INTERNATIONAL STANDARD

ISO 7176-23

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Wheelchairs —

Part 23: Requirements and test methods for attendant-operated stair-climbing devices

Fauteuils roulants —

Partie 23: Exigences et méthodes d'essai pour les monte-escalier manipulés par une tierce personne

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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

Attention is drawn to the possibility that some of the elements of this part of ISO 7176 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 7176-23 was prepared by Technical Committee ISO/TC 173, *Technical systems and aids for disabled or handicapped persons*, Subcommittee SC 1, *Wheelchairs*.

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

— *Part 1: Determination of static stability*

— *Part 2: Determination of dynamic stability of electric wheelchairs*

— *Part 3: Determination of efficiency of brakes*

— *Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range*

— *Part 5: Determination of overall dimensions, mass and turning space*

— *Part 6: Determination of maximum speed, acceleration and deceleration of electric wheelchairs*

— *Part 7: Measurement of seating and wheel dimensions*

— *Part 8: Requirements and test methods for static, impact and fatigue strengths*

— *Part 9: Climatic tests for electric wheelchairs*

— *Part 10: Determination of obstacle-climbing ability of electric wheelchairs*

— *Part 11: Test dummies*

— *Part 13: Determination of coefficient of friction of test surfaces*

— *Part 14: Power and control systems for electric wheelchairs — Requirements and test methods*

— *Part 15: Requirements for information disclosure, documentation and labelling*

— *Part 16: Resistance to ignition of upholstered parts — Requirements and test methods*

— *Part 19: Wheeled mobility devices for use in motor vehicles*

— *Part 22: Set-up procedures*

— *Part 23: Requirements and test methods for attendant-operated stair-climbing devices*

The following parts are also on the programme of work:

— *Part 20: Determination of the performance of stand-up wheelchairs*

— *Part 21: Electromagnetic compatibility of electrically powered wheelchairs and motorized scooters — Requirements and test methods*

— *Part 24: Requirements and test methods for user-operated stair-climbing devices*

— *Part 25: Requirements and test methods for batteries and their chargers for powered wheelchairs and motorized scooters*

— *Part 26: Vocabulary*

Annexes A to D of this part of ISO 7176 are for information only.

Introduction

The goal of this part of ISO 7176 is to create a common understanding, and to develop a means of qualifying and quantifying the various conditions and environments encountered in stair-climbing operations, and stair-climbing device performance. If the stair-climbing device can be used as a wheelchair, it shall also meet all ISO requirements for wheelchairs. This will allow the users and manufacturers to evaluate and communicate the pertinent safety and utility issues.

These tests are used to gather comparison information about factors relating to the performance of the stair-climbing device whilst in stair-climbing mode on stairs and on level ground. They include identification of suitable operating environments for each device and indications of various performance criteria in stair-climbing mode for on-stair operations and on level ground.

NOTE 1 When ascending stairs, present known attendant-operated stair-climbing devices are driven backwards, which means that the attendant goes backwards up the stairs with the occupant facing downstairs. Descending stairs is performed forwards with the occupant facing downstairs.

NOTE 2 Elements of this part of ISO 7176 may be used as a basis for developing requirements and test methods for stair-climbing devices not covered by this part of ISO 7176.

This part of ISO 7176 calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the manufacturer or test house from legal obligations relating to health and safety at any stage.

NOTE 3 The attendant should be familiar with the operation of the stair-climbing device and not apply forces other than those minimally necessary to operate the device.

Some stair-climbing devices may have adjustable components and/or alternative parts. Where there is an obligation to ensure that all variations conform to this part of ISO 7176, it is for those commissioning the tests to decide, which configurations should be tested.

It is anticipated that this part of ISO 7176 will continue to be developed and future revisions may include the results of ongoing work in the following areas:

— fatigue-strength test for joystick;

— determination of static stability on winding stairs;

— development of the fatigue-strength test for stair-climbing devices in informative annex B to a normative test method;

— development of the edge stop test in annex C to a normative test method;

— development of the configuration and position of the stair-climbing device for stability tests in annex D to a normative test method.

Wheelchairs —

Part 23: Requirements and test methods for attendant-operated stair-climbing devices

1 Scope

This part of ISO 7176 specifies requirements and test methods for electrically propelled stair-climbing devices and stair-climbing wheelchair carriers operated by an attendant. It also includes ergonomic, safety labelling and disclosure requirements.

This part of ISO 7176 is applicable to stair-climbing devices for which the attendant walks directly behind the device and where the device is driven backwards when ascending stairs.

NOTE This means that when ascending stairs the attendant walks backwards up the stairs, with the occupant facing downstairs. Descending stairs is performed forwards with the occupant facing downstairs.

2 Normative references

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

ISO 3880-1, *Building construction — Stairs — Part 1: Vocabulary.*

ISO 6440, *Wheelchairs — Nomenclature, terms and definitions.*

ISO 7176-1, *Wheelchairs — Part 1: Determination of static stability.*

ISO 7176-3, *Wheelchairs — Part 3: Determination of efficiency of brakes.*

ISO 7176-4, *Wheelchairs — Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range.*

ISO 7176-6, *Wheelchairs — Part 6: Determination of maximum speed, acceleration and deceleration of electric wheelchairs.*

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

ISO 7176-9, *Wheelchairs — Part 9: Climatic tests for electric wheelchairs.*

ISO 7176-11, *Wheelchairs — Part 11: Test dummies.*

ISO 7176-13, *Wheelchairs — Part 13: Determination of coefficient of friction of test surfaces.*

ISO 7176-14, *Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods.*

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

ISO 7176-16:1997, *Wheelchairs — Part 16: Resistance to ignition of upholstered parts — Requirements and test methods.*

ISO 7176-19, *Wheelchairs — Part 19: Wheeled mobility devices for use in motor vehicles.*

ISO 7176-21, *Wheelchairs — Part 21: Electromagnetic compatibility of electrically powered wheelchairs and motorized scooters — Requirements and test methods.*

ISO 7176-22, *Wheelchairs — Part 22: Set-up procedures.*

ISO 7193, *Wheelchairs — Maximum overall dimensions.*

3 Terms and definitions

For the purposes of this part of ISO 7176, the terms and definitions given in ISO 3880-1, ISO 6440, ISO 7176-15 and the following apply.

3.1
stair-climbing device
electrically propelled stair-climbing wheelchair or wheelchair carrier

3.2
attendant-operated stair-climbing wheelchair
wheelchair, operated by an attendant, intended by the manufacturer to be powered up and down on stairs with a seated occupant

3.3
attendant-operated stair-climbing wheelchair carriers
portable device, operated by an attendant, intended by the manufacturer to be attached to a wheelchair in order to power it up and down on stairs with a seated occupant

3.4
climbing
ascent or descent of stairs

3.5
winding stairs
stairs built in a curved construction

NOTE Normally the steps on winding stairs are wider on one side and narrower on the other side (see Figure 2).

3.6
attendant
person operating the stair-climbing device, not sitting on the device

3.7
occupant
person being transported by the stair-climbing device

3.8
U-shaped stairs
two flights of stairs at an angle of 180° to each other and connected by an intermediate landing

3.9
skew angle
angle of deviation between the pitch line of the stair and the axes of movement of the stair-climbing device

3.10
edge stop
device to stop forward movement of a balancing stair-climbing device when approaching the nosing of a downward step

NOTE See annex C.

4 Test apparatus and conditions

4.1 Test apparatus

In addition to the test apparatus specified below, further test apparatus described in the normative references are also required.

4.1.1 Standard test stairs with eight steps having a rise of 180 mm ± 5 mm and an overall pitch of 35° with a tolerance of $^{+1}_{0}{}^{\circ}$ (see Figure 1). A riser shall close the front face of each step. All nosing shall fall within a region contained between two imaginary parallel planes 10 mm apart and inclined at the overall pitch angle of the stairs.

The nosing shall be of a rigid material, smooth and rounded to a radius of 8 mm ± 1 mm. Each step shall be level and shall have a coefficient of friction that complies with ISO 7176-13. The width of the stairs shall be at least 500 mm wider than the stair-climbing devices under test, including the attendant. A fixed barrier shall limit the stair width on one side and sideways adjustable barriers on each step shall limit the stair width on the other side. The height of the barriers shall be 1 800 mm ± 100 mm above the stairs. The test stairs shall be capable of being connected to the landing platform (see 4.1.3). Provision for a handrail to be mounted if required shall be incorporated on both sides.

4.1.2 Winding test stairs with eight steps having a rise of 180 mm ± 5 mm. The winding angle shall be 19° ± 0,5° per step. The stair nosing shall have a tangentiality to the central axis of the stair of 75 mm ± 20 mm. The going/run of each step shall be 257 mm ± 10 mm at a point which is 760 mm ± 10 mm apart from the central axis of the stair when measured parallel to the stair nosing. The inner radius of the stair shall be 310 mm ± 10 mm. A riser shall close the front face of each step (see Figure 2).

The nosing shall be of a rigid material, smooth and rounded to a radius of 8 mm ± 1 mm. Each step shall be level and shall have a coefficient of friction that complies with ISO 7176-13. The width of the stairs shall be at least 500 mm wider than the stair-climbing devices under test, including the attendant. Movable barriers shall limit the stair width on each step on the outer side and a fixed barrier shall limit the stair width on the inner side. The height of the barriers shall be 1 800 mm ± 100 mm above the stairs. The test stairs shall be capable of being connected to the landing platform (see 4.1.3). Provision for a handrail to be mounted if required shall be incorporated on both sides.

4.1.3 Landing platform with a height equal to the height of the top step in 4.1.1 and 4.1.2 with a tolerance of ± 5 mm. The top of the platform shall be covered with a material whose coefficient of friction complies with ISO 7176-13. On one side the platform shall be capable of being rigidly connected to the test stairs. On the other sides the platform shall be equipped with movable barriers with a height of 1 800 mm ± 100 mm.

Recommended area of the platform is 2 m × 4 m.

NOTE If convenient, the test equipment in 4.1.1, 4.1.2 and 4.1.3 can be built in one piece.

Dimensions in millimetres

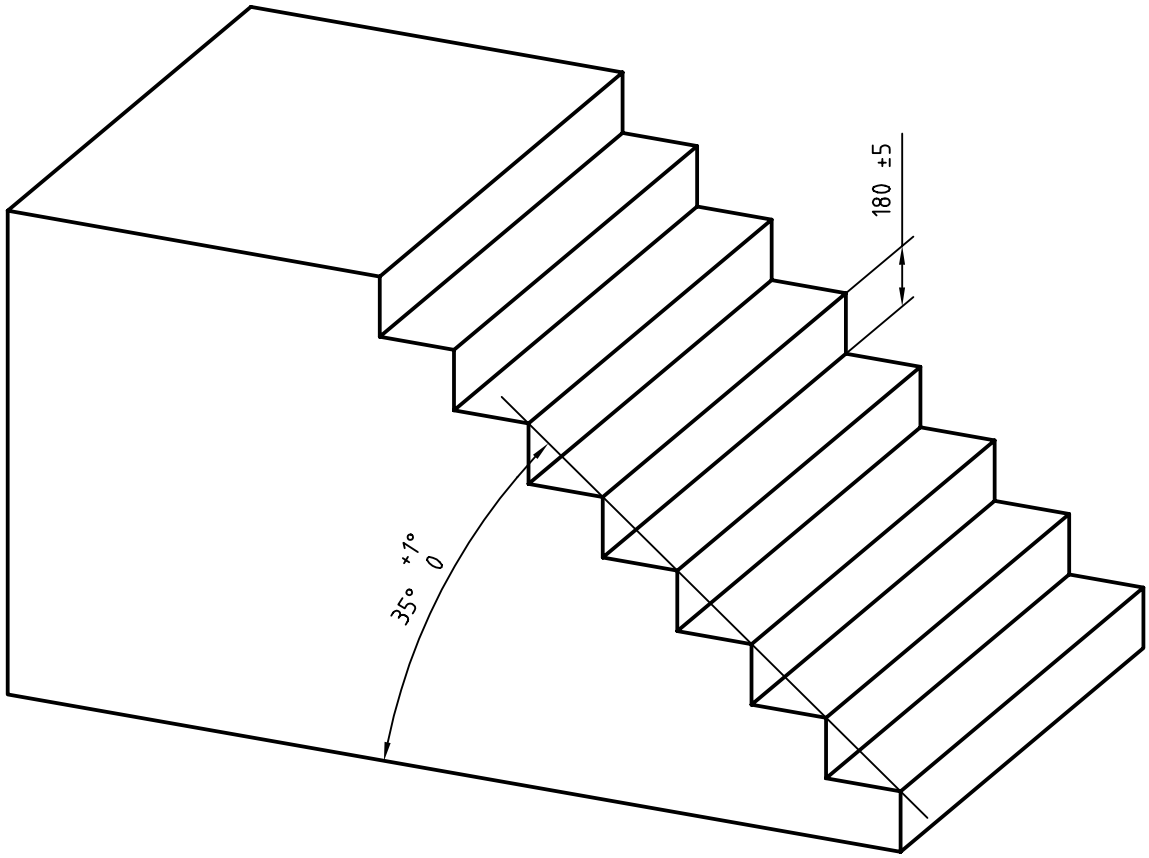


Figure 1 — Standard test stair with landing (see 4.1.1)

Dimensions in millimetres

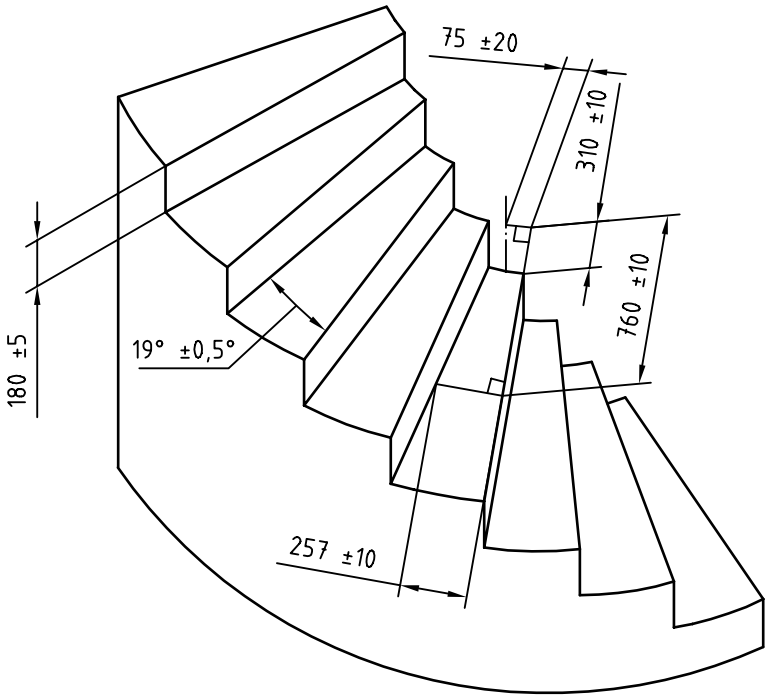


Figure 2 — Winding test stair (see 4.1.2)

4.1.4 Rigid horizontal test plane of sufficient size to accommodate the stair-climbing device during testing, such that the whole surface is contained between two imaginary parallel planes 5 mm apart. The surface of the plane shall have a coefficient of friction as defined in ISO 7176-13.

NOTE The imaginary planes are intended to provide a measure of control on the flatness of the test plane.

4.1.5 Test wheelchair recommended by the manufacturer of the stair-climbing device. If the manufacturer recommends several wheelchairs, priority shall be given to those conforming with ISO 7193. If no wheelchair is recommended, a wheelchair that conforms with ISO 7193 shall be used, or a surrogate wheelchair in accordance with specifications given in annex A.

4.1.6 Standard test dummy in accordance with ISO 7176-11, modified as follows:

Replace the lower leg portions of the 100 kg, 75 kg and 50 kg dummies with two footpieces with a shape that permits ready attachment to the footrests and which have the following properties:

a) mass 3,5 kg ± 0,5 kg;

b) height of centre of gravity 20 mm ± 2 mm above footplate surface.

NOTE 1 Two steel blocks each having dimensions 75 mm × 150 mm × 40 mm are suitable as footpieces.

NOTE 2 A human test occupant with the same mass may be used instead of the test dummy.

4.1.7 Energy consumption instrumentation, a device capable of measuring the ampere-hours used by the stair-climbing device which does not itself use more than 0,5 % of the ampere-hours used by the stair-climbing device.

4.1.8 Device for measuring time with an accuracy of 0,1 s.

4.1.9 Lifting gear for lifting the standard test stairs relative to the horizontal for the purposes of the test specified in 9.3.2.

4.1.10 Device for measuring linear dimensions up to 2 m with an accuracy of ± 1 mm.

4.1.11 Rectangular attendant-space gauge to simulate the space an attendant occupies when operating the stair-climbing device (see Figure 3), with a horizontal length of 640 mm ± 10 mm and horizontal width of 560 mm ± 10 mm or the distance between the midpoint of the handgrips of the tested stair-climbing device plus 200 mm ± 10 mm, whichever is larger. Both rear corners shall be rounded with a radius of 200 mm ± 10 mm. It shall be possible to attach the gauge to the midpoint of the handgrips of the tested stair-climbing device.

NOTE A frame made of wood or steel wire is suitable.

4.1.12 Rectangular foot-space gauge to simulate the area the feet of the occupant occupies when sitting on the stair-climbing device or the test wheelchair (see Figure 4), with a horizontal length of 300 mm ± 10 mm and a horizontal width of 300 mm ± 10 mm. Both front corners shall be rounded with a radius of 100 mm ± 10 mm. It shall be possible to attach the gauge to the footrest of the stair-climbing device so that it is in line with it and in line with the stair-climbing device.

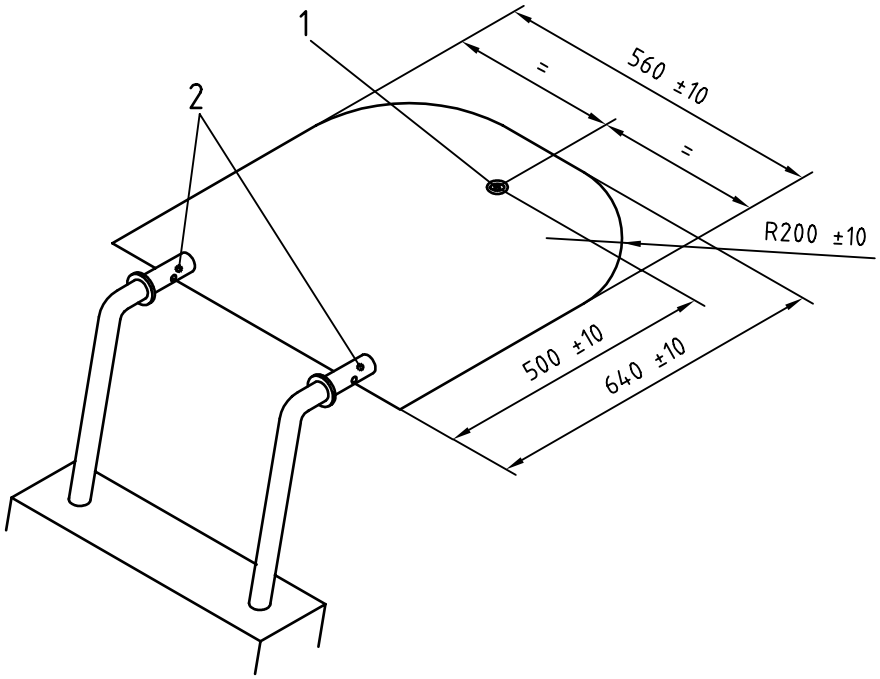
NOTE A frame made of wood or steel wire is suitable.

4.2 Test conditions

4.2.1 The test equipment specified in 4.1.1 to 4.1.4 shall remain immobile during the test.

4.2.2 The ambient temperature shall be (20 ± 5) °C.

Dimensions in millimetres



Key

1 Datum point
2 Handgrips of stair-climbing device

Figure 3 — Attendant-space gauge

Dimensions in millimetres

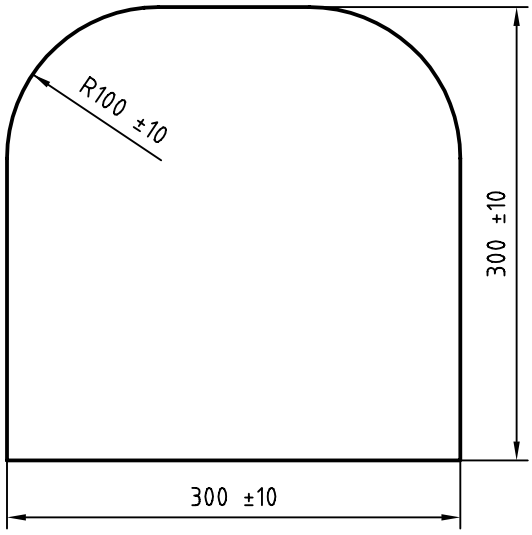


Figure 4 — Foot-space gauge

5 Preparation of the stair-climbing device

5.1 Stair-climbing wheelchairs

5.1.1 Before each test, prepare the stair-climbing wheelchair as specified in 5.1.2 to 5.1.6 if not otherwise stated in individual test procedure.

5.1.2 Equip and configure the stair-climbing wheelchair for stair-climbing operation in accordance with the manufacturer's instructions. For parts where there are no manufacturer's recommendations, set the adjustable parts of the stair-climbing device, where applicable, according to ISO 7176-22. For all other parts where there is a range for adjustments, set them as near as possible to the mid-position.

5.1.3 Charge the batteries to not less than 75 % of their rated capacity.

5.1.4 Load the stair-climbing device with a test dummy constructed in accordance with ISO 7176-11. The mass shall be equal to, or if there is no dummy of equal mass, the next size greater than, the maximum mass of occupant recommended by the manufacturer as shown in Table 1.

Replacement footpieces for the lower leg portion of the test dummy are specified in 4.1.6. Position each footpiece with the centre of gravity as close as possible to the centre of the footplate(s).

A human occupant may be used. In this case weights may be added on the seat of the stair-climbing wheelchair to supplement the mass of a small occupant (sandbags or similar items are recommended). Shoes with a minimum length of 300 mm shall be used. It is essential that appropriate precautions be taken to ensure the person's safety.

Table 1

Maximum occupant mass kg	**Test dummy mass** kg
Up to 25	25
> 25 to 50	50
> 50 to 75	75
> 75 to 100	100

NOTE Work is in progress to develop test dummies for heavier user masses.

5.1.5 If the stair-climbing wheelchair has pneumatic tyres, inflate them to the pressure recommended by the manufacturer of the stair-climbing wheelchair. If a pressure range is given, inflate to the highest pressure in the range. If there is no recommendation for inflation pressure from the stair-climbing wheelchair manufacturer, inflate the tyres to the maximum pressure recommended by the tyre manufacturer.

5.1.6 If the stair-climbing wheelchair has adjustable push handles (manœuvre device), adjust them as nearly as possible to a height of 1 500 mm ± 20 mm.

5.2 Stair-climbing wheelchair carriers

5.2.1 Before each test, prepare the, stair-climbing wheelchair carrier as specified in 5.2.2 to 5.2.8 if not otherwise stated in individual test procedure.

5.2.2 Charge the batteries to not less than 75 % of their rated capacity.

5.2.3 Select one standard wheelchair recommended by the manufacturer of the stair-climbing wheelchair carrier as test wheelchair. The selected wheelchair shall conform with ISO 7193, if not otherwise stated by the manufacturer of the stair-climbing wheelchair carrier.

5.2.4 Adjust the wheelchair in accordance to the instructions of the manufacturer of the stair-climbing wheelchair carrier. If there are no instructions, adjust the wheelchair in accordance with the instructions from the manufacturer of the wheelchair. For parts where there are no manufacturer's recommendations, set the adjustable parts of the wheelchair according to ISO 7176-22.

5.2.5 If the stair-climbing wheelchair carrier has pneumatic tyres, inflate them in accordance with 5.1.5.

5.2.6 If the stair-climbing wheelchair carrier has adjustable push handles (manœuvre device), adjust them as nearly as possible to a height of 1 500 mm ± 20 mm.

5.2.7 Load the wheelchair in accordance with 5.1.4.

5.2.8 Secure the test wheelchair to the stair-climbing wheelchair carrier for stair-climbing operation in accordance with the carrier manufacturer's instruction.

5.3 Recorded information

Record the following information:

a) the stair-climbing device used in the test;

b) wheelchair specified for the test, including its mass;

c) the position of any adjustable part;

d) the mass of the dummy.

6 Determination of working area requirements

6.1 Principle

6.1.1 Determination of minimum working area to operate the loaded stair-climbing device on stairs and landing, including the space necessary to manœuvre the stair-climbing device by an attendant.

6.1.2 All tests in clause 6 shall be performed using the attendant-space gauge (see 4.1.11) and the foot-space gauge (see 4.1.12). The stair-climbing device, the attendant-space gauge and the foot-space gauge shall not touch the barriers (see 4.1.1 and 4.1.2) during the test procedure.

6.1.3 Before each test, check the adjustment of the stair-climbing device and position of the test dummy against the instructions in clause 5 and correct if necessary.

NOTE When ascending stairs the stair-climbing device is driven backwards, which means that the attendant goes backwards up the stairs.

6.2 Determination of minimum stair width for straight stairs

6.2.1 Set up the standard test stairs connected to the landing platform.

6.2.2 With the stair-climbing device standing horizontally in front of the test stairs following the manufacturer's instructions, drive the device up the stairs to the landing platform.

6.2.3 Position the stair-climbing device for descending the stairs following the manufacturer's instructions. Drive the stair-climbing device down the stairs so that the whole stair-climbing device is on the horizontal plane.

6.2.4 Measure to an accuracy of ± 20 mm the narrowest position of the two barriers which it is possible to achieve without the stair-climbing device, the attendant-space gauge, the foot-space gauge or the test wheelchair (if used) having any interference with the barriers during the test procedure.

EXAMPLE

An example of a practical method is as follows:

— Measure the maximum width of the test stair-climbing device.

— Set the adjustable barriers so that the distance between the barriers is a little wider than the width of the stair-climbing device.

— Perform the test.

— Decrease/increase the width of the steps until the minimum stair width is determined.

6.3 Determination of minimum landing area for U-shaped stairs

6.3.1 Use the same test equipment as in 6.2.

6.3.2 Drive the stair-climbing device up the stairs onto the landing platform.

6.3.3 Turn the stair-climbing device 180°.

6.3.4 Measure to an accuracy of ± 20 mm the minimum length and width between the barriers which is possible to achieve without the stair-climbing device, the attendant-space gauge, the foot-space gauge or test wheel chair (if used) having any interference with the barriers during the test procedure.

6.4 Determination of minimum stair radius on winding stairs

6.4.1 The minimum stair radius is the distance on the winding test stairs, from the central axis of the stairs to the maximum excursion of the stair-climbing device while performing the test cycle.

6.4.2 Set up the winding test stairs connected to the landing platform and set the adjustable barriers at maximum distance from the centre point of the stairs.

6.4.3 With the stair-climbing device standing horizontally in front of the test stairs following the manufacturer's instructions, drive the device up the stairs to the landing platform. If there is no instruction from the manufacturer, place the stair-climbing device as close as possible to the adjustable barrier without hitting the adjustable barrier while ascending.

6.4.4 Position the stair-climbing device for descending the stairs following the manufacturer's instructions. Drive the device down the stairs so that the whole device is on the horizontal plane. The test cycle shall be performed safely and without any interference with the barrier. If there is no manufacturer's instruction, place the stair-climbing device as close as possible to the adjustable barrier without hitting the adjustable barrier while descending.

6.4.5 Decrease the stair radius by moving the barrier closer to the centre point in steps, until the stair-climbing device does not successfully complete the test cycle. Measure the stair radius to the barrier to an accuracy of ± 20 mm the minimum radius which is possible to achieve without the stair-climbing device, the attendant-space gauge, the foot-space gauge, or the test wheelchair (if used) having any interference with the barriers or becoming unsafe during the test procedure.

NOTE The space necessary for manœuvring of the device by an attendant shall be included in the measured area.

6.5 Recorded information

Record the measurements taken in 6.2, 6.3 and 6.4.

7 Skew angle

7.1 Principle

Stair-climbing devices often need to be operated under a skew angle. Testing is performed under such conditions.

All tests are performed with maximum speed if not otherwise specified by the manufacturer.

Before each test, check the adjustment of the stair-climbing device and position of the test dummy against the instructions in clause 5 and correct if necessary.

7.2 Requirements

7.2.1 The stair-climbing device shall be able to climb the steps at maximum speed, whether ascending or descending, at an approach skew angle of 9° from the edge of the step.

7.2.2 If the manufacturer claims that the stair-climbing device exceeds the above minimum requirements, the stair-climbing device shall be able to ascend or descend steps at this higher approach skew angle.

7.3 Test procedure

7.3.1 The stair-climbing device shall be driven up and down the stairs at skew angles of 9°, and at a higher skew angle if claimed by the manufacturer.

7.3.2 Set up the standard test stairs connected to the landing platform.

7.3.3 With the stair-climbing device standing horizontally in front of the test stairs and at a skew angle of 9°, drive the device up to the first step. Drive up the remaiding steps to the landing. Repeat the test procedure driving down the stairs.

Table 2 shall be used to assess the performance of the stair-climbing device.

Table 2

Definition	Comments
Completed	The test is completed according to the test procedure and requirements. The test shall be completed in 3 min.
Not completed	The test was impossible to complete. The reason why it was not completed shall be recorded.
NOTE Difficulties are for example instability or that the attendant has to apply forces other than minimally necessary to operate the stair-climbing device during the test procedure.	

7.3.4 If the test in 7.3.3 was completed and the manufacturer claims that the stair-climbing device is able to ascend and descend at a higher skew angle, repeat the test procedure (7.3.3) at this higher skew angle.

7.4 Recorded information

Record whether the stair-climbing device met the requirements in 7.2.1 and if the test was completed or the stair-climbing device was unsafe. For information purposes, record if a higher skew angle was approved (see 7.2.2).

8 Determination of theoretical energy consumption during stair-climbing operation

8.1 Principle

8.1.1 This test is an extension of ISO 7176-4, but the test track is the standard test stair and the formula given in 8.3.4 shall be used.

8.1.2 Before the test, check the adjustment of the stair-climbing device and position of the test dummy against the instructions in clause 5 and correct if necessary.

8.2 Requirements

This test determines the theoretical energy consumption and includes no pass/fail criteria.

8.3 Test procedure

8.3.1 The test is conducted on standard test stairs. The stair-climbing device shall be configured for stair-climbing operation and loaded with the test wheelchair (if used) and the test dummy (see clause 5).

8.3.2 The stair-climbing device shall be driven at maximum speed from a starting position immediately before the bottom of the stairs, up the stairs to a position on the landing at the top of the stairs and then back down the stairs to the starting position. This procedure is performed a total of 10 times.

8.3.3 Measure the ampere-hours used by the stair-climbing device during the test procedure to an accuracy of ± 5 %.

NOTE This test will not normally totally discharge the battery(ies) of a stair-climbing device, but care should be taken not to discharge the battery(ies) below the level recommended by the manufacturer.

8.3.4 Calculate the theoretical number of steps the stair-climbing device is capable of climbing up and down, using the formula

$$N = \frac{80C}{E}$$

where

N is the theoretical number of steps (up and down) that the stair-climbing device is capable of climbing before the battery(ies) is (are) discharged;

C is the capacity of the battery, in ampere-hours at a 5-h rate of discharge, declared by the battery manufacturer;

E is the ampere-hours used during the test.

8.4 Recorded information

Record the theoretical number of steps up and down as calculated according to 8.3.4 and the capacity of the battery, in ampere-hours at a 5-h rate of discharge, declared by the battery manufacturer.

9 Static stability

9.1 Principle

These tests are an extension of ISO 7176-1. Before each test, check the adjustment of the stair-climbing device and position of the test dummy against the instructions in clause 5 and correct if necessary.

9.2 Requirements

9.2.1 In the emergency position on stairs, as defined by the manufacturer of the stair-climbing device, the stair-climbing device shall remain in a safe and stable position without tilting, rolling or sliding.

9.2.2 If the manufacturer of the stair-climbing device claims that the device can be used on stairs steeper than 35°, the stair-climbing device shall remain in a safe and stable position without tilting, rolling or sliding at this higher angle.

NOTE 1 If the stair-climbing device tends to roll into a safer position when released by the attendant, this is acceptable.

NOTE 2 Further requirements are under consideration.

9.3 Test procedures

9.3.1 Determination of static stability on the level

The static stability in the forward, rearward and lateral directions shall be measured as specified in ISO 7176-1.

9.3.2 Determination of static stability on straight stairs

9.3.2.1 Place the stair-climbing device in normal ascending/descending position on the standard test stairs. The whole stair-climbing device including the attendant shall be standing on the test stairs. With the stair-climbing device in its least stable configuration and position (for guidance see annex D) and following the manufacturer's instructions, the attendant shall place the stair-climbing device in the emergency position, and let go of the stair-climbing device. Record whether the stair-climbing device remains in a safe and stable position without tilting, rolling or sliding.

9.3.2.2 If the test in 9.3.2.1 was approved and the manufacturer claims that the device can be used on stairs steeper than 35° (the standard test stair), the test procedure (9.3.2.1) shall be repeated at this higher angle.

NOTE 1 The following is an example of a practical method for testing at a higher angle for safe position. Following the above procedure and when the stair-climbing device is placed in the emergency position, lift the back end of the standard test stair until the pitch line is 42° with the stair-climbing device placed on the stairs in the safe position. The device should not roll, slide or be unstable at that angle. The test implies that the steps of the stair are inclined 7°.

NOTE 2 In the case of, for example, a track-driven stair-climbing device, the least favourable position relative to the lower step in contact with the device is with maximum overhang without interfering with the device to tip downward sufficiently for $3° \pm 0{,}5°$.

NOTE 3 The position should be the least favourable configuration and position relative to the lowermost step in contact with the device. For different types of device, some experimentation may be necessary to determine the least favourable position, which may include power on/off, brakes engaged or not engaged (for guidance see annex D).

9.4 Recorded information

Record the configuration of the stair-climbing device, the position on the test stair, whether the stair-climbing device met the requirements in 9.2, the angles measured according to 9.3 and information required in ISO 7176-1.

10 Effects of maximum acceleration

10.1 Principle

The stair-climbing device is driven at maximum speed up and down the standard test stair without pausing between the reversals. Before each test, check the adjustment of the stair-climbing device and position of the test dummy against the instructions in clause 5 and correct if necessary. If speed is adjustable, set to maximum speed.

10.2 Requirements

No reduced stability shall occur during the test.

10.3 Test procedure

10.3.1 Position the stair-climbing device on the standard test stairs so that the whole stair-climbing device stands on the stairs and in the lowest possible position on the stairs without touching the lower landing.

10.3.2 Drive the stair-climbing device at maximum speed up the stairs. Without stopping, reverse the controls so that maximum speed is applied in the downstairs direction. Without stopping, reverse the controls so that maximum speed is applied in the upstairs direction. The test is performed without reaching the top landing or the horizontal area at the bottom of the stairs.

The direction reversals continue for three cycles up and down.

10.3.3 Note points during the test at which lifting, sliding or tilting occurs.

NOTE For example, a videotape plus a scale may be used to analyse results.

10.3.4 If the manufacturer claims that the stair-climbing device climbs winding stairs, the test procedure given in 10.3.1 to 10.3.3 shall be repeated on the winding test stairs.

10.4 Recorded information

Record whether the stair-climbing device met the requirements in 10.2 and if any lifting, sliding or tilting occurred during the test.

11 Maximum speed on stairs

11.1 Principle

This test is an extension of ISO 7176-6. Maximum speed shall be measured when the stair-climbing device is climbing up respectively down the standard test stairs. The stair-climbing device shall be configured for stair-climbing operation and carrying the test wheelchair (if used) and the test dummy.

11.2 Requirements

This test determines the maximum speed on standard test stairs and has no pass/fail criteria.

11.3 Test procedure

11.3.1 Before the test, check the adjustment of the stair-climbing device and position of the test dummy against the instructions in clause 5 and correct if necessary. If speed is adjustable, set it to maximum speed.

11.3.2 The stair-climbing device shall be driven up the standard test stairs with the speed input device at the maximum position.

The time to ascend the last four steps, without reaching the top landing, shall be recorded.

11.3.3 The stair-climbing device shall be driven down the standard test stairs with the speed input device at the maximum position.

The time to descend the last four steps, without reaching the horizontal area at the bottom of the stairs, shall be recorded.

11.3.4 Perform the test procedure in 11.3 four times. The variance shall not exceed 10 % of the measurements of 11.3.2 and 11.3.3. Calculate the mean time for ascending and descending the four steps.

11.3.5 Calculate the time in minutes to one decimal figure for the stair-climbing device to ascend and to descend one step at maximum speed from the value obtained in 11.3.4.

11.4 Recorded information

Record battery type and capacity, at a 5-h rate of discharge, declared by the battery manufacturer and the time, in minutes, for ascending and descending one step as calculated in 11.3.5.

12 Braking effectiveness

12.1 Principle

These tests are an extension of ISO 7176-3 and test the braking effectiveness on stairs. Before each test, check the adjustment of the stair-climbing device and position of the test dummy in accordance with the instructions in clause 5 and correct if necessary.

12.2 Requirements

No brake failure, loss of friction or instability shall occur during the test. If the stair-climbing device is intended by the manufacturer to be used on horizontal ground (see note in 12.3.1), the stair-climbing device shall meet the requirements in ISO 7176-3.

12.3 Test procedures

12.3.1 Test on horizontal plane

The tests shall be performed in accordance with ISO 7176-3.

If the stair-climbing device is only intended by the manufacturer to be used to climb stairs, the running brake test procedure in ISO 7176-3 may be excluded.

12.3.2 Brake test while ascending

Conduct braking tests, with the stair-climbing device ascending the standard test stairs at maximum speed. Actuate the brake(s) to the maximum effect at the middle of the test stairs and maintain the brakes in operation until the stair-climbing device is brought to a complete stop. Measure the braking distance. Perform the test four times.

Calculate the average braking distance and record observations relevant to the test, such as tracking behaviour, loss of stability, sliding and brake failure.

NOTE The braking distance and measurements accuracy are given in ISO 7176-3.

12.3.3 Brake test while descending

Repeat the test specified in 12.3.2 with the stair-climbing device descending the standard test stairs.

12.3.4 Test of the effect of repeated full application of the brakes

Drive the stair-climbing device up and down the standard test stairs in the following manner as quickly as possible. Bring the stair-climbing device with maximum acceleration to full speed, then bring it to full stop as quickly as possible. Repeat the procedure in succession without interruption, travelling up and down the stairs 10 times.

Immediately following this exercise, carry out the braking test described in 12.3.3.

12.4 Recorded information

Record the result required in ISO 7176-6 and whether the stair-climbing device met the requirements in 12.2, the average braking distance measured in 12.3.2 and 12.3.3 together with observations such as brake failure, loss of friction (skidding), instability (tipping) difference (if any) between measurements in 12.3.3 and 12.3.4, as well as other observations relevant to the tests.

13 Static, impact, fatigue strengths and durability

13.1 Principle

These tests are an extension of ISO 7176-8.

13.2 Requirements

When tested, the stair-climbing device shall meet all the following requirements at the conclusion of all the tests included in 13.3.

a) The stair-climbing device shall be capable of operation as described by the manufacturer.

b) No component shall be fractured or have visible cracks.

NOTE Cracks in surface finishes, such as paint, that do not extend into the structural material do not constitute a failure.

c) No nut, bolt, screw, locking pin, adjustable component or similar item shall have become detached after having been tightened, adjusted or refitted once, with the exception of the footrests which may be adjusted after each of the two footrest-impact tests according to ISO 7176-8.

d) No electrical connector shall be displaced or disconnected.

e) All parts intended to be removable, folding or adjustable shall operate as described by the manufacturer.

f) All power-operated systems shall operate as described by the manufacturer.

g) Handgrips shall not be displaced.

h) No multi-position or adjustable component shall be displaced from the preset position, except as permitted in 13.2 c).

i) No component or assembly of parts shall exhibit deformation, free play or loss of adjustment that adversely affects the function of the stair-climbing device or attached wheelchair.

The requirements above are applicable only to the stair-climbing device. If the stair-climbing device is attached to a wheelchair, the requirements are valid for the connection(s) between the stair-climbing device and the wheelchair [in particular see item i)].

13.3 Test procedures

13.3.1 Sequence of tests

The sequence of tests shall be as follows:

a) static strength tests (13.3.3), performed in any order;

b) impact strength tests (13.3.4), performed in any order;

c) fatigue strength test (13.3.5) (optional);

d) durability test (13.3.6).

13.3.2 Preparation of the stair-climbing device

Before each test, check the adjustment of the stair-climbing device and the position of the test dummy against the instruction in clause 5 and correct if necessary. Secure the test dummy so that it is restrained and positioned in accordance with ISO 7176-8.

13.3.3 Static strength tests

13.3.3.1 Test procedure

The stair-climbing device shall be tested as specified in ISO 7176-8:1998, clause 8.

Depending on the construction of the stair-climbing device, it may not be possible to perform all tests. If a test is excluded, this shall be noted in the test report and the reason given.

13.3.3.2 Test procedure for handgrips

13.3.3.2.1 This test only applies to handgrips that project rearwards and/or upwards, and, in particular, does not apply to handgrips on handles that consist of a transverse bar.

13.3.3.2.2 With the stair-climbing device standing on the horizontal test plane, set up the means described in ISO 7176-8 for testing handgrips.

13.3.3.2.3 Ensure that the means for applying the force does not apply radial force to the handgrip (e.g. do not use clamps which cause the handgrip to be squeezed onto the push handle).

13.3.3.2.4 Carry out the test in accordance with ISO 7176-8 using a pull-off force of 750 N.

13.3.3.3 Recorded information

Record components, if any, that needed to be tightened, adjusted or replaced.

13.3.4 Impact strength test

13.3.4.1 Test procedure

The stair-climbing device shall be tested as specified in ISO 7176-8:1998, clause 9.

Depending on the construction of the stair-climbing device, it may not be possible to perform all tests. If a test is excluded, this shall be noted in the test report and the reason given.

13.3.4.2 Recorded information

Record components, if any, that needed to be tightened, adjusted or replaced.

13.3.5 Fatigue strength test

An optional test method for fatigue strength is given in annex B.

NOTE 1 See also the Introduction, last paragraph.

NOTE 2 It is anticipated that future work will lead to a normative test method.

13.3.6 Durability test

13.3.6.1 If the stair-climbing device has a variable speed, the test shall be performed at a medium speed.

13.3.6.2 With the stair-climbing device standing horizontally in front of the standard test stairs following the manufacturer's instructions, drive the stair-climbing device up the stairs onto the landing platform.

13.3.6.3 Immediately position the stair-climbing device for descending the stairs following the manufacturer's instructions. Drive the stair-climbing device down the stairs so that the whole stair-climbing device is on the horizontal plane.

13.3.6.4 The procedure shall be repeated without any stop for 10 min $^{+2}_{0}$ min, finishing at the starting point.

13.3.6.5 Let the stair-climbing device stand for 10 min ± 0,5 min with power off.

13.3.6.6 Perform the procedure given in 13.3.6.2 and 13.3.6.3 for a total of nine times (total time scale of approximately 3 h).

If necessary, the battery can be re-charged or replaced during rest time (see 13.3.6.5).

13.3.7 Recorded information

Record components, if any, that needed to be tightened, adjusted or replaced and if the battery has been re-charged or replaced.

13.4 Evaluation of test results

13.4.1 After completing all the tests, examine the stair-climbing device against the requirements of 13.2.

13.4.2 Check the test records to establish if any parts were adjusted, tightened or replaced more than once as specified in 13.2.

13.4.3 Test all power-operated systems on the stair-climbing device to establish if they operate as specified by the manufacturer.

13.4.4 If any of the requirements are not met, the stair-climbing device does not meet the requirements of this part of ISO 7176.

13.5 Recorded information

Record whether the stair-climbing device met the requirements of 13.2, together with a description of the failures identified by the procedures of 13.3 and the configuration of the stair-climbing device during the tests.

Record whether the stair-climbing device met any claims above the minimum requirements made by the manufacturer.

14 Climatic test

14.1 Principle

This test is an application of ISO 7176-9. The function of the stair-climbing device is tested after it has been exposed to environmental conditions which are expected in normal use, storage and transportation.

14.2 Requirements

The stair-climbing device shall continue to function according to the manufacturer's specifications after being subjected to all climatic tests specified in ISO 7176-9.

14.3 Test procedure

The stair-climbing device shall be tested as specified in ISO 7176-9.

The different functions shall be checked before and after each climatic test, but not necessarily on the standard test stairs.

NOTE Tests for corrosion are being considered.

14.4 Recorded information

Record whether the stair-climbing device met the requirements of 14.2, together with any functional changes in the stair-climbing device and any evidence of damage to the device.

15 Power and control systems

15.1 Principle

This test is an application of ISO 7176-14 and test methods and specifies the requirements for the power and control systems of stair-climbing device, including battery chargers.

15.2 Requirements

The stair-climbing device, including the battery charger, shall conform with the requirements given in ISO 7176-14.

If the battery charger is not mounted on the stair-climbing device, the manufacturer shall recommend a battery charger that:

a) conforms with the requirements in ISO 7176-14;

b) is suitable for the stair-climbing device.

15.3 Test procedure

The stair-climbing device shall be tested as specified in ISO 7176-14, with the following modifications:

a) If the stair-climbing device is intended by the manufacturer to be used only as a stair-climbing device, exchange the test on a slope with the test on the standard test stairs.

b) If the stair-climbing device is intended by the manufacturer to be used as a wheelchair as well as a stair-climbing device, perform the test on a slope and the test on the standard test stairs.

The battery charger shall also be tested according to ISO 7176-14.

15.4 Recorded information

Record whether the stair-climbing device and/or charger met the requirements in 15.2, as well as any reasons for terminating the test and the forces and/or pressures required to operate control devices.

16 Flammability

16.1 Principle

Upholstered parts of the stair-climbing device are tested against flammability according to ISO 7176-16.

16.2 Requirements

Stair-climbing devices equipped with upholstered parts shall conform to the ignition requirements of ISO 7176-16.

16.3 Test procedure

The test procedures of ISO 7176-16 apply.

16.4 Recorded information

Record whether the stair-climbing device met the requirements in ISO 7176-16:1997, clause 4.

17 Electromagnetic compatibility

17.1 Principle

The stair-climbing device is tested for electromagnetic emissions and for electromagnetic immunity according to ISO 7176-21.

17.2 Requirements

The stair-climbing device shall conform to the requirements of ISO 7176-21.

17.3 Test procedure

The test procedures of ISO 7176-21 apply.

17.4 Recorded information

Record whether the stair-climbing device met the requirements in ISO 7176-21.

18 Safety equipment

18.1 Requirements

The stair-climbing device shall be equipped with a mains switch according to 18.2, a battery charge indicator according to 18.3 and a postural support according to 18.4.

18.2 Mains switch

It shall be possible to switch off all power to the stair-climbing device using a switch which is independent of and separate from the driving switch. When switched off while the stair-climbing device is running, the stair-climbing device shall come to a safe full stop and shall remain in a safe position. When switched off while the stair-climbing device is standing, the stair-climbing device shall remain in a safe position.

18.3 Battery charge indicator

The stair-climbing device shall be fitted with an indicator showing a minimum battery charge sufficient for ascending at least 20 steps when loaded with maximum user mass.

If the stair-climbing device uses more power when descending, then the wording shall be read accordingly and noted in the test report.

18.4 Postural support

The stair-climbing device shall have a postural support as defined in ISO 7176-19.

18.5 Records

Record whether the stair-climbing device is equipped with a mains switch, battery charge indicator, a postural support and whether the equipment met the requirements in 18.2, 18.3 and 18.4 respectively.

19 Ergonomic aspects

19.1 Requirements

No ergonomic requirements or test methods are currently specified; however this does not absolve the manufacturer from the obligation of taking ergonomic aspects both for the user and the attendant into serious consideration and trying to implement good ergonomic features in the design of the stair-climbing device.

19.2 Component mass

If the stair-climbing device is intended to be dismantled for ease of transport:

a) any component that has a mass greater than 10 kg shall be provided with suitable handling device (e.g. handles), or

b) the user manual shall indicate the points where the component parts can be lifted safely and/or a method for handling during assembly.

20 Test report

The test report shall contain the following:

a) a statement that the tests have been carried out in accordance with ISO 7176-23;

b) the name and address of the testing institution;

c) the name and address of the manufacturer of the stair-climbing device;

d) the date of issue of the test report;

e) the type of the stair-climbing device and any serial and batch numbers;

f) the configuration of the stair-climbing device;

g) the name, model and weight of the test wheelchair(s), if used;

h) the size of test dummy used;

i) a statement on whether the stair-climbing device met all the requirements of this part of ISO 7176;

j) the results and details of measurements and tests according to clauses 6, 7, 8, 9, 11, 12, 13, 14, 15 and 16;

k) a description of failures identified by the procedures of clauses 9, 10, 12, 13, 14, 15, 17 and 18;

l) test reports from the tests performed in consistency with the normative reference and not covered by the information given according to items i), j) and k).

NOTE Those commissioning tests may require further information, such as identification of the point(s) in the test procedures where and when any failures occurred.

21 Labelling and documentation

The manufacturer's documentation and labelling shall conform to the requirements in ISO 7176-15. In addition, in the official language of the countries in which the stair-climbing device is marketed, the following shall be stated.

a) Permanently and easily visible on each stair-climbing device:

   1) This stair-climbing device must never be left by the attendant when in use except in an emergency situation.

   2) Adequate training shall have been given before use.

b) In the user manual:

   1) The product meets all the applicable requirements of ISO 7176-23, based on the intended use of the product as disclosed in the user manual and other manufacturer documentation.

   2) Information required from the normative references.

   3) Warning that any use of the stair-climbing device is dangerous if the operator is not aware of and/or does not follow the manufacturer’s instructions.

c) In the manufacturer's specification sheet:

   1) Instruction that the operator (attendant) shall always stand directly above the stair-climbing device when in use on stairs and not at the side, unless the stair-climbing device is designed to allow this.

   2) The minimum stair width for straight stairs (see 6.2).

   3) The minimum landing area for U-shaped stairs (see 6.3).

   4) The minimum stair radius on winding stairs, if the manufacturer claims that the stair-climbing device is designed for use on winding stairs (see 6.4).

   5) The theoretical number of steps the stair-climbing device is able to perform before the battery/ies is/are discharged (see clause 8).

   6) The maximum steps performed per minute (see clause 11).

7) Information that the stair-climbing device must never be left by the attendant when on stairs, except in emergency situations, and instructions, on how to leave the stair-climbing device in a safe position in an emergency situation (see 9.4).

8) Information in accordance with the requirements in 19.1, if the stair-climbing device is intended to be dismantled for ease of transport.

Annex A
(informative)

Surrogate wheelchair

The overall dimension of the surrogate wheelchair is determined as specified in ISO 7176-5; the seat and wheel dimension measured as specified in ISO 7176-7.

The specification of the surrogate wheelchair is as follows:

a) be of durable construction of four wheels, handrim-propelled, rear-driven;

b) have a total mass of 15 kg ± 3 kg;

c) have a centre of gravity located 450 mm ± 50 mm above the ground and 150 mm ± 50 mm in front of the rear axle;

d) have a frame which is designed to provide point(s) to anchor the stair-climbing device;

e) have a total width of 540 mm ± 40 mm;

f) have a total length of 1 120 mm ± 60 mm;

g) have an effective seat width of 420 mm ± 40 mm and an effective seat depth of 430 mm ± 40 mm and a seat plane angle of 4° ± 2°;

h) have a seat surface height at front edge of 550 mm ± 40 mm;

i) have a backrest with a width of 400 mm ± 40 mm and a height of 420 mm ± 40 mm and a backrest angle of 10° ± 2°;

j) have a footrest-to-seat dimension of 480 mm ± 40 mm;

k) have a footrest length of 180 mm ± 40 mm;

l) have a footrest-to-leg angle of 90° ± 5°;

m) have a leg-to-seat surface angle of 110° ± 5°;

n) have an armrest of traditional design;

o) have a handrim diameter of 530 mm ± 40 mm;

p) have a propelling-wheel diameter of 600 mm ± 20 mm;

q) have a horizontal location of wheel axle of 30 mm ± 20 mm;

r) have a vertical location of wheel axle of 150 mm ± 20 mm;

s) have a front wheel diameter of 150 mm ± 80 mm.

Annex B
(informative)

Fatigue-strength tests for stair-climbing devices

B.1 Principle

This annex gives information on the present attempt to develop a fatigue-strength test procedure, including pass/fail criteria, for stair-climbing devices.

The test procedures are similar or the same as those specified in ISO 7176-8. The main difference is that the two-drum machine is replaced by an escalator test machine.

B.2 Additional test apparatus

B.2.1 Escalator test machine

The escalator test machine consists of:

a) a minimum of four steps moving along a straight line inclined 30° to the horizontal, capable of bearing the weight of the loaded stair-climbing device;

— the width of the stair shall be at least 100 mm wider than the stair-climbing device;

— each step shall have a going and a rise of 146 mm ± 20 mm;

— the edge of the stair nosing shall have a radius of 4 mm ± 2 mm;

b) provision for the escalator to be driven by the stair-climbing device using the stair-climbing device's drive system;

c) provision to adjust the turning resistance of the escalator test machine so that the stair-climbing device when ascending stairs is not moving upwards or downwards but the stairs of the escalator are pushed downstairs;

d) provision to mount the stair-climbing device on steps which are in a straight line;

e) provision to hold the stair-climbing device on the escalator during the test in the position for climbing stairs as intended by the manufacturer with the restraints fixed to the frame of the stair-climbing device;

f) provision for two balancing restraints to be fixed to the handgrips of the stair-climbing device which provide some amount of freedom for the vertical movement of the stair-climbing device to work properly, if the stair-climbing device needs to be held in a balancing position by an attendant (balancing stair-climbing device);

g) means to measure the tension forces in the longitudinal restraints in the range of 10 N to 400 N with an accuracy of 5 %;

h) lateral restraints that restrict sideways movement to ± 50 mm, such that the restraints do not restrict climbing of the stair-climbing device;

i) provision to count the number of steps climbed by the stair-climbing device.

B.2.2 Drop-test machine

Drop-test machine as specified in ISO 7176-8, capable of lifting and dropping the stair-climbing device an adjustable distance from 10 mm to 100 mm.

B.3 Requirements

When tested, the stair-climbing device shall meet all requirements given in 13.2 at the conclusion of each test.

B.4 Escalator test

B.4.1 Preparation of the stair-climbing device

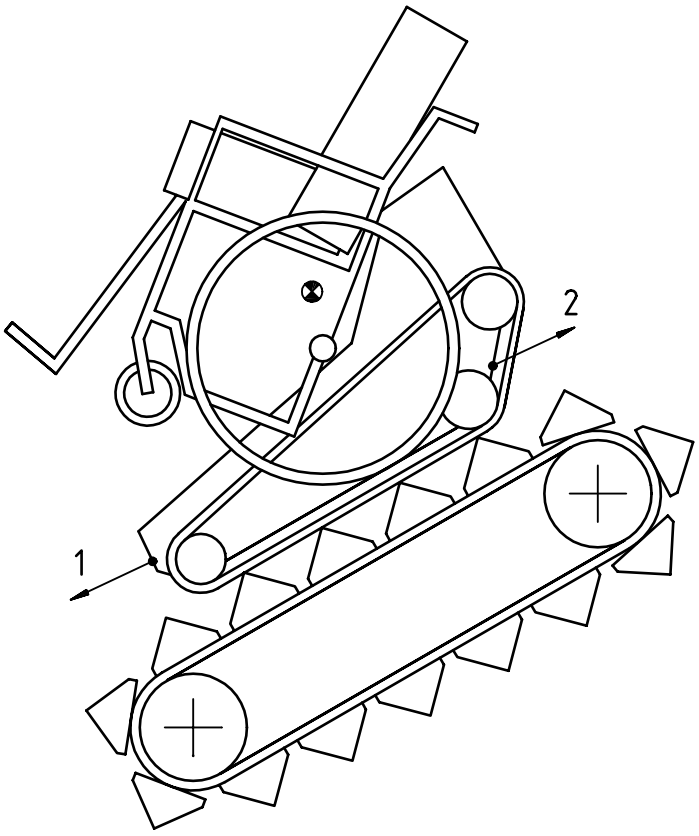
Before each test, the stair-climbing device shall be checked against the instructions in 13.4.

B.4.2 Positioning of the stair-climbing device

B.4.2.1 Position

Position the stair-climbing device in climbing mode on the escalator test machine so that all parts of the climbing gear are accommodated on the straight flight of steps (see Figures B.1 and B.2).

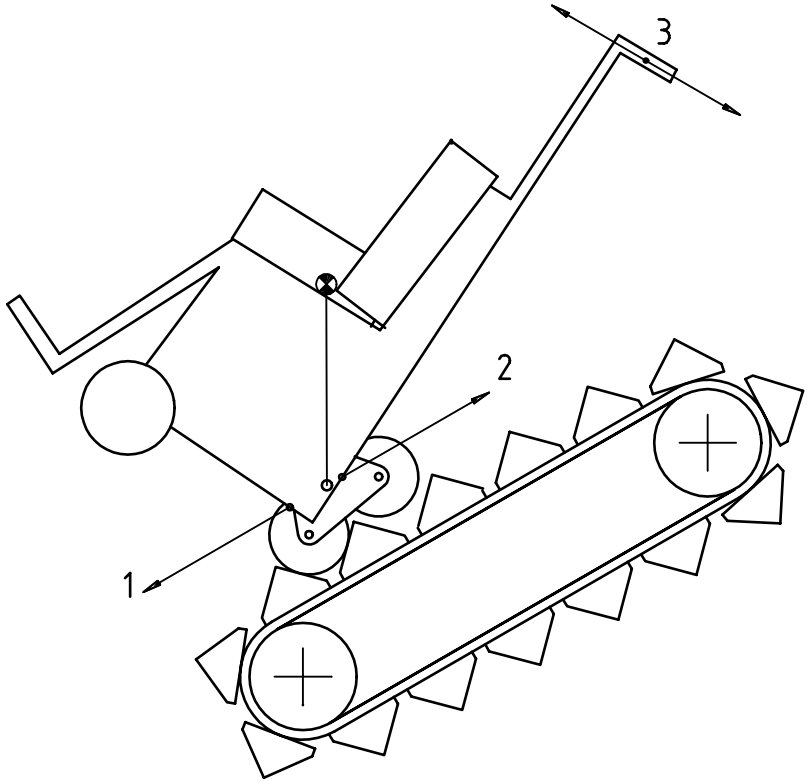
NOTE If necessary, non-structural covers that restrict access to the attachment points (see B.4.2.2 and B.4.2.3) may be removed.



Key

1 Lower longitudinal restraint
2 Upper longitudinal restraint

Figure B.1 — Self-standing stair-climbing device on escalator test machine



Key

1 Lower longitudinal restraint
2 Upper longitudinal restraint
3 Balancing restraints

Figure B.2 — Balancing stair-climbing device on escalator

B.4.2.2 Self-standing stair-climbing device

Restrain the stair-climbing device longitudinally by devices attached to the frame of the stair-climbing device as close to the pitch line of the stair as possible.

The means to restrain the stair-climbing device shall be parallel to the pitch line to ± 10° and such that the stair-climbing device has free movement along the pitch line of 30 mm ± 5 mm.

Care shall be taken to avoid restraints to generate any forces that offset or twist the stair-climbing device and without restriction of the climbing gear's movement perpendicular to the pitch line of the escalator. It shall be possible for the stair-climbing device to move laterally only ± 50 mm from its mid-position.

B.4.2.3 Balancing stair-climbing device

Stair-climbing devices with cluster wheels shall be reclined so that the combined centre of gravity of the stair-climbing device plus the test wheelchair (if used) is vertically above the main axle of the cluster wheel.

If there is no clear location of the main axle, the combined centre of gravity shall be vertically above a point which lies in the middle of the centres of the single wheels of the cluster wheel.

Stair-climbing devices with chain drives shall be reclined so that the combined centre of gravity is vertically above the axle of the wheel of the climbing gear which bears the load during a resting period during climbing (where the rise to the next step is being prepared while the lifting notch is reaching out).

Attach the longitudinal restraints as specified in B.4.2.2.

Restrain the stair-climbing device by attaching balancing restraints to the handles of the stair-climbing device.

The restraints shall lie in a vertical plane which passes through their attachment points and are within 10° perpendicular to a line that connects the main axle of the cluster wheel with the attachment point.

Restrain the stair-climbing device without restriction of the stair-climbing device's movement perpendicular to a plane which is defined by the nearest nosing and the pitch line of the escalator, so that it can move laterally only ± 50 mm from its mid-position.

B.4.3 Escalator test machine setting

NOTE An auxiliary power source for the stair-climbing device may be used for this test, or, provision may be made to charge or replace the batteries during the test.

B.4.3.1 Retarder setting of the escalator test machine

Set the retarder so that the weight of the stair-climbing device is counterweighted [see B.2.1 e)]. The tension forces in the longitudinal restraints shall not exceed 5 % of the total weight of the entire assembly of stair-climbing device. Small variations of the speed of the escalator test machine derived from any complicated kinematics of some climbing gears shall be disregarded.

Operate the stair-climbing device in its upstairs-climbing mode at maximum speed. Set the retarder of the escalator test machine to counterweight the stair-climbing device and hold the stair-climbing device as much as possible stationary on the escalator test machine.

B.4.3.2 Test runs

The test shall be performed according to manufacturer’s instructions.

Check the position of the test dummy and correct if necessary.

Run the test until the stair-climbing device has climbed 150 000[1)] steps.

B.5 Drop test

B.5.1 Principle

This proposed test is an adaptation of ISO 7176-8:1998, 10.5. The stair-climbing device shall be positioned as recommended by the manufacturer for the stair-climbing device to be standing on a stair landing prior to climbing stairs. Fit the foam pads for drop test as specified in ISO 7176-8.

Before the test, check the adjustment of the stair-climbing device and position of the test dummy in accordance with the instructions in clause 5 and correct if necessary, and secure the test dummy so that it is restrained in position during the test.

A recommended means of securing the test dummy is given in ISO 7176-8:1998, 10.3.

B.5.2 Setting self-standing stair-climbing device

Position the stair-climbing device on the test plane. The stair-climbing device shall be lifted at a structural part near the rear end of the climbing gear while the front end of the climbing gear still rests on the test plane. The lifting height shall be set so that the vertical component of the lift of the combined centre of gravity of the whole assembly of stair-climbing device plus surrogate wheelchair (if used) and dummy is 25 mm ± 3 mm.

A recommended method of performing the drop test on self-standing stair-climbing device is shown in Figure B.3.

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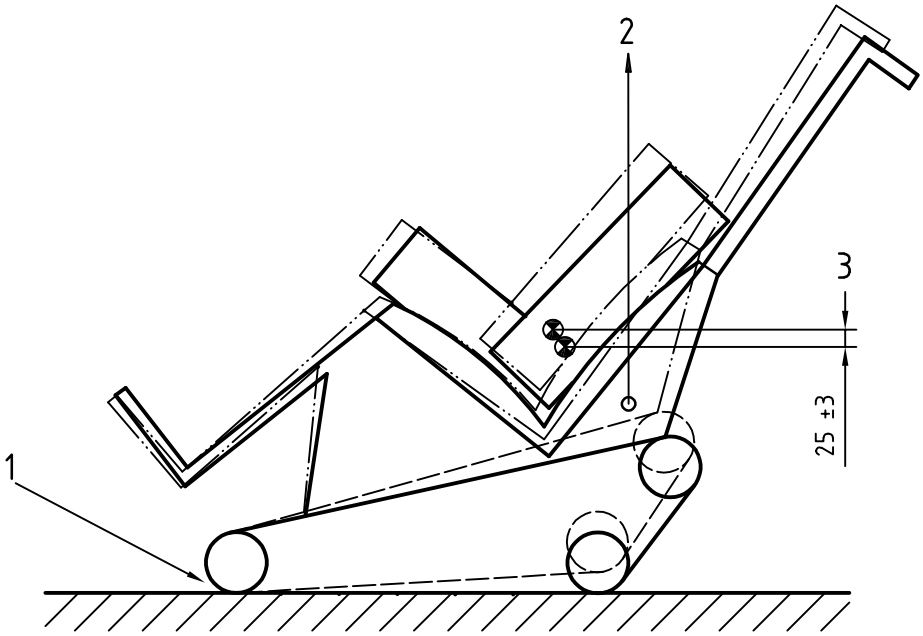
1) The number of steps for this test is under discussion.

Dimensions in millimetres



Key

1 Pivot
2 Lifting device
3 Vertical component of lift

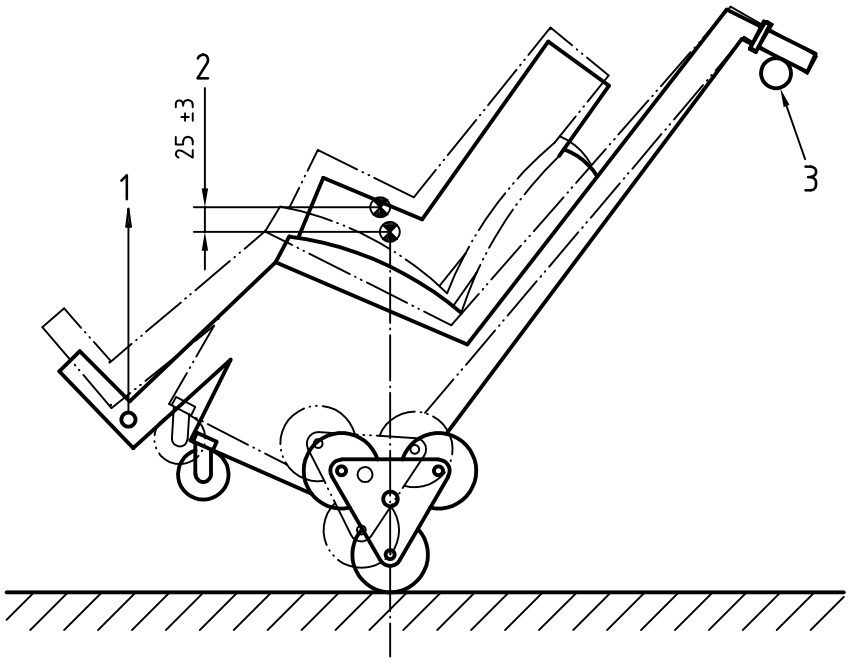
Figure B.3 — Drop-test arrangement for self-standing stair-climbing devices

B.5.3 Setting of balancing stair-climbing device

Position the stair-climbing device on the test plane. The stair-climbing device shall be reclined so that its combined centre of gravity is vertical ± 5° above the main axle of climbing gear. Rotate any cluster wheel so that one of its single wheels is vertical ± 5° below the main axle of the climbing gear. The handgrips shall be attached to a fixed support in a way that enables free pivot in the range of lifts and drops but prevents changing of position. The lower end of the stair-climbing device shall be lifted while the handgrips still are attached to the fixed support. The lifting height shall be set so that the vertical component of the lift of the combined centre of gravity of the whole assembly of stair-climbing device plus surrogate wheelchair (if used) and dummy is 25 mm ± 3 mm.

A recommended method of performing the drop test on a self-standing stair-climbing device is shown in Figure B.4.

Dimensions in millimetres



Key

1 Lifting device
2 Vertical component of lift
3 Pivot

Figure B.4 — Drop-test arrangement for balancing stair-climbing device

B.5.4 Test procedure

During the test run:

— ensure that wheels or tracks rotate after each set of (50 ± 10) cycles, so that not the same part of the wheel or track is loaded all the time;

— when the stair-climbing device has cluster wheels which have two, three, four or six single wheels, rotate it and check the drop height after each set of (25 ± 5) drops;

— when the climbing gear has cluster wheels which have five single wheels, rotate it and check the drop height, after each set of (50 ± 10) drops;

— ensure that all parts of the climbing gear are tested for the same number of drops, ± 10 %;

— ensure that the stair-climbing device is stationary before each drop;

Run the machine until 1 000[2)] drops have been completed.

2) The number of drops for the test is under discussion.

B.6 Recorded information

Record components, if any, that are cracked, deteriorated or needed to be tightened, adjusted or replaced.

Annex C
(informative)

Edge stop test for balancing stair-climbing devices

C.1 Principle

This annex provides information on the present state of development of an edge stop test procedure, including pass/fail criteria, for balancing stair-climbing devices. It is anticipated that future work will lead to a normative test method.

A balancing stair-climbing device that has to be pushed or pulled by an attendant toward the next step is subject to a standardized simulation of approaching to the nosing of a downward step. The effectiveness of the edge stop is tested against the nosing of the step.

NOTE "Edge stop" is defined in 3.10.

C.2 Additional test apparatus

C.2.1 The **upper landing** shall be a rectangular area with a step height of 180 mm ± 5 mm perpendicular to the test plane. The area shall have sufficient size to accommodate the stair-climbing device during the edge stop test. The surface of the plane shall have a coefficient of friction as defined in ISO 7176-13. The upper landing shall be fixed to the test plane.

NOTE The standard test stairs (see 4.1.1) and landing platform (see 4.1.3) may be used.

C.2.2 Supporting device, capable of holding a balancing stair-climbing device in its working position without the need of an attendant. It shall permit the stair-climbing device to travel with minimum additional friction on a horizontal surface without instability. The total mass of the supporting device shall not exceed 5 kg. An example of supporting gear is shown in Figure C.1.

C.2.3 Acceleration rig to pull a balancing stair-climbing device with constant force across level ground. An example of an acceleration rig is shown in Figure C.1.

C.3 Requirements

When tested in accordance with the test procedures specified in clause C.5, a single stair-climbing device shall stop on the test surface safely.

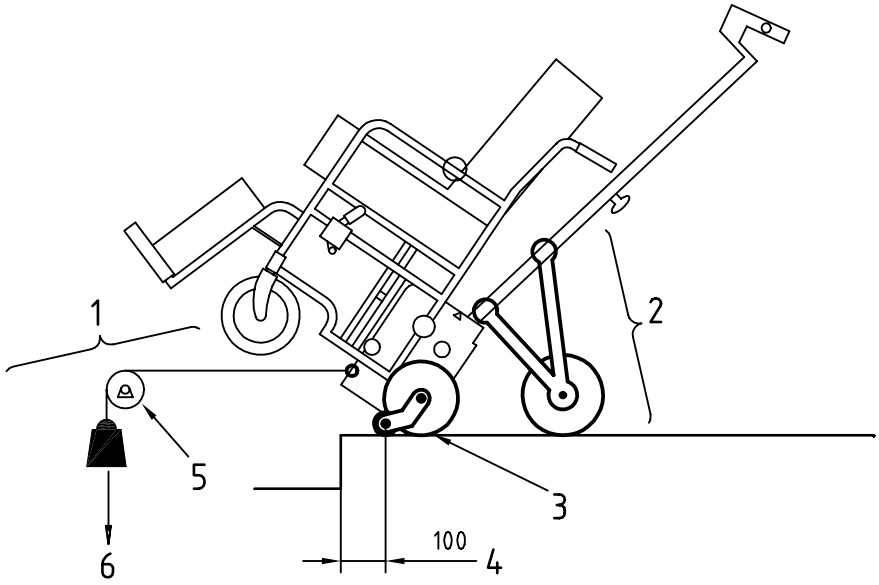
C.4 Preparation of the stair-climbing device

Before each test, the stair-climbing device shall be checked against the instruction in 13.3.2.

C.5 Test for the effectiveness of edge stops

Position the stair-climbing device on the upper landing (C.2.1), facing toward, and with its line of straight forward travel perpendicular to, the nosing of the step and the active point of the device for detection of the stair nosing at least 100 mm ± 10 mm apart from the nosing of the step.

Dimensions in millimetres



Key

1 Acceleration rig
2 Supporting gear
3 Wheel with detection device for stair nosings
4 Test run up
5 Pulley
6 10 kg test mass

Figure C.1 — Test arrangement for edge stop test

Attach the supporting device (C.2.2) such that the stair-climbing device is in its upright working position as intended by the manufacturer for stair climbing, with the stair-climbing device reclined so that its combined centre of gravity is 100 mm ± 10 mm to the rear of the main axis of the climbing gear.

Rotate any cluster wheel so that it is as much as possible in front of the main axis of the climbing gear but appropriate for the test.

Ensure that only one pair of single wheels of the cluster wheel carries the load.

Rotate any chain drives so that its lifting notches are as much as possible above the ground.

Ensure to test the edge stop without assistance or disturbance from any other brake or part of the stair-climbing device and that the stair-climbing device travels forwards without resistance. If necessary, adjust the inclination of the stair-climbing device to an angle that is as close as possible to the above specified inclination. Record adjustments in the test report.

Prevent the stair-climbing device from moving.

Attach the acceleration rig (C.2.3) to the frame of the stair-climbing device as close as possible to the ground.

Arrange the acceleration rig such that the stair-climbing device will be pulled gently by a force of 100 ± 10 N, in line with the horizontal straight forward line of travel to ± 5° and not decreased by more than 5 % during the test procedure. Care shall be taken not to generate any additional impacts during the test procedure.

Release the stair-climbing device from its initial position so that the stair-climbing device is accelerated gently.

C.6 Recorded information

Record whether:

a) the edge stop worked well and the stair-climbing device came to a safe stop on the landing;

b) the edge stop worked well, but the stair-climbing device skidded off the landing because of lack of tyre friction;

c) the edge stop failed to retain the stair-climbing device;

d) the stair-climbing device tipped (in any direction).

Record any other observations relevant to the test.

Annex D
(informative)

Configuration and position of the stair-climbing device for stability tests

D.1 Procedure for configuring the stair-climbing device

Remove any loose cushions.

If there is a risk of fluid spilling from batteries during the test, replace them by an object of the same mass and centre of gravity.

If the seat is capable of swivelling to more than one position around the vertical axis, adjust it so that the seat is facing forward.

Set adjustable parts of the stair-climbing device in the least stable configuration for forward/downward stability using Table D.1 as a guide.

Table D.1 — Typical adjustments for least stable forward/downward stability

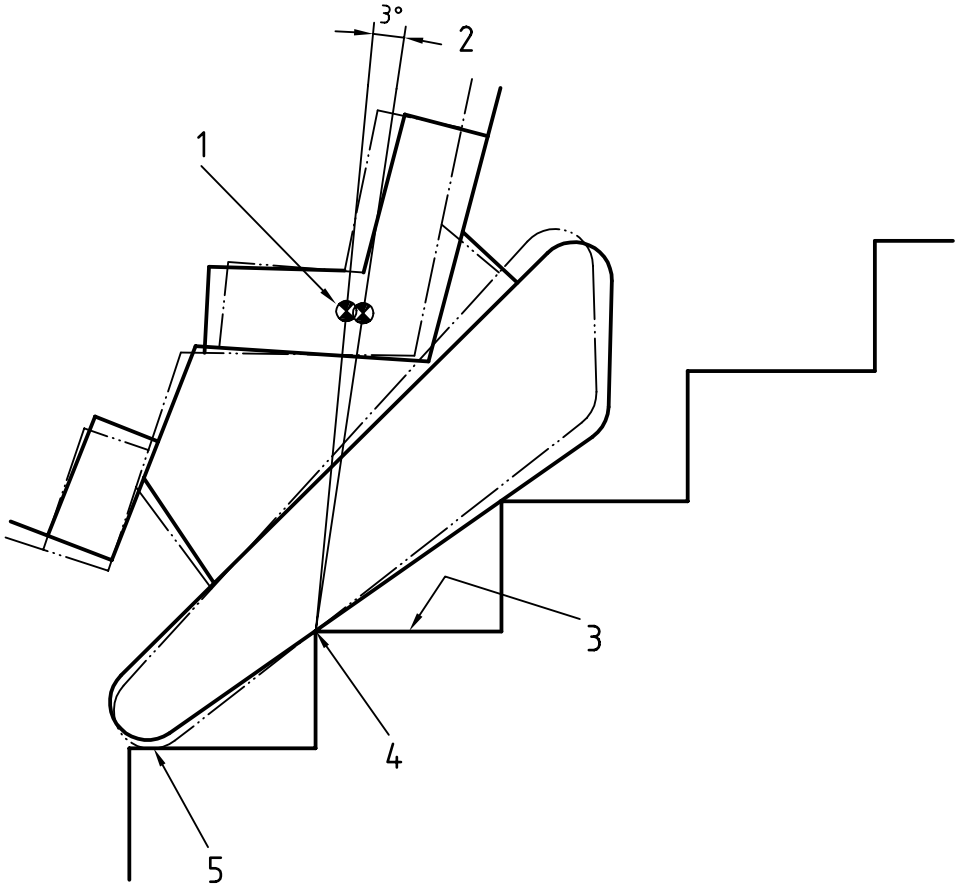
Adjustable component	Least stable
Rear-wheel or climbing gear position, fore-aft	Forward
Castor attachment to frame, fore-aft	Back
Seat position, fore-aft	Forward
Seat position, vertical	High
Seat-back position, fore-aft	Forward
Seat position, tilt	Upright
Seat position, reclined	Upright
Elevating leg-rest position	Up

D.2 Position of the stair-climbing device on stairs

The stair-climbing device shall be in its least stable position relative to the lowermost step in contact with the stair-climbing device.

The least stable position for a track-driven stair-climbing device (and other types of climbing gears which appear — from a lateral view — with a nearly straight baseline, such as stepping rails) is that in which as much as possible of the stair-climbing device is overhanging the lowermost contacted step in a downstairs direction, without interfering with the freedom of the stair-climbing device to tip downward for 3° ± 0,5° before coming in contact with the next lower step, when the lower end of the climbing gear is in its shortest configuration (see Figure D.1).

For other types of stair-climbing devices (e.g. stair-climbing devices with cluster wheels on two axles), some experimentation may be necessary to determine the least stable position.



Key

1 Centre of gravity
2 3° tipping
3 Lowermost contacted step
4 Axis of rotation for tipping downstairs
5 Contact with next step

Figure D.1 — Position of the stair-climbing device for downstairs static stability test

ICS 11.180.10

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