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Rubber, vulcanized — Determination of adhesion to wire cord

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

Reference number
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Foreword

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

This fifth edition cancels and replaces the fourth edition (ISO 5603:2017), which has been technically revised.

The main changes are as follows:

— the normative references have been updated.

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.

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.

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, *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 terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

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

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 × 3 × 0,15) mm + (6 × 0,27) mm or of construction (7 × 4 × 0,22) 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 °C to 125 °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 ± 2) °C or (27 ± 2) °C prior to use. It can be in the form of a 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 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 × 3 × 0,30) mm + (6 × 0,38) mm [when the thickness t is (2,5 ± 0,1) 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.

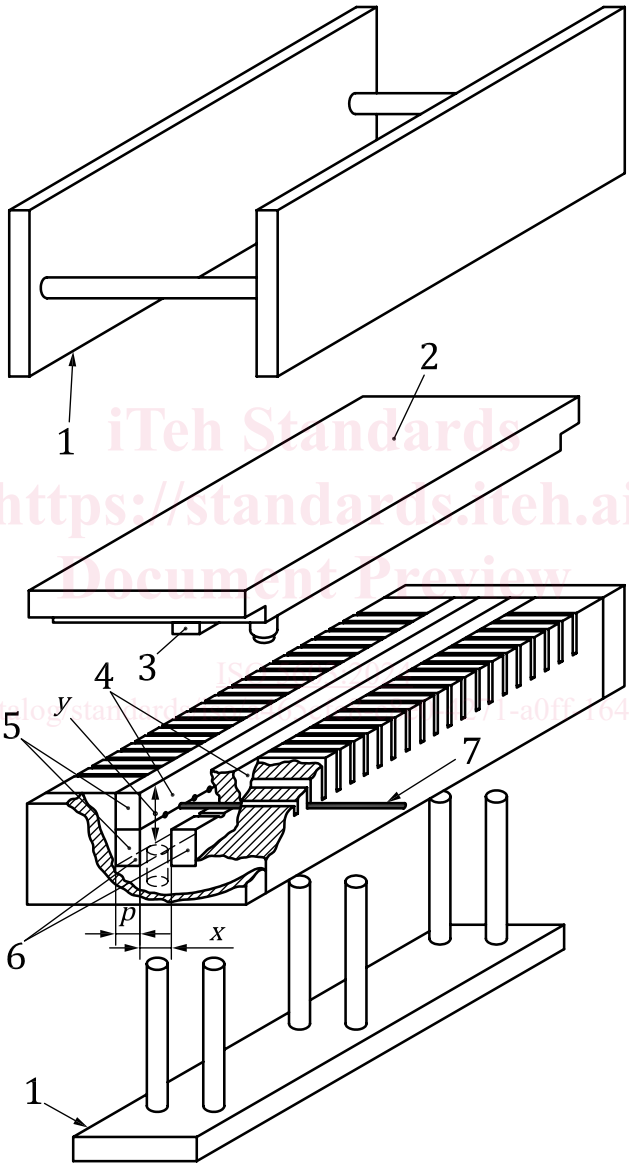
One suitable mould designed to accommodate steel cord fabric reinforcement is shown in Figure 1. This mould produces test pieces of length 310 mm containing 21 cords, but similar moulds employing other numbers of cords greater than nine are acceptable. The mould dimension x will depend on the embedded 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.

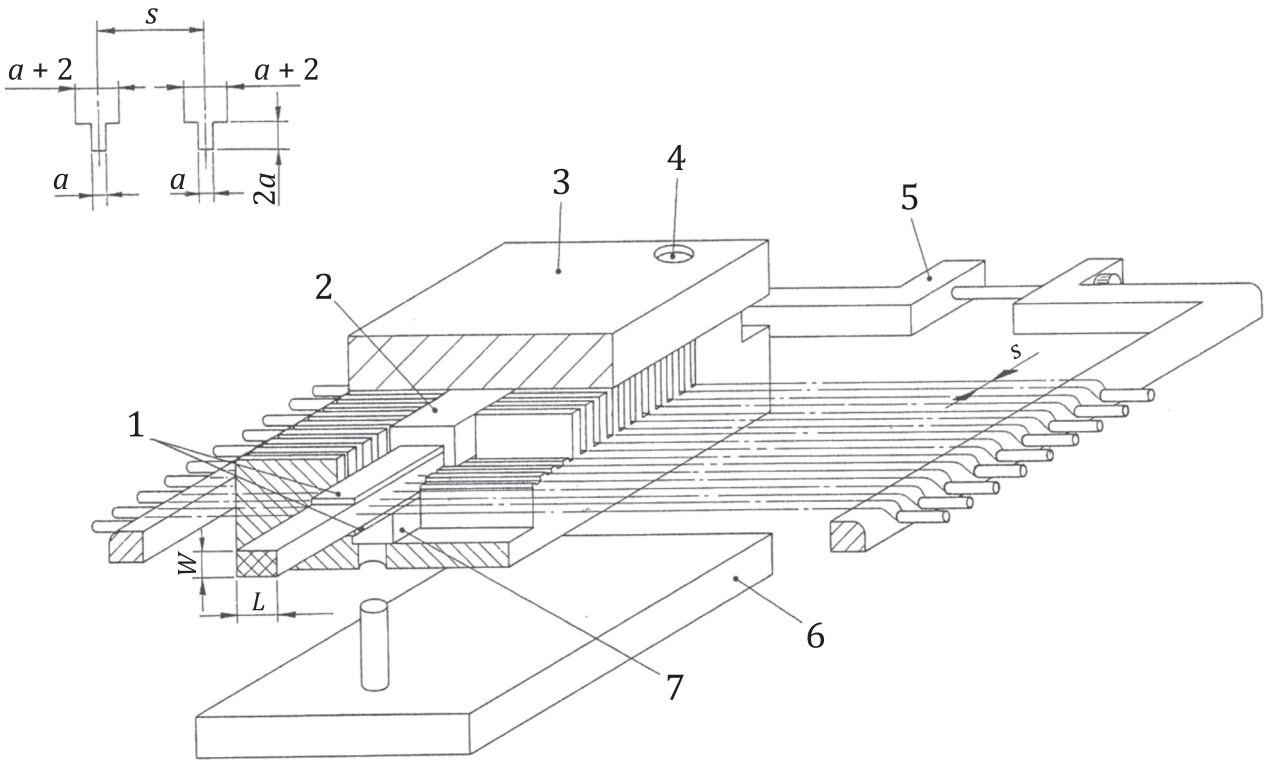


Key

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

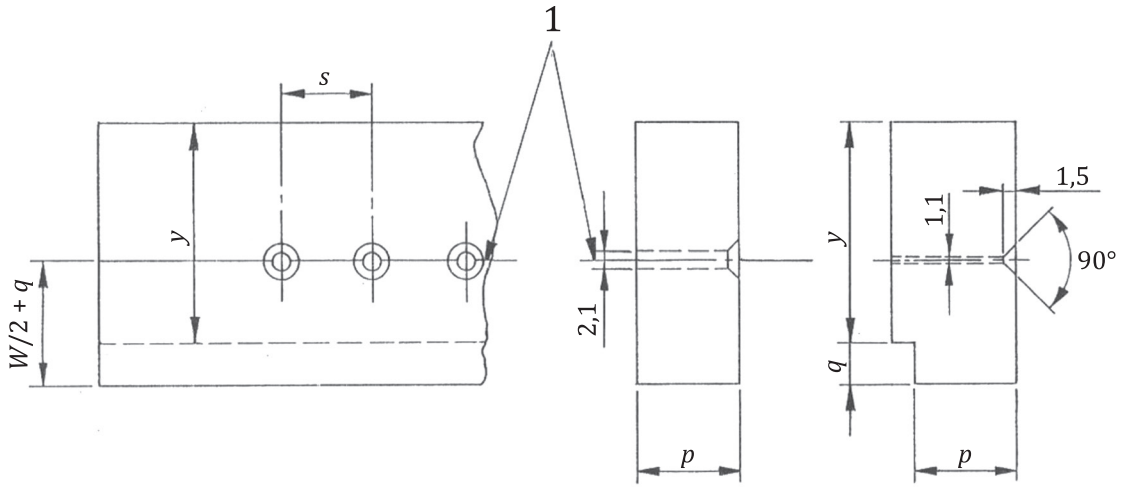


Key

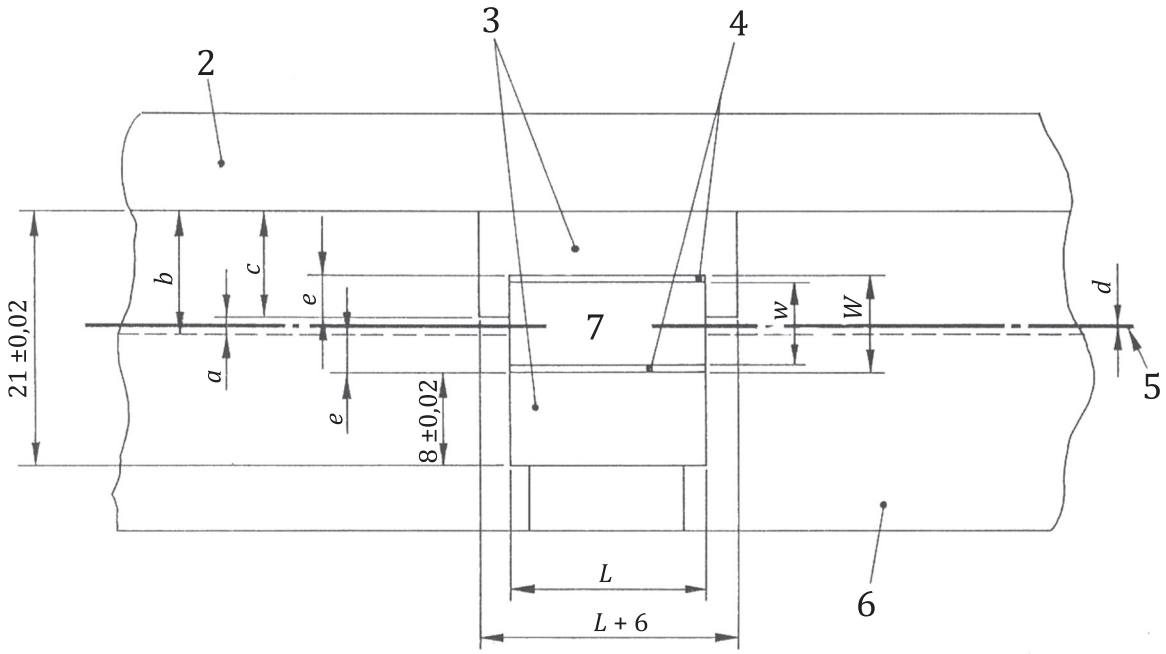
1 metal reinforcement sheets (thickness *t*)
2 upper ledge/spacer
3 cover plate
4 centring bolts
5 tensioning frame
6 extraction tool
7 lower edge
[a] Detail of cross-section of slot (for dimension *a*, see Figure 3).

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

Dimensions in millimetres



a) Spacers for the mould in Figure 1



b) Exchange ledges/spacers for the mould in Figure 2

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

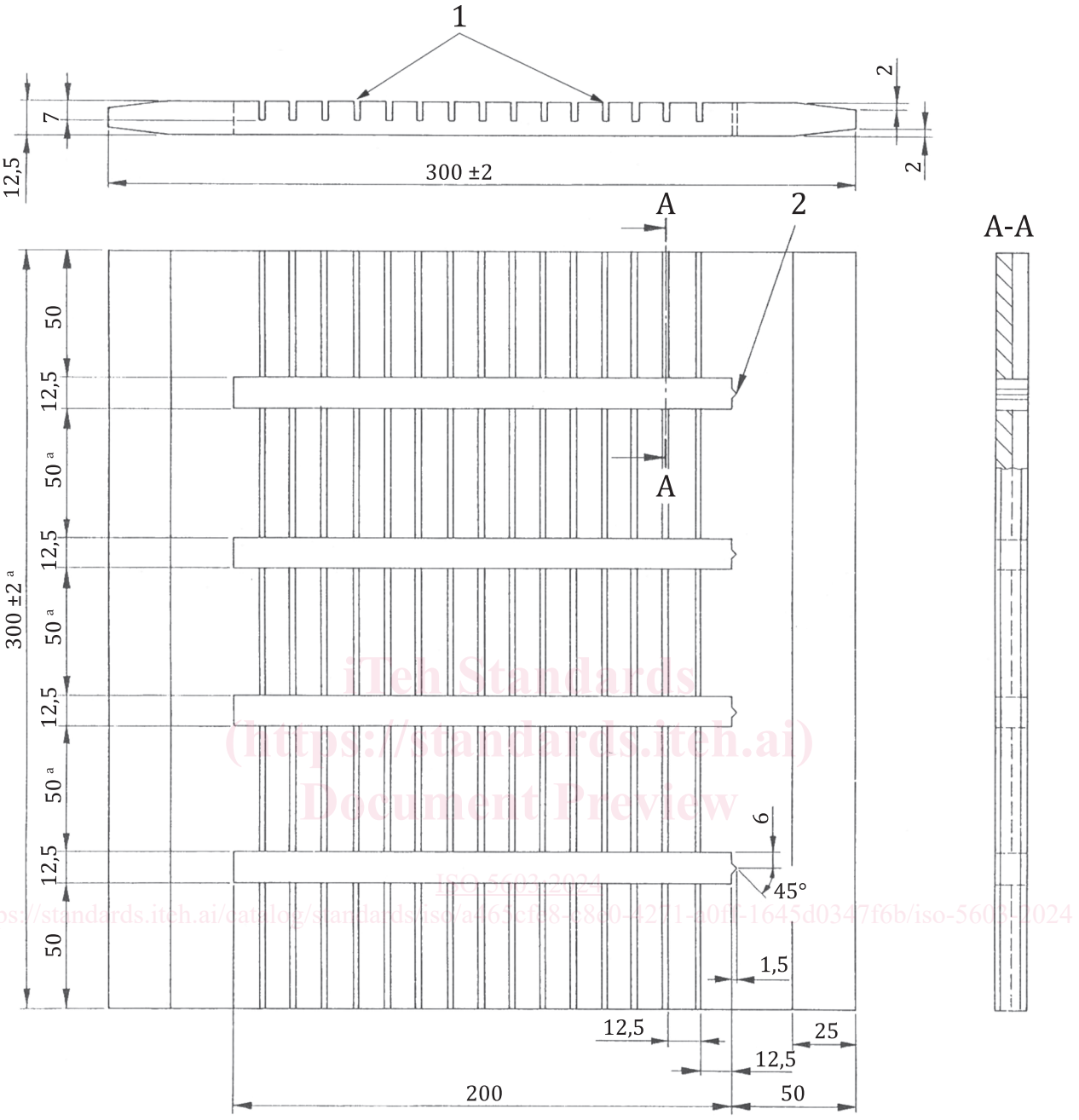
1 split line
2 cover plate
3 ledges/spacers
4 metal reinforcement sheets (thickness *t*)
5 cord
6 main mould body
7 rubber

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.

Dimensions in millimetres



Key

1 15 slots (1,8 ± 0,1) mm wide

2 identification number

Tolerances (except where otherwise stated):

dimensions ±0,2;

angles ±2°

NOTE 1 The material is mild steel, it can be flash chrome-plated.

NOTE 2 Dimensions marked with an asterisk (*) can be altered to accommodate the test grips.

Figure 4 — Mould for method 2