BS ISO 30021:2013

BSI Standards Publication

Plastics — Burning behaviour — Intermediate-scale fire-resistance testing of fibre-reinforced polymer composites

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PRI/26, Burning behaviour of plastics and rubbers.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

IISO (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.

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The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour* in collaboration with ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire containment*.

Introduction

Small ships, which are normally made of fibre reinforced plastics (FRP), are required to have fire resistance under international regulations such as *The Torremolinos International Convention for the Safety of Fishing Vessels*, superseded by *The 1993 Torremolinos Protocol*[1] and other national regulations. Therefore, development of a test method to prove the fire resistance of FRP construction of such ships is required. The construction panel of FRP in such ships would not have a height greater than 2 m.

Structures of railway passenger cars and other mass-transport media are, in many cases, made of FRP and should have fire-resistance performance to prevent fire propagation within the car., A fire-resistance test will be required for such structural members. In such applications, the structural dimensions are, in many cases, smaller than the size of the test specimen specified for the full-scale fire-resistance test in ISO 834-1.

This International Standard specifies a smaller test specimen than that specified in ISO 834-1. It has been developed as a method for determination of the fire resistance of FRP in various intermediate-scale non-loading applications, mainly in transport media, such as barriers and partitions in water crafts and vessels, railway vehicles, aircraft and road vehicles.

This International Standard has been developed by ISO/TC 61/SC 4 in close cooperation with ISO/TC 92/SC 2 and provides specific test procedures for FRP using ISO 834-12 as the basis of the intermediate-scale fire-resistance test.

INTERNATIONAL STANDARD **ISO 30021:2013(E)**

Plastics — Burning behaviour — Intermediate-scale fire-resistance testing of fibre-reinforced polymer composites

1 Scope

This International Standard specifies a method of determining the fire resistance of non-load-bearing separating elements made of fibre reinforced plastics (FRP) when exposed to heating on one face.

It is applicable to FRP products for which the end-use application is smaller than the full-scale fire test specimen specified in ISO 834-1. Fire barriers in transportation applications are a common example, since the end-use dimensions of the barrier products are often smaller than those specified in ISO 834-1.

This test is, in general, applicable to FRP products which have an essentially flat surface and can have stiffening members. This includes sandwich-panel-type structures in which the skins consist of FRP.

CAUTION — The attention of all persons concerned with managing and carrying out this fire-resistance test is drawn to the fact that fire testing is hazardous and there is a possibility of toxic and/or harmful smoke and gases being evolved during the test. Mechanical and operational hazards can also arise during the construction of the test elements or structures, their testing and disposal of test residues.

It is essential that an assessment of all potential hazards and risks to health is made and safety precautions are identified and provided. It is also essential that written safety instructions are issued, that appropriate training is given to relevant personnel and that laboratory personnel ensure that they follow written safety instructions at all times.

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.

ISO 472, *Plastics — Vocabulary*

ISO 834-1, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 834-12, *Fire resistance tests — Elements of building construction — Part 12: Specific requirements for separating elements evaluated on less than full scale furnaces*

ISO 13943, *Fire safety — Vocabulary*

EN 1363-2, *Fire resistance tests — Part 2: Alternative and additional procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472, ISO 834-12 and ISO 13943 apply.

4 Principle

The fire resistance of a vertically or horizontally oriented intermediate-scale specimen is determined by exposing one of its surfaces to the conditions specified in ISO 834-12. Alternatively, time-temperature curves as specified in EN 1363-2 can be used when their use is relevant to the end-use condition of the product to be tested.

Vertically oriented FRP specimens will be typically 1,5 m high and 1,5 m wide. Horizontally oriented FRP specimens will be typically 1,5 m long and 1,5 m wide. Test specimens shall be mounted in such a manner as to reflect the end-use condition, including stiffening members and/or insulation system, if any.

5 Test equipment

5.1 General

The test equipment shall comprise a furnace, restraint and support frames and instrumentation as specified in ISO 834-1 or ISO 834-12, together with a specimen mounting system as specified in 5.2.

5.2 Specimen mounting frame

The specimen mounting frame shall be made of non-combustible material, i.e. steel or concrete. The structure of the frame shall be strong enough to support the specimen at elevated temperature during the test. Any distortion of the mounting frame shall not affect the specimen.

NOTE Loading of the specimen will not be required in this test.

The linings of the specimen mounting frame, which has direct contact with the test specimen, shall consist of non-combustible materials, e.g. calcium silicate board, having an oven-dry density of (950 ± 100) kg m^{-3} and have a minimum thickness of 50 mm. The specimen mounting frame shall be robust enough to support the specimen during the test period in the elevated test temperature condition specified in ISO 834-12.

6 Test specimen

6.1 Number of specimen

For symmetrical constructions or constructions required to resist fire from one specified side only, one specimen shall be tested. For asymmetrical constructions required to resist fire from either side, two specimens shall be tested to permit a fire exposure onto each side of the construction.

6.2 Dimensions

The vertical and horizontal dimensions of the test specimen should each be at least (1000 ± 30) mm. The construction of the specimen shall represent the end-use condition, and thus, the dimension will be increased to that of the end-use condition.

6.3 Structure of specimen

The specimen should include any stiffening members, which are the part of the construction system of the FRP product in end-use.

NOTE ISO 10295-1 covers fire-resistance testing of penetration seals in building elements.

6.4 Insulation of specimen

Thermal insulation is usually attached to FRP constructions at the end-use when such a FRP construction is required to have fire-resistance performance. The insulation system, if used in the end-use condition, shall be mounted and fixed to the test specimen as closely as possible to the end-use condition.

Insulation system is normally attached to the side which has higher fire risk. The specimen should be tested in a way that the insulated side of the specimen is exposed to the test furnace.

The test specimen shall be provided with one vertical joint and/or one horizontal joint in the insulation representative of the end-use condition.

7 Conditioning

The test specimen shall be conditioned at a temperature of 23 ± 2 °C and relative humidity of 50 to 75 % for at least 24 h before the commencement of the test.

8 Application of instrumentation

8.1 Plate thermometer

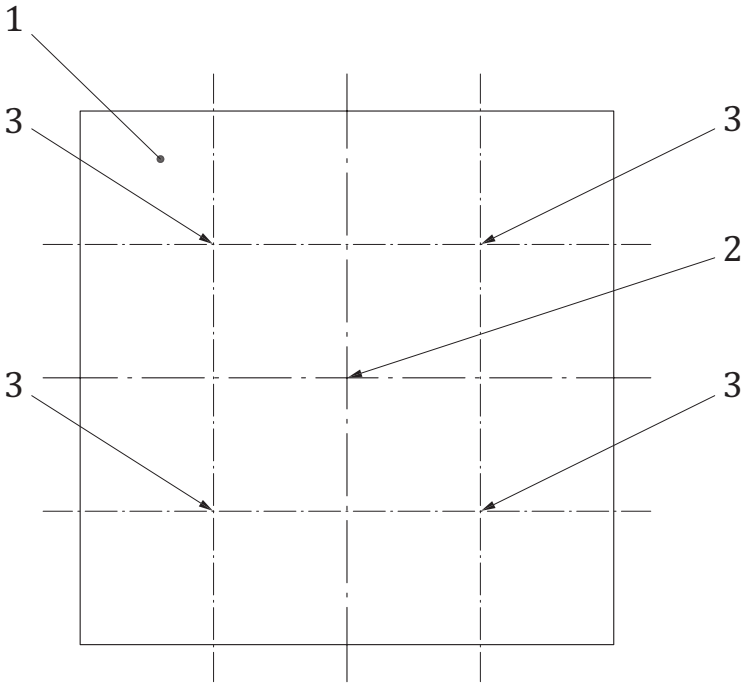
Plate thermometers used for measuring and control of the furnace temperature shall be located in accordance with ISO 834-12.

8.2 Temperature measuring points of the test specimen

Thermocouples for measuring temperatures on the unexposed surface of the specimen shall be attached to the specimen in accordance with ISO 834-12 at the positions corresponding to the entire centre of the unexposed surface of the specimen and centre of each quarter of the unexposed surface of the specimen, as shown in Figure 1.

The thermocouples and the insulation pads should preferably be attached to the surface of the specimen by the use of heat-resisting adhesive without any adhesive between the copper disc and the specimen or the copper disc and the pad, taking care to ensure that the air gap between them, if any, is of minimum size, as specified in ISO 834-1. Where gluing is not possible, pins, screws or clips which are only in contact with those parts of the pad which are not over the disc shall be used.

If the specimen includes insulation, additional unexposed temperature measurements shall be made at points opposite the centre of the vertical joint, at the centre of the horizontal joint and at the intersection between a horizontal and a vertical joint.



Key

1 Test specimen

2 Surface temperature measuring point at the entire centre of the test specimen

3 Surface temperature measuring point at the centre of each quarter of the test specimen

Figure 1 — Surface temperature measurement of the unexposed side of the test specimen

9 Test procedures

9.1 Temperature of the test room

The test shall be conducted in a laboratory atmosphere at a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 %.

9.2 Specimen mounting

The specimen shall be mounted in the specimen mounting frame in a way that smoke and gas will not pass through the junction between the specimen and the mounting frame. The whole area of the specimen shall be exposed to the heating conditions.

9.3 Temperature before the commencement of the test

The temperature obtained by the plate thermometers, unexposed surface thermocouples and ambient temperature thermocouple shall be checked to ensure consistency and recorded not more that 5 min before the commencement of the test.

Prior to the commencement of the test, the furnace temperature shall be less than 50 °C, and the temperature of unexposed surface of the specimen shall be within 5 °C of the initial ambient temperature.

9.4 Commencement of the test

The test shall start when the initial conditions are set. The commencement of the test shall be considered to be the moment when the furnace temperature rise starts following the standard heating curve specified in ISO 834-1 or EN 1363-2. The elapsed time shall be measured from this point and all systems for measurement and observation shall begin or be in operation at this time.

9.5 Heating condition

The furnace temperature controlled by the plate thermometers (8.1) shall follow the temperature conditions specified in ISO 834-1. Alternatively, a time-temperature curve as specified in EN 1363-2 can be used when it is relevant to the end-use condition of the product to be tested.

9.6 Measurement and observation

9.6.1 General

From the commencement of the test, the following measurements and observations shall be taken.

9.6.2 Temperature and pressure

Temperatures of all the thermocouples and plate thermometers and furnace pressure shall be measured as described in ISO 834-1 or ISO 834-12 and recorded at intervals not exceeding 1 min.

9.6.3 Smoke and gas penetration

Deformation of the specimen and smoke and/or hot gas penetration through the specimen and other behaviour of the specimen, if any, and the time at which the event occurs shall be observed and recorded. Cotton wool examination shall be carried out to observe the hot gas penetration.

9.6.4 Deformation and formation of holes and cracks

Particular attention shall be paid to the initiation and development of holes or cracks in the unexposed surface of the test specimen, since these will be considered in the determination of the integrity time, i.e. the time when failure of integrity by holes and cracks occurs. The integrity time shall be recorded.

9.6.5 Deflection

Deflection at the centre of the specimen in the direction of thickness should be measured during the test at intervals of not more than 1 min, with a tolerance of ± 2 mm.

NOTE Guidance on the application of deflection measurement is given in ISO 834-1.

9.6.6 Photograph

A photograph of the specimen, with a record of the time and date it was taken, should be taken during and after the test.

NOTE Video recording of the unexposed surface is useful for recording the time when integrity failure occurs.

9.7 Termination of test

The test of an FRP specimen may be terminated, as described in ISO 834-1, for one or more of the following reasons:

a) safety of personnel or impending damage to equipment;

b) attainment of selected failure criteria specified in the product standard; or

c) request of the sponsor.

However, the test may be continued after failure under b), to obtain additional data.

9.8 Observations after the test

After the termination of the test, the condition of, and any damage to, the test specimen, including the insulation system, shall be observed. Where necessary, this observation should be conducted after taking out any insulation systems.

10 Test report

The test report shall include all important information relevant to the test specimen and the fire test including the following specific items and those required by the standard relevant to the product of the test specimen.

a) date of the test;

b) the name and address of the test laboratory;

c) the name and address of the applicant/sponsor of the test;

d) the name and address of the manufacturer of the product;

e) the name and/or trade mark of the product, if available;

f) the assembling procedures, constructional details and components of the test specimen including the presence of stiffening members, with drawings including the dimensions of components and, where possible, photographs;

g) generic structure of the composite, e.g. number, thickness and composition of layers.

h) information concerning the location of all unexposed side thermocouples and their methods of attachment to the test specimen;

i) heating condition, e.g. time-temperature curve of ISO 834-1 or EN 1363-2;

j) duration of the test;

k) measured results of the temperature and the pressure, by means of plots along the elapsed time of the test; and

l) observations made during the test;

m) observations of the test specimen made after the test.

Bibliography

[1] The Torremolinos International Convention for the safety of Fishing Vessels, adopted on 2 April 1977 and superseded by the 1993 Torremolinos Protocol, International Maritime organization (IMO)

[2] IMO A.754(18) Recommendation on Fire Resistance Tests for “A”, “B” and “F” class divisions, adopted on 4 November 1993

[3] ISO 10295-1; *Fire tests for building elements and components — Fire testing of service installations — Part 1: Penetration seals*

[4] ISO 25762; *Plastics — Guidance on the assessment of the fire characteristics and fire performance of fibre-reinforced polymer composites*

[5] EN 45545-3:2013*Railway applications — Fire protection on railway vehicles — Part 3: Fire resistance requirements for fire barriers*

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