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SPECIFICATION FOR INDUSTRIAL AND SAFETY RUBBER KNEE BOOTS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

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SPECIFICATION FOR INDUSTRIAL AND SAFETY RUBBER KNEE BOOTS

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0. FOREWORD

0.1 This standard was adopted by the Indian Standards Institution on 24 October 1969, after the draft finalized by the Footwear Sectional Committee had been approved by the Chemical Division Council.

0.2 Footwear Sectional Committee while finalizing the draft standard on rubber knee boots, felt that this standard did not cover the requirements for boots intended for heavy duty. It was, therefore, decided to have a separate standard for the industrial rubber knee boots. It was also decided to include in this standard the requirements for industrial knee boots with steel toe-cap, since such boots were recommended for use in mines by the Technical Committee on Miners Boots (1963), set up by the Ministry of Labour & Employment which in turn had requested ISI to formulate a detailed specification.

0.3 This standard specifies 3 types of knee boots for the popularly known English sizes 5 to 11 (Paris Point 38 to 45), namely:

Type 1 — Non-oil resistant

Type 2 — Oil resistant

Type 3 — Fitted with protective steel toe-cap

Type 1 boots are intended for heavy duty purposes in engineering workshops, tanneries and in building industries while Type 2 boots are intended for use where the floor is covered with oil, grease, etc, such as in garages. Type 3 boots are intended for use in mining industry where toe-protection is needed. This specification does not cover the style of the boot, permits the use of both synthetic and natural rubbers and lays stress on functional and physical requirements of materials of construction and the boots as a whole. These boots, however, are not intended for protection against electric shocks.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded

*Rules for rounding off numerical values (*revised*).

off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the requirements, methods of sampling and test for industrial and safety rubber boots of knee height for men.

1.1.1 This standard is not intended to cover boots for protection against electric shocks.

2. TERMINOLOGY

2.1 For the purpose of this standard, definitions given in IS : 2050-1967* shall apply.

3. TYPES

3.1 This standard covers three types of knee boots as follows:

Type 1 — Industrial rubber knee boots made from non-oil resistant rubber with no steel toe-cap.

Type 2 — Industrial rubber knee boots made from oil resistant rubber with no steel toe-cap.

Type 3 — Safety rubber knee boots made from non-oil resistant rubber with steel toe-cap.

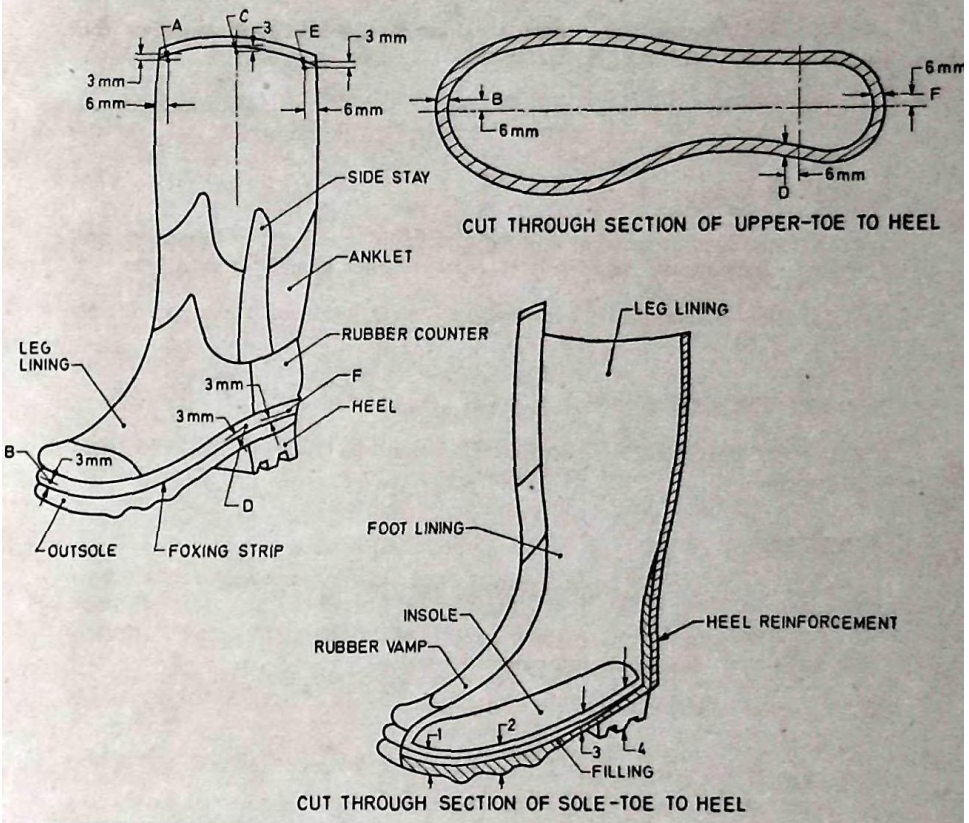
4. REQUIREMENTS

4.1 Type 1 Boots

4.1.1 *Design* — The boot shall be of rubber Wellington design with fabric lining and antislip sole design, as shown in Fig. 1.

4.1.2 The boots shall be made in sizes 5 (equivalent Paris Point 38) to 11 (equivalent Paris Point 45). The minimum height of the boot, measured on the inside of the back of the boot from insole to the top, shall be not less than 355 mm.

*Glossary of footwear terms.



	millimetres
A	1·5
B	3·5
C	1·5
D	3·5
E	1·5
F	4·0

NOTE—These illustrations show the general location of parts, all of which are not necessarily included in the construction, or implied in the specification.

FIG. 1 RUBBER BOOTS

4.1.3 The minimum substance (rubber and fabric) of the boot for the various parts of the boot shown in Fig. 1 shall be as follows:

Part of Boot	*Position*	*Minimum Substance* mm
Leg	*A*	1·5
	B	3·5
	C	1·5
	D	3·5
	E	1·5
	F	4·0
Sole	Overall	14·0
	Between cleats	7·0
Waist	Overall	7·0
Heel	Overall	25·0

4.1.4 *Materials*

4.1.4.1 *Cotton fabric* — For lining and insole, bleached cotton drill conforming to Variety No. 1 of IS : 177-1965* shall be used. The fabric shall be free from defects.

4.1.4.2 *Rubber* — The rubber parts of the boots shall be non-porous and homogeneous.

4.1.5 *Manufacture* — The various components of the boots shall be prepared from the materials prescribed in Table 1. The lining may consist of one or more fabrics, one forming the leg lining and the others acting as reinforcements The fabric shall be rubberized on one side and joined to form a complete lining. The strength of the composite upper when determined on a 75 × 25 mm strip shall be such that it withstands a minimum breaking load of 28 kg in both warp and weft directions. The toe of the boots shall be hardened.

4.1.6 *Physical Requirements*

4.1.6.1 *Heat treatment* — All rubber components shall be capable of withstanding, without developing any signs of brittleness or tackiness on ageing at 100 ± 1°C at atmospheric pressure, in an air oven, for a period of 24 hours (*see* **7.2**).

*Specification for cotton drill (*revised*).

TABLE 1 MATERIAL REQUIREMENTS

(*Clause* 4.1.5)

Sl No.	Component	Material
(1)	(2)	(3)
i)	Leg	Inside fabric, outside rubber
ii)	Vamp	do
iii)	Counter	Rubber
iv)	Inner reinforcement of vamp	Rubber or fabric
v)	Heel piece	Rubber
vi)	Outer toe-cap	Rubber
vii)	Backstrip	Rubber
viii)	Foxing strip	Rubber
ix)	Top binding	Rubber
x)	Insole	Fabric with sponge rubber
xi)	Filler	Rubber fabric composition
xii)	Outsole	Rubber
xiii)	Heel	Rubber
xiv)	Counter reinforcement	Rubber or fabric

4.1.6.2 *Hardness* — The hardness of rubber (*see* **7.3**) for sole and heel shall be 60 ± 5 IRHD*. The initial hardness shall not change by more than $+5, -2$ IRHD* after heat treatment, specified in **4.1.6.1.**

4.1.6.3 *Abrasion index* — The sole and heel shall have a minimum abrasion index (*see* **7.4**) of 75.

4.1.6.4 *Flexing endurance* — The body and sole shall withstand not less than the number of continuous flexes (*see* **7.5**) given below, after being aged and tested as specified in **4.1.6.1**, without the rubber face showing pinholes or any signs of cracking and without the separation of plies when viewed with the unaided eye. Pinholes or cracking caused due to machine failures or damage shall be ignored:

Part	*Number of Cycles, Min*
Body	150 000
Sole	50 000

4.1.6.5 *Adhesion* — The adhesion (*see* **7.6**) between fabric and rubber of the leg position, shall be such that the rate of separation does not exceed 25 mm per minute under a load of 3 kg.

4.1.6.6 *Leakage resistance* — Finished boots shall show no leakage when air with minimum pressure of 0·15 kgf/cm² is forced into the boots.

4.2 Type 2 Boots — In addition to all the requirements prescribed for Type 1 boots in **4.1.1** to **4.1.6**, Type 2 boots shall conform to the requirements prescribed in **4.2.1.**

4.2.1 *Resistance to Oil* — The rubber of upper, sole and heel of the boots shall be oil resistant.

4.2.1.1 The upper shall not show swelling more than 35 percent, sole and heel more than 38 percent in *iso*octane/toluene mixture at 27 ± 2°C.

4.3 Type 3 Boots — In addition to all the requirements given in **4.1.1** to **4.1.6**, Type 3 boots shall conform to the requirements given in **4.3.1** and **4.3.2.**

4.3.1 Type 3 boots shall be fitted with steel toe-caps as shown in Fig. 2.

4.3.1.1 *Steel toe-cap* — For Type 3 boots, steel toe-cap, made of steel

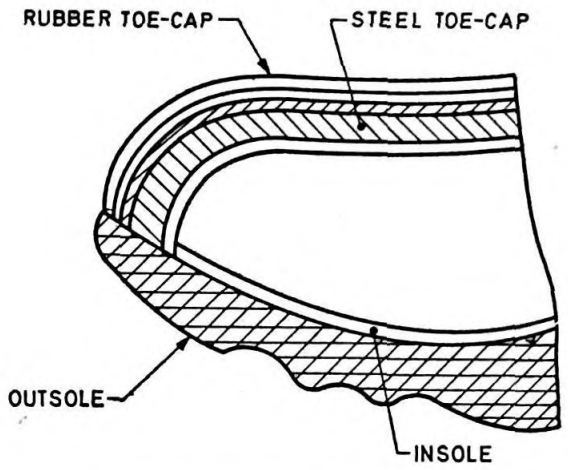


FIG. 2 CROSS SECTION OF TOE OF A BOOT FITTED WITH PROTECTIVE STEEL TOE-CAP

of thickness range 1·4 to 1·6 mm and having the following composition and hardness, may be used:

a) *Composition* — Carbon steel conforming to Designation C 60 as specified in IS : 1570-1961*; the limits for silicon, sulphur and phosphorus shall be as follows:

Sulphur, percent by weight, *Max*	0·06
Phosphorus, percent by weight, *Max*	0·06
Silicon, percent by weight	0·10 to 0·35

NOTE — If the steel is aluminium-killed, the limit for silicon content does not apply.

b) *Hardness* — The hardness should be of the order of 400 to 500 *HV* (*see* IS : 1501-1959†) at a load of 10 kg.

4.3.2 *Impact Resistance* — When boots are subjected to the impact test (Appendix A) for evaluating the safety factor of the boots, they shall withstand a blow of 14 kg.m. They shall be considered to have passed the test, if:

a) the clearance inside the boots at the moment of maximum depression, when subjected to impact test, is 13·5 mm or more; and

b) the clearance figure for three boots tested is either 13·0 mm or more, the figure for none of them falling below 12·7 mm.

5. MARKING AND PACKING

5.1 Boots shall be indelibly and legibly marked with the following particulars:

a) Size and type shall be stamped on the inside and moulded on the waist of the outsole; and

b) Manufacturer's identification or trade-mark, if any, on the outside.

5.1.1 The boots may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. Presence of this mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control during production. This system, which is devised and supervised by ISI and operated by the producer has the further safeguard that the products as actually marketed are continuously checked by ISI for conformity to the standard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

*Schedule for wrought steel for general engineering purposes.
†Method for Vicker hardness test for steel.

5.2 Packing — The boots may be packed in polyethylene bags in pairs after dusting with French chalk and then packed in wooden boxes.

6. SAMPLING AND CRITERIA FOR CONFORMITY

6.1 The scale of sampling and criteria for conformity shall be as agreed to between the purchaser and the supplier. Helpful guidance may be obtained from IS : 2051-1962* with regard to scale of sampling and criteria for conformity.

7. TEST METHODS

7.1 Thickness — The sole and heel measurements at four positions indicated on the drawing of a section cut through in line with the moulded joint lines (*see* Fig. 1). The positions are:

a) Centre of toe cleat,

b) The tread of the sole,

c) Midway between last cleat and breast of heel, and

d) Centre of back cleat of heel.

NOTE — Sole measurements may include fillers to a maximum of 3·0 mm. Heel measurements may include fillers to a maximum of 6·0 mm.

7.1.1 For finding out the substance of the various parts of the boot as indicated in **4.1.3**, take measurements at positions roughly indicated by *A*, *B*, *C*, *D*, *E*, and *F* in Fig. 1.

7.2 Heat Treatment — Subject the entire boot or test pieces cut from it to accelerated ageing at 100° ± 1°C, in an air oven, for 24 hours in accordance with the method prescribed in IS : 3400 (Part IV)-1965†.

7.3 Hardness — Prepare samples from sole and heel and test for hardness in accordance with the method prescribed in IS : 3400 (Part II)-1965‡.

7.4 Abrasion Index — Prepare samples from sole and heel and test for abrasion index in accordance with the method prescribed in IS : 3400 (Part III)-1965§. For the determination, reference compound D specified in IS : 3400 (Part III)-1965§ shall be used as standard reference compound.

7.5 Flexing Endurance — Prepare samples from the vamp and test in accordance with the method prescribed in Appendix B.

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*Methods of sampling and test for leather footwear.

†Methods of test for vulcanized rubbers: Part IV Accelerated ageing.

‡Methods of test for vulcanized rubbers: Part II Hardness.

§Methods of test for vulcanized rubbers: Part III Abrasion resistance — Du Pont constant load method.

7.6 Adhesion — Prepare samples 25 ± 5 mm long from the leg portions and test in accordance with the method prescribed in IS : 3400 (Part V)-1965*.

7.7 Resistance to Oil — Prepare samples from the leg and vamp portion and test in accordance with the method prescribed in IS : 3400 (Part VI)-1967†.

7.8 Leakage Test — Seal the top of the boots. Force air into the boots to a minimum pressure of 0·15 kg/cm². Immerse the boot in water to within 75 mm of the top and examine for escape of air.

7.9 Impact Test — Carry out the impact test on boots in accordance with the method prescribed in Appendix A.

APPENDIX A

(Clauses 4.3.2 and 7.9)

DETERMINATION OF IMPACT VALUE OF STEEL TOE-CAP

A-0. GENERAL

A-0.1 An impact test for determining the performance of toes of protective boots reinforced with steel toe-cap to withstand a blow of 14 kg.m is described here.

A-1. REQUIREMENTS

A-1.1 Test Specimen — The boot shall be tested only after a minimum of 24 hours of its manufacture.

A-1.2 The test shall be made on the toe of a size 8 boot, reinforced with steel toe-cap. Other sizes of boots shall be made similarly to the tested boots and the toe-cap shall be made of the same material, treated in the same way and of the size proportionate to the size of the boot in which it is to be used.

A-1.3 Pattern of Boot — The test shall apply only to boots of the particular pattern as given in Fig. 1.

A-2. TEST MACHINE

A-2.1 The test machine shall be such that a 27·0 ± 0·2 kg weight can be allowed to fall freely on vertical guides from various predetermined heights

*Methods of test for vulcanized rubbers: Part V Adhesion of rubbers to textile fabrics.
†Methods of test for vulcanized rubbers: Part VI Resistance to liquid.

to strike a cylindrical mild steel plunger 38 mm in diameter and 145 mm long. The plunger shall be freely supported in a vertical guide, and shall have attached to its lower end a horizontal mild steel bar 115 mm long, 38 mm wide and 10 mm thick. The bar shall be such that it can rest on the toe of the boot in a position specified in **A-4.1**. The upper end of the plunger shall have a mild steel plate 63 mm wide, screwed to it which can be replaced if worn out. The above dimensions shall have a tolerance of ± 1 mm.

A-2.1.1 The base of the machine shall be solidly constructed of hard-wood 75 mm thick. To this shall be bolted a metal block 50 mm thick to support the steel plate on which the boot rests (*see* **A-4.2**).

A-3. MEASUREMENT OF IMPACT VALUE

A-3.1 Point of Measurement of Clearance Inside the Boot — The position of point of measurement of clearance inside the boot shall be found by using a size 8 last of the same shape as that on which the boot to be tested was made (*see* Fig. 3). The toe point is found by placing the last on a flat surface so that its inside surface and toe touches two vertical planes at right angles to each other. X is the point of contact of the toe with one of these planes. A line XY is drawn from toe to heel (the heel point can be located by eye with sufficient accuracy) and 28 mm is marked off down this line from the toe to give point A. A line perpendicular to XY is drawn through A cutting the outside edge of the last at P and the inside edge at Q. O is then marked so that $OQ = 0{\cdot}42 \times PQ$.

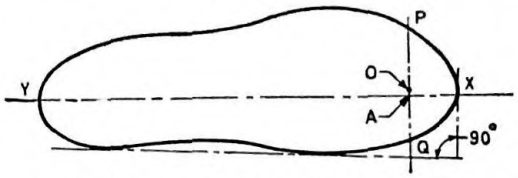


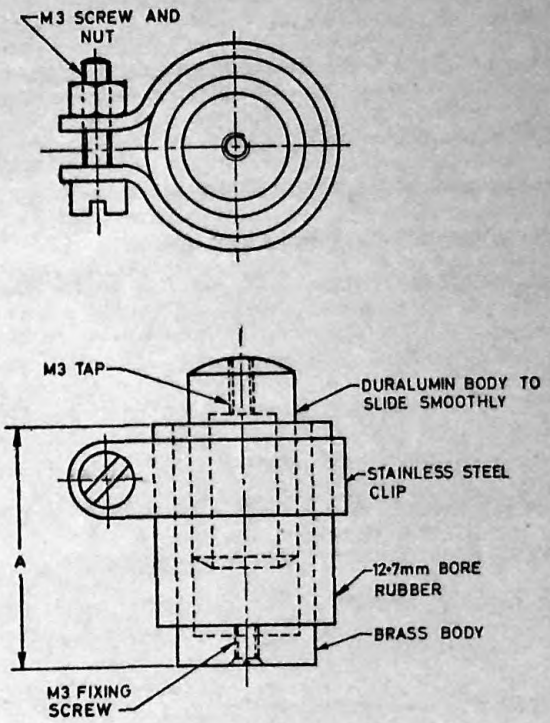
FIG. 3 POSITION FOR MEASUREMENT OF CLEARANCE INSIDE THE BOOT

NOTE — For a new last shape, the above procedure may be modified suitably by the testing laboratory if in their opinion the position obtained for measuring clearance is not a reasonable one.

A-3.1.1 The boot to be tested shall be drilled through the sole in such a manner that with the last in the boot, the drill comes through the insole at the point O on the last, and is approximately perpendicular to the surface of the last at the point. A suitable jig can be devised for this purpose.

A-3.2 Method of Measurement of Clearance at the Moment of Maximum Depression — A device capable of measuring the clearance, at the moment of maximum depression, between the insole and upper shall

be fixed to the insole by means of a screw passing through the hole drilled in the position defined in **A-3.1.1.** A suitable measuring device is shown in Fig. 4.



A = 11·90 mm
= 18·30 mm
= 21·40 mm

NOTE — Capsule size of 11·90 mm is intended for measuring depression under impact, size 18·30 mm for final clearance and size 21·40 mm for measuring initial clearance.

FIG. 4 CAPSULE FOR MEASURING THE CLEARANCE AT MOMENT OF MAXIMUM DEPRESSION

A-4. PROCEDURE

A-4.1 Clamping of Boot — The boot, with the measuring device inserted, shall be tightly clamped so that it cannot move longitudinally or laterally,

with its toe part on the flat horizontal steel plate. The angle of the boot shall be such that the forward 65 mm of the sole is judged by the operator to be on the average horizontal, and the boot shall be supported in this position by a wedge under the heel, the wedge being such that it supports only the heel and no part of the sole.

A-4.2 Position of Boot — The boot clamped as specified in **A-4.1** shall be positioned under the striking bar so that the measuring capsule is 10 mm behind the centre line of the bar. The bar shall rest on the boot with its longest direction roughly at right angles to the length of the boot.

A-4.3 Adjust the weight to a height of 508 $\pm$ 5 mm above the top of the vertical plunger as specified in **A-2.1** and allow it to fall freely. This gives the weight an impact of 14 kg.m as required in **4.3.2**. Measure the clearance inside the boot at the moment of maximum depression in millimetres and refer as such.

APPENDIX B

(*Clause* 7.5)

DETERMINATION OF FLEXING RESISTANCE

B-1. FLEXING RESISTANCE TEST FOR SOLE

B-1.1 Outline of the Method — This test determines resistance to initial cracking of rubber components of footwear cut out directly from the material, by the Ross flexing machine.

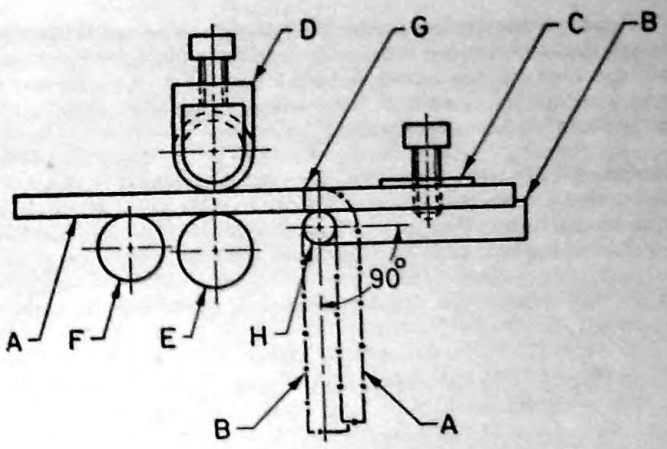
B-1.2 Apparatus

B-1.2.1 *Ross Flexing Machine* — A schematic diagram of Ross flexing machine is given in Fig. 5. The machine allows the fixed area of the specimen to bend freely over a rod of approximately 9·5 mm in diameter through an angle of 90°.

B-1.2.2 *Rule* — A rule of suitable length, graduated in steps of 0·25 mm is used for measuring the length of cut growth.

B-1.3 Procedure

B-1.3.1 *Test Specimen* — Cut out directly from the outer soles, test specimens of dimensions 25 $\pm$ 1 mm width and a minimum of 150 mm in length by the standard knife for cutting samples of Ross flexing machine.



A = Test specimen
B = Holder arm
C = Holder arm adjustment
D = Adjustable roller
E = Fixed lower roller
F = Supporting fixed roller
G = Pierced section
H = Rod over which specimen bends freely through a 90° angle

FIG. 5 SCHEMATIC DIAGRAM OF ROSS FLEXING MACHINE

B-1.3.2 Clamp the test specimens to the holder arm of the flexing machine in such a position that the designed surface of the sole could be flexed at 90°. The holder arm shall be in a horizontal position when the test specimens are attached. Let down the adjustable top rollers until they just touch the holder and lock in this position by means of the wing nuts, permitting free travel of the test specimens between the rollers during the bending movement.

B-1.3.2.1 After the test specimens have been attached as described, start the machine at 100 ± 5 cycles per minute. Make frequent observations and record the number of cycles at the initial crack. Record the number of cycles by the use of the counter.

B-1.4 Report — Average the results from observation of at least two test specimens and report as the number of cycles for crack.

B-2. FLEXING RESISTANCE FOR BODY

B-2.1 Apparatus — The machine has an adjustable stationary part, provided with grips 25·0 mm across for holding one end of each of the test

piece in a fixed position and a similar but reciprocating part for holding the other end of each of the test pieces. The reciprocating part is arranged so that the motion is in the direction of and in the same plane as the centre line between the grips. Its travel is adjusted so that the two sets of grips approach each other to a distance of 13 mm and separate to a distance of 57 mm. The eccentric which actuates the reciprocating part is driven by a constant speed motor to give 340 to 400 flexing cycles per minute. The motor should have sufficient power to flex at least six and preferably twelve test pieces at one test. The test pieces should be arranged in two equal groups so that one group is being flexed while the other group is being straightened, thus reducing the vibration in the machine. The grips shall hold the test pieces firmly and enable individual adjustment to be made to the test pieces.

B-2.2 Test Piece — The test piece shall have the dimensions shown in Fig. 6. Where the size and the style of the footwear permits, take four test pieces from one article of footwear. In other cases take three or two test pieces, whichever is possible, from one article of footwear. Cut the test

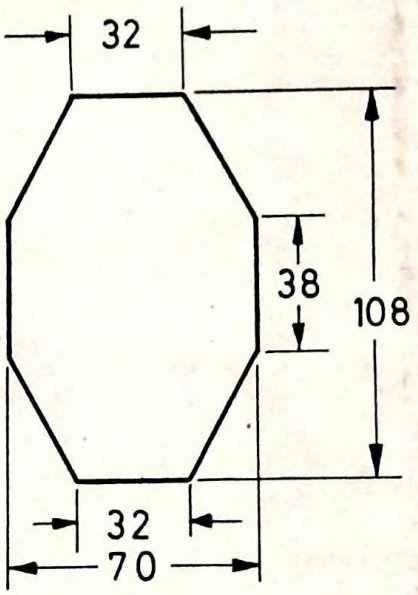


FIG. 6 TEST PIECE FOR FLEXING TEST

pieces from the thinnest portion of the upper containing the fewest plies of fabric. Take care to ensure that the test pieces are cut out cleanly from the sample material.

B-2.3 Procedure — Fold the test piece symmetrically about its major axis so that the rubber surface is outwards. In the folded condition insert one tapered end into the fixed central grip and push in until the sample touches the grip pins. Tighten this fixed grip. Take out the corresponding movable grip to its fullest extent; insert the test piece and pull flat and tighten the grip. It is recommended that clips may be used to keep the edges together during the insertion of the test piece in the grips, but their removal is essential before flexing commences.

NOTE — The test piece should not be under tension.

B-2.4 Expression of Results — A complete to-and-fro movement of the grip is counted as one flex cycle. Report the number of cycles required to start cracking. The flex cycle may be determined by using a trip counter operated by one of the movable grips. The ambient temperature during testing shall be not more than 27°C.

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2050-1967	Glossary of footwear terms (*under print*)	
2051-1962	Methods for sampling of leather footwear	1·50
2060-1962	Gents' leather shoes	4·50
2472-1969	Protective gaiters	5·50
3735-1966	Canvas shoe, rubber sole	3·00
3736-1966	Canvas boot, rubber sole	3·50
3737-1966	Leather safety boots for workers in heavy metal industries ...	3·50
3738-1966	Rubber knee boots	3·50
3976-1967	Safety rubber-canvas boots for miners	6·50
4585-1968	Football boots	4·00
5332-1969	Boy's and youth's school shoes	5·50
5333-1969	Leather cricket boots	4·00
5259-1969	Girls' and maids' school shoes	4·00
5557-1969	Industrial and safety rubber knee boots	6·00

Footwear Materials

177-1965	Cotton drills (*revised*)	2·50
178-1965	Cotton twills (*revised*)	2·00
179-1965	Dosuti (*revised*)	2·00
576-1954	Glazed kid for shoe uppers	1·00
578-1964	Full-chrome upper leather (*revised*)	1·50
579-1962	Sole leather (*revised*)	1·50
622-1956	Russet leather	1·00
1636-1960	Chrome waxed shoe leather	1·50
1720-1960	Cotton sewing thread, bleached or dyed	2·00
1746-1960	Shoe polish	2·50
1895-1961	Cotton tape *NEWAR*, grey or dyed	5·00
2276-1962	Vegetable and aluminium tanned snakeskins	4·00
2422-1963	Cotton fabric dyed, water resistant	2·00
2545-1963	Vegetable tanned lizardskins	2·50
2961-1964	Chrome retan upper leather	2·50
3297-1965	Water-resistant vegetable tanned sole leather	1·50
3840-1966	Lining leather	6·00
4128-1967	Fireman's leather boots	5·50
4512-1967	Footwear lasts, wooden	11·00