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Wheelchairs —

Part 1: Determination of static stability

Fauteuils roulants —

Partie 1: Détermination de la stabilité statique

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Foreword

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

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

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

This third edition cancels and replaces the second edition (ISO 7176-1:1999), all clauses, sub-clauses, tables, figures, and annexes of which have been technically revised.

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 postural support devices*

— *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 25: Batteries and chargers for powered wheelchairs*

— *Part 26: Vocabulary*

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

A Technical Report (ISO/TR 13570-1) is also available giving a simplified explanation of these parts of ISO 7176.

Introduction

It is important to know the static-stability characteristics of a wheelchair for prescription and adjustment purposes. Some occupants need large reserves of stability to ensure their safety while others prefer finely balanced wheelchairs which have better manoeuvrability. Static stability is only one factor affecting dynamic stability, others being the position of the wheelchair operator in the wheelchair, the skill of the wheelchair operator, the manner in which the wheelchair is propelled, and the environment in which the wheelchair is operated.

This part of ISO 7176 specifies tests in which static stability is measured with parking brake(s) applied, as is the case if the wheelchair is standing on a slope. Tests are also made with the wheels unlocked, simulating the situation where the wheelchair is standing on a slope with the wheels against obstacles, the situation on a level surface with the wheels unlocked and the wheelchair occupant reaching for an object, or instability while rolling. Tests are also made that determine the static stability of the wheelchair when it is protected against tipping over by a forward and/or rearward anti-tip device, and the effectiveness of those anti-tip devices if the wheelchair tips in that direction.

Wheelchairs —

Part 1:
Determination of static stability

1 Scope

This part of ISO 7176 specifies test methods for determining the static stability of wheelchairs. It is applicable to manual and electrically powered wheelchairs, including scooters, with a maximum speed not greater than 15 km/h, intended to provide indoor and/or outdoor mobility for one disabled person whose mass is within the range represented by ISO 7176-11.

For active stability-controlled wheelchairs, this part of ISO 7176 applies to the device in a stable, parked state.

This part of ISO 7176 provides a method for the measurement of the tipping angles (either wheelchair tipping angle or anti-tip device tipping angle), but this method is not applicable to wheelchairs with lateral anti-tip devices and does not consider sliding on the ground.

This part of ISO 7176 also includes requirements for test reports and information disclosure.

2 Normative references

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

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

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

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

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

3 Terms and definitions

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

3.1
active stability-controlled wheelchair
wheelchair that actively controls or enhances its stability (by electronic or other means) when static and/or when in motion

3.2
anti-tip device
device which limits the extent of tipping of a wheelchair

Note 1 to entry: Anti-tip devices can operate in forward, rearward, or lateral directions. Some anti-tip devices have a spring suspension. Some running wheels can act as anti-tip devices, but their primary function is to be running wheels. Foot supports can serve as anti-tip devices if the manufacturer designates that they are intended to serve in that capacity. A change in the wheelchair configuration or control characteristics to enhance stability is not considered an anti-tip device.

3.3
anti-tip device tipping angle
angle of the test platform from the horizontal at which the wheelchair starts to tip about the anti-tip device

3.4
contact point
midpoint of the region of contact between a wheel or other part of the wheelchair and the ground

Note 1 to entry: In the test procedures specified in this part of ISO 7176, the ground can be the test platform or its covering that lies between the test platform and the wheel or the post.

3.5
force detection point
point at which the force under an uphill wheel is monitored

Note 1 to entry: This can be determined as the point at which a sheet of paper will slide between the wheel and the contact surface.

3.6
lockable wheel
wheel equipped with parking brake, or wheel whose rolling motion is prevented by the means of propulsion (e.g. by hands, levers, motors)

3.7
non-lockable wheel
wheel that is not a lockable wheel

3.8
parked state
static position that will allow the occupant to transfer into or out of the seat

3.9
running wheel
wheel that normally runs on the surface while the wheelchair is travelling at a constant speed on a level surface

3.10
wheelchair tipping angle
angle of the test platform from the horizontal at which the vertical projection of the centre of mass moves outside of a polygon connecting the contact points of all the running wheels (to be assessed by empirical measure)

Note 1 to entry: The instant at which the wheelchair starts to tip is reached when the forces become zero under all uphill running wheels (i.e. one edge of the polygon lies directly below the centre of mass).

Note 2 to entry: A number of methods are available with which to determine when the forces become zero under the uphill wheels. These include, but are not limited to, the following: the ability to pull pieces of paper from beneath the wheels, visual identification of when the wheels lift from the test platform, or the use of force-sensing instrumentation.

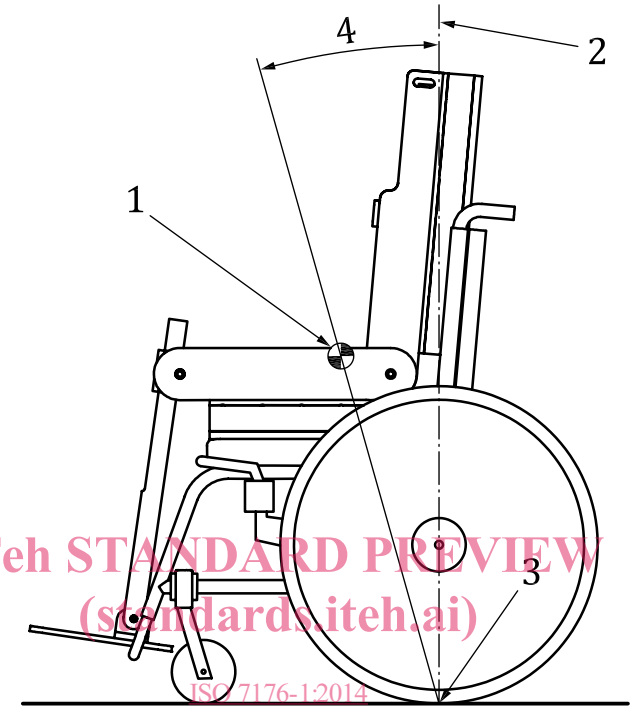
4 Principles

4.1 Static stability

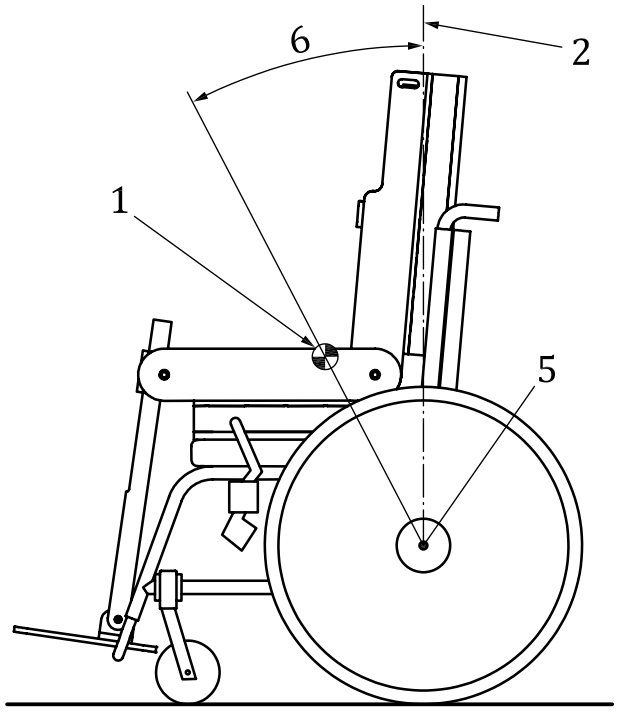
Theoretically, a loaded wheelchair is statically stable as long as the gravity force line from the centre of mass is inside the area on the ground that is confined by the outline of the contact points (see 3.4) of its wheels. Wheelchair stability increases as the angle between a vertical plane through the axis of tip and a plane that contains the centre of mass and the axis of tip increases. A wheelchair will tip when it is tilted beyond this measured angle (see Figure 1) about the axis of tip. The wheelchairs can either tip about the

contact point when the wheels are locked or about the wheel axle when the wheels are unlocked (see Figure 1).

Since the location of the centre of mass is not known, it is not possible to measure the tipping angle directly. Therefore it is determined with the wheelchair on an adjustable slope test platform. The angle of the slope on which the wheelchair starts to tip is measured. The angle of the test platform represents the tipping angle.



a) wheelchair with wheels locked



b) wheelchair with wheels unlocked

Key

1 centre of mass of wheelchair plus dummy
2 vertical
3 axis of tip when wheel is locked
4 wheelchair tipping angle when wheel is locked
5 axis of tip when wheel is unlocked
6 wheelchair tipping angle when wheel is unlocked

Figure 1 — Demonstration of wheelchair tipping angles (example in rearward direction)

In the case of a test with unlocked wheels, the axis of tip lies in the wheel axles, and the relevant centre of gravity is that of the loaded wheelchair excluding the mass of the unlocked wheels about the wheelchair tips.

NOTE Since this is a rather minor effect, it is not explicitly shown in the figures of this part of ISO 7176.

4.2 Effectiveness of anti-tip devices

The wheelchair is brought to a situation in which it is in unstable equilibrium about an axis between the two running wheels nearest the anti-tip device(s). From this state, the wheelchair should be able to freely tip until its anti-tip device(s) contact the test surface. It is observed whether the anti-tip device is capable of preventing the wheelchair from tipping over completely.

5 Apparatus

5.1 Test platform, a flat, hard platform with adjustable slope that is large enough to accommodate the wheelchair to be tested, with a test surface that lies between two imaginary parallel planes 5 mm apart and has no more than 0,5° of variation in slope or cross slope throughout the test.

NOTE 1 The imaginary planes are intended to provide a measure of control on the flatness of the test platform.

NOTE 2 Visible lines parallel and normal to the hinge of the test platform can assist in positioning the wheelchair.

5.2 Means by which the slope of the test platform can be **adjusted**.

The slope of the test platform can be increased in a stepwise or continuous fashion. If the slope is increased in a stepwise fashion, during the last two to three degrees of slope inclination, the steps should not be greater than 0,5° and should not be so abrupt that they affect the validity of the tipping angle (either wheelchair tipping angle or anti-tip device tipping angle). Between the steps, pauses should be made that are long enough to allow settling of any rocking of the wheelchair. Any means to dampen rocking of the wheelchair should not be so that they affect the validity of the tipping angle (either wheelchair tipping angle or anti-tip device tipping angle). If otherwise the slope of the test platform is increased in a continuous fashion, during the last two to three degrees of slope inclination before the tipping angle is reached, the rate of increase in the slope should not exceed 0,5 °/s.

5.3 Roll restraint, a means to prevent an unlocked wheel or anti-tip device from rolling that does not affect the wheelchair's freedom to tip about the axle of the restrained wheel.

Roll restraint surfaces that contact a wheel shall be perpendicular to the test plane. The height of the roll restraint shall be sufficiently large to prevent rolling of the wheels during testing (see Figure 2).

NOTE Placing a rigid barrier in contact with the downhill wheels is an acceptable method for testing when the downhill wheels are unlocked.

5.4 Slide restraint, means to prevent a locked wheel or anti-tip device from sliding that does not affect the wheelchair's freedom to tip about the contact point (see 3.4) of the restrained wheel or post.

NOTE 1 See Annex A.

NOTE 2 Placing a rigid barrier in contact with the downhill wheels is not acceptable for the tests when the downhill wheels are locked, because it changes the axis of tip.

5.5 Tipping limiter, means to limit the extent of tipping of the wheelchair relative to the test platform that does not affect the stability of the wheelchair, restrict the wheelchair's freedom to deform, or restrict the wheelchair's freedom to tip sufficiently to detect a zero force under the uphill wheels of the wheelchair, or in the case of 11.2, from tipping onto its anti-tip wheels (see Figure 2).

5.6 Angular measurement device, means to measure the angle of the slope of the test platform with respect to the horizontal with an accuracy of ±0,5°.

5.7 Test dummy, as specified in ISO 7176-11.

5.8 Dummy securement, means to secure the torso, thigh, and lower leg portions of the test dummy as specified in ISO 7176-22.

6 Set-up procedure

Set up the test wheelchair as specified in ISO 7176-22.

Select and fit a test dummy as specified in ISO 7176-22.

For active stability-controlled wheelchairs, where the manufacturer specifies that the wheelchair is stable only when the wheelchair is powered on, the tests should be conducted with power on and the systems active, and Table 4 annotated to note that the chair is unstable when powered off. In all other instances, the wheelchair should be tested both with systems active and when powered off to determine the least and most stable conditions. Ensure to record the appropriate setting for each result in Table 4.

Evaluation of the safety of active stability-controlled wheelchairs due to power shut down (commanded or not) while in use should be assessed in accord with ISO 7176-14.

Do not load the wheelchair with a human test occupant, except as approved for clinical evaluations.

All adjustments shall be within the effective range of adjustment specified by the manufacturer in the operator manual, a permanent affixed label on the wheelchair, or a physical barrier installed to prevent movement into that area.

NOTE During setup, 'uphill' and 'downhill' refer to directions when the test platform is inclined during the test.

7 General test procedure

The static stability tests are based on a common procedure that is modified to suit each test. The common test procedure is as follows.

a) Increase the slope of the test platform until the tipping angle (either wheelchair tipping angle or anti-tip device tipping angle) is reached, and then prevent further movement of the platform.

b) Ensure that the result is not affected by inadvertent contact between the wheelchair and the test equipment or floor.

c) Recheck the positions of the test dummy and wheelchair to ensure that no inadvertent movement has occurred. If the configuration of the wheelchair reproducibly or irreversibly changes during the test (e.g. if the tyre rolls off the rim or the wheelchair partially folds),

— record the nature of the occurrence and the angle of the test platform at which this occurs in the comments section of the test report [item (j) in Clause 12], and

— complete the test.

d) Measure and record the tipping angle (either wheelchair tipping angle or anti-tip device tipping angle) to the nearest 1°.

e) Lower the test platform to horizontal.

f) Where applicable (e.g. in the tests for static stability with anti-tip devices), allow the running wheels of the wheelchair to drop back onto the test platform.

CAUTION — These tests can be hazardous. It is essential that appropriate safety precautions be taken to protect the test personnel.

8 Test for static stability in the forward direction

8.1 General

The test methods specified in Clauses 8 to 11 of this part of ISO 7176 can be performed in any sequence.

a) For wheelchairs with non-lockable front wheels, measure the forward wheelchair tipping angles as specified in 8.2 and 8.4 only.

b) For wheelchairs with lockable front wheels, measure the forward wheelchair tipping angles as specified in 8.2 to 8.5.

c) For wheelchairs with a single front wheel or if the contact points of the front wheels are less than one wheel diameter apart, then treat the wheelchair as if it had only one front wheel. In such circumstances, the wheelchair will tip in a more lateral direction, and the tests specified in Clause 8 shall be omitted. This aspect of stability is measured in Clause 10.

