BS ISO 16840-3:2014

BSI Standards Publication

Wheelchair seating

Part 3: Determination of static, impact and repetitive load strengths for postural support devices

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National foreword

This British Standard is the UK implementation of ISO 16840-3:2014.

The UK participation in its preparation was entrusted to Technical Committee CH/173/1, Wheelchairs.

A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

ISO 16840-3

Second edition
2014-01-15

Wheelchair seating —

Part 3: Determination of static, impact and repetitive load strengths for postural support devices

Sièges de fauteuils roulants —

Partie 3: Détermination des efforts statiques, d'impact et cycliques pour les dispositifs de maintien de la posture

Reference number
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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 173, *Assistive products for persons with disability*, Subcommittee SC 1, *Wheelchairs*.

This second edition cancels and replaces the first edition (ISO 16840-3:2006), which has been technically revised.

ISO 16840 consists of the following parts, under the general title *Wheelchair seating*:

— *Part 1: Vocabulary, reference axis convention and measures for body segments, posture and postural support surfaces*

— *Part 2: Determination of physical and mechanical characteristics of devices intended to manage tissue integrity — Seat cushions*

— *Part 3: Determination of static, impact and repetitive load strengths for postural support devices*

— *Part 4: Seating systems for use in motor vehicles*

Introduction

Postural support devices (PSD), constructed as additional components to wheelchair seating or as wheelchair seating in its own right, are widely available and used extensively by people with disabilities. The selection or prescription of the most appropriate PSD is intended to be, where appropriate, partially dependent on knowledge of its ability to withstand static, impact, and repeated loads. This part of ISO 16840 is intended to specify test methods to provide this information.

The tests involve mounting the PSD on rigid test fixtures to simulate mounting on a wheelchair. Rigid test fixtures are utilized to provide a worst-case situation, which is repeatable and avoids destroying multiple wheelchairs during testing. Static, impact, and repeated loads are then applied to simulate normal usage. In some of the defined tests, performance criteria have been established. In others, no minimum requirements are currently specified. Tests are repeated at increasing forces or torques until one or more performance limits are reached. Repetitive load tests with a specific load or torque application are intended to induce fatigue-related performance limits.

Tests represented in this part of ISO 16840 were derived from ISO 7176-8. Many of the test principles and much of the test equipment are the same for this part of ISO 16840 and ISO 7176-8.

It is anticipated that parts of this part of ISO 16840 will continue to be developed and that future revisions can include the results of ongoing work in the following areas:

— further development of the test forces based on clinical data is necessary in order to determine actual impact, static, and repetitive forces that PSDs are subjected to;

— further work for the collection of data on the most common failures experienced in actual use of PSDs is ongoing.

INTERNATIONAL STANDARD **ISO 16840-3:2014(E)**

Wheelchair seating —

Part 3: Determination of static, impact and repetitive load strengths for postural support devices

1 Scope

This part of ISO 16840 specifies test methods for the determination of static, impact, and repetitive load strengths as well as disclosure requirements for postural support devices (PSD) with associated attachment hardware intended for use with an undefined wheelchair.

This part of ISO 16840 does not apply to the strength of PSDs under crash conditions in a motor vehicle.

This part of ISO 16840 does not apply to PSDs that are designed to fail under certain static, dynamic, or repetitive loads.

NOTE 1 ISO 16840-4 provides test methods and requirements for some PSDs when used as part of a wheelchair seat in a motor vehicle.

NOTE 2 Performance criteria have been established in some of the defined tests. In others, no minimum requirements are currently specified.

NOTE 3 For masses greater than 150 kg or less than 25 kg, appropriate extrapolation of test apparatus dimensions, mounting point separation, etc. are permitted.

NOTE 4 Rigid surrogate test fixtures are utilized to provide a worst-case situation, and consequently this part of ISO 16840 does not test a PSD on a particular wheelchair.

NOTE 5 If one PSD achieves a higher loading at the point of failure than another, it does not necessarily mean that it is better or worse. The type of failure and flexibility of the PSD can be considered as well. The maximum offset distance to the centre of the PSD from the adjacent attachment point can also be considered.

2 Normative references

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

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 898-7, *Mechanical properties of fasteners — Part 7: Torsional test and minimum torques for bolts and screws with nominal diameters 1 mm to 10 mm*

ISO 7176-8:1998, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths*

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

ISO 7176-26:2007, *Wheelchairs — Part 26: Vocabulary*

ISO 16840-2, *Wheelchair seating — Part 2: Determination of physical and mechanical characteristics of devices intended to manage tissue integrity — Seat cushions*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 7176-26 and the following apply.

3.1
elastic attachment hardware
hardware that allows a PSD to move when a force is applied and returns to its original position when the force is removed

EXAMPLE A PSD designed with a spring that allows movement.

3.2
deformable support surface
support surface which conforms to the shape of the body part being supported

Note 1 to entry: The surface might or might not return to its original shape but remains conformable over time.

EXAMPLE Foam or fluid seat supports are examples of deformable support surfaces.

3.3
passive support surface
PSD that moves with minimal resistance to follow the body part being supported

Note 1 to entry: Passive support surfaces do not necessarily move back to a specific position.

EXAMPLE A mobile arm support is a passive support surface that allows movement with minimal resistance.

3.4
active support surface
PSD that is powered to change its position or support surface shape

EXAMPLE An alternating pressure seat support or an electronically operated back support surface that reclines.

3.5
continuous lateral support
support surface which has a depth that projects a minimum of 75 mm as measured perpendicular to its uncompressed adjacent support surface and has an angle between the adjacent support surface and the lateral support which is less than or equal to 120°

Note 1 to entry: See Figure 1.

Note 2 to entry: Figure 2 shows a support with a contoured surface that is not considered to be a lateral support.

Note 3 to entry: If there are difficulties in establishing the location of the adjacent support surface, use the reference planes as specified in ISO 7176-26.

Dimensions in millimetres

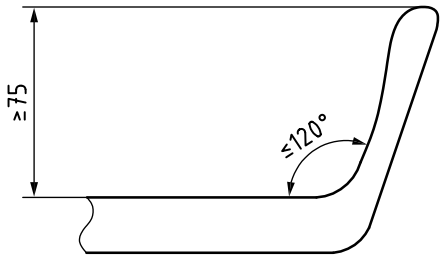


Figure 1 — Cross section of a support surface with continuous lateral support

Dimensions in millimetres

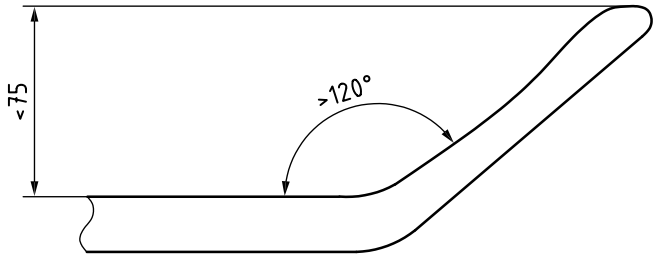


Figure 2 — Cross section of a support surface with a contour not considered a lateral support

3.6
discontinuous lateral support
lateral support which is separate from the adjacent support surface

Note 1 to entry: See Figure 3.

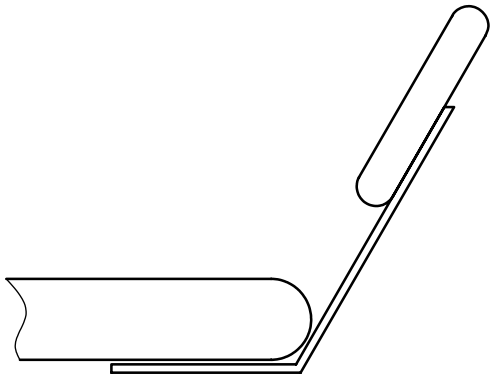


Figure 3 — Example of a lateral support discontinuous with the adjacent support surface

3.7
pivot axis
axis about which a pivoted arm rotates

3.8
mounting point
intended attachment point or points of any PSD

4 Test apparatus

4.1 Rigid test fixtures, fixtures used for securing or positioning PSDs during testing, as specified below. The fixtures shall be rigid when subjected to the forces required in Clauses 7, 8, and 9 for the user mass specified by the manufacturer of the PSD.

4.1.1 Adjustable rigid test frame, for simulating a wheelchair frame, typically used to attach the sling seat or sling back, which allows the full range of angle adjustment of PSD attachment hardware.

NOTE The testing of one piece shells with a combination of two rigid frames can be used.

The outside dimensions between the adjustable rigid components of the test frame should be adjustable from 280 mm ± 30 mm to 580 mm ± 30 mm. An informative example of an adjustable rigid test frame is shown in Figure 4.

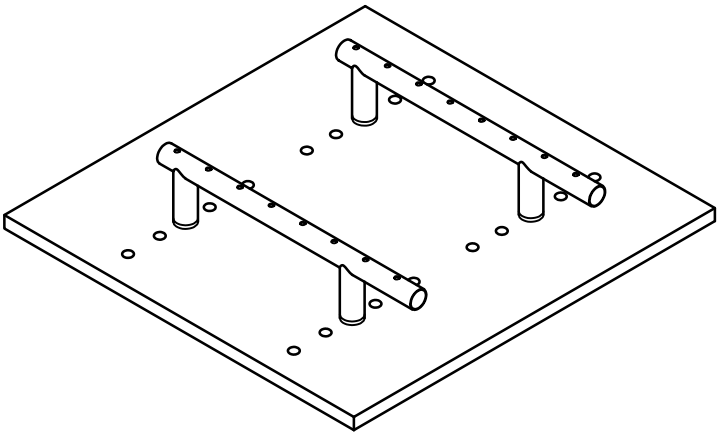
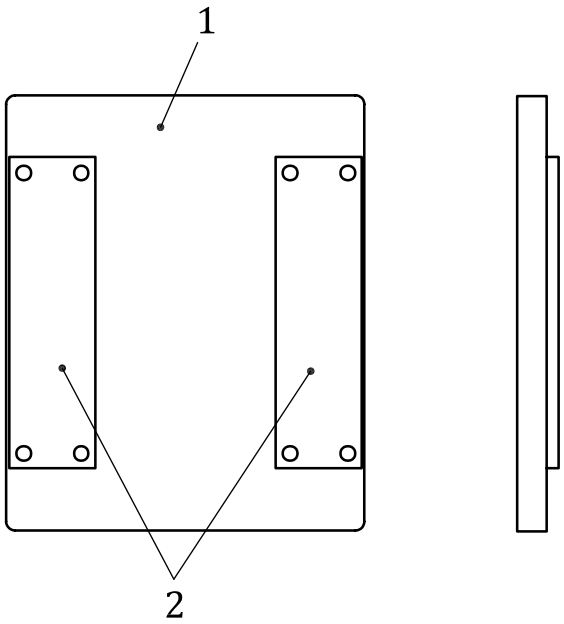


Figure 4 — Example of an adjustable rigid test frame

4.1.2 Rigid surrogate support surface, for PSDs intended for use with a rigid support surface and where a support surface is not supplied, a surrogate rigid support surface will be required. An example is shown in Figure 5.

Holes can be drilled or other modifications made to accommodate the mounting of a variety of attachment hardware.



Key

1 plywood

2 steel

Figure 5 — Example of rigid surrogate support surface for testing attachment hardware

4.1.3 Pivoting test frame, for applying a torque [of up to 50 Nm (±3 %) for a duration of no less than 5 s applied at a rate not to exceed 50 Nm (±3 %) per second] to a loading pad in order to simulate forward leaning of a seated user of postural support devices.

EXAMPLE An informative example of a pivoting test frame is shown in Figures 6 and 7.

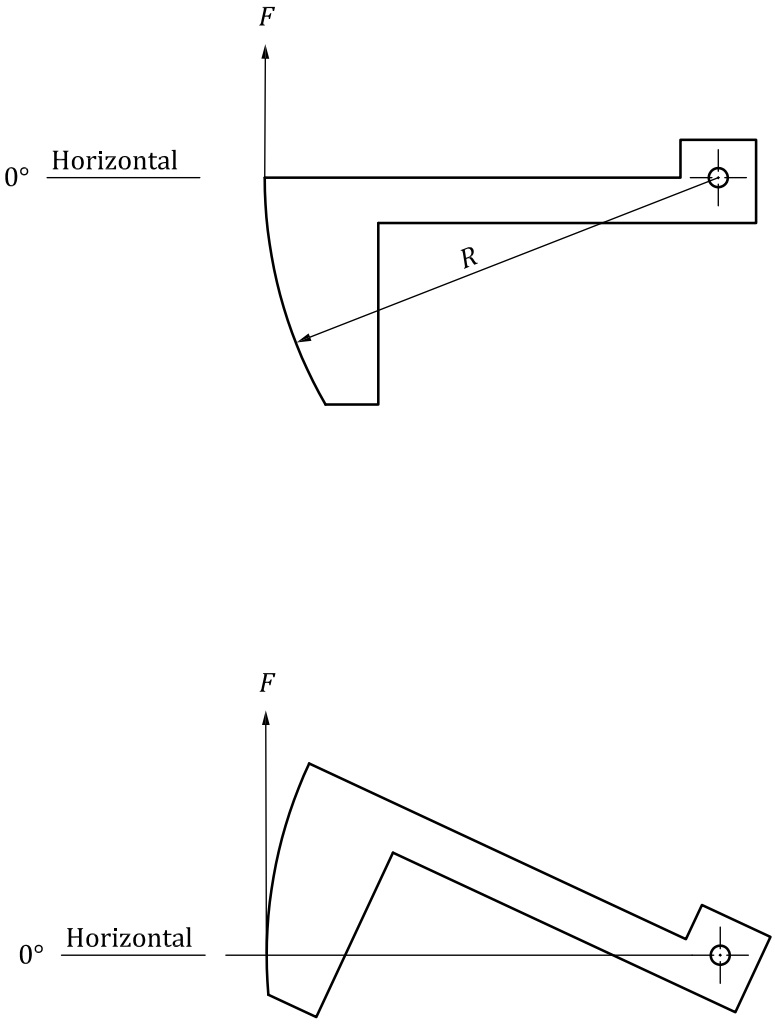


Figure 6 — Example of a pivoting test frame

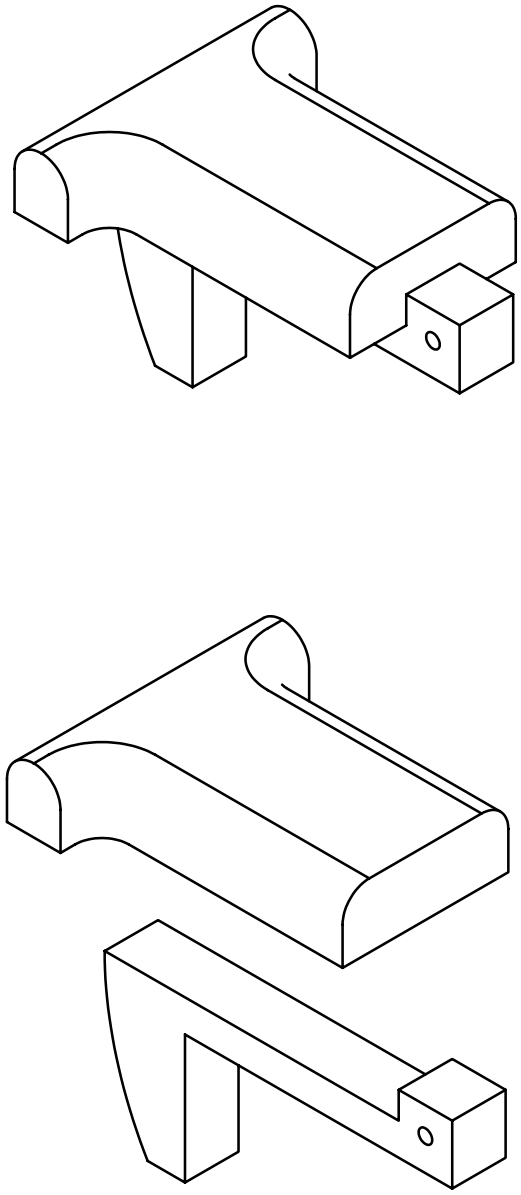
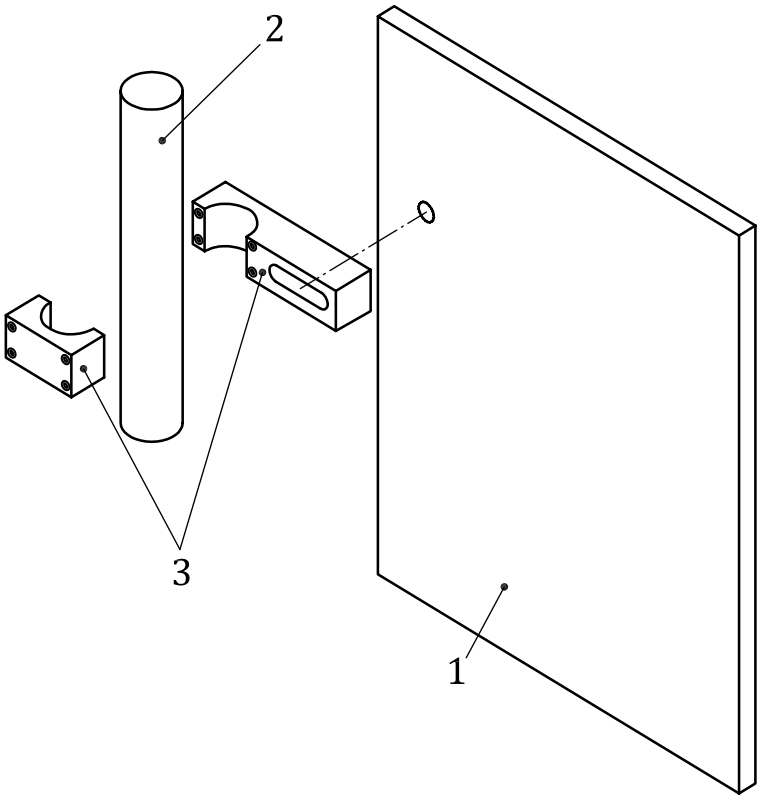


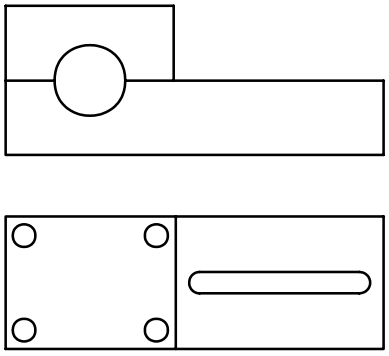
Figure 7 — Variable torso loading pad used with a pivoting test frame

4.2 Surrogate attachment hardware, hardware to secure PSDs, intended for use with attachment hardware, but provided without attachment hardware. Surrogate attachment hardware allows the attachment of PSDs to a rigid test fixture.

EXAMPLE An informative example of surrogate attachment hardware is shown in Figure 8.



a) Setup of surrogate attachment hardware



b) Detail of surrogate attachment hardware

Key

1 PSD to be tested
2 rigid test frame
3 surrogate attachment hardware

Figure 8 — Example of surrogate attachment hardware to secure PSD

4.3 Loading pads, pads for the application of loads to PSDs, as specified below.

4.3.1 Seat loading pad, comprising a rigid contoured loading indenter (RCLI) as specified in ISO 16840-2.

4.3.2 Pelvic loading pad, made of a rigid material, with convex surface elements and variable width.

Based on anthropometric data for different body sizes, the following pelvic loading pads are specified:

— 25 kg;

— 50 kg;

— 75 kg;

— ≥100 kg.

Add a protective layer between the loading pad and the PSD being tested. Select the smallest loading pad to match the range application for the PSD. For example, if the PSD is designed for a user with a mass in the range 25 kg to 49 kg, use the 25 kg loading pad for testing. The smaller radius and width of the pad will more properly test for slippage.

Figure 9 illustrates the features of the pelvic loading pad when used with the specifications contained in Table 1.

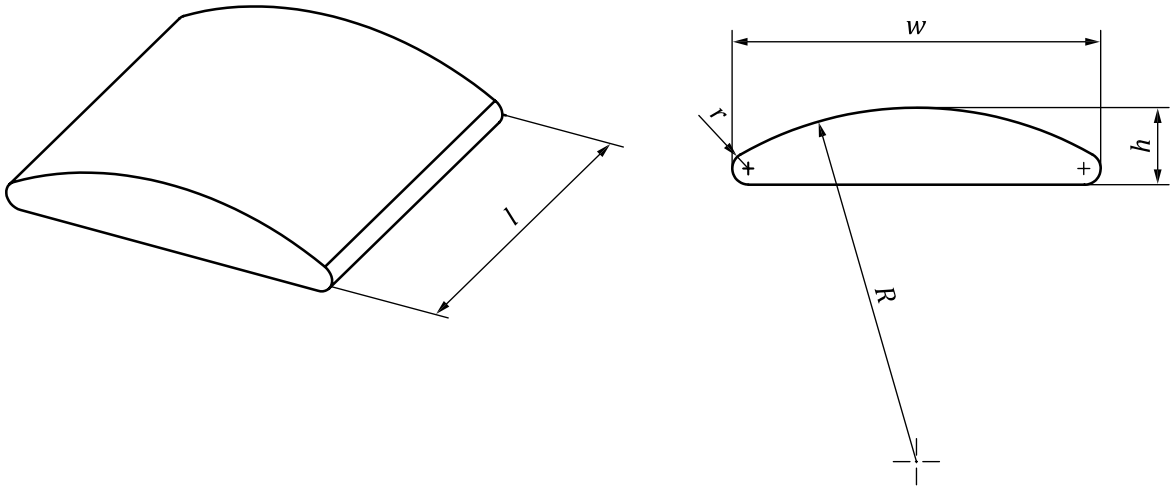


Figure 9 — Pelvic loading pad (dimensions specified in Table 1)

Table 1 — Dimensions of pelvic loading pads shown in Figure 9

Dimensions	User mass				
	25 kg to 49 kg	50 kg to 74 kg	75 kg to 99 kg	≥100 kg	Tolerance
Width, *w* (mm)	210	270	323	360	±10
Height, *h* (mm)	62	79	95	106	±5
Length, *l*	Variable[a]	Variable[a]	Variable[a]	Variable[a]	
Convex radius, *R* (mm)	210	270	323	360	±10
Radius of side edge, *r* (mm)	21	27	32	36	±3
[a] To fit PSD being tested.					

4.3.3 Torso loading pad, made of a rigid material, of various sizes, to simulate the upper torso.

Based on anthropometric data for different body sizes, the following torso convex loading pads are specified:

— 25 kg;

— 50 kg;

— 75 kg;

— ≥100 kg.

Add between the loading pad and the PSD being tested. Select the smallest loading pad to match the range application for the PSD. For example, if the PSD is designed for a user with a mass in the range 25 kg to 49 kg, use the 25 kg loading pad for testing. The smaller radius and width of the pad will more properly test for slippage.

Figure 10 illustrates the features of the torso loading pad when used with the specifications contained in Table 2.

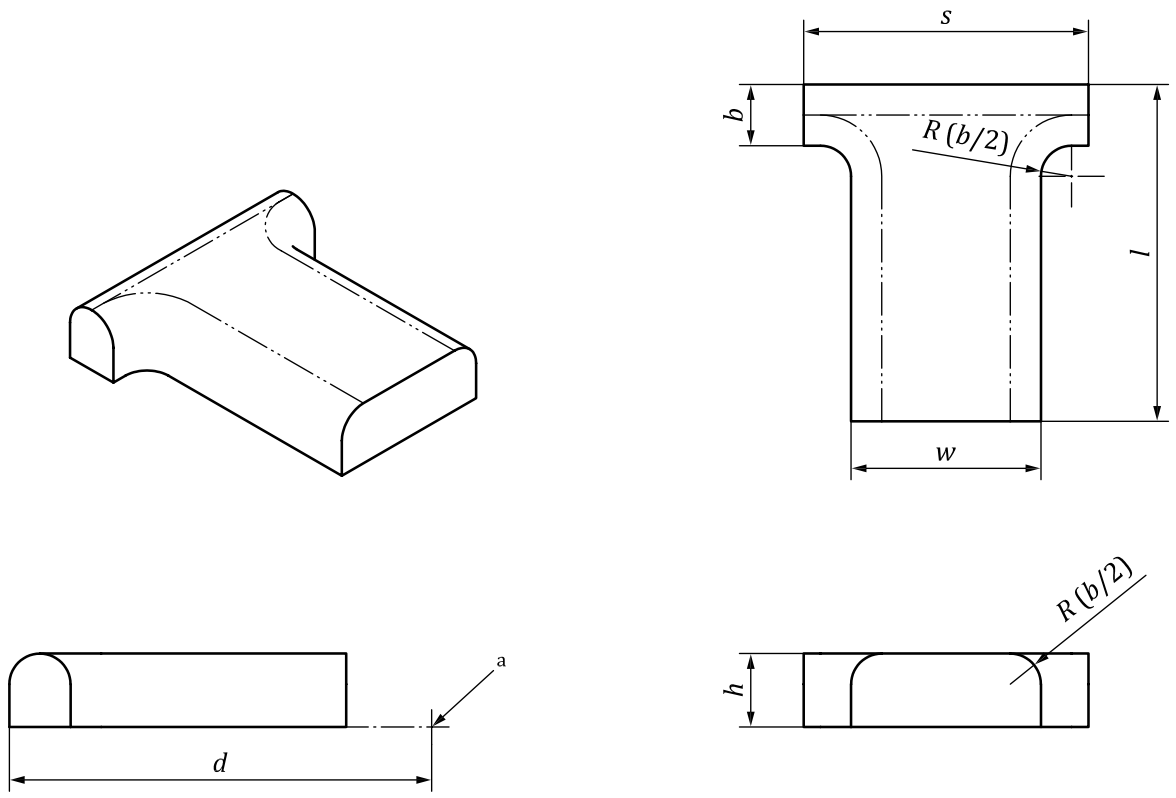


Figure 10 — Torso loading pad (dimensions specified in Table 2)

Table 2 — Dimensions of torso loading pads

Dimensions	User mass				
	25 kg to 49 kg	50 kg to 74 kg	75 kg to 99 kg	≥100 kg	Tolerance
Width, *w* (mm)	200	250	310	360	±10
Height, *h* (mm)	85	100	120	140	±10
Length, *l*	Variable	Variable	Variable	Variable	
Arm width, *b* (mm)	75	80	100	120	±10
Shoulder length, *s* (mm)	300	400	465	525	±10
Shoulder to pivot axis, *d* (mm)	360	535	600	660	±10

4.3.4 **Convex loading pad**, made of a rigid material, as shown in Figure 11.

Dimensions in millimetres

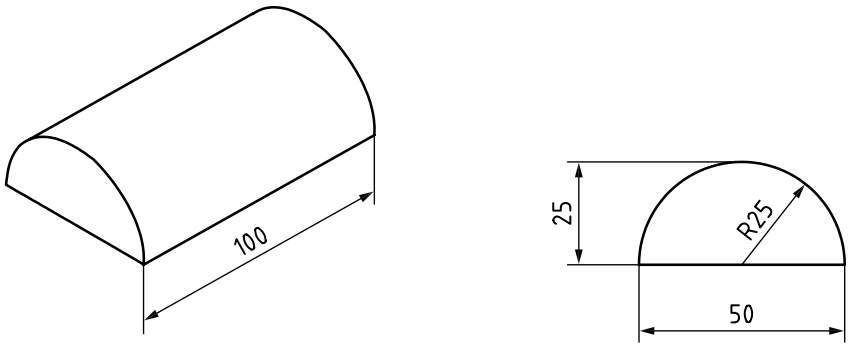


Figure 11 — Example of a convex loading pad (dimensions are illustrative only)

4.3.5 **Concave loading pad**, made of a rigid material, with form as shown in Figure 12.

Dimensions in millimetres

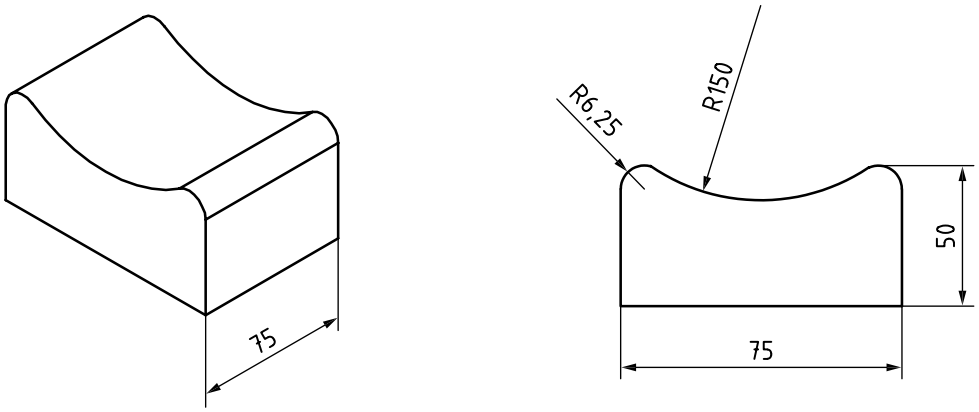


Figure 12 — Example of concave loading pad (dimensions are illustrative only)

4.3.6 Convex hemispherical loading pad, made of a rigid material such as metal or hardwood as shown in Figure 13.

Dimensions in millimetres

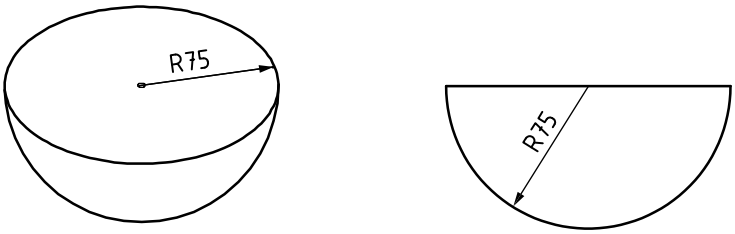


Figure 13 — Example of convex hemispherical loading pad (dimensions are illustrative only)

4.4 Static loading device, a device for applying forces to a PSD, which

a) measures the applied force to an accuracy of ±3 %,

b) applies the force at a rate no greater than 100 N/s,

c) maintains the applied force for a duration no less than 5 s, and

d) measures the displacement of the loading pad during force application.

4.5 Impact loading device, a device for applying an impact load to the PSD as specified below.

4.5.1 Seat surface and back support impact loading device, for applying an impact load to the PSD, consisting of

a) an impact pendulum as specified in 5.5 of ISO 7176-8:1998, and

b) a means to measure the angle of the longitudinal axis of the pendulum prior to being dropped to an accuracy of ±1°.

4.5.2 Foot support impact loading device, consisting of

a) an impact pendulum as specified in 5.7 of ISO 7176-8:1998, and

b) a means to measure the angle of the longitudinal axis of the pendulum prior to being dropped to an accuracy of ±1°.

4.6 Repetitive loading device, a device for repeatedly applying a load to the PSD, which

a) applies the applied force or torque to an accuracy of ±3 %,

b) applies the force or torque at a rate not greater than 100 N/s or 50 Nm/s,

c) completely releases the force or torque,

d) reapplies the force or torque until the specified number of cycles is achieved.

4.7 Test environment, an environment within which to conduct the tests and which can be maintained at (23 ± 10) °C, with relative humidity of (50 ± 35) % as defined in ISO 554.

5 Failure modes

Testing is conducted either until a device is considered to have failed or until completion of a test after which the device is inspected for failure.

The following indicate failure of a device:

a) fractures or visible cracks, tears, or broken stitches that compromise the normal intended use;

b) any detached nut, bolt, screw, locking pin, component, or similar item;

c) slippage in the position or adjustment of a PSD of more than 10 mm at the point of loading compared to its original setup;

d) in the case of any webbing-like material used in a support, a change, as a result of testing, in the pre-test length or angle of the support as reflected by a displacement of the pad of greater than 10 mm and/or 5°;

e) displacement or disconnection of any electrical connector which compromises the normal intended use;

f) any parts intended to be removable, foldable, or adjustable ceasing to operate as described by the manufacturer;

g) any power-operated PSDs ceasing to operate as described by the manufacturer;

h) any multi-position or adjustable PSD becoming permanently displaced more than 10 mm or 5° at the point of loading from the preset position;

i) any component or assembly of parts exhibiting permanent deformation or maladjustment (in addition to slippage);

j) inability to achieve maximum load under specified test conditions.

EXAMPLE Due to excessive excursion.

6 Preparation of PSD for testing

6.1 Secure the PSD to the rigid test fixture specified in 4.1, according to the PSD manufacturer's instructions for attachment to a wheelchair.

6.2 If a PSD is provided with its attachment hardware as a system from a manufacturer, set up the PSD and attachment hardware together as a unit. Secure separate PSDs intended to be attached with hardware, but supplied without attachment hardware, using surrogate attachment hardware as specified in 4.2.

6.3 If a combination of PSDs is provided for testing as a unit from a manufacturer, set up the complete system. Each element of the system shall then be tested as specified in a relevant clause of this part of ISO 16840.

NOTE Various fasteners, e.g. hook and loop, can be used to assist in maintaining the position of PSDs for testing, providing they do not interfere with the test procedure. The loading pad can be connected to an inertial arrestor to prevent injury if the PSD breaks under test loads.

6.4 Adjust all PSDs, including passive support surfaces and active support surfaces, to a configuration which minimizes their ability to withstand static, impact, and repeated loads but which remain within the limits of adjustment specified by the manufacturer.

EXAMPLE An example of the worst-case situation for some PSDs might be a position that would cause a situation of maximum moment arm. For example, with the PSD at full extension, position and angle, and with full lateral offset.

6.5 Tighten all fastenings as specified in the manufacturer's instructions. If not specified, tighten to the minimum torque as specified in ISO 898-7.

NOTE 1 Further information can be obtained through the ISO website (www.iso.org).

NOTE 2 The input hand force required on PSDs which are designed to have frequent adjustments by hand and are supplied with knobs or handles can be found in Table 3. The PSD can be fixed in position using knobs and handles with the forces/torque indicated.

Table 3 — Hand forces for knobs, hand levers, and cranks

Type	Diameter/length (imperial)	Diameter/length (metric)	Force/torque
Knobs	1,5 in to 3,0 in	38 mm to 76 mm	2,3 Nm
Hand levers	2 in	50 mm	66 N
Cranks	3,5 in to 19 in	90 mm to 500 mm	89 N one hand

6.6 Place the PSD in the test environment for acclimatization.

6.7 As the PSD is tested in static, impact, and repeated load testing, there is no specified order of testing and a new PSD shall be used for each test. Do not retighten/readjust the position of the PSD during impact and repeated load testing.

7 Test methods for static strength of PSDs

7.1 Preparation

Prepare the test PSD as specified in Clause 6.

7.2 Test procedure

Conduct the following tests in the test environment specified in 4.7.

Select and, if necessary, modify the most appropriate loading pad from 4.3.

Apply a test load as specified in 7.3 to each of the PSDs according to the relevant procedures in 7.4 to 7.10.

NOTE As the PSD is tested in static, impact, and repeated load testing, there is no specified order of testing and a new PSD can be used for each test.

7.3 Load application

Apply a static force as follows:

a) Align the loading pad to apply the test force or torque at the centre of the support surface within 10 mm. If using a pivoting torso loading pad, align the loading pad relative to the pivot axis per Table 2.

b) For pelvic supports, align the loading pad to apply the force perpendicular, within ±10°, to the support surface. The angle of the force might need to be adjusted to accommodate displacement of the PSD under load.

c) Measure the position of the loading pad under the pre-load load.

d) Apply a force using the static loading device as specified in 4.4.

e) Relax all force to eliminate tension in the support for (30 ± 10) min to allow the support materials to recover from any temporary elongation.

f) Record the following:

1) the maximum displacement permitted by the movement of elastic attachment hardware or deformable support surfaces or passive support surfaces;

2) the force or torque to displace or move components that are designed to move; such components include elastic attachment hardware or deformable support surfaces or passive support surfaces;

3) the maximum force/torque applied;

4) if failure occurs, the force/torque at which it occurs and the type of failure;

5) the offset distance from the attachment point to the point of local application;

6) the rigid test fixture used for each test;

7) the loading pad used for each test.

g) Remove the force or torque.

7.4 Lateral and medial support surface test methods

The following tests apply to, but are not limited to, the following lateral support devices:

— lateral trunk supports;

— lateral pelvic supports;

— lateral upper leg supports;

— lateral knee supports;

— lateral lower leg supports;

— lateral head support;

— medial knee supports.

7.4.1 Lateral supports: outward lateral forces

7.4.1.1 Identify if the lateral support is continuous or discontinuous as specified in 3.5 and 3.6.

7.4.1.2 Select and, if necessary, modify an appropriate-sized loading pad as specified in 4.3.

7.4.1.3 For continuous lateral supports, apply the test force, *F*, as specified in 7.3 but at a point which is 75 % ± 5 % of the total depth of the support, measured from the uncompressed adjacent support surface as shown in Figure 14.

7.4.1.4 For discontinuous lateral supports, apply the test force, *F*, as specified in 7.3 but at a point which is 75 % ± 5 % of the total depth of the support, measured from the uncompressed adjacent support surface as shown in Figure 15.

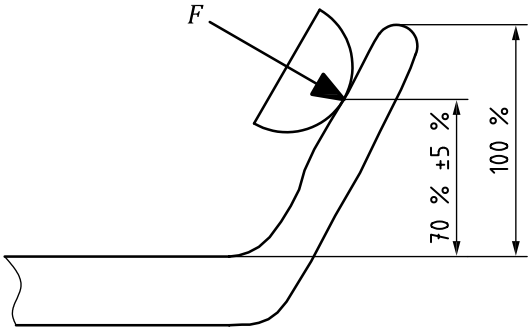


Figure 14 — Example of force application to lateral support continuous with the adjacent support surface

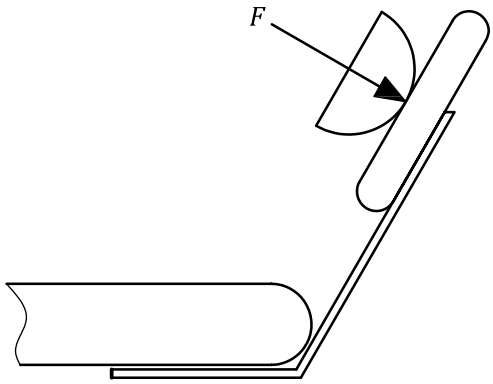


Figure 15 — Example of force application to lateral support discontinuous with the adjacent support surface

7.4.2 Lateral supports: inward lateral forces

The following test procedure is designed to test the inward strength of PSD components that can receive forces during transfer or contact with the environment.

7.4.2.1 Identify if the lateral support is continuous or discontinuous as specified in 3.5 and 3.6.

7.4.2.2 Select and, if necessary, modify an appropriate-sized loading pad as specified in 4.3.

7.4.2.3 For continuous lateral supports, apply the inward test force, *F*, as specified in 7.3 but at a point which is (75 ± 5) % of the total depth of the support measured from the uncompressed adjacent support surface as shown in Figure 16.

7.4.2.4 For discontinuous lateral supports, apply the inward test force, *F*, as specified in 7.3 but at a point which is (70 ± 5) % of the total depth of the support measured from the uncompressed adjacent support surface as shown in Figure 17.

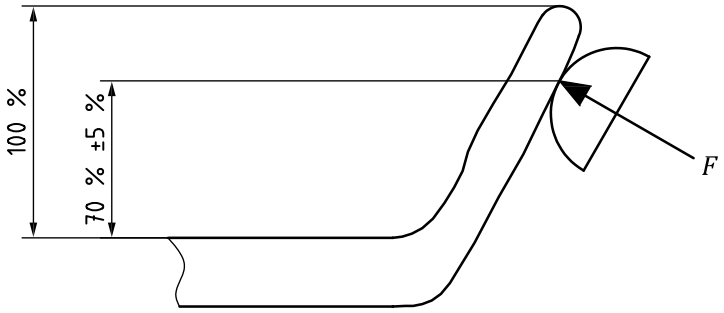


Figure 16 — Example of force application to lateral support continuous with the adjacent support surface

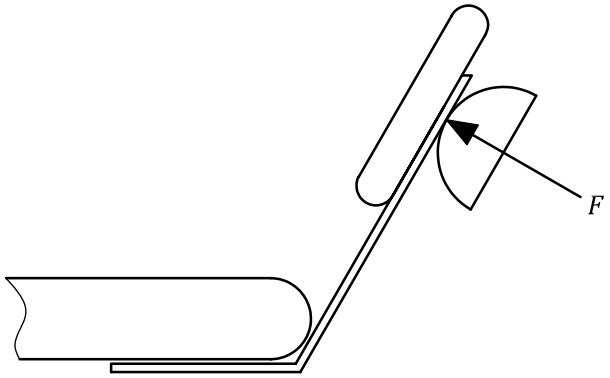


Figure 17 — Example of force application to lateral support discontinuous from its adjacent support surface

7.4.3 Medial knee supports: inward forces

7.4.3.1 Identify if the medial support is continuous or discontinuous as specified in 3.5 and 3.6.

7.4.3.2 Select and, if necessary, modify an appropriate-sized loading pad as specified in 4.3.

7.4.3.3 For medial knee supports, apply the test force in the inward direction as specified in 7.3 to the centre of the support surface ±10 mm.

NOTE This load simulates the inward forces on a medial knee support in the horizontal plane.

7.5 Anterior pelvic and trunk support: anterior forces

7.5.1 Pelvic support

7.5.1.1 For the purpose of selecting the appropriate pelvic loading pad, the "user mass" for the support being tested shall be the maximum user mass specified by the manufacturer as suitable for the support. Select the appropriate pelvic loading pad (as specified in 4.3). For supports that use straps, attach the straps to an adjustable rigid test frame (as specified in 4.1.1) or surrogate support surface (as specified in 4.1.2). The mounting point separation on the adjustable rigid test frame shall be as specified in Table 4. Research has demonstrated that the most adverse condition for testing anterior pelvic supports occurs with the smallest size user and the closest mounting point separation.

EXAMPLE An example of the test setup is given in Figure 18.

7.5.1.2 Set up a means for applying the test force, so that the line of force application is perpendicular to the adjustable rigid test frame representing the seat surface. The line of force application shall also be at the midpoint of the loading pad.

7.5.1.3 Apply the pre-load as specified in Table 4.

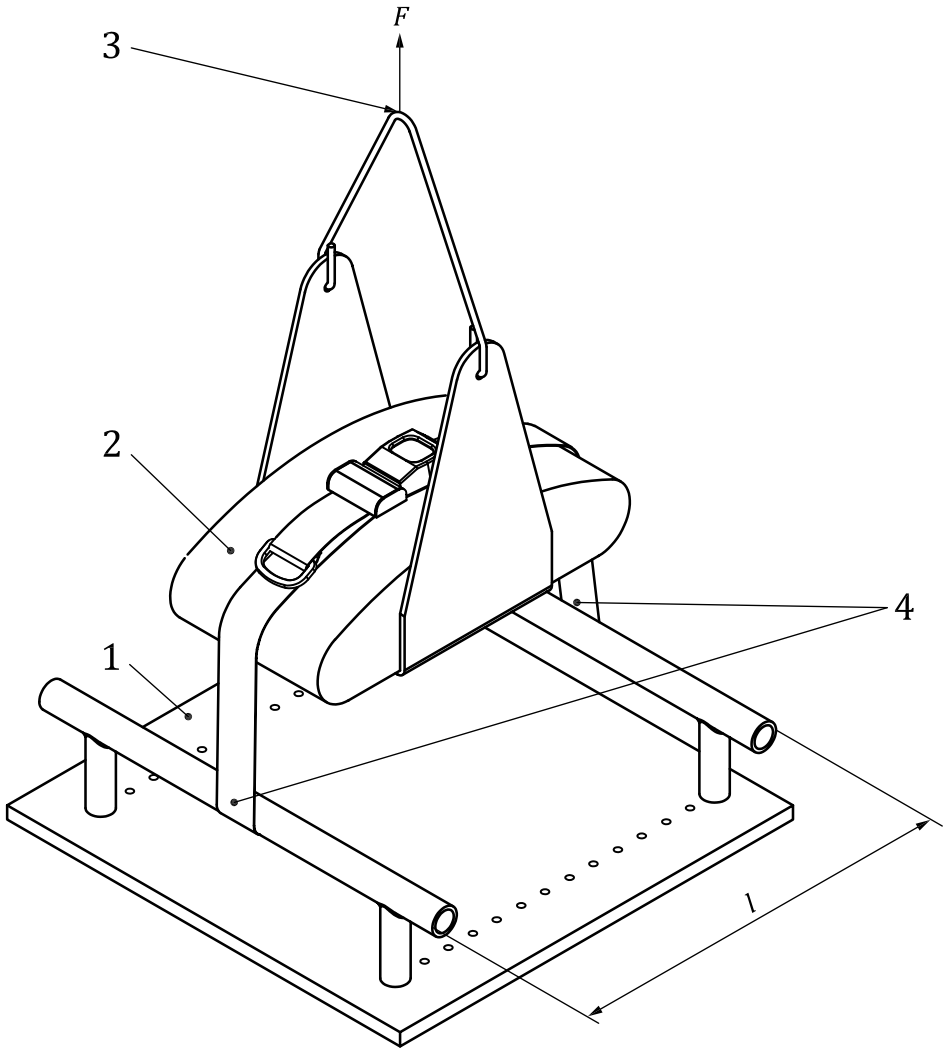
7.5.1.4 Measure the position of the loading pad or devise a means to use this position as a zero reference to measure from in steps 7.5.1.6 and 7.5.1.8 below.

7.5.1.5 Apply the test force away from the test frame surface, against the anterior pelvic support as specified in 7.3, to the maximum force specified in Table 4.

7.5.1.6 If no failure has occurred according to Clause 5, record the maximum displacement of the loading pad.

7.5.1.7 Relax all force to eliminate tension in the support for (30 ± 10) min to allow the support materials to recover from any temporary elongation.

7.5.1.8 Apply the pre-load force again as specified in Table 4 and measure the position of the loading pad. Any difference between this position and the original position found in 7.5.1.4 is the displacement resulting from permanent deformation of the support. Record the displacement permitted by the support.



Key

1 adjustable rigid test frame
2 pelvic convex loading pad
3 midpoint of the loading pad
4 mounting points
F test force
l mounting point separation
a The adjustable rigid test frame is attached to the anterior pelvic support.

Figure 18 — Example of test setup for static load testing of the anterior pelvic support

Table 4 — Anterior pelvic support mounting point separation and static load parameters

Parameter	User mass						
	25 kg	50 kg	75 kg	100 kg	125 kg	>150 kg	Tolerance
Mounting point separation (mm)	280	360	430	480	530	580	±30 mm
a Maximum load is based on 10 × (mass) expressed in Newtons.							

Table 4 *(continued)*

Parameter	User mass						
	25 kg	**50 kg**	**75 kg**	**100 kg**	**125 kg**	**>150 kg**	**Tolerance**
Pre-load (N)	50	50	50	50	50	50	±3 %
Maximum load (N)[a]	250	500	750	1 000	1 250	1 500	±3 %
[a] Maximum load is based on 10 × (mass) expressed in Newtons.							

7.5.2 Trunk support

7.5.2.1 For the purpose of selecting the appropriate torso loading pad, the "user mass" for the support being tested shall be the maximum user mass specified by the manufacturer as suitable for the support. Select the appropriate torso loading pad (as specified in 4.3). For supports that use straps, attach the straps to an adjustable rigid test frame (as specified in 4.1.1) or surrogate support surface (as specified in 4.1.2). Attach the loading pad to the pivoting test frame (as specified in 4.1.3). See example in Figure 7. Install the support to the test frame or surrogate support surface according to the manufacturer's instructions.

7.5.2.2 Devise a means of applying torque to the pivoting test frame. (See example in Figure 6.) Locate the torso loading pad in relationship to the pivot axis per Table 2. (See Figure 7 for an example setup.)

7.5.2.3 Apply the setup torque as specified in Table 5.

7.5.2.4 Measure the angular position of the loading pad.

7.5.2.5 Apply the test torque away from the test frame surface, against the anterior trunk support as specified in 7.3, to the maximum torque specified in Table 5.

7.5.2.6 If no failure has occurred according to Clause 5, record the maximum angular displacement of the loading pad.

7.5.2.7 Relax all torque to eliminate tension in the support for (30 ± 10) min to allow the support materials to recover from any temporary elongation.

7.5.2.8 Apply the setup torque again as specified in Table 5 and measure the angular position of the loading pad. Any difference between this angle and the original angle found in 7.5.2.4 is the displacement resulting from permanent deformation of the support. Record the displacement angle permitted by the support.

Table 5 — Anterior trunk support static load parameters

Parameter	User mass						
	25 kg	**50 kg**	**75 kg**	**100 kg**	**125 kg**	**>150 kg**	**Tolerance**
Setup torque (Nm)	18	27	30	33	36	39	±3 %
Maximum torque[a] (Nm)	63	185	315	460	630	820	±3 %
a Maximum load is based on 7 × (mass) × (pivot length, d/1 000) expressed in Newton-metres.							

7.6 Head support: posterior forces

7.6.1 Select and, if necessary, modify the convex hemispherical loading pad specified in 4.3.6.

7.6.2 Apply the test force, *F*, in increments of 15 N (±3 %).

7.6.3 Set up a means for applying the test force, *F*, so that its line of action is perpendicular to the head support surface and its point of application is at the centre (tolerance ±10 mm) of the head support surface as shown in Figure 19.

7.6.4 Additionally, set up a means for applying the test force, *F*, perpendicular to the head support surface at points 35 mm ± 5 mm horizontally in turn right and left of the centre of the head support surface.

7.6.5 Apply each of these test forces as specified in 7.3.

7.6.6 Any lateral head supports should be tested as specified in 7.4.

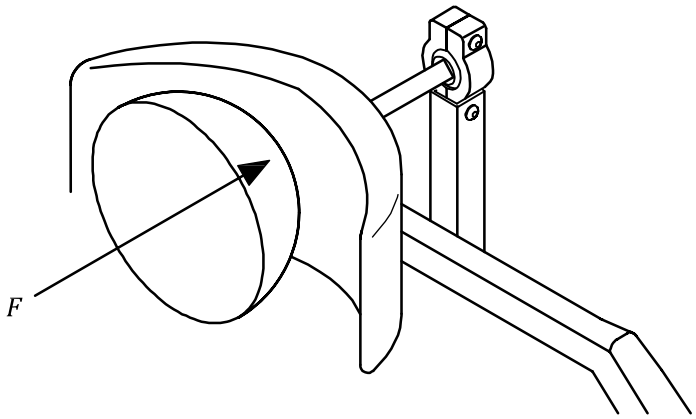


Figure 19 — Example of posterior force application to head support

7.7 Back support: posterior force

7.7.1 Select and, if necessary, modify an appropriately sized loading pad specified in 4.3.

7.7.2 Set up a means for applying a force, *F*, so that its point of application is at the midline (tolerance ±10 mm) of the top of the back support surface and its line of action is at an angle of 40° to 50° to the back support surface as shown in Figure 20.

7.7.3 Apply the test force as specified in 7.3.

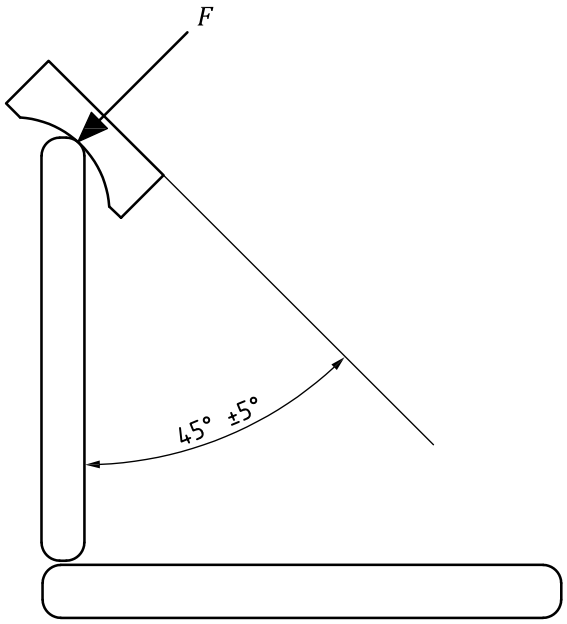


Figure 20 — Example of posterior force application to back support

7.8 Back support: anterior forces

7.8.1 Select and, if necessary, modify an appropriate-size loading pad as specified in 4.3.

7.8.2 Set up a means for applying a force, *F*, so that its line of action is along the midline (tolerance ±10 mm) and perpendicular to the back support surface and its point of application is at 30 mm ± 10 mm below the top of the back support surface as shown in Figure 21. If there are difficulties in establishing this location, use the back support reference plane as defined in ISO 7176-26.

7.8.3 Apply the test force, *F*, as specified in 7.3.

Dimensions in millimetres

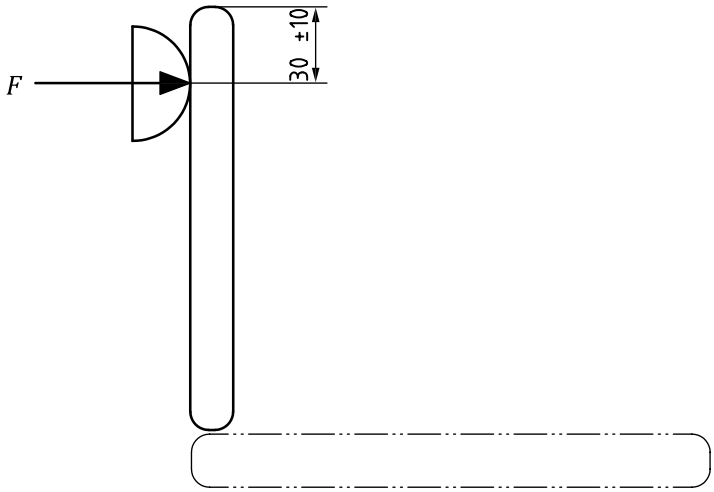


Figure 21 — Example of anterior force application to back support

7.9 Arm supports, integral: downward forces

This test applies only to PSDs that include arm supports.

Carry out the test procedure specified in 8.4 of ISO 7176-8:1998 with the PSD mounted in the rigid test fixture as specified in 4.1.

NOTE This part of ISO 16840 does not address upwards forces on arm supports integral to PSDs. It is considered to be unrealistic to apply the test for lifting a wheelchair and occupant to a PSD since the type and mass of the wheelchair, on which the PSD would be used, are not predictable.

7.10 Foot supports, integral: downward forces

This test applies only to PSDs which include foot supports.

Carry out the test procedure specified in 8.5 of ISO 7176-8:1998 with the PSD mounted in the rigid test fixture as specified in 4.1.

NOTE This part of ISO 16840 does not address upwards forces on foot supports integral to PSDs. It is considered to be unrealistic to apply the test for lifting a wheelchair and occupant to a PSD since the type and mass of the wheelchair, on which the PSD would be used, are not predictable.

8 Test methods for impact strength

8.1 Preparation

Prepare the test PSD as specified in Clause 6.

8.2 Test procedure — general

Conduct the tests within this clause in the test environment specified in 4.7. If the rigid test fixture is used in a vertical orientation, Table 6 provides information on the vertical drop height for a given pendulum angle.

Apply an impact load to each of the PSDs according to the relevant procedures in 8.3 to 8.5.

As the PSD is tested to failure in static, impact, and repeated load testing, there is no specified order of testing and a new PSD shall be used for each test.

8.3 Back support resistance: posterior impact

8.3.1 Set up the impact loading device specified in 4.5.1 so that the pendulum is vertical ±1° when the ball strikes the back support surface.

8.3.2 Adjust the pendulum so that the impact load is normal to the back support reference plane as defined in ISO 7176-26:2007, 4.9.2, and its point of application is 30 mm ± 10 mm below the top of the back support surface as shown in Figure 22.

8.3.3 Raise the pendulum by 5° ± 1° from touching the back support and then release it to strike the back support as shown in Figure 22.

8.3.4 If any failure mode specified in Clause 5 occurs, record the failure mode and discontinue testing following the instruction specified in 8.3.6.

8.3.5 Repeat the impact increasing the release angle of the pendulum by 5° until any failure mode specified in Clause 5 occurs, or until the release angle reaches 90°.

8.3.6 Record the maximum pendulum angle achieved and the vertical drop height of the ball as specified in Table 6.

Dimensions in millimetres

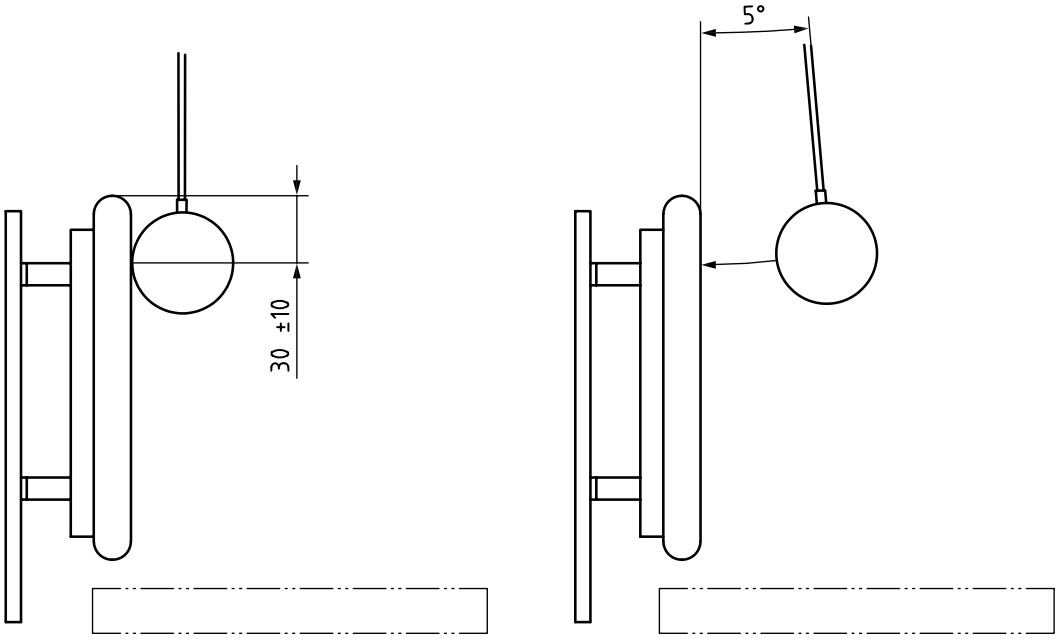


Figure 22 — Back support impact test alignment and setup

Table 6a — Vertical drop heights derived from angles of vertical pendulum (1 000 mm arm length)

Pendulum angle degrees	**Vertical drop height** mm	**Pendulum angle** degrees	**Vertical drop height** mm	**Pendulum angle** degrees	**Vertical drop height** mm
5	4	35	181	65	577
10	15	40	234	70	658
15	34	45	293	75	741
20	60	50	357	80	826
25	94	55	426	85	913
30	134	60	500	90	1 000

Table 6b — Vertical drop heights derived from angles of vertical pendulum (1 200 mm arm length)

Pendulum angle degrees	**Vertical drop height** mm	**Pendulum angle** degrees	**Vertical drop height** mm	**Pendulum angle** degrees	**Vertical drop height** mm
5	5	35	217	65	692
10	18	40	281	70	790
15	41	45	352	75	889
20	72	50	428	80	991
25	113	55	511	85	1 096
30	161	60	600	90	1 200

8.4 Foot supports: impact for PSDs with integral foot supports

8.4.1 This test applies to PSDs with integral foot supports.

8.4.2 Position the rigid test fixture such that its foot support surface is vertical ±1°.

8.4.3 Set up the impact loading device specified in 4.5.2 with the pendulum vertical ±1° and central (tolerance ±10 mm) to the front edge of one foot support. For PSDs with a single, integral foot support, set up the impact loading device with the pendulum vertical ±1° and central (tolerance ±10 mm) to the front edge of the foot support.

8.4.4 Lift and release the pendulum, starting at 5° ± 1°.

8.4.5 If any failure mode specified in Clause 5 occurs, record the failure mode and discontinue testing following the instruction specified in 8.4.7.

8.4.6 Repeat the impact increasing the starting angle of the pendulum by 5° until any failure mode specified in Clause 5 occurs, or until the impact angle reaches 90°.

8.4.7 Record the maximum pendulum angle achieved.

8.5 Seat surface: impact

8.5.1 Position the rigid test fixture such that the seat surface is vertical ±1°.

8.5.2 Set up the impact loading device specified in 4.5.1 so that the pendulum is vertical ±1° when the ball strikes the seat surface.

8.5.3 Adjust the pendulum so that the impact load is applied to a point 75 mm ± 25 mm posterior to the front edge of the seat surface as shown in Figure 23.

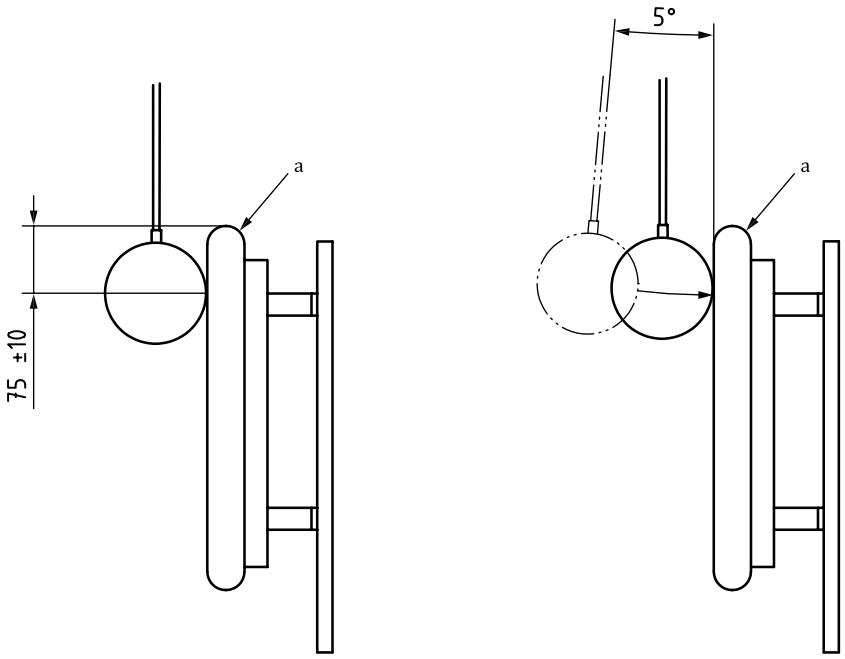
8.5.4 Lift and release the pendulum starting at 5° ± 1° to strike the seat surface as shown in Figure 23.

8.5.5 If any failure mode specified in Clause 5 occurs, record the failure mode and discontinue testing following the instruction specified in 8.5.7.

8.5.6 Repeat the impact increasing the starting angle of the pendulum by 5° until any failure mode specified in Clause 5 occurs, or until the impact angle reaches 90°.

8.5.7 Record the maximum pendulum angle achieved and the vertical drop height of the ball as specified in Table 6.

Dimensions in millimetres



Key
a Front element of PSD.

Figure 23 — Setup for seat surface resistance to impact test

9 Test methods for repetitive load

These tests apply to seat surfaces, back supports, and anterior pelvic and thoracic support devices.

9.1 Preparation

Set up the PSD as specified in Clause 6.

9.2 Test procedure

9.2.1 Conduct the following tests in the test environment specified in 4.7.

9.2.2 Apply a repetitive test load to each of the PSDs according to the relevant procedures in 9.3 to 9.5.

9.2.3 As the PSD is tested to failure in static, impact, and repeated load testing, there is no specified order of testing and a new PSD shall be used for each test.

9.2.4 Record the following:

a) the maximum displacement permitted by the movement of elastic attachment hardware or deformable support surfaces or passive support surfaces;

b) the force or torque to displace or move components that are designed to move; such components include elastic attachment hardware or deformable support surfaces or passive support surfaces;

c) maximum force or torque applied;

d) if failure occurs, the force or torque at which it occurs and the type of failure;

e) the offset distance (moment) from the attachment point to the point of local application;

f) the rigid test fixture used for each test;

g) the loading pad used for each test;

h) cycles completed.

9.3 Seat surface: repetitive load

9.3.1 Mount the seat support on a rigid test fixture as specified in 4.1.

9.3.2 Select the loading pad as specified in 4.3.1.

9.3.3 Set up the means to apply a repetitive load, as specified in 4.6, such that the loading pad is perpendicular, within ±5°, to the seat surface and in the centreline, within ±10 mm, of the seat surface.

9.3.4 Set the repetitive test load within 10 % of L, calculated by Formula (1):

$$L = 10 \times m \tag{1}$$

where

L is the numerical value of the repetitive test load, expressed in Newtons (N);

m is the numerical value of the maximum user mass recommended by the manufacturer, expressed in kilograms.

9.3.5 Apply the repetitive test load, as specified in 4.6. This test is derived from an assumption of a user loading a seat 10 times per hour over a 15 h day, for a 7 d week.

9.3.6 If any failure mode specified in Clause 5 occurs, record the number of cycles and the failure mode, and discontinue testing.

NOTE Test to intended use and report number of cycles.

9.4 Back support: repetitive load

9.4.1 Mount the back support on a rigid test fixture as specified in 4.1.

9.4.2 Select the appropriate loading pad as specified in 4.3.3.

9.4.3 Set up the means to apply a repetitive load, as specified in 4.6, such that the loading pad is perpendicular, within ±5°, to the back support and in the centreline, within ±10 mm, of the back support.

9.4.4 Set the repetitive test load within 10 % of L, calculated by Formula (1).

9.4.5 Apply the repetitive test load, as specified in 4.6.

9.4.6 If any failure mode specified in Clause 5 occurs, record the number of cycles and the failure mode, and discontinue testing.

NOTE Test to intended use and report the number of cycles.

9.5 Anterior pelvic support: repetitive load

9.5.1 Throughout this clause, the anterior pelvic support will be referred to as support; the applicable pelvic loading pad will be referred to as the loading pad.

9.5.2 Set up each support and the associated testing equipment as specified in 7.5.1.1 and 7.5.1.2.

9.5.3 Set up the means to apply a repetitive load, as specified in 4.6, such that the loading pad is perpendicular, within ±5°, to the support and in the centreline, within ±10 mm, of the support.

9.5.4 Pre-load the support by applying a pre-load to the loading pad as given in Table 7.

9.5.5 Measure the position of the loading pad or devise a means to use this position as a zero reference to measure from in 9.5.10 below.

9.5.6 Set the repetitive test load to the maximum load as given in Table 7.

9.5.7 Apply the repetitive test load as specified in 4.6 for 1 000 cycles.

9.5.8 If any failure mode specified in Clause 5 occurs during the 1 000 cycles, record the failure mode and the number of cycles and discontinue testing.

9.5.9 Relax all force to eliminate tension in the support for (30 ± 10) min to allow the support materials to recover from any temporary elongation.

9.5.10 Apply the pre-load specified in Table 7 and measure the position of the loading pad. Any difference between this position and the original position found in 9.5.5 is the displacement resulting from permanent deformation of the support. Record the displacement.

Table 7 — Anterior pelvic support mounting point separation and repetitive load parameters

Parameter	User mass						
	25 kg	50 kg	75 kg	100 kg	125 kg	>150 kg	Tolerance
Mounting point separation (mm)	280	360	430	480	530	580	±30 mm
Pre-load (N)	50	50	50	50	50	50	±3 %
Maximum load (N)[a]	125	250	375	500	625	750	±3 %

[a] Maximum load is based on 5 × (mass) expressed in Newtons.

9.6 Anterior trunk support: repetitive load

9.6.1 Throughout this clause, the anterior trunk support will be referred to as support; the applicable variable torso loading pad will be referred to as the convex loading pad.

9.6.2 Set up each support and the associated testing equipment as specified in 7.5.2.1 and 7.5.2.2.

9.6.3 Set up the means to apply a repetitive torque, as specified in 4.6, such that the loading pad is located relative to the pivot axis according to Table 2.

9.6.4 Pre-load the support by applying a setup torque per Table 8 to the pivoting test frame.

9.6.5 Record the angular position of the loading pad.

9.6.6 Set the repetitive load to the maximum torque as given in Table 8.

9.6.7 Apply the repetitive test torque as specified in 4.6, for 1 000 cycles.

9.6.8 If any failure mode specified in Clause 5 occurs during the 1 000 cycles, record the failure mode and the number of cycles and discontinue testing.

9.6.9 Relax all torque to eliminate tension in the support for (30 ± 10) min to allow the support materials to recover from any temporary elongation.

9.6.10 Apply the setup torque specified in Table 8 and measure the angular position of the loading pad. Any difference between this angle and the original angle found in 9.6.5 is the displacement resulting from permanent deformation of the support. Record the displacement angle.

Table 8 — Anterior trunk support repetitive load parameters

Parameter	User mass						
	25 kg	50 kg	75 kg	100 kg	125 kg	>150 kg	Tolerance
Setup torque (Nm)	18	27	30	33	36	39	±3 %
Maximum torque (Nm)[a]	31	92	157	230	315	410	±3 %

[a] Maximum load is based on 3,5 × (mass) × (pivot length, d/1 000) expressed in Newton-metres.

10 Test report

The test report shall contain the following:

a) a statement that the PSD and attachment hardware have been tested to this part of ISO 16840 (ISO 16840-3);

b) the name and address and accreditation status of the organization that performed the tests;

c) the name and address of the manufacturer of the PSD;

d) the date of issue of the test report;

e) the model designation, part number, and/or any other information that will uniquely identify the postural support device;

f) the maximum user mass intended for use of the PSD;

g) a list of all the tests applied to the device;

h) the rigid test fixtures and/or adjacent parts used for each test;

i) description of setting, adjustments of PSDs used for each test;

j) in addition, for static test results,

   1) the maximum elastic deformation of the PSD, before one of the failure modes occur,

2) the maximum force or torque achieved,

3) if failure occurs, the type of failure as specified in Clause 5,

4) the offset distance (moment) to the point of force or torque application from the attachment point to the adjacent PSD;

k) in addition, for impact test results,

1) the pendulum release angle before the failure modes occur, or a statement that there was no failure as a result of the test,

2) the vertical drop height of the ball, and

3) if failure occurs, the type of failure as specified in Clause 5;

l) in addition, for repetitive load test results,

1) the force or torque applied during repetitive loading to the seat support, back support, anterior pelvic support and/or anterior trunk support,

2) if failure occurs, the type of failure as specified in Clause 5,

3) the number of cycles completed, and

4) either: a) the linear displacement resulting from permanent deformation as measured in 9.5.10 or b) the angular displacement resulting from deformation as measured in 9.6.10;

m) a statement of the type or types of covering material on the PSD.

11 Disclosure requirement

The following results from Clause 10 shall be disclosed in the manufacturer's presale literature and product literature as specified in ISO 7176-15.

Report the test results:

— for static tests, Clause 10 j) 2) and j) 4);

— for impact tests, Clause 10 k) 1) and 10 k) 2);

— for repetitive load testing, Clause 10 l) 1) and l) 4).

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