

AUTOMOTIVE INDUSTRY STANDARD

**Procedure for Determining the
"H" Point and the Torso Angle for
50th Percentile Adult Male in
Seating Positions of Motor Vehicles**

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ON BEHALF OF

AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE
P. B. No. 832, Pune 411 004

UNDER

CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY

MINISTRY OF SHIPPING, ROAD TRANSPORT & HIGHWAYS
(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)
GOVERNMENT OF INDIA

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Status chart of the Standard to be used by the purchaser
for updating the record

Sr. No.	Corr-igenda	Amend-ment	Revision	Date	Remark	Misc.

General remarks:

INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work on the preparation of the standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MOST) has constituted a permanent Automotive Industry Standards Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CTSC). After approval, the Automotive Research Association of India, (ARAI), Pune, being the Secretariat of the AIS Committee, has published this standard.

Based on deliberations in the CMVR-TSC and AISC it has been decided to create a suite of standards related to Passive Safety which are founded on dynamic (or crash) testing of passenger cars and utility vehicles. These standards would then form the basis of the notification and implementation of advanced passive safety norms in the latter part of this decade as per the Safety Road Map adopted for India.

The determination of “H point” of seating position in vehicles under consideration is an important part of conducting the dynamic tests envisaged in this suite of standards. Accordingly, the existing national standard IS 13749:1993 is being revised and aligned with European practice.

Towards this the necessary assistance has been taken from the National and International standards such as ECE regulations, EEC Directives, SAE, ISO and Indian Standards, list of which is given below.

This standard is primarily directed towards providing dimensions for the 50th percentile 3 DH-machine as most of the references from other standards are for this anthropometry. Further requirements for deriving 95th percentile anthropometry from this machine have also been provided as an additional resource.

Finally, an attempt has been made from other non-mandated resources to provide additional recommendatory dimensions and weights for the 3D H-machine. This will help engineers working in the area of safety to construct such machines.

- | | |
|---|---|
| 1. EEC Directive
77/649/EEC
(last amended by
90/630/EEC) | Field of vision of motor vehicle drivers
Annex III: Procedure for determining the “H” point and the actual torso angle for seating positions in motor vehicles. |
| 2. EEC Directive
74/60/EEC
(last amended by
2000/4/EC) | Motor vehicles interior fittings
Annex IV: Procedure for determining the H-point and actual seat-back angle and for verifying the relative positions of the R and H points and the relationship between the design seat-back angle and the actual seat back angle. |

3. ECE R12
(Revision 3 –
Amendment 3, 2002) Uniform provisions concerning the approval of vehicles with regard to the protection of the driver against the steering mechanism in the event of impact.
Annex 6: Procedure for determining the H point and the actual torso angle for seating positions in motor vehicles.
4. ECE R32
(Revision 1, 1999) Uniform provisions concerning the approval of vehicles with regard to the behavior of the structure of the impacted vehicle in a rear end collision.
Annex 3: Procedure for determining the H point and the actual torso angle for seating positions in motor vehicles.
5. ECE R33
(Revision 1 –
Amendment 1, 2000) Uniform provisions concerning the approval of vehicles with regard to the behavior of the structure of the impacted vehicle in a head-on collision.
Annex 3: Procedure for determining the H point and the actual torso angle for seating positions in motor vehicles
6. ECE R 94
(Revision 1 –
Amendment 4, 2003) Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a frontal collision.
Annex 6: Procedure for determining the H point and the actual torso angle for seating positions in motor vehicles
7. ECE R 95
(Revision 1 –
Amendment 4, 2005) Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a lateral collision.
Annex 3: Procedure for determining the H point and the actual torso angle for seating positions in motor vehicles
8. SAE J826
JUN 2002 H-point machine and design tool procedures and specifications
9. ISO 6549:1980 Road Vehicles – Procedure for H-point determination”

The Automotive Industry Standards Committee (AISC) responsible for preparation of this standard is given in Annex : 5

Procedure for Determining the "H" Point and the Torso Angle for 50th Percentile Adult Male in Seating Positions of Motor Vehicles

0. SCOPE

- 0.1 The procedure described is used to establish the "H" point location and the torso angle for one or several seating positions in a motor vehicle for a 50th percentile adult male and to verify the relationship of measured data to design specifications given by the vehicle manufacturer⁽¹⁾.
- 0.2 A vehicle complying with the requirements of IS 13749 is deemed to meet the requirements of this standard

1. REFERENCES

- 1.1 IS:13749 - 1993 : Automotive Vehicles – Determination of H point Method of Test

2. DEFINITIONS

- 2.1 **"Reference data"** means one or several of the following characteristics of a seating position:
- 2.1.1. the "H" point and the "R" point and their relationship,
- 2.1.2. the measured torso angle and the design torso angle and their relationship.
- 2.2. **"Three-dimensional 'H' point machine" (3 DH machine)** means the device used for the determination of "H" points and torso angles. This device is described in Annex 1.
- 2.3. **"H point"** means the pivot centre of the torso and thigh of the 3 DH machine installed in the vehicle seat in accordance with Paragraph 4 below. The "H" point is located in the centre of the centreline of the device which is between the "H" point sight buttons on either side of the 3 DH machine. The "H" point corresponds theoretically to the "R" point (for tolerances see item 3.2.2 below). Once determined in accordance with the procedure described in Paragraph 4, the "H" point is considered fixed in relation to the seat-cushion structure and to move with it when the seat is adjusted;
- 2.4. **'R' point"**, or **"seating reference point"** means a design point defined by the vehicle manufacturer for each seating position and established with respect to the three-dimensional reference system;
- 2.5. **"Torso-line"** means the centreline of the probe of the 3 DH machine with the probe in the fully rearward position;

(1) In any seating position other than front seats where the "H" point cannot be determined using the "Three- dimensional 'H' point machine" or procedures, the "R" point indicated by the manufacturer may be taken as a reference at the discretion of the competent authority.

- 2.6. **"Torso angle"** means the angle measured between a vertical line through the "H" point and the torso line using the back angle quadrant on the 3 DH machine. The torso angle corresponds theoretically to the design torso angle (for tolerances see item 3.2.2 below);
- 2.7. **"Design torso angle"** means the angle measured between a vertical line through the "R" point and the torso line in a position which corresponds to the design position of the seat-back established by the vehicle manufacturer;
- 2.8. **"Centreplane of occupant"** (C/LO) means the median plane of the 3 DH machine positioned in each designated seating position; it is represented by the co-ordinate of the "H" point on the "Y" axis. For individual seats, the centreplane of the seat coincides with the centreplane of the occupant. For other seats, the centreplane of the occupant is specified by the manufacturer;
- 2.9. **"Three dimensional reference system"** means a system as described in Annex 2.
- 2.10. **"Fiducial marks"** are physical points (holes, surfaces, marks or indentations) on the vehicle body as defined by the manufacturer;
- 2.11. **"Vehicle measuring attitude"** means the position of the vehicle as defined by the co-ordinates of fiducial marks in the three-dimensional reference system.

3. REQUIREMENTS

3.1. Data presentation

For each seating position where reference data are required in order to demonstrate compliance with the provisions of the present Directive, all or an appropriate selection of the following data shall be presented in the form indicated in Annex 3.

- 3.1.1. the coordinates of the "R" point relative to the three-dimensional reference system;
- 3.1.2. the design torso angle;
- 3.1.3. all indications necessary to adjust the seat (if it is adjustable) to the measuring position set out in item 4.3 below.

3.2. Relationship between measured data and design specifications

- 3.2.1. The coordinates of the "H" point and the value of the torso angle obtained by the procedure set out in item 4 below shall be compared, respectively, with the coordinates of the "R" point and the value of the design torso angle indicated by the vehicle manufacturer.

- 3.2.2. The relative positions of the "R" point and the "H" point and the relationship between the design torso angle and the torso angle shall be considered satisfactory for the seating position in question if the "H" point, as defined by its coordinates, lies within a square of 50 mm side length with horizontal and vertical sides whose diagonals intersect at the "R" point, and if the torso angle is within 5° of the design torso angle.
- 3.2.3. If these conditions are met, the "R" point and the design torso angle shall be used to demonstrate compliance with the provisions of this standard.
- 3.2.4. If the "H" point or the torso angle does not satisfy the requirements of item 3.2.2 above, the "H" point and the torso angle shall be determined twice more (three times in all). If the results of two of these three operations satisfy the requirements, the conditions of item 3.2.3 above shall apply.
- 3.2.5. If the results of at least two of the three operations described in item 3.2.4 above do not satisfy the requirements of item 3.2.2 above, or if the verification cannot take place because the vehicle manufacturer has failed to supply information regarding the position of the "R" point or regarding the design torso angle, the centroid of the three measured points or the average of the three measured angles shall be used and be regarded as applicable in all cases where the "R" point or the design torso angle is referred to in this standard.

4. PROCEDURE FOR "H" POINT AND TORSO ANGLE DETERMINATION

- 4.1. The vehicle shall be preconditioned at the manufacturer's discretion, at a temperature of $20 \pm 10^{\circ}\text{C}$ to ensure that the seat material reaches room temperature. If the seat to be checked has never been sat upon, a 70 to 80 kg person or device shall sit on the seat twice for one minute to flex the cushion and back. At the manufacturer's request, all seat assemblies shall remain unloaded for a minimum period of 30 minutes prior to installation of the 3 DH machine.
- 4.2. The vehicle shall be at the measuring attitude defined in item 2.11 above.
- 4.3. The seat, if it is adjustable, shall be adjusted first to the rearmost normal driving or riding position, as indicated by the vehicle manufacturer, taking into consideration only the longitudinal adjustment of the seat, excluding seat travel used for purposes other than normal driving or riding positions. Where other modes of seat adjustment exist (vertical, angular, seat-back, etc.) these will be then adjusted to the position specified by the vehicle manufacturer. For suspension seats, the vertical position shall be rigidly fixed corresponding to a normal driving position as specified by the manufacturer. In the absence of specification of seat back angle by the manufacturer, it shall be adjusted to an angle as near as possible to 25° .
- 4.4. The area of the seating position contacted by the 3 DH machine shall be covered by a muslin cotton, of sufficient size and appropriate texture, described as a plain cotton fabric having 18.9 threads per cm^2 and weighing 0.228 kg/m^2 or knitted or non-woven fabric having equivalent characteristics.

If a test is run on a seat outside the vehicle, the floor on which the seat is placed shall have the same essential characteristics ⁽¹⁾ as the floor of the vehicle in which the seat is intended to be used.

- 4.5. Place the seat and back assembly of the 3 DH machine so that the centreplane of the occupant (C/LO) coincides with the centreplane of the 3 DH machine. At the manufacturer's request, the 3 DH machine may be moved inboard with respect to the C/LO if the 3 DH machine is located so far outboard that the seat edge will not permit leveling of the 3 DH machine.
- 4.6. Attach the foot and lower leg assemblies to the seat pan assembly, either individually or by using the T-bar and lower leg assembly. A line through the "H" point sight buttons shall be parallel to the ground and perpendicular to the longitudinal centreplane of the seat.
- 4.7. Adjust the feet and leg positions of the 3 DH machine as follows:
 - 4.7.1. Designated seating position: driver and outside front passenger.
 - 4.7.1.1. Both feet and leg assemblies shall be moved forward in such a way that the feet take up natural positions on the floor, between the operating pedals if necessary. Where possible the left foot shall be located approximately the same distance to the left of the centreplane of the 3 DH machine as the right foot is to the right. The spirit level verifying the transverse orientation of the 3 DH machine is brought to the horizontal by readjustment of the seat pan if necessary, or by adjusting the leg and foot assemblies towards the rear.

The line passing through the "H" point sight buttons shall be maintained perpendicular to the longitudinal centreplane of the seat.

- 4.7.1.2. If the left leg cannot be kept parallel to the right leg and the left foot cannot be supported by the structure, move the left foot until it is supported. The alignment of the sight buttons shall be maintained.
- 4.7.2. Designated seating position: outboard rear

For rear seats or auxiliary seats, the legs are located as specified by the manufacturer. If the feet then rest on parts of the floor which are at different levels, the foot which first comes into contact with the front seat shall serve as a reference and the other foot shall be so arranged that the spirit level giving the transverse orientation of the seat of the device indicates the horizontal.

- 4.7.3. Other designated seating positions:

The general procedure indicated in item 4.7.1 above shall be followed except that the feet shall be placed as specified by the vehicle manufacturer.

(1) Tilt angle, height difference with a seat mounting, surface texture, etc.

- 4.7.4. In case of seats referred to in paragraphs 4.7.2 and 4.7.3 with multiple seating positions where R points of the seating position have not been defined by manufacturer, the centerline for 3 DH machine positioning for each seating position shall be determined by dividing the total seat width by the number of occupants and deriving the centerline there from.

Further as explained in paragraph 4.5 above, at the manufacturers request the 3 DH machine may be moved inboard with respect to the C/LO if the 3 DH machine is located so far outboard that the seat edge profile will not permit proper leveling of the 3 DH machine.

- 4.8. Apply lower leg and thigh weights and level the 3 DH machine.
- 4.9. Tilt the back pan forward against the forward stop and draw the 3 DH machine away from the seat-back using the T-bar. Reposition the 3 DH machine on the seat by one of the following methods:
- 4.9.1. If the 3 DH machine tends to slide rearward, use the following procedure. Allow the 3 DH machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required i.e. until the seat pan contacts the seat-back. If necessary, reposition the lower leg.
- 4.9.2. If the 3 DH machine does not tend to slide rearward, use the following procedure. Slide the 3 DH machine rearward by applying a horizontal rearward load to the T-bar until the seat pan contacts the seat-back (see Figure 2 of Annex 1).
- 4.10. Apply a 100 ± 10 N load to the back and pan assembly of the 3 DH machine at the intersection of the hip angle quadrant and the T-bar housing. The direction of load application shall be maintained along a line passing by the above intersection to a point just above the thigh bar housing (see Figure 2 of Annex 1). Then carefully return the back pan to the seat-back. Care must be exercised throughout the remainder of the procedure to prevent the 3 DH machine from sliding forward.
- 4.11. Install the right and left buttock weights and then, alternately, the eight torso weights. Maintain the 3 DH machine level.
- 4.12. Tilt the back pan forward to release the tension on the seat-back. Rock the 3 DH machine from side to side through 10° arc (5° to each side of the vertical centreplane) for three complete cycles to release any accumulated friction between the 3 DH machine and the seat.

During the rocking action, the T-bar of the 3 DH machine may tend to diverge from the specified horizontal and vertical alignment. The T-bar must therefore be restrained by applying an appropriate lateral load during the rocking motions. Care shall be exercised in holding the T-bar and rocking the 3 DH machine to ensure that no inadvertent exterior loads are applied in a vertical or fore and aft direction.

The feet of the 3 DH machine are not to be restrained or held during this step. If the feet change position, they should be allowed to remain in that attitude for the moment.

Carefully return the back pan to the seat-back and check the two spirit levels for zero position. If any movement of the feet has occurred during the rocking operation of the 3 DH machine, they must be repositioned as follows:

Alternately, lift each foot off the floor the minimum necessary amount until no additional foot movement is obtained. During this lifting, the feet are to be free to rotate; and no forward or lateral loads are to be applied. When each foot is placed back in the down position, the heel is to be in contact with the structure designed for this.

Check the lateral spirit level for zero position; if necessary, apply a lateral load to the top of the back pan sufficient to level the 3 DH machine's seat pan on the seat.

- 4.13. Holding the T-bar to prevent the 3 DH machine from sliding forward on the seat cushion, proceed as follows:
 - a) return the back pan to the seat-back;
 - b) alternately apply and release a horizontal rearward load, not to exceed 25 N, to the back angle bar at a height approximately at the centre of the torso weights until the hip angle quadrant indicates that a stable position has been reached after load release. Care shall be exercised to ensure that no exterior downward or lateral loads are applied to the 3 DH machine. If another level adjustment of the 3 DH machine is necessary, rotate the back pan forward, re-level, and repeat the procedure from 4.12.
- 4.14. Take all measurements:
 - 4.14.1. The co-ordinates of the "H" point are measured with respect to the three-dimensional reference system.
 - 4.14.2. The torso angle is read at the back angle quadrant of the 3 DH machine with the probe in its fully rearward position.
- 4.15. If a re-run of the installation of the 3 DH machine is desired, the seat assembly should remain unloaded for a minimum period of 30 minutes prior to the re-run. The 3 DH machine should not be left loaded on the seat assembly longer than the time required to perform the test.
- 4.16. If the seats in the same row can be regarded as similar (bench seat, identical seats, etc.) only one "H" point and one "torso angle" shall be determined for each row of seats, the 3 DH machine described in Annex 1 being seated in a place regarded as representative for the row. This place shall be:
 - 4.16.1. in the case of the front row, the driver's seat;
 - 4.16.2. in the case of the rear row or rows, an outer seat.

ANNEX - 1
(see 2.2)

**DESCRIPTION OF THE THREE DIMENSIONAL
"H" POINT MACHINE (3 DH MACHINE)**

1. Back and Seat Pans

The back and seat pans are constructed of reinforced plastic and metal; they stimulate the human torso and thigh and are mechanically hinged at the "H" point. A quadrant is fastened to the probe hinged at the "H" point to measure the torso angle. An adjustable thigh bar, attached to the seat pan, establishes the thigh centreline and serves as a baseline for the hip angle quadrant.

2. Body and Leg Elements

Lower leg segments are connected to the seat pan assembly at the T-bar joining the knees, which is a lateral extension of the adjustable thigh bar. Quadrants are incorporated in the lower leg segments to measure knee angles. Shoe and foot assemblies are calibrated to measure the foot angle. Two spirit levels orient the device in space. Body element weights are placed at the corresponding centres of gravity to provide seat penetration equivalent to a 76 kg male. All joints of the 3 DH machine should be checked for free movement without encountering noticeable friction.

3. Dimensions and Weights of 3D H Point Machine Subsystems

- 3.1. The mandated dimensions and weights are given in paragraph 2 above and figure 2 below. They are also given in Tables 1 and 2 below:

Table 1
Mandatory Dimensions for the 3 DH Machine
(Refer Fig: 2 in Annex 1)

Sr. No	Parameter	Dimension	Tolerance
1.	H-point to knee point	432 mm	± 5mm
2.	Knee point to ankle point	417 mm	± 5mm
3.	T-bar length	108-424 mm (Adjustable)	

Table 2
Mandatory weight of the 3 DH machine
(Refer paragraph 2 of Annex 1)

Sr. No	Parameter	Weight	Tolerance
1.	Weight of the complete 3 DH manikin	76 kg	± 1.2 kg

- 3.2. Tables 3 and 4 below give recommendatory values for some select dimensions and weights of the 3 DH machine. These values are not mandatory and have been provided here only to serve as a guideline where sought for the construction of 3 DH machines by the test agency.

Table 3**Non-Mandatory Values of Select 3 DH Machine Dimensions**

Sr. No	Parameter	Dimension
1.	Width across shoulders at widest location	395 mm
2.	Distance across outside of H-point apertures	393 mm
3.	Horizontal distance from H-point to rear of buttock section	134 mm
4.	Vertical distance above seat base of h-point	97.5 mm
5.	Ankle pivot to heel point	107 mm

Table 4**Non-Mandatory Weights of 3 DH Machine Sub-systems**

Sr. No.	Parameter	Recommended minimum weight
1.	Components simulating back and seat of the body	16 kg
2.	Torso weights (8 no's)	31 kg
3.	Seat weights (2 no's)	8 kg
4.	Thigh weights (2 no's)	7 kg
5.	Leg weight	13 kg
	TOTAL WEIGHT	75 kg

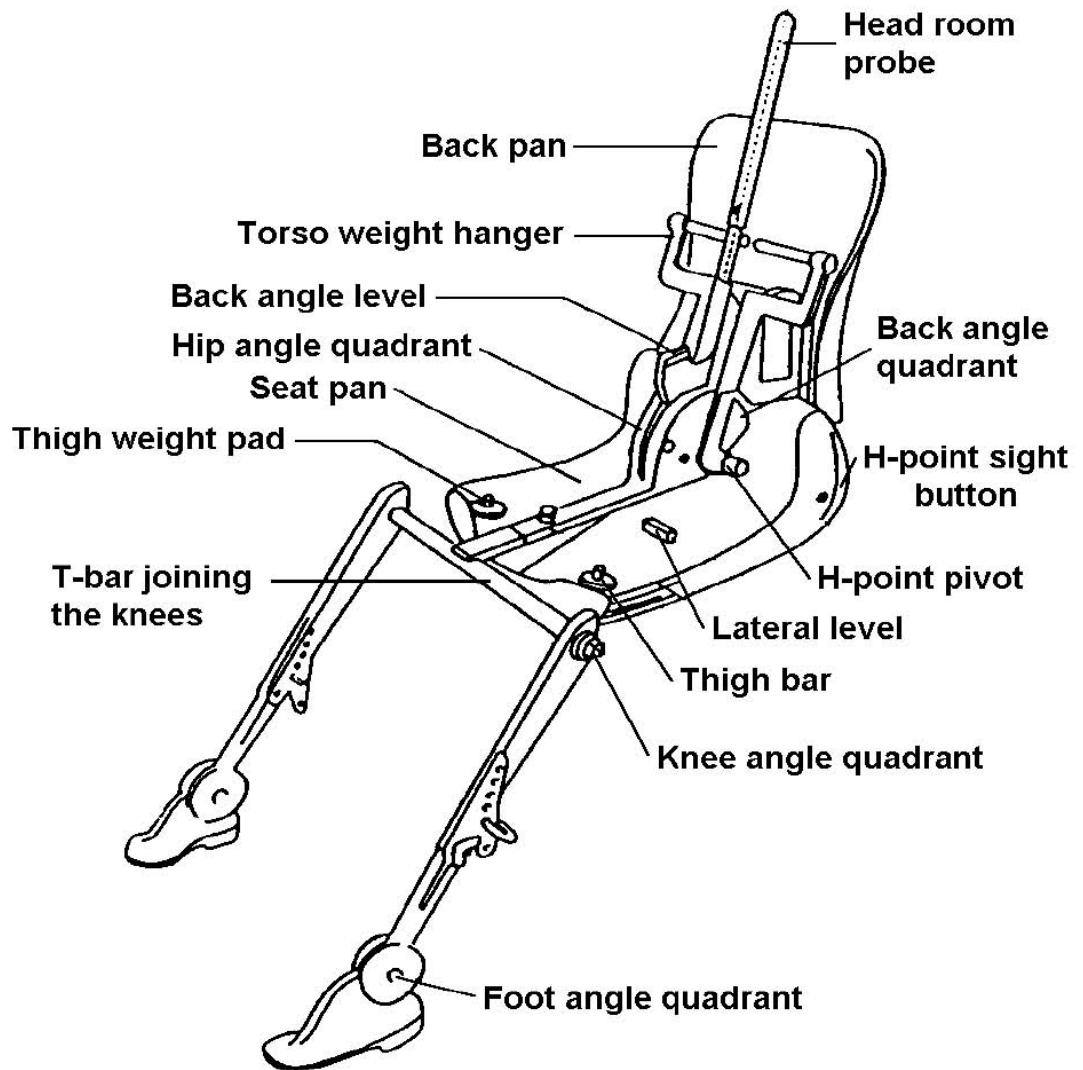


Figure 1

3 DH Machine Elements Designation

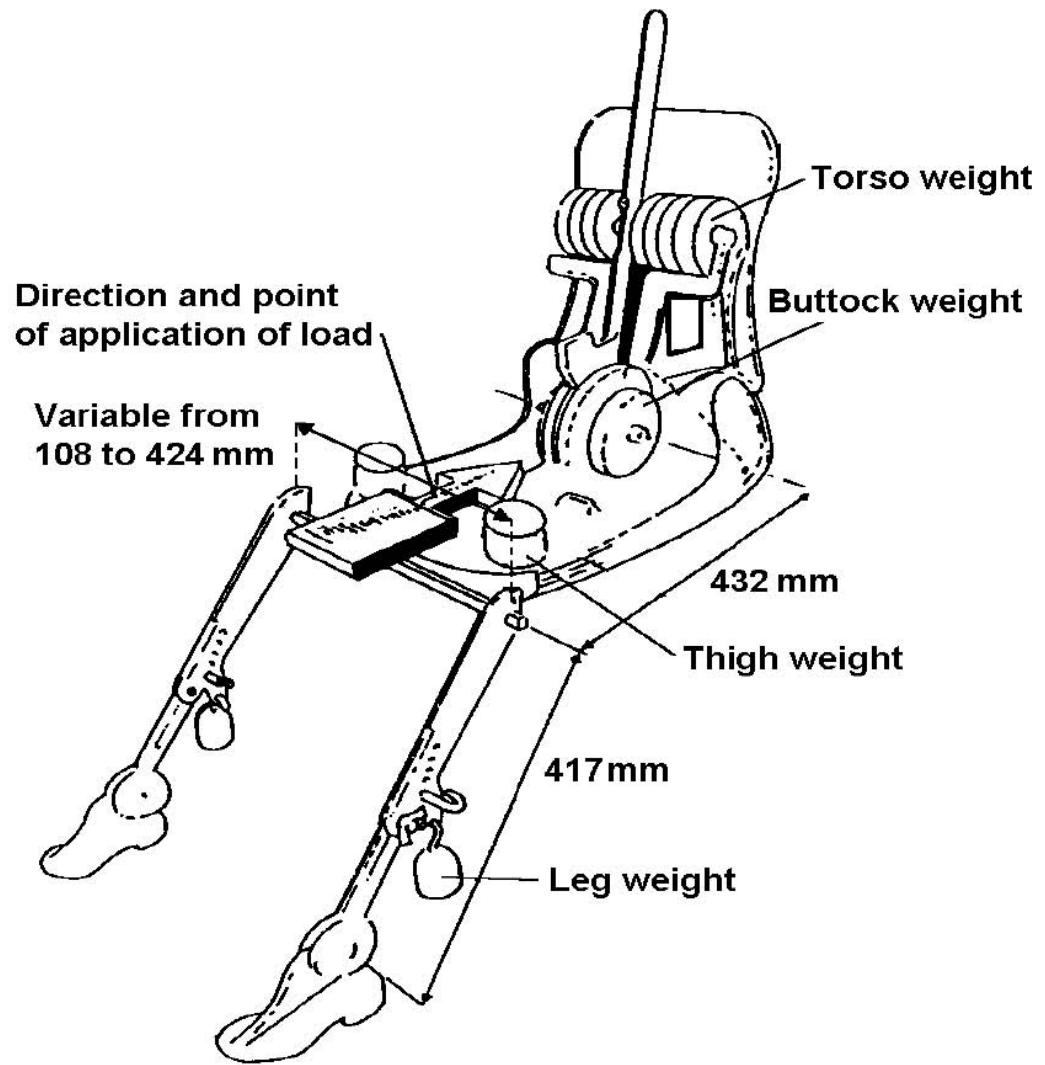


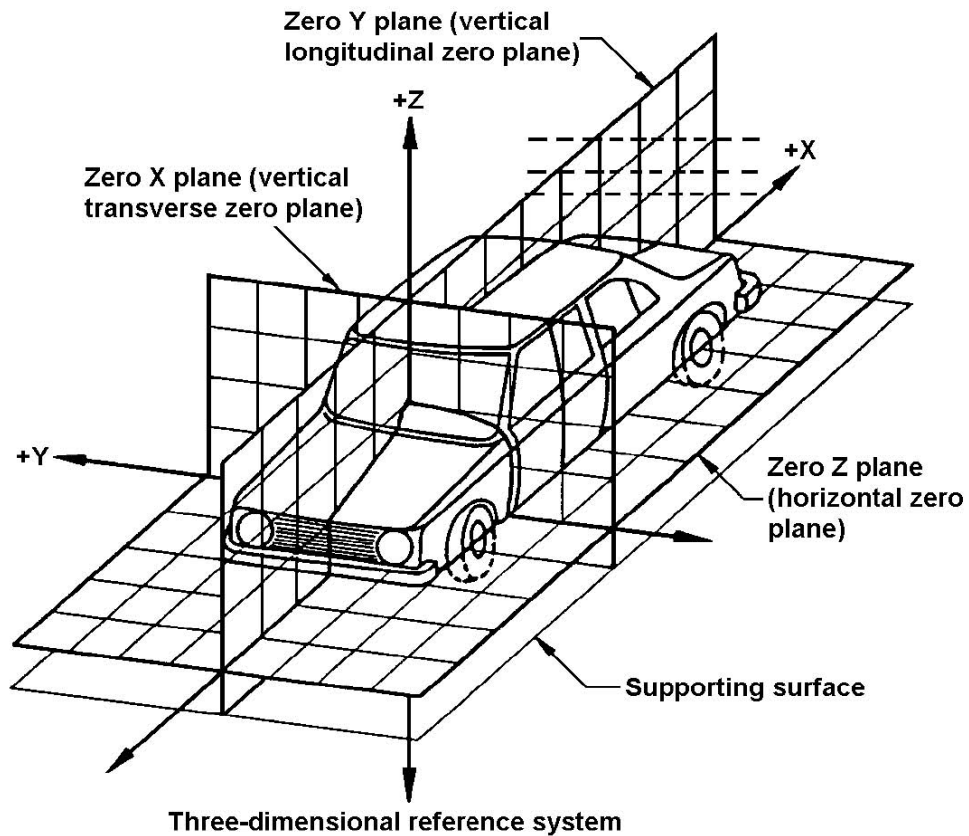
Figure 2

Dimensions of the 3 DH Machine Elements and Load Distribution

ANNEX - 2
(see 2.9)

THREE-DIMENSIONAL REFERENCE SYSTEM

1. The three-dimensional reference system is defined by three orthogonal planes established by the vehicle manufacturer (see Figure).
2. The vehicle measuring attitude is established by positioning the vehicle on the supporting surface such that the coordinates of the fiducial marks correspond to the values indicated by the manufacturer.
3. The coordinates of the "R" point and the "H" point are established in relation to the fiducial marks defined by the vehicle manufacturer.



ANNEX - 3
 (See 3.1)
REFERENCE DATA CONCERNING SEATING POSITIONS

1. Coding of reference data

Reference data are listed consecutively for each seating position. Seating positions are identified by a two-digit code. The first digit is an Arabic numeral and designates the row of seats, counting from the front to the rear of the vehicle. The second digit is a capital letter which designates the location of the seating position in a row, as viewed in the direction of forward motion of the vehicle; the following letters shall be used:

- L = left
- C = centre
- R = right

2. Description of vehicle measuring attitude

2.1 Co-ordinates of fiducial marks

- X
- Y
- Z

3. List of reference data

3.1 Seating position:.....

3.1.1 Co-ordinates of "R" point

- 3.2 X**
- Y**
- Z**

3.3 Design torso angle:

3.1.2 Specification for seat adjustment ⁽¹⁾

- horizontal:
- vertical:
- angular:
- torso angle:.....

Note: List reference data for further seating positions under 3.2, 3.3, etc.

(1) Strike out what does not apply.

ANNEX - 4

**PROCEDURE FOR MEASURING 95TH PERCENTILE ADULT
MALE H-POINT AND TORSO ANGLE REQUIREMENTS
USING 50TH PERCENTILE MANIKIN**

1. In certain applications there may be a need to measure the H-point and Torso angle for a 95th percentile adult male.
2. In order to undertake these measurements using a 50th percentile 3DH Machine the following settings shall be made on the machine:

- 2.1 Thigh and Lower Leg Length Settings

Setting	50 th percentile	95 th percentile
Thigh length	432 mm	456 mm
Lower leg length	417 mm	459 mm

- 2.2 Leg positioning

In the case of 95th percentile settings also, the procedure described in paragraph 4 for determining the H point using the 50th percentile 3DH Machine shall be adopted with the exception of paragraph 4.7.1.1 which in the case of 95th percentile settings shall read as follows:

“The right foot and leg assembly is placed on the accelerator pedal and the heel on the floor as far forward as specified by the manufacturer. However, the foot angle shall never be less than 87°. This is accomplished by inserting the positive pin of the H-point machine into the foot assembly. The shoe sole of the device shall touch, and, if specified by the manufacturer, is allowed to depress the accelerator pedal through some portion of its travel.

ANNEX - 5
(See Introduction)
COMMITTEE COMPOSITION *
Automotive Industry Standards Committee

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Members	Representing
Representative from	Ministry of Shipping, Road Transport & Highways (Dept. of Road Transport & Highways), New Delhi
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* At the time of approval of this Automotive Industry Standard (AIS)