
Wheelchairs —

Part 8:

Requirements and test methods for static,
impact and fatigue strengths

Fauteuils roulants —

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*Partie 8: Prescriptions et méthodes d'essai pour la résistance statique, la
résistance aux chocs et la résistance à la fatigue*

ISO 7176-8:1998

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International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

Printed in Switzerland

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Foreword

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

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.

International Standard ISO 7176-8 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 the efficiency of brakes*
- Part 4: *Determination of energy consumption of electric wheelchairs and scooters*
- Part 5: *Determination of overall dimensions, mass and turning space*
- Part 6: *Determination of maximum speed, acceleration and retardation of electric wheelchairs*
- Part 7: *Method of 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 the 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: *Requirements and test methods for resistance to ignition of upholstered parts*
- Part 17: *Serial interface for electric wheelchair controllers*
- Part 18: *Stair traversing devices*
- Part 19: *Wheeled mobility devices for use in motor vehicles*
- Part 20: *Determination of the performance of stand-up type wheelchairs*
- Part 21: *Requirements and test methods for electromagnetic compatibility of powered wheelchairs and motorized scooters.*
- Part 22: *Set up procedure for adjustable wheelchairs.*

Parts 17 to 22 are included in the work programme, but at early stages.

NOTE A technical report will also be made available giving a simplified explanation of these parts of ISO 7176.

Introduction

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.

Many wheelchairs 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.

However, there is also a need to be able to make comparisons between different products; a reference configuration that gives a basis for such comparisons is specified.

It is anticipated that all parts of this International Standard will continue to be developed and future revisions may include the results of ongoing work in the following areas:

- the fatigue testing of electrically powered wheelchairs, and in particular, the speed and size of obstacle of the two-drum test machine;
- requirements for wheelchairs where the mass of the user exceeds 100 kg;
- development of the design recommendations in annex B to normative requirements;
- development of more precisely defined failure criteria, and, in particular, a tracking test to determine if any test damage is acceptable (see annex E);
- consideration whether the fatigue test requirements should be revised for manual wheelchairs intended for 'active users' and fitted with very small castors;
- a more precisely defined set up procedure for the reference configuration of adjustable wheelchairs as given in ISO 7176-22, which is under preparation;
- further development of the test dummies to improve the way in which they load the backs of test wheelchairs, and in particular to improve their suitability for use with wheelchairs with low backrests.

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Wheelchairs —

Part 8:

Requirements and test methods for static, impact and fatigue strengths

1 Scope

This part of ISO 7176 specifies requirements for static, impact and fatigue strength of wheelchairs including scooters intended for users whose mass does not exceed 100 kg. It specifies the test methods for determining whether the requirements have been met. It also specifies requirements for disclosure of the test results.

The test methods may also be used to verify manufacturers' claims that a product exceeds the minimum requirements of this part of ISO 7176.

A reference configuration is specified for adjustable wheelchairs and scooters to enable test results to be used for the comparison of performance.

It applies to occupant- and attendant-propelled manual wheelchairs and electrically powered wheelchairs intended to provide indoor and outdoor mobility for people with disabilities. For electrically powered wheelchairs, it applies to those with a maximum speed of not more than 15 km/h where not more than two wheels are driven and which have three or more wheels located on two parallel, transverse axes.

NOTE 1 This part of ISO 7176 does not apply to wheelchairs where the wheels lie on more than two axes (e.g. in 'diamond' configuration).

NOTE 2 Clauses of this part of ISO 7176 may be used as a basis for developing requirements and test methods for wheelchairs not covered by this part of ISO 7176.

The application of this part of ISO 7176 is limited to wheelchairs with a maximum occupant mass of 100 kg because this is the maximum mass of test dummy available in ISO 7176-11. Further work is needed to investigate the effects of the lifestyle of people with larger body masses.

NOTE 3 For the purposes of this part of ISO 7176, "wheelchair(s)" is used as an abbreviation for manual wheelchair(s) or electrically powered wheelchair(s), including scooter(s), to which the requirements and test methods are applied.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7176. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7176 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 845: 1988, *Cellular plastics and rubbers — Determination of apparent (bulk) density*.

ISO 2439: 1997, *Flexible cellular polymeric materials — Determination of hardness (indentation technique)*.

ISO 6440:1985, *Wheelchairs— Nomenclature, terms and definitions*.

ISO 7176-6: 1988, *Wheelchairs — Part 6: Determination of maximum speed acceleration and retardation of electric wheelchairs*.

ISO 7176-7:—¹⁾, *Wheelchairs — Part 7: Method of measurement of seating and wheel dimensions*.

ISO 7176-11: 1992, *Wheelchairs — Part 11: Test dummies*.

ISO 7176-15: 1996, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling*.

3 Definitions

For the purposes of this part of ISO 7176, the definitions given in ISO 6440, ISO 7176-11 and ISO 7176-7 and the following definitions apply.

- 3.1 maximum user mass:** Maximum mass of user specified by the wheelchair manufacturer.
- 3.2 specification sheets:** Manufacturer's pre-sale literature that gives wheelchair performance information.
- 3.3 footpiece(s):** Component(s) used to replace the lower leg portion of the standard test dummies.
- 3.4 negative camber:** Situation when the wheels are inclined towards each other so that the tops of the wheels are closer to each other than the bottoms.
- 3.5 test dummy back:** Rear face of the body portion of the test dummy (see reference plane in figure 4).

4 Requirements

4.1 Strength requirements

When tested in accordance with clauses 8, 9 and 10, a single wheelchair shall meet all the following requirements at the conclusion of all the tests.

- a) 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.

- b) No nut, bolt, screw, locking-pin, adjustable component or similar item shall have become detached after having been tightened, adjusted or refitted once. However, in addition, footrests may be adjusted after each of the two footrest impact tests (see 9.6).
- c) No electrical connector shall be displaced or disconnected.
- d) All parts intended to be removable, folding or adjustable shall operate as described by the manufacturer.
- e) All power-operated systems shall operate as described by the manufacturer.
- f) Handgrips shall not be displaced.
- g) Any multiposition or adjustable component shall not be displaced from the preset position, except as permitted in 4.1b).

¹⁾ To be published.

- h) No component or assembly of parts shall exhibit deformation, free play or loss of adjustment that adversely affects the function of the wheelchair.

4.2 Disclosure requirements

Manufacturers shall disclose in their specification sheets, in the manner and sequence specified in ISO 7176-15, the following:

- a) the model designation and/or any other information that will uniquely identify the wheelchair model;
- b) the mass of the test dummy used in the test;
- c) whether the wheelchair meets the strength requirements of this part of ISO 7176.

5 Test apparatus

5.1 Loading device: capable of applying forces to the wheelchair in the range 15 N to 2000 N to an accuracy of $\pm 3\%$.

5.2 Concave loading pad: made of metal or hard wood as shown in figure 1.

5.3 Convex loading pad: made of metal or hard wood, as shown in figure 1.

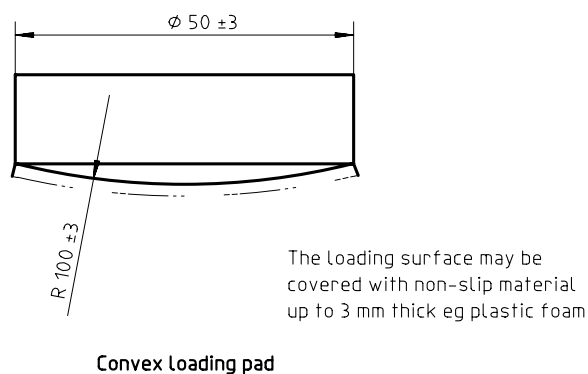
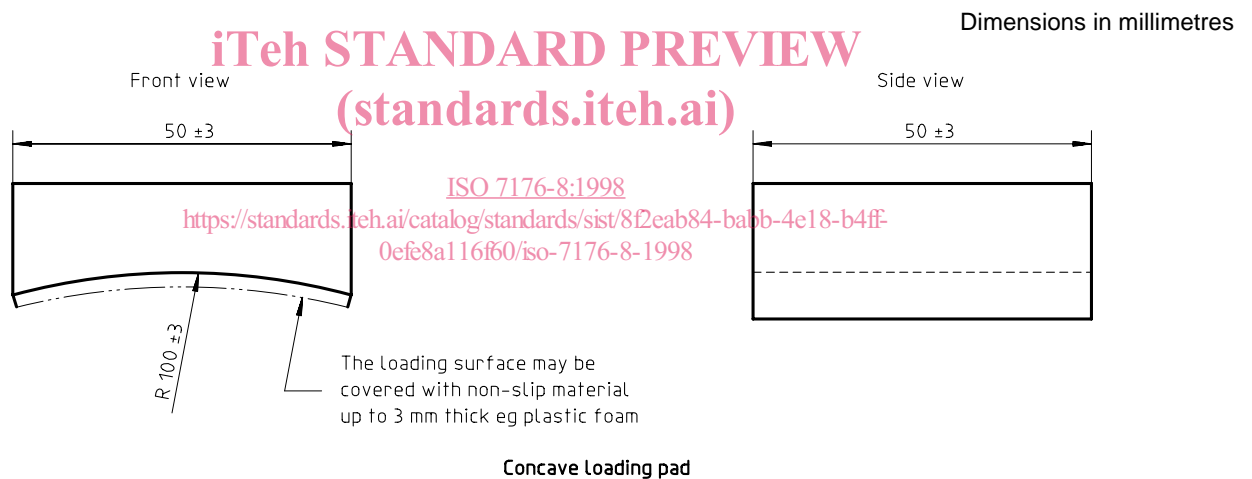


Figure 1 — Loading pads for static loads

5.4 Horizontal test plane: Rigid test plane, of sufficient size to stand the wheelchair during testing, such that the whole surface is contained between two imaginary parallel planes 5 mm apart.

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

5.5 Backrest impact test pendulum: as shown in figure 2a) or 2b).

5.6 Handrim impact test pendulum: as shown in figure 3.

NOTE The pivot axis of this pendulum may be rotated through 90° so it may also be used for the impact test in 9.7.

Dimensions in millimetres

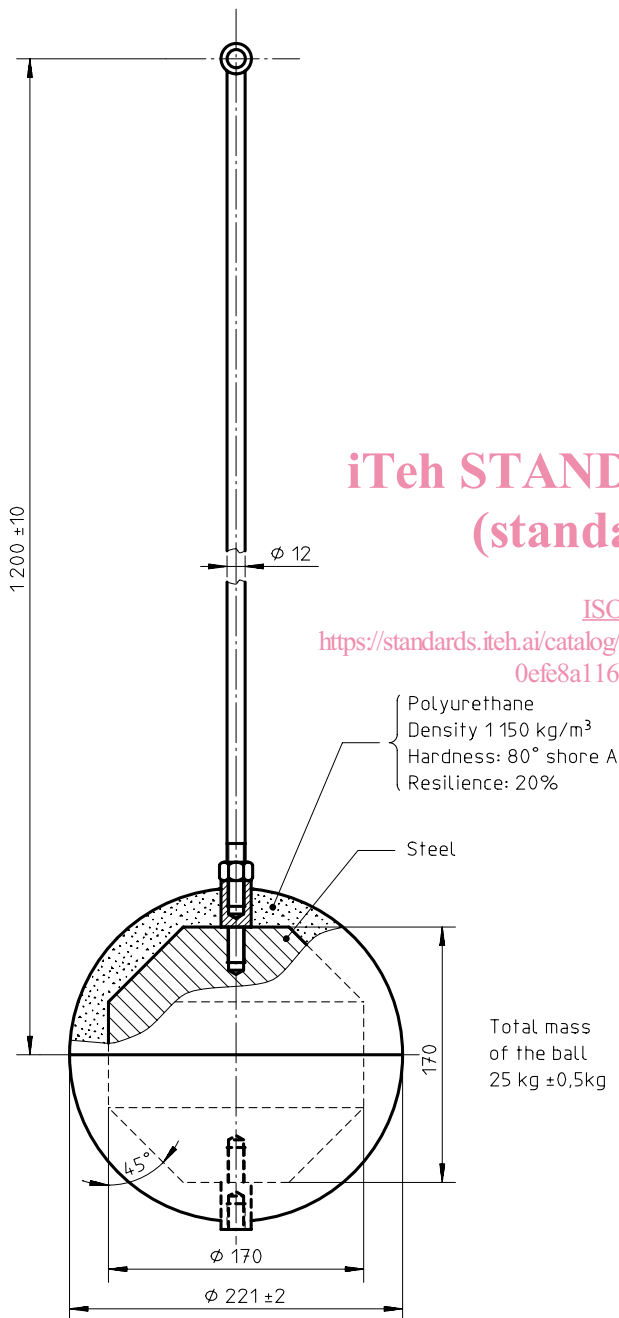
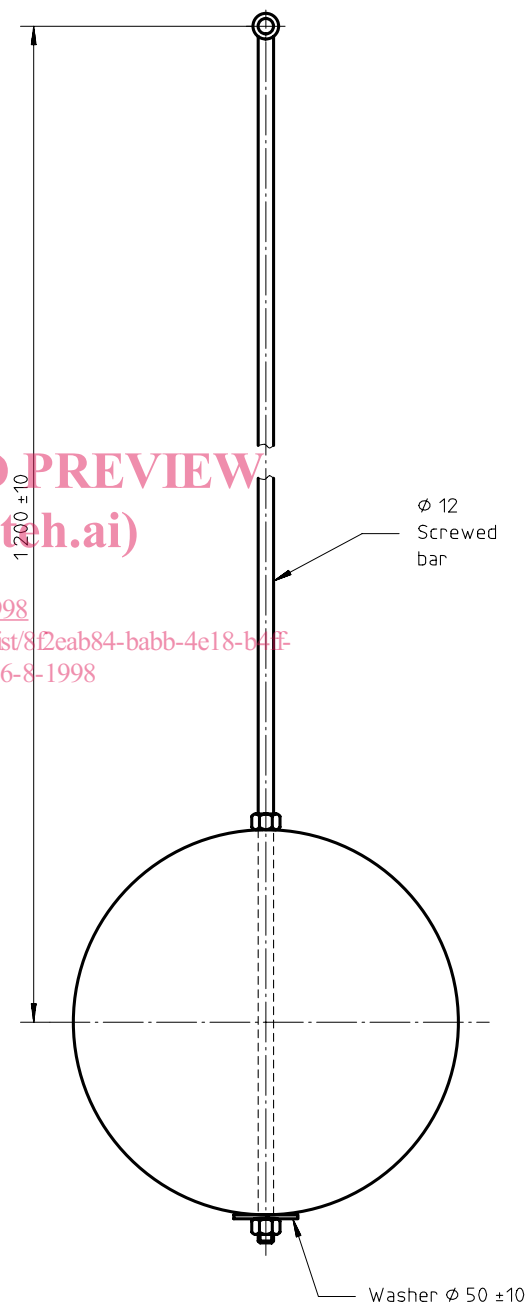


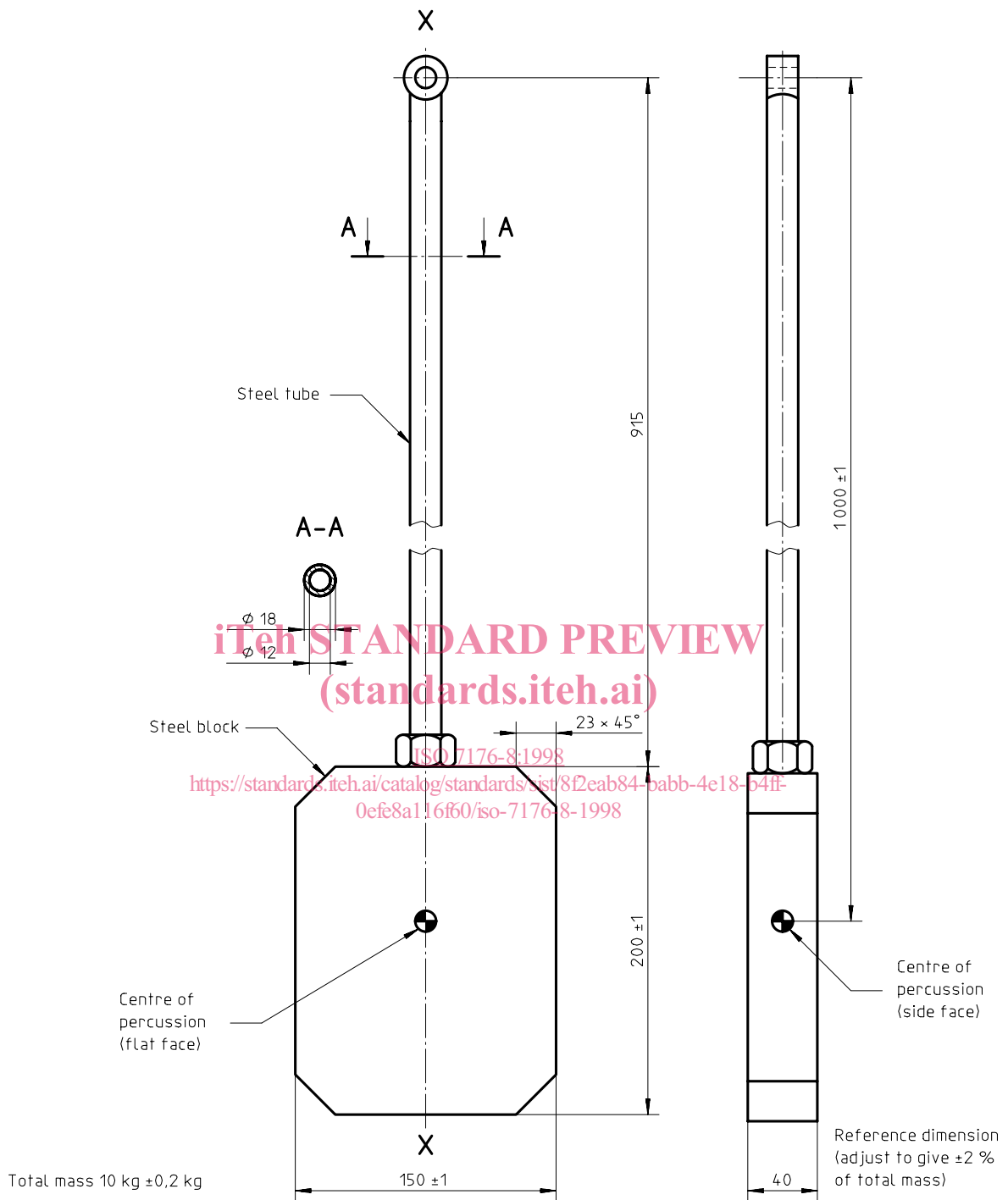
Figure 2 a) — Backrest impact pendulum



Regulation association football size 5 (soccer ball) filled with lead shot 3,5 ± 1 mm dia. and closed cell high density foam Density 75 ± 15 kg/m³ — ISO 845 Hardness 325 ± 60 N — ISO 2439 To a total mass 25 ± 0,5 kg Sphericity ± 20 mm

Figure 2 b) — Backrest impact pendulum

Dimensions in millimetres



Pivot axis to be capable of being repositioned at 90° to the position shown about axis X-X

Figure 3 — Handrim impact test pendulum

5.7 Castor and footrest impact test pendulum, with the following properties:

- a) total mass 10 kg ± 0,25 kg;
- b) distance from pivot to centre of percussion 1,000 mm ± 2 mm;

c) shape and mass distribution from the following formula:

$$d = I/mr_g + r_g$$

where

- I is the inertia of the pendulum about its pivot in kilograms per square metre;
- r_g is the distance from the pivot to the centre of gravity in metres;
- d is the distance from the pivot to the centre of percussion in metres;
- m is the pendulum mass in kilograms.

NOTE 1 The handrim impact test pendulum (see 5.6) may be used although other shapes may be more convenient.

NOTE 2 See annex D for the derivation of the above formula.

5.8 Test dummies (see figure 4), as specified in ISO 7176-11 modified as follows:

Replace the lower leg portions of the 100 kg, 75 kg and 50 kg dummies with two footpieces whose shape permits ready attachment to the wheelchair footrests and which has 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 Two steel blocks each having dimensions 75 mm x 150 mm x 40 mm are suitable as footpieces.

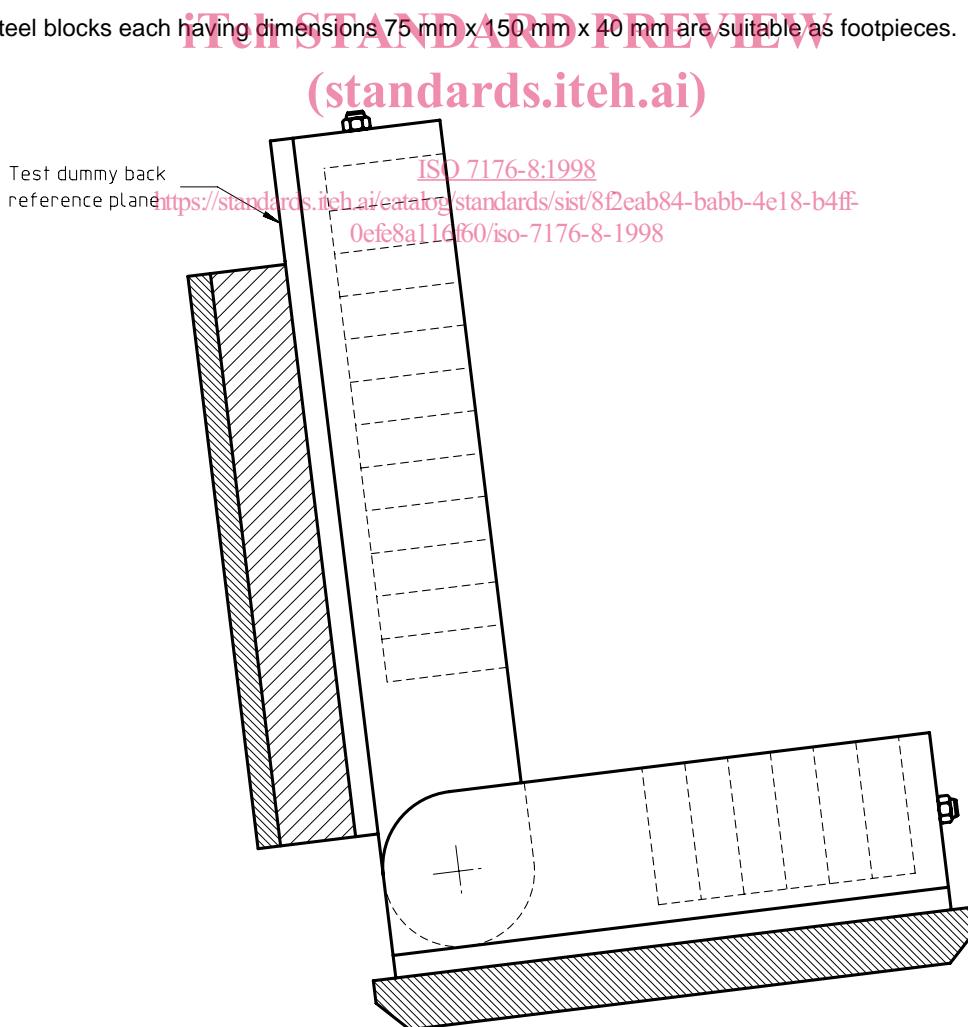


Figure 4 — Test dummy back reference plane

5.9 Two-drum test machine, consisting of the following:

- a) two metal horizontal parallel cylindrical drums of $250 \text{ mm} \pm 25 \text{ mm}$ diameter and at least 100 mm wider than the track of the wheelchair (see figure 5). The distance between the drums shall be capable of being set to the same dimensions as the wheelbase of the wheelchair to be tested;
- b) each drum to have two slats as specified in figure 5;
- c) provision for the drums to be driven so that the "reference drum" may be rotated so that its mean surface speed is $1,0 \text{ m/s} \pm 0,1 \text{ m/s}$ over any 10 revolutions with the other drum rotating in the range 2 % to 7 % faster;
- d) provision to mount the wheelchair with its driven wheels or, in the case of attendant-propelled manual wheelchairs, the rear wheels, on the "reference drum" and its other on the second drum;
- e) provision to restrain the wheelchair longitudinally, while permitting free vertical movement. The restraints shall be attached to the axles of the wheels that are mounted on the reference drum, or to the wheelchair frame as close to the axles as is possible;

NOTE 1 A recommended restraint consists of metal rods with ball joints at each end.

- f) lateral wheelchair restraints that restrict sideways movement to $\pm 50 \text{ mm}$, such that the restraints do not restrict vertical movement;

NOTE 2 Recommended lateral restraints are webbing straps.

- g) provision to measure the speed of the "reference drum" to an accuracy of $\pm 0,01 \text{ m/s}$;
- h) provision to count the number of revolutions of the "reference drum";
- i) provision for a powered wheelchair to drive one of the drums using its own drive system when the drive-wheel(s) have a common axle, and provision to drive the other drum at the appropriate speed as specified above;
- j) provision for the turning resistance of the drums to be adjusted in such a way that the current drawn by the wheelchair's motors may be maintained at a set value with the roller speed maintained within the limits above.

NOTE 3 — Usually it will be necessary to drive the drums in order to obtain the correct value of wheelchair motor current.

5.10 Drop test machine: capable of dropping the wheelchair from $50 \text{ mm} \pm 5 \text{ mm}$ onto a rigid horizontal test plane, of rotating the wheelchair wheels so that the load is not always on the same part of the wheels, of ensuring that the wheelchair is stationary prior to each drop, and having provision to record the total number of drops.

NOTE The horizontal test plane may comprise a number of elements on which the wheels drop separated by spaces in which devices are located that lift the wheelchair before each drop.

5.11 A means to prevent the wheelchair from tipping during the static tests which does not apply force to the wheelchair in the unloaded condition and in which any restraining forces are applied to

- the thigh portion of the test dummy when it is in place; or
- the seat surface of the wheelchair or the seat support structure when a test dummy is not fitted.

NOTE Figure 6 illustrates the use of horizontal bars which are positioned to touch, but not apply force to, the test dummy or seat surface.

5.12 A means to prevent the wheelchair from moving fore-and-aft during the static and impact tests which does not apply force to the unloaded wheelchair and in which any reaction forces are applied to the circumference of the wheels (i.e. the tyres).

NOTE For example, stops positioned to touch but not apply force to the wheels of the unloaded wheelchair.

Dimensions in millimetres

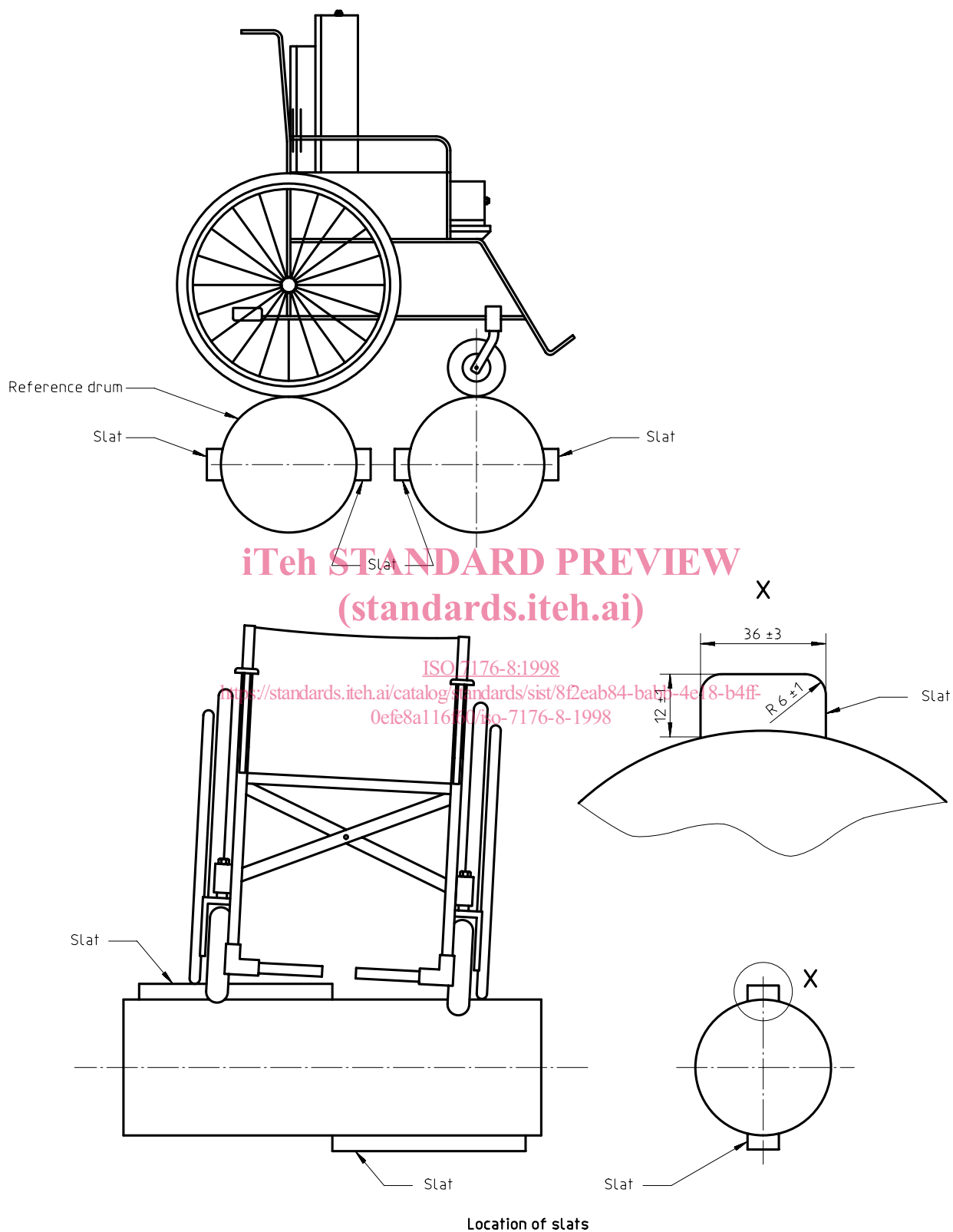


Figure 5 — Two-drum test machine

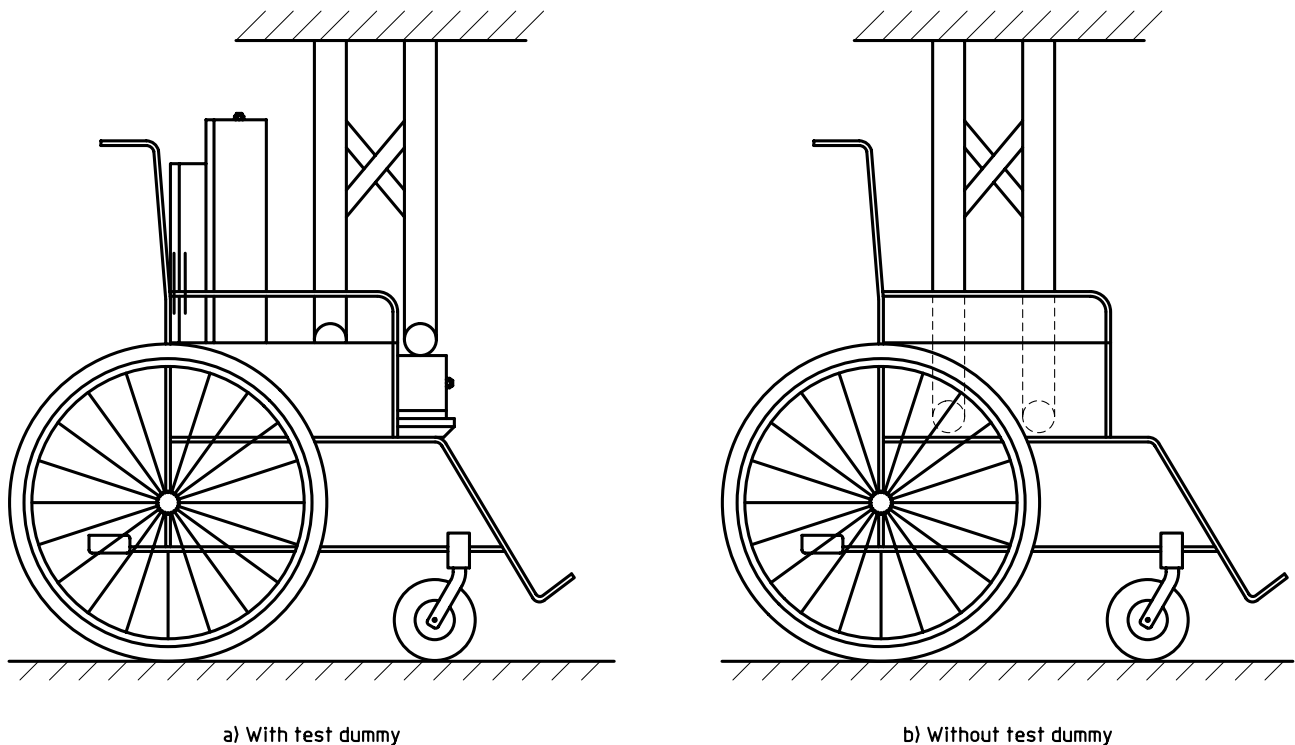


Figure 6 — Method of preventing wheelchair from tipping
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5.13 Means to measure the angle of the longitudinal axis of the pendulum prior to an impact test to an accuracy of $\pm 2^\circ$.

5.14 A means to secure the test dummy so that it is restrained according to the test procedure without deforming the wheelchair (see 10.3).

5.15 A means to measure the current drawn from the power source of the electrical wheelchair to an accuracy of $\pm 10\%$.

6 Preparation of test wheelchair

6.1 Equipping the wheelchair

Fit any appropriate armrests and/or footrests specified by those commissioning the tests.

If the wheelchair has a rigid seat, fit the thinnest cushion recommended by the manufacturer.

If the wheelchair is fitted with a seat consisting of a single membrane of flexible material, remove any cushions, including cushions that are attached by touch and close fasteners.

NOTE 1 'Velcro'²⁾ is a typical touch and close fastener.

NOTE 2 Batteries may be removed and replaced with material of the same mass ± 1 kg.

²⁾ 'Velcro' is a tradename of a suitable product available commercially. This information is given for the convenience of the user of this part of ISO 7176 and does not constitute an endorsement by ISO of this product.