INTERNATIONAL STANDARD

ISO 10542-2

First edition
2001-07-15

Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint systems —

Part 2: Four-point strap-type tiedown systems

Assistances et aides techniques pour les personnes invalides ou handicapées — Systèmes d'attache du fauteuil roulant et de retenue de l'occupant —

Partie 2: Systèmes de sangles d'attache à quatre points

Reference number
ISO 10542-2:2001(E)

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Printed in Switzerland

Foreword

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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 10542 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10542-2 was prepared by Technical Committee ISO/TC 173, *Technical systems and aids for disabled or handicapped persons*, Subcommittee SC 1, *Wheelchairs*.

ISO 10542 consists of the following parts, under the general title *Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint systems*:

— *Part 1: Requirements and test methods for all systems*

— *Part 2: Four-point strap-type tiedown systems*

Annexes A and B form a normative part of this part of ISO 10542. Annex C is for information only.

Introduction

Providing effective protection for the wheelchair-seated occupant of a motor vehicle usually requires that after-market equipment be installed to secure the wheelchair and restrain the person in the wheelchair. ISO 10542-1 gives requirements for all wheelchair tiedown and occupant-restraint systems. The provisions of ISO 10542-1 apply except as amended and supplemented by this part of ISO 10542, which gives particular requirements and test methods for wheelchair tiedowns and occupant-restraint systems (WTORS) that use four-point, strap-type wheelchair tiedowns.

Technical systems and aids for disabled or handicapped persons — Wheelchair tiedown and occupant-restraint systems —

Part 2:
Four-point strap-type tiedown systems

1 Scope

This part of ISO 10542 specifies test methods and requirements for design and performance, for instructions and warnings to installers and users, and for product marking and labelling for wheelchair tiedown and occupant-restraint systems (WTORS).

It applies only to WTORS that use belt-type occupant restraints and four-point strap-type wheelchair tiedowns that are intended for adult-occupied wheelchairs used as forward-facing seats by passengers and drivers of motor vehicles.

This part of ISO 10542 applies primarily to complete WTORS, but other parts of ISO 10542 can also be applied to components and subassemblies sold separately and as replacement parts.

This part of ISO 10542 applies to WTORS intended for use with all types of manual and powered wheelchairs intended for use by adults, including three- and four-wheeled scooters.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 10542. 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 10542 are encouraged to investigate the possibility of applying the most recent edition of the normative document 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 10542-1:—[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*.

3 Terms and definitions

For the purposes of this part of ISO 10542, the terms and definitions given in ISO 10542-1 apply.

4 Design requirements

The design requirements of ISO 10542-1 apply with the addition of the following.

1) To be published.

a) Four-point, strap-type tiedowns shall be designed for effective attachment and tensioning on a wide range of wheelchair types and sizes whilst meeting the angles in Figures 1 and 2, by providing adjustment in strap assembly length, adjustment in the fore/aft location of vehicle anchor points, or both.

NOTE 1 Figure C.1 shows recommended securement point zones on wheelchairs for which a four-point, strap-type tiedown system should be effective.

b) All securement-point end fittings of four-point tiedown assemblies shall engage with the securement points of the surrogate wheelchair shown and specified in Figure E.1 and Figure E.4 of ISO 10542-1:—.

5 Instructions for installers

In addition to the requirements in 5.2 of ISO 10542-1:—, manufacturers' instructions for installers shall include the recommendations for distances between anchor points of wheelchair tiedowns and the information illustrated in Figures 1 and 2 indicating that:

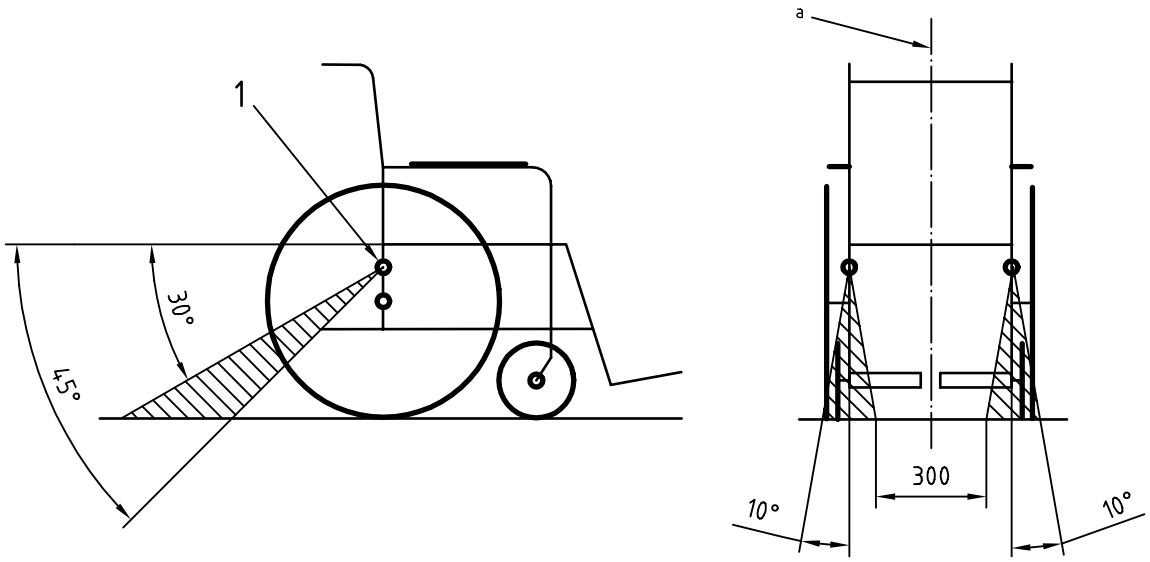
a) the side-view projected angle for the rear tiedown straps is between 30° and 45° from the horizontal,

b) the side-view projected angle for the front tiedown straps is between 40° and 60°,

c) the rear-view projected angle of the rear tiedown straps is within 10° of the wheelchair reference plane, and

d) the front-view-projected angle of the front tiedown straps is within 25° of the wheelchair reference plane, but angled so as to provide some lateral stability to the wheelchair.

Dimensions in millimetres



Key

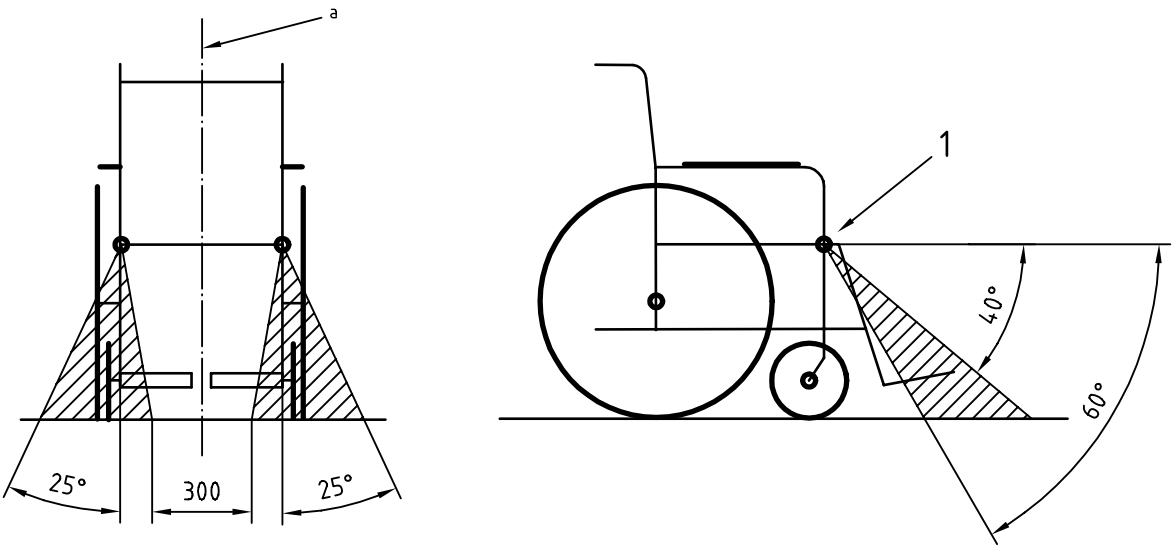
1 Rear securement points

NOTE The angles shown are obtained by projecting the angle of each tiedown strap onto a vertical plane parallel to (side view) or perpendicular to (rear view) the wheelchair reference plane.

[a] Wheelchair reference plane

Figure 1 — Preferred angles of rear wheelchair-tiedown straps and locations of tiedown anchor points

Dimensions in millimetres



Key

1 Front securement points

NOTE The angles shown are obtained by projecting the angle of each tiedown strap onto a vertical plane parallel to (side view) or perpendicular to (rear view) the wheelchair reference plane.

[a] Wheelchair reference plane

Figure 2 — Preferred angles of front tiedown straps and locations of tiedown anchor points

6 User and maintenance instructions

In addition to the requirements in 5.3 of ISO 10542-1:—, manufacturers' instructions for users shall include recommendations for preferred angles of tiedown strap assemblies and Figures 1 and 2, including statements that, whenever possible,

a) the side-view projected angle for the rear tiedown straps should be between 30° and 45° from the horizontal,

b) the side-view projected angle for the front tiedown straps should be between 40° and 60°,

c) the rear-view projected angle of the rear tiedown straps should be within 10° of the wheelchair reference plane, and

d) the front-view-projected angle of the front tiedown straps should be within 25° of the wheelchair reference plane, and angled laterally so as to provide some lateral stability to the wheelchair.

Annex A
(normative)

Test method for frontal impact testing of WTORS with tiedowns having four adjustable-length strap assemblies

A.1 Principle

ISO 10542-1:—, annex A, specifies methods for dynamically testing a WTORS in a frontal impact and indicates that the WTORS should be installed and the wheelchair secured using the WTORS manufacturer's instructions and recommendations. These procedures should also be followed when testing WTORS that include four-point, strap-type tiedowns with two or more fixed-length strap assemblies. For four-point tiedowns with four adjustable-length strap assemblies and four longitudinally fixed anchor points, the angles and lengths of the strap assemblies can have an effect on test results. To reduce variability in results obtained from testing a given WTORS within and between laboratories, it is desirable to specify a consistent method for setting up the pre-test geometry.

A.2 Purpose and rationale

This annex specifies additional requirements to the test set-up procedures specified in ISO 10542-1:—, A.4, when testing a WTORS that uses a four-point, strap-type tiedown with four adjustable-length strap assemblies. The procedures specified in A.3 are based on typical and expected conditions in actual vehicles, but are not intended to be representative of all real-world situations.

A.3 Modifications to wheelchair tiedown set-up procedures

A.3.1 The procedures specified in ISO 10542-1:—, A.4, apply with the exception that A.4.7 shall be replaced by A.3.2 through A.3.4 of this part of ISO 10542.

A.3.2 Secure the SWC with the four-point tiedown, selecting anchor points that

a) are symmetrical about the wheelchair reference plane,

b) are located 1 300 mm $\pm$ 20 mm from the front anchor point to the rear anchor point,

c) have a lateral distance between rear anchor points equal to the lateral distance between rear securement points of the surrogate wheelchair, $\pm$ 25 mm, and

d) have a lateral distance between front anchor points of 300 mm to 810 mm.

NOTE For purposes of locating the anchor points, the front-to-back location of an anchor point is the location of the primary fastener that secures the anchorage to the test platform or, in the case of multiple fasteners, the centre of these fasteners. The lateral location of an anchor point is considered to be the centre of the location where the tiedown end fitting contacts the anchorage hardware attached to the test platform.

A.3.3 Secure the surrogate wheelchair in accordance with the WTORS manufacturer's instructions to achieve lengths of the rear tiedown strap assemblies of 495 mm to 533 mm, measured from the interface of the tiedown end fitting and the securement point on the wheelchair to the anchor point.

NOTE For purposes of measuring the rear tiedown length, the anchor point is considered to be the point at which a straight line along the length of the strap assembly intersects with the wheelchair ground plane.

A.3.4 Tension adjustable-length tiedown straps to the manufacturer's specifications, making sure that the SWC reference plane is parallel to the centreline of the impact simulator within $\pm 3^{\circ}$.

Annex B
(normative)

Test methods for measuring occupant-restraint belt lengths and geometry

B.1 Principle

ISO 10542-1:—, annex B, specifies methods for setting up and measuring occupant-restraint belt geometry on the ATD and length adjustments to ensure that the restraint system will accommodate a wide range of user situations and wheelchair sizes. These methods use the wheelchair securement procedures specified in annex A of ISO 10542-1:—. For WTORS with four-point, strap-type tiedowns having four adjustable-length strap assemblies and four longitudinally fixed anchor points, annex A of this part of ISO 10542 specifies additional procedures for securing a wheelchair that are to be used in conjunction with ISO 10542-1:—, A.4. These same additional procedures for securing a wheelchair should be used when setting up WTORS in accordance with ISO 10542-1:—, annex B to measure occupant-restraint belt geometry and lengths.

B.2 Modifications to test set-up procedures

Clauses B.1 to B.6 of ISO 10542-1:— apply, with the exception that, when securing the surrogate wheelchair with strap-type tiedowns having four adjustable-length strap assemblies and four longitudinally fixed anchor points, select tiedown anchor points and position the surrogate wheelchair in accordance with annex A.

Annex C
(informative)

Recommendations for securement point locations on wheelchairs and adjustment lengths of strap assemblies

C.1 Principle

In order for four-point, strap-type tiedowns to secure wheelchairs effectively in public-transit vehicles, the four adjustable strap assemblies must be able to reach to, and be tensioned for, available points of attachments (i.e. securement points) on a wide range of wheelchairs. Because of the need for each strap assembly to include anchorage hardware, wheelchair attachment end fittings, and adjustment and tensioning components, there are practical limits to the minimum strap assembly lengths that can be achieved. There are also practical limits to the maximum strap assembly lengths, beyond which the straps become unwieldy for everyday use.

Clause C.2 defines recommended zones for placement of wheelchair securement points based on these considerations, and

a) the consensus of WTORS manufacturers on achievable and reasonable lower and upper length requirements for four-point, strap-type tiedowns with four adjustable-length strap assemblies and four longitudinally fixed anchor points, as given in clause A.3, and

b) typical longitudinal spacing of fixed tiedown anchor points.

NOTE These recommended zones are being implemented in ISO 7176-19, *Wheelchairs — Part 19: Wheeled mobility devices for use in motor vehicles*, as required zones for wheelchair securement points intended for use by four-point, strap-type tiedowns systems. Designing four-point strap-type tiedowns to work effectively with securement points in these zones will help ensure compatibility between wheelchairs and four-point, strap-type tiedowns in the real world.

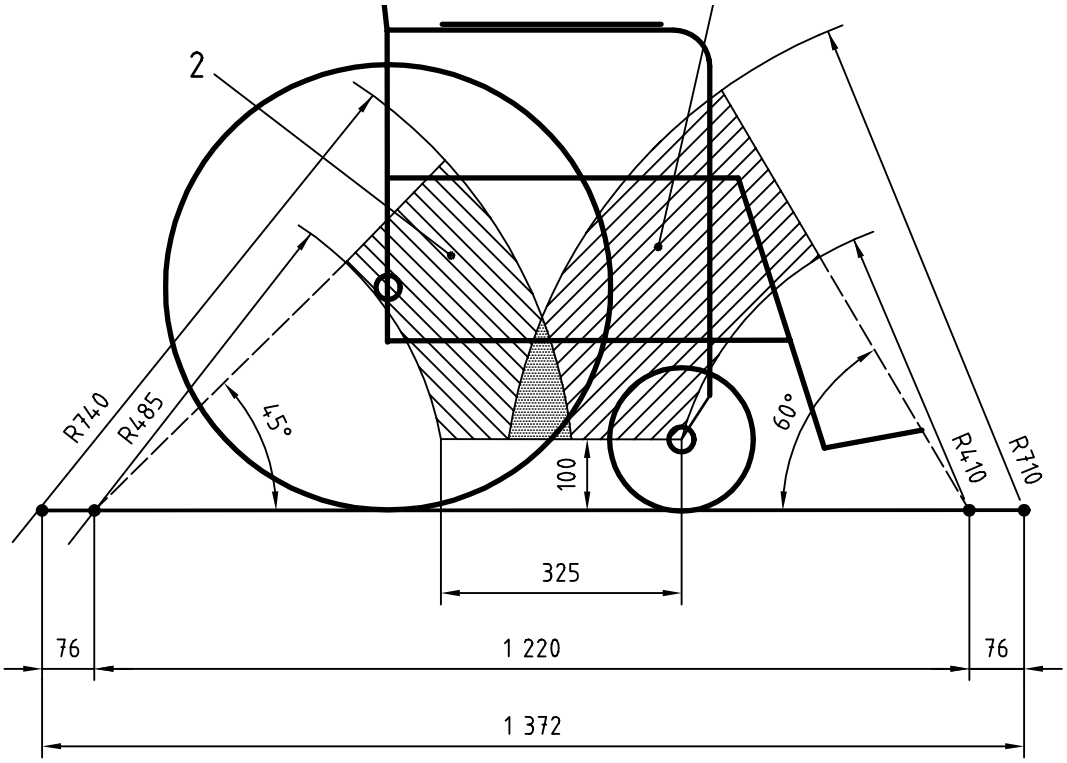
C.2 Securement point zones

Figure C.1 illustrates front and rear wheelchair securement-point zones (shaded areas) that are derived from the consensus on achievable and reasonable upper and lower tiedown adjustment lengths and typical fore/aft distances between fixed front and rear anchor points. Positioning of securement points on wheelchairs within these zones will help ensure that a wheelchair can be effectively secured using a four-point strap-type tiedown system with four adjustable-length strap assemblies.

C.3 Recommendations for strap assembly adjustment lengths

Table C.1 indicates recommendations for upper and lower strap assembly lengths for four-point tiedowns that have four adjustable strap assemblies and longitudinally fixed anchor points. These values are based on WTORS manufacturers' consensus at the time of standard development. Lower length recommendations are based on minimum lengths that were considered to be reasonably achievable, given the need for anchorage, securement, adjustment, and tensioning components. Upper length recommendations are based on maximum strap lengths that will not become unwieldy in real-world situations. These strap adjustment recommendations should be achieved with at least 25 mm of webbing extending from the adjustment mechanisms.

Dimensions in millimetres



Key

1 Front securement point zone

2 Rear securement point zone

NOTE 1 The distance between front and rear anchor points may not be limited to 1 372 mm in actual vehicles.

NOTE 2 Locations of zones over wheelchair are illustrative only and do not imply acceptable securement-point locations on wheelchair frame.

Figure C.1 — Side-view illustration of preferred zones for front and rear wheelchair securement points

Table C.1 — Upper and lower length recommendations for tiedown strap assemblies

Location of strap assembly	Lower length recommendation mm	Upper length recommendation mm
Rear	485	740
Front	410	710
NOTE Length is defined as the straight-line distance from the point of intersection of the tiedown end fitting with the wheelchair securement point, to the point at which a straight line along the length of the strap assembly intersects with the wheelchair ground plane.		

ICS 11.180

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