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Reference	Date
CED 22:5/ T- 3	**22 03 2013**

TECHNICAL COMMITTEE: FIRE FIGHTING SECTIONAL COMMITTEE, CED 22

ADDRESSED TO :

1 Interested Members of Civil Engineering Division Council, CEDC
2. All members of CED 22 & CED 22:5
3. All others interested

Dear Sir,

Please find enclosed the following draft :

Doc No.	Title
CED 22 (7887)	**Protective Helmets for two wheeler riders – Specification (Fourth Revision of IS 4151)** **ICS No. 13.340.20;43.140**

Kindly examine the draft and forward your views stating any difficulties which you are likely to experience in your business or profession, if this is finally adopted as National Standard.

Last Date for comments : **30 05 2013**

Comments if any, may please be made in the format as given overleaf and mailed to the undersigned at the above address.

In case no comments are received or comments received are of editorial nature, you will kindly permit us to presume your approval for the above document as finalized. However, in case of comments of technical in nature are received then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional Committee for further necessary action if so desired by the Chairman, Sectional Committee.

The document is also hosted on BIS website **www.bis.org.in**.

Thanking you,

Yours faithfully,

(C. R. Rajendra)
Sc `F' & Head (Civil Engg.)
email : ced@bis.org.in

Encl: as above

FORMAT FOR SENDING COMMENTS ON BIS DOCUMENTS

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Please e-mail your comments to ced@bis.org.in or srikanthyajjala@bis.org.in or Fax to 011 23235529

NAME OF THE COMMENTATOR/ORGANIZATION:

DOC. NUMBER AND TITLE:

Sl.No. (1)	Clause/Subclause/ Para No. (2)	Comments/suggestions (3)

Doc: CED 22 (7887)
IS 4151:

Draft *Indian Standard*

PROTECTIVE HELMETS FOR TWO WHEELER RIDERS – SPECIFICATION

(*Fourth Revision*)

Last date for receipt of comments is: 30 05 2013

Fire Fighting Sectional Committee, CED 22

FOREWORD

Helmet is one of the most important items of personal protective equipment used by scooter and motorcycle riders for protection against the hazards connected with driving on roads. This standard has been framed to cover provisions of protective helmets for everyday use by the scooter and motorcycle riders.

The protection given by wearing of the helmets for which requirements have been laid in this standard is not complete and wearing of the helmet may not prevent injury and/or death in severe accidents.

This standard was first issued as an emergency Indian Standard in 1967 (made as firm in 1968) and subsequently revised in 1976, 1982 and 1993. This revision has been taken up on the basis of experience gained during these years and to bring in line with latest thinking at international level, such as European regulations. The standard has been aligned with EC Regulation No. 22, Revision 4 incorporating 05 series of amendments to the extent possible, keeping in view Indian conditions.

The principal modifications are with respect to the following:

a) Impact absorption test has been modified with number of additional impact points, use of kerb stone anvil, increased impact velocity and head injury criteria etc.
b) New tests to simulate the abrasion of helmet, chin guard and for effectiveness of the retention system.
c) Inclusion of side impact test under various conditions of temperature and humidity.
d) Allowance for ventilation of the head, while wearing the helmet.

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 `Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft *Indian Standard*

PROTECTIVE HELMETS FOR TWO WHEELER RIDERS – SPECIFICATION

(*Fourth Revision*)

1 SCOPE

1.1 This standard covers the requirements regarding the materials, construction, workmanship, finish, mass and performance for protective helmets (with or without lower face cover) for everyday use by two wheeler riders.

1.2 The helmets covered by this standard are not intended for high-speed competitive events.

2 REFERENCES

The standards listed below 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*
1884:1993	Automotive vehicles: Electric horns – Specification (Third revision)
9973:1981	Specification for visor for scooter helmets
9779:1981	Sound level meters
9844:1981	Methods of testing corrosion resistance of electroplated and anodized aluminium coatings by neutral salt spray test

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply (*see* Fig. 1).

3.1 Two Wheeler

Any two wheeled motor vehicle with or without detachable side car.

3.2 Protective Helmet

A helmet primarily intended to protect the wearer's head against impact (*see* Fig. 1).

3.3 Shell

The hard part of the protective helmet which gives it its general shape.

3.4 Protective Padding

A material used to absorb impact energy.

3.5 Comfort Padding

A material provided for the wearer's comfort.

3.6 Retention System

The complete assembly by means of which the helmet is maintained in position on the head, including any devices for adjustments of the system or to enhance the wearer's comfort.

3.6.1 *Chin Strap*

A part of the retention system consisting of a strap that passes under the wearer's jaws to keep the helmet in position.

3.6.2 *Chin Cup*

It is an accessory of the chinstrap that fits round the point of the wearer's chin.

3.7 Peak

It is an extension of the shell above the eyes.

3.8 Lower Face Cover

A detachable, movable or integral (permanently fixed) part of the helmet covering the lower part of the face.

3.8.1 *Protective lower face cover*

A detachable, movable or integral (permanently fixed) part of the helmet covering the lower part of the face and intended to protect the chin of the user against impacts.

3.8.2 *Non protective lower face cover*

A detachable, movable or integral (permanently fixed) part of the helmet covering the lower part of the face that does not protect the chin of user against impact.

3.9 Visor

A transparent protective screen extending over the eyes and covering all or part of the face.

3.10 Basic Plane of the Human Head

A plane at the level of the opening of the external auditory meatus (external ear opening) and the lower edge of the orbits (lower edge of the eye sockets) (*see* Annex A).

3.11 Basic Plane of the Headform

A plane, which corresponds to the basic plane of the human head (*see* Annex A).

3.12 Central Vertical Axis

The line relative to human head or headform or helmet that lies in the plane of symmetry, and that is normal to the basic plane at a point equidistant from the front and back of the head or the headform or (for helmet) of the headform that simulates the head that the helmet is intended to fit (Fig. 2 A of Annex A).

3.13 Reference Plane (*see* Annex A)

A construction plane parallel to the basic plane of the headform at a distance from it, which is a function of the size of the headform.

3.14 Neck Curtain

A part of the helmet attached to the lower edge of the helmet designed to protect against adverse weather conditions, dirt and small stones.

3.15 Ocular areas means two circles of minimum diameter 52 mm spaced symmetrically about the vertical centre line of the visor, the distance between the centres of the circles being 64 mm measured in the horizontal front plane of the visor as worn.

PROTECTIVE HELMET

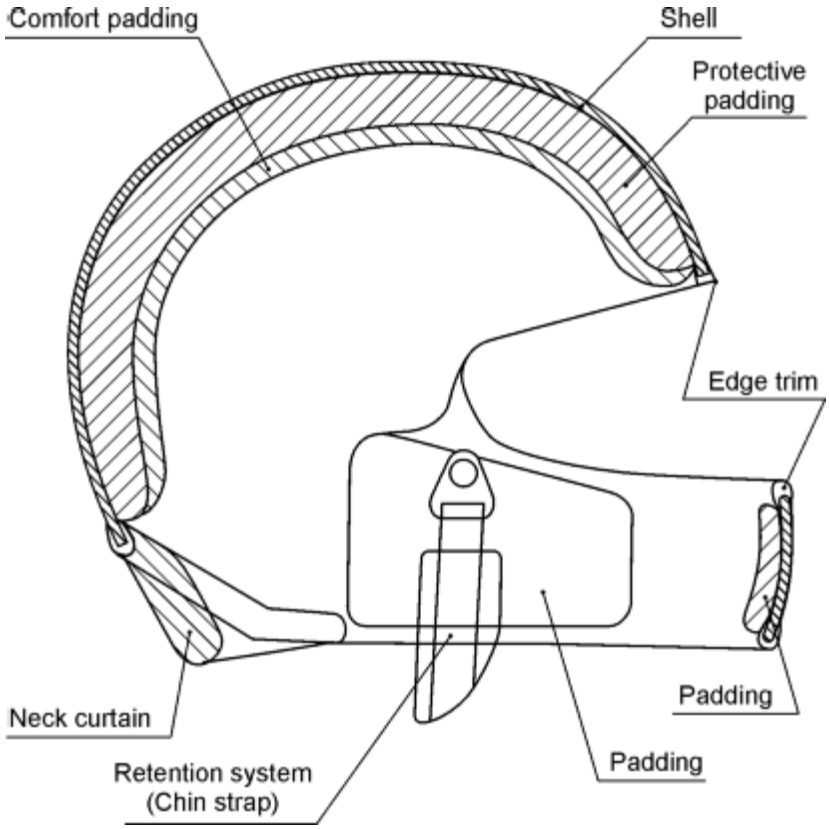


Fig 1 TYPICAL SKETCH SHOWING INTERNAL COMPONENTS OF HELMET

4 MATERIAL

4.1 Shell

The shell of the helmet shall be of metallic or non-metallic materials conforming to the test requirements.

4.2 Protective Padding

It may be of expanded polystyrene or any other material having similar properties.

4.3 Comfort Padding

It may be of expanded polyurethane foam, polyethylene or any other suitable material having similar properties.

4.4 Retention System

The criteria for selection of material for chin strap and comfort padding shall be sweat-resistant, not-irritant and shall not be known to cause skin disease.

4.5 Metal Parts

The metal parts in helmet shall be either inherently corrosion resistant or shall have been treated for corrosion resistance. Such parts shall show no sign of corrosion when subjected to test as specified in IS 9844.

4.6 VISOR

If provided, it shall conform to IS 9973.

5 SIZES

Helmets shall be of the sizes matching to the sizes of headform of 500, 520, 540, 560, 570, 580, 600 and 620 mm.

6 CONSTRUCTIONAL REQUIREMENTS

6.1 General

6.1.1 The basic construction of the helmet shall be in the form of a hard outer shell containing additional means of absorbing impact energy and a retention system.

6.1.2 The protective helmet may be fitted with earflaps and a neck curtain. It may also have a detachable peak, a visor and a lower face cover. Visor, if fitted, shall meet the requirements of IS 9973. If fitted with a non protective lower face cover the outer surface of the cover shall be marked "Does not protect chin from impacts" and/or with the symbol shown in Figure 2 indicating the unsuitability of the lower face cover to offer any protection against impacts to the chin.

Fig 2 Symbol ‘Does not protect chin from impacts’

6.1.3 No component or device shall be fitted to or incorporated in the protective helmet unless it is designed in such a way that it shall not cause injury and that, when it is fitted to or incorporated in the protective helmet, the helmet still complies with the requirements of this standard.

6.2 Shell

The extent of the protection provided shall be as given in **6.2.1** to **6.2.7**.

6.2.1 The shell shall cover all areas above plane AA and shall extend downwards at least as far as the lines CDEF on both sides on the headform (*see* Fig. 2 of Annex A).

6.2.2 At the rear, the rigid parts and, in particular, the shell shall not be within a cylinder of diameter 100 mm and with axis situated at the intersection of the medium plane of symmetry of the headform and of a plane parallel to and 110 mm below the reference plane (*see* Fig. 1 of Annex A).

6.2.3 The helmet shall not dangerously affect the wearer's ability to hear and shall conform to the requirements laid down in **7.6** (Audibility Test).

6.2.4 The temperature in the space between the head and the shell shall not rise inordinately. To prevent this ventilation holes may be provided in the shell. Ventilation may be provided for increasing the comfort of the rider.

6.2.5 The outer surface shall be perfectly smooth. Above the reference plane, the shape shall be in the form of continuous, convex curve, except where shaping is provided for functional purposes. Below the reference plane, irregularities in the curve shall be smoothly faired. The shell shall not incorporate an integral peak, but may incorporate in integral lower face cover. Where means for attaching a visor are not provided, the profile at the front edge shall not prevent the wearing of goggles.

6.2.6 All projections from or irregularities in the outer surface of the shell greater than 2 mm shall be tested for shear assessment according to test for surface friction and projections as per **7.4**. The outer surface of the helmet shall be tested for friction assessment according to test for surface friction & projections.

6.2.7 All external projection shall be radiused and any external projections other than press fasteners shall be smooth and adequately faired. Rivet heads shall be radiused and shall not project more than 2 mm above the outer surface of the shell and shall have a radius of minimum of 1 mm. All external projections more than 2mm above the outer surface of the shell shall have a radius of minimum of 2 mm. The later specific requirements shall not apply if a projection satisfies the requirement in **7.4.1** and **7.4.2**.

6.2.8 There shall be no inward-facing sharp edges on the inside of the helmet. Rigid projecting internal parts shall be covered with padding so that any stresses transmitted to the head are not highly concentrated.

6.2.9 The various components of the protective helmets shall be so assembled that they are not liable to become easily detached as a result of an impact.

6.3 Protective Padding

The protective padding shall cover all the areas defined in **6.2.1** taking into account the requirements given in **6.2.3**.

6.4 Retention System

The helmet shall be held in place on the wearer's head by means of a retention system, which is secured under the lower jaw. All parts of the retention system shall be permanently attached to the system or to the helmet.

6.4.1 *Chin Strap*

If the retention system includes a chinstrap, the strap shall not be less than 20 mm wide under a load of 150 N ± 5 N applied under the conditions given in **7.5.2**.

6.4.2 The chin strap shall not include a chin-cup.

6.4.3 Chinstraps shall be fitted with a device to adjust and maintain tension in the strap.

6.4.4 Chin strap fastening and tensioning devices shall be positioned on the straps either so that there are no rigid parts extending more than 130 mm vertically below the headform reference plane with the helmet mounted on the appropriate sized headform, or so that the whole of the device is between the bony projections of the undersize of the lower jaw.

6.4.5 If the retention system includes either a double-D ring or sliding bar fastening device then means shall be provided to prevent the retention system being completely undone and also to retain the free end of the strap when the retention system is adjusted.

6.4.6 Sliding bar and double-D ring fastening devices shall be fitted with a pulling type flap to be used for releasing the retention system. Its colour must be red and its minimum dimensions must be 10 x 20 mm.

6.4.7 If a retention system includes a quick-release mechanism, then the method of release of this mechanism shall be self-evident. Any levers, tabs, buttons or other components which need to be operated to release the mechanism shall be coloured red, those parts of the rest of the system which are visible when closed shall not be similarly coloured, and the mode of operation shall be permanently indicated.

6.4.8 The retention system shall remain closed when the tests described in **7.2** (Impact absorption test), **7.5** (dynamic test of retention system) and **7.7** (retention test) are carried out.

6.4.9 The buckle of the retention system shall be designed so as to preclude any possibility of incorrect manipulation. This means, inter-alia, that it must not be possible for the buckle to be left in a partially closed positions.

6.4.10 The characteristics or the materials used in the manufacture of helmets shall be known not to undergo appreciable alteration under the influence of ageing, or of the circumstances of use to which the helmet is normally subjected, such as exposure to sun, extremes of temperature and rain. For the parts of the helmet coming into contact with the skin, the materials used shall be known not to undergo appreciable alteration through the effect of perspiration or of toilet preparations. The manufacturer shall not use materials known to cause skin troubles. The suitability of a proposed new material shall be established by the manufacturer.

6.4.11 After the performance of one of the prescribed test, the protective helmet shall not exhibit any breakage or deformation dangerous to the wearer.

6.5 Peripheral Vision

6.5.1 To carry out the test, protective helmet shall be selected from among the existing sizes of a helmet type the size if considers likely to yield the least favorable results.

6.5.2 The helmet shall be placed on the head form corresponding to its size of a helmet type by the procedure set out in Annex B.

6.5.3 In the above conditions there shall be no occultation in the field of vision bounded by, (*see* Fig. 1 and Fig. 2 of Annex A).

6.5.3.1 *Horizontally*

Two segments of dihedral angles symmetrical in relation to the median longitudinal vertical plane of the headform and situated between the reference and the basic planes.

Each of these dihedral angles is defined by longitudinal vertical median plane of the headform and the vertical plane forming an angle of not less than 105° with the median longitudinal vertical plane and whose edge is the straight line LK.

6.5.3.2 *Upwards*

A dihedral angle defined by the reference plane of the headform and a plane forming an angle of not less than 7° with the reference plane and whose edge is the straight line L_1, L_2; the points L_1 and L_2 representing the eyes.

6.5.3.3 *Downwards*

A dihedral angle defined by the basic plane of the headform and a plane forming an angle of not less than 45° with the basic plane and whose edge is the straight line K_1, K_2.

6.6 Workmanship and Finish

6.6.1 All edges shall be smooth and rounded. Any external or internal projection permitted under **6.2.6** and **6.2.7** shall be soft, smooth and adequately faired to other surfaces.

6.7 Mass

The protective helmets with lesser mass are preferred and may be available with the increasing availability of more advanced composites and materials. However, mass of the complete helmet (without peak, visor and detachable lower face cover, if provided) shall not exceed 1500 g.

6.8 Conspicuity

6.8.1 *General*

Helmet may be marked by conspicuity markings to aid both during day and night time visibility as specified in clauses to follow:

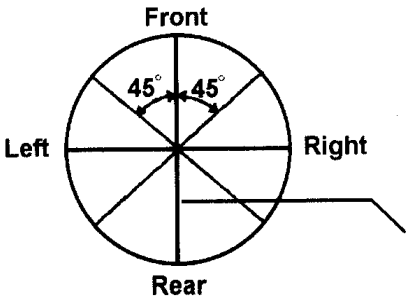
a) Position of the markings shall be on the front, rear, right and left side of the helmet;

b) The reflective parts shall not be removable without damage to the helmet.

6.8.2 *Reflective Parts*

6.8.2.1 *Geometry*

The total surface area and shape of the reflective part used shall be such that in each direction, corresponding to one of the areas defined in the figure 3, visibility is ensured by a surface area of at least 18 cm^2 of simple shape and measured by application on a plane.



Longitudinal vertical plane of symmetry

In each surface area of minimum 18 cm^2 it shall be possible to mark: either a circle of 40 mm diameter; or, a rectangle at least 12.5 cm^2 in surface area and at least 20 mm in width.

Each of these surfaces shall be situated as near as possible to the point of contact with the shell of a vertical plane parallel to the longitudinal vertical plane of symmetry, to the right and to the left, and as near as possible to the point of contact with the shell of a vertical plane perpendicular to the longitudinal plane of symmetry, to the front and to the rear.

7 TESTS FOR HELMETS

7.1 Each type helmet shall be conditioned as shown below.

Number of helmets to be conditioned					**Total**
Test	Solvent + Ambient Temperature and Hygrometry Conditioning	Solvent + Heat Conditioning	Solvent + Low Temperature Conditioning	Solvent + Ultra violet Radiation Conditioning and Moisture Conditioning	
Impact absorption	2	1	1	1	5
Rigidity	2				2
Retention system	1				1

The largest size of each helmet type shall be tested for impact absorption and rigidity. For tests of the rentention system, helmet size shall be chosen such that the helmet to be tetsed shall be that offering the least favourable conditions (such as thickest padding, etc.)

Additionally, for each smaller headform size within the size range of the helmet type two helmets shall undergo the impact absorption test. One helmet shall be heat conditioned, and the other low temperature conditioned. The conditioned helmets shall be impacted against either anvil, in equal numbers if possible, at the choice of the laboratory.

7.1.1 *Types of Conditioning*

7.1.1.1 *Solvent conditioning*

Take a cotton cloth approximately 150 mm square and a quantity approximately 25 ml of a solvent consisting of test liquid with (70 percent octane and 30 percent toluene). Using the cloth soaked in the solvent, apply the solvent to all those regions of the outside surface of the helmet shell within 50 mm of the chin strap fixings and

keep these regions wet within the solvent for 7.5 ± 2.5 s. Repeat the procedure on the remainder of the external surfce including any chin guard, keeping these regions wet for 12.5 ± 2.5 s. No further conditioning or testing be done during the following 30 min.

7.1.1.2 *Ambient temperature and hygrometry conditioning*

The helmet shall be exposed to a temperature of 25 ± 5°C and a relative humidity of 65 ± 5 percent for at least 4 h.

7.1.1.3 *Heat conditioning*

The helmet shall be exposed to a temperature of 50 ± 2°C for not less than 4 h and not more than 6 h.

7.1.1.4 *Low-temperature conditioning*

The helmet shall be exposed to a temperature of -20 ± 2°C for not less than 4 h and not more than 6 h.

7.1.1.5 *Ultraviolet-radiation conditioning and moisture conditioning*

The outer surface of the protective helmet shall be exposed successively to ultraviolet irradiation by a 125 watt zenon filled quartz lamp for 48 h at a range of 25 cm, followed by spraying for 4 to 6 hours with water at ambient temperature at the rate of 1 litre per minute.

7.2 Impact Absorption Test

7.2.1 *Requirements*

7.2.1.1 The absorption efficiency shall be considered sufficient where the resultant acceleration measured at the centre of gravity of the headform at no time exceeds 275 g, and the Head Injury Criterion does not exceed 2400.

7.2.1.2 The helmet shall not become detached from the headform.

7.2.2 *Principle*

Impact absorption capacity is determined by recording against time, the acceleration imparted to a headform fitted with the helmet, when dropped in guided free fall at a specified impact velocity upon a fixed steel anvil. The details of test machine are given in Annex C. The figure 1 of Annex C shows a typical test machine.

7.2.3 *Positioning of the Helmet after Conditioning*

7.2.3.1 The helmet shall be positioned in accordance with the requirements of Annex B on a headform of appropriate size selected from among those listed in **6.1** of Annex C when testing impact points B, X, P, R. The helmet shall then be tipped towards the rear so that the front edge of the helmet in the median plane is displaced by 25 mm; the retention system shall then be adjusted under the chin of the headform; if the system includes an adjustable chinstrap, the strap is tightened as for normal use.

7.2.3.2 When testing impact Point 'S' on a helmet with a protective lower face cover, the helmeted headform is tipped forwards so that the central vertical axis of the headform is inclined at an angle of 65 ± 3° to the vertical with the vertical longitudinal plane of symmetry of the helmeted head form in the vertical position. If the impact point would be within 15 mm of the rim, the helmeted headform shall be re-positioned so that the impact point is not less than 15 mm from the rim.

7.2.3.3 The test headform shall be so positioned that the designed point on the helmet is vertically above the centre of the anvil. The plane tangential to the point of impact shall be horizontal. This prescription does not apply to S impact point.

7.2.3.4 The protective helmets placed on the market with a visor shall be tested with the visor in the closed position.

7.2.4 *Impact Velocity*

7.2.4.1 The test shall be completed not more than five minutes after the helmet is taken from the conditioning chamber. Tests at Point S shall be carried out after tests as Points B, X, P and R. The drop height shall be such that the unit constituted by the headform and helmet falls on the test anvil at a velocity, which, immediately before impact, is equal to:

7.5 (+ 0.15, -0) m/s for both anvils specified in C 3 of Annex C.

5.5 (+ 0.15, -0.0) m/s for tests at point S.

7.2.4.2 *Measurements*

The velocity of the moving mass is measured between 1 cm and 6 cm before impact, to an accuracy of 1%. The acceleration against time at the centre of gravity of the headform is measured and recorded and the Head Injury Criterion (HIC) as prescribed in **5.2** of Annex C shall be calculated.

7.2.5 *Selection of Points of Impact*

7.2.5.1 Each test shall be carried out with 4 impacts on one helmet on the points B, X, P, and R, in this sequence. When a helmet with a protective lower face cover is being tested then an additional Point S shall be impacted after the four other points, but only against the anvil specified in **3.1** of Annex C.

7.2.5.2 After each impact the helmet shall be re-positioned correctly on the headform prior to the next impact, without interfering with the adjustment of the retention system. Before each impact on the Point S the helmet shall be re-positioned correctly on the headform and the retention system adjusted under the chin of the headform; if the system includes an adjustable chin strap, the strap is tightened as much as possible.

7.2.6 The points of impact are defined for each helmet (Fig. 3 of Annex A).

B, in the frontal area, situated in the vertical longitudinal plane of symmetry of the helmet and at an angle of 20° measured from Z above the ‘AA’ Plane.

X, in either the left or right lateral area, situated in the central transverse vertical plane and 12.7 mm below the ‘AA' Plane.

R, in the rear area, situated in the vertical longitudinal plane of symmetry of the helmet and at an angle of 20° measured from Z above the ‘AA' Plane.

P, in the area with a radius of 50 mm and a centre at the intersection of the central vertical axis and the outer surface of the helmet shell.

S, in the lower face cover area, situated within an area bounded by a sector of 20° divided symmetrically by the vertical longitudinal plane of symmetry of the helmet.

Impacts at Points B, X and R should be within 10 mm radius of the defined point.

7.2.7 *Combination of Conditioning and Anvils*

Conditioning solvent plus	Anvils
Ambient	Flat and kerbstone[1)]
Heat	Kerbstone[2)]
Low temperature[3)]	Flat
Ultraviolet radiation and moisture	Flat or kerbstone (to be selected by the laboratory)

NOTES

1) Point ‘S’ shall only be impacted against the flat anvil.

2) Only for the largest helmet size. For smaller headforms in the size range of the helmet type either anvil may be used.

3) Only for each helmet size subjected to low temperature conditioning shall undergo the impact test at point ‘S’.

7.3 Rigidity Test

7.3.1 *Requirements*

The helmet shall be tested by the method prescribed in **7.3.2** and shall meet the following requirements:

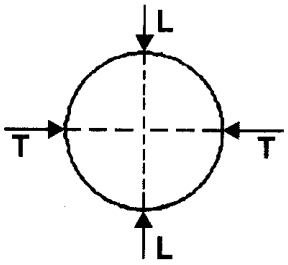
7.3.1.1 Along each axis, the deformation measured under the 630 N load shall not exceed by more than 40 mm than that measured under the initial 30 N load.

7.3.1.2 After restoration of the 30 N load, the deformation measured shall not exceed by more than 15 mm than that measured under the initial 30 N load.

7.3.2 *Procedure*

7.3.2.1 The helmet, after undergoing ambient temperature and humidity conditioning shall be placed between two parallel plates by means of which a known load can be applied along the longitudinal axis [(1)] (line LL in the Fig. 4) or the transverse axis (line TT in the Fig. 4). The surface of the plates shall be large enough to contain a circle of at least 65 mm in diameter. An initial load of 30 N shall be applied at a minimum plates speed of 20 mm/min, and after two minutes the distance between the plates shall be measured. The load shall then be increased by 100 N at a minimum plate speed of 20 mm/min and then wait for two minutes. This procedure shall be repeated until the application of a load of 630 N.

[(1)] During the test along the longitudinal axis the contact point between the helmet and one of the two plates must be the `B' impact point.



7.3.2.2 The load applied to the plates shall then be reduced to 30 N at a minimum plate speed of 20 mm/min and kept at that value for five minutes, the distance between the plates shall then be measured.

7.3.2.3 The helmet used for the test along the longitudinal axis shall be a new helmet and another new helmet shall be used for the test along the transverse axis.

7.4 Test for Projections and Surface Friction

An appropriate size of helmet shall be subjected to the test described in **7.4.1** or to the test described in **7.4.2** .

7.4.1 *Test for Projections and Surface Friction (Method A)*

7.4.1.1 *Requirements*

When tested against the bar anvil the helmet shall satisfy the following requirements:

7.4.1.1.1 The peak longitudinal force measured on the anvil shall not exceed 2,500 N, nor shall its integral with respect to time over the duration of the impact exceed 12.5 N for any of the selected impact points.

7.4.1.1.2 When tested against the abrasive anvil, a second helmet shall satisfy the following requirements:

The peak longitudinal force measured on the anvil shall not exceed 3,500 N, nor shall its integral with respect to time over the duration of the impact exceed 25 N for any of the selected impact points.

7.4.1.2 *Principle*

The rotation-inducing forces caused by projections on the helmet and friction against the outer surface of the helmet which occur when a helmeted headform is dropped vertically on to an inclined anvil are measured in the longitudinal axis of the anvil. The peak force and its integral with respect to time over the duration of the positive impulse are used as performance criteria. The details of test machine are given in Annex D. The Fig.1 of Annex D shows the typical test machine.

7.4.1.3 *Selection and positioning of the helmet*

7.4.1.3.1 An appropriate size helmet shall be selected to fit the headform referred to in **7.1** of Annex C. The horizontal axis of the helmet shall be determined by placing the helmet on a headform, of a type referred to in **6** of Annex C, according to the requirements of Annex B. The helmet shall then be removed from that headform and placed on a headform of a type referred to in **6.1** of Annex C. A load of 50 N is applied to the crown of the helmet in order to adjust the helmet on the headform such that there is contact between the crown of the headform and the inner surface of the helmet. The horizontal plane of the helmet shall then be adjusted to be within 90° ± 5° of vertical axis of the headform. The retention system is then adjusted under the chin of the headform: if the system includes an adjustable chin strap, the strap is tightened as much as possible.

7.4.1.3.2 The test headform shall be so positioned that the chosen impact point on the helmet is vertically above the upper part of the face of the anvil.

7.4.1.3.3 The helmet shall be tested in any condition in which it may be placed on the market, that is both with and without accessories if they are supplied as original equipment. Helmets placed on the market with a visor shall be tested with the visor in the closed position.

7.4.1.4 *Procedure*

The drop height shall be such that the unit constituted by the headform and helmet falls on the test anvil at a velocity, which, immediately before impact, is equal to 8.5 (-0.0/+0.15) m/s.

7.4.1.5 *Selection of impact points*

Any point on the helmet shell may be selected. The impact point should be selected with regard to the anvil against which the helmet is to be tested, taking into account the function of the anvils given in **1.3.2** and **1.3.4** of Annex D. The helmet shall be tested as many times as necessary to ensure that all notable features are evaluated.

NOTE - The primary impact site on any projection is likely to be opposite to the site where the projection receives maximum support. For example, the primary impact

site on a visor cover plate assembly is opposite to the area where the visor and cover plate locates in a recess in the shell.

When the abrasive anvil is used, evaluate the front, rear, sides and crown areas of the helmet, selecting within the general areas, sites on the outer surface which are likely to produce the greatest force and/or the greatest impulse where impulse is the integral of force with respect to time over the duration of the impact. Examples of such areas are those having the greatest radius of curvature (i.e. the flattest surface) or areas having more than one type of surface, for example a visor fixing cover plate or a painted shell partially overlaid by a fabric cover.

The rim of the shell and the upper and lower edge of the visor situated within an area bounded by a sector of 120° divided symmetrically by the vertical longitudinal plane of symmetry of the helmet do not constitute a projection for the purpose of this test.

7.4.2 *Test for Projections and Surface Friction (Method B)*

7.4.2.1 *Requirements*

7.4.2.1.1 For shear assessment the tested projection, shall shear away, shall be detached or alternatively shall not prevent the assessment bar from sliding past the projection. In all cases the bar on the horizontal carriage shall travel past the projection.

7.4.2.1.2 For friction assessment the abrasive carriage shall not be brought to rest by the helmet.

7.4.2.2 *Principle*

The rotation-inducing forces caused by projections on the helmets and friction against the outer surface of the helmets are assessed firstly by a shear impact on the projections using a shear edge against which the projections shall shear away, be detached, or permit the shear edge to slide past the projections. The friction is assessed by the displacement of a carriage abrading the outer surface of the helmet. The shear impact and abrading carriage displacement are generated by a drop weight device. The details of the test machine are given in Annexure D. The figure 2 of Annexure D shows typical test machine.

7.4.2.3 *Positioning of the helmets*

7.4.2.3.1 The helmet is placed on a headform of appropriate size in accordance with the requirements of Annex B. The helmet is tipped towards the rear so that the front edge of the helmet in the median plane is displaced by 25 mm; if the helmet includes an adjustable chin strap, the strap shall be tightened as much as possible. The headform shall be so positioned that the chosen location on the helmet can be positioned in contact with the upper surface of the horizontal carriage.

7.4.2.3.2 The helmet shall be tested in any condition in which it may be placed on the market, that is both with and without accessories if they are supplied as original

equipment. Helmets placed on the market with a visor shall be tested with the visor in the closed position.

7.4.2.4 *Procedure*

7.4.2.4.1 *Test of projection*

The headform is adjusted in order to have the chosen projection on the carriage so that the shear edge is positioned 50 mm from the projection and makes lateral contact with the projection after the drop weight is released from its upper position.

7.4.2.4.2 *Test of outer-surface*

The abrasive paper is mounted on the carriage in the position specified in **2.2** of Annex D. The chosen outer surface of the helmet is lowered on to the abrading carriage at the centre of the flat surface without abrasive paper. A loading mass is applied in accordance with **2.8** of Annex D.

The drop weight is released from its upper position in accordance with **2.5** of Annexure D. The abrasive paper shall be changed after every test.

7.4.2.4.3 *Selection of test points*

Any point on the helmet may be selected for friction and/or shear assessment. A helmet shall be tested as many times as necessary to ensure that all notable features are evaluated with one test only per feature. Re-orientate the helmet as necessary to allow every feature to be tested. For shear assessment evaluate all different external projections greater than 2 mm above the outer surface of the shell. For friction assessment, evaluate areas of the outer surface that are likely to produce the greatest friction.

The rim of the shell and the upper and lower edge of the visor situated within an area bounded by a sector of 120° divided symmetrically by the vertical longitudinal plane of symmetry of the helmet do not constitute a projection for the purpose of this test.

7.5 Dynamic Test of Retention System

7.5.1 *Requirements*

Helmet shall be tested for their retention system by the method given in **7.5.2** and it shall meet the following requirements:

7.5.1.1 During the test, the dynamic displacement of the point of application of the force shall not exceed 35 mm.

7.5.1.2 After two minutes, the residual displacement of the point of application of the force, as measured under a mass of 15 kg ± 0.5 kg shall not exceed 25 mm.

7.5.1.3 Damage to the retention system shall be accepted provided that it is still possible to take the helmet easily off the headform and that the requirements given in **7.5.1.1** and **7.5.1.2** above are met.

7.5.1.4 In the case of retention system fitted with quick release mechanism it must be possible to release the mechanism in accordance with **7.11**.

7.5.2 *Procedure*

7.5.2.1 The helmet shall be positioned as prescribed in Annex B. The details of the test machine are given in Annex E. The figure 1 of Annex E shows the typical test machine.

7.5.2.2 In this position the helmet shall be held by the shell at a point traversed by the vertical axis passing through the centre of gravity of the headform. The headform is equipped with a load-bearing device aligned with the vertical axis passing through the centre of gravity of the headform and with a device to measure the vertical displacement of the point of application of the force.

7.5.2.3 A guide and arrest device for a falling mass shall then be attached below the headform. The mass of the headform so equipped in this way shall be 15 ± 0.5 kg; this produces the preloading on the retention system for determining the position from which the vertical displacement of the point of application of the force shall be measured.

7.5.2.4 The falling mass of 10 kg ± 0.1 kg shall then be released and shall drop in a guided free fall from a height of 750 mm ± 5 mm.

7.6 Audibility Test

7.6.1 *Requirements*

The sound transmission loss shall not be more than 10 dB over the frequency range 250 to 2000 Hz.

7.6.2 *Procedure*

7.6.2.1 The helmet shall be tested for their sound attenuation properties by the method given in **7.6.2.2** and Annex F.

7.6.2.2 This test shall be carried out under the prevailing atmospheric conditions and the back-ground noise level shall be such that the reading indicated on the sound level meter by the noise is at least 10 dB of below that of the horn sound level.

This test shall be carried out in an open space in which there is no obstacle within a radius of 12 m and no acoustical focusing affects or nearby parallel walls.

7.6.2.3 The horn shall be mounted 1.2 m above the ground and shall be fixed in a rigid manner on a base whose mass shall be at least 10 times that of the horn and not less than 15 kg and shall be adjustable side ways and up and down. The sound

waves are emitted from the horn by using suitable 12 V dc power supply and are directed towards the rear of the headform at the distance of 2 m. The two readings are taken with and without helmet. The difference shall be recorded to the nearest dB.

7.7 Retention (Detaching) Test of Helmet

7.7.1 *Requirements*

The angle between the reference line situated on the shell of the helmet and the reference plane of the headform shall not exceed 30°.

7.7.2 *Procedure*

7.7.2.1 The helmet previously conditioned at ambient temperature and hygrometry, shall be placed on and secured to the appropriate headform, selected from those listed in Fig. 1 of Annex A in accordance with the requirements of **7.2.3.1**.

7.7.2.2 A device to guide and release a falling mass (the total mass being 3 ± 0.1 kg) is hooked on to the rear part of the shell in the median vertical plane of the helmet, as shown in Fig. 1 of Annex G.

7.7.2.3 The falling mass of 10 kg ± 0.01 kg is then released and dropped in a guided free fall from a height of 0.50 m ± 0.01 m. The guiding device shall be such as to ensure that the impact speed is not less than 95% of the theoretical speed.

7.8 Micro-slip Test of the Chin Strap

7.8.1 *Requirements*

The total slippage through the grip shall not exceed 10 mm

7.8.2 *Procedure*

7.8.2.1 The test rig consists of a flat horizontal robust base, a weight for applying a load, a freely rotatable horizontal roller of diameter not less than 20 mm, and in the same horizontal plane as the top of the roller a clamp capable of reciprocating horizontal motion at right angles to the axis of the roller with a total amplitude of 50 ± 5 mm at a frequency between 0.5 Hz and 2 Hz. A typical test machine is shown in Figure 1 of Annexure H.

7.8.2.2 Take a sample of the strap at least 300 mm long, including the tensioning and adjusting device and any additional strap fastening. Fix the upper end of the strap to the reciprocating clamp level with the top of the roller and drape the strap over the roller. Attach a weight to the lower end of the strap so that when the weight is lifted by the strap it imposes a tensile force of 20 ± 1 N. Adjust the apparatus so that when the reciprocating clamp is at the centre of its motion the weight is just resting on the base with the strap barely in tension and the strap buckle is between the clamp and roller and will not touch the roller during reciprocation.

7.8.2.3 Operate the reciprocating clamp for 20 cycles. Note the position of the components on the strap. Operate the reciprocating clamp for 500 cycles then record the distance through which the components have slipped along the strap.

7.9 Test for Resistance to Abrasion of the Chin Strap

7.9.1 *Requirements*

After the test described in **7.9.2.5** the strap shall withstand a tension of 3 KN without breaking when tested as per **7.9.2.6**.

7.9.2 *Procedure*

The test shall be performed on every device in which the strap slides through a rigid part of the retention system, with the following exceptions:

7.9.2.1 Where the micro-slip test described in **7.8**, shows that the strap slips less than half the prescribed value; or

7.9.2.2 Where the composition of the material used, or the information already available, renders the test superfluous in the judgment of the technical service.

7.9.2.3 The test rig as mentioned is similar to that described in **7.8.2.1** except that the amplitude is 100 ± 10 mm and the strap passes over a representative surface of the associated adjuster or other strap fitting through an appropriate angle. The typical test machine is shown in Fig. 2 of Annex H.

7.9.2.4 Select an arrangement of the apparatus appropriate for the particular design of both the strap and the fitting likely to cause abrasion. Grip one end of the strap in the oscillating clamp, arrange the strap to be threaded through the fitting as designed and hang a weight on the end to tension the strap with a force of 20 ± 1 N. Mount or otherwise steady the fitting in such a position that movement of the oscillating clamp slides the strap through the fitting, in a manner simulating slippage of the fitting on the strap when the helmet is on the head.

7.9.2.5 Oscillate the clamp for a total of 5000 cycles at a frequency between 0.5 and 2 Hz.

7.9.2.6 Mount the abraded strap in a tensile testing machine using clamps which avoid local breakage of the strap, and so that there is a length of 150 ± 15 mm of strap, including the abraded portion, between the clamps. Operate the machine to stretch the strap at a speed of 100 ± 20 mm per min.

7.10 Tests for Retention Systems Relying on Quick-Release Mechanisms

7.10.1 *Inadvertent Release by Pressure*

7.10.1.1 Requirement

7.10.1.1.1 If the retention system is designed to be released by pressure on a certain part, the system shall not release when a rigid sphere of diameter 100 mm is pressed with a force of 100 ± 5 N directly in the line of movement of the part.

7.10.1.1.2 If such a system incorporates more than one quick-release mechanism, or one such mechanism requiring more than one operation to release it, the system shall be deemed not to comply with this requirement if sufficient opening of the system is caused by the pressure of the sphere on only one quick-release mechanism or for only one operation, whichever is appropriate, to allow the release of the appropriate headform.

7.11 Ease of Release

7.11.1 *Requirement*

After the additional force has been removed, the opening system shall be capable of being operated by a force not exceeding 30 N. However, if the quick release mechanism is incorporated in the helmet shell, the opening system shall be capable of being operated by a force not exceeding 60 N.

7.11.1.1 Procedure

7.11.1.2 The helmet shall be mounted on the test machine as shown in Annexure E as described in **7.5.2.3** such that a static force of 150 ± 5 N is applied to the retention system. An additional static force of 350 ± 5 N shall be applied to the retention system for at least 30 seconds and then removed.

7.11.1.3 The buckle opening force shall be applied using a dynamometer or similar device in the manner and direction of normal use. In the case of a push button the contact end shall be a polished metal hemisphere with radius 2.5 ± 0.1 mm. The opening force shall be applied on the geometric centre of the push button or respective application areas.

7.12 Durability of Quick-release Mechanisms

7.12.1 *Requirement*

The quick release mechanism shall not fracture nor disengage when a tensile force of 2.0 kN ± 50 N is progressively applied to the retention system in the direction in which the mechanism is designed to bear load. Following the application and removal of the force the quick release mechanism shall still be capable of operation.

7.12.2 *Procedure*

Subject the quick-release mechanism to the following procedures in the order given.

7.12.2.1 Using apparatus appropriate to the particular design of mechanism carry out the following procedure. Close and lock the mechanism. Apply a loading force of 20 ± 1 N in the direction in which the mechanism is designed to bear load, then

unlock and disengage the mechanism under load. Complete this cycle in not less than 2 s. Repeat for a total of 5000 cycles.

7.12.2.2 If the quick-release mechanism incorporates metal components carry out the following procedure:

Place the complete mechanism in a closed cabinet so that the mechanism can be continuously wetted by a spray while still allowing free access of air to all parts of the mechanism. Subject the mechanism to a spray of a solution consisting of 5% ± 1% (m/m) of reagent grade sodium chloride in distilled or de-ionized water for a period of 48 ± 1 h at a temperature of 35° C ± 5° C. Rinse the mechanism thoroughly in clean running water to remove salt deposits and allow it to dry for 24 ± 1 h.

7.12.2.3 Repeat the procedure given in **7.12.2.1**.

8 MARKINGS

8.1 The protective helmet submitted for the approval in conformity with **9**, shall bear the following marking,

a) Manufacturer's Trade Name or Mark

b) Model Name

c) Batch No.

d) Month and year of manufacturing

e) Size

f) The maximum mass quoted should include all the accessories that are supplied with the helmets, within the packaging, as it is placed on the market, whether or not those accessories have actually been fitted to the helmet.

g) Indication of the unsuitability of the lower face cover to offer any protection against impact to the chin (As described in **6.1.2**)

8.2 The marking shall be indelible, clearly legible and in readily accessible place. The marking shall not be within the main field of vision.

8.3 Every protective helmet placed on the market shall bear a clearly visible label with the following inscription,

'For adequate protection, this helmet must fit closely and be securely attached. Any helmet that has sustained a violent impact should be replaced'

and, if fitted with a non protective lower face cover:

‘Does not protect chin from impacts” together with the symbol indicating the unsuitability of the lower face cover to offer any protection against impacts to the chin.

8.4 Additionally where hydrocarbons, cleaning fluids, paints, transfers or other extraneous additions affect the shell material adversely a separate and specific warning shall be emphasized in the above mentioned label and worded as follows:

“Warning − Do not apply paint, stickers, petrol or other solvent to this helmet.”

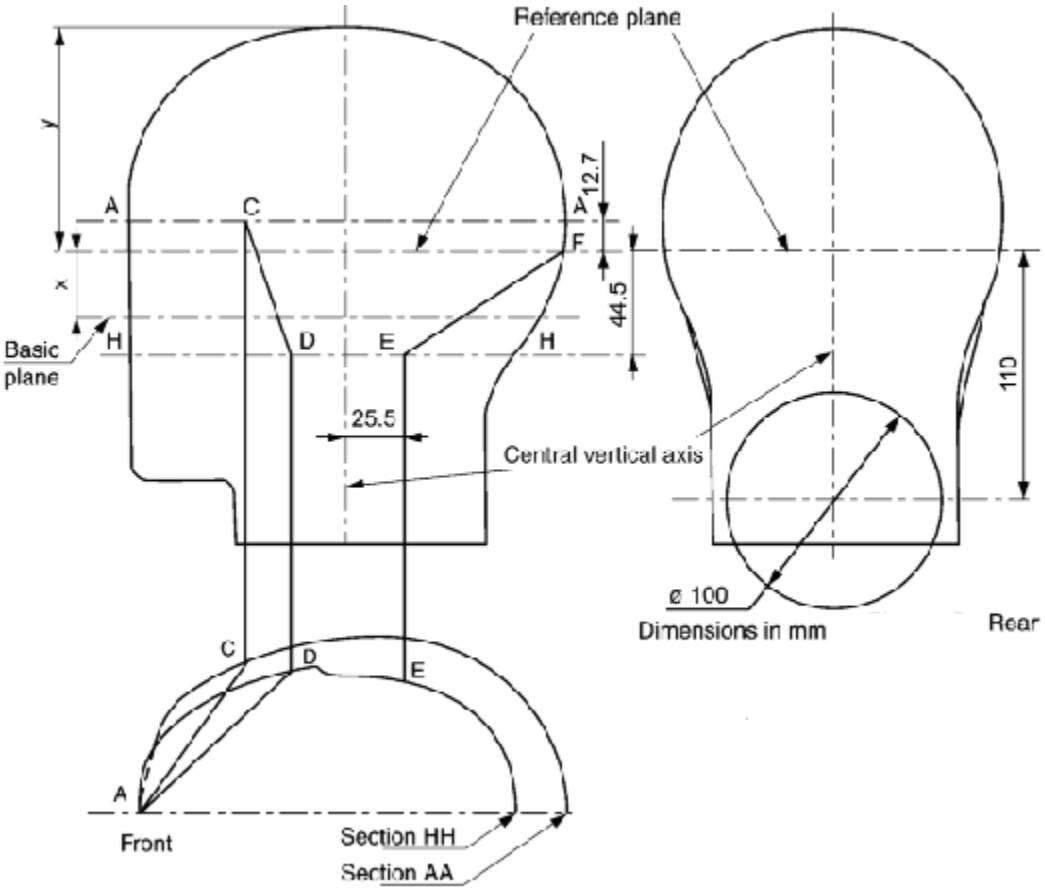
8.5 BIS Certification Marking

The helmet may also be marked with the Standard Mark.

8.5.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act,* 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Clause* **6.2**)



All dimensions are in millimeters

Headforms	Size	X	Y	AC	HD
A	500	24	89.5	80	88
C	520	25	93	82	90
E	540	26	96	84	92
G	560	27	99	86	94
J	570	27.5	102.5	87	95
K	580	28	104	88	96
M	600	29	107	90	98
O	620	30	110	92	100

Note: For details see Annexure J and Annexure K

Minimum extent of protection

Fig. 1 HEADFORM

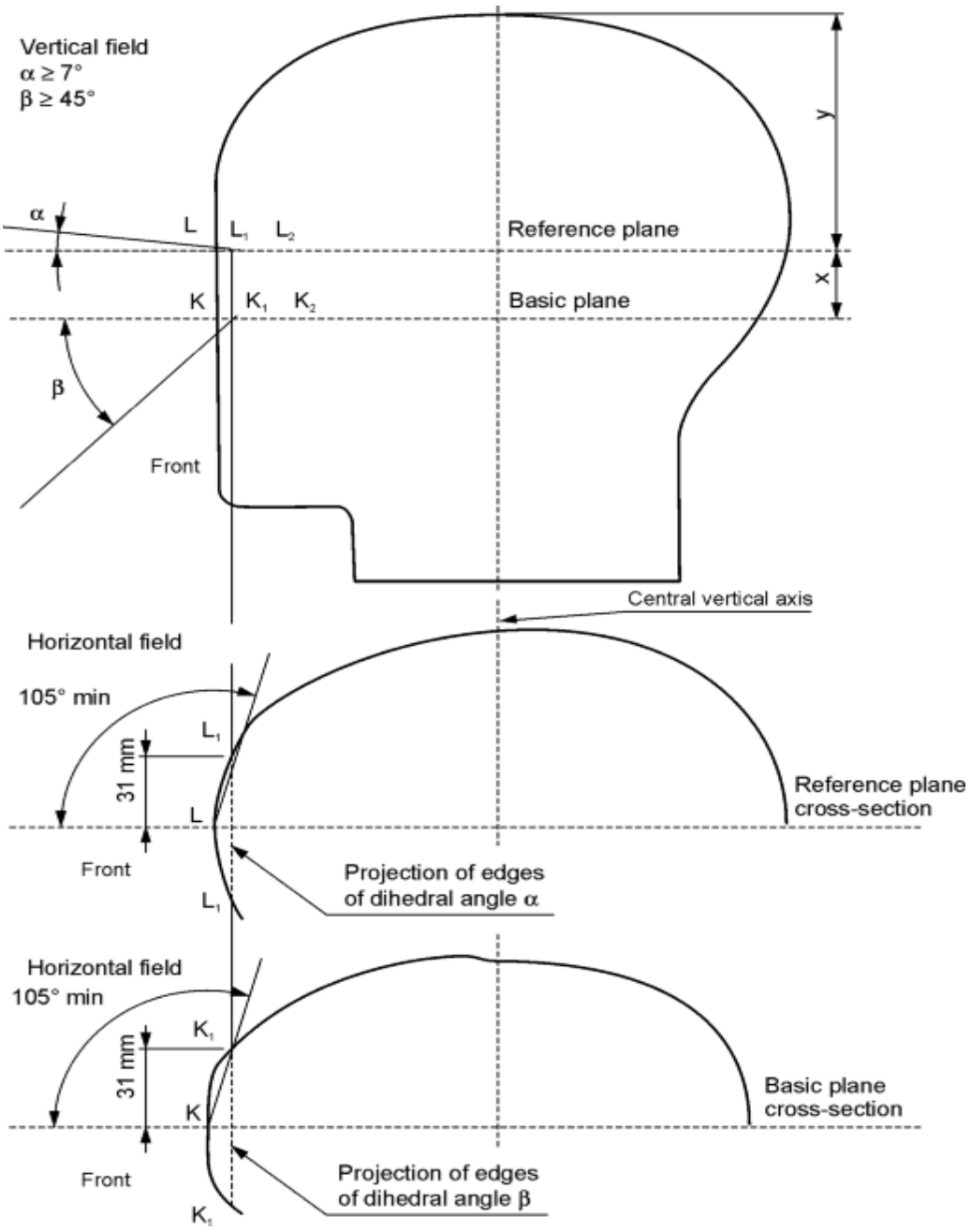


Fig. 2A PERIPHERAL VISION

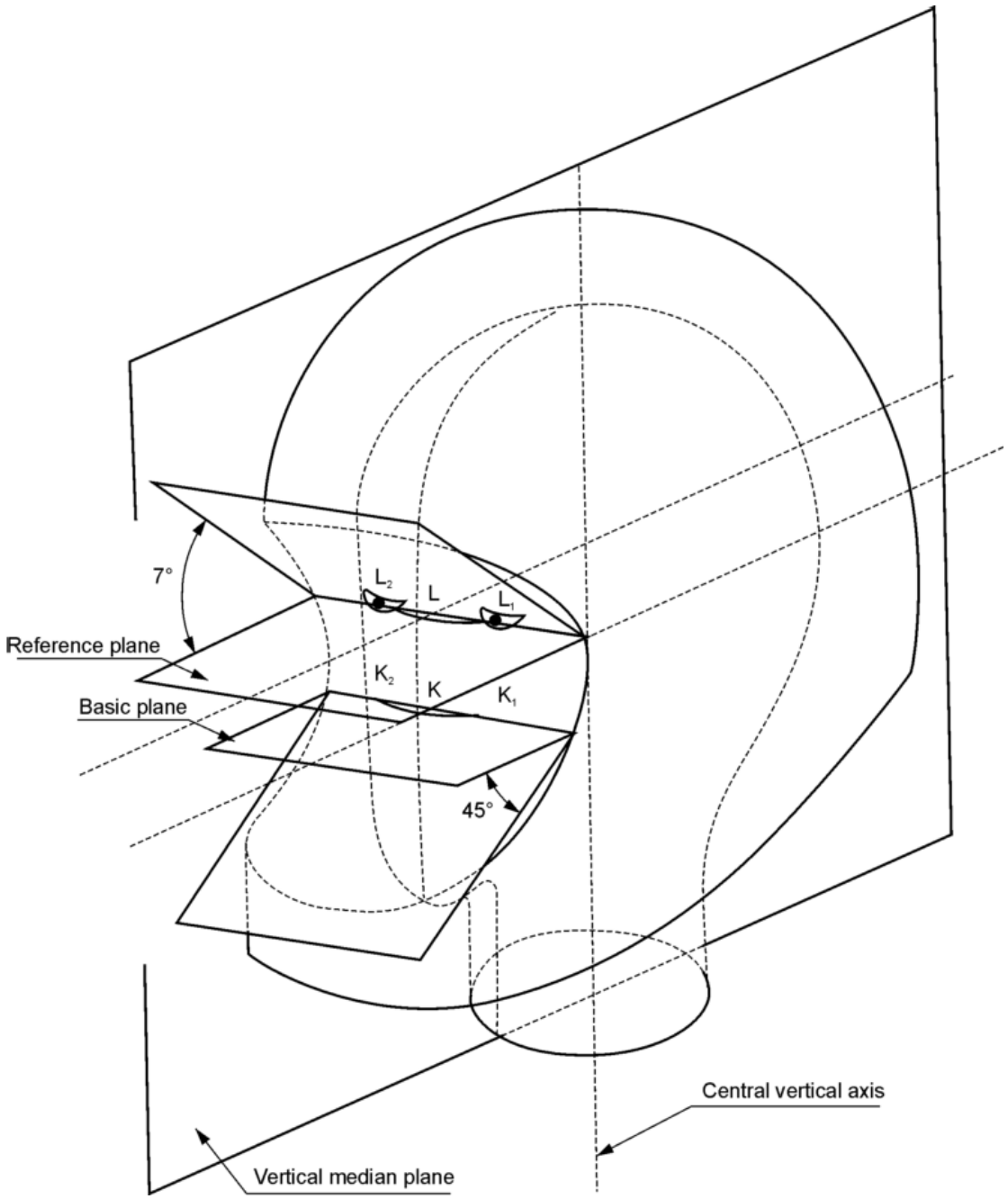


Fig. 2B PERIPHERAL VISION – VERTICAL FIELD

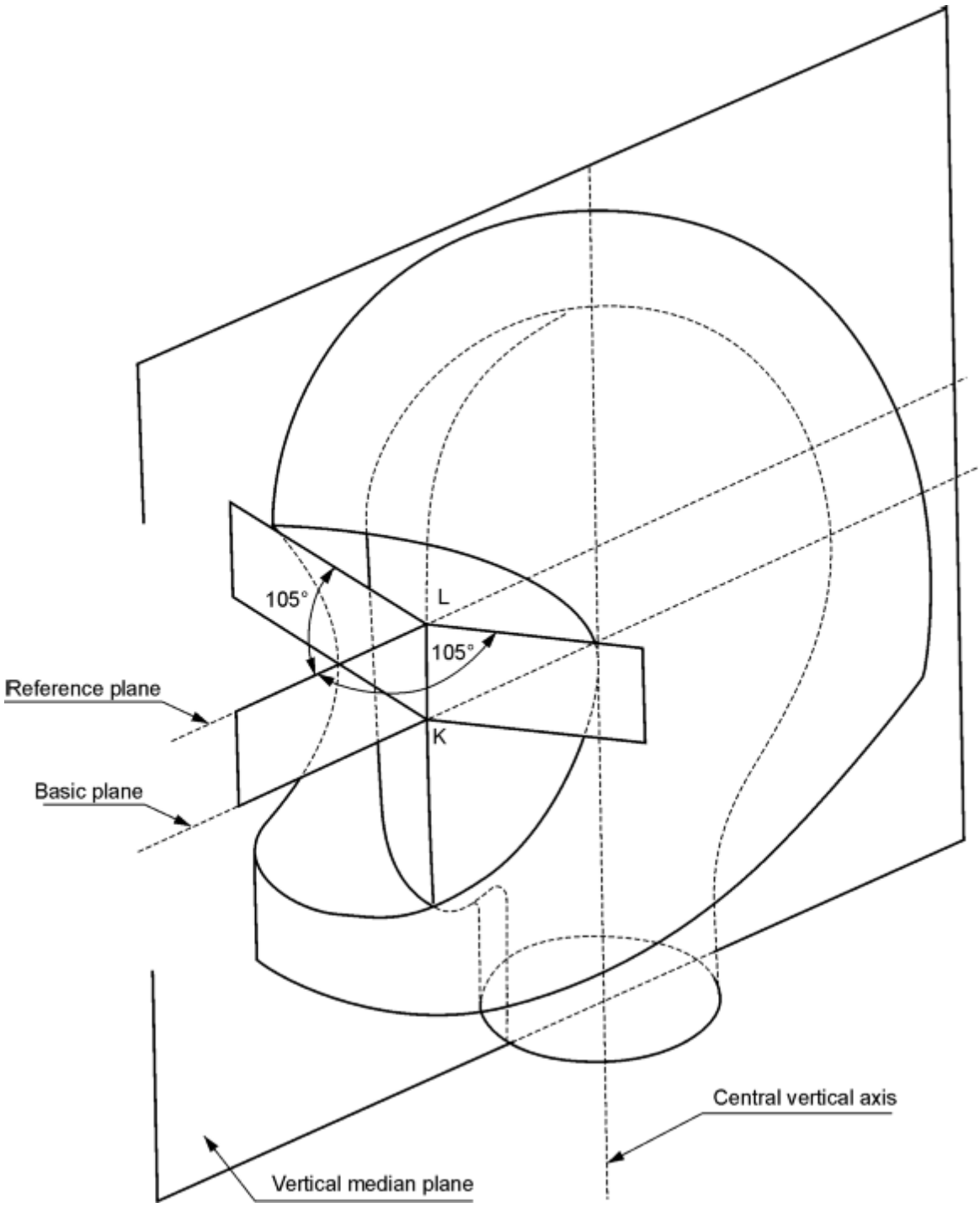


Fig. 2C PERIPHERAL VISION – HORIZONTAL FIELD

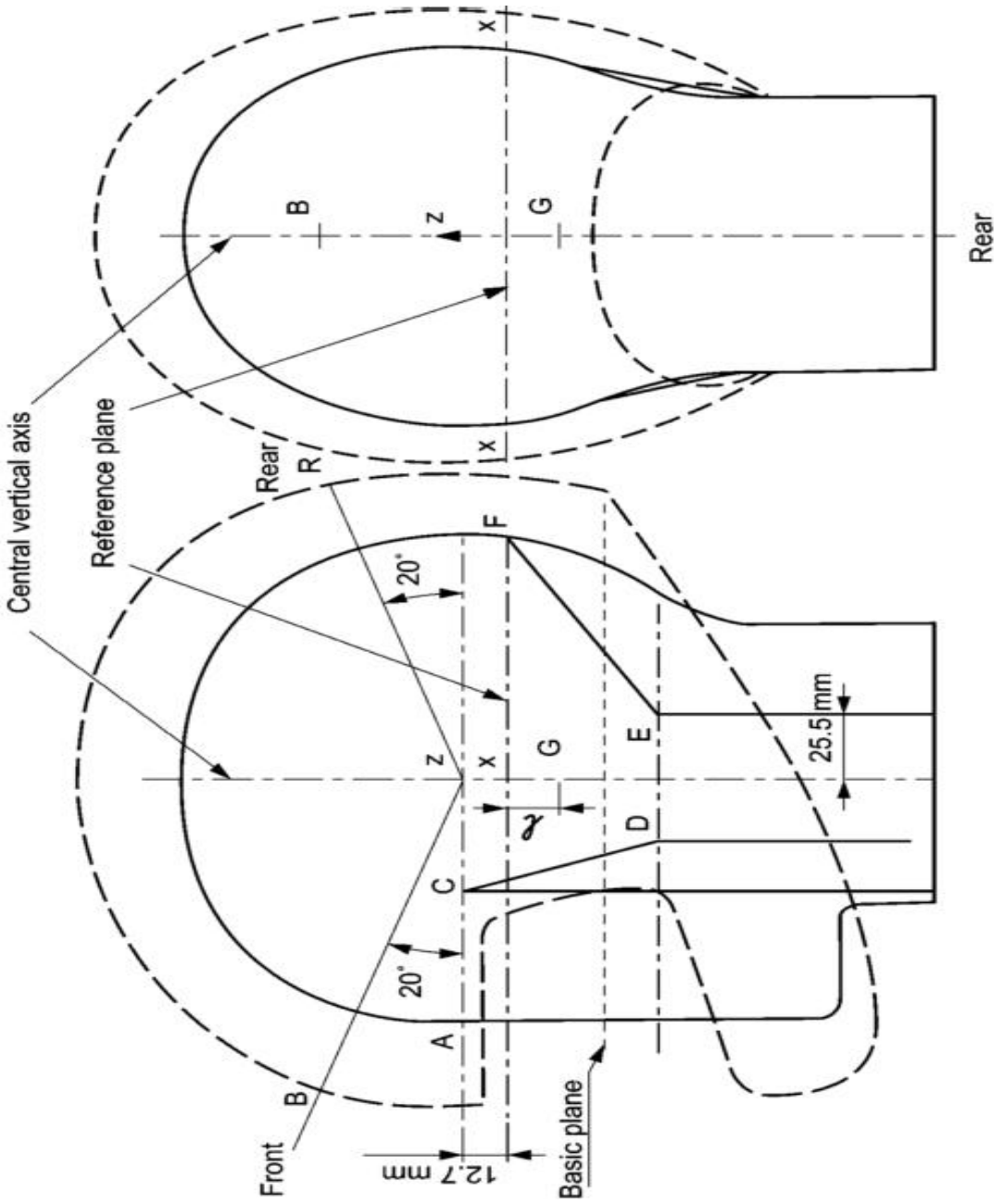


Fig. 3 IDENTIFICATION OF IMPACT POINTS

ANNEX B
(*Clause* **6.5.2**)

POSITIONING OF THE HELMET ON THE HEADFORM

B-1 The helmet is placed on a headform of appropriate size. A load of 50 N is applied on the crown of the helmet in order to adjust the helmet on the headform. It shall be ascertained that the vertical median plane of the helmet coincides with the median vertical plane of the headform.

B-2 The front edge of the helmet is placed against a gauge to check the minimum angle for the upward field of vision. The following points are then checked.

B-2.1 That the line AC and the ACDEF zone are covered by the shell (*see* Fig. 1, Annex –A)

B-2.2 That the requirements for the minimum downward angle and the horizontal field of vision are satisfied.

B-2.3 Requirements mentioned in **6.2.2** relating to the rear projection shall be met.

B-3 If one of the above conditions is not met, the helmet is moved slightly from front to rear to seek a position where all the requirements are met. Once such a position is determined, a horizontal line is drawn on the shell at the level of the *AA* plane. This horizontal line shall determine the reference plane for the positioning of the helmet during the tests.

ANNEX C
(*Clause* **7.2.2.**)

APPARATUS FOR IMPACT ABSORPTION TEST (*see* **Fig. 1)**

C-1 The test apparatus shall comprise of the following:

a) A base,
b) An anvil rigidly fixed to a base,
c) A free fall guidance system,
d) A mobile system supporting the helmeted headform,
e) A metal headform fitted with a tri-directional accelerometer and a measuring assembly, and
f) A system by which the point of impact may be brought into correspondence with the centre of the anvil.

C-2 BASE

C-2.1 The base shall be made of steel or concrete or a combination of these materials and have mass of at least 500 kg. It shall be so constructed that there is no significant deformation of surface under the test load.

C-2.2 No part of the base or anvil shall have a resonance frequency liable to affect the measurements.

C-3 ANVILS

C-3.1 The flat steel anvil shall have a circular impact face of 130 mm ± 3mm diameter.

C-3.2 The kerbstone anvil shall have two sides forming an angle of (105 ± 5)°, each of them with a slope of (52.5 ± 2.5)° towards the vertical and meeting along a striking edge with a radius of 15 mm ± 0.5 mm. The height must be at least 50 mm and the length not less than 125 mm. The orientation is 45° to the longitudinal vertical plane at Points B, X, P and R, and 45° to the base plane at Point X (front low, back up).

C-4 MOBILE SYSTEM AND GUIDES

The mobile system supporting the headform shall be such that its characteristics do not affect the measurement of acceleration at the centre of gravity of the headform. It shall also be such that any point in the area *ACDEF* can be positioned vertically above the centre of the anvil. The guides shall be such that the impact velocity is not less than 95% of the theoretical velocity.

C-5 ACCELEROMETER AND MEASURING ASSEMBLY

C-5.1 The accelerometer shall be capable of withstanding a maximum acceleration of 2,000 g without damage. Its maximum mass shall be 50 grams. The measuring

system including the drop assembly shall have a frequency response in accordance with channel frequency class (CFC) 1000 in accordance with ANNEX L.

C-5.2 The HIC shall be calculated as the maximum (depending from t_1 and t_2 of the equation):

$$\text{HIC} = \left[\frac{1}{t_2 - t_1} \int_{t_2}^{t_1} a(t)dt \right]^{2.5} (t_2 - t_1)$$

Where; 'a' is the resultant acceleration as a multiple of 'g' and t_1 and t_2 are any two points in time (sec) during the impact. The acceleration data has to be sampled at a frequency of at least 8 000 Hz and filtered in accordance with ANNEX L (CFC 1000).

C-6 HEADFORMS

The headform to be used for the impact absorption test shall be made of a metal of characteristics such that the headform present no resonance frequency below 3000 Hz. The general characteristics of the test headform shall be used shall be as given below.

C- 6.1 General Characteristics of Test Headforms

Symbols	Size (mm)	Mass kg
A	500	3.1 ± 0.10
E	540	4.1 ± 0.12
J	570	4.7 ± 0.14
M	600	5.6 ± 0.16
O	620	6.1 ± 0.18

C- 6.2 The shape of the test headforms shall be:

C- 6.2.1 Above the reference plane, in conformity with the detailed dimensions of the test headforms shown in Annexure J;

C- 6.2.2 Below the reference plane, in conformity with the detailed dimensions of the test headforms shown in Annexure A;

C- 6.2.3 The centre of gravity of the headform shall be near the Point G on the central vertical axis at "1" mm below the reference plane, as defined in Annexure K. The headform shall contain, near its centre of gravity, a housing for a tri-directional accelerometer.

C- 6.2.4 For tests other than those of impact - absorption, headforms complying only with the geometrical provisions of **6.2.1** & **6.2.2** above, may be used.

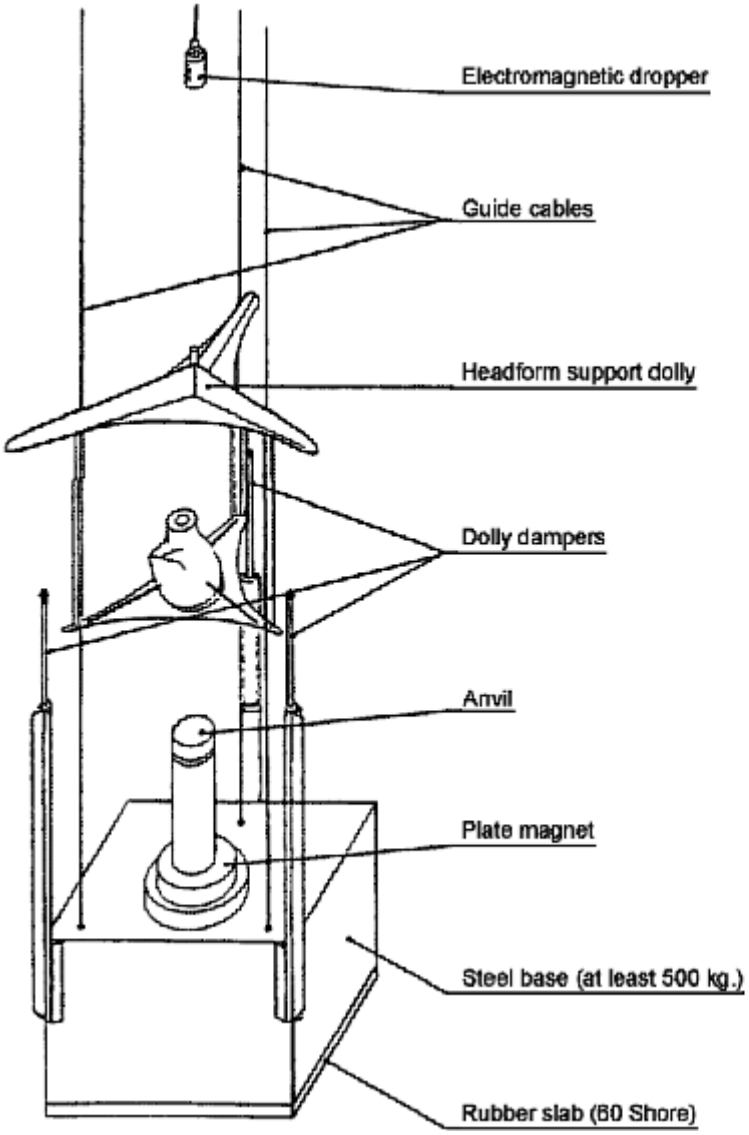


Fig. 1 TEST MACHINE HEADFORM DROP ASSEMBLY

ANNEX D
(*Clause* **7.4.1.2.**)

APPARATUS FOR TEST FOR PROJECTIONS AND SURFACE FRICTION

D-1 METHOD A

D-1.1 The test apparatus shall comprise:

a) An anvil rigidly fixed to a base,
b) A free fall guidance system,
c) A mobile system supporting the helmeted headform,
d) A headform conforming to that referred to in **D - 1.6** of this Annex,
e) A system which may be adjusted such that the point of impact can be brought into correspondence with the upper part of the face of the anvil,
f) A means of recording the continuously changing transmitted anvil force during the impact, and
g) A suitable energy absorbing base and catch net to prevent damage to the helmet after the impact.

D-1.2 Base

This shall conform to the requirements specified in **C - 2** of Annex C.

D-1.3 Anvil

D-1.3.1 The anvil is mounted securely at an angle of 15° to the vertical with provision for fore-and-aft adjustment. The anvil has a minimum width of 200 mm and is adaptable to carry either of two different impact surfaces as follows.

D-1.3.2 The bar anvil consists of a series of at least 5 horizontal bars at 40 mm centres. Each bar is made from a steel strip of height 6 mm and width 25 mm with its uppermost edge machined to a 1 mm radius and the lower 15 mm of its face chamfered at an angle of 15° so that, as mounted, the upper edge of each bar is fully exposed from vertically above. The bars are casehardened to a depth of approximately 0.5 mm.

D-1.3.3 The bar anvil should be used to assess the tangential forces and their integrals with time caused by projections on the helmet, e.g. visor fittings, screws, press studs and steps in the shell surface, etc.

D-1.3.4 The abrasive anvil is a sheet of grade 80 closed-coat aluminum oxide abrasive paper with a minimum supported length of 225 mm and is securely clamped to the base of the anvil to prevent slippage.

D-1.3.5 The abrasive anvil should be used to assess the tangential forces and their integrals with time caused by friction against the outer surface of the helmet. This is particularly applicable to selected areas of helmets, the outer surface of which either have significant variations of curvature or are made of more than one material.

D-1.3.6 The anvil is fitted with force transducer(s) connected to recording apparatus so that the transmitted longitudinal force component can be measured and continuously recorded with an accuracy of ± 5 % during a glancing blow to any part of its exposed surface.

D-1.4 Mobile System and Guides

The mobile system supporting the headform shall be such that its characteristics do not affect the measurement of force in the anvil. It shall also be such that any point on the helmet can be positioned vertically above the anvil. The guides shall be such that the impact velocity is not less than 95 % of the theoretical velocity.

D-1.5 Force and Measuring Assembly

The force transducers fitted to the anvil shall be capable of withstanding a maximum force of 20,000 N without damage. The measuring system including the anvil assembly shall have a frequency response in accordance with channel frequency class (CFC) 1000 in accordance with ANNEX L.

D-1.6 Headform

The headform shall be that referred to in **C - 6.1** of Annex C characterized by the Symbol J.

D-2 METHOD B

D-2.1 The test apparatus shall comprise:

a) A horizontal guided carriage with interchangeable attachments for abrasive paper or a shear edge.
b) A horizontal guide and support for this carriage
c) A roller with a wire rope or a strap or a similar-flexible connection
d) lever connecting the headform to the test apparatus with a hinge
e) An adjustable system supporting the headform
f) A drop weight to load the lower end support of the wire rope, or a strap, after the weight is released
g) A system to support a headform and to apply a force to the helmet normal to the carriage

D-2.2 Carriage

D-2.2.1 For friction assessment the carriage bears a sheet of grade 80 closed-coat Aluminium oxide abrasive paper with a supported length of 300.0 (-0.0/+3.0) mm and ecurely clamped to the carriage to prevent slippage. At its end towards the drop weight

and in this direction the carriage has a 80 mm ± 1 mm long smooth steel area not being covered by the abrasive paper and higher than the rest of the carriage by the thickness of the abrasive paper plus 0.5 ± 0.1 mm.

D-2.2.2 For shear assessment the carriage is provided in the middle, with a bar made form a steel strip of height 6 mm and width 25 mm with is uppermost edges machined to a 1 mm radius. The bar is casehardened to a minimum depth of 0.3 mm.

D-2.2.3 The carriage and either attachment shall have a total mass of 5.0 (-0.2/+0.0) kg.

D-2.3 Horizontal Guide

The horizontal guide, which guides and supports the carriage, may consist of two cylindrical bars on which the ball bearings of the carriage may freely travel.

D-2.4 Roller with a Wire Rope or Strap

The rollers shall have a diameter of at least 60 mm and lead the wire rope or strap from the horizontal into the vertical direction. The horizontal end of the wire rope or strap is fixed to the carriage; the vertical end is fixed to the drop weight.

D-2.5 Drop Weight

The drop weight shall have a mass of 15.0 (-0.0/+0.5) kg. For shear assessment the free drop height shall be 500.0 (-0.0/ + 5.0) mm with provision for further possible travel of at least 400 mm. For testing the friction assessment the free drop height shall be 500.0 (-0.0/+0.5) mm with provision for further possible travel of at least 400 mm.

D-2.6 Headform Support

The system supporting the headform shall be such that any point on the helmet can be positioned in contact with the upper surface of the carriage.

D-2.7 Lever and Hinge

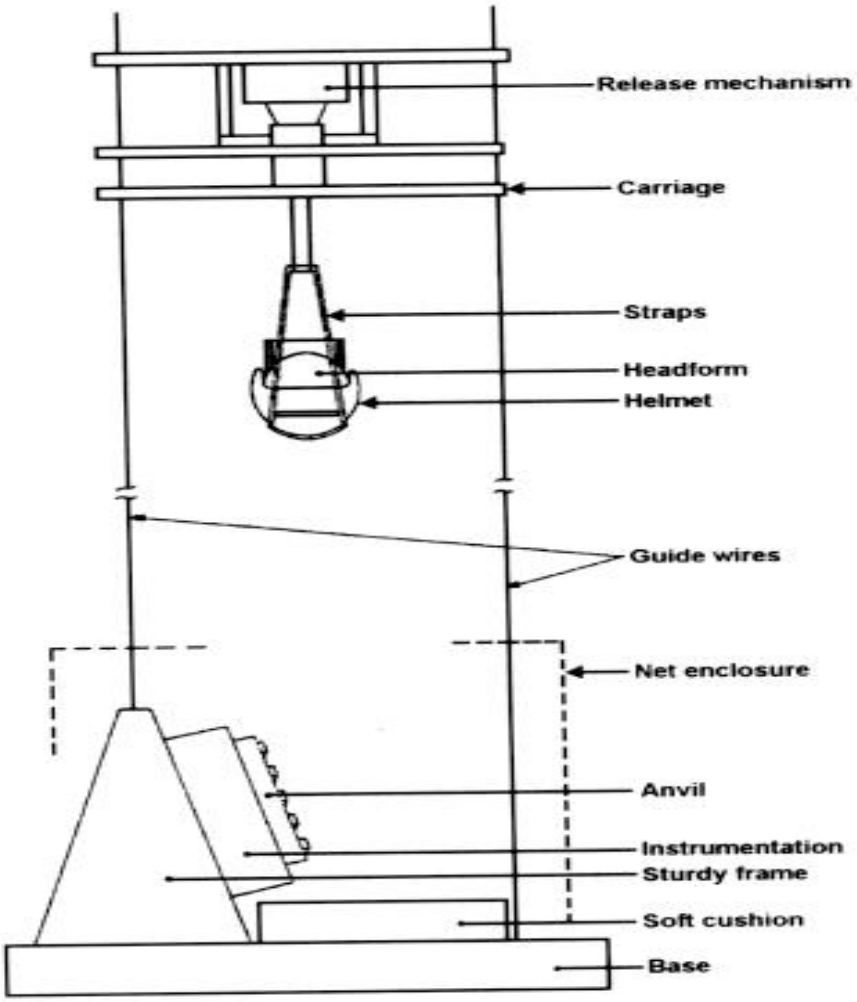
A rigid lever shall connect the headform support of the test apparatus with a hinge. The height of the hinge pivot above the upper surface of the carriage shall not be greater than 150 mm.

D-2.8 Loading Mass

A loading system is used to generate a force of 400.0 (-0.0/+10.0) N on the helmet normal to the surface of the carriage. This force shall be measured before each test.

D-2.9 Verification of the Test Apparatus

With the unloaded carriage and a drop height of 450 mm the velocity of the carriage after 250 mm of travel shall be 4.0 ± 0.1 m/sec. The requirements shall be verified after every 500 helmet tests or once every 6 months whichever is sooner.



Example of a Suitable Test Apparatus for
Projections and Surface Friction
(Method A)

Fig. 1

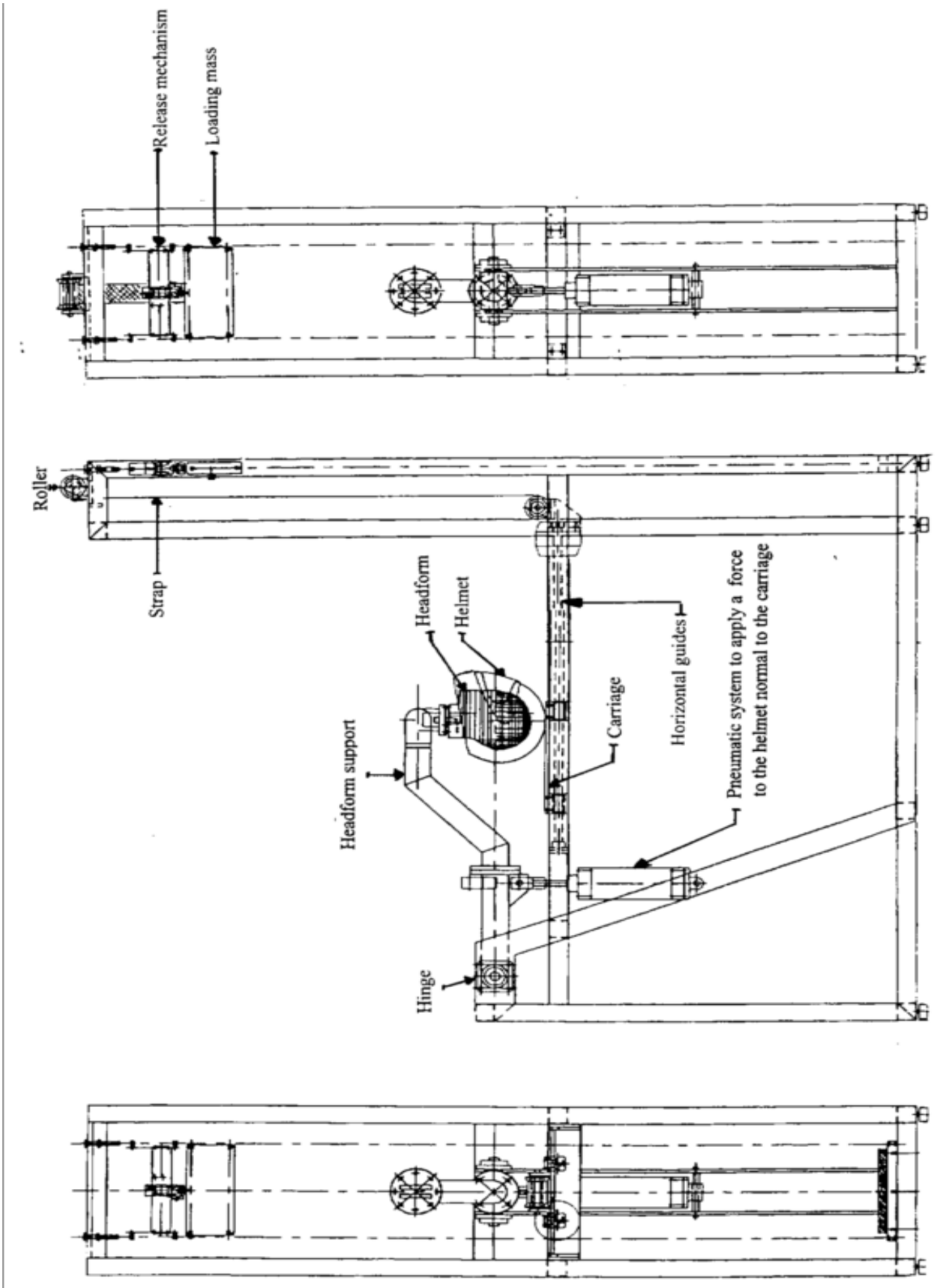


Figure 2: Example of a Suitable Test Apparatus for Projections and Surface Friction (method B)

ANNEX E
(*See Clause* **7.5.2.1**)

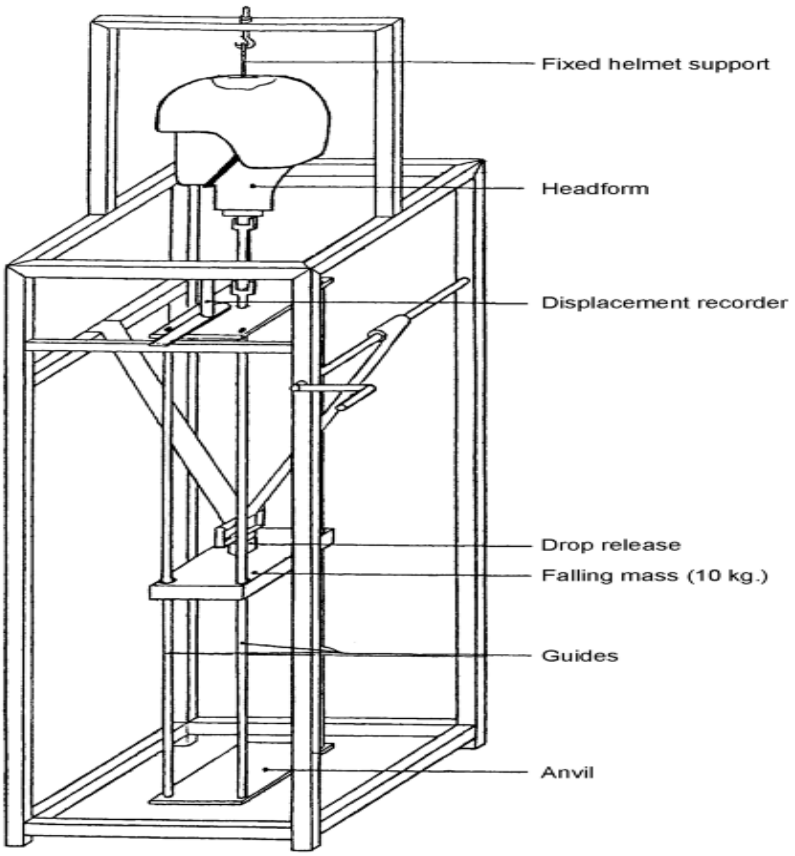


Fig. 1 DYNAMIC TEST OF RETENTION SYSTEM

ANNEX F
(*See Clause* **7.6.2.1**)

APPARATUS FOR AUDIBILITY TEST

`

F-1 MEASURING APPARATUS

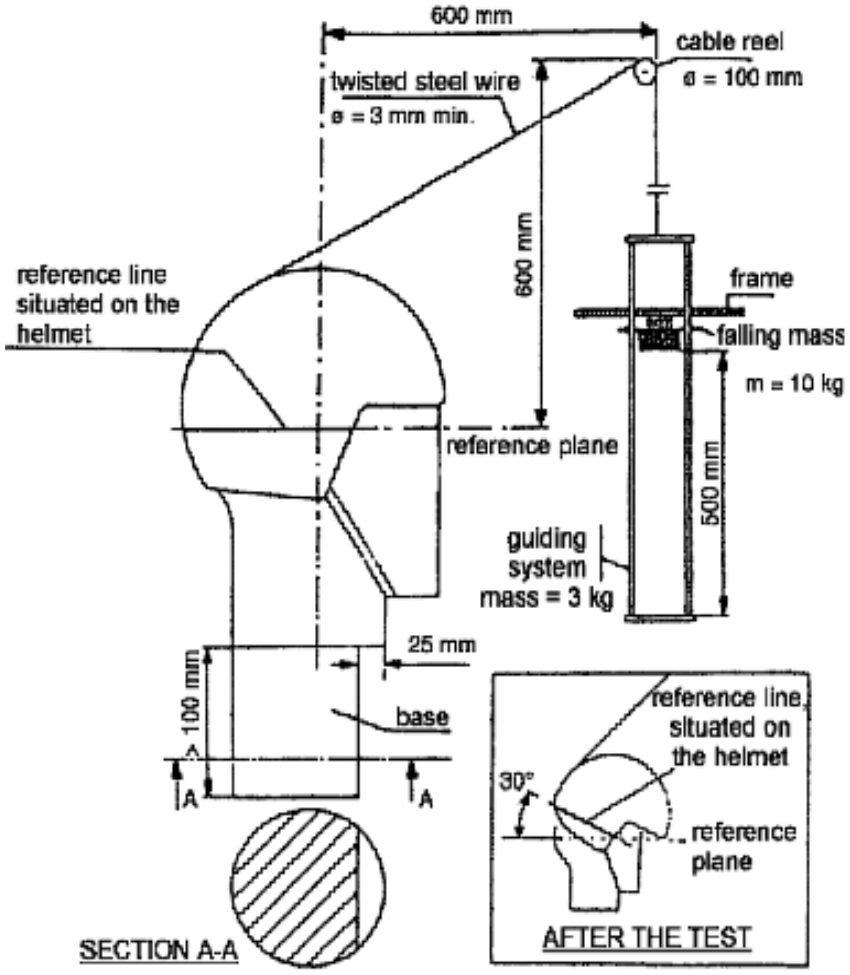
Measuring Apparatus shall consist of a headform and sound level meter in accordance with IS 9779. The microphone of sound level meter shall be fitted at a place corresponding to the right or left human ear's location.

F-2 SOUND SOURCE

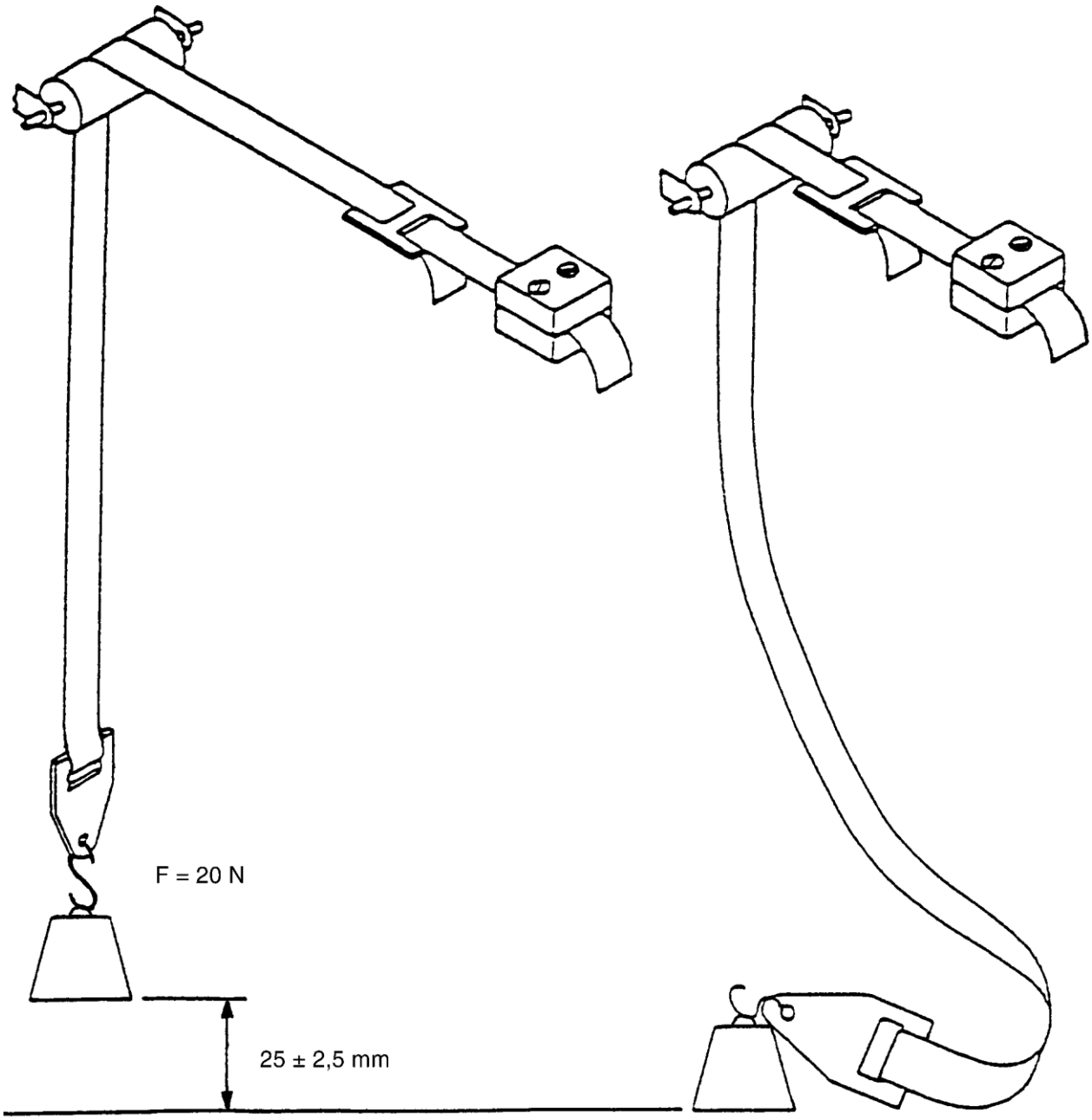
The sound surface shall be a horn conforming to Type 2A of IS 1884 (which has sound pressure level range of 90 to 115 dB(A). The sound source shall be located so that sound is incident from back of the headform.

ANNEX G
(*Clause* **7.7.2.2**.)

Fig. 1 RETENTION (DETACHING) TEST APPARATUS



ANNEX H
(*Clause* **7.8.2.1**)



Taut position Slack position

Fig. 1 APPARATUS FOR TESTING SLIPPAGE OF THE CHINSTRAP

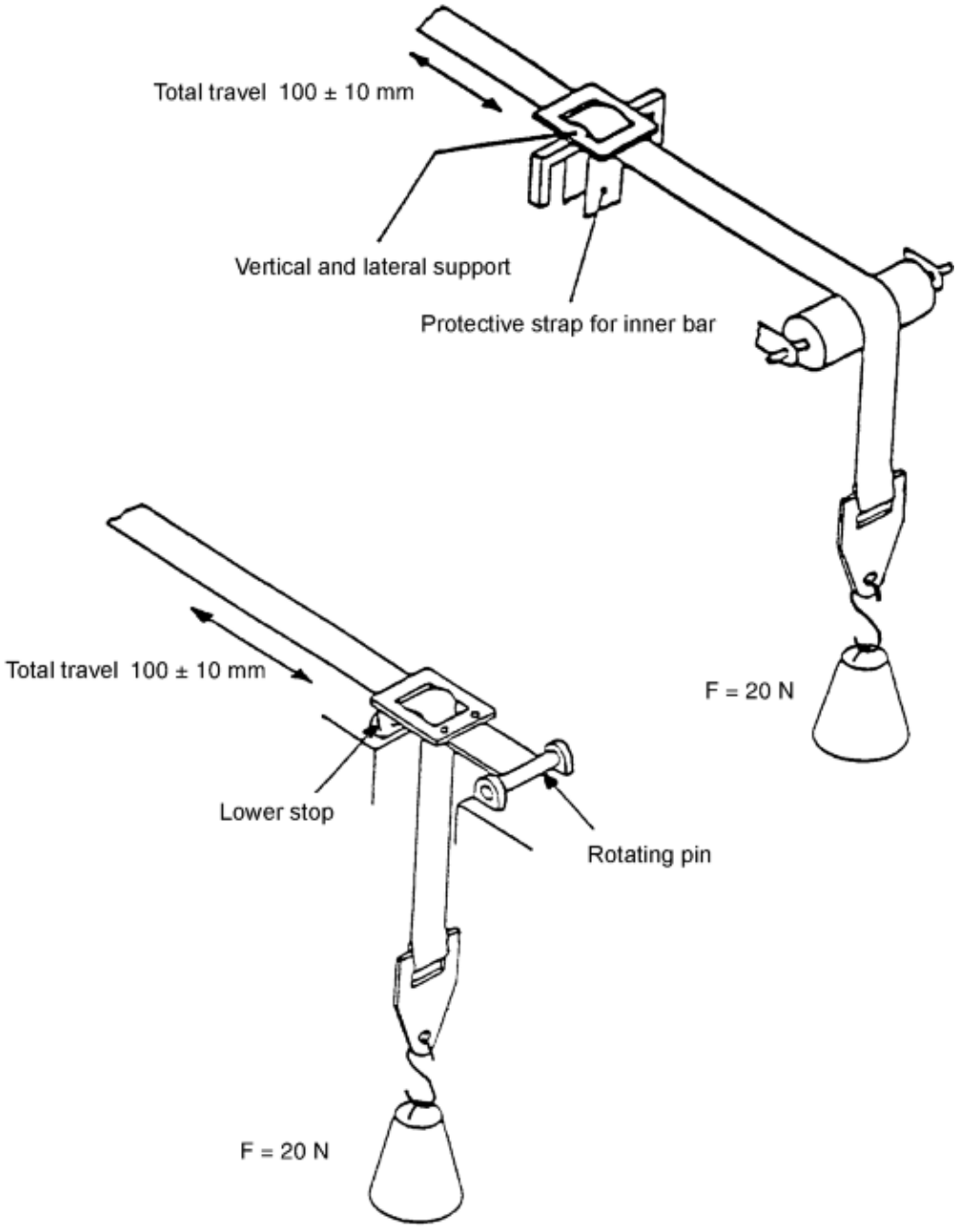
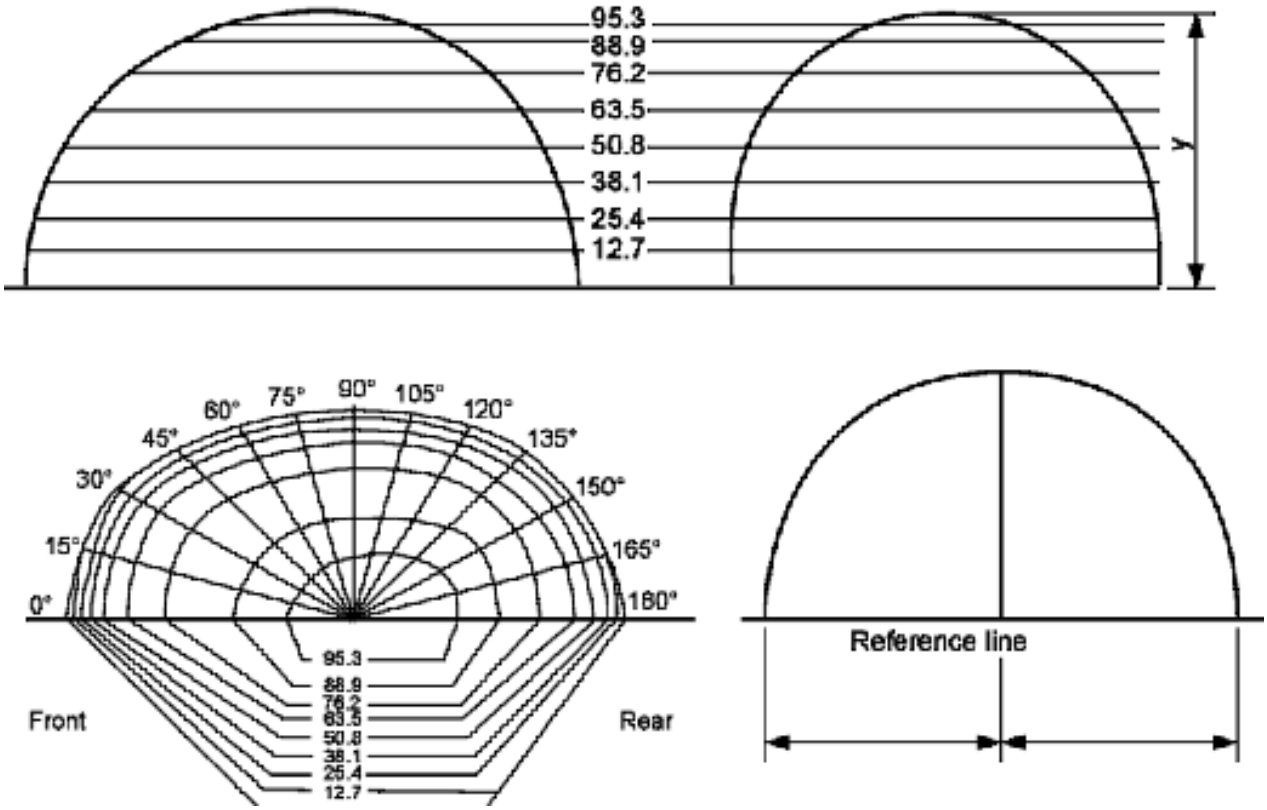


Fig. 2 APPARATUS FOR TESTING ABRASION OF THE CHIN STRAP

ANNEX J
(Note to Fig. 1 of ANNEX A)

REFERENCE HEADFORMS



REFERENCE HEADFORMS
(shape, dimensions above reference plane)
Dimensions in millimeters

A (Dimensions in millimeters)													
Height above reference line	0° Front	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	88.1	86.4	83.1	75.4	69.9	66.8	66.5	69.3	73.4	78.8	84.1	87.6	88.1
12.7	86.9	85.3	83.1	75.4	69.9	66.8	66.5	69.3	73.4	78.8	84.1	87.6	88.1
25.4	84.6	83.6	82.3	75.4	69.9	66.8	66.5	69.3	73.4	78.8	84.1	86.1	86.1
38.1	80.8	80.3	79.5	72.9	67.6	65.3	65.0	67.6	71.6	76.5	81.3	82.8	82.8
50.8	74.7	74.4	74.0	68.1	63.2	61.0	60.7	63.2	66.8	71.6	73.7	76.7	76.7
63.5	64.8	64.8	64.8	59.9	55.6	53.3	53.1	55.4	59.2	63.5	67.6	67.6	67.6
76.2	45.7	45.7	45.5	43.4	41.4	40.4	40.4	42.4	46.2	50.5	54.6	54.6	54.6
82.6	31.0	31.2	31.2	31.0	30.0	29.7	30.2	32.5	36.1	40.4	43.9	44.5	44.5
Dimension: Y : 89.7 mm - Head circumference : 500 mm													

C (Dimensions in millimeters)													
Height above reference line	0° Front	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	91.2	89.7	86.1	78.7	72.6	69.9	69.6	72.4	76.7	82.0	87.4	90.4	91.2
12.7	89.9	88.6	86.1	78.7	72.6	69.9	69.6	72.4	76.7	82.0	87.4	90.4	91.2
25.4	87.6	87.1	85.3	78.7	72.6	69.9	69.6	72.4	76.7	82.0	87.4	89.2	89.9
38.1	84.6	83.8	82.3	76.5	70.6	68.1	68.1	70.6	74.7	79.8	84.3	85.6	86.4
50.8	78.5	78.2	77.5	72.4	66.5	64.3	64.3	66.5	70.4	75.4	79.5	80.3	80.8
63.5	69.3	69.1	69.1	64.5	59.4	57.2	57.4	59.7	63.5	68.3	71.9	71.9	71.9
76.2	52.3	52.3	52.3	49.3	46.2	45.2	45.7	48.0	51.6	56.1	59.4	59.7	59.9
82.6	39.9	39.9	39.9	38.1	37.1	36.6	36.8	38.6	41.9	46.2	50.5	51.1	51.3
88.9	20.6	20.6	20.6	21.3	22.1	22.9	23.9	25.4	28.2	31.8	34.3	34.5	34.5
Dimension: Y : 92.7 mm - Head circumference : 520 mm													

E (Dimensions in millimeters)													
Height above reference line	0° Front	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	94.5	93.0	89.7	82.0	76.2	73.2	72.9	75.7	79.8	84.8	90.7	93.7	94.5
12.7	93.2	91.9	89.7	82.0	76.2	73.2	72.9	75.7	79.8	84.8	90.7	93.7	94.5
25.4	91.2	90.7	88.9	82.0	76.2	73.2	72.9	75.7	79.8	84.8	90.7	92.7	93.0
38.1	87.6	87.9	85.9	80.0	74.7	71.6	71.4	74.2	77.7	82.6	88.6	89.2	89.2
50.8	82.0	82.3	81.0	75.4	70.4	67.8	67.6	70.4	73.9	79.0	83.8	84.3	84.3
63.5	73.4	73.7	73.4	68.6	64.0	61.5	61.2	63.5	67.1	71.9	76.5	76.5	76.5
76.2	57.7	57.9	58.2	55.9	52.6	50.5	50.3	52.1	55.1	59.7	64.5	64.8	64.8
82.6	46.5	46.5	46.5	45.2	43.2	42.4	42.9	44.4	47.5	52.3	56.4	56.9	56.6
88.9	30.5	30.5	30.7	31.0	31.2	31.2	31.8	33.8	36.8	40.4	43.9	44.2	44.2
Dimension: Y : 96 mm - Head circumference : 540 mm													

G (Dimensions in millimeters)													
Height above reference line	0° Front	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	97.5	95.8	93.0	85.1	79.5	76.2	75.9	78.5	83.1	88.4	94.0	97.0	97.5
12.7	96.3	95.3	92.7	85.1	79.5	76.2	75.9	78.5	83.1	88.4	94.0	97.0	97.5
25.4	93.7	92.7	91.4	85.1	79.5	76.2	75.9	78.5	83.1	88.4	94.0	95.8	96.3
38.1	90.4	89.7	88.9	83.3	77.7	75.2	74.9	77.0	81.3	86.6	91.7	92.7	93.0
50.8	86.1	85.6	84.6	79.0	73.7	71.1	70.9	73.2	78.0	82.8	87.1	87.9	88.1
63.5	77.5	77.2	76.5	72.1	67.3	64.5	64.3	66.5	70.9	75.9	79.0	79.0	80.0
76.2	63.8	63.8	64.0	61.2	57.4	54.9	54.9	56.9	61.5	66.5	68.8	69.1	69.1
88.9	39.9	39.6	39.6	39.1	38.4	37.8	38.4	40.4	44.2	49.8	52.8	53.1	53.1
95.3	20.6	20.6	20.6	21.3	22.4	23.4	23.9	25.4	28.7	33.6	37.8	39.1	39.1
Dimension: Y : 99.1 mm - Head circumference : 560 mm													

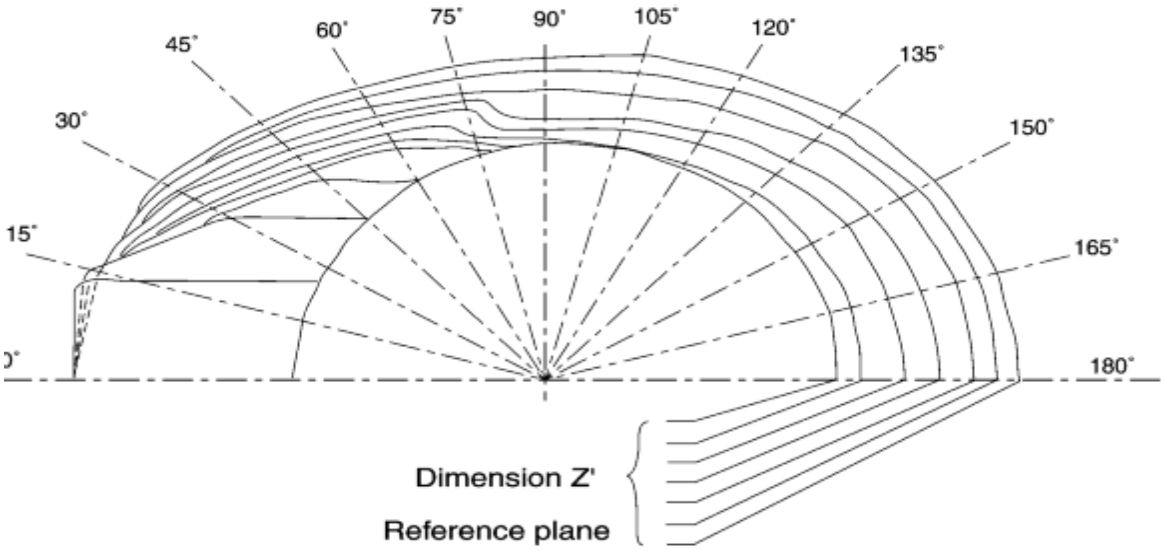
J (Dimensions in millimeters)													
Height above reference line	0° Front	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	100.8	98.8	96.3	88.1	82.0	79.5	79.2	82.0	85.9	91.7	96.8	100.1	100.8
12.7	99.6	98.0	95.8	88.1	82.0	79.5	79.2	82.0	85.9	91.7	96.8	100.1	100.8
25.4	96.8	95.8	94.5	88.1	82.0	79.5	79.2	82.0	85.9	91.7	96.5	98.3	98.8
38.1	93.7	92.7	91.9	86.1	80.0	77.2	77.7	80.0	83.8	89.4	94.5	95.8	96.0
50.8	89.2	88.6	87.9	82.0	76.2	73.9	74.4	77.0	80.5	85.9	90.4	90.9	90.9
63.5	81.5	80.8	81.0	75.9	70.6	68.1	68.3	71.1	71.4	79.5	83.8	84.1	84.1
76.2	69.3	69.1	69.3	65.3	61.2	58.9	59.2	61.7	65.0	69.3	73.2	73.4	73.4
88.9	47.2	47.5	48.0	46.2	44.4	43.7	44.2	46.2	50.0	54.1	58.2	58.4	58.4
95.3	32.8	32.8	33.3	32.5	32.0	32.3	33.0	35.1	38.1	42.2	46.5	47.2	47.2
Dimension: Y : 102.4 mm - Head circumference : 570 mm													

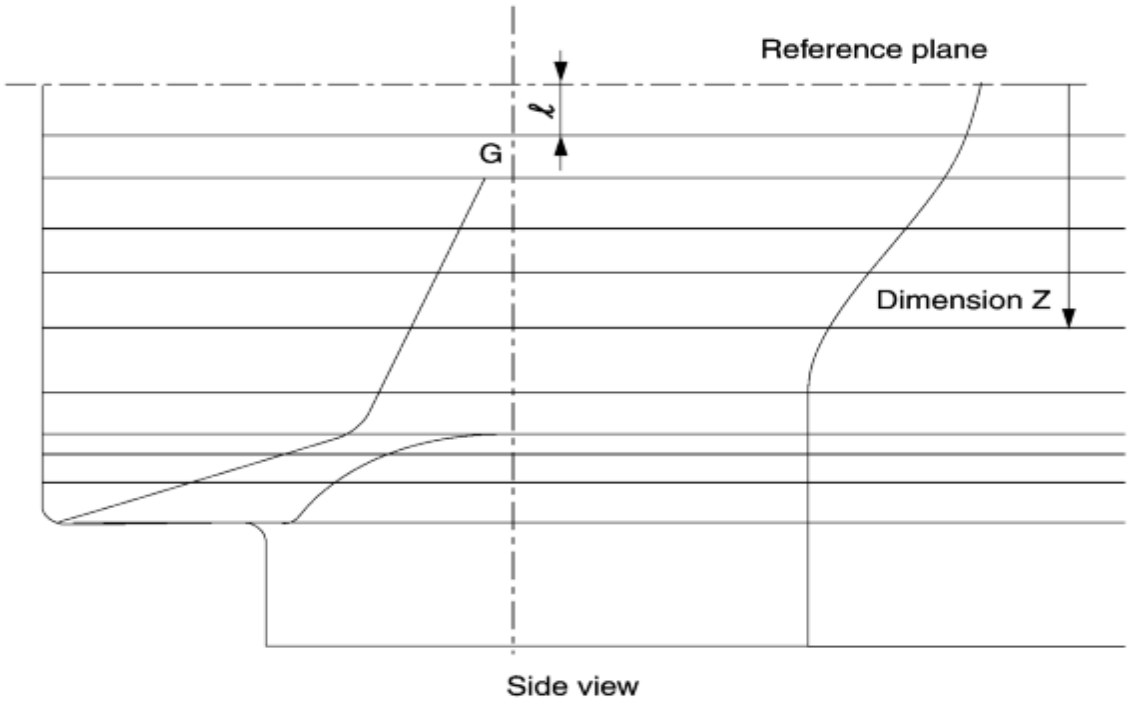
K (Dimensions in millimeters)													
Height above reference line	0° Front	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	102.4	101.1	97.0	89.7	84.1	81.3	80.8	83.3	87.9	92.7	98.3	101.6	102.4
12.7	101.1	100.1	97.0	89.7	84.1	81.3	80.8	83.3	87.9	92.7	98.3	101.6	102.4
25.4	98.8	98.3	96.3	89.7	84.1	81.3	80.8	83.3	87.9	92.7	98.3	99.8	100.6
38.1	95.5	95.2	93.7	87.4	82.0	79.5	79.5	81.5	85.9	90.4	95.5	97.0	97.7
50.8	90.9	90.4	89.7	83.6	78.5	76.2	76.2	78.5	83.1	87.4	91.9	92.5	93.2
63.5	83.1	82.8	82.0	77.2	72.1	69.9	70.4	72.4	76.7	80.8	84.6	85.1	85.6
76.2	71.1	71.1	71.4	68.1	63.8	61.2	61.2	63.0	67.1	71.6	74.9	75.2	75.2
88.9	51.8	51.8	51.8	50.8	48.5	46.7	47.2	49.3	52.1	56.9	60.7	60.7	60.7
95.3	37.6	37.3	37.3	37.3	36.8	36.6	37.1	38.9	42.2	47.0	51.1	51.8	51.3
101.6	18.3	17.8	17.8	18.0	18.5	19.3	20.1	21.8	24.9	29.0	33.8	36.1	36.6
Dimension: Y : 103.9 mm - Head circumference : 580 mm													

M (Dimensions in millimetres)													
Height above reference line	0° Front	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	105.7	103.9	100.6	92.7	86.9	84.1	83.8	86.4	90.7	96.0	102.1	105.7	105.7
12.7	104.4	103.4	100.3	92.7	86.9	84.1	83.8	86.4	90.7	96.0	102.1	105.7	105.7
25.4	102.1	101.6	99.8	92.7	86.9	84.1	83.8	86.4	90.7	96.0	102.1	104.4	104.4
38.1	99.3	98.8	97.8	90.9	85.3	82.6	82.3	84.6	88.9	94.0	99.8	100.8	101.1
50.8	95.0	94.7	93.5	86.9	81.3	79.0	78.7	81.0	85.3	90.4	96.0	96.5	96.3
63.5	87.1	87.1	86.9	80.8	75.4	73.2	73.2	75.4	79.5	84.8	89.4	89.7	89.4
76.2	75.9	76.2	76.2	71.6	67.1	64.8	64.8	66.5	70.6	75.4	80.0	80.0	79.3
88.9	58.2	58.2	58.2	56.6	54.6	52.3	52.3	53.8	56.9	61.7	66.8	67.1	66.8
95.3	45.5	45.7	46.0	46.0	44.5	43.4	43.2	44.5	47.2	52.1	57.7	58.2	57.9
101.6	26.4	26.2	26.7	27.7	28.7	29.5	30.0	31.2	34.0	38.6	42.7	43.2	42.7
Dimension: Y : 107.2 mm - Head circumference : 600 mm													

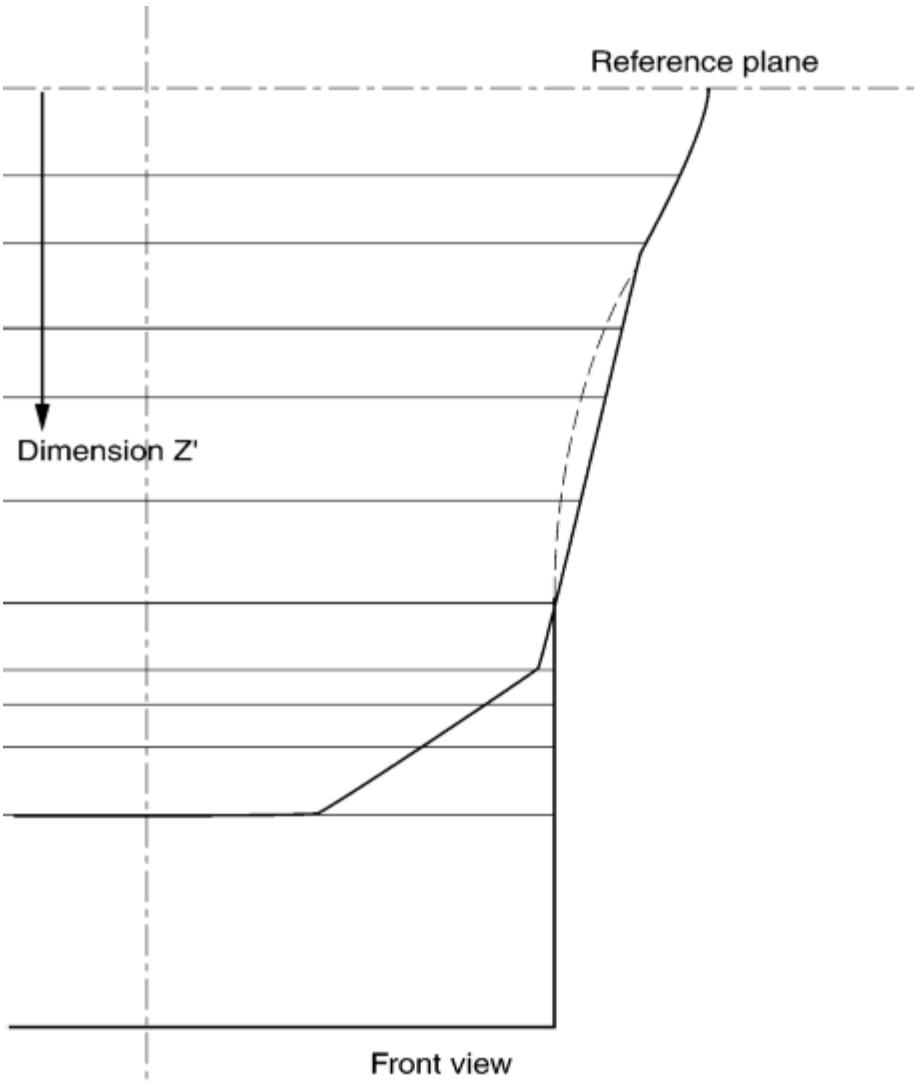
O (Dimensions in millimetres)													
Height above reference line	0° Front	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	108.7	107.4	103.4	95.8	90.4	87.6	87.1	90.2	94.2	99.8	105.4	108.0	108.7
12.7	107.7	106.4	103.4	95.8	90.4	87.6	87.1	90.2	94.2	99.8	105.4	108.0	108.7
25.4	105.2	104.4	102.9	95.8	90.4	87.6	87.1	90.2	94.2	99.8	105.4	106.7	106.9
38.1	102.4	102.1	101.1	94.2	88.9	86.1	85.9	88.9	93.0	98.6	103.4	104.1	104.1
50.8	97.8	97.5	96.5	90.2	85.1	82.3	82.6	85.3	89.9	94.7	99.6	100.3	100.3
63.5	91.2	91.2	90.4	84.3	79.2	76.7	77.0	79.8	83.8	88.4	93.0	93.2	93.2
76.2	81.0	81.3	80.8	76.2	71.6	69.3	69.6	71.9	75.7	80.5	84.6	84.6	84.6
88.9	64.5	64.5	64.5	61.5	58.4	57.2	57.7	60.2	63.5	68.1	71.9	71.4	71.9
95.3	54.1	53.8	54.1	52.6	50.3	49.0	49.5	51.6	55.4	60.5	64.3	64.0	64.0
101.6	37.6	37.6	38.1	38.4	38.1	37.8	38.4	40.4	43.4	48.0	51.3	51.3	51.1
Dimension: Y : 110.2 mm - Head circumference : 620 mm													

ANNEX K





REFERENCE HEADFORMS
(shape, dimensions below reference plane)


Reference plane
Dimension Z'
Front view

A													
Dimension Z'	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	88.0	86.5	83.0	75.5	70.0	67.0	66.5	69.5	73.5	78.5	84.0	87.0	88.0
-11.1	88.0	86.5	82.5	74.5	68.5	66.0	66.0	68.5	72.0	77.0	81.5	84.5	85.0
-19.9	88.0	88.0	82.5	74.0	66.5	63.0	61.5	64.5	67.5	72.5	77.0	80.0	80.5
-30.6	88.0	89.5	81.0	71.5	65.0	62.0	56.0	58.0	61.5	66.5	71.0	73.5	74.0
-39.4	88.0	89.5	79.0	69.0	63.0	60.0	54.0	55.0	58.0	61.5	65.0	67.5	67.0
-52.5	88.0	89.5	77.0	67.0	60.5	54.0	51.5	52.0	53.5	56.5	59.0	60.0	58.5
-65.6	88.0	89.5	75.5	65.0	58.5	52.5	50.5	51.0	51.5	52.5	53.0	54.0	54.5
-74.4	88.0	89.5	73.5	62.5	58.0	51.0	50.5	51.0	51.5	52.5	53.0	54.0	54.5
-78.8	88.0	89.5	71.5	60.5	49.5	50.0	50.5	51.0	51.5	52.5	53.0	54.0	54.5
-84.4	88.0	89.5	69.5	47.5	49.5	50.0	50.5	51.0	51.5	52.5	53.0	54.0	54.5
-92.8	88.0	92.0	47.5	47.5	49.5	50.0	50.5	51.0	51.5	52.5	53.0	54.0	54.5
-119.0	47.0	47.0	47.5	47.5	49.5	50.0	50.5	51.0	51.5	52.5	53.0	54.0	54.5
Dimension l : 11.1 mm - Head circumference : 500 mm													

C													
Dimension Z'	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	91.5	89.5	86.0	79.0	72.5	70.0	69.5	72.5	77.0	82.0	87.5	90.5	91.5
-11.5	91.5	89.5	85.5	77.0	71.0	68.5	68.5	71.0	74.5	80.0	84.5	87.5	88.0
-20.6	91.5	91.0	85.5	76.5	69.0	65.5	64.0	66.5	70.0	75.5	80.0	83.0	83.5
-31.8	91.5	92.5	84.0	74.0	67.0	64.5	58.0	60.5	64.0	69.0	73.5	76.0	76.5
-40.8	91.5	92.5	81.5	71.5	65.5	62.0	56.0	57.0	60.0	64.0	67.5	70.0	69.5
-54.4	91.5	92.5	80.0	69.5	62.5	56.0	53.5	54.0	55.5	58.5	61.0	62.0	61.0
-68.0	91.5	92.5	78.0	67.0	61.0	54.5	52.0	53.0	53.5	54.5	55.0	56.0	56.5
-77.1	91.5	92.5	76.0	65.0	60.0	52.5	52.0	53.0	53.5	54.5	55.0	56.0	56.5
-81.7	91.5	92.5	74.0	62.5	51.0	51.5	52.0	53.0	53.5	54.5	55.0	56.0	56.5
-87.6	91.5	92.5	72.0	49.5	51.0	51.5	52.0	53.0	53.5	54.5	55.0	56.0	56.5
-96.2	91.5	95.5	49.0	49.5	51.0	51.5	52.0	53.0	53.5	54.5	55.0	56.0	56.5
-123.4	48.5	48.5	49.0	49.5	51.0	51.5	52.0	53.0	53.5	54.5	55.0	56.0	56.5
Dimension l : 11.5 mm - Head circumference : 520 mm													

E													
Dimension Z'	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	94.5	93.0	90.0	82.0	76.5	73.5	73.0	76.0	80.0	85.0	91.0	94.0	94.5
-11.9	94.5	93.0	88.5	79.5	73.0	70.5	70.5	73.0	77.0	82.5	87.0	90.5	91.0
-21.3	94.5	94.0	88.5	79.0	71.0	67.5	66.0	69.0	72.0	77.5	82.5	85.5	86.0
-32.8	94.5	95.5	86.5	76.5	69.5	66.5	60.0	62.5	66.0	71.0	76.0	78.5	79.0
-42.1	94.5	95.5	84.5	74.0	67.5	64.0	57.5	59.0	62.0	66.0	70.0	72.0	71.5
-56.2	94.5	95.5	82.5	71.5	64.5	57.5	55.5	55.5	57.0	60.5	63.0	64.0	63.0
-70.2	94.5	95.5	80.5	69.5	62.5	56.0	54.0	55.0	55.5	56.0	56.5	57.5	58.0
-79.6	94.5	95.5	78.5	67.0	62.0	54.5	54.0	55.0	55.5	56.0	56.5	57.5	58.0
-84.3	94.5	95.5	76.5	64.5	53.0	53.5	54.0	55.0	55.5	56.0	56.5	57.5	58.0
-90.4	94.5	95.5	74.5	51.0	53.0	53.5	54.0	55.0	55.5	56.0	56.5	57.5	58.0
-99.3	94.5	98.5	50.5	51.0	53.0	53.5	54.0	55.0	55.5	56.0	56.5	57.5	58.0
-127.4	50.0	50.0	50.5	51.0	53.0	53.5	54.0	55.0	55.5	56.0	56.5	57.5	58.0
Dimension l : 11.9 mm - Head circumference : 540 mm													

G													
Dimension Z'	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	97.5	95.5	93.0	85.5	79.5	76.0	76.0	78,5	83.0	88.5	94.0	97.0	97.5
-12.3	97.5	95.5	91.5	82.0	75.5	73.0	73.0	75.5	79.0	85.0	90.0	93.0	93.5
-21.9	97.5	97.0	91.5	81.5	73.5	69.5	68.0	71.0	74.5	80.0	85.0	88.5	89.0
-33.8	97.5	98.5	89.5	78.5	71.5	68.5	62.0	64.0	68.0	73.5	78.0	81.0	81.5
-43.5	97.5	98.5	87.0	76.5	69.5	66.0	59.5	61.0	63.5	68.0	72.0	74.5	74.0
-58.0	97.5	98.5	85.0	74.0	66.5	59.5	57.0	57.5	59.0	62.5	65.0	66.0	64.5
-72.4	97.5	98.5	83.0	71.5	64.5	58.0	55.5	56.5	57.0	58.0	58.5	59.5	60.0
-82.1	97.5	98.5	81.0	69.0	63.5	56.0	55.5	56.5	57.0	58.0	58.5	59.5	60.0
-86.9	97.5	98.5	78.5	66.5	54.5	55.0	55.5	56.5	57.0	58.0	58.5	59.5	60.0
-93.2	97.5	98.5	77.0	52.5	54.5	55.0	55.5	56.5	57.0	58.0	58.5	59.5	60.0
-102.4	97.5	101.5	52.0	52.5	54.5	55.0	55.5	56.5	57.0	58.0	58.5	59.5	60.0
-131.4	51.5	51.5	52.0	52.5	54.5	55.0	55.5	56.5	57.0	58.0	58.5	59.5	60.0
Dimension l : 12.3 mm - Head circumference : 560 mm													

J													
Dimension Z'	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	101.0	99.5	95.5	88.5	82.5	79.5	79.5	82.0	86.0	92.0	97.0	100.5	101.0
-12.7	101.0	99.5	94.5	85.0	78.0	75.5	75.5	78.0	82.0	88.0	93.0	96.5	97.0
-22.7	101.0	100.5	94.5	84.5	76.0	72.0	70.5	73.5	77.0	83.0	88.0	91.5	92.0
-35.0	101.0	102.0	92.5	81.5	74.0	71.0	64.0	66.5	70.5	76.0	81.0	84.0	84.5
-45.0	101.0	102.0	90.0	79.0	72.0	68.5	61.5	63.0	66.0	70.5	74.5	77.0	76.5
-60.0	101.0	102.0	88.0	76.5	69.0	61.5	59.0	59.5	61.0	64.5	67.5	68.5	67.0
-75.0	101.0	102.0	86.0	74.0	67.0	60.0	57.5	58.5	59.0	60.0	60.5	61.5	62.0
-85.0	101.0	102.0	84.0	71.5	66.0	58.0	57.5	58.5	59.0	60.0	60.5	61.5	62.0
-90.0	101.0	102.0	81.5	69.0	56.5	57.0	57.5	58.5	59.0	60.0	60.5	61.5	62.0
-96.5	101.0	102.0	79.5	54.5	56.5	57.0	57.5	58.5	59.0	60.0	60.5	61.5	62.0
-106.0	101.0	105.0	54.0	54.5	56.5	57.0	57.5	58.5	59.0	60.0	60.5	61.5	62.0
-136.0	53.5	53.5	54.0	54.5	56.5	57.0	57.5	58.5	59.0	60.0	60.5	61.5	62.0
Dimension l : 12.7 mm - Head circumference : 570 mm													

K													
Dimension Z'	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	102.5	101.0	97.0	90.0	84.0	81.5	81.0	83.5	88.0	93.0	98.5	101.5	102.5
-12.9	102.5	101.0	96.0	86.0	79.0	76.5	76.5	79.0	83.0	89.5	94.5	98.0	98.5
-23.0	102.5	102.0	96.0	86.0	77.0	73.0	71.5	74.5	78.0	84.0	89.5	93.0	93.5
-35.5	102.5	103.5	94.0	82.5	75.0	72.0	65.0	67.5	71.5	77.0	82.0	85.0	85.5
-45.7	102.5	103.5	91.5	80.0	73.0	63.5	62.5	64.0	67.0	71.5	75.5	78.0	77.5
-60.9	102.5	103.5	89.5	77.5	70.0	62.5	60.0	60.5	62.0	65.5	68.5	69.5	68.0
-76.1	102.5	103.5	87.5	75.0	68.0	61.0	58.5	59.5	60.0	61.0	61.5	62.5	63.0
-86.2	102.5	103.5	85.5	72.5	67.0	59.0	58.5	59.5	60.0	61.0	61.5	62.5	63.0
-91.3	102.5	103.5	82.5	70.0	57.5	58.0	58.5	59.5	60.0	61.0	61.5	62.5	63.0
-97.9	102.5	103.5	80.5	55.5	57.5	58.0	58.5	59.5	60.0	61.0	61.5	62.5	63.0
-107.6	102.5	106.5	54.5	55.5	57.5	58.0	58.5	59.5	60.0	61.0	61.5	62.5	63.0
-138.0	54.5	54.5	54.5	55.5	57.5	58.0	58.5	59.5	60.0	61.0	61.5	62.5	63.0
Dimension l : 12.9 mm - Head circumference : 580 mm													

M													
Dimension Z'	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	106.0	104.0	101.0	93.5	87.0	84.5	84.0	86.5	91.0	96.0	102.0	106.0	106.0
-13.3	106.0	104.0	98.5	88.5	81.5	79.0	79.0	81.5	85.5	92.0	97.0	100.5	101.5
-23.7	106.0	105.0	98.5	88.0	79.5	75.0	73.5	76.5	80.5	86.5	92.0	95.5	96.0
-36.5	106.0	106.5	96.5	85.0	77.5	74.0	67.0	69.5	73.5	79.5	84.5	87.5	88.0
-47.0	106.0	106.5	94.0	82.5	75.0	71.5	64.0	66.0	69.0	73.5	78.0	80.5	80.0
-62.6	106.0	106.5	92.0	80.0	72.0	64.0	61.5	62.0	63.5	67.5	70.5	71.5	70.0
-78.3	106.0	106.5	90.0	77.0	70.0	62.5	60.0	61.0	61.5	62.5	63.0	64.0	64.5
-88.7	106.0	106.5	87.5	74.5	69.0	60.5	60.0	61.0	61.5	62.5	63.0	64.0	64.5
-94.0	106.0	106.5	85.0	72.0	59.0	59.5	60.0	61.0	61.5	62.5	63.0	64.0	64.5
-100.7	106.0	106.5	83.0	57.0	59.0	59.5	60.0	61.0	61.5	62.5	63.0	64.0	64.5
-110.7	106.0	109.5	56.5	57.0	59.0	59.5	60.0	61.0	61.5	62.5	63.0	64.0	64.5
-142.0	56.0	56.0	56.5	57.0	59.0	59.5	60.0	61.0	61.5	62.5	63.0	64.0	64.5
Dimension l : 13.3 mm - Head circumference : 600 mm													

O													
Dimension Z'	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180° Rear
0	108.5	107.5	103.5	96.0	90.5	87.5	87.0	90.0	94.5	100.0	105.0	108.0	108.5
-13.7	108.5	107.5	101.5	91.5	84.0	81.0	81.0	84.0	88.0	94.5	100.0	103.5	104.5
-24.4	108.5	108.0	101.5	91.0	81.5	77.5	76.0	79.0	83.0	89.0	94.5	98.5	99.0
-37.6	108.5	109.5	99.5	87.5	79.5	76.5	63.0	71.5	76.0	81.5	87.0	90.5	91.0
-48.4	108.5	109.5	97.0	85.0	77.5	73.5	66.0	67.5	71.0	76.0	80.0	83.5	82.0
-64.5	108.5	109.5	94.5	82.0	74.0	66.0	63.5	64.0	65.5	69.5	72.5	73.5	72.0
-80.6	108.5	109.5	92.5	79.5	72.0	64.5	62.0	63.0	63.5	64.5	65.0	66.0	66.5
-91.4	108.5	109.5	90.5	77.0	71.0	62.5	62.0	63.0	63.5	64.5	65.0	66.0	66.5
-96.8	108.5	109.5	87.5	74.0	60.5	61.0	62.0	63.0	63.5	64.5	65.0	66.0	66.5
-103.8	108.5	109.5	85.5	58.5	60.5	61.0	62.0	63.0	63.5	64.5	65.0	66.0	66.5
-114.0	108.5	113.0	58.0	58.5	60.5	61.0	62.0	63.0	63.5	64.5	65.0	66.0	66.5
-146.2	57.5	57.5	58.0	58.5	60.5	61.0	62.0	63.0	63.5	64.5	65.0	66.0	66.5
Dimension l : 13.7 mm - Head circumference : 620 mm													

ANNEX L

Road vehicles – Measurement techniques in impact tests – Instrumentation

L-1 The requirements are aimed at facilitating comparisons between results obtained by different testing laboratories, while its recommendations will assist such laboratories in meeting those requirements. It is applicable to instrumentation including that used in the impact testing of vehicle subassemblies. It does not include optical method.

L-2 Terms and definitions

The following terms and definitions shall apply.

L-2.1 Data channel

all the instrumentation from, and including, a single transducer (or multiple transducers, the outputs of which are combined in some specified way) to, and including, any analysis procedures that may alter frequency content or the amplitude content of data.

L-2.2 Transducer

first device in a data channel used to convert a physical quantity to be measured into a second quantity (such as an electrical voltage), which can be processed by the remainder of the channel.

L-2.3 Channel amplitude class CAC

designation for a data that meets certain amplitude characteristics as specified by this standard.

NOTE — The CAC number is numerically equal to the upper limited of the measurement range.

L-2.4 Channel frequency class CFC

Frequency class designated by a number indication that the channel frequency response lies within limits specified by Figure 1 for CFCs 1 000 and 600, or is filtered using the algorithm given in annex A

NOTE — This number and the value of the frequency F_H (*see* Figure 1), in hertz, are numerically equal.

L-2.5 Calibration value

mean value measured and read during calibration a data channel.

L-2.6 Sensitivity

ratio of the output signal (in equivalent physical units) to the input signal (physical excitation) when an excitation is applied to the transducer

EXAMPLE — 10.24_m v:g/v for a strain gauge accelerometer.

L-2.7 Sensitivity coefficient

slope of the straight line representing the best fit to the calibration values, determined by the method of least squares within the channel amplitude class

L-2.8 Calibration factor of a data channel

mean value of the sensitivity coefficients evaluated over frequencies evenly spaced on a logarithmic scale between F_L and $F_H/2.5$

L-2.9 Linearity error

ratio of the maximum difference between the calibration value and the corresponding value read on the straight line at the upper limit of the channel amplitude class

NOTE — It is expressed as a percentage (*see* **4.6**).

L-2.10 Transverse sensitivity of a rectilinear transducer

sensitivity to excitation in a nominal direction perpendicular to its sensitive axis

NOTE 1- The transverse sensitivity of a rectilinear transducer is usually a function of the nominal direction of the axis chosen.

2- The cross sensitivity of force and bending moment transducer is complicated by the complexity of loading cases.

L-2.11 Transverse sensitivity ratio of a rectilinear transducer

ratio of the transverse sensitivity of a rectilinear transducer to its sensitivity along its sensitive axis.

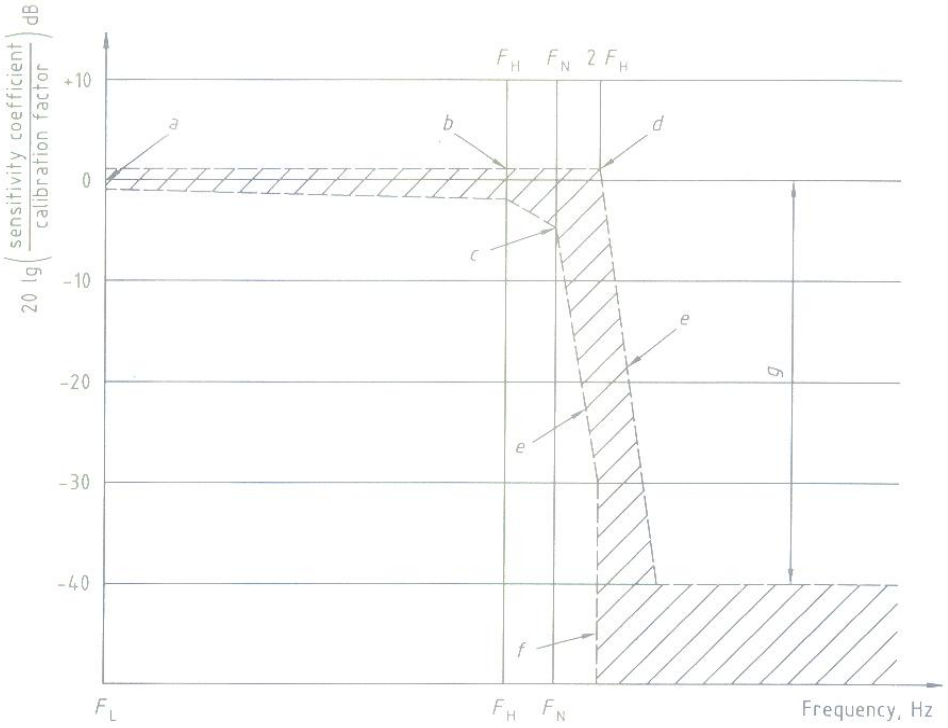
NOTE — The cross sensitivity of force and bending moment transducer is complicated by the complexity of loading cases.

L-2.12 Phase delay time of a data channel

time equal to the phase delay, expressed in radians, of a sinusoidal signal, divided by the angular frequency of that signal, and expressed in radians per second

L-2.13 Environment

aggregate, at a given moment, of all external condition and influences to which the data channel is subject



Logarithmic scale	
a	± 0,5 dB
b	+ 0,5; – 1 dB
c	+ 0,5; – 4 dB
d	+ 0,5 dB
e	– 24 dB/octave
f	– ∞
g	– 40 dB

CFC	F_L Hz	F_H Hz	F_N Hz
1 000	⩽ 0,1	1 000	1 650
600	⩽ 0,1	600	1 000

Figure 1 — Frequency response limits — CFC 1000 and CFC 600

L-3 Performance requirements

L-3.1 Linearity error

The absolute value of the linearity error of a data channel at any frequency in the CFC (channel frequency class) shall be less than or equal to 2.5 % of the CAC over the whole measurement range.

L-3.2 Amplitude against frequency

The frequency response of a data channel shall lie within the limiting curves given in Figure 1 for CFCs 1 000 and 600. For CFCs 180 and 60, the frequency response on the channel is determined by the filter algorithm given in annex A. The zero decibels line is defined by the calibration factor. For CFCs 180 and 60, the frequency response of the data channel shall remain within 0,5 dB of the zero decibel line at frequency ranging from 0.1 Hz to the CFC, before the digital filter is applied (*see* **4.6.2.3.2**).

L-3.3 Phase delay time of a data channel

The phase delay time of a data channel between its input and output shall be determined; it shall not vary by more than 1/10 F_H s between 0.03 F_H and F_H .

L-3.4 Time

L-3.4.1 Time base

A time base shall be recorded that shall give at least 0.01 s with an accuracy of 1 %.

L-3.4.2 Relative time delay

The relative time delay between the signals of two or more data channels, regardless of their frequency class, shall not exceed 1 ms, excluding phase delay caused by phase shift. Two or more data channels whose signals are combined shall have the same frequency class and shall have a relative time delay not greater than 1/10 F_H s.

The requirement is applicable to analog signals, synchronization pulses and digital signals.

L-3.5 Transducer transverse sensitivity ratio of a rectilinear transducer

The transducer transverse sensitivity ratio of a rectilinear transducer shall be less than 5% in any direction.

L-3.6 Calibration

L-3.6.1 General

The channel shall be calibrated at least once a year against reference equipment traceable to known standards. The method used to carry out a comparison with reference equipment shall not cause an error greater than 1% of the CAC. The use of reference equipment is limited to the range of frequencies for which it has been calibrated.

Data channel subsystems may be evaluated individually and the results factored into the accuracy of the total data channel. This can be made, for example, by an

electrical signal of known amplitude simulating the output signal of the transducer, allowing a check to be made on the gain of the data channel, excluding the transducer.

L-3.6.2 Accuracy of reference equipment for calibration

L-3.6.2.1 General

The accuracy of the reference equipment shall be certified or endorsed by an approved metrology service.

L-3.6.2.2 Static calibration

L-3.6.2.2.1 Acceleration

The error shall be less than 1.5 % of the channel amplitude class.

L-3.6.2.2.2 Force and displacement

The error shall be less than 1 % of the channel amplitude class.

L-3.6.2.3 Dynamic calibration

L-3.6.2.3.1 Acceleration

The error for the reference accelerations expressed as a percentage of the channel amplitude class shall be less than1.5 % at below 400 Hz, less than 2 % between 400 Hz and 900 Hz, and less than 2.5 % between 900 Hz and maximum frequency at which the reference acceleration is used (*see* **4.6.4**).

L-3.6.2.3.2 Forces and displacements

A method for the evaluation of the dynamic response during the calibration of data channels for forces and displacement has not been including in this international standard, since no satisfactory method is known at presents. The problem is to be reconsidered at a later date.

L-3.6.2.4 Time

The relative error in the reference time shall be less than 10^{-5}.

L-3.6.3 Sensitivity coefficient and linearity error

The sensitivity coefficient and the linearity error shall be determined by measuring the output signal of the data channel against a known input signal, for various of this signal.

The calibration of the data channel shall cover the whole range of the amplitude class.

For bi-directional channel, both the positive and negative values shall be used.

If the calibration equipment cannot produce the requires input, due to the excessively high values of the quantity to be measured, calibrations shall be carried out within the limits of these calibration standard, and these limits shall be recorded in the report.

A total data channel shall be calibrated at a frequency or at spectrum of frequencies, with its significant value being between F_L and F_H /2.5.

L-3.6.4 Calibration of frequency response

The response curves of phase and amplitude against frequency shall be measuring the output signals of the data channel in terms of phase and amplitude against a known input signal, for various values of this signal varying between F_L and ten times the CFC or 3 000 Hz, whichever is the lower.

L-3.7 Environmental effects

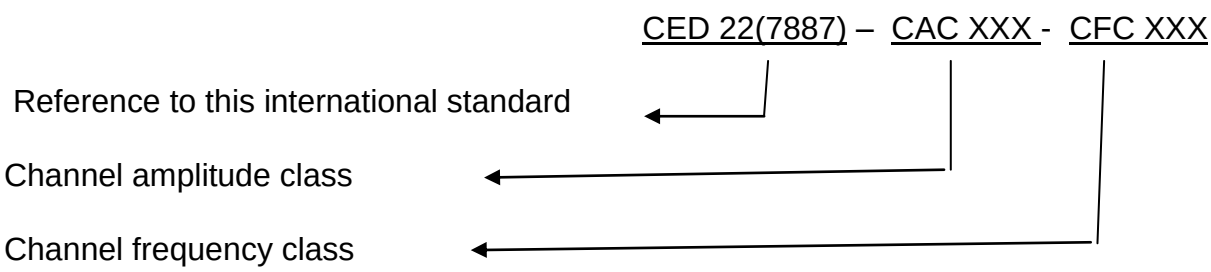
The existence or nonexistence of an influence of environmental effect shall be checked regularly (i.e. electric or magnetic flux, cables velocity, etc.). This can be done, for example, by recording the output of spare channel equipped with dummy transducers.

If significant output signal are obtained, corrective action shall be taken – for example, the re-allocation or replacement of cables.

L-3.8 Choice and designation of data channel

The CAC and CFC define the data channel, and their values are chosen for a given application by the party requiring the application.

A data channel in accordance with this standard shall be designated as follows:



The type of filter used, phaseless or phase shifting shall be declared for each channel.

For CFCs 180 and 60, the Butterworth four-pole phaseless filter, as specified in Annex A, shall be used.

If the calibration of the amplitude or frequency response does not cover the complete CAC or CFC, owing to limited properties of the calibration equipment, then the CAC or CFC shall be marked with an asterisk.

EXAMPLE — A measurement carried out in accordance with this international standard, where the channel amplitude class is 200 m/s^2 , the channel frequency class 1 000, and the calibration of the amplitude response did not cover the complete CAC, is designated as following:

CED 22(7887) – CAC*200 m/s^2 – CFC 1 000

The test report shall indicate the calibration limits.