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British Standard

Methods of testing vulcanized rubber

Part A48. Determination of static adhesion to textile cord (H-pull test)

[ISO title : Rubber, vulcanized — Determination of static adhesion to textile cord — H-pull test]

Méthodes d'essai des elastomères vulcanisé
Partie A48. Détermination de l'adhérence statique au câblé textile (essai d'arrachement en H)

Prüfverfahren für vulkanisierte Elastomere
Teil A48. Bestimmung der statischen Haftung an Textilcord (H-Zugprüfung)

British Standards Institution

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Methods of testing vulcanized rubber

Part A48. Determination of static adhesion to textile cord (H-pull test)

1 Scope and field of application

This International Standard specifies a method for the determination of the static adhesion of textile tyre cord to vulcanized rubber. 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. It yields data, however, on which judgement may be based as to the service quality of the material.

The method may 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 Reference

ISO 471, *Rubber — Standard temperatures, humidities and times for the conditioning and testing of test pieces.*

3 Principle

Assessment of the adhesion between a rubber and textile cord by measuring the force required to pull a single cord from a block of cured 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 Z apart, into cavities in a mould of width C.

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, 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.

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 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 test to improve the reproducibility of results. The formation of this rubber flash can be almost completely eliminated by using a mould of the form shown in figure 3. The technique requires the cord length between the rubber strips to be held in position during cure by a deformable surface, rather than a groove, so that there are no voids into which excess rubber can flow.

Two methods are shown in figure 3.

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 the annex.

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 Device, to provide a tensioning force of 0,49 ± 0,1 N.

This may be achieved, for example, by suspending a mass of 50 ± 1 g on one end of each cord during assembly of the test piece and removing it prior to placing the mould into the curing press. The masses may 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 ± 1 g.

5.3 Testing machine, conforming to appropriate requirements for the verification of testing machines. It should be capable of accurately registering the applied forces during the test, while maintaining the specified constant rate of separation of the jaws, i.e. 100 ± 10 mm/min.

NOTE — Inertia (pendulum) type dynamometers are apt to give results which differ because of frictional and inertial effects. A low inertia type of dynamometer with a suitable recorder gives results which are free from these effects and is therefore to be preferred.

5.4 Test piece grips.

The design of the test piece grips shall be as shown in figure 4 or figure 5. Two grips are required.

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

6 Test piece

6.1 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).

NOTE — Although this method specifies that the rubber strips shall be 3,2 mm thick, an interlaboratory test gave equivalent values for 3,2 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.

6.2 Preparation

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

6.2.2 Cut strips of cotton fabric to the same dimensions as those of the rubber compound. (If the rubber compound is calendered onto the fabric, eliminate this step.)

6.2.3 If necessary, place the bottom spacer bars in the mould (figure 3 type mould).

6.2.4 Using a mould at room temperature, place the fabric strips in the bottom of the mould cavities (see the note to 6.2.11).

6.2.5 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.)

6.2.6 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 by the bare hand. 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 on the other end of the cord.

6.2.7 If required, place the upper spacer bars in the mould.

6.2.8 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 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.

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

6.2.10 Identify the test pieces in the mould, and cover the mould with a smooth metal plate if the upper press platen is not smooth.

6.2.11 Remove the tensioning devices from the cords and place the mould in a press which has been preheated to the vulcanizing temperature. Adjust the pressure to a minimum of 3,5 MPa with reference to the mould surface. After vulcanizing for the specified time, immediately remove the test pad from the mould and cool at room temperature.

NOTE — A preheated mould may be used, but this will alter the vulcanizing conditions (time and temperature) of the rubber. If a preheated mould is used, the materials should exhibit sufficient green tackiness to permit the pad to be prefabricated in a cold mould and then transferred to the preheated mould.

6.2.12 Cut the pads using scissors, a sharp knife, or clicker die to produce "H" pieces consisting of a single cord with each end embedded in the centre of a rubber tab approximately 25 mm in length. If necessary, trim off all excess rubber flash. When using method B, the trimming shall be carried out with great care to avoid cutting into the test piece.

6.3 Number of test pieces

At least 8 test pieces shall be used.

7 Time-interval between vulcanization and testing

Unless otherwise specified for technical reasons, the following requirements for time intervals shall be observed.

For all test purposes, the minimum time between vulcanization and testing shall be 16 h.

The maximum time between vulcanization and testing shall be 4 weeks, and, for evaluations intended to be comparable, the tests shall, as far as possible, be carried out after the same time interval.

8 Conditioning of test pieces

8.1 When tests are performed at standard laboratory temperatures, the test piece shall be maintained at the conditions of test for at least 16 h immediately before testing, according to ISO 471.

8.2 When tests are made at higher or lower temperatures, the test pieces shall be maintained at the conditions of test for a period of time sufficient to reach temperature equilibrium with the testing environment, or for the period of time required by the specification covering the material or product being tested, and shall then be tested immediately.

9 Test temperature

The test should normally be carried out at the standard laboratory temperature and relative humidity specified in ISO 471. When other temperatures are used, they shall be selected from those given in ISO 471.

The same temperature shall be used throughout any one test, or series of tests intended to be comparable.

10 Procedure

The force required to separate the cord from the rubber may be determined at room temperature or at an elevated temperature.

10.1 Testing at room temperature

Attach the test piece grips to the tension tester and set them 1 mm apart. Take care to ensure axial alignment. Adjust the speed of the movable grip to 100 ± 10 mm/min. Insert the test piece in the grips and start the tester. Record, to the nearest 1,0 N, the maximum force required to separate the cord from the rubber.

10.2 Testing at elevated-temperature

Proceed as described in 10.1, but enclose the test piece grips in an oven attached to the tester. Heat the test pieces in the oven, controlled at the test temperature, for not less than 15 min and not more than 60 min total elapsed time for testing of any one test piece. Alternatively, heat the test pieces in an oven adjacent to the testing machine and then remove them, one at a time, and test within 15 s of removal. The technique for heating and testing the test pieces shall be agreed upon by the purchaser and the supplier.

11 Expression of results

Record the cord adhesion value, in newtons, and calculate the arithmetic mean of the results.

Describe the appearance of the cord indicating whether the rubber has remained adhered to it or not.

12 Test report

The test report shall include the following particulars :

a) a reference to this International Standard;

b) the complete identification of the cord;

c) details of the rubber compound, cure time and temperature;

d) the method of preparing test pieces;

e) the conditioning temperature and relative humidity;

f) the test temperature;

g) any non-standardized procedure(s);

h) the number of test pieces tested;

j) all individual test results and the arithmetic mean of the results;

k) the type of grip used;

m) the type of failure;

n) the date of test.

Annex

Preparation of silicone-rubber-faced bars

A.1 Silicone compound preparation

A.1.1 The compound used shall be a self-bonding grade of silicone rubber of hardness about 60 IRHD.

A.1.2 Depending on the mould plate size available, press out between sheets of polyester a 50 to 60 g piece of the compound, using two flat mould plates to obtain as even a thickness (1,5 mm) as possible.

The pressing is best done in a hydraulic press at very low pressure (less than 175 kPa). A hand-pump press is preferable. The platens may be heated to 50 to 70 °C, if preferred.

A.1.3 After pressing for 2 to 3 min, examine the silicone rubber to see if the required thickness has been reached. It may not be possible to attain 1,5 mm, but up to 2 mm is permissible.

A.1.4 Remove the sheet of silicone rubber and store it on a flat cool surface, still protected by the polyester film.

A.2 Bar preparation

A.2.1 Remove as much old silicone rubber as possible by scraping, mechanical wire-brushing of the bars, or similar means.

A.2.2 Degrease the bars in a vapour degreasing bath, using trichloroethylene or perchloroethylene, for 30 to 60 min.

A.2.3 Abrade the bars on the bonding surfaces only, using fine emery cloth. Light shot or vapour blasting may be used, but it is advisable to protect the non-bonding surfaces to prevent unnecessary roughening.

A.2.4 Finally clean the bars by wiping liberally with a clean cloth soaked in a petroleum solvent, the solvent being allowed to evaporate. Apply the silicone strip as soon as possible after cleaning.

A.3 Bonding procedure

A.3.1 Cut strips from the polyester film-protected silicone rubber to fit the bonding areas on the bars. If the silicone rubber is unavoidably thick, the width of the strips (normally about 10 mm) may be reduced by 1 to 2 mm to prevent excessive spew.

A.3.2 Peel the polyester film from one face of the strip, place the exposed face on the freshly cleaned bonding area and, manually, lightly press into contact.

Avoid contact with the exposed silicone surface and the prepared bar surface to prevent contamination and hence poor bonding.

A.3.3 Prepare two bars at a time. These should be used as a pair, and preferably marked for easy identification.

A.3.4 Place the bars in a suitable mould, side by side, with the siliconed faces uppermost. The top layers of polyester film may now be removed if preferred, but to facilitate easy demoulding a piece of polyester film, sufficient to cover the mould cavity, should be inserted. Alternatively, the mould lid should be sprayed with a PTFE aerosol mould lubricant.

A.3.5 With the lid located by the matching holes and pegs of the bars, place the mould in a press while the platens are warming up, and use a low pressure to spread the silicone. When the full curing temperature of 160 °C is reached, apply the highest possible safe pressure and vulcanize for 15 min.

A.3.6 Cool the bars, preferably in the mould in the press still under pressure. If this is not possible, allow the complete mould to cool out of the press, as at this stage the silicone is still weak and prone to damage when hot.

A.3.7 When cool, carefully remove the faced bars from the mould. This may be facilitated by removing one of the screwed-in mould end stops, allowing a thin lever to be inserted under the bars.

A.3.8 Excess silicone spew, etc., may then be trimmed off, or this may be deferred until after the oven cure.

A.3.9 When all the bars to be re-faced have been press-cured, store them for 18 to 24 h at 200 °C. Remove excess spew, etc., if this was not carried out at the previous stage.

NOTES

1 When in use, the silicone rubber may protrude beyond the edge of the bar. If a trial pull-through test piece is moulded, the amount of excess silicone may be measured by examining the test piece cross-section, which will be of H-section if the silicone protrudes. The edge of the silicone should be trimmed back from the edge of each bar by slightly less than the depth of the indentation caused in the pull-through test piece.

2 With normal usage, a minimum of 500 test mouldings can be expected before the bars need to be refaced.

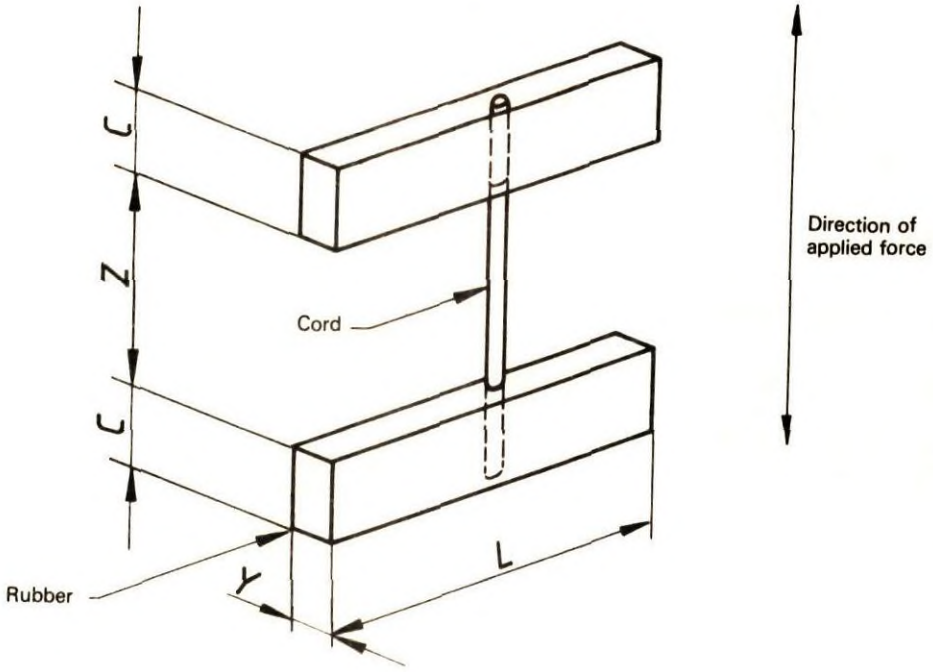


Figure 1 — Test piece

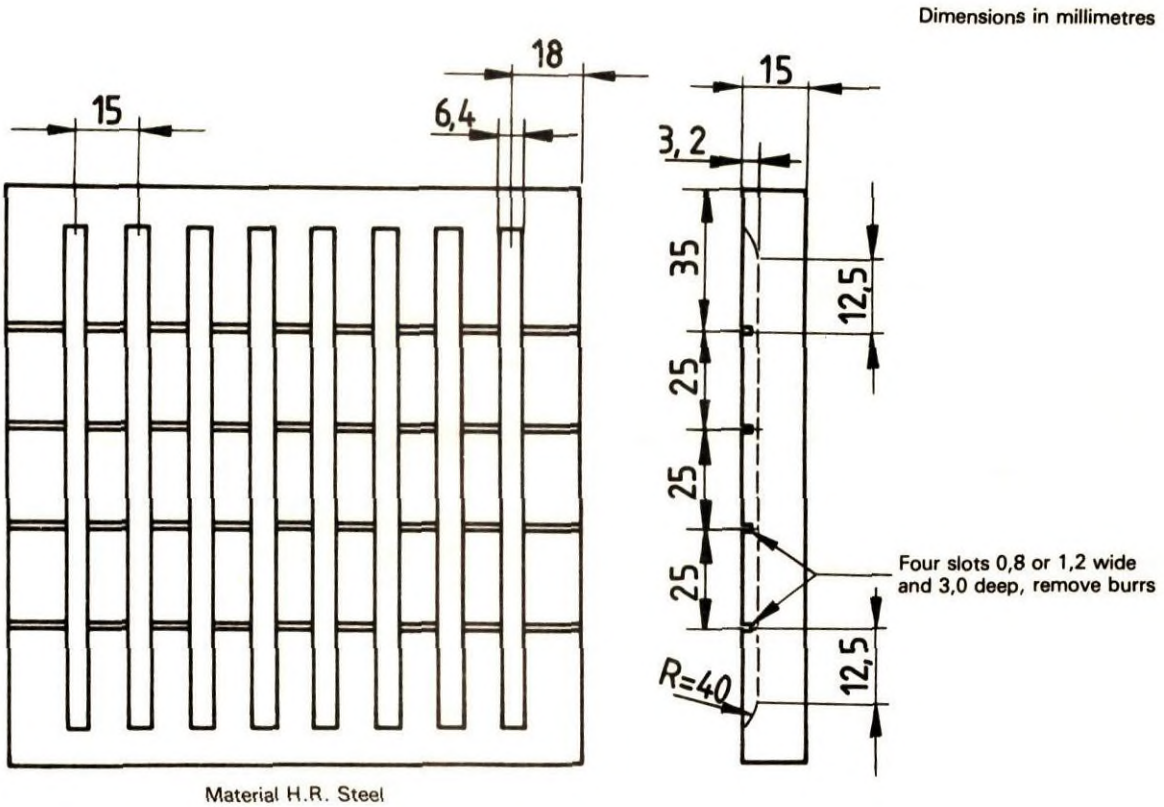
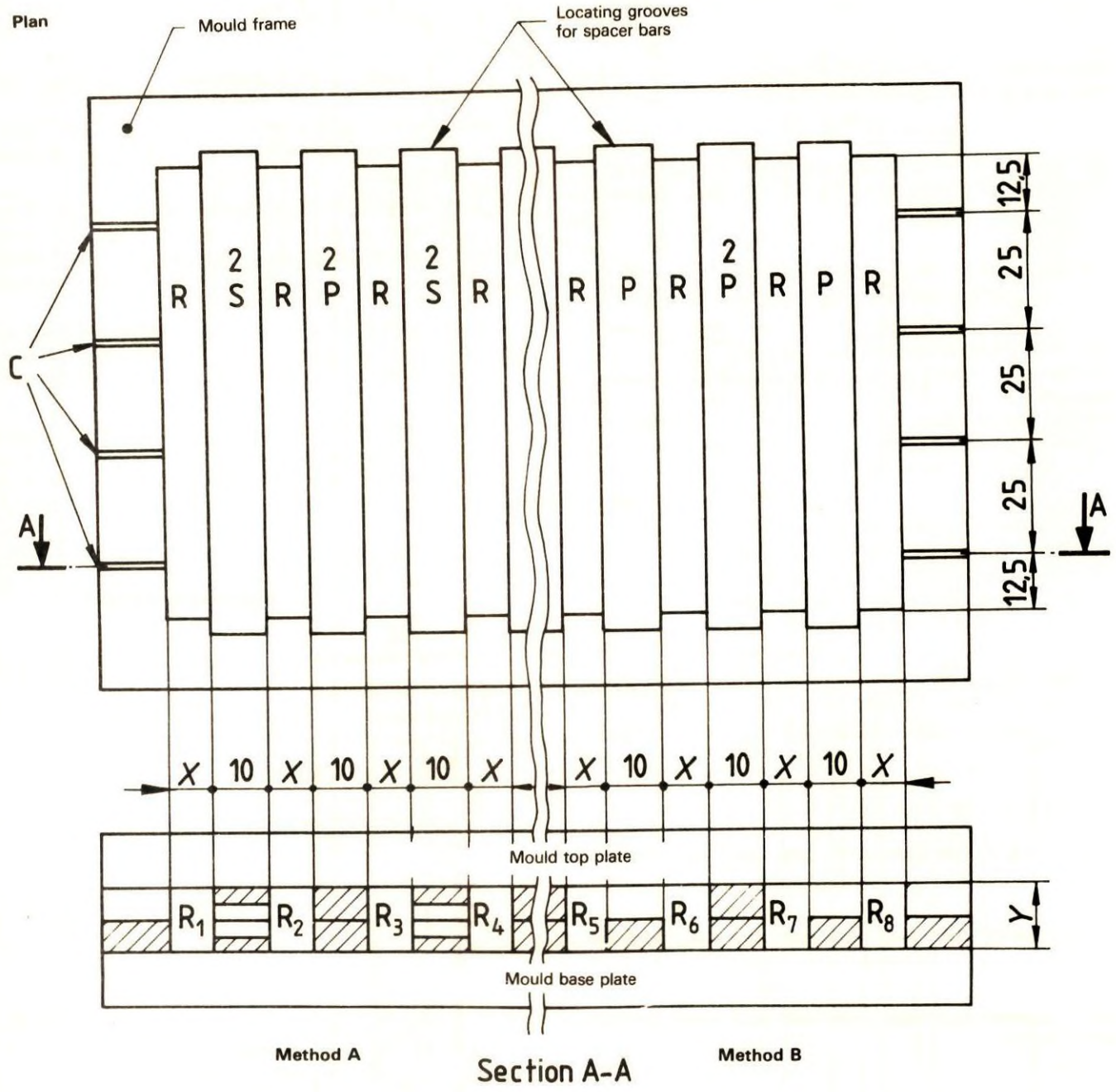


Figure 2 — Suitable mould for H-pull test

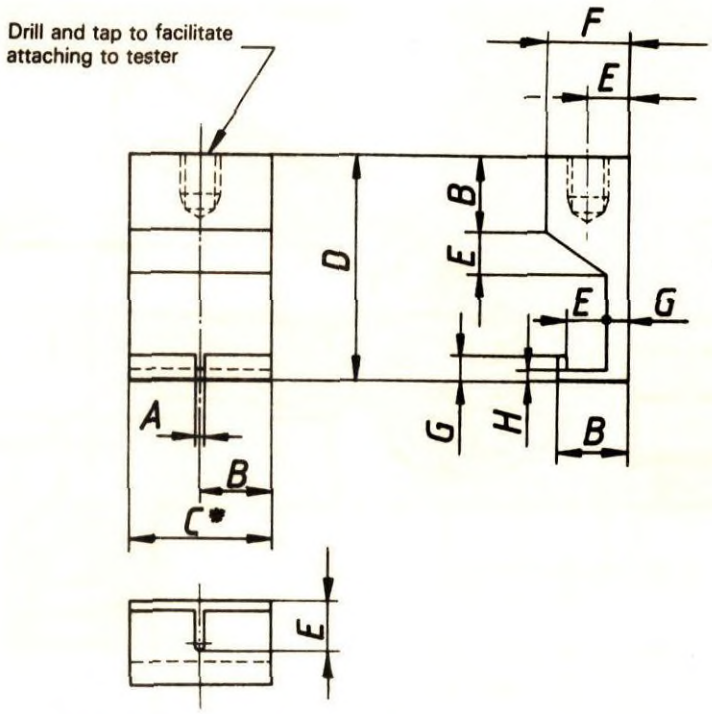
NOTE — The mould as shown will produce 16 test pieces. It may be fabricated to produce a larger or smaller number but the dimensions that govern the size of the test pieces shall not be altered.

Dimensions in millimetres



R — Rubber cavity, width X and depth Y (see 5.1 and 6.1)
S — Silicone-rubber-faced bar
P — Plain spacer bar
C — Cord grooves, width 0,8 or 1,2 (see clause 5.1)

Figure 3 — Methods of preparation of test pieces



Dimension	mm
A	1,6
B	12,5
*C**	25,0
D	40,0
E	7,0
F	14,0
G	4,0
H	2,0

Figure 4 — Test piece grip

NOTE — The important dimension is indicated by an asterisk and shall not be altered. All other dimensions are included for guidance and may be altered if desired.

Dimensions in millimetres

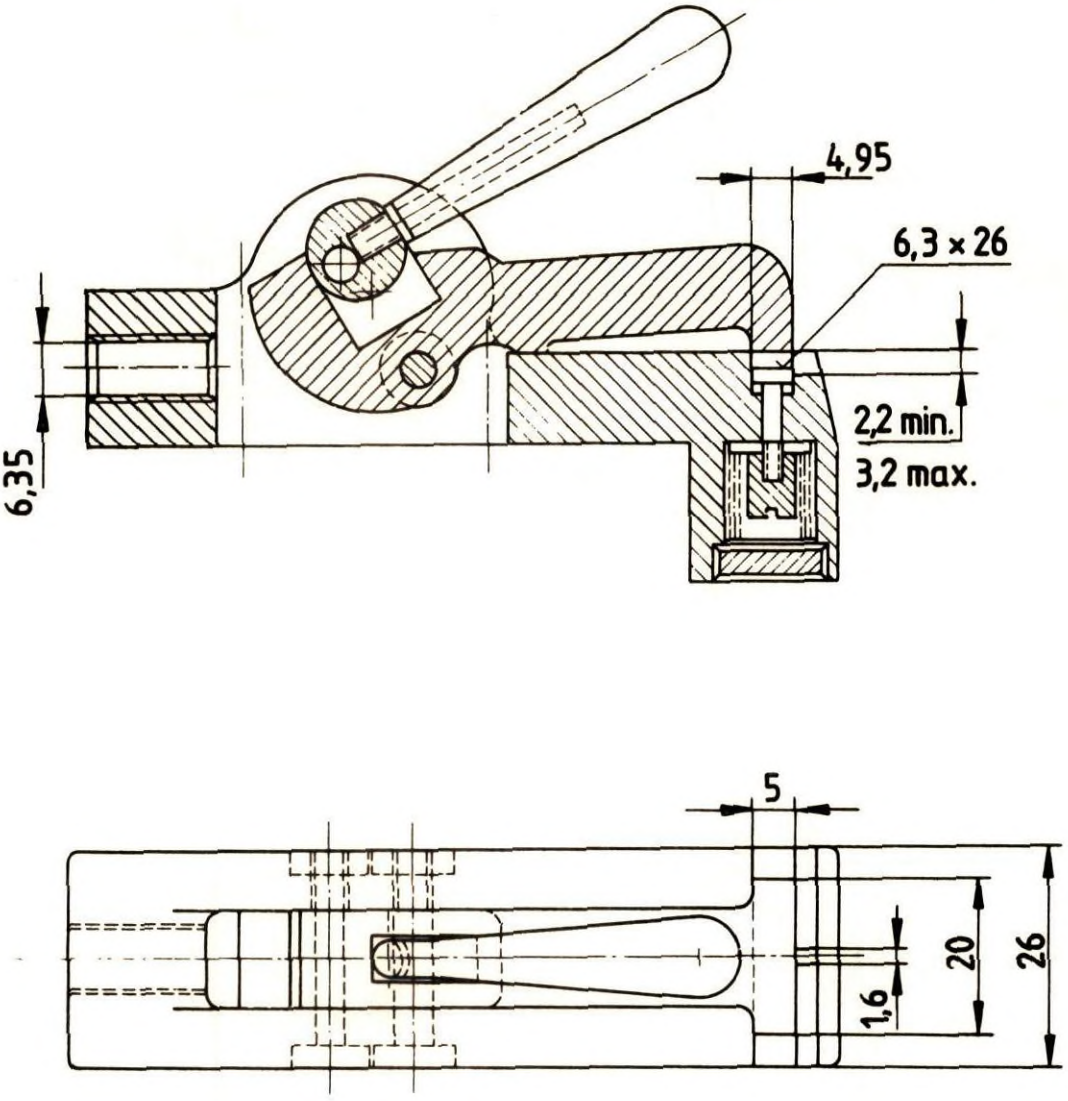


Figure 5 — Alternative test piece grip

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