

Strength and stability of furniture —

Part 3: Methods for determination of strength of settees

UDC 684.433.3:645.412.3:620.1

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Furniture and Household Equipment Standards Committee (FHM/-) to Technical Committee FHM/1 upon which the following bodies were represented:

British Rubber Manufacturers' Association
Business Equipment Trade Association
Consumer Standards Advisory Committee of BSI
Consumers' Association
Department of Education and Science
Design Council
Furniture Industry Research Association
Greater London Council
Local Authorities Management Services and Computer Committee
Mail Order Traders' Association of Great Britain
National Bedding Federation

This British Standard, having been prepared under the direction of the Furniture and Household Equipment Standards Committee, was published under the authority of the Board of BSI and comes into effect on 30 September 1985

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First published, as part of BS 4875-1, October 1972
First revision, as Part 3, September 1985

The following BSI references relate to the work on this standard:
Committee reference FHM/1
Draft for comment 82/36676 DC

ISBN 0 580 14645 6

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
<hr/>	
1 Scope	1
2 Principle	1
3 General requirements for tests	1
4 Inspection before and after testing	3
5 Apparatus	3
6 Determination of seat and back loading points	8
7 Procedures	8
8 Interpretation of results	15
9 Test report	15
<hr/>	
Appendix A Explanation of furniture test levels	16
<hr/>	
Figure 1 — Loading point template	4
Figure 2 — Position of loading point template	5
Figure 3 — Loading surface curves for chair seat and back loading template	5
Figure 4 — Seat loading pad (plan and side elevations)	6
Figure 5 — Smaller seat loading pad	6
Figure 6 — Back loading pad	6
Figure 7 — Impactor	7
Figure 8 — Impact hammer	9
Figure 9 — Seat static load test	10
Figure 10 — Back static load test	10
Figure 11 — Arm and wing sideways static load tests	11
Figure 12 — Arm downwards static load tests	11
Figure 13 — Seat fatigue test	12
Figure 14 — Back fatigue test	13
Figure 15 — Diagonal base test	14
Figure 16 — Arm impact test	14
Figure 17 — Drop test	15
<hr/>	
Table 1 — Test data (purpose of each test)	2
Table 2 — Summary of test procedures	2
Table 3 — Relationship of test levels to use of furniture	16
Table 4 — Specific applications for furniture in relation to test levels	16
<hr/>	
Publications referred to	Inside back cover
<hr/>	

Foreword

This Part of BS 4875 has been prepared under the direction of the Furniture and Household Equipment Standards Committee, and forms a revision of part of BS 4875-1:1972. Together with Parts 1, 2 and 4 it supersedes BS 4875-1:1972 which is withdrawn.

The major changes introduced by this revision are that the realism of the tests has been improved by specifying the use of more realistic apparatus, and a template is specified to determine the loading points. The opportunity has been taken to align the standard with an international standard in course of preparation in ISO/TC 136/SC 1 “Furniture — Test methods”.

The tests described in this Part of BS 4875 reproduce normal use and common types of mis-use to which seating may be subjected. As a result the methods are applicable to nearly all seating. Four test levels are given for the tests to cover the variations in severity of end-use that arises from the use of delicate styles, short life furniture, robust serviceable styles, etc. Whilst the tests reproduce normal use and common types of mis-use they do not reproduce any abuse to which the article may be subjected.

Appendix A gives an explanation of the furniture test levels used in this standard. The tests are designed to be applied to an article that is fully assembled and ready for use and are only intended to determine strength of the structure; they do not assess durability of filling materials, upholstery fabrics or foam cushions. The tests also do not reproduce the effects caused by degradation of structural materials by sunlight or chemical attack.

Other Parts of BS 4875 are as follows:

- *Part 1: Methods for determination of strength of chairs and stools;*
- *Part 2: Methods for determination of stability of chairs and stools;*
- *Part 4: Methods for determination of stability of settees;*
- *Part 5: Methods for determination of strength of tables and trolleys;*
- *Part 6: Methods for determination of stability of tables and trolleys;*
- *Part 7: Methods for determination of strength of storage furniture;*
- *Part 8: Methods for determination of stability of storage furniture.*

Attention is drawn to BS 6250 which specifies performance requirements for domestic and contract furniture using this standard as the method of test, and to BS 5459 and BS 5873 which specify performance requirements for office and educational furniture using methods that are very similar to those in this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 4875 describes methods for determination of strength of the structure of all types of settees, and other articles such as benches with seats for from two to four persons.

This standard does not apply to chairs or stools which are covered by BS 4875-1. It does not apply to multiple seating units for stadium seating as the loads applied are not representative of this type of use.

NOTE 1 Tests carried out according to the requirements of this standard are intended to demonstrate the ability of the item to give satisfactory service in its intended environment. It should be understood that such tests do not ensure that structural failure will not eventually occur as a result of habitual mis-use or after an excessively long period of service.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Principle

2.1 General

The principle is to determine the strength of the structure of an article of furniture by applying to various parts loads or forces simulating normal functional use, as well as acceptable mis-use, according to a graded scale of severity (see Appendix A).

The interrelation of the tests is shown in Table 1 and a summary is given in Table 2.

The sequence as a whole determines the following:

- a) static strength and initial damage;
- b) fatigue strength and damage propagation;
- c) ability to withstand acceptable mis-use and demonstration of sufficient residual strength.

The severity of loading is graded by varying the number of applications or the magnitude of forces applied.

2.2 Static tests

The principle of static tests is to assess the static strength of the article under the high levels of loading that only occasionally occur.

2.3 Fatigue tests

The principle of fatigue tests is to assess the strength of the component parts of the article under the repeated operations, movement, or applications of loads occurring during daily use.

2.4 Impact tests

The principle of impact tests is to assess the impact strength of the article under the rapid rates of loading that only occasionally occur.

3 General requirements for tests

3.1 Test loading

All loads and forces shall be measured to an accuracy of $\pm 5\%$.

NOTE The tests may in certain cases be carried out by means of loads or forces. For practical purposes, a force of 10 N may be taken to be equal to the downward force due to a mass of 1 kg.

The apparatus used to apply seat loading shall not restrain the article from overturning, nor hinder horizontal movement of the article when the back force is applied.

3.2 Moisture content and conditioning

Before the tests are commenced the article shall be sufficiently old to ensure that all component materials have developed their full strength.

At least 4 weeks in normal conditions shall elapse from manufacture in the case of glued joints in timber, plastics moulded parts, etc.

Parts made of timber products shall be checked with an electric moisture meter to ensure that the moisture content is between 8 % and 12 %. If the moisture content is too high the article shall be allowed to dry out in a warm ventilated room until the moisture content is between 8 % and 12 %.

If a standard atmosphere is required for conditioning or testing, that atmosphere shall be at a temperature of 23 ± 3 °C and a relative humidity of $50 \pm 5\%$.

3.3 Emergency tests

When there is not time for furniture to be aged or to reach equilibrium the moisture content shall be measured where applicable at the beginning and at the end of the testing sequence, and these measurements shall be included in the report if they are outside the limits specified, together with the age of the article when testing commenced.

3.4 Rate of carrying out the tests

The forces shall be applied at a sufficiently slow rate to ensure that negligible dynamic load is applied and also to ensure that kinetic heating does not occur.

During the static load tests described in 7.1 to 7.3 the forces shall be maintained for at least 10 s during each cycle.

NOTE It is recommended that the tests are carried out at a maximum rate of six cycles per minute.

3.5 Setting-up of furniture

The articles shall be tested as delivered. Self-assembly furniture shall be assembled according to instructions supplied with the article. If the article can be combined in different ways the most adverse combination shall be used for each test.

Table 1 — Test data (purpose of each test)

Sequence	Number	Title	Primary purpose	Secondary purpose	Type
1	1a	Seat static load test	Basic strength	Damage initiation	Functional
	1b	Back static load test			
2	2	Arm and wing sideways static load test			
3	3	Arm downwards static load test	Service durability	Damage propagation	
4	4a 4b	Seat fatigue test Back fatigue test			
5	5a	Leg forwards and sideways test	Handling strength		
	5b	Static load test			
	5c	Diagonal base test			
6	6	Seat impact test	Impact strength	Residual strength	Acceptable misuse
7	7a	Back impact test			
	7b	Arm impact test			
8	8	Drop test			

Table 2 — Summary of test procedures

Number	Title	Description	Test level ^a (see Appendix A)			
			2	3	4	5
1a	Seat static load test	Seat force (in N)	1 100	1 300	1 600	2 000
1b	Back static load test	Back force (in N) at each pad	410	560	760	760
		Balancing seat force (in N) at each pad	1 100	1 300	1 600	2 000
2	Arm sideways static load test	Force applied (in N)	300	400	600	900
	Wing sideways static load test	Force applied (in N)	200	300	400	500
3	Arm downwards static load test	Force applied (in N)	700	800	900	1 000
4a	Seat fatigue test	Number of cycles 950 N seat force	25 000	50 000	100 000	200 000
4b	Back fatigue test	Number of cycles 400 N back force	25 000	50 000	100 000	200 000
5a	Leg forwards static load test	Maximum forward force (in N)	375	500	620	760
5b	Leg sideways static load test	Maximum forward force (in N)	300	390	490	760
		Balancing seat force (in N)	780	1 000	1 250	1 800
5c	Diagonal base force test	Force applied (in N)	250	375	500	620
6	Seat impact test	Drop height (in mm)	140	180	240	300
7a	Back impact test and Arm impact test	Drop height (in mm)	120	210	330	620
7b		Angle (in degrees)	28	38	48	68
8	Drop test	Drop height (in mm)	75	100	150	200

^a Test level 1 does not apply to this standard; the remaining test levels are numbered 2 to 5 to correspond with the tests described in BS 4875-1.

4 Inspection before and after testing

Immediately before commencement of testing, each article shall be thoroughly inspected. Any defects in the members, joints or attachments shall be noted so that they are not attributed to the effect of the tests when the tests have been completed. A complete dimensional check shall be carried out on all articles that may suffer permanent deformation as a result of testing.

Immediately after completion of the tests, the article shall again be thoroughly inspected. Any apparent defects shall be noted and a determination made of any changes that have taken place since the initial inspection.

Fittings in self-assembly furniture shall be tightened before testing, and after each test level if testing is carried out at more than one test level.

NOTE Fittings in self-assembly furniture that come loose during the tests do not constitute a test failure. Manufacturers of self-assembly furniture should be recommended to issue instructions with the furniture that fittings should be tightened occasionally.

Each article shall be subjected to each of the tests at the same test level in the order specified and the occurrence of any of the following shall be recorded as defects affecting the strength of the article:

- a) any fracture of any member, joint or component, including seat suspensions and castors;
- b) any fracture or cracking through the thickness of any part of a structural shell;
- c) any loosening, shown to be permanent by hand pressure applied to suitable members, of joints intended to be rigid;
- d) any loosening of the underframe or base inserts moulded into a structural shell relative to the shell surface, shown to be permanent by means of hand pressure applied to the underframe or base;
- e) any free movement in the back, arms, legs or other components of the article greater than that noted in the initial inspection;
- f) any deformation of any part of the article or any cracks that will adversely affect its appearance or strength;
- g) any impairment of the operation of any mechanical part;
- h) any clearly audible noise developed during testing.

NOTE The test results are only valid for the article tested. When the test results are intended to be applied to other similar articles, the test specimen should be representative of the production model. Information on the scale of sampling to be employed can be obtained from BS 6001.

¹⁾ All loading pads should be capable of pivoting at least in the vertical plane and if design constrictions allow it, also in the horizontal plane.

5 Apparatus

NOTE For details of the sources of suitable test equipment write to Enquiry Section (London), BSI, 2 Park Street, London W1A 2BS enclosing a stamped addressed envelope for reply.

5.1 Means of applying required loads or forces.

5.2 Means of measuring dimensions to an accuracy of ± 0.2 mm.

5.3 Loading point template, (see Figure 1, Figure 2 and Figure 3) consisting of two shaped members fastened together by a pivot at one end. The contours of the shaped surfaces are so devised as to sink into the upholstery for a representative distance under moderate loads. For this purpose the seat loading arm shall have a total mass of 20 kg, applied through the seat loading point. The apparatus is marked as shown in Figure 1 so that the template can be positioned easily with the two members at an angle of 90°; to each other.

5.4 Stops, to prevent the article from sliding but not from overturning. Stops shall be not higher than 12 mm, except in cases where the design of the article necessitates the use of higher stops, where the lowest stop which will prevent the article from moving shall be used.

5.5 Seat loading pad¹⁾, a naturalistically shaped indenter as illustrated in Figure 4, consisting of a rigid shaped surface.

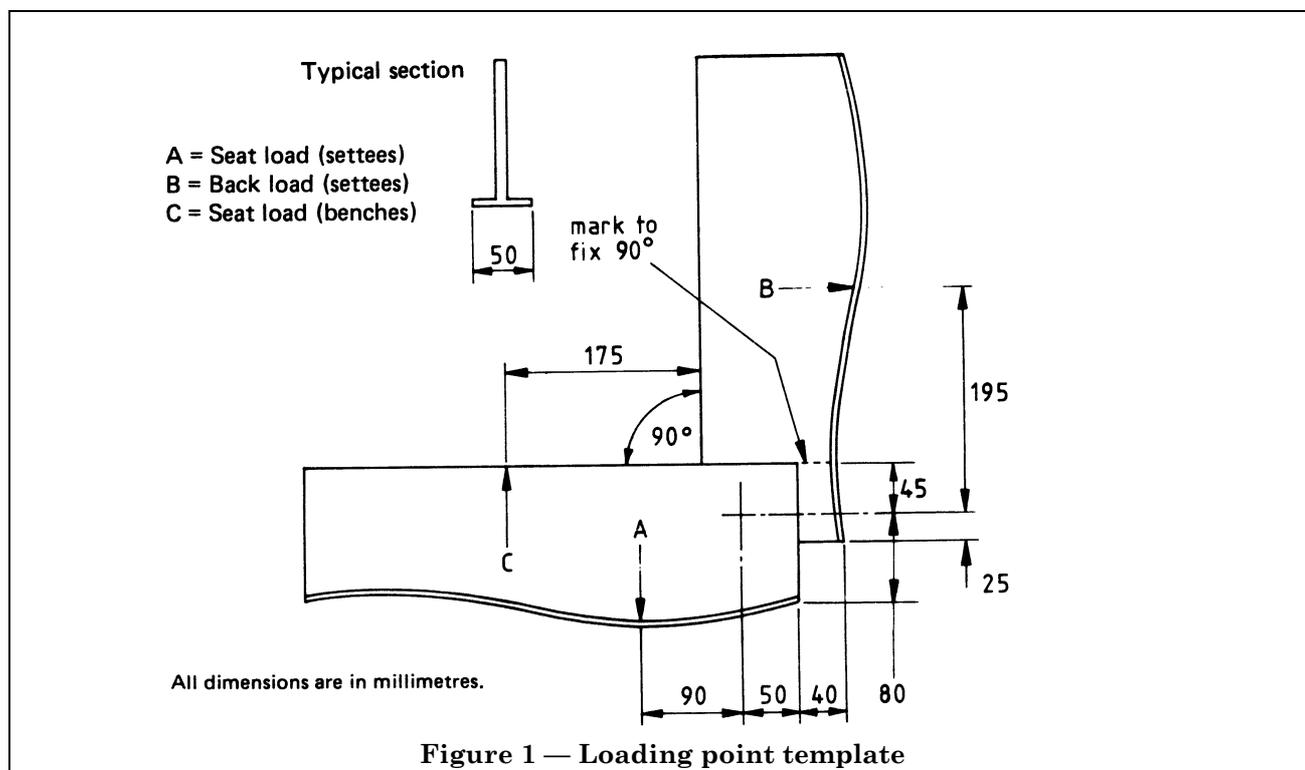
NOTE The shape, being complex, is defined not in a drawing but in existing moulds.

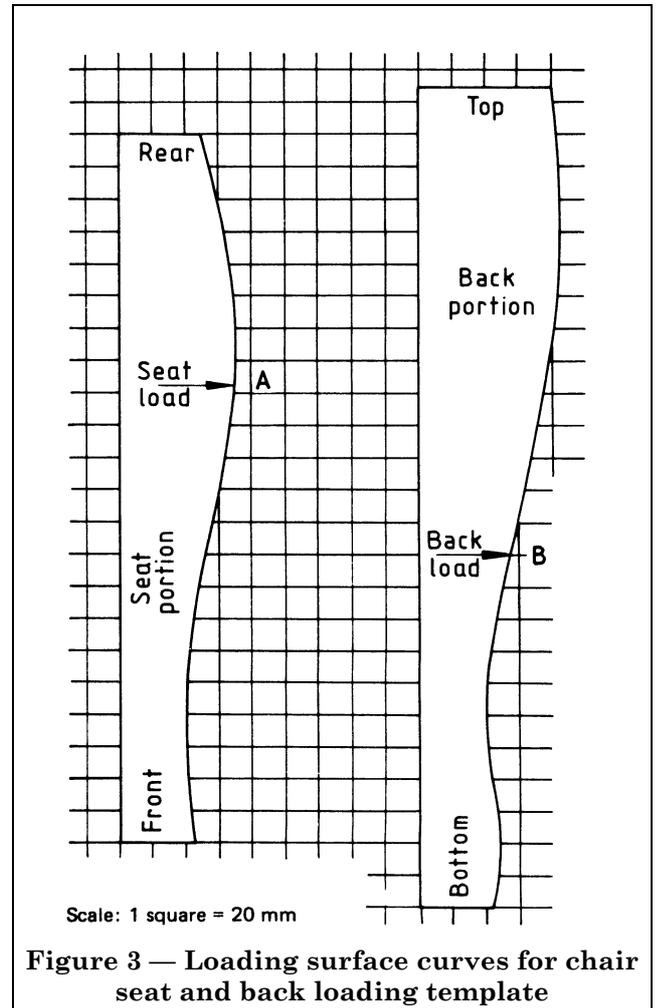
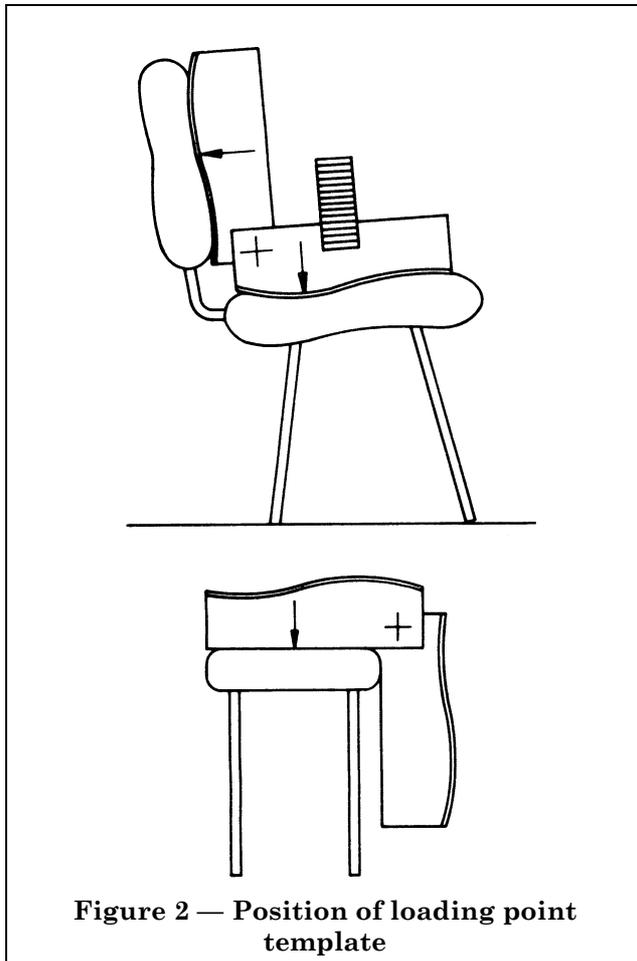
5.6 Smaller seat loading pad¹⁾, a rigid circular object 200 mm in diameter having a face with a convex spherical curvature of 300 mm radius and a 12 mm front edge radius (see Figure 5).

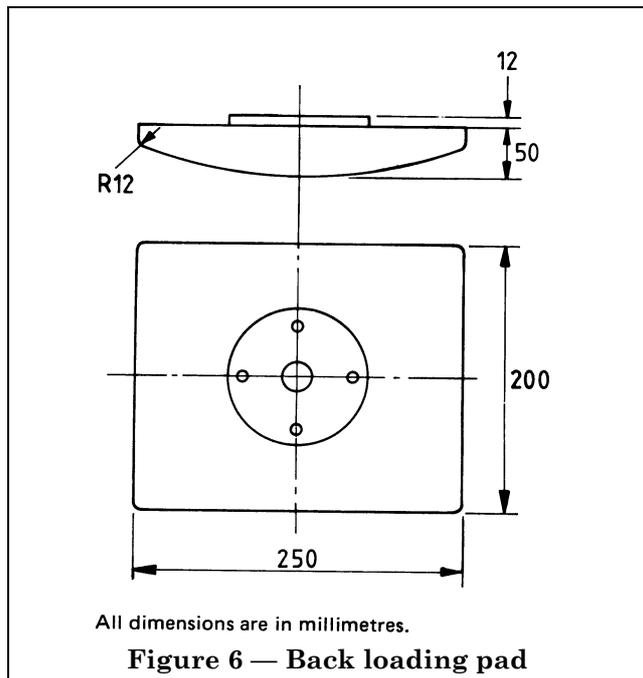
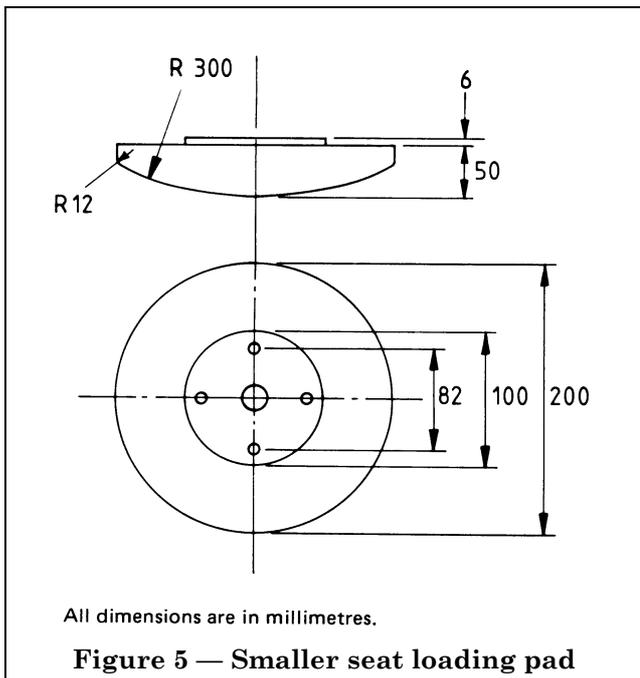
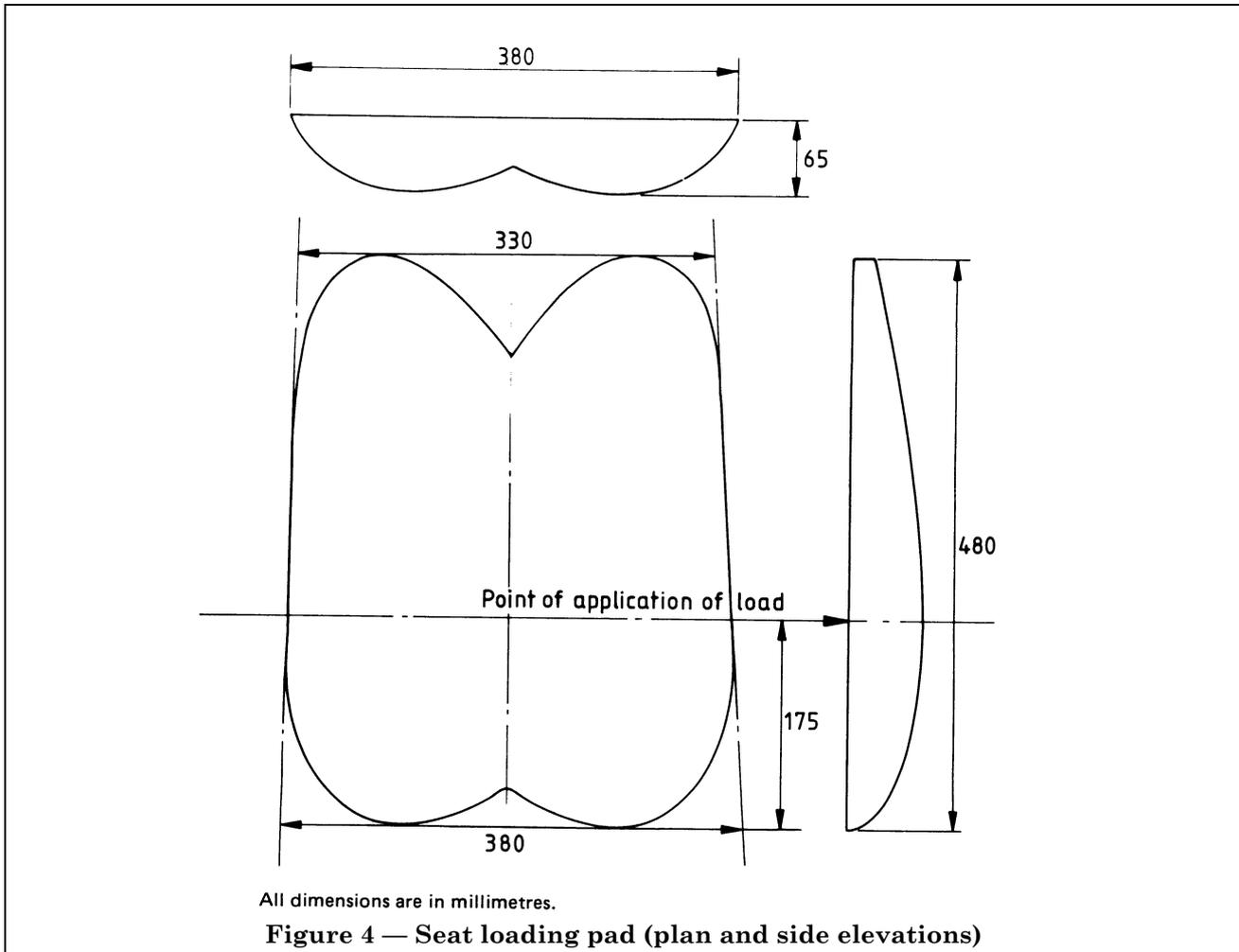
5.7 Back loading pad¹⁾, a rigid rectangular object 200 mm high and 250 mm wide having a face curved across the width of the pad with a convex cylindrical curvature of 450 mm radius and with a 12 mm radius on all front edges (see Figure 6).

5.8 Foam for facing pads, the seat and back loading pads (5.5, 5.6 and 5.7) are faced with a 25 mm thick layer of polyether foam with a hardness index, when measured in accordance with BS 4443-2, of 135/660 N at a density of 27 kg/m³ to 30 kg/m³. Alternatively a layer of the polyether foam described above may be positioned between the loading pad and the test structure.

5.9 Local loading pad¹⁾, a rigid cylindrical object 100 mm in diameter having a flat face with a 12 mm radius on the front edge.







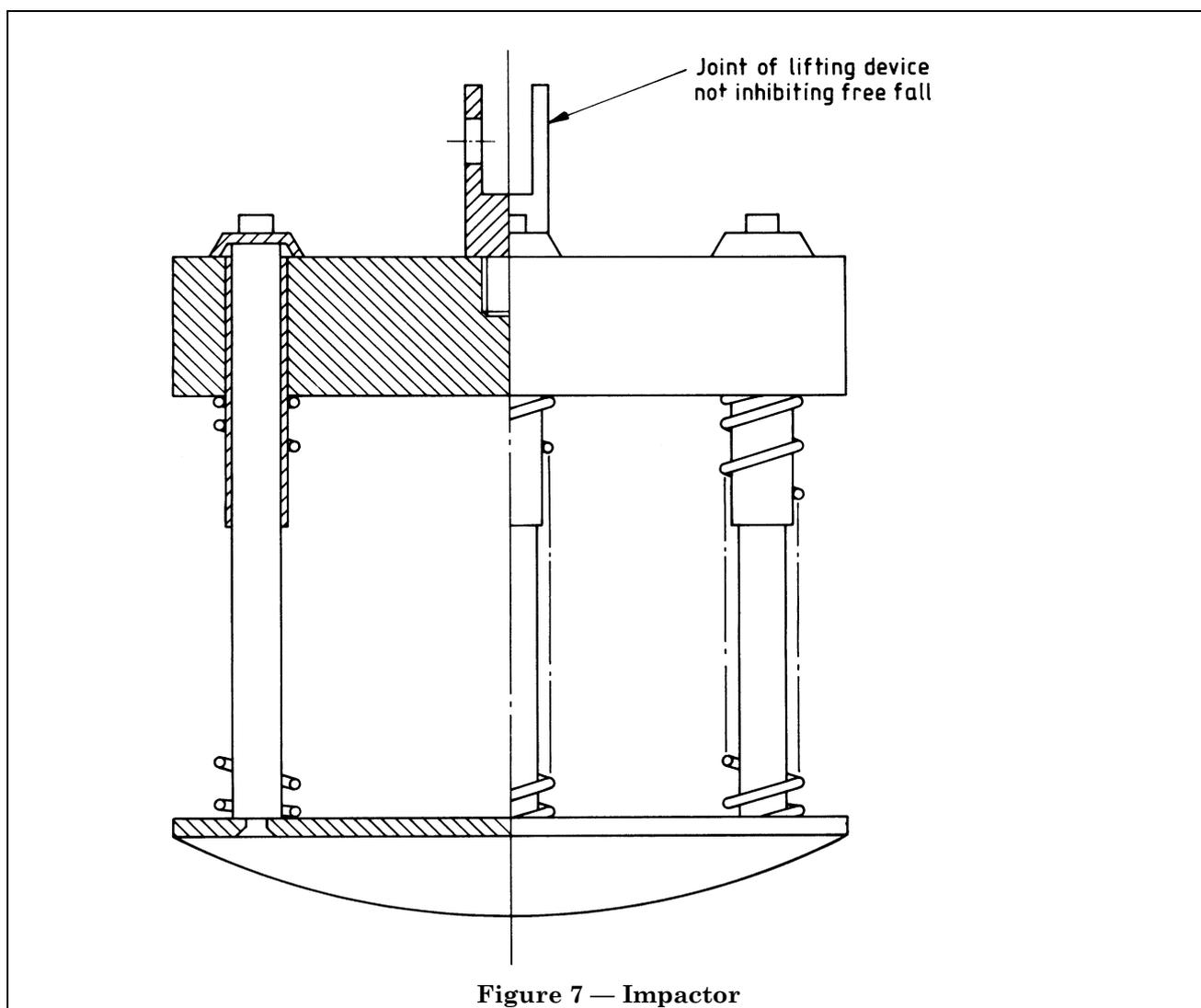


Figure 7 — Impactor

5.10 Impactor, a mass that is free to move in relation to the rest of the assembly approximately 200 mm in diameter separated from the striking surface by means of springs. The moving parts, less the springs, have a mass of not less than 17 kg, and the whole apparatus has a mass of 25 ± 0.1 kg. The springs are 400 ± 5 mm long with a closed length of 124 ± 5 mm, a spring rate of 0.69 ± 0.1 kg/mm and are set to a working length of 253 ± 0.5 mm (see Figure 7). The striking surface is an approximately flat leather pad containing fine dry sand.

5.11 Impact hammer, a striker in the form of a cylinder having a mass of 6.5 kg, supported from a pivot by a steel tube 38 mm in diameter with a wall thickness of 1.6 mm and having a mass of 2.00 ± 0.02 kg. The distance between the pivot and the centre of gravity of the striker is 1 m. The pendulum arm is pivoted by a low friction bearing (see Figure 8).

5.12 Floor, comprising a rubber mat 2 mm thick having a hardness of 97 IRHD when measured in accordance with BS 903-A26, resting on a concrete floor.

NOTE This floor is specified only for the drop test (7.8).

5.13 Double back loading pad²⁾, a pad consisting of two rigid rectangular objects 200 mm high and 250 mm wide, whose faces are curved across the width of the pad with a convex cylindrical curvature of 450 mm radius and with a 12 mm radius on all front edges. The distance between the pads shall be adjustable so that the centres can be sited over the back loading positions on each seat.

6 Determination of seat and back loading points

6.1 General

If the number of seats in the article is not obvious divide the total seat length (in mm) by 600 mm and round to the nearest whole number to determine the number of seats. Divide the total seat length into seats of equal length. Mark the position of each of the seat(s).

6.2 Settees

Position the template (5.3) with its load applied at the seat loading point on the centreline of the seat as far towards the rear as possible. Adjust its position by pushing the back loading portion into the back, so levering the seat portion forward until the shape of the template correlates with that of the seat (see Figure 3). Mark the required loading points from the template. Repeat the procedure on the other seats.

6.3 Benches

Set up the template (5.3) at angle of 90° with the aid of the mark as shown in Figure 3. Place on the bench as shown in Figure 2. Mark the required loading point from the template.

7 Procedures

7.1 Test 1: seat and back static load tests

7.1.1 Test 1a: seat static load test. Carry out the test at the following positions (see Figure 9):

- on each seat for articles with two seats;
- on one end seat and the centre seat for articles with three seats;
- on one end seat and one of the centre seats for articles with four seats.

During the test load the other seat(s) that is not being tested with a force of 750 N applied through the smaller seat loading pad (5.6).

Mount the seat loading pad (5.5) to conform to the seat plane first at the seat loading point (see clause 6), and subsequently on the front edge of the seat. Apply the appropriate downward force, V_s , specified in Table 2 for a total of 10 times. Repeat the procedure on the remaining positions as specified above.

7.1.2 Test 1b: back static load test. Position the centres of the double back loading pad (5.13) at the back loading points (see clause 6) or at 100 mm below the top of the back, whichever is the lower. Prevent the article from rearwards movement by placing stops behind the rear feet or castors.

During the test load both seats beneath the back positions being tested with the force specified in 7.1.1 at the seat loading point (see Figure 10).

Apply the appropriate test force, H_s , specified in Table 2 perpendicular to the back when under load a total of 10 times with the balancing seat force specified in Table 2 applied at the seat loading point, see clause 6.

For units with three seats (1, 2, 3) carry out the test at positions 1 and 2. For units with four seats (1, 2, 3, 4) carry out the test at positions 1, 2 and 2, 3.

If the article tends to overturn reduce the back force to a magnitude that just prevents rearwards overturning and report the actual force used³⁾.

NOTE Since one position of the seat loading pad in the seat static load test is the same as that specified for the back static load test, it is convenient to perform these two tests as a combined seat and back static load test (test 1).

7.2 Test 2: arm and wing sideways static load test

Apply two outward forces, H_a , of the appropriate magnitude specified in Table 2 between the arms of the article at the point along the arms most likely to cause failure. Apply the forces 10 times, using the local loading pad (5.9) (see Figure 11).

If a settee has wings, i.e. two side pieces at the top of a settee against which the head may be rested, repeat the test by applying the appropriate forces specified in Table 2 outwards from the wings.

7.3 Test 3: arm downwards static load test

Apply a vertical force, V_a , of the appropriate magnitude specified in Table 2, using the smaller seat loading pad (5.6), at the point along the arms most likely to cause a failure. Apply the force 10 times (see Figure 12).

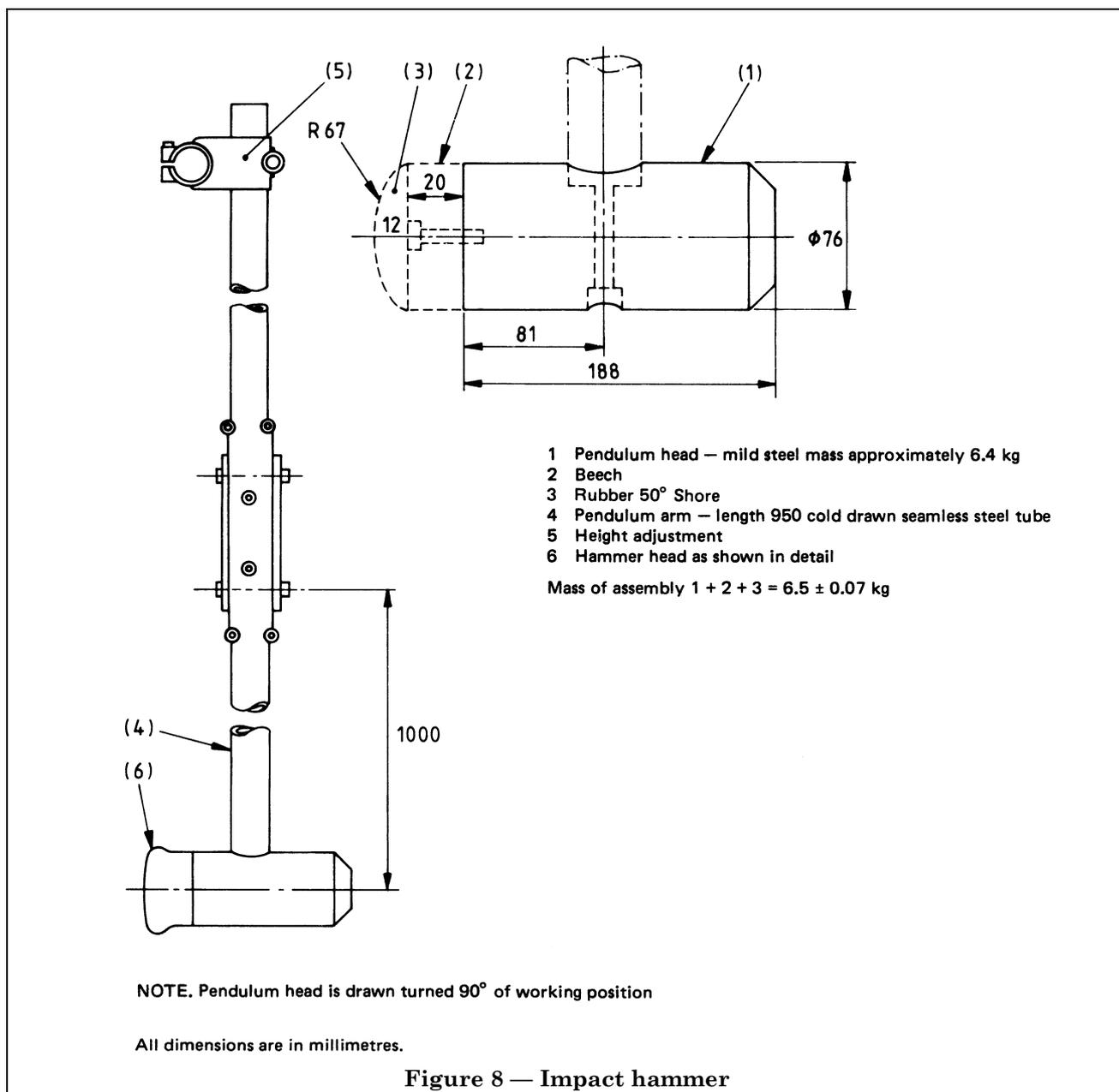
²⁾ See clause 8 for situations where a reduced back force of less than 410 N per pad is used.

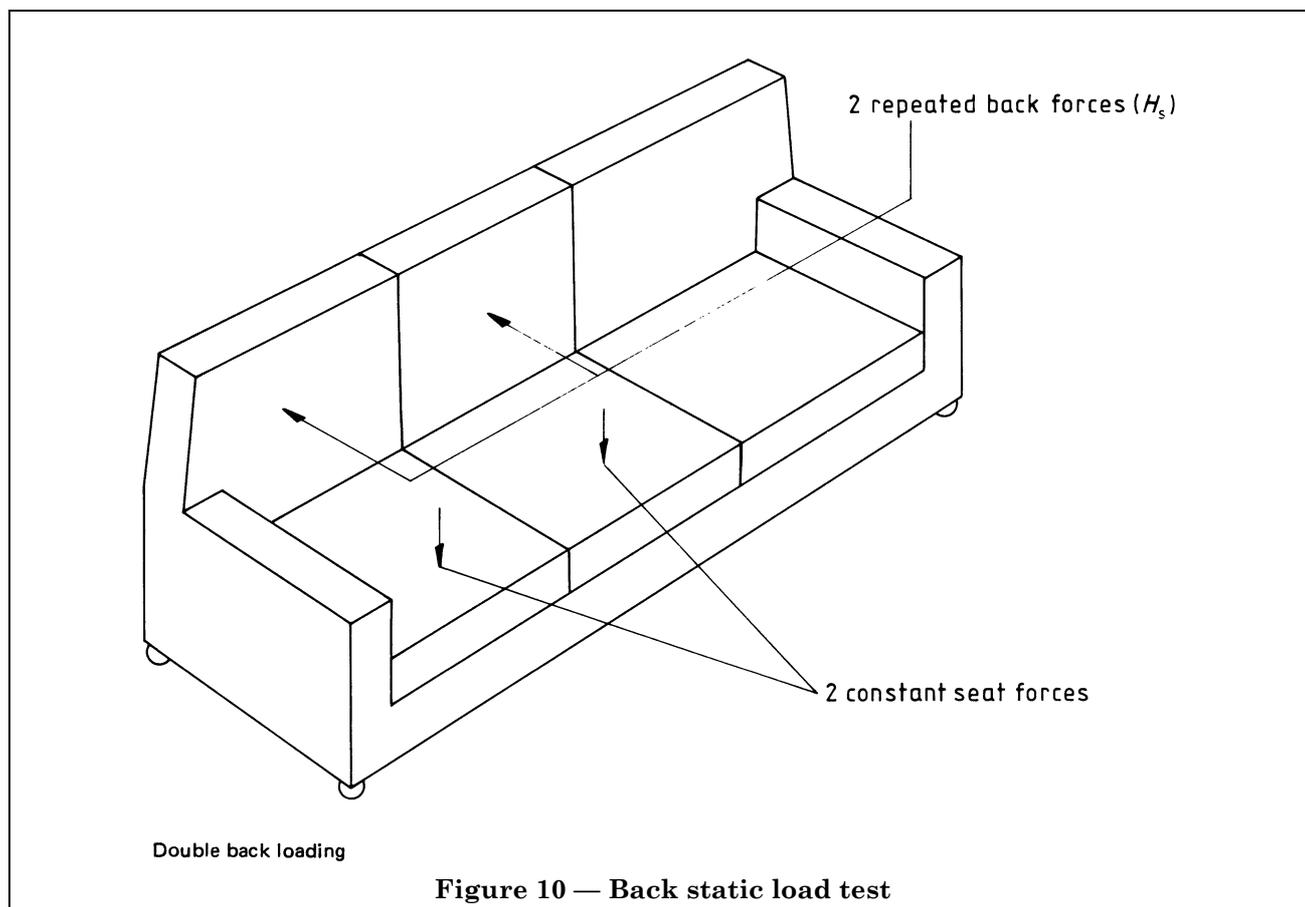
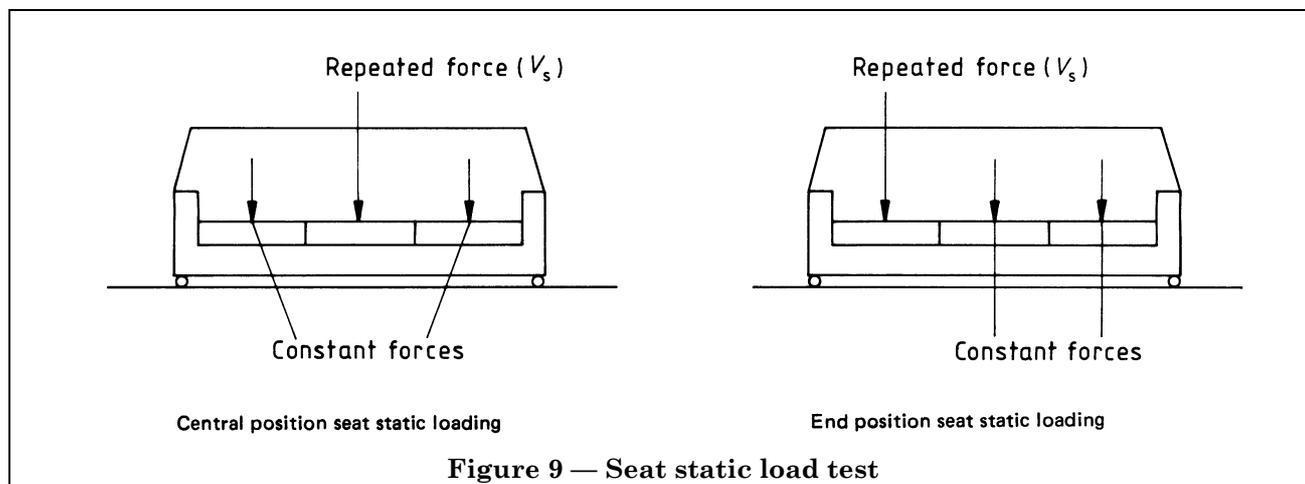
³⁾ See clause 8 for situations where a reduced back force of less than 410 N per pad is used.

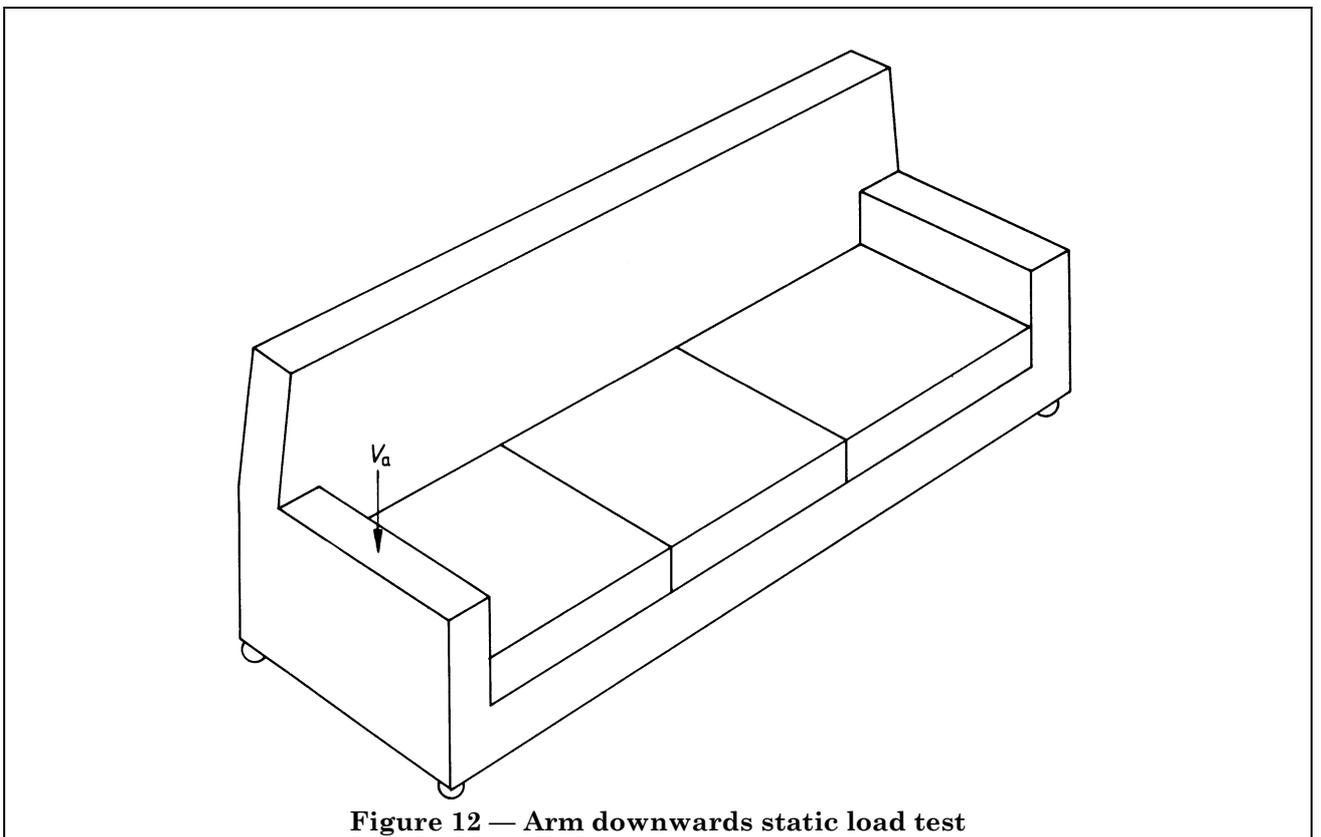
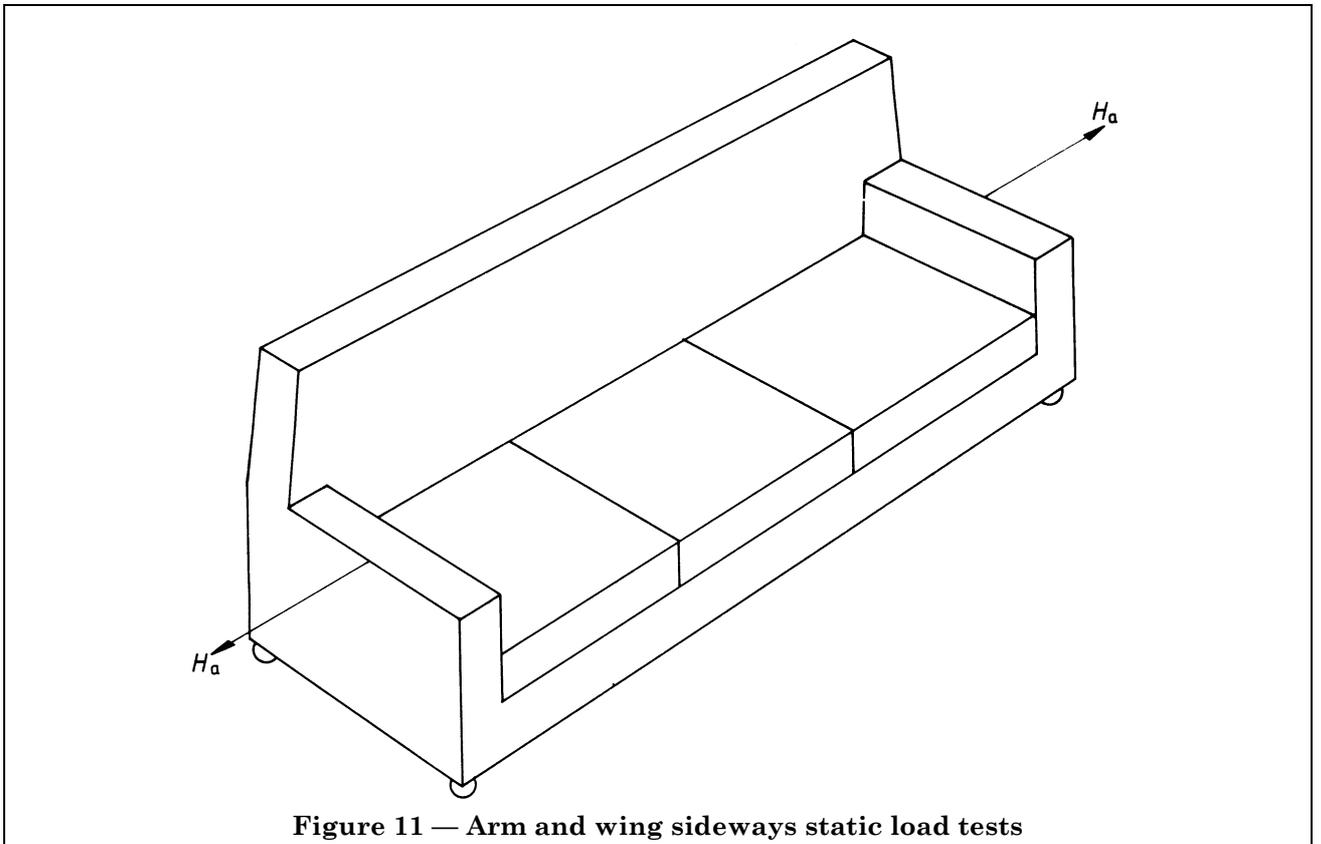
If the article tends to overturn apply a balancing load large enough to prevent the article from overturning when the full force is applied, on the side of the seat opposite to that on which the full force is applied.

7.4 Test 4: seat and back fatigue tests

NOTE Because the number of cycles and the seat load are common to both the seat and back fatigue tests it is normally convenient to perform these two tests together as a combined seat and back fatigue test (test 4).







7.4.1 Test 4a: seat fatigue test. Apply the test force of 950 N by means of the seat loading pad (5.5) positioned at the seat loading point (see clause 6 and Figure 13). Carry out the test at the positions given in 7.1.1

7.4.2 Test 4b: back fatigue test. Position the centre of the back loading pad (5.7) either at the back loading point (see clause 6) or at 100 mm below the top of the back, whichever is the lower. Prevent the article from rearwards movement by placing stops behind the rear feet or castors. Conduct the test by the repeated application of a force of 330 N or, if the article tends to overturn, of such lesser force to just prevent rearwards overturning. Record the magnitude of any reduced force used. Conduct the test using the back loading pad (5.7). During each cycle apply a force of 950 N to the seat. Carry out the test at the positions specified in 7.1.1 (see Figure 14).

7.5 Test 5: leg static load test

7.5.1 General. Leg tests are applicable to articles with legs or pedestals. There are no rearward leg loading tests because assessment of durability when subjected to them will have been demonstrated in the back static strength test.

Articles without legs or pedestals shall be subjected to the diagonal base test (7.5.4) instead of the tests in 7.5.2 and 7.5.3.

7.5.2 Test 5a: leg forwards static load test. Restrain the front feet of the article from movement. Apply the appropriate force specified in Table 2 at the seat loading point (see clause 6) by means of the loading pads (5.5 or 5.6). Apply a horizontal force centrally to the rear of the article at seat level in a forward direction using the local loading pad (5.9). The horizontal force used shall have the appropriate magnitude specified in Table 2, but if the article tends to overturn, reduce the forward leg force until forwards overturning is prevented. Record the magnitude of any reduced force used. Apply the forward leg force 10 times.

7.5.3 Test 5b: leg sideways static load test. Perform the test in the same manner as the leg forwards static loading test except that a pair of front and rear feet shall be restrained from movement whilst a horizontal force is applied centrally to the side of the article at seat level in a sideways direction towards the restrained feet. Apply the force 10 times. The maximum force shall be the appropriate force specified in Table 2.

Apply the appropriate balancing force specified in Table 2 at a suitable position across the seat but not more than 150 mm from the unloaded edge of the seat. If the article tends to overturn with the vertical seat force in its furthest position from the unloaded edge, reduce the horizontal seat force to a magnitude that just prevents sideways overbalancing, and record the actual force used.

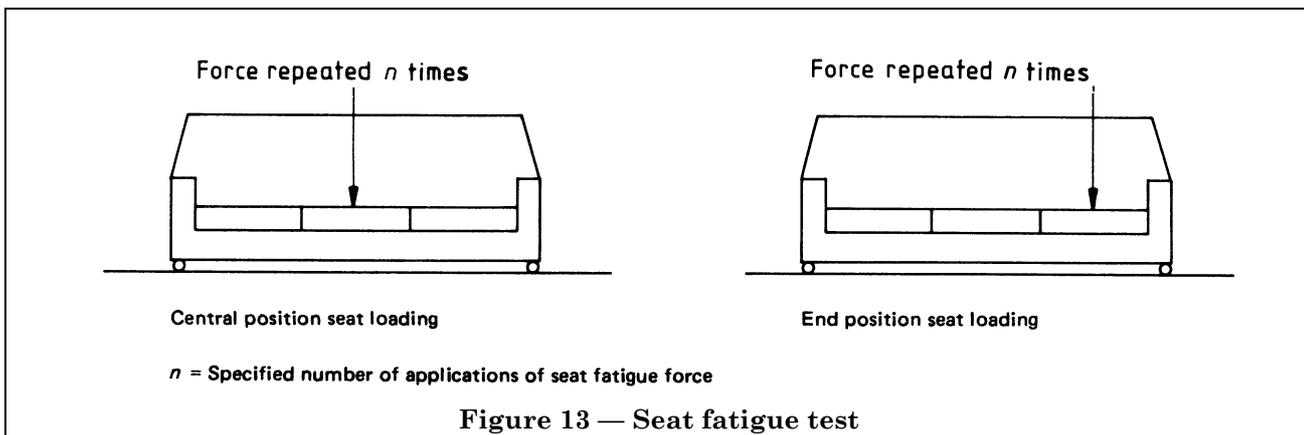
7.5.4 Test 5c: diagonal base test. Apply simultaneously two opposing forces of the appropriate magnitude specified in Table 2 to one pair of diagonally opposite corners of the article. Apply the forces 10 times in an inward direction as near as possible to the lowest point of the article (see Figure 15).

7.6 Test 6: seat impact test

Allow the impactor (5.10) to fall freely onto the seat at the seat loading point (see clause 6) from the appropriate height specified in Table 2. Repeat the procedure 10 times. Repeat the test at any other position considered likely to cause failure, and in particular as near to the front edge as is possible at its most vulnerable point.

When testing an unupholstered article place a piece of foam (5.8) approximately 30 mm thick on the seat.

In cases of soft upholstery, where it is difficult to measure the drop height accurately first place a 2 kg mass having a diameter of 200 mm on the article and determine the drop height from the underside of the mass.



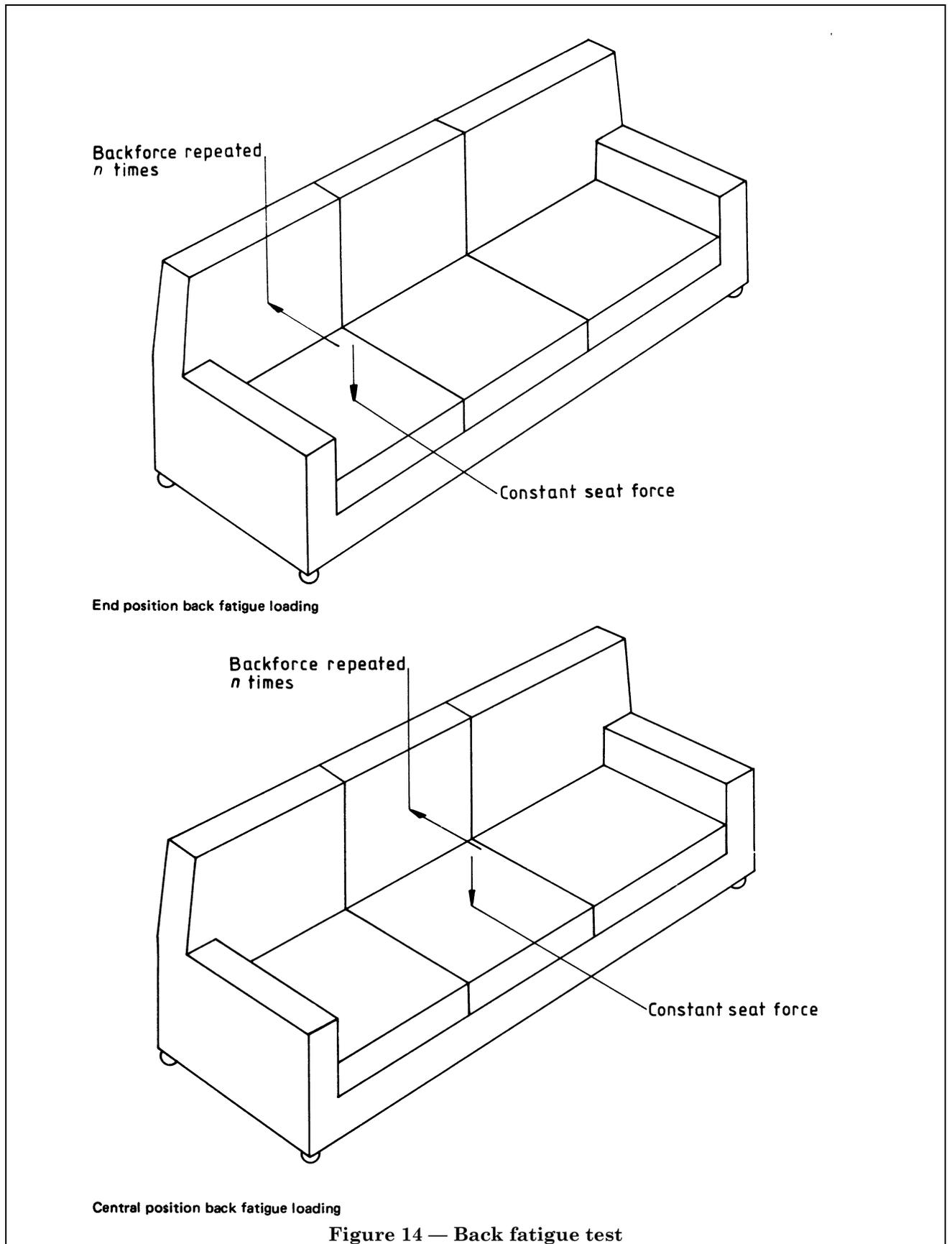
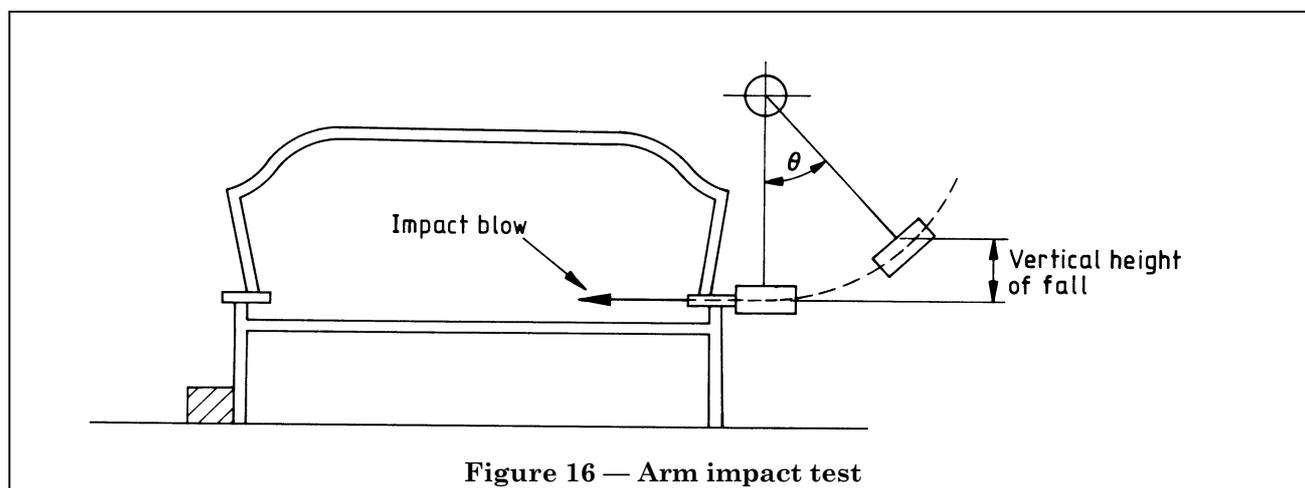
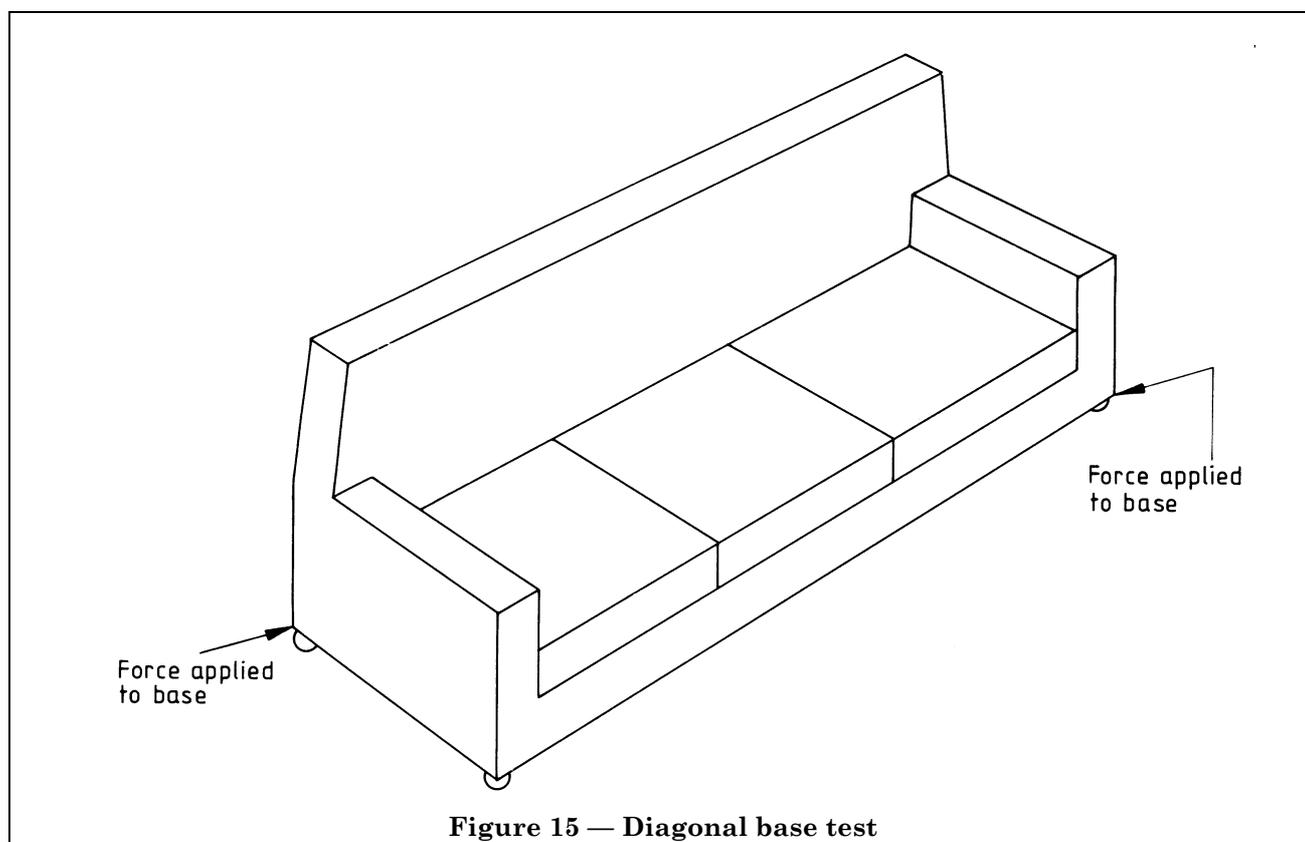


Figure 14 — Back fatigue test



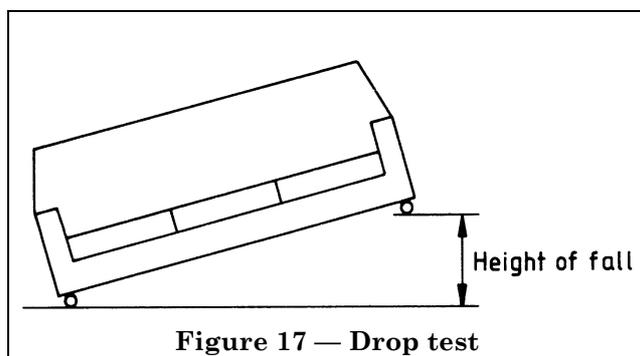


Figure 17 — Drop test

7.7 Test 7: back and arm impact tests

7.7.1 Test 7a: back impact test. Place the article with its front feet prevented by stops from moving forward. Strike the centre of the top outside of the back, or, when there is no back, the centre of the seat front edge with the impact hammer (5.11) horizontally. Drop the impact hammer through the appropriate vertical height (or angle) given in Table 2 at the following back positions:

- a) at both positions for articles with two seats;
- b) at one end position and one centre position for articles with three seats;
- c) at one end position and one centre position for articles with four seats.

Repeat the procedure 10 times.

If the article has wings, rearrange the position of the article and repeat the test with the impact hammer hitting the outside of the top of one wing at right angles to the surface and in the position most likely to cause failure.

7.7.2 Test 7b: arm impact test. Carry out this test in the same manner as for the back impact test except apply the impact in an inward direction to the outside face of one arm at the position most likely to cause failure (see Figure 16). Place the stops against the feet on the opposite side of the article to the arm being tested.

7.8 Test 8: drop test

Lift up the article at one end and then allow to fall freely from the appropriate height specified in Table 2 so that the impacting feet or castors strike the floor (5.12) (see Figure 17).

8 Interpretation of results

Each article shall be considered to have passed the tests at the appropriate test level if no defects are observed (see clause 4), if a backforce of not less than 410 N was used in 7.1.2 and if the requirements of the appropriate product specification are met.

9 Test report

The test report shall include the following particulars:

- a) the number of this British Standard, i.e. BS 4875-3;
- b) details of the article of seating tested;
- c) the test level that the article has been tested against;
- d) details of any defects observed before the tests;
- e) details of any defects observed after the tests;
- f) if required:
 - i) any damage which does not impair the function of the article;
 - ii) the magnitude of any non-standard forces used, see 7.1, 7.4 and 7.5;
- g) the moisture content, if emergency tests have been carried out, see 3.3;
- h) the test result, pass or fail;
- i) details of any deviation from the test procedures.

Appendix A Explanation of furniture test levels

Table 3 gives the type of use that might be expected from each furniture test level.

Table 3 — Relationship of test levels to use of furniture

Test level	Description of performance		Example
2	Careful domestic		Domestic bedroom
3	General domestic	Careful contract	Domestic living/dining room or hotel bedroom
4	Severe domestic	General contract	Settees where rough treatment and careless handling occur, e.g. college study, hotel reception
5		Severe contract	Settees intended for exceptionally severe use, e.g. termini, student common room and barrack room

Examples of the use of furniture for specific applications are given in BS 6250, and for information purposes are reproduced in Table 4.

Table 4 — Specific applications for furniture in relation to test levels

Type of use	Strength of frame (test level)				
	1	2	3	4	5
Folding garden and camping		X	X		
Domestic		X	X	X	
Office			X	X	X
Educational				X	X
Institutional					X
Hotel			X	X	
Non-specialized hospital			X	X	X
Military					X
Bar				X	X
Church			X		
Police station				X	X
Recreation room					X
Common room					X
Public hall				X	X

Publications referred to

BS 903, *Methods of testing vulcanized rubber.*

BS 903-A26, *Determination of hardness.*

BS 4443, *Methods of test for flexible cellular materials.*

BS 4443-2, *Method 7 — Indentation hardness tests.*

BS 5459, *Specification for performance requirements and tests for office furniture*⁴⁾.

BS 5873, *Educational furniture*⁴⁾.

BS 6001, *Sampling procedures and tables for inspection by attributes.*

BS 6250, *Domestic and contract furniture.*

⁴⁾ Referred to in the foreword only.

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