
Wheelchairs

Part 28: Requirements and test methods for stair- climbing devices

Fauteuils roulants —

*Partie 28: Exigences et méthodes d'essai pour les dispositifs monte-
escalier*

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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 7176-28 was prepared by Technical Committee ISO/TC 173, *Assistive products for persons with disability*, Subcommittee SC 1, *Wheelchairs*.

This part of ISO 7176 becomes applicable as of the date of publication. It replaces ISO 7176-23 and ISO 7176-24. However, ISO 7176-23 and ISO 7176-24 remain valid for a transitional period of two years, to enable manufacturers and test houses to adapt their production lines and procedures for measuring and testing.

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

- Part 1: *Determination of static stability*
- Part 2: *Determination of dynamic stability of electric wheelchairs*
- Part 3: *Determination of effectiveness of brakes*
- Part 4: *Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range*
- Part 5: *Determination of dimensions, mass and manoeuvring 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 electrically powered wheelchairs*
- Part 11: *Test dummies*
- Part 13: *Determination of coefficient of friction of test surfaces*
- Part 14: *Power and control systems for electrically powered wheelchairs and scooters — 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 as seats in motor vehicles*
- Part 21: *Requirements and test methods for electromagnetic compatibility of electrically powered wheelchairs and scooters, and battery chargers*

- Part 22: *Set-up procedures*
- Part 23: *Requirements and test methods for attendant-operated stair-climbing devices*
- Part 24: *Requirements and test methods for user-operated stair-climbing devices*
- Part 25: *Batteries and chargers for powered wheelchairs — Requirements and test methods*
- Part 26: *Vocabulary*
- Part 28: *Requirements and test methods for stair-climbing devices*

The following two Technical Reports are also available:

- ISO/TR 13570-1, *Wheelchairs — Part 1: Guidelines for the application of the ISO 7176 series on wheelchairs*
- ISO/TR 13570-2, *Wheelchairs — Part 2: Typical values and recommended limits of dimensions, mass and manoeuvring space as determined in ISO 7176-5¹⁾*

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1) Under preparation.

Introduction

This part of ISO 7176 was written in response to the need for common terminology in the field of stair-climbing devices, to give a means of evaluating important safety features, and to establish a means of qualifying and quantifying the performance of stair-climbing devices under the various conditions and environments encountered in their operation. It allows occupants and manufacturers to compare the pertinent safety and utility issues of all functions and features of a given stair-climbing device.

The tests specified in this part of ISO 7176 are used to gather comparative information about factors relating to the safety and performance of a stair-climbing device while in climbing mode on stairs and in climbing mode or crawling mode on landings, as well as in driving mode. They include identification of suitable operating environments for each stair-climbing device and indications of various performance criteria in climbing mode for operations on stairs and on driving surfaces.

This part of ISO 7176 specifies tests for the “reference configuration” of the stair-climbing device. Since some stair-climbing devices have adjustable components and/or alternative parts, testing in different configurations may be needed to determine whether a given variation conforms to this part of ISO 7176.

Other parts of ISO 7176 might be applicable to stair-climbing devices that can also be used as wheelchairs. All technical aspects which are relevant for wheelchairs and covered in ISO 7176 are adapted, modified and/or extended for the various needs of the different operational modes of a stair-climbing device.

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Wheelchairs —

Part 28: Requirements and test methods for stair-climbing devices

1 Scope

This part of ISO 7176 is applicable to stair-climbing chairs and stair-climbing wheelchair carriers where the stair-climbing device climbs backwards up the stairs, with the occupant facing downstairs, and climbs forwards down the stairs with the occupant also facing downstairs.

This part of ISO 7176 is applicable to stair-climbing devices which are intended for the transport of adults and those intended for the transport of children. It is not applicable to stair-climbing devices which are intended to be operated by children as operating occupants or assistants.

This part of ISO 7176 specifies requirements and test methods for electrically powered stair-climbing devices. It is not applicable to manually powered stair-climbing devices.

NOTE 1 Some clauses in this part of ISO 7176 might be useful for testing manually powered stair-climbing devices.

This part of ISO 7176 specifies tests to demonstrate the stair-climbing device's ability to perform safely on stairs with a pitch of 35°, or higher if declared by the manufacturer. It also includes ergonomic, labelling and disclosure requirements.

NOTE 2 When the stair-climbing device is tested in driving mode as specified this part of ISO 7176, the device need not be tested a second time for the same aspects as a wheelchair.

NOTE 3 Some requirements apply only for a specified range of rated loads.

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 3880-1, *Building construction — Stairs — Vocabulary*

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

ISO 7176-2, *Wheelchairs — Part 2: Determination of dynamic stability of electric wheelchairs*

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

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

ISO 7176-5, *Wheelchairs — Part 5: Determination of dimensions, mass and manoeuvring space*

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

ISO 7176-7, *Wheelchairs — Part 7: Measurement of seating and wheel dimensions*

ISO 7176-8, *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 7176-10, *Wheelchairs — Part 10: Determination of obstacle-climbing ability of electrically powered 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 electrically powered wheelchairs and scooters – Requirements and test methods*

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

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

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

ISO 7176-21:2009, *Wheelchairs — Part 21: Requirements and test methods for electromagnetic compatibility of electrically powered wheelchairs and scooters, and battery chargers*

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

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

ISO 14971, *Medical devices — Application of risk management to medical devices*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3880-1, ISO 7176-5, ISO 7176-7, ISO 7176-15, ISO 7176-26 and the following apply.

NOTE This part of ISO 7176 makes use of some terms in ISO 3880-1 that are defined in relation to horizontal stairs. Since this part of ISO 7176 uses these terms for test stairs that can be tilted, the terms are redefined in this clause.

3.1 actuator

part of a climbing mechanism that is intended to transmit the load of the stair-climbing device to the stairs during climbing

NOTE An actuator can be a track, wheel, leg, finger or other part. In clusters, actuators are called cams.

3.2 angle of recline

rearward inclination of a manually stabilized stair-climbing device while it is climbing stairs

3.3 assistant

person operating the stair-climbing device but not being transported by the stair-climbing device

3.4 assistant-operated stair-climbing device

stair-climbing device intended to be operated by an **assistant** (3.3)

3.5 cam

actuator (3.1) of a **cluster** (3.8)

NOTE If the cam is a wheel, it can be freely rotating, have a unidirectional freewheel function, be temporarily braked or be driven. If the cam is eccentric, it usually has a curved or spiral shape of varying diameter. Some cams might consist of hinged posts or “shoes”.

3.6 climbing

ascending or descending stairs

3.7

climbing mechanism

part of the stair-climbing device that provides the ability to climb stairs

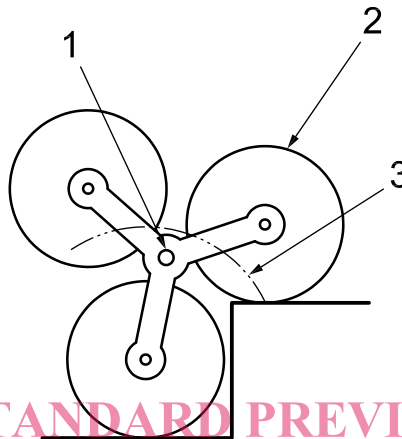
3.8

cluster

type of **stepwise climbing mechanism** (3.49) in which cams revolve around a common axis

NOTE 1 For details and examples, see Figures 1 and 2.

NOTE 2 The usual number of cams in a cluster ranges from 2 to 5. During climbing, each cam can perform the function of a lower actuator and an upper actuator as the cluster rotates.



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Key

- 1 common axis
- 2 cam (wheel)
- 3 path of lowest points of cams relative to the common axis

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Figure 1 — Cluster details

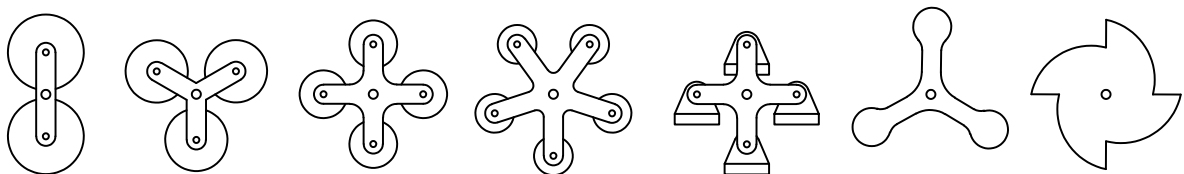


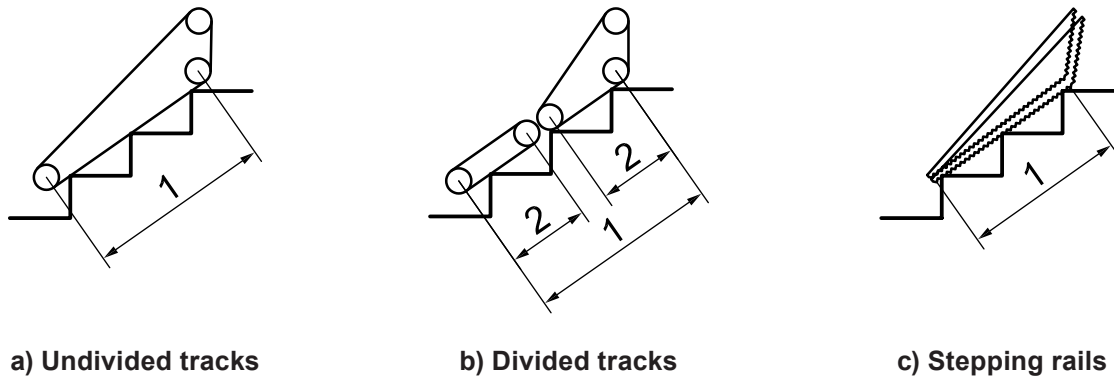
Figure 2 — Examples of clusters

3.9

continuous climbing mechanism

type of climbing mechanism that extends over several steps and moves along their pitch line in a continuous fashion

EXAMPLE Climbing mechanisms which appear to have a nearly flat bottom when viewed from the side, such as tracks or stepping rails. Figure 3 shows the most common types.



Key

- 1 overall length of the stair-contacting area of a continuous climbing mechanism
- 2 section length of the stair-contacting area of one section of a divided continuous climbing mechanism

Figure 3 — Continuous climbing mechanisms

3.10 crawling

moving on landings

NOTE Any means provided by a stair-climbing device for moving on landings is considered crawling, including manual propulsion, power-assisted manual propulsion and driving. Using the climbing mechanism to move on a landing is also considered crawling.

3.11 direct operating force

manual force exerted by the operator (3.33) between the stair-climbing device and its surroundings to cause operation in accordance with the manufacturer's instructions for use

EXAMPLE Forces acting on push handles of a stair-climbing device or on handrails of stairs.

NOTE Forces due to the weight of the stair-climbing device, test wheelchair and occupant are not direct operating forces.

3.12 docking

attaching (a wheelchair) to a stair-climbing wheelchair carrier

3.13 driving

use of the stair-climbing device to provide wheeled mobility on driving surfaces

NOTE Some stair-climbing chairs and some stair-climbing wheelchair carriers include such wheelchair functions.

3.14 driving surface

surface on which a wheelchair is typically driven in normal use

EXAMPLES Level floors, inclined floors, smooth floors, carpeted floors, edging strips, thresholds, sidewalks, kerbs, small obstacles, uneven ground.

3.15 dynamically controlled stair-climbing device manually stabilized stair-climbing device

(3.26) that, when in climbing mode, controls the operation of its climbing mechanism in response to changes in **direct operating forces** (3.11) and/or movement of the centre of mass of the occupant and/or changes in the contact points between the stair-climbing device and the surfaces that support it

3.16**edge stop**

device intended to stop forward movement of a stair-climbing device when it is on a landing above stairs and approaching the nosing of the top step

3.17**exaggerated test set-up**

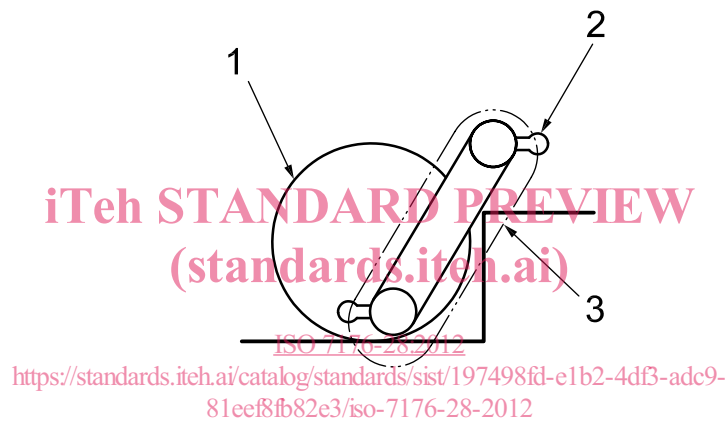
configuration of the stair-climbing device under test that simulates foreseeable adverse distribution of the occupant's mass and any additional masses

3.18**finger drive**

type of stepwise climbing mechanism where the lower actuator is fixed to the stair-climbing device and the upper actuator is movable relative to the stair-climbing device

NOTE Finger drives are known where the lower actuator is a wheel and the upper actuator is a finger. The lowest point of the finger moves along an oval path. Each actuator remains in its function as the lower or upper actuator.

See Figure 4.

**Key**

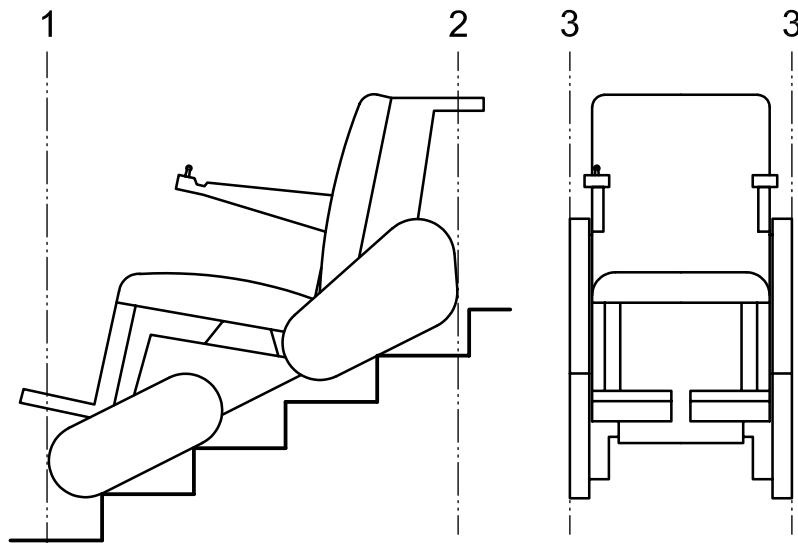
- 1 lower actuator (wheel)
- 2 upper actuator (finger)
- 3 path of lowest point of finger relative to climbing mechanism

Figure 4 — Example of a finger drive

3.19**front vertical plane**

vertical plane which is perpendicular to the horizontal component of the forward direction of travel and tangential to the most forward point of the climbing mechanism when the stair-climbing device is in climbing mode and placed on stairs with a pitch of $(35 \pm 5)^\circ$

See Figure 5.



Key

- 1 front vertical plane (3.19)
- 2 rear vertical plane (3.35)
- 3 side vertical plane (3.40)

Figure 5 — Reference planes

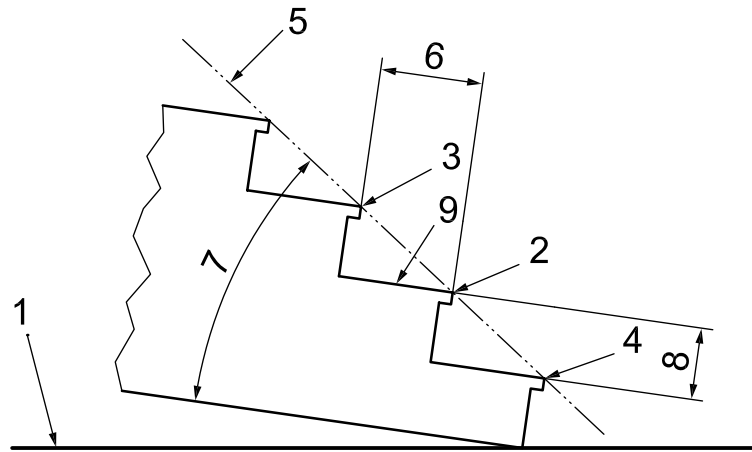
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**3.20
going**

distance between the nosing of a step and the nosing of the next higher step, measured perpendicular to the nosing of the measured step and parallel to its tread

NOTE Adapted from ISO 3880-1.

See Figure 6.

**Key**

- 1 horizontal test plane
- 2 nosing of measured step
- 3 nosing of next higher step
- 4 nosing of next lower step
- 5 pitch line
- 6 going (3.20)
- 7 pitch (3.34)
- 8 rise (3.37)
- 9 tread (3.51)

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Figure 6 — Measurement of going, pitch and rise (example with tilted stairs)

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3.21**hazardous situation**

circumstance in which people or animals are exposed to one or more potential source(s) of physical injury or damage to health, or property or the environment is exposed to one or more potential source(s) of damage

NOTE This includes tipping, sliding, tumbling, squeezing, trapping or any other situation that is reasonably considered to be hazardous.

3.22**least stable configuration**

set-up of the stair-climbing device that gives least stability in the test direction

3.23**least stable position**

placement of the stair-climbing device on the test plane or stairs that gives least stability in the test direction

3.24**locating**

placing (the stair-climbing device) on stairs so that, where the **span** (3.42) has an odd number of steps, a particular step is the middle step of the span, or, where the span has an even number of steps, a particular step is immediately below the middle of the span

3.25**lower actuator**

actuator of a stepwise climbing mechanism that is below the upper actuator when both actuators are in contact with two adjacent steps