INTERNATIONAL STANDARD

**ISO 4647**

Second edition
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# Rubber, vulcanized — Determination of static adhesion to textile cord — H-pull test

*Caoutchouc vulcanisé — Détermination de l'adhérence statique au câblé textile — Essai d'arrachement en H*



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## Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 4647 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.



This second edition cancels and replaces the first edition (ISO 4647:1982), which has been technically revised primarily concerning updating the references, including a reference to ISO 5893 for the apparatus, updating the test report format and the addition of a calibration schedule.



# Rubber, vulcanized — Determination of static adhesion to textile cord — H-pull test

**WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This standard 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.**

**CAUTION — Certain procedures specified in this International Standard may 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 International Standard specifies a method for the determination of the static adhesion of textile cord to vulcanized rubber using the H-pull test. It is applicable to cords made from natural or man-made fibres.



The property levels obtained with this method are affected considerably by the history of the cord and the rubber compound. The method yields data, however, on which a judgement as to the service quality of the material can be based.



The method is primarily intended for use with tyre cord. However, it can be applied, if desired, to similar cords for use in other rubber products, but it is limited to cords of linear density not exceeding 800 mg/m (tex).

## 2 Normative references

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.

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

ISO 18899:2004, *Rubber — Guide to the calibration of test equipment*

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

## 3 Principle

The adhesion between a rubber and textile cord is assessed by measuring the force required to pull a single cord from a block of vulcanized rubber, the force being applied along the longitudinal axis of the cord and the length of cord embedded in the rubber being fixed (see Figure 1).

The adhesion measured is essentially a shearing force acting at the cord-to-rubber interface. The two strips of rubber and the interconnecting cord form a test piece resembling the letter “H”, from which the test derives its name.

## 4 Materials

The materials comprise any combination of rubber compound, textile cord and adhesive agreed upon by both the cord user and the supplier. The vulcanizing conditions, both time and temperature, shall be exactly specified.

Square-woven, approximately 340 g/m$^2$ cotton fabric, or its equivalent, shall be used to support the rubber strips. This may be grey fabric or fabric that has been frictioned on one side. Alternatively, the rubber compound may be calendered to the frictioned side of the cotton fabric. The rubber surface which will be in contact with the cords shall be protected by a protective film, for example starch paper or polyethylene.

The thickness of the rubber compound required to fill the mould completely shall be determined by the supplier and the purchaser.

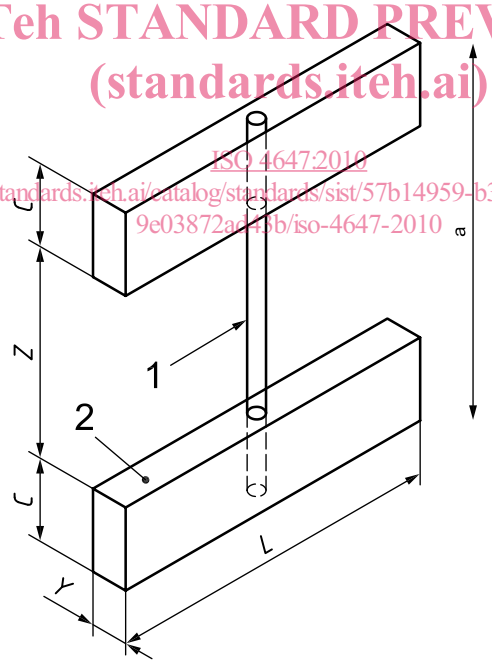
NOTE The decision as to which rubber compound to use is normally made by the cord user.

## 5 Apparatus

### 5.1 Mould.

The dimensions of the test pieces are controlled by the specifications and tolerances of the mould. The test pieces are prepared by laying strips of rubber, of thickness $Y/2$ (see Figure 1), spaced a distance $Z$ apart, into cavities in a mould of width $C$.






**Key**

1 cord

2 rubber

a Direction of applied force.

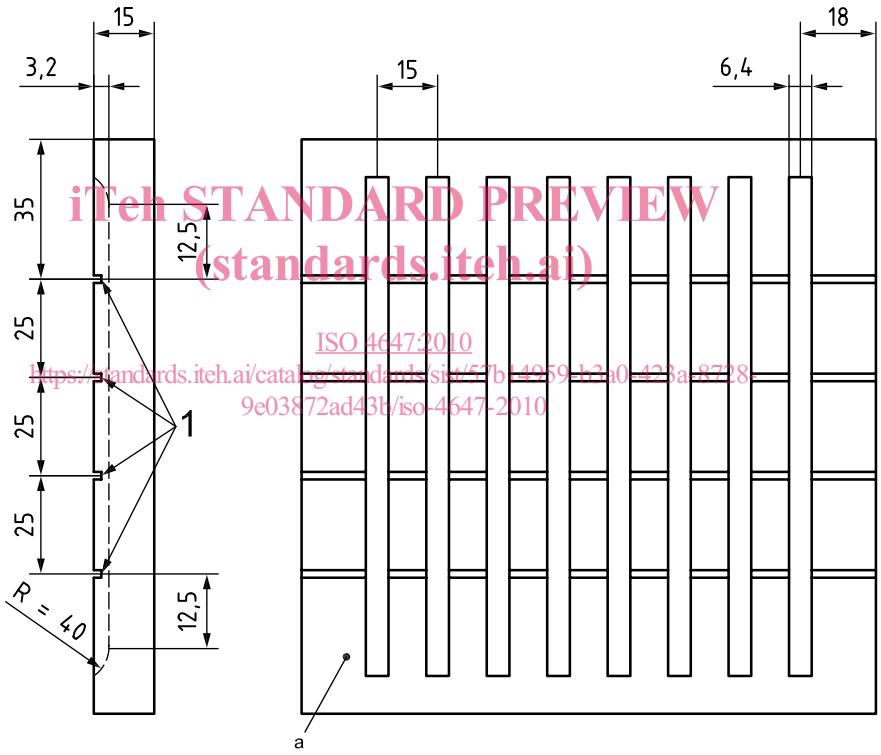
**Figure 1 — Test piece**

Cords are stretched over and perpendicular to the rubber strips, with a distance $L$ between each cord. Two further strips of rubber are applied above the cord, the mould closed and put into a press, and the test pieces vulcanized.

It is common practice to use moulds which allow many identical test pieces to be produced simultaneously as a test pad.

One example of a suitable mould is shown in Figure 2. It is recommended that the width of the cord groove be 0,8 mm for cords of linear density 560 mg/m (tex) or less, and 1,2 mm for cords of linear density more than 560 mg/m (tex) and up to 800 mg/m (tex). Although this form of mould is simple to use, the moulding pressure tends to force excess rubber down the cord groove between the rubber strips, particularly when the cord is much narrower than the groove. This “flash” shall be removed from the cord by careful cutting before the test to improve the reproducibility of the results. The formation of this rubber flash can be almost completely eliminated by using a mould of the form shown in Figure 3, which shows two methods for preparing test pieces. The technique requires the cord length between the rubber strips to be held in position during vulcanization by a deformable surface, rather than a groove, so that there are no voids into which excess rubber can flow.

Dimensions in millimetres






**Key**

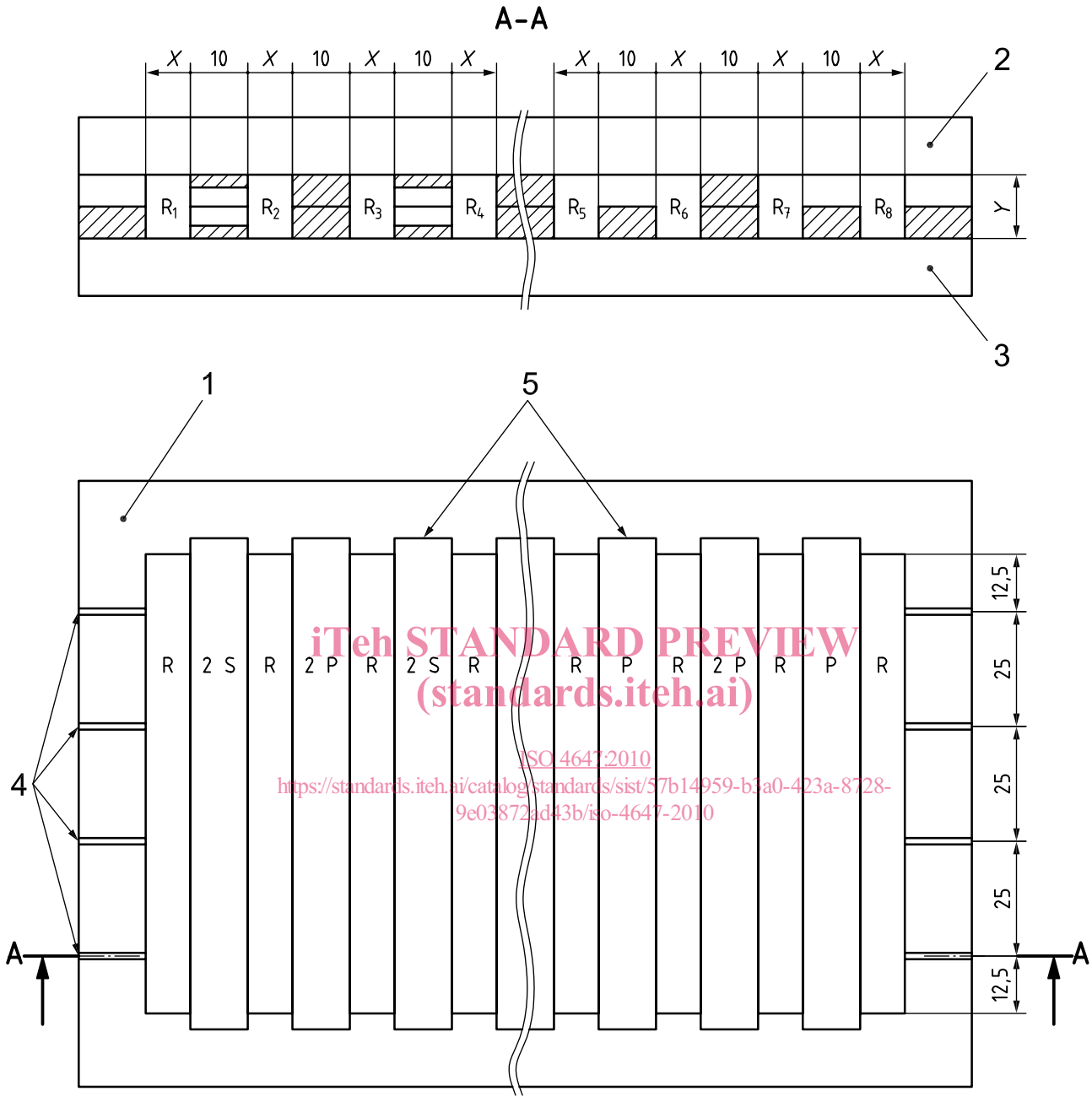
1 four slots 0,8 mm or 1,2 mm wide and 3,0 mm deep, with all burrs removed

The mould shown will produce 16 test pieces. It may be fabricated to produce a larger or smaller number, but the dimensions that govern the size of the test pieces may not be altered.

[a] Material: hot-rolled steel.

**Figure 2 — Suitable mould for H-pull test**

Dimensions in millimetres




a) Method A b) Method B



**Key**

1 mould frame
2 mould top plate
3 mould base plate
4 cord grooves, width 0,8 mm or 1,2 mm (see 5.1)
5 locating grooves for spacer bars
R rubber cavity, width $X$ and depth $Y$ (see 5.1 and 7.1)
S silicone-rubber-faced bar
P plain spacer bar

**Figure 3 — Methods of preparation of test pieces**

In method A, the cord between the rubber strips $R_1$ and $R_2$, and between $R_3$ and $R_4$, is held between specially prepared silicone-rubber-faced bars. A suitable method for the preparation of such bars is described in Annex A.

In method B, the upper strip of rubber is made sufficiently wide to cover the whole distance $R_5$ to $R_6$ (and $R_7$ to $R_8$), with the addition of a thin cellophane or polyester strip applied to the central portion of the rubber, which contacts the cords, to prevent the adherence of rubber to the cord in this region.

**5.2 Tensioning device**, capable of providing a tensioning force of 0,49 N ± 0,1 N. This can be achieved, for example, by suspending a mass of 50 g ± 1 g on one end of each cord during assembly of the test piece and removing it prior to placing the mould in the vulcanizing press. The masses can be of the hook type or designed in such a manner that they can be clamped to the cord. In any event, the total mass shall be 50 g ± 1 g.

**5.3 Tensile-testing machine**, complying with the requirements of ISO 5893, capable of measuring force with an accuracy corresponding to class 1 and with a rate of traverse of the moving grip of 100 mm/min ± 10 mm/min.

**5.4 Test piece grips**, of a design as shown in Figure 4 or Figure 5. Two grips are required.

NOTE The two types of grip do not necessarily give the same results.

## 6 Calibration

The requirements for calibration of the test apparatus are given in Annex B.



## 7 Test piece



### 7.1 Dimensions

The standard test piece shall be a length of cord embedded in rubber strips, nominally 6,4 mm wide and 3,2 mm thick (see 5.1).

Although this method specifies that the rubber strips shall be 3,2 mm thick, an interlaboratory test gave equivalent values for 3,2-mm-thick and 6,4-mm-thick test pieces. The embedded length of cord may be reduced to 5 mm or increased to 10 mm where the adhesion is very high or very low respectively, but the results obtained using different embedded lengths are not comparable.

### 7.2 Preparation

**7.2.1** Cut the rubber compound into strips, 6 mm wide and of a suitable length, leaving the protective film attached. This can be done with scissors or with a clicker die cutter.

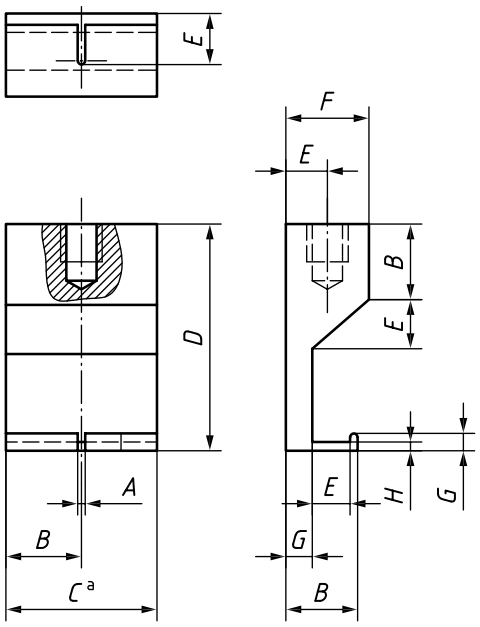
**7.2.2** Cut strips of cotton fabric to the same dimensions as those of the rubber compound. (If the rubber compound is calendered onto the fabric, do not carry out this step.)

**7.2.3** If necessary, place the bottom spacer bars in the mould (Figure 3 type mould).

**7.2.4** Using a mould at room temperature, place the fabric strips in the bottom of the mould cavities (see 7.2.11, second paragraph).

**7.2.5** Place the rubber strips in the mould cavities with the protective-film side on top. (If the rubber is calendered onto the fabric, the fabric side shall be on the bottom.)

Dimensions in millimetres




| Dimension | Value in mm |
|---|---|
| *A* | 1,6 |
| *B* | 12,5 |
| *C*[a] | 25,0 |
| *D* | 40,0 |
| *E* | 7,0 |
| *F* | 14,0 |
| *G* | 4,0 |
| *H* | 2,0 |

[a] This dimension is the most important one and shall not be altered. All other dimensions are included for guidance and may be altered if desired.

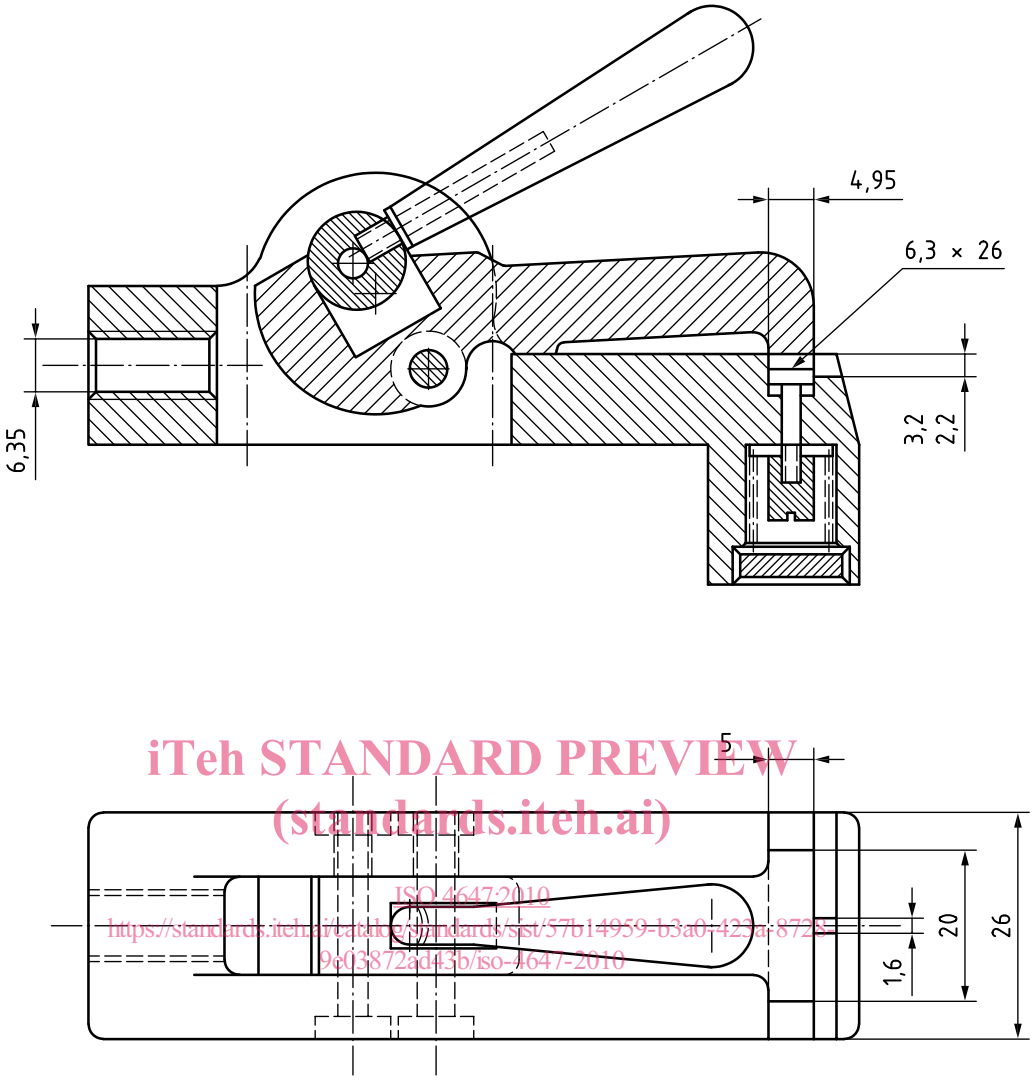


Break all sharp edges and corners with slight radii.

The threaded hole is drilled and tapped to facilitate attaching the grip to the tester.

**Figure 4 — Test piece grip**

Dimensions in millimetres






NOTE The lower part of the grip is spring loaded with a spring tension of between 5 N and 15 N to minimize deformation of the rubber.

**Figure 5 — Alternative test piece grip**

**7.2.6** Remove the protective film from the rubber strips and immediately place the cords in the cord slots. The portion of the cord to be embedded in the rubber shall not be touched with bare hands. The procedure for handling calendered cords shall be agreed upon by the purchaser and the supplier. Knot each cord at one end so that it is secured firmly against the cord slot on one side of the mould. Take care to prevent the loss of cord twist. Attach a tensioning device to the other end of the cord.

**7.2.7** If required, place the upper spacer bars in the mould.

**7.2.8** Remove the protective film from additional strips of rubber and place them in the mould cavities on top of the cords. The side from which the protective film was removed shall be facing down. When preparing test pieces by method B, these additional strips of rubber shall be 22 mm wide, with a strip of protective film or similar material replaced over the central 10-mm-wide area.

**7.2.9** Place strips of fabric on top of the rubber strips. (If the rubber is calendered onto the fabric, eliminate this step.)