INTERNATIONAL STANDARD

ISO 16840-3

First edition
2006-07-01

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
ISO 16840-3:2006(E)

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Published in Switzerland

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Foreword

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

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

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

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

ISO 16840-3 was prepared by Technical Committee ISO/TC 173, *Assistive products for persons with disability*, Subcommittee SC 1, *Wheelchairs*.

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*

The following parts are under preparation:

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

— *Part 5: Determination of pressure relief characteristics of seat cushions intended to manage tissue integrity*

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 should 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. Forces are then applied to simulate static loads encountered during normal use. Impact and repeated loads are also applied to simulate normal usage. The rigid test fixture is utilized to provide a worst-case situation, which is repeatable and avoids destroying multiple wheelchairs during testing. There is no minimum performance requirement currently specified in this part of ISO 16840. Usually tests are performed at increasing force until one or more failures occur. Repeated load tests are performed at a specific force until one or more failures occur. It is not required to test beyond a noted number of cycles.

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 wheelchairs.

This part of ISO 16840 does not test the transportability or the use of the PSD in a motor vehicle.

NOTE At the present time there are no minimum or maximum strength requirements specified in the test procedures for testing for PSDs. In the future, minimum or maximum loads for testing might be specified for testing on a pass/fail basis. The maximum displacement, the maximum force achieved before failure and the type of failure that occurs is disclosed for comparison purposes.

2 Normative references

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

ISO 554:1976, *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, *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 given 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 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 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 extends a minimum of 75 mm forward/upward of 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°

See Figure 1.

NOTE 1 Figure 2 shows a support with a contoured surface that is not considered to be a lateral support.

NOTE 2 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

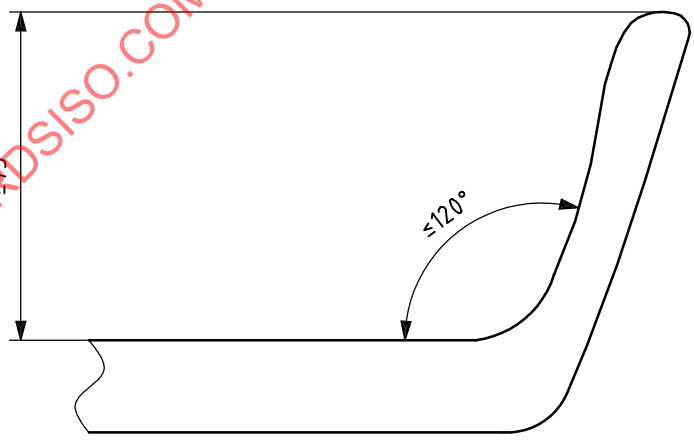


Figure 1 — Cross-section of a support surface with continuous lateral support

Dimensions in millimetres

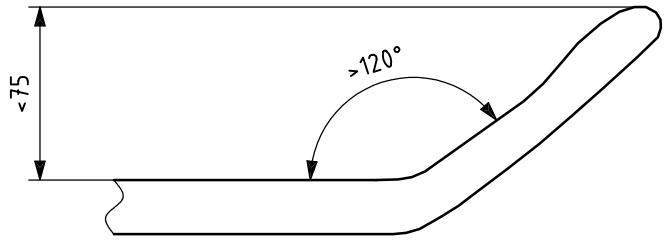


Figure 2 — Cross-section of a support surface with a contour not considered a lateral support

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

See Figure 3.

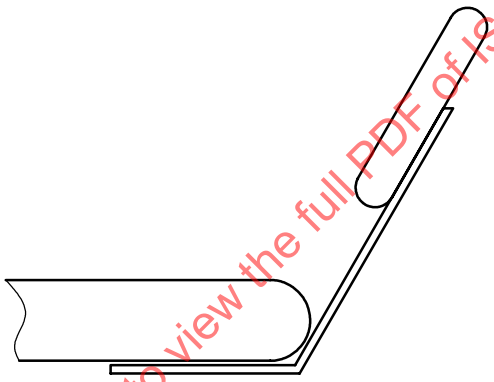


Figure 3 — Example of a lateral support discontinuous with the adjacent support surface

3.7
anchor point
intended attachment point or points of any PSD

4 Test apparatus

4.1 Rigid test fixtures, for securing or positioning PSDs during testing as specified below.

4.1.1 Adjustable rigid test frame, for simulating the tubes of 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.

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.

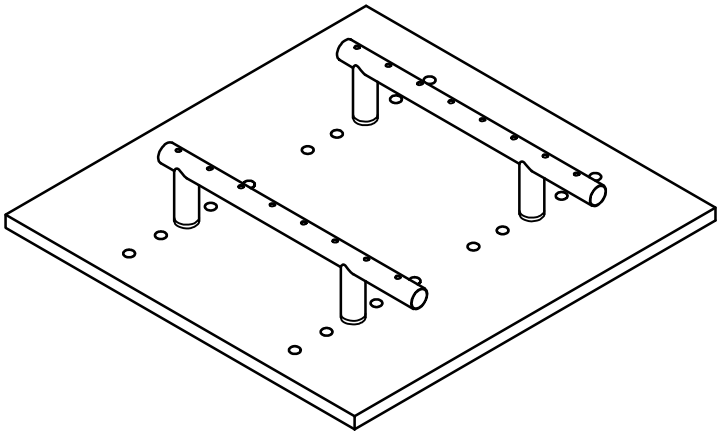
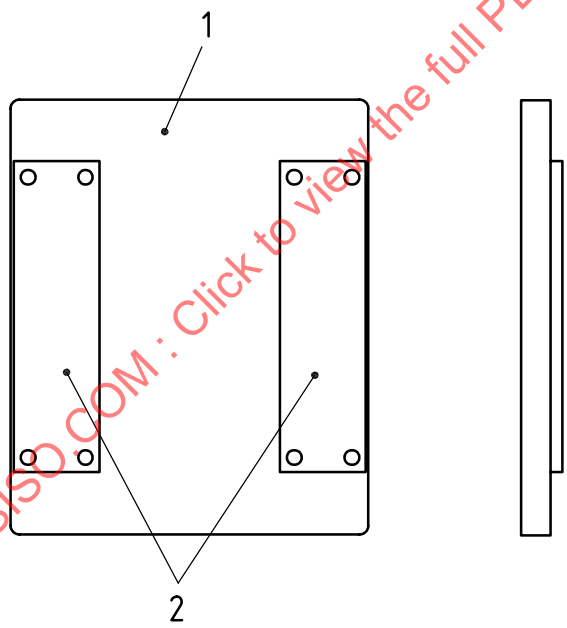


Figure 4 — Example of an adjustable rigid test frame

4.1.2 Rigid surrogate support surface, of securing attachment hardware for PSDs intended to be used with rigid flat support surfaces but which are provided without rigid flat support surfaces.

An example of a rigid surrogate support surface is shown in Figure 5. Holes may be drilled or other modifications made to accommodate the mounting of a variety of attachment hardware.



Key

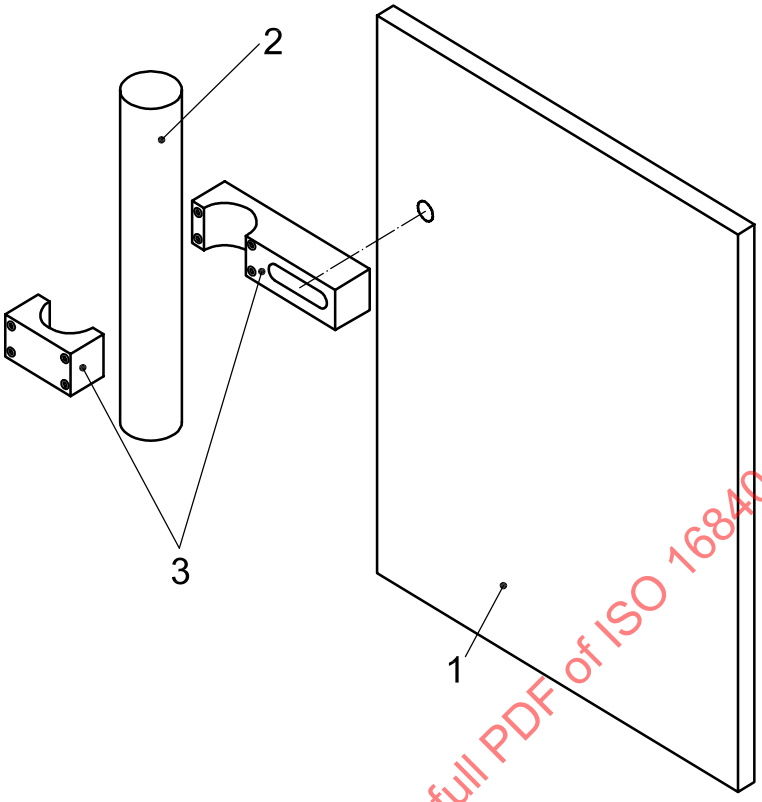
1 plywood

2 steel

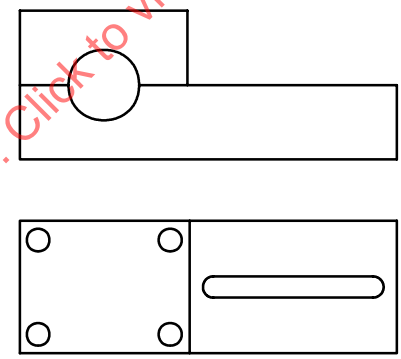
Figure 5 — Example of rigid surrogate support surface for testing attachment hardware

4.2 Surrogate attachment 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.

An informative example of surrogate attachment hardware is shown in Figure 6.



a) Set-up of surrogate attachment hardware



b) Detail of surrogate attachment hardware

Key

1 rigid surrogate support surface
2 member of PSD
3 surrogate attachment hardware

Figure 6 — Example set-up of surrogate attachment hardware to secure PSD

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

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

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

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

— 25 kg;

— 50 kg;

— 75 kg;

— 100 kg.

Add a maximum of 10 mm foam padding to the outer surface of the loading pad with a vinyl or fabric cover to reduce the friction 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 7 illustrates the features of the variable convex loading pad when used with the specifications contained in Table 1.

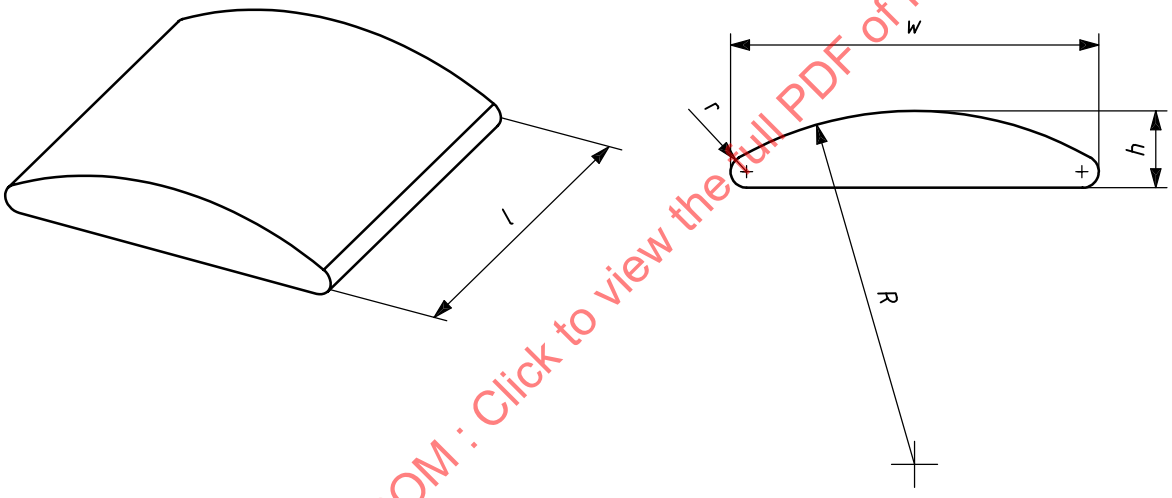


Figure 7 — Variable convex loading pad

Table 1 — Variable convex loading pad dimensions

Dimensions	User mass				
	25 kg	50 kg	75 kg	⩾ 100 kg	Tolerance
Width (mm), w	210	270	323	360	± 10
Height (mm), h	62	79	95	106	± 5
Length, l	Variable [a]	Variable [a]	Variable [a]	Variable [a]	
Convex radius (mm), R	210	270	323	360	± 10
Radius of side edge (mm), r	21	27	32	36	± 3

[a] To fit PSD being tested.

4.3.3 Variable torso convex loading pad, made of a rigid material, of variable size to simulate the upper torso. Based on anthropometric data for different body sizes, the following torso convex loading pads are specified:

— 25 kg;

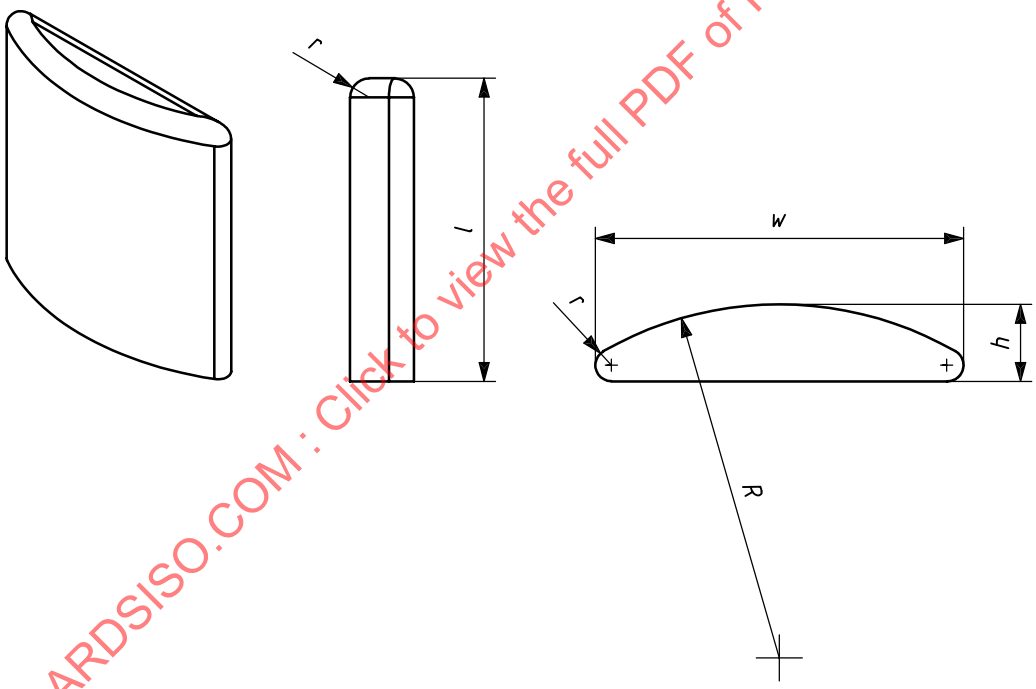
— 50 kg;

— 75 kg;

— 100 kg.

Add a maximum of 10 mm foam padding to the outer surface of the loading pad with a vinyl or fabric cover to reduce the friction 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 8 illustrates the features of the variable torso convex loading pad when used with the specifications contained in Table 1.



NOTE The top end of the loading pad in Figure 8 is curved to avoid cutting “over the shoulder” devices.

Figure 8 — Variable torso convex loading pad

4.3.4 **Convex loading pad**, made of a rigid material, as shown in Figure 9. Dimensions are illustrative only.

Dimensions in millimetres

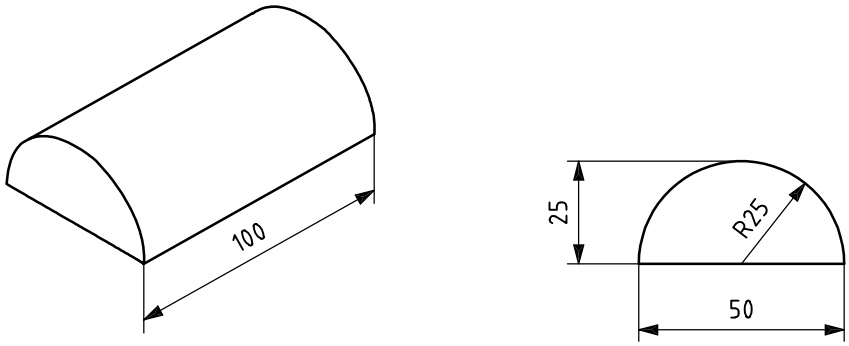


Figure 9 — Example of a convex loading pad

4.3.5 **Concave loading pad**, made of a rigid material, as shown in Figure 10. Dimensions are illustrative only.

Dimensions in millimetres

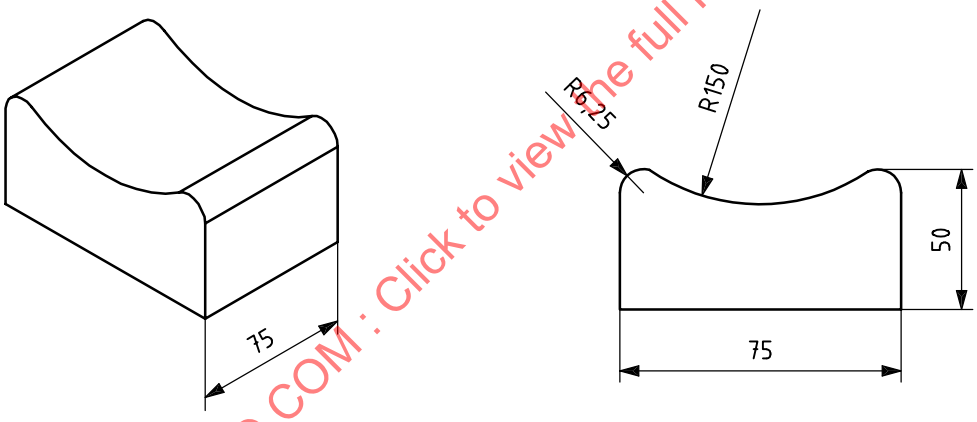


Figure 10 — Example of concave loading pad

4.3.6 **Convex hemispherical loading pad**, made of a rigid material such as metal or hardwood as shown in Figure 11. Dimensions are illustrative only.

Dimensions in millimetres

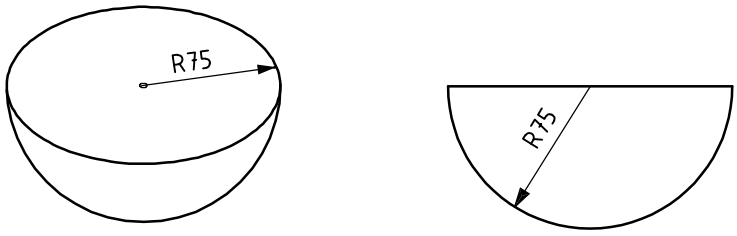


Figure 11 — Example of convex hemispherical loading pad

4.4 Static loading 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 movement of the loading pad during force application.

NOTE Pre-loading up to 5 N may assist with the set up and accuracy of measuring force application angles.

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

4.5.1 Seat surface, back support and head 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 for repeatedly applying a load to the PSD, which

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

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

c) releases the force,

d) reapplies the force until the specified number of cycles is achieved, and

e) avoids a frequency of loading that is the resonant frequency of any active support surface.

NOTE Pre-loading to 5 N can assist with the set up and accuracy of measuring load angles.

4.7 Test environment within which to conduct the tests and which can be maintained at 23 °C ± 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 are specifications indicating failure of a device:

a) fractures or visible cracks, tears or broken stitches (but cracks in surface finishes, such as paint, that do not extend into the structure of the material do not constitute a failure);

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 set-up;

d) in the case of any webbing-like material used in a support, either

— an increase (elasticity), during any test condition, greater than 10 % of the length of the support, or

— an increase, as a result of testing, in the pre-tensioned length greater than 5 % of the length of the support;

e) displacement or disconnection of any electrical connector;

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 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) the applied load starting to decrease as a result of the PSD beginning to yield or deform.

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.

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.

6.3 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 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.

6.4 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 Further information can be obtained through the ISO web site (www.iso.ch). At the time this document was published, a document called "fasteners1.pdf" could be downloaded which contained a list of ISO standards concerning fasteners.

6.5 Place the test PSD in the test environment for at least 60 min before 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.

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.

7.3 Load application

Apply a static force as follows.

a) Align the loading pad to apply the test force at the centre of the support surface within ± 10 mm.

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

c) Measure the position of the loading pad where it first touches the PSD.

d) Apply a force using the static loading device as specified in 4.4, until one or more of the failure modes listed in Clause 5 occurs.

e) 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 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 force at which failure occurs;

   4) the type of failure;

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

   6) the rigid test fixture used for each test;

   7) the loading pad used for each test.

f) Remove the force.

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

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

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

c) For continuous lateral supports, apply the test force, F, as specified in 7.3 but at a point which is 70 % to 80 % of the total depth of the support, measured from the uncompressed adjacent support surface as shown in Figure 12.

d) For discontinuous lateral supports, apply the test force, F, as specified in 7.3 to the centre ± 10 mm of the support surface as shown in Figure 13.

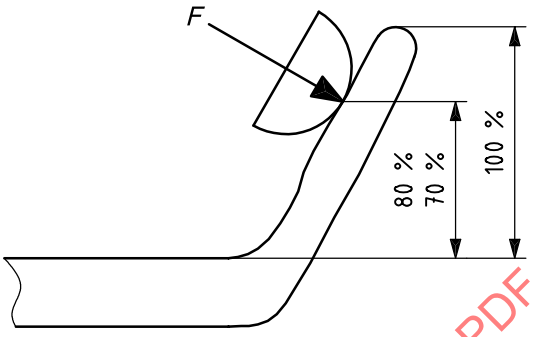


Figure 12 — Example of force application to lateral support continuous with the adjacent support surface

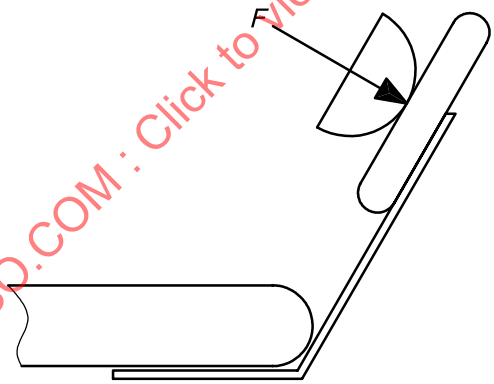


Figure 13 — Example of force application to lateral support discontinuous with the adjacent support surface

7.4.2 Lateral supports: inward lateral forces

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

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

b) Select and if necessary modify an appropriate sized loading pad as specified in 4.3.

c) For continuous lateral supports apply the inward test force, F, as specified in 7.3 but at a point which is 70 % to 80 % of the total depth of the support measured from the uncompressed adjacent support surface as shown in Figure 14.

d) For discontinuous lateral supports, apply the inward test force, F, as specified in 7.3 to the centre within ± 10 mm of the support surface as shown in Figure 15.

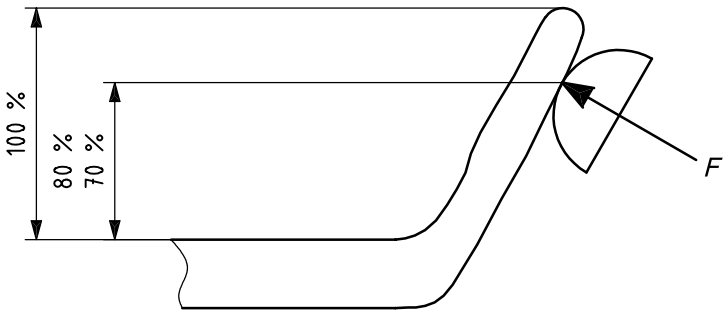


Figure 14 — Example of force application to lateral support continuous with the adjacent support surface

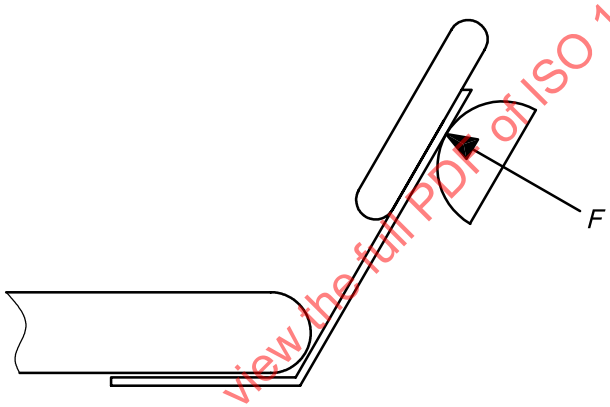


Figure 15 — Example of force application to lateral support discontinuous from its adjacent support surface

7.4.3 Medial knee supports: inward forces

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

b) Select and if necessary modify an appropriate sized loading pad as specified in 4.3.

c) 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 support and anterior trunk support: anterior forces

a) For the purpose of selecting the appropriate convex loading pad, the “user mass” for the support being tested shall be the minimum user mass specified by the manufacturer as suitable for the support. Select the appropriate variable convex loading pad or variable torso convex 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). For supports that attach by a rigid means to the wheelchair, attach to an adjustable rigid test frame. The anchor point separation to the adjustable rigid test frame shall be as specified in Table 2. Research has demonstrated that the most adverse condition for testing anterior pelvic supports and anterior trunk supports occurs with the smallest size user and the closest anchor point separation.

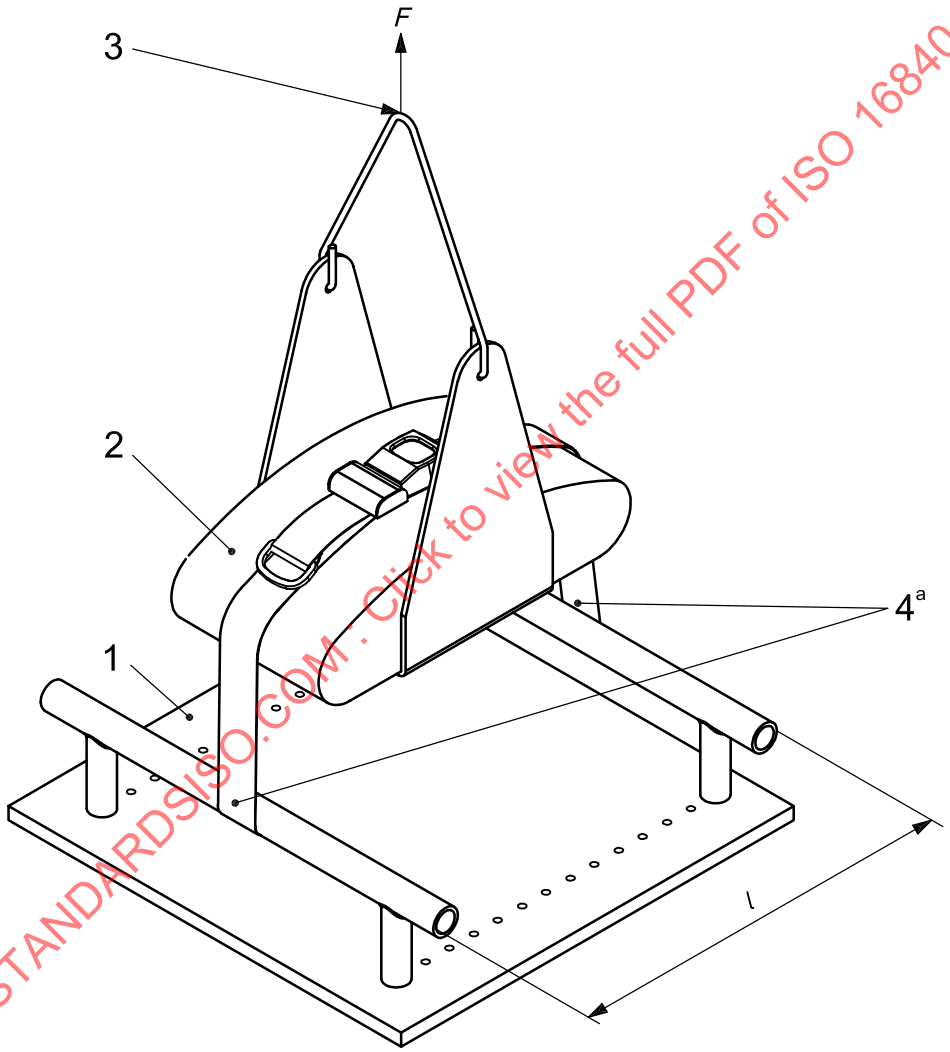
An example of the test set-up is given in Figure 16.

Table 2 — Anchor point separation dimensions

User mass	25 kg	50 kg	75 kg	100 kg	125 kg	⩾ 150 kg
Anchor point separation, l (mm) [a]	280 ± 30	360 ± 30	430 ± 30	480 ± 30	530 ± 30	580 ± 30
[a] See Figure 16.						

b) 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 mid-point of the loading pad.

c) Apply the test force away from the test frame surface, against the anterior pelvic support or anterior trunk support as specified in 7.3.



Key

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

Figure 16 — Example of test set-up for static load testing of the anterior pelvic support

7.6 Head support: posterior forces

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

b) 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 17.

c) Apply the test force as specified in 7.3.

d) Additionally, set up a means for applying the test force perpendicular to the head support surface at points 35 mm ± 5 mm horizontally on each side of the centre of the head support surface.

e) Apply each of these test forces as specified in 7.3.

Any lateral head supports should be tested as specified in 7.4

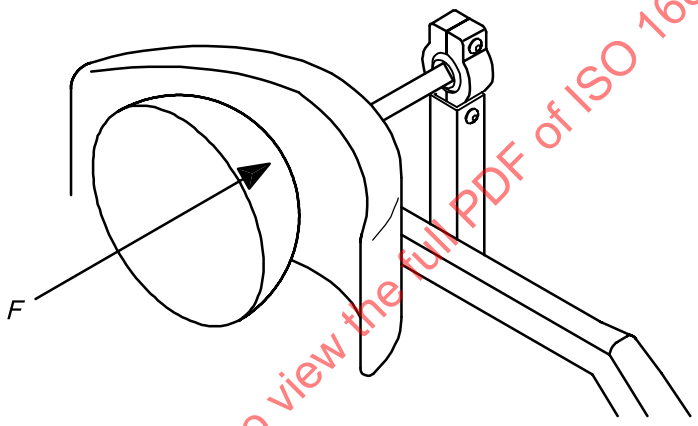


Figure 17 — Example of posterior force application to head support

7.7 Back support: posterior force

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

b) 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 18.

c) Apply the test force as specified in 7.3.

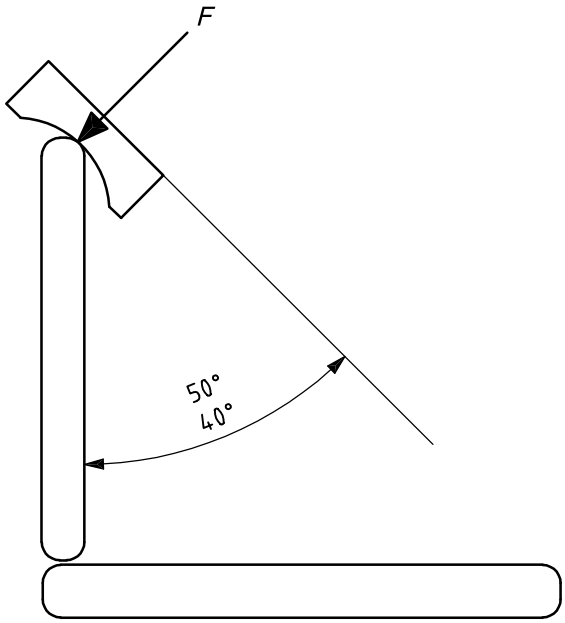


Figure 18 — Example of posterior force application to back support

7.8 Back support: anterior forces

a) Select and if necessary modify an appropriate size loading pad as specified in 4.3.

b) 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 19. If there are difficulties in establishing this location, use the back support reference plane as defined in ISO 7176-26.

c) Apply the test force, F, as specified in 7.3.

Dimensions in millimetres

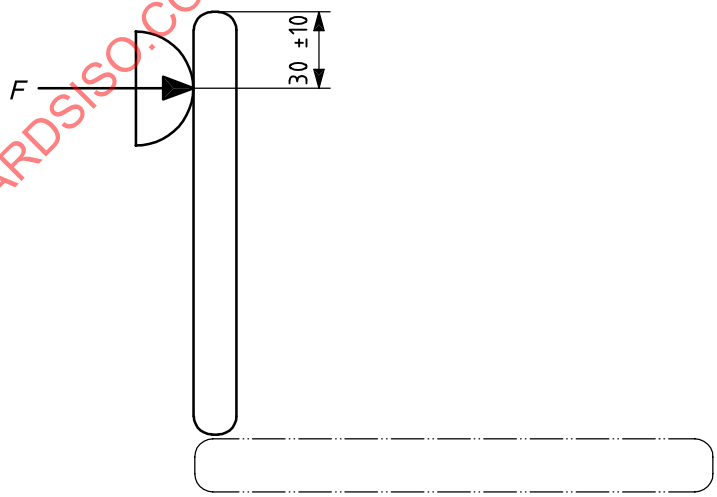


Figure 19 — Example of anterior force application to back support

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

Conduct the following tests in the test environment specified in 4.7. If the rigid test fixture is used in a vertical orientation, Table 3 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 8.6.

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

a) 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.

b) Adjust the pendulum so that the impact load is normal to the back support reference plane as defined in ISO 7176-26, and its point of application is 30 mm ± 10 mm below the top of the back support surface as shown in Figure 20.

c) Raise the pendulum by 5° ± 1° from touching the back support and then release it to strike the back support as shown in Figure 20.

d) If any failure mode specified in Clause 5 occurs, record the failure mode and discontinue testing following the instruction specified in f).

e) 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°.

f) Record the maximum pendulum angle achieved and the vertical drop height of the ball as specified in Table 3.

Dimensions in millimetres

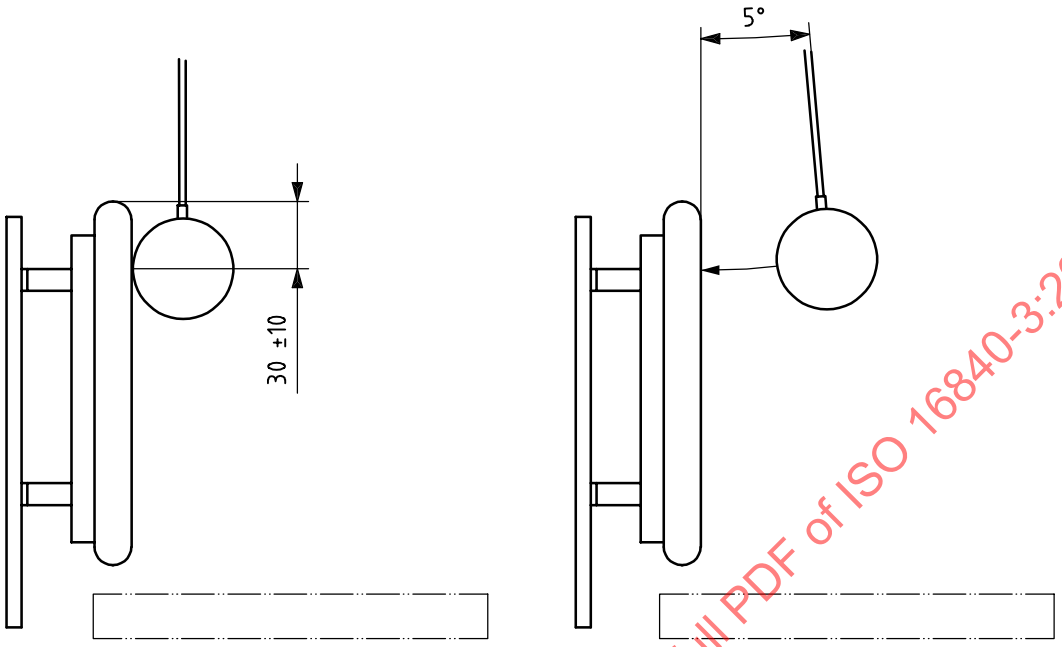


Figure 20 — Back support impact test alignment and set-up

Table 3 — Vertical drop heights derived from angles of vertical pendulum

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

8.4 Head support resistance: posterior impact

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

b) Set up the impact loading device specified in 4.5.1 so that the pendulum is vertical ± 1° when the ball strikes the head support.

c) Adjust the pendulum so that the impact load is perpendicular to and central (tolerance ± 10 mm) to the head support surface.

d) Raise the pendulum by 5° ± 1° from touching the head support and then release it to strike the head support.