
Wheelchairs —

Part 19:

**Wheeled mobility devices for use in motor
vehicles**

Fauteuils roulants —

*Partie 19: Dispositifs de mobilité montés sur roues et destinés à être
utilisés dans des véhicules à moteur*



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

STANDARDSISO.COM : Click to view the full PDF of ISO 7176-19:2001

© ISO 2001

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword.....	iv
Introduction.....	vi
1 Scope	1
2 Normative references	1
3 Terms, definitions and abbreviations	2
4 Design requirements	6
5 Performance requirements	8
6 Identification, labelling, user instructions, warning and disclosure requirements	11
7 Test report	15
Annex A (normative) Test method for frontal impact test	16
Annex B (normative) Specifications for four-point strap-type securement points on wheelchairs	22
Annex C (normative) Test methods for accessibility to four-point strap-type securement points with hook end-fittings	24
Annex D (informative) Draft test methods for scoring and rating accommodation of vehicle-anchored belt restraints	27
Annex E (informative) Guidelines for surrogate tiedown devices	30
Bibliography	31

STANDARDSISO.COM : Click to view the full PDF of ISO 7176-19:2001

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 3.

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 part of ISO 7176 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 7176-19 was prepared by Technical Committee ISO/TC 173, *Technical systems and aids for disabled or handicapped persons*, Subcommittee SC 1, *Wheelchairs*.

ISO 7176 consists of the following parts, under the general title *Wheelchairs*:

- *Part 1: Determination of static stability*
- *Part 2: Determination of dynamic stability of electric wheelchairs*
- *Part 3: Determination of effectiveness of brakes*
- *Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range*
- *Part 5: Determination of overall dimensions, mass and turning space*
- *Part 6: Determination of maximum speed, acceleration and deceleration of electric wheelchairs*
- *Part 7: Measurement of seating and wheel dimensions*
- *Part 8: Requirements and test methods for static, impact and fatigue strengths*
- *Part 9: Climatic tests for electric wheelchairs*
- *Part 10: Determination of obstacle-climbing ability of electric wheelchairs*
- *Part 11: Test dummies*
- *Part 13: Determination of coefficient of friction of test surfaces*
- *Part 14: Power and control systems for electric wheelchairs — Requirements and test methods*
- *Part 15: Requirements for information disclosure, documentation and labelling*
- *Part 16: Resistance to ignition of upholstered parts — Requirements and test methods*
- *Part 22: Set-up procedures*

The following parts are also on the work programme:

- *Part 19: Wheeled mobility devices for use in motor vehicles*
- *Part 21: Electromagnetic compatibility of electrically powered wheelchairs and motorized scooters — Requirements and test methods*
- *Part 23: Requirements and test methods for attendant-operated stair-climbing devices*
- *Part 24: User-operated stair-climbing devices — Requirements and test methods*
- *Part 25: Requirements and test methods for batteries and their chargers for powered wheelchairs and motorized scooters*

Annexes A to C form a normative part of this part of ISO 7176. Annexes D and E are for information only.

STANDARDSISO.COM : Click to view the full PDF of ISO 7176-19:2001

Introduction

Transportation safety research has verified that the design of the vehicle seat, as well as the occupant restraints and occupant compartment in motor vehicles, can play a vital role in reducing the severity of injury during a collision. People with disabilities must often remain in their wheelchairs whilst travelling in motor vehicles as drivers or passengers. Since most wheelchairs were not designed with this purpose in mind, the majority of wheelchair users have a lower level of travel safety when seated in their wheelchairs in a moving motor vehicle. Also, if wheelchairs can be adequately secured in vehicles, the safety of other passengers is enhanced in the case of a vehicle collision.

This part of ISO 7176 sets out the design, performance requirements and associated test methods for wheelchairs that are intended for use as a seat in a motor vehicle. The ISO 10542 series for wheelchair tiedown and occupant restraint systems provides performance requirements and test methods for the equipment necessary to secure a wheelchair and provide restraint for the wheelchair occupant.

The dynamic test requirements specified in this part of ISO 7176 are representative of conditions that occur in a 48 km/h frontal vehicle impact with a wheelchair forward facing. Dynamic performance of rearward facing wheelchairs in a frontal impact, and of occupied wheelchairs in rear, side or rollover crashes, may be addressed in future international standards. Wheelchair impact testing using surrogate wheelchair tiedowns that are representative of different types of commercial tiedowns may also be addressed in future international standards (see annex E).

This part of ISO 7176 was developed with the recognition that a wheelchair may be secured by various types of wheelchair tiedown systems which use different numbers and types of wheelchair securement points and different types of anchorages. Effective wheelchair securement in the real world requires compatibility of the wheelchair securement available in transportation vehicles and the method of securement provided on the wheelchair. When this part of ISO 7176 was developed, there was a large variety of securement systems in use throughout the world. Of these, the four-point strap-type tiedown was considered to be the most widely used generic securement method. The requirements of this part of ISO 7176 are also based on well-documented motor vehicle crash statistics, which clearly indicate that more than fifty per cent of all serious injuries occur in a frontal crash.

For these reasons, this part of ISO 7176 requires that a wheelchair provides for effective securement in a frontal impact using the four-point strap-type securement system. Thus, a wheelchair shall provide four securement points, as a minimum, and be dynamically tested when secured by these points, using a four-point strap-type tiedown system. In addition, this part of ISO 7176 allows for the provision and testing of other methods of securement, such as clamping or docking systems.

Whilst the four-point strap-type tiedown system has proven to be applicable for a wide range of wheelchairs, it is a tiedown method that cannot be implemented independently by the wheelchair occupant, and therefore requires involvement by a second person. Accordingly, it is desirable to progress towards a securement method that can be implemented independently by the wheelchair-seated passenger. Work has commenced within ISO/TC 173 SC 1 to specify the requirements for a universal interface device (UID) that will facilitate the independent securement of wheelchairs by docking-type securement devices.

This part of ISO 7176 has also been developed with the recognition that use of a pelvic belt alone as an occupant restraint does not provide the wheelchair occupant with the same level of crash protection in a frontal impact as does the use of both a pelvic and an upper torso restraint. Therefore, the provisions and test methods of this part of ISO 7176 are based on the use of both pelvic and upper torso belt-type restraints.

This part of ISO 7176 should be viewed in the totality of daily wheelchair use and the range of standards to which all wheelchairs are expected to comply. The primary objective of wheelchairs is to serve as effective mobility devices and, in that respect, they shall first comply with the applicable requirements as set out in the other parts of the ISO 7176 series. Transportation is, in fact, only one of many daily activities that introduce unique circumstances and requirements that wheelchairs and wheelchair occupants may experience. Wheelchair products complying with this part of ISO 7176 will have additional features that provide increased levels of occupant security and safety whilst their occupants are riding in a motor vehicle. However, a wheelchair's failure to comply with the provisions of this part of ISO 7176 should not be used to limit access to, and availability of, motor vehicle transportation for wheelchair users.

STANDARDSISO.COM : Click to view the full PDF of ISO 7176-19:2001

Wheelchairs —

Part 19: Wheeled mobility devices for use in motor vehicles

1 Scope

This part of ISO 7176 specifies wheelchair design and performance requirements and associated test methods, as well as requirements for wheelchair labelling, presale literature disclosure, user instructions and user warnings. These requirements are applicable to wheelchairs that are designed to be secured by any type of wheelchair tiedown in accordance with ISO 10542-1 and any other applicable parts of the ISO 10542 series.

This part of ISO 7176 applies to all manual and powered wheelchairs, including scooters, which, in addition to their intended function as mobility devices, are also intended for use as forward-facing seating by adult occupants of motor vehicles. It also applies to wheelchairs with add-on components designed to meet one or more of the requirements of this part of ISO 7176.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 7176. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 7176 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3795, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*

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

ISO 7176-15, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling*

ISO 10542-1, *Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint systems — Part 1: Requirements and test methods for all systems*

ISO 10542-2, *Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint systems — Part 2: Four-point strap-type tiedown systems*

FMVSS 20949 CFR part 571.209; Seat Belt Assemblies; Oct. 1, 1992

ECE R 16, *Uniform provisions concerning the approval of safety belts and restraint systems for adult occupants of power-driven vehicles*, revision 3, amendment 2, 16 August 1993

3 Terms, definitions and abbreviations

For the purposes of this part of ISO 7176, the following terms, definitions and abbreviations apply.

3.1

add-on components

hardware that is attached to the wheelchair frame subsequent to sale by the wheelchair manufacturer, in a manner that requires the use of tools for removal, in order to enhance the design and/or performance of the wheelchair

3.2

adult

person having a mass greater than 36 kg

3.3

anchor point

point (area) on a vehicle interior component, floor, wall, wheelchair or wheelchair tiedown, to which an anchorage is attached

3.4

anchorage

assembly of components and fittings by which loads are transferred directly from the wheelchair tiedown to the vehicle, or from the occupant restraint to the vehicle, wheelchair, wheelchair tiedown, or vehicle interior component

3.5

anthropomorphic test device¹⁾

ATD

articulated physical analogue of a midsize male used to represent a wheelchair occupant in a test

3.6

belt

length of webbing material used as part of an occupant restraint or postural support

3.7

clamp-type tiedown

method of wheelchair securement or tiedown that uses mechanical linkages and/or grips that require manual positioning of the end-fittings on the wheelchair

NOTE Tightening of the tiedown on the wheelchair may be either by manual effort or by an external power source that is operated by an electrical switch.

3.8

docking-type tiedown

method of wheelchair securement by which portions of the wheelchair, or add-on components fastened to the wheelchair, align and mate with anchorages fastened to the vehicle upon movement of the wheelchair into position in the vehicle

NOTE 1 Lockdown of the wheelchair may occur automatically during wheelchair engagement, or may require manual intervention through operation of a mechanical lever or electrical switch.

NOTE 2 Release of the wheelchair may require operation of a mechanical lever or an electrical switch.

3.9

excursion

horizontal movement of an ATD or wheelchair target relative to its initial position on an impact sled during a test

1) Hybrid II and Hybrid III ATDS can be purchased from: First Technology Safety Systems, Inc., Plymouth, Michigan, USA and Vector Research, Inc., Milan, Ohio, USA.

3.10**forward-facing**

orientation in which the wheelchair-seated occupant faces the front of the vehicle with the wheelchair reference plane within ten degrees of the longitudinal axis of the vehicle

3.11**four-point tiedown**

wheelchair tiedown system that attaches to the wheelchair frame at four separate securement points and also attaches to the vehicle at four separate anchor points

3.12**four-point strap-type tiedown**

four-point tiedown that uses four strap assemblies to secure the wheelchair in the vehicle

3.13***g***

abbreviation for acceleration due to gravity measured at sea level: one *g* is equal to 9,8 ms⁻²

NOTE The term is used to specify the levels of accelerations and/or decelerations in simulation impact testing.

3.14**H-point**

point located on the left and right sides of the pelvic region of an anthropomorphic test device (ATD) that represents the approximate locations of the human hip joint centres in the side views, as specified by the ATD manufacturer

3.15**head restraint**

device intended to limit rearward displacement of the wheelchair occupant's head

3.16**impact simulator**

device for accelerating, decelerating, or a combination of decelerating and accelerating, a section of a vehicle or simulated vehicle structures, including instrumentation for measuring data required by this part of ISO 7176

3.17**impact sled**

part of an impact simulator on which components can be mounted for impact testing

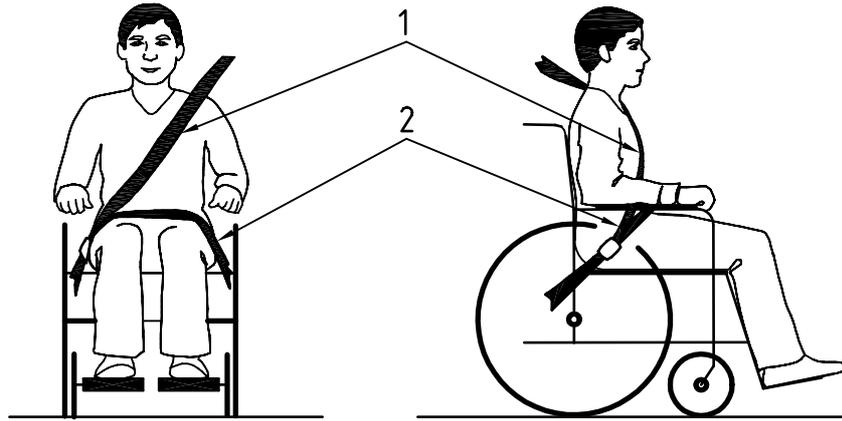
3.18**occupant restraint**

system or device intended to restrain a motor-vehicle occupant during an impact in order to prevent ejection, and prevent or minimize contact with the vehicle interior components and other occupants

3.19**pelvic restraint****pelvic belt****lap belt****lap restraint****lower torso restraint**

belt restraint assembly intended to limit movement of the pelvis

NOTE See Figure 1.



Key

- 1 Diagonal shoulder belt
- 2 Pelvic belt

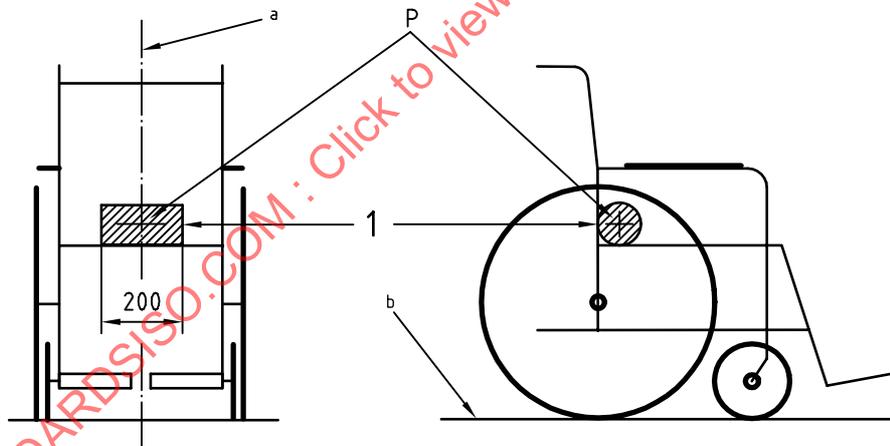
NOTE Use of a pelvic belt alone is not recommended in transport.

Figure 1 — Pelvic and upper torso belt

**3.20
point P**

reference point that lies at the cross-sectional centre of a 100 mm diameter, 200 mm long, lightweight (max. 0,5 kg) cylinder positioned with the longitudinal axis perpendicular to the wheelchair reference plane, such that the curved surface of the cylinder contacts with the backrest and the upper surface of the seat

NOTE See Figure 2.



Key

- 1 Cylinder, diameter 100 mm
- a Wheelchair reference plane
- b Wheelchair ground plane

Figure 2 — Wheelchair reference point P and wheelchair reference plane

**3.21
postural support
postural belt**

component or belt used to support a person in a desired seated position, but not intended to provide occupant-restraint in a vehicle impact

3.22**power(ed)**

systems which are operated by means of an energy source other than manual effort

3.23**securement points**

points on the wheelchair to which wheelchair tiedowns connect

3.24**strap**

length of webbing material used in a wheelchair tiedown

3.25**surrogate tiedown**

wheelchair securement system used during wheelchair testing to simulate commercial tiedown systems

NOTE Guidelines are provided in annex E.

3.26**tilt-in-space**

type of wheelchair seat design that allows the complete seat structure to rotate in the wheelchair reference plane relative to and about an axis located on the wheelchair base

3.27**upper torso restraint****shoulder belt****diagonal belt****diagonal restraint****torso harness**

portion of the occupant restraint intended to limit movement of the chest and head by application of restraint forces to the shoulders and chest

3.28**wheelchair footprint**

space outlined on the horizontal wheelchair ground plane by projecting vertically down from the outermost edges of the structural members that comprise the mobile base and seat of the wheelchair

3.29**wheelchair ground plane**

plane representing the surface on which the wheelchair rests

NOTE See Figure 2.

3.30**wheelchair reference plane**

vertical plane in longitudinal centreline of the wheelchair

NOTE See Figure 2.

3.31**wheelchair tiedown****wheelchair securement**

device or system designed to secure a forward-facing wheelchair in place in a motor vehicle

NOTE The vehicle-anchored tiedown component may be installed using either permanent fasteners or by using a mechanical coupling that allows for position adjustment for different wheelchairs.

3.32**wheelchair tiedown and occupant-restraint system****WTORS**

complete restraint system for wheelchair-seated occupants comprised of equipment for wheelchair tiedown and a belt-type occupant restraint

4 Design requirements

4.1 Wheelchair securement

The wheelchair shall be designed to:

- provide for forward-facing securement in a motor vehicle by one or more types of wheelchair tiedown systems in accordance with ISO 10542;
- have a minimum of four securement points, two at the front and two at the rear, in accordance with the specifications in annex B.

4.2 Occupant restraints

Wheelchairs may be provided with wheelchair-anchored occupant-restraint belts, or be designed to accommodate vehicle or tiedown-anchored occupant-restraint belts, or both.

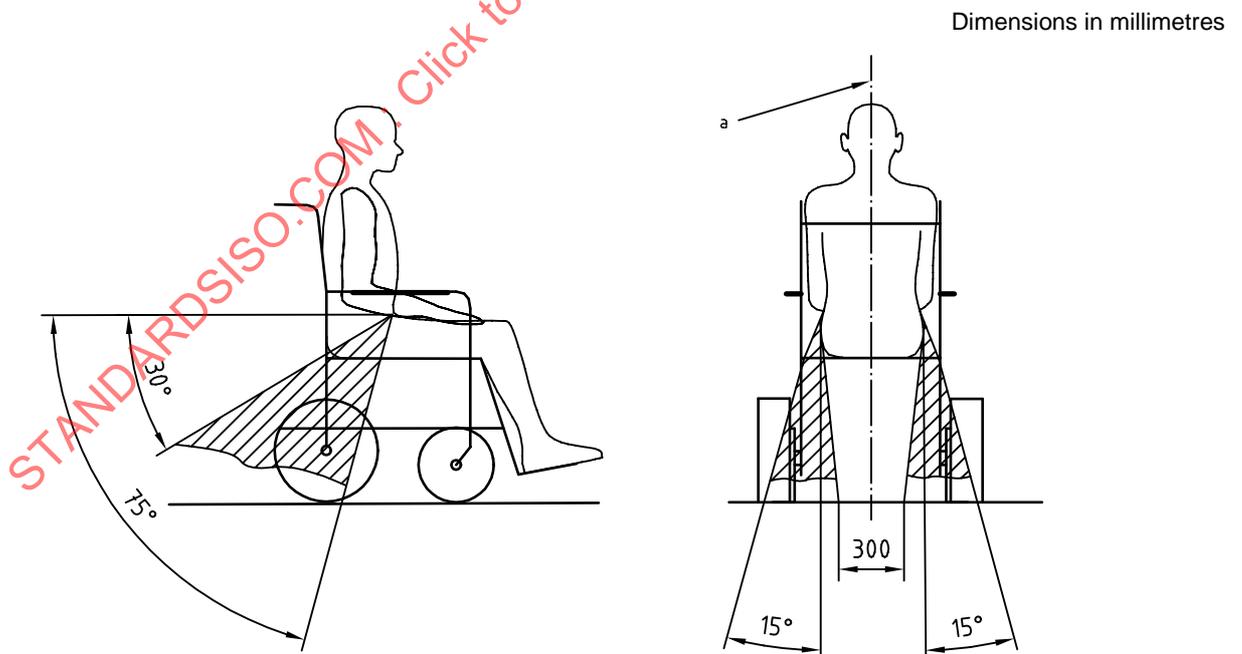
4.2.1 Wheelchair-anchored pelvic belt

If a wheelchair-anchored pelvic belt, intended for use as an occupant restraint in a vehicle, is provided as part of the wheelchair, it shall:

- have its anchor point located so that the projected side-view angle of the belt is between 30° and 75° to the horizontal, as indicated in Figure 3, when placed snugly on the ATD used in the frontal impact test of annex A;

NOTE A steeper (larger) pelvic-belt angle within the zone shown in Figure 3 is desirable.

- provide for a range of adjustment of the pelvic restraint that allows for increasing and decreasing the total belt length by 200 mm from the nominal set-up conditions, with at least 25 mm of webbing extending through any fitting where adjustment takes place.
- produce rear-view projected angles of the pelvic belt within the zones shown in Figure 3.



a Wheelchair reference plane

NOTE Angles indicated are obtained by projecting the angle of the pelvic belt onto a vertical plane that is parallel to (side view) or perpendicular to (rear view) the wheelchair reference plane.

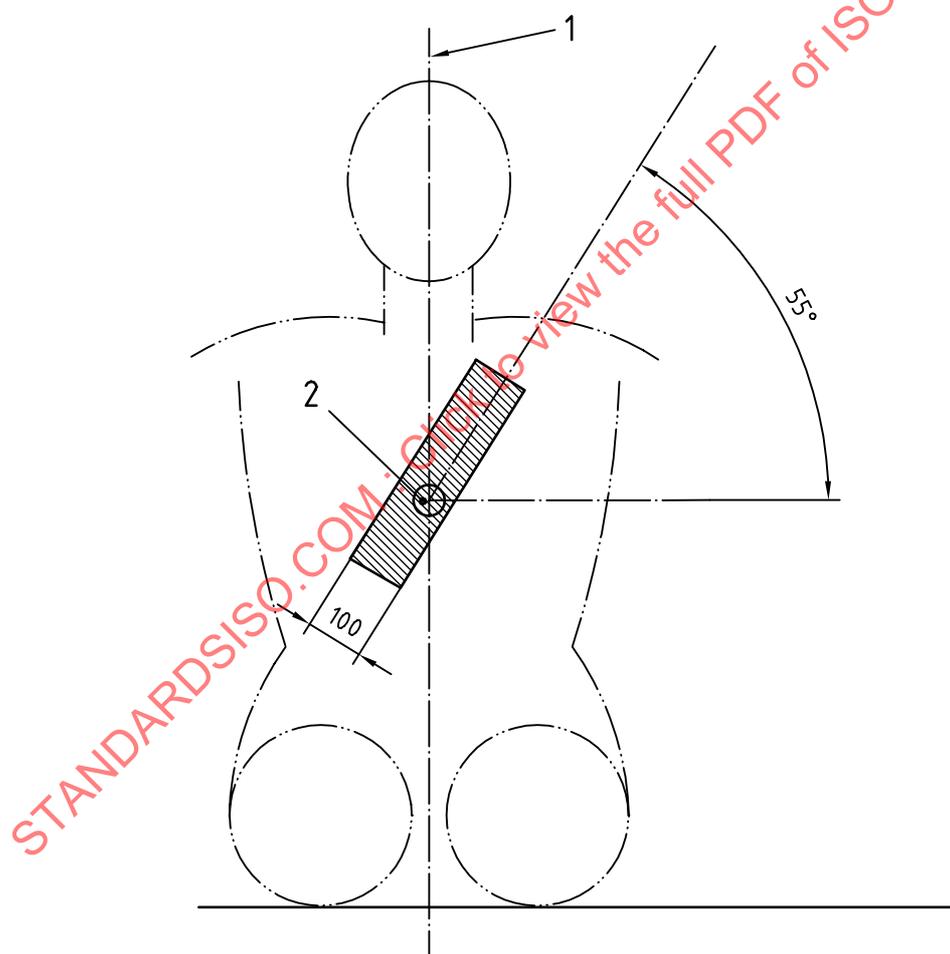
Figure 3 — Range of required angles of wheelchair-anchored pelvic belts when installed on the appropriate-size ATD used in the test of annex A

4.2.2 Wheelchair-anchored shoulder belt

If a wheelchair-anchored shoulder belt, intended for use as an occupant restraint in a vehicle, is provided as part of the wheelchair, it shall be designed to:

- fit over the shoulder and across the chest of the ATD used in the test of annex A, and as illustrated in Figure 4;
- have an upper anchor point or upper guide point at, or above, the shoulder of the ATD used in the test of annex A;
- provide for a range of adjustment in the upper-torso restraint that allows for increasing the length by 200 mm, and shortening the length by 300 mm, from the nominal set-up conditions, as defined by the ATD set-up in annex A (A.4.7 to A.4.10), with at least 25 mm of webbing extending through any fitting where adjustment takes place;
- have the junction of the shoulder and pelvic belts of three-point belt restraints located not less than 150 mm from the ATD centreline.

Dimensions in millimetres



Key

- Centreline
- Centre of sternum

Figure 4 — Location of shoulder belt on occupant's torso

4.2.3 Accommodation of vehicle or tiedown-anchored occupant belt restraints

Wheelchairs should be designed to enhance the effectiveness of belt-type occupant-restraint systems. If the wheelchair is intended for use with either vehicle or tiedown-anchored occupant restraints, it should be designed to allow the unobstructed fitting of the restraint belts to the occupant.

NOTE Annex D contains draft test methods and performance criteria for rating a wheelchair with regard to accommodating vehicle or tiedown-anchored belt restraints. These test methods and disclosure requirements, with modifications based on experience of use, will be considered for addition as a requirement in future versions of this part of ISO 7176.

5 Performance requirements

5.1 Wheelchair-anchored belt restraints

- a) All webbing, metal parts, buckles, release mechanisms and adjustment mechanisms of wheelchair-anchored belt restraints shall conform with applicable subsections of either ECE Regulation No.16, and/or FMVSS 209, as indicated in Tables 1 and 2, respectively, or as specified in equivalent mutually recognized regulations.
- b) All webbing of wheelchair-anchored belt restraints and postural belts shall have a burning rate not exceeding 100 mm/min when tested as specified in ISO 3795.

Table 1 — Applicable subsections of ECE regulation No. 16

Section	Component	Subject	ECE No.16 tests referenced
6.2.1.1	rigid parts	sharp edges	—
6.2.1.2	rigid parts	corrosion	7.2
6.2.1.4	rigid parts	cold impact test	7.5.4
6.2.2.1	buckles	correct use and size	—
6.2.2.2	buckles	closing/releasing	7.8.2
6.2.2.3	buckles	cold mating	7.5.3
6.2.2.4	buckles	repeated testing	7.7
6.2.3.2	adjustment devices	micro-slip	7.3
6.2.3.4	belt adjusting device	force	7.5.6
6.2.5	various belt retractors	performance	7.2, 7.6.1 - 7.6.4
6.2.6	preloading devices	performance	7.2, 7.9.2
6.3.1	belts	general specifications	—
6.3.2	belts	strength	7.4.1.1, 7.4.2
6.3.3	belts	strength	7.4.1, 7.4.2
6.4.2	belts	strength	7.4.1.6, 7.4.2, 7.5

Table 2 — Applicable subsections of FMVSS 209

Section	Component	Subject	FMVSS 209 tests referenced
S4.1 (d)	hardware	burrs and sharp edges	—
S4.1 (e)	release mechanism	design	—
S4.1 (h)	webbing	unravelling	—
S4.2 (a)	webbing	belt width	S5.1(a)
S4.2 (b)	webbing	breaking strength	S5.1(b)
S4.2 (c)	webbing	elongation	S5.1(c)
S4.2 (d)	webbing	abrasion resistance	S5.1(d), S5.3(c)
S4.2 (e)	webbing	light resistance	S5.1(e)
S4.2 (h)	webbing	stain resistance	S5.1(h)
S4.3 (a)	hardware	corrosion resistance	S5.2(a)
S4.3 (b)	hardware	temperature resistance	S5.2(b)
S4.3 (d)	buckle release	release force	S5.2(d)
S4.3 (e)	adjustment device	adjustment force	S5.2(e)
S4.3 (f)	tilt-lock devices	locking angles	S5.2(f)
S4.3 (g)	buckle latch	separation force	S5.2(g)
S4.3 (i)	belt retractor	performance	S5.2(i)
S4.3 (j)	belt retractor	performance	S5.2(j)
S4.3(k)	belt retractor	performance	S5.2(k), S4.4
S4.4 (a)	pelvic restraints	performance	S5.3(a)
S4.4 (b)	3-pt restraints	performance	S5.3(b)

5.2 Frontal impact

The wheelchair shall be tested in accordance with annex A using a four-point strap-type tiedown in accordance with ISO 10542-2. It may also be tested using other methods of securement.

The requirements in 5.2.1 and 5.2.2 shall be met during and after each test conducted.

5.2.1 During the test

- a) The horizontal excursions of the ATD and the wheelchair with respect to the impact sled shall not exceed the limits shown in Table 3.
- b) The knee excursion shall exceed the wheelchair point P excursion as follows:

$$X_{\text{knee}} / X_{\text{wc}} \geq 1,1$$

NOTE Compliance with this requirement reduces the potential for the wheelchair to apply large horizontal loads to the wheelchair occupant.

Table 3 — Horizontal excursion limits (mm)

Measurement point	Excursion variable	Excursion limits
Wheelchair point P	X_{wc}	200
ATD knee	X_{knee}	375
ATD front of head	X_{headF}	650
ATD rear of head	X_{headR}	400

where

X_{wc} is the horizontal distance relative to the sled platform between the contrast target placed at or near point P on the test wheelchair at time t_0 and the point P target at the time of peak wheelchair excursion;

X_{knee} is the horizontal distance relative to the sled platform between the ATD knee-joint target at time t_0 and the knee joint target at the time of peak knee excursion;

X_{headF} is the horizontal distance relative to the sled platform between the most forward point on the ATD's head above the nose at time t_0 and the most forward point on the dummy's head at the time of peak forward head excursion; and

X_{headR} is the horizontal distance relative to the sled platform between the most rearward point on the ATD's head at time t_0 and the most rearward point on the dummy's head at the time of peak rearward head excursion.

c) Batteries of powered wheelchairs, or their surrogate replacement parts shall:

- not move completely outside the wheelchair footprint;
- not move into the wheelchair user's space (e.g. shall not contact the back of the ATD's legs).

5.2.2 After the test

- a) The wheelchair shall remain in an upright position on the test platform and the ATD shall be retained in the wheelchair in a seated posture, as determined by the ATD torso being oriented at not more than 45° to the vertical when viewed from any direction.
- b) The wheelchair securement points shall not show visible signs of material failure.
- c) Components, fragments or accessories of the wheelchair with a mass in excess of 100 g shall not have completely separated from the wheelchair.
- d) Wheelchair components that may contact the occupant shall not fragment or separate in a manner that produces sharp edges, as defined by having a radius of less than 2 mm.
- e) Primary load carrying components of the wheelchair shall not show visible signs of failure.
- f) Locking mechanisms of tilt-in-space seat adjusters shall not show signs of failure.
- g) Removal of the ATD from the wheelchair shall not require the use of tools.
- h) Release of wheelchair from the tiedown system shall not require the use of tools.
- i) The post-test height of the average of left and right ATD H-points relative to the wheelchair ground plane shall not have decreased by more than 20 % from the pre-test height.

5.3 Accessibility of securement points intended for use with four-point strap-type tiedowns with hook-type end-fittings

When tested in accordance with annex C, each wheelchair securement point intended for use with a four-point strap-type tiedown with hook end-fittings shall:

- a) allow one-handed attachment and engagement of the hook gauge specified in Figure C.2 within a time period of 10 s; and
- b) allow one-handed disengagement and removal of the same hook gauge within a time period of 10 s.

NOTE Securement points should also be provided with sufficient clear space to allow webbing and associated end-fittings of tiedown assemblies without hook end-fittings to be easily inserted and attached or detached.

6 Identification, labelling, user instructions, warning and disclosure requirements

ISO 7176-15 applies with the addition of the following.

6.1 Identification and labelling

- a) The wheelchair and/or its components shall be provided with permanent labels or markings that indicate the location of securement points for four-point strap-type tiedowns, using the symbol in Figure 5, where
 - each symbol has an overall height of at least 12 mm;
 - the line width used to make the symbol is between 10 % and 20 % of the overall symbol height; and
 - the symbol is of sufficient contrast to the background to be visible in normal room lighting from a distance of 1 m.

Dimensions in millimetres

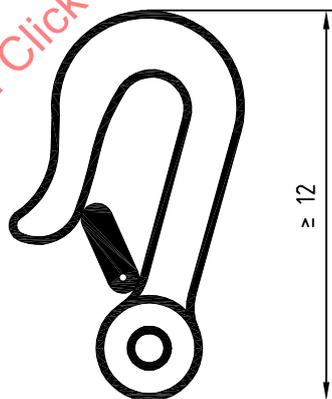


Figure 5 — Symbol required at each four-point strap-type securement point

- b) For wheelchairs intended to provide attachment points for tiedowns in addition to the four-point strap-type, affix appropriate markings and/or wording to indicate the location and type of any additional tiedowns.
- c) Indicate that the wheelchair is in accordance with the requirements specified in ISO 7176/19-20XX.
- d) Indicate that any belt restraints anchored to the wheelchair and intended for use as an occupant restraint in a vehicle by a wheelchair manufacturer conform to ISO 7176/19-20XX.
- e) Indicate that any postural support belts supplied by the wheelchair manufacturer that are not intended to be used as an occupant restraint in a moving vehicle should not be used for that purpose.

6.2 Presale literature

In addition to the requirements in ISO 7176-15, the wheelchair manufacturer's presale literature shall include:

- a) a statement that the wheelchair is designed to be forward-facing when used as a seat in a motor vehicle and that it is in accordance with the requirements specified in ISO 7176/19-20XX;
- b) a description of the types of tiedowns that are suitable for use with the wheelchair (i.e. four-point strap-type, clamp systems, docking system, etc.);
- c) a statement that ease of access to, and manoeuvrability in, motor transit vehicles can be significantly affected by wheelchair size and turning radius, and that smaller wheelchairs and/or wheelchairs with a shorter turning radius will generally provide greater ease of vehicle access and manoeuvrability to a forward-facing position;
- d) a statement of whether the wheelchair provides for, and has been tested with, any wheelchair-anchored occupant restraint belts.

6.3 User and maintenance instructions

User instructions shall be provided with each wheelchair in at least the official languages of the countries in which the wheelchair is marketed.

6.3.1 The user instructions shall include the following statements:

- a) the wheelchair is designed to be forward-facing when used as a seat in a motor vehicle;
- b) the wheelchair is in accordance with the requirements specified in ISO 7176/19-20XX;
- c) wheelchair users should transfer to the vehicle seat and use the vehicle-installed restraint system whenever it is feasible.

6.3.2 The user instructions shall include descriptions of/ information on:

- a) the types of tiedowns that are suitable for use with the wheelchair (i.e., four-point strap-type, clamp systems, specific type of docking system, etc.);
- b) the locations of wheelchair tiedown securement points and the marking used to identify them;
- c) belt-restraint anchor-point locations, if any, and the specifications for anchorage hardware and fasteners that are compatible with the anchor points;
- d) the locations of all wheelchair securement points used in the frontal impact test of annex A, with illustrations;
- e) how the wheelchair is to be secured in a vehicle;
- f) the types of tiedown end-fittings that are compatible with the wheelchair securement points;
- g) the correct positioning of occupant restraint belts on the user, including statements that:
 - the pelvic belt should be worn low across the front of the pelvis, so that the angle of the pelvic belt is within the preferred zone of 30° to 75° to the horizontal, as shown in Figure 3,
 - a steeper (greater) angle within the preferred zone is desirable (see 4.2.1),
 - belt restraints should not be held away from the body by wheelchair components or parts, such as the wheelchair armrests or wheels, along with an illustration similar to that of Figure 6,
 - upper torso belts should fit over the shoulder and across the chest, as illustrated in Figure 4,

- belt restraints should be adjusted as tightly as possible, consistent with user comfort,
 - belt webbing should not be twisted when in use;
- h) the recommended settings for any adjustable parts, including where applicable seat and back rest positions, when the wheelchair is in use in a motor vehicle.

6.3.3 The user instructions shall include illustrations of:

- a) the incorrect placement of belt restraints using Figure 6 as an example, and
- b) the correct placement of belt restraints using Figure 7 as an example.

6.3.4 The user instructions shall include the following statements/warnings in 12-point font or larger:

- a) Whenever possible the occupied wheelchair shall be located in a forward-facing configuration and secured by the tiedowns in accordance with the WTORS manufacturer's instructions.

NOTE 1 Testing to this part of ISO 7176 does not preclude rearward facing wheelchairs being used in appropriate vehicles and circumstances.

NOTE 2 Instructions for use and the performance of rearward facing wheelchairs in a frontal impact and of occupied wheelchairs in rear, side or roll over crashes may be addressed in future International Standards.

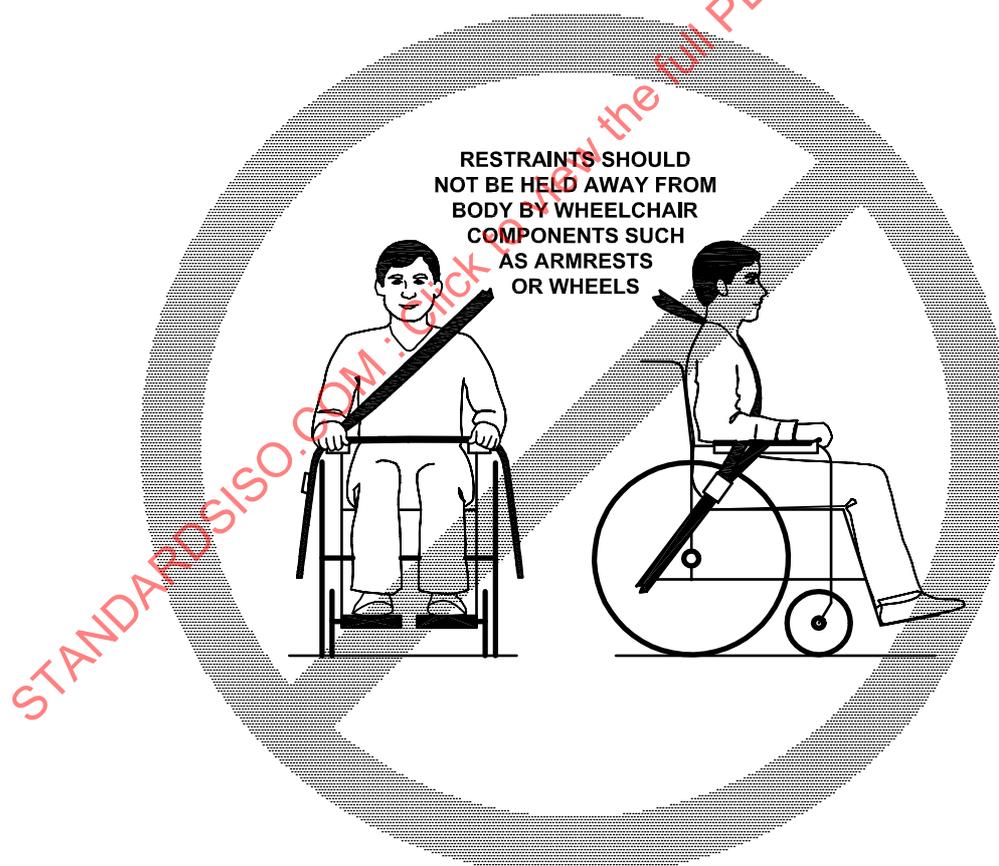


Figure 6 — Illustration of improper belt fit

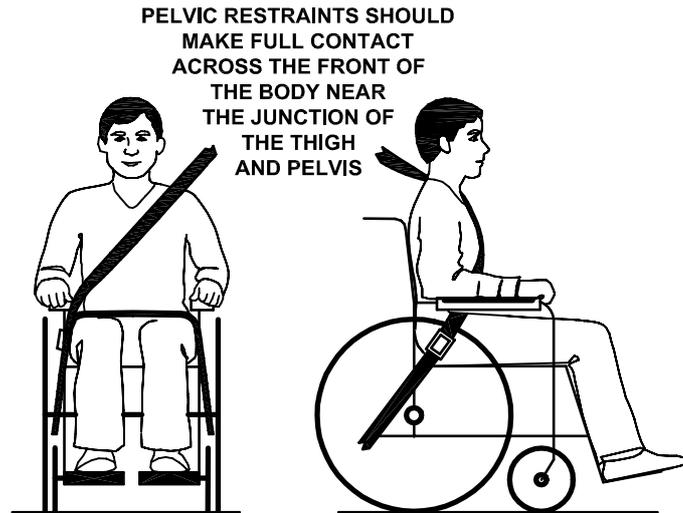


Figure 7 — Illustration of proper belt fit

- b) This wheelchair is suitable for use in vehicles and has met the performance requirements for travelling forwards-facing in frontal impact conditions. Its use in other configurations within a vehicle has not been tested.
- c) The wheelchair has been dynamically tested in a forward-facing orientation with the ATD restrained by both pelvic and upper torso belts.
- d) Both pelvic and upper torso belts should be used to reduce the possibility of head and chest impacts with vehicle components.
- e) In order to reduce the potential of injury to vehicle occupants, wheelchair-mounted trays not specifically designed for crash safety should:
- be removed and secured separately in the vehicle, or
 - be secured to the wheelchair but positioned away from the occupant with energy-absorbing padding placed between the tray and the occupant.
- f) When possible, other auxiliary wheelchair equipment should be either secured to the wheelchair or removed from the wheelchair and secured in the vehicle during transit, so that it does not break free and cause injury to vehicle occupants in the event of a collision.
- g) Postural supports should not be relied on for occupant restraint in a moving vehicle unless they are labelled as being in accordance with the requirements specified in ISO 7176/19-20XX.
- h) The wheelchair should be inspected by a manufacturer's representative before reuse following involvement in any type of vehicle impact.
- i) Alterations or substitutions should not be made to the wheelchair securement points or to structural and frame parts or components without consulting the manufacturer.
- j) Spill-proof sealed batteries, such as "gelled electrolyte", should be installed on powered wheelchairs when used in a motor vehicle.

7 Test report

7.1 The following shall be included in each test report conducted in accordance with this part of ISO 7176:

- a) a reference to this part of ISO 7176;
- b) the name and address of the testing institution;
- c) the date of issue of the test report;
- d) a unique test report number shown on each numbered page;
- e) the manufacturer, product type and designation and serial number of the test wheelchair and the WTORS used;
- f) a photograph of the complete test set-up.

7.2 The test report shall also include:

- a) the measured or calculated value of the test velocity change;
- b) a photograph of the WTORS and wheelchair as set up prior to the test;
- c) a graph of the impact sled deceleration plotted against time superimposed on Figure A.1;
- d) the test results as specified in 5.2;
- e) a statement as to whether or not the wheelchair met the requirements of the clauses listed in (d) above, and any other relevant observations;
- f) the test reports and documentation on file shall also include statements and evidence regarding:
 - whether or not securement points intended for use with four-point, strap-type tiedowns are in accordance with the design requirements specified in clause 4.1,
 - whether or not securement points intended for attachment of four-point strap-type tiedowns are in accordance with the accessibility requirements specified in 5.3,
 - if applicable, whether or not wheelchair-anchored belt restraints are in accordance with the requirements specified in 4.2.1, 4.2.2, 5.1 and 5.2,
 - whether the wheelchair, its components and related literature are in accordance with the labelling requirements specified in clause 6 (6.1, 6.2 and 6.3);
- g) a record of the settings used for adjustable parts, including, where applicable, seat and backrest.

Annex A (normative)

Test method for frontal impact test

A.1 General

The wheelchair and ATD are mounted in a forward-facing configuration on the impact sled of an impact simulator. The wheelchair is secured by a tiedown and the ATD is restrained by an appropriate occupant restraint system. The sled is subjected to a defined deceleration-time pulse in order to achieve a specified horizontal velocity change (ΔV). Observations and measurements are made to determine if the wheelchair can be effectively secured and offers effective occupant restraint under these frontal impact conditions.

A.2 Test sample

An unused complete wheelchair is required for each test conducted.

A.3 Apparatus

A.3.1 Impact simulator and tiedown/restraint equipment

An impact simulator and tiedown/restraint equipment shall be used that includes:

- a) an impact sled equipped with a flat, horizontal, structurally rigid platform on which the wheelchair can be mounted and to which the WTORS can be fastened;
- b) a horizontal track or guide path to provide unidirectional movement of the sled during the impact event;
- c) a means to drive the impact sled through a change in velocity of $48(+2 -0)$ km/h;
- d) a rigid structure attached to the impact sled to which the upper-torso belt can be anchored in the manner and to the geometry specified by the WTORS manufacturer;
- e) a four-point strap-type tiedown and complete upper and lower restraint system that are in accordance with ISO 10542;
- f) if an additional test is to be performed using a different tiedown, once the four-point strap-type test is complete, the tiedown shall conform to the dynamic performance requirements specified in 6.2 of ISO 10542-1;

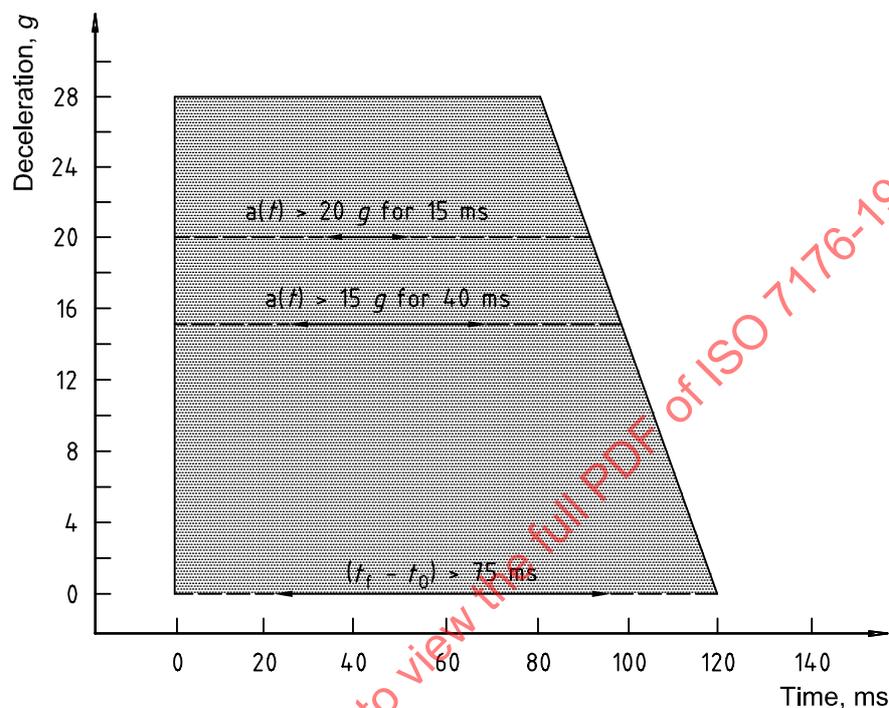
NOTE 1 For wheelchairs with a mass of 85 kg or more, and/or with wheelchair-anchored belt restraints, it is recommended that a surrogate tiedown, designed as described in annex E, be used instead of a commercial wheelchair securement system.

- g) a vehicle-anchored three-point belt restraint or two-point shoulder belt that is accordance with ISO 10542-1, as required to supplement the restraint provided with the wheelchair;
- h) a means to accelerate and/or decelerate the impact sled and test set-up such that the processed sled acceleration- and/or deceleration-time pulse:
 - 1) falls within the shaded area of Figure A.1,
 - 2) exceeds $20 g$ for a cumulative time period of at least 15 ms,

- 3) exceeds 15 g for a cumulative time period of at least 40 ms, and
- 4) has a duration of at least 75 ms from t_0 to t_f , where t_0 is the start time and t_f is the stop time, as seen on Figure A.1;

i) a Hybrid II or Hybrid III anthropomorphic test device (ATD) with a total mass of $(76,3 \pm 1)$ kg.

NOTE 2 A larger (heavier) ATD of these types may be used, if desired, by the manufacturer.



The acceleration/deceleration of the impact sled shall stay within the shaded area and exceed the indicated levels for the specified continuous (unbroken arrows) and cumulative (broken arrows) time periods.

Figure A.1 — Acceleration/deceleration requirements for the (48^{+2}_0) km/h delta V impact test

A.3.2 Dynamic measurements

A means shall be provided to:

- a) measure the ATD and wheelchair horizontal excursions specified in 5.2.1 with an accuracy of ± 5 mm;

NOTE A side-view high-speed camera or video system with a minimum frame rate of 500 frames per second is recommended.

- b) measure the horizontal acceleration and/or deceleration of the impact sled in the direction of travel, at a sampling rate in accordance with ISO 6487 and with an accuracy of $\pm 0,5$ g;
- c) measure the horizontal velocity change (delta-V) of the impact sled during the impact with an accuracy of $\pm 0,5$ km/h;
- d) filter analogue transducer signals using a low-pass filter in accordance with ISO 6487, including:
 - 1) prefiltering of all transducer signals to Channel Class 1000 (-4 dB at 1 650 Hz) prior to digitizing at 10,000 Hz, and
 - 2) filtering of the digitized accelerometer and load-cell signals to Channel Class 60 (-4 dB at 100 Hz).

A.4 Test preparation and procedure

A.4.1 Perform the following prior to initiating the test:

- a) Adjust the ATD to achieve a static resistance of 1 g at each joint indicated by just noticeable movement from the weight of the distal body segment as specified by the ATD manufacturer.
- b) Place snug-fitting cotton clothing on the pelvis, thighs and torso of the ATD.
- c) Prepare the wheelchair for use in a motor vehicle as specified by the manufacturer's user instructions in 6.3.2 h). If a range is specified for any adjustments, the midpoint of the range should be used.
- d) Equip the wheelchair with any required add-on components.
- e) If a pelvic belt, intended for use as an occupant restraint, is provided as a component of the wheelchair, install it on the wheelchair according to the manufacturer's instructions.
- f) If the wheelchair is equipped with liquid electrolyte type batteries they should be replaced by the nearest equivalent gel, sealed or a surrogate battery. Supplementary weights, if used, shall provide equivalent mass distribution to the original batteries.
- g) Inflate any pneumatic tyres to the pressure recommended by the wheelchair manufacturer.

A.4.2 Install the wheelchair tiedown anchorages on the sled platform in accordance with the WTORS manufacturer's vehicle installation instructions, or as specified in ISO 10542 for other specific types of tiedowns. When a range of installation dimensions are specified, use the midpoint of the range.

A.4.3 Position the wheelchair facing forward on the sled platform with the wheelchair reference plane parallel to the direction of sled travel $\pm 3^\circ$.

A.4.4 Secure the wheelchair with the wheelchair tiedown according to the WTORS manufacturer's instructions and as specified in ISO 10542-1. For testing with four-point, strap-type tiedowns, follow the procedures in annex A of ISO 10542-2. If parking brakes are fitted, apply them.

A.4.5 If applicable, adjust the seat and backrest as follows.

- a) Rotate the backrest rearward to obtain a backrest plane angle not exceeding 10° relative to the vertical.
- b) For wheelchairs with independently adjustable seat angles, adjust the seat frame to a maximum incline angle of 10° relative to the horizontal.

NOTE Measure this angle with an inclinometer without the ATD in the wheelchair.

- c) For tilt-in-space wheelchairs, adjust the longitudinal seat frame members to a maximum angle of 30° , relative to the horizontal, without the ATD in the wheelchair;
- d) If the seat position adjusts front to back, select the position recommended by the manufacturer. If no position is recommended, select the midpoint of the adjustment range.
- e) If other seat components are adjustable, they shall be adjusted to fit the ATD intended for use by the manufacturer.
- f) Lock any adjustment mechanisms that provide for tilt of the seat or backrest.

A.4.6 Position the ATD in the wheelchair sitting upright and symmetrically located about the wheelchair midline, with the pelvis and buttocks as far back on the wheelchair seat as possible and the elbows resting on the armrest or on the ATD's thighs.

A.4.7 If the wheelchair is provided with postural belts, install and fasten the belts around the ATD as recommended by the manufacturer.

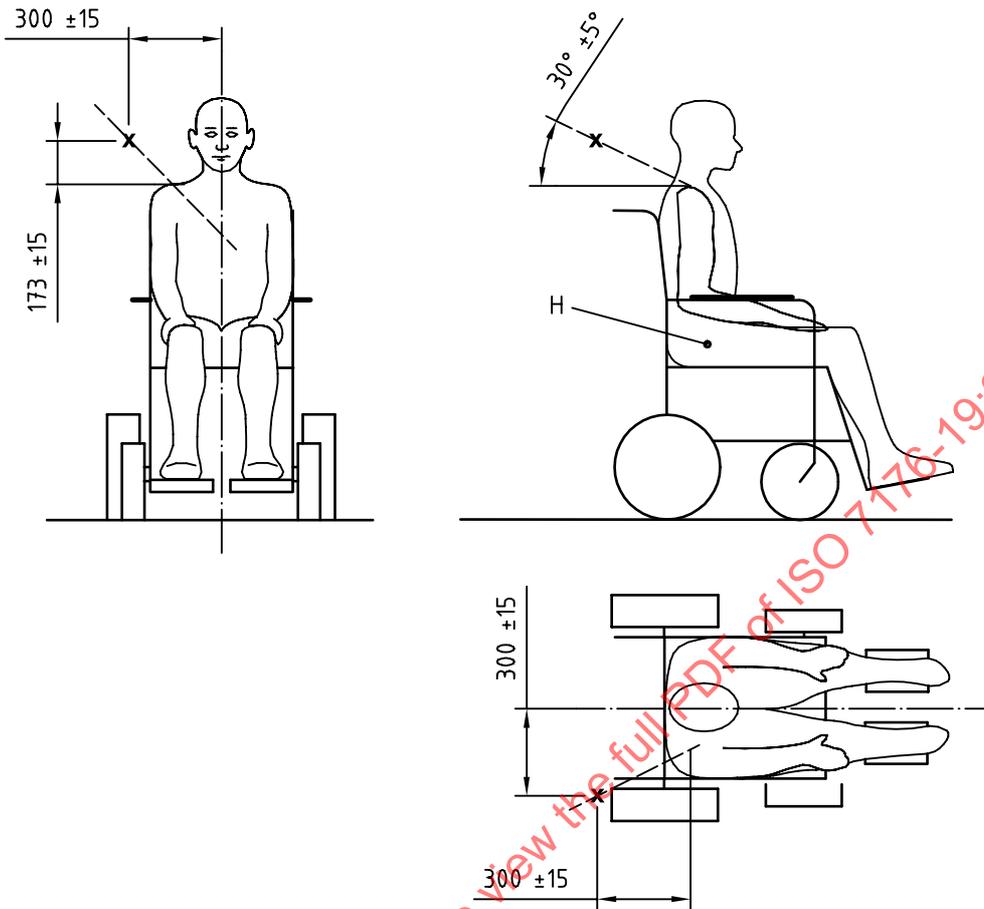
A.4.8 If the wheelchair is not equipped with a pelvic belt restraint, install the vehicle-anchored three-point belt of the specified WTORS as follows.

- a) Locate and attach the floor anchorages of the pelvic belt as specified by the WTORS manufacturer to achieve side-view pelvic belt angles between 30° and 75° to the horizontal, when the pelvic belt is positioned as low as possible on the ATD's pelvis.
- b) Bolt the upper anchorage for the shoulder belt to the rigid support structure of A.3.1d at a location that provides a good fit of the shoulder belt to the ATD's chest and shoulder as illustrated in Figure A.2.
- c) Place the pelvic and shoulder belts on the ATD with the pelvic belt located as low as possible on the ATD's pelvis and the shoulder belt over the shoulder and chest of the ATD.
- d) If an emergency-locking or automatic-locking retractor is provided, adjust the pelvic and shoulder belts to achieve a snug fit.
- e) If an emergency-locking or automatic-locking retractor is not provided:
 - 1) pull the pelvic belt snugly against the ATD pelvis and/or thighs;
 - 2) place the shoulder belt over the ATD's chest and shoulder with a 75 mm × 75 mm × 25 mm thick plate inserted between the ATD's chest and the belt webbing;
 - 3) adjust the shoulder belt to achieve a snug fit and then remove the plate.

A.4.9 If the wheelchair provides anchor points for both the lower and upper torso belts on the wheelchair, install and position the belts on the ATD as specified by the wheelchair manufacturer. If ranges of belt anchor points are provided, select anchor points appropriate to achieve a good fit of the belts to the ATD as indicated in 4.2.1, 4.2.2, Figure 3 and Figure 4.

A.4.10 If the wheelchair is equipped with a wheelchair-anchored pelvic belt intended for use with a vehicle-anchored upper torso belt, proceed as follows.

- a) Buckle the pelvic belt around the ATD pelvis and adjust to achieve a snug fit. If a range of pelvic belt anchor points is provided, select anchor points appropriate to achieve a good fit of the belt to the ATD's pelvis as indicated in Figure 3.
- b) Bolt the upper anchorage of a two-point shoulder belt to the rigid support structure of A.3.1d), and the lower anchorage to the sled platform at locations that provide a good fit of the shoulder belt to the ATD's chest and shoulder as illustrated in Figure 4.
- c) If an emergency-locking or automatic-locking retractor is provided, adjust the shoulder belt to achieve a snug fit.
- d) If an emergency-locking or automatic-locking retractor is not provided, place a 75 mm × 75 mm × 25 mm thick plate between the ATD's chest and the belt webbing. Adjust the shoulder belt to achieve a snug fit with the plate in place and then remove the plate.



The anchor point may be located on either side of the wheelchair and the ATD is located relative to the top centre of the ATD's shoulder. Adjust the anchor-point location to give a good fit to the ATD chest and shoulder. The lateral position of the anchor point should be adjusted to achieve a good fit over the ATD's shoulder. If the ATD head contacts the upper shoulder belt anchorage during a test, the anchorage may be moved upward, rearward and outward so as to maintain the desired side-view angle above the shoulder and a good fit to the ATD. Any contact with the anchorage should be noted in the Test Report.

Figure A.2 — Test location for upper anchor point of shoulder belt

A.4.11 If a high-speed camera or high-speed video is used for the measurements specified in A.3.2, apply contrast markers appropriate to the measurement system at:

- a) the lateral aspect and centre of the ATD's knee joint, and
- b) at the point P of the wheelchair (see Figure 2), or a point on the side of the seatback of a wheelchair that is as close to the wheelchair point P as possible.

A.4.12 Ensure that the wheelchair reference plane is aligned parallel to the centreline of impact within $\pm 3^\circ$.

A.4.13 Record the locations of all WTORS anchor points relative to the wheelchair rear axles and the projected angles of any tiedown straps and all restraint belts relative to the horizontal longitudinal axis of the sled platform.

A.4.14 Measure and record the height (± 5 mm) of the ATD's left and right H-point vertically from the sled platform.

A.4.15 Conduct the impact test by activating the sequence of events to record data and fire the impact sled.

A.5 Post test measurements and calculations

A.5.1 Examine the wheelchair and ATD to determine and/or measure:

- a) whether the ATD remained in the wheelchair;
- b) whether the wheelchair remained on the test platform;
- c) whether any securement points on the wheelchair showed signs of failure;
- d) whether any load-carrying parts of the wheelchair became separated, deformed or fractured; and
- e) whether rigid wheelchair components greater than 100 g became detached.

A.5.2 Determine peak excursions X_{wc} , X_{knee} , X_{headF} and X_{headR} as defined in 5.2.1, to an accuracy of ± 5 mm.

A.5.3 Measure the height of the left and right H-points of the ATD above the wheelchair ground plane (i.e. the raised platform) and compute the average change in height from the pre-test position.

A.5.4 Use an inclinometer to estimate the maximum projected angle, relative to the vertical, of the ATD's torso in the post-test orientation, when viewed from any direction.

A.5.5 Release the occupant restraint, remove the ATD and record any wheelchair deformation that hinders removal of the ATD from the wheelchair.

A.5.6 Release the wheelchair from the tiedown and document any conditions that prevent removal of the wheelchair.

A.5.7 Measure and record the movement of adjustable components from their pre-test settings.

STANDARDSISO.COM : Click to view the full PDF of ISO 7176-19:2001

Annex B (normative)

Specifications for four-point strap-type securement points on wheelchairs

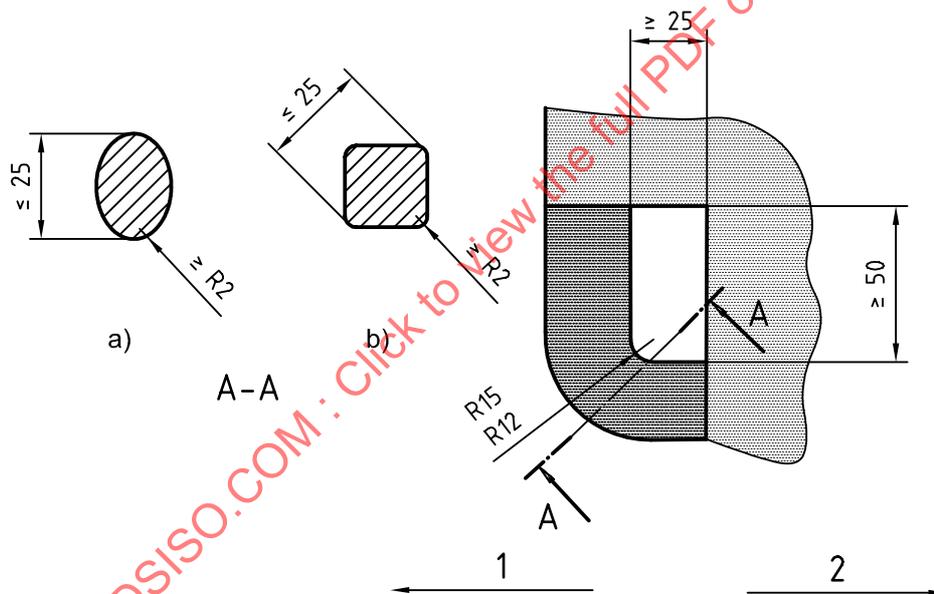
B.1 Principle

This annex establishes geometric and location design requirements for wheelchair securement points intended to be engaged by the end-fittings of four-point strap-type tiedown assemblies that are in accordance with ISO 10542.

B.2 Geometric specifications

The securement points shall have dimensions in accordance with those given in Figure B.1.

Dimensions in millimetres



Key

- 1 Anchor point
- 2 Wheelchair

NOTE Cross-section A-A continues through the elbow.

Figure B.1 — Example of required securement-point geometry, including minimum dimensions for the rectangular securement-point opening and minimum radii of the structural members

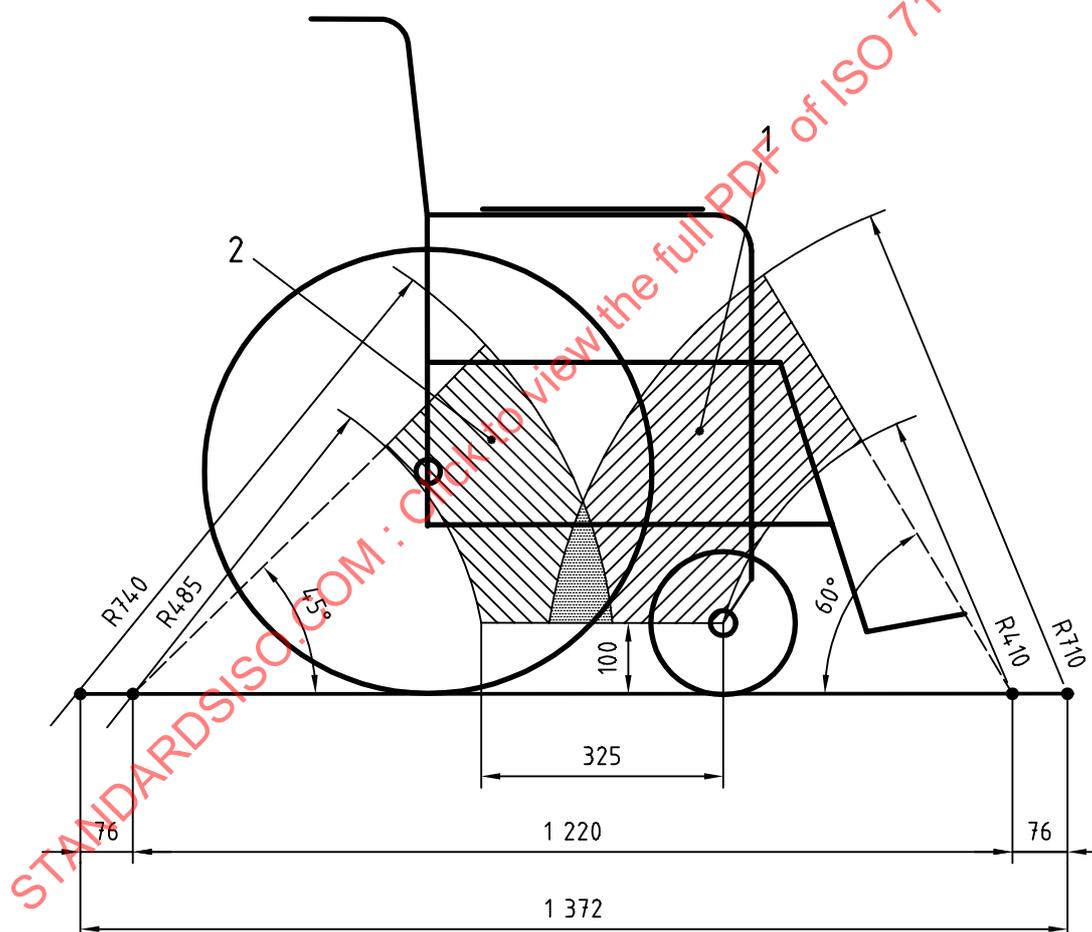
B.3 Location specifications

Wheelchair securement points intended for engagement with four-point strap-type tiedown assemblies shall be located in the zones shown in Figure B.2, such that:

- the locations of the front and rear securement points relative to the wheelchair ground plane, and with respect to each other, fall within the shaded regions of Figure B.2;
- the horizontal longitudinal distance between front and back securement points is not less than 100 mm;
- the lateral horizontal distance between left and right rear securement points is not less than 250 mm;
- the lateral horizontal distance between left and right front securement points is not less than 100 mm.

NOTE The securement-point location is defined as the centre of contact between the hook gauge and the securement-point structural member, when the wheelchair is secured in accordance with procedures of annex A.

Dimensions in millimetres



The zones are measured from fixed tiedown anchor point locations within a typical four-point tiedown wheelchair station configuration. Locations of zones over wheelchair are illustrative only and do not imply acceptable securement point locations on wheelchair frame. The distance between front and rear anchor points may not be limited to 1 372 mm in actual vehicles. These zones are based on minimum and maximum strap lengths required by ISO 10542-2 and estimates of typical distances in vehicles between front and rear vehicle anchor points.

Figure B.2 — Required front and rear securement point location zones for wheelchairs intended to be secured by four-point strap-type tiedowns

Annex C (normative)

Test methods for accessibility to four-point strap-type securement points with hook end-fittings

C.1 Principle

Securement points on the wheelchair should be easily accessible on both sides of the wheelchair. This annex specifies equipment, conditions and procedures to assess the one-handed accessibility of securement points that are in accordance with the specifications of annex B.

C.2 Equipment to be tested

A complete commercial or prototype wheelchair designed for securement by a four-point strap-type tiedown is required. The wheelchair manufacturer shall adjust the wheelchair to fit the anthropomorphic test dummy (ATD) or shall provide adjustment instructions to the testing facility.

C.3 Apparatus

- a) A rigid platform with wheelchair securement space as shown in Figure C.1.
- b) A hook end-fitting as specified by Figure C.2.
- c) An ATD having the same anthropometric characteristics as the Hybrid II or III.
- d) A timing device that is accurate to ± 0.5 s.