BRITISH STANDARD

BS EN
61033:2006

Test methods for the determination of bond strength of impregnating agents to an enamelled wire substrate

The European Standard EN 61033:2006 has the status of a British Standard

ICS 17.220.99; 29.035.01

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 61033:2006. It is identical with IEC 61033:2006.

The UK participation in its preparation was entrusted by Technical Committee GEL/15, Material specifications, to Subcommittee GEL/15/3, Resins and varnishes.

A list of organizations represented on GEL/15/3 can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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EUROPEAN STANDARD

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EN 61033

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English version

Test methods for the determination of bond strength of impregnating agents to an enamelled wire substrate
(IEC 61033:1991 + A1:2006)

Méthodes d'essai pour la détermination du pouvoir agglomérant des agents d'imprégnation sur fil émaillé
(CEI 61033:1991 + A1:2006)

Prüfverfahren zur Bestimmung der Verbackungsfestigkeit von Imprägniermitteln auf einem Lackdraht-Substrat
(IEC 61033:1991 + A1:2006)

This European Standard was approved by CENELEC on 2006-11-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 61033:2006 E

Foreword

The text of the International Standard IEC 61033:1991 + A1:2006, prepared by IEC TC 15, Standards on specifications for electrical insulating materials, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 61033 on 2006-11-01 without any modification.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2007-11-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2009-11-01

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 61033:1991 + A1:2006 was approved by CENELEC as a European Standard without any modification.

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CONTENTS

INTRODUCTION

This standard deals with three methods of test to determine the bond strength of impregnating agents in conjunction with enamelled wire substrates.

The methods are as follows:

1) Twisted coil test: method A
2) Helical coil test: method B
3) Wire bundle test: method C

TEST METHODS FOR THE DETERMINATION OF BOND STRENGTH OF IMPREGNATING AGENTS TO AN ENAMELLED WIRE SUBSTRATE

1 Scope

This standard describes three methods of test to determine the bond strength of impregnating agents such as solvent-based varnishes and solventless resins to an enamelled wire substrate. Bond strength may be affected by cure, by test temperature, by thermal ageing, and for any impregnating agent, by the chosen type of wire enamel.

These three methods of test cover the prevailing standard practice of testing bond strength. For a certain group of materials, one of these methods may be assigned to be the referee method subject to a specification in the relevant specification sheet.

2 Methods of test

2.1 Method A: twisted coil test

2.1.1 Principle

In this test, 0,315 mm diameter enamelled winding wire in the form of a twisted coil is impregnated and cured. The maximum force to break this specimen is a measure of the bond strength.

2.1.2 Specimen

Prepare a random wound coil from an enamelled winding wire (see note 1) by means of a suitable winding equipment (see figure 1a). To prevent opening of the coil after removal from the winding equipment, each end of the winding wire, or short piece of enamelled wire may be wrapped around the coil two or three times in opposite directions. For this purpose the winding equipment is provided with appropriate notches (see figure 1b). For winding the coil, the following dimensions apply:

winding diameter:	57 mm ± 1 mm
width of the slot:	6 mm ± 1 mm
number of turns:	100 (see note 2)
nominal wire diameter:	0,315 mm

NOTES

1 For enamelled winding wire see also IEC 317.

2 Instead of 100 turns, two times 50 turns may be used to provide a bifilar winding that allows a.c. current heating of the coil if desired.

Remove the coil from the winding equipment and stretch it into an oval shape. Twist the coil two full turns around its longitudinal axis by means of a twisting device (see figures 2a and 2b). The twisted coil formed is about 7 mm in diameter and 85 mm to 90 mm in length and serves as substrate for the impregnating agent.

Unless otherwise specified in the purchase contract, treat the twisted coil once with the impregnating agent. With the twisted coil in the vertical position, immerse it in the impregnating agent for 5 min ± 1 min (see note). Remove it slowly and uniformly at a maximum rate of 1 mm/s. Drain horizontally for 10 min to 15 min and cure horizontally according to the manufacturer's recommendation or to an agreed schedule. If more than one treatment is to be given, dip, drain and cure the twisted coil vertically, reversing the direction for each subsequent treatment.

Prepare five specimens for each test temperature.

NOTE - Some impregnating agents, such as high viscosity or thixotropic products may require alternative processing methods.

2.1.3 Equipment

Use equipment according to ISO 178.

Dimensions of the supports of the test equipment shall comply with figure 3.

2.1.4 Procedures

With the specimen properly positioned according to figure 3, adjust the crosshead speed so that the maximum force is reached in about 1 min.

For tests at elevated temperatures (see note), a heating cabinet attached to the equipment may be used. Before testing, the test specimen shall be kept in the cabinet at the test temperature for a time just sufficient to ensure that the test specimen reaches this temperature. Extended heating of the specimen could affect the property.

NOTE - In case of current heating, the test temperature of the test specimen should be determined by adequate means, e.g. thermocouple, resistance measurements.

2.1.5 Result

The bond strength is expressed as the median value of the five measurements in newtons.

2.1.6 Report

Report the following:

– reference to test method A of this standard;
– details of the impregnating agent;
– details of the substrate (type of enamelled winding wire);
– details of specimen preparation (single or bifilar coil, impregnating details);
– test temperatures;
– bond strength and the minimum and maximum measured values for each test temperature;
– if the winding wire or test specimens have been washed in any manner so that they are no longer in an "as received" condition, such procedure shall be noted in the report.

2.2 Method B: helical coil test

2.2.1 Principle

In this test, 1 mm diameter wire in the form of a helical coil is coated with varnish and cured. The force necessary to break this coil is a measure of the bond strength.

2.2.2 Specimen

Prepare a helical coil (see figure 4) from an enamelled winding wire (see note) by means of a suitable winding equipment. For winding the coil, the following dimensions apply:

nominal wire diameter:	1 mm
mandrel diameter:	6,3 mm ± 0,1 mm
length of coil:	75 mm ± 2 mm
winding tension:	10 N ± 1 N

NOTE - For enamelled winding wire see also IEC 317. Coils may be wound in a long continuous length and then cut off to size.

Unless otherwise agreed in the purchase contract, treat the helical coil once with the impregnating agent. With the helical coil in the vertical position, immerse it in the impregnating agent for 60 s ± 10 s (see note). Remove it slowly and uniformly at a maximum rate of 1 mm/s. Drain horizontally for 10 min to 15 min and cure horizontally according to the manufacturer's recommendation or to an agreed schedule. If more than one treatment is to be given, dip, drain and cure the helical coil vertically reversing the direction for each subsequent treatment.

Prepare five specimens for each test temperature.

NOTE - Some impregnating agents, such as high viscosity or thixotropic products may require alternative processing methods.

2.2.3 Equipment

Use equipment according to ISO 178.

Dimensions of the supports of the test equipment shall comply with figure 5.

2.2.4 Procedures

With the specimen properly positioned according to figure 5, adjust the crosshead speed so that the maximum force is reached in about 1 min.

For tests at elevated temperatures (see note), attach a heating cabinet to the equipment. Before testing, keep the test specimen in the cabinet at the test temperature for a time just sufficient to ensure that the test specimen reaches this temperature.

2.2.5 Result

The bond strength is expressed as the median value of the five measurements in newtons.

2.2.6 Report

Report the following:

– reference to test method B of this standard;
– details of the impregnating agent;
– details of the substrate (type of enamelled winding wire);
– details of specimen impregnation;
– test temperatures;
– bond strength and the minimum and maximum measured values for each test temperature;
– if the winding wire or test specimens have been washed in any manner so that they are no longer in an "as received" condition, such procedure shall be noted in the report.

2.3 Method C: wire bundle test

2.3.1 Principle

In this test, 2 mm diameter wire in the form of a bundle is coated with varnish and cured. The force necessary to pull the central wire from the bundle is a measure of the bond strength.

2.3.2 Specimen

Prepare a wire bundle (see figure 6 or 7) from an enamelled winding wire (see note 1) in accordance with either procedure a) or b) below.

a) Arrange six lengths of wire 15 mm ± 0.5 mm long into a bundle around the end of a central wire at least 120 mm long as shown in figure 6 and secure in position by binding in two places with annealed copper wires 0,35 mm diameter. Ensure that the end of the centre wire is flush with the end of the bundle.

b) Arrange six lengths of wire, approximately 105 mm long, into a bundle around the end of a wire 120 mm long as shown in figure 7, so that they overlap 15 mm ± 0,5 mm and secure in position by binding with annealed copper wire, 0,35 mm diameter. Insert a 50 mm length of the same wire into the central hole of the end of the bundle of six wires to be gripped in the jaws of a tensile testing machine and bind the end with copper wires as for the overlapped section on which the bond strength is to be determined.

NOTES

1 For enamelled winding wire see also IEC 317.

2 Carefully straighten the wire to be used for the specimens without damage to the surface of the enamel. If the wire is straightened by pulling, limit the elongation of the wire to less than 5 %. Cut the lengths of wire necessary to prepare one test specimen from the same reel to ensure their diameters are sufficiently uniform to prevent the centre wire slipping during varnishing. At the ends of the wires ensure that there are no barbs or other protrusions which would influence the bond strength.

When assembling the wires in accordance with procedures a) or b) use a jig to position the ends of the outer wires to provide the required overlap. A plate, having a 2,8 mm diameter hole through which the centre wire passes until it meets a stop giving exactly 15 mm protrusion above the plate, has been found satisfactory. This can be used either to position the outer wires before these are secured by final tightening of the binding wires or, with the addition of a retaining collar, to assemble the bundle from the separate pieces of wire. A suitable design is shown in figure 8. This jig may be used on its side so that the bundle is horizontal to enable a known tension, for example 3 N, to be applied to the binding wire.

Immerse the test specimen in the varnish to be tested with the single protruding wire uppermost for 5 min, then withdraw and drain for 15 min. Different durations of immersion and draining may be used and should in such cases be noted in the report. Cure the specimens in accordance with the manufacturer's recommendations. During all these operations, hold the test piece in a vertical position, and ensure that no excess varnish adheres to the end of the test specimen away from the protruding centre wire. Similarly, do not allow any undue meniscus round the protruding wire.

Prepare five specimens for each test temperature.

NOTE - Some impregnating agents, such as high viscosity or thixotropic products may require alternative processing methods.

2.3.3 Equipment

Use equipment according to ISO 178.

Dimensions of the supports of the test equipment shall comply with figure 8.

2.3.4 Procedures

Pull the test specimen made in accordance with procedure a) in a tensile testing machine by means of a special jig (see figure 9), which allows the protruding wire to be held in one tensometer jaw while the bundle at the other end is held in the jig which is fixed to the opposite jaw of the testing machine. Pull specimens made in accordance with procedure b), with each end held in the jaws of the testing machine. With the specimen properly positioned adjust the jaws' speed so that the maximum force is reached in about 1 min.

For tests at elevated temperatures, attach a heating cabinet to the equipment. Before testing, keep the test specimen in the cabinet at the test temperature for a time just sufficient to ensure that the test specimen reaches this temperature.

2.3.5 Result

The bond strength is expressed as the median value of the five measurements in newtons.

2.3.6 Test report

Report the following:

– reference to test method C of this standard;
– details of the impregnating agent;
– details of the substrate (type of enamelled winding wire);
– details of specimen impregnation;
– test temperatures;
– bond strength and the minimum and maximum measured values for each test temperature;
– if the winding wire or test specimens have been washed in any manner so that they are no longer in an "as received" condition, such procedure shall be noted in the report.

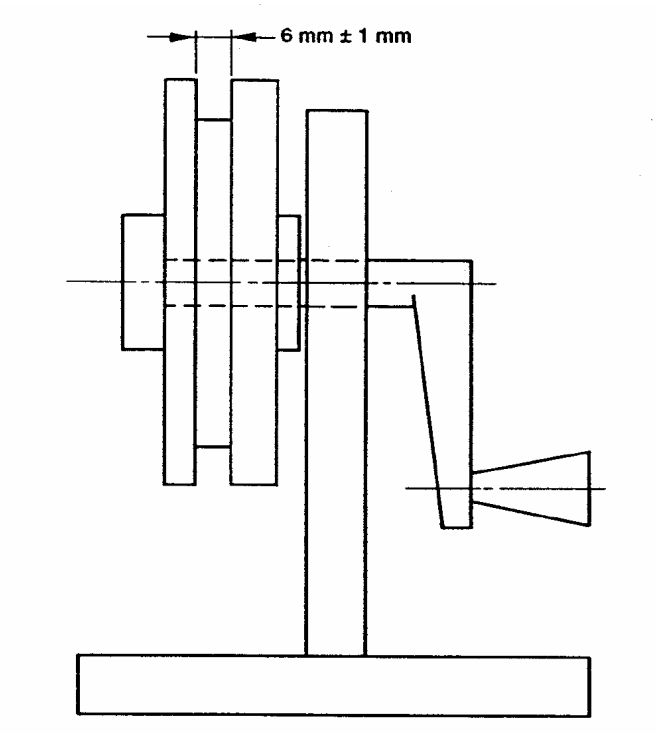


Figure 1a – Coil winder

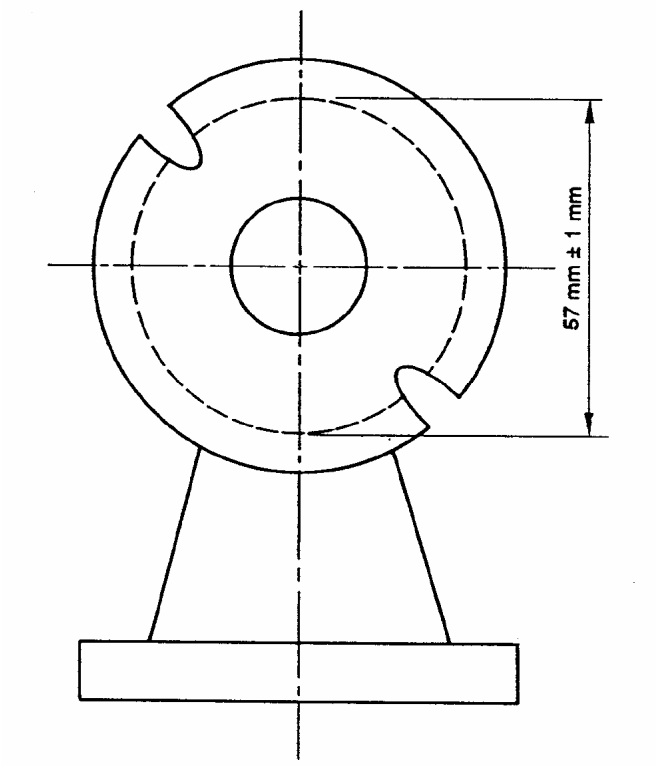


Figure 1b – Coil winder, front view

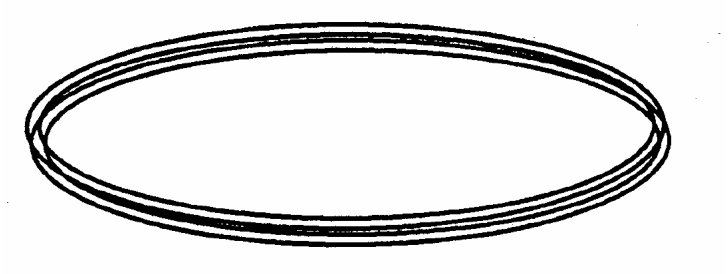
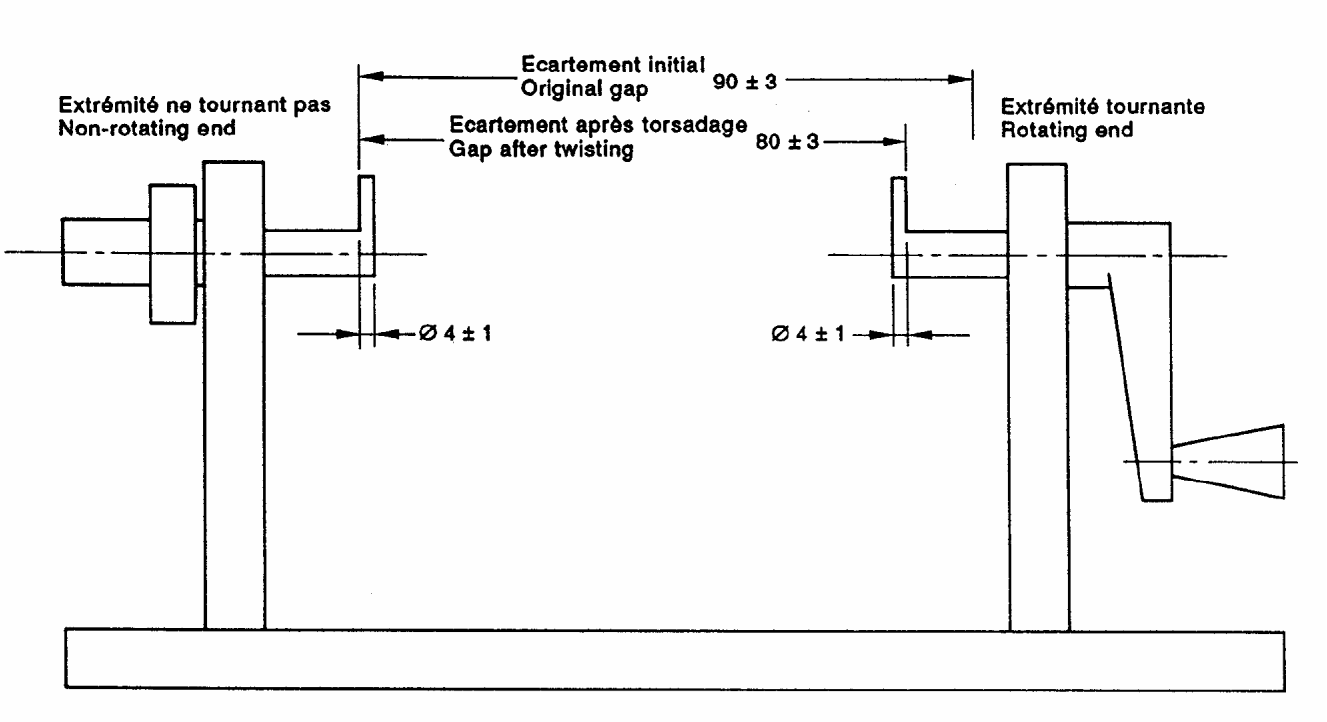
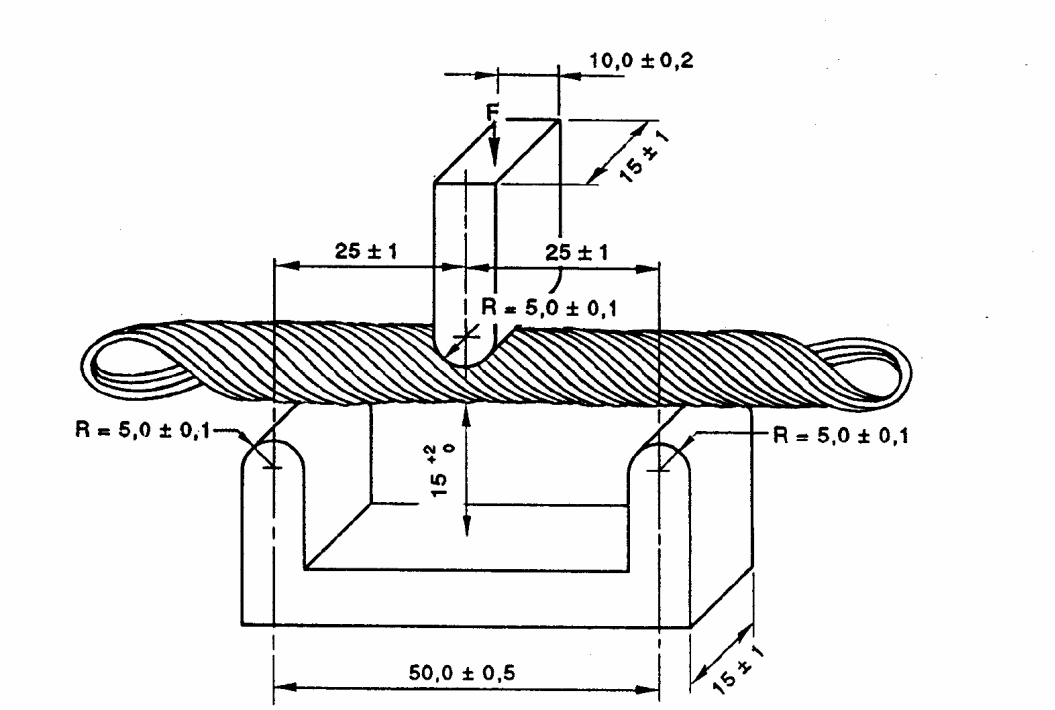


Figure 2a – Oval shaped coil



Dimensions in millimetres

Figure 2b – Coil twister



Dimensions in millimetres

Figure 3 – Arrangement of supports

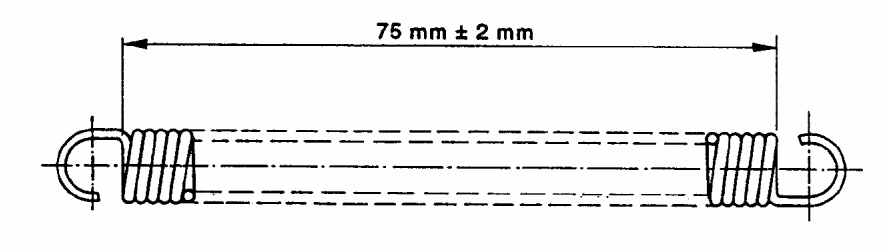
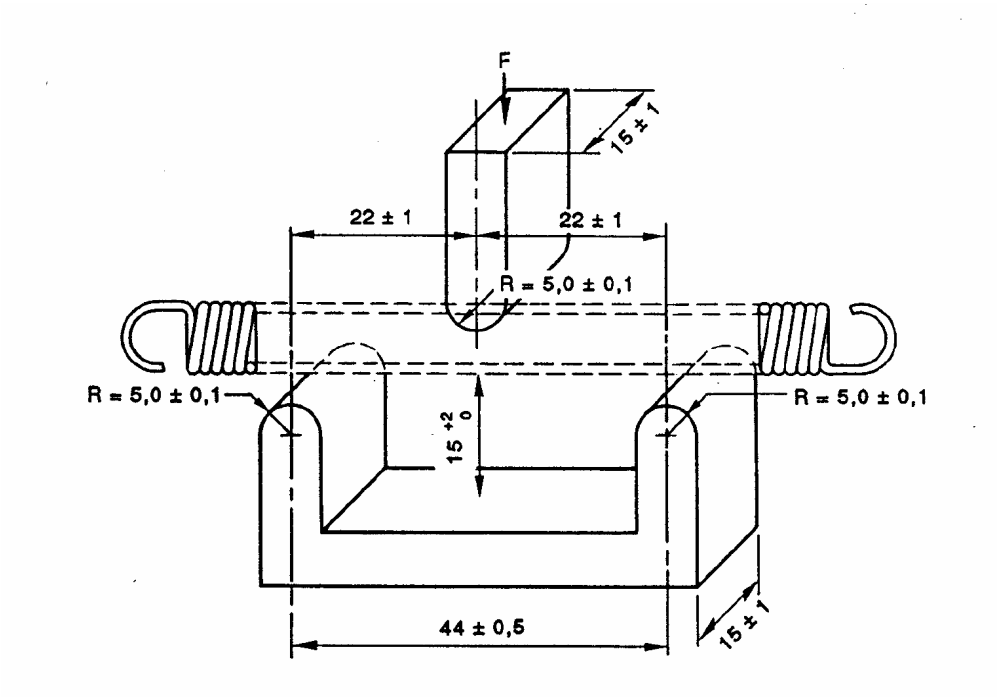
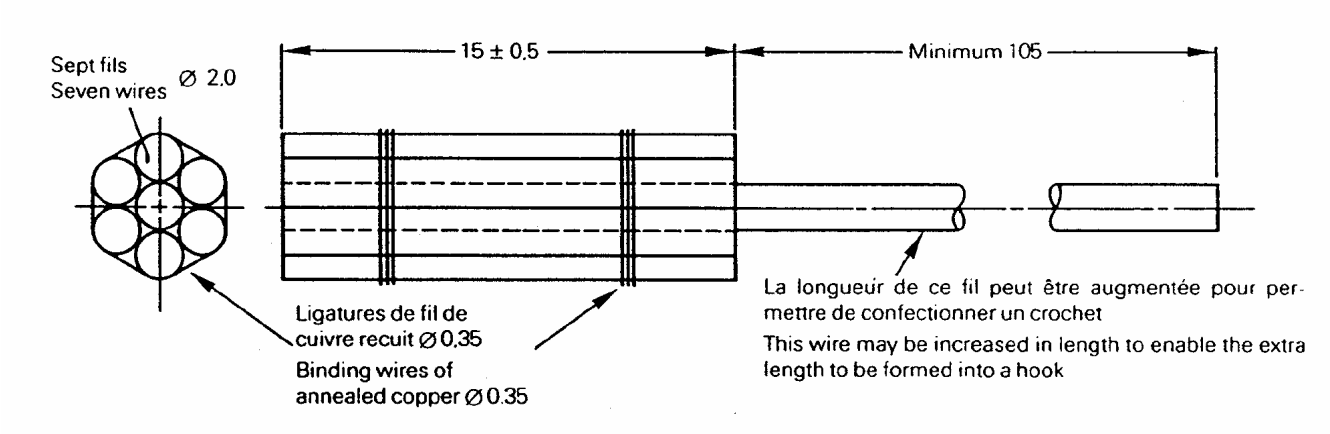


Figure 4 – Helical coil test specimen



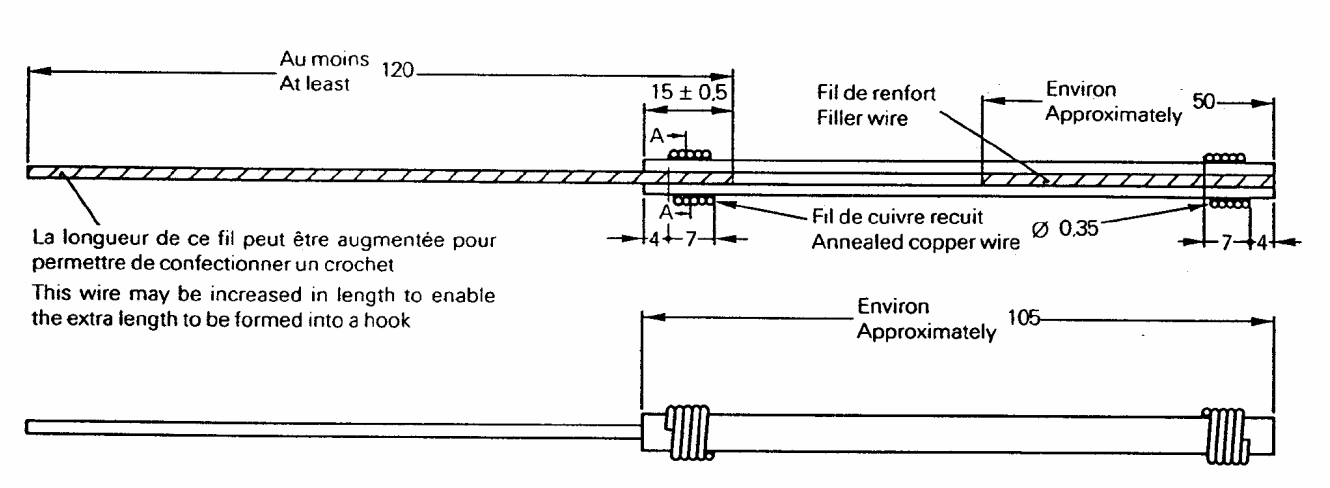
Dimensions in millimetres

Figure 5 – Arrangement of supports



Dimensions in millimetres

Figure 6 – Test specimen



Dimensions in millimetres

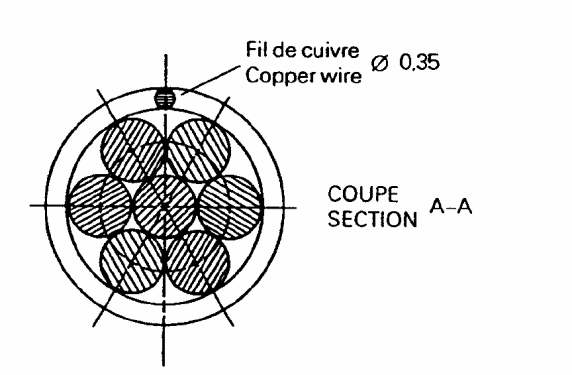


Figure 7 – Alternative test specimen

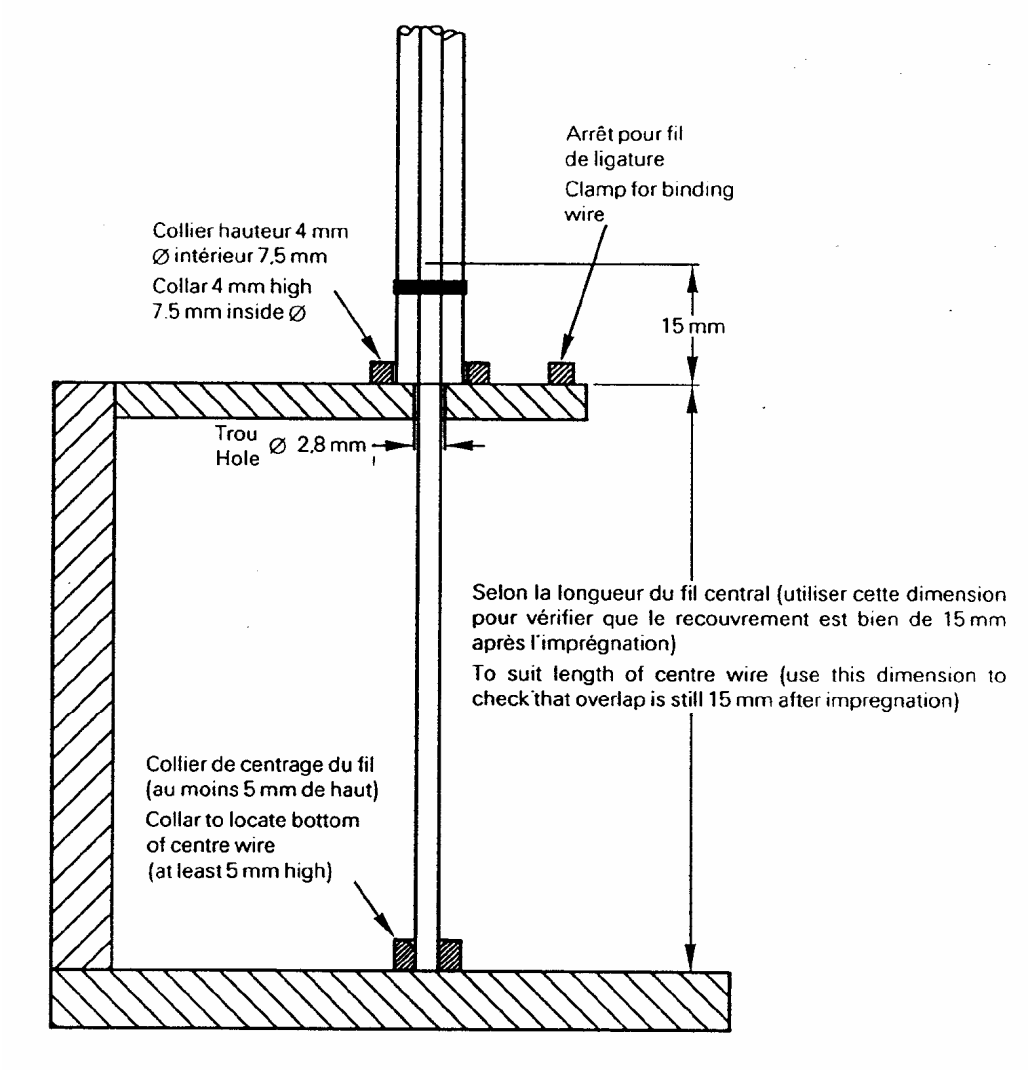


Figure 8 – Diagram of jig for use with bundle test

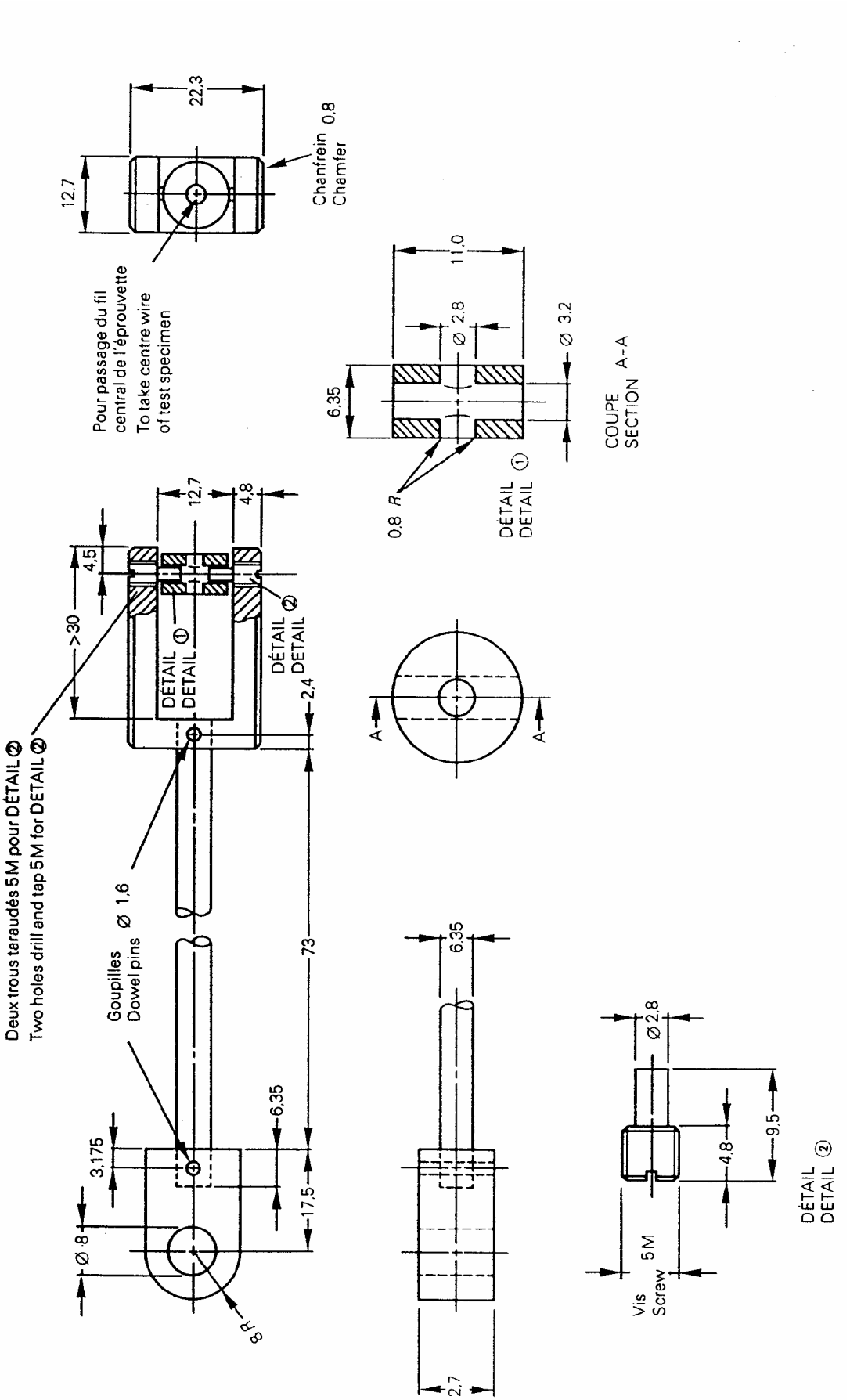


Figure 9 – Stirrup jig for holding test specimen in tensile testing machine

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60317	Series	Specifications for particular types of winding wires	EN 60317	Series
ISO 178	1975	Plastics - Determination of flexural properties of rigid plastics	-	-

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