
**Rubber, vulcanized — Determination
of adhesion to wire cord**

*Caoutchouc vulcanisé — Détermination de l'adhérence à un câble
métallique*

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Foreword

ISO (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.

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 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html (standards.iteh.ai)

This document was prepared by Technical Committee ISO/TC 45, *rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.
ISO 5603:2017

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This fourth edition cancels and replaces the third edition (ISO 5603:2011), of which it constitutes a minor revision to update the normative references in [Clause 2](#).

Rubber, vulcanized — Determination of adhesion to wire cord

WARNING 1 — Persons using this document should be familiar with normal laboratory practice. 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 to ensure compliance with any national regulatory conditions.

WARNING 2 — Certain procedures specified in this document might involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate documentation on safe handling and disposal after use.

1 Scope

This document specifies two methods for determining the adhesion strength of vulcanized rubber to wire cord which is embedded in the rubber.

The two methods do not necessarily give the same results.

They are applicable primarily to test pieces prepared in the laboratory under standard conditions and used for the development and control of materials and processes utilized in the manufacture of products reinforced with wire cord.

NOTE The methods can also be used for single wire, for example bead wire.

Method 1 reduces the dependence of the measured adhesion on the modulus and strength properties of the rubber.

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2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes 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 2393, *Rubber test mixes — Preparation, mixing and vulcanization — Equipment and procedures*

ISO 5893:2002, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 18899:2013, *Rubber — Guide to the calibration of test equipment*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at <http://www.electropedia.org/>

— ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Principle

The adhesion strength is determined by measuring the force required to pull out a single cord from the surrounding rubber of a prepared test piece. The force is directed along the axis of the cord, using a test jig containing a suitably chosen circular- or square-shaped hole to ensure uniformity of stress.

Test pieces of cord and rubber are prepared together by vulcanizing them under pressure.

In method 1, the exterior surface of the rubber is suitably reinforced.

In method 2, such reinforcement is not employed.

5 Materials

5.1 Wire cord, conforming to the specification of the bonding system to be investigated. If no specification is given, brass-plated steel cord of construction $(1 \times 3 \times 0,15) \text{ mm} + (6 \times 0,27) \text{ mm}$ or of construction $(7 \times 4 \times 0,22) \text{ mm}$ shall be used.

NOTE The sizes of the cords are defined here in terms of their diameter and the number of component wires, starting from the centre core of the cord.

For quality control of cord, it shall be tested in the condition received, i.e. neither cleaned nor dried.

It is essential that the wire cord be stored in a dry atmosphere to prevent any surface deterioration. Storage can conveniently be carried out in an airtight container which also contains a desiccating material (for example silica, SiO_2). The container shall only be opened when removing wire cord and shall then be closed immediately. It is also essential that the cord not be contaminated with dust from the desiccating material.

5.2 Unvulcanized rubber compound, conforming to the specification of the bonding system to be investigated. Whenever possible, the rubber shall be freshly milled. If for any reason the rubber cannot be remilled, the surface shall be freshened by wiping with a solvent and allowed to dry. The preferred solvent is heptane, but a suitable alternative could be a petroleum solvent with a distillation range of about $65 \text{ }^\circ\text{C}$ to $125 \text{ }^\circ\text{C}$; these solvents shall possess a maximum residue on evaporation of 3 mg per 100 cm^3 of solvent. The compound shall be stored at a standard laboratory temperature of $(23 \pm 2) \text{ }^\circ\text{C}$ or $(27 \pm 2) \text{ }^\circ\text{C}$ prior to use. It can be in the form of calendered sheet of suitable thickness and shall be protected by a dark-coloured polyethylene film.

5.3 Reinforcement material, to stiffen the rubber block. This applies only to method 1. The reinforcement can either be a sheet metal strip treated with adhesive promoter (when the thickness t is at least $0,5 \text{ mm}$) or a strip of rigid rubberized steel cord fabric. A suitable fabric is one containing steel cords of high bending stiffness, for example one of construction $(1 \times 3 \times 0,30) \text{ mm} + (6 \times 0,38) \text{ mm}$ [when the thickness t is $(2,5 \pm 0,1) \text{ mm}$ maximum].

6 Apparatus

6.1 Mould, capable of producing a test piece in which a multiplicity of cords is embedded equally spaced along its length. Different moulds are employed for the two methods.

a) Method 1

The mould is of a semi-follow-on type to obtain maximum consolidation of rubber around the cord during the pressing stage, but thereafter becomes a fixed-cavity mould.

One suitable mould designed to accommodate steel cord fabric reinforcement is shown in [Figure 1](#). This mould produces test pieces of length 310 mm containing 21 cords, but similar moulds employing other numbers of cords greater than nine are acceptable. The mould dimension x will depend on the embedded length of test piece required (which is governed by the diameter of wire cord used, see

8.2). The mould shall be provided with pairs of inserts or spacers to obtain the different lengths of cord embedment. Dimension y is sufficiently great to allow the incorporation of excess rubber during moulding (see 8.3.1).

Another suitable mould designed to accommodate steel strip reinforcement is shown in Figure 2. A tensioning device for the cords can be used with this mould. Figure 3 details some mould dimensions and describes the exchangeable steel spacers which are required for different cord sizes for the moulds shown in Figures 1 and 2.

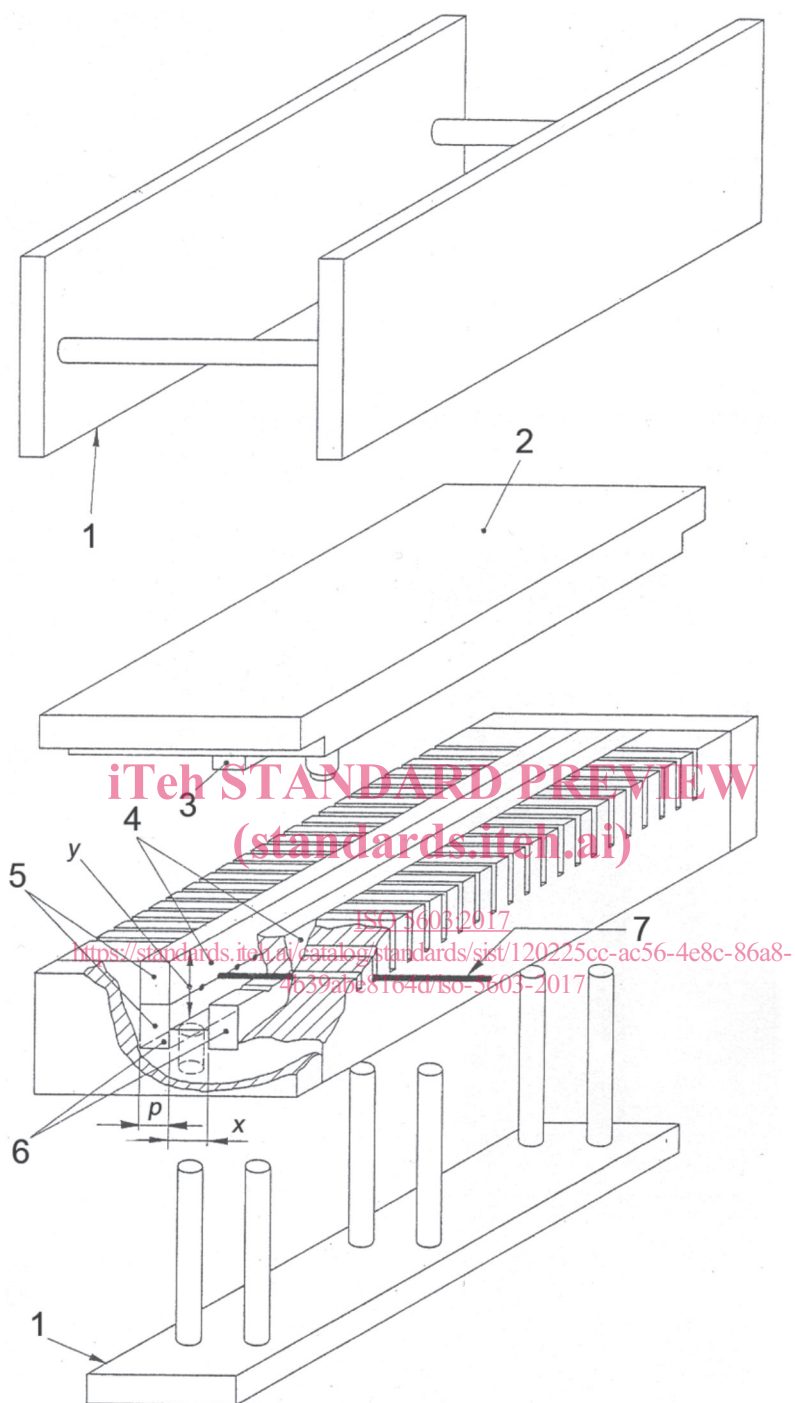
Any mould producing test pieces of the correct dimensions and applying the moulding force directly on to the rubber, for example by use of a suitable spring, is also acceptable.

If desired, the moulds can impart suitable features on to the moulded test piece to facilitate cord centring during subsequent testing.

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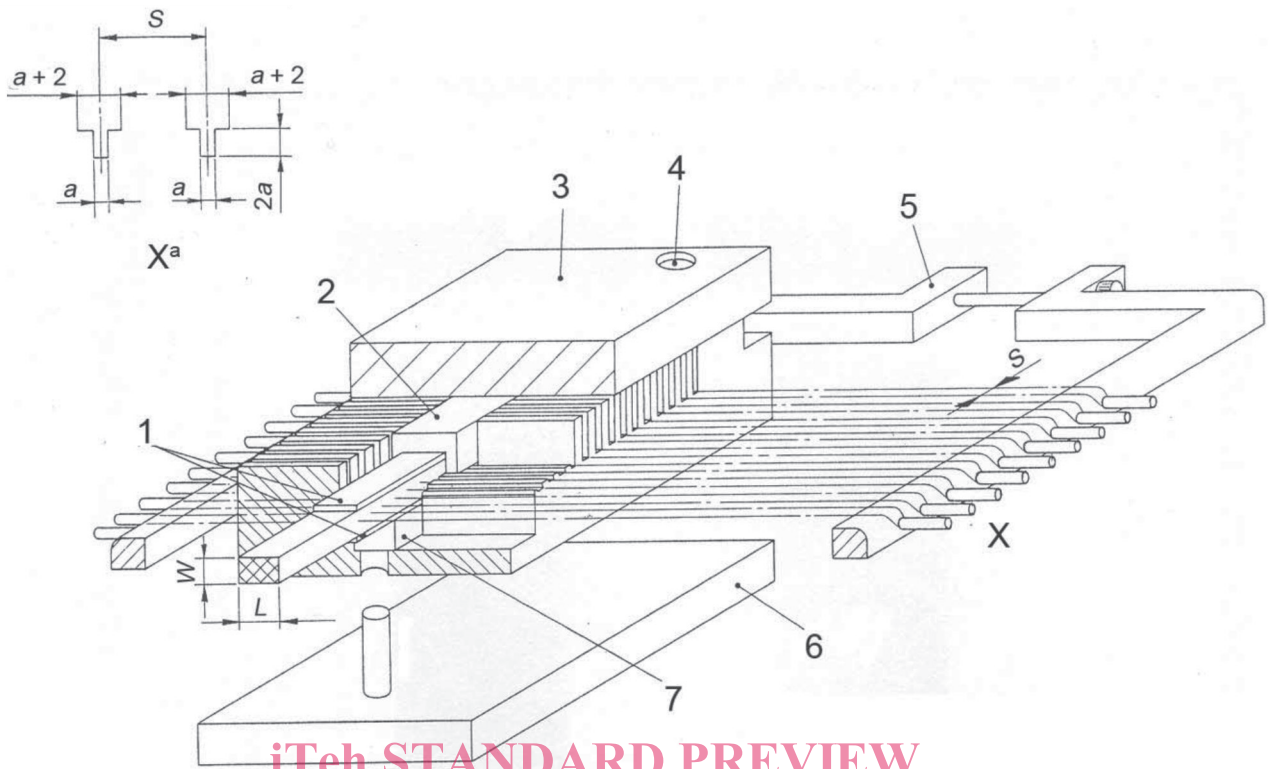


Key

- | | | | |
|---|--------------------|---|-----------------------|
| 1 | extraction tool | 5 | pair of steel spacers |
| 2 | semi-follow-on lid | 6 | bottom spacers |
| 3 | ram | 7 | steel cord |
| 4 | top spacers | | |

Figure 1 — Layout of one type of semi-follow-on mould and its extraction tools for method 1

Dimensions in millimetres

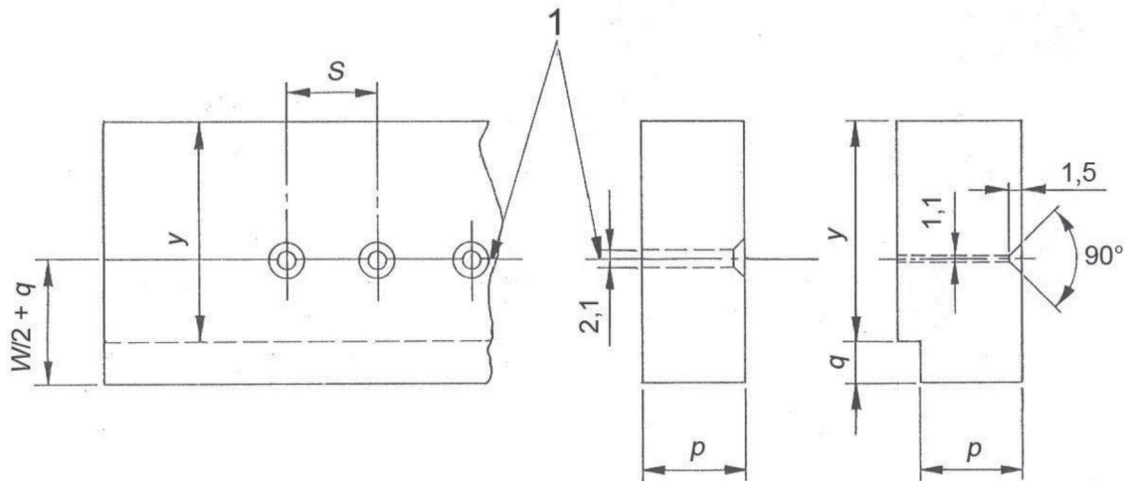


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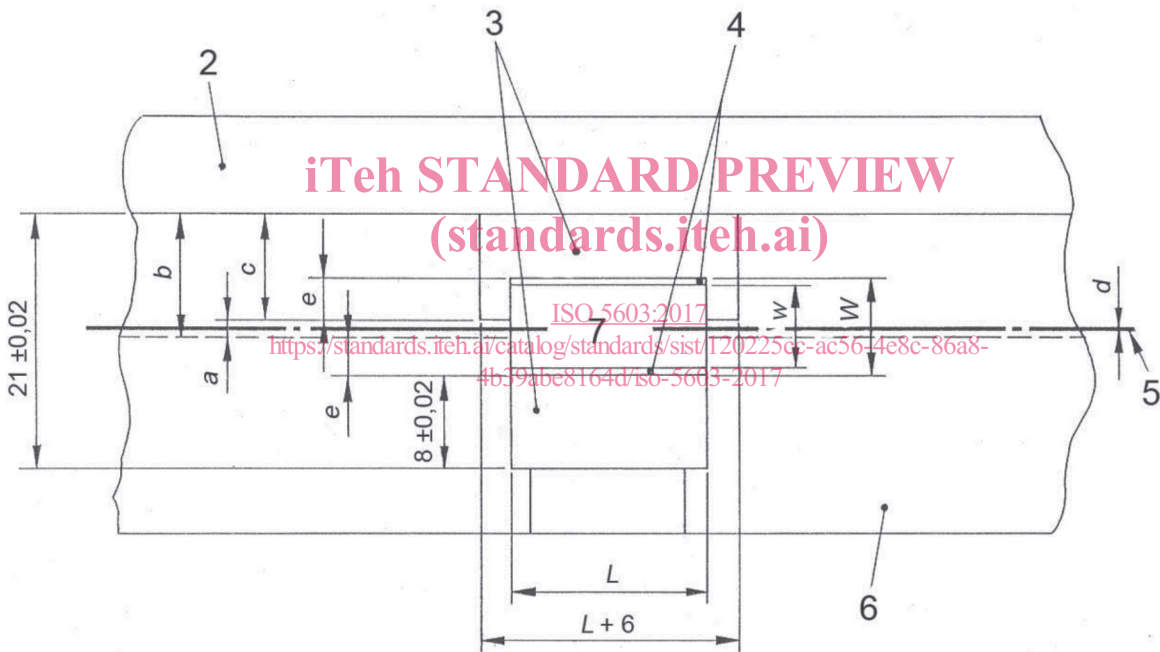
Key

- 1 metal reinforcement sheets (thickness t)
- 2 upper ledge/spacer
- 3 cover plate <https://standards.iteh.ai/catalog/standards/sist/120225cc-ac56-4e8c-86a8-4b39abe8164d/iso-5603-2017>
- 4 centring bolts
- 5 tensioning frame
- 6 extraction tool
- 7 lower edge
- a Detail of cross-section of slot (for dimension a , see [Figure 3](#))

Figure 2 — Layout of a second type of semi-follow-on mould and its extraction tool for method 1



a) Spacers for the mould in [Figure 1](#)



b) Exchange ledges/spacers for the mould in [Figure 2](#)

Cord diameter d	Details of ledge chosen			
	a	b	c	e
$\geq 0,5$ but $< 0,7$	$0,7 \pm 0,02$	$9,85 \pm 0,2$	$9,15 \pm 0,02$	$3,15 \pm 0,02$
$\geq 0,7$ but $< 1,0$	$1,0 \pm 0,02$	$10,0 \pm 0,2$	$9,0 \pm 0,02$	$3,0 \pm 0,02$
$\geq 1,0$ but $< 1,4$	$1,4 \pm 0,02$	$10,2 \pm 0,2$	$8,8 \pm 0,02$	$2,8 \pm 0,02$
$\geq 1,4$ but $< 1,7$	$1,8 \pm 0,02$	$10,4 \pm 0,2$	$8,6 \pm 0,02$	$2,6 \pm 0,02$

$a = b - c$ is the slot width
 b is the slot depth
 $2e + a = w + 2t = W$
 $e = 21 - (b + 8) = 13 - b$

Key

- | | | | |
|---|---|---|-----------------|
| 1 | split line | 5 | cord |
| 2 | cover plate | 6 | main mould body |
| 3 | ledges/spacers | 7 | rubber |
| 4 | metal reinforcement sheets (thickness t) | | |

Figure 3 — Details of spacers used in the two types of semi-follow-on mould for method 1

b) Method 2

The mould is described in [Figures 4](#) and [5](#). The mould is designed to produce four test blocks (each of length 200 mm) with the preferred dimensions (see [8.2](#)), each containing 15 steel cords. When testing cords with a diameter equal to or less than 1,7 mm, the mould in [Figures 4](#) and [5](#) shall be used to produce blocks and, when testing cords with a diameter greater than 1,7 mm, the mould shall be suitably modified. If more than one-third of the cords break at the 12,5 mm embedment, it is advisable to reduce the embedment by use of a suitable mould insert. Moulds designed to produce any other number of test blocks of the required dimensions are acceptable, and moulds designed to produce blocks with different embedded cord lengths are permitted.