MCH1 - SPECIFICATION FOR HEAD PROTECTION FOR MOTORCYCLISTS

VERSION 1/2011-385.6769

Specification for Protective Helmets for Motorcyclists

GHVI
Global Helmet Vaccine Initiative
SUPPORTS
DECADE OF ACTION FOR ROAD SAFETY 2011-2020

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Introduction and Background

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Road traffic crash injuries are a major public health crisis and a leading cause of death and injury around the world. About 1.24 million people die each year as a result of road traffic crashes, and an additional 20 to 50 million sustain non-fatal injuries (WHO, 2013). Approximately 90 percent of these fatalities and injuries occur in low- and middle-income countries (WHO, 2009), inflicting pain and suffering on individuals, families, and communities. In addition, road traffic crashes represent a tremendous burden on the health care system and developing economies.

Already considered a problem of significant proportion, the situation is set to worsen, with estimates that by 2030 road crashes will be the fifth leading cause of death (WHO, 2013) unless corrective action is taken.

In response to the growing level of road trauma, the United Nations launched the Decade of Action for Road Safety in 2011. The Decade calls for the implementation of effective countermeasures to combat risk factors associated with road traffic crashes, such as motorcycle helmet use.

In many low- and middle-income countries, where motorcycles and bicycles are an increasingly common means of transport, users of two-wheeled vehicles compose a large proportion of those injured or killed on the roads. Motorcycle and bicycle riders are highly vulnerable road users, as they often share traffic space with fast-moving cars, buses and trucks, and also because they are less visible. In addition, their lack of physical protection puts them at high risk of injury if they are involved in a collision.

In high-income countries, motorcycle fatalities typically comprise five to 18 percent of overall traffic fatalities (Koornstra et al., 2002; Mohan, 2002). However, in low- and middle-income countries, car ownership and use rates are generally much lower; as such, use of motorcycles and other two-wheeled vehicles is typically high. For example, the 2010 Traffic Accident Report from the National Traffic Safety Committee in Vietnam reports that two-wheeled vehicles compose 94% of the country's motorized vehicle fleet. The situation is similar in many other countries in the region and globally.

Reflecting this difference, the levels of motorcycle rider fatalities as a proportion of those injured on the roads are typically higher in low- to middle-income countries than in high-income countries (see Figure 1).

Figure 7

Road traffic deaths by type of road user, by WHO region

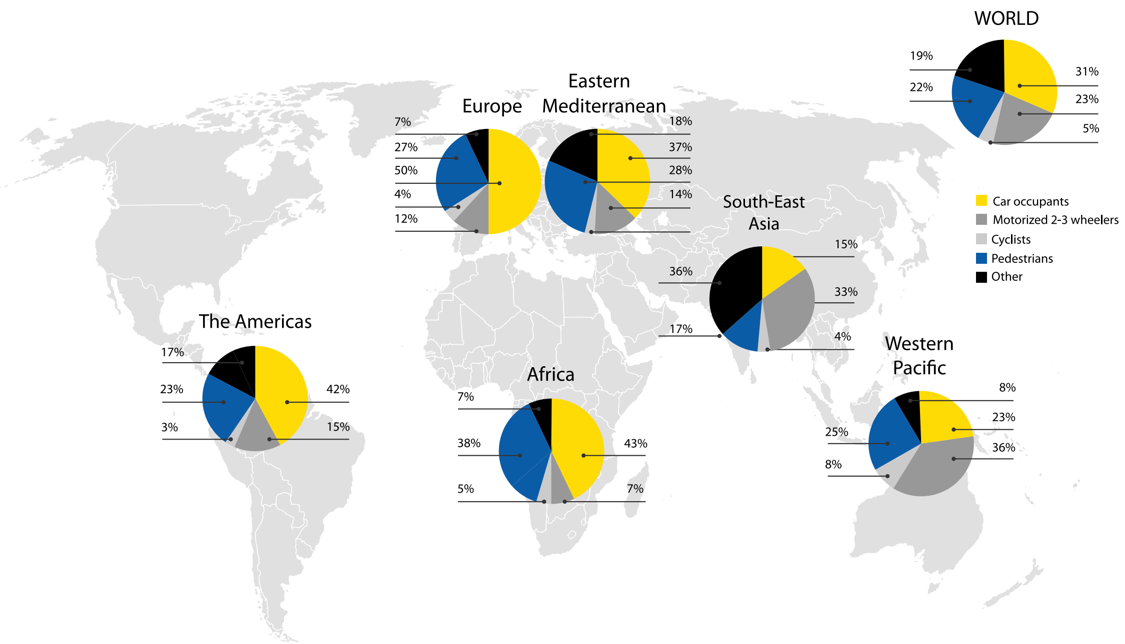


Figure 1: Road traffic deaths by type of road user, by WHO region
Source: WHO Global Status Report on Road Safety, 2013

Head injuries are a leading cause of death and disability

Injuries to the head and neck are the main cause of death, severe injury, and disability among users of motorcycles and bicycles. In European countries, an investigation into the effectiveness of motorcycle helmets found that head injuries contribute to approximately 75 percent of deaths among motorized two-wheeled vehicle users (European Commission COST 327 Final Report, 2001). In some low- to middle-income countries head injuries are estimated to account for up to 88 percent of such fatalities (Umar, 2002). The social costs of head injuries for survivors, their families, and communities are high, in part because they frequently require specialized or long term care. Blincoe et al. (2002) reported that head injuries also result in much higher medical costs than any other type of injury, as these injuries exert a high toll on a country's health care costs and its economy.

Globally, the use of motorcycles and bicycles is rising, particularly in Asia. This rapid growth in the use of motorcycles in many low- and middle-income countries is already being accompanied by a considerable increase in the number of head injuries and fatalities that will only continue to increase if present trends continue unchecked. However, helmets have been proven to reduce the likelihood of severe injury from road traffic crashes by 69 percent and to reduce the likelihood of fatality by 42 percent (Liu et al., 2008).

Helmet affordability

Lack of awareness and affordability contribute to low helmet use rates. A study of the affordability of helmets in 18 countries demonstrates that in low-income countries, helmets are unaffordable for the majority of the population. For example, in low-income countries with an hourly wage of three dollars or less, nearly 20 hours of factory work would be necessary to purchase a single motorcycle helmet (Hendrie et al., 2004). Given other more basic needs such as food, clothing and housing, it is not surprising that helmet use remains low in these countries. The availability of an affordable and effective motorcycle helmet in low- and middle-income countries would certainly improve the current road safety situation in these countries.

How a helmet works

A helmet aims to decrease the risk of serious head and brain injury by reducing the impact of a force or collision to the head.

A helmet works in three ways:

- It prevents direct contact between the skull and the impacting object by acting as a mechanical barrier between the head and the object.
- It spreads the forces of the impact over a greater surface area so that zthey are not concentrated on particular areas of the skull.
- It reduces the deceleration of the skull, and hence the brain movement, by absorbing energy and managing the impact. The soft material incorporated in the helmet absorbs impact energy and therefore reduces the magnitude of the forces transmitted to the skull and brain. This reduced force brings the head to a halt more slowly than would occur if no helmet was worn. This means that there is a significantly reduced risk of damage to the neural tissues.

These three functions are achieved by combining the properties of four basic components of the helmet as described below (see Figure 2).

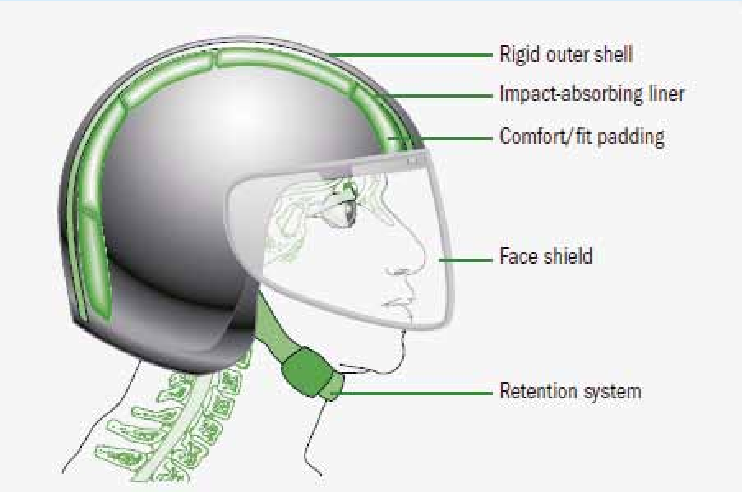


Figure 2: Helmet Components
Source: WHO Helmet Manual, 2006

The shell

This is the strong outer surface of the helmet that distributes the impact over a large surface area, and therefore reduces the local forces applied to the skull and brain. Although the shell is tough, it is designed to deform when it hits anything hard. It provides protection against direct penetration and it also protects the energy absorbing padding inside the helmet from abrasions and knocks during daily use.

The impact-absorbing liner

This is made of a soft, crushable padded material – usually expanded polystyrene. This layer cushions and absorbs the shock by deforming and crushing as the helmeted head comes to a stop. Effective motorcycle helmets have at least 20 mm of energy absorbing material, anything less than this and the possibility of liner "bottoming" or complete liner crush is too great. When the liner is completely crushed, it is no longer capable of absorbing impact energy and consequently, all energy is transmitted directly to the skull and brain.

The comfort padding

This is the soft foam and cloth layer that sits next to the head. It is important to maintain the proper fit of the helmet, particularly during normal use on a motorcycle. The comfort padding limits helmet movement and ensures that the helmet will remain on the head in the event of an impact.

The retention system

The retention system is the primary helmet component that will keep the helmet on the head in a crash. The retention system typically consists of some type of webbing that has either a d-ring or quick release attachment system for securing the helmet to the head. Retention systems are specifically designed to keep the helmet on during an impact; consequently, it must be used properly in order for the helmet to function as designed. One of the most significant problems related to helmet wearing is proper use of the retention system. Research has found that too many riders either do not fasten the retention system while wearing the helmet or do not fasten the retention system properly (Kasantikul, 2004).

Helmet use is effective at reducing head injuries

Wearing a helmet is the most effective method of reducing head injuries and fatalities resulting from motorcycle crashes. A systematic review of 53 studies on the effectiveness of motorcycle helmets is summarized in the table below (Liu et al., 2008):

Table 1: Summary of systematic review of effectiveness of motorcycle helmets in case of a crash
Source: Liu et al., 2008

Effect of not wearing a helmet	Effect of wearing a helmet
• Increases the risk of sustaining a head injury • Increases the severity of head injuries • Increases the time spent in hospital • Increases the likelihood of dying from a head injury	• Decreases the risk and severity of injuries by about 69% • Decreases the likelihood of death by up to 42%, with the probability depending on the speed of the motorcycle involved • Decreases the costs of health care associated with crashes

Additionally, a recent study found that "compared with helmeted motorcyclists, non-helmeted motorcyclists were more than four times as likely to have head injuries and more than ten times as likely to have brain injuries," in case of a crash (Yu et al., 2011).

2

Rationale

Rationale for the *MCH1 - Specification for Head Protection for Motorcyclists*

The MCH1 - Specification for Head Protection for Motorcyclists ('MCH1') should not replace existing motorcycle helmet standards. MCH1 is intended to provide a technically feasible standard that can be implemented in regions that currently do not have an existing motorcycle helmet standard and do not possess the technical expertise to develop their own motorcycle helmet standard test procedures. MCH1 builds upon the knowledge base developed by those countries that currently have motorcycle helmet standards.

The tests included in this standard have all been published in other safety helmet standards. For those countries that have an existing motorcycle helmet standard, this standard could be introduced as a revision to an existing, but outdated or inactive motorcycle helmet standard. This approach would permit introduction of helmets that are likely to achieve higher compliance among the riding population.

There are no new tests or procedures related to this standard. The tests that are included in this standard are not inclusive of all tests that exist in other motorcycle helmet standards. However, the tests that are included will assure that helmets meeting this standard will provide excellent head protection for motorcycle riders. The equipment and procedures used in MCH1 are not technically challenging and are consistent with other international motorcycle helmet standards. The impact test apparatus consists of a monorail drop tower that can be easily modified to allow for free motion headform testing such as that used in the UN/ECE 22 standard. Therefore, this standard represents an adequate initial standard that if desired by the standards governing body, will allow for future harmonization with other international motorcycle helmet standards (e.g. UN/ECE 22).

All helmet standards are developed to assure a minimum level of protection is provided to helmet users. All standards include a minimum extent of coverage requirement as well as performance requirements for the retention system and the energy absorbing liner. Other requirements may include helmet stability and retention system durability. The major features of the MCH1 relative to other international standards are described in the Appendix.

3

MCH1 – Specification for Head Protection for Motorcyclists

(Version 1/2011 - 385.6769)

MCH1 - Specification for Head Protection for Motorcyclists (Version 1/2011-385.6769)

1) Scope

MCH1 specifies requirements for helmets intended to provide protection for riders and passengers of motorcycles and motorcycles with side cars, excluding participants in competitive events. MCH1 has no restrictions pertaining to any particular style of motorcycle helmet other than the requirement that all motorcycle styles (e.g. full face, jet, open face, ventilated, etc.) claiming to meet this standard must meet performance requirements specified in MCH1. MCH1 defines the areas of the head that are to be protected for single impact injuries. It covers the basic performance requirements for shock absorption, strength and effectiveness of the retention system, as well as marking and labeling requirements. Requirements for visors, goggles, detachable peaks and detachable face covers are not included in MCH1. However, as a transitional standard, MCH1 leads to adoption of UN/ECE 22.

2) Reference publications

MCH1refers to the following publications:

EN 960:2006 Headforms for use in the testing of protective helmets

Society of Automotive Engineers (SAE) Standard J211-JUL2007 Instrumentation for Impact Tests – Part 1 – Electronic Instrumentation

3) Definitions

The following definitions apply in the MCH1:

Acceleration of a body
Acceleration measured in meters per second squared, in units of g

Acceleration of a body due to gravity
Self explanatory, (g = 9.8 m/s2)

Basic plane of a headform
Plane relative to the headform that corresponds to the basic plane of the human head

Basic plane of the human head (Frankfort Horizontal Plane)
Plane that is located at the central point of the upper margin of the external auditory meatus (porion) and the inferior margins of the orbits of the eyes (orbitale)

Central vertical axis
Line relative to the headform that lies in the median plane of symmetry and that is normal to the basic plane at a point equidistant from the front and back of the headform

Please see Appendix for further information regarding the scope and description of helmet standards and testing procedures.

Basic plane of the human head (Frankfort horizontal plane)
Plane that is located at the central point of the upper margin of the external auditory meatus (porion) and the inferior margins of the orbits of the eyes (orbitale)

Central vertical axis
Line relative to the headform that lies in the median plane of symmetry and that is normal to the basic plane at a point equidistant from the front and back of the headform

Crown
Point where the central vertical axis meets the top of the headform

Cushioning material
Soft material used to ensure a comfortable fit of the helmet on the head

Drop height
Vertical distance between the lowest point (impact point) of the elevated helmet and the impact surface on a drop test apparatus

Fastening system
Those devices used to connect all components of the helmet

Frontal plane
Vertical plane that is perpendicular to the median and reference planes and passes through the crown (see Figure 3)

Helmet
Device to be worn on the head intended to reduce the risk of head injury while riding on a motorcycle and including:
a) a shock-attenuating system
b) a retention system
c) manufacturer's attachments (if any)

Helmet model
Category of helmets that do not differ in such essential respects as the materials, dimensions, construction of the helmet, retention system or the protective padding

Helmet positioning index (HPI)
The vertical distance measured at the median plane, from the front edge of the helmet to the basic plane, when the helmet is placed on the reference headform

Horizontal plane
Plane that passes across the body at right angles to both the frontal and median plane (see Figure 3)

Maximum value of acceleration, a_{max}
Highest point on the acceleration-time curve, encountered during impact, in units of g

Median plane
Vertical plane that passes through the headform from front to back and divides the headform into right and left halves (see Figure 3)

Outer covering (shell)
Outer material that gives the helmet its form

Permanent marking and warning
Information that remains legible and cannot be removed in its entirety under conditions of normal use

Rear
Point at the posterior intersection of the median and reference planes

Reference plane
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

Retention system
System which secures the helmet firmly to the head by passing under the mandible in whole or in part when adjusted according to manufacturer's instructions

Support assembly
The drop assembly in the monorail or twin wire drop system minus the weight of the headform, ball clamp, ball clamp bolts and accelerometer

Test area
The area on and above the test line where an impact site shall be located

Test line
The line that defines the boundaries of the test area

Peak
An attachment to the helmet intended to reduce sun glare

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

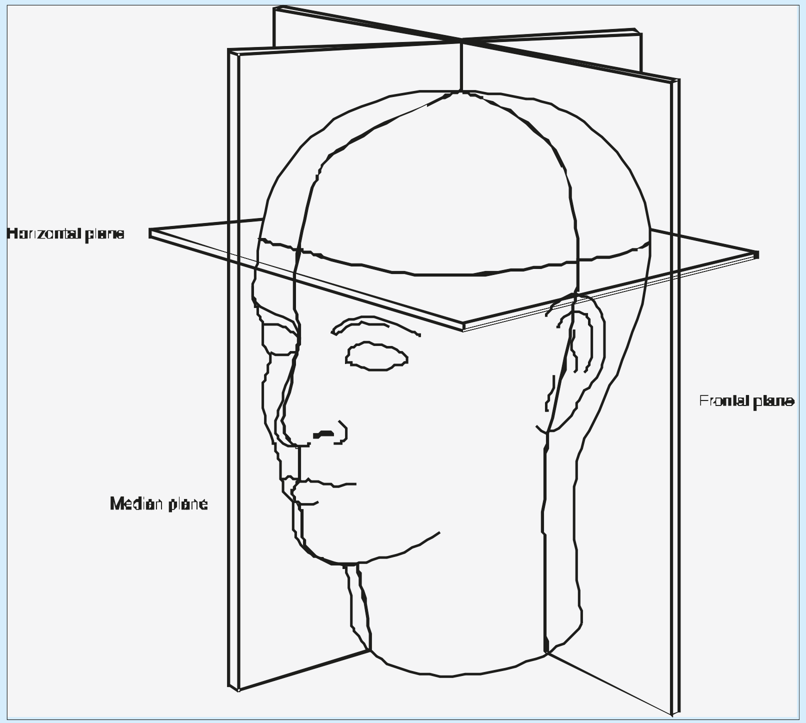


Figure 3: Orientation Planes

4) General requirements

4.1 Construction requirements - materials

All materials used shall be known not to be adversely affected by ordinary household soap and cleaners as recommended by the manufacturer. Paints, glues and finishes used in manufacturing shall be compatible with the materials used in the construction of the helmet.

Material coming in contact with the wearer's head shall not be of any type known to cause skin irritation or disease or undergo significant loss of strength, flexibility, or other physical changes as a result of contact with perspiration, oil or grease from the wearer's head. Adhesive material used to attach padding or straps to the helmet shall be of a formulation that will not alter the chemical or physical properties of the materials to an extent as to reduce their protective qualities.

All materials used in the fabrication of helmets shall be known to be suitable for use in the design of protective helmets. The materials shall not undergo appreciable alteration due to aging or normal use, such as exposure to sun, extremes of temperature, and rain. All materials used in the construction of the helmet shall be resistant to irreversible polymeric changes when exposed to temperatures from 10ºC to 50ºC.

4.2 Construction requirements - projections

A helmet shall not have any internal rigid projections more than 3 mm. Rigid projections outside any helmet's shell shall be limited to those required for operation of essential accessories and shall not protrude more than 5 mm. All parts shall be well finished and free of sharp edges and other irregularities which would present a potential hazard to the user or others.

4.3 Construction requirements - retention system

The minimum width of the retention system straps shall be 15 mm.

5) Test requirements

5.1 General

Helmets shall be capable of meeting the requirements in this standard throughout their full range of available sizes. Each helmet shall be tested on the headform size of best fit. All testing shall be done with the visor and all accessories removed (if applicable).

5.2 Samples for testing

To test conformance to this standard, 5 samples of each helmet size of each helmet model offered for sale are required. 1 of each sample shall be conditioned in each of the environments described in Clause 6.1 for 4 to 24 hours prior to testing.

5.3 Extent of protection

The entire area of the helmet above the test line stipulated in Clause 6.3 shall attenuate impact energy to the minimum requirements specified in Clause 5.8.

5.4 Peripheral vision

All helmets shall allow unobstructed vision through a minimum of 105° to the left and right sides of the median plane when measured in accordance with the procedures described in Clause 6.5.

5.5 Penetration resistance

When tested in accordance with Clause 6.6 at ambient temperature no contact with the test headform by the test dowel shall be made within any aperture on the helmet.

5.6 Effectiveness of retention system

When tested in accordance with Clause 6.7 at ambient temperature the helmet shall remain on the test headform.

5.7 Strength of retention system

When tested in accordance with Clause 6.8 the retention system shall not detach and the maximum elongation of the retention system shall not exceed 25 mm when measured between preliminary and test load positions.

5.8 Shock absorption

When the helmet is tested in accordance with Clause 6.9 the peak headform acceleration (amax) shall not exceed 275 g.

5.9 Helmet Labeling

All helmets shall have permanent labels and warnings that are in accordance with Clause 7.1.1 and 7.1.2. All helmets shall be sold with packaging that is in accordance with Clause 7.1.3 and instructions that are in accordance with Clause 7.2.

6) Test methods

6.1 Conditioning environments

Helmets shall be conditioned to one of the following environments prior to testing in accordance with the test schedule specified in Clause 6.4. All test helmets shall be stabilized within the ambient condition for 4 to 24 hours prior to further conditioning and testing.

(a) Ambient conditioning
The sample shall be exposed to a temperature of 20 ± 5°C and a relative humidity not exceeding 75% for 4 to 24 hours.

(b) Low temperature conditioning
The sample shall be exposed to a temperature of -10 ± 3°C for 4 to 24 hours. Testing shall begin within 60 seconds of removal from the low temperature conditioning chamber. Complete all helmet testing within 5 minutes after removal from the conditioning environment. Helmets may be returned to the conditioning environment in order to meet this requirement. Helmets shall remain in the conditioning environment for 15 minutes for each 5 minutes that they are out of the conditioning environment.

(c) Elevated temperature conditioning
The sample shall be exposed to a temperature of 50 ± 2°C for 4 to 24 hours. Testing shall begin within 60 seconds of removal from the elevated temperature conditioning chamber. Complete all helmet testing within 5 minutes after removal from the conditioning environment. Helmets may be returned to the conditioning environment in order to meet this requirement. Helmets shall remain in the conditioning environment for 15 minutes for each 5 minutes that they are out of the conditioning environment.

(d) Water immersion conditioning
The sample shall be fully immersed "crown" down in potable water at a temperature of 23 ± 5°C to a crown depth of 305 mm ± 25 mm for 4 to 24 hours. Testing shall begin within 60 seconds of removal from the water immersion conditioning chamber. Complete all helmet testing within 5 minutes after removal from the conditioning environment. Helmets may be returned to the conditioning environment in order to meet this requirement.

Helmets shall remain in the conditioning environment for 15 minutes for each 5 minutes that they are out of the conditioning environment.

6.2 Test headforms

A headform, capable of accepting an accelerometer mounted at its center of gravity and conforming to the requirements of a three quarter headform as defined in EN 960:2006 shall be used. Headforms used for impact testing shall be rigid and be constructed of low resonance K–1A magnesium alloy. The headform and supporting assembly shall have a total combined mass as described in the following table, with the supporting assembly contributing to no more than 25% of the total mass.

Table 2: Test Headforms

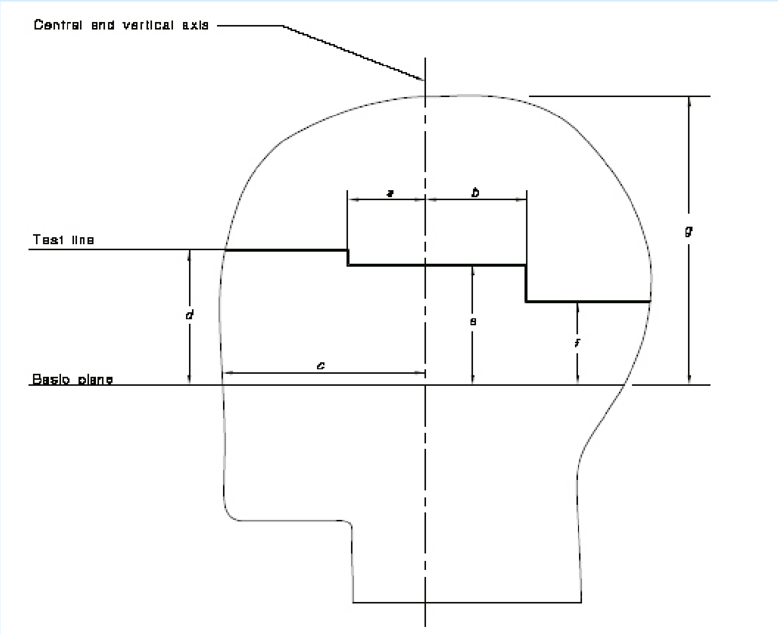
Headform Label	Size Designation	Mass
A	495 mm	3.10 kg +\- 0.10 kg
E	535 mm	4.10 kg +\- 0.12 kg
J	575 mm	4.70 kg +\- 0.14 kg
M	605 mm	5.60 kg +\- 0.16 kg
O	625 mm	6.10 kg +\- 0.18 kg

6.3 Marking the test line

A reference headform that is firmly seated with the basic plane horizontal shall be used for reference marking. The complete helmet to be tested shall be placed on the applicable reference headform whose circumference is not greater than the internal circumference of the headband when adjusted to its largest setting, or, if no headband is provided, to the corresponding interior surface of the helmet.

The helmet shall be positioned on the reference headform and a static force of 50 N shall be applied normal to the apex of the helmet. The helmet shall be centered laterally and seated firmly on the applicable reference headform according to its helmet positioning index (HPI). If the HPI and corresponding headform size are not available from the manufacturer, the test technician shall choose the headform and HPI value.

Maintaining the force and position described above, a test line shall be drawn on the outer surface of the helmet coinciding with that on the headform (see Figure 4).



6.4 Test schedule

Helmet samples shall be tested according to the test schedule shown in Table 3. The sequence of testing shall be as follows.

1. Peripheral vision test (if applicable)
2. Penetration resistance test (if applicable)
3. Effectiveness of retention system test (if applicable)
4. Strength of retention system test
5. Shock absorption test

Table 3: Test Schedule

Sample	Peripheral Vision Test	Penetration Resistance Test	Effectiveness of Retention System Test	Strength of Retention System Test	Shock Absorption Test
Helmet 1 – Ambient Temperature	X	X		X	X
Helmet 2 – Low Temperature				X	X
Helmet 3 – Elevated Temperature				X	X
Helmet 4 – Water Immersion				X	X
Helmet 5 – Ambient Temperature			X		

6.5 Peripheral vision test

Position the helmet on a reference headform in accordance with the HPI and place a 50 N preload ballast on top of the helmet to set the comfort or fit padding. (Note: peripheral vision clearance may be determined when the helmet is positioned for marking the test lines). Peripheral vision is measured horizontally from each side of the median plane around the point K (see Figure 5).

Point K is located on the front surface of the reference headform at the intersection of the basic and median planes. The vision shall not be obstructed within 105° from point K on each side of the median plane. Measurement may be performed with a physical measuring device (i.e. a peripheral vision template or a test headform with point K clearly marked) or with laser measurement equipment.

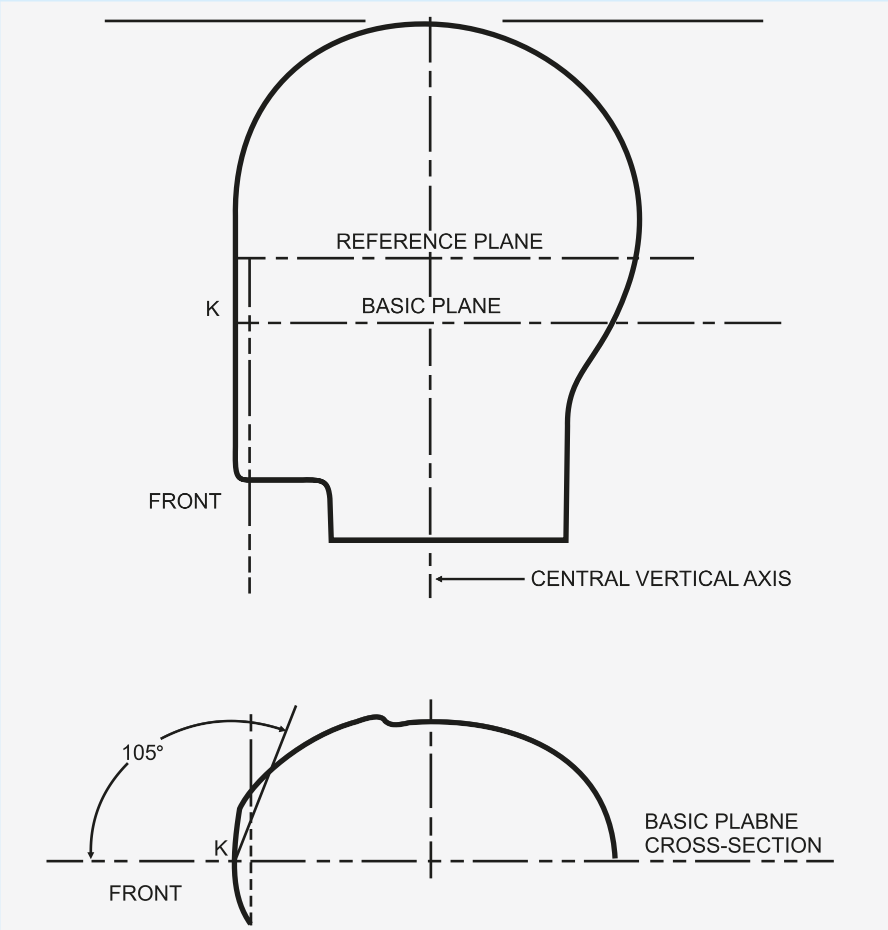


Figure 5: Peripheral Vision

6.6 Penetration resistance test

6.6.1 Apparatus

The apparatus for the penetration test shall include a full size reference headform that meets the requirements of EN960:2006.

6.6.2 Method

Position the helmet on a reference headform in accordance with the HPI and place a 50 N preload ballast on top of the helmet to set the comfort or fit padding. Using a metal test dowel with a diameter of 20 mm, attempt to make contact with the headform by trying to enter any part of the metal dowel end through all of the openings of the helmet. Record the location of any metal dowel to headform contact (see Figure 6).

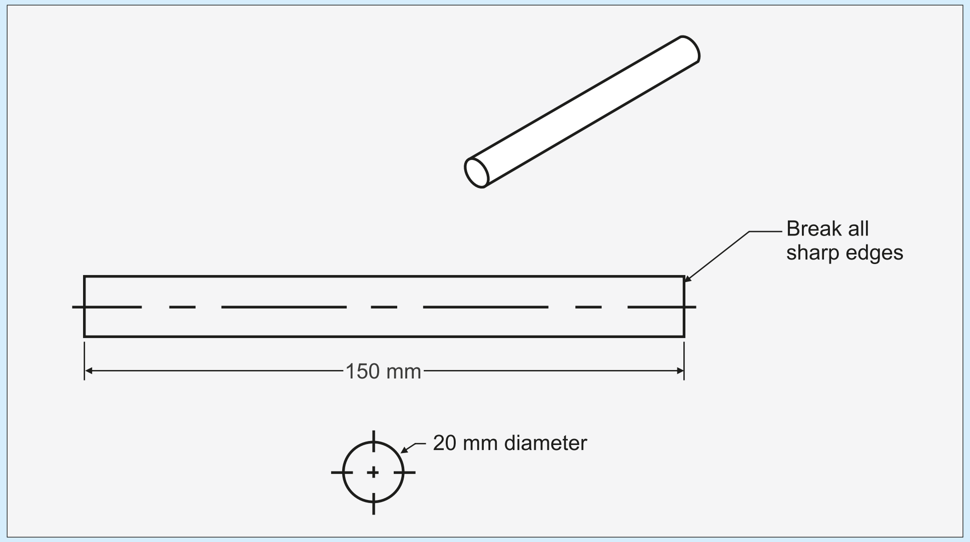


Figure 6: Metal Dowel for Penetration Resistance Test

6.7 Retention system effectiveness test

6.7.1 Apparatus

The apparatus for the retention system effectiveness test shall include a full size reference headform that meets the requirements of EN960:2006.

6.7.2 Method

Secure the reference headform to a fixture that will prevent headform movement when a tangential force is applied to the helmet. Position the helmet on a reference headform in accordance with the manufacturer's instructions. A flexible strap and hook mechanism shall be attached to the front lower edge of the helmet such that it is in line with the mid-sagittal plane. The total mass of the falling weight guide apparatus shall be 3 ± 0.1 kg and shall be able to accommodate drop heights of up to 100 cm. A 10 ± 0.1 kg drop weight shall then be raised to a height of 50 cm ± 0.5 cm and released (see Figure 7).

This procedure shall be repeated with the hook mechanism attached to the rear edge of the helmet.

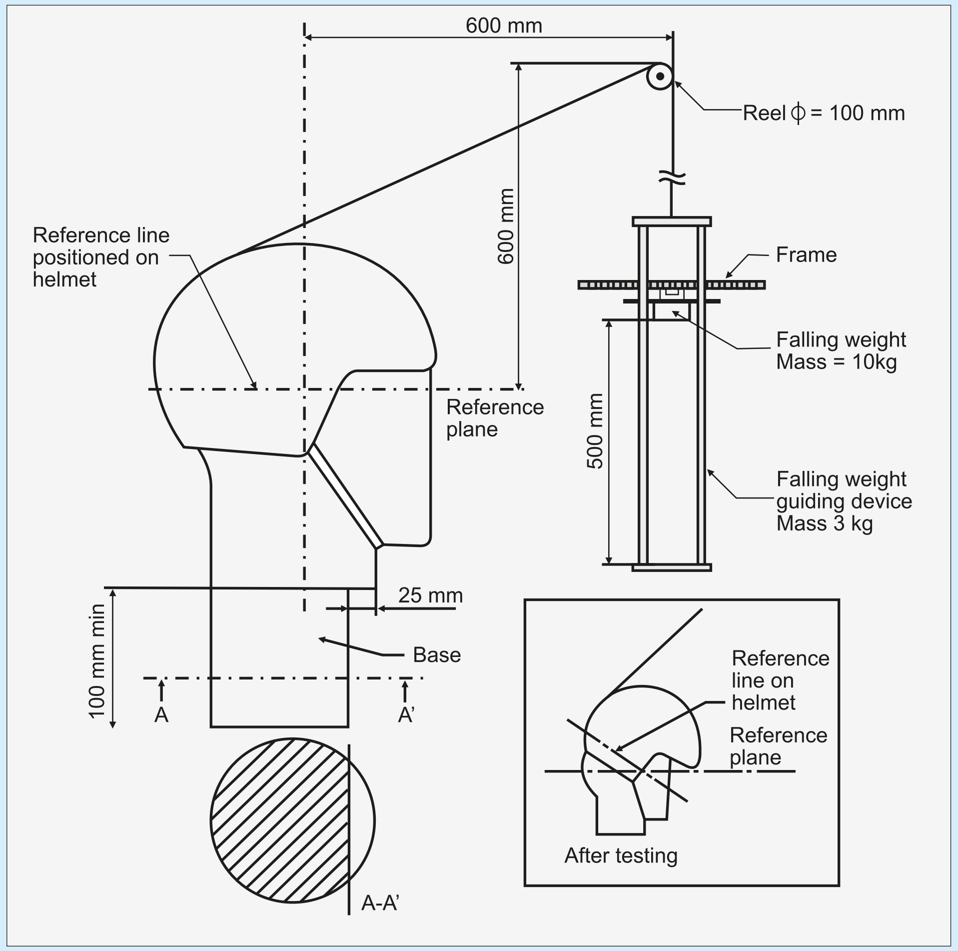


Figure 7: Typical Retention System Effectiveness Test Apparatus

6.8 Retention system strength test

6.8.1 Apparatus

The retention system strength test device consists of both an adjustable loading mechanism by which a static tensile load is applied to the helmet retention assembly and a means for holding the test headform and helmet stationary. The retention system test device shall allow the retention assembly to be fastened around 2 freely moving rollers, both of which have a 12.5 mm diameter and a 75 mm center-to-center separation, and which are mounted on the adjustable portion of the tensile loading device (see Figure 8).

6.8.2 Method

Place the subject helmet on the test headform such that the basic plane is normal to the force of gravity and adjust it in accordance with the manufacturer's HPI. Securely fasten the retention system around the 2 freely moving rollers in a manner that avoids contact between the rollers and the helmet's buckle. Apply a preliminary load of 45 ± 3 N in the direction normal to the basic plane to the retention system and hold for a minimum of 30 seconds. Record the displacement measurement on the moveable test device.

Increase the load to 500 ± 5 N and maintain this load for 120 seconds (+0 seconds, -10 seconds) by adjusting the load applied to the retention system as necessary. After 120 seconds (+0 seconds, -10 seconds) at full test load, measure and record the displacement measurement of the retention system. The maximum elongation shall be the difference between the initial measurement and the measurement taken after 120 seconds.

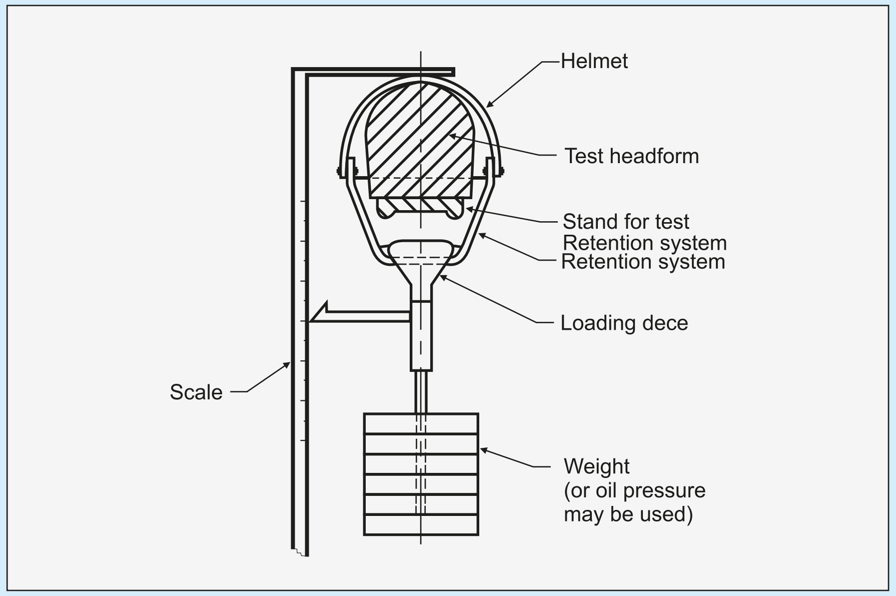


Figure 8: Typical Retention System Strength Test Apparatus

6.9 Shock absorption test

6.9.1 Apparatus

The test apparatus for the shock absorption test shall consist of the following:

(a) The headform employed in this test shall conform to all requirements under Clause 6.2.

(b) The test headform shall be mounted on a guided freefall system as shown in Figure 9 with an adjustable mounting for the helmeted headform to permit impacts to be delivered to any location on the helmet at or above the test line. A monorail guided freefall system shall also be acceptable. The total mass of this support assembly shall not exceed 25% of the combined mass of the drop assembly (i.e. supporting assembly plus the test head form).

The center of gravity of the drop-assembly unit shall lie within a cone having a vertical axis and forming at most a 10° included angle with the vertex as the point of impact.

(c) A linear accelerometer shall be placed at the center of gravity of the test headform and its sensitive axis shall be aligned to within 5° of the vertical when the helmet and headform are in the impact position. The accelerometer shall be capable of withstanding a maximum acceleration of 1000 g without damage and shall have a frequency response of at least 5 to 900 Hz. A triaxial accelerometer with identical performance specifications is also acceptable.

(d) The flat anvil shall be made of steel or another similar rigid metal and shall be firmly attached to the base of the drop assembly. The impact face shall have a minimum diameter of 150 mm.

(e) The hemispherical anvil shall be made of steel or another similar rigid metal and shall be firmly attached to the base of the drop assembly. The hemispherical anvil shall have a hemispherical impact surface with a radius of 48 ± 1 mm.

(f) The rigid mount for the anvils shall consist of a solid mass of at least 135 kg, the upper surface of which shall consist of a steel plate with a minimum thickness of 12 mm and minimum surface area of 0.1 m^2.

(g) The data acquisition system shall be capable of collecting impact data at a rate of not less than 10 kHz per channel. The acceleration data channel and filtering shall comply with SAE Recommended Practice J211 DEC2003, Instrumentation for Impact Tests, Requirements for Channel Class 1000. All equipment shall conform to all requirements of SAE J211:2003.

6.9.2 System verification
The shock absorption test instrumentation shall be verified before and after each series of tests (at least at the beginning and end of each test day) by dropping a spherical impactor onto a modular elastomer programmer (MEP) test surface.

The spherical impactor shall be a device made of low resonance material (for example, magnesium, aluminum alloy, or stainless steel) that couples mechanically with the ball arm connector of the drop assembly in place of the impact test headform. When mounted, the device presents a spherically machined impact face with a radius of 73 mm on its bottom surface. All radii from the center of the curvature of the impact face to its outer edge shall form angles of no less than 40° with the downward vertical axis. The center of curvature shall be within 5 mm of the vertical axis drawn through the center of the ball arm. The total mass of the spherical impactor drop assembly shall be 5.0 ± 0.1 kg.

The MEP shall be 152 mm in diameter and 25 mm thick, and shall have a durometer of 60 ± 2 Shore A. The MEP shall be affixed to the top surface of a flat 6.35 mm thick aluminum plate. The geometric center of the MEP pad shall be aligned with the central vertical axis of the accelerometer.

The impactor shall be dropped onto the MEP at an impact velocity of 5.44 m/s ± 2% as measured within the last 40 mm of free fall of the impactor. Typically, this requires a minimum drop height of 1.50 meters plus a height adjustment to account for friction losses. 6 impacts, at intervals of 75 ± 15 seconds, shall be performed at the beginning and end of the test series (at a minimum at the beginning and end of each test day). The first 3 of 6 impacts shall be considered warm-up drops, and their impact values shall be discarded from the series. The second 3 impacts shall be recorded. All recorded impacts shall fall within the range of 380 g to 425 g. The mean of the 3 post-test results shall not differ by more than 5% from the mean of the pre-test results. Otherwise, the results shall be discarded and the tests repeated with new samples after the source of this difference has been rectified.

The components of the data acquisition system, including all transducers, shall be calibrated to traceable national reference standards at an interval of not greater than 5 years.

6.9.3 Helmet impact test locations
Each helmet shall be tested at 4 impact locations on or above the test line described in Clause 6.3. Each impact location shall be a distance of at least one-fifth of the circumference of the test headform from any prior impact location on that helmet.

6.9.4 Method
The helmet shall be placed on the appropriate headform according to the manufacturer's HPI. The helmet shall be dropped onto the flat anvil with an impact velocity of 6.0 m/s ± 3%. Typically, this requires a minimum drop height of 1.83 meters, plus a height adjustment to account for friction losses. The helmet shall be dropped onto the hemispherical anvil with an impact velocity of 5.2 m/s ± 3%. Typically, this requires a minimum drop height of 1.38 meters, plus a height adjustment to account for friction losses. The impact velocity shall be measured during the last 25 mm of free-fall for each test. Following impact, the drop assembly shall be raised and the headform shall be oriented to another impact site.

6.9.4.1
The first impact shall be made not more than 60 seconds after the helmet has been removed from the conditioning environment. Following testing, the helmet shall be immediately returned to its conditioning environment for a minimum of 15 minutes before another impact test is conducted.

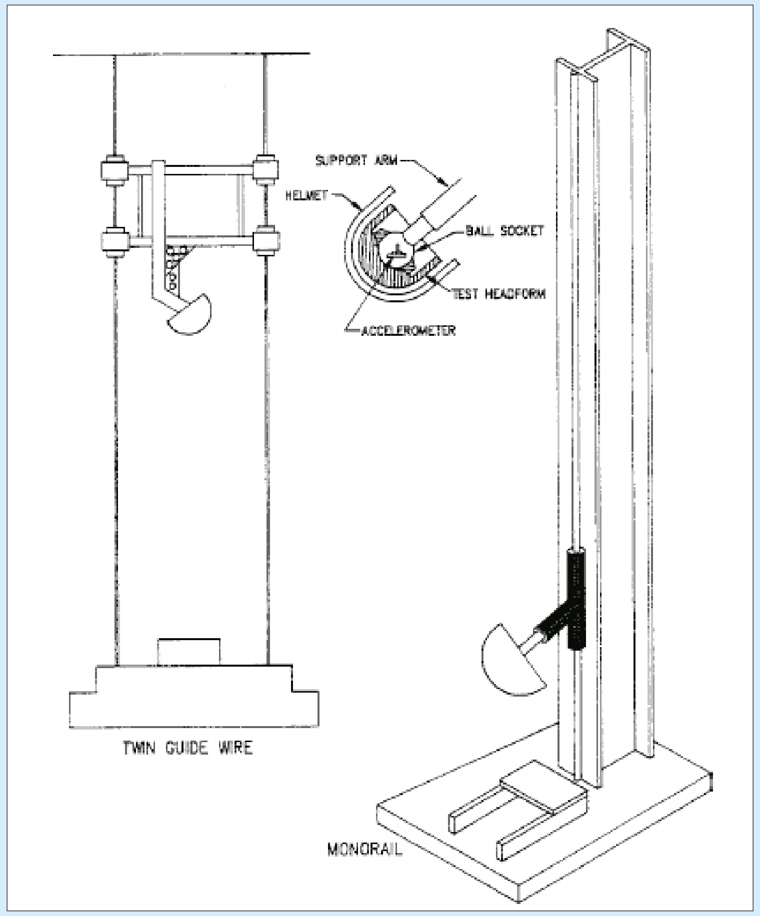


Figure 9: Typical Drop Assembly Apparatus

7) Labeling, Warnings and Instructions

7.1 Labeling
7.1.1 Helmet labeling
Every helmet shall have indelibly printed on it or otherwise permanently affixed to it the following information, clearly and prominently displayed in no less than 8 point font:

(a) Name of manufacturer
(b) Website address of the manufacturer or other contact information
(c) The model name or model number of the product
(d) The size or size range of the circumference of the helmet, quoted as the circumference (in centimeters) of the head which the helmet is intended to fit
(e) The week and year of manufacture of the product

7.1.2 Warnings
Every product shall have indelibly printed on it or otherwise permanently affixed to it the following information statements, clearly and prominently displayed:

(a) Words to the following effect: For adequate protection this helmet must fit closely. Purchasers are advised to secure the helmet and to ensure that it cannot be pulled or rolled off the head.
(b) Words to the following effect: This helmet is made to absorb some of the energy of a blow by partial destruction of its component parts and, even though damage may not be apparent, any helmet which has suffered an impact to the head in an accident or received a similar severe blow or other abuse should be replaced.
(c) Words to the following effect: To maintain the full efficiency of this helmet there must be no alteration to the structure of the helmet or its component parts.
(d)For helmets fitted with a single chin strap, words to the following effect: The chin strap must pass underneath the jaw to maintain tension all the time the helmet is in use. The law requires that the helmet be securely fastened to the head.
(e) Words to the following effect: The protection given by this helmet may be severely reduced by the application of paint, adhesive stickers and transfers, cleaning fluids and other solvents. Use only materials recommended by the helmet manufacturer.

7.1.3 Packaging
The packaging in which the helmet is sold or is to be sold shall have indelibly printed on it or otherwise permanently affixed to it, clearly and prominently displayed, the information required by section 7.1.1.

7.2 Instructions
Every product shall bear or be accompanied by legible written instructions that clearly state the following information, with line drawings or photographs illustrating the sequence of steps where needed:

(a) How the product is to be fitted and adjusted properly
(b) How the product is to be assembled, if applicable
(c) How the product should be inspected for deficiencies
(d) How the product is to be maintained, cleaned and dried
(e) How the product is to be stored
(f) If a visor is included with the helmet, information shall be included stating that the visor has not undergone testing to this specification

8) Test Report

The test report shall include at least the following information:
(a) The number and year of publication of this specification
(b) The name or trademark of the manufacturer or the body taking

responsibility for manufacture
(c) Identification details of the head protector tested including range of sizes offered for sale
(d) Photographs of the front and side of the helmet; a test line should be on the helmet in the photograph
(e) Results of tests in accordance with Clause 6, including information to clearly identify the impact test locations for each helmet tested
(f) Any evidence that shows correspondence with requirements in clause 5 and 6
(g) Date of testing
(h) Name of technician who performed the testing and if applicable, the laboratory manager or supervisor
(i) Name of testing laboratory

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4

Appendix

Appendix

Extent of coverage requirements

The extent of coverage refers to the amount of coverage that must be provided by the helmet shell. In certain standards, it also refers to the area in which the helmet must provide protection. For most standards around the world, a full size International Standards Organization (ISO) headform is used to define the extent of coverage required by the test standard. The dimensions for the headforms are specified in standard EN 960:2006 "Headforms for use in the testing of protective helmets". Different size headforms are used depending upon the size of the test helmet.

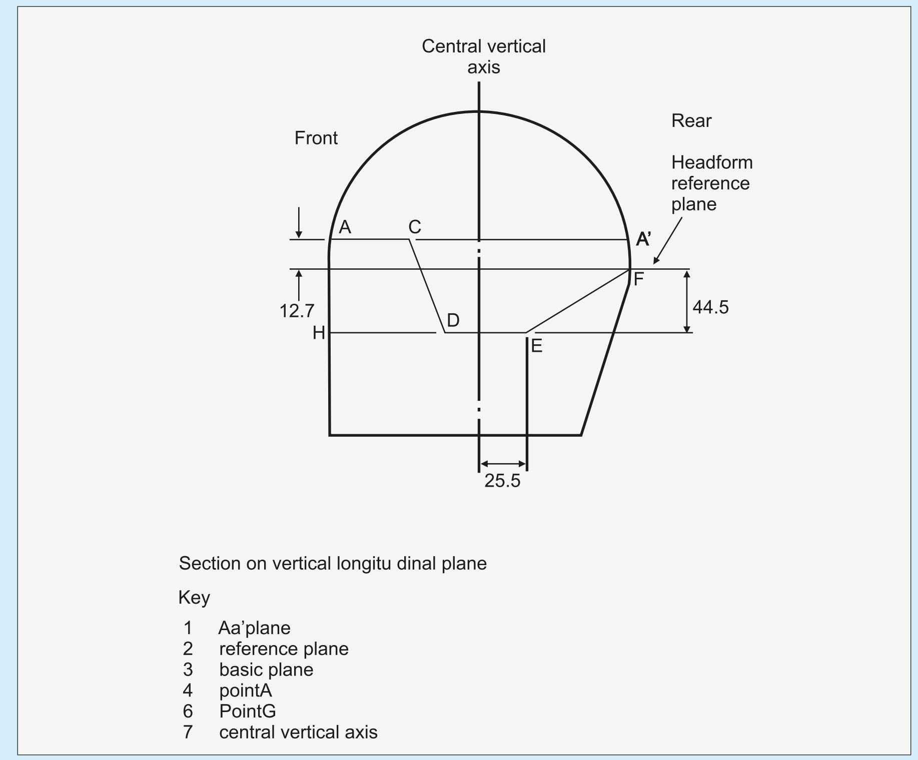

Figure A1: Principal Planes and Reference Points of a Headform
Source: EN960:2006

All ISO headforms include a basic plane and a reference plane (see Figure A1). The basic plane is approximately equivalent to the anatomical Frankfort horizontal plane of the human head. The reference planes on each headform are used as a reference mark to draw both the areas of protection and the test line (depending upon the motorcycle helmet standard).

The Frankfort horizontal plane corresponds to the longitudinal plane which passes through the lower level of the eye orbits and the upper level of the external opening of the ear canals.

Figure A1 illustrates the extent of coverage requirements for the current UN/ECE 22 regulation as well as for many other countries. The general requirement is that the helmet must cover the area included in the marking "ACDEF" shown in Figure A1. As noted above, the location of the line "ACDEF" varies depending upon the size of the test headform. The Vietnamese standard permits half helmets to cover the area included in the line AA'.

This extent of coverage requirement is intended to ensure that the helmet has sufficient coverage and energy absorbing material to provide adequate head protection in the event of an impact.

Strength of retention system requirements

The retention system strength test ensures that the chin strap and retention system hardware will not break or elongate excessively during an impact. Either of these situations could allow a helmet to come off during an accident. The retention system strength test requires that the chin strap remain intact and not elongate more than 25 mm when subjected to a load of 500 N for a period of 2 minutes. This test is performed on 1 helmet under ambient conditions and on 3 other helmets after each is conditioned in hot, cold or wet environments. The purpose of testing the helmet in different conditioning environments is to simulate the conditions under which the helmet will normally be used. Subjecting the helmet and retention system to other conditioning environments will also ensure that the materials that are used in the helmet are not degraded in any of these environments.

This retention system strength test has been found to be effective at evaluating the performance of the retention system and while retention system failures do occur occasionally, no research to date has been presented that implies retention system failures represent a significant problem in motorcycle accidents.

Retention system effectiveness requirements

The retention system effectiveness test is designed to evaluate how well a helmet will stay on your head during an accident. The procedure involves orienting the headform vertically and attaching a hook to the back of the helmet and releasing a falling drop weight from a known distance in order to attempt to pull the helmet off the head. The helmet fails if it comes off the headform during the test. The retention system effectiveness test was designed to simulate the forces that are typically seen during a crash situation and the pass/fail criteria is that the helmet must remain on the head immediately following the test.

Impact performance requirements

The purpose of the impact performance testing is to ensure that helmets meeting *MCH1* will adequately protect the head in a motorcycle accident. This test involves securing the helmet on a headform and dropping the helmet/headform assembly onto a fixed steel anvil. This test is meant to simulate the effect of falling from a motorcycle and impacting the pavement. Research has shown that approximately 87% of all head impacts in a motorcycle accident are to a flat surface (Hurt et al., 1981). This same research found that 90% of most severe motorcycle accident head impacts could be simulated in a laboratory using a flat anvil test with a drop height of 1.8 meters.

Given that it is impossible to predict where a motorcycle rider will strike his or her head in an accident, it is important that the helmet provide protection at all points with the designated extent of coverage.

Under *MCH1*, the helmet is tested with two types of anvils, a flat anvil and hemispherical anvil. These anvils represent the most common shapes of surfaces that may be encountered in actual riding conditions. Instrumentation within the headform records the force applied to the headform in multiples of the acceleration due to gravity, or "g" units. The pass/fail criteria for this standard is that no single impact is allowed to exceed 275 g. This value has been traditionally used as the pass/fail criteria for other motorcycle helmet standards (e.g. the UN/ECE 22 standard).

Impact tests are performed on different helmets, each of which has been subjected to one of four environmental conditions. These environments are: ambient (room temperature), high temperature, low temperature, and immersion in water for 4 to 24 hours.

By permitting impact tests to be performed anywhere on or above the test line marked on the helmet, the standard permits any combination of impact site, anvil type, anvil impact order, or conditioning environment permissible. Thus, *MCH1* will test for a "worst case" combination of test parameters. What constitutes a worst case may vary, depending on the particular helmet involved.

For further information about the MCH1 - Specification for Head Protection for Motorcyclists Version1/2011-385.6769, please contact:

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