TECHNICAL SPECIFICATION

ISO/TS 29062

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Road vehicles — Child restraint systems — Sled test method to enable the evaluation of side impact protection

Véhicles routiers — Systèmes de retenue pour enfants — Méthode d'essai sur chariot pour permettre l'évaluation de la protection en choc latéral

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Foreword

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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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 29062 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 12, *Passive safety crash protection systems*.

Introduction

0.1 Objective and notes on applicability

The objective of this Technical Specification is to create a test method that simulates lateral impact involving child restraint systems (CRS) as observed in the field with the ultimate goal of improving the protection of children.

It is explicitly stated that it is not possible to compare the performance of forward- and rearward-facing CRS according to this Technical Specification, unless they are each tested in their respective worst case conditions.

The worst case condition corresponds to maximum intrusion close to the child's head. In ECE Regulation No. 95 side impact tests and similar real-world accidents, for a rearward-facing CRS this applies to the rear seat position and for a forward-facing CRS this applies to the front passenger seat position. In real-world accidents, for either forward-facing or rearward-facing CRS, the worst case depends on the impact point and may be in either the front or the rear seat of the vehicle.

0.2 Background data and development of the method

This Technical Specification has been prepared on the basis of accident data. The specification addresses the struck side impact conditions, which, from research data, are shown to be the conditions that in real accidents produce the majority of fatalities and serious injuries.

A major aim has been to use methods that are relatively inexpensive. Thus, the specification has been developed through a progression of tests from full-scale vehicle impacts, via double sled dynamic tests, to a single sled with a hinged panel, representing the intruding vehicle's side structure.

The data from the full size tests were first replicated on two sled rigs in which one sled represents the struck vehicle and the second sled represents the striking vehicle and the intruding side structure. The data from this method were analysed and used to develop a close approximation of the side impact event on a single sled. In this procedure, the intruding side structure is represented by a pivoted panel that is rotated in relation to the test seat at a relative velocity within a band of velocities measured in full scale tests. The movement represents the deformation of the inner side structure of the passenger compartment relative to the non-struck side of the vehicle.

Further information about the background data, development of the test method and experiences can be found in ISO/TR 14646.

Road vehicles — Child restraint systems — Sled test method to enable the evaluation of side impact protection

1 Scope

This Technical Specification specifies a test method for child restraint systems in side impact collisions. The test method simulates the conditions in which most of the serious injuries occur, and for which the child restraint characteristics can improve the protection of the child.

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 6487, *Road vehicles — Measurement techniques in impact tests — Instrumentation*

ISO 8721, *Road vehicles — Measurement techniques in impact tests — Optical instrumentation*

ISO 13216-1, *Road vehicles — Anchorages in vehicles and attachments to anchorages for child restraint systems — Part 1: Seat bight anchorages and attachments*

ISO/TR 14646:2007, *Road vehicles — Side impact testing of child restraint systems — Review of background data and test methods, and conclusions from the ISO work as of November 2005*

ECE Regulation No. 44-04, *Uniform provisions concerning the approval of restraining devices for child occupants of power-driven vehicles ("child restraint system")*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
child restraint system
CRS
any free-standing device intended to provide child vehicle occupants with an approved restraint

NOTE CRSs comprise various categories such as car beds, infant restraints, toddler seats (forward- and rearward-facing), booster cushions and booster seats. Combination products may cover two or more of these product categories.

3.2
struck side
side of a vehicle where lateral impact occurs

3.3
non-struck side
opposite side to the struck side

3.4
hinged panel
impactor to the child seat, which simulates the intruding inner side structure of the passenger compartment in lateral impact

3.5
intrusion plane
extension upwards of the hinged panel inner surface, adjacent to the dummy head

3.6
sled deceleration starting point
t_0
start of the acceleration of the sled, e.g. the first contact of a deceleration sled with the braking system

4 Boundary conditions

When analysing test results of ECE Regulation No. 95 side impact tests, it becomes evident that injuries are caused by a combination of both structural intrusion and vehicle acceleration. The intrusion is defined by intrusion shape, intrusion depth and intrusion velocity. In addition, geometrical properties (such as door panel height, distance between side structure and CRS) of the struck car have a considerable influence. An appropriate side impact test procedure for CRS should be capable of reproducing the following properties:

- Intrusion velocity range: 7 m/s – 10 m/s
- Intrusion depth: approx. 250 mm
- Sled acceleration range: 10 g – 15 g
- Door panel height with respect to CR point: approx. 500 mm
- Distance between panel and CRS centre line: approx. 300 mm

In addition, the timing of the impact between the intruding panel and CRS/dummy needs to be controlled for appropriate definition of impact severity.

For background data and justifications, see ISO/TR 14646.

In principle it is possible to achieve the above conditions by various test setups, e.g. realization of the intrusion by a translational panel. The hinged panel method described below is one possible method which has been shown to be capable of meeting the physical parameters mentioned above.

5 Test method

5.1 General

The test conditions are intended to represent the loadings in full-scale impact as closely as possible.

When a vehicle experiences impact to its side by the front of another vehicle, the struck vehicle (body) is subject to a lateral acceleration and a velocity change. In addition, the struck side of that vehicle may intrude rapidly into the passenger compartment, impacting occupants seated on the struck side adjacent to the impact. As regards a child restraint, the body acceleration affects the reaction of the anchorages and the inertial displacement of the CRS while the side intrusion affects the direct loading on the CRS.

This complex interaction cannot be replicated entirely in a simple sled test procedure. For the test procedure given in this Technical Specification, the body acceleration and intrusion of the inner panel structure have been specified independently:

— body acceleration is reproduced by the sled acceleration;

— intrusion is simulated by the motion of a hinged panel mounted on the sled.

For two vehicles of equal mass, the velocity change of the struck vehicle in a side impact will be about one half of the impact velocity of the striking vehicle. Thus this method simulates a side impact of approximately 50 km/h.

Due to the early impact between panel and CRS when using a test method that represents intrusion, mathematical simulations have shown that the velocity change in the direction of travel of the struck vehicle has a marginal influence on the dummy readings. In the test method according to this Technical Specification, the forward velocity component is therefore disregarded in order to simplify the test set-up.

In order to avoid excessive deformation of the ISOFIX attachments on the CRS in the side impact test setup, the anchorages are mounted to the test rig in a way to allow some movement in the Y direction.

5.2 Test facility and equipment

5.2.1 Test rig

The test rig comprises a sled fitted with

— test bench;

— hinged panel;

— 2- and 3-point belt and ISOFIX anchorages (in accordance with ECE Regulation No. 44 and Annex A);

— top tether anchorages, seat bight anchorages, and floor (in accordance with ECE Regulation No. 44 and Annex A).

See Figures 1 to 6.

The sled is equipped with a means of generating a Δv corridor as shown in Figure 7 with a velocity change of 25 km/h $\pm$ 1 km/h.

For the simulation of the intruding panel (inner side structure) on side impact, the hinged panel is moved during the sled deceleration by a means that generates a panel angular velocity as given in Figures 8 and 9.

The ISOFIX anchorages should be movable in the Y direction to avoid damage of the attachments, thus avoiding damage to the test equipment (e.g. dummies). The ISOFIX anchorages are individually fixed to a sliding system allowing a movement of up to 200 mm. For a forward-facing CRS the test bench backrest is also movable in the Y direction and mechanically linked with the intruding panel.

In a similar way, attachment of the CRS with seat belts should also have provisions to allow movement in the Y direction.

5.2.2 Dimensions and specifications

The design and specifications of the test bench with anchorages is shown in Figures 1 to 6. The design and specifications of the hinged panel with padding are shown in Figures 3 and 6.

NOTE The figures show one practical solution, where the seat back of the bench is moved to avoid conflict with the hinged panel. Alternative solutions may be used to avoid this interaction, as long as the relevant geometry and characteristics of the panel are maintained.

The stiffness and strength of the hinged panel structure shall be sufficient in order that the panel structure will remain essentially undeformed during the test and to avoid excessive oscillations of the panel.

The panel padding consists of 55 mm thick padding material. The mechanical properties are defined by a drop test and a response corridor, see Annex B.

5.3 Test dummies

Specification of the dummies allowing adequate measurements in the side impact method is not included in this Technical Specification. The most appropriate dummies according to state-of-the-art for this application should be used.

NOTE Dummy recommendations are intended to be part of a subsequent publication by ISO/TC 22/SC 12/WG 5, not yet available by the time of publication of this Technical Specification.

5.4 Instrumentation

5.4.1 General

The instrumentation shall comply with current International Standards. The measurement techniques shall comply with ISO 6487, and the optical instrumentation shall comply with ISO 8721.

5.4.2 Instrumentation of the test rig with the hinged panel

The following parameters shall be measured:

— sled acceleration and velocity change;

— panel angular velocity.

There shall be a capability of determining head containment within the CRS and head contact with the intrusion plane should it occur, e.g. photographically.

The impacting panel surface, covered with the defined padding, should allow the identification and analysis of contact areas between the child dummy and the impacting panel.

5.4.3 Instrumentation of the dummy

The following parameters shall be measured:

— head and chest acceleration, by tri-axial accelerometers;

— neck forces and moments;

— chest compression (optional);

— head displacement, e.g. by high speed video or film analysis.

5.5 Test installation

Only new and untested CRSs should be used.

The CRS shall be installed with a standard seat belt according to the specifications of Annex A, or with ISOFIX anchorages (see ISO 13216-1 or ECE Regulation No. 44) as applicable. Anti-rotational devices shall be used in accordance with the manufacturer's recommendations when applicable.

The lateral distance between the centre line of the CRS and the inner panel plane shall be 300 mm at test commencement.

Taking into account the head containment as the most important issue, the CRS should be tested in the most upright position allowed by the CRS manufacturer for the specific orientation being used.

5.6 Test conditions

5.6.1 Sled motion specifications

The sled velocity change shall be 25 km/h with a tolerance of ± 1 km/h.

The sled deceleration shall comply with a Δv corridor as shown in Figure 7.

NOTE See ISO 7862 for general specifications relating to the sled pulse definition.

5.6.2 Hinged panel motion specifications

- The total angular change shall be not less than 25° and the intrusion shall be not less than 250 mm, see Figures 3 and 6;
- The angular velocity corridors are different for rearward-facing and forward-facing CRSs, to compensate for different distances from the head to the hinge and to achieve comparable translational velocities of the panel at the position of the dummy's head. The specification is based on two sets of test data as follows.
  - Tests equivalent to ECE Regulation No. 95 involving a super mini car[1] produced in the late nineties to early 2000:
    - for rearward-facing CRSs the velocity curve shall pass through the upper defined rectangle in Figure 8 and the angular velocity must not exceed 14,4 rad/s;
    - for forward-facing CRSs the velocity curve shall pass through the upper defined rectangle in Figure 9 and the angular velocity must not exceed 16 rad/s.
  - Tests equivalent to ECE Regulation No. 95 involving a sample of 17 cars representing different manufacturing dates and sizes:
    - for rearward-facing CRSs the velocity curve shall pass through the defined rectangle in Figure 8, and the angular velocity must not exceed 11,2 rad/s;
    - for forward-facing CRSs the velocity curve shall pass through the defined rectangle in Figure 9, and the angular velocity must not exceed 12,8 rad/s.

The hinged panel motion shall not be affected by contact with the CRS within the first 50 ms after t_0.

1) According to Euro NCAP car categorization.

6 Parameters to be recorded

The performance criteria have to be specified in relation to the selected dummies. Below is listed what is necessary, and what is desirable, to record.

The following parameters shall be recorded:

— direct dummy head contact with the intruding panel;

— head containment within the child restraint system.

The following parameters are recommended to be recorded or calculated:

— head injury criterion (HIC);

— head resultant acceleration;

— head excursion in relation to the intrusion plane;

— neck axial tension;

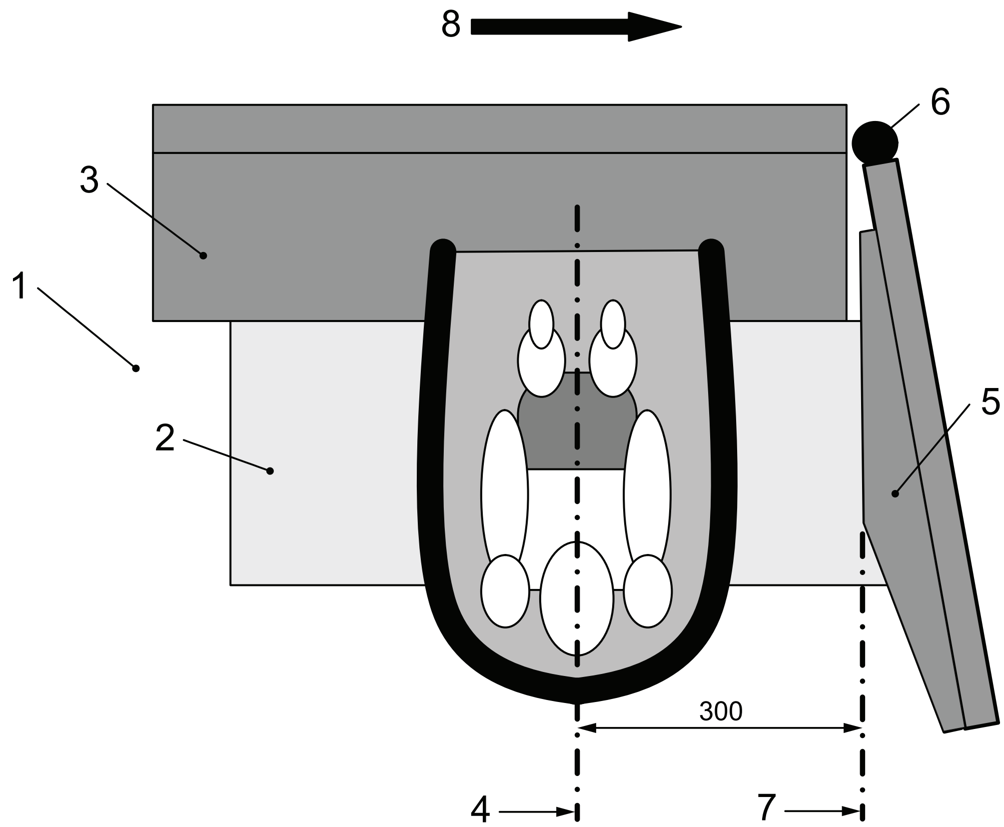
— neck shear force (lateral component);

— neck lateral bending moment;

— chest resultant acceleration;

— chest compression (if applicable to the dummy used).

Dimensions in millimetres

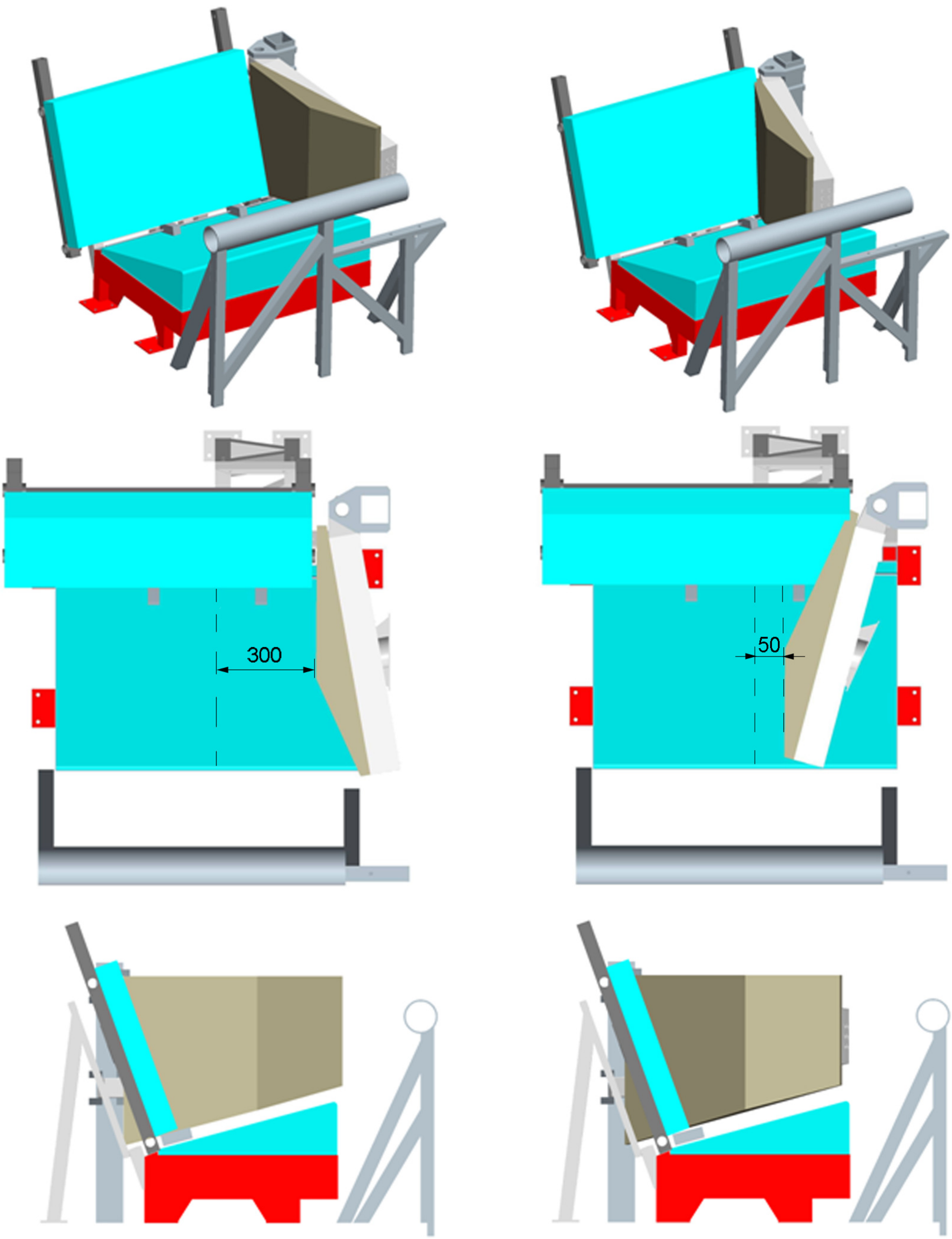


Key

1 sled
2 ECE R.44 test bench cushion
3 ECE R.44 test bench backrest
4 CRS centreline
5 hinged panel (principle)
6 hinge
7 inner panel plane
8 travel direction of a deceleration sled (opposite direction for an acceleration device)

Figure 1 — Test configuration of a rearward-facing CRS, with ECE Regulation No. 44 bench prepared for side impact testing

Dimensions in millimetres



Initial panel position (front, top, side)

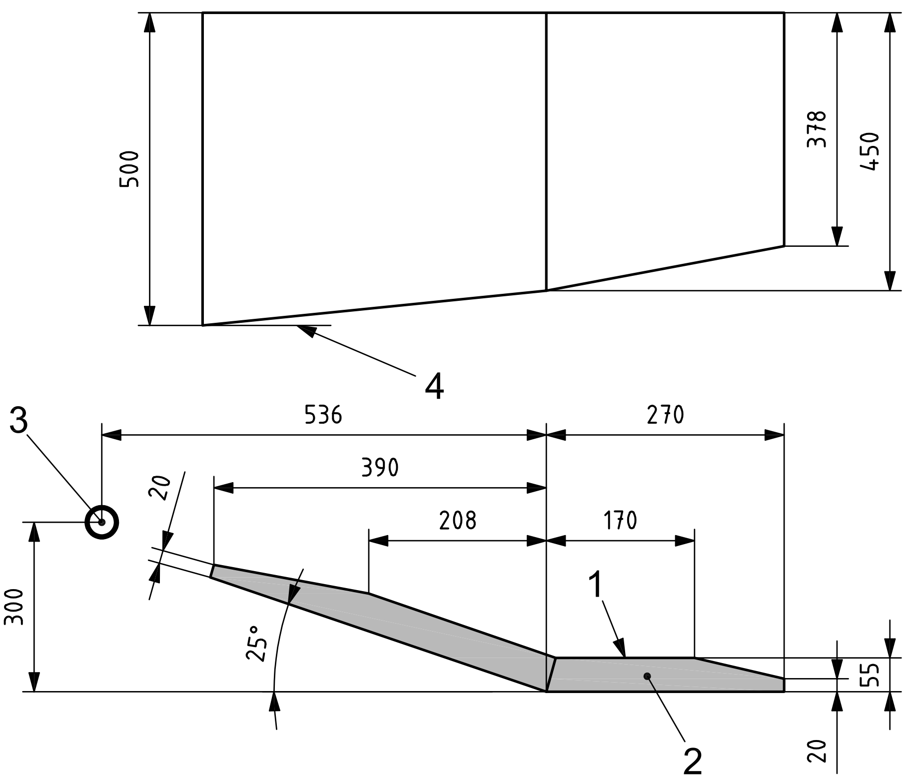
Panel position in maximum intrusion (front, top, side)

NOTE 1 Figure 2 shows one possible solution for realization of the set-up for visualization of the intrusion by the hinged panel.

NOTE 2 The “dashboard tube” displayed in Figure 2 may have a support function for a large rearward-facing CRS. It does not necessarily need to be present.

Figure 2 — Seat bench construction with hinged panel for testing of a rearward-facing CRS

Dimensions in millimetres



Key

1 panel structure (not shown)

2 padding material as described in Annex B, thickness from 20 mm to 55 mm

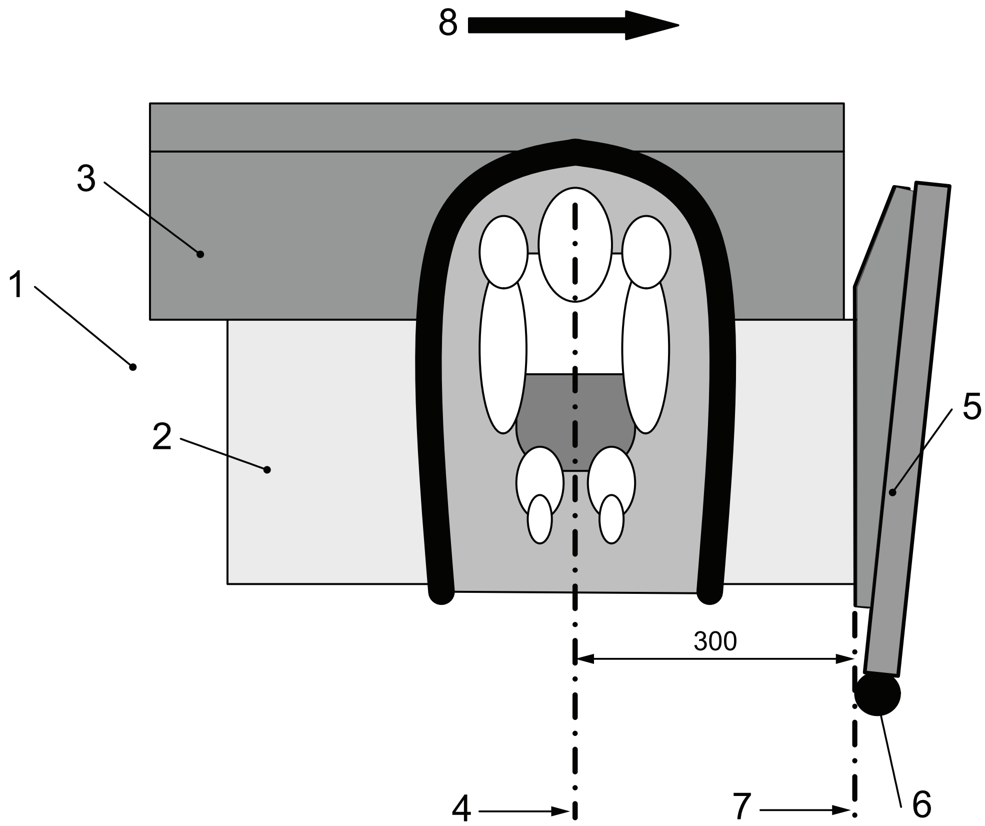
3 hinge position

4 CR point base line

NOTE For markets where armrest structures are common, the addition of an optional armrest simulation could be considered.

Figure 3 — Dimensions of a hinged panel and padding for testing of a rearward-facing CRS

Dimensions in millimetres

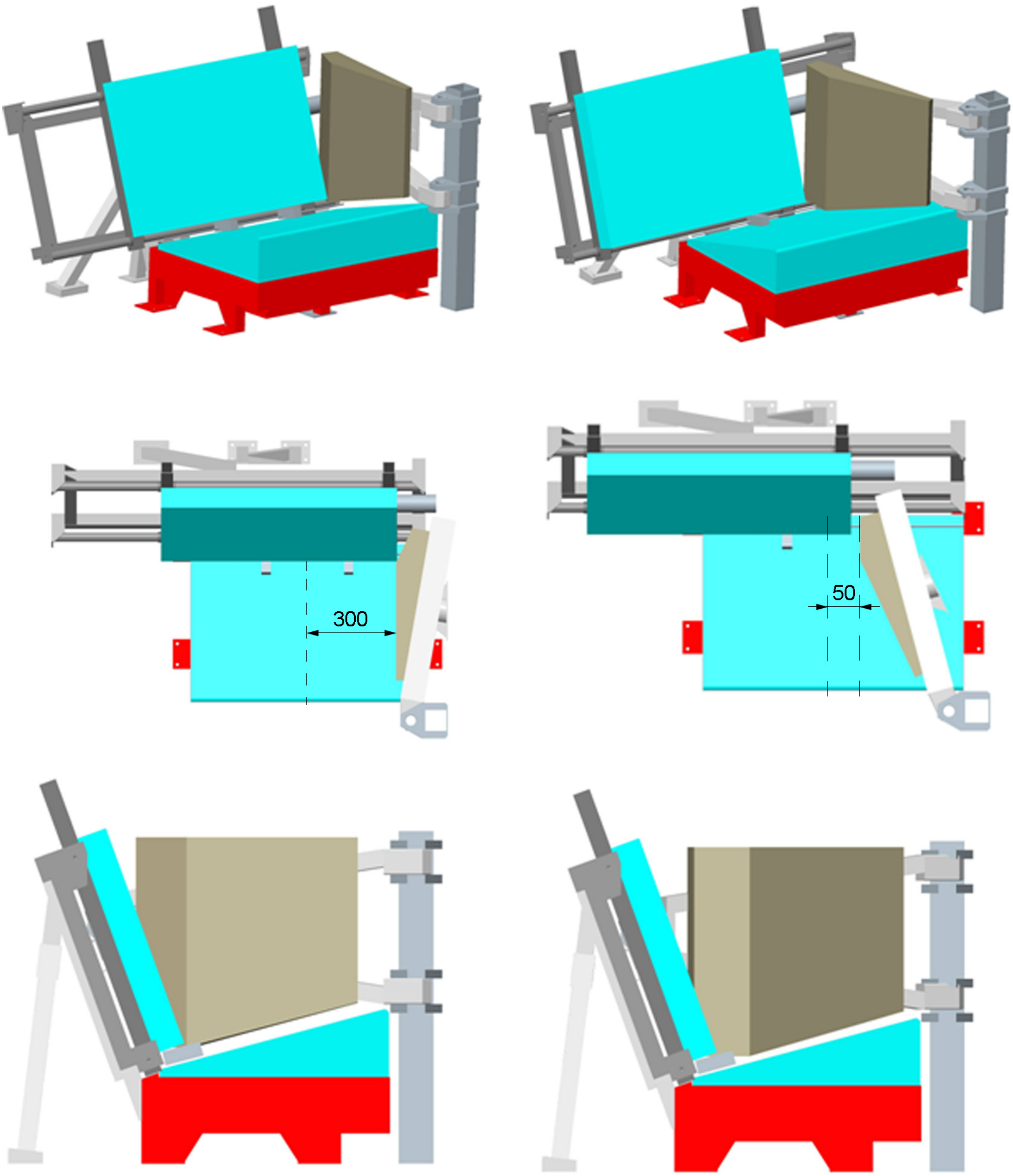


Key

1 sled
2 ECE R.44 test bench cushion
3 ECE R.44 test bench backrest
4 CRS centreline
5 hinged panel (principle)
6 hinge
7 inner panel plane
8 travel direction of a deceleration sled (opposite direction for an acceleration device)

Figure 4 — Test configuration of a forward-facing CRS, with ECE Regulation No. 44 bench prepared for side impact testing

Dimensions in millimetres



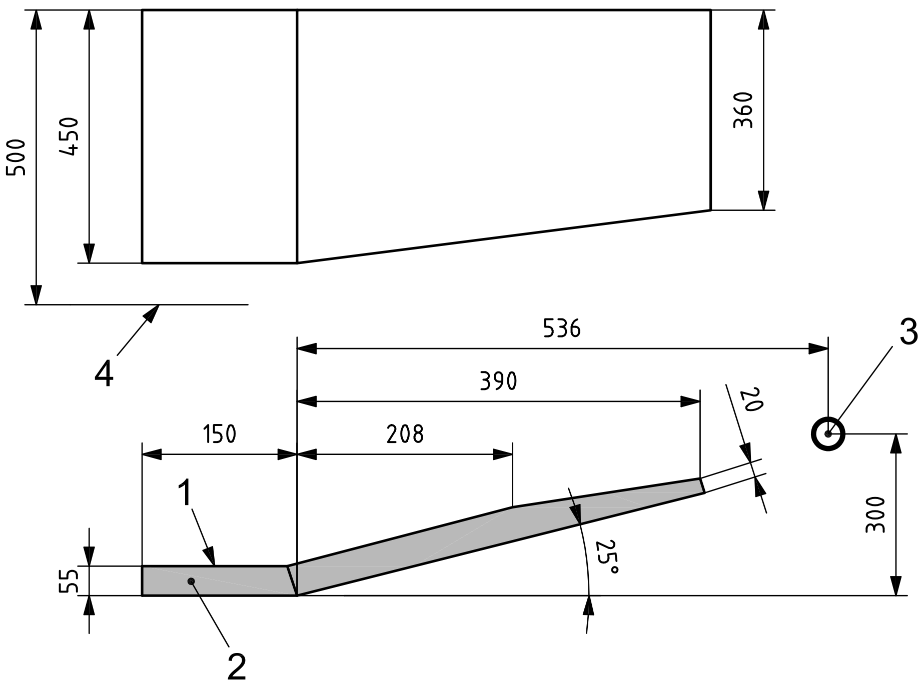
Initial panel position (front, top, side)

Panel position in maximum intrusion (front, top, side)

NOTE Figure 5 shows one possible solution for realization of the set-up for visualization of the intrusion by the hinged panel.

Figure 5 — Seat bench construction with hinged panel for testing of a forward-facing CRS

Dimensions in millimetres



Key

1 panel structure (not shown)

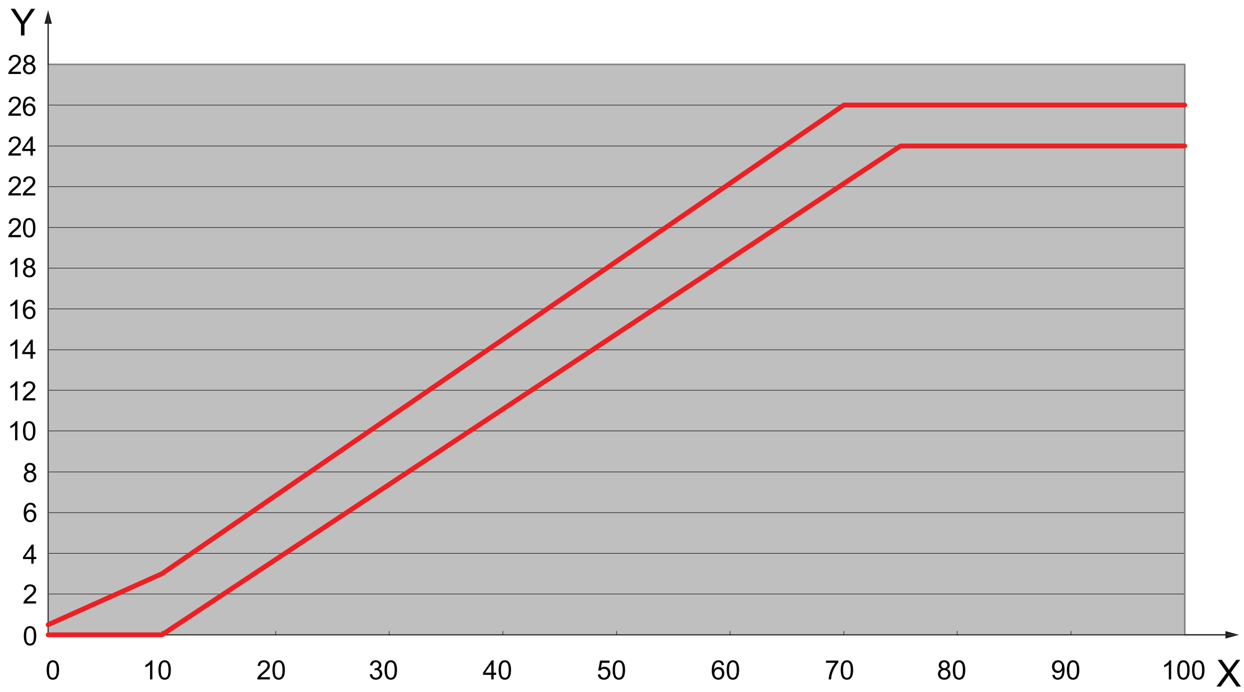
2 padding material in accordance with Annex B, thickness from 20 mm to 55 mm

3 hinge position

4 CR point base line

NOTE For markets where armrest structures are common, the addition of an optional armrest simulation could be considered.

Figure 6 — Dimensions of a hinged panel and padding for testing of a forward-facing CRS



Key

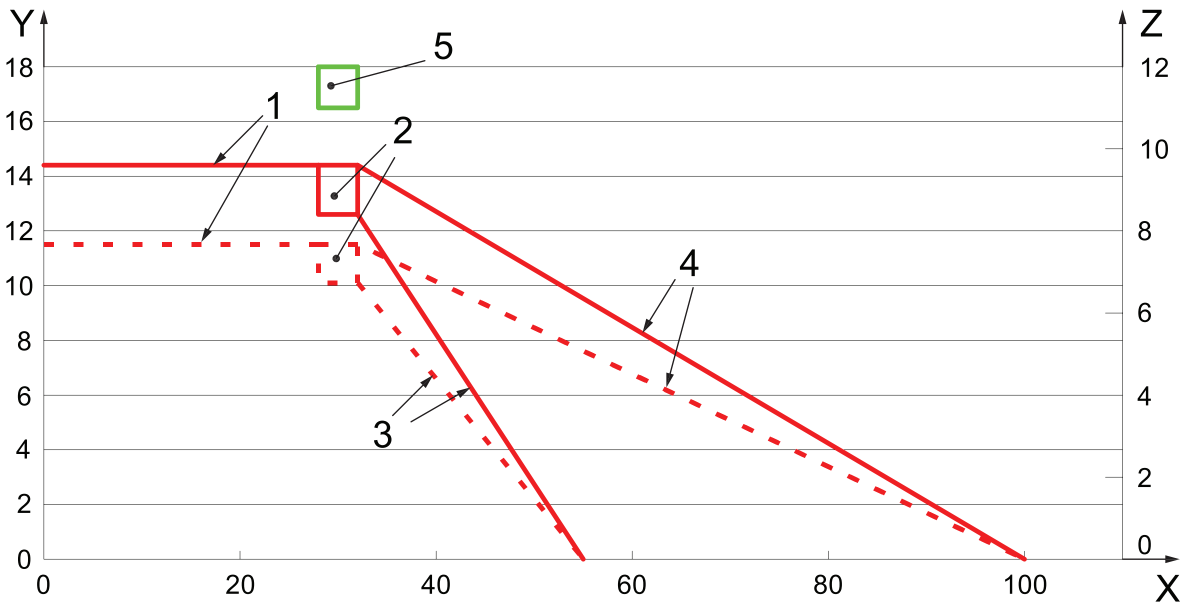
X time in milliseconds

Y Δv in kilometres per hour

Figure 7 — Sled velocity change corridor

Table 1 — Sled velocity change corridor limits

Time ms	**Lower limit** km/h	**Upper limit** km/h
0	0	0,5
10	0	3
70		26
75	24	
100	24	26



Key

X time in milliseconds

Y angular velocity in radians per second

Z angle in degrees

1 angular velocity boundary line before 28 ms

2 defined angular velocity rectangle (12,6 rad/s to 14,4 rad/s at 28 ms to 32 ms or 10,1 to 11,5 rad/s)

3 angular velocity lower boundary line after 32 ms

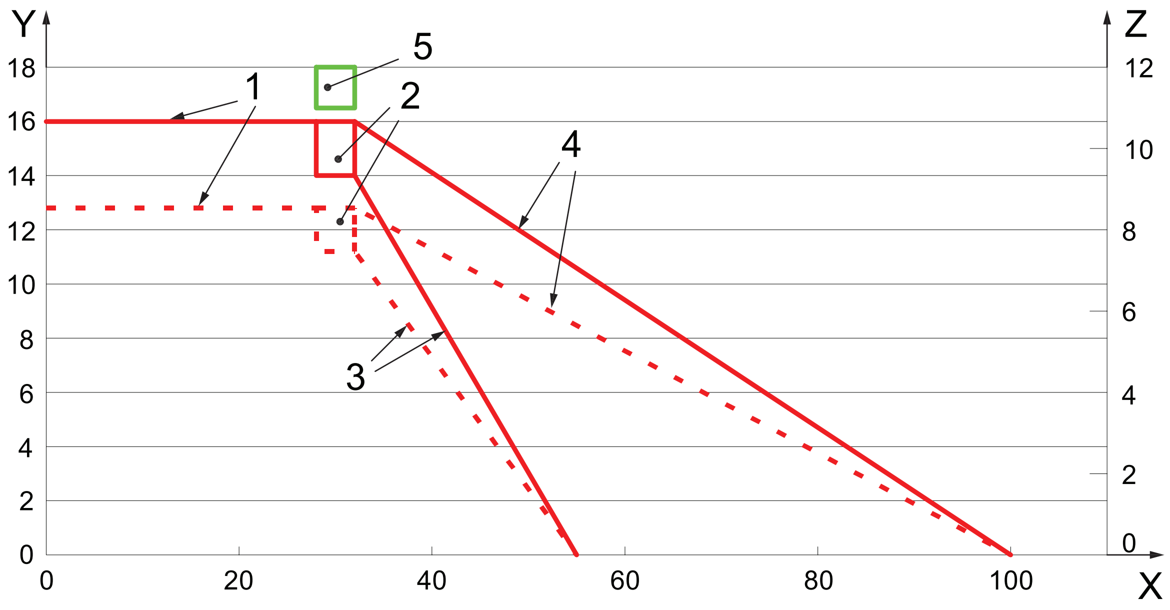
4 angular velocity upper boundary line after 32 ms

5 defined angle rectangle (17° to 18° at 28 ms to 32 ms)

The angular velocity curve shall pass through the defined angular velocity rectangle. It shall be kept below the upper boundary line. The angle curve shall pass through the defined angle rectangle.

NOTE The aim of the angular velocity is to reproduce a maximum linear velocity of 7 m/s to 10 m/s in the area of the dummy's head as recognised in barrier-to-car tests. For rearward-facing CRS the distance of the head to the hinge line is approximately 750 mm. This would require an angular velocity of approximately 9 rad/s to 13 rad/s.

Figure 8 — Angular velocity and angle specifications for rearward-facing child restraints



Key

X time in milliseconds

Y angular velocity in radians per millisecond

Z angle in degrees

1 angular velocity boundary line before 28 ms

2 defined angular velocity rectangle (14 rad/s to 16 rad/s at 28 ms to 32 ms or 11,2 rad/s to 12,8 rad/s)

3 angular velocity lower boundary line after 32 ms

4 angular velocity upper boundary line after 32 ms

5 defined angle rectangle (17° –18° at 28-32 ms)

The angular velocity curve shall pass through the defined angular velocity rectangle. It shall be kept below the boundary line. The angle curve shall pass through the defined angle rectangle.

NOTE The aim of the angular velocity is to reproduce a maximum linear velocity of 7 m/s to 10 m/s in the area of the dummy's head as recognised in barrier-to-car tests. For forward-facing CRS the distance of the head to the hinge line is approximately 600 mm. This would require an angular velocity of approximately 11,5 rad/s to 16,5 rad/s.

Figure 9 — Angular velocity and angle specifications for forward-facing child restraints

Annex A
(normative)

Further specifications and instructions for systems attached with belts

The standard safety belt installation shall be in accordance with the latest version of ECE Regulation No. 44, Annex 13.

However, in contrast to ECE Regulation No. 44 the pillar loop is not used. Instead of the pillar loop the retractor is positioned at point “P”.

The dynamic crash test installation shall be in accordance with the latest version of ECE Regulation No. 44, Annex 21.

NOTE ECE Regulation No. 44 can be downloaded at: http://www.unece.org/trans/main/wp29/wp29regs.html.

Annex B
(normative)

Panel padding specification

B.1 General

The door panel is padded with 55 mm of padding material, which shall comply with the performance criteria as described in Clause B.3 and realized in a test set up as described in Clause B.2. An example for material meeting the requirements is described in Clause B.4.

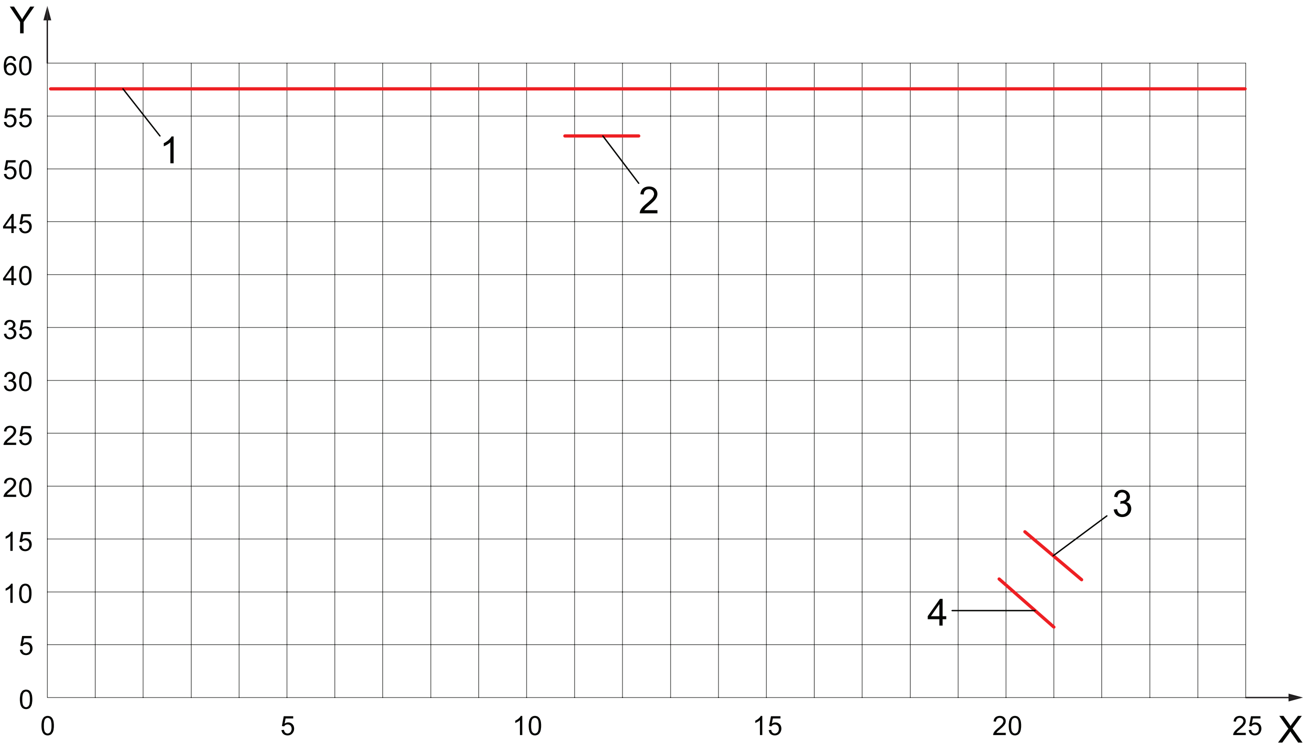
B.2 Test procedure for the assessment of panel padding material

The test set up consists of a simple drop test using a spherical head form. The spherical head form has a diameter of 150 mm and a mass of 6 kg (± 0,1 kg). The impact speed is 4 m/s (± 0,1 m/s). The instrumentation should allow the assessment of the time of first contact between the impactor and the sample as well as the head form acceleration at least in direction of impact (Z-direction).

The material sample should have the dimensions of 400 mm × 400 mm. The sample should be impacted in its centre.

B.3 Performance criteria for the padding material

The time of first contact between sample material and head form, t_0, is 0 ms. The specification for the acceleration-time characteristics is shown in Figure B.1.



Key

X time in milliseconds

Y acceleration represented by g force

1 upper limit of 58 g

2 lower limit for the maximum peak at 53 g (11 ms to 12 ms)

3 upper limit for the decline of acceleration (15 g at 20,5 ms to 10 g at 21,5 ms)

4 lower limit for the decline of acceleration (10 g at 20 ms to 7 g at 21 ms)

Figure B.1 — Corridor for the padding material

B.4 Example of material meeting the test requirements

Using 35 mm rubber cell foam Polychloropren CR4271 at the side of the panel structure and 20 mm Styrodur C2000 on top guarantees the above requirements to be met. The Styrodur needs to be replaced after each test.

Bibliography

[1] ISO 7862, *Road vehicles — Sled test procedure for the evaluation of adult restraint systems in simulation of frontal collisions*

[2] ISO/TR 13214, *Road vehicles — Child restraint systems — Compilation of regulations and standards*

[3] ECE Regulation No.95, *Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a lateral collision*

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