 Length and width of panel (individual measurements and average value in mm).

6.7 Thickness of panel (individual measurements and average value in mm).

6.8 Fibre content of panel (when measured) — individual measurements and average value in percent by volume and by weight.

6.9 Porosity level shown by ultrasonic scan picture (when measured)

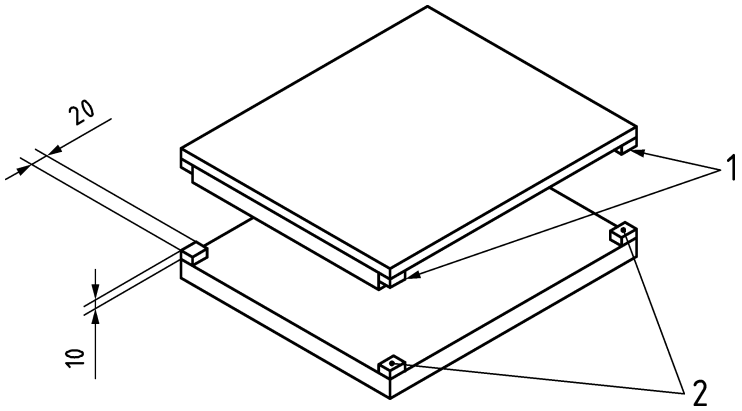
6.10 Special notes



Key

1 Frame with centering holes
2 Ram
3 Base
4 Centering pins
a 1° draft all around
≥ 0,2 mm minimum

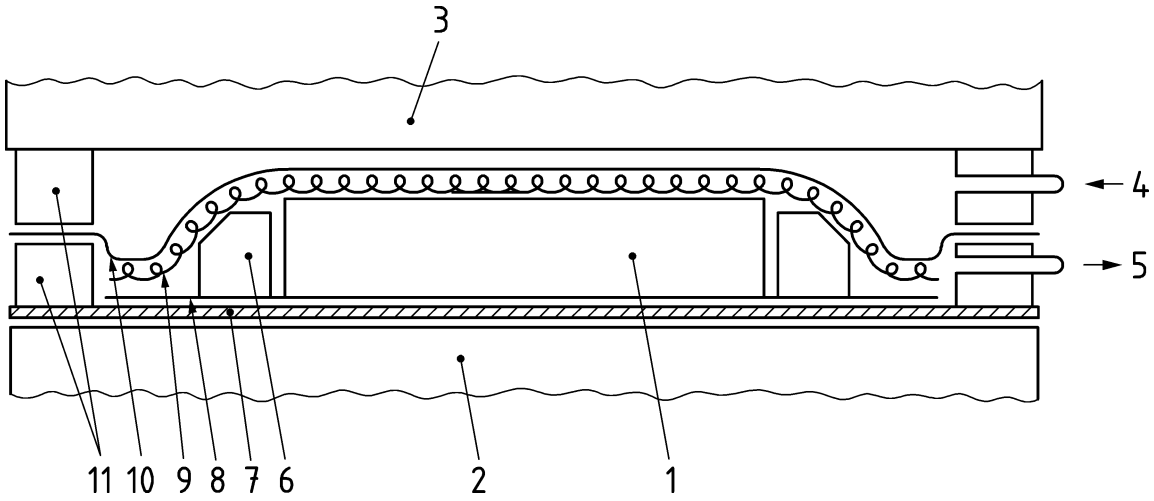
Figure 1 — Pressing tool 1 for the production of test laminates or panels



Key

1 Distance pieces of variable thickness
2 Guides

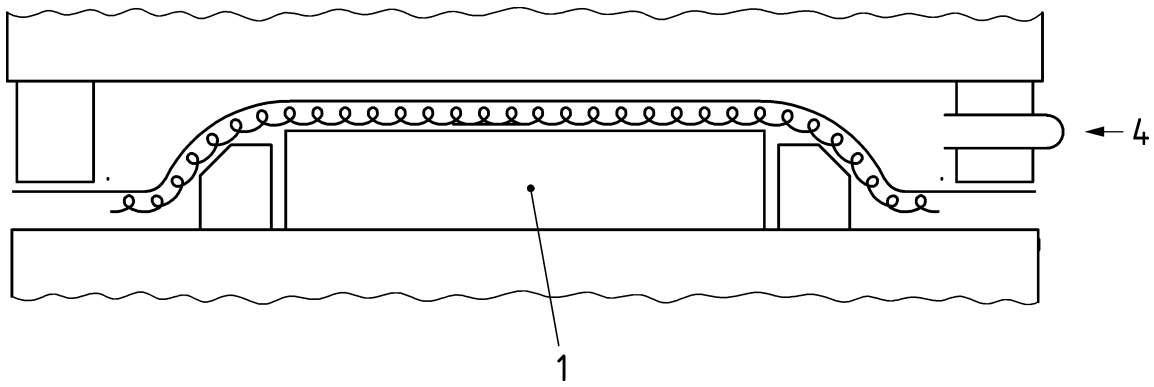
Figure 2 — Pressing tool 2 for the production of test laminates or panels



Key

1 Build-up see Figure 5
2 Lower press plates
3 Upper press plates
4 To air pressure supply
5 To vacuum supply
6 Metal edge (4.2.9)
7 Metal plate (4.2.1)
8 Release film (4.2.4)
9 Breather mat. (4.2.7)
10 Pressure blanket (4.2.6)
11 Rubber pressure retaining rings (4.2.3)

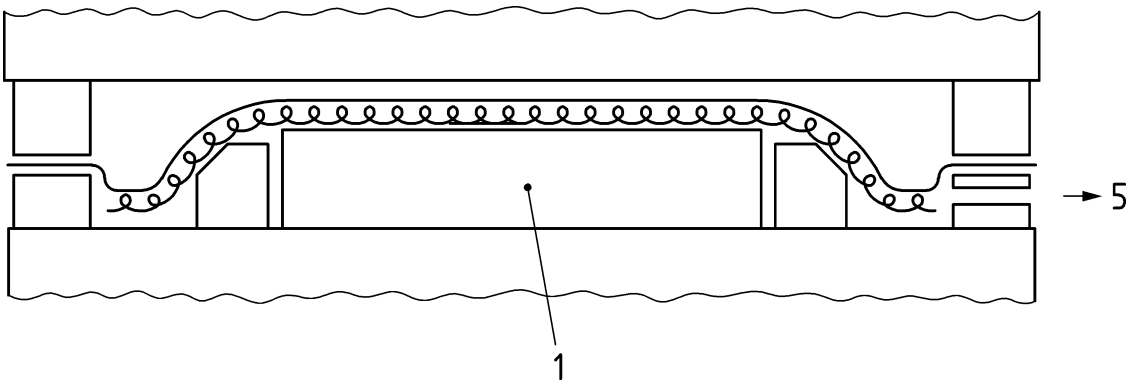
3a) — Pressure and vacuum method



Key

1 Build-up see Figure 5
4 To air pressure supply

3b) — Pressure method



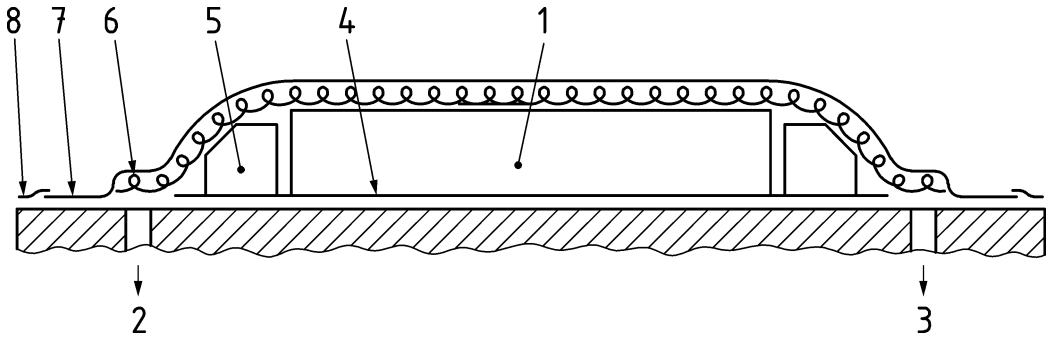
Key

1 Build-up see Figure 5

5 To vacuum supply

3c) — Vacuum method

Figure 3 — Schematic example of press curing



Key

1 Build-up see Figure 5

2 Ventilation to normal atmosphere outside autoclave

3 Attachment for measuring purpose, such as temperature and pressure

4 Release film (4.2.4)

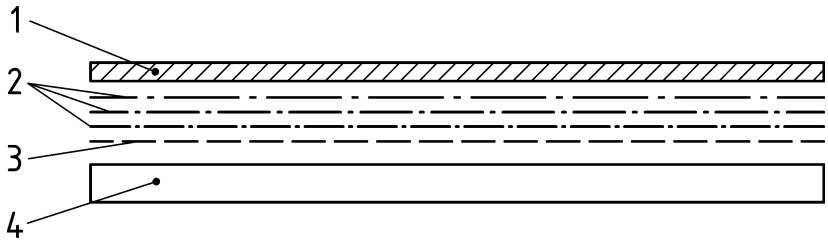
5 Metal edge surrounding (4.2.9)

6 Breather material (4.2.7)

7 Pressure blanket (4.2.6)

8 Sealing tape (4.2.10)

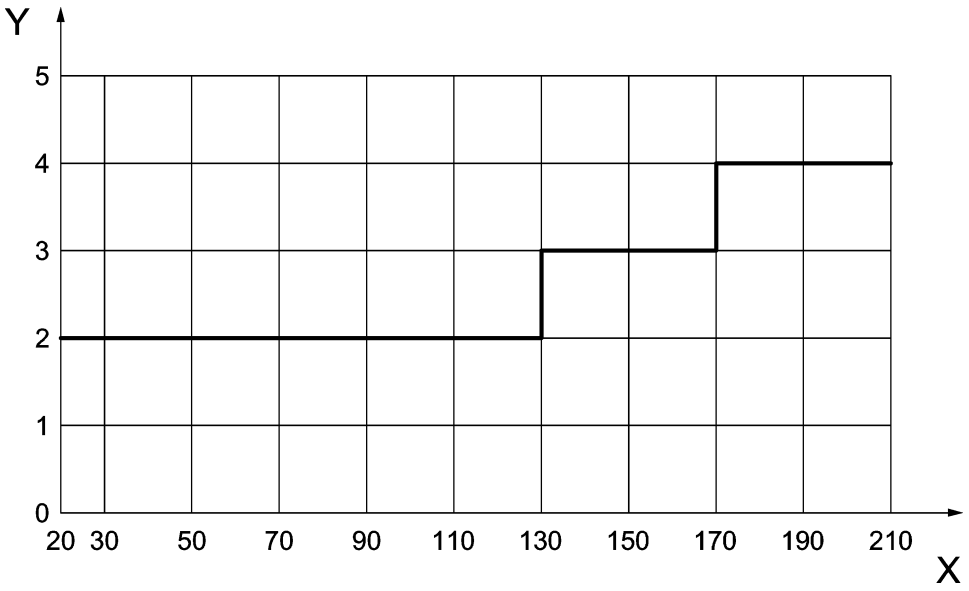
Figure 4 — Schematic example for autoclave curing



Key

1 Metal cover plate (4.2.2)
2 Absorption material (4.2.8)
3 Perforated release film (4.25)
4 Laminate lay-up

Figure 5 — Example of build-up of laminate with resin absorption layers, perforated release film and pressure plate to obtain the required panel quality



Key

X Curing temperature
Y Permitted variation in temperature

Figure 6 — Example for permissible variation of curing temperature

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