BRITISH STANDARD

BS 5395-2: 1984

Reprinted, incorporating Amendment No. 1 and Corrigenda Nos. 1, 2 and 3

Stairs, ladders and walkways –

Part 2: Code of practice for the design of helical and spiral stairs

Confirmed December 2011

ICS 91.060.30

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Elements and Components (of Diverse Materials) for Buildings Standards Committee (ECB/-) to Technical Committee ECB/2 upon which the following bodies were represented:

Aluminium Federation
British Woodworking Federation
Concrete Society
Department of Health and Social Security
Department of the Environment, Building Research Establishment, Princes Risborough Laboratory
Department of the Environment, Housing and Construction
Energy Industries Council
Engineering Equipment and Materials Users' Association
Greater London Council
Health and Safety Executive
Incorporated Association of Architects and Surveyors
Institution of Mechanical Engineers
Institution of Structural Engineers
Joinery Managers' Association Ltd.
London Transport Executive
Royal Institute of British Architects
Scottish Development Department
Spiral Stair Manufacturers' Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Institution of Building Control Officers
Co-opted members

This British Standard, having been prepared under the direction of the Elements and components (of Diverse materials) for Buildings Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 January 1984

The following BSI references relate to the work on this standard:
Committee reference ECB/2
Draft for comment 82/12150 DC

ISBN 978 0 580 67560 7

Amendments issued since publication

Amd. No.	Date of issue	Comments
6076	July 1989	Indicated by a sideline in the margin
	July 2008	Corrigendum to replace poor quality figures
C2	March 2009	Table 2: "Minimum outer going" corrected to "Maximum outer going" This corrigendum corrects an error that appears in some versions of this standard only.
C3	June 2009	Corrigendum to replace incorrect figures including keys and to correct equation in **5. 2**

Contents

Foreword

This standard has been prepared under the direction of the Elements and Components (of Diverse Materials) for Building Standards Committee. As a consequence of the publication of this Part of this standard, the number of the existing BS 5395:1977 has been changed to BS 5395-1. BS 5395-3 covers industrial type stairs, ladders and walkways.

This standard is based on accepted good practice by designers and manufacturers of helical and spiral stairs, It should be borne in mind that helical and spiral stairs are not normally permitted for use as means of escape where large numbers of persons are involved.

In drafting this standard the committee acknowledged the need for research into the structural behaviour of stairs.

Appendix A describes a recommended procedure for load tests on stairs. Further investigations are required to determine the appropriate loads for each stair category.

The proper functioning and durability of a prefabricated stair designed in accordance with this standard depends on care in handling during transportation and on site, as well as careful site storage, correct installation and temporary protection, and subsequent proper maintenance. Some general advice is given in BS 5395-1, but the manufacturer should inform the purchaser in writing of the precautions necessary.

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 12, 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 this standard gives recommendations for the design of helical and spiral stairs, to be used internally or externally in all types of building constructions. It covers only stairs which are circular on plan and does not deal with ramps.

NOTE 1 Appendix B gives guidance on the geometry of helical and spiral stairs.
NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this standard the following definitions apply.

2.1
spiral stair

a stair describing a helix around a central column [see Figure 1(a)]

2.2
helical stair

a stair describing a helix around a central void [see Figure 1(b)]

2.3
going

the chord length on plan between two points on consecutive tread nosings at the same radius from the geometric centre of the stair, measured as described in **5.4**

2.4
rise

the vertical distance between two consecutive steps

2.5
clear headroom

the distance measured vertically from the pitch line of a stair or from a floor or landing to any obstruction overhead

2.6
clear width

the unobstructed walking area throughout the stair's rise, measured as described in **5.6**

2.7
outside diameter

the diameter of the outer edge of the handrail, strings or treads, whichever is the greater

2.8
pitch line

a line drawn from the floor or landing below a stair to connect points on consecutive tread nosings at the same radius from the geometric centre of the stair

2.9
nosing

the front edge of a tread

2.10
riser

the part closing the front face of the step

2.11
tread

the horizontal part or upper surface of the step

3 Alternative materials, components and methods of design and construction

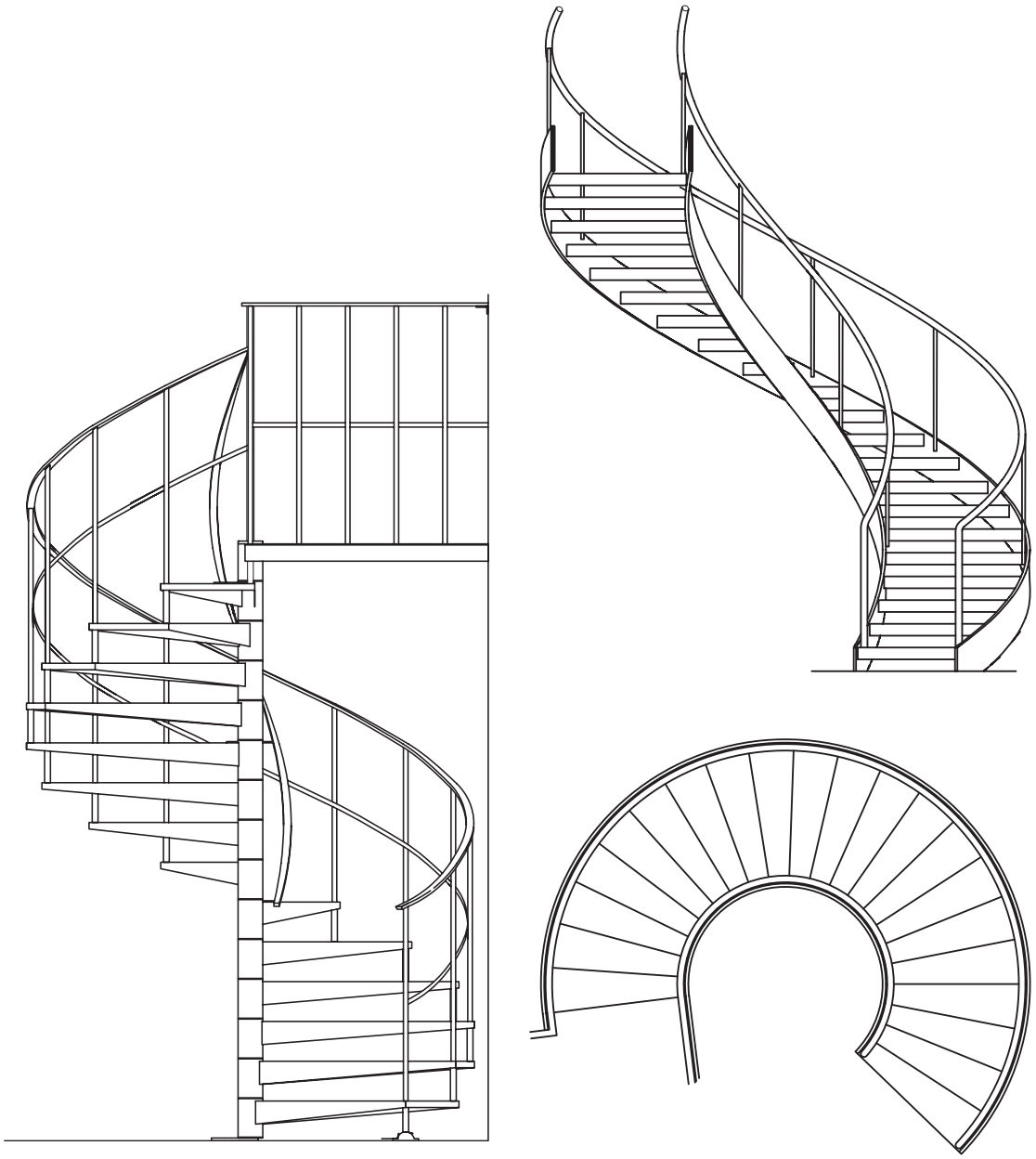
Where materials, components and methods of design and construction are not covered by this standard or by any other British Standard, this is not necessarily to be regarded as discouraging their use. The designer should satisfy himself by reference to appropriate manufacturers' literature and test evidence issued by competent, independent authorities that the materials and methods to be employed are such as to ensure a level of performance at least equal to that obtained by following the recommendations of this standard.

4 Materials

Structural materials should be selected from those listed in Table 1 and should be in accordance with the appropriate British Standard.

Where stairs are constructed from two or more different materials, the materials should be compatible. For example, they should not give rise to electromagnetic or electrogalvanic action e.g. between different metals, chemical corrosion e.g. of metal fixings in timber, or differential movement e.g. between concrete and brickwork.

For guidance on surface-finishing materials see clause **8** of BS 5395-1:1977.



(a) Spiral stair

(b) Helical stair

NOTE. Balusters are shown widely spaced for clarity. In areas frequented by children, the widest gap should not permit a sphere of 100 mm diameter to pass through.

Figure 1 – Typical layouts for stairs

Table 1 – Structural materials

Material	British Standards		Other recommendations
	Code of practice	Specification	
Concrete	BS 8110		
Reinforced and granolithic terrazzo		BS 4357	
Natural stone	BS 5390		Not suitable for use in escape stairs (see clause **6**)
Cast stone	BS 5628-3	BS 1217	Not suitable for use in escape stairs (see clause **6**) Hopton stone and York stone are particularly suitable as aggregates
Brick and block	BS 5628-3	BS 187 BS 3921 BS 6073-1	
Aluminium	CP 118[a]		Not suitable for use in escape stairs (see clause **6**)
Cast iron		BS 1452	
Copper alloys		BS 2870 BS 2872 BS 2874	Aluminium bronze (grades CA 101 to 106 inclusive) or phosphor bronze (grades PB 101 to 104 inclusive) should be used See fire safety recommendations in clause **6**
Steel, including stainless steel	BS 449 BS 5950	BS 1449	See fire safety recommendations in clause **6** Austenitic stainless steel grade SS 16 316 should be used for external stairs
Plastics materials	BS 6180[b]		Not suitable for use in escape stairs (see clause **6**)
Hardwoods Softwoods	BS 5268-2	BS 1186-1 and BS 1186-2	
Exterior grade plywood	BS 5268-2	BS 6566-1 to BS 6566-8	
Marine plywood	BS 5268-2	BS 1088 & BS 4079[c]	
Laminated timber	BS 5268-2	BS 4169	

[a] To be revised as BS 8118.
[b] See clause **10** of BS 6180:1982.
[c] To be revised as BS 1088.

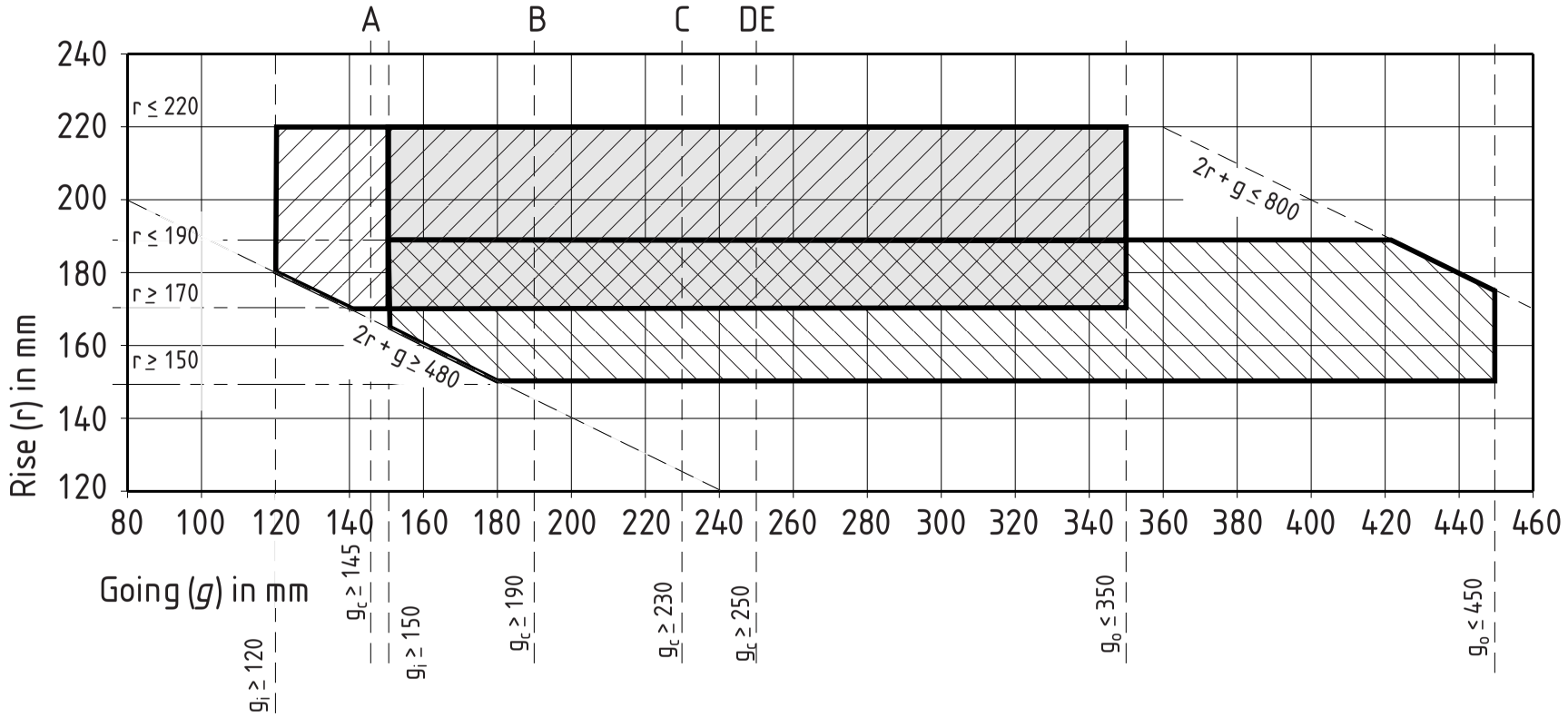
Table 2 – Sizes of stairs

1.	2.	3.			4.		5.
Stair category	**Rise,** r	**Going,** g			$2r + g$		**Clear widths**[c]
		Minimum inner going, g_1	**Minimum centre going,** g_c	**Maximum outer going,** g_o	**Min.**	**Max.**	**Min.**
	mm	mm	mm	mm	mm	mm	mm
A. *Small private stair*[a] intended to be used by a limited number of people who are generally familiar with the stair. Typical outside diameter 1 300 mm to 1 800 mm, e.g. internal stair in a dwelling serving one room not being a living room or kitchen, access stair to a small room or plant in an office, shop or factory, not used by the public, or fire escape for small number of people	170 to 220	120	145	350	480	800	600
B. *Private stair*[a] similar to category A but also providing the main access to the upper floor of a private dwelling. Typical outside diameter 1 800 mm to 2 250 mm	170 to 220	120	190	350	480	800	800
C. *Small semi-public stair*[b] intended to be used by limited number of people, some of whom may be unfamiliar with the stair, e.g. stair in factory, office, shop, or common stair serving more than one dwelling. Typical outside diameter 2 000 mm to 2 250 mm	170 to 220	150	230	350	480	800	800
D. *Semi-public stair* intended to be used by larger numbers of people, some of whom may be unfamiliar with the stair. Typical outside diameter 2 150 mm to 2 550 mm, e.g. stair serving a large floor area in factory, office, shop, or common stair serving more than one dwelling	150 to 190	150	250	450	480	800	900
E. *Public stair* intended to be used by large numbers of people at one time, e.g. stair in place of public assembly. Typical outside diameter 2 500 mm to 3 500 mm	150 to 190	150	250	450	480	800	1 000

[a] For private use, single-file stairs are provided because the user is rarely passed on the stairs and is generally able to use the outer going.

[b] For semi-public stairs used for a limited number of persons (up to 50) and serving a limited floor area, single file stairs with a limited passing capacity are provided.

[c] See also **5.9** and clause **6**.



Key

Stair categories		**Minimum stair clear width**
A	Small private stair	600 mm
B	Private stair	800 mm
C	Small public stair	800 mm
D	Semi-public stair	900 mm
E	Public stair	1 000 mm

NOTE This figure should be used in conjunction with Clause **5** and Table 2.

Figure 2 – Relationship between rise and going

5 Design

5.1 General. Except where otherwise shown in **5.2** to **5.12** and Table 2, the recommendations for straight stairs in **11.2** and clauses **12, 14, 15** and **16** of BS 5395-1:1977 should be followed.

5.2 Relation between rise and going. If a graph is plotted of rise against going and lines are drawn on the graph at the practicable limits of both risers and treads, a polygon is formed within which all acceptable combinations of rise and going should lie. To obtain the recommended values for rise and going, the polygon should be reduced in size by plotting the lines given by the relationship:

$$480 \leqslant (2r + g) \leqslant 800$$

where

r is the rise;

g is the going.

The rise and going should be determined using values for $(2r + g)$ obtained from column 4 of Table 2, or from the graph in Figure 2.

5.3 Rise. Recommended rises are given in column 2 of Table 2.

The maximum number of risers in a single flight should be 16 except where it is not practicable to fit in intermediate landings at 16 riser intervals. In such cases the number of risers may be increased to 22. In no case should the number of risers be less than three in a single flight.

5.4 Going. Recommended goings are given in column 3 of Table 2. It should be noted that the inner and outer goings differ considerably from the centre going.

The inner going, which is the minimum going, should be measured at a point 270 mm horizontally from the inner handrail or from the column face where no inner handrail is fitted (see Figure 3).

The centre going should be measured at the central point of the clear width (see Figure 3).

The outer going, which is the maximum going, should be measured at a point 270 mm horizontally from the outer handrail or string, whichever is the least radius (see Figure 3).

5.5 Clear headroom. Normally, the clear headroom should be not less than 2 000 mm, but it may be reduced to 1 900 mm wherever this is not practicable, e.g. at a distance 150 mm or less from the centre column or inner handrail across the tread.

NOTE 1 The horizontal distance of 150 mm allows for tapered downstand beams in which the depth diminishes towards the circumference of the stair [see Figure 1(a)].

NOTE 2 The notion of clearance used in BS 5395-1 is not applicable to helical and spiral stairs. The recommendations for minimum clear headroom given in this clause will ensure adequate clearance.

5.6 Clear width. Recommended minimum clear widths for stairs are given in column 5 of Table 2.

The clear width should be determined as follows.

a) where there is an inner handrail, measure the radial distance between the outside[1)] face of this rail and the inside face of the outer handrail *or* the inside edge of the outer string, whichever is the nearer [see Figure 3(a)];

b) where there is no inner handrail, measure the radial distance between the centre column *or* the outside[1)] edge of the inner string and the inside face of the outer handrail *or* the inside edge of the outer string, whichever is the nearer to the centre of the tread in each case [see Figure 3(b)].

5.7 Landings. Landings at storey levels should subtend an angle of not less than 60° at the geometric centre on plan [see Figure 4(a)].

Intermediate or rest landings should have a plan area of not less than two consecutive treads or subtend an angle of 45° at the geometric centre on plan, whichever is the greater [see Figure 4(b)].

5.8 Guarding of stairs and landings. Protection against falling should follow the recommendations of **12.3** of BS 5395-1:1977. For safety reasons any gap between the end of a tread and the centre column of a stair should never exceed 100 mm (see Figure 5).

Balustrades and handrails should follow the recommendations of BS 6180 provided that the definition of pitch line given in **2.8** of this standard is used. In areas frequented by children, the widest gap in a balustrade should not permit a sphere of 100 mm diameter to pass through.

An inner handrail should be provided for semi-public and public stairs (categories C, D and E in Table 2).

5.9 Passage of large objects. Designers should consider whether the minimum clearances recommended in Table 2 are sufficient for the passage of large objects, such as furniture, coffins. The limiting factor in the size of the stairwell. However stairs may have balustrades and handrails that can be dismantled temporarily.

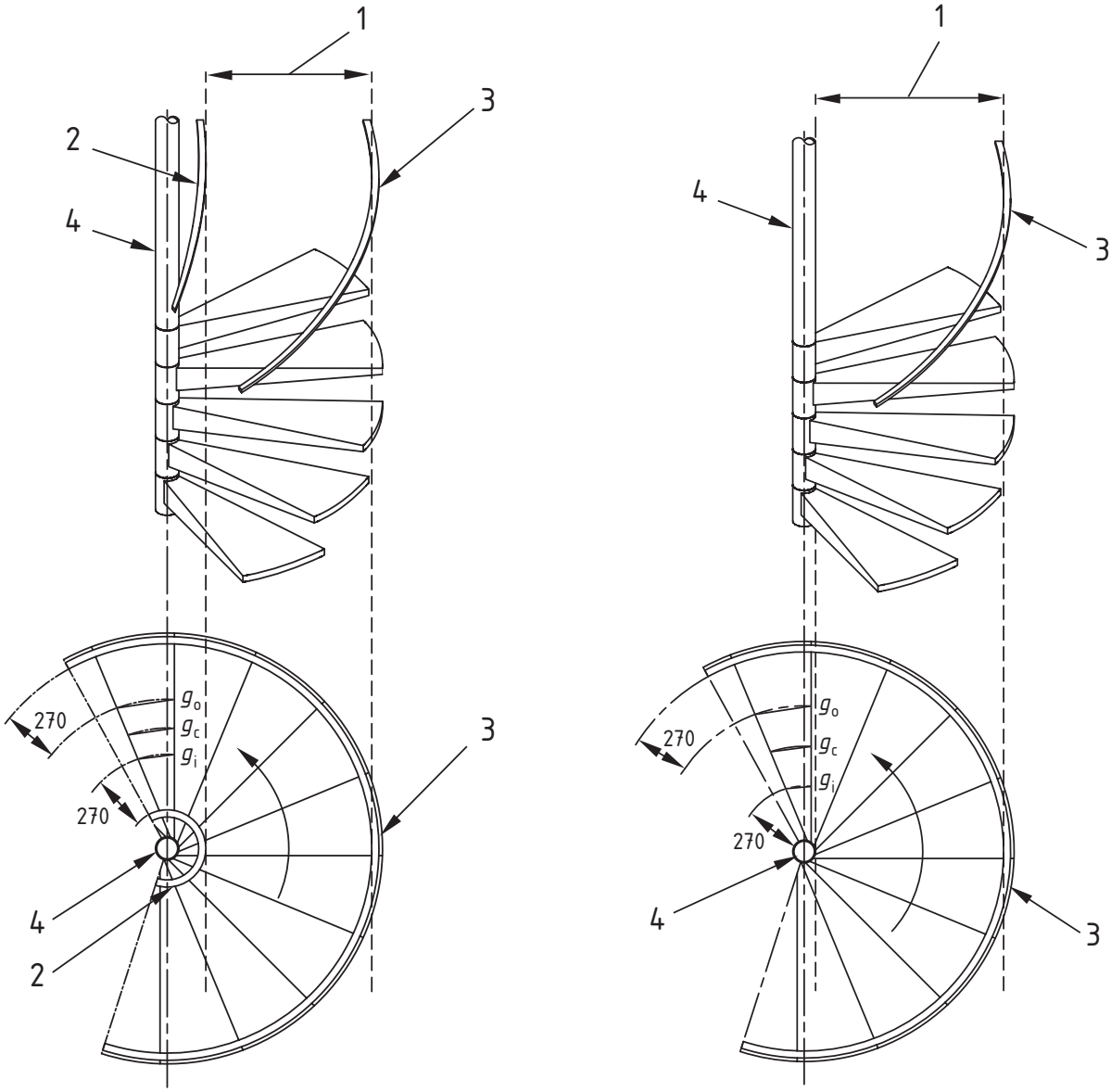
[1)] In all cases, the term "outside" refers to the edge or face furthest from the centre of the stair.

5.10 Deflection. Helical and spiral stairs should be designed to be rigid enough to give confidence to the user, since they can be subject to oscillations. Stairs should be designed to limit deflections under working conditions to the maximum values given in the appropriate standard (see Table 1).

5.11 Accuracy. For general guidance on accuracy in building, see BS 5606. The maximum permissible deviation for any size should not exceed the appropriate value given in Table 2 of BS 5606:1978. For further guidance see **11.2.3** of BS 5395-1:1977.

Consistency of rise and going are of prime importance for user confidence and safety.

5.12 Nosings. Nosings should be horizontal and straight between the pitch lines (see **2.8**) corresponding to the inner and outer goings.



(a) Spiral stair with inner handrail

(b) Spiral stair without inner handrail

NOTE. Figure 3(a) shows a spiral stair only, but the same method of measurement applies to a helical stair. All dimensions are in millimetres.

Key

1 Clear width
2 Inner handrail
3 Outer handrail
4 Centre column

Figure 3 – Measurement of clear width and goings

6 Fire protection and means of escape

Stairs in most buildings form the main vertical escape routes and are often in the first protected areas reached by people escaping from a fire. The recommendations for planning, construction and protection of escape routes to prevent rapid spread of fire, given in CP 3: Chapter IV-1[2)], or BS 5588-1,BS 5588-2, BS 5588-3 or BS 5588-8 as appropriate, should be followed.

The minimum clear widths given in Table 2 may be insufficient for escape stairs, depending on the building use and the number of its occupants.

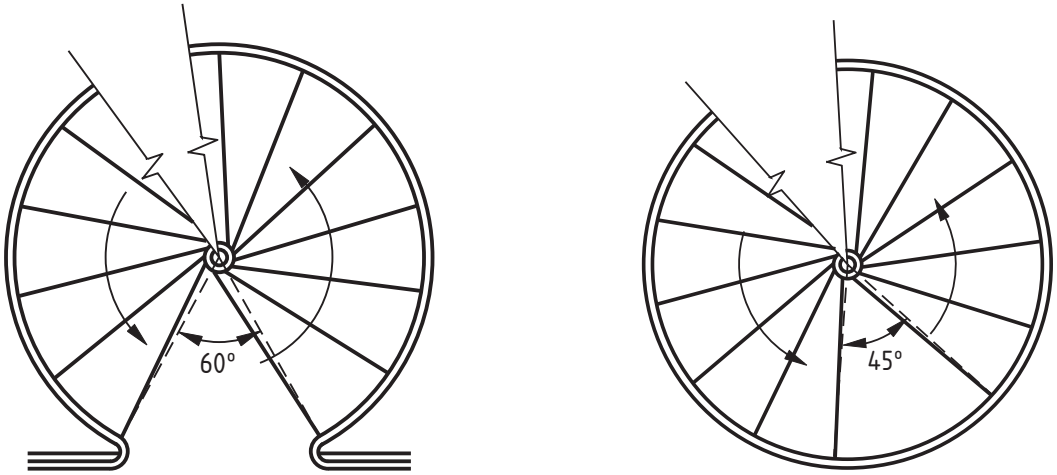
The following materials should never be used to form the only escape stair in a building or a stair for fire fighting:

a) materials having a low melting point, e.g. aluminium, owing to the likelihood of their early collapse when exposed to heat;

b) stone, since when subjected to heat or cold water during fire-fighting operations it can collapse without warning;

c) plastics materials not covered by (a), since these give off toxic fumes when subjected to heat.

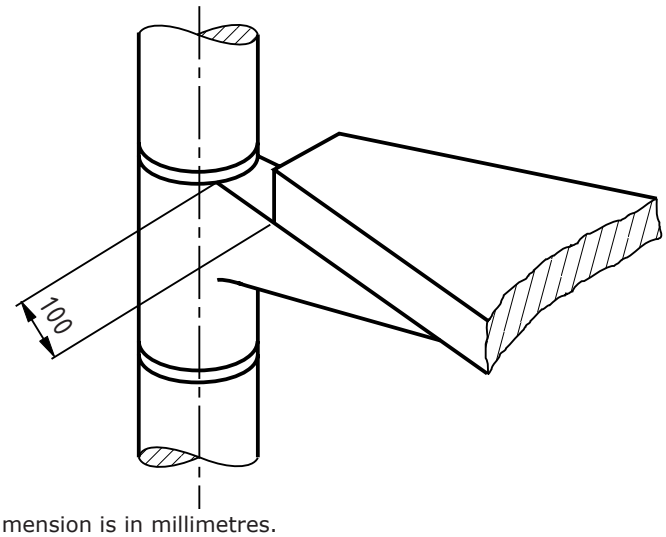
NOTE Further information may be obtained from Home Office, Scottish Home and Health Department "Guide to the Fire Precaution Act 1971" Nos. 1, 2 and 3, available from HMSO.



(a) At storey level

(b) Intermediate or rest landing

Figure 4 – Landings



Dimension is in millimetres.

Figure 5 – Maximum gap between column and tread

[2)] To be revised as Part of BS 5588.

Appendix A Load tests

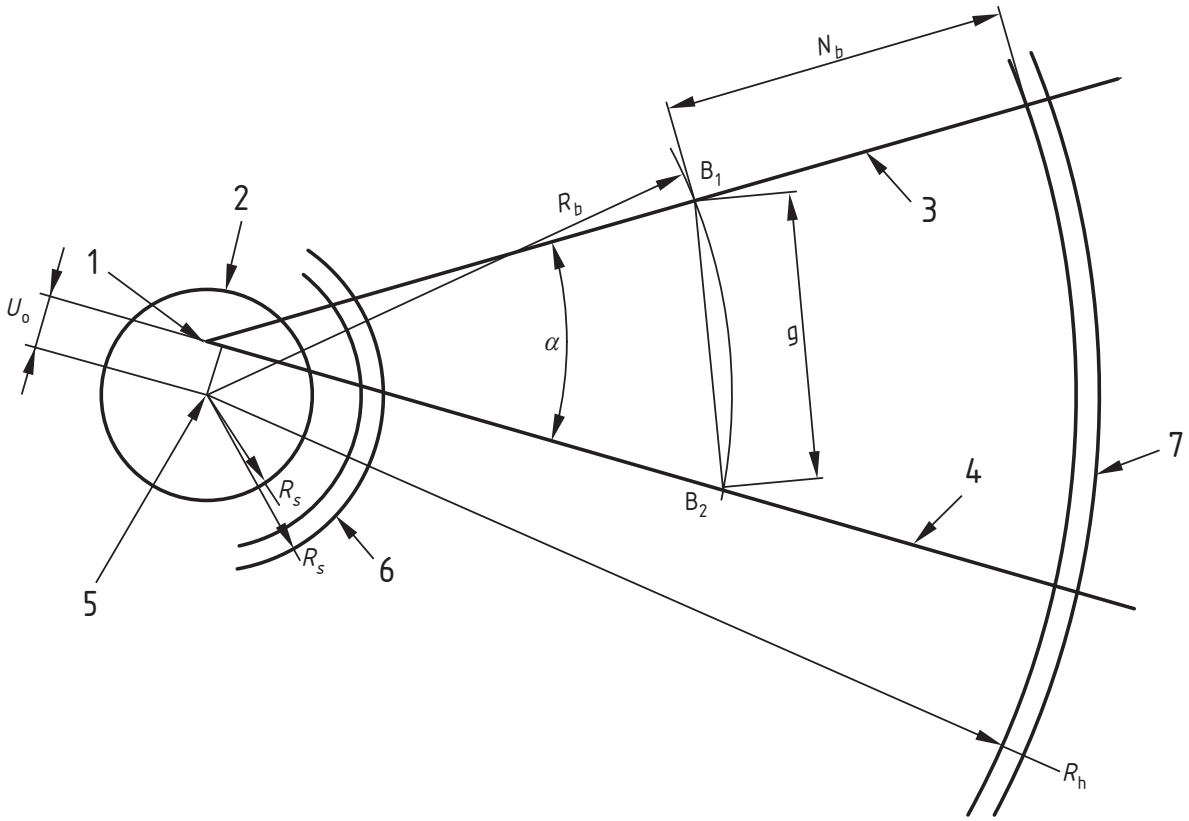
The following procedure may be used to test helical and spiral stairs.

a) Apply a uniformly distributed lead of 3 kN/m^2 to 5 kN/m^2 [3] to each tread. Check deflections and displacements.

b) Remove the lead from all treads forming the lower 180° segment of the stair. Check deflections and displacements.

c) Remove the load from all remaining treads except one tread at mid-height. Increase load on this tread to double the previous load. Check deflections and displacements.

d) Check individual treads by placing on them two loads of 0.9 kN spaced 300 mm apart and placed symmetrically about the centre-line of the tread.



Key

1 Centre from which tread radiates
2 Centre column (if applicable)
3 Tread nosing
4 Tread nosing above
5 Geometric centre = centre of column or well (centre for $R_s/R_b/R_h$)
6 Inner handrail (if applicable)
7 Outer handrail

Figure 6 – Calculation of going

[3] This range of uniformly distributed loads is taken from BS 6399-1. The actual value used should be chosen to suit the stair category and the intended function of the stair.

Appendix B Design geometry

NOTE Further information may be obtained from "Specifying the geometry of helical and spiral stairs", by Dr G.M.B. Webber, in Journal of the Institution of Building Control Officers, Spring/March 1983 Vol X no. 1 issue no. 37.

B.1 Going. The going (in mm) on a spiral or helical stair can be determined at any point using the equation:

$$g = 2R_b \sin \frac{\alpha}{2} \quad \text{...(1)}$$

where

α is the angle subtended by the tread;

R_b is the radius at any point B (see Figure 6).

Hence inner going, g_i (in mm), may be calculated from the equation:

$$g_i = 2(R_s + 270) \sin \frac{\alpha}{2} \quad \text{...(2)}$$

where

R_s is the radius on plan of the outside face of the inner handrail or string or the centre column, whichever is the greater.

Similarly the centre going, g_c (in mm), is given by the equation:

$$g_c = (R_s + R_h) \sin \frac{\alpha}{2} \quad \text{...(3)}$$

where

R_h is the radius on plan of the inside face of the outer handrail or string, whichever is the lesser.

The outer going, g_o (in mm), may likewise be obtained from the equation:

$$g_o = 2(R_h - 270) \sin \frac{\alpha}{2} \quad \text{...(4)}$$

The clear width, W (in mm), is given by the equation:

$$W = R_h - R_s \quad \text{...(5)}$$

The distance N_b (in mm), shown in Figure 6, is given by the equation:

$$N_b = \sqrt{(R_h^2 - U_o^2)} - \sqrt{(R_b^2 - U_o^2)} \quad \text{...(6)}$$

NOTE Equations (1) to (6) allow for the fact that the geometric centre of the circle (the centre of the staircase pole) is very rarely the point from which the leading edges of the treads radiate.

B.2 Clear headroom. The clear headroom and the pitch line of a helical or spiral stair varies with the distance from the centre (see Figure 7).

The clear headroom H_b (in mm) at any point B, distance R_b from the centre, provided there are no other obstructions, is given by the equation:

$$H_b = r(\phi_b/\alpha) - L_b \quad \text{...(7)}$$

where

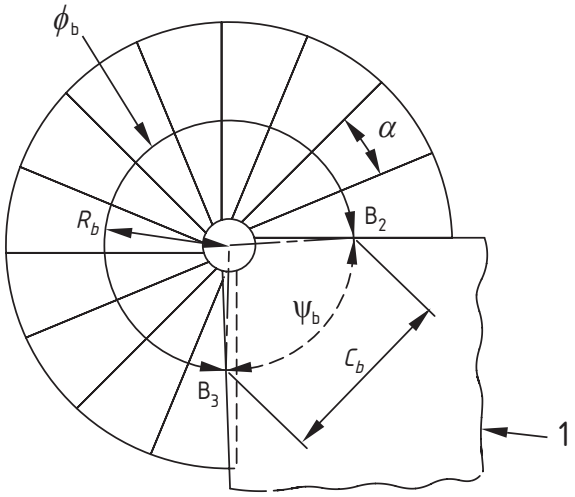
ϕ_b is the angle of rotation at distance R_b from the centre = $360 - \psi_b$ and $\sin \psi_b/2 = C_b/2R_b$;

α is the angle of taper of tread;

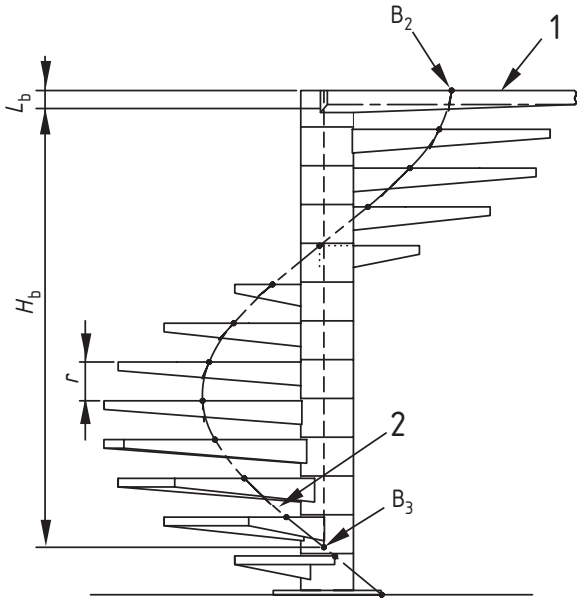
L_b is the thickness of landing vertically above pitch line at point B;

r is the rise.

NOTE Equation (7) applies only where there is a pitch line beneath the landing edge, i.e. where $(\phi_b/\alpha - 1)$ is less than the total number of consecutive treads.



(a) Plan



(b) Elevation

Key
1 Landing
2 Pitch line at distance R_b from the centre

Figure 7 – Calculation of clear headroom

Publications referred to

BS 187, *Specification for calcium silicate (sandlime and flintlime) bricks.*
BS 449, *Specification for the use of structural steel in building.*
BS 1088 & 4079, *Specifications for plywood for marine craft.*
BS 1186, *Timber for and workmanship in joinery.*
BS 1186-1, *Specification for timber.*
BS 1186-2, *Quality of workmanship.*
BS 1217, *Specification for cast stone.*
BS 1449, *Steel plate, sheet and strip.*
BS 1452, *Specification for grey iron castings.*
BS 2870, *Specification for rolled copper and copper alloys: sheet, strip and foil.*
BS 2872, *Specification for copper and copper alloys. Forging stock and forgings.*
BS 2874, *Specification for copper and copper alloy rods and sections (other than forging stock).*
BS 3921, *Specification for clay bricks.*
BS 4169, *Specification for glued-laminated timber structural members.*
BS 4357, *Specification for precast terrazzo units.*
BS 5268, *Structural use of timber.*
BS 5268-2, *Code of practice for permissible stress design, materials and workmanship.*
BS 5390, *Code of practice for stone masonry.*
BS 5395, *Stairs, ladders and walkways.*
BS 5395-1, *Code of practice for the design of straight stairs.*
BS 5395-3, *Code of practice for the design of industrial type stairs, permanent ladders and walkways.*
BS 5588, *Fire precautions in the design and construction of buildings.*
BS 5588-1, *Residential buildings.*
BS 5588-2, *Code of practice for shops.*
BS 5588-3, *Code of practice for office buildings.*
BS 5588-8, *Code of practice for means of escape for disabled people.*
BS 5606, *Code of practice for accuracy in building.*
BS 5628, *Code of practice for use of masonry.*
BS 5628-3, *Materials and components, design and workmanship.*
BS 5950, *Structural use of steelwork in building.*
BS 6073, *Precast concrete masonry units.*
BS 6073-1, *Specification for precast concrete masonry units.*
BS 6180, *Code of practice for protective barriers in and about buildings.*
BS 6399, *Loading for buildings.*
BS 6399-1, *Code of practice for dead and imposed toads.*
BS 6566, *Plywood.*
BS 6566-1, *Specification for construction of panels and characteristics of plies including marking.*
BS 6566-2, *Glossary of terms.*
BS 6566-3, *Specification for acceptance levels for post-manufacture batch testing including sampling.*
BS 6566-4, *Specification for tolerances on the dimensions of plywood panels.*
BS 6566-5, *Specification for moisture content.*
BS 6566-6, *Specification for limits of defects for the classification of plywood by appearance.*
BS 6566-7, *Specification for classification of resistance to fungal decay and wood borer attack.*
BS 6566-8, *Specification for bond performance of veneer plywood.*
BS 8110, *Structural use of concrete.*

CP 3, *Code of basic data for the design of buildings.*

CP 3: Chapter IV-1 *Flats and maisonettes (in blocks over two storeys).*

CP 118, *The structural use of aluminium*[4)].

HMSO. Home Office, Scottish Home and Health Department "Guide to the Fire Precaution Act 1971" Nos 1, 2 and 3.

Journal of the Institution of Building Control Officers, Spring/March 1983 Vol X No. 1 Issue No. 37 "Specifying the geometry of helical and spiral stairs" Dr G M B Webber.

[4)] To be revised as BS 8118.

British Standards Institution (BSI)

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover.
Tel: +44 (0)20 8996 9000 Fax: +44 (0)20 8996 7400

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services.
Tel: +44 (0)20 8996 9001 Fax: +44 (0)20 8996 7001
Email: orders@bsigroup.com

You may also buy directly using a debit/credit card from the BSI Shop on the Website http://www.bsigroup.com/shop.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre.
Tel: +44 (0)20 8996 7111 Fax: +44 (0)20 8996 7048
Email: info@bsigroup.com

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration.
Tel: +44 (0)20 8996 7002 Fax: +44 (0)20 8996 7001
Email: membership@bsigroup.com

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsigroup.com/BSOL.

Further information about BSI is available on the BSI website at http://www.bsigroup.com.

Copyright

BSI Group Headquarters
389 Chiswick High Road,
London W4 4AL, UK
Tel +44 (0)20 8996 9001
Fax +44 (0)20 8996 7001
www.bsigroup.com/standards