BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY

भारतीय मानक मसौदा

जयपुर पैर – विशिष्टि

(IS 17034 का पहला पुनरीक्षण)

Draft Indian Standard

Jaipur Foot — Specification

(First revision of IS 17034)

Artificial Limbs, Rehabilitation Appliances and Equipment for the Persons with Disability Sectional Committee, MHD 09	Last date for comments: **04 July 2025**

FOREWORD

(*Formal clauses will be added later*)

For an ergonomically efficient gait, the lower limb prosthesis must function in sync with the sound limb. The foot and ankle being the part that makes the first ground contact plays a critical role in providing this. Together the ankle and foot acts as a base of support during stance, a shock absorber for impact and a lever to propel the body forwards during swing.

The Jaipur Foot by virtue of its biomimetic design mirrors the functions of a normal human foot. Despite being non-articulated, it provides movement in three planes – dorsiflexion, pronation/supination and transverse rotation.

It is the most widely used artificial foot in India and rest of the developing world.

The prosthesis is hand-fabricated, using locally available raw materials of variable quality and fitted on the amputee. In practice, the wide safety margins inherent in the design and fabricated methodology of the prosthesis adequately compensate for all but gross variations in material or construction. For conformity that the Jaipur foot enjoys flexibility in several planes tests are incorporated in this standard.

After gaining experience test methods suitable for assessment of compliance of test requirements given in the standards have been included.

This standard was first published in 2018. This revision has been brought out to include the following:

1. In Table 2 for specifications of different components of rubber, values for relative density, relative volume loss, shrinkage at 100°C for 1 hour and compression set at constant strain have been modified.
2. For performance tests to determine Dorsiflexion, Pronation, Supination, Internal and External Rotation, the range of final values have been modified.

In addition to above, references to Indian Standards have been updated to latest version.

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 shall be rounded off in accordance with IS 2: 2022 ‘Rules for Rounding Off Numerical Values (*second revision*)’. The

number of significant places retained in the rounded off value should be the same as that of the value in this standard.

1 SCOPE

This standard covers dimensions and other requirements of Jaipur foot, used as one of the parts of prosthetics system.

2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS 3400 (Part 1): 2021/ISO 37: 2017	Methods of Test for Vulcanized Rubber Part 1 Tensile stress-strain properties (*fourth revision*)
IS 3400 (Part 2/Sec 2): 2023/ISO 48-2: 2018	Methods of Test for Rubber, Vulcanized or Thermoplastic Part 2 Determination of Hardness Section 2 Hardness Between 10 IRHD and 100 IRHD (*fifth revision*)
IS 3400 (Part 3): 2021/ISO 4649: 2017	Methods of Test for Vulcanized Rubber Part 3 Abrasion Resistance using a Rotating Cylindrical Drum Device (*third revision*)
IS 3400 (Part 4): 2012/ISO 188: 2011	Methods of Test for Vulcanized Rubber Part 4 Accelerated ageing and heat resistance (*third revision*)
IS 3400 (Part 7): 2021/ ISO 132: 2017	Methods of Test for Vulcanized Rubber Part 7 Determination of flex cracking and crack growth (De Mattia) (*second revision*)
IS 3400 (Part 9): 2020/ISO 2781: 2018	Methods of Test for Vulcanized Rubber Part 9 Rubber, Vulcanized or Thermoplastic — Determination of Density (*fourth revision*)
IS 3400 (Part 10/Section 1): 2022/ISO 815-1: 2019	Methods of test for Rubber, Vulcanized or Thermoplastic Part 10 Compression set Section 1 At ambient or elevated temperatures *(third revision)*

3 TERMINOLOGY AND DEFINITIONS

For the purpose of this standard the terminology and definitions of various parts as given in **3.1** to **3.4** shall apply (*see* also Fig. 1A and 1B).

3.1 Foot Length

The longitudinal length between mid-heel to mid grate toe as define in Fig.1.

3.2 Foot Height

The maximum height of the foot at heel section.

3.3 Girth Circumference

Circumference measured at ankle level section.

3.4 Ball Circumference

Circumference measured at ball girth section.

4 SHAPE AND DIMENSIONS

4.1 The dimensions and permissible tolerances of Jaipur foot for sizes 4 to 10 shall be as given in Table 1.

Table 1 Dimensional Requirements of Jaipur Foot in Relation to Standard Shoe Sizes

(*Clause* 4.1)

All dimensions in millimeters

Sl No.	*Foot Size*	*Foot Length (From Mid Heel to Mid Grate Toe)*	*Height of the Prosthetic Foot*	*Circumferential Length at Ankle Level*	*Circumferential Length at the Ball Girth*
(1)	(2)	(3)	(4)	(5)	(6)
i)	04	205 ± 3	110 ± 3	205 ± 3	185 ± 3
ii)	05	215 ± 3	110 ± 3	215 ± 3	195 ± 3
iii)	06	225 ± 3	120 ± 3	215 ± 3	195 ± 3
iv)	07	235 ± 3	120 ± 3	225 ± 3	205 ± 3
v)	08	245 ± 3	120 ± 3	225 ± 3	205 ± 3
vi)	09	255 ± 3	120 ± 3	235 ± 3	215 ± 3
vii)	10	265 ± 3	120 ± 3	235 ± 3	215 ± 3

4.2 For satisfactory performance and correct fitment, the shape of foot at various places that is, in toe, heel and medico-lateral surfaces shall be as indicated in Fig. 1A and Fig. 1B.

5 MATERIAL

The Jaipur foot shall be made from microcellular rubber sheet, tread rubber, skin rubber, cushion rubber compound as shown in Fig. 1C. The material shall comply with the requirements given in Table 2. All the tests of vulcanized rubber shall be carried out at 27°C ± 2°C

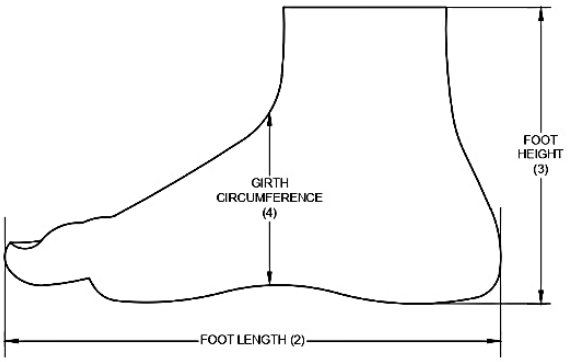

FIG. 1A JAIPUR FOOT

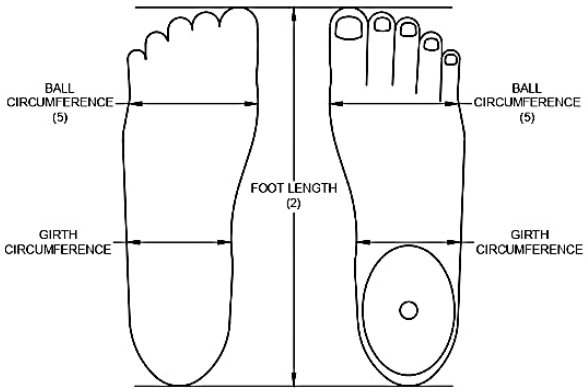

FIG. 1B JAIPUR FOOT

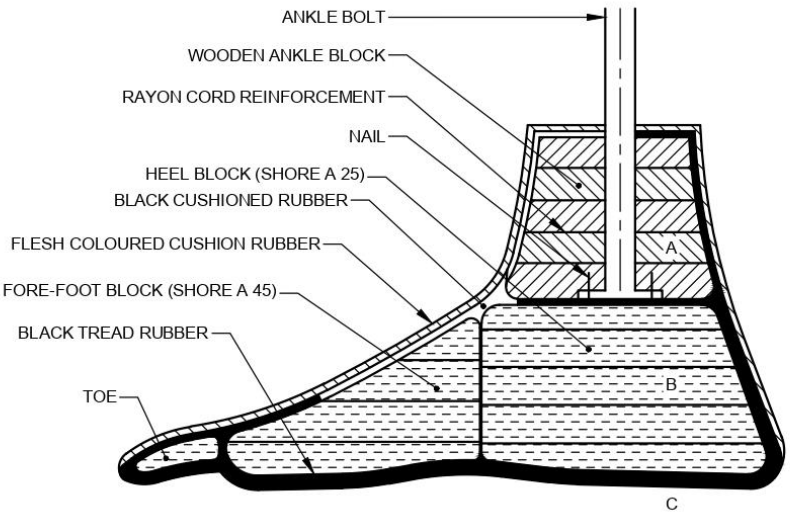

FIG. 1C COMPOSITE STRUCTURE OF FOOT

Table 2 Specification of Different Components of Rubber used for Fabrication of Jaipur Foot

(*Clause* 6)

Cushion Rubber	Skin Rubber	Tread Rubber	Micro Cellular Rubber Compound	*Different Component of Rubber (1)*	
Natural Rubber	Natural Rubber	Natural Rubber and SBR	Natural Rubber and Synthetic Rubber	*Base Polymer (2)*	
45 to 50 IRHD	50 ± 5 IRHD	55 ± 5 RHD	45 ± 5 RHD	*Before Ageing (3)*	**Hardness**
± 4 IRHD	± 4 IRHD	± 4 IRHD	± 5 IRHD	*Change after Ageing at 100 °C for 24 h (4)*	
1.1 *Max*	1.2 *Max*	1.1 *Max.*	0.4 ± 0.5	*Relative Density (5)*	
NA	220 cc *Max*	220 cc *Max*	600 cc *Max*	*Relative Volume Loss (6)*	
0.5 percent *Max*	0.5 percent *Max*	0.5 percent *Max*	3 percent *Max*	*Shrinkage at 100 °C for 1 h (7)*	
No crack growth at 60000 cycle	No crack growth at 60000 cycle	No crack growth at 60000 cycle	Initially crack growth at 5000 cycles	*Resistance to Flex Crack (8)*	
12 percent *Max*	12 percent *Max*	12 percent *Max*	25 percent *Max*	*Compression Set at Constant Strain (9)*	
12.5 MN/m^2 *Min*	12.5 MN/m^2 *Min*	12.5 MN/m^2 *Min*	NA	*Before Ageing (10)*	*Tensile Strength*
10.5 MN/m^2 *Min*	10.5 MN/m^2 *Min*	10.5 MN/m^2 *Min*	NA	*After Ageing at 100 °C for 24 h (11)*	
600 percent *Max*	600 percent *Max*	600 percent *Max*	NA	*Before Ageing (12)*	*Elongation at Break*
450 percent *Max*	450 percent *Max*	450 percent *Max*	NA	*After Ageing at 100 °C for 24 h (13)*	

6 TESTS

6.1 Hardness

The material shall conform to the requirements of hardness specified in Table 2 when tested in accordance with IS 3400 (Part 2/Sec 2).

6.2 Relative Density

The relative density of the material shall conform to the requirements specified in Table 2 when tested in accordance with IS 3400 (Part 9).

6.3 Relative Volume Loss

The material shall conform to the requirements of relative volume loss with abrasion test specified in Table 2 when tested in accordance with IS 3400 (Part 3).

6.4 Shrinkage Test

The material shall conform to the requirements of shrinkage test specified in Table 2 when tested in accordance Annex B.

6.5 Resistance to Flex Cracking

The material shall conform to the requirement of flex cracks test specified in Table 2 when tested in accordance with IS 3400 (Part 7).

6.6 Accelerated Ageing Test

The material after accelerated ageing test shall conform to the requirements for change in hardness and tensile strength and elongation at break specified in Table 2 when tested in accordance with IS 3400 (Part 1), IS 3400 (Part 2/Sec 2) and IS 3400 (Part 4).

6.7 Compression Set

The material shall conform to the requirements of compression set test specified in Table 2 when tested in accordance with IS 3400 (Part 10/Sec 1).

6.8 Tensile Strength and Elongation at Break

The material shall conform to the requirements of tensile strength and elongation at break specified in Table 2 when tested in accordance with IS 3400 (Part 1).

6.9 Performance Test

The performance of the Jaipur foot shall be confirmed through load deflection test and cycle loading test when tested in accordance to Annex A.

6.9.1 Linear or angular deflection of the foot consequent to controlled incremental loading shall be as per **6.9.2.1**, **6.9.2.2**, **6.9.2.3**, **6.9.2.4** and **6.9.2.5**.

6.9.2 The important functional characteristics of the Jaipur foot when tested on load deflection and cyclic loading apparatus as described in Annex A shall be as follows:

6.2.9.1 In the sagittal plane dorsal deflection (dorsiflexion plus toe extension) from the horizontal shall be 20° to 35° when the forefoot is loaded to 60 kg.

6.9.2.2 The heel of the Jaipur foot shall be compressible by 10 to 30 mm at a uniformly applied peak load of 60 kg. When the heel is compressed, the planter flexion of the forefoot shall also occur simultaneous.

6.2.9.3 The pronation and supination of foot shall be 20° to 30° and 15° to 25° respectively at a peak load of 40 kg.

6.2.9.4 An internal and external rotation shall be 10° to 15° and 4° to 12° respectively at a peak load of 40 kg.

6.2.9.5 After a prolonged cyclic loading of up to 300 000 cycles the essential functional features of the foot shall be re-examined and foot shall not show any appreciable changes in its flexibility in several planes. The testing shall be carried out 10-12 h in a day and cyclic loading will be from 30 to 60 cycles per minute. After completion of determined period of prolonged cyclic loading, the foot shall be allowed to cool down for half an hour before its functional parameters are re-examined.

a) Similar values for dorsiflexion and heel compression shall be obtained, proving that no deterioration occurs after such simulated fatigue; and
b) Also, no gross structural changes shall occur, except for minor thinning of the sole as a result of prolonged cyclic loading.

7 MARKING

7.1 Each Jaipur foot shall be marked with the following:

a) Indelibly and clearly with its size and side, either stamped or engraved at the lower sole; and

b) Manufacturer’s name, initials or recognized trade- mark.

7.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

8 PACKAGING

Jaipur foot shall be packed in polyethylene bags, using suitable cushioning material and shall than be packed in individual cartons.

ANNEX A

(Clause 6.9)

TEST METHODS FOR PERFORMANCE TEST
[Figure/Sketch of the testing apparatus are depicted in Fig 2A to 2M]

A-1 The performance of the Jaipur foot shall be confirmed through load deflection test and cycle loading test as given in below:

A-1.1 This measures linear or angular deflection of the foot consequent to controlled, incremental loading. It consists of a spring balance suspended from a cantilever attached to a vertical steel column. A sliding bracket rides over the column. Attached to the sliding bracket is a lever arm that has at its free end two clamping devices to hold the prosthesis vertically or horizontally. A thread shaft runs through a nut incorporated in the sliding bracket. The thread shaft is rotated through a beveled gear system operated by a hand wheel. By rotating the thread shaft, the sliding bracket can be made to slide up or down, carrying the clamped prosthesis with it.

For holding the foot horizontally, a clamping device is used to attach the foot on the upper surface of the lever arm.

A-1.2 Clamping Devices

The free end of the horizontal lever arm has a longitudinal opening through which the carriage bolt of the prosthesis can be passed and fixed with a nut. The lever arm carries, on its under-surface, a vertical plate with a forward-facing concavity that receives the ankle of the prosthesis. The ankle is held in place by another plate that passes in front of it and which is screwed onto the concave plate, thereby sandwiching the ankle firmly, and fixing the foot vertically.

A-2 The cyclic loading apparatus which simulates continuous use is utilized for fatigue studies. As in the load deflection equipment, the cyclic loading apparatus has a sliding bracket which rides over a vertical steel column. A thread shaft runs though and is not incorporated in the sliding bracket; the shaft is rotated through a beveled gear system which is operated by a hand wheel.

A lever arm with a prosthesis clamping device at its free end is attached to the sliding bracket. The lever arm tilts downward at 20°. Thus, the sole of an ankle foot prosthesis held in a clamp makes an angle of 20° with the horizontal plane.

A horizontal plate is fixed below the foot clamp. The plate is hinged works like a rocking platform, and is lifted periodically through a distance of 2.5 cm by a rotating cam driven through a belt-pulley system by a motor. A reduction gear is affected so that the plate is lifted by the cam 60 times a minute. The plate, as it lifts dorsiflexes the fixed foot and simulates forefoot loading. The cam has a ball bearing ring to avoid friction with the plate.

A-3 The important functional characteristics of the Jaipur foot as revealed by the load deflection and cyclic loading apparatuses are as follows:

A-3.1 In the sagittal plane it is capable of 20° to 35° dorsal deflection (dorsiflexion plus toe extension) from the horizontal when the forefoot is loaded to 60 kg, the deflection is load dependent and varies directly with the load. The load deflection parameters, for a given size produced from the same mould, are uniform with a narrow intra-group variation. The peak deflection at 60 kg is essentially identical for extreme foot size 6 and 9, dorsiflexion is associated with rolling forward of the heel.

A-3.2 For dorsiflexion and ankle torsion, the mid-heel to toe break distance is used as the best estimate of the length of the moment arm, since the level of the axes in either case is mid-heel.

For pronation/supination, the best-guess axis is a longitudinal line passing through the second toe. The distance from the point of application of the force to the axis for both supination and pronation is = (width at toe break/2 since this line passes through the mid-point of the breadth of the foot at the toe break level.

A-4 The compressibility is uniformly loading dependent. Although considerable intra-group variation exists, the peak compressibility is not size or weight dependent. When the heel is compressed, simultaneous planter flexion of the forefoot occurs.

A-5 Jaipur foot enjoys flexibility in several planes. The flexibility (deformability) of the Jaipur foot is due to:

a) The variable density of the rubber core block;
b) Interaction at the interface of the wooden ankle block and rubber heel-block; and
c) The quality and thickness of the external rubber shell.

The direction, width and number of layers of the tyre cord strips appear to restrain and modulate flexibility in various directions thereby simulating facial, muscular and tendons functions in the living foot. The individual prosthesis being hand fabricated, it is possible for the fabricator to modify a desired functional attribute of the prosthesis by altering either the hardness of the inner core or by altering the orientation, pattern and number of layers of the tyre cord bands at a desired site in the external shell.

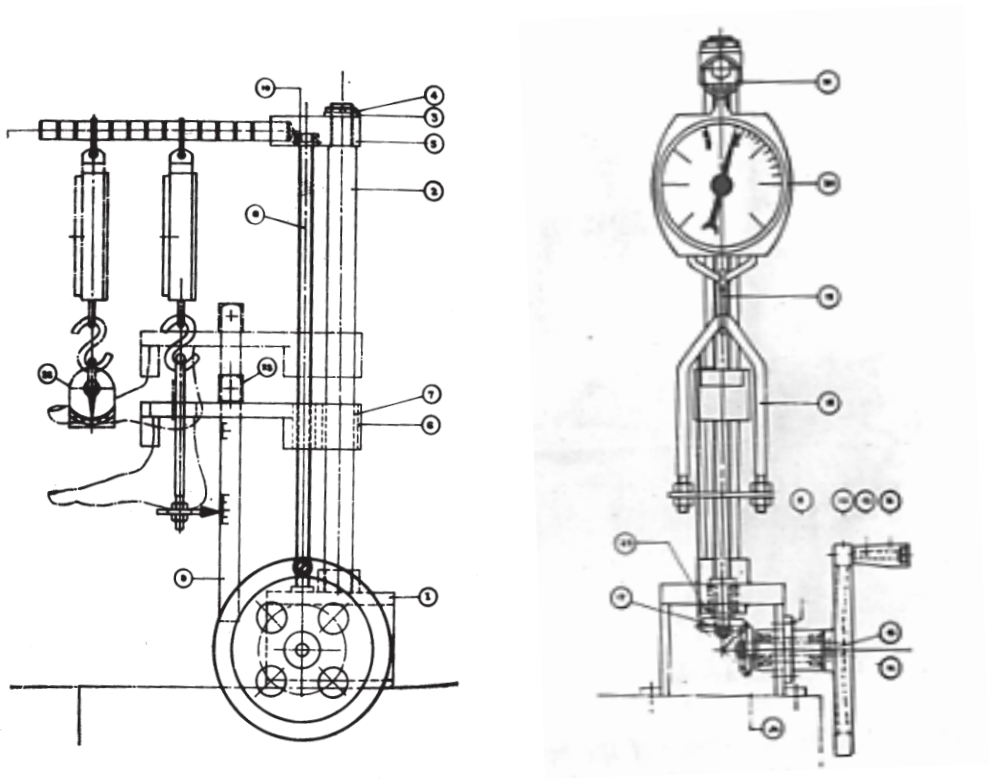

FIG. 2A LOAD DEFLECTION APPARATUS (SIDE VIEW) AND (FRONT VIEW)

1 = Base; 2 = Column; 3 = Washer; 4 = Nut, 5 = Cantilever; 6 = Sliding Bracket; 7 = Bush; 8 = Thread Shaft; 9 = Steel Scale 25 cm; 10 = Ball BEARING 115; 11 = BRG Housing; 12 = Hand Wheel; 13 = Screw; 14 = Handle; 15 = Shaft; 16 = Locking Pin; 17 = Bevel Gear; 18 = Heel compression Stirrup; 19 = Link; 20 = Spring Balance; 21 = Ring; 22 = Dorsiflexion Stirrup with Goniometer on the. Side-arm; 23 = Bracket; 24 = Key; 25 = External Circlip;

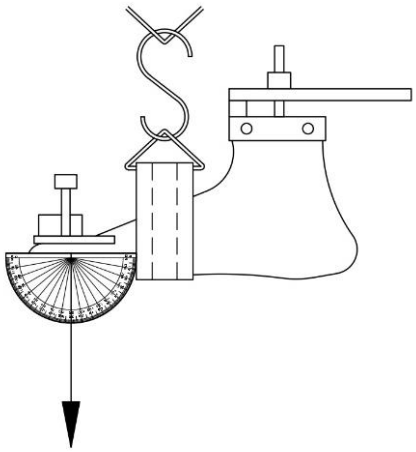

FIG. 2B SLING FOR MEASURING DORSIFLEXION

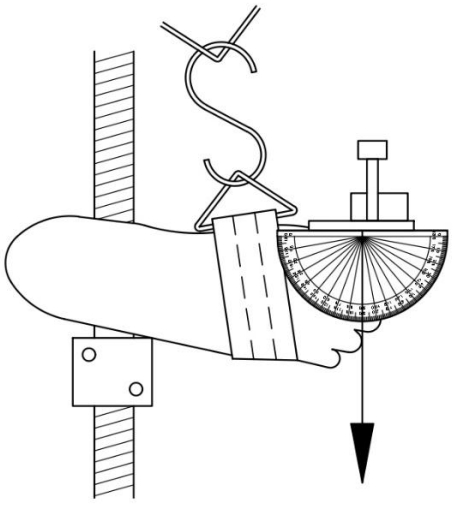

FIG. 2C SLING FOR MEASURING MEDICAL TORSION

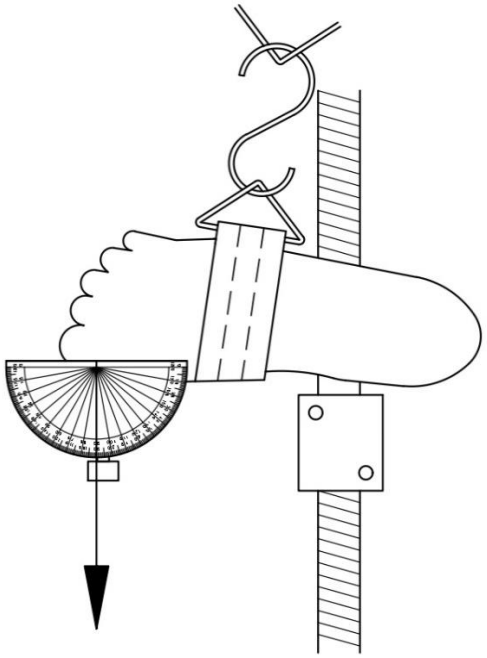

FIG. 2D SLING FOR INTERNAL TORSION

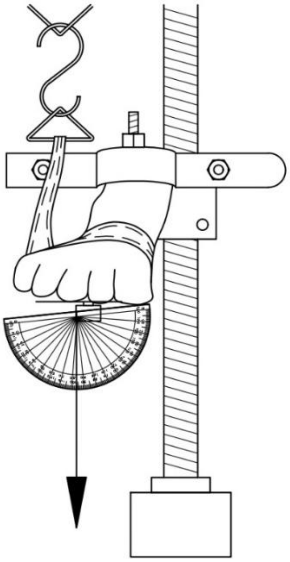

FIG. 2E SLING FOR MEASURING PRONATION

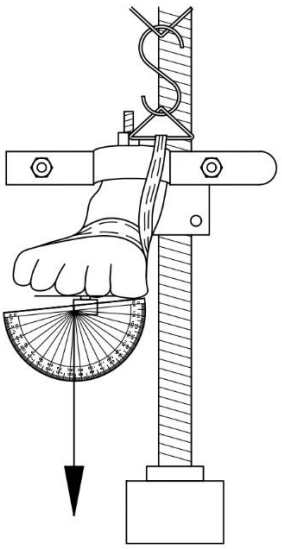

FIG. 2F SLING FOR MEASURING SUPINATION

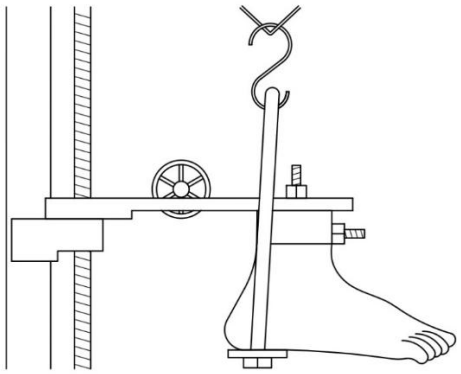

FIG. 2G MEASURING HEEL COMPRESSION

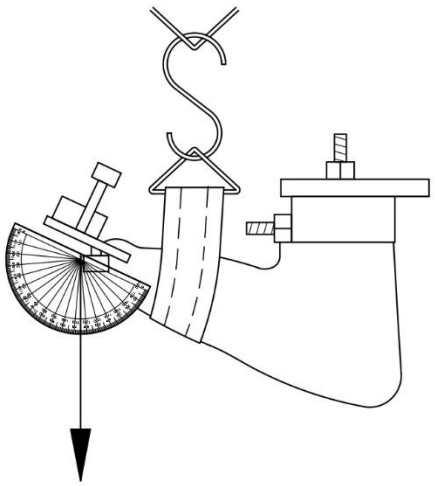

FIG. 2H MEASURING DORSIFLEXION

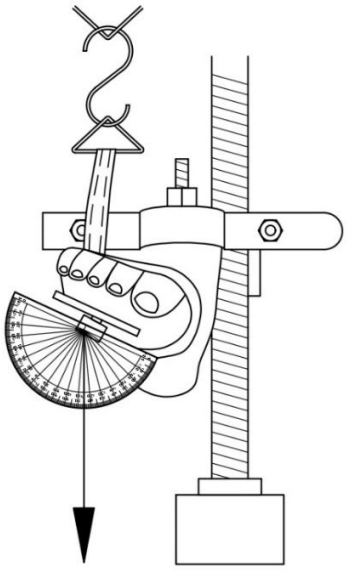

FIG. 2I MEASURING PRONATION

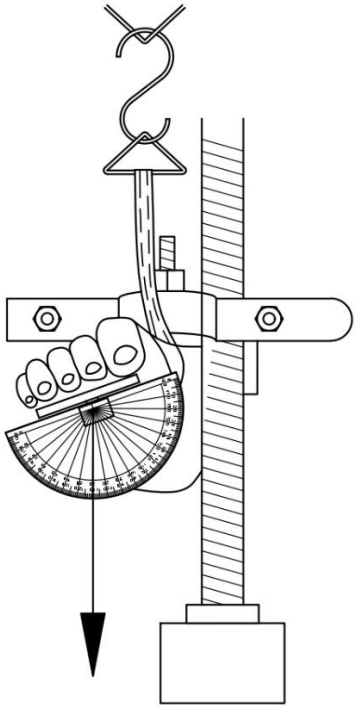

FIG. 2J MEASURING SUPINATION

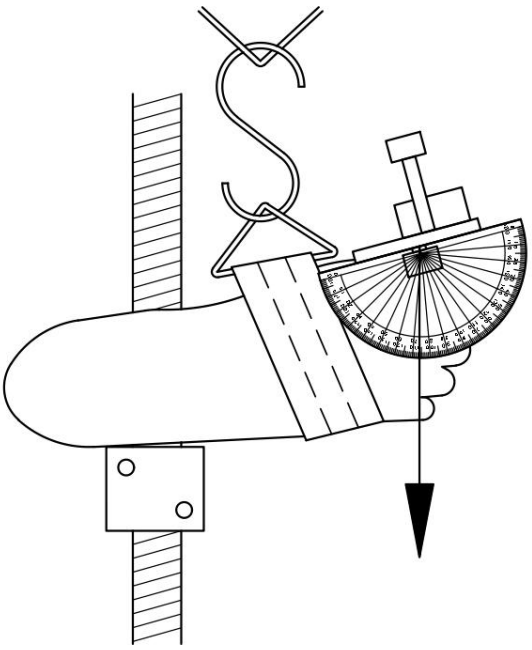

FIG. 2K MEASURING TORSION

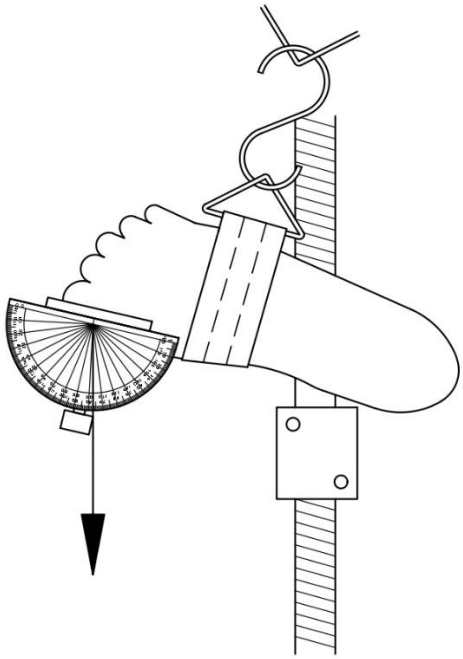

FIG. 2L LATERAL TORSION

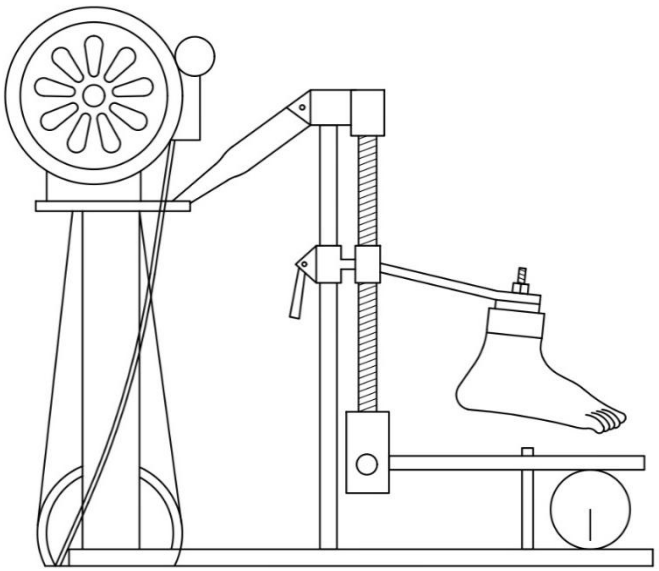

FIG. 2M CYCLIC LOADING APPARATUS IN USE

ANNEX B

(*Clause* 6.4)

TEST METHOD FOR SHRINKAGE TEST

B-1 APPARATUS

B-1.1 Electrically operated and thermostatically controlled heating cabinet (oven) with natural replacement of air.

B-1.2 Suitable scale, least count 0.5 mm.

B-2 TEST SPECIMEN

B-2.1 A sample of the test specimen about 200 mm in length shall be taken measured with an accuracy of 0.5 mm.

B-2.2 Number of Specimens — Three.

B-3 CONDITIONING

No pre-conditioning is required.

B-4 PROCEDURE

B-4.1 The specimen prepared in accordance with **B-2.1** shall be kept horizontally in the oven at a temperature and for a duration specified in relevant specification.

B-4.2 After this period, the specimen shall be taken out of the oven and cooled down in air to 27± 2°C.

B-4.3 The longitudinal shrinkage of the rubber shall be measured with an accuracy of 0.5 mm. Also, the specimen shall be examined visually for any cracks.

B-5 TABULATION OF OBSERVATION

Length of Specimen before Shrinkage Test, l_1	Length of Specimen after Shrinkage Test, l_2	Visual Examination Before of Surface Condition

B-6 CALCULATION

$$\text{Percentage shrinkage} = \frac{l_1 - l_2}{l_1} \times 100$$

The results for the three test pieces shall be within 5 percent of the mean value; if they do not fall within the given range, the test shall be repeated.