DESIGN GUIDE: TIMBER STAIRS

A GUIDE TO DESIGNING AND MANUFACTURING SAFE AND COMPLIANT STAIRCASES

Produced for JELD-WEN (UK) Ltd

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CONTENTS

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Note: Whilst every effort has been made to ensure the accuracy of advice given, the BWF cannot accept liability for loss or damage arising from the use of the information supplied in this publication.

FOREWORD

This Design Guidance (Guide) has been prepared by the British Woodworking Federation to provide industry guidance (minimum requirements) for the manufacture of timber stairs for the UK market.

In 2004 the British Standards Institution (BSI) declared the standard 'BS 585 Wood Stairs' Obsolescent, and since this point there has been increased pressure on the staircase market related to a mismatch between UK and EU standards, regulations and codes that have arisen to deal with specific domestic situations.

From this environment the BWF Stair Scheme which JELD-WEN were part of, emerged with a focus on effective design and manufacturing principles to support the sector in defining effective design amidst the mêlée of oftentimes conflicting standards and regulations.

IT'S ALL IN THE BADGE

The BWF Stair Scheme is the only accreditation and certification scheme of its kind in the UK. Ranging from domestic, common and fire protected common stairs, the standard expected of the manufacturers for their stairs is high with a drive to improve quality and safety in use, supported by an effective factory production control system and adherence to the core principles and values laid down in the BWF Code of Conduct.

JELD-WEN are regularly audited to ensure our products and production meet these high standards, and the new third-party certification for fire protected common stairs, supported by The Loss Prevention Certification Board (LPCB) is opening up new markets for timber stairs. JELD-WEN is currently the only LPCB certified UK timber stair manufacturer for this certification. The stair scheme is managed by the BWF, and includes various manufacturers, as well as approved suppliers, who play an important part in maintaining these high standards.

Whilst the BWF Stair Scheme does not accredit installation, guidance is available on the installation of staircases.

1 INTRODUCTION

How to support Effective Design Principles		
Prescription Tables	**Calculations to Approved Methods**	**Testing to Approved**

This Guide is provided to assist stair designers, manufacturers and building professionals involved in the design and specification of timber stairs for the UK market. It draws information from a plethora of standards and regulations impacting upon staircases. This Guide covers stair specifications for basic flights, handrails, balusters and other guarding by providing advice on suitable sections, by reference to historical data, design tables, calculation or suitable test methods.

Woodworking remains an innovative sector and design will no doubt evolve as new techniques and materials are introduced and more testing and calculations are made available. It is recommended that you check to ensure that you have the latest version of this guide at www.bwfstairscheme.org.uk.

It is important to note that design and manufacture is only part of the delivery of effective staircases, and installation practices must also be adhered to. Whilst the BWF Stair Scheme does not accredit installation, a separate guide focusing on the installation of staircases is also available to support the installers.

2 SCOPE

This Guide covers stairs for private dwellings such as single family dwelling houses or individual flats or apartments within a building. For imposed loadings this guide refers to EN 1991-1-1:2002 (+ UK National Annex) together with the additional guidance published in PD6688-1-1:2011 for occupancy type A1. Stair terminology can be found in EN 14076. The Guide draws from the range of standards that impact upon staircases, which are shown in Appendix A.

This Guide does not cover Alternating Tread Stairs, or ladders, or the production of timber stairs for external use or non-domestic applications.

Timber stairs can be constructed in a number of different shapes and styles, incorporating a number of non-timber components and can be installed in a variety of locations. These aspects can have a considerable effect upon the accuracy that can be achieved during production of the stairs and eventually during installation. It is therefore not the intention of this Guide to provide information on the levels of accuracy that have to be achieved for any particular finished stair.

Fire protection advice of timber stairs, where required, is provided in Section 3 'Performance Requirements' of this Guide.

Stairs sold as complete kits can be CE marked through the EOTA guidance document ETAG 008 (for full title, see Appendix A).

3 PERFORMANCE REQUIREMENTS

3.1 STANDARDS RELATED TO THE PERFORMANCE OF STAIRCASES

The section covers the key performance criteria for staircases and draws essential information from the relevant standards and regulations. Wherever a conflict exists, the Building Regulations in the appropriate region are deemed to take precedence.

3.2 STRUCTURAL STABILITY

The imposed loads to a stair are dynamic and caused by persons moving along the stair. The stairs will need to be either designed to reduce the potential bounce or have sufficient stiffness provided from the fixings, (fixings are covered separately in the BWF Stair Scheme Installation Guide).

The serviceability limit state for a staircase shall be determined in accordance with Section 7 of Eurocode 5.

The National Annex to BS EN 1991-1-1 provides loading conditions for various occupancy classes. These indicate vertical loading requirements for stairs and landings, as well as horizontal loads to handrails and balustrades.

These loadings are identified in Section 5 'Loadings' Tables 5.1 and 5.2.

3.3 DURABILITY

The usage pattern, and environmental conditions for the stairs which will affect the moisture content of timber and wood-based products, will impact on durability.

Table 3.1 Indicative moisture content values that should be considered for stairs

Location	Moisture content range	Approximate relative humidity
Internal use – heated	7% to 11%	50%
Internal use – unheated	10% to 14%	65%

3.4 SAFETY IN USE

Consideration of the risk to users should be made to improve the safety in use of stairs. The following aspects particularly should be taken into account. Much of this is now covered by following instruction in the Building Regulations detailed in Section 7 'Layout of a staircase'.

3.5 ACCESSIBILITY

Accessibility is an increasing concern for housing stock and has had significant attention through the evolution in Building Regulations and various housing standards in recent times. Layout is critical to this and required parameters are set out in Section 7 'Layout of a Staircase'.

3.6 FIRE CHARACTERISTICS

Fire characteristics in Building Regulations are made up of two types, 'Reaction to fire' and 'Fire resistance'.

3.6.1 REACTION TO FIRE

This characteristic is not required for stairs, particularly in dwellings. It is generally accepted that timber is classed as a Category E product under BS EN 13501-1 unless given a fire retardant surface coating.

3.6.2 FIRE RESISTANCE – FOR COMPARTMENTATION

Stairs in themselves do not have to provide a fire resistance capability unless they are separating two compartments. For example, if the stair to an upstairs flat is 'exposed' to the flat below then a fire resistance capacity will be required. This is usually provided by the fitting of a fire resistant covering to the underside of the stair (plasterboard is the usual choice). If it is necessary to carry out a fire resistance test the appropriate standard to follow is BS EN 1365-6.

3.6.3 CERTIFICATED FIRE

It is not normally required for a stair within a single dwelling to require fire protection or to exhibit any limited levels of combustibility. However, where fire performance is required then the staircase will need to be independently certificated by the Scheme's certification partner the Loss Prevention Certification Board (LPCB)

4 MATERIAL SELECTION

4.1 GENERAL

Although the mechanical strength of a stair is important, the selection of timber and wood-based products is usually determined by non-structural grading requirements. There is no direct relationship between strength grading rules and joinery grades, however the tabulated information can be directly related to the particular species listed. The information contained within the tables in this section should be used to identify an acceptable minimum non-structural grade level to be used for the various component parts of a stair.

4.2 TIMBER

The quality or grade of the timber is important and the particular grade required to achieve a classification within a strength class is given in BS EN 1912:2012, Structural Timber. Strength classes. Assignment of visual grades and species

A list of timber species commonly used for staircases is given in Table 4.1. This list should not be considered exhaustive, but if a species is not on the list, manufacturers should check properties of species or grade chosen to ensure that performance has been proven through calculation or test.

Table 4.1 Acceptable species and strength class
Strength Classes can be taken from BS EN 1912:2012
Structural Timber. Strength classes. Assignment of visual grades and species

Common name	Botanical name	Strength class
American black walnut	Juglans nigra	D30
American red oak	Quercus rubra	D40
American white oak	Quercus alba	D50
Meranti	Shorea spp	variable
Sapele	Entandrophragma cylindricum	D40
Beech	Fagus sylvatica	D40
American Black Cherry	Prunus serotina	D30 (guide value)
Yellow Poplar	Lirodendron tulipifera	D40 (guide value)
American White Ash	Fraxinus spp	D35
Caribbean pitch pine	Pinus caribaea	C27
Douglas fir	Pseudotsuga menziesii	C24
European larch	Larix decidua	C24
European oak	Quercus robur	C24
European redwood	Pinus silvestris	C24
European whitewood	Picea abies	C24
Hemlock	Tsuga heterophylla	C24
Parana pine	Araucaria angustifolia	C24
Radiata Pine	Pinus radiata	C24
Southern yellow pine	Pinus palustris	C24

4.3 WOOD-BASED COMPONENTS

Wood-based panels can be used in stair components.

Table 4.2 Indicates the minimum specification for two environmental situations.

Board type	Internal heated	Internal unheated
Plywood	BS EN 636-1, 2, 3	BS EN 636-2, or 3
Particle board	BS EN 312-4	BS EN 312-5
Oriented strand board	BS EN 300 (Type OSB/2)	BS EN 300 (Type OSB/3)
Fibreboards	BS EN 622-2 (Type HB.LA)	BS EN 622-2 (Type HB.LA1)
Internal use – heated	7% to 11%	50%

4.4 ADHESIVES

Adhesives should be selected as appropriate for the environment. The minimum performance level for internal adhesives should be at least Class D3 from BS EN 204 or Class C1 of BS EN 12765.

4.5 NON-TIMBER MATERIALS

4.5.1 GLASS

Glass is often used to form treads, risers and balustrades. This Guide does not provide information on the use of glass in these situations. Advice can be sought from the BWF Technical Department.

4.5.2 METALS

Metals are often used to connect components together and to form components in place of timber. Components that provide structural strength such as screws, nails and bolts, should be selected and designed in accordance with Eurocode 5. Metals used to provide components such as balustrades or stair strings are not covered by this Guide and reference should be made to a competent person with structural engineering knowledge of the metal. Any metal component used in a stair designed to this Guide should be capable of achieving the appropriate corrosion resistance when subject to the neutral salt spray test specified in BS EN 1670. The minimum class should be Class 2 for all heated environments and Class 3 for all unheated environments. Some species of timber contain extractives that can interact with metals; care should be taken to ensure that adequate protection is provided against corrosion.

5 LOADINGS

For imposed loadings this guide refers to EN1991-1-1:2002 (+ UK National Annex) together with the additional guidance published in PD6688-1-1:2011 for occupancy type A1.

Loads for determining performance are provided in Tables 5.1 and 5.2. Note when using these tables, the point load is applied at the position that gives the most onerous requirement. Where individual balusters are used each should be capable of resisting half the concentrated load.

Total displacement of a handrail should not exceed 25 mm. If this is not achievable, the handrail should be capable of withstanding 2.5 times the applied load during single test, without failure.

Table 5.1 Loading to strings, treads and landings

	Uniformly Distributed Load (UDL) (UK NA Table NA3) Q_k (kN/m2)	Concentrated load (UK NA Table NA3) Q_k (kN)
Occupancy class A1	1.5	2.0

Table 5.2 Horizontal loads to handrails and balustrades

	Horizontal UDL to handrail (UK NA Table NA8) Q_k (kN/m)	Horizontal UDL applied to infill (PD 6688-1-1 Table 2) (kN/m²)	Horizontal concentrated load (PD 6688-1-1 Table 2) (kN)
Occupancy class A1	0.36	0.5	0.35

6 COMPONENTS

6.1. COMPONENT DIMENSIONS

Table 6.1 gives prescriptive minimum sizes of a component for a standard stair (in accordance with one or more of the relevant assessment standards listed in Appendix). The component sizes assume a maximum 900 mm overall stair width, with 13 full risers and treads let into strings.

Table 6.2 gives further prescriptive minimum dimensions for stair treads, with and without risers, calculated for different strength classes of timber.

Where a combination is not represented by these tables, calculation or testing to demonstrate performance should be conducted as per the requirements in Section 8 'Demonstrating Performance', (note: loads used during tests are subject to factors to account for the specific duration of the tests).

Table 6.1 Prescriptive dimensions for staircase components

Component	Prescriptive design sizes (mm)
Strings	220 x 26
Treads	20
	18 plywood
	22 MDF
Risers	9
	9 plywood
	9 MDF
Winder	20
	18 plywood
	22 MDF
Newel	82 x 82
Handrail	68 x 45
Balusters to stair (900 mm high) & landings in domestic use	27 square or 35 turned at narrowest dimension

Table 6.2 Tread thickness for Occupancy Class A1 stairs

Grade	E (N/mm²)	Fm,k (N/mm²)	Length of tread string to string (mm)	Depth of Tread (nosing to back edge of tread) mm											
				string to string		200 mm		225 mm		250 mm		275 mm		300 mm	
				(mm)	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser
C24 and D30	11000	24		18	34	18	32	18	31	18	30	18	29	18	28
				18	38	18	36	18	34	18	33	18	32	18	31
			800	18	41	18	39	18	37	18	36	18	35	18	34
			900	18	44	18	42	18	40	18	39	18	38	18	37
			1000	28	47	26	45	25	43	24	42	23	41	23	39
			1100	35	51	33	48	32	46	31	45	30	43	29	42
				40	53	38	51	37	49	35	47	34	46	33	44

Grade	E (N/mm²)	Fm,k (N/mm²)	Length of tread string to string (mm)	Depth of Tread (nosing to back edge of tread) mm											
				string to string		200 mm		225 mm		250 mm		275 mm		300 mm	
				(mm)	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser
C27	11500	27	600	18	34	18	32	18	31	18	30	18	29	18	28
			700	18	37	18	35	18	34	18	33	18	32	18	31
			800	18	40	18	38	18	37	18	36	18	35	18	34
			900	18	44	18	41	18	40	18	39	18	37	18	36
			1000	26	47	24	44	23	43	22	41	22	40	21	39
			1100	33	50	31	47	30	45	29	44	28	43	28	41
			1200	39	53	37	50	35	48	34	46	33	45	32	44

Note: For the purposes of this table "w" means with and "w/o" means without

Table 6.2 Tread thickness for Occupancy Class A1 stairs (continued)

Grade	E (N/mm²)	Fm,k (N/mm²)	Length of tread string to string (mm)	Depth of Tread (nosing to back edge of tread) mm											
				string to string		200 mm		225 mm		250 mm		275 mm		300 mm	
				(mm)	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser
D40	13000	40	600	18	32	18	31	18	29	18	28	18	28	18	27
			700	18	36	18	34	18	33	18	31	18	31	18	30
			800	18	39	18	37	18	35	18	34	18	33	18	32
			900	18	42	18	40	18	38	18	37	18	36	18	35
			1000	18	45	18	43	18	41	18	40	18	38	18	37
			1100	29	48	27	45	26	44	25	42	24	41	24	40
			1200	35	51	33	48	32	46	31	45	30	43	29	42

Grade	E (N/mm²)	Fm,k (N/mm²)	Length of tread string to string (mm)	Depth of Tread (nosing to back edge of tread) mm											
				string to string		200 mm		225 mm		250 mm		275 mm		300 mm	
				(mm)	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser
D50	14000	50	600	18	31	18	30	18	29	18	28	18	27	18	26
			700	18	35	18	33	18	32	18	31	18	30	18	29
			800	18	38	18	36	18	35	18	33	18	32	18	32
			900	18	41	18	39	18	37	18	36	18	35	18	34
			1000	18	44	18	42	18	40	18	39	18	38	18	36
			1100	25	47	24	44	23	43	22	41	21	40	21	39
			1200	32	49	31	47	30	45	29	44	28	42	27	41

Note: For the purposes of this table "w" means with and "w/o" means without

Table 6.2 Tread thickness for Occupancy Class A1 stairs (continued)

Grade	E (N/mm²)	Fm,k (N/mm²)	Length of tread string to string (mm)	Depth of Tread (nosing to back edge of tread) mm											
				string to string		200 mm		225 mm		250 mm		275 mm		300 mm	
				(mm)	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser	w riser	w/o riser
D40	13000	40	600	18	32	18	31	18	29	18	28	18	28	18	27
			700	18	36	18	34	18	33	18	31	18	31	18	30
			800	18	39	18	37	18	35	18	34	18	33	18	32
			900	18	42	18	40	18	38	18	37	18	36	18	35
			1000	18	45	18	43	18	41	18	40	18	38	18	37
			1100	29	48	27	45	26	44	25	42	24	41	24	40
			1200	35	51	33	48	32	46	31	45	30	43	29	42

Note: For the purposes of this table "w" means with and "w/o" means without

The design sizes tabulated are calculated using EN 1995-1-1 (Eurocode 5) assuming the tread is a simply supported beam subjected to the loads given in Table 5.1.

Reduced tread sizes may be achieved by carrying out a more rigorous structural analysis stairwell as a system.

6.2 DESIGN OF COMPONENTS

The following clauses give guidance on the joints within a stair. In the absence of test evidence or calculation, these recommendations should be considered as a minimum.

6.2.1 TREADS

Timber members of more than one piece should be jointed as specified in BS 1186-2.

6.2.2 RISERS

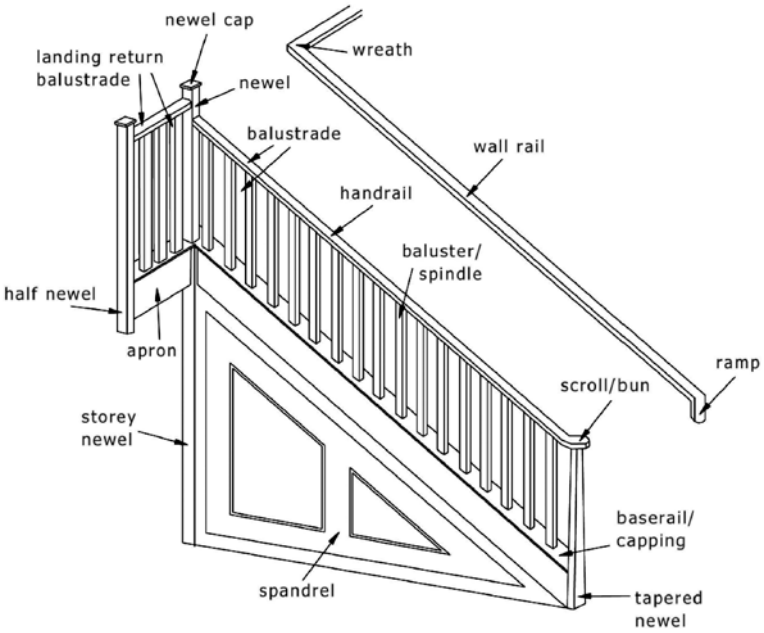
Risers should be fixed to the edge of the lower tread with No.10 gauge screws at centres not exceeding 230 mm. Penetration should be not less than 23 mm or 1.5 times the riser thickness.

The top of each riser should be located into a groove in the underside of the tread with a minimum depth of 5mm up to a maximum depth of a quarter of the tread thickness. This joint should be further supported by angle blocks 75 mm long and 38 mm width on the shorter edges, glued to the riser and tread. The number of blocks will vary according to the width of the stair.

Width up to 900 mm, 2 blocks

Width between 900 mm and 990 mm, 3 blocks

Width between 990 mm and 1200 mm (and tapered treads over 1200 long), 4 blocks



6.2.3 STRINGS

Strings should be housed to receive the treads and risers to a depth of 12 mm or 0.4 times the string thickness, whichever is the greater. This housings should be tapered to receive wedges to support the tread and riser. The wedges should be fitted with adhesive to form a rigid joint. Where the aesthetics demand, wedges may be omitted, but an alternative side restraint system will be needed.

Where strings are fitted into newels, the ends of the strings should have tenons formed to fit into the newels. The tenons should be not less than 12 mm thick and not less than 45 mm long. However, where two strings are joined to a newel one or both tenons may be reduced in length or haunched to allow both tenons to be accommodated.

For winder stairs, the upper and lower strings may need to be enlarged to accommodate the housings of the winders where the stair turn occurs.

Where a stair is to be supported on timber carriages the design and fabrication should be checked by a person qualified in structural detailing.

6.2.4 NEWELS

Newels should be housed not less than 12 mm deep receive the ends of the treads and risers and should be morticed for strings and handrails as required.

6.2.5 HANDRAILS AND BALUSTRADES

Handrails and balustrades should be designed in accordance with BS 5395-1. Stairs with a rise of over 600 mm should have a handrail. Where the stair width exceeds 1000 mm a handrail should be fitted on both sides. On winder flights the handrail should be fitted on the wider side of the stair, see also NHBC guidance document.

Individual lengths of handrail to a stair flight should be capable of being held continuously without interruption from any fixing or support.

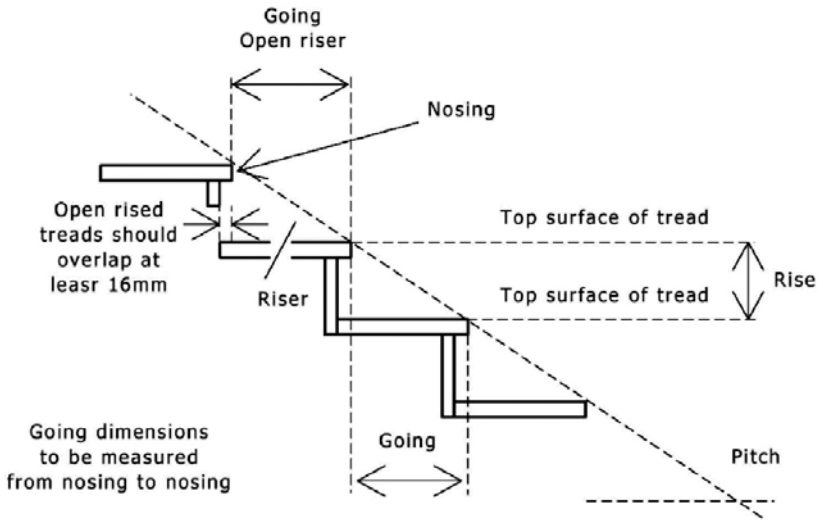
Stairs in non-domestic situations should be fitted with a handrail which commences at least 300 mm before the first tread and is continuous at least 300 mm beyond the last upper nosing of the flight. Elliptical handrails may be a maximum of 50 mm wide to the upper surface. For further details see Section 7 'Layout of a staircase' Clause 7.5.

6.2 DESIGN OF COMPONENTS

In order to facilitate the movement of furniture it may be necessary to construct stairs with demountable handrails and newels. These components must still be designed to the same criteria as fixed components.

7 LAYOUT OF A STAIRCASE

The following section summarises regional guidance given for compliance with the Building Regulations. The full guidance documents are listed in Appendix C.



7.1 STEEPNESS OF STAIRS – RISE (R) AND GOING (G)

Diagram A

From AD K 2013 page 4 diagram 1.1 – Measuring rise and going – Dwellings

In all locations

The maximum pitch of a stair is 42°.

The normal relationship between the dimensions of rise (R) and going (G) is: 550 mm ≤ (2R + G) ≤ 700 mm.

Note: maximum R and minimum G cannot be used together as this would result in a pitch greater than 42°.

Treads cannot have a breadth (measured from the nosing to the back edge of the tread) less than the going. (i.e. consecutive treads must overlap)

Regulations in England state that:

R 150 mm - 220 mm and G 220 mm - 300 mm

Regulations in Wales state that:

R 155 mm to 220 mm and G 245 mm to 260 mm

or

R 165 mm to 200 mm and G 223 mm to 300 mm

or

Maximum R 220 mm and Minimum G 220 mm following also the maximum pitch and the limits of 2R+G.

The requirements for the steepness of stairs can alternatively be met by following the recommendations of BS 5395-1:1977.

Regulations in Scotland state that:

R 100 mm to 220 mm and G 225 mm or greater

Regulations in Northern Ireland state that:

R 100 mm to 220 mm and G 225 mm or greater

7.2 HEADROOM FOR STAIRS

For standard stairs England, Northern Ireland, Scotland and Wales

The minimum headroom must be 2 m as shown in Diagram B below.

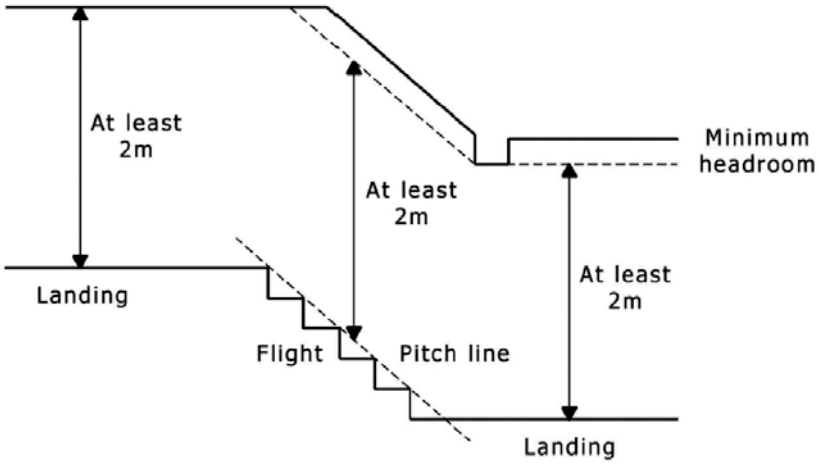


Diagram B
From AD K 2013 page 7 diagram 1.3 – Minimum headroom – Dwellings

For loft conversions in England, Northern Ireland, Scotland and Wales

Where there is not enough space to give 2 m headroom as shown in Diagram B, reduced headroom would be permitted as shown in Diagram C below.

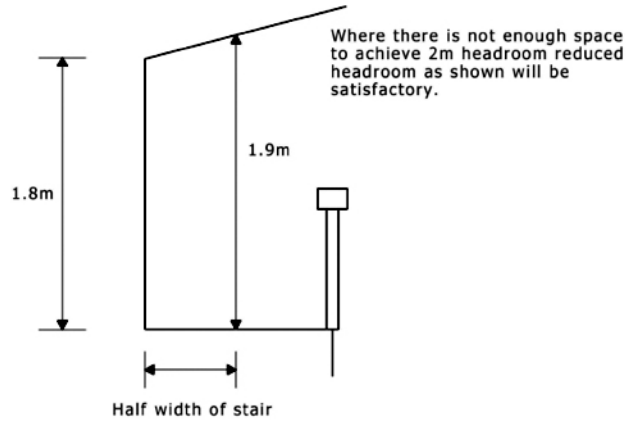


Diagram C
From AD K 2013 page 8 diagram 1.4 – Reduced headroom for loft conversions – Dwellings

7.3 WIDTH OF FLIGHTS OF STAIRS

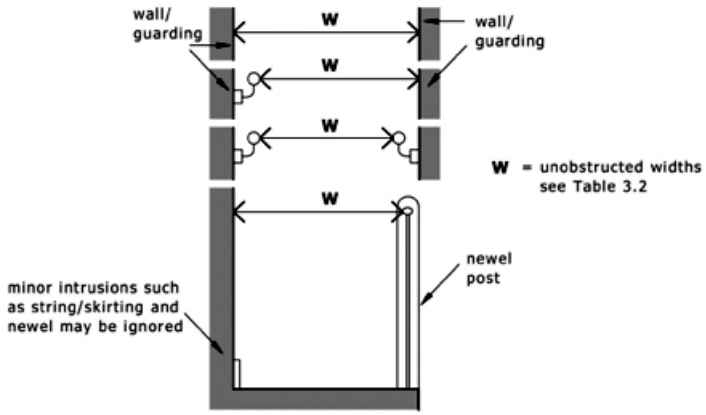


Diagram D
From DFPNI Technical Booklet H 2012 page 25 diagram 3.4 – Measuring the width of a private stair and a common stair in a block of dwellings.

Regulations in England, Northern Ireland and Wales state that:

Where a stepped change in level within the entrance storey of a dwelling is unavoidable, e.g. on severely sloping plots, the minimum stair width is 900 mm

Regulations in Scotland state that:

The clear or effective width of a stair should allow users to move up and down unhindered and permit people to pass on a flight.

The effective width should be measured between handrails or, where there is no handrail present, between any walls or protective barriers, see Diagram D.

The effective width of a private stair shall be:

900 mm where the stair passes between one storey and another or connects levels within a storey.

600 mm where the stair serves only sanitary accommodation and/or one room other than accessible sanitary accommodation, a kitchen or an enhanced apartment.

800 mm where a continuous handrail is fitted to both sides of the flight.

7.4 LENGTH OF FLIGHTS OF STAIRS

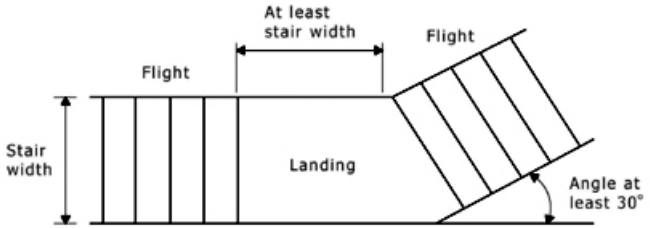


Diagram E
From AD K 2013 page 9 diagram 1.6 – Change in direction between flights – Dwellings

Regulations in England, Northern Ireland and Wales state that:

Where a stair has more than 36 risers in consecutive flights there must be a least one change in direction between flights, see Diagram E.

Stairs in dwellings can have a single step and there is no limit on the number of risers between landings.

Regulations in Scotland state that:

Generally, a flight should have not more than 16 rises and not less than 3 rises. There may be less than 3 rises; within an apartment (excluding an enhanced apartment); within sanitary accommodation (other than accessible sanitary accommodation); between a landing and an adjoining level where the route of travel from the adjoining level to the next flight changes direction through 90°.

7.5 HANDRAILS FOR STAIRS

Regulations in England, Northern Ireland and Wales state that: Position the top of the handrail between 900 mm and 1100 mm from the pitch line or floor

The handrail may form the top of the guarding if the heights can be matched. Handrails are required on both sides of stairs 1000 mm wide or wider. Where a stepped change in level within the entrance storey of a dwelling is unavoidable, for example on severely sloping plots, if a flight consists of three or more risers, a suitable continuous handrail is required on each side of the flight and any intermediate landings.

Regulations in Wales state that: Stairs should have a handrail on at least one side if they are less than 1m wide and a handrail on both sides if they are wider. Handrails should be between 900 mm and 1000 mm measured to the top of the handrail from the pitch line or floor

Regulations in Scotland state that: Position the top of the handrail between 840 mm and 1000 mm from the pitch line or floor.

A handrail need only be provided to one side on a flight of a private stair, however, the side on which the handrail is not fixed should permit the installation of a second handrail at a future date provided a clear width of 800 mm is maintained. For a private stair the handrail should have a profile and projection that will allow a firm grip.

Regulations in Northern Ireland state that: Where the circulation route within the entrance storey or the access to the circulation route within the principal storey includes a stair, the stair shall have a suitable continuous handrail on each side of the flight and any intermediate landing.

Flights in a private stair with a total rise of more than 600 mm should have a continuous handrail that gives firm support and a firm grip and be located:

(a) on at least one side where the stair is less than 1000 mm wide; or

(b) on both sides where the stair is 1000 mm wide or more.

Where only one handrail is required on a flight with tapered treads, it should be located on the outer side of the flight. Handrails are not required beside the two steps at the bottom of a private stair. Handrails should be at a height between 900 mm and 1000 mm measured vertically above the pitch line. Handrails may form the top of guarding.

7.6 WINDERS

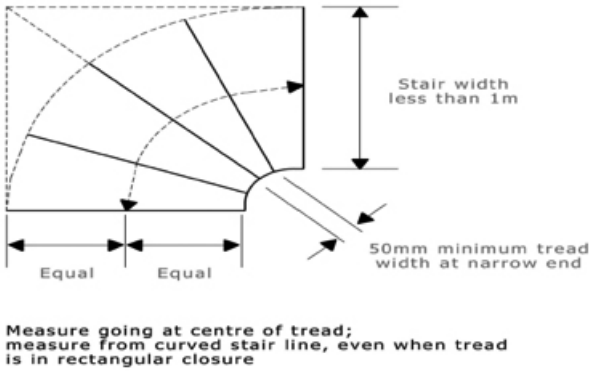


Diagram F
From AD K 2013 page 12 diagram 1.9 – Measuring tapered treads – Winder flight

Regulations in England and Northern Ireland state that:

The rise and going must conform to the limits given above for straight flights. Consecutive tapered treads must have the same going, but if a stair consists of straight and tapered treads then the going of the tapered treads must not be less than the going of the straight treads, see Diagrams F and G.

Regulations in Wales state that:

Stairs designed to BS 585-1:1989 will offer reasonable safety.

Regulations in Scotland state that:

A flight consisting wholly of tapered treads should be constructed in accordance with BS 5395-2:1984 but the provisions of the technical guidance should be taken into account.

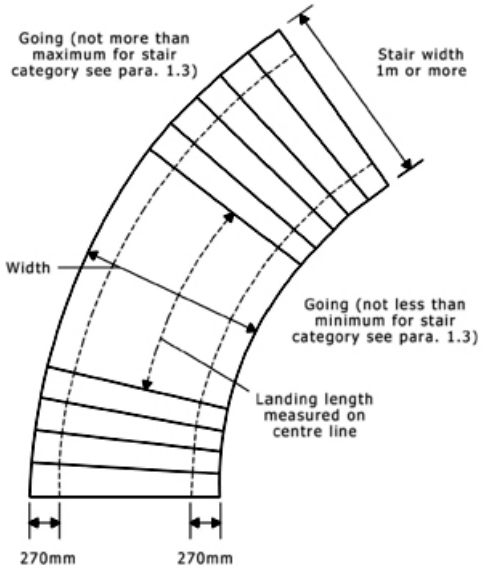


Diagram G
From AD K 2013 page 12 diagram 1.9 – Measuring tapered treads – Helical Stairs

Supplementary information for winders:

The following information supplements the guidance given above for the relevant Building Regulations for winders:

1. The clear width of the flight is measured between strings
2. The maximum clear width for a winder flight is 1000 mm
3. The walk line approaching (or leaving) a winder is taken from the centre line of the clear width of the narrowest straight flights above or below the winder flight.
4. The maximum change in direction through the winder flight is 180
5. The width of any tapered treads at their narrowest part must be 50 mm or more - measured nosing to nosing, i.e. measurement from nosing to riser must be 50 mm plus the projection of the nosing.
6. The walk-line through the winder flight will follow the arc of the circle, centred on the newel post (or the intersection of strings where there is no newel post) and tangent to the centre line of the clear width of the narrowest straight flights above or below the winder flight.
7. The going shall be measured from the intersection of this arc with the nosings of consecutive treads.
8. The going, as measured above, shall be the same for each tapered tread, but, the angle of each tapered tread does not need to be the same.

7.7 GUARDING OF STAIRS

Regulations in England and Wales state that: Guarding to stairs and landings must be a minimum height of 900 mm. Design should prevent children being held fast by the guarding (a 100 mm diameter sphere should not be able to pass through any openings) and guarding should not be readily climbable by children. Guarding should be provided at the sides of flights and landings where there is a drop of more than 600 mm. Ensure that guarding can resist, as a minimum, the loads given in BS EN 1991-1-1 with its UK National Annex and PD 6688-1-1. Further guidance on the design of barriers and infill panels is given in BS 6180.

Regulations in Scotland state that: Guarding to a stair within a dwelling must have a height of 840 mm on a stair flight, 900 mm on a landing.

Where a handrail forming the top of a protective barrier to a flight meets a protective barrier to a landing, the height of the protective barrier to the landing may be reduced in height for a distance of not more than 300 mm to allow a smooth transition.

Regulations in Northern Ireland state that: Guarding to stairs and landings must be a minimum height of 900 mm. Design should prevent children being held fast by the guarding (a 100 mm diameter sphere should not be able to pass through any openings) and guarding should not be readily climbable by children. Guarding should be provided at the sides of flights and landings where there is a drop of more than 600 mm. Ensure that guarding can resist, as a minimum, the loads given in BS EN 1991-1-1 with its UK National Annex and PD 6688-1-1. Further guidance on the design of barriers and infill panels is given in BS 6180.

7.8 LANDINGS FOR STAIRS

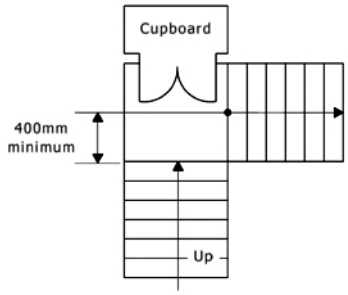


Diagram H
From AD K 2013 page 10 diagram 1.7 – Cupboard opening onto landing

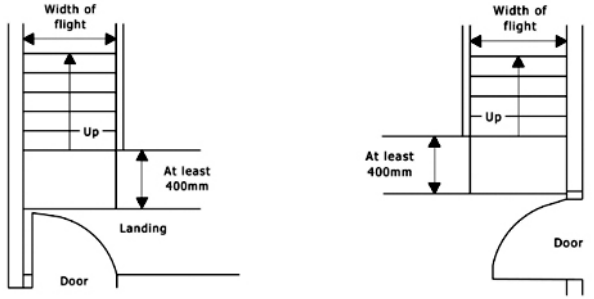


Diagram I
From AD K 2013 page 11 diagram 1.8 – Landings next to a door – dwellings

Regulations in England, Northern Ireland and Wales state that: Landings, which must be level, must be provided at the top and bottom of every flight and their length and width must be at least the same as the narrowest width of the stair.

A landing may include part of the floor and should be kept clear of permanent obstructions. Cupboards may open onto a landing at the top of a flight but only when they are kept shut when under normal use, see Diagram H. A door may open across a landing at the bottom of a flight but there must be an unobstructed area at least 400 mm long, see Diagram I.

Regulations in England, Northern Ireland and Wales state that:

The maximum length of a landing is 1.2 m.

7.9 LAYOUT OF STEPS

Regulations in England, Northern Ireland and Wales state that:

All treads shall be level. Steps may have open risers but the treads must overlap by 16 mm and a 100 mm diameter sphere should not be able to pass through the opening.

Regulations in Scotland state that:

A private stair may be constructed with open risers and without contrasting nosings.

In a stair with open risers the stair treads should overlap by at least 15 mm and a 100 mm diameter sphere should not be able to pass through the opening.

8 DEMONSTRATING PERFORMANCE

Demonstrating performance through calculation
PrEN 16481 provides models for the calculation of the following elements of various types of timber staircase.

Types of stair for which the information within prEN 16481 is valid without further verification are:

- Stair with closed strings, with or without risers
- Stairs with cut strings, with or without risers
- Stairs combining the above, i.e. stair with one cut sting, one closed string, and with risers
- Stair with semi-closed strings, without risers (not suited to risers)

Determination of mechanical stress (stress resultants and deformations) in two ways:

- Separate determination of mechanical stress of treads and strings
    - o All forms of single treads
    - o Straight stairs with vertical support in places described in the following manner
    - o Turning stairs (with winders) with vertical support in all places in which the string changes direction
- Interrelated determination of mechanical stress of treads and strings
    - o All other stairs

Static systems and cross-section properties

- Treads
    - o Straight tread without riser
    - o Straight tread with riser
- Winder treads
    1. Idealised ground plan of tread
    2. Static system for closed strings – single span beam
    3. Static system for cut strings – single span beam with two cantilever arms
- Kite winders
- Closed strings
    1. Including connections at top and bottom steps
    2. Includes cross-braced treads
- Cut strings

Joints

- Loose-jointed connections – do not transmit bending moments
- Rigid connections
- Deformable connections

Modelling of string corner connections

1. Connections of wall string corner joints
2. Connection of outer string corner

Modelling of connections to the construction

1. Fastening at the bottom step
2. Fastening at the top step
3. Corner fastening in direction of wall

Table 8.1 Modelling of tread string connections

String type Closed or cut	Tread type With or without cross-bracing	Risers With or without risers
Closed	Cross-braced	With
Closed	Cross-braced	Without
Closed	Without cross-bracing	Without
Closed	Without cross-bracing	With
Cut	Cross-braced	With
Cut	Without cross-bracing	Without
Cut	Without cross-bracing	With
Closed	Kite winder	

Table 8.2 Demonstrating performance through testing

DD CEN/TS 15680:2007				BS 585-2:1985		
Clause	**Assessment**	**Load**	**Type**	**Test from appendix B**	**Description**	**Reason for test**
4	Mechanical strength	Concentrated static load	Balusters of prefabricated railing systems: handrails or balustrades.			
5	Mechanical strength	Distributed static load	Prefabricated systems of handrails and balustrades	4	Balustrade static load	To ensure that the balustrade is able to support a horizontal UDL of 0.36 kN/m without excessive deflection *
6	Mechanical strength	Dynamic load	Prefabricated systems of handrails and balustrades	5	Balustrade impact load	To ensure that a balustrade is able to resist the impact of a person falling against it
7	Mechanical strength	Vertical static load	Handrails			
8	Mechanical strength	Concentrated static loads	Panels of prefabricated systems: handrails and balustrades			
9	Load bearing capacity	Distributed static load	Flight of stairs	7	Stair strength and tread strength	To confirm the strength factor for the stair
10	Deflection	Distributed static load	Flight of stairs	2	Deflection	To establish the stiffness of the stair
11	Mechanical strength	Dynamic loads	a) Steps included in flights, or b) Flights of stairs in prefabricated stairs	Fibreboards	BS EN 622-2 (Type HB.LA)	BS EN 622-2 (Type HB.LA1)

DD CEN/TS 15680:2007				BS 585-2:1985		
Clause	**Assessment**	**Load**	**Type**	**Test from appendix B**	**Description**	**Reason for test**
12	Bending strength	Concentrated static load	Steps of prefabricated stairs	7	Stair strength and tread and tread strength	To confirm the strength factor for the stair
13	Deflection	Concentrated vertical static load	Steps of prefabricated stairs or components	3	Tread Deflection	To ensure that materials used for treads will be sufficiently stiff
				1	Preload	To establish a datum See appendix A for subsequent deflection measurements
				6	Tread impact strength	To ensure that materials used for treads have adequate resistance to impact loads
				8	Nosing impact load	To ensure that materials used for nosings and the methods used for jointing nosings to treads are adequate to resist vertical impact loading
				9	Riser impact load	To ensure that materials used for risers or the infills between treads and the fixing of risers to treads and strings are adequate to resist loads in normal service

APPENDIX A

Standards applying to staircase performance

A.1 DESIGN STANDARDS

BS 585-1:1989	Wood stairs. Specification for stairs with closed risers for domestic use, including straight and winder flights and quarter or half landings
BS EN 15644:2008	Traditionally designed prefabricated stairs made of solid wood. Specifications and requirements
BS 5395-1:2010	Stairs. Code of practice for the design of stairs with straight flights and winders constructed of wood-based materials
BS 5395-2:1984	Stairs, ladders and walkways. Code of practice for the design of helical and spiral stairs
BS 5395-4:2011	Code of practice for the design of stairs for limited access
BS 6180:2011	Barriers in and about buildings. Code of practice
BS EN 942:2007	Timber in joinery. General requirements
BS EN 14076:2004	Timber stairs. Terminology

A.2 STRUCTURAL STANDARDS

BS EN 1995-1-1:2004+A1:2008	Eurocode 5. Design of timber structures. General. Common rules and rules for buildings
NA to BS EN 1995-1-1:2004+A1:2008	UK National Annex to Eurocode 5. Design of timber structures. General. Common rules and rules for buildings
PD 6688-1-1:2011	Recommendations for the design of structures to BS EN 1991-1-1
prEN 16481	Timber stairs, structural design, calculation methods
BS EN 1912:2012	Structural Timber – Strength classes – Assignment of visual grades and species

Note: Materials that form part of the structural elements of the stair should conform to the specifications for structural materials as defined in the standards above.

A.3 TEST STANDARDS

BS 585-2:1985	Wood stairs. Specification for performance requirements for domestic stairs
CEN/TS 15680:2007	Prefabricated timber stairs. Mechanical test methods
ETAG 008:2002	Guideline for European Technical Approval of prefabricated stair kits, Part 1 prefabricated stair kits in general, excluding severe climatic conditions Published by the European Organisation for Technical Approvals (EOTA)

A.4 FIRE CLASSIFICATION AND FIRE RESISTANCE

(see Section 3, clause 3.6)

BS EN 13501-1:2007+A1:2009	Fire classification of construction products and building elements. Classification using test data from reaction to fire tests
BS EN 1365-6:2004	Fire resistance tests for load bearing elements. Stairs

APPENDIX B

NHBC Guidance for handrails on winder flights

Accessed from: http://www.nhbc.co.uk/Builders/Technicaladviceandsupport/TechnicalGuidance/66/filedownload,37245,en.pdf on 25 /10/2013

QUESTION

Where stairs have tapered treads/winders, is a handrail required to the outside of the stairs?

CONSIDERATIONS

- A safe handhold is required for the full rise of any stairs with a total rise greater than 600mm.
- A suitable newel post can provide a safe handhold.

ANSWER

Single newel

In England, Wales and Scotland where the stairs have between one and four tapered treads/winders and the newel provides a safe handhold, a handrail is not required to the outside of the stairs.

Additional Handrail not needed *

Additional Handrail not needed *

Additional Handrail not needed

Additional Handrail needed

Double newels

In England, Wales and Scotland where the newels provide a safe handhold, a handrail is not required to the outside of the stairs.

Additional Handrail not needed

Additional Handrail not needed *

* In Northern Ireland a handrail should be fitted to the outside of all tapered stairs (required by building regulations).

Where a handrail is needed to the outside of the stairs, it should be continuous for the whole rise to avoid the need to change hands. Handrails need not join at corners to be considered continuous provided they extends into the corner and provide an easy transfer of a handhold from one handrail to the other.

Amended

NHBC
NHBC House, Davy Avenue, Knowlhill, Milton Keynes, Bucks MK5 8FP
Tel: 0844 633 1000 Fax: 0844 633 0022 www.nhbc.co.uk

HB1674 06/11

APPENDIX C

Accessing guidance for compliance with the Building Regulations

England

Approved Document K – 2013 edition, Protection from falling, collision and impact

http://www.planningportal.gov.uk/uploads/br/BR_PDF_AD_K_2013.pdf

Scotland

Technical Handbook – 2013 edition, section 4, Safety

Domestic - http://www.scotland.gov.uk/Resource/0043/00435253.pdf

Wales

Approved Document K – 1998 edition with 2000 and 2010 amendments, Protection from falling, collision and impact

http://wales.gov.uk/docs/desh/publications/130205building-regs-approved-document-k-falling-en.pdf

Approved Document M – 2004 edition with 2010 amendments, Access to and use of buildings

http://wales.gov.uk/docs/desh/publications/130205building-regs-approved-document-m-access-en.pdf

Northern Ireland

Technical Booklet H – October 2012 edition, Stairs, ramps, guarding and protection from impact.

http://www.dfpni.gov.uk/tbh_online_version_pdf.pdf

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