Road vehicles — Pedestrian protection — Impact test method for pedestrian thigh, leg and knee

Véhicules routiers — Protection des piétons — Méthode d’essai de choc pour la cuisse, la jambe inférieure et le genou des piétons
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11096 was prepared by Technical Committee ISO/TC 22, Road vehicles, Subcommittee SC 10, Impact test procedures.

This second edition cancels and replaces the first edition (ISO 11096:2002), which has been technically revised.
Introduction

The intent of this International Standard is to help standardize the pedestrian leg impactor test method that will allow a test organization to use the results from pedestrian impact tests conducted by other test organizations.

The method is based on the simulated impact of a motor vehicle on an adult pedestrian. It is anticipated that biomechanical data for children will later be studied in order to determine the potential for child pedestrian protection. Research suggests that safety improvements in vehicles derived from such pedestrian impact tests would also be beneficial to motorcyclists and bicyclists (see Annex D).
Road vehicles — Pedestrian protection — Impact test method for pedestrian thigh, leg and knee

1 Scope

This International Standard specifies a test method for simulating the lateral impact between the front of a passenger vehicle or light truck vehicle derived from passenger cars (as defined in ISO 3833) and an adult pedestrian.

The test method addresses the reduction of pedestrian thigh, leg and knee injuries. It is not applicable to testing for, or the evaluation of, injuries to other pedestrian body regions, nor does it directly cover the potential risk of injury to children or human soft tissue. It is not applicable to vehicles with deployable devices designed for activation in the event of impact with a pedestrian.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1176, Road vehicles — Masses — Vocabulary and codes
ISO 3784, Road vehicles — Measurement of impact velocity in collision tests
ISO 3833, Road vehicles — Types — Terms and definitions
ISO 6487, Road vehicles — Measurement techniques in impact tests — Instrumentation
ISO/TR 15766, Road vehicles — Pedestrian protection — Targets for the assessment of the biofidelity of pedestrian-leg test devices

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1176 and ISO 3833, and the following apply.

3.1 Legform impactor

3.1.1 knee joint
mechanical joint of a legform impactor with deformable elements simulating a human knee in lateral impact only

3.1.2 thigh
mechanical components above the legform impactor knee joint
3.1.3
leg
mechanical components below the legform impactor knee joint

3.1.4
knee joint centre
centre of the bending part of a knee joint's deformable element before deformation

3.1.5
valgus angle
angle of the knee joint in abduction

3.2 Vehicle

3.2.1
impact point
point on the vehicle at which initial contact occurs

3.2.2
front face
foremost part of the front of the vehicle, and that most likely to strike the pedestrian's leg

3.2.3
corner
extremity on either side of the front face located at the point at which a vertical plane, set at 60° to the centreline of the vehicle, comes in contact with, and is tangential to, the outer surface of the front face

NOTE See Figure 1.

Key
1 straight edge
2 corner of front face
3 vehicle centreline

Figure 1 — Corner of front face
4 Test equipment

4.1 Impact test site

The impact test site shall consist of a flat, smooth and hard surface with a slope not exceeding 1 % under the test vehicle, as shown in Figure 2.

![Diagram of impact test site]

Key
1 impactor
2 ground reference plane (GRP)
3 ground
4 vehicle

Figure 2 — Impact test site
4.2 Legform impactor

The legform impactor shall be a device sensitive to the characteristics of the front face, with a knee joint in accordance with the model specified in 5.1.1 and shown in Figure 3.

![Diagram of legform impactor]

Dimensions in millimetres

Key
1 thigh
2 knee joint
3 leg
a Trajectory.

Figure 3 — Legform impactor

4.3 Propulsion system

The legform impactor shall be propelled by a propulsion system in accordance with 5.2.

4.4 Applicable vehicles

The test method is applicable to passenger cars and light commercial vehicles of up to 3.5 tonnes.

5 Requirements

5.1 Legform impactor

5.1.1 Physical properties

The dimensions (see Figure 3) and mass distribution of the legform impactor used in the test are based on a 50th percentile male\(^1\). They and the other physical properties of the legform impactor shall be as follows.

a) Leg length between the bottom and the knee joint centre: \((493 \pm 5)\) mm.

b) Thigh length between the knee joint centre and the top: \((428 \pm 5)\) mm.

c) Centre of gravity of leg from the knee joint centre: \((233 \pm 10)\) mm.
d) Centre of gravity of thigh from the knee joint centre: (218 ± 10) mm.

e) Total legform impactor mass: (13.4 ± 0.1) kg.

f) Thigh mass including skin and foam: (8.6 ± 0.1) kg.

g) Leg mass including skin and foam: (4.8 ± 0.1) kg.

h) Moment of inertia around y axis of leg: (0.12 ± 0.001) kg m².

i) Moment of inertia around y axis of thigh: (0.127 ± 0.001) kg m².

j) An adaptor may be fitted to the top of the thigh to permit the attachment of the legform impactor to the propulsion system. If used, the thigh with adaptor shall still comply with the thigh requirement of mass, centre of gravity and moment of inertia.

k) There shall be a simulation of flesh or skin on the outer surface of the legform impactor. This material shall be human-like.

5.1.2 Shape of legform impactor

The shape of the legform impactor shall be cylindrical. The outer diameter of the thigh and that of the leg shall be the same: (120 ± 10) mm, including a “flesh” thickness of (30 ± 5) mm.

5.1.3 Biofidelic performance characteristics

The legform impactor shall meet the biofidelic performance targets given in Annex A.

5.1.4 Certification of legform impactor

The legform impactor shall meet the certification requirements given in Annex B.

5.1.5 Calibration of legform impactor deformable elements

Once the structural design of the deformable knee element meeting the requirements specified in 5.1.3 and 5.1.4 is completed, the designer of the legform impactor shall provide a calibration test procedure in which each batch of deformable knee elements shall be checked to see if their performance is acceptable. Such a calibration test procedure may be applied statically if this test proves that the characteristics of the batch are similar to those of the original design. The response adopted as a requirement for a calibration test should allow for a reasonable variation in production.

5.2 Propulsion of legform impactor

The legform impactor shall be propelled in free flight into the stationary test vehicle. The method of legform impactor propulsion is at the discretion of the test office; however, the knee joint should be supported during legform impactor acceleration. The trajectory of the legform impactor shall be parallel to the ground within ± 6° at impact with the vehicle, and its angular velocity at this time shall be less than 50°/s. Because of the effect of gravity and depending on the length of free flight, this may require that the trajectory of the legform impactor at the time of its release from the propulsion system be at an angle above horizontal. There shall be no contact between the legform impactor and the propulsion system during impact with the vehicle.

5.3 Legform impactor setting

5.3.1 The legform impactor shall be straight, and vertical in pitch and roll at the time of impact (see Figure 2). The tolerances for pitch, roll and yaw shall be ± 5°.