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Castors and wheels — Test methods and apparatus

Roues et roulettes — Méthodes et appareillage d'essais

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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 22878 was prepared by Technical Committee ISO/TC 110, *Industrial trucks*, Subcommittee SC 3, *Castors and wheels*.

Introduction

Castors and wheels are used in many applications and environments.

For many of these, specific requirements are needed. Thus the need arose for an International Standard on testing of castors and wheels suitable for users, original equipment manufacturers and testing houses.

Castors and wheels — Test methods and apparatus

1 Scope

This International Standard specifies the test methods and apparatus to be used to check the performance of castors and wheels.

The tests to be used for specific types of castor and wheel, and the relevant acceptance criteria, values and applicability are given in ISO 22879 to ISO 22884.

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 22877, *Castors and wheels — Vocabulary, symbols and multilingual terminology*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 22877 apply. The symbols are listed in the individual tests, and a combined list of symbols is given in Annex A.

4 Test methods

4.1 General requirements

4.1.1 Test sequence

Tests shall be carried out in a predefined sequence to allow repeatability of testing conditions.

4.1.2 Test sample

All tests within the sequence shall be made with the same castor(s) or wheel(s), unless otherwise specified in the appropriate standard. Castors and wheels shall not be artificially cooled during testing.

4.1.3 Application of test load

The test load shall always be applied directly so that its centre of gravity lies central to the mounting plane of the castor(s), or the centre of the test frame (where required) on which the sample(s) under test are mounted (see Figures 3 and 7). Unless otherwise specified, the test load shall be a real weight.

4.1.4 Test report

Actual readings and test results of each test and indication if the test is passed or failed shall be clearly given in the test report, including the following information:

— reference to the relevant International Standard;

— type of the test machine which was used;

— details of any deviation from this International Standard;

— main features of the test sample;

— name and address of location where the test was carried out;

— date of the test.

4.2 Wheel play test

4.2.1 Objectives

This test is to determine the initial wheel play at the beginning of the test sequence, and the final wheel play at the end of the test sequence.

4.2.2 Symbols

The symbols of Table 1 shall be used.

Table 1

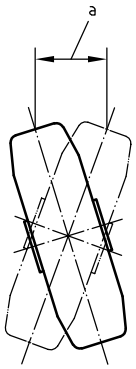
Symbol	Meaning of the symbol
d_{W1}	maximum initial wheel play
d_{W2}	maximum wheel wear play

4.2.3 Apparatus

4.2.3.1 Device to clamp the fork with the fitted wheel under test.

4.2.4 Procedure

The measurements shall be taken with the wheel and axle bush assembled as during test (original product). Clamp the fork of the castor rigidly in a vertical position, ensuring that the fork width is maintained and the movement of the wheel is not impaired. The wheel play shall not include any side movement of the wheel on the axle. Wheel play shall be quoted in millimetres and measured as shown in Figure 1. To determine the wear play, subtract the initial wheel play from the final wheel play.



[a] Measured wheel play.

Figure 1 — Wheel play test

4.3 Swivel play test

4.3.1 Objectives

This test is to determine the initial swivel play at the beginning of the test sequence, and the final swivel play at the end of the test sequence.

4.3.2 Symbols

The symbols of Table 2 shall be used.

Table 2

Symbol	Meaning of the symbol
d_{S1}	maximum initial swivel play
d_{S2}	maximum swivel wear play

4.3.3 Apparatus

4.3.3.1 Lever, of at least 200 mm in length, suitable to be rigidly fixed to the mounting plane of the castor under test as in Figure 2.

4.3.4 Procedure

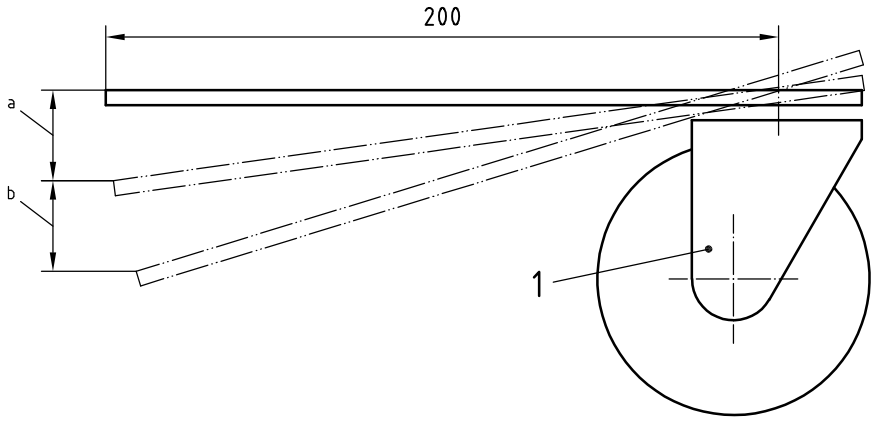
The measurements shall be taken with the wheel and axle bush assembled as during test (original product). Clamp the fork of the castor rigidly in a vertical position, ensuring that the fork width is maintained and the movement of the swivel is not impaired. Make a mark on the fixed and swivelling parts of the castor. Measure the swivel play at (200 ± 2) mm from the swivel axis of the castor when

— the marks are aligned, and

— the mounting plane is rotated through $(90 \pm 5)°$.

The larger of these two values shall be taken. Swivel play shall be quoted in millimetres and measured as in Figure 2. To determine the swivel wear play, subtract the initial swivel play from the final swivel play.

Dimensions in millimetres



Key

1 fork of castor (clamped)

a Initial swivel play (the maximum of this value is d_{S1}).

b Swivel wear play (the maximum of this value is d_{S2}).

Figure 2 — Swivel play test

4.4 Electrical resistance test

4.4.1 Objectives

This test is to measure the electrical resistance of the sample.

4.4.2 Symbols

The symbols of Table 3 shall be used.

Table 3

Symbol	Meaning of the symbol
F_{17}	test load
R	electrical resistance

4.4.3 Apparatus

4.4.3.1 Instrument, having a nominal open circuit voltage of 500 V d.c., preferably an insulation tester (ohm meter), or any suitable instrument known to give comparable results.

The instrument shall be sufficiently accurate to determine the resistance within 10 % and shall not dissipate more than 3 W in the product.

The resistance values obtained will vary with the applied voltage, and errors may occur when low test voltages are involved. In case of dispute, the voltage applied to the product shall be not less than 40 V, except where this conflicts with the requirement not to dissipate more than 3 W in the test piece.

4.4.4 Procedure

The wheel(s) shall be perfectly clean and dry. Place the castor and/or wheel on a metal plate that is insulated from the floor and from the apparatus. A piece of wet blotting paper of the size of the contact area may be added between the metal plate and the castor if furniture castors or swivel chair castors are tested. Keep the tread in contact with the metal plate by applying a load F_{17} on the castor or wheel as specified in 4.1.3. Using the insulation tester, measure the resistance between the mounting plane of the castor or axle of the wheel and the metal plate. It is necessary to take three readings each with a different part of the tread in contact with the metal plate.

4.5 Fatigue test for braking and/or locking device

4.5.1 Objectives

This test is to determine if there is any wear and/or permanent deformation that would adversely affect the performance of the braking and/or locking device. This test is not applicable to braking and/or locking devices based on a threaded mechanism.

4.5.2 Symbols

The symbols of Table 4 shall be used.

Table 4

Symbol	Meaning of the symbol
n_{E}	number of locking actions
f_{E}	frequency of locking actions
F_3	test load

4.5.3 Apparatus

4.5.3.1 Test apparatus to simulate as effectively as possible what happens when the braking and/or locking device is operated and released with the castor stationary.

4.5.4 Procedure

Place the castor loaded with F_3 in the test apparatus. Carry out the braking/locking actions in accordance with n_{E} and f_{E}.

4.6 Efficiency check of wheel braking and/or locking device

4.6.1 Objectives

This test is to determine the performance of the wheel braking and/or locking device. It is recommended that this test should follow test in 4.5, where applicable.

4.6.2 Symbols

The symbols of Table 5 shall be used.

Table 5

Symbol	Meaning of the symbol
F_{11}	test load
F_{K1}	horizontal traction force

4.6.3 Apparatus

4.6.3.1 Low friction device that allows either

— linear movement, or

— circular movement.

4.6.3.2 Force measuring device.

4.6.3.3 Pulling device to pull force equal to F_{K1}.

4.6.3.4 Time measuring instrument.

An example of test apparatus is given in Figure 3.

4.6.4 Procedure

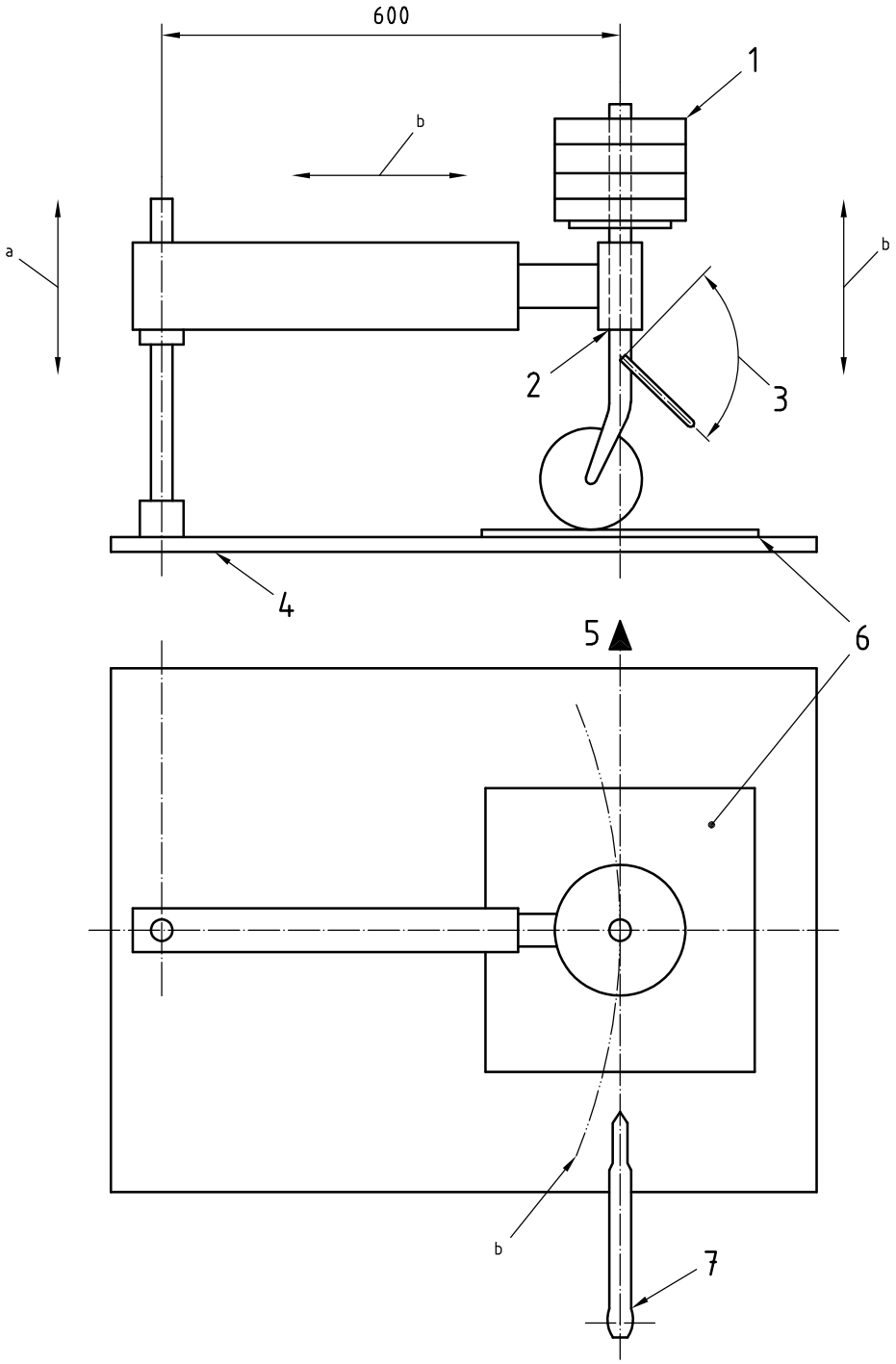
Place the castor on a horizontal smooth steel surface, clean from visible dirt. Engage the braking and/or locking device. Apply a load F_{11} to the mounting plane of the castor. Then gradually apply a horizontal tractive force (F_{K1}) in line with the running direction of the wheel. The force F_{K1} shall be applied for (10^{+2}_{0}) s then released. Gradually apply the force F_{K1} once more for (10^{+2}_{0}) s and monitor if the wheel revolves around its axle. Repeat the above procedure applying the force in the opposite direction. If during the application of the force F_{K1} the wheel skids on the floor, change the material of the test surface in order to have a higher grip, then repeat the test.

4.7 Efficiency check of swivel braking and/or locking device

4.7.1 Objectives

This test is to determine the performance of the swivel braking and/or locking device. It is recommended that this test should follow test in 4.5.

Dimensions in millimetres



Key

1 load
2 spring attachment point
3 brake operation
4 steel plate
5 reverse load
6 test surface
7 spring balance load applied tangentially

[a] Adjustment.
[b] Free movement.
[c] Non-rotational free movement.

Figure 3 — Example of test apparatus for tests as in 4.6, 4.7, 4.9 and 4.10

4.7.2 Symbols

The symbols of Table 6 shall be used.

Table 6

Symbol	Meaning of the symbol
F_{11}	test load
F_{K2}	horizontal traction force

4.7.3 Apparatus

4.7.3.1 Low friction device that allows either

— linear movement, or

— circular movement.

4.7.3.2 Force measuring device.

4.7.3.3 Pulling device, to pull force equal to F_{K2}.

4.7.3.4 Time measuring instrument.

An example of test apparatus is given in Figure 3.

4.7.4 Procedure

Place the castor on a horizontal smooth steel surface, clean from visible dirt. Engage the braking and/or locking device. Apply a load F_{11} to the mounting plane of the castor. Then gradually apply a horizontal traction force (F_{K2}) along the swivel axis at $(90 \pm 5)^{\circ}$ in the running direction of the wheel. The force F_{K2} shall be applied for (10^{+2}_{0}) s then released. Gradually apply the force F_{K2} once more for (10^{+2}_{0}) s and monitor if swivelling movement is detected. Repeat the above procedure applying the force in the opposite direction. If during the application of the force F_{K2} the wheel skids on the floor, change the material of the test surface in order to have a higher grip, then repeat the test.

4.8 Dynamic test

4.8.1 Objectives

This test is to verify that a load capacity, under a dynamic application, will not cause damage and/or excessive wear to be a prejudice to the performance of the castor or wheel under test.

This test applies to

— castors for institutional applications,

— castors for hospital beds,

— castors for applications up to 1,1 m/s (4 km/h), and

— castors for applications over 1,1 m/s and up to 4,4 m/s (16 km/h).

4.8.2 Symbols

The symbols of Table 7 shall be used.

Table 7

Symbol	Meaning of the symbol
F_{max}	load capacity
v_1	average speed of running period
v_2	speed at impact with obstacles
h_1	distance between obstacles
d_c	height of obstacles
n	number of obstacles to be passed by the wheel
n_{r1}	number of revolutions of the wheel
t_{z1}	running period
t_{z2}	pause

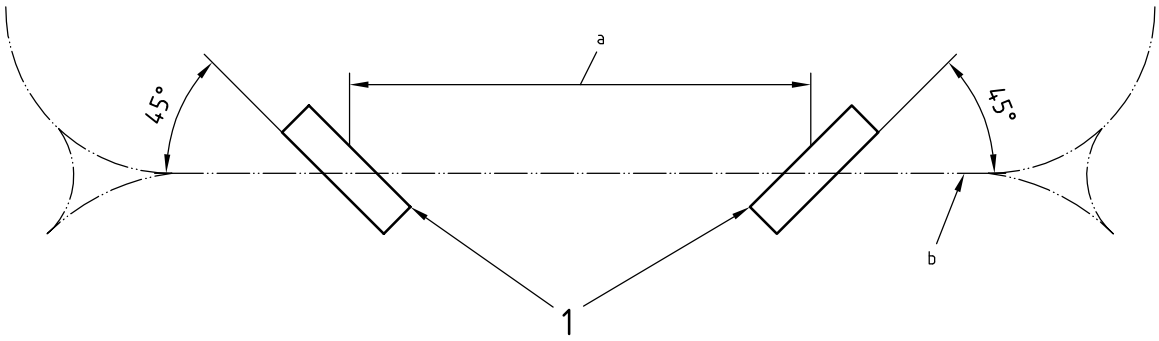
4.8.3 Apparatus

4.8.3.1 Test machine, which can have a linear track (Figure 4), a circular track (Figure 5) or drum (Figure 6), with a smooth steel surface. It shall be able to run the sample at speeds as v_1 and v_2 and apply a load F_{max} as defined in 4.1.3.

Rectangular metal obstacles shall be placed on the track at $(45 \pm 3)^\circ$ to the running direction, alternately to the right and left of it. The obstacles shall be (100 ± 2) mm wide, height as per h_1 and featuring rounded edges with radius of one-third of its height. Such a radius may not be larger than 5 mm or less than 1,5 mm. The obstacles shall be positioned as d_c.

4.8.3.2 Time measuring instrument.

4.8.3.3 Portable hardness meter.



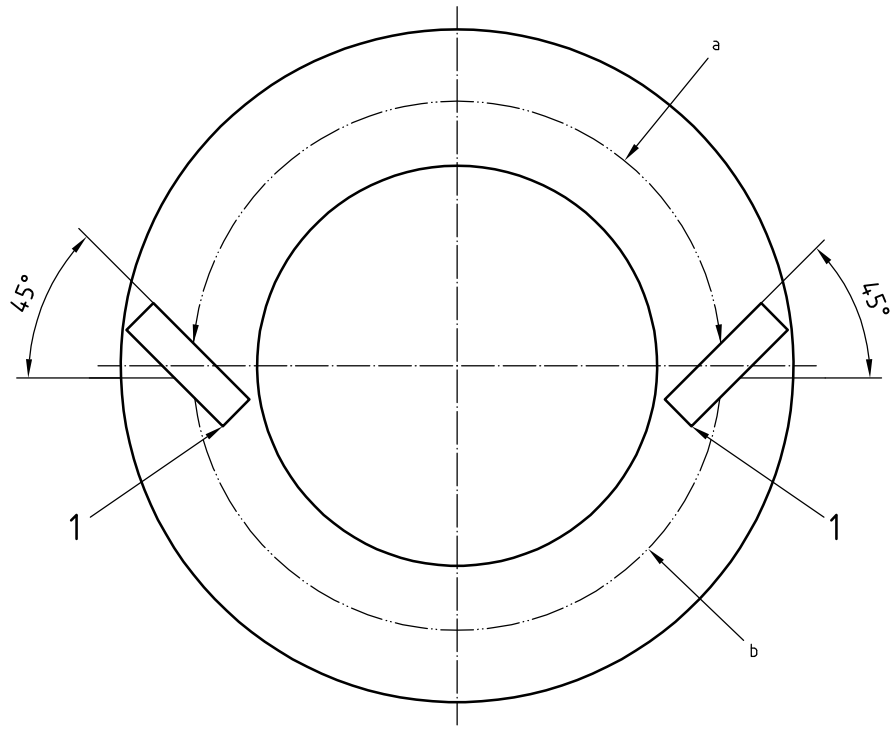
Key

1 obstacles

[a] Distance d_c between obstacles.

[b] Typical path of castor.

Figure 4 — Plan view of a linear track dynamic test machine



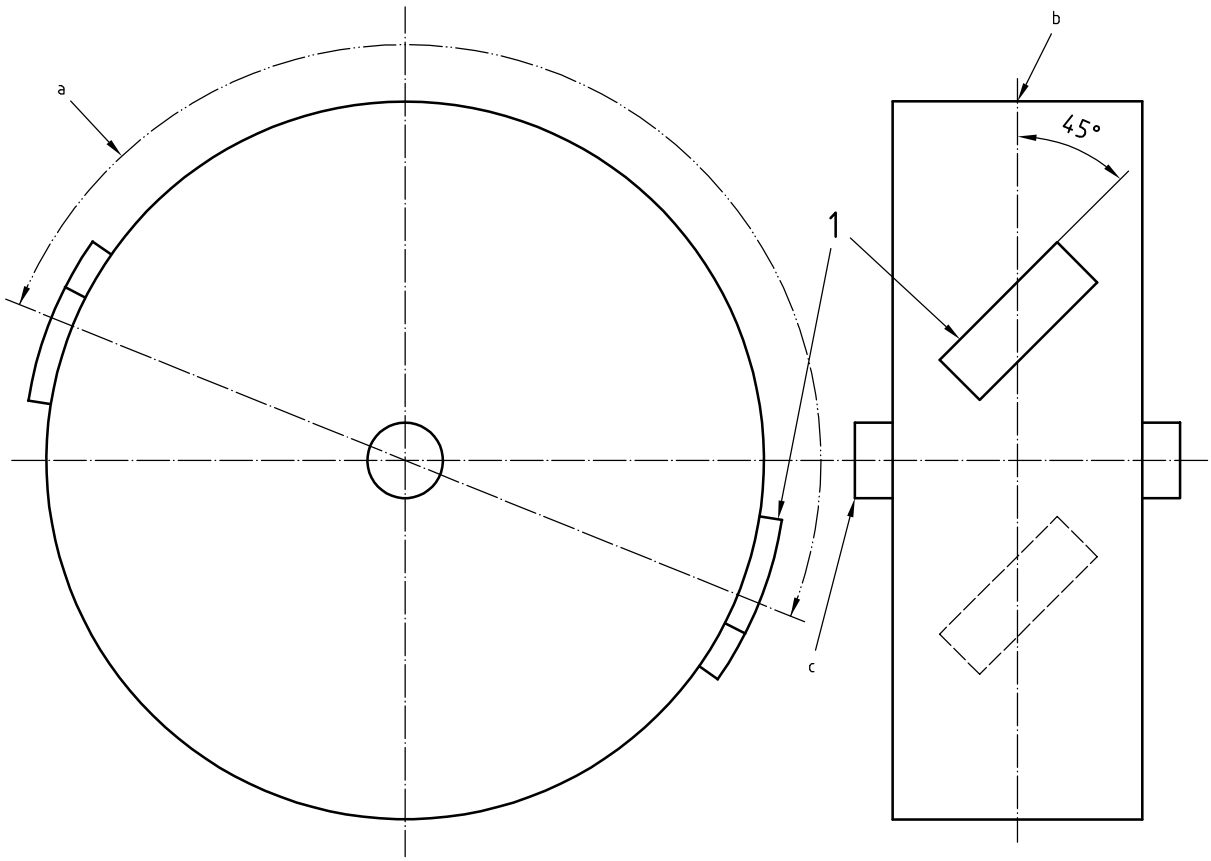
Key

1 obstacles

a Distance d_c between obstacles.

b Typical path of castor.

Figure 5 — Plan view of a circular track dynamic test machine



Key

1 obstacles

a Distance d_c between obstacles.

b Typical path of castor.

c Horizontal axis.

Figure 6 — Cylindrical drum dynamic test machine

4.8.4 Procedure

Place the castor or wheel in the test apparatus with a correct fitting.

EXAMPLE Fixed with all fixing bolts, correctly tightened.

The test consists of a continuous running period of duration t_{z1}, which is followed by a pause of duration t_{z2}. When a circular track (Figure 5) is used, the direction of travel shall be reversed at the commencement of each new running period.

The castor shall be made to run, under load, until it has passed a number of obstacles n. When the total number of revolutions n_{r1} specified exceeds the revolutions required with obstacle contact, remove the obstacles and proceed with the test until all necessary revolutions have been completed. The obstacles shall be removed in a period of time not exceeding t_{z1}.

4.9 Static test

4.9.1 Objectives

This test is to determine the static performance of a castor and/or wheel.

4.9.2 Symbols

The symbols of Table 8 shall be used.

Table 8

Symbol	Meaning of the symbol
F_{max}	load capacity
F_6	test load
y_1	load factor
t_{y1}	time of application of the load
t_{y2}	time elapsed prior to inspection

4.9.3 Apparatus

4.9.3.1 Test machine which applies a test load (either F_{max} multiplied by y_1 or F_6) as 4.1.3.

4.9.3.2 Time measuring instrument.

An example of test apparatus is given in Figure 3.

4.9.4 Procedure

Place the castor or wheel in the test apparatus with a correct fitting on a horizontal smooth steel surface.

EXAMPLE Fixed with all fixing bolts, correctly tightened.

Apply the test load (either F_{max} multiplied by y_1 or F_6) as defined in 4.1.3 for a period of time t_{y1}.

Readings shall be taken at time t_{y2} from when the load is removed.

4.10 Contact pressure test

4.10.1 Objectives

This test is to determine the contact pressure between the wheel and the floor.

4.10.2 Symbols

The symbols of Table 9 shall be used.

Table 9

Symbol	Meaning of the symbol
F_2	test load
t_{y1}	time of application of the load
A	surface area

4.10.3 Apparatus

4.10.3.1 Horizontal smooth steel surface, on which graph and carbon paper are placed.

4.10.3.2 Castor, able to receive the load F_2, mounted vertically above the plate (see an example in Figure 3).

4.10.3.3 Time measuring instrument.

Other methods of establishing the contact area obtained under the load F_2 for a time of application of t_{y1} are permissible, provided the accuracy is not less than that of the procedure described above.

4.10.4 Procedure

On a horizontal smooth steel surface, place the graph and carbon paper so that the carbon paper will mark the graph paper when the load F_2 is imposed on the castor for t_{y1} h. Measure the area of the impression transferred.

The contact pressure, p, is the ratio of the load F_2 and the surface area, A:

$$p = \frac{F_2}{A}$$

NOTE This formula calculates average contact pressure; it does not recognize that the contact pressure across a wheel profile can be much higher than the average.

4.11 Performance test for chair castor brake

4.11.1 Objectives

This test is to determine the efficiency of the brake.

This test applies to castors of Type U.

4.11.2 Symbols

The symbols of Table 10 shall be used.

Table 10

Symbol	Meaning of the symbol
F_1	test load (including frame)
v_3	travel speed
F_{w1}	minimum rolling resistance (Type H)
F_{w2}	minimum rolling resistance (Type W)

4.11.3 Apparatus

4.11.3.1 Rigid three-arm frame, that will not distort when the stated load is imposed (see Figure 7), on which three castors are mounted.

4.11.3.2 Force measuring device.

4.11.3.3 Pulling device, to pull the force equal to F_{w1} or F_{w2}.

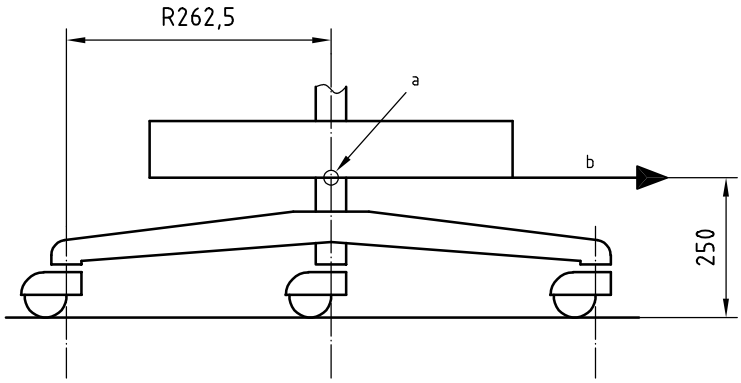
4.11.3.4 Speed measuring instrument.

4.11.3.5 Time measuring instrument.

4.11.3.6 Table with a horizontal smooth steel surface shall be provided for testing Type W castors.

4.11.3.7 Table with a horizontal smooth steel surface, covered with textile having the characteristics given in Table 11, shall be provided for testing Type H castors.

Dimensions in millimetres



[a] Centre of gravity.

[b] Application of force.

Figure 7 — Three-arm frame

Table 11

Requirements for	Characteristics of textile floor covering
Production method	tufted
Upper surface	loop pile
Nap count per square metre	100 000 to 130 000
Backing material	synthetic latex
Raw material used for loop pile	100 % polyamide
Yarn type	filament yarn
Pile thickness of fully trimmed sample	3,5 mm
Pile density of fully trimmed sample	450 g/m^2
The floor covering shall be conditioned before values are measured by running the test frame and castors five times over the area of the covering which will be used for the test.	

4.11.4 Procedure

Apply a test load F_1 (including frame) to the three-arm frame.

Apply a horizontal tractive force in the running direction at 250 mm from the floor to the column of the frame (see Figure 7) in such a way as to obtain a travel speed v_3 over the test table for a distance of 250 mm.

This test shall be performed three times with each test load F_1. Measure the average value of the resistance to rolling between 100 mm and 250 mm of travel.

4.12 Impact test

4.12.1 Objectives

This test is to determine the resistance to impact.

4.12.2 Symbols

The symbols of Table 12 shall be used.

Table 12

Symbol	Meaning of the symbol
m	free falling mass
h_2	drop height

4.12.3 Apparatus

4.12.3.1 Test rig, placed on a solid floor (see Figure 8).

A castor is rigidly vertically mounted upside down in the rig so that a free falling mass m can impact the tread of the wheel(s).

In the case of a twin wheel castor, both wheels shall be impacted simultaneously.

4.12.4 Procedure

Allow the free-falling mass m to impact the castors ten times within a period of 10 min from a height h_2.

4.13 Dynamic test for castors for furniture and swivel chairs only

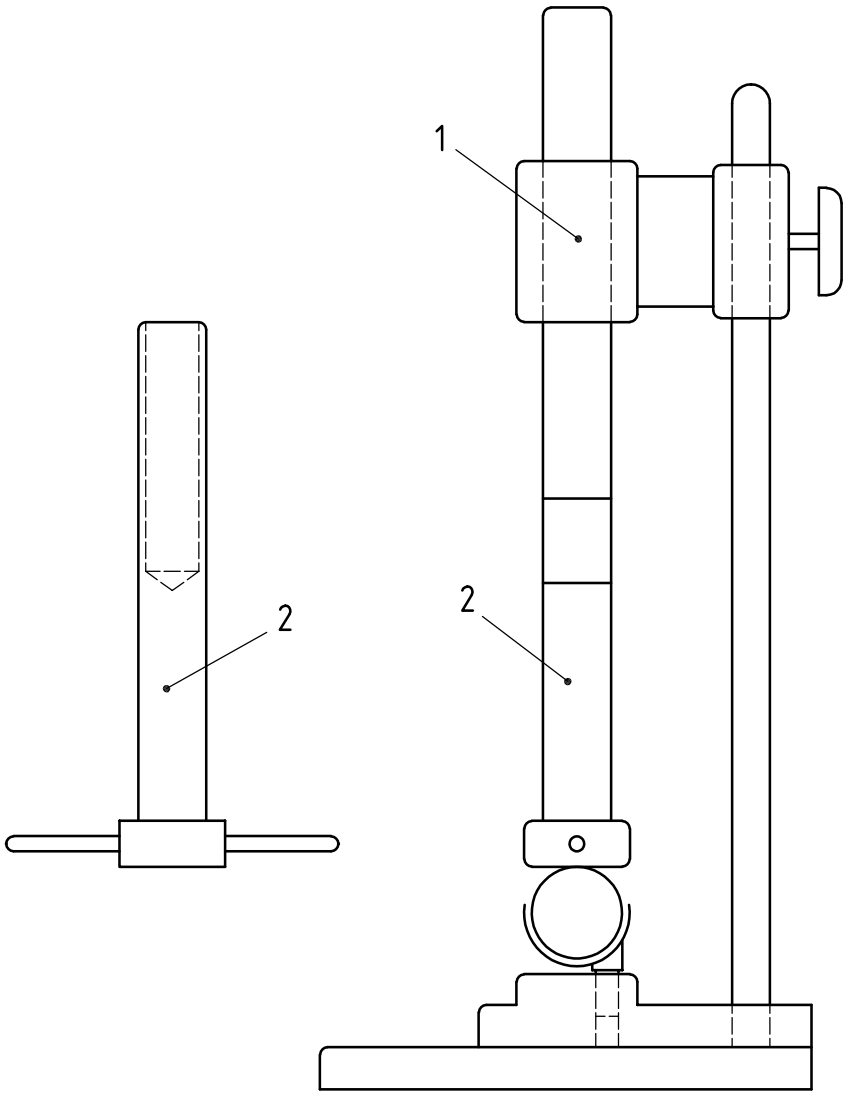
4.13.1 Objectives

This test is to verify that a load capacity, under a dynamic application, will not cause damage and/or excessive wear to be prejudice to the performance of the castor under test.

This test applies to

— castors for swivel chairs, and

— castors for furniture.



Key

1 free slide fit

2 free falling mass (including handle)

Figure 8 — Impact test rig for swivel chair castors and furniture castors

4.13.2 Symbols

The symbols of Table 13 shall be used.

Table 13

Symbol	Meaning of the symbol
F_7	test load
h_1	height of obstacles
n_{r2}	number of cycles
t_{z1}	running period
t_{z2}	pause
f_z	frequency

4.13.3 Apparatus

4.13.3.1 Test machine, with a linear or circular motion (see Figures 9 and 10), and a horizontal smooth steel surface.

The machine shall allow one or more castors to be mounted in such a way so as to run for a distance of $\left(1^{+0,025}_{0}\right)$ m over two metal obstacles. At the end of 1 m the running direction of the castors shall be reversed.

4.13.3.2 Two metal obstacles, placed at $(90 \pm 3)^{\circ}$ to the running direction of the castors.

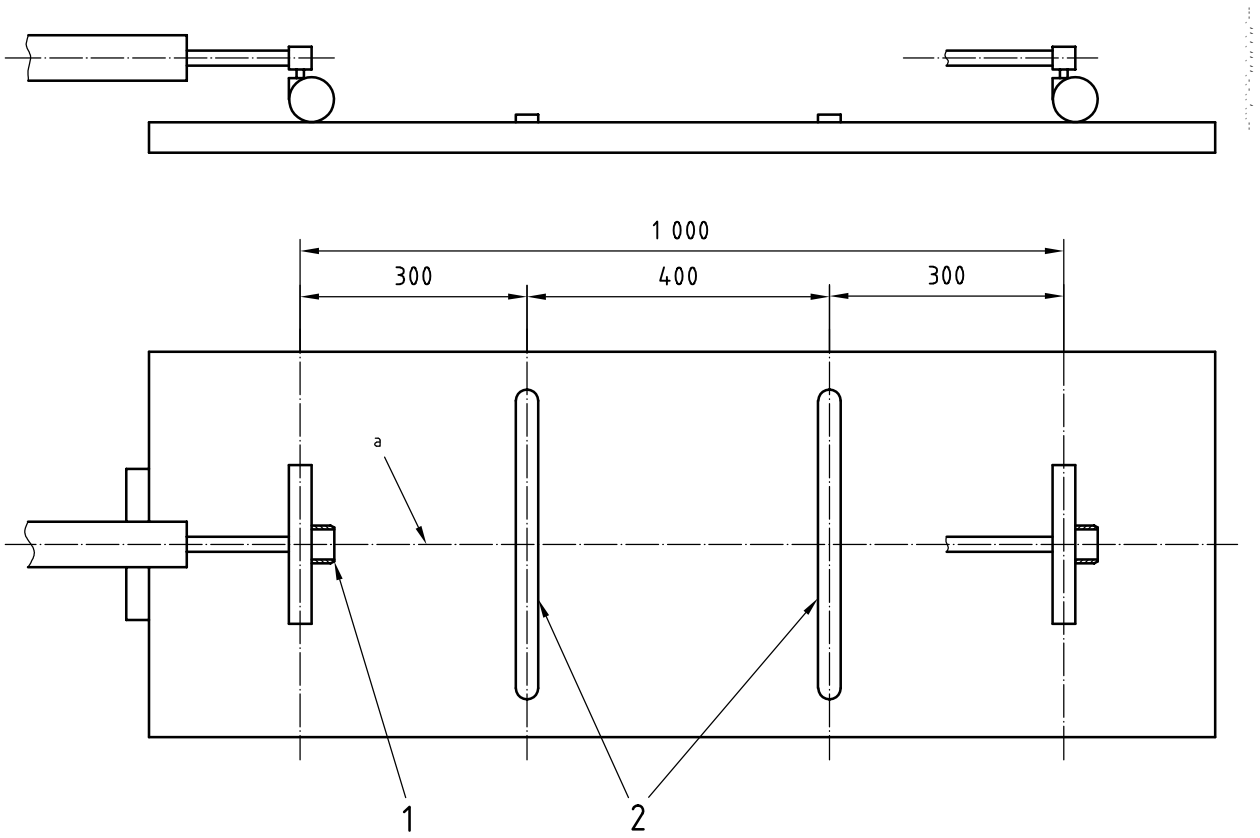
The two metal obstacles shall be (50 ± 1) mm wide and h_1 mm high and long enough to ensure that the castor(s) being tested always impact the full face of the metal obstacles. The metal obstacles shall have a radius on both sides equal to their height h_1.

4.13.4 Procedure

Place the castor in the test apparatus with a correct fitting.

The test consists of a continuous sequence of cycles n_{r2}performed at a load F_7 completing f_z cycles per minute. The cycle consists in a path in 1 m forward and 1 m return stroke and impact with two spaced obstacles occurs in each direction. The running period is defined as t_{z1} followed by a pause t_{z2}.

Dimensions in millimetres



Key

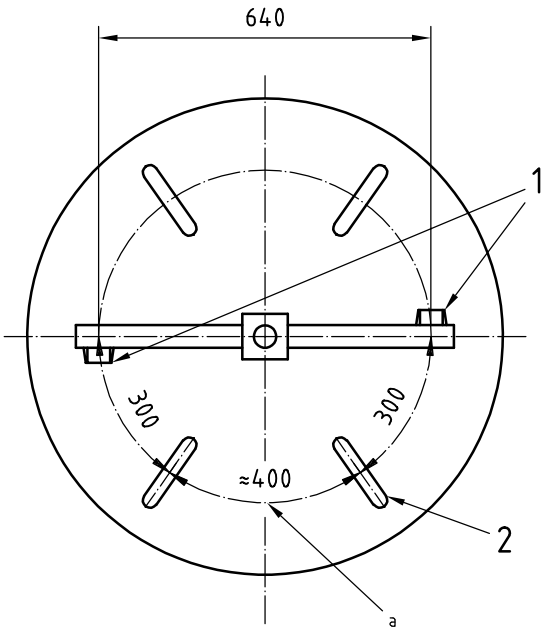
1 castor

2 obstacle

[a] Path of castor.

Figure 9 — Linear track dynamic test machine

Dimensions in millimetres



Key

1 castor

2 obstacle

[a] Path of castor.

Figure 10 — Circular track dynamic test machine

4.14 Long distance running test

4.14.1 Objectives

This test is to determine the performance over a long distance.

4.14.2 Symbols

The symbols of Table 14 shall be used.

Table 14

Symbol	Meaning of the symbol
F_7	test load
n_{r2}	number of cycles
t_{z1}	running period
t_{z2}	pause
f_z	frequency

4.14.3 Apparatus

4.14.3.1 Test machine, with a linear or circular motion, similar to that shown in Figures 9 and 10 but with a horizontal smooth steel surface without any obstacles.

The machine shall allow one or more castors to be mounted to run the test for a distance of 1 m. At the end of 1 m the running direction of the castor shall be reversed.

4.14.4 Procedure

Place the castor in the test apparatus with a correct fitting.

The test consists of a continuous sequence of cycles n_{r2} performed at a load F_7 completing f_z cycles per minute. The cycle consists in a path of 1 m forward and 1 m return stroke. The running period is defined as t_{z1} followed by a pause t_{z2}.

4.15 Rolling resistance test

4.15.1 Objectives

This test is to determine the resistance to rolling.

4.15.2 Symbols

The symbols of Table 15 shall be used.

Table 15

Symbol	Meaning of the symbol
F_1	test load (including frame)
v_3	travel speed
F_{w3}	horizontal traction force

4.15.3 Apparatus

The apparatus for this test is identical to that of 4.11.3.

4.15.4 Procedure

Apply a test load F_1 (including frame) to the three-arm frame.

Apply a horizontal traction force in such a way as to obtain a travel speed v_3 over the test table, with the castors arranged in the running direction, for a maximum period of 10 s.

No measurements are taken for the first 5 s of the test because of higher friction and initial acceleration.

4.16 Swivel resistance test

4.16.1 Objectives

This test is to determine the resistance to swivel.

4.16.2 Symbols

The symbols of Table 16 shall be used.

Table 16

Symbol	Meaning of the symbol
F_9	test load
v_3	travel speed
F_{w4}	swivel resistance

4.16.3 Apparatus

4.16.3.1 Test machine, with a linear or circular motion, which allows the castors to be positioned at 90° to the running direction.

4.16.3.2 Force measuring device.

4.16.3.3 Pulling device.

4.16.3.4 Time measuring instrument.

4.16.3.5 Table with a horizontal smooth steel surface shall be provided for testing Type W castors.

4.16.3.6 Table with a horizontal smooth steel surface, covered with textile having the characteristics given in Table 11, shall be provided for testing Type H castors.

4.16.4 Procedure

Mount one or more castors on a linear or circular test machine with the castor(s) positioned at 90° to the running direction.

Apply a load F_9 to the castor(s). A horizontal tractive force provided by a test machine with a speed of v_3, for a period of 2 s will cause the castors to swivel. Measure the highest force required to cause the swivelling and determine the swivel resistance F_{w4}.

4.17 Stem retention test

4.17.1 Objectives

This test is to determine the stem retention in the housing of the castor.

4.17.2 Symbols

The symbol of Table 17 shall be used.

Table 17

Symbol	Meaning of the symbol
F_{min}	minimum pull-out force

4.17.3 Apparatus

4.17.3.1 Test rig that allows a force to be applied between the castor and the stem in the direction of the longitudinal axis of the stem.

4.17.3.2 Force measuring device.

4.17.3.3 Pulling device.

4.17.3.4 Time measuring instrument.

4.17.4 Procedure

Apply a steadily increasing load until the required force F_{min} is reached. Then maintain this force for a minimum period of 2 min.

Annex A
(normative)

Combined list of symbols

Symbol	Description	Unit
A	surface area	mm^2
b	top plate outer dimension (width of rectangular plate)	mm
b_f	fork width	mm
b_t	nominal depth of bearing seat	mm
b_T	wheel width	mm
b_{T1}	hub width	mm
b_{T2}	tyre width	mm
b_{T3}	tread width	mm
d	top plate outer dimension (triangular or square plate)	mm
d'	bolt hole spacing (triangular or square plate)	mm
d_b	bolt hole spacing (width of rectangular plate)	mm
d_c	distance between obstacles	mm
d_e	wheel spacing	mm
d_g	distance between slotted bolt centres	mm
d_l	bolt hole spacing (length of rectangular plate)	mm
d_{S1}	maximum initial swivel play	mm
d_{S2}	maximum swivel wear play	mm
d_{W1}	maximum initial wheel play	mm
d_{W2}	maximum wheel wear play	mm
D	wheel diameter	mm
D_d	bore diameter	mm
D_{G1}	fixing bolt diameter	mm
D_{G2}	single fixing bolt diameter	mm
D_M	hub diameter	mm
D_p	stem diameter	mm
D_s	nominal diameter of bearing seat	mm
f_E	frequency of locking actions	cycles/min
f_z	frequency	cycles/min
F_1	test load (including frame)	N
F_2 to F_{10}	test loads	N
F_{max}	load capacity	N
F_{min}	minimum pull-out force	N
F_{K1} and F_{K2}	horizontal tractive forces	N
F_{w1}	minimum rolling resistance (Type H)	N
F_{w2}	minimum rolling resistance (Type W)	N
F_{w3}	horizontal tractive force	N
F_{w4}	swivel resistance	N
h	overall height	mm

Symbol	Description	Unit
h_1	height of obstacle	mm
h_2	drop height	mm
l	top plate outer dimension (length of rectangular plate)	mm
l_Q	stem length	mm
m	mass of free-falling weight	kg
n	number of obstacles	—
n_E	number of locking actions	—
n_{r1}	number of wheel revolutions	—
n_{r2}	number of cycles	—
r_1	external corner radius	mm
r_2	internal corner radius	mm
r_3	tread curvature	mm
r_m	swept radius	mm
t_{y1}	time of application of the load	h
t_{y2}	elapsed time prior to inspection	h
t_{z1}	running period	min
t_{z2}	pause	min
R	electrical resistance	Ω
v_1	average speed of running period	m/s
v_2	speed at impact with obstacles	m/s
v_3	travel speed	mm/s
y_1	load factor	—
β	angle of inclination	degrees

Bibliography

[1] ISO 2878, *Rubber, vulcanized — Antistatic and conductive products — Determination of electrical resistance*

[2] ISO 22879, *Castors and wheels — Requirements for castors for furniture*

[3] ISO 22880, *Castors and wheels — Requirements for castors for swivel chairs*

[4] ISO 22881, *Castors and wheels — Requirements for use on manually propelled equipment for institutional applications*

[5] ISO 22882, *Castors and wheels — Requirements for castors for hospital beds*

[6] ISO 22883, *Castors and wheels — Requirements for applications up to 1,1 m/s (4 km/h)*

[7] ISO 22884, *Castors and wheels — Requirements for applications over 1,1 m/s (4 km/h) and up to 4,4 m/s (16 km/h)*

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