BRITISH STANDARD

BS 7945:1999

Non-domestic furniture — Seating — Determination of stability

ICS 97.140

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee FW/2, Domestic and contract furniture, upon which the following bodies were represented:

Association of Building Engineers
Association of Manufacturers of Domestic Appliances
Association of Suppliers to the Furniture Industry Ltd.
British Coatings Federation Ltd.
British Contract Furnishing Association
British Furniture Manufacturers' Federation
British Laminated Plastics Fabricators Association Ltd.
British Plastics Federation
British Retail Consortium
British Shops and Stores Association
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Consumer Policy Committee of BSI
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Royal Society for the Ecouragement of Arts, Manufacturers and Commerce
Royal Society for the Prevention of Accidents
SATRA Technology Centre
Society of Glass Technology

This British Standard, having been prepared under the direction of the Consumer Products and Services Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 November 1999

Amendments issued since publication

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The following BSI references relate to the work on this standard:
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Foreword

This British Standard has been prepared by Technical Committee FW/2. It determines stability of non-domestic seating and is based on BS EN 1022:1996 *Domestic furniture — Seating — Determination of stability.*

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

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1 Scope

This British Standard specifies methods for determination of the stability of all types of non-domestic seating, other than office seating, that can be used by adults. For seating that can be converted into beds, this standard applies only to the seating configuration. The standard does not apply to domestic seating, which is specified in BS EN 1022:1996.

Chair stability can be determined by either experimental or calculative methods. Both methods are based on the same forces and points of application. If the result of the calculative method is uncertain or marginal the results should be checked, if possible, by the experimental method.

The calculative method is invalid for chairs which visibly flex under horizontal loads and for the tests specified in **8.2**, **8.3**, **8.4**.

2 Definitions

For the purposes of this standard, the following definitions apply.

2.1

stability

ability to withstand forces that tend to cause the loaded article to overbalance

2.2

load bearing structure

any part of a chair which supports a portion of the loads exerted by the sitter as its primary function, e.g. the seat frame but not the upholstery

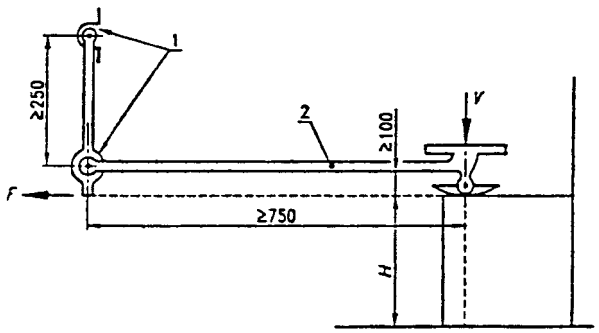
3 Test equipment

3.1 The tests can be applied by any device because results are dependent on correctly applied loads and not upon the apparatus, except when the discs described in **3.4** are used. The device shall not hinder any movement of the article being tested. A suggested device is shown in Figure 1. For tolerances see **4.2**.

3.2 *Loading pad*, rigid circular object 200 mm in diameter with a face having a convex spherical curvature of 300 mm radius with a 12 mm edge radius. The pad shall be pivoted on a ball joint as near to the loading surface of the pad as is practical. The loading pad shall be mounted on a device which can apply a vertical force as specified.

3.3 *Local loading device*, a rigid rod 20 mm in diameter with a hemispherical end.

Dimensions in millimetres



H loaded seat height
V vertical load
F horizontal force
1 low friction bearings
2 horizontal bar

Figure 1 — Suggested linkage arrangement constraining loading pad

3.4 *Horizontal force application device*, which can apply a force either at a given value or at a gradually increasing value, e.g. a spring balance.

3.5 *loading discs*, each with a mass of 10 kg, diameter 450 mm and thickness 48 mm.

3.6 *Support apparatus*, to support the main stack of discs in reclining chair tests. It should be as light as possible and not heavier than 2.5 kg. Figure 2 shows a basic design.

3.7 *Loading point template* (Figures 3 and 4), which consists of two sections, a seat portion with seat loading point *A* and a back portion with back loading point *B*.

The sections are linked to each other by a pivot, and the contour of the surface of the seat section is designed so that it sinks a representative distance into the seat when a weight of 20 kg is applied to loading point *A*.

3.8 *Stops*, to prevent the article from sliding, but not from overturning, not higher than 12 mm, except in cases where the design of the item necessitates the use of higher stops, in which case the lowest that will prevent the item from sliding shall be used.

3.9 *Testing surface*, horizontal, flat, rigid.

Dimensions in millimetres

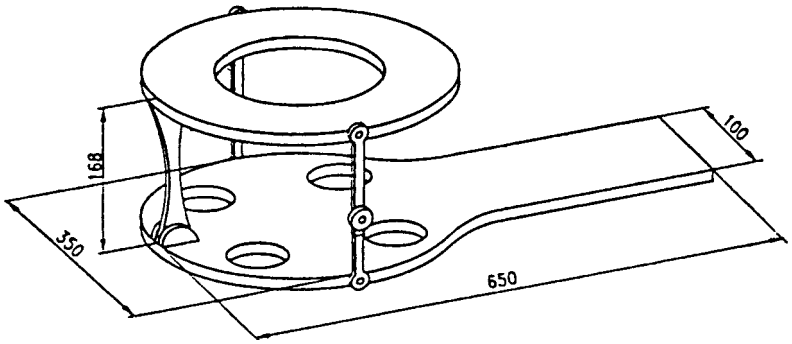
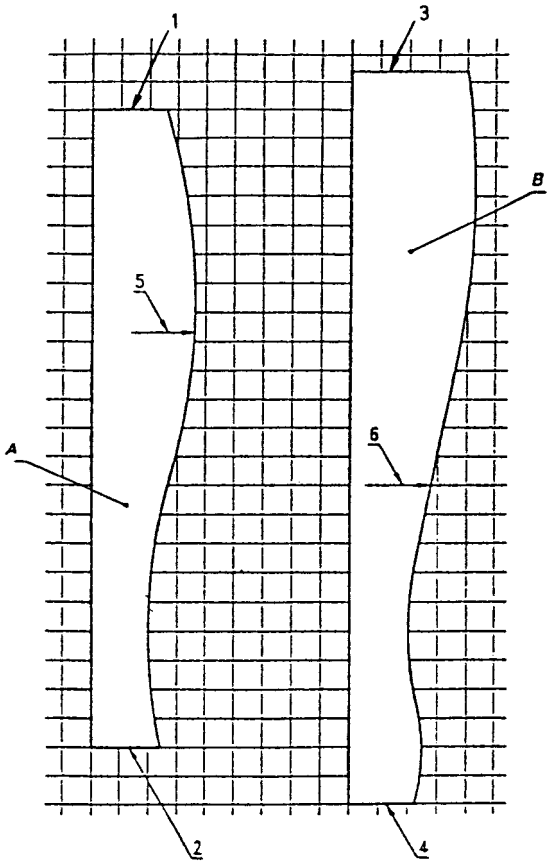


Figure 2 — Support apparatus



A seat portion
B back portion
1 rear
2 front
3 top
4 bottom
5 seat load
6 back load

NOTE Scale: 1 side of square = 20 mm

Figure 3 — Loading surface curves for seat and back loading point template

4 Conditioning

No prior conditioning of the articles is required.

5 General test requirements

5.1 General

The furniture shall be tested as delivered. Knock-down furniture shall be assembled in accordance with the manufacturer's instructions. If the furniture can be assembled or combined in different ways, the most adverse configuration shall be used for each test. Knock-down fittings shall be tightened before testing. In the case of designs not covered in the test procedures, the tests shall be carried out as far as possible as described and deviations from the test procedure shall be recorded in the test report.

Position the article on the floor surface (**3.9**) with its legs or base restrained by stops (**3.8**).

The tests shall be carried out in the configuration most likely to cause overbalancing.

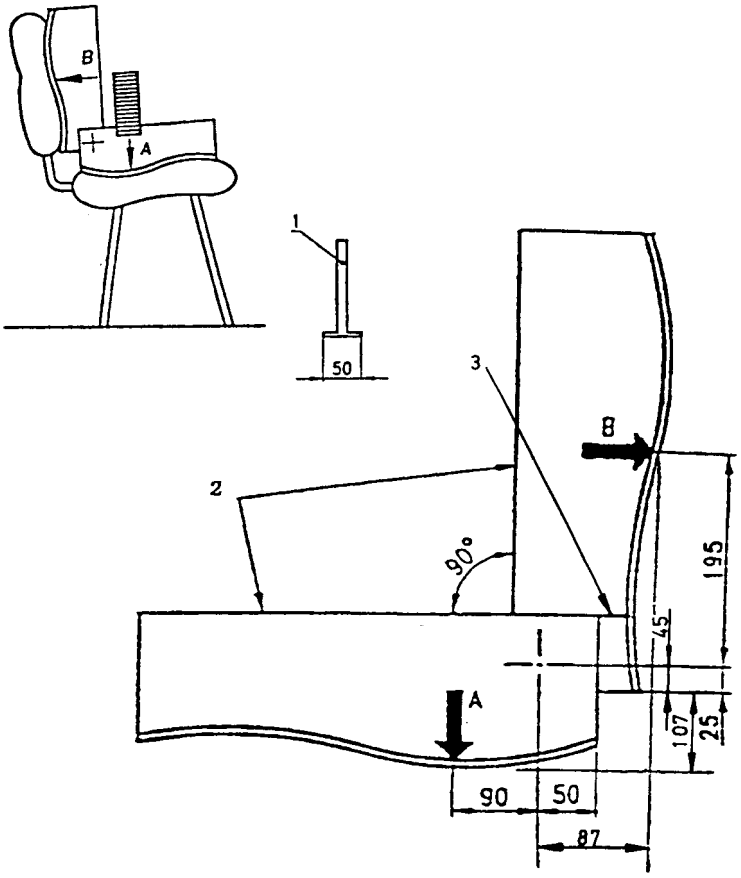
Stools shall fulfil the forwards overbalancing requirements in all directions. The other stability tests are not applicable.

NOTE 1 The test results are only valid for the tested article. When the test results are intended to be applied to production models, the test specimen should be representative of the production model.

NOTE 2 The tests are described in terms of the application of forces. Masses can, however, be used.

NOTE 3 Vertical loads may be applied either by using the loading pad **3.2**, or by using the local loading device **3.3** which is more convenient.

Dimensions in millimetres



A seat load (chairs)

B back load (chairs)

1 typical section

2 straight edge for determination of seat or back inclination

3 mark to fix 90°

Figure 4 — Loading point template

5.2 Tolerances

Unless otherwise stated, the following tolerances shall apply.

— All forces shall have an accuracy of ±5 % of the nominal force.

— All masses shall have an accuracy of ±0.5 % of the nominal mass.

— All dimensions shall have an accuracy of ±1 mm of the nominal dimension.

— All angles shall have an accuracy of ±2° of the nominal angle.

— The tolerance for position of loading pads shall be ±5 mm.

NOTE The relationship 10 N = 1 kg may be used for this purpose.

6 Determination of seat and back loading positions

The seat and back loading points shall be determined using the loading point template (**3.7**) specified as follows. In some cases it may not be possible to determine the loading points by means of the loading point template. In such cases, the loading points of 175 mm forward of the seat/back junction and 300 mm upward from the seat/back junction shall be used.

Position the loading point template (**3.7**) on the seat and back centreline as far towards the rear as possible with its load applied at the seat loading point.

Adjust the position of the template by pushing the back portion into the back of the furniture, so levering the seat portion forwards until the shape of the loading point template correlates with that of the seat. In cases where the loading point template can be settled in more than one position, the position having the smallest angle between the seat and back portions of the loading point template shall be used. The angle shall in no cases be less than 90°. Mark the loading points from the loading point template. When a seat has more than one sitting place, repeat the procedures on the other sitting places.

If the number of sitting places in the article is not obvious, divide the total seat length (in millimetres) by 600 and round it to the nearest whole number to determine the number of places. Divide the total seat length into that number of places of equal length.

7 Test procedures for all seating (experimental method)

7.1 Forwards overbalancing (all seating)

Position the furniture with the stops (**3.8**) against the front feet or base.

Apply a force of 600 N vertically (for multiple sitting places to a maximum of 2 places) by means of the loading pad (**3.2**) acting at points 50 mm from the front edge of the load bearing structure at those points most likely to result in overbalancing. At each loaded position apply a force F of 20 N for at least 5 s horizontally outwards along a horizontal line extended forward from the point where the base of the loading pad meets the upper surface of the seat (see Figure 5).

Record whether or not the seating overbalances.

For calculative method see clause **9**.

7.2 Sideways overbalancing, all seating without arms

Position the test specimen with stops (**3.8**) against the feet or base on one side (as appropriate).

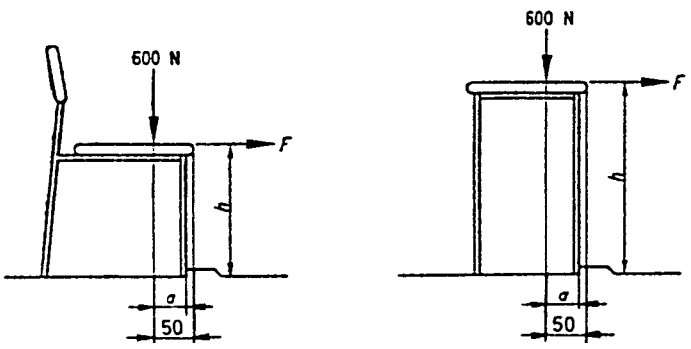
Apply a force of 600 N vertically by means of the loading pad so as to act at a point 60 mm from the edge of the load bearing structure of the side nearest the stopped feet at those positions most likely to result in overbalancing.

Apply a sideways force F of 20 N horizontally outwards for at least 5 s along a line from the point where the base of the loading pad meets the upper surface of the seat (see Figure 6).

Record whether or not the seating overbalances.

For calculative method see clause **9**

Dimensions in millimetres



a the minimum horizontal distance from the overturning axis to the vertical projection of the seat loading point (see also Figures 6, 7 and 8)

Figure 5 — Forwards overturning of chairs and stools

Dimensions in millimetres

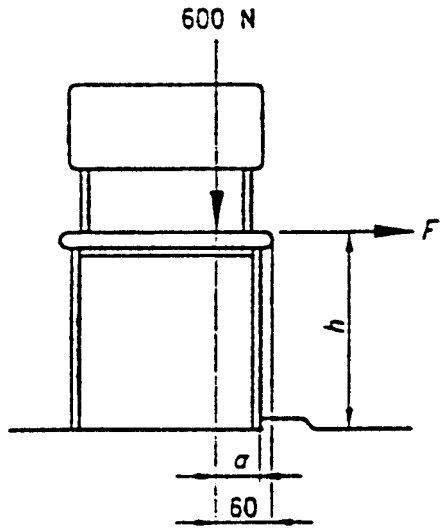


Figure 6 — Sideways overturning for chairs without arms

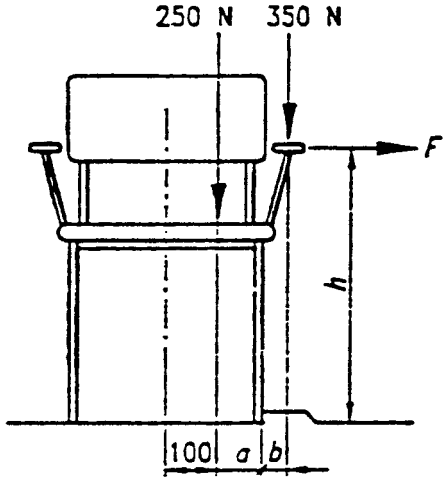
7.3 Sideways overbalancing, all seating with arms

Position the article with the stops (**3.8**) against the feet or base of one side. Apply a vertical force of 250 N at a point 100 mm to the side of the fore and aft centre line of the seat (see Figure 7) which is nearest the stopped feet and between 175 mm and 250 mm forward of the rear edge of the seat. Apply a vertical force *F* of 450 N by means of the loading pad (**3.2**) at a position on the centre line of the arm up to a maximum 40 mm inwards from the outer edge of the arm at the most adverse position along its length. Apply a horizontal force *F* of 20 N outwards, and perpendicular to the line joining the stopped feet, for at least 5 s, at the upper surface of the armrest in line with the vertical arm force and on the side with stopped feet (see Figure 7).

Record whether or not the seating overbalances.

For calculative method see clause **9**.

Dimensions in millimetres



b the minimum horizontal distance from the overturning axis to the vertical projection of the arm loading point

Figure 7 — Sideways overturning for chairs with arms

7.4 Rearwards overbalancing, all seating with backs

This point only applies to articles with backs extending 50 mm or more above the unloaded seat.

Position the article with the stops (**3.8**) against the rear feet or base. Apply a vertical force of 600 N to the seat by means of the loading pad (**3.2**) at the seat loading position (*a*) determined by the loading point template. Determine the distance (*h*) in millimetres between the loaded seat and the floor. For articles having a value of $h \geq 720$ mm use a force *F* of 80 N. For articles having a value of $h < 720$ mm calculate the force *F*, in newtons, required from the following formula:

$$F = 0{,}285\,7\,(1000 - h)$$

where

h is in millimetres

F is in newtons

Apply the force *F* horizontally for at least 5 s in a rearward direction to the back of the article at the point (*b*) determined by the loading point template, or at the top edge of the back rest, whichever is the lower (see Figure 8).

When the seat has more than one sitting place, carry out the procedure on two most adverse sitting places simultaneously.

For calculative method see clause **9**.

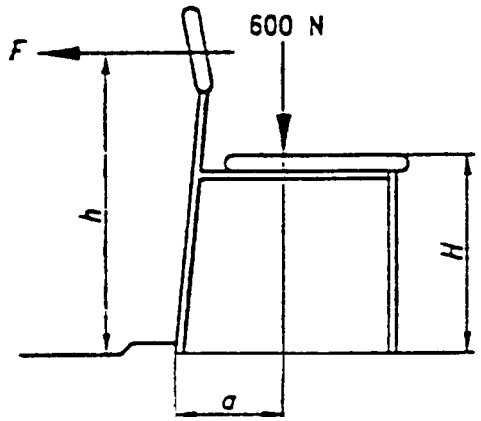


Figure 8 — Rearwards overbalancing

7.5 Displacement rearwards overbalancing, all seating

Tilt the article rearwards about its feet so that the front edge of the seat moves through a horizontal distance of 100 mm (see Figure 9).

Dimensions in millimetres

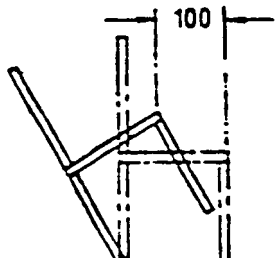


Figure 9 — Displacement rearwards overbalancing

8 Test procedures for seating with variable geometry: experimental method

NOTE There is no calculative method for seating with variable geometry.

8.1 General

In addition to the tests or calculations of **7.1** to **7.5**, seating with variable geometry shall be subjected to the following tests for tilting, rocking or reclining, provided their geometry falls within the limiting configurations for the appropriate tests.

The test shall be carried out with the seating in the fully tilted or reclined condition.

γ is the angle between the seat and back;

θ is the angle of inclination of the back from the horizontal [see Figures 10a), 12a) and 14a)].

For seats with shaped or padded seats or backs the seat loading template shall be used to establish the relevant angles of inclination.

If the height of the stack of loading discs used in tests **7.2**, **7.3**, **7.4** and **7.6** exceeds the height of the backrest, prevent the upper discs from sliding off by the use of a light support, e.g. a piece of cardboard [see Figure 10b)].

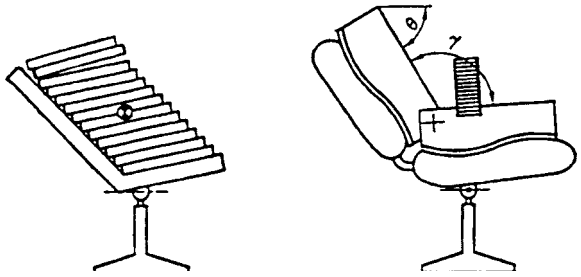
When testing rocking chairs, it may be necessary to restrain the loading discs with lightweight strapping, e.g. tape, string or webbing.

8.2 Tilting chairs

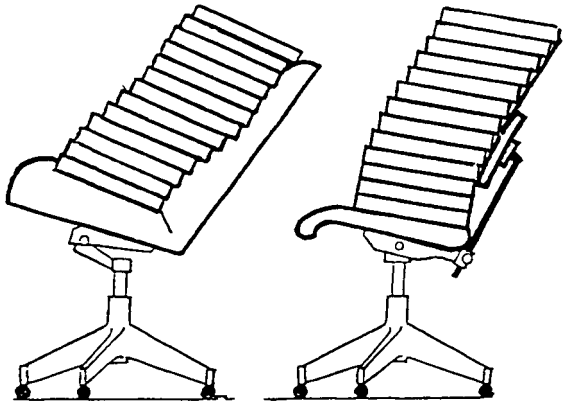
NOTE Test method valid for all values of θ and values of γ between 90° and 120°.

Load the chair with 13 loading discs (**3.5**) so that the discs are firmly settled against the chair back, as shown in Figures 11a) and 11b).

Report whether or not the chair overbalances.



a) Test for tilting chairs



b) Practical example of test method

Figure 10 — Test for tilting chairs with practical example

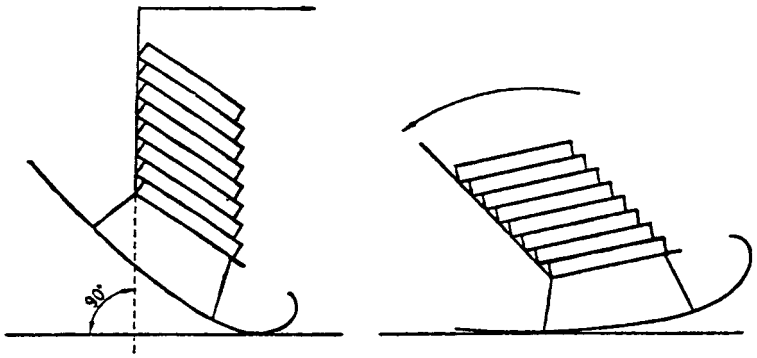
8.3 Rocking chairs

The most adverse floor surfacing shall be used, e.g. smooth and shiny or carpet or rubber.

Load the chair with eight loading discs (**3.5**) so that the discs rest against the chair back.

Rock the chair forwards as far as is practicable or until the back is vertical [see Figure 11a)]. Allow the chair to rock rearwards freely under gravity [see Figure 11b)].

Record whether or not the chair overbalances.



a) Method for rocking chairs: rock forwards

b) Method for rocking chairs: rock freely rearwards

Figure 11 — Method for rocking chairs

8.4 Reclining chairs with footrests

NOTE Test method valid for values of θ less than 55° and values of γ between 90° and 120°.

Load the back of the chair with eight loading discs (**3.5**) and place three loading discs onto the footrest [see Figures 12a) and 12b)] at a distance Z from the intersection of the seat and back (see Figure 13).

Record whether or not the chair overbalances.

In some cases the forward reclining stability test (**8.4**) cannot be carried out on a reclining chair because the footrest folds up. In which case the forwards stability test from **6.1** shall be applied with the footrest in the folded condition only.

However, in those cases where the footrest does not fold as the sitter's weight is moved towards the footrest (e.g. lever operated chairs) the reclining test from **8.4** shall be applied to the footrest in its fully extended position.

8.5 Reclining chairs without footrests

NOTE Test method valid for values of θ less than 45° and values of γ between 90° and 120°.

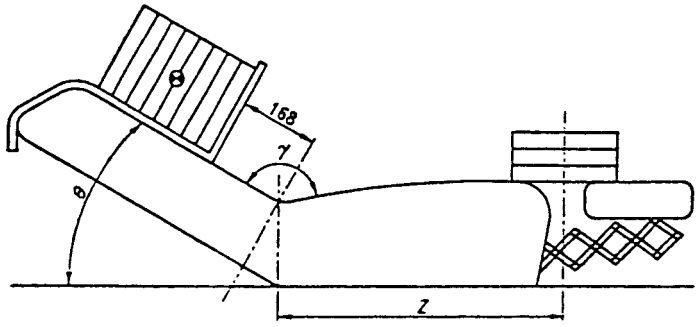
Load the back of the chair with eight loading discs (**3.3**) and place three loading discs onto the front of the seat of the chair [see Figures 14a) and 14b)] at a distance X from the intersection of the seat and back (see Figure 13).

Record whether or not the chair overbalances.

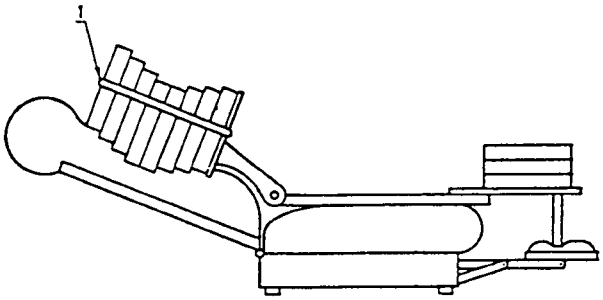
Table 1 — Values of X and Z

θ (degrees)	X (mm)	Z (mm)
0	474	614
10	424	564
20	375	515
30	325	464
45	252	392
60	194	314

Dimensions in millimetres



a) Test for reclining chairs with footrests



1 Elastic cord

b) Practical example of test method: reclining chairs with footrests

Figure 12 — Test for reclining chairs with footrests with practical example

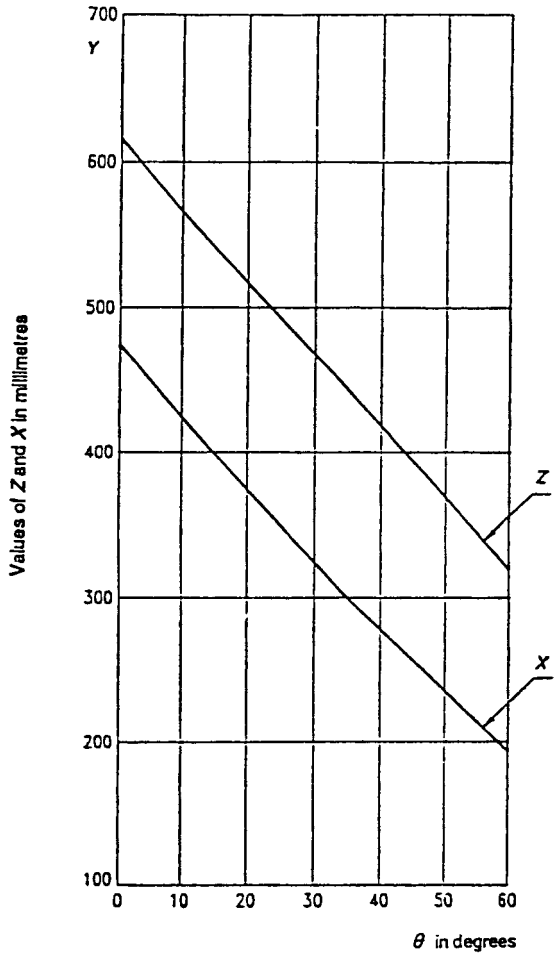
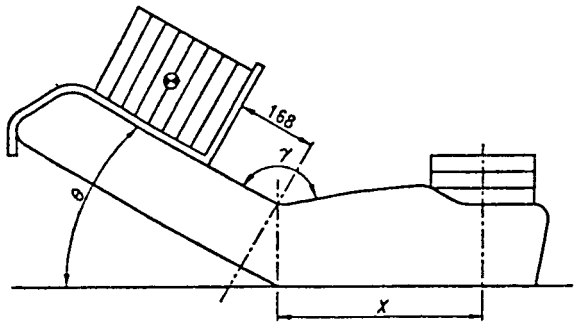
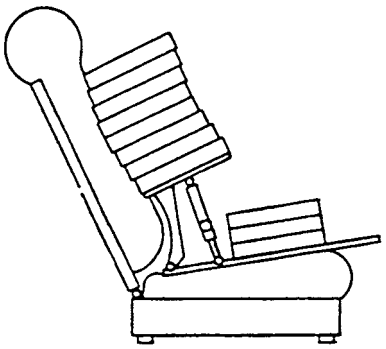


Figure 13 — Values of Z and X (mm)

Dimensions in millimetres



a) Test for reclining chairs without footrests



b) Practical example of test method: reclining chairs without footrests

Figure 14 — Reclining chairs without footrests with practical example

9 Calculative method

9.1 General

Forwards, rearwards and sideways stability for seats with fixed geometry can be determined by the calculative method described in this clause.

In the calculative method, the resistance against overbalancing, caused by vertical and horizontal forces, is taken into consideration based on the moments about the restrained supporting points. For this calculation distances a, b and h shall be measured under the specified vertical load.

— Distance a is the minimum horizontal distance from the overturning axis to the vertical projection of the seat loading point (see Figures 5, 6, 7 and 8);

— Distance b is the minimum horizontal distance from the overturning axis to the vertical projection of the arm loading point (see Figure 7);

— Distance h is the vertical distance from the loading point to the test floor (see Figures 5, 6, 7 and 8);

— Distance H is the loaded seat height (see Figure 8).

First determine the loading points as described in **7.1** to **7.4** and measure the distances a, b and h.

NOTE The overturning axis does not always pass through the outer edge of the feet. The overturning axis can be some distance inside the edge of the feet, e.g. when the legs are chamfered or rounded at the bottom.

A simple method of finding the part of contact between the leg and the floor is to push a piece of paper under the leg.

Position the unloaded chair with the stops against the two relevant supporting points. Apply a gradually increasing horizontal force F_o acting to tilt the chair over the two restrained supporting points in accordance with F as shown in Figures 5, 6, 7 and 8.

Record the value F_o when the seating overturns.

Calculate the force F_c that would be required to overbalance the chair had it been loaded with the test loads.

9.2 Forwards and sideways overbalancing for chairs without arm rests

Calculate the force F_c required to overturn the chair from the formula:

$$F_c = F_o + 600a/h$$

F_c shall be $\geq$20 N.

9.3 Sideways overbalancing for chairs with arm rests

Calculate the force F_c required to overturn the chair from the formula:

$$F_c = F_o + 1/h\ (250a + 350b)$$

F_c shall be $\geq$20 N.

9.4 Stools, all directions

Determine the stability of stools in the manner described in **8.4** except that the stopped feet shall be those required to tilt the stool about the axis having the lowest stability.

F_c shall be $\geq$20 N.

9.5 Rearwards overbalancing

Calculate the force F_c required to overturn the chair from the formula:

$$F_c = F_o + 600a/h$$

F_c shall be 80 N when $H > 720$ mm.

F_c shall be $\geq 0.285\,7\ (1\,000 - H)$ when $H \leq 720$ mm.

10 Interpretation of results

An article is stable if it reaches the specified loading without overbalancing.

11 Test report

The test report shall include at least the following information:

a) a reference to this British Standard;

b) the piece of furniture tested (relevant data);

c) the test results, overbalanced/not overbalanced;

d) details of any deviations from this British Standard;

e) the name and address of the test laboratory;

f) the date of test.

Bibliography

Standards publications

BS EN 1022:1996, *Domestic furniture — Seating — Determination of stability.*

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