IHRA/PS-WG Child Head Test Method

Passenger vehicles - Pedestrian protection - Impact test method for child pedestrian head

Introduction

The intent of this IHRA proposal is to help reducing pedestrian head injuries by providing a standardized test method.

The test method specified applies to children.

1 Scope

This IHRA proposal specifies a test method to simulate the head impact of an child pedestrian to the front structure of a passenger vehicle.

Research suggests that safety improvements in vehicles derived from these pedestrian impact tests may be beneficial also to bicyclists in vehicle front impact.

1.1 For this test method 'child' covers a range of statures, typically appropriate for children, but this range will also include some short adults.

1.2 This test procedure is intended to require pedestrian head protection for vehicle impact speed up to 30 to 50 km/h.

NOTES:

1. The purpose of this procedure is to simulate an impact between the head of a child pedestrian and the striking vehicle.

2. Another test procedure, IHRA/PS-WG Adult Head Test Method, applies to an adult pedestrian

3. This test procedure provides an estimate of the potential severity of the pedestrian's head injury, based on the Head Injury Criterion.
   It does not address the risk of injury to any other body region.

4. This test procedure does not consider the possibility of a child pedestrian's head impacting objects other than the striking vehicle, such as the road surface.

5. This test performance does not consider any downward pitching of the vehicle due to pre-impact braking.

6. Child head form impactor mass is determined from the effective head mass of 6-year child.

2 Normative references

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

ISO 1176: 1990, Road vehicles - Masses - Vocabulary and codes.
ISO 3784: 1976, Road vehicles - Measurement of impact velocity in collision tests.
ISO 3833: 1977, Road vehicles - Types - Terms and definitions.
ISO 6487: 1987, Road vehicles - Measurement techniques in impact tests - Instrumentation.

3 Definitions

3.1 Normal ride attitude

The vehicle attitude in driving order positioned on the ground , with the tires inflated to recommended pressures , the front wheels in the straight-ahead position , with maximum capacity of all fluids necessary for operation of the vehicle , (with all standard as provided by the vehicle manufacturer), with one adult male 50th percentile dummy or an equivalent mass placed on the driver's seat , and with one adult male 50th percentile dummy or an equivalent mass placed on the front passenger's seat , and the suspension set in normal running conditions specified by the manufacturer (especially for vehicles with an active suspension or a device for automatic levelling) .

3.2 Ground reference plane

A horizontal plane, either real or imaginary, that passes through all tire contact points of a vehicle while the vehicle is in its normal ride attitude. If the vehicle is resting on the ground, then the ground plane and the ground reference plane are one and the same. If the vehicle is raised off the ground such as to allow extra clearance below the bumper, then the ground reference plane is above the ground plane.

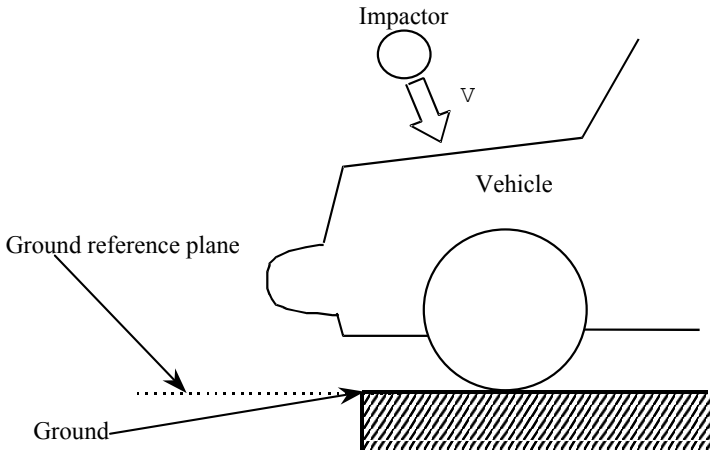


Figure 1: Configuration of IHRA Head Impact Test Procedure

3.3 Front structure (Child Headform Test Area)

The outer structure that includes the upper surfaces of the bonnet and of the wings (outer fenders), the scuttle (cowl top), the windscreen, the A pillars and the roof. It is bounded by the front reference line in the front and the rear reference line in the rear, as defined in section 3.4.1 and 3.4.2, and by the side reference lines as defined in sections 3.5 and 3.7.

NOTES:
The child headform test area and the adult headform test area as defined in section 3.3 of IHRA/PS-WG Adult Head Test Method is overlapping. It is lead by to reflect the actual accident data simply, however, there is no significant difference for the pedestrian relief ratio between the overlapping test method (keep the overlapping area) and the boundary line test method (separate the overlapping area to adult and child test area using a boundary line). (see IHRA/PS/209)

3.4 Wrap around reference lines

3.4.1 Front reference line (FL)
The 1000mm wrap around reference line is the geometric trace described on the vehicle front structure by one end of a 1000mm long flexible tape, when it is held in a vertical fore and aft plane of the vehicle and traversed across the front of the vehicle front structure and bumper of the vehicle when it is in the normal ride attitude. The tape is held taught throughout the operation with one end held in contact with the ground reference plane, vertically below the front face of the bumper and the other end held in contact with the vehicle front structure.

3.4.2 Rear reference line (RL)
The 1700 mm wrap around reference line is found using a similar procedure of the FL using an alternative tape of 1700 mm length (see Figure 2A). For small cars where the wrap around distance to the windscreen reference line as defined in section 3.8 is less than 1700 mm at any point, then the rear windscreen reference line will be used as the rear reference line at that point (see Figure 2B).

3.5 Bonnet rear reference line (BRL)

The geometric trace of the most rearward points of contact between a 165 mm sphere and a bonnet when the sphere is traversed across a bonnet while maintaining contact with the windshield (see Figure 3A).

3.6 Side reference line (SL) of front structure up to the BRL

The geometric trace of the highest points of contact between a straight edge and the side of a front structure, when the straight edge, held parallel to the lateral vertical plane of the vehicle and inclined inwards by 45° is traversed down the side of front structure, while maintaining contact with the surface of the body shell. (see Figure 3B).

3.7 Side reference lines beyond the BRL

The geometric trace of the highest points of contact between a straight edge and the side of a front structure, when the straight edge, held parallel to the lateral vertical plane of the vehicle and inclined inwards by 45° is traversed down the side of front structure, while maintaining contact with the surface of the body shell. (see Figure 3C).

3.8 Rear of windscreen reference line (RWL)

The windscreen reference line is defined as the geometric trace of contact between a straight edge and the upper windscreen frame, when the straight edge, held parallel to the vertical longitudinal plain of the car and inclined rearwards by 75 degrees, is traversed across and in contact with the upper windscreen frame, see Figure 2A.

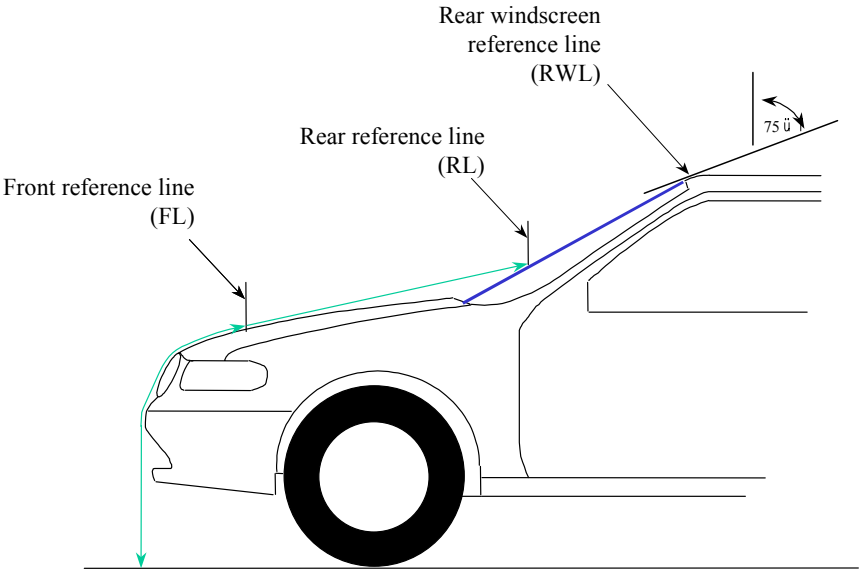


Figure 2A. Determination of FL, RL and RWL

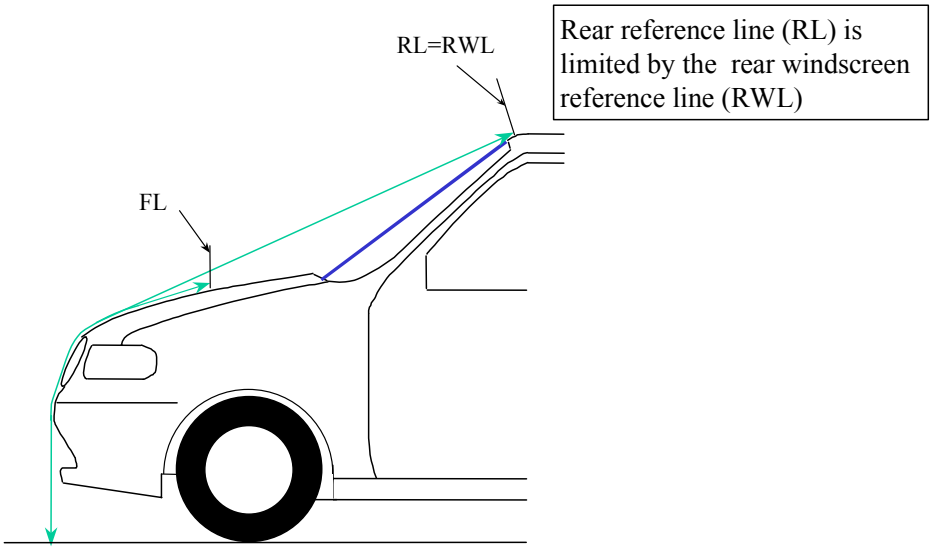


Figure 2B. Determination of FL, RL and RWL for small cars

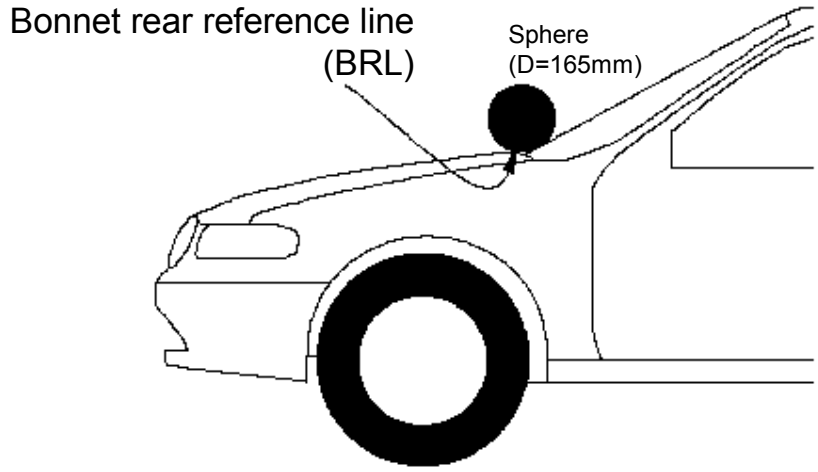


Figure 3A: Determination of bonnet rear reference line (BRL)

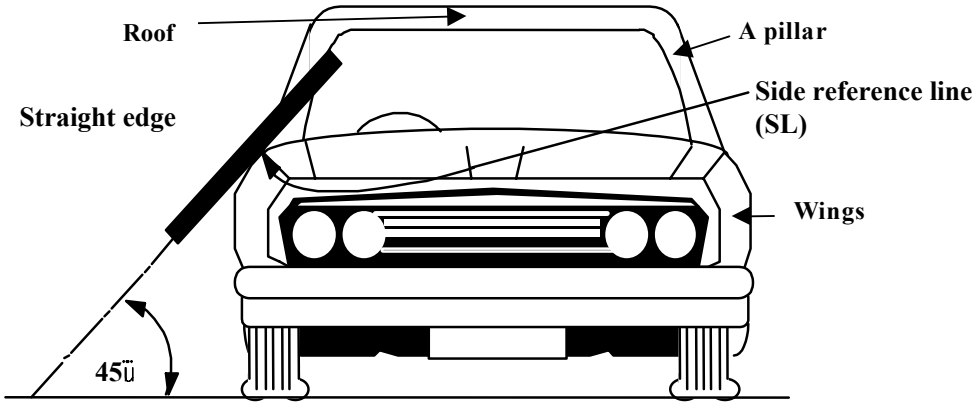


Figure 3B: Determination of side reference lines of front structure up to the BRL

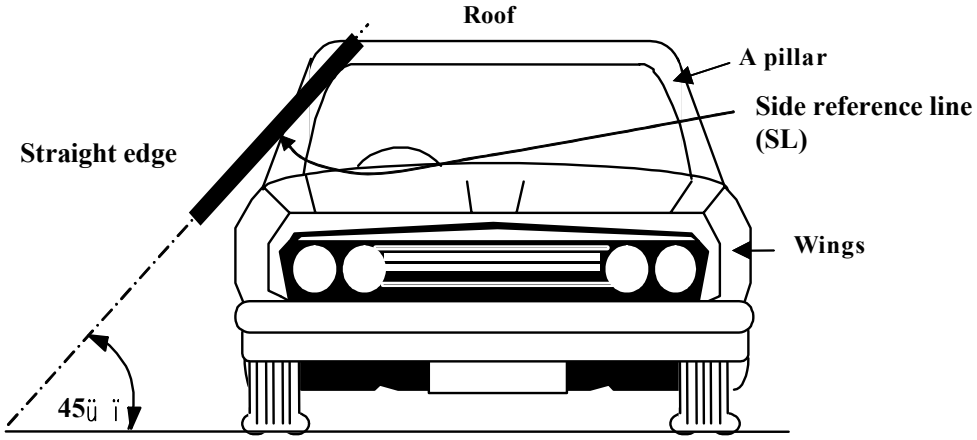


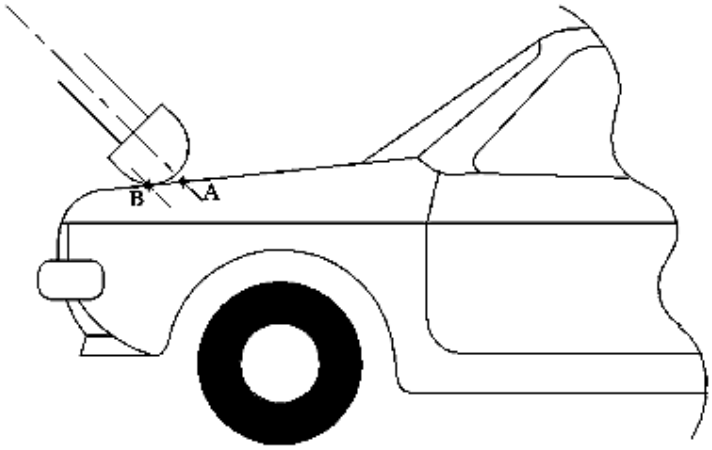
Figure 3C: Determination of side reference lines of front structure beyond the BRL

3.9 Target Point

This location is defined as the intersection of the headform longitudinal axis projection onto the vehicle (point A on Figure 4).

3.10 Impact Point

This location is the actual first contact point of the headform with the vehicle (point B on Figure 4). The proximity of this point with the target point is dependent upon both the angle of travel by the headform and contour of the vehicle surface.



A: Target Point
B: Impact Point

Figure 4: Target point and impact point

3.11 Head Injury Criterion

HIC shall be calculated from the resultant of accelerometer time histories using the formula ($t_2 - t_1 \leq 15$ msec)

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

where

a is the resultant acceleration as a multiple of " g " ;

t_1 and t_2 are the two time instants (expressed in seconds) during the impact, defining the beginning and the end of the recording for which the value of HIC is a maximum

4 Test equipment

4.1 Impact test site

A flat, smooth and hard surface with a slope not exceeding 1 %.

4.2 Head form impactor

As described in section 5 and shown in Figure 5.

4.3 Applicable vehicles

Passenger vehicle.

5 Requirements

5.1 Head form impactor

5.1.1 Size and mass

The contact surface of the head form impactor shall be spherical. The diameter is 165±1 mm as shown in Figure 5. The mass shall be 3,5 ± 0,07 kg. The moment of inertia about an axis through the centre of gravity and perpendicular to the direction of impact shall be with in the rage of 0,0075 to 0,0200 kgm^2 . The centre of gravity of the head form impactor including instrumentation shall be located in the geometric centre of the sphere with a tolerance of ± 2 mm.

5.1.2 Instrumentation

A recess in the sphere shall allow for mounting one triaxial or three uniaxial accelerometers within ± 10 mm seismic mass location tolerance from the centre of the sphere for the measurement axis, and ± 1 mm seismic mass location tolerance from the centre of the sphere for the perpendicular direction to the measurement axis.
The instrumentation response value CFC, as defined in ISO 6487: 1987, shall be 1000. The CAC response value, as defined in ISO 6487: 1987, shall be 500 g for the acceleration.

5.1.3 First natural frequency

First natural frequency of the headform impactor shall be over 5000 Hz.

5.2 Propulsion of the headform impactor

The headform impactor shall be in 'free flight' at the moment of impact, at the required impact velocity (see section 7.2) and the required impact angle (see section 7.3 and 7.4). The impactor shall be released to free flight at such a distance from the vehicle that the test results are not influenced by contact of the impactor with the propulsion system during rebound of the impactor. The method of headform propulsion is at the discretion of the test authorities.

5.3 Certification of the headform impactor

The headform impactor shall meet the performance requirements specified in Annex A. The certified impactor may be used for a maximum of 20 impacts before re-certification. The impactor shall be re-certified if more than one year has elapsed since the previous certification or if the transducer output, in any impact, has exceeded the specified CAC.

5.4 Temperature and humidity conditions

The stabilised temperature of the headform impactor at the time of impact shall be 20° ± 4° C. A relative humidity should be 10 to 70 percent after a soak period of at least four hour prior to its application in a test.

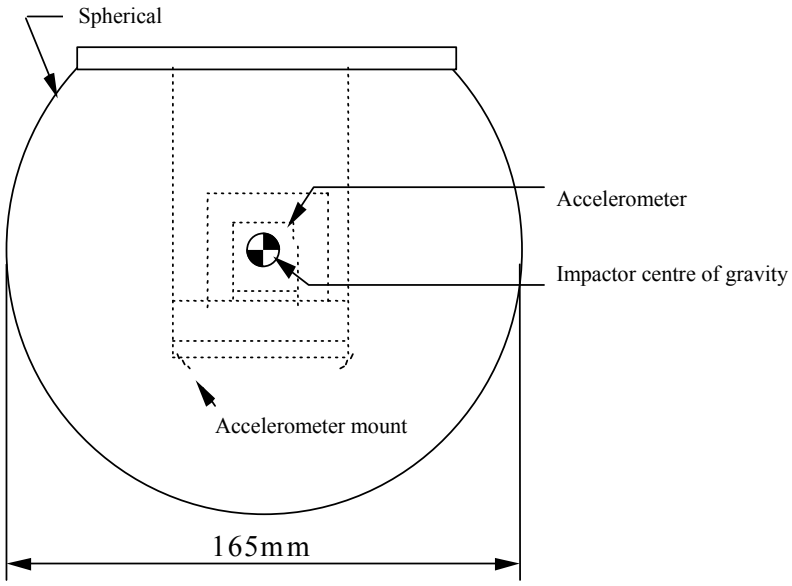


Figure 5: Head form impactor

5.5 Rear face of head impactor

A plane at the outer surface of the head form impactor which is perpendicular to the direction of travel, and typically perpendicular to the axis of one of the accelerometers as

well as being a flat plate used for access to the accelerometers and an attachment point for the propulsion system.

6 Preparation of test vehicle

6.1 Either a complete vehicle or a cut - body, adjusted to the following conditions, shall be used for the test. All the parts of the vehicle structure and components that may be involved in a pedestrian head impact shall be in place in the test vehicle.

6.2 The parking brake shall be applied, or the cut - body shall be securely mounted.

6.3 Sufficient time must be allowed before testing for the temperature of all vehicle components to stabilize (see section 7.1).

7 Test conditions

7.1 Atmospheric conditions

Relative humidity and temperature shall be measured at the time of the test, and recorded in the test report.

7.2 Impact velocity

The headform velocity at the time of impact shall be dependent on the vehicle impact speed selected (30, 40 or 50 km/h), the shape category of the vehicle under test and the location of each selected test point. (see Figure 7 and Table 1)

7.3 Direction of impact

The direction of impact shall be in the fore and aft vertical plane of the section of the vehicle to be tested. The tolerance is ± 2°. The direction of impact of tests to the front structure shall be downward and/or rearward.

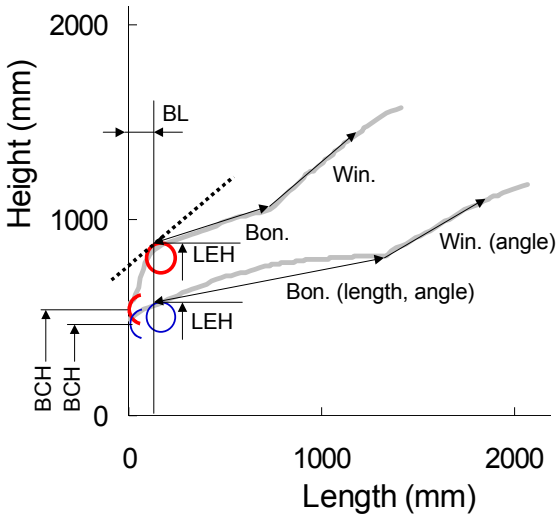
7.4 Angle of impact

The angle of the velocity vector of the head form impactor at impact with respect to horizontal shall be dependent on the vehicle impact speed selected (30, 40 or 50 km/h), the shape category of the vehicle under test and the location of each selected test point. (see Figure 7 and Table 1)

7.5 Impact points

7.5.1 Tests shall be made to the front structure within the boundaries as defined in section 3.3. During all tests of the front structure, up to thebonnet rear reference line, the centre of the head form impactor shall, at the time of first contact, be a minimum of 82.5 mm inside the defined side reference lines (see 3.5) of the sections under test. For tests beyond the bonnet rear reference line, the centre of the head form impactor shall, at the time of first contact, be a minimum of [0,0] mm inside the impact recommend line (see Figure 8).

7.5.2 The points selected for testing shall be indicated in the test report.



Sedan + Light vehicle + Sports type

		Lower	Middle	Upper
BL	(mm)	127	127	127
BCH	(mm)	435	475.5	516
LEH	(mm)	565	702	839
Bon. length	(mm)	1200	917.5	635
Bon. angle	(deg.)	11	14.5	18
Win. angle	(deg.)	29	34.5	40
Bottom depth	(mm)	42	98	154
Bootm hight	(mm)	182	225.5	269

SUV

		Lower	Middle	Upper
BL	(mm)	195	195	195
BCH	(mm)	544	640	736
LEH	(mm)	832	1000	1168
Bon. length	(mm)	1023	933.5	844
Bon. angle	(deg.)	11	9.75	8.5
Win. angle	(deg.)	36	39.5	43
Bottom depth	(mm)	48	123	198
Bootm hight	(mm)	248	348	448

1Box

		Lower	Middle	Upper
BL	(mm)	188	188	188
BCH	(mm)	448	576	704
LEH	(mm)	864	1004	1144
Bon. length	(mm)	361	259	157
Bon. angle	(deg.)	40	40	40
Win. angle	(deg.)	30	38	46
Bottom depth	(mm)	63	95	127
Bootm hight	(mm)	214	292.5	371

Figure 6. Vehicle shape classification by corridors

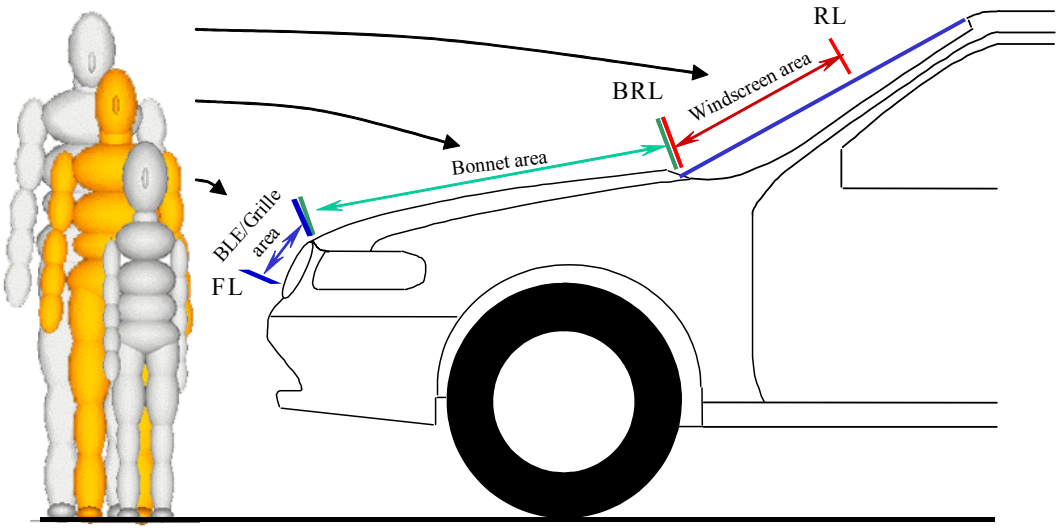


Figure 7. Principles of headform impact test

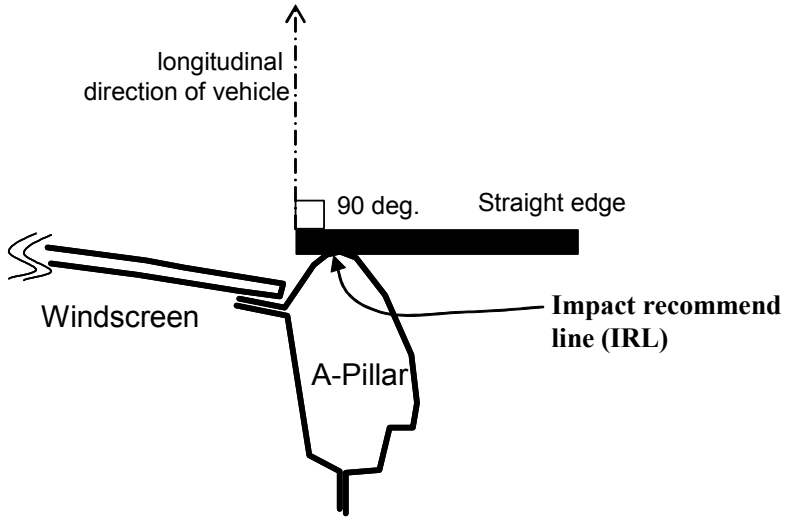


Figure 8 Impact recommend line (IRL) for the A-Pillar

Table 1. Headform test conditions (impact velocity and impact angle)

Shape Corridor	Car impact speed 30km/h					
	Impact Velocity (km/h)			Impact Angle (deg.)		
	Bonnet	Windscreen	BLE/Grille	Bonnet	Windscreen	BLE/Grille
Sedan +	21.6 +/- 3.0	nc	nc	65.1 +/- 0.8	nc	nc
SUV	21.3 +/- 1.2	nc	21.3 +/- 6.0	55.6 +/- 5.5	nc	26.0 +/- 7.5
One box	20.1 +/- 0.6	nc	21.9 +/- 5.1	47.5 +/- 2.8	nc	20.3 +/- 8.0

Shape Corridor	Car impact speed 40km/h					
	Impact Velocity (km/h)			Impact Angle (deg.)		
	Bonnet	Windscreen	BLE/Grille	Bonnet	Windscreen	BLE/Grille
Sedan +	30.0 +/- 4.0	nc	nc	66.0 +/- 6.3	nc	nc
SUV	27.2 +/- 1.6	nc	32.0 +/- 3.6	59.2 +/- 2.6	nc	22.5 +/- 4.2
One box	27.6 +/- 0.8	nc	33.2 +/- 3.2	49.8 +/- 1.8	nc	17.4 +/- 6.1

Shape Corridor	Car impact speed 50km/h					
	Impact Velocity (km/h)			Impact Angle (deg.)		
	Bonnet	Windscreen	BLE/Grille	Bonnet	Windscreen	BLE/Grille
Sedan +	38.5 +/- 5.0	nc	nc	65.2 +/- 6.5	nc	nc
SUV	34.0 +/- 1.5	nc	44.5 +/- 1.0	61.9 +/- 3.8	nc	18.1 +/- 3.8
One box	36 +/- 0.5	nc	46.5 +/- 2.0	47.4 +/- 2.1	nc	14.8 +/- 3.6

*nc: No Contact, ** Child Headform Impact Test Conditions
*** Linear interpretation to be used to determine impact conditions for in-between speeds if required.

8 Recording of test results

Data shall be acquired in accordance with ISO 6487.

8.1 Head form impactor data

8.1.1 The velocity of the head form impactor shall be measured at some point during the free flight before impact, in accordance with the method specified in ISO 3784. The accuracy of velocity measurement shall be ± 0,01m/sec.
The measured velocity shall be adjusted considering all factors that may affect the impactor between the point of measurement and the point of impact to give the velocity of the impactor at the time of impact. The angle of the velocity vector at the time of impact shall be calculated or measured.

8.1.2 The acceleration time histories shall be recorded, and HIC shall be calculated.

8.1.3 The first point of contact on the front structure of the vehicle shall be recorded.

8.2 Threshold

In child headform to front structure tests, the head injury criterion HIC, calculated from the resultant of the headform accelerometer time histories, in accordance with section 3.11, shall not exceed 1000.

Annex: A

Certification procedure for head form impactor

A1 Drop test

A1.1 Performance Criteria

The head form impactor shall meet the requirements specified in section 2 when tested as specified in section 3.

A1.2. Requirements

A1.2.1 When the head form impactor is dropped from a height of 376 ± 1 mm in accordance with section 3 the peak resultant acceleration measured by one triaxial (or three uniaxial) accelerometer (accelerometers) in the head form impactor shall be not less than 245 g and not more than 300 g. The acceleration time curve shall be uni-modal.

A1.2.2 The instrumentation response values CFC and CAC for the accelerometer shall be 1000 Hz and 500 g respectively as defined in ISO 6487: 1987.

A1.2.3 Temperature conditions

The head form impactor shall have a temperature of 20 ± 2°C at the time of impact. The temperature tolerances at a relative humidity of 10 to 70 percent after a soak period of at least four hour prior to its application in a test.

A1.3. Test Procedure

A1.3.1 The head form impactor shall be suspended from a drop rig as shown in Figure A1.

A1.3.2 The head form impactor shall be dropped from the specified height by means that ensure instant release onto a rigidly supported flat horizontal steel plate, over 50 mm thick and over 300 mm square which has a clean dry surface and a surface finish of between 0,2 and 2,0 micrometers.

A1.3.3 The head form impactor shall be dropped with the rear face of the impactor at the test angle chosen in 7.4 with respect to the vertical as specified in Figure A1. The suspension of the head form impactor shall be such that the head form impactor does not rotate during the fall.

A1.3.4 The drop test shall be performed three times, with the head form impactor rotated 120° around its symmetrical axis after each test.

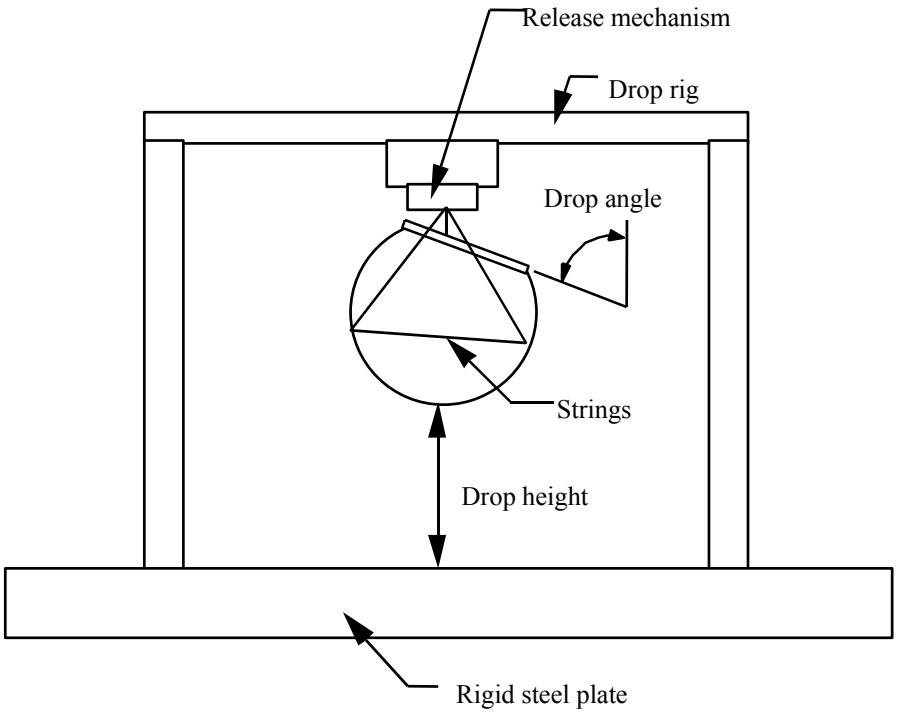


Figure A1: Test set-up for dynamic head form impactor biofidelity test

NOTE:
Does not require a lateral headform certification test in the IHRA headform certification test procedure because of following reasons,
1) Skin deformation speed in the lateral headform certification test is quite high comparing to the skin deformation speed in the vehicle headform test.
2) First natural frequency of the headform impactor is regulated as over 5000 Hz therefore resonance problem is already solved.