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Wheelchairs —

Part 11: Test dummies

Fauteuils roulants —

Partie 11: Mannequins d'essai

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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 7176-11 was prepared by Technical Committee ISO/TC 173, *Assistive products for persons with disability*, Subcommittee SC 1, *Wheelchairs*.

This second edition cancels and replaces the first edition (ISO 7176-11:1992), which has 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 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*

A technical report (ISO/TR 13570-1) is also available giving a simplified explanation of the parts of ISO 7176.

Introduction

When testing wheelchairs it is often necessary to simulate a human occupant. Test dummies designed for motor vehicle crash testing are used where it is appropriate to do so, but they are expensive. A need exists for an affordable alternative. The first edition of ISO 7176-11, published in 1992, specified a set of test dummies that would be suitable for most wheelchair tests. The designs were intended to provide an appropriate total load mass, to approximate the mass distribution of a human occupant, to avoid unrepresentative damage to the wheelchair, to be durable and to be inexpensive to manufacture.

Experience of using the first edition of ISO 7176-11 and related test dummy specifications showed that test dummies did not always provide repeatable results, particularly for static and dynamic stability tests. Several areas for improvement have been identified: to extend the mass range, to enable a test dummy of arbitrary mass to be made, to enable verification of the location of the overall centre of mass and to enable adjustment of the position of the overall centre of mass. This second edition of ISO 7176-11 is intended to provide these improvements.

The ability to measure and adjust the location of the overall centre of mass eliminates the need to specify many aspects of test dummy design. It also allows for the mass of a test dummy to be altered as needed.

The formulae provided in this part of ISO 7176 for the location of the overall centre of mass are based on data and research available to date. It is expected that the range of masses and the mass distribution of wheelchair occupants will change over time. Revisions can be made to this part of ISO 7176 to reflect such changes as and when data becomes available.

Wheelchairs —

Part 11: Test dummies

1 Scope

This part of ISO 7176 specifies requirements for test dummies of any mass greater than or equal to 25 kg, to be used in the evaluation of wheelchairs. This part of ISO 7176 provides formulae that specify the location of the overall centre of mass of test dummies, the masses of the segments that comprise the test dummies and the locations of pivots that connect the segments. It also specifies the characteristics of loading pads that support the segments.

The specified location for the centre of mass is approximately the same as that of a human being of the corresponding mass when seated in a wheelchair, and also, for masses up to 100 kg, when in a standing position in a stand-up wheelchair. This part of ISO 7176 does not attempt to represent the mass distribution of a person with limb atrophy or amputation. This part of ISO 7176 is intended to enable the construction of test dummies that will produce comparable results for stability, performance and durability testing of manual wheelchairs and electrically powered wheelchairs, including scooters.

This part of ISO 7176 also includes informative tables of mass and locations of centre of mass, which are derived from the formulae, corresponding to example test dummy masses up to 300 kg in 25 kg increments.

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

3 Terms and definitions

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

3.1
forward location
distance forward from the back support reference plane, measured perpendicular to it

NOTE For the purposes of this document, the back support reference plane is equivalent to the front surface of the test fixture's back support when the test dummy is fitted in the test fixture (see 5.1).

3.2
height
distance upward from the seat reference plane, measured perpendicular to it

NOTE For the purposes of this document, the seat reference plane is equivalent to the upper surface of the test fixture's seat when the test dummy is fitted in the test fixture (see 5.1).

3.3
loading pad
component, consisting of a loading plate and a foam cushion, intended to transfer the load between a segment of the test dummy and the wheelchair under test

NOTE The foam cushion is the part of the loading pad intended to make contact with the wheelchair.

3.4
loading plate
rigid flat plate for use in a loading pad

3.5
lower leg segment
segment of the test dummy that represents the lower legs and feet of a human being

3.6
overall centre of mass
centre of mass of the whole test dummy

3.7
test dummy
device used to represent the mass and mass distribution of a human being, for the purpose of testing a wheelchair

3.8
thigh segment
segment of the test dummy that represents the upper legs and buttocks of a human being

3.9
torso segment
segment of the test dummy that represents the torso, head and arms of a human being

4 Symbols and abbreviated terms

CoM	centre of mass
m_{dummy}	nominal mass of the test dummy
m_{leg}	mass of the lower leg segment
m_{thigh}	mass of the thigh segment
m_{torso}	mass of the torso segment
l_{thigh}	distance from the hip pivot axis to the knee pivot axis
l_{leg}	distance from the knee pivot axis to the ankle pivot axis
x_{ankle}	forward location of the ankle pivot axis
x_{dummy}	forward location of the overall centre of mass
x_{hip}	forward location of the hip pivot axis
x_{knee}	forward location of the knee pivot axis
x_{leg}	forward location of the CoM of the lower leg segment
x_{thigh}	forward location of the CoM of the thigh segment
x_{torso}	forward location of the CoM of the torso segment
y_{ankle}	height of the ankle pivot axis
y_{dummy}	height of the overall centre of mass
y_{hip}	height of the hip pivot axis
y_{knee}	height of the knee pivot axis
y_{leg}	height of the CoM of the lower leg segment
y_{torso}	height of the CoM of the torso segment
y_{thigh}	height of the CoM of the thigh segment

NOTE In this part of ISO 7176, all linear dimensions are expressed in millimetres and all masses are expressed in kilograms.

5 Test equipment

5.1 Test fixture, for measuring the location of the overall centre of mass. The test fixture shall:

a) conform to the dimensions shown in Figure 1;

b) be constructed so that the seat and back support are perpendicular within ± 0,5°;

c) be constructed so that the foot support and seat are parallel within ± 0,5°;

d) have provision for the height of the foot support to be adjusted within the range shown in Figure 1 or include rigid spacers to be placed on the foot support, such that the upper surface of the uppermost

rigid spacer can be located within the range shown in Figure 1 and such that it is parallel to the seat as specified in b);

e) include means to secure the torso segment and thigh segment so that the torso loading pad and thigh loading pad are in contact with the back support and seat respectively, with the foam cushions compressed;

f) include a means to secure the lower leg segment so that the foot loading pads are in contact with the foot support or uppermost rigid spacer as specified in d);

g) have mass not exceeding 28 kg or 15 % of m_{dummy}, whichever is greater;

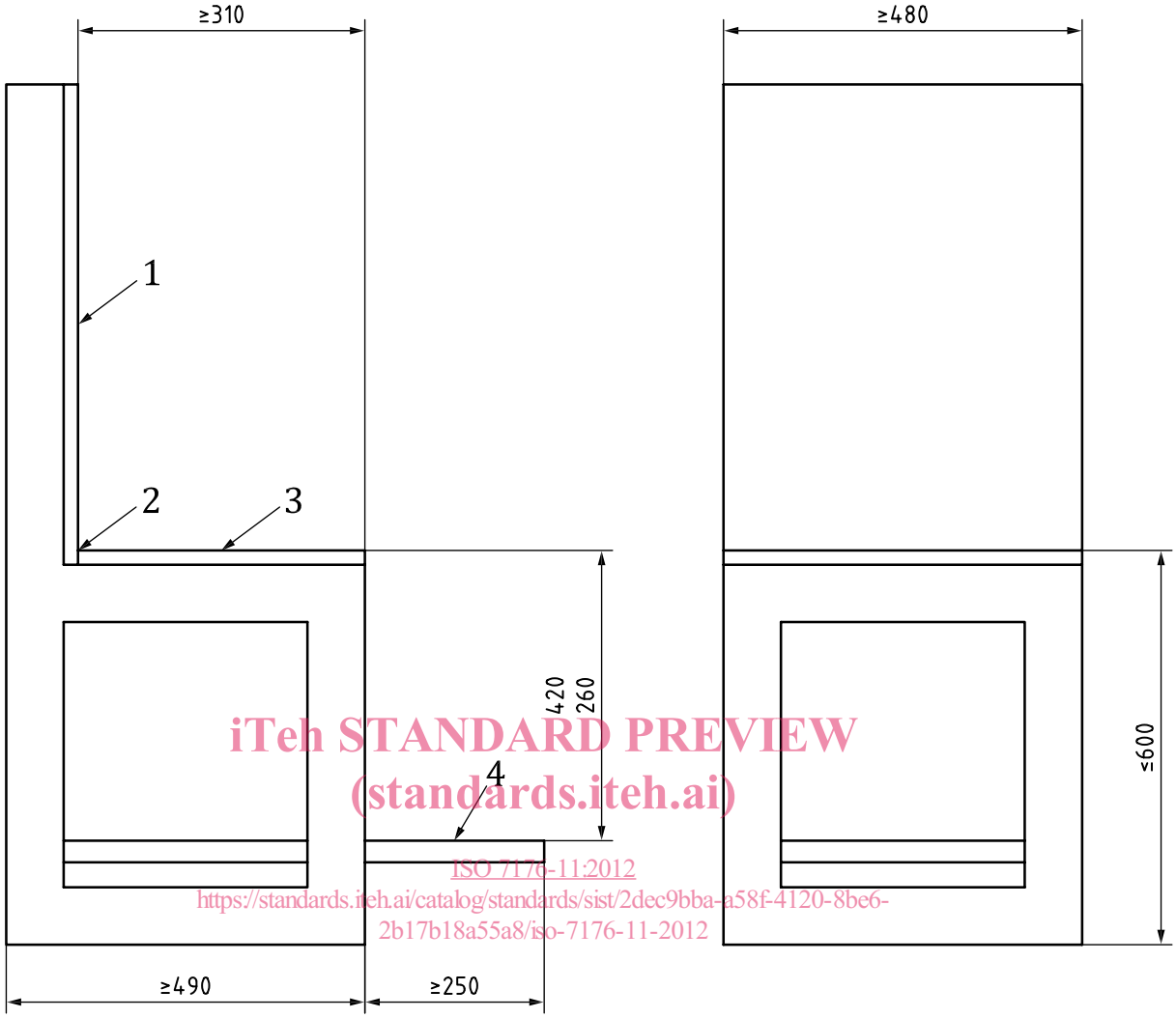
h) be constructed with sufficient stiffness that during use no dimensional change exceeds 5 mm;

i) if necessary, be fitted with means for manual handling, such as handles.

The recommended seat depth is 310 mm for 25 kg test dummies, and 375 mm for test dummies of 50 kg and above.

Plywood specified for structural use in unprotected exterior conditions, of thickness 19 mm, and solid timber specified for structural use, of thickness 60 mm, is suitable for use in the construction of test fixtures for test dummies of 125 kg or less.

Dimensions in millimetres



Key

1 back support
2 seat reference point
3 seat
4 foot support

Figure 1 — Test fixture

5.2 Inclinometer or **plumb line**, for measuring the angle of inclination of the test fixture (5.1) with an uncertainty that does not exceed 0,2°, when using the balance method specified in Annex A.

5.3 Scales, to measure the combined weight of the test fixture (5.1) and the test dummy, with an uncertainty that does not exceed 0,2 kg.

5.4 Test surface, constructed of a hard material, such as a concrete or hardwood platform, which does not deviate from level by more than 2 mm within the area occupied by the test fixture (5.1) when using either method specified in Annex A.

6 Materials

6.1 General

The material and construction of the test dummy shall be selected so that the dummy meets the requirements of mass and mass distribution specified in 7.5 and 7.6 and so that it does not distort beyond the specified limits under the stresses it will encounter during use.

NOTE 1 Steel, nominally 6 mm thick, aluminium, nominally 12 mm thick, and plywood specified for structural use in unprotected exterior conditions, nominally 19 mm thick, have all been used successfully for test dummy segments.

NOTE 2 Plywood, nominally 19 mm thick, has been used successfully for loading plates.

6.2 Rigid spacers

Any material used to position the overall centre of mass shall meet the requirements specified in 6.1.

NOTE Lightweight material, such as expanded polystyrene rigid foam insulation for domestic purposes, has been successfully used for rigid spacers.

6.3 Foam cushions

Foam cushions for loading pads shall be made of material that compresses to (15 ± 3) mm when tested as follows.

Conduct the test at an ambient temperature of (20 ± 5) °C.

Prepare a homogeneous test sample (i.e. one with no surface 'skinning', such as from a manufacturing process) of thickness (30 ± 5) mm, cut to an area of (140 000 ± 4 000) mm^2, with the minimum dimension of its large surface no smaller than 300 mm.

Place the sample with one of its large surfaces on a flat surface. Using a flat plate, apply to the upper surface of the sample a uniformly distributed force of (920 ± 20) N perpendicular to the lower surface of the sample, for (60 ± 10) s.

NOTE 1 The area of the sample corresponds to the area of the thigh loading plate of a 100 kg test dummy. The force applied corresponds to the combined weight of the torso segment and thigh segment of a 100 kg test dummy.

NOTE 2 The test sample may be built up from sheets of foam that are below the required thickness.

NOTE 3 Some closed-cell foam that has an indentation hardness index equal to (750 ± 250) N when measured as specified in ISO 2439, method A (for PVC, polyurethane and latex foams of the open-cell type) is suitable.

7 Specifications

7.1 General

7.1.1 A test dummy consists of three segments: the torso segment, thigh segment and lower leg segment. The segments have associated loading pads and may also have rigid spacers between the segments and loading pads. The lower leg segment may have either one or two leg members. Typically, the torso segment and thigh segment each consists of a frame loaded with weights, which are added, removed or repositioned to adjust the mass and location of CoM of the segment.

The foam cushions of the loading pads should be the only parts of the test dummy that come into contact with the wheelchair under test. The dimensions of the torso, thigh and lower leg segments should be

